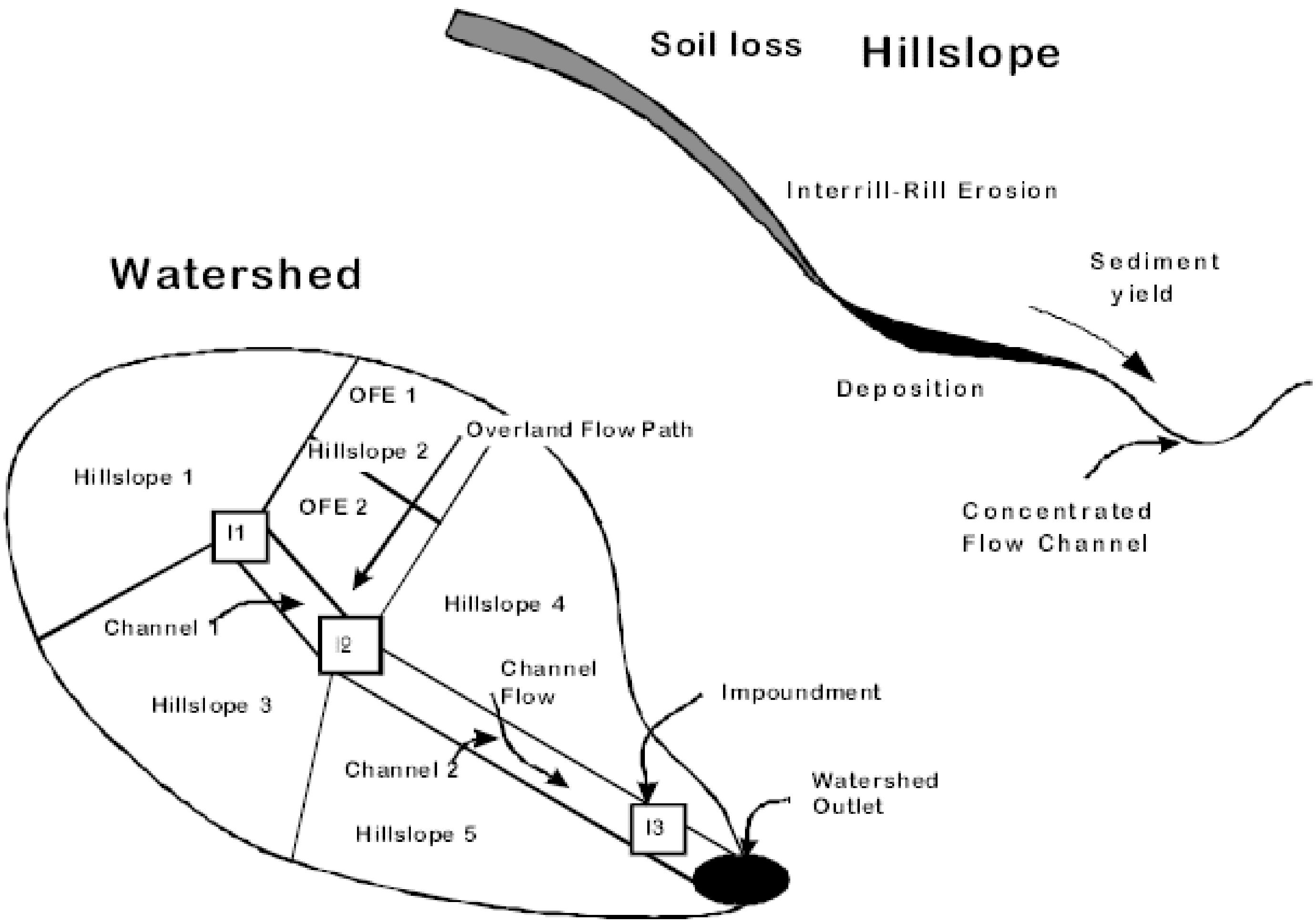
WEPP USER SUMMARY

USDA- Water Erosion Prediction Project



USDA - Agricultural Research Service
USDA - Natural Resource Conservation Service
USDA - Forest Service
USDI - Bureau of Land Management

NSERL Report NO. 11, July 1995
National Soil Erosion Research Laboratory
USDA-ARS-MWA
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West Lafayette, IN 47907-1196

This User Summary document is part of a packet of material released with the WEPP Erosion Prediction Model (computer program) in August of 1995, 2012 and 2024, the WEPP erosion model and interface, file builders, graphics plotting programs, and sample data sets. For additional information on the WEPP models, please contact:

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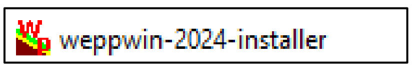
WEPP QUICK START GUIDE

Hardware and Setup Requirements

This version of the Water Erosion Prediction Project (WEPP) model is designed to run on Microsoft Windows 10 and 11 PC's. The WEPP model is also available for Ubuntu Linux systems. The model is compatible with both 32 bit and 64 bit systems.

Installation from Website

After downloading the WEPP model and interface from: https://www.ars.usda.gov/midwest-area/west-lafayette-in/national-soil-erosion-research/docs/wepp/wepp-downloads/ double click on the program to start the installation process (e.g. weppwin-2024-installer.exe).



The recommended WEPP install package requires administrator privileges. In addition to the WEPP model software the WEPP user interface requires the Microsoft Visual C++ redistributable. This Microsoft package is automatically installed if needed. If you do not have administrator privilege the WEPP non-admin install package can be used. This will attempt to use whatever Microsoft Visual C++ redistributable is installed on your system. If a compatible Microsoft package is not installed the full WEPP installation must be done as administrator.

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INTRODUCTION

The objective of the Water Erosion Prediction Project is "to develop new generation water erosion prediction technology for use by the USDA-Soil Conservation Service, USDA-Forest Service, and USDI-Bureau of Land Management, and other organizations involved in soil and water conservation and environmental planning and assessment" (Foster and Lane, 1987).

The computer programs on the install package are a major step towards meeting the project objectives. The WEPP erosion model represents prediction technology based on fundamental hydrologic and erosion mechanics science. WEPP allows both spatial and temporal estimates of erosion and deposition on watersheds consisting of hillslopes and channels which may range from very simple and uniform to very complex and nonuniform, and impoundments. The satellite programs accompanying the WEPP program consist of an interface and several file builders and graphics programs. The interface is meant to be an easy-to-use tool for the user to organize WEPP runs and input/output files. The file builders allow rapid creation of new WEPP model input files or modification of existing data files. The graphics programs allow the user to view the location of detachment and deposition predicted on the profile, as well as the erosion (and many other variables) predicted through time.

MODEL DESCRIPTION

Model Summary

The WEPP model may be used in both hillslope and watershed applications. The model is a distributed parameter, continuous simulation, erosion prediction model, implemented as a set of computer programs for personal computers (PC's). The distributed input parameters include rainfall amounts and intensity, soil textural qualities, plant growth parameters, residue decomposition parameters, effects of tillage implements on soil properties and residue amounts, slope shape, steepness, and orientation, and soil erodibility parameters. Continuous simulation means that the computer program simulates a number of years, with each day having a different set of input climatic data. On each simulation day a rain storm may occur, which then may or may not cause a runoff event. If runoff is predicted to occur, the soil loss, sediment deposition, sediment delivery off-site, and the sediment enrichment for the event will be calculated and added to series of sum totals. At the end of the simulation period, average values for detachment, deposition, sediment delivery, and enrichment are determined by dividing by the time interval of choice. The entire set of parameters important when predicting erosion are updated on a daily basis, including soil roughness, surface residue cover, canopy height, canopy cover, soil moisture, etc. This continuous updating relieves the user of the difficult job of determining temporal distributions of important parameters, such as cover values.

In watershed applications, the WEPP model applies to field areas that include ephemeral gullies which may be farmed over and are known as concentrated flow gullies, or constructed waterways such as terrace channels and grassed waterways. For rangeland applications, it applies to areas that include gullies that are up to the size of ephemeral gullies in cropland, i.e., about 1 to 2 meters

(3 to 6 ft) wide and 1 meter (3 ft.) deep. The hillslope routines of WEPP are used for the overland flow portion of the area and the watershed routines of WEPP are used on channels and impoundments. The procedure does not apply to areas having permanent channels such as classical gullies and perennial streams.

A watershed is defined as one or more hillslopes draining into one or more channels and/or impoundments. The smallest possible watershed includes one hillslope and one channel. Runoff characteristics, soil loss and deposition are first calculated on each hillslope with the hillslope component of WEPP for the entire simulation period. Main results are saved in a pass file that is used during the watershed routing. Then the model combines simulation results from each hillslope and performs runoff and sediment routing through the channels and impoundments each time runoff is produced on one of the hillslopes or channels, or if there is an outflow from one of the impoundments. Channel and impoundment parameters such as canopy height and impoundment water level are updated on a daily basis.

The major inputs to WEPP are a climate data file, a slope data file, a soil data file, and a cropping/management data file. The contents of each of these input files will be discussed in detail later in this document. If the user is simulating irrigation, additional input files are necessary. Applying WEPP in a watershed application also requires additional input files which provide information on channel and impoundment characteristics as well as watershed configuration. The climate file can easily be built using the CLIGEN program, either within the WEPP interface or outside of it, and the user has the option to choose from over 2700 weather stations in the United States. The slope file is easy to build either within the interface slope file builder, or by hand. The slope file builder has the added advantage of allowing the user to graphically preview the slope shape. The soil file can also be created through use of the soil file builder in the WEPP interface, or through use of a text editor. The cropping/management input file contains the largest number of different types of input parameters which describe the different plants, tillage implements, tillage sequences, management practices, etc. The user may wish to edit existing cropping/management input files, either using the interface file builder or a text editor.

Apart from the input required for hillslope simulations, a watershed simulation requires additional files to describe the watershed configuration (the structure file), the channel topography (the channel slope file), the channel soils (the channel soil file), the channel management practices (the channel management file), and the channel hydraulic characteristics (the channel file). If the user chooses to use impoundments and/or irrigation then an impoundment file and/or an irrigation file are necessary. As with the hillslope input files, watershed specific files can be created with the file builders in the WEPP interface or they can be edited with a text editor.

The WEPP computer program produces many different kinds of output, in various quantities, depending upon the wishes of the user. The most basic output contains the runoff and erosion summary information, which may be produced on a storm-by-storm, monthly, annual, or average annual basis. The time-integrated estimates of runoff, erosion, sediment delivery, and sediment enrichment are contained in this output, as well as the spatial distribution of erosion on the hillslope. The program predicts detachment or deposition at each of a minimum of 100 points on a hillslope, and the sum totals of these values are divided by the number of years of simulation to give average annual detachment or deposition at each point. Some points on a hillslope may experience detachment during some rainfall events, and deposition during other events. The output file is clearly delineated into two sections, one for on-site effects of erosion, and one for off-site effects. The on-site effects contain the time-integrated (average annual) soil loss estimates over the areas of the hillslope experiencing net soil loss. This output value is the one most closely analogous to USLE erosion estimates, and it is the output most related to on-site loss of productivity. Also included in the on-site effects section are estimates of the average sediment deposition occurring on the hillslope, and the table of detachment/deposition at a minimum of 100 points on the hillslope. The output file section on off-site impacts of erosion includes the estimated average annual sediment delivery from the hillslope, as well as particle size distributions of the detached sediment and sediment leaving the hillslope, and an estimate of the enrichment of the specific surface area of the sediment. This information may be useful in determining potential impacts of different management systems on sediment and sediment-borne pollutants reaching waterways.

In addition to the output files specific to each hillslope, the watershed component of WEPP produces several kinds of output, depending upon the wishes of the user. The most basic information is the erosion and runoff summary output for the whole watershed, which may be produced on a monthly, annual, or average annual basis. A summary of runoff and sediment yield estimates for each element of the watershed is included in this output, as well as significant results for the whole watershed: sediment delivery ratio, enrichment ratio, specific surface index, particle size distribution of the sediment leaving the area. If impoundments are present in the watershed, an impoundment output file may be created that details on an annual and average annual basis incoming and outgoing volumes of runoff and sediment. Incoming and outgoing volumes of each sediment particle class are also included in this output.

Abbreviated summary information for each runoff event (rainfall, runoff, soil loss, etc.) can also be generated. This event output file is similar to the event output file that may be created for hillslopes. Similarly, a very large graphical output data file can be created that can be accessed with a graphical program which allows the user to plot different variables. Other outputs include detailed soil, plant, water balance, crop, yield, winter, and rangeland files. These files can be useful to the user who would like to study the response of the model under specific conditions.

For each hillslope, spatial information (point values of detachment/deposition) may also be created in a plotting output file, which when used with the plotting program allows the user to see the profile shape and locations of detachment and deposition on the hillslope. Abbreviated summary information for each runoff event (rainfall, runoff, soil loss, etc.) can also be generated, and this information is useful in determining frequency distributions of the runoff and erosion events. A very large graphical output data file can be created which allows detailed examination of many parameter values within the model on a daily basis.

Other outputs include detailed soil, plant, water balance, crop yield, winter, and rangeland files. Most often these files are created and viewed when trying to determine the reasons behind various WEPP model responses. Data from these files can also be imported into spreadsheet programs if the user desires to manipulate or graph these outputs.

The WEPP computer program may also be run in a single storm mode. For these types of simulations, the user must input all of the parameters needed to drive the hydrologic and erosion components of the model for the single day of simulation. Single storm simulations can be quite useful when the purpose is to understand a portion of the hydrologic and erosion processes, and have been used extensively in validation of various parts of the WEPP model. However, single storm simulations have limited value when trying to predict long term average annual detachment.

The purpose of the WEPP model interface is to assist the user in easily building their input files, setting up groups of model runs, and examining the model results. This document will provide a brief step-by-step guide to using the interface and running the WEPP model. For a more detailed description of the interface see the "WEPP Windows Interface Tutorial" document. The interface allows the user to define sets of WEPP simulations, then save these sets as a unique name. For example, someone doing model validation might want to create a set of simulations for experimental location A, and a second set of simulations for experimental location B. Once the run information has been entered, it is likely that little or no changes will have to be made in order to rerun the simulation set (for example with an updated WEPP version). The interface allows the user to rapidly determine the effects of different input sets on runoff, erosion, and sediment delivery.

As a whole, the output provides a potentially powerful tool for conservation planning. The model estimates where and when soil loss problems occur on a given hillslope for a given management system, and allows the user to easily view and interpret the results. The WEPP computer programs provide an inexpensive and rapid method for evaluating various soil conservation options.

Model Components

The WEPP model as applied to hillslopes can be subdivided into nine conceptual components: climate generation, winter processes, irrigation, hydrology, soils, plant growth, residue decomposition, hydraulics of overland flow, and erosion. This section will give a brief description of each component. A detailed description of the model components can be found in the technical model documentation, which is a separate document.

Simulated climate for WEPP model simulations is normally generated using the CLIGEN model, which is a computer program run separately from the WEPP erosion model. CLIGEN creates climate input data files for WEPP which contain daily values for rainfall amount, duration, maximum intensity, time to peak intensity, maximum and minimum temperatures, solar radiation, wind speed, wind direction, and dew point temperature. The rainfall for a day is disaggregated into a simple single-peak storm pattern (time-rainfall intensity format) for use by the infiltration and runoff components of the model. Input climate files to WEPP can also be constructed so as to accept breakpoint rainfall data.

Winter processes modeled in WEPP include soil frost and thaw development, snowfall, and snow melting. Simple heat flow theory is used with the daily information on temperatures, solar radiation, residue cover, plant cover, and snow cover to determine the flow of heat into or out of the soil, and then the subsequent changes to frost and thaw depths. Solar radiation, air temperature, and wind drive the snow melting process.

The irrigation component of WEPP allows simulation of both stationary sprinkler and furrow irrigation systems. The sprinkler irrigation component accommodates solid set, side-roll, and hand-move systems, while the furrow component can simulate uniform inflow, surge, and cutback flows Spatial variations in application rate and depth within a sprinkler irrigation area are assumed to be negligible, and a sprinkler event is simulated as a rainfall event of uniform intensity. The scheduling options available for both sprinkler and furrow irrigation are depletion-level and fixed-date. Depletion-level scheduling determines the date and amount of irrigation based upon the available soil moisture depletion. Fixed-date scheduling uses predetermined irrigation dates and amounts. The user may also use a combination of the two scheduling methods.

The hydrology component of WEPP computes infiltration, runoff, soil evaporation, plant transpiration, soil water percolation, plant, and residue interception of rainfall, depressional storage, and soil profile drainage by subsurface tiles. Infiltration is calculated using a modified Green and Ampt infiltration equation. Runoff is computed using the kinematic wave equations or an approximation to the kinematic wave solutions obtained for a range of rainfall intensity distributions, hydraulic roughness, and infiltration parameter values. The water balance routines are a modification of the SWRRB water balance (Williams et al., 1985).

The impacts of tillage on various soil properties and model parameters are computed within the soils component of the WEPP model. Tillage activity during a simulation acts to decrease the soil bulk density, increase the soil porosity, change soil roughness and ridge height, destroy rills, increase infiltration parameters, and change erodibility parameters. Consolidation due to time and rainfall after tillage and its impacts on the soil parameters is also simulated.

The plant growth component for croplands calculates above and below ground biomass production for both annual and perennial crops in cropland situations, and for rangeland plant communities in rangeland situations. Work is underway by the USDA Forest Service to incorporate plant growth routines applicable for forested conditions. The plant growth routines in WEPP are based upon an EPIC (Williams et al., 1989) model approach, which predicts potential growth based upon daily heat unit accumulation. Actual plant growth is then decreased if water or temperature stresses exist. Several different types of management options for cropland and rangeland plants can be simulated.

Plant residue decomposition for croplands is based upon a "decomposition day" approach, which is similar to the growing degree day approach used in many plant growth models. Each residue type has an optimal rate for decomposition, and environmental factors of temperature and moisture act to reduce the rate from its optimum value. The WEPP model tracks the type and amounts of residue from the previous 3 crop harvests. The model also allows several types of residue management, including residue removal, shredding, burning, and contact herbicide application.

For rangelands, the plant growth component simulates the aggregate above and below ground biomass production for the entire plant community. The plant growth routines in WEPP are based on the ERHYM-II(White, 1987) and SPUR models (Wight and Skiles, 1987). Plant growth for rangelands are based on a potential growth curve. Actual plant growth is initiated in the spring when temperature is above a threshold and is a function of water stress. Decomposition of surface litter is based on temperature and precipitation. Root biomass decomposition is based on temperature and soil water content.

The impacts of soil roughness, residue cover, and living plant cover on runoff rates, flow shear stress, and flow sediment transport capacity are computed in the hydraulics of overland flow section of the WEPP model. Rougher surfaces, fields with more residue cover, and closely spaced crops tend to increase the soil surface resistance to flow, which in turn decreases runoff rates, decreases flow shear stress acting on the soil, and decreases sediment transport capacity of the flow.

The erosion component of the WEPP model uses a steady-state sediment continuity equation to estimate the change in sediment load in the flow with distance downslope. Soil detachment in interrill areas is modeled as a function of rainfall intensity and runoff rate, while delivery of interrill sediment to rills is a function of slope and surface roughness. Detachment of soil in the rills is predicted to occur if the hydraulic shear stress of the flow exceeds a critical value, and the sediment already in the flow is less than the flow's transport capacity. Simulation of deposition in rills occurs when the sediment load in the flow is greater than the capacity of the flow to transport it. Adjustments to soil detachment are made to incorporate the effects of canopy cover, ground cover, and buried residue. The WEPP model also computes the effects of selective deposition of different sediment classes and estimates a sediment size distribution leaving a hillslope. An enrichment ratio of the sediment specific surface area is also estimated.

In addition to the model components used in hillslope applications, the watershed simulations use three more components: channel hydrology and hydraulics, channel erosion and impoundments. The channel hydrology component computes infiltration, soil evaporation, plant transpiration, soil water percolation, rainfall interception, depression storage and soil drainage in the same way as the hillslope hydrology component. Excess rainfall is then combined with runoff from upstream elements: hillslopes, channels, or impoundments. Transmission losses are computed using a modified form of the Green-Ampt infiltration formula. Runoff peaks are then computed using either the CREAMS peak computation method (Knisel, 1980), i.e., an empirical formula that is a function of the volume of runoff, the contributing area and its slope, and the time of concentration, or a modified form of the rational formula as used in the EPIC model (Sharpley and Williams, 1980).

The channel erosion component predicts detachment and deposition in channels in a similar manner as for rills on a hillslope. Detachment occurs if the shear stress is greater than a critical value and if the incoming sediment load from upstream and lateral channels, impoundments and/or hillslopes is less than the transport capacity of the channel. If the sediment load is greater than the transport capacity, deposition is predicted to occur. The particle size distribution of the sediment leaving the channel and an enrichment ratio are also calculated. An enrichment ratio is also computed for the entire watershed.

Downslope damage by detached sediment can be minimized by the use of impoundments. Typical impoundments include terraces, farm ponds, and check dams. Impoundments form small pond areas which reduce the flow velocity, thus decreasing the sediment carrying capacity and allowing sediment to settle out of suspension. Impoundments can significantly impact sediment yield by trapping as much as 90% to 100% of incoming sediment, dependent upon particle size, impoundment size, and inflow and outflow rates (Haan et al., 1994).

The impoundment routines in WEPP route runoff and sediment through an impoundment determining the total amount of runoff leaving the structure, the amount of sediment deposited in the structure, and the amount and size of sediment leaving the structure. Since impoundments are one of the best methods to limit off-site damages from water erosion, the impoundment routines are crucial to the usefulness of WEPP.

User requirements dictate that the WEPP Surface Impoundment Element (WEPPSIE) technology must simulate several types of impoundments including farm ponds, terraces, culverts, filter fences, and check dams. Furthermore, the basic framework of the impoundment element requires four sections: 1) daily input, 2) hydraulic simulation, 3) sedimentation simulation, and 4) daily output. The impoundment routines must also include a front end user interface that develops stage-discharge and stage-area relationships for a given impoundment. This section of the User's Guide describes what types of impoundments can be simulated, how to properly represent an impoundment through the required inputs, and how to interpret the output.

The impoundment routines simulate hydraulic routing and sedimentation for situations where ponding occurs, e.g., when runoff enters a farm pond, terrace, check dam, trash barrier, etc. Up to 10 impoundments can be defined in a given watershed simulation. Geometry and the type of outflow structure(s) define an impoundment. Geometry for each impoundment is defined by a series of stage-area and stage-length points input by the user. The outflow structure(s) for each impoundment is defined by the stage-discharge relationship. WEPPSIE contains continuous outflow functions for any combination of the following possible structures: 1) drop spillways, 2) perforated risers, 3) culverts, 4) open channels, 5) emergency spillways, 6) rock fill check dams, 7) filter fence, and 8) straw bale check dams with pertinent information for each structure entered by the user. If the user encounters a structure that is not defined in the WEPPSIE code, a discrete stage-discharge relationship can be entered.

The impoundment component allows calculation of outflow hydrographs and sediment concentration for various types of structures suitable for both large or small impoundments: drop spillways, culverts, filter fences and straw bales, perforated risers, and emergency spillways. Deposition in the impoundment is calculated assuming complete mixing, and later adjusted to take into account stratification, non-homogeneous concentrations, and the shape of the impoundment. The model uses a continuity mass balance equation to predict outflow concentration, assuming complete mixing in the impoundment.

Limits of Application

The erosion predictions from the WEPP model are meant to be applicable to "field-sized" areas or conservation treatment units. When applied to a single hillslope, the model simulates a representative profile, which may or may not approximate the entire field. For large broad zones in which there is a definite slope shape dominating an entire field, one profile representation may be sufficient to adequately model the site. However, for very dissected landscapes, in which several different, distinct slope shapes exist, several hillslopes will need to be simulated(either as separate runs within the Hillslope Interface, or as a single watershed simulation in the Watershed Interface). The maximum size "field" is about a section (640 acres) although an area as large as 2000 acres is needed for some rangeland applications. The model should not be applied to areas having permanent channels such as classical gullies and perennial streams, since the processes occurring in these types of channels are not simulated in WEPP. Use of the watershed application of WEPP is necessary to simulate flow, erosion, and deposition in ephemeral gullies, grassed waterways, terrace channels, other channels, and impoundments.

Because of the greater complexity of watershed applications of the WEPP model and the interface, it is recommended that the user first be familiar and comfortable with hillslope applications and the hillslope interface.

INPUT DATA FILES

The hillslope component of the WEPP erosion model requires a minimum of four input data files to run: 1) a climate file, 2) a slope file 3) a soil file, and 4) a plant/management file. An additional input file can be created which contains the answers to all of the model interactive questions (called a run file), and use of which greatly speeds model runs. For the case of irrigation and/or watershed option applications, additional input files are required.

In addition to the files required to run WEPP on each hillslope, a watershed simulation requires a minimum of seven files: 1) a hillslope information pass file, 2) a structure file, 3) a slope file, 4) a soil file, 5) a management file, 6) a climate file, and 7) a channel file. The pass file is automatically created upon running the WEPP model; the structure file is automatically created by the interface; all other files can be built with the corresponding file builders. Note that the slope, soil, management, and climate files are almost identical to corresponding input hillslope files. An impoundment input file is necessary if impoundments are present in the watershed, and when irrigation is used on the channels, an irrigation file is required that is identical to a hillslope irrigation file.

This document will describe the input files specific to the hillslope and watershed applications of the WEPP erosion model. The WEPP interface program contains samples of all the following data files, as well as file builder programs which allow the user to create (or modify) input data files. A description of the interfaces and file builders follows this section, and example data input files are given in the appendix.

WEPP input files have a version number as the first line of each file. Some parameters and formatting differences are noted when inputs only apply to a specific version.

Climate Input File

The climate data required by the WEPP model includes daily values for precipitation, temperatures, solar radiation, and wind information. A stand-alone program called CLIGEN is used to generate either continuous simulation climate files or single storm climate files. To run CLIGEN, a stations file and a state database file are required. Weather data statistics for over 2700 stations within the United States are available to run with CLIGEN. All available state climate data files have been included on the install package..

There are two major versions of CLIGEN: version 4.3 and version 5.3. The main difference is that version 5.3 includes updates for improved random number generation and statistics in the CLIGEN generated climate file used by WEPP. For a description of the input file to CLIGEN see the document “Format of CLIGEN weather station statistics input files.”

The following describes the output file from CLIGEN that is read by WEPP as the climate file to be used in the WEPP simulation.

The CLIGEN program can currently build 3 types of WEPP climate input files: continuous simulation with ip/tp data; single storm with ip/tp data; and TR-55 design single storm with ip/tp data. Those users wishing to use breakpoint rainfall as input to WEPP will need to create their climate files by hand. Table 1 gives the descriptions of the input variables in the WEPP climate input files. Both the continuous and single storm WEPP simulation modes require the same format climate file structure. Sample climate files can be found in the appendix.

Table 1. Climate input file description

Line 1: a) CLIGEN version number - real (datver)
- 0.0 - use actual storm ip values in this file
- 4.0 - WEPP will internally multiply ip by a factor of 0.70 to compensate for the steady-state erosion model assumption.
- 4.30 – Reference to which version of CLIGEN generated this file
- 5.30 - Reference to which version of CLIGEN generated this file

Line 2: a) simulation mode - integer (itemp)
- 1 - continuous
- 2 - single storm

b) breakpoint data flag - integer (ibrkpt)
- 0 - no breakpoint data used
- 1 - breakpoint data used

c) wind information/ET equation flag - integer (iwind)
- 0 - wind information exists - use Penman ET equation
- 1 - no wind information exists - use Priestley-Taylor ET equation

Line 3: a) station i.d. and other information - character (stmid)

Line 4: variable name headers

Line 5: a) degrees latitude (+ is North, - is South) - real (deglat)
b) degrees longitude (+ is East, - is West) - real (deglon)
c) station elevation (m) - real (elev)
d) weather station years of observation - integer (obsyrs)
e) beginning year of CLIGEN simulation - integer (ibyear)
f) number of climate years simulated and in file - integer (numyr)
g) command line that was used to run CLIGEN (version 5.1+ only)

Line 6: monthly maximum temperature variable name header

Line 7: observed monthly average maximum Temp. (degrees C) - real (obmaxt)

Line 8: monthly minimum temperature variable name header

Line 9: observed monthly average minimum Temp. (degrees C) - real (obmint)

Line 10: monthly average daily solar radiation variable name header

Line 11: observed monthly average daily solar radiation (langleys) - real (radave)

Line 12: monthly average precipitation variable name header

Line 13: observed monthly average precipitation (mm) - real (obrain)

Line 14: daily variables name header

Line 15: daily variables' dimensions

For CLIGEN generated (no breakpoint data) input option

Line 16: ***(repeated for the number of simulation days)***
a) day of simulation - integer (day)
b) month of simulation - integer (mon)
c) year of simulation - integer (year)
d) daily precipitation amount (mm of water) - real (prcp)
e) duration of precipitation (hr) - real (stmdur)
f) ratio of time to rainfall peak/rainfall duration - real (timep)
g) ratio of maximum rainfall intensity/average rainfall intensity - real (ip)
h) maximum daily temperature (degrees C) - real (tmax)
i) minimum daily temperature (degrees C) - real (tmin)
j) daily solar radiation (langleys/day) - real (rad)
k) wind velocity (m/sec) - real (vwind)
l) wind direction (degrees from North) - real (wind)
m) dew point temperature (degrees C) - real (tdpt)

For breakpoint precipitation input option

Lines 16 & 17 are repeated for the number of simulation days.

Line 16: a) day of simulation - integer (day)
b) month of simulation - integer (mon)
c) year of simulation - integer (year)
d) number of breakpoints - integer (nbrkpt)
e) maximum daily temperature (degrees C) - real (tmax)
f) minimum daily temperature (degrees C) - real (tmin)
g) daily solar radiation (langleys/day) - real (rad)
h) wind velocity (m/sec) - real (vwind)
i) wind direction (degrees from North) - real (wind)
j) dew point temperature (degrees C) - real (tdpt)

Line 17: ***(repeated for number of breakpoints, maximum of 50 points/day***)
a) time after midnight (hours) - real (timem)
b) cumulative precipitation at this time (mm of water)- real (pptcum)

Slope Input File

The WEPP model requires information about the landscape geometry, which is entered by way of the slope input file. Required information includes slope orientation, slope length, and slope steepness at points down the profile. In the profile application of WEPP, the user may visualize the slope profile as a line running up and down the hill, having a representative width which applies to the entire field or a portion of the field.

The WEPP model allows the user to simulate many types of nonuniformities on a hillslope through the use of strips or Overland Flow Elements (OFE's). Each OFE on a hillslope is a region of homogeneous soils, cropping, and management. This current version of the WEPP model allows simulation of up to 10 OFE's on an individual hillslope. All of the remaining input files (slope, soil, management, irrigation) must provide information for each OFE which the user would like to simulate the hydrologic and erosion processes on.

At the top of the slope file is general information on the profile as well as the number of OFE's for which the file contains information. Slope shape is described by using pairs of distance to points from the top of the OFE and the slope at these points. Adjoining OFEs ***must*** have the same point slope at their borders. A typical S-shaped profile, for example, could be described using three input points: zero slope at the hill top, a steep slope somewhere on the center portion of the hill, and a flatter toe slope at the end of the profile. Slope length does not end where deposition begins. The slope profile must be described to the end of the field, or to a concentrated flow channel, grassed waterway, or terrace. The point(s) where detachment ends and deposition begins is calculated by the model and given as output. Table 2 provides a description of the slope input data file. A sample slope data file may be found in the appendix.

Table 2. Slope input file description for hillslope applications.

Line 1: version control number - real (datver)
97.5 – Supported version control number

Line 2: number of overland flow elements - integer (nelem)

Line 3: a) aspect of the profile (degrees from North) - real (azm)
b) representative profile width (m) - real (fwidth)

Repeat Lines 4 & 5 for the number of overland flow elements on Line 2

Line 4: a) number of slope points on the OFE - integer (nslpts)
b) length of the overland flow element (m) - real (slplen)

Repeat 5a) and 5b) for the number of slope points indicated on Line 4a)
(user may input up to 20 slope point pairs per OFE and can place on multiple lines)

Line 5: a) distance from top of OFE to the point (m or m/m) - real (xinput)
b) slope steepness at the point (m/m) - real (slpinp)
a) distance from top of OFE to the point (m or m/m) - real (xinput)
b) slope steepness at the point (m/m) - real (slpinp)
a) distance from top of OFE to the point (m or m/m) - real (xinput)
b) slope steepness at the point (m/m) - real (slpinp)
" " " " " " " "
" " " " " " " "

There are two ways of entering distance to the point data (Line 5a): either enter the actual distance in meters or enter the nondimensional distance, which is the actual distance in meters divided by the total slope length of the OFE (however, don't mix the two methods). A minimum of two slope points are required to describe the slope on each OFE - a point at the beginning of the OFE (distance = 0.0) and a point at the end of the OFE (distance = slplen of OFE or distance = 1.0 = slplen/slplen). The user may currently enter up to a maximum of 20 slope points per OFE to describe the slope shape. The slope file builder accessed by the WEPP interface allows the user to easily build and graphically view the slope data files needed by the WEPP model. The version control number on Line 1 should be set to 97.5, though older slope files which do not contain the version control number line can still be used with WEPP. The WEPP user interface program allows slope files to be created from slope segment inputs.

Soil Input File

Information on soil properties to a maximum depth of 1.8 meters are input to the WEPP model through the soil input file. The user may input information on up to 8 different soil layers. WEPP internally creates a new set of soil layers based on the original set parameter values. If the entire 1.8 meters is parameterized, the new soil layers represent depths of 0-100 mm, 100-200 mm, 200-400 mm, 400-600 mm, 600-800 mm, 800-1000 mm, 1000-1200 mm, 1200-1400 mm, 1400-1600 mm, 1600-1800 mm. As with the slope file, soil parameters must be input for each and every Overland Flow Element (OFE) on the hillslope profile and for each channel in a watershed, even if the soil on all OFEs is the same. Accurate estimation of soil physical and hydrological parameters is essential when operating the WEPP erosion prediction model. Table 3 lists the input parameters in the soil input file, and the discussion following the table is meant to assist the users in determining input parameter values.

There are several versions of the soil file that can be used as input for WEPP. The differences in format are specified by the version number in line 1 which indicates how the remainder of the file is interpreted by WEPP.

Table 3. Soil input file description.

Line 1: version control number - real (datver)
97.5 – Base set of soil properties
2006.2 – Adds a separate restricting layer below profile
7777 – Adds additional layer parameters
7778 – Adds additional layer parameters and anisotropy ratio

Line 2: a) User comment line - character*80, (solcom)

Line 3: a) number of overland flow elements(OFE’s) or channels integer (ntemp)
b) flag to use internal hydraulic conductivity adjustments - integer (ksflag)
0 - do not use adjustments (conductivity will be held constant)
1 - use internal adjustments

Lines 4 & 5 are repeated for the number of OFE's or channels on Line 3a.

Line 4: a) soil name for current OFE or channel - character (slid)
b) soil texture for current OFE or channel - character (texid)

c) number of soil layers for current OFE or channel - integer (nsl)
d) albedo of the bare dry surface soil on the current OFE or channel - real (salb)
e) initial saturation level of the soil profile porosity (m/m) - real (sat)
f) baseline interrill erodibility parameter (kg*s/m^4) - real (ki)
g) baseline rill erodibility parameter (s/m) - real (kr)
h) baseline critical shear parameter (N/m^2) - real (shcrit)
i) effective hydraulic conductivity of surface soil (mm/h) - real (avke)

Line 5: Version 97.5 and 2006.2 ***(repeated for the number of soil layers indicated on Line 4c.)***

a) depth from soil surface to bottom of soil layer (mm) - real (solthk)
b) percentage of sand in the layer (%) - real (sand)
c) percentage of clay in the layer (%) - real (clay)
d) percentage of organic matter (volume) in the layer (%) - real (orgmat)
e) cation exchange capacity in the layer (meq/100 g of soil) - real (cec)
f) percentage of rock fragments by volume in the layer (%) - real (rfg)

Line 5: Version 7777 ***(repeated for the number of soil layers indicated on Line 4c.)***

a) depth from soil surface to bottom of soil layer (mm) - real (solthk)
b) Bulk density for layer (gm/cc)
c) Hydraulic conductivity for layer (mm/h)
d) Field capacity for layer (mm/mm)
e) Wilting point for layer (mm/mm)
f) percentage of sand in the layer (%) - real (sand)
g) percentage of clay in the layer (%) - real (clay)
h) percentage of organic matter (volume) in the layer (%) - real (orgmat)
i) cation exchange capacity in the layer (meq/100 g of soil) - real (cec)
j) percentage of rock fragments by volume in the layer (%) - real (rfg)

Line 5: Version 7778 ***(repeated for the number of soil layers indicated on Line 4c.)***

a) depth from soil surface to bottom of soil layer (mm) - real (solthk)
b) Bulk density for layer (gm/cc)
c) Hydraulic conductivity for layer (mm/h)
d) Anisotropy ratio for layer (mm/h / [mm/h])
e) Field capacity for layer (mm/mm)
f) Wilting point for layer (mm/mm)
g) percentage of sand in the layer (%) - real (sand)
h) percentage of clay in the layer (%) - real (clay)
i) percentage of organic matter (volume) in the layer (%) - real (orgmat)
j) cation exchange capacity in the layer (meq/100 g of soil) - real (cec)
k) percentage of rock fragments by volume in the layer (%) - real (rfg)

Line 6: Applies to versions 2006.2, 7777 and 7778 format soil files

a) Indicates if a restricting layer is present (0=no restricting layer, 1=restricting layer present)
b) Thickness of restricting layer (mm)
c) Hydraulic conductivity of restricting layer (mm/h)

Soil Input Parameter Estimation Procedures

The key parameter for WEPP in terms of infiltration is the Green and Ampt effective conductivity parameter (K_e). This parameter is related to the saturated conductivity of the soil, but it is important to note that it is not the same as or equal in value to the saturated conductivity of the soil. The second soil-related parameter in the Green and Ampt model is the wetting front matric potential term. That term is calculated internal to WEPP as a function of soil type, soil moisture content, and soil bulk density: it is not an input variable.

The effective conductivity (avke) value for the soil may be input on Line 4i of the soil input file, immediately after the inputs for soil erodibility. If the user does not know the effective conductivity of the soil, he/she may insert a zero (0.0) and the WEPP model will calculate a value based on the equations presented here for the time-variable case (see Equation 1 below).

The model will run in 2 modes by either: A) using a "baseline" effective conductivity (K_b) which the model automatically adjusts within the continuous simulation calculations as a function of soil management and plant characteristics, or B) using a constant input value of K_e. The second number in line 3 of the soil file contains a flag (0 or 1) which the model uses to distinguish between these two modes. A value of 1 indicates that the model is expecting the user to input a K_b value which is a function of soil only, and which will be internally adjusted to account for management practices. A value of 0 indicates the model is expecting the user to input a value of K_e which will not be internally adjusted and must therefore be representative of both the soil and the management practice being modeled. It is essential that the flag (0 or 1) in line 3 of the soil file be set consistently with the input value of effective conductivity for the upper soil layer.

"Baseline" Effective Conductivity Estimation Procedures for Croplands

Values for "baseline" effective conductivity (K_b) may be estimated using the following equations:

For soils with $\leq$ 40% clay content:

$$K_b = -0.265 + 0.0086*SAND^{1.8} + 11.46*CEC^{-0.75} \quad \textbf{[1]}$$

For soils with > 40% clay content:

$$K_b = 0.0066exp(244/CLAY) \quad \textbf{[2]}$$

where SAND and CLAY are the percent of sand and clay, and CEC (meq/100g) is the cation exchange capacity of the soil. In order for [1] to work properly, the input value for cation exchange capacity should always be greater than 1 meq/100g. These equations were derived based on model optimization runs to measured and curve number (fallow condition) runoff amounts. Forty three soil files were used to develop the relationships (Table 4)..

Table 4. Optimized and estimated effective hydraulic conductivity values for the case of constant effective conductivity for fallow soil, K_{ef}, and Baseline K_b.

Soil	Sand Content %	Clay Content %	Organic Matter Content %	CEC meq/100g	Simulator Measured K_e mm/hr	Opt. Constant K_{ef} mm/hr	Est. Constant K_{ef} mm/hr	Opt. Baseline K_b mm/hr	Est. Baseline K_b mm/hr
Sharpsburg	5.2	40.1	2.8	29.4	7.3	1.6	1.8	1.8	1.8
Hersh	72.3	10.9	1.1	7.7	15.8	6.5	6.4	17.6	21.3
Keith	48.9	19.3	1.5	18.3	3.5	4.7	4.8	11.5	10.5
Amarillo	85.0	7.3	0.3	5.1	15.0	7.0	7.3	26.6	28.7
Woodward	51.7	13.0	2.2	11.6	12.0	4.5	4.9	9.2	12.0
Heiden	8.6	53.1	2.2	33.3	4.7	0.3	0.3	0.34	0.45
Los Banos	15.5	43.7	2.0	39.1	3.9	0.8	1.0	1.1	1.1
Portneuf	19.5	11.1	1.2	12.6	7.9	2.0	2.5	2.7	3.0
Nansene	20.1	12.8	1.9	16.6	5.3	2.2	2.6	2.8	3.0
Palouse	9.8	20.1	2.6	19.6	2.6	1.8	1.9	2.0	1.5
Zahl	46.3	24.0	2.5	19.5	5.7	5.0	4.5	14.1	9.5
Pierre	16.9	49.5	2.7	35.7	2.4	0.4	0.3	0.71	0.61
Williams	40.8	26.9	2.6	22.7	8.3	4.4	4.1	12.9	7.7
BarnesND	39.3	26.5	3.9	23.2	16.7	4.4	4.0	11.7	7.2
Sverdrup	75.3	7.9	2.0	11.0	20.3	6.3	6.6	14.5	22.2
BarnesMN	48.6	17.0	3.2	19.5	19.1	4.7	4.7	10.4	10.3
Mexico	5.5	25.3	2.5	21.3	6.2	0.3	0.3	0.34	1.1
Grenada	1.8	20.2	1.8	11.8	3.4	0.6	0.6	0.7	1.6
Tifton	86.4	2.8	0.7	2.1	14.9	6.6	7.4	14.8	32.6
Bonifay	91.2	3.3	0.5	1.7	34.8	14.8	14.2	60.2	36.4
Cecil	69.9	11.5	0.7	2.0	13.3	7.4	6.0	17.2	24.4
Hiwassee	63.7	14.7	1.3	4.4	13.6	6.3	5.8	17.2	18.7
Gaston	37.2	37.9	1.7	9.2	3.6	1.8	1.7	6.3	7.7
Opequon	37.7	31.1	2.3	12.9	7.6	1.9	1.7	6.3	7.3
Frederick	25.1	16.6	2.1	8.2	2.9	2.7	3.0	5.9	4.9
Manor	44.0	25.2	2.5	13.2	10.0	4.6	4.3	14.1	9.2
Collamer	6.0	15.0	1.7	9.2	3.6	0.7	0.7	0.73	2.1
Miamian	31.3	25.9	2.4	14.9	4.4	1.4	1.5	3.3	5.5
Lewisburg	38.5	29.3	1.4	12.5	3.7	1.8	1.8	5.5	7.6
Miami	4.2	23.1	1.3	13.3	0.9	1.6	1.5	1.7	1.5
Colonie	90.5	2.1	0.1	10.0		14.5	14.2	38.3	30.4
Pratt	89.0	2.2	0.4	3.1		13.3	14.2	32.8	32.4
Shelby	27.8	29.0	3.0	16.5		2.9	3.2	7.8	4.6
Monona	7.1	23.5	2.0	20.1		1.7	1.7	1.9	1.2
Ontario	44.2	14.9	4.5	11.8		4.2	4.4	8.6	9.4
Stephensville	73.2	7.9	1.6	7.2		6.2	6.4	13.7	21.9
Providence	2.0	19.8	0.8	9.3		0.7	0.6	0.7	1.9
Egan	7.0	32.2	3.7	25.1		1.7	1.7	1.8	1.0
Barnes	39.4	23.2	3.4	18.4		4.1	4.0	10.0	7.4
Thatuna	28.0	23.0	4.3	16.2		1.3	1.4	2.6	4.6
Caribou	38.8	13.7	3.8	13.2		4.3	4.0	8.2	7.6
Tifton	87.0	5.7	0.7	4.1		7.2	7.4	26.6	30.4
Cecil	66.5	19.6	0.9	4.8		6.3	6.2	29.7	22.8

Table 5 shows the results of comparisons to measured natural runoff plot data from 11 sites. Model efficiency is a quantification of how well the model predicted runoff on an individual storm basis. At each of the eleven sites the model predicted runoff better on a storm-by-storm basis using the estimated K_b values (equations [1] and [2]) than did the curve number approach. For purposes of erosion prediction, it is more important to predict the individual storms accurately than to predict the total annual runoff volume, because it is a relatively small number of intense storms which cause most of the erosion

Table 5. WEPP estimated runoff in terms of: A) model efficiency on a storm-by-storm basis and B) in terms of average annual runoff.

A. Comparison of model efficiency

Site	Number of Years	Number of Events	Model Efficiency WEPP Opt. K_b	CN	WEPP Est. K_b
Bethany, MO	10	109	0.82	0.72	0.81
Castana, IA	12	90	0.48	0.10	0.12
Geneva, NY	10	97	0.73	0.58	0.62
Guthrie, OK	15	170	0.86	0.77	0.85
Holly, MS	8	208	0.87	0.79	0.69
Madison, SD	10	60	0.77	0.69	0.74
Morris, MN	11	72	0.59	-1.06	-0.21
Pendleton, OR	11	82	0.06	-0.33	-0.69
Presque Isle, ME	9	99	0.45	-0.25	0.32
Tifton, GA	7	64	0.67	0.44	0.59
Watkinsville, GA	6	110	0.84	0.74	0.84

B. Comparison of annual runoff

Site	Number of years	Rainfall # events	Rainfall Depth (mm)	Annual runoff (mm) Meas.	CN	WEPP
Bethany, MO	10	109	754	222	175	205
Castana, IA	12	90	747	102*	125	148
Geneva, NY	10	97	828	168*	79	110
Guthrie, OK	15	170	745	154	78	121
Holly, MS	8	208	1328	557	216	299
Madison, SD	10	60	577	61*	69	65
Morris, MN	11	72	604	40*	33	75
Pendleton, OR	11	82	595	72	60	27
Presque Isle, ME	9	99	846	120*	89	47
Tifton, GA	7	64	1227	301	135	171
Watkinsville, GA	6	110	1445	429	395	392

*indicates winter runoff not measured

Physically, the K_b value should approximate the value of K_e for the first storm after tillage on a fallow plot of land. Table 4 lists the optimized K_b versus a measurement of K_b obtained using the data from the WEPP cropland erodibility sites under a rainfall simulator. In general, the rainfall simulator measured K_b values tended to be greater than the corresponding optimum K_b values.

Time-Invariant Effective Conductivity Values for Cropland

For the case of time-invariant effective hydraulic conductivity (K_e-constant) the flag in line 3 of the soil file must be set at 0. In this case the input value of K_e must represent both the soil type and the management practice. This method is corollary to the curve number approach for predicting runoff, and in fact, the estimation procedures discussed here were derived using curve number optimizations, so the runoff volumes predicted should correspond closely to curve number predictions. One difference between this method and the curve number method is that no soil moisture correction is necessary, since WEPP takes into account moisture differences via internal adjustments to the wetting front matric potential term of the Green and Ampt equation.

The estimation procedure involves two steps. In step one a fallow soil K_e (K_{ef}) is calculated. In step 2 the fallow soil K_{ef} is adjusted based on management practice using a runoff ratio to obtain the input value of K_e.

Step 1: Use the hydrologic soil group and percent sand content to estimate K_{ef} (mm/hr):

Hydrologic Soil Group	Formula
A	K_{ef} = 14.2
B	K_{ef} = 1.17 + 0.072(SAND)
C	K_{ef} = 0.50 + 0.032(SAND)
D	K_{ef} = 0.34

Step 2: Multiply K_{ef} by the value in the table below to obtain K_e (mm/hr):

	Hydrologic Soil Group		
	A	B,C	D
Fallow	1.00	1.00	1.00
Conv. Tillage - Row Crop	1.37	1.64	1.87
Conserv. Till. - Row Crop	1.49	1.85	2.35
Small Grain	1.84	2.14	2.48
Alfalfa	2.86	3.75	6.23
Pasture (Grazed)	3.66	4.34	5.96
Meadow (Grass)	6.33	9.03	15.5

For other cases, such as rotations, ratios of K_e/K_{ef} may be estimated from curve number (CN) values using the equation:

$$K_e = \frac{56.82 K_{ef}^{0.286}}{1 + 0.051 e^{0.062 CN}} - 2 \quad [3]$$

Adjustments for Wormholes

Accounting for infiltration differences as a function of wormholes may be made by adjusting the input value of effective hydraulic conductivity. The suggestions listed here are preliminary guidelines which are based on interpretations of personal communications regarding the effects of biopores on permeability classes from the SCS Soil Survey Laboratory Staff. The first step is to identify the biopore influence class from Table 6. Then, the input value of either K_e or K_b as calculated above should be multiplied by the ratio shown in Table 7 below.

Table 6. Classes of biopore influence defined by abundance and size classes.

	Pore Size		
Abundance	Medium	Coarse	Very Coarse
Few	Small	Moderate	Moderately Large
Common	Moderate	Moderately Large	Large
Many	Moderately Large	Large	Very Large

Table 7. Increase in Input K_e or K_b by biopore influence.

Input K_e, K_b(mm/hr)	Biopore Influence	Ratio for K_e, K_d Increase
Very Low	Moderate	12
<0.5	Large	15
	Very Large	18
Low	Moderate	9
0.5-1	Large	12
	Very Large	15
Moderately Low	Moderate	6
1-2	Large	9
	Very Large	12
Moderate	Moderate	3
2-3	Large	6
	Very Large	9
Moderately High	Moderate	2
3-5	Large	2.5
	Very Large	3

Time-Invariant Effective Conductivity Values for Rangelands

For rangeland simulations the user should use a time-invariant effective hydraulic conductivity (K_e-constant) the flag in line 3 of the soil file should be set at 0. In this case, the input value of K_e must represent both the soil type and the management practice. One difference between this method and the curve number method is that no soil moisture correction is necessary, since WEPP takes into account moisture differences via internal adjustments to the wetting front matric potential term of the Green and Ampt equation.

Baseline default effective hydraulic conductivity equations for rangelands were developed from data collected from 34 locations across the western United States as part of a joint Agricultural Research Service and Natural Resource Conservation Service project (Interagency Rangeland Water Erosion Team field experiments). For rangelands, the default K_e-constant value is estimated as a function of both abiotic and biotic components and may be computed using the following equations. If the user enters a value of 0.0 for AVKE on line 4I, the model will automatically use the equations.

For plant communities with rill cover less than 45%.

$$K_e = 57.99 - 14.05*\ln(CEC) + 6.2*\ln(ROOT10) - 473.39*BASR^2 + 4.78*RESI \quad [4]$$

For plant communities with rill cover equal to or exceeding 45%.

$$K_e = -14.29 - 3.40*\ln(ROOT10) + 0.3783*SAND + 2.0886*ORGMAT + 398.64*RROUGH - 27.39*RESI + 64.14*BASI \quad [5]$$

where K_e is effective hydraulic conductivity (mm/hr), CEC is the cation exchange capacity (meq/100gm), ROOT10 is root biomass in the surface top 10 cm of the soil profile (kg/m^2), BASR is the fraction of the rill surface area covered by basal area cover, RESI is the fraction of the interrill area covered by litter, SAND is the % sand content, ORGMAT is the % organic matter content of the surface horizon, RROUGH is the random roughness of the soil surface (m), and BASI is the fraction of the interrill surface area covered by basal area cover.

These equations were derived from model optimization runs of measured runoff from rainfall simulation experiments on rangelands. The rainfall simulation experiments consisted of two rainfall events: a dry run (1 hour duration at 57 mm/hr) and a wet run (30 minute duration at 57 mm/hr) on plots 10.7 m long and 3 m wide. The K_e-constant optimization runs were performed on the wet runs. Figure 1 shows the relationship between predicted K_e-constant with the model optimized K_e-constant. Table 8 lists the mean optimized K_e values for the 34 rangeland locations evaluated. Figure 2 shows the results of using model predicted K_e-constant for estimating sediment yield on rangelands. Table 9 through Table 11 provide background information on the type of plant community, average above ground standing and root biomass, canopy cover and the spatial distribution of ground cover, slope, soils, and applied rainfall information. From these tables all the necessary information is available to parameterize the single event version of the WEPP model for these 34 rangeland locations. These values can also be used to initialize the continuous version of the model if the user lacks on-site information about root biomass, spatial distribution of ground cover, plant spacing, and random roughness. It is important to note that these predictive K_e equations were developed for an arbitrarily chosen rainfall event. Thus, a constant K_e is predicted for each location with no adjustments for management impacts. In reality, the effective hydraulic conductivity of a hillslope is a non-linear function of rainfall intensity, initial soil moisture, canopy and ground cover and distribution of soil characteristics. These equations, therefore, may not be suitable for rangeland plant communities outside of the range of data the equations were developed from.

Table 8. Soil characteristics and optimized effective hydraulic conductivity from USDA-IRWET[1] rangeland rainfall simulation experiments used to develop WEPP[2].

	Location	Soil family	Soil series	Surface texture	Sand (%)	Clay (%)	Organic matter (%)	CEC (meq/100g of soil)	Effective hydraulic conductivity (mm/hr)
1)	Prescott, AZ	Aridic argiustoll	Lonti	Sandy loam	48.0	18.2	1.3	14.0	7.0
2)	Prescott, AZ	Aridic argiustoll	Lonti	Sandy loam	48.8	17.9	1.3	14.5	5.6
3)	Tombstone, AZ	Ustochreptic calciorthid	Stronghold	Sandy loam	69.1	16.7	1.8	13.0	28.7
4)	Tombstone, AZ	Ustollic haplargid	Forest	Sandy clay loam	70.3	11.2	1.5	9.8	8.7
5)	Susanville, CA	Typic argixeroll	Jauriga	Sandy loam	32.0	18.1	6.4	26.6	16.7
6)	Susanville, CA	Typic argixeroll	Jauriga	Sandy loam	32.0	18.1	6.4	26.6	17.2
7)	Akron, CO	Ustollic haplargid	Stoneham	Loam	50.6	22.7	2.5	19.5	7.3
8)	Akron, CO	Ustollic haplargid	Stoneham	Sandy loam	63.8	17.1	2.4	14.3	16.5
9)	Akron, CO	Ustollic haplargid	Stoneham	Loam	58.8	23.7	2.2	15.5	8.8
10)	Meeker, CO	Typic camborthid	Degater	Silty clay	6.5	44.2	2.4	19.8	8.0
11)	Blackfoot, ID	Pachic cryoborall	Robin	Silt loam	14.3	18.1	7.5	25.0	7.0
12)	Blackfoot, ID	Pachic cryoborall	Robin	Silt loam	14.1	20.1	9.9	30.4	7.8
13)	Eureka, KS	Vertic argiudoll	Martin	Silty clay loam	2.4	46.9	6.0	44.0	2.9
14)	Sidney, MT	Typic argiboroll	Vida	Loam	51.1	14.8	5.2	16.4	22.5
15)	Wahoo, NE	Typic argiudoll	Burchard	Loam	26.1	35.1	5.1	30.8	3.3
16)	Wahoo, NE	Typic argiudoll	Burchard	Loam	35.7	29.5	4.8	25.6	15.3
17)	Cuba, NM	Ustollic camborthid	Querencia	Sandy loam	68.2	8.4	1.5	9.0	16.5
18)	Los Alamos, NM	Aridic haplustalf	Hackroy	Sandy loam	49.8	7.0	1.4	7.2	6.3
19)	Killdeer, ND	Pachic haploborall	Parshall	Sandy loam	68.9	12.6	3.6	14.3	23.2
20)	Killdeer, ND	Pachic haploborall	Parshall	Sandy loam	70.6	11.7	3.5	12.9	22.4
21)	Chickasha, OK	Udic argiustoll	Grant	Loam	53.8	14.4	4.0	13.0	17.8
22)	Chickasha, OK	Udic argiustoll	Grant	Sandy loam[3]	56.6	10.5	2.3	8.3	13.6
23)	Freedom, OK	Typic ustochrept	Woodward	Loam	50.7	12.5	3.1	12.2	14.9
24)	Woodward, OK	Typic ustochrept	Quinlan	Loam	43.7	13.9	2.3	11.6	20.4
25)	Cottonwood, SD	Typic torrert	Pierre	Clay	13.1	49.6	3.2	36.1	9.3
26)	Cottonwood, SD	Typic torrert	Pierre	Clay	22.4	44.2	3.7	31.6	3.6
27)	Amarillo, TX	Aridic paleustoll	Olton	Loam	29.9	27.5	3.0	20.1	8.4
28)	Amarillo, TX	Aridic paleustoll	Olton	Loam	41.7	25.7	2.5	18.4	5.8
29)	Sonora, TX	Thermic calciustoll	Purbes	Cobbly clay	12.3	41.6	8.9	44.5	2.2
30)	Buffalo, WY	Ustollic haplargid	Forkwood	Silt loam	31.9	27.9	2.8	18.3	5.9
31)	Buffalo, WY	Ustollic haplargid	Forkwood	Loam	34.0	34.2	2.4	21.5	4.6
32)	Newcastle, WY	Ustic torriothent	Kishona	Sandy loam	58.6	16.5	1.7	12.3	21.7
33)	Newcastle, WY	Ustic torriothent	Kishona	Loam	55.2	18.8	2.2	14.4	23.1
34)	Newcastle, WY	Ustic torriothent	Kishona	Sandy loam	62.2	14.5	1.4	15.7	9.0

[1]Interagency Rangeland Water Erosion Team is comprised of ARS staff from the Southwest and Northwest Watershed Research Centers in Tucson, AZ and Boise, ID, and NRCS staff members in Lincoln, NE and Boise, ID.
[2]For single event simulations the depth of the soil profile must be greater than or equal to 0.25 m.

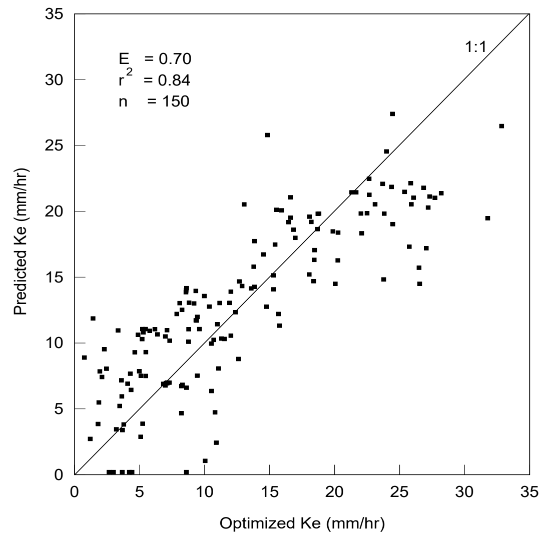


Figure 1. Observed versus WEPP predicted effective hydraulic conductivity (K_e), Nash-Sutcliffe efficiency coefficient (E), and coefficient of determination (r^2) from USDA-IRWET rangeland rainfall simulation experiments used to develop the baseline effective hydraulic conductivity equation for the rangeland component of the WEPP model. The lower limit of predicted K_e is set to 0.2 mm within the model.

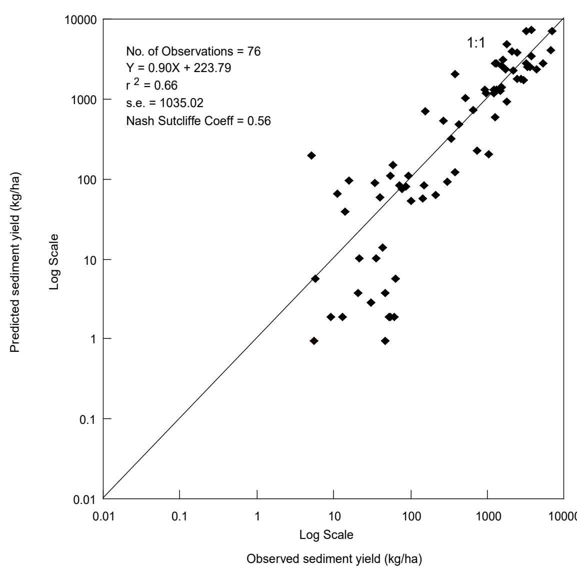


Figure 2. Observed vs. predicted sediment yield for rangeland plant communities with optimized effective hydraulic conductivities (E is the Nash-Sutcliffe efficiency coefficient, r^2 is the coefficient of determination, and s.e. is the standard error).

Table 9. Biotic mean site characteristics from USDA-IRWET [1] rangeland rainfall simulation experiments used to develop the WEPP model.

Location	Rangeland cover type[2]	Range site	Dominant species by weight (descending order)	Ecological status[3]	Biomass Standing (kg/m^2)	Biomass Litter (kg/m^2)	Biomass Root (kg/m^2/0.1m)	Plant Spacing
1) Prescott, AZ	Grama-Galleta	Loamy upland	Blue grama Goldenweed Ring muhly	54	990	0.03	0.09	1177
2) Prescott, AZ	Grama-Galleta	Loamy upland	Rubber rabbitbrush Blue grama Threeawn	36	2,321	0.09	0.09	530
3) Tombstone, AZ	Creosotebush-Tarbush	Limy upland	Tarbush Creosotebush	38	775	NA[4]	0.12	NA
4) Tombstone, AZ	Grama-Tobosa-Shrub	Loamy upland	Blue grama Tobosa Burro-weed	55	752	NA	0.45	NA
5) Susanville, CA	Basin Big Brush	Loamy	Idaho fescue Squirreltail Wooly mulesears	55	5,743	0.44	2.23	NA
6) Susanville, CA	Basin Big Brush	Loamy	Idaho fescue Squirreltail Wooly mulesears	55	5,743	0.44	2.23	NA
7) Akron, CO	Wheatgrass-Grama-Needlegrass	Loamy plains #2	Blue grama Western wheatgrass Buffalograss	76	1,262	0.24	0.46	157
8) Akron, CO	Wheatgrass-Grama-Needlegrass	Loamy plains #2	Blue grama Sun sedge Bottlebrush	44	936	0.20	0.64	152
9) Akron, CO	Wheatgrass-Grama-Needlegrass	Loamy plains #2	Buffalograss Blue grama Prickly pear cactus	45	477	0.09	1.16	78
10) Meeker, CO	Wyoming big sagebrush	Clayey slopes	Salina wildrye Wyoming big sagebrush Western wheatgrass	60	1,583	0.11	0.36	NA
11) Blackfoot, ID	Mountain big sagebrush	Loamy	Mountain big sagebrush Letterman needlegrass Sandberg bluegrass	15	1,587	0.65	0.31	500
12) Blackfoot, ID	Mountain big sagebrush	Loamy	Letterman needlegrass Sandberg bluegrass Prairie junegrass	22	1,595	0.50	0.74	2527
13) Eureka, KS	Bluestem prairie	Loamy upland	Buffalograss Sideoats grama Little bluestem	45	526	0.04	2.91	91
14) Sidney, MT	Wheatgrass-Grama-Needlegrass	Silty	Dense clubmoss Western wheatgrass Needle & thread grass	58	2,141	0.08	1.82	NA

15) Wahoo, NE	Bluestem prairie	Silty	Kentucky bluegrass Dandelion Alsike clover	11	1,239	0.06	0.48	187
16) Wahoo, NE	Bluestem prairie	Silty	Primrose Porcupinegrass Big bluestem	37	3,856	0.09	0.17	55
17) Cuba, NM	Blue grama-Galleta	Loamy	Galleta Blue grama Broom snakeweed	47	817	0.02	0.90	NA
18) Los Alamos, NM	Juniper-Pinyon Woodland	Woodland community	Colorado rubberweed Sagebrush Broom snakeweed	NA[5]	1,382	0.04	0.12	NA
19) Killdeer, ND	Wheatgrass-Needlegrass	Sandy	Clubmoss Sedge Crocus	43	1,613	0.09	0.75	2402
20) Killdeer, ND	Wheatgrass-Needlegrass	Sandy	Sedge Blue grama Clubmoss	52	1,422	0.13	0.41	2384
21) Chickasha, OK	Bluestem prairie	Loamy prairie	Indiangrass Little bluestem Sideoats grama	60	2,010	0.26	0.97	NA
22) Chickasha, OK	Bluestem prairie	Eroded prairie	Oldfield threeawn Sand paspalum Scribners dichanthelium Little bluestem	40	396	0.07	0.72	NA
23) Freedom, OK	Bluestem prairie	Loamy prairie	Hairy grama Silver bluestem Perennial forbs	30	1,223	0.15	1.16	NA
24) Woodward, OK	Bluestem-Grama	Shallow prairie	Sideoats grama Hairy grama Western ragweed	28	1,505	0.1	0.65	NA
25) Cottonwood, SD	Wheatgrass-Needlegrass	Clayey west central	Green needle grass Scarlet globemallow Western wheatgrass	100	2,049	0.10	3.21	NA
26) Cottonwood, SD	Blue grama-Buffalograss	Clayey west central	Blue grama Buffalograss	30	529	0.03	4.10	NA
27) Amarillo, TX	Blue grama-Buffalograss	Clay loam	Blue grama Buffalograss Prickly pear cactus	72	2,477	0.22	0.47	36
28) Amarillo, TX	Blue grama-Buffalograss	Clay loam	Blue grama Buffalograss Prickly pear cactus	62	816	0.19	0.55	40
29) Sonora, TX	Juniper-Oak	Shallow	Buffalograss Curly mesquite Prairie cone flower	35	2,461	0.15	0.86	NA
30) Buffalo, WY	Wyoming big sagebrush	Loamy	Wyoming big sagebrush Prairie junegrass Western wheatgrass	33	7,591	0.18	0.24	322

31) Buffalo, WY	Wyoming big sagebrush	Loamy	Western wheatgrass Bluebunch wheatgrass Green needlegrass	40	2,901	0.09	0.19	880
32) Newcastle, WY	Wheatgrass-Needlegrass	Loamy plains	Prickly pear cactus Needle-and-thread Threadleaf sedge	21	1,257	0.05	0.49	16
33) Newcastle, WY	Wheatgrass-Needlegrass	Loamy plains	Cheatgrass Needle-and-thread Blue grama	22	2,193	0.12	0.38	83
34) Newcastle, WY	Wheatgrass-Needlegrass	Loamy plains	Needle-and-thread Threadleaf sedge Blue grama	50	893	0.02	0.41	64

[1] Interagency Rangeland Water Erosion Team is comprised of ARS staff from the Southwest and Northwest Watershed Research Centers in Tucson, AZ and, Boise, ID, and NRCS staff members in Lincoln, NE and Boise, ID.

[2] Definition of Cover Types from: T.N. Shiflet, 1994. Rangeland cover types of the United States, Society for Range Management, Denver, CO.

[3] Ecological status is a similarity index that expresses the degree to which the composition of the present plant community is a reflection of the historic climax plant community. This similarity index may be used with other site criterion or characteristics to determine rangeland health. Four classes are used to express the percentage of the historic climax plant community on the site (I 76-100; II 51-75; III 26-50; IV 0-25). USDA, National Resources Conservation Service. 1995. National Handbook for Grazingland Ecology and Management. National Headquarters, Washington, D.C. in press.

[4] NA - Data not available.

[5] Ecological status indices are not appropriate for woodland and annual grassland communities.

Table 10. Mean canopy and ground cover spatial distribution characteristics from USDA-IRWET[1] rangeland rainfall simulation experiments used to develop WEPP.

Location	Interrill cover (fraction)					Rill cover (fraction)					Total ground cover (fraction)	Canopy cover (fraction)
	Litter	Rock	Basal	Crypto	Soil	Litter	Rock	Basal	Crypto	Soil		
1) Prescott, AZ	0.144	0.016	0.121	0.000	0.196	0.123	0.039	0.031	0.000	0.329	0.474	0.477
2) Prescott, AZ	0.164	0.018	0.148	0.000	0.180	0.096	0.041	0.033	0.001	0.318	0.502	0.511
3) Tombstone, AZ	0.110	0.130	0.000	0.000	0.084	0.077	0.487	0.020	0.000	0.094	0.823	0.323
4) Tombstone, AZ	0.052	0.001	0.014	0.000	0.117	0.120	0.033	0.176	0.000	0.488	0.396	0.184
5) Susanville, CA	0.208	0.011	0.044	0.000	0.024	0.371	0.138	0.074	0.000	0.132	0.844	0.286
6) Susanville, CA	0.112	0.013	0.022	0.000	0.038	0.340	0.209	0.063	0.000	0.204	0.758	0.184
7) Akron, CO	0.280	0.000	0.099	0.016	0.048	0.294	0.000	0.120	0.046	0.097	0.855	0.443
8) Akron, CO	0.224	0.000	0.015	0.012	0.028	0.463	0.001	0.056	0.050	0.151	0.821	0.278
9) Akron, CO	0.423	0.000	0.095	0.001	0.019	0.346	0.000	0.088	0.002	0.025	0.956	0.538
10) Meeker, CO	0.074	0.000	0.002	0.000	0.030	0.226	0.000	0.113	0.005	0.550	0.420	0.106
11) Blackfoot, ID	0.634	0.000	0.044	0.000	0.029	0.216	0.000	0.007	0.000	0.070	0.902	0.707
12) Blackfoot, ID	0.760	0.000	0.071	0.000	0.039	0.090	0.000	0.003	0.000	0.037	0.924	0.870
13) Eureka, KS	0.218	0.000	0.006	0.000	0.157	0.334	0.000	0.023	0.000	0.261	0.582	0.382
14) Sidney, MT	0.049	0.001	0.007	0.046	0.019	0.230	0.002	0.159	0.320	0.170	0.812	0.120
15) Wahoo, NE	0.495	0.000	0.121	0.029	0.063	0.199	0.000	0.012	0.028	0.053	0.884	0.707
16) Wahoo, NE	0.450	0.000	0.093	0.127	0.022	0.192	0.000	0.011	0.090	0.016	0.962	0.692
17) Cuba, NM	0.171	0.000	0.006	0.000	0.033	0.663	0.000	0.025	0.000	0.103	0.864	0.209
18) Los Alamos, NM	0.214	0.000	0.011	0.000	0.048	0.515	0.000	0.056	0.000	0.157	0.796	0.272
19) Killdeer, ND	0.495	0.000	0.121	0.029	0.063	0.199	0.000	0.012	0.028	0.053	0.884	0.707
20) Killdeer, ND	0.450	0.000	0.093	0.127	0.022	0.192	0.000	0.011	0.090	0.016	0.962	0.692
21) Chickasha, OK	0.338	0.000	0.096	0.000	0.026	0.395	0.001	0.115	0.000	0.030	0.945	0.460
22) Chickasha, OK	0.064	0.000	0.005	0.004	0.072	0.425	0.001	0.168	0.036	0.225	0.703	0.145
23) Freedom, OK	0.200	0.000	0.114	0.015	0.060	0.294	0.003	0.046	0.045	0.225	0.716	0.388
24) Woodward, OK	0.214	0.001	0.102	0.018	0.117	0.193	0.002	0.049	0.042	0.264	0.619	0.450
25) Cottonwood, SD	0.181	0.000	0.156	0.013	0.110	0.286	0.010	0.034	0.002	0.209	0.682	0.460
26) Cottonwood, SD	0.126	0.004	0.172	0.006	0.034	0.298	0.013	0.171	0.019	0.158	0.808	0.341
27) Amarillo, TX	0.201	0.000	0.030	0.000	0.001	0.631	0.000	0.109	0.000	0.029	0.970	0.231
28) Amarillo, TX	0.101	0.000	0.003	0.000	0.000	0.736	0.000	0.027	0.000	0.133	0.867	0.104
29) Sonora, TX	0.176	0.032	0.005	0.019	0.162	0.139	0.124	0.155	0.031	0.158	0.681	0.394
30) Buffalo, WY	0.362	0.002	0.051	0.000	0.115	0.162	0.004	0.004	0.001	0.299	0.587	0.530
31) Buffalo, WY	0.387	0.025	0.030	0.000	0.242	0.131	0.029	0.004	0.000	0.153	0.605	0.683
32) Newcastle, WY	0.057	0.000	0.014	0.016	0.021	0.343	0.000	0.105	0.233	0.211	0.768	0.108
33) Newcastle, WY	0.474	0.000	0.014	0.002	0.065	0.302	0.000	0.016	0.001	0.125	0.810	0.556
34) Newcastle, WY	0.137	0.001	0.038	0.022	0.126	0.185	0.003	0.045	0.039	0.406	0.468	0.323

[1]Interagency Rangeland Water Erosion Team is comprised of ARS staff from the Southwest and Northwest Watershed Research Centers in Tucson, AZ and Boise, ID, and NRCS staff members in Lincoln, NE and Boise, ID.

Table 11. Precipitation and topographic characteristics from USDA-IRWET[1] rangeland rainfall simulation experiments used to develop WEPP[2].

Location	Precipitation volume (mm)	Precipitation Duration (hr)	Slope (%)	Random roughness (m)
1) Prescott, AZ	28.13	0.49	5	0.015
2) Prescott, AZ	27.00	0.46	4	0.017
3) Tombstone, AZ	25.82	0.44	10	0.013
4) Tombstone, AZ	26.08	0.47	4	0.007
5) Susanville, CA	23.79	0.40	13	0.017
6) Susanville, CA	22.69	0.41	13	0.010
7) Akron, CO	38.47	0.66	7	0.010
8) Akron, CO	32.67	0.58	8	0.009
9) Akron, CO	34.13	0.61	7	0.013
10) Meeker, CO	23.56	0.42	10	0.013
11) Blackfoot, ID	45.19	0.81	7	0.031
12) Blackfoot, ID	36.00	0.62	9	0.026
13) Eureka, KS	26.28	0.44	3	0.009
14) Sidney, MT	21.69	0.42	10	0.006
15) Wahoo, NE	16.66	0.31	10	0.010
16) Wahoo, NE	28.86	0.50	11	0.010
17) Cuba, NM	22.28	0.43	7	0.007
18) Los Alamos, NM	21.81	0.42	7	0.007
19) Killdeer, ND	38.17	0.67	11	0.011
20) Killdeer, ND	33.08	0.57	11	0.010
21) Chickasha, OK	24.39	0.42	5	0.006
22) Chickasha, OK	23.58	0.39	5	0.005
23) Freedom, OK	23.20	0.42	6	0.010
24) Woodward, OK	25.14	0.41	6	0.009
25) Cottonwood, SD	22.87	0.40	8	0.008
26) Cottonwood, SD	21.84	0.40	12	0.006
27) Amarillo, TX	29.72	0.51	3	0.008
28) Amarillo, TX	28.30	0.48	2	0.007
29) Sonora, TX	24.98	0.42	8	0.006
30) Buffalo, WY	25.06	0.44	10	0.027
31) Buffalo, WY	30.53	0.52	7	0.016
32) Newcastle, WY	48.87	0.92	7	0.017
33) Newcastle, WY	39.81	0.68	8	0.019
34) Newcastle, WY	33.80	0.58	9	0.021

[1]Interagency Rangeland Water Erosion Team is comprised of ARS staff from the Southwest and Northwest Watershed Research Centers in Tucson, AZ and Boise, ID, and NRCS staff members in Lincoln, NE and Boise, ID.

[2]For single event model runs from rainfall simulation experiments with a constant rainfall intensity, the coefficients IP and TP are set to 1.0. All slopes were input as uniform.

Baseline Soil Erodibility Parameter Estimation

The soil erodibility parameters are input to the model on Line 4 (f, g, h) of the soil input data file. The WEPP erosion model is very sensitive to the input values for baseline interrill erodibility (K_i), rill erodibility (K_r), and critical hydraulic shear (τ_c). For cropland, the input baseline erodibility values represent those for a freshly tilled soil with no crop residue present. For rangeland, the input baseline erodibility values represent those for a fully consolidated rangeland area which has all surface residue removed. Adjustments to these erodibilities are made internally in the WEPP model to account for effects such as consolidation, incorporated residue, etc. Estimation procedures for baseline erodibilities are not final at this time; however, the following sets of equations are provided as the best estimate for K_i, K_r, and τ_c based upon extensive evaluation of the WEPP cropland and rangeland erodibility experimental results.

For cropland soils containing 30% or more sand, the equations are:

$$K_i = 2{,}728{,}000 + 192{,}100*VFS \quad \textbf{[6]}$$

$$K_r = 0.00197 + 0.00030*VFS + 0.03863*EXP(-1.84*ORGMAT) \quad \textbf{[7]}$$

$$\tau_c = 2.67 + 0.065*CLAY - 0.058*VFS \quad \textbf{[8]}$$

where VFS is percent very fine sand, ORGMAT is percent organic matter in the surface soil (and we assume that organic matter equals 1.724 times organic carbon content), and CLAY is percent clay. In these equations the value for VFS used must be less than or equal to 40% (if your value for VFS is greater than 40%, use 40%), the value for ORGMAT must be greater than 0.35% (if your value for ORGMAT is less than 0.35%, use 0.35%), and the value for CLAY must be less than 40% (if your value for CLAY is greater than 40%, use 40%).

For cropland soils containing less than 30% sand, the equations are:

$$K_i = 6{,}054{,}000 - 55{,}130*CLAY \quad \textbf{[9]}$$

$$K_r = 0.0069 + 0.134*EXP(-0.20*CLAY) \quad \textbf{[10]}$$

$$\tau_c = 3.5 \quad \textbf{[11]}$$

In equations [9] and [10], CLAY must be 10% or greater (if your value for CLAY is less than 10%, use 10% in the equations).

The experimental soil texture parameters for the high (equal to or greater than 30% sand) and low (less than 30 % sand) sand soils are given below:

Table 12. Range of experimental soil texture parameters for cropland erosion studies.

VARIABLE	HIGH SAND SOILS	LOW SAND SOILS
CLAY	3 - 40 %	11 - 53 %
SILT	5 - 44 %	38 - 78 %
VFS	4 - 39 %	1 - 19 %
ORGMAT	0.35 -5.6 %	1.2 - 3.3 %

Table 13. Mean erodibilities and critical shear, soil properties, and number of soils for each textural classification for soil included in the study resulting in equations for baseline erodibility parameters.

TEXTURE	# of SOILS	K_i (kg*s/m^4)	K_r (s/m)	τ_c (Pa)	% CLAY	% SILT	% SAND	% VFS	% OM
Clay Loam	3	4,315,290	.0048	4.7	33.2	29.6	37.2	8.1	1.9
Loam	9	5,434,716	.0085	3.3	19.7	35.2	45.3	14.7	2.9
Sand	3	5,641,494	.0248	2.1	4.5	8.0	87.5	16.9	0.5
Sandy Loam	7	4,974,960	.0102	2.5	12.4	19.0	68.6	10.2	1.2
Silt Loam	9	5,083,455	.0121	3.5	18.1	70.7	11.1	7.3	2.1
Clay	1	2,154,983	.0089	2.9	53.1	38.3	8.6	4.5	2.4
Silty Clay	1	4,475,042	.0117	4.8	49.5	40.9	9.6	7.3	2.6
Silty Clay Loam	1	3,409,795	.0053	3.2	39.8	55.4	4.8	4.6	3.3

Experimental K_i values for cropland are usually between 2,000,000 and 11,000,000 kg*s/m^4. Experimental K_r values usually are between 0.002 and 0.045 s/m, and values for τ_c are usually between 1 and 6 N/m^2 on cropland soils.

For rangeland soils, the baseline erodibility equations are:

$$K_i = 1,810,000 - 19,100*SAND - 63,270*ORGMAT - 846,000*\Theta_{fc} \quad [\ 12\ ]$$

$$K_r = [\ 0.000024*CLAY - 0.000088*ORGMAT - 0.00088*BD_{dry} - 0.00048*ROOT10\ ] + 0.0017 \quad [\ 13\ ]$$

$$\tau_c = 3.23 - 0.056*SAND - 0.244*ORGMAT + 0.9*BD_{dry} \quad [\ 14\ ]$$

where Θ_{fc} is the volumetric water content of the soil at 0.033MPa (m^3/m^3), BD_{dry} is the dry soil bulk density (g/cm^3), ROOT10 is the total root biomass within the 0.0 to 0.1 m soil zone (kg/m^2), and the other variables are as defined previously. Equations [12], [13] and [14] may possibly predict negative values for K_i, K_r, and τ_c when applied to rangeland soils greatly different than those in the experimental studies. In these cases, it is recommended that the user abide by these suggested ranges for the rangeland erodibility indices: K_i should range between 10,000 and 2,000,000 kg*s/m^4; K_r should range between 0.0001 and 0.0006 s/m; and τ_c should range between 1.5 and 6.0 N/m^2.

Soil Albedo

Albedo is the fraction of the solar radiation which is reflected back to the atmosphere. This parameter is used to estimate the net radiation reaching the soil surface, which is then used in the evapotranspiration calculations within the WEPP water balance routines. The input parameter value for soil albedo on Line 4d of the soil input file is for a bare, dry soil surface. WEPP will internally adjust the albedo value for the effects of soil moisture, vegetation, residue cover, and snow cover.

Soil albedo for a dry surface can be estimated by an equation proposed by Baumer (1990):

SALB = 0.6 / exp(0.4*ORGMAT) **[15]**

where ORGMAT is the percent organic matter in the surface soil (%). Note that this equation will result in estimating a soil albedo value of 0.60 for soils having zero organic matter, and a value of 0.08 for soils with 5 percent organic matter).

Initial Saturation

The definition of initial saturation ("sat" on Line 4e of soil file) is the fraction of the porosity filled by water at the beginning of the simulation. The continuous option of the WEPP model operates for a minimum of one year with the starting date of January 1. Therefore, "initial" soil water content refers to the soil water content on January 1 of the first simulation year. This parameter is used to initialize the soil water content for each soil layer. The total soil water content (soilwa) and the available soil water content (st) for each layer is calculated in WEPP by using the following equations:

Initial soil water content

(SOILWA, m/layer)=(SAT*POR*RFG)*DG **[16]**

Initial plant available water content

(ST, m/layer)=((SAT*POR*(1-RFG))-thetdr)*DG **[17]**

where

POR= layer's porosity cm^3/cm^3 = 1-bd/2.65
RFG=correction of porosity for rock content , fraction by volume
DG=thickness of soil layer, m
thetdr= volumetric soil water content at 1500Kpa tension, m^3/m^3

The soil water content of the top soil layer is changed daily depending on the infiltration of the rainfall, irrigation water and/or snow melt and, soil evaporation and percolation to the lower layers. The soil water content of the lower soil layers are subject to change due to the percolation, plant transpiration, and/or flow to the drainage tiles.

Though the value for initial saturation can range between 0.0 and 1.0, more reasonable values would be somewhere between 0.5 and 0.95. Many soils on January 1 might have fairly high moisture contents due to fall and winter rainfall and snow accumulation, thus a value of about 0.9 might be appropriate. For other cases, the recommended value would be 0.7, which is about field capacity moisture content for many soils. Another option would be to use the WEPP model to generate the graphical output file, and then view the soil moisture content and soil porosity with time and estimate the initial saturation value based on the values on January 1 for other years during the simulation period.

Cation Exchange Capacity

Cation exchange capacity is the quantity of cations adsorbed on soil particle surfaces per unit of mass of the soil under chemically neutral conditions. Soils range in CEC from almost zero to over 100 meq/100 grams. CEC is used in the WEPP model to estimate baseline effective hydraulic conductivity (Equation [1]). Table 14 and Table 15 contain some typical values for CEC that can be used by WEPP model users. Better values can be obtained from soil testing of the field, since CEC is a commonly reported soil test result.

Table 14. Relation between soil texture and CEC.

Soil texture	Cation Exchange Capacity (milliequivalents per 100 g of soil)
Sands	1-5
Fine sandy loams	5-10
Loams and silt loams	5-15
Clay loams	15-30
Clays	30-150

Source: Donahue et al. (1977).

Table 15. Representative CEC of the common soil colloids.

Soil colloid	Cation Exchange Capacity (meq/100g of colloid)
Humus	100-300
Vermiculite clay	80-150
Montmorillonite	60-100
Illite	25-40
Kaolinite	3-15
Sesquioxides	0-3

Source: Donahue et al. (1977).

Plant/Management Input File

The plant/management input file contains all of the information needed by the WEPP model related to plant parameters (rangeland plant communities and cropland annual and perennial crops), tillage sequences and tillage implement parameters, plant and residue management, initial conditions, contouring, subsurface drainage, and crop rotations.

For readability, the WEPP management file is structured into Sections. A Section is a group of data which are related in some manner.

The WEPP management file can become very complex, especially for multiple OFE simulations. It is recommend to use the WEPP user interface or other software to assist in creating these files.

Although the rangeland section formatting is still accepted, the WEPP model has not been updated for rangeland applications. The WEPP cropland management scenarios can be adapted for some rangeland applications. Another option is to use the more recently developed USDA-ARS RHEM model for rangeland applications.

The management file contains the following Sections in the following order:

- Information Section - contains the WEPP version.
- Plant Growth Section - plant growth parameters.
- Operation Section - tillage and other implement parameters.
- Initial Condition Section - contains initial conditions and parameters which are OFE or channel specific.
- Surface Effects Section - tillage sequences and other surface-disturbing dated-sequences of implements.
- Contour Section - contouring parameters.
- Drainage Section - drainage parameters.
- Yearly Section - management information.
- Management Section - indexes into the Yearly Scenarios.

Within Sections, there may be several instances of data groupings. Each unique data grouping is referred to as a Scenario. For instance, the Contour Section may contain several different groups of contouring parameters. Each unique contour grouping is called a Contour Scenario. Likewise, each unique plant used by WEPP, and its associated parameters is called a Plant Scenario.

By arranging data into Scenarios, information which is accessed frequently by WEPP need only be stored once in the management file. When WEPP needs scenario information, it will access it through an index into the appropriate scenario. Similarly, scenarios may also be accessed by other scenarios within the management file. For example, the Surface Effects scenarios will index into an Operation Scenario when it needs to reference a specific operation. The Yearly Scenario can index into the Surface Effects, and Contouring scenarios.

All scenarios are ultimately used by the Management Section through indices into the Yearly scenarios. With this scenario hierarchy, simple scenarios are found toward the top of the management file; more complex ones below them.

Some management file conventions:

1 At most 10 data values per line.
2. WEPP expects the following to be on lines by themselves: text information (such as scenario names and comments), looping parameters (such as `nini', `ntill', etc.), option flags (such as `lanuse', `imngmt', etc.), dates, and scenario indexes.
3. Anything on a line after the `#' character is a comment. Comments may not follow text information that is read by the model.

Plant/Management Input File Sections

The general form of a Section is:

Scen.number	-the number of scenarios declared.
Scen.loop.name	-the scenario name.
Scen.loop.description	-text comments.
Scen.loop.data	-the scenario data parameters.

To read a scenario, WEPP will loop the number of times specified by the value `Scen.number', reading the "loop" data into memory for future use.

The plant/management file for WEPP v95.7 is described in Table 16. Please note that although this management file convention allows the "mixing" of Scenarios of different land usage, this flexibility is not currently supported by the WEPP erosion model. Also, there are several scenarios that have empty "slots" where information will eventually be placed when WEPP supports those options.

Table 16. Plant/Management input file description.

---------- **Information Section** --

Info.version:

1.1)WEPP version, (up to) 8 characters- (datver)

95.7 – Initial version
98.4 – Update
2016.3 – Residue management updates, additional parameters

Note `datver' is used to detect older management file formats, which are incompatible with the current WEPP erosion model..

Info.header

2.1)number of Overland Flow Elements for hillslopes, integer (nofe), or number of channels for watershed (nchan)

3.1)number of TOTAL years in simulation, integer (nyears * nrots)

---------- **Plant Growth Section** --

Note `ncrop' is the number of unique plant types grown during the simulation period. For example, if the crops grown during the simulation are corn and wheat, `ncrop' = 2. A different type of residue on a field besides the current crop growth being simulated also needs to be assigned a crop number. For example if you are planting continuous corn into a field that is coming out of set-aside acreage that had a clover cover crop present the fall before that was killed with herbicides that fall, you need to input the clover crop parameters so that the decomposition section of the model will have the correct parameters (thus `ncrop' would be 2)

Plant.number:

0.1)number of unique plant types, integer (ncrop)

Plant.loop.name:

1.1)plant name, (up to) 35 characters (crname)

Plant.loop.description:

2.1)description, (up to) 55 characters (may be blank)

3.1)description, (up to) 55 characters (may be blank)

4.1)description, (up to) 55 characters (may be blank)

Plant.loop.landuse:

5.1)for use on land type..., integer - (iplant)

1)crop
2)range
3)forest
4)roads

Plant.loop.cropland:*(read when iplant=1; cropland)*

6.1)harvest units, (i.e., bu/a, kg/ha, t/a, etc.) up to 15 characters - (crunit)

7.1)canopy cover coefficient, real - (bb)
7.2)parameter value for canopy height equation, real - (bbb)
7.3)biomass energy ratio, real - (beinp)
7.4)base daily air temperature (degrees C), real - (btemp)
7.5)parameter for flat residue cover equation (m^2/kg), real - (cf)
7.6)growing degree days to emergence (degrees C), real - (crit)
7.7)critical live biomass value below which grazing is not allowed (kg/m^2), real - (critvm)
7.8)height of post-harvest standing residue; cutting height (m), real - (cuthgt)
7.9)fraction canopy remaining after senescence (0-1), real (decfct)
7.10)plant stem diameter at maturity (m), real - (diam)

8.1)heat unit index when leaf area index starts to decline (0-1), real - (dlai)
8.2)fraction of biomass remaining after senescence (0-1), real - (dropfc)
8.3)radiation extinction coefficient, real - (extnct)
8.4)standing to flat residue adjustment factor (wind, snow, etc.), real - (fact)
8.5)maximum Darcy Weisbach friction factor for living plant, real - (flivmx)
8.6)growing degree days for growing season (degrees C), real - (gddmax)
8.7)harvest index, real - (hi)
8.8)maximum canopy height (m), real - (hmax)

9.1)use fragile or non-fragile operation mfo values, integer - (mfocod)
    1)fragile
    2)non-fragile

10.1)decomposition constant to calculate mass change of above-ground biomass (surface or buried), real - (oratea)
10.2)decomposition constant to calculate mass change of root-biomass, real - (orater)
10.3)optimal temperature for plant growth (degrees C), real - (otemp)
10.4)plant specific drought tolerance, real - (pltol)
10.5)in-row plant spacing (m), real - (pltsp)
10.6)maximum root depth (m), real - (rdmax)
10.7)root to shoot ratio, real - (rsr)
10.8)maximum root mass for a perennial crop (kg/m^2), real - (rtmmax)
10.9)period over which senescence occurs (days), integer - (spriod)
10.10)maximum temperature that stops the growth of a perennial crop (degrees C), real - (tmpmax)

11.1)critical freezing temperature for a perennial crop (degrees C), real - (tmpmin)
11.2)maximum leaf area index, real - (xmxlai)
11.3)optimum yield under no stress conditions (kg/m^2), real - (yld)
11.4)Release canopy cover, real (version 2016.3)– (rcc)

Note (input 0.0 on Line 11.3 to use model calculated optimum yield)

Plant.loop.rangeland:*(read when iplant=2; rangeland)*

6.1)change in surface residue mass coefficient, real - (aca)
6.2)coefficient for leaf area index, real - (aleaf)
6.3)change in root mass coefficient, real - (ar)
6.4)parameter value for canopy height equation, real - (bbb)
6.5)daily removal of surface residue by insects, real - (bugs)
6.6)frac. of 1st peak of growing season, real - (cf1)
6.7)frac. of 2nd peak of growing season, real - (cf2)
6.8)c:n ratio of residue and roots, real - (cn)
6.9)standing biomass where canopy cover is 100%,(kg/m^2) real - (cold)
6.10)frost free period, (days) integer - (ffp)

7.1)projected plant area coefficient for grasses, real - (gcoeff)
7.2)average. canopy diameter for grasses, (m) real - (gdiam)
7.3)average height for grasses (m), real - (ghgt)
7.4)average number of grasses along a 100 m belt transect, real - (gpop)
7.5)minimum temperature to initiate growth,(degrees C) real - (gtemp)
7.6)maximum herbaceous plant height (m), real - (hmax)
7.7)maximum standing live biomass, (kg/m^2) real - (plive)
7.8)plant drought tolerance factor, real - (pltol)
7.9)day of peak standing crop, 1st peak, (julian day) integer - (pscday)
7.10)minimum amount of live biomass, (kg/m^2) real - (rgcmin)

8.1)root biomass in top 10 cm, (kg/m^2) real - (root10)
8.2)fraction of live and dead roots from maximum at start of year, real - (rootf)
8.3)day on which peak occurs, 2nd growing season (julian day), integer - (scday2)
8.4)projected plant area coefficient for shrubs, real - (scoeff)
8.5)average canopy diameter for shrubs (m), real - (sdiam)
8.6)average height of shrubs (m), real - (shgt)
8.7)average number of shrubs along a 100 m belt transect, real - (spop)
8.8)projected plant area coefficient for trees, real - (tcoeff)
8.9)average canopy diameter for trees (m), real - (tdiam)
8.10)minimum temperature to initiate senescence, (degrees C) real - (tempmn)

9.1)average height for trees (m), real - (thgt)
9.2)average number of trees along a 100 m belt transect, real - (tpop)
9.3)fraction of initial standing woody biomass, real - (wood)

Plant.loop.forest:*(read when iplant=3; forest)*

Note no values; plants for Forestland not yet supported.

Plant.loop.roads:*(read when iplant=4; roads)*

Note no values; plants for Roads not yet supported.

Note **Plant.loop** values repeat `ncrop` times.

---------- **Operation Section** --

Op.number:
0.1)number of unique operation types, integer (nop)

Op.loop.name:
1.1)operation name, (up to) 35 characters (opname)

Op.loop.description:
2.1)description, (up to) 55 characters (may be blank)

3.1)description, (up to) 55 characters (may be blank)

4.1)description, (up to) 55 characters (may be blank)

Op.loop.landuse:
5.1)for use on land type, integer - (iop)
1)crop
2)range
3)forest
4)roads

Op.loop.cropland:*(read when iop=1; cropland)*

6.1)interrill tillage intensity for fragile crops, real - (mfo1)
6.2)interrill tillage intensity for non-fragile crops, real - (mfo2)
6.3)number of rows of tillage implement, integer - (numof)

7.1)implement/residue code, integer - (code1/resma1)
1)planter
2)drill
3)cultivator
4)other

Note: Following codes only valid for version 2016.3
10) residue addition without surface disturbance
11) residue removal (flat only) without surface disturbance
12) residue addition with disturbance
13) residue removal (flat only) with disturbance
14) shredding/cutting
15) burning
16) silage
17) herbicide application
18) residue removal by fraction (standing and flat) without surface disturbance
19) residue removal by fraction (standing and flat) - with surface disturbance

7.2)cultivator position, integer - (cltpos)
(read when code1/resma1 = 3; cultivator)
1)front mounted
2)rear mounted

8.1)ridge height value after tillage (m), real - (rho)
8.2)ridge interval (m), real - (rint)
8.3)rill tillage intensity for fragile crops, real - (rmfo1)
8.4)rill tillage intensity for non-fragile crops, real - (rmfo2)
8.5)random roughness value after tillage (m), real - (rro)
8.6)fraction of surface area disturbed (0-1), real - (surdis)
8.7)mean tillage depth (m), real - (tdmean)

Note: Resurface parameters only for version 2016.3 format
8.8) Fraction residue resurfaced for fragile crops (0-1), real – (resurf1)
8.9) Fraction residue resurfaced for non-fragile crop (0-1), real – (resurnf1)

Note: Lines 9 and 10 only for version 2016.3 format

9.1) Read when resma1 is 10,11,12,13,14,15,18,19:

When resma1=10,12: crop index specifying residue type – (iresa1)
When resma1=11,13: fraction of residue removed (0-1) – (frmov1)
When resma1=14: fraction of residue shredded (0-1) – (frmov1)
When resma1=15: fraction of standing residue burned (0-1) (fbrna1)
When resma1=18,19: fraction of flat residue removed (0-1) (frfmov1)

10.1) Read when resma1 is 10, 12, 15, 18, 19:

When resma1=10,12: amount of residue added (kg/m^2) – (resad1)
When resma1=15: fraction of flat residue burned (0-1) (fbrnol)
When resma1=18,19: fraction of standing residue removed (0-1) (frsmov1)

Op.loop.rangeland:*(read when iop=2; rangeland)*

******Note****** no values; operations for Rangeland not yet supported.

Op.loop.forest:*(read when iop=3; forest)*

******Note****** no values; operations for Forestland not yet supported.

Op.loop.roads:*(read when iop=4; roads)*

******Note****** no values; operations for Roads not yet supported.

******Note*** Op.loop values repeat `nop' times.***

---------- Initial Condition Section --------------------------------------

Note `nini' is the number of different initial conditions to be read into the WEPP model. The initial conditions are the conditions which exist at the beginning of the simulation. Estimates of the initial conditions for a continuous simulation can be made by using long term average conditions which exist on January 1st. For a single storm simulation, the user must input the correct values for initial conditions since they will greatly affect the model output. For continuous model simulations, especially ones in which significant soil and residue disturbance are caused by tillage and the simulation is for several years, the effect of initial conditions on model output is minimal.[1]

Ini.number:
0.1)number of initial condition scenarios, integer - (nini)

Ini.loop.name:
1.1)scenario name, (up to) 8 characters (oname)

Ini.loop.description:
2.1)description, (up to) 55 characters (may be blank)
3.1)description, (up to) 55 characters (may be blank)
4.1)description, (up to) 55 characters (may be blank)

Ini.loop.landuse:
5.1)land use, integer - (lanuse)
1)crop
2)range
3)forest
4)roads

Ini.loop.landuse.cropland:*(read when lanuse=1; cropland)*

6.1)bulk density after last tillage (g/cm^3), real - (bdtill)
6.2)initial canopy cover (0-1), real - (cancov)
6.3)days since last tillage, real - (daydis)
6.4)days since last harvest, integer - (dsharv)
6.5)initial frost depth (m), real - (frdp)
6.6)initial interrill cover (0-1), real - (inrcov)

7.1)Plant Growth Scenario index of initial residue type, integer - (iresd)
Note `iresd' refers to a Plant Growth Scenario.

8.1)initial residue cropping system, integer - (imngmt)
1)annual
2)perennial
3)fallow
9.1)cumulative rainfall since last tillage (mm), real - (rfcum)

[1]The WEPP Shell Interface can optionally create these scenarios from WEPP model runs.

9.2)initial ridge height after last tillage (m), real - (rhinit)
9.3)initial rill cover (0-1), real - (rilcov)
9.4)initial ridge roughness after last tillage (m), real - (rrinit)
9.5)rill spacing (m), real - (rspace)

Note if `rspace' is 0.0 or less, WEPP will set rill spacing to 1.0 meter.

10.1)rill width type, integer - (rtyp)
1)temporary
2)permanent

Note For most cases, input a value of "1" for rill width type. To use a constant rill width, unaffected by flow or tillage, input "2" here for permanent rills.

11.1)initial snow depth (m), real - (snodpy)
11.2)initial depth of thaw (m), real - (thdp)
11.3)depth of secondary tillage layer (m), real - (tillay(1))
11.4)depth of primary tillage layer (m), real - (tillay(2))
11.5)initial rill width (m), real - (width)

Note The primary tillage layer (tillay(2)) is the depth of the deepest tillage operation. The secondary tillage layer is the average depth of all secondary tillage operations. If no tillage, set tillay (1) = 0.1 and tillay (2) = 0.2 The current version of WEPP (v95.7/v2012/v2024) internally fixes tillay(1)=0.1 and tillay(2)=0.2, so the input values here at present have no impact on model simulations.

Note If rill width type (rtyp) is temporary, WEPP will estimate a value for rill width as a function of flow discharge rate for each storm, and reset rill width to 0.0 when a tillage occurs. If `width' is 0.0 and rill width type (rtyp) is permanent, WEPP will set the permanent rill width to the rill spacing, functionally forcing the model to assume broad sheet flow for flow shear stress and transport computations.

12.1)initial total dead root mass (kg/m^2), real - (sumrtm)
12.2)initial total submerged residue mass (kg/m^2), real - (sumsrm)

Note: Forest understory parameters only for version 2016.3 format
12.3)Initial understory interrill cover (0-1), real – (usinrcol)
12.4)Initial understory rill cover (0-1), real – (usrilcol)

Note See page (100) for information on estimating sumrtm and sumsrm.

Ini.loop.landuse.rangeland:*(read when lanuse=2; rangeland)*

6.1)initial frost depth (m), real - (frdp)
6.2)average rainfall during growing season (m), real - (pptg)
6.3)initial residue mass above the ground (kg/m^2), real - (rmagt)
6.4)initial residue mass on the ground (kg/m^2), real - (rmogt)
6.5)initial random roughness for rangeland (m), real - (rrough)

6.6)initial snow depth (m), real - (snodpy)
6.7)initial depth of thaw (m), real - (thdp)
6.8)depth of secondary tillage layer (m), real - (tillay (1))
6.9)depth of primary tillage layer (m), real - (tillay (2))

Note The primary tillage layer (tillay (2)) is the depth of the deepest tillage operation. The secondary tillage layer is the average depth of all secondary tillage operations. If no tillage, set tillay (1) = 0.1 and tillay (2) = 0.2 The current version of WEPP (v95.7) internally fixes tillay(1) = 0.1 and tillay(2) = 0.2, so the input values here at present have no impact on model simulations.

7.1)interrill litter surface cover (0-1), real - (resi)
7.2)interrill rock surface cover (0-1), real - (roki)
7.3)interrill basal surface cover (0-1), real - (basi)
7.4)interrill cryptogamic surface cover (0-1), real - (cryi)
7.5)rill litter surface cover (0-1), real - (resr)
7.6)rill rock surface cover (0-1), real - (rokr)
7.7)rill basal surface cover (0-1), real - (basr)
7.8)rill cryptogamic surface cover (0-1), real - (cryr)
7.9)total foliar (canopy) cover (0-1), real (cancov)

Ini.loop.landuse.forest:*(read when lanuse=3; forest)*

Note no values; initial conditions for Forestland not yet supported.

Ini.loop.landuse.roads:*(read when lanuse=4; roads)*

Note no values; initial conditions for Roads not yet supported.

Note ***Ini.loop* values repeat `nini' times.**

---------- Surface Effects Section ---

Note A Surface Effect Scenario is a sequence of surface-disturbing (tillage) operations performed on one field or overland flow element during one calendar year.

Surf.number:
0.1)number of Surface Effect Scenarios, integer (nseq)

Surf.loop.name:
1.1)scenario name, (up to) 8 characters - (sname)

Surf.loop.description:
2.1)description, (up to) 55 characters (may be blank)

3.1)description, (up to) 55 characters (may be blank)

4.1)description, (up to) 55 characters (may be blank)

Surf.loop.landuse:
5.1)for use on land type, integer - (iseq)
1)crop
2)range
3)forest
4)roads

Surf.loop.number:
6.1)number of operations for surface effect scenario, integer - (ntill)

Surf.loop.loop.cropland:*(read when iseq=1; cropland)*

7.1)day of tillage (julian), integer - (mdate)

8.1)Operation Scenario index, integer - (op)

Note `op' refers to the Operation Scenario.

9.1)tillage depth (m), real - (tildep)

10.1)tillage type, integer - (typtil)
1)primary
2)secondary

Note Primary tillage is the operation which tills to the maximum depth. Secondary tillage is all other tillage operations.

Surf.loop.loop.rangeland:*(read when iseq=2; rangeland)*

Note no values; surface effects for Rangeland not yet supported.

Surf.loop.loop.forest:*(read when iseq=3; forest)*

Note no values; surface effects for Forestland not yet supported.

Surf.loop.loop.roads:*(read when iseq=4; roads)*

Note no values; surface effects for Roads not yet supported.

***Note* Surf.loop.loop values repeat `ntill' times. Surf.loop values repeat `nseq' times.**

---------- Contour Section --

Note A Contour Scenario is the combination of slope length, slope steepness, and ridge height which is associated with one (or more) overland flow element(s) or a field in a hillslope simulation. Contour Scenarios are used when the effects of contour farming or cross-slope farming are to be examined. The contour routines within the WEPP model at this time are fairly simple. The inputs for the Contour Scenarios are the row grade of the contours (assumed uniform), the contour row spacing (distance between ridges), the contour row length (the distance runoff flows down a contour row), and the contour ridge height. WEPP computes the amount of water storage within a contour row. If the runoff produced by a rainfall event exceeds the storage the contours are predicted to fail and a message is sent to the output which informs the user that his contour system has failed. There are now two options for contour simulations, and what happens when contours are predicted to fail. In v2012.8 and earlier versions of WEPP, erosion estimates are made continuing to assume that all flow is down the contour rows (even when they were predicted to fail). The model will count the number of contour failures and report this to the user in the output file. A newer contour simulation option available in v2024 predicts runoff and soil loss up-and-down a hillslope profile after contour failure. Erosion estimates will continue to be made up-and-down the profile until a subsequent tillage operation occurs that will reset the simulation, so that predictions will again made down the contour rows. For the NRCS web-based interface, NRCS set the contour row spacing equal to the rill spacing, set the contour row length to 50 feet, set the contour ridge height to the OFE soil ridge height, and forced contour failure if the ridge height on a day was 2 inches or less. There is an option setting within the updated Windows interface allowing a user to choose which contour simulation option they prefer.

If a user receives a message that their contour system has failed, their options are to redesign the contour system so that the contour rows are shorter and/or the contour ridge height is greater, or use the watershed application of WEPP to simulate the flow down the contour rows then into the failure channel, gully, or grassed waterway. When the contour option is used, all of the flow and sediment for an overland flow element are assumed to be routed to the side of the slope. When contours hold on an OFE, no sediment will be predicted to exit the bottom of that overland flow element, and an average detachment rate is calculated at the 100 points down the hillside based on the sediment exiting off the side of the OFE. Users are advised not to simulate contoured OFEs below non-contoured ones, since there is a large likelihood of failure of the contours due to inflow of water from above overtopping the contour ridges.

Cont.number:

0.1)number of Contour Scenarios - (ncnt)

Cont.loop.name:

1.1)scenario name, (up to) 8 characters - (cname)

Cont.loop.description:

2.1)description, (up to) 55 characters (may be blank)

3.1)description, (up to) 55 characters (may be blank)

4.1)description, (up to) 55 characters (may be blank)

Cont.loop.landuse:

5.1)for use on land type..., integer - (icont)

1)crop

Note `icont' must be 1, as only cropland supports contouring.

Cont.loop.cropland:*(read when icont=1; cropland)*

6.1)contour slope (m/m), real - (cntslp)
6.2)contour ridge height (m), real - (rdghgt)
6.3)contour row length (m), real - (rowlen)
6.4)contour row spacing (m), real - (rowspc)

Note: permanent flag is only for 2016.3 format
6.5) permanent flag (0 or 1), integer (contours_perm)

******Note*** <u>Cont.loop</u> values repeat `ncnt' times.***

---------- Drainage Section --

Drain.number:
0.1)number of Drainage Scenarios - (ndrain)

Drain.loop.name:
1.1)scenario name, (up to) 8 characters - (dname)

Drain.loop.description:
2.1)description, (up to) 55 characters (may be blank)

3.1)description, (up to) 55 characters (may be blank)

4.1)description, (up to) 55 characters (may be blank)

Drain.loop.landuse:

5.1)for use on land type..., integer - (dcont)
1)crop
2)range
4)roads
******Note****** `dcont' must be 1, 2, or 4, as forestland does not support drainage.

Drain.loop.drainage:*(read when dcont=1; cropland)*

6.1)depth to tile drain (m), real - (ddrain)
6.2)drainage coefficient (m/day), real - (drainc)
6.3)drain tile diameter (m), real - (drdiam)
6.4)drain tile spacing (m), real - (sdrain)

Drain.loop.rangeland:*(read when dcont=2; rangeland)*

******Note****** no values; drainage for Rangeland not yet supported.

Drain.loop.roads:*(read when dcont=4; roads)*

Note no values; drainage for Roads not yet supported.

Note **_Drain.loop_ values repeat `ndrain' times.**

---------- Yearly Section --

Note `nscen' is the number of management scenarios used by the simulation. A management scenario contains all information associated with a particular Year/OFE/Crop - its Surface Effect, Contour, Drainage, Plant Growth scenarios and management data.

Year.number:
	0.1)number of Yearly Scenarios - (nscen)

Year.loop.name:
	1.1)scenario name, (up to) 8 characters - (mname)

Year.loop.description:
	2.1)description, (up to) 55 characters (may be blank)

	3.1)description, (up to) 55 characters (may be blank)

	4.1)description, (up to) 55 characters (may be blank)

Year.loop.landuse:
	5.1)for use on land type..., integer - (iscen)
		1)crop
		2)range
		3)forest
		4)roads

Year.loop.cropland:*(read when iscen=1; cropland)*

	6.1)Plant Growth Scenario index, integer - (itype)

Note `itype' refers to a Plant Growth Scenario. The value for `itype' corresponds to the order that the plants are read into WEPP from the Plant Growth Section. For example, if the plants being grown are corn and soybeans and in the Plant Growth Section the first plant read in is corn and the second soybeans, then corn will have a reference index of 1 and soybeans will have a reference index of 2. So for any year when corn is being grown, `itype' will equal 1 and for any year when soybeans are being grown, `itype' will equal 2.

	7.1)Surface Effect Scenario index, integer - (tilseq)

Note `tilseq' refers to a Surface Effects Scenario order number index. If nseq = 0, then `tilseq' must be 0.

8.1)Contour Scenario index, integer - (conset)

Note `conset' refers to a Contour Scenario order number index. If `ncnt' = 0 on line 0.1 of the Contour Section, then `conset' must be 0.

9.1)Drainage Scenario index, integer - (drset)

Note `drset' refers to a Drainage Scenario order number index. If `ndrain' = 0 on line 0.1 of the Drainage Section, then `drset' must be 0.

10.1)cropping system, integer - (imngmt)
1)annual
2)perennial
3)fallow

Year.loop.cropland.annual/fallow:*(read when imngmt=1 or imngmt=3; annual/fallow crops)*

11.1)harvesting date or end of fallow period (julian day), integer - (jdharv)

12.1)planting date or start of fallow period (julian day), integer - (jdplt)

13.1)row width (m), real - (rw)

14.1)residue management option, integer - (resmgt)

Note: Options 1-6 only for version 95.7 and 98.4 format. For 2016.3 format see the operation section for more options.

1)herbicide application
2)burning
3)silage
4)shredding or cutting
5)residue removal
6)none
7)annual cutting – only in version 2016.3

Year.loop.cropland.annual/fallow.herb:*(read when resmgt=1; herbicide application)*

15.1)herbicide application date (julian), integer - (jdherb)

Note Herbicide application here refers to use of a contact herbicide which the WEPP model will simulate as immediately converting all standing live biomass to dead residue.

Note – only for management file version 98.4, for the 2016.3 file format use the operation records to specify an annual/fallow herbicide applications.

Year.loop.cropland.annual/fallow.burn:*(read when resmgt=2; burning)*

15.1)residue burning date (julian day), integer - (jdburn)

16.1)fraction of standing residue lost by burning (0-1), real - (fbrnag)

17.1)fraction of flat residue lost by burning (0-1), real - (fbrnog)

Note - *only for management file version 98.4, for the 2016.3 file format use the operation records to specify annual/fallow burning operations.*

Year.loop.cropland.annual/fallow.silage:(*read when resmgt=3; silage)*

15.1)silage harvest date (julian day), integer - (jdslge)

Note - *only for management file version 98.4, for the 2016.3 file format use the operation records to specify an annual/fallow silage operation.*

Year.loop.cropland.annual/fallow.cut:*(read when resmgt=4; cutting)*

15.1)standing residue shredding or cutting date (julian day), integer - (jdcut)
16.1)fraction of standing residue shredded or cut (0-1), real - (frcut)

Note - *only for management file version 98.4, for the 2016.3 file format use the operation records to specify an annual/fallow residue shredding or cutting operation.*

Year.loop.cropland.annual/fallow.remove:*(read when resmgt=5; residue removal)*

15.1)residue removal date (julian day), integer - (jdmove)
16.1)fraction of flat residue removed (0-1), real - (frmove)

Note - *only for management file version 98.4, for the 2016.3 file format use the operation records to specify an annual/fallow residue removal operation.*

Year.loop.cropland.annual.cut:*(read when resmgt=7; annual plant cutting)*

Note: Option 7 for annual cutting is only available for 2016.3 file format.

15.1) annual cutting removal flag

1) Annual cutting based on fractional height with removal from field
4) Annual cutting based on fractional height, biomass left on field
5) Annual cutting based on crop cutting height, with removal from field
6) Annual cutting based on crop cutting height, biomass left on field

16.1) Number of annual cuttings

17.1) Julian day of cutting

17.2) Cutting height amount fraction

*****Note*** (Line 17 repeats for number of cuttings indicated on Line 16.1)**

Year.loop.cropland.perennial:*(read when imngmt=2; perennial crops)*

11.1)approximate date to reach senescence (julian day), integer - (jdharv)

******Note****** Enter 0 if the plants do not senesce. This parameter is only important in situations in which the perennial plant is neither cut nor grazed.

12.1)planting date (julian day) integer (jdplt)

******Note****** Set jdplt =0 if there is no planting date (this means the perennial is already established).

13.1)perennial crop growth stop date, if any (julian), integer - (jdstop)

******Note****** The perennial growth stop date is the date on which the perennial crop is permanently killed, either by tillage or herbicides (not frost). For example, if a bromegrass field is to be prepared for a subsequent corn crop, the date which the bromegrass is plowed under or killed with herbicides must be entered. A zero (0) is entered if the perennial crop is not killed during the year.

14.1)row width (m), real - (rw)

******Note****** (set rw = 0.0 if unknown or seed broadcast - WEPP model then sets rw = pltsp)

15.1)crop management option, integer - (mgtopt)
1)cutting
2)grazing
3)not harvested or grazed

Note: Options 4-7 are only available in 2016.3 format file

4)cutting based on plant cutting height, biomass left on field

5)grazing with cycles based on fraction of height removed

6)grazing with fixed days based on fraction of height removed

7)cutting with fixed days based on fraction of height removed, biomass left on field

Year.loop.cropland.perennial.cut:*(read when mgtopt=1; cutting)*

16.1)number of cuttings, integer - (ncut)

Year.loop.cropland.perennial.cut.loop:

17.1)cutting date (julian), integer - (cutday)

****Note**** Man.loop.cropland.perennial.cut.loop values repeat `ncut' times.

Year.loop.cropland.perennial.graze:*(read when mgtopt=2; grazing)*

16.1)number of grazing cycles, integer - (ncycle)

Year.loop.cropland.perennial.graze.loop:
17.1)number of animal units, real - (animal)
17.2)field size (m^2), real - (area)
17.3)unit animal body weight (kg), real - (bodywt)
17.4)digestibility, real - (digest)

18.1)date grazing begins (julian day), integer - (gday)

19.1)date grazing ends (julian day), integer - (gend)

****Note**** Year.loop.cropland.perennial.graze.loop values repeat `ncycle' times.

Note: Options 5,6,7 only available for format 2016.3 management file

If mgtopt = 5 (grazing cycles based on height percent removal)

17.1)fraction of plant height removed

18.1)date grazing begins (julian day), integer - (gday)

19.1)date grazing ends (julian day), integer - (gend)

If mgtopt = 6 (grazing fixed days based on plant height percent removal)

17.1)day of grazing (Julian)
17.2)fraction of plant height removed (real)

If mgtopt = 7 (cutting fixed days based on percent height removal, biomass left on field)

17.1)day of cutting (Julian)
17.2)fraction of plant height removed which is then left on field (real)

Year.loop.rangeland:*(read when iscen=2; rangeland)*

6.1)Plant Growth Scenario index, integer - (itype)

****Note**** `itype' refers to a Plant Growth Scenario order index.

7.1)Surface Effects Scenario index, integer - (tilseq)

****Note**** `tilseq' refers to the Surface Effects Scenario order index.

8.1)Drainage Scenario index, integer - (drset)

****Note**** `drset' refers to a Drainage Scenario order index. If `ndrain' = 0 , `drset' must be 0.

9.1)grazing flag, integer - (grazig)
0)no grazing
1)grazing

Year.loop.rangeland.graze:*(section read when grazig=1)*

10.1)pasture area (m^2), real - (area)
10.2)fraction of forage available for consumption (0-1), real - (access)
10.3)maximum digestibility of forage (0-1), real - (digmax)
10.4)minimum digestibility of forage (0-1), real - (digmin)
10.5)average amount of supplemental feed per day (kg/day), real - (suppmt)

11.1)number of grazing cycles per year, integer - (jgraz)

Year.loop.rangeland.graze.loop:*(section read when grazig=1)*

12.1)number of animals grazing (animal units per year), real - (animal)
12.2)average body weight of an animal (kg), real - (bodywt)

13.1)start of grazing period (julian date), integer - (gday)

14.1)end of grazing period (julian date), integer - (gend)

15.1)end of supplemental feeding day (julian day), integer - (send)

16.1)start of supplemental feeding day (julian day), integer - (ssday)

****Note**** *Year.loop.rangeland.graze.loop values repeat `jgraz' times.*

10.1)herbicide application date, integer - (ihdate)

Year.loop.rangeland.herb:*(section read when ihdate > 0)*

11.1)flag for activated herbicides, integer - (active)

12.1)fraction reduction in live biomass, real - (dleaf)
12.2)fraction of change in evergreen biomass, real - (herb)
12.3)fraction of change in above and below ground biomass, real - (regrow)
12.4)fraction increase of foliage, real - (update)

13.1)flag for decomp. of standing dead biomass due to herbicide application, integer - (woody)
11.1)rangeland burning date, integer - (jfdate)

Year.loop.rangeland.burn:*(section read when jfdate > 0)*

12.1)live biomass fraction accessible for consumption following burning, real - (alter)
12.2)fraction reduction in standing wood mass due to the burning, real - (burned)
12.3)fraction change in potential above ground biomass, real - (change)
12.4)fraction evergreen biomass remaining after burning, real - (hurt)
12.5)fraction non-evergreen biomass remaining after burning, real - (reduce)

Year.loop.forest: *(read when iscen=3; forest)*

******Note****** no values; yearly information for Forestland not yet supported.

Year.loop.roads: *(read when iscen=4; roads)*

******Note****** no values; yearly information for Roads not yet supported.

******Note*** Year.loop values repeat `nscen' times***.

---------- Management Section --

******Note****** The management scenario contains all information associated with a single WEPP simulation. The yearly scenarios are used to build this final scenario. The yearly scenarios were built from the earlier scenarios - plants, tillage sequences, contouring, drainage, and management practices.

Man.name:
1.1)scenario name, (up to) 8 characters - (mname)

Man.description:
2.1)description, (up to) 55 characters (may be blank)
3.1)description, (up to) 55 characters (may be blank)
4.1)description, (up to) 55 characters (may be blank)

Man.ofes:

5.1)number of ofes in the rotation, integer - (nofe)

Man.OFE.loop.ofe:

6.1)Initial Condition Scenario index used for this OFE, integer - (ofeindx)

Note `ofeindx' is an index of one of the defined Initial Condition Scenarios. Man.OFE.loop values repeat `nofe' times.

Man.repeat:

7.1)number of times the rotation is repeated, integer - (nrots)

Man.MAN.loop.years:

8.1)number of years in a single rotation, integer - (nyears)

Man.MAN.loop.loop.crops:

9.1)number of crops per year, integer (nycrop)

Note nycrop is the number of crops grown during the current year for a field or overland flow element. For the case of continuous corn, nycrop=1. If two crops are grown in a year, then nycrop=2. The number of crops for a year, for the purpose of WEPP model inputs, is determined in the following manner: For a single crop planted in the spring and harvested in the fall, the value of nycrop is 1. However, any time during a year that another crop is present on a field, it must be counted as another crop. For example, for a continuous winter wheat rotation, the wheat growing from January 1 to a harvest date in July is crop number 1, while the wheat planted in October and growing to December 31 is crop number 2. Another example would be a perennial alfalfa growing from January 1 to March 30, plowing the alfalfa under on March 30, a corn crop planted on April 25 and harvested on October 11, then planting a winter wheat crop on October 17. Here the alfalfa would be crop number 1, the corn would be crop number 2, and the wheat would be crop number 3. For areas in which the field lies fallow for periods of time in conjunction with planting of winter annuals, care must be taken to include a fallow crop at the beginning of the calendar year as crop number 1, followed by the winter annual planted that fall as crop number 2.

Man.MAN.loop.loop.loop.man:

10.1)Yearly Scenario index used this Year on this OFE with this Crop, integer - (manindx)

Note `manindx' is an index of one of the defined ordered Management Scenarios.

Notes Man.MAN.loop.loop.loop (line 10.1) values repeat for the total number of crops grown during the current year on the current OFE (`nycrop').

Man.MAN.loop.loop.loop values repeat `nofe' times.
Man.MAN.loop.loop values repeat `nyears' times.
Man.MAN.loop values repeat `nrots' times.

Plant Specific Parameters for Cropland

The WEPP crop growth model is a modification of the EPIC crop growth model (Williams et al., 1989) which accounts for water and temperature stresses on biomass production and harvested yield. The WEPP crop component was designed so that parameters may be adjusted for each different crop and for variations within crop varieties. Included in Table 17 and in the WEPP management file builder are estimates of crop parameters for many of the major crops grown in the United States that should provide realistic results. Since the crop growth component was not intended to serve as a crop yield prediction model, the user is advised to use caution when adjusting parameter values in order to overcome errors. In the cases where actual yield/biomass values are vastly different from those predicted by WEPP or crop parameters are not available for a particular crop of interest, the plant parameters may be adjusted ***WITH CARE***. Other sources of errors should be considered before modifying a cropping and management input due to simulation output discrepancies. Crop inputs are best modified for research or sensitivity analysis purposes.

The crop residue decomposition component of WEPP is based on the RESMAN Residue Management model (Stott and Rogers, 1990; Stott and Barrett, 1993; Stott, 1991). This component estimates the amount of residue present daily as standing, flat, or buried, as well as dead roots. It also determines the amount of surface cover provided by the residue.

When the crop of interest is not listed as a choice in the WEPP management file, it is best to start with the crop parameters of a similar crop that currently exist in the crop file. If that option is not feasible, such as the case with many vegetable crops, the Crop Parameter Intelligent Database System (CPIDS) may be consulted for parameterization assistance. Crop parameters may also be refined to better reflect local growing and seasonal conditions. These refinements should better simulate the growing conditions in the field (canopy cover, height, biomass) and not just adjustments in crop yields. The following section provides details on the individual plant parameters, as well as some suggestions on adjustments to these.

BB – BB describes the relationship between canopy cover and vegetative biomass as shown in Figure 3. This parameter is crop-dependent. Increasing the value of BB in small increments causes two effects in the canopy cover and biomass relationship. In observing a single, constant canopy cover value, the calculated vegetative biomass decreases while the BB increases. When observing a constant vegetative biomass value with an increasing BB, the canopy cover will increase. In other words, as BB increases, the rate of canopy cover development as a function of biomass increases. For example, with a high value of BB (14 for alfalfa, bromegrass, and soybeans), canopy cover approaches 1.0 (100%) very rapidly. On the other extreme, canopy cover for corn increases slowly as biomass increases as shown in Figure 3. When adjusting the BB from a similar crop, if the plant has more canopy cover given less total biomass on the field, increase BB slightly. If the crops have similar canopy covers but the biomass of the crop to be parameterized is less, the BB value may be increased slightly. The crop's biomass and canopy cover, if known, can be plotted as shown in Figure 3 and a linear regression can be performed on the transformed data. Adjustments to this parameter should be made with care and knowledge of the crop under consideration.

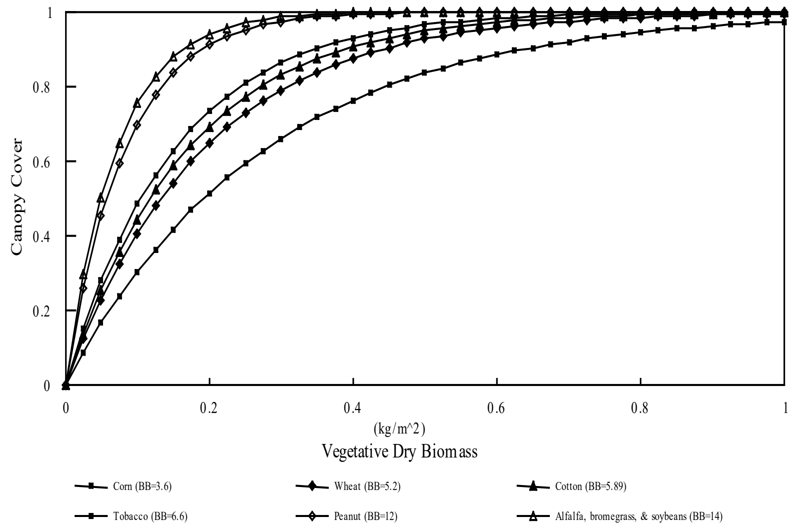


Figure 3. Canopy Cover and Biomass.

BBB - BBB, a canopy height parameter, behaves similarly to BB. BBB defines the relationship between vegetative biomass and canopy height as shown in Figure 4. Note that the Y-axis has been normalized by plotting the ratio of canopy height to the maximum canopy height. Higher BB values indicate greater height for a given biomass. BBB affects the rate that maximum canopy height is reached, not the maximum canopy height (see HMAX). To estimate BBB for a crop not available on the WEPP crop parameter list, values of biomass and canopy cover can be plotted as shown in Figure 4, and a linear regression can be performed on log-transformed data.

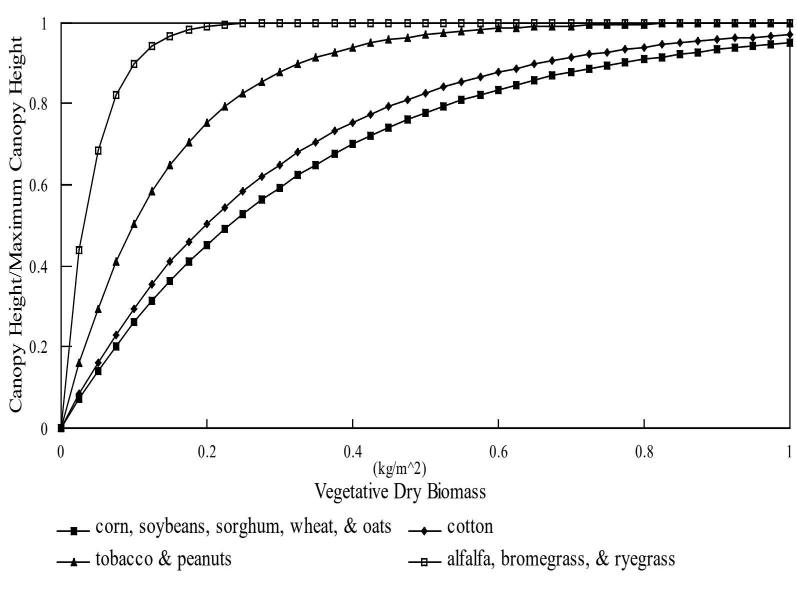


Figure 4. Canopy Height and Biomass Relationship.

BEINP (kg/MJ) - BEINP is the biomass energy ratio of a crop. This crop parameter reflects the potential growth rate of a given crop per unit of intercepted photosynthetically active radiation. BEINP can greatly change the rate of growth, incidence of stress during the growing season, and yield in the model. This parameter should be adjusted only if absolutely indicated and then only based on research results. Data for BEINP should reflect unstressed cropping conditions, i.e., no nutrient, temperature, or water stresses.

Adjusting the BEINP Plant Growth Parameter

In terms of erosion, perhaps the most important factor related to plant growth is the amount of biomass produced by the crop. The BEINP parameter is the biomass energy conversion factor. Increasing the value of BEINP will increase the amount of biomass that the crop produces, which will increase both the residue left at harvest and crop yield. The relative amount of yield to total biomass produced may be adjusted using the harvest index. If the user knows that a particular variety of corn, for example, produces 8000 lbs/acre of residue and 120 bushels per acre of grain on the average, he/she may adjust the BEINP and HI parameter values until the model calculates those amounts over a long-term (e.g., 10 years) simulation. If a variety of corn was bred to have a thicker stalk, so as to produce 12,000 lbs/acre of residue and 120 bushels per acre on the average, the BEINP parameter could be increased and the HI value decreased to reflect that difference. The grain yield does not directly influence erosion calculations, but residue left at harvest will have a significant effect on erosion. The WEPP interface management file builder contains crop parameter data to represent low, medium, and high productivity corn and soybeans, as well as a lodging-resistant corn variety.

BTEMP (°C) - BTEMP reflects the minimum or base daily air temperature required for plant growth. When the average daily air temperature exceeds the base temperature of the plant, growth is initiated for the simulation. Base temperatures are stable for cultivars within a species. It is not recommended that this parameter be changed. To compensate for crop varieties with longer or shorter growing seasons and different geographic locations, the sum of growing degrees to maturity (GDDMAX) may be modified.

CF (m^2/kg) - parameter used to convert residue mass to percent surface cover [NSERL #10, equation 9.3.2]. Crop-specific CF represents the amount of soil surface covered completely by a kilogram of residue. This parameter is extremely important because the WEPP erosion routines are quite sensitive to percent surface cover.

CRIT (°C days) - CRIT represents the accumulation of growing degree days from planting to emergence. When the accumulation of growing degree days after planting has reached this value, the plants emerge and above ground biomass appears. A higher daily average temperature will cause the plant to emerge faster due to a quicker accumulation of growing degree days. The WEPP model will consider the plants emerged when CRIT is reached or at 14 days after planting, whichever comes first.

CRITVM (kg/m^2) - Critical live biomass value of a perennial crop below which grazing is not allowed. If the live biomass value falls below CRITVM, no grazing is allowed on that day. If the live biomass is greater than CRITVM, grazing is allowed and the total biomass removed is calculated by equation 8.3.3, NSERL #10. This is used to 'update' the remaining amount of biomass.

CUTHGT (m) - Height of post-harvest standing residue; cutting height; or cutting height for harvest of perennial crops. This should reflect the amount of standing residue available for conversion to flat residue cover for annual crops. For perennial crops at a cutting harvest, the cutting height determines the amount of plant material harvested.

DECFCT - Fraction of the canopy cover remaining after senescence. If the crop does not reach senescence before harvesting, DECFCT is 1. DECFCT is used to compute the daily decline in canopy cover after senescence begins.

DIAM (m) - Diameter of the stem (stalk, trunk, etc.) at plant maturity. In the case of crops that do not reach maturity before harvest, the maximum stem diameter is used. This value should reflect the portion of the stem at the base of the plant near the soil surface. DIAM is used to initialize residue amounts.

DLAI - DLAI reflects the fraction of the growing season that must be reached before the leaf area index begins declining. The cumulative growing degrees or heat units from planting to leaf area index decline is divided by the total growing degrees accumulated between planting and crop maturity. For vegetables and other annual crops that may be harvested before the leaf area index begins to decline, DLAI is set to 1.0.

DROPFC - DROPFC represents the fraction of live biomass remaining after senescence. It is used to update the decline in crop biomass during senescence.

EXTNCT - EXTNCT is the radiation extinction coefficient. It is used to calculate intercepted photosynthetically active radiation from daily solar radiation and leaf area index.
FACT - Adjustment factor to account for the effect of wind and snow on standing to flat residue conversion. FACT is the fraction of the previous day's residue that remains standing for the current day. This factor is set to a default value of 0.99 in the WEPP Version 95.7 interface file builder for all crops, but the parameter has no effect when all biomass is removed from a field.

FLIVMX - Maximum friction factor (Darcy-Weisbach) for living plant. Used to account for hydraulic roughness for crops such as cotton, small grains, alfalfa, and grasses. Most generally crops are assigned values based on whether they are planted (or drilled) perpendicular or parallel to water flow. For the case of wide-row crops such as corn or crops planted parallel to the flow of water, FLIVMX should be set to 0.0. Crops that are drilled or grown in narrow rows perpendicular to the flow of water, e.g., wheat, should be assigned a FLIVMX of 2.0-3.0. For perennial grasses and pasture situations, FLIVMX should be set to 12.0. When a furrow or rill has more than 50% of the flow impeded due to living plant stems and leaves, set FLIVMX to at least 3.0.

GDDMAX (°C days) -Potential accumulation of growing degree days or heat units from planting to maturity. The growing degrees begin accumulation with the planting date and once GDDMAX is reached, the plant growth is stopped and no updates are made until the start of leaf drop or harvest occurs. If the user does not know the growing degree days to crop maturity, entering a value of 0.0 will cause the model to calculate GDDMAX based on the crop planting date and harvest date. For perennial crops GDDMAX should be set to 0.0. Growth of a perennial crop stops when the average daily air temperature is less than the plant base temperature (BTEMP), and the plant becomes dormant once the five-day average daily temperature drops below the critical minimum temperature (TMPMIN)., Figure 5, Figure 6, and Figure 7show growing degree days and growing season days for corn, sorghum, and soybeans (Kiniry et al., 1991).

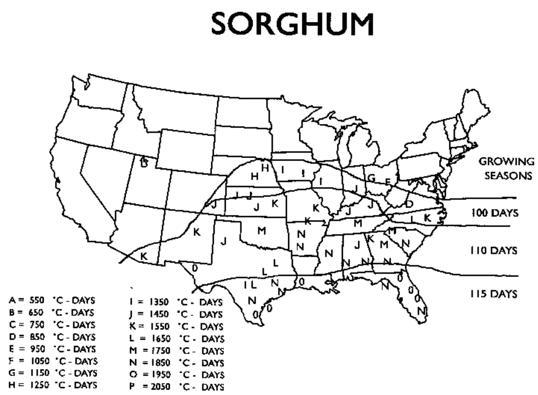


Figure 5. Potential heat units for sorghum--planted two weeks later than corn (Kiniry et al., 1991).

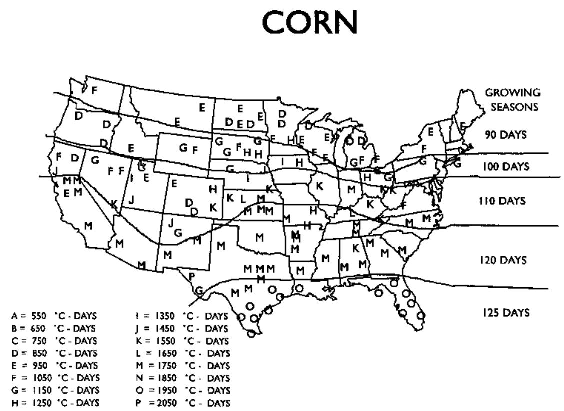


Figure 6. Potential heat units for corn (Kiniry et al., 1991).

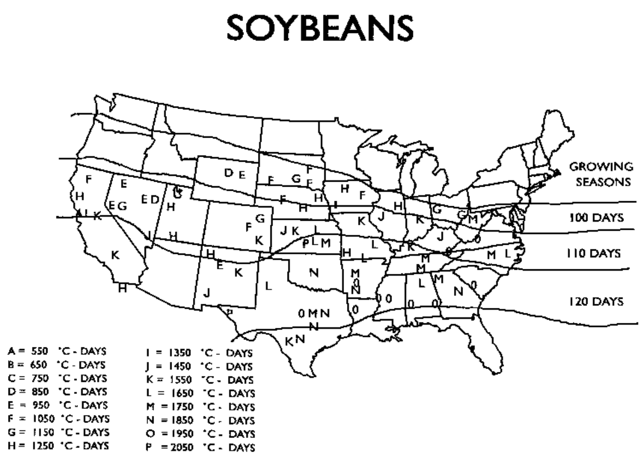


Figure 7. Potential heat units for soybeans--planted four weeks later than corn (Kiniry et al., 1991).

HI - HI is the normal harvest index of the unstressed crop (dry crop yield/dry above ground biomass). This crop parameter should be based on experimental data where crop stresses have been minimized to allow the crop to attain its potential. The WEPP crop growth component uses the harvest index and adjustments for water stresses to estimate crop yield. The harvest index concept was originally developed for grain crops and has been extended to tuber crops and crops where vegetative biomass is harvested. WEPP does not use the HI for perennial crops with multiple cuttings. Instead, harvested biomass is estimated as a function of the cutting height and the canopy height.

HMAX (m) - The maximum canopy height (HMAX) of the crop is used in an empirically-based equation with BBB and the above ground biomass to calculate a current canopy height. HMAX may be adjusted after observation of the crop.

ORATEA - ORATEA represents the maximum rate of residue decay that occurs under conditions considered optimum for the soil microbial population. Within the WEPP model, ORATEA is adjusted by an environmental factor (EF) to account for the daily changes in the temperature and soil water content. Since the EF differs for standing, flat, and buried residues, these three pools are kept separate for estimating residue mass. Increasing ORATEA will increase the rate of residue mass lost from a field. The ORATEA value should not be adjusted, however, unless specific field data verifying the need for change exist.

ORATER - ORATER is similar to ORATEA, but is specific to the dead root biomass.

OTEMP (°C) - OTEMP is the optimal temperature for plant growth and is stable for cultivars within a species. It is not recommended that this temperature be changed once it is determined for a cultivar. Differences in varieties and maturity lengths will be accounted for in the growing degree days to emergence (CRIT) and maturity (GDDMAX). Temperature stress is a function of OTEMP. Temperature stress occurs when the air temperature is significantly higher or lower than OTEMP.

PLTOL - Plant specific tolerance to moisture stress. PLTOL is the fraction of total soil porosity that soil moisture must decrease to before water stress occurs, and water uptake is reduced. For example, for PLTOL = 0.25, water uptake by the plant is not reduced until soil water falls below 0.25 times soil porosity. If the user inputs a value of 0.0 for PLTOL, the WEPP model will set PLTOL to 0.25. WEPP internally limits the value of PLTOL to the range of 0.1 to 0.4.

PLTSP (m) - Normal in-row plant spacing. PLTSP is used to calculate the plant population and basal area. PLTSP may be observed and changed to reflect common planting practices. Values for in-row plant spacing may be found in seed catalogs or reference materials such as Lorenz and Maynard (1988).

RCC – The release canopy cover coefficient is available in 2016.3 version management files. The range is 0 to 1 and represents the fraction on the growth curve that the plant should begin growth at. This is used for crops that may have been planted before the previous crop has been harvested. The first day of WEPP simulated crop growth starts at the rcc fraction instead of at 0.

RDMAX (m) - Maximum rooting depth for a crop. RDMAX may be drawn from research or observed in the field. The depletion-level of soil moisture is updated for the current rooting depth which is calculated from RDMAX and the ratio of current growing degree days to GDDMAX.

RSR - Root to shoot ratio is the ratio of root biomass to above ground biomass (both dry weights). This ratio is used to update total plant root biomass for all crops using the increase in the current day's biomass value.

RTMMAX (kg/m^2) - RTMMAX is the maximum root biomass for a perennial crop. Live root biomass will be accumulated until the maximum value is reached. Once this point is reached, the growth and death of the root are assumed equal. RTMMAX should be set to 1.0 for annual crops.

SPRIOD (days) - Number of days over which senescence occurs, i.e., the senescence period for a particular crop. During this time, the canopy cover and biomass are linearly decreased using DECFCT and DROPFC, respectively.

TMPMAX (°C) - Maximum temperature that inhibits growth of a perennial crop. Since this parameter is not used for annual crops, 0 may be entered. The growth of a perennial plant will be stopped until the average daily temperature drops below this upper limit.

TMPMIN (°C) - Minimum critical temperature that causes dormancy in a perennial crop. Plant growth stops when the average daily temperature is at or below TMPMIN. This parameter is not used for annual crops, and a 0 may be entered.

XMXLAI - XMXLAI is the maximum leaf area index potential for a specific, unstressed crop. Once a canopy cover exists, the current leaf area index is adjusted using XMXLAI and vegetative biomass. This value is obtained through research data. The maximum leaf area index for many crops such as corn, soybeans, grain sorghum, cotton, and alfalfa is 5.0. Some crops have higher XMXLAI such as 8 or 9 for wheat, oats, and barley. A typical leaf area index development curve as a function of biomass is shown in Figure 8. XMXLAI affects the rate of biomass development. Also, LAI affects evaporation and transpiration until LAI exceeds 3.0 and the plant transpiration rate equals the potential evaporation rate.

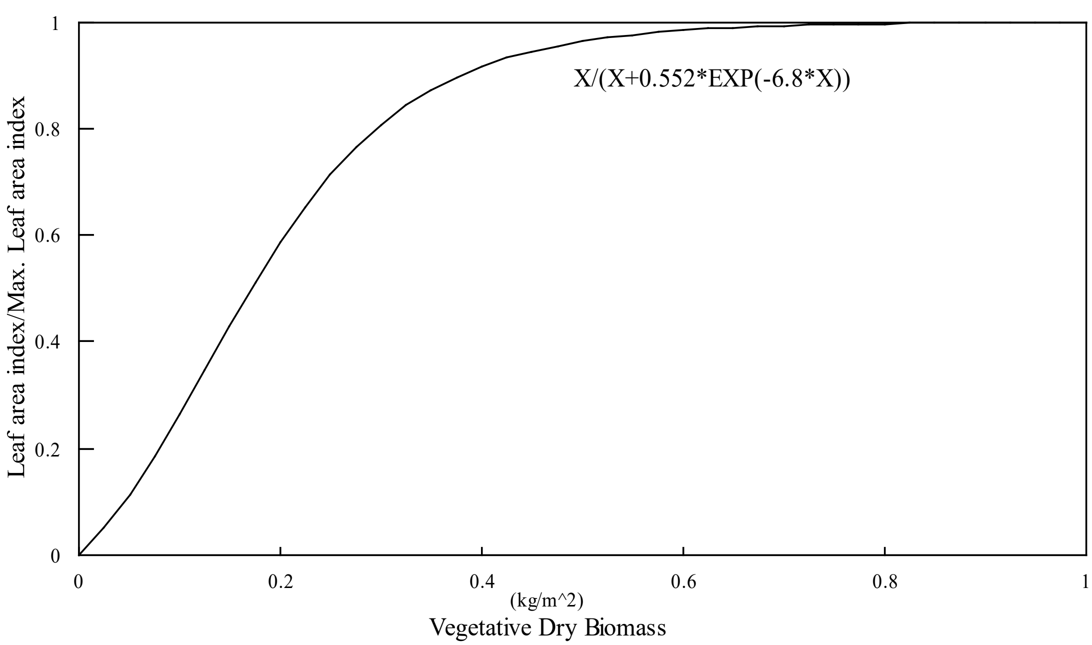


Figure 8. WEPP leaf area and vegetative biomass relationship.

YLD (kg/m²) - YLD is the optimum yield for the specific crop under unstressed conditions. The crop growth model in WEPP does not account for biomass and yield variation due to nutrient, pest, and other management factors. WEPP estimates an unstressed crop yield and compares it to YLD. This ratio is then used to adjust biomass accumulation to simulate unstressed yields equal to YLD. During the simulation, the model applies water and temperature stresses to the potential daily increase in biomass. YLD will reflect the sum of multiple harvests or cuttings when applicable (e.g., multiple harvests for vegetable crops). If a 0.0 is entered for YLD, WEPP will calculate and use its internal optimal yield value. For the current version of WEPP (v2024) it is recommended that the user enter a value of 0.0 here, and control biomass production and yields by altering the BEINP and HI parameters.

Table 17. Suggested values for the cropland plant specific input parameters for the WEPP erosion model (versions 95.7/2012.8/2024).

Symbol	Variable	Winter Wheat	Spring Wheat	Corn	Soybeans	Sorghum	Canola
β_c	BB	5.20	5.20	3.60	14.00	3.60	5.20
β_h	BBB	3.00	3.00	3.00	3.00	3.00	3.00
be_{inp}*	BEINP	25/30/35	25/30/35	18/28/35	20/23/25	12/17/25	30/45/60
T_b	BTEMP (C)	4.00	4.00	10.00	10.00	10.00	2
cf	CF	5.40	5.40	2.30	7.20	3.00	5.0
-	CRIT (C-days)	60.00	60.00	60.00	60.00	60.00	45.00
-	CRITVM (kg m ^{2})	-	-	-	-	-	-
-	CUTHGT (m)	0.152	0.152	0.304	0.152	0.609	0.152
C_{cg}	DECFCT	1.00	1.00	0.65	0.10	0.90	0.10
D	DIAM (m)	0.0064	0.0064	0.0508	0.0095	0.0317	0.0060
D_g	DIGEST	-	-	-	-	-	-
F_{lai}	DLAI	0.80	0.80	0.80	0.90	0.85	0.49
-	DROPFC	1.00	1.00	0.98	0.10	0.98	0.10
-	EXTNCT	0.65	0.65	0.65	0.45	0.60	0.65
F_{ct}	FACT	0.99	0.99	0.99	0.99	0.99	0.99
-	FLIVMX	3.00	3.00	0.00	0.00	0.00	3.00
G_{dm}**	GDDMAX (C-days)	1700	1700	1700	1150	1450	1500
HI	HI	0.42	0.42	0.50	0.31	0.50	0.30
H_{cm}	HMAX (m)	0.91	0.91	2.60	1.01	1.01	0.90
-***	ORATEA	0.0085	0.0085	0.0065	0.0130	0.0074	0.0130
-***	ORATER	0.0085	0.0085	0.0065	0.0130	0.0074	0.0130
T_o	OTEMP (C)	15.00	15.00	25.00	25.00	27.50	21.00
-	PLTOL	0.25	0.25	0.25	0.25	0.25	0.25
P_s	PLTSP (m)	0.005	0.005	0.219	0.025	0.130	0.100
R_{dx}	RDMAX (m)	0.30	0.30	1.52	1.00	1.50	1.40
R_{sr}	RSR	0.25	0.25	0.25	0.25	0.25	0.25
-	RTMMAX (kg m $^{-2}$)	-	-	-	-	-	-
S_p	SPRIOD(days)	14	14	30	14	40	14
T_{cu}	TMPMAX(C)	-	-	-	-	-	-
T_{cl}	TMPMIN(C)	-	-	-	-	-	-
LAI_{mx}	XMXLAI	5.00	5.00	3.50	5.00	5.00	4.5

* Three values of *BEINP* have been provided for most crops illustrated. These values represent the crops grown under Low/Medium/High fertility levels.

** Growing degree days for crops to reach maturity varies by variety and region. Values here are typical for varieties grown near Indianapolis, IN. Values of 0.0 should be input for perennial crops.

*** Values for ORATEA and ORATER are tentative and based on wheat=0.0085, corn=0.0065, soybeans=0.0130 .

Table 17 (cont.). Suggested values for the cropland plant specific input parameters for the WEPP erosion model (versions 95.7/2012.8/2024).

Symbol	Variable	Cotton	Oats	Alfalfa	Bromegrass	Peanut	Tobacco	Annual Ryegrass
β_c	BB	5.89	5.20	14.00	14.00	12.00	6.60	14.00
β_h	BBB	3.50	3.00	23.00	23.00	6.92	7.00	23.00
be_{inp}*	BEINP	17.50	17/20/23	8/13/15	15/25/35	9/11/13	25.00	20/25/30
T_b	BTEMP (C)	12.00	4.00	4.00	10.00	13.50	10.00	10.00
cf	CF	3.00	5.40	5.00	5.00	2.70	3.00	5.00
-	CRIT (C-days)	90.00	60.00	30.00	30.00	60.00	60.00	30.00
-	CRITVM (kg m^{-2})	-	-	0.10	0.10	-	-	-
-	CUTHGT (m)	0.900	0.152	0.152	0.152	0.000	0.000	0.152
C_{cg}	DECFCT	0.25	1.00	0.70	0.70	1.00	0.75	1.00
D	DIAM (m)	0.0127	0.0079	0.0045	0.0022	0.0090	0.0510	0.0064
D_g	DIGEST	-	-	0.60	0.50	-	-	-
F_{lai}	DLAI	0.85	0.90	0.85	0.85	1.00	0.70	0.85
-	DROPFC	0.10	1.00	0.90	0.90	1.00	0.70	1.00
-	EXTNCT	0.65	0.65	0.65	0.65	0.65	0.90	0.65
F_{ct}	FACT	0.99	0.99	0.99	0.99	0.99	0.99	0.99
-	FLIVMX	3.00	3.00	12.00	12.00	0.00	0.00	3.00
G_{dm}**	GDDMAX (C-days)	2200	1500	0 **	0 **	1500	1500	1000
HI	HI	0.50	0.42	0.90	0.90	0.42	0.90	0.42
H_{cm}	HMAX (m)	1.06	1.14	0.80	0.51	0.66	1.06	0.80
-***	ORATEA	0.0100	0.009	0.015	0.009	0.015	0.0065	0.015
-***	ORATER	0.0065	0.009	0.015	0.009	0.006	0.0074	0.006
T_o	OTEMP (C)	27.50	15.00	20.00	25.00	25.00	25.00	15.00
-	PLTOL	0.25	0.25	0.25	0.25	0.25	0.25	0.25
P_s	PLTSP (m)	0.101	0.005	0.006	0.006	0.076	0.220	0.038
R_{dx}	RDMAX (m)	1.20	0.30	2.43	0.30	1.20	0.76	0.30
R_{sr}	RSR	0.25	0.25	0.33	0.33	0.33	0.33	0.33
-	RTMMAX (kg m^{-2})	-	-	0.60	0.34	-	-	-
S_p	SPRIOD(days)	30	14	14	14	14	14	14
T_{cu}	TMPMAX(C)	-	-	32.0	32.0	-	-	-
T_{cl}	TMPMIN(C)	-	-	0.5	1.1	-	-	-
LAI_{mx}	XMXLAI	6.00	8.00	6.00	9.00	4.50	3.40	6.00

* Three values of *BEINP* have been provided for most crops illustrated. These values represent the crops grown under Low/Medium/High fertility levels.

** Growing degree days for crops to reach maturity varies by variety and region. Values here are typical for varieties grown near Indianapolis, IN. Values of 0.0 should be input for perennial crops.

*** Values for ORATEA and ORATER are tentative and based on wheat=0.0085, corn=0.0065, soybeans=0.0130 .

Irrigation Input Files

Both stationary sprinkler and furrow irrigation can be simulated in a hillslope profile application of the WEPP erosion model. Zero, one, or two irrigation data files may be required to run the WEPP model depending on the irrigation scheduling option chosen. Formats for the data files, dependent on the irrigation method (stationary sprinkler or furrow) and scheduling alternative (soil moisture depletion-level, fixed-date), are discussed in the following sections.

Depletion-level Irrigation Scheduling

Table 18 describes the irrigation input parameters when using depletion-level scheduling for both sprinkler and furrow irrigation. Sample irrigation data files may be found in the Appendix. Lines 1 and 2 contain variables used to determine whether the data file has the correct format. Line 3 contains variables that will not be changed during the simulation. Line 4 defines variables which the model uses to determine the operating parameters each time an irrigation occurs. Note that the formats for lines 3 and 4 differ for stationary sprinkler and furrow systems.

Table 18. Depletion-level scheduling irrigation input data file description.

Line 1: version control number (95.7) - real (datver)

Line 2:
a) number of Overland Flow Elements - integer (itemp)
b) flag indicating type of irrigation system - integer (jtemp)
  1 - stationary sprinkler
  2 - furrow
c) flag indicating irrigation file scheduling type - integer (ktemp)
  1 - depletion

Line 3:
a) minimum irrigation depth (m) - real (irdmin)
b) maximum irrigation depth (m) - real (irdmax)

******Note****** Line 3b is not included in furrow irrigation data files

Stationary Sprinkler Irrigation Systems (jtemp = 1 on Line 2b)

Line 4:
a) flag identifying OFE for with the line applies - integer (ofeflg)
b) application rate of irrigation system (m/s) - real (irrate)
c) ratio of application depth to amount of water needed to fill the soil profile to field capacity - real (aprati)
d) maximum value for the ratio of available soil water depletion to available water holding capacity (depletion ratio at which irrigation will occur) - real (deplev)
e) sprinkler nozzle impact energy factor - real (nozzle)
f) Julian date of the beginning of the period during which irrigation might occur (julian day) - integer (irbeg)
g) year of the beginning of the period during which irrigation might occur (year) - integer (yrbeg)
h) Julian date of the end of the period during which irrigation might occur (julian day) - integer (irend)

i) year of the end of the period during which irrigation might occur (year) - integer (yrend)

Furrow Irrigation Systems (jtemp = 2 on Line 2b)

Line 4:
a) flag identifying OFE for which the line applies - integer (ofeflg)
b) flag identifying the last OFE over which irrigation water should advance when an irrigation occurs - integer (endpln)
c) furrow supply rate (m^3/s) - real (florat)
d) estimate of time duration that water will be supplied to a furrow (s) - real (timest)
e) number of supply rate - duration combinations - integer (depsrg)
1 - continuous,
2 - cutback
4 through 6 - surge
f) ratio of desired application depth at lower end of the furrow to amount of water needed to fill soil profile to field capacity (m/m) - real (filrat)
g) max. value for ratio of available soil water depletion to available water holding capacity (ratio at which irrigation will occur) - real (deplev)
h) Julian date of beginning of the period during which irrigation might occur (julian day) - integer (irbeg)
i) year of beginning of the period during which irrigation might occur (year) - integer (yrbeg)
j) Julian date of the end of the period during which irrigation might occur (julian day) - integer (irend)
k) year of end of the period during which irrigation might occur (year) - integer (yrend)

****Note**** Line 4 is repeated as many times as necessary to define all irrigation periods for all overland flow elements.

The repeated occurrences of line 4 must be carefully organized to simulate the desired irrigation periods. The first "n" occurrences of line 4 must be in order of increasing OFE number, where "n" is the number of overland flow elements. The remaining lines must be in order based on the ending dates of the previous irrigation periods for the overland flow elements with the following additional criteria:

If no additional irrigation periods are desired for an overland flow element, all parameter values except the flag identifying the OFE should be zero.

If the ending date of the irrigation periods of two or more overland flow elements are the same, subsequent lines of data must occur in order of increasing OFE number.

To prevent any depletion-level irrigation on a flow element, the only occurrence of line 4 for that OFE should contain all 0.0 values except for the OFE flag.

Fixed-date Irrigation Scheduling

Table 19 contains the input file description for fixed-date scheduling option irrigation files. Sample data files can be found in the appendix. Lines 1 and 2 contain variables used to determine whether the data file has the correct format. Line 3 defines irrigation dates for specific overland flow elements. For a stationary sprinkler irrigation system, line 4 contains an irrigation rate, the amount of water applied, and a nozzle energy adjustment factor (which affects interrill detachment). For furrow systems, line 4 contains a single variable which specifies the number of inflow rate - duration combinations (surges) of the irrigation event. Line 5 provides the inflow rate - duration information and is repeated for the number of "surges" indicated on line 4.

Table 19. Fixed-date scheduling irrigation input data file description.

Line 1	version control number (95.7), real (datver)
Line 2	a) number of overland flow elements - integer (itemp) b) flag indicating irrigation system - integer (jtemp) 1 - stationary sprinkler 2 - furrow c) flag indicating irrigation file scheduling type - integer (ktemp) 2 - fixed-date
Line 3:	a) flag identifying the OFE for which the line applies - integer (ofeflg) b) Julian date of the irrigation event (julian day) - integer (irday) c) year of the irrigation event (year) - integer (iryr)

For Stationary Sprinkler Irrigation Systems (jtemp = 1 on Line 2b)

Line 4	a) application rate of the system for the current OFE (m/s) - real (irint) b) irrigation depth for the current OFE (m) - real (irdept) c) nozzle energy adjustment factor for the current OFE - real (nozzle)

*****Note***** Lines 3 and 4 are repeated as many times as necessary to define all irrigation periods for all overland flow elements

For Furrow Irrigation Systems (jtemp = 2 on Line 2b)

Line 4:	a) number of inflow rate - duration combinations - integer (surges)

*****Note***** (maximum surges allowed is 20)

Line 5:	a) supply rate to furrow during time period (m^3/s) - real (qspply) b) beginning time (from midnight) of a particular supply rate (s) - real(tstart) c) ending time (from midnight) of a particular supply rate (s) - real (tend) d) duration of the depletion phase (s) - (tdepl)

*****Note***** Lines 3, 4, and 5 are repeated as many times as necessary to define all irrigation periods for all overland flow elements.

The occurrences of lines 3-5 must be carefully organized to simulate the irrigation events as desired. The first "n" occurrences of line 3 must be in order of increasing OFE, where "n" is the number of overland flow elements. To prevent any fixed-date irrigation on an overland flow element, the first (and only) occurrence of line 3 for that element should specify 0 for the irrigation day.

For stationary sprinkler systems, the remaining information in the data file (past the first "n" occurrences of line 3) has pairs of lines, with a line of type 4 followed by a line of type 3. These pairs are in order based on the irrigation dates for the overland flow elements. Thus, the first line of the pair contains the application rate and depth for the current irrigation event while the second line of the pair contains the next irrigation date for the current OFE. If two or more overland flow elements have the same irrigation date, subsequent pairs of lines of data must occur in order of increasing OFE number. To indicate that no additional irrigations are to occur on an OFE, the second line of the pair of lines should have zeroes for irrigation day and year.

For furrow irrigation systems, the remaining information in the data file (past the first "n" occurrences of line 3) consists of groups of three types of lines, with a line of type 4 followed by the proper number (surges) of line type 5, then a single line of type 3. The groups of lines are in order based on the specified irrigation dates for the overland flow elements. Lines 4 and 5 provide information for the current irrigation event and line 3 contains the next irrigation date for the current OFE. To indicate that no additional irrigations are to occur on an OFE, the line of type 3 should have zeroes for irrigation day and year.

Watershed Input Files

Pass File

The pass file contains all information from each hillslope needed by the watershed components of WEPP. To allow more flexibility, three versions of the watershed model can be used: version 1 is the hillslope version, version 2 and 3 both apply to areas with channel and impoundment elements. Version 2 either calculates runoff and erosion on every hillslope or reads information from a corresponding hillslope pass file. It then merges all results from each hillslope in a master pass file (Table 20) that will be used by the watershed component of WEPP. Hillslope pass files can be created either when version 2 of WEPP is run or when the hillslope components are used by themselves (version 1). Version 3 reads hillslope simulation results from the master pass file. In this case, only the channel and impoundment components of the model are run and the master pass file must have been created previously. In other words, version 3 can only be run if version 2 has been run previously for the same watershed and with identical hillslopes and climate files.

Table 20. Watershed master pass file.

Line 1:	General simulation header
Line 2:	blank line
Line 3:	Version number - real (ver)
Line 4:	Number of hillslopes in the watershed - integer (nhill)
Line 5:	Maximum number of simulation years - integer (maxyrs)
Line 6:	Beginning year of watershed climate file - integer (iwsbyr)
Line 7:	blank line
Lines 8-10:	Specific simulation header
Line 11:	blank line
Line 12:	a) Hillslope number - integer (ihill)
	b) Hillslope input climate file - string (wshcli(ihill))
	c) Particle diameter for each particle class - real (dia(i), i=1,ncpart)
	d) Hillslope area - real (harea(ihill))
	******Note****** *Line 12 is repeated for the number of hillslopes*
Line 13:	blank line
Line 14:	Header
Line 15:	blank line
	******Note****** *Line 16 is repeated for each simulated day*
Line 16:	a) “NO EVENT” or “EVENT” header
	b) year - integer (year)
	c) day - integer (day)
	******Note*******If there is an event, lines 17 through 24 are added, variables are given for every hillslope*
Line 17:	runoff duration (seconds) - integer (dur(ihill))
Line 18:	time of concentration (hours) - real (tcs(ihill))
Line 19:	alpha value (for EPIC peak calculation) - real (oalpha(ihill))

Line 20:	runoff depth (m) - real (runoff(ihill))
Line 21:	runoff volume (m^3) - real (runvol(ihill))
Line 22:	runoff peak (m^3/s) - real (peakro(ihill))
Line 23:	soil detachment (kg) - real (det(ihill))
Line 24:	soil deposition (kg) - real (dep(ihill))
Line 25:	sediment concentration for each particle class (kg/m^3) - real (sedcon(i,ihill), i = 1, npart)
Line 26:	fraction of sediment in each particle class - real (frcflw(i,ihill), i = 1,npart)

Structure file

The watershed structure file describes the watershed configuration. For each channel element or impoundment, it indicates what hillslopes, channels and/or impoundments are draining into it from the top or laterally from the left or right. For this purpose, each element in the watershed is given an ID number. These numbers need to comply with the following rules:

> All hillslope ID numbers are attributed first, i.e., channel or impoundment ID numbers are always greater than those of hillslopes.
>
> Any upstream element of a channel or impoundment has a lesser ID number than the ID number of the channel or impoundment itself.

These rules are illustrated by a typical example of a watershed represented in Figure 9. A channel element is defined as a reach of channel for which the soil conditions, the management practices, the irrigation schedule, and the hydraulic characteristics are identical. The direction from which upstream elements drain into a channel is always relative to the direction of flow in the channel element. For an impoundment, it is relative to the direction of flow in the next downstream channel. The structure file lists every channel element and impoundment in the order of increasing ID number. On the same line are listed ID numbers of hillslopes, channels and impoundments draining into it from the left side, the right side or from the top, as explained in Table 21. Table 22 shows the structure file that corresponds the example watershed in Figure 9

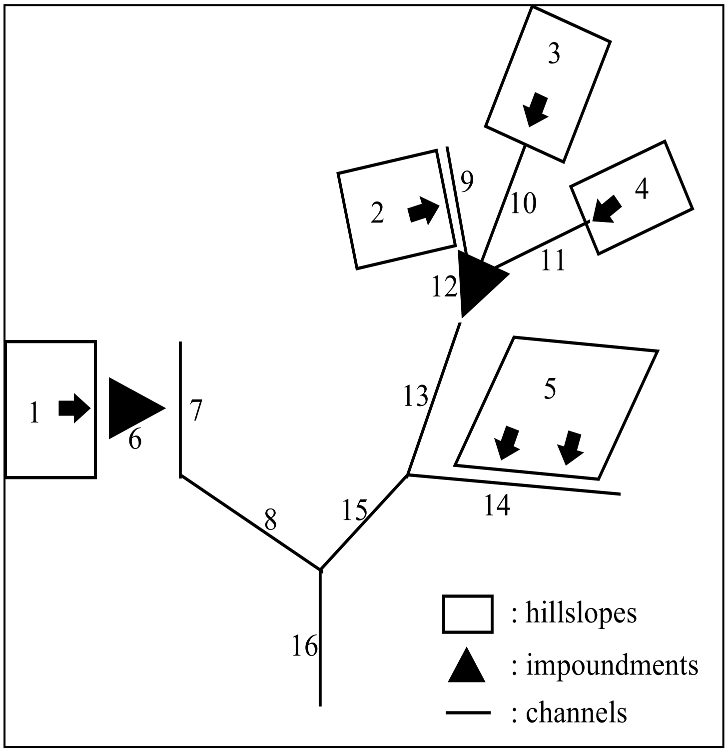


Figure 9. Example of a typical watershed

Table 21. Structure file description.

Line 1: version number - real (ver)

Line 2: a) Element type - integer (elmt)
2 if the element is a channel
3 if the element is an impoundment
b) ID number of the hillslope draining from the left side - integer (nhleft)
c) ID number of the hillslope draining from the right side - integer (nhrght)
d) ID number of the hillslope draining from the top - integer (nhtop)
e) ID number of the channel draining from the left side - integer (ncleft)
f) ID number of the channel draining from the right side - integer (ncrght)
h) ID number of the channel draining from the top side - integer (nctop)
i) ID number of the impoundment draining from the left side - integer (nileft)
j) ID number of the impoundment draining from the right side - integer (nirght)
k) ID number of the impoundment draining from the top side - integer (nitop)
Note*Line 2 is repeated for every channel or impoundment ordered in increasing ID number*

Table 22. Structure file example

95.7										
3	0	1	0	0	0	0	0	0	0	element # 6: impoundment
2	0	0	0	0	0	0	0	6	0	element # 7: channel
2	0	0	0	0	0	7	0	0	0	element #8: channel
2	0	2	0	0	0	0	0	0	0	element #9: channel
2	0	0	3	0	0	0	0	0	0	element #10: channel
2	0	0	4	0	0	0	0	0	0	element #11: channel
3	0	0	0	11	9	10	0	0	0	element #12: impoundment
2	0	0	0	0	0	0	0	0	12	element #13: channel
2	0	5	0	0	0	0	0	0	0	element #14: channel
2	0	0	0	14	13	0	0	0	0	element #15: channel
2	0	0	0	15	8	0	0	0	0	element #16: channel

Some restrictions apply to the watershed configuration for hillslopes, channels, and impoundments. Those are explained here and summarized in Table 23.

a) Hillslope rules

1. Up to 3 hillslopes may feed a channel (left and right laterally and from the top)
2. Only one hillslope may feed an impoundment.

b) Channel rules

1. A channel may be fed by up to 3 hillslopes (left and right laterally and from the top)
2. A channel may be fed by up to 3 impoundments (left and right laterally and from the top)
3. A channel may be fed by up to 3 channels. Although they are said to come from the left, the right and the top, all 3 channels come in at the inlet (i.e., at the channel top).
4. If channel A feeds channel B, then a hillslope cannot feed channel B from the top.

c) Impoundment rules

1. An impoundment may be fed by up to 3 channels (left and right laterally and from the top), except when it feeds a channel laterally in which case it may be fed by only one hillslope.
2. If fed by a hillslope, impoundments may be fed by only one hillslope
3. Impoundments cannot be fed by both hillslopes and channels.

Table 23. Summary of watershed structure rules.

	Fed By	Feed
Hillslopes	Nothing	Channels, impoundments
Channels	Channels, impoundments, hillslopes	Channels, impoundments, nothing (outlet)
Impoundments	Channels, hillslopes	Channels, nothing (outlet)

Channel slope file

The watershed components require information about each channel's length, width, and slope, which is entered by way of the channel input slope file. This file is similar to the hillslope input slope file, with some small differences:

1. Instead of the number of OFE's on the hillslope, the file must contain the number of channels in the watershed.
2. Channel width can be different and is specified for every channel. For a hillslope profile, all OFE's have the same representative width.

At the top of the file is the general information as well as the number of channels for which the file has information. Then each channel element, ordered by increasing ID number, is described by its orientation, its channel width, its length and the slope steepness at points down the channel, as shown in Table 24.

Table 24. Channel slope input file.

Line 1:	version control number - real (ver)
Line 2:	number of channels - integer (nchan)
	Repeat lines 3 to 5 for the number of channels indicated on line 2.
Line 3:	a) aspect of the channel (degrees from North) - integer (azm) b) width of the channel (m) - real (chnwid)
Line 4:	a) number of slope points for the channel - integer (nslpts) b) length of the channel (m) - real (chnlen)
	Repeat 5a) and 5b) for the number of slope points indicated in 4a). A maximum of 20 slope points is allowed for each channel.
Line 5:	a) non dimensional distance from top of channel to point (m/m) - real (xinput) b) slope steepness at point (m/m) - real (slpinp) a) non dimensional distance from top of channel to point (m/m) - real (xinput) b) slope steepness at point (m/m) - real (slpinp) "

<u>Warning</u>: For channels that are laterally fed by hillslopes, the length of the channel must be equal to the width of the hillslope. Having different values may result in erroneous sediment delivery ratios at the outlet of the watershed.

Channel soil file

The channel soil file includes information about each channel's soil characteristics. The file content is identical to the soil file for a hillslope profile in which the number of channels would replace the number of overflow elements. Soils parameters must be input for each and every channel in the order of increasing channel ID number. The user should refer to the description of the hillslope soil input file (Table 3) for a detailed description of the file and an accurate estimation of the soil physical and hydrological parameters.

Channel management file

The channel management soil file includes information about each channel management practices. Each channel may have its own management practices which may also be different from practices in surrounding hillslopes. The channel management file content is identical to the management file for a hillslope profile in which the number of channels would replace the number of overland flow elements(Table 16).

Channel climate file

The channel climate input file is identical to the hillslope climate file. Although climate files of hillslopes in the watershed may be different from one another, only one climate file is allowed for all channels.

Note: The watershed version has not been tested with different climate files on various parts of the watershed. The user is advised to use a single input climate file for all elements of a watershed. Also, the interface uses the climate file specified in the watershed options window for all elements of the watershed.

Watershed channel file

The watershed channel file includes all the information required to perform hydraulic routing in the channels: choice of runoff peak calculation method, channel shape and hydraulic parameters, and control structure parameters. Channel hydraulic parameters must be entered for each and every channel, in the order of increasing channel ID number. Table 25 lists and defines every parameter of the channel file and the discussion that follows gives a more thorough description of them and is intended to assist the user in estimating their correct value.

Table 25. Channel file description.

Line 1:	version control number 99.1 - real (ver)
Line 2:	number of channel elements - integer (nchan)
Line 3:	flag for the runoff peak calculation method - integer (ipeak) 1 - use modified EPIC computation method 2 - use CREAMS computation method 3 – Kinematic Wave computation method 4 – Muskingum-Cunge (constant) computation method 5 – Muskingum-Cunge (modified var) computation method
Line 4:	length to width watershed ratio. ***Note*** Although this value is used only when the CREAMS computation method is selected, a value must be entered on this line.
	Repeat lines 5 to 15 for the number of channels indicated on line 2.
Line 5:	comment line.
Line 6:	comment line.

Line 7: comment line.

Line 8: flag to indicate the shape of the channel - integer (ishape)
- 1 - triangular
- 2 - naturally eroded channel

Line 9: flag to indicate the type of control section at the channel outlet - integer (icntrl)
- 0 - no control structure
- 1 - critical flow
- 2 - normal flow
- 3 - normal flow with a different roughness
- 4 - rating curve at the channel outlet.

Line 10: flag to indicate friction slope calculation method - integer (ienslp)
- 1 - CREAMS calculation method
- 2 - the friction slope is equal to the bed slope.

Line 11: flag to indicate the type of channel output - integer (flgout)
- 0 - this flag is presently overridden by output flags governing the general WEPP model output. A value of 0 nevertheless needs to be input here.

Line 12: a) inverse slope of the channel banks (m/m) - real (chnz)
Note if the channel is rectangular or naturally eroded, this parameter is not used but a value of 0 must be entered.
b) Manning roughness coefficient for bare soil in the channel - real (chnnbr).

Line 13: a) total Manning roughness coefficient in channel allowing for vegetation - real (chnn).
b) channel erodibility factor (s/m) - real (chnk).
c) channel critical shear stress (N/m^2) - real (chntcr).
d) depth to nonerodible layer in mid-channel (m) - real (chnedm).
e) depth to nonerodible layer along the side of the channel (m) - real (chneds).

Line 14: a) control structure slope (m/m) - real (ctlslp).
b) control structure average inverse side slope (m/m) - real (ctlz).
c) control structure Manning roughness coefficient - real (ctln).

Note if “no control structure” option is chosen on line 9, 14a) is overridden by information in the channel slope file, 14b) is overridden by 12a), and 14c) is overridden by 12b). Nonetheless, this line must be present, even though its values are not used.

Line 15 is only present if a “rating curve” has been selected on line 9.

Line 15: a) rating curve coefficient - real (rccoeff).
b) rating curve exponent - real (rcexp).
c) minimum depth required for discharge (m) - real (rcoset).

To calculate erosion on a channel element, the WEPP model uses the peak runoff rate value. In the watershed version, runoff peaks are calculated at the outlet of each channel element with two possible methods. The first method is a modified expression of the rational formula as used in the EPIC (Erosion Prediction Impact Calculator) model (Sharpley and Williams, 1990). The peak is calculated as the product of a coefficient by the volume of runoff divided by the time of concentration of the watershed at the channel outlet.

$$Peak = \frac{\alpha * volume}{t_c}$$

where *Peak* is the peak runoff rate (m^3/s), volume is the runoff volume (m^3) and t_c if the time of concentration (seconds). The coefficient alpha(α) represents the fraction of rain that falls during the time of concentration. A more detailed discussion about the calculation of this coefficient and how its values for various parts of the watershed are combined is given in the technical documentation (NSERL Report #10).

The second method available to estimate peak runoff rates is the peak calculation model used in the CREAMS model (Knisel, 1980). The peak is calculated with an empirical formula in function of the watershed area (area in acres), its slope (slope (m/m)), the runoff volume (volume (ft^3)) and the length to width ratio of the watershed (lw (m/m)).

$$\text{Peak} = 7.17 * 10^{-4} * \text{area}^{0.7} * \text{slope}^{0.159} * \text{volume}^{0.717\,\text{area}^{0.0166}} * \frac{1}{\text{lw}^{0.187}}$$

where Peak is the peak runoff rate in ft^3/s. This equation has been statistically derived using data from watersheds whose areas ranged from 70 ha to 62 km^2. For smaller areas, it is therefore recommended that the EPIC method be used. The user is cautioned that the CREAMS method will yield unreasonably high estimates of peak runoff rates for small field-scale watersheds.

Although the length to width ratio is only used when the CREAMS calculation method is selected, it needs to be entered for both methods. If the EPIC-modified formula is selected, the value of the length to width ratio is not important and can be zero, for example. The peak calculation method and the watershed length to width ratio are selected only once and cannot vary during the simulation for different sub-watersheds. The length to width ratio needs to be selected so that it represents average conditions for as much as possible of the sub-watersheds.

Channel outlet control structure

The WEPP model needs to know what flow conditions exist at the outlet of a channel in order to calculate the energy gradeline when backwater effects are to be taken into account. If a control structure exists, the flow conditions are specified on line 9 and the control structure parameters (slope, side slope and Manning coefficient) are specified on line 14 for a well-defined flow condition or on line 15 if the flow conditions are defined by a rating curve. If a rating curve or no control structure is selected (line 9), the control structure parameters (line 14) are not relevant and can all be zero. However, line 14 must still be present. In the case of a rating curve, the curve parameters will be read on line 15. In case of no control structure, the parameters on line 14 are overridden by the slope of the last segment of the channel element indicated in the slope file, the inverse side slope, and the Manning coefficient of the channel (line 12).

Friction slope

WEPP allows for two methods to calculate the friction slope in a channel. Either the friction slope is taken equal to the topographic channel slope or it is calculated to take into account backwater effects as is done in the CREAMS model. Details of the calculation methods are indicated in the technical documentation(NSERL Report #10). In general, backwater effects need to be taken into account for low grade channels (0.1 to 0.5 % slope), for channels with heavy vegetation or for channels with a restricted outlet such as a weir or a ridge.

Side slope of the channel

For triangular channels, the user should enter here the inverse value of the slope of the banks of the channel. For naturally-eroded channels, the inverse side slope is defined as the ratio of half of the channel width by the vertical depth at the center point of the channel bed. Although shear stress components calculations take into account the specified shape of the channel, friction slope calculations assume a triangular shape.

Manning coefficient

Table 26 and Table 27 will guide the user in choosing an accurate Manning coefficient for flow in an ephemeral channel covered with either bare soil or with vegetation. Presently there is no updating of the Manning coefficient with plant growth, the user should therefore choose a value that can be associated with the average vegetation characteristics. If the conditions are not homogeneous within the channel, the user should refer to a hydraulic reference handbook such as Chow (1959) to calculate a global Manning's coefficient.

Table 26. Estimates of Manning "n" for an excavated or dredged channel (Chow, 1959)

Type of channel	Minimum	Normal	Maximum
Earth, straight and uniform			
clean, new	0.016	0.018	0.020
clean, old	0.018	0.022	0.025
gravel, clean	0.022	0.025	0.030
short grass, few weeds	0.022	0.027	0.033
Earth, winding and sluggish			
no vegetation	0.023	0.025	0.030
grass, some weeds	0.025	0.030	0.033
earth bottom, rubble sides	0.028	0.030	0.035
stony bottom, weedy banks	0.025	0.035	0.040
cobble bottom, clean sides	0.030	0.040	0.050
Drag-line excavated or dredged			
no vegetation	0.025	0.028	0.033
light brush on banks	0.035	0.050	0.060
Rock cuts			
smooth and uniform	0.025	0.035	0.040
jagged and irregular	0.035	0.040	0.050
Channels not maintained, weeds and brush uncut			
dense weeds, high as flow depth	0.050	0.080	0.120
clean bottom, brush on sides	0.040	0.050	0.080
same, highest stage of flow	0.045	0.070	0.110
dense brush, high stage	0.080	0.100	0.140

Channel soil parameters

The channel soil erodibility and the channel soil shear stress should be estimated using methods similar to those for hillslope rill erodibility and critical shear stress. The reader should refer to the section on soil parameters for hillslope applications.

Table 27. Estimates of Manning "n" for channel flow and typical soil covers (from the CREAMS manual, Knisel (1980))

Cover	Cover density	Minimum	Normal	Maximum
Smooth, bare soil; some roughness		0.03	0.035	0.045
Corn stalks, residue in place		0.05	0.10	0.13
Wheat straw, residue in place		0.06	0.15	0.25
Grass, higher than flow depth	poor condition	0.04	0.05	0.06
	good condition	0.08	.....	0.10
	dense condition	0.20	.....	0.30
small grain (20% to maturity)	7- in rows with flow	0.13	.....	0.30
	14-in rows with flow	0.13	.....	0.20
	rows across flow		0.30	
sorghum and cotton		0.07	.....	0.09
Sudan grass			0.20	
Lespedeza			0.10	
Lovegrass			0.15	

Rating curve

Instead of entering control structure parameters, the user can enter the parameters of a rating curve for the outlet of the channel. The rating curve is defined by three coefficients: the coefficient (rcoeff), the exponent (rcexp) and the minimum water depth required for discharge (rcoset (m)). The discharge (q(m^3/s)) should be expressed as a function of the water depth (h (m)) by:

$$q = rcoeff * (h - rcoset)^{rcexp}$$

rcoeff and *rexp* values should be set according to rating tables for weirs, flumes, vanes, etc. Their units depend on their values.

Impoundment file

Table 28. Impoundment input file description.

Line 1 : Version number - real (ver)
Line 2 : Number of impoundments in the watershed - integer (npound)

The rest of the file is repeated for each impoundment

Line 3 : Comment lines - character (impdes)
Line 4 : Comment line
Line 5 : Comment line

Drop spillway section

Line 6 : Drop spillway index - integer (ids)

0 : no drop spillway is present, skip the four drop spillway description lines
1 : drop spillway with circular riser and circular barrel
2 : drop spillway with rectangular box riser and circular barrel
3 : drop spillway with rectangular box riser and rectangular box barrel

if ids =1

Line 7 : comment line - character (strdes)
Line 8 : diameter of riser (m) - real (diars)
stage of riser inlet (m) - real (hrs)
weir coefficient - real (coefw)
orifice coefficient - real (coefo)
Line 9 : diameter of barrel (m) - real (diabl)
height of riser above barrel bottom (m) - real (hrh)
length of barrel (m) - real (lbl)
slope of barrel (m/m) - real (sbl)
height of barrel outlet above exit channel bottom (m) - real (hblot)
Line 10 : Entrance head loss coefficient, - real (ke)
Bend head loss coefficient - real (kb)
Friction head loss coefficient - real (kc)

if ids = 2

Line 7 : comment line (strdes)
Line 8 : length of riser box section (m) - real (lenrs)
width of riser box section (m) - real (widrs)
stage of riser inlet (m) - real (hrs)
weir coefficient - real (coefw)
orifice coefficient - real (coefo)
Line 9 : diameter of barrel (m) - real (diabl)
height of riser inlet above barrel bottom (m) - real (hrh)
length of barrel (m) - real (lbl)
slope of barrel (m/m) - real (sbl)
height of barrel outlet above exit channel bottom (m) - real (hblot)
Line 10 : Entrance head loss coefficient, - real (ke)
Bend head loss coefficient - real (kb)
Friction head loss coefficient - real (kc)

if ids = 3

Line 7 : comment line (strdes)
Line 8 : length of riser box section (m) - real (lenrs)
width of riser box section (m) - real (widrs)
stage of riser inlet (m) - real (hrs)
weir coefficient - real (coefw)
orifice coefficient - real (coefo)
Line 9 : height of barrel box section (m) - real (hitbl)
width of barrel box section (m) - real (widbl)
height of riser inlet above barrel bottom (m) - real (hrh)
length of barrel (m) - real (lbl)
slope of barrel (m/m) - real (sbl)

height of barrel outlet above exit channel bottom (m) - real (hblot)
Line 10 : Entrance head loss coefficient, - real (ke)
Bend head loss coefficient - real (kb)
Friction head loss coefficient - real (kc)

Culvert section
Line 11 : Culvert index - integer (icv)
0 : no culvert is present , skip the three culvert lines(12-14)
1 : culvert is present
Number of identical culverts - integer (ncv)
Line 12 : Comment lines - character (strdes)
Line 13 : Cross-sectional area of culvert (m2) - real (arcv)
Cross-sectional height of culvert (m) - real (hitcv)
Stage of culvert inlet (m) - real (hcv)
Flow length of culvert (m) - real (lcv)
Slope of culvert (m/m) - real (scv)
Height of culvert outlet above exit channel bottom (m) - real (hcvot)
Line 14 : Entrance head loss coefficient, - real (ke)
Bend head loss coefficient - real (kb)
Friction head loss coefficient - real (kc)

Repeat lines 11 to 14 for the culvert #2

Rock-fill check dam section
Line 15 : Rock-fill dam index - integer (irf)
0 : no rock-fill check dam is present. Skip the two rock-fill dam description lines
1 : Rock-fill check dam is present
Line 16 : Comment line - character (strdes)
Line 17 : Flow length of the rock-fill check dam (m) - real (lnrf)
Stage at which flow through the rock-fill check dam occurs (m) - real (hrf)
Overtopping stage (m) - real (hotrf)
Cross-sectional width of the rock-fill check dam (m) - real (wdrf)
Average diameter of the rocks forming the dam (m) - real (diarf)

Emergency spillway section
Line 18 : Emergency spillway index - integer (ies)
0 : No emergency spillway is present. Skip the description section.
1 : Emergency spillway or open channel outlet is present
2 : User specified stage-discharge relationship is present

if ies = 1
Line 19 : Comment line
Line 20 : Bottom width of the exit channel (m) - real (bwes)
Side slopes of the exit channel (m/m) - real (sses)
Manning roughness coefficient for the vegetation in the exit channel - real (nes)
Stage of the exit channel (m) - real (hes)
Maximum stage for flow through the exit channel (m) - real (hmxes)
Line 21 : Slope of section #1 of the exit channel (m/m) - real (ses1)

Length of section #1 of the exit channel (m) - real (les1)
Slope of section #2 of the exit channel (m/m) - real (ses2)
Length of section #2 of the exit channel (m) - real (les2)
Slope of section #3 of the exit channel (m/m) - real (ses3)

If ies = 2

Line 19 : Comment line
Line 20 : Number of points of the stage-discharge relationship - integer (npts)
Line 21 : Stage of the beginning of the user defined stage-discharge relationship (m) - real (hes)
Line 22 : Stage of the user defined stage-discharge relationship (m) - real (hest(i), i=1,npts)
Line 23 : Discharge of the user defined stage-discharge relationship (m^3/s) - real (qes(i), i=1,npts)

Filter fence section

Line 24 : Filter fence index - integer (iff)
0: No filter fence straw bale or trash barrier is present. Skip the description section.
1: Filter fence is present
2: Straw bales or trash barrier is present
Line 25 : Comment line
Line 26 : Slurry flow rate (m/s) - real (vsl)
Cross-sectional width of filter fence, straw bales or trash barrier (m) - real (wdff)
Stage at which flow begins (m) - real (hff)
Overtopping stage (m) -real (hotff)

Perforated riser section

Line 27: Perforated riser index - integer (ipr)
0: No perforated riser is present, skip the description section
1: Perforated riser is present.
Line 28: Comment line
Line 29: Stage of riser opening (m) - real (hr)
Height below the datum of the restricting orifice (m) - real (hb)
Height of the slots (m) - real (hs)
Stage of the datum (i.e., bottom of the slots) (m) - real (hd)
Diameter of the riser (m) - real (diar)
Area of the slots (m^2) - real (as)
Diameter of the restricting orifice (m) - real (diab)
Line 30: Height of the riser inlet above barrel bottom (m) - real (hrh)
Flow length of the barrel (m) - real (lbl)
Slope of barrel (m/m) - real (sbl)
Diameter of barrel (m) -real (diabl)
Line 30: Orifice coefficient for the restricting orifice - real (cb)
Weir coefficient - real (coefw)
Orifice coefficient - real (coefo)
Orifice coefficient for the slots - real (cs)
Line 31: Entrance head loss coefficient, - real (ke)
Bend head loss coefficient - real (kb)
Friction head loss coefficient - real (kc)

Miscellaneous and stage-area-length data

Line 32: Stage at which the overtop flag goes off (m) -real (htop)
Stage at which the full of sediment flag goes off (m) - real (hfull)
Stage at the beginning of the simulation (m) - real (h)
Initial time step (hr) - real (deltat)
Infiltration rate (m/d) - real (qinf)

Line 33 : Structure size - integer (isize)
1 : small structure with little to no permanent pool
2 : large structure (>1ac) with a permanent pool greater than 1 meter deep.
Number of particle size subclass divisions - integer (ndiv)

Line 34 : Number of stage-area-length points utilized - integer (nalpts)

Line 35 : Minimum stage (m) - real (hmin)
Area at minimum stage (m^2) - real (a0)
Length at minimum stage (m) - real (l0)

Line 36 Stage at point i (m) (must be > 0.0) - real (hal(i), i=1,nalpts)

Line 37 : Area at point i (m^2) - real (area(i), i=1,nalpts)

Line 38: Length at point I (m) - real (length(i), i=1,nalpts)

Detailed descriptions of the input parameters needed for each outflow structure are presented in the following order:

1. Drop Spillway
2. Perforated Riser
3. Culvert
4. Emergency Spillway or Open Channel
5. Rock Fill Check Dam
6. Filter Fence / Straw Bales / Trash Barriers
7. User Specified Stage-Discharge Relationship

Following the outflow structure input parameter descriptions is a description of general impoundment characteristics; including user-specified stage-area and stage-length relationships. Finally, a description of the WEPPSIE output files is presented.

Drop Spillway

A drop spillway is a common outflow structure used in farm ponds and sediment detention basins. It consists of a vertical riser connected to a horizontal or near horizontal barrel as seen in Figure 10. In order to define the outflow function, the following dimensions must be entered in via the interface or using a text editor:

D_{RS}	Diameter of circular riser (m); for circular risers.
L_{RS}	Length of riser box section (m); for box section risers.
W_{RS}	Width of riser box section (m); for box section risers.
H_{RS}	Stage of riser inlet (m).
C_W	Weir coefficient, usually 3.0 to 3.2.
C_O	Orifice coefficient, approximately 0.6.
D_{BL}	Diameter of barrel (m); for circular barrels.
H_{BL}	Height of barrel box section (m); for box section barrels.
L_{BL}	Length of barrel box section (m); for box section barrels.
H_{RH}	Height of riser inlet above barrel bottom (m).
L_{BL}	Flow length of barrel (m).

S_{BL}	Slope of barrel (m/m).
H_{BLOT}	Height of barrel outlet above the outlet channel bottom (m).
K_e	Entrance loss coefficient; see Figure 11.
K_b	Bend loss coefficient; see Table 29.
K_c	Head loss coefficient; see Table 30.

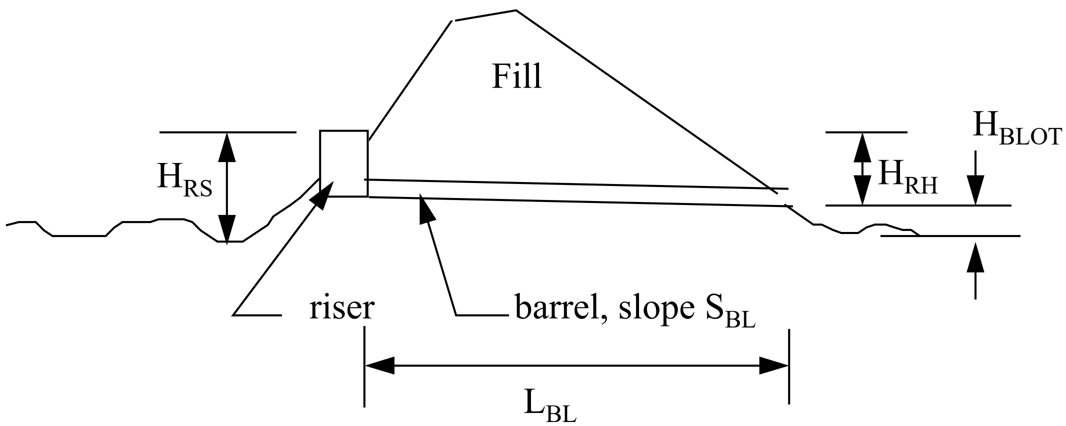


Figure 10. Drop spillway definition sketch.

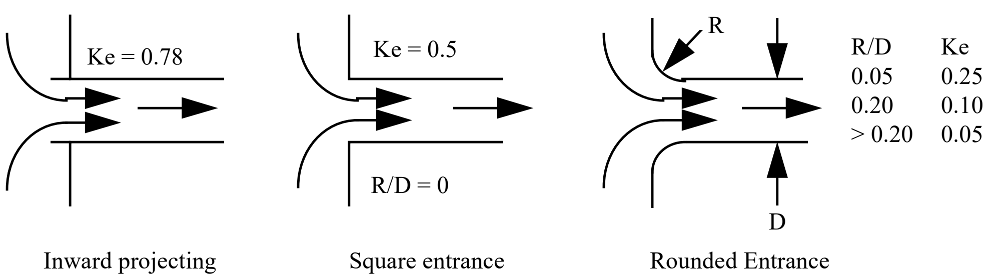


Figure 11. Entrance loss coefficients (Schwab et al., 1966).

Table 29. Bend loss coefficients (Schwab et al.,1981)

$\frac{R}{D} = \frac{\textit{Bend Radius to Pipe Center Line}}{\textit{Pipe diameter}}$	Bend coefficient, K_b 45º Bend	90º Bend
0.5	0.7	1.0
1	0.4	0.5
2	0.3	0.4
5	0.2	0.3

Table 30a. Head loss coefficients for circular pipe flowing full (English units)(Schwab et al., 1966).

$$K_c = \frac{5087 * n^2}{d^{4/3}}$$, where d = diameter (in)

Pipe inside diameter		*Flow area*	*Manning coefficients of roughness n*				
mm	in	sq. ft	0.010	0.012	0.014	0.016	0.018
152	6	0.196	0.0467	0.0672	0.0914	0.1194	0.1510
203	8	0.349	0.0318	0.0458	0.0623	0.0814	0.1030
254	10	0.545	0.0236	0.0340	0.0463	0.0604	0.0765
305	12	0.785	0.0185	0.0267	0.0363	0.0474	0.0600
381	15	1.23	0.0138	0.0198	0.0270	0.0352	0.0446
457	18	1.77	0.01078	0.0155	0.0211	0.0276	0.0349
533	21	2.41	0.00878	0.0126	0.0172	0.0225	0.0284
610	24	3.14	0.00735	0.01058	0.0144	0.0188	0.0238
762	30	4.91	0.00546	0.00786	0.01070	0.0140	0.0177
914	36	7.07	0.00428	0.00616	0.00839	0.01096	0.0139
1219	48	12.57	0.00292	0.00420	0.00572	0.00747	0.00945
1524	60	19.63	0.00217	0.00312	0.00424	0.00554	0.00702

Table 30b. Head loss coefficients for square conduits flowing full (English units).

$$K_c = \frac{29.16 * n^2}{R^{4/3}}$$, where R = hydraulic radius (ft)

Conduit size		*Flow area*	*Manning coefficients of roughness n*		
m x m	ft x ft	ft2	0.012	0.014	0.016
0.61 x 0.61	2 x 2	4	0.01058	0.01440	0.01880
0.91 x 0.91	3 x 3	9	0.00616	0.00839	0.01096
1.22 x 1.22	4 x 4	16	0.00420	0.00572	0.00746
1.52 x 1.52	5 x 5	25	0.00312	0.00425	0.00554
1.83x 1.83	6 x 6	36	0.00245	0.00333	0.00435
2.13 x 2.13	7 x 7	49	0.00199	0.00271	0.00354
2.44 x 2.44	8 x 8	64	0.00196	0.00227	0.00296
2.74 x 2.74	9 x 9	81	0.00142	0.00194	0.00253
3.05 x 3.05	10 x 10	100	0.00124	0.00168	0.00220

Perforated Riser

Perforated risers are often used to slowly empty terrace systems. A perforated riser is similar to a drop spillway in that both have a riser that empties into a subsurface conduit. The perforated riser includes a bottom orifice plate to limit flow to the subsurface conduit and slots along the riser to allow complete drainage of the terrace.

A typical perforated riser contains N horizontal rows of side orifices spaced a uniform distance S. The side orifices have a total area A_s distributed over a length H_s. This typical perforated riser also incorporates a bottom orifice plate with a flow area A_b located a distance h_b below the slots. An illustration of this typical perforated riser is given in Figure 12. In order to define the outflow function, the following parameters must be entered:

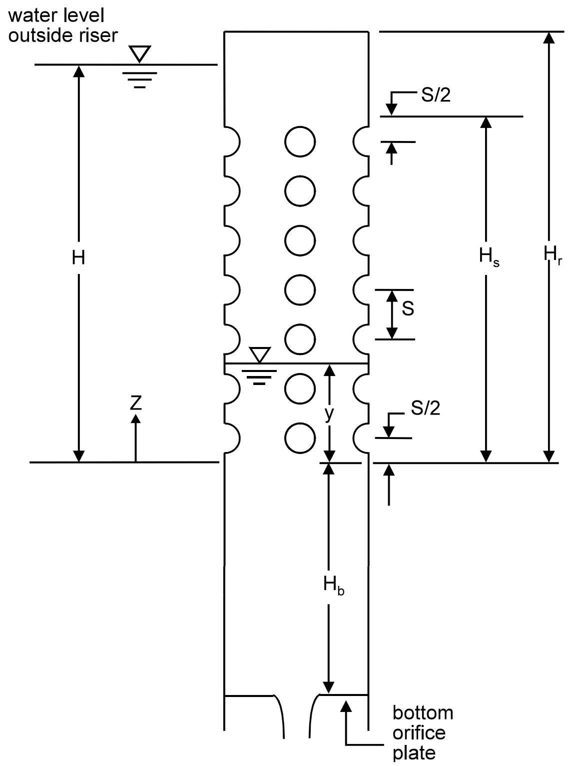


Figure 12. Perforated riser definition sketch.

H_r	Stage of the riser opening (m).
H_b	Height below the datum of the restricting orifice (m).
H_s	Height of the slots (m).
H_d	Stage of the datum (i.e., the bottom of the slots) (m).
D_r	Diameter of the riser (m).
A_s	Area of the slots (m^2). Use the total slot area.
D_b	Diameter of the restricting orifice (m).
C_b	Orifice coefficient for the restricting orifice, approximately 0.6.
C_S	Orifice coefficient for the slots, approximately 0.611.

The next variables are the same as for the drop inlet spillway

H_{rh}	Height of riser inlet above barrel bottom (m).
L_{BL}	Flow length of barrel (m).
S_{BL}	Slope of barrel (m/m).
D_{BL}	Diameter of the barrel (m).
C_W	Weir coefficient, usually 3.0 to 3.2.
C_O	Orifice coefficient, approximately 0.6.
K_e	Entrance loss coefficient; see Figure 11.
K_b	Bend loss coefficient; Table 29
K_c	Head loss coefficient; see Table 30.

Culvert

Culverts (sometimes called trickle tube spillways) can be used as outlet structures for farm ponds and sediment basins as shown in Figure 13. Culverts are also used to control flows under roadways, often resulting in ponding upstream of the culvert forming an impoundment. Often more than one culvert is used to drain an impoundment; sometimes the numerous culverts are identical; and sometimes the culverts have different sizes, shapes, lengths, etc. To cover the many possibilities, WEPP allows the user to enter information on two sets of N_{CV} identical culverts. In order to define the outflow function for each set of identical culverts, the following dimensions must be entered for each set of culverts:

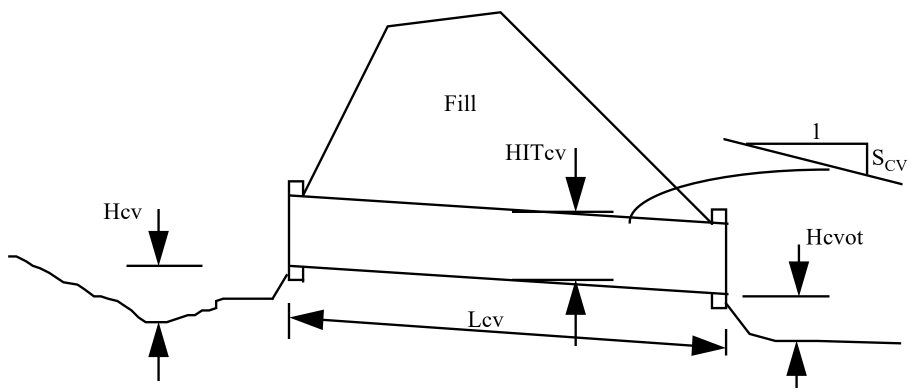


Figure 13. Culvert definition sketch.

N_{CV}	Number of identical culvert outlet structures.
A_{CV}	Cross-sectional area of culvert (m^2).
HIT_{CV}	Cross-sectional height of culvert (m)for square conduits or diameter for circular conduit.
H_{CV}	Stage of culvert inlet (m).
L_{CV}	Flow length of culvert (m).
S_{CV}	Slope of culvert (m/m).
H_{CVOT}	Height of culvert outlet above the outlet channel bottom (m).
K_e	Entrance loss coefficient; see Figure 11
K_b	Bend loss coefficient; see Table 29
K_c	Friction loss coefficient; see Table 30
K, M, c, Y	Inlet control coefficients; see Table 31

Table 31. Inlet control coefficients (FHA, 1985)

Shape and Material	Inlet Edge Description	UNSUBMERGED K	UNSUBMERGED M	SUBMERGED C	SUBMERGED Y
Circular	Smooth tapered inlet throat	0.534	0.555	0.0196	0.89
	Rough tapered inlet throat	0.519	0.640	0.0289	0.90
Elliptical inlet face	Tapered inlet-beveled edges	0.536	0.622	0.0368	0.83
	Tapered inlet-square edges	0.503	0.719	0.0478	0.80
	Tapered inlet-thin edge projecting	0.547	0.800	0.0598	0.73
Rectangular	Tapered inlet throat	0.475	0.667	0.0179	0.97
Rectangular Concrete	Side tapered - less favorable edges	0.56	0.667	0.0466	0.85
	Side tapered - more favorable edges	0.56	0.667	0.0378	0.87
Rectangular Concrete	Slope tapered - less favorable edges	0.50	0.667	0.0466	0.65
	Slope tapered - more favorable edges	0.50	0.667	0.0378	0.71
Rectangular Box	45° wingwall flares d= .043 D	0.510	0.337	0.0309	0.80
	18° to 33.7° wingwall flares d= .083 D	0.486	0.667	0.0249	0.83
Rectangular Box	90° headwall w/ 3/4" chamfers	0.515	0.667	0.0375	0.79
	90° headwall w/ 45° bevels	0.495	0.667	0.0314	0.82
	90° headwall w/ 33.7° bevels	0.486	0.667	0.0252	0.685
Rectangular Box	3/4" chamfers; 45° skewed headwall	0.522	0.667	0.0402	0.73
	3/4" chamfers; 30° skewed headwall	0.533	0.667	0.0425	0.70
	3/4" chamfers; 15° skewed headwall	0.545	0.667	0.0450	0.68
	45° bevels; 10-45° skewed headwall	0.498	0.667	0.0327	0.75
Rectangular Box 3/4" chamfers	45° non-offset wingwall flares	0.497	0.667	0.0339	0.803
	18.4° non-offset wingwall flares	0.493	0.667	0.0361	0.806
	18.4° non-offset wingwall flares with 30° skewed barrel	0.495	0.667	0.0386	0.71
Rectangular Box Top Bevels	45° wingwall flares - offset	0.497	0.667	0.0302	0.835
	33.7° wingwall flares - offset	0.495	0.667	0.0252	0.881
	18.4° wingwall flares - offset	0.493	0.667	0.0227	0.887

Emergency Spillways and Open Channels

In many larger farm ponds and sedimentation basins, emergency spillways are used to route the excess runoff from very large storm events that cannot be routed through the principle spillway (drop inlet or culvert) in order to keep the excess flow from overtopping and breaching an earthen dam. Emergency spillways typically have three sections: 1) a sloped approach, 2) a flat crest and 3) a sloped exit as seen in Figure 14. Sometimes an open channel forms the only outlet structure. In WEPP, open channels are defined as emergency spillways. In order to define the outflow function, the following dimensions must be entered:

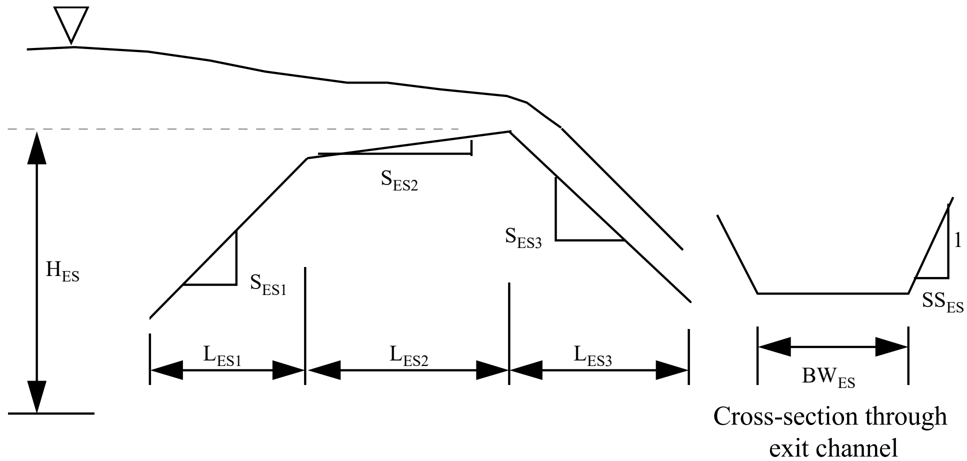


Figure 14. Emergency Spillway and open channel definition sketch.

BW_{ES}	Bottom width of the exit channel (m).
SS_{ES}	Side slopes of the exit channel (m/m).
N_{ES}	Manning's n for the vegetation in the exit channel; see Table 26 and Table 27
H_{ES}	Stage of the exit channel or stage of the beginning of the user defined stage-discharge relationship (m).
H_{MXES}	Maximum stage for flow through the exit channel (m).
S_{ES1}	Slope of section #1 of the exit channel (m/m); note the positive orientation seen in Figure 14.
L_{ES1}	Length of section #1 of the exit channel (m).
S_{ES2}	Slope of section #2 of the exit channel (m/m); note the positive orientation seen in Figure 14.
L_{ES2}	Length of section #2 of the exit channel (m).
S_{ES3}	Slope of section #3 of the exit channel (m/m); note the positive orientation seen in Figure 14.

Rock-Fill Check Dam

Construction, mining, and silviculture operations need inexpensive temporary sediment traps. Porous rock-fill check dams provide an inexpensive, easily constructed solution. A porous rock-fill check dam is simply a pile of rocks obstructing the free flow of sediment laden water. Frequently a rock-fill check dam is constructed with a coarse sand or fine gravel core in order to trap the most sediment and then covered by a larger rip rap used to prevent washout. A schematic of a rock-fill check dam appears in Figure 15. In order to define the outflow function, the following parameters must be entered:

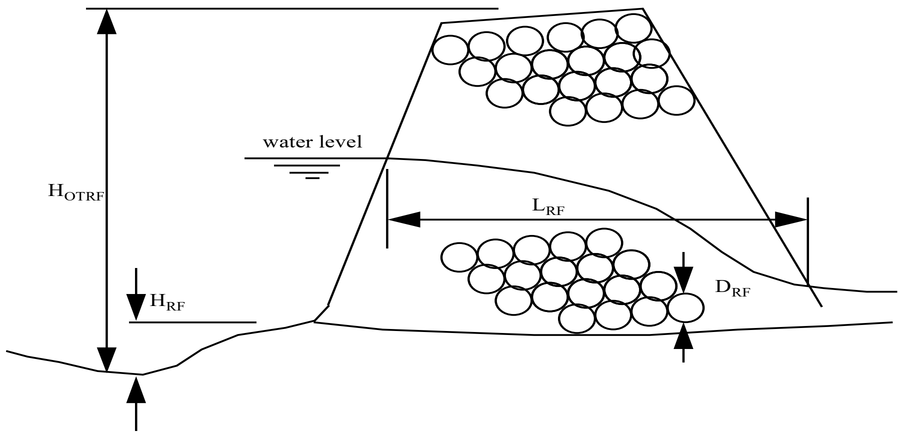


Figure 15. Rock-fill check dam definition sketch.

L_{RF}	Flow length of the rock-fill check dam (m); (estimate the average flow length for the average flow depth during the simulation, Figure 15).
H_{RF}	Stage at which flow through the rock-fill check dam occurs (m).
H_{OTRF}	Stage at which the rock- fill check dam is overtopped (m).
W_{RF}	Cross-sectional width of the rock-fill check dam (m); estimate the average cross-sectional width for the average flow depth during the simulation.
D_{RF}	Average diameter of the rocks forming the check dam (m); for check dams with a fine particle core with a rip rap outer layer, consider only the rock that forms the core of the check dam.

Filter Fence, Straw Bales, and Trash Barriers

Check dams can also be constructed with straw bales or filter fence. Both straw bale and filter fence check dams provide inexpensive, easily constructed sediment trapping structures. A schematic of a straw bale or a filter fence check dam is shown in Figure 16. A slurry flow rate is used to determine the discharge through a filter fence, straw bales, or a trash barrier. It should be noted that slurry flow rates are estimates at best; furthermore for trash barriers engineering judgment must be used in estimating an appropriate slurry flow rate. The user should also note that WEPP will compute outflows when the stage is greater than the overtop stage when in reality most filter fences and straw bales will wash out before overtopping occurs. If overtopping occurs, it is strongly suggested that the user redesigns the outflow structure or switches to a more permanent structure. In order to define the outflow function, the following parameters must be entered:

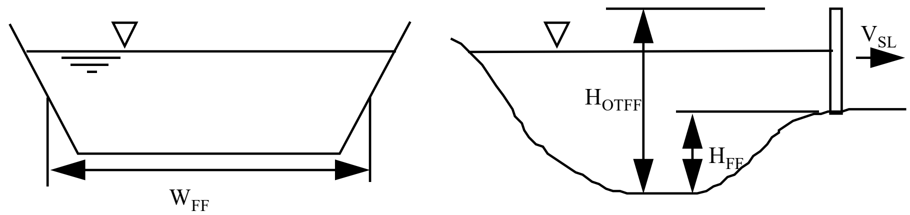


Figure 16. Straw bales and filter fence check dam definition sketch.

V_{SL}	Slurry flow rate (m/s); depends upon the type of material forming the check dam and the sediment composition of the incoming water (see Table 32).
W_{FF}	Cross-sectional width of filter fence, straw bales, or trash barrier (m); use the average cross-sectional width of the check dam at the average flow.
H_{FF}	Stage at which flow through the filter fence, straw bales, or trash barrier begins (m).
H_{OTFF}	Stage at which the filter fence, straw bales, or trash barrier is overtopped (m).

Table 32. Slurry flow rates recommended by state.

	Slurry Flow Rate		
Material	gpm/ft^2	m/sec	Reference
Straw bales	5.6	0.00381	VSWC, 1980[1]
Burlap (10 oz.)	2.4	0.00161	VSWC, 1980[1]
Synthetic fabric	0.3	0.000205	VSWC, 1980[1]; Maryland, 1983[2]

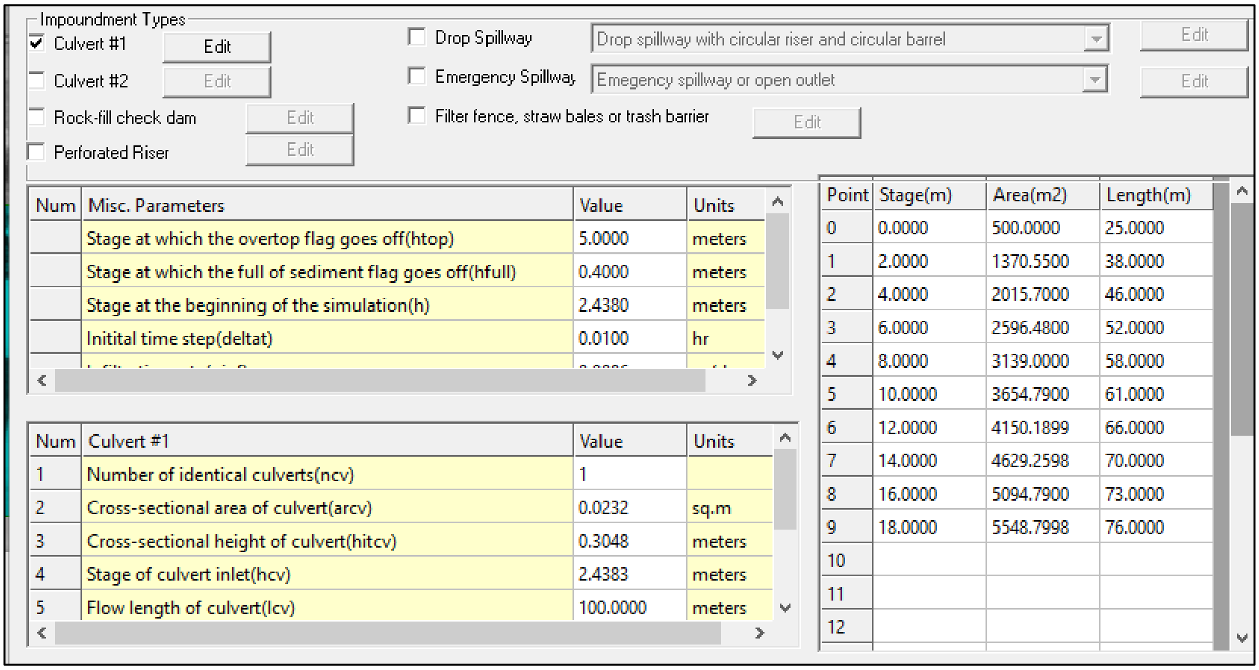
[1] Virginia Soil and Water Commission (1980)
[2] Maryland Water Resources Administration (1983)

General Impoundment Characteristics and Stage-Area-Length relationships

Miscellaneous inputs include those inputs that are not specific to an outflow structure, but are required for the simulation. Stage-area-length relationships take the form of power functions developed from discrete stage-area-length points entered by the user. Since regression routines are used to develop the power functions, it is recommended that the user enters as many points as possible (ideally more than 10). In order to define the miscellaneous inputs and stage-area-length functions, the following parameters must be entered:

H_{OT}	Stage at which the overtop flag goes off (m); set at the discretion of the user. This is a flag variable used to alert the user that the simulated stage was higher than the overtop stage, H_{OT}. This can be used for filter fence and straw bales to alert the user that the stage has reached a point where wash out might occur.
H_{FULL}	Stage at which the full-of-sediment flag goes off (m); set at the discretion of the user. This is a flag variable used to notify the user when sediment has filled the impoundment above the full-of-sediment stage, H_{FULL}. The user can use this flag to determine when an impoundment must be cleaned out, or when an impoundment is full of sediment and no longer operational.
H	Stage at the beginning of the simulation (m); often the permanent pool stage.
DT	Initial time step (hr); 0.1 hr recommended, 0.01 hr for filter fences.
Q_{INF}	Infiltration rate (m/d) defined as either the saturated hydraulic conductivity of a confining layer, or in the case of a very porous layer sitting above an impervious layer, the saturated hydraulic conductivity of the porous layer.
I_{SIZE}	Defines the structure size 1 indicates the structure is a small terrace, filter fence, or porous rock-fill check dam with little to no permanent pool; 2 indicates that the structure is a larger (>1 ac) farm pond with a permanent pool greater than 1 m deep.
N_{DIV}	Number of particle size subclass divisions; 2 is recommended (although increasing above 2 helps the accuracy somewhat).
H_{MIN}	Minimum stage (m); stage forming the bottom of the impoundment at the beginning of simulation.
A_{MIN}	Area at the minimum stage (m^2).
L_{MIN}	Length at the minimum stage (m).
N_{ALPTS}	Number of stage-area-length points used; ideally N_{ALPTS} > 10.
H_{AL}(I)	Stage at point I, (m); I = 1 to N_{ALPTS}; (must be greater than 0.0).
AREA(I)	Area at point I (m^2); I = 1 to N_{ALPTS}.
LENGTH(I)	Length at point I (m); I = 1 to N_{ALPTS}.

Example Impoundment Input file




```
99.1
1
Test impoundment with 1 culvert only
Jim Ascough II
March 21, 1994
0       # Drop Spillway
1 1     # Culvert 1
default
0.0232 0.3048 2.4383 100.0000 0.0100 5.0000
0.5000 1.0000 0.0621 0.519 0.64 0.0289 0.9
0 0     # Culvert 2
0       # Rockfill Checkdam
0       # Emergency Spillway
0       # Filter Fence
0       # Perforated Riser
5.0000 0.4000 2.4380 0.0100 0.008640
2 2
9        # Number of stage-area-length points
0.0000 500.0000 25.0000
2.0000 4.0000 6.0000 8.0000 10.0000 12.0000 14.0000 16.0000 18.0000
1370.5500 2015.7000 2596.4800 3139.0000 3654.7900 4150.1899 4629.2598 5094.7900 5548.7998
38.0000 46.0000 52.0000 58.0000 61.0000 66.0000 70.0000 73.0000 76.0000
```

Impoundment Output Files

The output files provide the user with summary information on impoundment performance on a daily, monthly, yearly, and length of simulation basis. There are three impoundment output files: the output summary file whose name is specified by the user or automatically named by the interface, "hydraulc", and "sediment"; these three files are described in the following paragraphs.

Impoundment Summary output file

The file named "output" is created for runs with any number of impoundments, and provides yearly and end of simulation summaries of performance for each impoundment. The "output" file is arranged in the following order:

1. Input data is returned for the user to verify the inputs that describe each outflow structure used on an impoundment and the general impoundment characteristics including the stage-area-length points entered by the user. This section is repeated for each impoundment included in a watershed simulation.

2. Output summary data for the first year of simulation. First, stage summary data is returned including the maximum impoundment stage for the year, and the stage of deposited sediment for the year are returned. Next, hydraulic summary data are returned including total inflow and outflow volumes for the year, and the peak inflow and outflow rates. Following the hydraulic summary, sedimentation summary data for the year is returned including trapping efficiency, average and peak influent and effluent concentrations, and influent, effluent, and retained sediment mass broken down by size class. The overtop flag and full of sediment flag complete the yearly summary. A yearly summary is repeated for each impoundment.

3. Output summary data for each consecutive year of simulation as described above.

4. Output summary data for the entire simulation in a format similar to (2).

Impoundment File: "hydraulc"

The output file "hydraulc" is created on watershed simulations where there is only one impoundment. The "hydraulc" file provides the user with hydraulic data summarized daily, monthly, yearly, and at the end of simulation. Included in the "hydraulc" file are:

1. The peak inflow and outflow rates for the day, month, year, and the length of the simulation.
2. The daily inflow and outflow volume and total inflow and outflow volume for each day, month, year, and the entire simulation.
3. The maximum stage for each day, month, year, and the entire simulation.
4. The average influent and effluent sediment concentration and the peak effluent sediment concentration for each day, month, year, and the entire simulation.
5. The trapping efficiency averaged over each month, year, and the entire simulation.
6. The minimum stage after deposition for each day, month, year, and the entire simulation.

Impoundment File: "sediment"

The output file "sediment" provides the user with a detailed breakdown by particle size class of mass of sediment entering, leaving, and retained in the impoundment. This detailed sediment breakdown is output for each day, month, year, and at the end of the simulation. Given the large amount of output data included in this file, it is created only when there is only one impoundment on the watershed. The sediment retained for each day is the total sediment retained in the impoundment for the entire simulation up to the given day.

Irrigation file

Irrigation files include the information necessary to determine irrigation dates and application rates for each channel element. The format of the channel irrigation file is the same as for a hillslope irrigation file in which overland flow elements would be replaced by channel elements, entered in increasing ID number. The user should refer to the hillslope section for a complete description of these files.

WEPP Hillslope Model Input Run File

The WEPP erosion model may be run in two ways: interactively, with the user manually typing the answers to questions concerning the type of simulation and input/output file names to the computer screen; or automatically, with the user directing the answers to the interactive questions into the WEPP model through use of an input run file. The WEPP user interface program creates these run files automatically for the user based upon the answers on the run description line that the user fills in within the interface. Figure 17 shows the screen input flow structure for the WEPP erosion prediction model (Version 95.7).

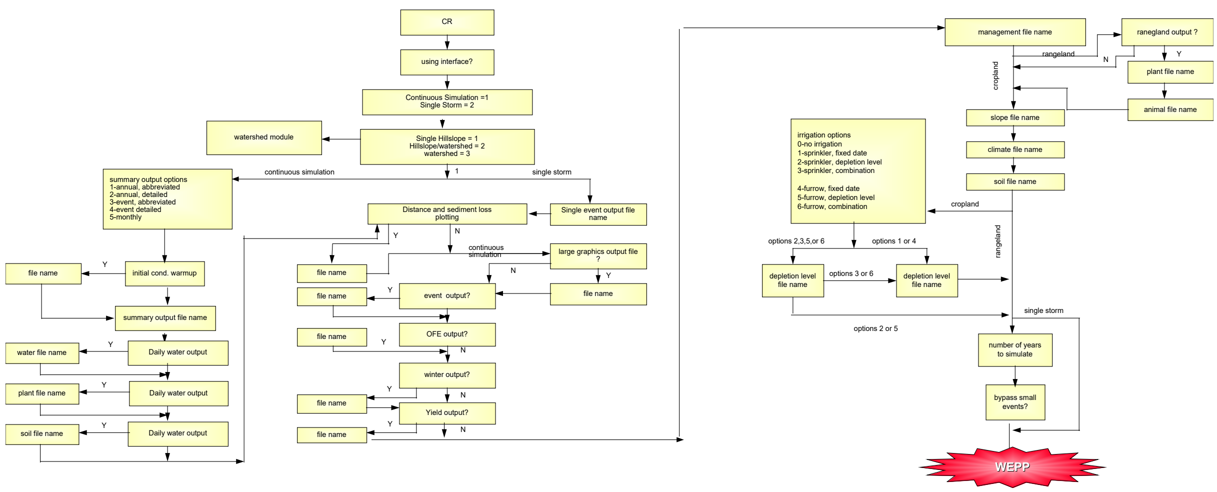


Figure 17. Interactive screen question sequence of WEPP hillslope erosion model version 95.7

WEPP Watershed component Input Run File

Similarly to the hillslope version, the watershed version may be run in two ways: interactively with the user manually typing answers to questions concerning the simulation and input / output file names; or automatically with all user answers being included in a run file. The user interface program creates this run file automatically based on the user selections. Figure 18 depicts the input flow structure for the two different options of the watershed version: channel routing only, or hillslope simulation and channel routing.

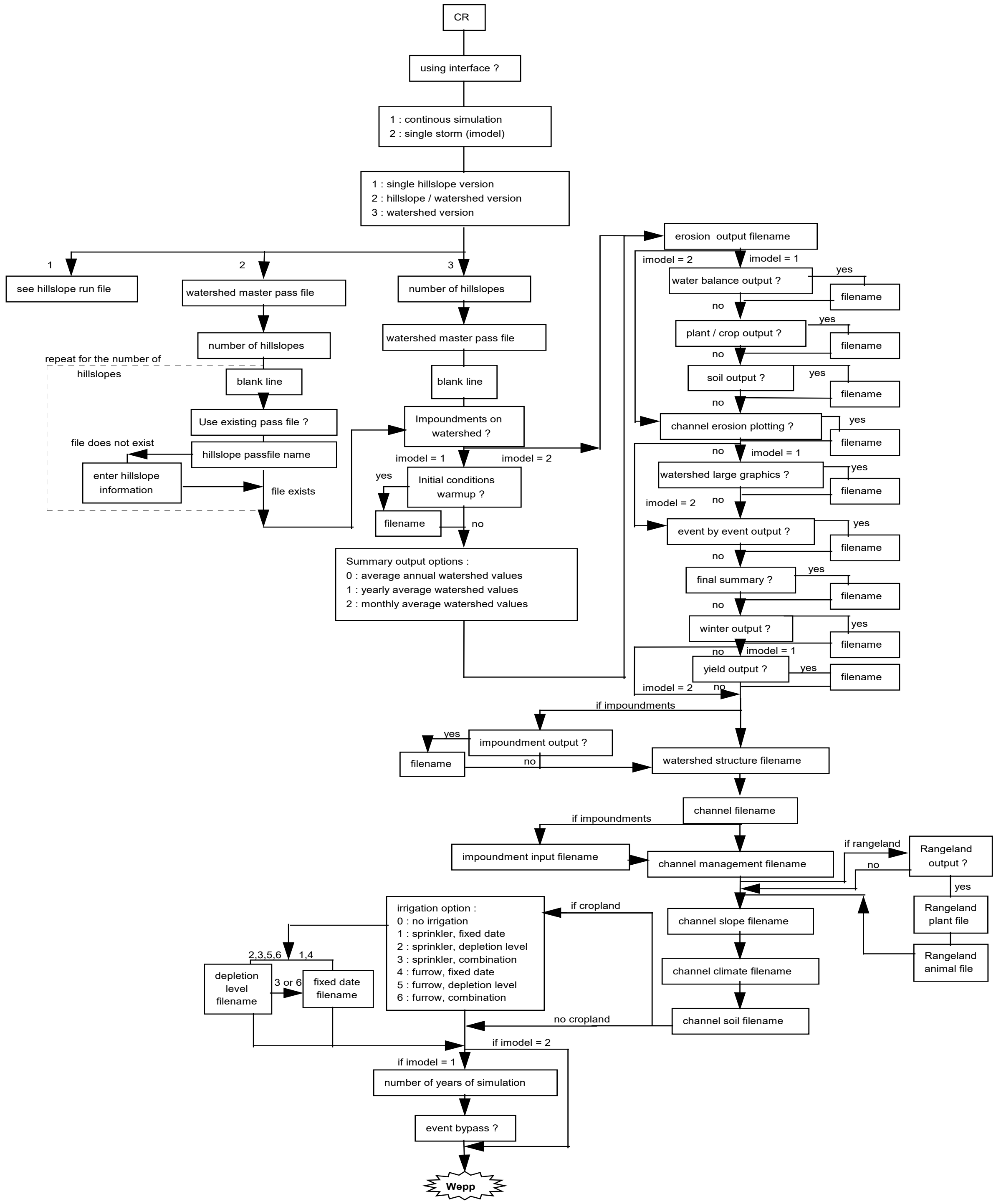


Figure 18. Interactive screen questions sequence for run options 2 and 3 of the WEPP erosion model, version 95.7

SUPPLEMENTAL WEPP INPUT FILES

If these optional files are present they supply extra inputs to the WEPP model to further customize the model simulation. The files should be placed in the same directory as the .run file. These options have been added over the years, some are experimental as noted in the descriptions.

partsize.dat

This allows a custom particle size distribution for the detached sediment to be input to WEPP. This particle size distribution will be used instead of the default 5 classes defined in the model. Up to 10 particle size classes can be input in the partsize file, each OFE must also be defined in the file. This file is used primarily for mining applications in place of the default particle size distributions for agricultural soil assumptions in WEPP.

This model version should function properly for single OFE hillslopes. It has not been well tested for multiple OFE hillslopes.

The format of the "partsize.dat" file is:

Line 1 – Number of particle size classes for an OFE (npart)
Line 2 - Particle class information consisting of:

a) frac – fraction of detached sediment in this size class at point of detachment
b) dia - diameter of this size class (mm)
c) spg – specific gravity of this size class (g/cc)
d) frcly – fraction of primary clay in this size fraction (g/g)
e) frslt – fraction of primary silt in this size fraction (g/g)
f) frsnd – fraction of primary sand in this size fraction (g/g)
g) frorg – fraction of organic matter in this size fraction (g/g)

Line 2 repeats for the number of size classes (npart) indicated on Line 1. Limit maximum 10 classes.

Lines 1 and 2 repeat for the number of overland flow elements (OFEs) in the simulation.

Example partsize.dat file, this is an example of 2 OFE’s with 10 particle size classes for each OFE:

```
10
0.150  0.002   2.65   1.000   0.000   0.000   0.001
0.020  0.010   2.60   0.950   0.050   0.000   0.050
0.050  0.030   2.50   0.900   0.100   0.000   0.040
0.300  0.050   2.20   0.800   0.150   0.005   0.060
0.020  0.075   2.00   0.600   0.300   0.100   0.030
0.010  0.100   2.00   0.000   0.000   1.000   0.001
0.050  5.000   1.80   0.500   0.200   0.300   0.045
0.050 10.000   1.60   0.400   0.300   0.300   0.050
0.100 20.000   1.40   0.450   0.200   0.350   0.060
0.250 50.000   2.20   0.300   0.400   0.300   0.040
10
0.150  0.002   2.65  10.000   0.000   0.000   0.001
0.020  0.010   2.60   0.950   0.050   0.000   0.050
0.050  0.030   2.50   0.900   0.100   0.000   0.040
```

```
0.300  0.050   2.20   0.800   0.150   0.005   0.060
0.020  0.075   2.00   0.600   0.300   0.100   0.030
0.010  0.100   2.00   0.000   0.000  10.000   0.001
0.050  5.000   1.80   0.500   0.200   0.300   0.045
0.050 10.000   1.60   0.400   0.300   0.300   0.050
0.100 20.000   1.40   0.450   0.200   0.350   0.060
0.250 50.000   2.20   0.300   0.400   0.300   0.040
```

wepp_ui.txt

The presence of this file indicates that an alternate version of the water balance computation that uses an hourly step is activated. The default WEPP water balance uses a daily timestep. When using this option the soil file format should be the 7778 format. The wepp_ui.txt file is an empty file.

beinpcalib.txt

This file contains a list of biomass energy parameters (BEINP) adjustment factors that when loaded will modify the BEINP values in the management input file. This file is mainly intended to make yield and biomass calibration easier. After a model run is completed the yield values can be analyzed and subsequent runs can change the calibration factors in this file without creating a new management file. The number of crops in the management file must equal the number of crops and match the order of crops in the beinpcalib.txt file. A value of 1.0 will cause the existing BEINP value in the crop management file to the use NEW_BEINP = BEINP * factor

The format of the beinpcalib.txt file is the following:

a) crop name, matching crop name from management file
b) crop index, matching index from management file
c) adjustment factor to apply to BEINP parameter for crop in management file

Example beinpcalib.txt file, with 3 crops:

```
L130_soyb 1 0.686489
L42_Corn 2 0.784807
L179_weed 3 1.0000
```

pmetpara.txt

Check to see if special ET coefficients input file exists - if it does then assume that user wants to use the FAO Penman-Montieth dual coefficient method. The mid-season basal crop coefficients (kcb) ofcommon crops is provided in Chapter 7, Table 17 and the readily available water in the root zone coefficients (p) is presented in Chapter 8, Table 22 in the online document, Crop Evapotranspiration: Guidelines for Computing Crop Water Requirements - FAO Irrigation and drainage paper 56, Rome, Italy (https://www.fao.org/4/X0490E/x0490e00.htm#Contents).

The format of the pmetpara.txt file is the following:

Line 1; records – number of records(lines) in this file
Line 2: Penman-Montieth parameters

a) crop name, same as a crop name in the management file input
b) mid-season crop coefficient for Penman-Monteith dual coefficient method (kcb).

c) coefficient p for readily available root zone soil water formula (rawp)
d) line in the file (line) integer, not used
e) logical name/comment, character string

frost.txt

The frost.txt file is used to define sublayers in the soils for the purpose of better modeling the freeze thaw processes. For more information on these processes, follow Dun et al. (2010).

The format of the frost.txt is the following:

Line 1: a) Apply water redistribution in soil layers (1=yes, 0=no)
b) Number of freeze/thaw layers in top two 10 cm soil layers
c) Number of freeze/thaw layers within each remaining 20 cm soil layers

Line 2: a) Thermal conductivity adjustment factor for snow
b) Thermal conductivity adjustment factor for residue
c) Thermal conductivity adjustment factor for soil
d) Lower limit of conductivity for crop/fallow frozen soil
e) Lower limit of conductivity for pasture frozen soil
f) Lower limit of conductivity for forest frozen soil

Example frost.txt file:

```
1 10 8
0.100000 0.200000 0.300000 0.000010 0.000020 0.500000
```

If frost.txt file is absent, then the model defaults these parameter values as:

```
1 10 10
1.0 1.0 1.0 0.000010 0.000010 0.500000
```

Citation: Dun, S., Wu, J.Q., McCool, D., Frankenberger, J., & Flanagan, D. (2010). Improving Frost-Simulation Subroutines of the Water Erosion Prediction Project (WEPP) Model. Transactions of the ASABE. 53. 10.13031/2013.34896.

wepp-co2.txt

Reads the CO_2 specific parameters for each crop defined in the management file. **This file is optional and experimental and work in this area is still in progress. Currently does not correctly handle multiple OFEs.**

The format of wepp-co2.txt file is the following:

Line 1: a) Current atmospheric CO_2 level for simulation (ppm).
Line 2: a) vpth - Threshold vapor pressure deficit (vpd). Leaf conductance is insensitive to vpd until it exceeds the threshold value, vpth (typically 0.5 to 1.0 kPa).
b) vpda - vpd above vpth (e.g., 4.0 kPa). Leaf conductance is assumed to decline linearly as vpd increases beyond vpth.

c) vpdb - The corresponding fraction of the maximum leaf conductance at a given vpd (e.g., 0.7).
d) gsi - Maximum stomatal conductance (ms^{-1}). This parameter represents the maximum stomatal conductance under conditions of high solar radiation and low vapor pressure deficit. Maximum stomatal conductance values for 246 species and cultivars are reported in Korner, Scheel, & Bauer (1979).
e) xptbe - Biomass energy ratio at elevated CO_2 concentrations. This value can be estimated experimentally from short-term crop growth at elevated CO_2 levels. Calculate the ratio of crop growth at elevated CO_2 to crop growth at approximately 330 ppm CO_2. Multiply this ratio by the biomass energy ratio at 330 ppm to obtain xptbe. Typical ratios are 1.1 to 1.2 for C_4 crops, and 1.3 to 1.4 for C_3 crops (Kimbel, 1983).
f) xptco2 – Elevated CO_2 concentration corresponding to the xptbe value, which is higher than the current CO_2 level (e.g., 550 or 660 ppm).
g) wavp – Parameter relating vpd to biomass energy ratio at 330 ppm CO_2. As vpd increases, biomass energy ratio decreases. The crop parameter wavp represents the rate of decline in biomass energy ratio per unit increase in vpd. The value of wavp varies by species, but a range of 6 to 8 is suggested for most crops (Stockle & Kiniry, 1990).

Citations:

Kimball, B.A. (1983). Carbon Dioxide and Agricultural Yield: An Assemblage and Analysis of 430 Prior Observations. Agronomy Journal, 75(5), 779-788. doi:https://doi.org/10.2134/agronj1983.00021962007500050014x

Korner, C., Scheel, J.A., & Bauer, H. (1979). Maximum leaf diffusive conductance in vascular plants. Photosynthetica, 13(1), 45-82.

Stockle, C.O., & Kiniry, J.R. (1990). Variability in crop radiation-use efficiency associated with vapor-pressure deficit, Field Crops Research, 25(3-4), 171-181, https://doi.org/10.1016/0378-4290(90)90001-R.

Example wepp-co2.txt file for corn and soybean crop rotation in the order used in the management file:

```
550
Corn        0.5    4.0    0.75   0.007  40.0   660.0  8.0
Soybeans    0.5    4.0    0.75   0.007  31.0   660.0  8.0
```

tc.txt

If this file is present in the same directory as other WEPP input files than during a watershed simulation another output file is created named “tc_out.txt” in the same directory. This output file contains the following:

```
Element Chan   Day Year  Runoff    Time of   Storm    Storm
                          (m^3)    Conc(hr)   Dur(hr)   Peak(hr)
```

The input file tc.txt does not have to contain any data since WEPP only tests for the existence of the file.

wepp_ch.txt

The presence of the wepp_ch.txt file indicates that temporal channel erodibility adjustments are to be done during a watershed simulation. The default WEPP approach is to have a constant erodibility for the watershed channels.

This file contains no data - the WEPP behavior is triggered by the file being in the same directory as other WEPP input files.

chan.inp

The chan.inp file contains additional options for the updated watershed routing methods.

The format of chan.inp file is the following:
Line 1: a) ichout – flag for type of channel flow output:
0 – no output
1 – peak flow time and rate
2 – daily average flowrate
3 – timestep flowrate
b) dtchr – timestep for routing (secs)

Line 2: a) unit area baseflow coefficient (m^3/s/m^2) range 1e-6 or smaller

Line 3: a) nchnum – number of channels to include in the output

Line 4 a) channel identifiers from watershed structure file, listed on one line

Example chan.inp file, with 3 hillslopes and 2 channels, from structure file channel ids are 4 and 5

```
3 600
0
2
4 5
```

WEPP INTERFACE PROGRAM

Purpose

The purpose of the WEPP interface program is to allow users to have an easy way to interact with the WEPP erosion model. The interface provides the best available tools to create and modify model input, organize sets of model simulation runs, and rapidly view and interpret model outputs.

Hardware and Setup Requirements

This version of the Water Erosion Prediction Project (WEPP) model is designed to run on Microsoft Windows Personal Computers (PCs). The current version works on 32 and 64 bit Windows 7 and Windows 10 systems and Windows 11.

WEPP Windows User Interface Installation

For installation instructions and examples see the WEPP Windows Interface Tutorial:

2013 Version:

https://www.ars.usda.gov/ARSUserFiles/50201000/WEPP/wepp-tutorial-2013.pdf

2024 Version:
https://www.ars.usda.gov/ARSUserFiles/50201000/WEPP/wepp-tutorial-2024.pdf

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APPENDIX

Estimated values for variables SUMRTM and SUMSRM

West Lafayette, Indiana, continuous simulations on a silt loam soil.

Cropping Management System	SUMRTM (kg/m^2)	SUMSRM (kg/m^2)
Continuous Tilled Fallow	0.0	0.0
Fall Moldboard Plow, Corn	0.03	0.18
Spring Chisel Plow, Corn	0.03	0.65
No-till Corn w/anhydrous app.	0.26	0.12
Fall Moldboard plow, Soybeans	0.03	0.13
Spring Chisel Plow, Soybeans	0.03	0.02
No-till, Soybeans	0.03	0.0
Continuous alfalfa	0.0	0.0
Continuous winter wheat	0.10	0.40

***Note**: Users can obtain values for their location by using the warm-up feature of the WEPP/Shell Interface and obtaining the SUMRTM and SUMSRM values from the created initial condition files.

Example Input Files

Num	Date	Operation Type		Name	Comments
1	1/1/1	Initial Conditions		Corn after corn	
2	5/1/1	Tillage		Field cultivator, secondary tillage, after duckfoot points	Depth: 4.00 in; Type: Sec
3	5/5/1	Tillage		Tandem Disk	Depth: 4.00 in; Type: Sec
4	5/10/1	Tillage		Planter, double disk openers	Depth: 2.00 in; Type: Sec
5	5/10/1	Plant - Annual		Corn, Jefferson IA, High production 125 bu/acre	Row Width: 30.00 in
6	6/5/1	Tillage		Cultivator, row, multiple sweeps per row	Depth: 3.00 in; Type: Sec
7	10/15/1	Harvest - Annual		Corn, Jefferson IA, High production 125 bu/acre	
8	11/1/1	Tillage		Plow, Moldboard, 8"	Depth: 8.00 in; Type: Pri

Example Plant/Management Input File 98.4

```
98.4
#
#
#
#

1 # number of OFE's
1 # (total) years in simulation

#######################
# Plant Section       #
#######################

1  # Number of plant scenarios


Corn
High production level-125 bu/acre for Jefferson Iowa
J. M. Laflen, Feb 28, 1998
Cutting height 1 foot,  non-fragile residue,  30 inch rows
1  #landuse
```

```
WeppWillSet
3.60000 3.00000 35.00196 10.00000 2.30000 55.00000 0.00000 0.30404 0.65000 0.05100
0.85000 0.98000 0.65000 0.99000 0.00000 1700.00000 0.50000 2.60099
2  # mfo - <non fragile>
0.00650 0.00650 25.00000 0.25000 0.21900 1.51995 0.25000 0.00000 30 0.00000
0.00000 3.50000 0.00000

######################
# Operation Section  #
######################

5  # Number of operation scenarios


FCSTACDP
`Field cultivator, secondary tillage, after duckfoot points
(from WEPP distribution database)
Maximum depth of 10 cm (4 inches)
1  #landuse
0.6000 0.3500 0
4 # pcode - other
0.0250 0.3000 0.6000 0.3500 0.0150 1.0000 0.0500

TAND0002
`Tandem Disk'
From converted V92.2 file `ANSI1.MAN'
NOTE: MFO values are the min and max of original values.
1  #landuse
0.5000 0.5000 0
4 # pcode - other
0.0500 0.2300 0.5000 0.5000 0.0260 1.0000 0.1000

PLDDO
`Planter, double disk openers'
(from WEPP distribution database)
Tillage depth of 2 inches
1  #landuse
0.2000 0.1000 6
1 # pcode - planter
0.0250 0.7500 0.2000 0.1000 0.0120 0.1500 0.0500

CULTMUSW
`Cultivator, row, multiple sweeps per row'
(from WEPP distribution database)

1  #landuse
0.4000 0.2000 0
4 # pcode - other
0.0750 0.7500 0.4000 0.2000 0.0150 0.8500 0.0500

MOPL
`Plow, Moldboard', 8"
(from WEPP distribution database)

1  #landuse
0.9800 0.9500 0
4 # pcode - other
0.0500 0.4000 0.9800 0.9500 0.0430 1.0000 0.1500



###############################
# Initial Conditions Section  #
###############################

1  # Number of initial scenarios
```

```
Default
Default corn initial conditions set - continuous corn - spring/summer tillage only
90 percent cover, approximately 200 days since last tillage
500 mm of rain since last tillage in summer prior
1  #landuse
1.10000 0.00000 200 92 0.00000 0.90000
1 # iresd  <Corn>
1 # mang annual
500.12601 0.02000 0.90000 0.02000 0.00000
1  # rtyp - temporary
0.00000 0.00000 0.10000 0.20000 0.02540
0.50003 0.19997




############################
# Surface Effects Section  #
############################

1  # Number of Surface Effects Scenarios


#
#   Surface Effects Scenario 1 of 1
#
Year 1
From WEPP database
Your name, phone

1  # landuse  - cropland
5 # ntill - number of operations
  121  # mdate  --- 5 / 1
  1  # op --- FCSTACDP
      0.102  # depth
      2  # type
  125  # mdate  --- 5 / 5
  2  # op --- TAND0002
      0.102  # depth
      2  # type
  130  # mdate  --- 5 / 10
  3  # op --- PLDDO
      0.051  # depth
      2  # type
  156  # mdate  --- 6 / 5
  4  # op --- CULTMUSW
      0.076  # depth
      2  # type
  305  # mdate  --- 11 / 1
  5  # op --- MOPL
      0.203  # depth
      1  # type


#######################
# Contouring Section  #
#######################

0  # Number of contour scenarios


#######################
# Drainage Section    #
#######################

0  # Number of drainage scenarios
```

```
######################
# Yearly Section     #
######################

1  # looper; number of Yearly Scenarios
#
# Yearly scenario 1 of 1
#
Year 1



1  # landuse <cropland>
1  # plant growth scenario
1  # surface effect scenario
0  # contour scenario
0  # drainage scenario
1 # management <annual>
   288  # harvest date --- 10 / 15 / 0
   130  # planting date --- 5 /10 /0
   0.7620  # row width
   6   # residue man - <none>


######################
# Management Section  #
######################

Manage
description 1
description 2
description 3
1   # number of OFE's
    1   # initial condition index
1  # rotation repeats
1  # years in rotation

#
# Rotation 1: year 1 to 1
#

   1    #  <plants/yr 1> - OFE: 1>
      1 # year index
```

Example Plant/Management Input File (2016.3)

```
2017.1
#
#
#
#

1 # number of OFE's
1 # (total) years in simulation

######################
# Plant Section      #
######################

1  # Number of plant scenarios


Corn
```

```
High production level-125 bu/acre for Jefferson Iowa
J. M. Laflen, Feb 28, 1998
Cutting height 1 foot,  non-fragile residue,  30 inch rows
1  #landuse
WeppWillSet
3.60000 3.00000 35.00196 10.00000 2.30000 55.00000 0.00000 0.30404 0.65000 0.05100
0.85000 0.98000 0.65000 0.99000 0.00000 1700.00000 0.50000 2.60099
2  # mfo - <non fragile>
0.00650 0.00650 25.00000 0.25000 0.21900 1.51995 0.25000 0.00000 30 0.00000
0.00000 3.50000 0.00000 0.00000

#######################
# Operation Section   #
#######################

5  # Number of operation scenarios


FCSTACDP
`Field cultivator, secondary tillage, after duckfoot points
(from WEPP distribution database)
Maximum depth of 10 cm (4 inches)
1  #landuse
0.6000 0.3500 0
4 # pcode - other
0.0250 0.3000 0.6000 0.3500 0.0150 1.0000 0.0500 0.0000 0.0000

TAND0002
`Tandem Disk'
From converted V92.2 file `ANSI1.MAN'
NOTE: MFO values are the min and max of original values.
1  #landuse
0.5000 0.5000 0
4 # pcode - other
0.0500 0.2300 0.5000 0.5000 0.0260 1.0000 0.1000 0.0000 0.0000

PLDDO
`Planter, double disk openers'
(from WEPP distribution database)
Tillage depth of 2 inches
1  #landuse
0.2000 0.1000 6
1 # pcode - planter
0.0250 0.7500 0.2000 0.1000 0.0120 0.1500 0.0500 0.0000 0.0000

CULTMUSW
`Cultivator, row, multiple sweeps per row'
(from WEPP distribution database)

1  #landuse
0.4000 0.2000 0
4 # pcode - other
0.0750 0.7500 0.4000 0.2000 0.0150 0.8500 0.0500 0.0000 0.0000

MOPL
`Plow, Moldboard', 8"
(from WEPP distribution database)

1  #landuse
0.9800 0.9500 0
4 # pcode - other
0.0500 0.4000 0.9800 0.9500 0.0430 1.0000 0.1500 0.0000 0.0000


###############################
# Initial Conditions Section  #
```

```
###############################

1  # Number of initial scenarios


Default
Default corn initial conditions set - continuous corn - spring/summer tillage only
90 percent cover, approximately 200 days since last tillage
500 mm of rain since last tillage in summer prior
1  #landuse
1.10000 0.00000 200 92 0.00000 0.90000
1 # iresd  <Corn>
1 # mang annual
500.12601 0.02000 0.90000 0.02000 0.00000
1  # rtyp - temporary
0.00000 0.00000 0.10000 0.20000 0.02540
0.50003 0.19997 0.00000 0.00000




############################
# Surface Effects Section  #
############################

1  # Number of Surface Effects Scenarios


#
#   Surface Effects Scenario 1 of 1
#
Year 1
From WEPP database
Your name, phone

1  # landuse  - cropland
5 # ntill - number of operations
  121  # mdate  --- 5 / 1
  1  # op --- FCSTACDP
      0.102  # depth
      2  # type
  125  # mdate  --- 5 / 5
  2  # op --- TAND0002
      0.102  # depth
      2  # type
  130  # mdate  --- 5 / 10
  3  # op --- PLDDO
      0.051  # depth
      2  # type
  156  # mdate  --- 6 / 5
  4  # op --- CULTMUSW
      0.076  # depth
      2  # type
  305  # mdate  --- 11 / 1
  5  # op --- MOPL
      0.203  # depth
      1  # type


#######################
# Contouring Section  #
#######################

0  # Number of contour scenarios


#######################
```

```
# Drainage Section    #
######################

0  # Number of drainage scenarios


######################
# Yearly Section      #
######################

1  # looper; number of Yearly Scenarios
#
# Yearly scenario 1 of 1
#
Year 1



1  # landuse <cropland>
1  # plant growth scenario
1  # surface effect scenario
0  # contour scenario
0  # drainage scenario
1 # management <annual>
   288  # harvest date --- 10 / 15 / 0
   130  # planting date --- 5 /10 /0
   0.7620  # row width
   6   # residue man - <none>


######################
# Management Section  #
######################

Manage
description 1
description 2
description 3
1   # number of OFE's
    1   # initial condition index
1  # rotation repeats
1  # years in rotation

#
# Rotation 1: year 1 to 1
#

   1    #  <plants/yr 1> - OFE: 1>
      1 # year index
```

Example 1 year Climate Input Data File (partial)

```
4.10
  1   0   0
  Station:  DELPHI IN                                  CLIGEN VERSION 4.1
Latitude Longitude Elevation (m) Obs. Years   Beginning year  Years simulated
   40.58   -86.67        204          44           95               1
Observed monthly ave max temperature (C)
  1.4   3.8  10.1  17.7  23.6  28.5  30.1  28.9  25.7  19.3  10.9   3.7
Observed monthly ave min temperature (C)
 -8.0  -6.2  -1.2   4.5   9.9  15.1  17.1  15.9  11.9   5.8   0.6  -5.1
Observed monthly ave solar radiation (Langleys/day)
125.0 189.0 286.0 373.0 465.0 514.0 517.0 461.0 374.0 264.0 156.0 111.0
Observed monthly ave precipitation (mm)
 51.4  49.0  67.4  91.3  94.4 100.3 108.9  93.0  72.5  69.3  71.3  65.3
da mo year  prcp  dur   tp     ip  tmax  tmin  rad  w-vl w-dir  tdew
            (mm)  (h)               (C)   (C)  (l/d)  (m/s)(Deg)   (C)
 1  1   95   8.7  2.42 0.02   1.01  -1.1  -8.9  54.  6.2  286.  -5.1
 2  1   95   0.0  0.00 0.00   0.00  -6.4 -13.7  95.  6.4  271. -10.1
 3  1   95   3.2  1.64 0.07   1.01  -4.1 -13.3 146.  3.6  142. -19.4
 4  1   95   0.0  0.00 0.00   0.00  10.4 -14.7 117.  6.7  292. -18.8
 5  1   95   0.0  0.00 0.00   0.00   0.9  -0.4  89.  6.1  257.  -0.4
 6  1   95   0.0  0.00 0.00   0.00   8.4   3.1  82.  6.6  264.   1.1
 7  1   95   0.0  0.00 0.00   0.00  -3.9  -6.7 103.  4.1   68.  -7.5
 8  1   95   0.0  0.00 0.00   0.00   7.2  -2.3 151.  2.8  187.  -6.1
 9  1   95  21.9  0.86 0.80   4.80   1.5  -0.9 143.  6.1    9.  -2.9
10  1   95   0.0  0.00 0.00   0.00   4.1 -10.9 134.  4.3  311.  -3.6
11  1   95   0.0  0.00 0.00   0.00   4.0 -13.5 163.  0.0    0. -13.0
12  1   95   0.0  0.00 0.00   0.00  -2.0 -12.2 189.  3.6  335.  -7.2
13  1   95   0.0  0.00 0.00   0.00  -4.6  -7.2 119.  8.2  301.  -6.0
14  1   95   0.0  0.00 0.00   0.00  -7.6 -10.1  79.  5.7  235. -11.7
15  1   95   0.0  0.00 0.00   0.00  -5.8  -8.8  94.  4.4  326. -21.2
16  1   95   0.0  0.00 0.00   0.00  -3.8 -12.1  98.  4.6   99. -14.3
17  1   95   0.0  0.00 0.00   0.00   0.6  -4.0 121.  3.8  270. -12.0
18  1   95   0.0  0.00 0.00   0.00   2.2 -15.2 104.  9.5  298. -14.1
```

Example single storm Climate Input Data File

```
4.10
  2   0   0
  Station:  DELPHI IN                                  CLIGEN VERSION 4.1
Latitude Longitude Elevation (m) Obs. Years   Beginning year  Years simulated
   40.58   -86.67        204          44            1               1
Observed monthly ave max temperature (C)
  1.4   3.8  10.1  17.7  23.6  28.5  30.1  28.9  25.7  19.3  10.9   3.7
Observed monthly ave min temperature (C)
 -8.0  -6.2  -1.2   4.5   9.9  15.1  17.1  15.9  11.9   5.8   0.6  -5.1
Observed monthly ave solar radiation (Langleys/day)
125.0 189.0 286.0 373.0 465.0 514.0 517.0 461.0 374.0 264.0 156.0 111.0
Observed monthly ave precipitation (mm)
 51.4  49.0  67.4  91.3  94.4 100.3 108.9  93.0  72.5  69.3  71.3  65.3
da mo year  prcp  dur   tp     ip  tmax  tmin  rad  w-vl w-dir  tdew
            (mm)  (h)               (C)   (C)  (l/d)  (m/s)(Deg)   (C)
 1  1    1 160.0  6.00 0.40   2.86  -1.1  -8.9  54.  6.2  286.  -5.1
```

Example Slope Input Data File 95.7 (1 ofe)

```
95.7
1
100      100
3        100
0.0,0.0    0.5,0.09    1.0,0.0
```

Example Slope Input file (97.5)

```
97.5
#
# from slope
#
#
1
180.000 2.787
8 39.020000
 0.000000, 0.000000 0.023439, 0.020000 0.210953, 0.020000 0.268767, 0.090000 0.543765, 0.090000 0.620326,
0.030000 0.957814, 0.030000 1.000000, 0.015000
```

Example Soil File (2006.3)

```
2006.2
comments: soil file
1 1
's2' 'SIL' 3 0.230000 0.750000 5418299.000000 0.020200 3.500000 4.620300
   254 27.4 11.5 3.000 9.9 2.5
   1143 34.7 17.0 1.000 6.8 2.9
   1727 39.8 17.0 0.330 6.8 34.1
1 25.000000 360
```

Example Soil Data File 95.7 (1 ofe)

```
95.7
#
#        Created on 06Jul95 by `WSOL', (Ver. 15Apr95)
#        Author: me
#
Soil Example comment line
1        1
'CARIBOU'        'loam'   6        0.14     0.34     4.78317e+006     0.00523  2.93     5.95
200      38.8     13.7     3.76     13.2     32.9
300      44.7     14       2.31     12.5     38.9
400      43.2     12.3     1.49     9.8      53
640      64.5     7.7      0.73     6.6      48.8
1040     36.3     19.2     0.37     10.8     63
1430     36.3     19.2     0.41     10.2     46
```

Example Depletion-level Sprinkler Irrigation Input File (2 year, 2 ofe)

```
95.7
    2     1     1
0.013 0.025
    1 0.176E-05 1.3  0.5  1.0   175    94   185    94
    2 0.176E-05 1.3  0.5  1.0   175    94   185    94
    1 0.176E-05 1.3  0.5  1.0   185    94   195    94
    2 0.176E-05 1.3  0.5  1.0   185    94   195    94
    1 0.176E-05 1.3  0.5  1.0   175    95   185    95
    2 0.176E-05 1.3  0.5  1.0   175    95   185    95
    1 0.176E-05 1.3  0.5  1.0   185    95   195    95
    2 0.176E-05 1.3  0.5  1.0   185    95   195    95
    1 0.000E+00 0.0  0.0  1.0     0     0     0     0
    2 0.000E+00 0.0  0.0  1.0     0     0     0     0
```

Example Fixed-date Sprinkler Irrigation Input File (2 year, 2 ofe)

```
95.7
    2     1     2
```

```
    1   175    94
    2   175    94
.176E-05 0.0032  1.0
    1   185    94
.176E-05 0.0032  1.0
    2   185    94
.176E-05 0.0032  1.0
    1   195    94
.176E-05 0.0032  1.0
    2   195    94
.176E-05 0.0032  1.0
    1     0     0
.176E-05 0.0032  1.0
    2     0     0
```

Example Depletion-level Furrow Irrigation Input File (2 year, 2 ofe)

```
95.7
    2     2     1
0.013
    1     2 0.315E-04 14400.  1    0.9    0.5    175    94    185    94
    2     2 0.315E-04 14400.  1    0.9    0.5    175    94    185    94
    1     2 0.315E-04 14400.  1    0.9    0.5    195    94    205    94
    2     2 0.315E-04 14400.  1    0.9    0.5    195    94    205    94
    1     2 0.315E-04 14400.  1    0.9    0.5    175    95    185    95
    2     2 0.315E-04 14400.  1    0.9    0.5    175    95    185    95
    1     2 0.315E-04 14400.  1    0.9    0.5    195    95    205    95
    2     2 0.315E-04 14400.  1    0.9    0.5    195    95    205    95
    1     0 0.000E+00     0.  0    0.0    0.0      0     0      0     0
    2     0 0.000E+00     0.  0    0.0    0.0      0     0      0     0
```

Example Fixed-date Furrow Irrigation Input File (2 year, 2 ofe)

```
95.7
    2     2     2
    1   175    94
    2   175    94
    2
.315E-03     0. 14400.
.315E-03 43200. 57600.
    1   185    94
    2
.315E-03     0. 14400.
.315E-03 43200. 57600.
    2   185    94
    1
.158E-03     0. 14400.
    1   195    94
    1
.158E-03     0. 14400.
    2   195    94
    1
.710E-04     0. 28800.
    1   175    95
    1
.710E-04     0. 28800.
    2   175    95
    2
.315E-03     0. 14400.
.315E-03 43200. 57600.
    1   185    95
    2
.315E-03     0. 14400.
.315E-03 43200. 57600.
    2   185    95
    1
.158E-03     0. 14400.
    1   195    95
    1
.158E-03     0. 14400.
    2   195    95
.710E-04     0. 28800.
    1     0     0
    1
.710E-04     0. 28800.
    2     0     0
```

Sample hillslope run input file[1]

```
         1         2         3         4         5
12345678901234567890123456789012345678901234567890123456789012345678901234567890
95.7                                                        # WEPP: version
Yes                                                         # WEPP: Exit on errors?
1                                                           # WEPP: Continuous simulation
1                                                           # WEPP: Mode
Yes                                                         # Hill: Create pass file?
E:\WEPP\INPUT\HILL\PASS\TWO.hil                             # Hill: Pass output
1                                                           # Hill: Annual; abbreviated
No                                                          # Hill: Warmup output?
E:\WEPP\OUTPUT\SUMMARY\TWO.sum                              # Hill: Summary output
No                                                          # Hill: Water output?
No                                                          # Hill: Crop output?
No                                                          # Hill: Soil output?
Yes                                                         # Hill: Plotting output?
E:\WEPP\OUTPUT\PLOT\TWO.plo                                 # Hill: Plotting output
Yes                                                         # Hill: Graphics output?
E:\WEPP\OUTPUT\WGR\DATA\TWO.wgr                             # Hill: Graphics output
No                                                          # Hill: Event/OFE output?
No                                                          # Hill: Event/OFE output?
No                                                          # Hill: Event/OFE output?
No                                                          # Hill: Winter output?
Yes                                                         # Hill: Yield output?
E:\WEPP\OUTPUT\YIELD\TWO.yld                                # Hill: Yield output
E:\WEPP\INPUT\MAN\DATA\CBWNTMF.man                          # Hill: Management input
E:\WEPP\INPUT\SLOPE\DATA\UNIFORM.slp                        # Hill: Slope input
E:\WEPP\INPUT\CLIMATE\DATA\WEST_LAF.cli                     # Hill: Climate input
E:\WEPP\INPUT\SOIL\DATA\CARIBOU.sol                         # Hill: Soil input
0                                                           # Hill: No irrigation
2                                                           # Hill: Number of years
0                                                           # Hill: All events
```

Complex Slope File for 2 Channel Watershed

```
95.7
#
#       Created on 11Mar94 by `WSLP', (Ver. 11Mar94)
#       Author: Your Name, Phone #, e-mail address, etc..
#
2
200     5
7       100
0,0 0.2,0.05 0.37,0.09 0.55,0.02 0.71,0.06 0.88,0.03 1,0.01
200     5
7       100
0,0 0.2,0.05 0.37,0.09 0.55,0.02 0.71,0.06 0.88,0.03 1,0.01
```

Structure File with 2 Channels

```
95.7
2          # number of channels
1          # IPEAK : EPIC
1.50       # Length to width ratio
First channel
First series of tests

1          # shape : triangular
2          # control structure : uniform
1          # friction slope : CREAMS
4          # output type
5.0        0.030
0.040      0.0082    3.5      0.3       0.3
0.026      5.0       0.060
Second channel
First series of tests

1          # shape : triangular
2          # control structure : uniform
1          # friction slope : CREAMS
4          # output type
5.0        0.030
0.042      0.0082    3.5      0.3       0.3
0.026      5.0       0.060
```

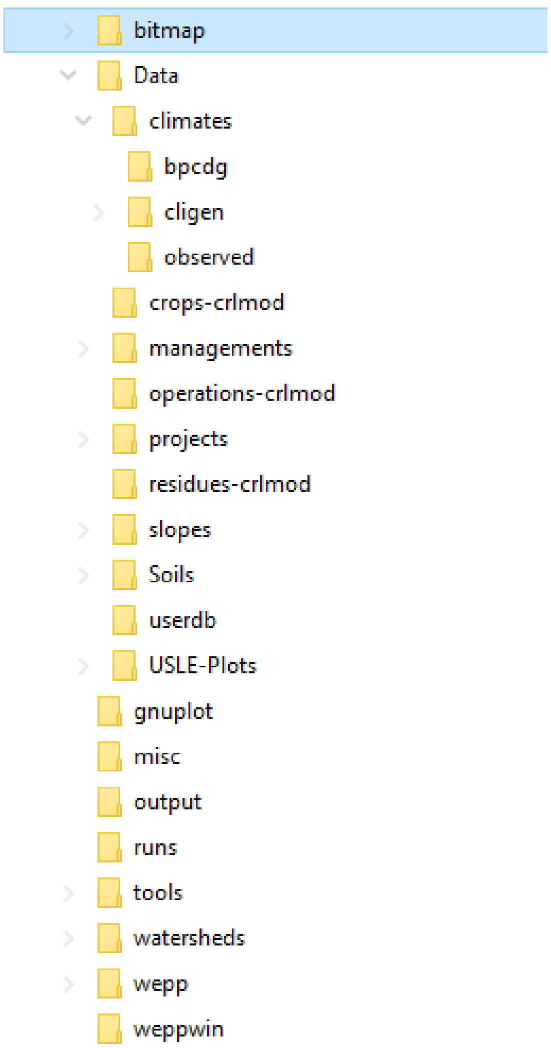
Impoundment File with 2 Impoundments

```
95.7
2    Number of Impoundments
Test Impoundment With Rock Fill
Test file
August 1995
    0
    0    0
    0    0
    1
Impoundment With Rock Fill Outlet
       2.5       1.0       2.0       2.0      0.50
    0
    0
    0
      2.00       1.0      0.00       0.1     0.009
    2    2
   14
       0.0     250.0      12.0
# Stage data
       1.0       2.0       3.0       4.0       5.0       6.0       7.0
       8.0       9.0      10.0      12.0      14.0      16.0      18.0
# Area data
    450.00     650.0     825.0    1000.0    1125.0    1250.0    1375.0
   1500.00    1650.0    1800.0    2075.0    2315.0    2545.0    2775.0
# Length data
      16.0      19.0     21.00      23.0      24.5      26.0      27.5
      29.0      30.0      31.0      33.0      35.0      37.0      38.0
Test Impoundment With Emergency Spillway Only
Test file
August 1995
0       # Drop Spillway: Not Present
0       0       # Culvert: Not Present
0       0       # Culvert: Not Present
0       # Rock-fill Check dam: Not Present
1       # Emergency Spillway: Open Channel
Impoundment With Open Channel Outflow Structure
        6.0957  3       0.1     4.87656 6.0957
        0.04    12.191  0       3.048   0.25
```

```
0       # Filter Fence: Not Present
0       # Perforated Riser: Not Present
6.1     0.876   4.75    0.1     0.00086
2       2
   14
       0.0      250.0       12.0
# Stage data
       1.0        2.0        3.0        4.0        5.0        6.0        7.0
       8.0        9.0       10.0       12.0       14.0       16.0       18.0
# Area data
    450.00      650.0      825.0     1000.0     1125.0     1250.0     1375.0
   1500.00     1650.0     1800.0     2075.0     2315.0     2545.0     2775.0
# Length data
      16.0       19.0      21.00       23.0       24.5       26.0       27.5
      29.0       30.0      31.0        33.0       35.0       37.0       38.0
```

Files and Directory Structure Installed with the WEPP Interface

The default installation directory is c:/wepp The following subdirectories are setup:



bitmap	Images used in interface program
Data/climates/bpcdg	Breakpoint generator program and example
Data/climates/cligen	CLIGEN programs and data files
Data/climates/observed	Examples of observed climate files
Data/crops-crlmod	CRLMOD WEPP crop records
Data/managements	Management files used by the interface
Data/operations-crlmod	CRLMOD WEPP operations records
Data/projects	Project files defining runs used by the interface
Data/residues-crlmod	CRLMOD WEPP residue records
Data/slopes	Slope input files used by the interface
Data/soils	Soil input files used by the interface
Data/userdb	Where user created operations, crops records are saved
Data/USLE-Plots	WEPP model files for USLE data
gnuplot	Graphing program files
misc	
output	When WEPP output files are written
runs	Where interface files build input files for the model
tools	External Python programs that can be called from the interface
watersheds	Where the interface builds watershed setup files
wepp	Main WEPP science model location
weppwin	Main WEPP interface program and help files