A Department of Ecology Report

WASP Implementation and Model Modifications Manual

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WASP Implementation and Model Modifications Manual

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Introduction

Project Objective

The Washington Department of Ecology (Ecology) recently adapted a new state rule addressing sediment quality known as the Sediment Management Standards (SMS), Chapter 173-204 WAC. The rule identifies how sediment quality standards will be used to control sediment contamination from ongoing, permitted discharge sources and to effect contaminated sediment site cleanup. The rule requires the application of specific numerical models for predicting the environmental effects of ongoing discharges and the recontamination potential of contaminated sediment sites after active cleanup.

One of the models specifically listed in the rule is the Water Analysis Simulation Program (WASP) developed and maintained by the U.S. Environmental Protection Agency (EPA). This model is considered to be the recommended EPA standard for dynamic analysis and is supported and updated by the U.S. EPA Center for Exposure Assessment Modeling in Athens, Georgia.

WASP is a dynamic compartment ("box") modeling program for aquatic systems, including both the water column and the underlying benthos. The time-varying processes of advection, dispersion, point and non-point mass loading, and boundary exchange are represented in the basic program. The WASP framework includes a component (TOXI4) specifically designed for the estimation of exposure concentrations for organic chemicals. The TOXI4 component has the capability of simulating up to three chemicals and solids types. TOXI4 can simulate the effects of a variety of transformation and degradation processes, such as sorption, ionization, oxidation, volatilization, and photolysis, on the total, dissolved and particulate chemical concentrations in the water column and benthos.

The goal of this project will be to modify the most recently available version of the WASP model (version 4.32) for application to the SMS. The modifications to be completed by AScI will include development of a 32-bit version of the model, modifications to WASP's segmentation algorithms, providing for an automatic preprocessor for the TOXI4 and hydrodynamic (DYNHYD) components of WASP, adding the capability of performing limited sensitivity analyses, and the incorporation of error explanations.

WASP System Requirements

The WASP modeling system was developed and implemented on the IBM personal computer compatible environment and will only execute in this environment. The FORTRAN programs can be ported to other environments/platforms with little difficulty.

Ecology is provided with 32-bit versions of the WASP and DYNHYD executables. These executables require the user to load a kernel (DBOS). This kernel loads "over" DOS and does not interfere with any of DOS normal functions. The 32-bit executables are virtual and will allocate memory on a as need basis. These executables make use of all of the computers available RAM. It will be required to remove DBOS before executing Microsoft Windows. To do the user should type the following:

KILL_DBO <Enter>

Given below is an example CONFIG.SYS file that maybe used as a model for reconfiguring your system's file. This is considered a minimum configuration. Note the location of the given files may not exactly match your system. Most of the components of the WASP modeling system support extended memory in some fashion. EMS/XMS memory will allow the programs to load their overlay structures and store large data structures in memory increasing the efficiency of execution. For the programs to use the extended memory of your machine (if available) an EMS/XMS driver most be loaded at bootup. The WASP modeling system was developed and tested using Quarterdeck's QEMM extended/expanded memory manager. It will also work with the extended/expanded memory manager that comes with DOS (EMM386.SYS). The CONFIG.SYS file below illustrates the command line needed to activate the expanded memory manager at bootup. Note that with QEMM386.SYS one program needs to be loaded. If EMM386.SYS is used HIMEM.SYS will need to be loaded as well. HIMEM.SYS allows the loading of the operating system into high memory thus giving the user more low memory (0 to 640 k region). For more detailed information on QEMM386.SYS, EMM386.SYS and HIMEM.SYS see the QEMM manual and/or the DOS manual.

Example CONFIG.SYS

```
BREAK=OFF

DEVICE=C:\DOS\ANSI.SYS
DEVICE=C:\QEMM\QEMM386.SYS RAM
                or
DEVICE=C:\DOS\EMS386.SYS
DEVICE=C:\DOS\HIMEM.SYS

BUFFERS = 32
FILES=50
FCBS=16,8
DOS=HIGH,UMB
```

The WASP modeling system works like most commercial software packages and can be executed from any directory or hard drive. Placing the directory of WASP in your system path will allow you to execute all of the programs. Project directories can be utilized to help manage the large amount files created. The AUTOEXEC.BAT given below illustrates how to add the WASP modeling system to your DOS system path (Note: the example assumes that the user has installed the programs in a directory called WASP).

Example AUTOEXEC.BAT

```
PATH C:\;C:\DOS;C:\QEMM;C:\WP51;C:\WASP
SET PROMPT=$P$G->
```

Common User Access (CUA)

The preprocessor and postprocessor programs were designed to adhere to the common user access protocol for keystrokes. The CUA standard was developed by IBM to give guidance in the development of application software so that the user would automatically know the keystrokes required to accomplish a specific task. The CUA standard has been adopted by many of the large commercial software developers. The following list gives examples for some of the CUA compliant keystroke sequences used throughout the WASP modeling system:

1. <F1> -- Context sensitive help for the field where the cursor is located
2. <F2> -- Display picklist if available
3. <Control-Enter> -- Accept information that has been entered into a data entry form.
4. <ESC> -- Abort the entered information in a data entry form or back up one level in a pulldown menu structure.
5. <Home/End> -- Move down/up in a column in a data entry screen
6. <Control-Home/End> -- Jump to the top/bottom of a data entry column

Computer System Requirements

Because of the complexity and the computational burden of the WASP modeling system, a high speed personal computer is recommended. However, the model(s) will execute on any personal computer with at least 20 megabytes of hard disk storage and 640 kilobytes of random access memory. A mouse is supported throughout the modeling system. The WASP modeling system has only been tested under DOS 5.0 but should function correctly under earlier versions of DOS, as long as the following criteria are observed. For the all the programs to function correctly there must be at least 545 kilobytes of RAM available before beginning execution of the program(s). To determine the amount of memory available for program execution type the following:

DOS 5.0 type *MEM*

655360 bytes total conventional memory
655360 bytes available to MS-DOS
548560 largest executable program size <--- Available RAM

7979008 bytes total EMS memory
3325952 bytes free EMS memory

3145728 bytes total contiguous extended memory
0 bytes available contiguous extended memory
3338240 bytes available XMS memory
MS-DOS resident in High Memory Area

DOS 4.01 and lower type *CHKDSK*

Volume 486-33 created 07-02-1991 10:30a
Volume Serial Number is 2A2F-16EF

210309120 bytes total disk space
192512 bytes in 6 hidden files
987136 bytes in 216 directories
203317248 bytes in 5528 user files
5812224 bytes available on disk

4096 bytes in each allocation unit
51345 total allocation units on disk
1419 available allocation units on disk

655360 total bytes memory
548560 bytes free <------- Available RAM

These commands will return the amount of memory available for execution. Note these numbers highlighted above are in bytes, divided by 1024 to get kilobytes. If you do not have enough memory free see the following sections on CONFIG.SYS and AUTOEXEC.BAT configurations. It should be noted that DOS 5.0 yields the most free memory of any other versions of DOS. If you are connected to a Local Area Network (LAN) you may have to disable this function. This may aid in regaining some memory being occupied by the LAN. Without enough memory the program(s) performance and execution is questionable.

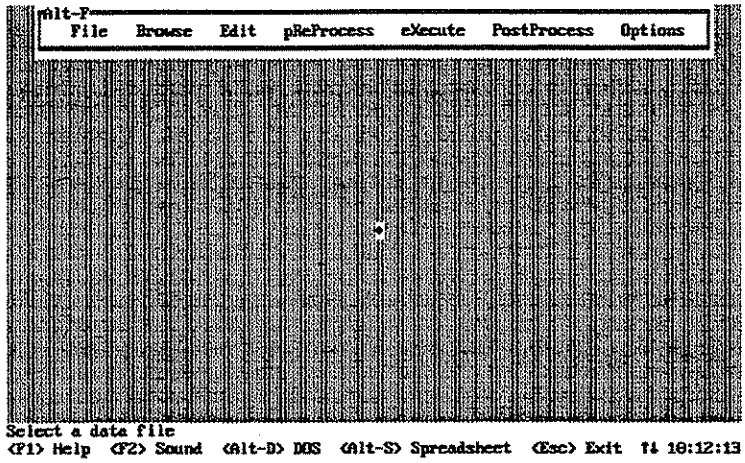
WASP Interactive Support Program Modifications (WISP)

WISP is an interactive menu driven point and shoot user environment that allows for the easy execution of the WASP modeling system of programs. WISP has the capabilities of allowing you to view/edit your WASP/DYNHYD input datasets as well as execute and post process the results. The ability to execute the WASP modeling system from any subdirectory you hard drive on your system . The user will need to add the subdirectory in which the WASP files are installed to your DOS PATH statement. This will require a modification of your AUTOEXEC.BAT file which is located in your boot drive root directory (see SYSTEM REQUIREMENTS). Edit the AUTOEXEC.BAT and add WASP (or whatever the name of the subdirectory where you installed the WASP modeling system) to the PATH statement.

PATH C:\;C:\DOS;C:\UTILS;C:\WP51;**C:\WASP**

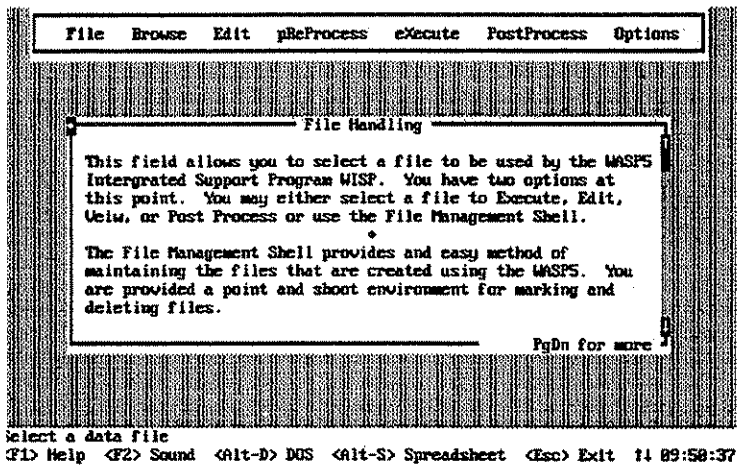
For further information on the DOS path statement see your DOS manual.

WISP provides a user shell for the WASP modeling system and allows for the execution and manipulation of all data that is used or produced by its associated programs. Once WISP is loaded the user will not need to access any operating system commands. WISP provides file management, dataset creation, editing, post processing and links to outside programs. Note: WISP has "Hot-Key" access once it is loaded, for every menu choice a letter is highlighted, by press the highlighted key the option is automatically selected. The following are some basic descriptions of the purposes of the various fields of the WISP program. The figure below illustrates the main menu of WISP.



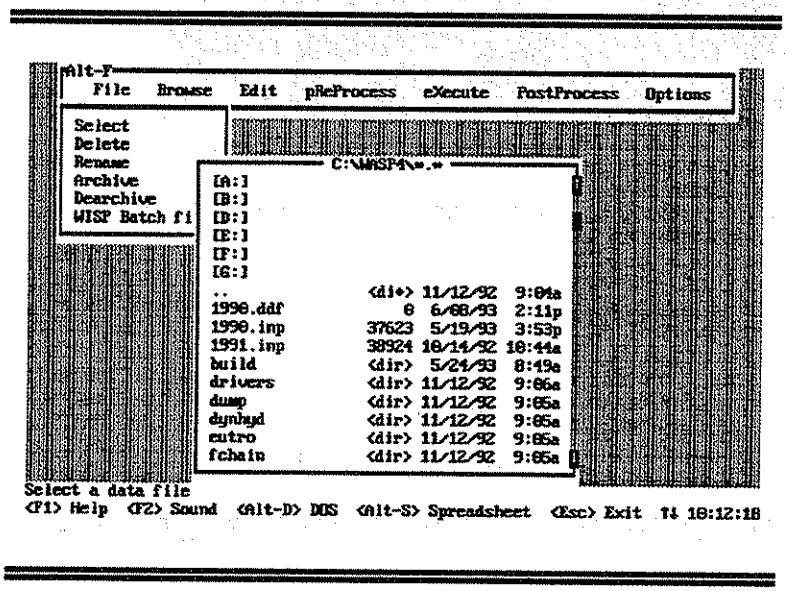
WISP Help Facility

The WISP has context sensitive help built into the program. Context sensitive help can be called up at any point within the WISP program by pressing the F1 key. Help will be displayed for the current item (where cursor is placed). To remove the help screen press the ESC key. By Pressing F1 twice the user will receive an index of all help that is available. The context sensitive help is really all the user needs to successful use the WISP program.



File Manager

The File Management Shell provides an easy method of maintaining the files that are created during WASP model simulations. Because this is a diverse modeling system many large files are created by the various programs. WISP helps you maintain these files while protecting the files needed by the WASP modeling system.



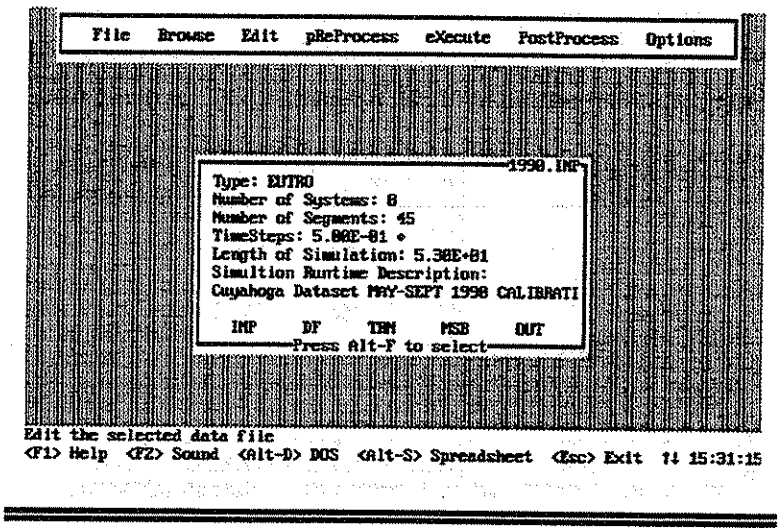
File Select will allow the user to pick the file in which to work. The file can be any of the existing valid input/output or simulation results files that exist. Upon the selection of a file the user can do several things as described below.

File Selection

File Selection allows the user to select ANY of the WASP model simulation files (*.INP, *.EDF, *.TDF, *.TRN, *.OUT). When one file is selected all the files that are associated with that file are activated by WISP. In other words, if you are working on a project called River and your WASP input file is called RIVER.INP, upon selection of RIVER.INP all the associated simulation results files will be available for review or manipulation (if they exist) without returning to the File Selection Menu. Note that WISP determines simulation results files based on predetermined file convention. If this file convention is not followed WISP will not recognize the files. The naming convention is given in the table below:

File Extension	File Type
*.INP	Simulation input file. *WISP* determines file type automatically.
*.EDF	EUTRO4 Results File
*.TDF	TOXI4 Results File
*.MSB	WASP Mass Balance Table
*.OUT	Model Input Echo File
*.TRN	WASP Transport File

Upon the selection of a valid file, the File Dialog box will be displayed in the middle of the screen. Basic information about the file is displayed in the file dialog box that allows the user to determine if the appropriate dataset was selected. The dialog box will also display what result files are available, if any. The bottom line of the dialog box will have flags for the different files that are created and used by the WASP Modeling system. INP-indicates input file, DF-indicates simulation result file, TRN-refers to transport result file, MSB-indicates mass balance table for specific system, OUT-refers to the echo out of the user input file. If the flags are illuminated in bright color attributes the file exists and can be processed and manipulated. If the flag is in diminished colors the file does not exist. If the input file does not exist WISP will not allow you to execute until a valid input file is created or selected. The same is true for post processing, if there are no valid files for post processing you will not be able to execute the post processor. The figure below gives an illustration of WISP's File Dialog box.

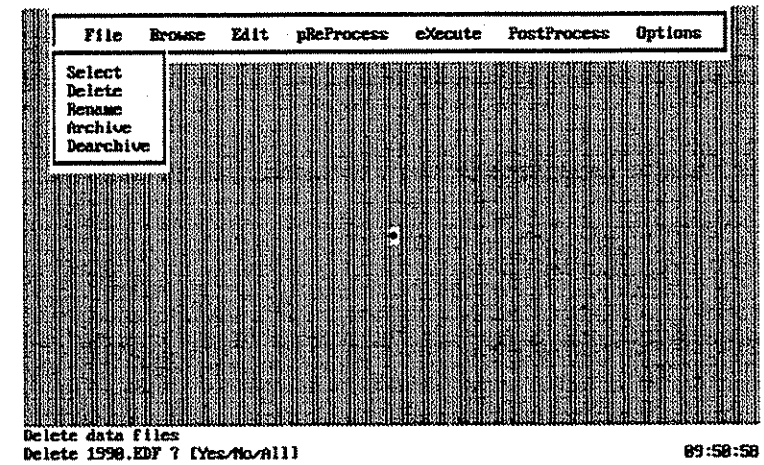


File Deletion

Deletion is available so you may manage the large numbers of files that get created with every model execution. You can simply TAG the files you would like to delete and WISP will do the rest. This process works much like the commercial file management systems.

You will have 2 options when you select DELETE:

1. Selective answer Y or N on every file tagged. This method insures that you really want to delete the file or not.
2. <A> will cause all tagged files to be deleted without inquiring whether you want them deleted or not!



Rename

The rename option allows the user to rename a project file before making modifications to the current files. The rename option will copy your project files to another name before you continue with the modification of the current selected project files. This is a quick way to do sensitivity analysis and not lose any of the previous model input and result files due to overwriting.

Archiving

Because the simulation result files can get rather large and are not always needed, the user has the option of archiving project files. By archiving the user selects the appropriate INP file, and all files related to that input file are automatically selected. Upon agreeing to the archive process for a particular project, all the files are compressed into one file which can be dearchived later. The archive process usually recovers 60-80% of the disk space that was being used by the simulation result files. For the archive option to work correctly the user needs a copy of PKware's PKzip.

De-Archive

De-Archive allows the user to select a previously created archive to decompress. The compressed files will be reconstituted in the current default directory and the archive file will be deleted.

WISP Batch Mode

With the addition of the "uncertainty" algorithms to the WASP preprocessor it became necessary to modify WISP so that multiple datasets could be run in a single pass. PreWASP will create a WISP batch command file which will be created to instruct WISP as to which sets of files will be executed. From the file manager the user may select a batch command file to executed. This file acts as a pointer to the individual files that need to be execute. Upon selection of the input file WISP will execute the commands in sequential order. The format of the file is as follows:

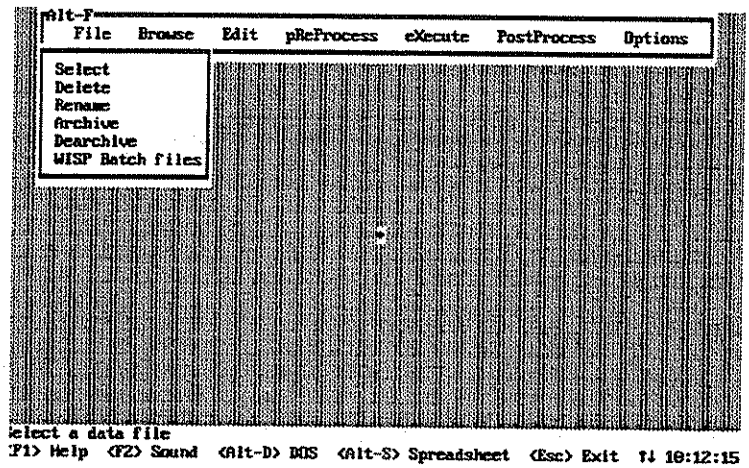
RUN FILE1.INP

RUN FILE2.INP

RUN FILE3.INP

RUN FILEx.INP

END

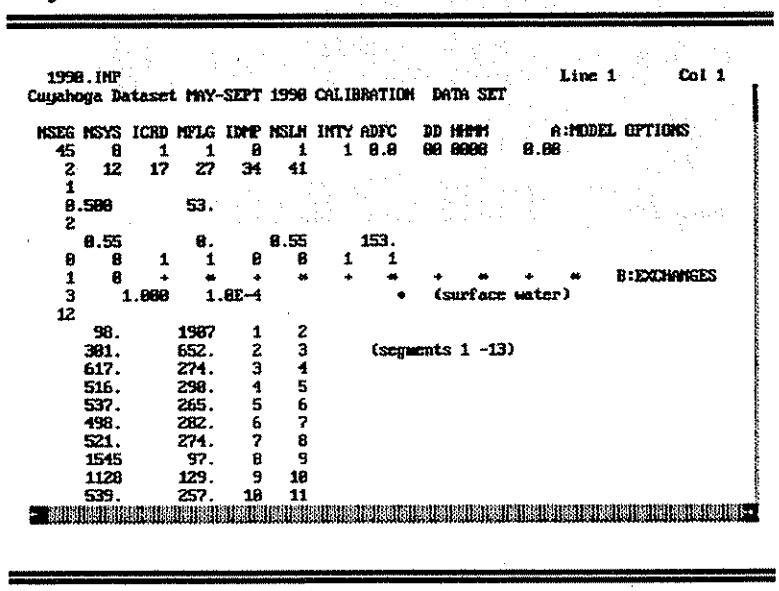


These WISP Batch Files are created automatically by the WASP preprocessor, but, the user could create them by hand using the ASCII editor to run a sequence of WASP simulations.

In order for the file manager to recognize the batch command file it must have the extension *.WBF (WISP Batch File). This option can be used manually by creating the appropriate *.WBF file using an ASCII editor and selecting it from the Batch file option.

Browser

The browser allows the user to quickly view any of the WASP model files without loading them into the editor. The browser serves two purposes: 1) it allows for files to be viewed rapidly, 2) there is no chance of changing the file contents. The browser can handle a file of any size. The commands available while browsing are described in Appendix A. The browser is illustrated below, and looks very much like a text editor.

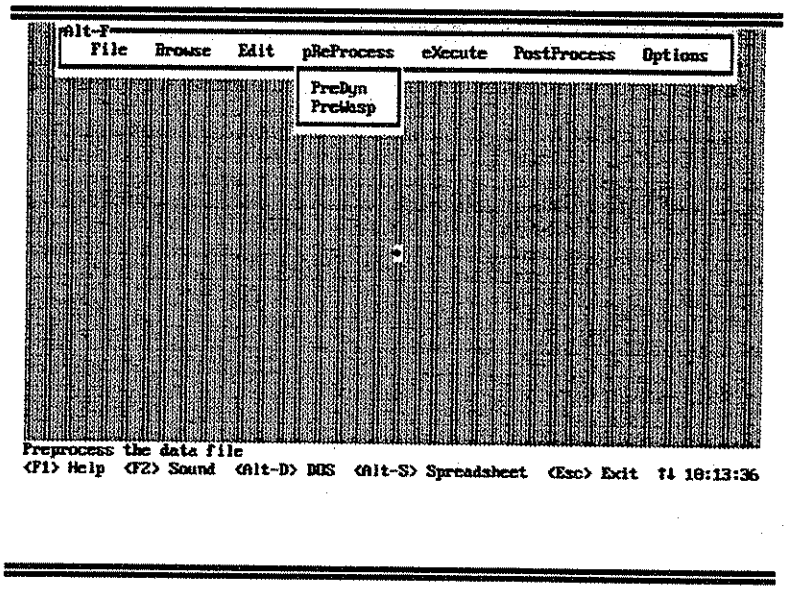


Editor

The WISP offers an ASCII compatible editor which the user can use to create and edit input files without the use of the preprocessor programs. The editor is full featured, so block manipulation and cutting and pasting can be accomplished. The editor is a separate program and can be used for other tasks as well. You need to make sure that EDITOR.EXE and WISP.OPL can be found along the system path. All the commands for the editor are given in Appendix B. The WISP editor offers an extensive set of text editing commands. The editor can only read/write ASCII compatible files.

Preprocessor

The WISP preprocessor option allows the user to select the preprocessor (PREWASP, PREDYN) to load. If user has selected a valid input file, the appropriate preprocessor will be loaded and along with the input file in which to work with. With PREDYN it will be required to select the file from within the program. For additional information on the use of the preprocessor see the appropriate sections of this User's Manual.



Execution

The appropriate model program execution is automatically handled by WISP. The user must select a valid input dataset before the user can attempt the execute option. If the WISP file dialog box returns a file type of UNKNOWN the user will not be able to use the execute option. WISP will only execute when a valid input file has been selected and can determine the file type. When a valid input file has been selected WISP will chose the appropriate model to execute, passing the input file in which to run.

Postprocessing

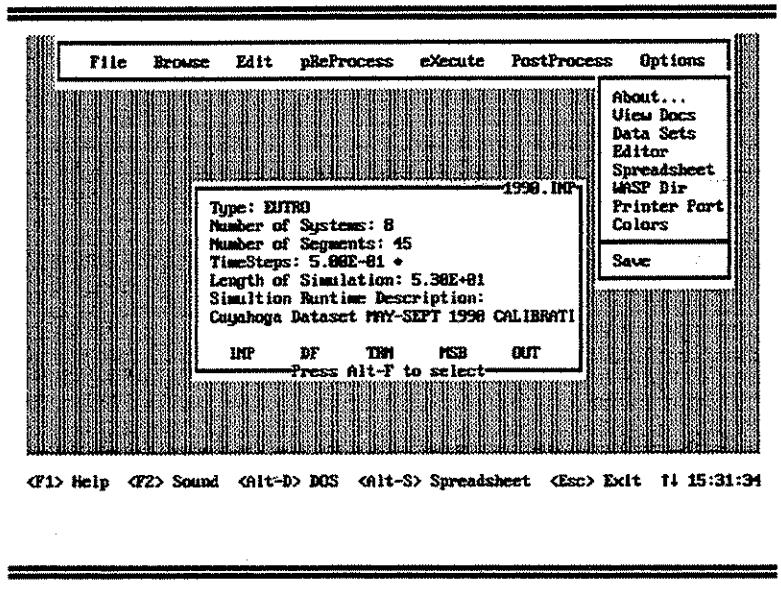
Upon selection of the post processor WISP will load the post processor with the appropriate simulation results file. If the current selected file is the input file (INP) then WISP will pass the simulation result file (DF) to the post processor. If an appropriate file is not available the post

processor will not execute. The post processor allows the user to interactively view the simulation results graphically or export the results to several other formats.

The post processor is capable of processing up to 5 simulation results files created by either WASP and DYNHYD. By default when the input file is the hot file (indicated by the Dialog Box) the DF file is passed to the post processor. To select the WASP TRN file for processing, press ALT-F then toggle to the TRN indicator press RETURN and then ESC. The active file name displayed in the upper right hand corner of the dialog box should be filename.TRN. If the file is not available you will not be able to select it. For more information on the post processor program see the section in the User's Manual.

Configuration Options for WISP

Because WISP is meant to be used as user shell to the WASP modeling system several options are presented to the user to allow for the customization of the program to best suit the user's needs. The Options menu of WISP is where all the customization can occur. All modifications to the WISP program that are saved to disk at permanent, there is not way to recall the default values. Please be careful in your modifications.



View Documents

The view document option allows the user to view the user support documentation that are included with the WASP models. This includes the README.1ST, RELEASE.TXT and UPDATE.DOC files. Note that additional information files maybe added in the future to accommodate changes in the WASP model.

The README.1ST document contains some basic information and capabilities of the WASP modeling system. There are brief descriptions for all the files contained on the distribution diskettes, system requirements to adequately execute the models. A description is given for the software required to recompile the models.

The RELEASE.TXT gives a description of changes that have occurred in the models from one release to another. This is a good source of information for improvements and "bug" fixes that have occurred in the model from one release to another.

UPDATE.DOC contains all information that has changed since the printing of the EPA published manual. Any changes to the model(s) that have been made that requires changes in input values are documented here. The addition of new algorithms to the model would also be explained in this document.

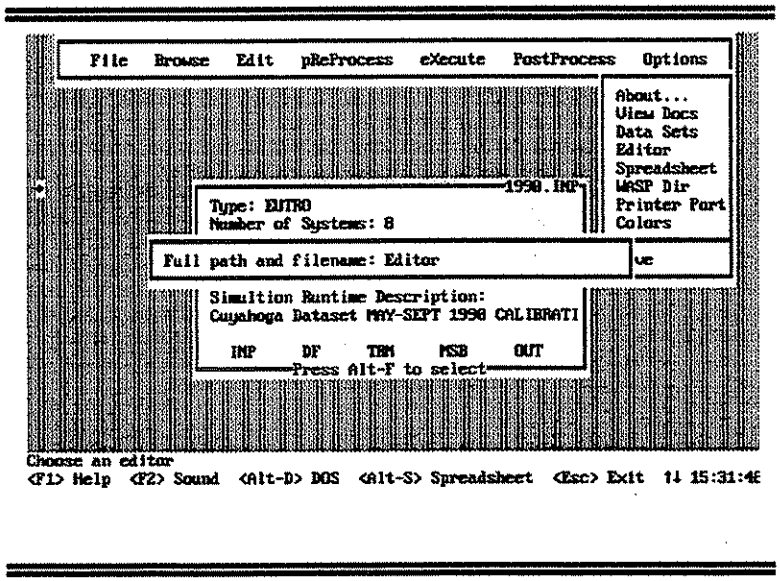
Editor

The default editor for WISP is the one that is provided with the WISP package. WISP is automatically configured to use this editor. Because one editor is not all things to everyone, we have provided an option for hooking in YOUR OWN editor. You may elect to add your editor to the WISP configuration, you must provide the full path (including Drive) and file name (including extension) in the editor configuration menu as illustrated by:

C:\BRIEF\B.EXE

If WISP can not locate the file in the given directory it will issue a beep and not accept the command line. This command would add BRIEF as my editor to use with WASP.

IMPORTANT: The FORTRAN programs expect the input files to be straight ASCII files. Make sure that you use an ASCII editor



that is capable of accepting the filename on the command line (most editors have this capability). Most word processors have an option for straight ASCII editing but there are usually some elaborate steps to importing and exporting ASCII text. The use of a non-ASCII editor can lead to some unexplainable errors.

Spreadsheet

The spreadsheet option informs WISP were the user's spreadsheet program is located. Note the spreadsheet configuration is much like the external editor, the user must provide the PATH and EXECUTABLE name for WISP to execute when the spreadsheet option is selected. When the spreadsheet option is created from W5DSPLY a comma delimited ASCII file is created that can be directly imported by most popular spreadsheet programs. Note: there is no generic format the can be automatically imported by all spreadsheet programs. Some user input would be required to successfully import a file.

This example illustrates how to add Borland's Quattro Professional spreadsheet program:

C:\QPRO\Q.EXE

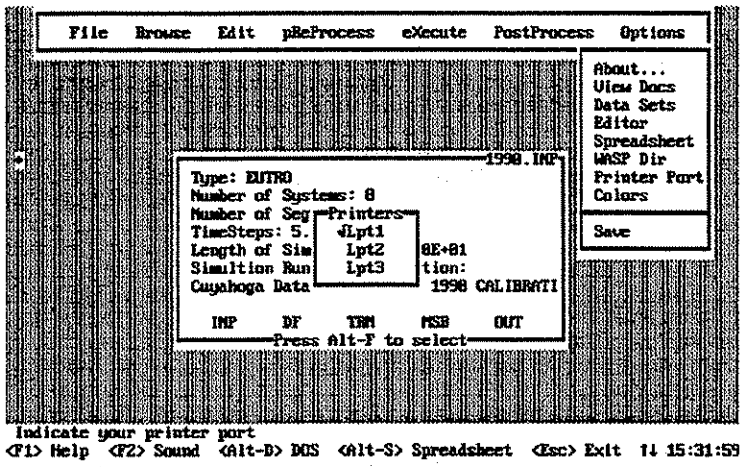
If WISP can not locate the file in the given directory it will issue a beep and not accept the command line.

WASP Directory

The default WASP directory option is initialized to C:\WASP\. This information is important so that WISP knows exactly where the models are installed. If you elect to execute the WASP models from other subdirectories WISP provides a control file (WASP.CTL) to the models that contains the name of the file to execute and the path to the runtime files. If you move the WASP models from this default drive or directory to another you need to update the drive and directory here. If you do not the typical error returned by WASP/DYNHYD is unable to open MESSFILE.DAT.

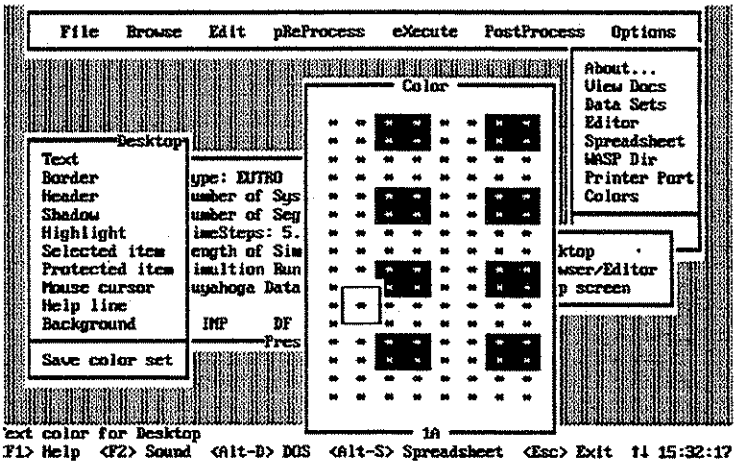
Printer Port

The printer port option allows the user to select which hardware port all printed output will be sent. Printing is available from WISP and the W5DSPLY programs. Note: only the standard LPTx printer ports are supported. If your printer is connected to a serial port (COMx) please see your DOS manual on how to use the MODE command to redirect COM output to the LPTx designation. The user is required to select one of the options given in the configuration screen illustrated below. There is no way to override these choices without using the DOS mode command to redirect the output.



Colors

WISP allows for the user to completely customize the color palette for all windows. This allows the user to select the colors that are most comfortable to them. The color option only pertains to the WISP program and has no control over any others.



WASP Routine Execution

The user may execute the WASP system of models in a number of fashions. The first method of execution would be through WISP. When using WISP the appropriate executable (TOXI or EUTRO) is selected based on the active input dataset selected by the user.

If WISP is not used, the user would have to know which executable to run (TOXI4 or EUTRO4) and the name of the input dataset. Inorder to execute the TOXI or EUTRO model the dataset must be prepared before with either the PreWASP program or a generated by the user with their own editor. If you know the input file that you want to execute is for the organic chemical model the user would type the following information from the system prompt in the WASP default directory:

TOXI4 <Enter>

This will load the TOXI4 program and then the user would be presented a pick list of input datasets from the current directory. Use the up/down arrow keys to select the appropriate dataset, once the cursor is on the correct dataset name simply press enter. The model will give the user some indication of the current state of execution, unless the user selected the no runtime information option during the building of the input dataset. The same steps would be repeated for the eutrophication model substituting EUTRO4 for TOXI4. NOTE: If WISP is not used the WASP programs have to be executed from the directory which contains the executables.

Once the WASP models are running there are several options available to the user to query intermediate simulation results. If the user selected the option that allows the displaying of intermediate results to the screen, the user has several options during runtime.

Abort Simulation -- the user can elect to abort an simulation by pressing the ESC key. When the ESC key is pressed the simulation will continue to the next simulation dump interval and query the user if they indeed want to abort the simulation. If the user selects Y then the

simulation is aborted and all output files are closed correctly and can be processed by the post processor without errors. If the user selects N the simulation will continue.

Change Segments -- at any time the user may elect to change the segments that are displayed in the runtime grid. To do this press the C key. The user will be presented with a pick list of available segments. The user will be required to select 6 segments by using the arrow keys and the Enter key to select. If there are less then 6 segments in your simulation the C key will not do anything.

Water Quality -- By default the first displayed intermediate result screen shows the water quality calculations. For the TOXI model, this would be Total Chemical 1 thru 3 and Solids 1 thru 3 with the units of mg/l, and finally the segment flow (cms). For the EUTRO model the ammonia, nitrate, orthophosphate, dissolved oxygen, BOD, chlorophyll-a, organic nitrogen, organic phosphorus are displayed in units of mg/l. And again the segment flow (cms) is displayed. The water quality screen can be toggled back and forth between the transport screen by pressing W for water quality and T for transport. Note that the screen will not change until the next simulation dump interval is encounter, this is done to increase efficiency and not poll the keyboard every time step. Any example of a WASP runtime screen is given below.

TOXI4 -- Intermediate Simulation Results

Simulation Time	2.60 days	Percent Complete:	130.21	Real Time:	15:33:53
Time Step:	0.5787		Segments	Iterating:	-

	4	6	8	10	12	14
Total Chem 1	0.625E+00	0.500E+01	0.375E+01	0.625E+00	0.153E-06	0.000E+00
Total Solids 1	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Solids 2	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Solids 3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Chem 2	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total Chem 3	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Segment Flow	0.100E+03	0.100E+03	0.100E+03	0.100E+03	0.200E+03	0.200E+03

Simulation Completed--Press Return to Exit

Transport -- The transport screen can be displayed by pressing the T key once the intermediate simulation screen has been displayed. At the next simulation dump interval the transport screen will be displayed. The screen contains information pertaining to the actual transport (advection, dispersion and time step) information being used by the model. A description of each of the transport display variables is given below:

Max DT.--is the maximum time step that can be used by WASP as calculated on a segment by segment basis. Remember that the lowest time step for any given segment will control the simulation. This field would be used to determine if the user supplied time step is within range of the calculated. Optimally, the user would like to enter a time step that approximates the maximum calculated if the time step optimizer option was not selected. If you have a simulation that is unstable this would be a good area to investigate and compare time steps. This information is available in the transport simulation file that can be processed by the W5DSPLY program.

Velocity -- this is the calculated or simulated (from hydrodynamic interface file) velocities for each segment (m/sec). If the user inputted aQb information the depth and velocity variations could be observed at runtime or reviewed in the transport simulation file.

Depth -- this is the segment depth (m) as specified by the user or calculated as a function of flow using the aQb formulation as specified by the user.

Volume -- is the user specified or simulated (hydrodynamic interface file) segment volumes (m3). If the user is not using a hydrodynamic interface file these volumes should be constant for each segment. If the volumes are changing, the flow continuity may not be in balance. If linked to a hydrodynamic program these volumes can change at every time step.

Flow In/Flow Out -- is the flow in and out of segment (cms). During simulations using descriptive flows these values should be the same, if not the flow continuity may not be preserved. When they are not equal, the segment volumes should be changing.

Dispersion -- is the total dispersion within a given segment (m2/day) as defined by the user.

During the execution of WASP all runtime messages or errors are displayed on the bottom line of the screen. Care has been taken to inform the user of any liberties that WASP has taken to change your inputted values to match values supplied in external linkage files. WASP will inform the user if any of changes have been made via the bottom line. While it is impossible to trap all the possible errors that can occur, a good many have been trapped in WASP. If WASP encounters a runtime error there are two places the user can look. The first being the bottom line of the runtime screen or in the OUT file. If trapped internally in WASP the bottom line of the screen will tell you where and why.

DYNHYD Routine Execution

The user may execute the DYNHYD model in a number of fashions much like WASP. The first method would allow WISP to do the execution. To execute DYNHYD without WISP type:

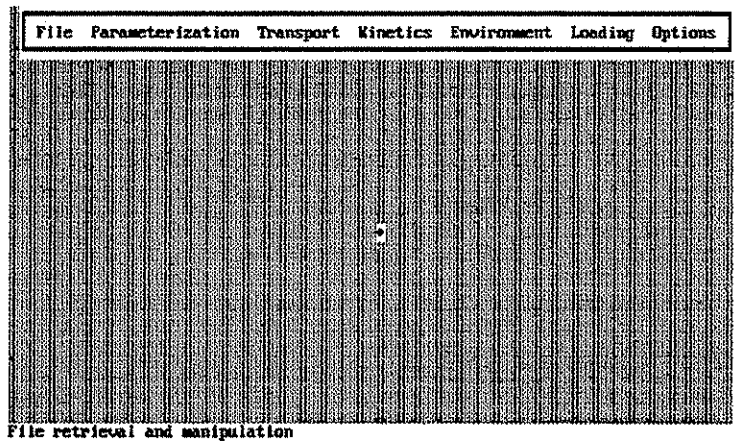
DYNHYD5 <Enter>

If WISP is not used DYNHYD will give you a pick list of all the *.INP in the current directory (note it makes no checks for valid DYNHYD input files). Simply select the input file you would like to execute by using the up/down arrows and press enter.

WASP Preprocessor (PREWASP)

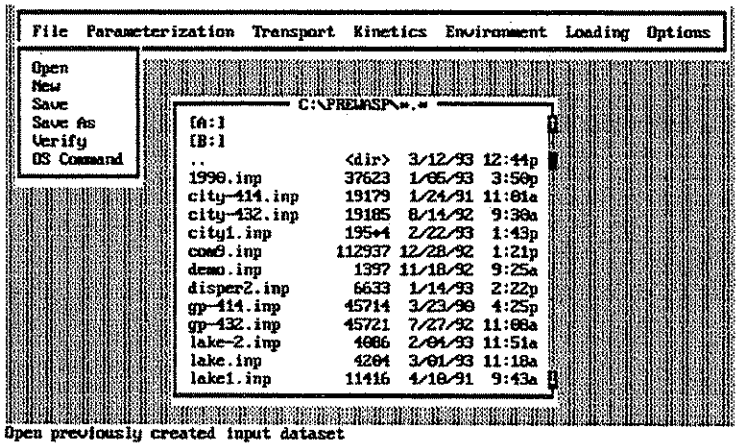
Introduction

The WASP preprocessor aids the user in the development of an input file for the WASP suite of models. This document assumes the user is creating an input file from scratch and will illustrate all the major functions of PreWASP. PreWASP has been designed to allow the user to rapidly develop WASP input datasets with little difficulty. The PreWASP program provides data entry forms for all WASP options. Before going into the data entry information some background information needs to be given to explain WASP terminology. The user is referred to the WASP documentation for a more in-depth explanation of the terms and the input given below. The WASP eutrophication model (EUTRO4) consists of eight state variables ammonia, nitrate, orthophosphate, chlorophyll-a, biological oxygen demand, dissolved oxygen, organic nitrogen, organic phosphorus (NH4, NO3, OPO4, Chl-a, BOD, DO, ON, OP) and the organic chemical model (TOXI4) consists of six state variables 3-Chemicals and 3-Solids. These represents the complete systems (state variables) that are solved iteratively by WASP. Before beginning to use PreWASP the user most have a good idea which state variables are going to be simulated, as well as, the model network or segmentation. The behavior and key sequences are very similar, if not, the same to that of the other software programs in the WASP modeling system. From any point within the PreWASP program the user may select context sensitive help by pressing the F1 key. The PreWASP program is executed from the WISP menu under Preprocess. If you have a file selected in WISP and it is a WASP (TOXI or EUTRO) input file, WISP will pass the input filename to PreWASP. If no file is selected PreWASP will allow the user to create a file from scratch or recall a file from the default subdirectory. The user is protected from continuing on in the construction of an input file until all pertinent information is provided that would help parameterize the input forms (e.g. number of segments are specified before the user enters segment volumes). The PreWASP main menu breaks the WASP input file out to five components as given below.



File retrieval and manipulation

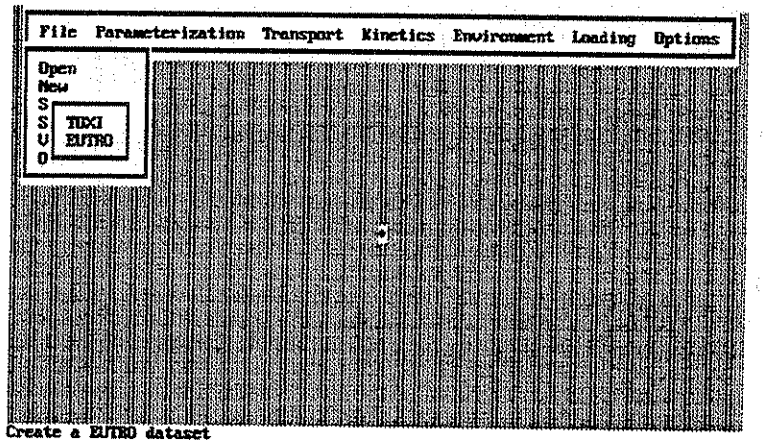
The PreWASP file manager works the same as the other file managers in the other programs in the WASP modeling system. The user is not required to use the file manager of WISP to correctly select and edit previously created input files. PreWASP provides options that allows the user to select a previously created input file, create a new file, or save current file to a different name. The use may elect to load the PreWASP program from WISP without selecting a file to work with and create a file from scratch.



Open previously created input dataset

If the user elects to create a file from scratch the user will have to provide the type of input file to be created (i.e. EUTRO or TOXI). This step is required as PreWASP will configure itself to the file type. When the user selects NEW the user will be prompted for the file type for the input file

that is going to be defined.

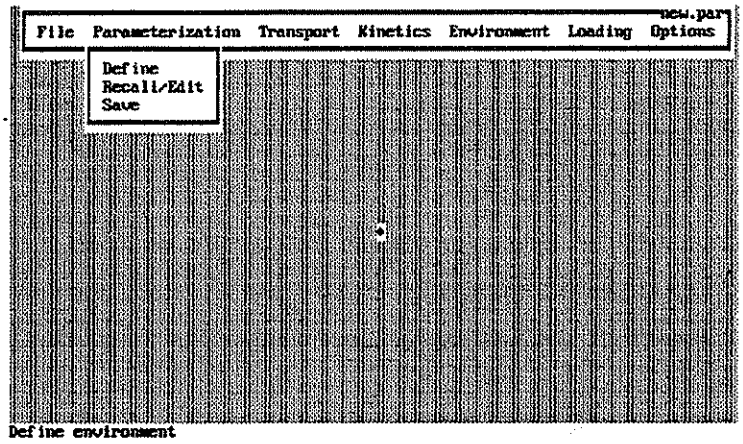


Parameterization

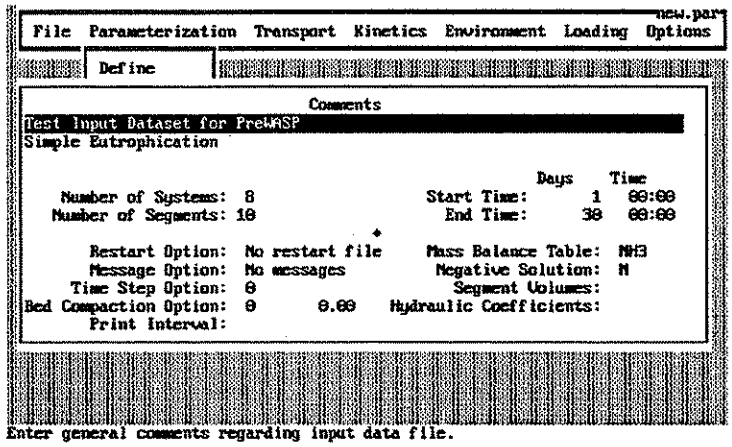
Create/Edit/Recall

PreWASP allows the user to build "generic" environments that can be used as templates for other input datasets. These templates are not part of any input dataset and can be created by the user from scratch or retrieved from previously created WASP input datasets. The user is cautioned against changing parameterization data by recalling a new file in over a previously created file as information could be lost. The recall option should be the first thing the user should do during the parameterization of an input dataset. PreWASP allows the development of generic environments that can be developed and recalled for other applications. If the user elects to recall a previously created environmental template the recall edit option should be used. The environmental parameter template files can be stored in any directory and have the extension *.PAR. When RECALL is selected the user is given a picklist of all the *.PAR files in the default directory. When a template is recalled the user can edit the parameter file to customize the system spatial and temporal data. The user can develop their own template and elect to save the environment to

disk by using the Save function.



The parameterization data entry form allows the user to inform PreWASP of spatial and temporal data that will control the data entry forms that will be generated in later forms. Note the user must provide the parameterization data before any of the other forms can be accessed. Given below to describe all the data entry fields for this form and all its sub-forms.



Comments

The comment fields are used to describe the input dataset for the users purpose only. WASP does not use this information and it is only echoed back out to the user. This information is also

displayed to the user in the file dialog box of WISP. It is a good idea to use these fields to display information that can aid the user in the identification of the input dataset.

Systems

The system designation field allows the user to define the number of system (WASP State Variables) that will be simulated. There are three options for this field: Simulated, Constant, and Bypassed. The user can toggle the level by pressing the spacebar.

- Simulated: indicates to WASP that the user would like the model to calculate all equations associated with that state variable every time step. This is the most common selection.
- Constant: indicates to WASP that the user would like to hold the mass of this system constant and not allow the equations pertaining to this system to be calculated but allow its mass to influence the rates and fate of the other system's that can be affected by the presence of this systems mass. An example would be to include the influence of algae on dissolved oxygen without simulating the dynamics of algae. The user would provide initial concentrations for algae (that would never change), enter rate constants for respiration and oxygen production. This would simulate a steady state affect of algal influences on dissolved oxygen without providing all the information needed to simulate algae.
- Bypassed: indicates to WASP that NO calculations should be done for the particular system. When a system is bypassed in WASP the user does not have to provide boundary concentrations or initial conditions. When bypassing systems in WASP make sure that you are not removing an integral part of the problem you are trying to solve.

Time Step

There are two options for providing time step information to WASP. The first would be to allow WASP to calculate its own time step. This would be done by selecting time option of 1. The PreWASP program would then prompt for the maximum time step that could ever be employed by the model. If the user wanted simulation results every day the user should select a maximum time step of one day. If the user elects to provided a time step to the model, option zero should be used. When the user is providing the time step the user is free to vary the time step as the model simulates. The user would be required to provide time and the time step (time function) to PreWASP. When WASP is simulating it will plot the information internally and will change the time step based on the time functions entered by the user. Note: The user provide time step

function is the ONLY time function in WASP that can consist of 1 set of points, all others require at least 2.

Print Interval

The print interval is the user specified time function in which simulation results will be written out to disk. The WASP model does not have to write information out every time step but can be controlled by the user. Depending on the size of the network and time frame being simulated by WASP the simulation result files can get rather large. The user has full control over the time frame in which the information is written out to disk. This function works like all other time functions in WASP. The user must provide the desired time step and simulation time that this interval should be used. the user most provide at least 2 pairs of data.

Begin Time/End Time

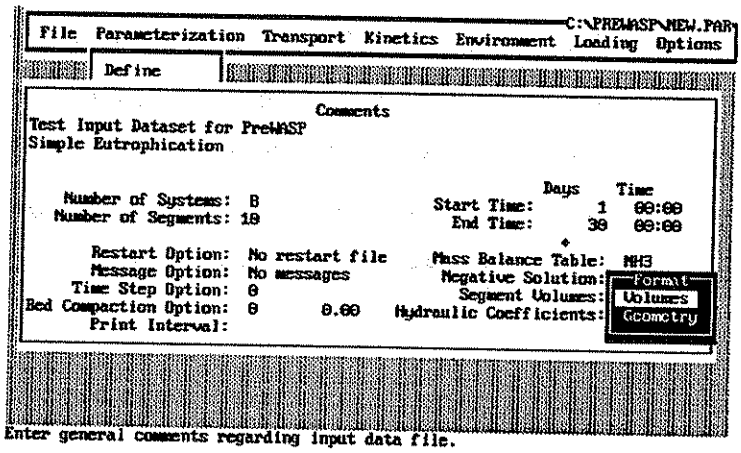
This field allows the user to enter the beginning and ending time for the simulation. Note that WASP is not a Julian model, these entries are used to set the beginning time for all time functions. Note that Day 1, hour 00, minute 00 is equivalent to time zero. This information is used to calculate the length of simulation and where the time functions will begin. If you have daily flow information for 30 days and elect to start the simulation at day 15, WASP will move the pointers ahead in all the time functions to the beginning time specified by the user.

Mass Balance Table

This picklist allows the user to select the state variable in which WASP will create a Mass Balance analysis table that can be viewed by the user. Note that WASP does complete mass balance on all state variables but only has the option to write the mass balance table out for 1 state variable across the whole network. The mass balance table indicates the amount of mass advected, dispersed and decayed (kinetics) within the system. The mass balance table is written out to a separate file that can viewed by the user from WISP (MSB file option).

Segment Volumes

There are two options presented to the user that allows the entering or calculation of the segment volumes. If the user knows the segment volumes they can be entered directly using the volumes option. If the user has geometry information (lengths, widths, depths) this information can be entered into the geometry option where the volumes will be calculated for them.



Both options require the user to specify the number of segments before they enter this field. Both options require some common information be entered in both forms. The segment type and segment located beneath need to be specified. There are four options for segment type:

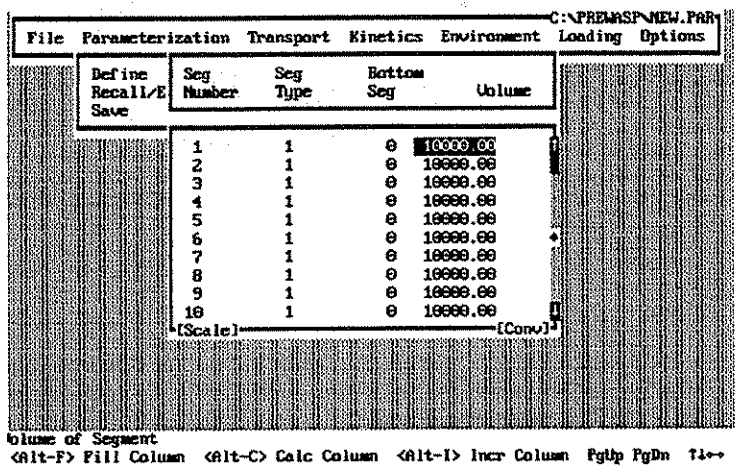
1. surface segment--is any segment that has an air-water interface. Note that reaeration can only occur at type 1 segments.
2. subsurface segment--is any water column segment that does not have an air/water interface.
3. surface benthic segment--is any benthic segment that has a water interface.
4. subsurface benthic segment--any underlying benthic segments.

Note: in EUTRO4 application the use of type 3 and 4 segments is rare.

The segment located beneath the segment being defined would have to be a type 2,3 or 4. If there is no segment beneath the segment being defined set this field to 0. This information is used by WASP to build a map of the segment structure and pass transversed light through the water column. Without this information entered no light will be passed out of the surface water column segment. The last information that would be entered is the actual segment volume or the

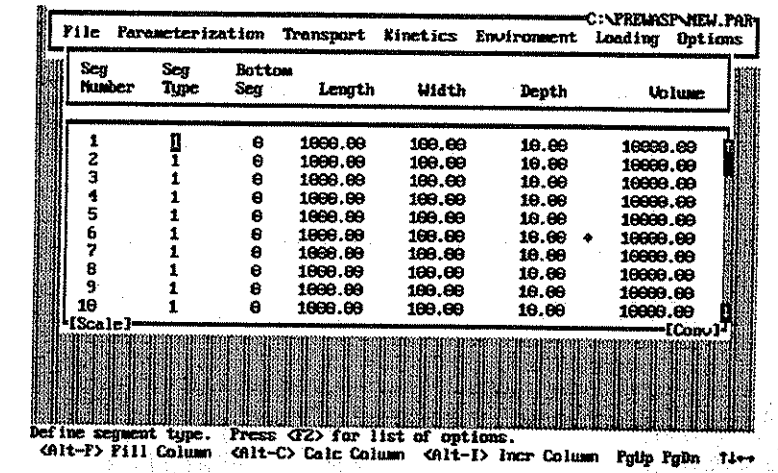
geometric information needed to calculate the volumes. Note the assumption of WASP is that all segments are rectangular but not necessarily for the volume calculations.

The first option for entering segment volume information allows the user to directly enter the volumes and the segment type and bottom segment directly. See the section on column operations for using fast fill options.



The second option allows the user to enter geometry information and have PreWASP calculate the volumes. The entry screen is very similar to the first option but, besides segment type and bottom segment the user will have to enter lengths, widths and depths so that the volume can be

calculated. See the section on column operations for using fast fill options.



Column Operations

These column operations are available for most of the data entry fields. They allow the user to rapidly complete sequential data entry as well as scale and convert input data. There are three column operations that could be employed by the user.

1. **ALT-C** -- column operation allows the user to mark a column or portion of column of data and perform an arithmetic function on the existing data. If the user would like to multiple the values in a column by 10, place the cursor on the top of the field to be marked, press ALT-C arrow down until you have reached the bottom of the data and press enter. PreWASP will them prompt for the arithmetic function to perform. To multiple the values by 10 the user would enter *10 followed by CTRL-ENTER, to divide by 10, /10, add 10, +10, subtract 10, -10. Note that the calculation operation can only do one step mathematics.
2. **ALT-A** --auto increment a marked field. This column operation allows the user to mark an uninitialized field and increment the field from the top marking to the bottom marking by 1. To use this option place the cursor on the field that you want to start as 1, press ALT-A and pagedown/arrow down to mark the field you would like to increment. Press enter and the fields will automatically be incremented.
3. **ALT-I** -- increment a marked field. This column operation allows the user to mark an uninitialized field and increment the field from the top marking to the bottom marking by any arithmetic operation. To use this option place the cursor on the field that you want to start as the seed, press ALT-I and pagedown/arrow down to mark the field you would like to increment. To increment the values by 2 the user would enter +2 followed by CTRL-ENTER.

4. **ALT-R** -- read time variable information in from an external file. This option is available from all the time variable data entry forms. ALT-R will prompt the user for the file name of the file that contains the data to be read into the preprocessor. PreWASP will automatically determine the number of columns of data that resides in the data file. It is the users responsible to assign the appropriate column to the time and value column of the PreWASP data entry form.

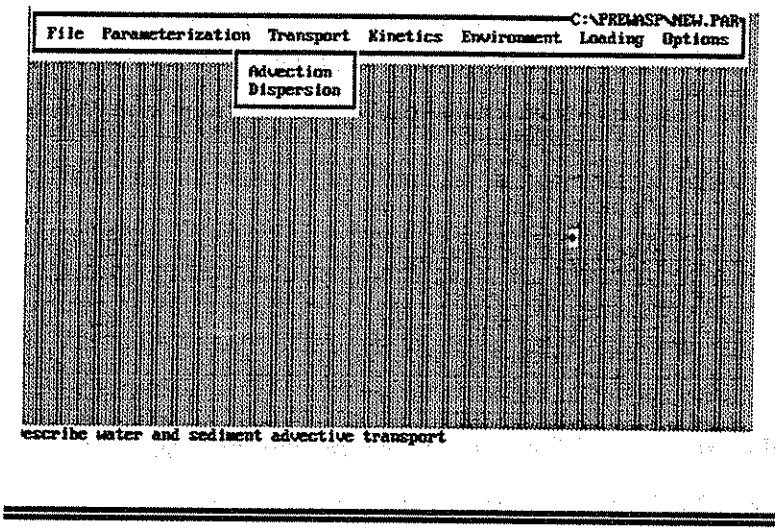
Scale and Conversion

Several of the data entry forms have markings along the window frame that state Scale and Conversion. These data entry points are used to store the scale and conversion factor for the particular data that is being entered. WASP expects all of its input to be in particular units, if the user has measured data that is in different units then the internal units of WASP they may elect to use a conversion factor that WASP would use to convert the data. The Scale function is used to adjust/scale the input data, if the user wanted to see the effects of doubling the flow from a previous simulation, they would simply have to enter a scale factor of 2 for the flows. To activate either one of these functions place the mouse cursor on the word scale or conversion and hit the left mouse bottom, from the keyboard press ALT-V for conversion and ALT-L for scale.

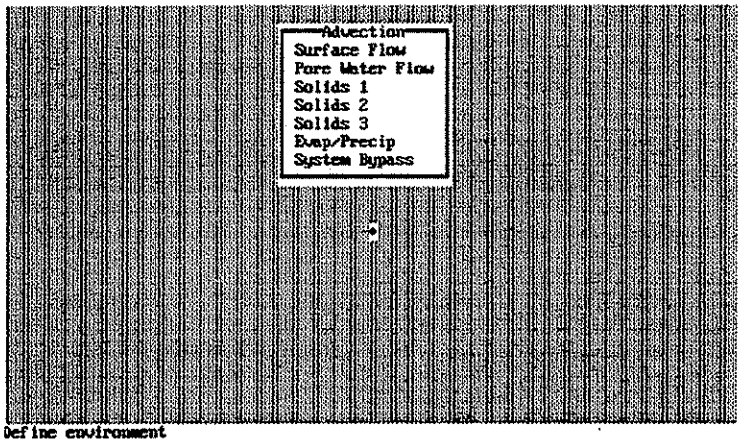
Transport

This group of parameters defines the advective and dispersive transport of simulated model variables. Input parameters include advective flows, sediment transport velocities, dispersion coefficients, cross-sectional areas, and characteristic lengths. Although the nominal units expected by the model are SI or English, other units can be used along with proper specification of conversion factors. The WASP transport structure is very generic which allows it to be applied to a whole host of waterbodies. WASP breaks the water transport processes into advective and

dispersive processes.



There are several options available to the user as well as several different transport phenomena. The WASP model provides for six different transport fields (surface water, pore water, three sediment transport fields, evaporation/precipitation), these fields can be used concurrently or independently of one another. For each of the 6 main transport fields the user may specify up to 5 different flow (transport) patterns with their own individual flow time functions. The user will pick the flow fields for which transport information will be entered. The user will also have to specify the number of flow functions to consider for each flow field. Number of Flow Fields -- under advection, the user has a choice of up to six flow fields. To simulate surface water transport, select water column flow in the preprocessor or set the number of flow fields to 1. When simulating pore water flow, select this option in the preprocessor or set the number of flow fields to 2.



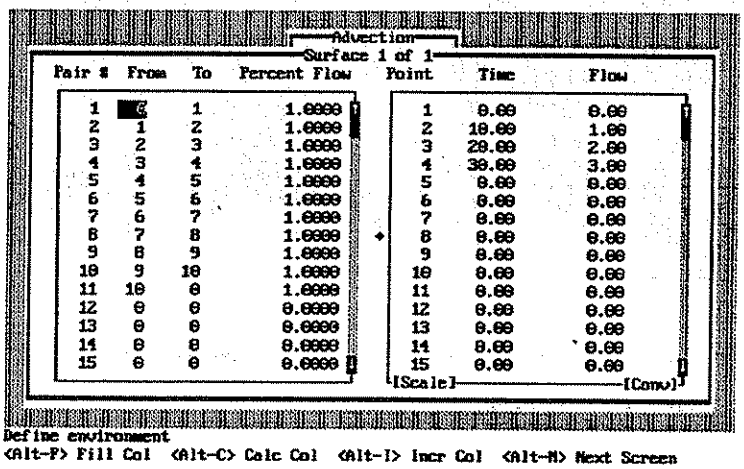
Flow Option

There are currently 3 flow options available for WASP. These options only pertain to surface water flow. The first two options pertain to how WASP will calculate the exchange of mass between adjoining segments that have flow in both directions across a segment interface. There are three flow options available for surface water flow:

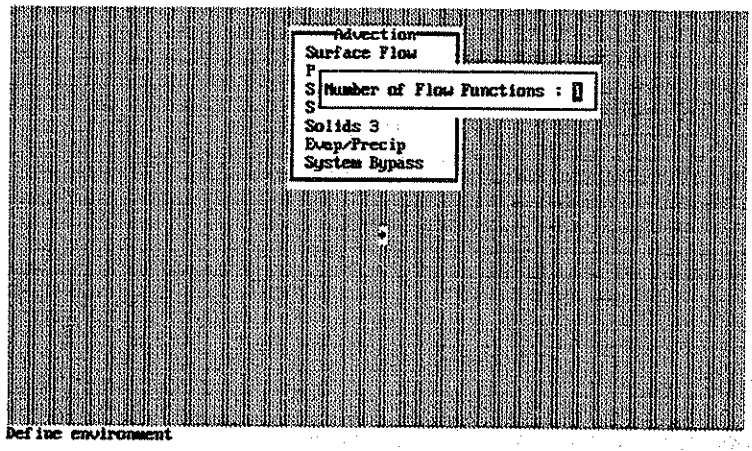
1. WASP will calculate net transport across a segment interface that has opposing flow. WASP will net the flows and move the mass from the segment that has the higher flow leaving. If the opposed flows are equal no mass is moved.
2. Pertains to mass and water being moved without regard to net flow.
3. This option is used when linking WASP to a hydrodynamic model. When option 3 is selected the user can not provide any additional surface flow information. Upon execution of a WASP input dataset using option 3 the hydrodynamic linkage file must already be created and exist in the directory that the input dataset resides. The file must have the extension of *.HYD.

For each of the flow fields, the user can specify up to 5 time function/transport patterns. The user must specify the number of flow functions. When entering the actual transport information in PreWASP the user must specify the segments in which transport is occurring. The user will specify a from and to segment. Note that flow from outside the system (boundary) comes from a segment designated as 0. Flow leaves the system from a segment number to 0. For each flow pair that is defined, the user must provide a percentage of flow that enters/leaves through this

continuity function. The user is responsible for providing the flow continuity to the PreWASP program. The flow function provides flow routing information in the percent of flow entering and leaving each segment interface. Note that WASP does not enforce flow continuity.



The time function for providing the flow is the same as all other time functions in the WASP input dataset. The user must provide at least 2 pairs of data to derive the flow. The model is dimensioned to handle at least 40 pairs of data.



Advective Flow, m3/sec--Steady or unsteady flows can be specified between adjoining segments, as well as entering or leaving the network as inflow or outflow. The user must be careful to check for continuity errors, as the model does not require that flow continuity be maintained. For

example, the user may specify that more flow enters a segment than leaves. For simulations using hydrodynamic results from DYNHYD5, flows from the *.HYD file are used and flow continuity is automatically maintained.

Dispersion

Number of Exchange Fields-- Under dispersion, the user has a choice of up to two exchange fields. To simulate surface water toxicant and solids dispersion, select water column dispersion in the preprocessor or set the number of exchange fields to 1. To simulate exchange of dissolved toxicants with the bed, the user should also select pore water diffusion in the preprocessor or set the number of exchange fields to 2.

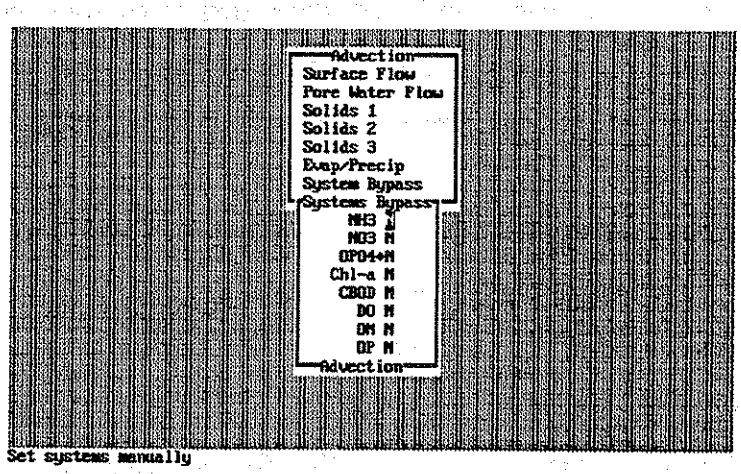
Dispersion Coefficients, m2/sec--Dispersive mixing coefficients can be specified between adjoining segments, or across open water boundaries. These coefficients can model pore water diffusion in benthic segments, vertical diffusion in lakes, and lateral and longitudinal dispersion in large water bodies. Values can range from 10-10 m2/sec for molecular diffusion to 5x102 m2/sec for longitudinal mixing in some estuaries. Values are entered as a time function series of dispersion and time, in days.

Cross-Sectional Area, m2--Cross-sectional areas are specified for each dispersion coefficient, reflecting the area through which mixing occurs. These can be surface areas for vertical exchange, such as in lakes or in the benthos. Areas are not modified during the simulation to reflect flow changes.

Characteristic Mixing Length, m--Mixing lengths are specified for each dispersion coefficient, reflecting the characteristic length over which mixing occurs. These are typically the lengths between the center points of adjoining segments. A single segment may have three or more mixing lengths for segments adjoining longitudinally, laterally, and vertically. For surficial benthic segments connecting water column segments, the depth of the benthic layer is a more realistic mixing length than half the water depth.

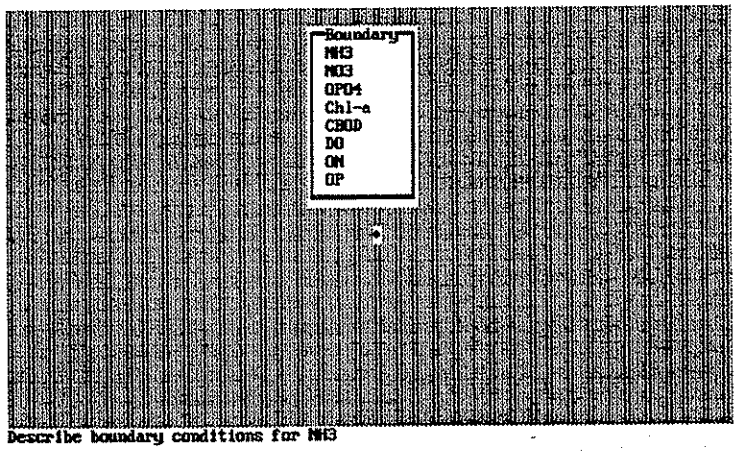
System Bypass Options

For both the advective and dispersive transport functions in WASP the user has the ability to bypass the affect of the particular transport phenomenon on the particular state variable of WASP. If the user would like to see the affect of algae on the system when it is not allowed to transport, the user would set the bypass flag for Chlorophyll-a to yes in either advection or dispersion (possibly both).

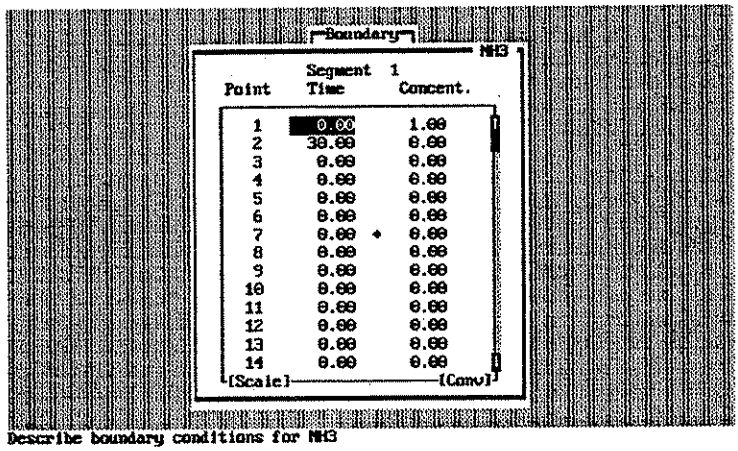


Boundary Parameters

This group of parameters includes boundary concentrations, waste loads, and initial conditions. Boundary concentrations must be specified for any segment receiving flow inputs, outputs, or exchanges. When the transport patterns are entered by the user in the advection and dispersion data entry forms PreWASP will determine the boundary segments and require the user to enter boundary concentration information. WASP requires that a boundary concentration be specified for every system that is being simulated (as specified in the parameterization data entry form). If a boundary is not specified PreWASP will warn the user and WASP will not execute properly. To specify a boundary for a system, move the cursor to the system that a boundary needs to be specified and press enter.



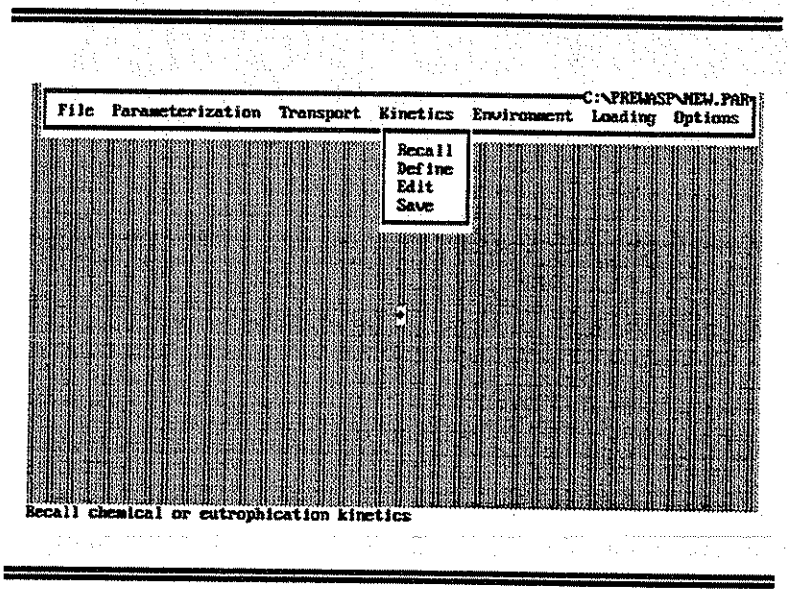
The user will be given a data entry form that allows for the definition of a time variable boundary information. The user will have to provide a value (boundary concentration) and the corresponding time value for that concentration. WASP calculates time variable boundary concentration by doing linear interpolation between the values provided by the user. Note for any boundary time function there needs to be at least 2 data points to define the curve. The user has the ability to enter scale and conversion factors for each system independently, the internal units for WASP boundary concentrations are mg/l.



When completed with the data entry in the boundary time function data entry form the user should press CTRL-ENTER to accept the information.

Kinetics

This data entry group includes constants and kinetic for the water quality constituents being simulated. Specified values for constants apply over the entire network for the whole simulation. If eutrophication kinetics were developed for the Potomac River the user may elect to save the kinetic portion of the WASP dataset to a separate file that could be recalled into any other eutrophication dataset.

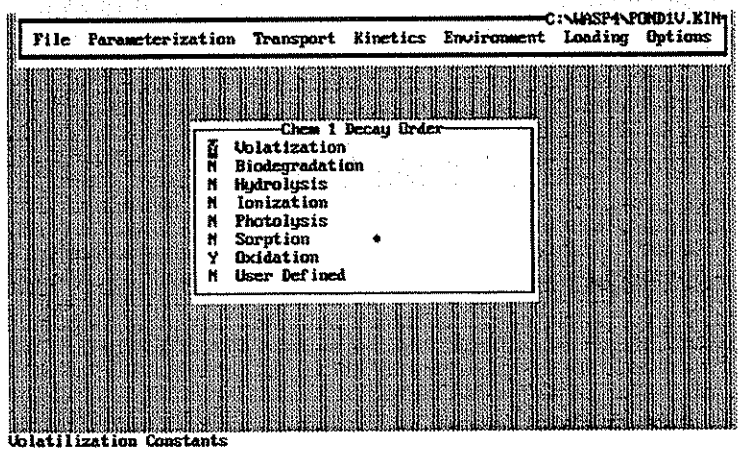


If the user elects Recall, PreWASP will give them a directory picklist of all the files with the extension *.KIN. Once a kinetic template file has been recalled the user has the ability to modify the information for their particular application. Once kinetic information has been saved to a WASP input dataset, the Recall option does not need to be used as all the kinetic information read from the input file will be entered into the data entry forms.

The user has the ability to select a level of complexity for which to develop a EUTRO4 input dataset. The levels of complexity offered to the user are descrete parameterizations to answer a particular water quality question. The user is not forced to use one of the descrete levels but, can opt for the User Defined option that allows the user to parameterize WASP for their own particular problem. Upon the selection of a complexity level the user will be given pre-configured data entry forms for kinetics that need to be entered. All other information that is not needed will

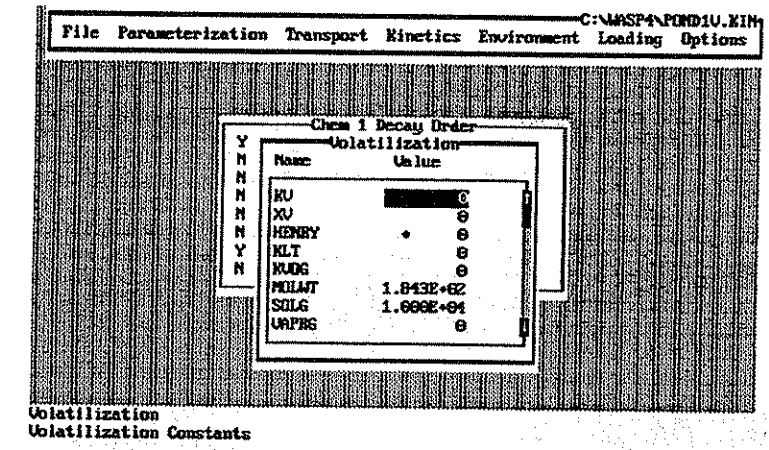
be protected so that user does not have to worry about entering information for constants that will not be used.

Once the level of complexity is selected the user is presented with a form that allows the user to select the WASP system that they want to define kinetic constants.



The user can select the system for which information needs to be entered or browsed by placing the cursor down through the choices and then pressing Enter to select. Once a system is selected PreWASP will display a data entry form for the kinetics that are available for that particular system. The kinetic constants that need to be entered for the particular level of complexity that has been selected will be highlighted, the constants not needed will be displayed in diminished

colors.

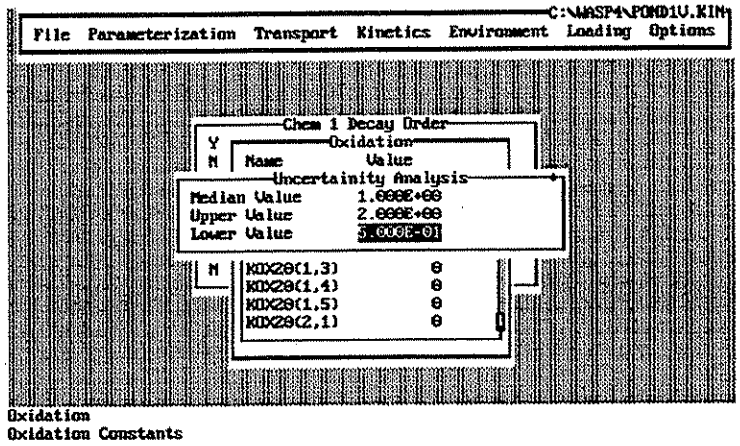


This data entry will display all the constants that could potentially have values assigned to them, but, guards against over parameterization to answer a particular water quality question.

Sensitivity Analysis

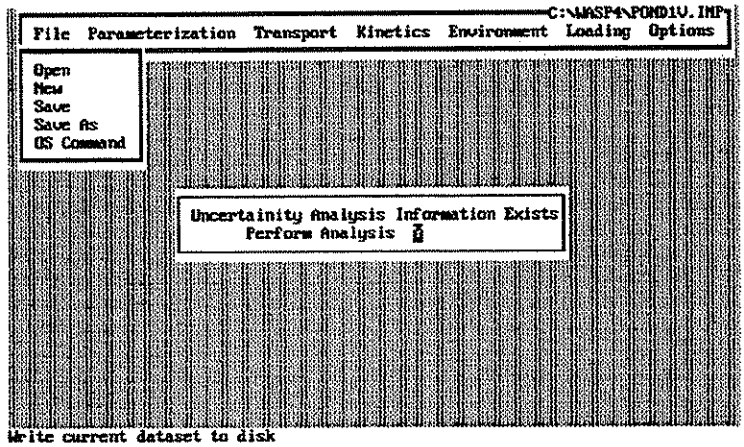
PreWASP allows the user to perform a sensitivity analysis on an individual rate constant. To activate this option the user should place the cursor on the constant in which the sensitivity analysis will be performed and press ALT-U. This will cause the display of the entry form as illustrated below. The user will have to provide a median, upper and lower constant value. Once the information is entered correctly the user should press Control-Enter to save the information.

Once this information has been saved the kinetic screen reverts back to the normal entry form.



Note: the PreWASP program can only perform a sensitivity analysis on a single constant. If the use elects to do a sensitivity analysis on another constant it will over right the previously defined sensitivity analysis. When the user elects to save the input file PreWASP will recognize that a sensitivity analysis was requested to be performed. The user will be given the option to perform the analysis or not. If the user elects to perform the sensitivity analysis on a file called RIVER.INP, PreWASP will write out four datasets:

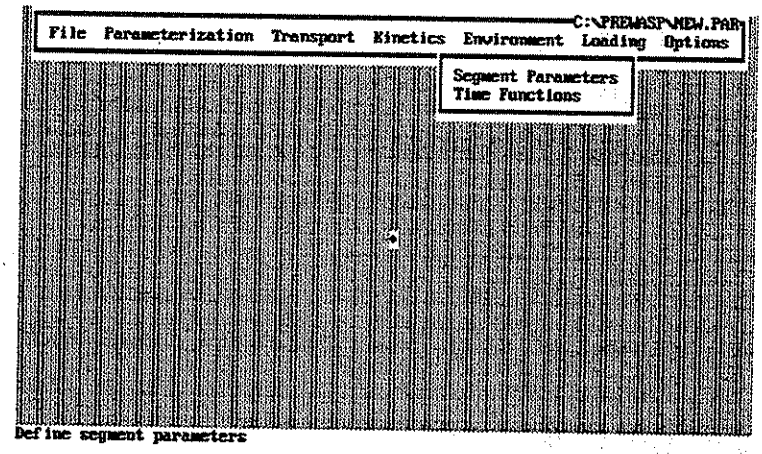
1. Median Value Input file (RIVERM.INP)
2. Upper Value Input File (RIVERU.INP)
3. Lower Value Input File (RIVERL.INP)
4. Base Input File (RIVER.INP)



PreWASP will also create a WISP Batch File (see WISP section) that the user can select from the WISP File manager area. The WISP batch file will execute the series of WASP input files to perform the sensitivity analysis. The resulting simulation files can be plotted against one another using the post processor (see section on overlaying result files).

Environmental Conditions

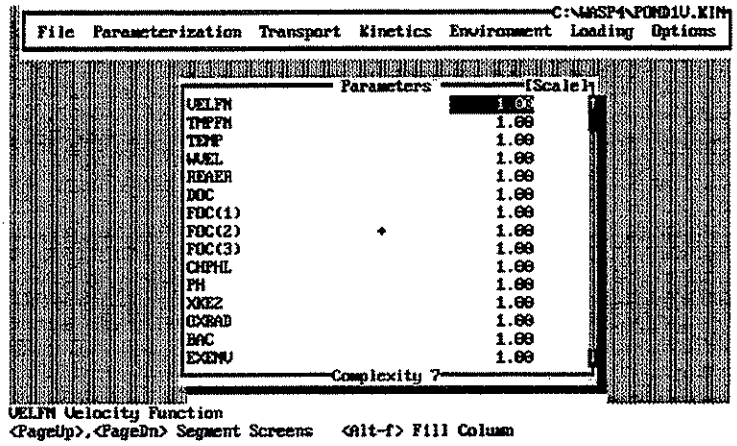
Once the kinetic information has been defined by the user PreWASP will select the environmental segment parameters and time functions that might be needed to successfully apply the model to a waterbody. The user has the ability to select between segment specific parameters and environmental time functions.



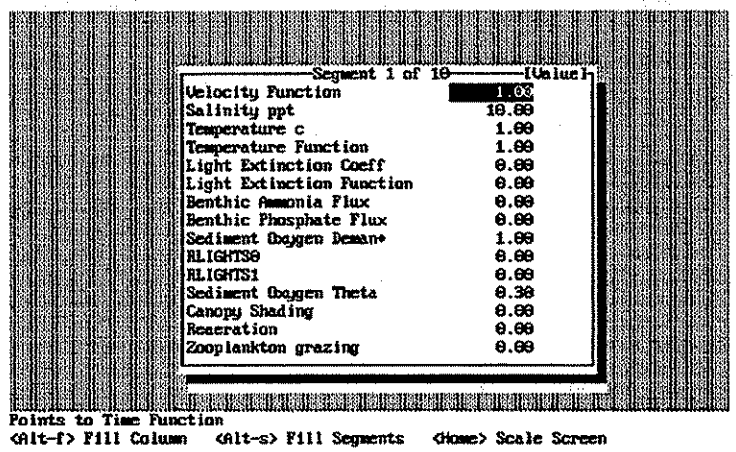
Segment Parameters

When segment parameter definition is selected the user will be presented with a form of suggested segment parameters that might need to be included in the input file based on the level of complexity selected by the user. The parameters that could possibly be included will be unprotected, all others will be protected. The first screen presented to the user is the Scale factor screen. This screen provides a way for the user to specify a value that will be multiplied by the

actual segment specific that is specified later. Usually, these values are set to one.



Once the scale values have been set, the user should press the Page-Down key. The user will then be presented with a segment specific screen, the segment number that is being defined is located in the middle of the top portion of the window frame.

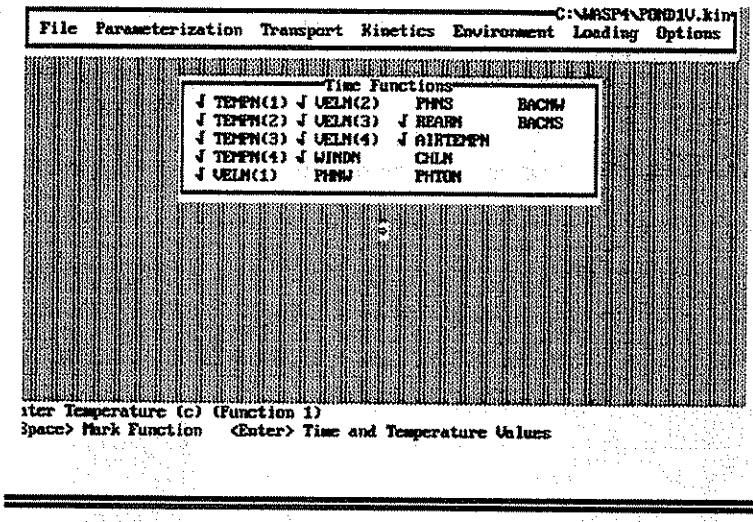


Only the segment parameters that where activated by PreWASP (based on level of complexity and constants selected) will be available to the user. The user is referred to the WASP manual for a detailed explanation on how time functions and segment environmental parameters interact. There is a quick fill option available from the segment data entry screen. If the user wishes to set a parameter to a specific value for all the segments or a range of segments press ALT-S. The user

will be prompted for the value and the range of segments to fill. Once the value has been assigned press enter. If the user is filling out each segment individually, to go to the next segment press Page-Down, to go to the previous segment press Page-Up. To accept the form press Control-Enter.

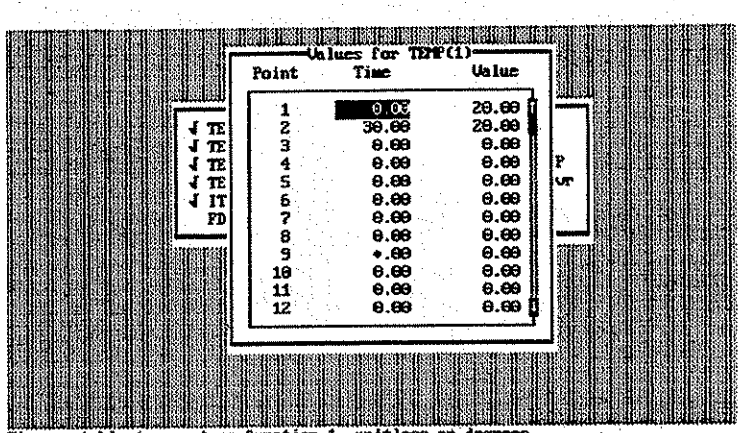
Time Functions

The time function data entry forms allow the user to enter time variable environmental information. PreWASP will offer a possible selection of environmental time functions that should be used in the simulation being defined based upon segment parameters and constants selected by the user.



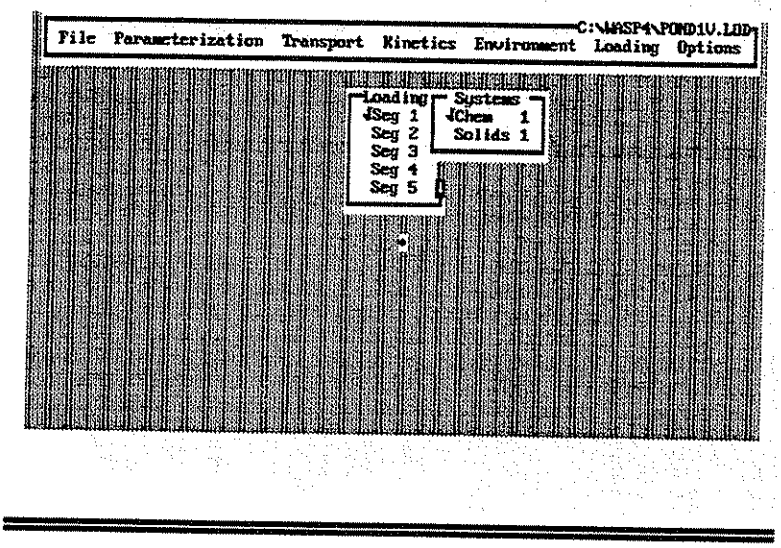
The user can provide information for all the time functions suggested by PreWASP or toggle on/off any of the functions displayed by pressing the space bar. To enter information for the function place the cursor on the function that should be defined and press enter. This will display a data entry form as exhibited below. The user must specify the time and the associated value associated with the particular time function. Note that time must increment from one row to the next and the user must specify at least two sets of points. Once the form has been complete press

Control-Enter to accept the information.



Loading

Waste loads can be entered into the preprocessor by selecting the segment that the load should enter followed by selecting the systems in which load information exists. A picklist is given for the segments, to enter a load press the spacebar on the segment to receive the load and then tag the systems to load using the spacebar as well. Once the selection have been made press the Control-Enter to enter the time variable information.



Initial Conditions

Because WASP is a dynamic model, the user must specify initial conditions for each variable in each segment. Initial conditions include the constituent concentrations at the beginning of the simulation. The product of the initial concentrations and the initial volumes give the initial constituent masses in each segment. For steady simulations, where flows and loadings are held constant and the steady-state concentration response is desired, the user may specify initial concentrations that are reasonably close to what the final concentrations should be. For dynamic simulations where the transient concentration response is desired, initial concentrations should reflect measured values at the beginning of the simulation. In addition to chemical concentrations, the dissolved fractions must be specified for each segment at the beginning of the simulation. For tracers, the dissolved fractions will normally be set to 1.0. For tracers, as well as dissolved oxygen, eutrophication, and sediment transport, the initial dissolved fractions remain constant throughout the simulation. The density of each constituent must be specified under initial conditions. For tracers, this value should be set to 1.0.

DYNHYD Preprocessor (PreDYN)

The preprocess PreDYN is an interactive preprocessor program that allows users to rapidly develop an input dataset for DYNHYD5.

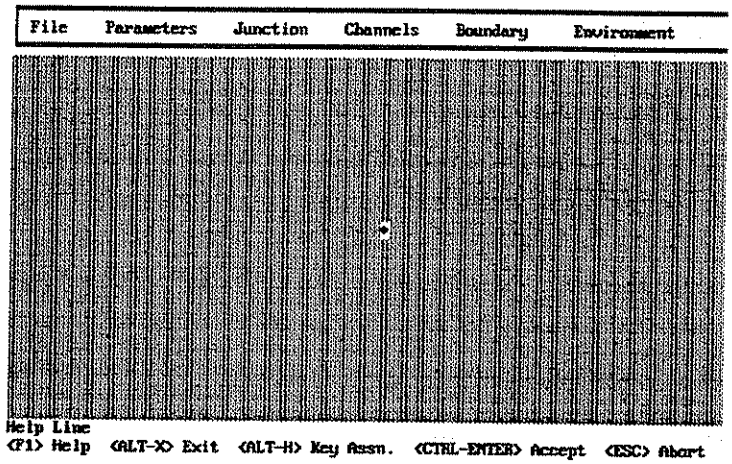
Overview of DYNHYD5

The WASP5 hydrodynamics model DYNHYD5 is an enhancement of the Potomac Estuary hydrodynamic model DYNHYD2 (Roesch et al., 1979), which was a component of the Dynamic Estuary Model (Feigner and Harris, 1970). DYNHYD5 solves the one-dimensional equations of continuity and momentum for a branching or channel-junction (link-node), computational network. Driven by variable upstream flows and downstream heads, simulations typically proceed at 1- to 5-minute intervals. The resulting unsteady hydrodynamics are averaged over larger time intervals and stored for later use by the water-quality program.

The Hydrodynamic Equations

The hydrodynamic model solves one-dimensional equations describing the propagation of a long wave through a shallow water system while conserving both momentum (energy) and volume (mass). The equation of motion, based on the conservation of momentum, predicts water velocities and flows. The equation of continuity, based on the conservation of volume, predicts water heights (heads) and volumes. This approach assumes that flow is predominantly one-dimensional, that Coriolis and other accelerations normal to the direction of flow are negligible, that channels can be adequately represented by a constant top width with a variable hydraulic depth (i.e., "rectangular"), that the wave length is significantly greater than the depth, and that bottom slopes are moderate. Although no strict criteria are available for the latter two assumptions, most natural flow conditions in large rivers and estuaries would be acceptable. Dam-break situations could not be simulated with DYNHYD5, nor could small mountain streams.

PreDYN was developed much like the rest of the programs in the WASP modeling system. It adheres to the common user access (CUA) standards as described earlier. The PreDYN program is executed from the WISP preprocessor menu. PreDYN restricts the user from gaining entry to data entry forms before appropriate spatial and temporal parameterization has occurred.



File Operations

This menu item controls all the file input/output manipulations. Files are created and saved through this menu option. The user is not allowed to progress forward in the creation of an input dataset until the user instructs PreDYN what to do.

Open File

This option allows the user to OPEN a previously created DYNHYD5 input file. The PreDYN can read previously created input files as long as the header information is included in the input file.

Create New File

Create a NEW file from scratch. The user is prompted to enter a filename, if the file exists the user will be warned of a possible file over-write. It is best to provide the filename at this

point. Once a filename is given it is displayed in the upper right-hand corner of the Main Menu. Note: the user has the option to save the input file to another name at any point.

Save File

This option writes the current input dataset out to disk. The filename will be that of the one given at creation or read in from disk. If you like to store the file under another file name use the Save As option. Note: PreDYN creates a backup of the old dataset before writing out to disk. The file will have the extension of BAK.

RIVER.INP	Current Input File
RIVER.BAK	Most recently revised file.

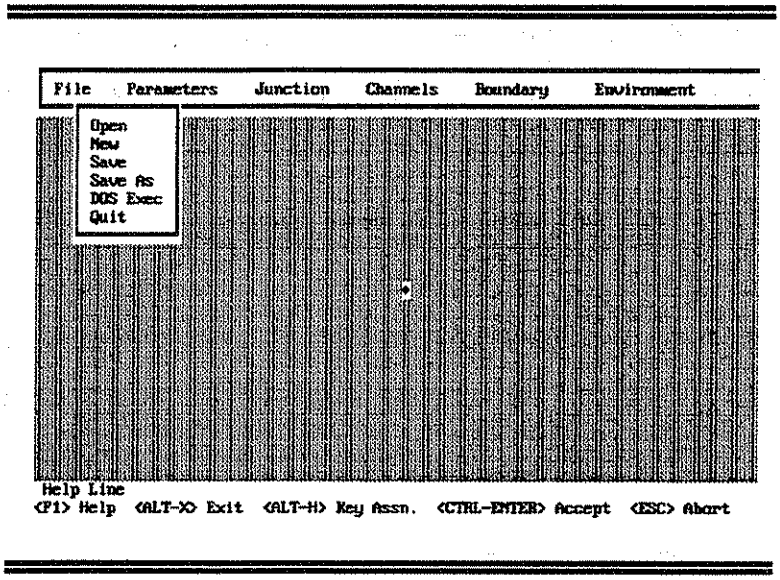
To use a BAK file you MUST copy it to a *.INP file first, outside PreDYN or use the EXEC DOS option.

Open

This option allows the user to read a previously created dataset in for editing and save it to another file name. This option will allow the user to create sensitivity analysis dataset rapidly.

DOS Commands

This option is a "doorway" to the operating system. It allows the user to drop to DOS to do some type of operations and then return to PreDYN un-interrupted. Note: There are memory limitations when you drop out of the program. There will not be enough memory to run most applications. WARNING: Do not load any "Terminate Stay Resident" programs for the Exec DOS option as it will yield unpredictable results.



Parameters

The Parameterization data entry form provides basic information to the PreDYN program that allows the other forms to be dimensioned. This form needs to be completed before the user can go onto any other forms. The user specifies the number of junctions and channels and simulation runtime in this form.

Junction Information

A physical interpretation of this computational network can be developed by picturing the links as channels conveying water and the nodes as junctions storing water. Each junction is a volumetric unit that acts as a receptacle for the water transported through its connecting channels. Taken together, the junctions account for all the water volume in the river or estuary. Parameters influencing the storage of water are defined within this junction network. Each channel is an idealized rectangular conveyor that transports water between two junctions, whose midpoints are at each end. Taken together, the channels account for all the water movement in the river or estuary. Parameters influencing the motion of water are defined within this channel network. The link-node computational network, then, can be viewed as the overlapping of two closely related physical networks of channels and junctions.

Junctions are equivalent to segments in the water quality model, whereas channels correspond to segment interfaces. Channel flows are used to calculate mass transport between segments in the water quality model. Junction volumes are used to calculate pollutant concentrations within water quality segments.

Link-node networks can treat fairly complex branching flow patterns and irregular shorelines with acceptable accuracy for many studies. They cannot handle stratified water bodies, small streams, or rivers with a large bottom slope. Link-node networks can be set up for wide, shallow water bodies if primary flow directions are well defined. Results of these simulations should be considered descriptive only.

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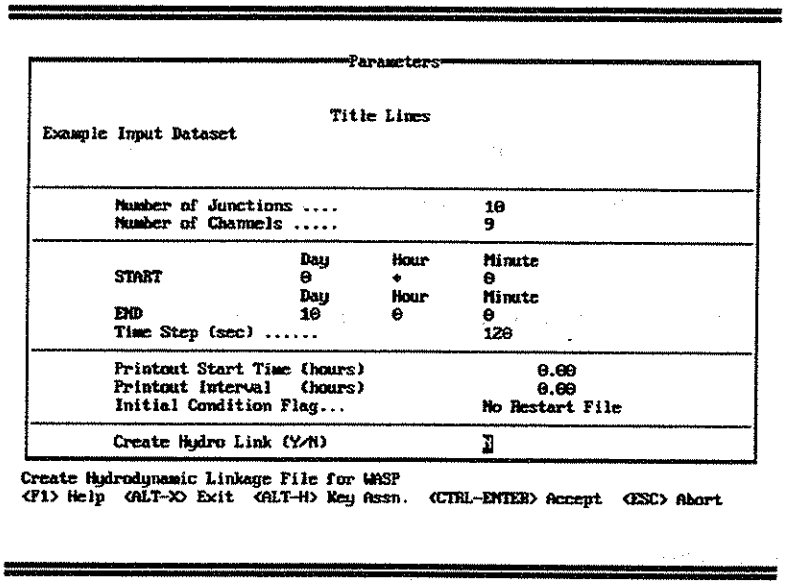


Linkage to WASP5

The hydrodynamic results generated by a DYNHYD5 simulation are to be stored for use by WASP5, then both the networks and the time steps must be compatible (though not identical). To link with WASP5 the user must specify which hydrodynamic junctions will be linked to WASP5 segments. It is no longer necessary to link junctions and segments one to one, the user has the capability of linking in a section of the hydrodynamic simulation (windowing). It is important to insure the "windowed" section is contiguous and does not cause dynamic boundary effects discussed earlier. When linking boundary junctions to WASP5 they are designated as 0 segment (the WASP convention for boundaries). You must provide the linkage map for WASP5 at runtime of DYNHYD5, see the following diagram for the explanation of mapping.

WASP5 may have additional segments not represented by junctions. For example, WASP5 benthic segments will have no corresponding junctions. Junction numbering need not correspond to segment numbering. Junction to segment mapping is specified in the DYNHYD5 input data set. The WASP5 time step must be an even multiple of the DYNHYD5 time step. The ratio of

time steps must be specified in the DYNHYD5 input data set as parameter NODYN. Typical ratios are between 6 and 30. Segmentation and time steps for WASP5 are discussed in the next section. DYNHYD5 averages each channel flow over NODYN hydrodynamic time steps, and stores this average value for use at the corresponding WASP5 segment interface. DYNHYD5 stores each junction volume at the end of NODYN time steps for use at the corresponding WASP5 segment. This averaging and storage process continues for the entire hydrodynamic simulation. WASP5 will use these flows and volumes, repeating the sequence if the water quality simulation is longer than the hydrodynamic simulation. If the volumes of the segments differ by more then 5% from the beginning to the end of the hydrodynamic summary file WASP5 will abort.

Interval to Process Scratch File

The interval in which to process the DYNHYD scratch file. Whenever DYNHYD is preparing a hydrodynamic linkage file it generates a SCRATCH where intermediate information is stored. Depending on your model network and time scale for execution this scratch file can get rather large. This interval specifies when the scratch file should be processed and re-initialized. A suggested value would be every half day (12 hours).

WASP Time Step

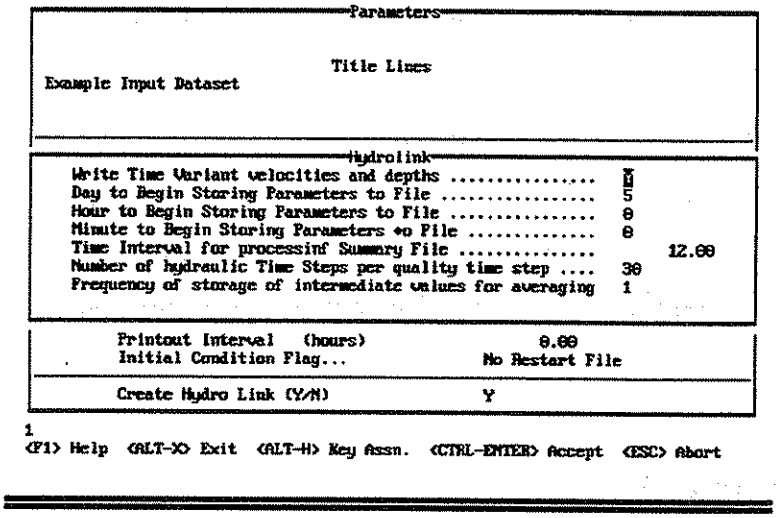
This number specifies how many Hydrodynamic Time Steps = 1 WASP Time step. Because DYNHYD will be providing flows, volumes, depths and velocities to WASP as it simulates through time, DYNHYD will have to force the WASP time step to insure everything stays in synch.

WASP Time Step = (NODYN * DYNHYD Time Step)/86400

Frequency to Write.

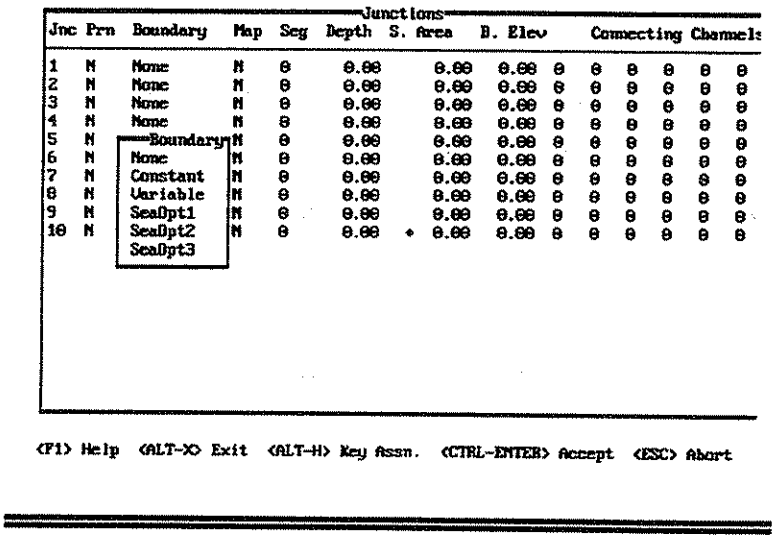
This number specifies the frequency in which intermediate results are written to the scratch file for processing (averaging). If you are in a highly dynamic environment a suggested value would be 1.

If you are simulating in a rather static environment you may experiment with higher values. 1 means write information every time step to the scratch file, 2 means write every other time step.



DYNHYD Boundary Information

The downstream boundaries can be defined by either specifying outflows or surface elevations (tidal function). Surface elevations at each downstream boundary can be specified by an average tidal function or by a variable tidal function.



Print Junction Results

Write out simulation results for this junction. Write results to disk that can later be processed by the graphical post processor.

Junction Map

Yes or No for mapping this Junctions results out to WASP. Note: if the junction is a Boundary Junction the WASP segment is automatically set to 0.

WASP Segment to Map

Specify the WASP Segment number that you want to assign to this DYNHYD Junction. This map overlays the DYNHYD flows, volumes, velocities and depths for this junction to the WASP segment.

Junction Depth

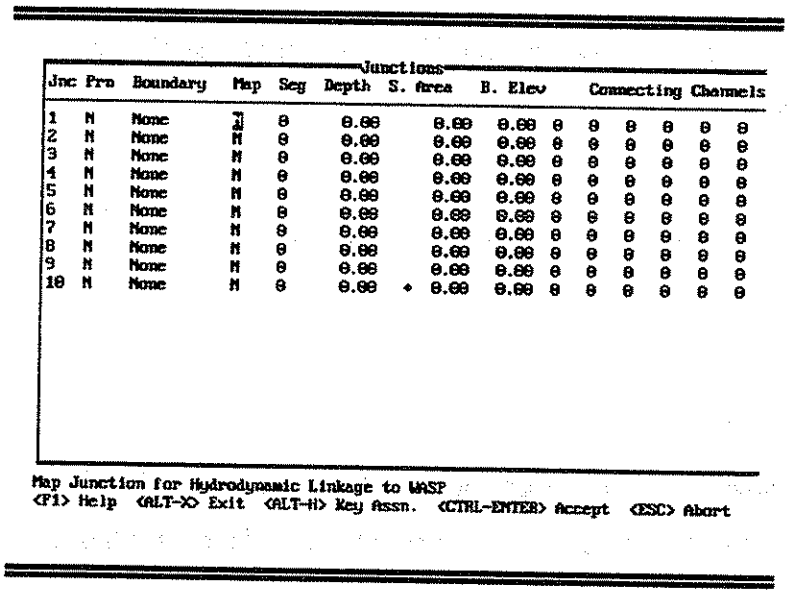
The hydraulic radius, R, is the channel cross sectional area divided by the wetted perimeter. In natural channels where the width is much larger than the depth, the wetted perimeter is almost equal to the width. Over a channel length, then, the average hydraulic radius is approximately equal to the volume of water divided by the surface area:

Junction Surface Elevation

Surface elevation or head, m--Junction heads represent the mean elevation of the water surface above or below an arbitrary horizontal datum. The datum is usually the mean local sea level. If initial surface elevations are not input, they will be calculated from bottom elevation and depth.

Junction bottom elevation

Bottom elevation, m--The mean elevation of the junction bottom above or below the datum is defined as the bottom elevation. If initial surface elevations are specified, bottom elevations will be calculated internally by subtracting the mean depth from the mean head.



Channel

Enter the channels that are connected to this junction. The minimum number of channels that can be attached to a junction is 1, the maximum is 6.

Channel Length

Width, m--There is no apparent limit on the width of a channel. If a channel is too wide in relation to its length, however, the mean velocity predicted may mask important velocity patterns occurring on a more local scale. For well defined channels, the network channel widths are equated to the average bank to bank width.

Channel Depth

Hydraulic radius, m--Previous applications of DYNHYD have used channels whose widths are greater than ten times the channel depth. Consequently, the hydraulic radius is usually assumed to be equal to the mean channel depth.

Cross-sectional area, m2--The cross-sectional area of a channel is equal to the product of the channel width and depth. Depth, however, is a channel parameter that must be defined with respect to junction head or water surface elevation (since both vary similarly with time). Initial values of width and depth based on the initial junction heads and the initial cross-sectional areas are computed internally. As the junction heads vary, the channel cross-sectional areas are adjusted accordingly.

Channel Orientation

Channel orientation, degrees--The channel orientation is the direction of the channel axis measured from true north. The axis is assumed to point from lower junction number to higher junction number, which by convention, is the direction of positive flow (i.e.: upstream to downstream).

Manning's Coefficient

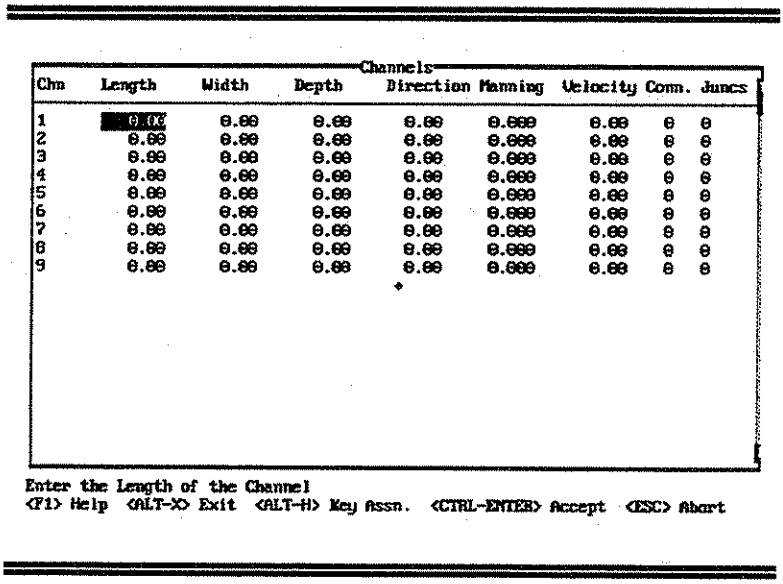
Roughness coefficients, sec/m1/3--Channels are assigned "typical" Manning Roughness coefficients. The value of this coefficient should usually lie between 0.01 and 0.08. Because this parameter cannot be measured, it serves as a "knob" for the calibration of the model.

Channel Velocity

Velocity, m/sec--An initial estimate of the mean channel velocity is required. Although any value may be assigned, the computational time required for convergence to an accurate solution will depend on how close the initial estimate is to the true value. Convergence is usually rather quick.

Junction Connections

Enter the junctions that are connected by this channel. The user MOST provide 2 Junctions, no other number is accepted.



'DYNHYD Boundary Information

The downstream boundaries can be defined by either specifying outflows or surface elevations (tidal function). Surface elevations at each downstream boundary can be specified by an average tidal function or by a variable tidal function.

Constant In/Outflow -- User specified in/out flow for a particular Junction.

Time Variable In/Outflows -- User specified time variable in/out flow for a particular Junction.

Seaward Option 1

This seaward option allows the user to input regression coefficients for the curve that best fits the variation in observed heads over a single average tidal cycle. The heads are then computed from the curve, as given by

$$Y(t) = A1 + A2\ SIN(WT) + A3\ SIN(2WT) + A4\ SIN(3WT) + A5\ COS(WT) + A6\ COS(2WT) + A7\ COS(3WT)$$

where Y(t) is the head (water surface elevation above datum, m) at time t (hours), W is 2 pi/T where T is the period (hours), and A1-A7 are coefficients specified by the user. The average tidal curve is repeated throughout the simulation.

Seaward Option 2

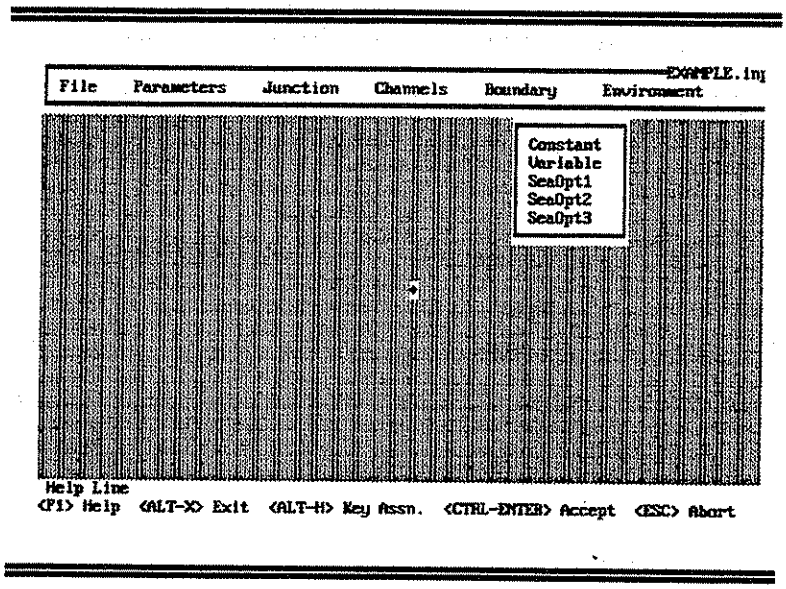
For this seaward boundary option, the user inputs time and tidal elevations pairs which represent a single, average, tidal cycle. The model then obtains the best fit to these data using the following equation for the curve

$$Y(t) = A1 + A2\ SIN(WT) + A3\ SIN(2WT) + A4\ SIN(3WT) + A5\ COS(WT) + A6\ COS(2WT) + A7\ COS(3WT)$$

where Y(t) is the head (water surface elevation above datum, m) at time t (hours), W is 2 pi/T where T is the period (hours), and A1-A7 are coefficients. The fitted curve (not the input elevations) is then used to determine the head during the simulation (the average tidal function is repeated throughout the simulation). Caution, ensure there are enough points input to adequately fit the curve! Compare predictions to input data!

Seaward Option 3

For this seaward option, the user inputs multiple times and tidal heights pairs (such as times and heights for low and high tides over multiple tidal cycles). The tidal heights at times between those input are estimated using a half-sine curve.

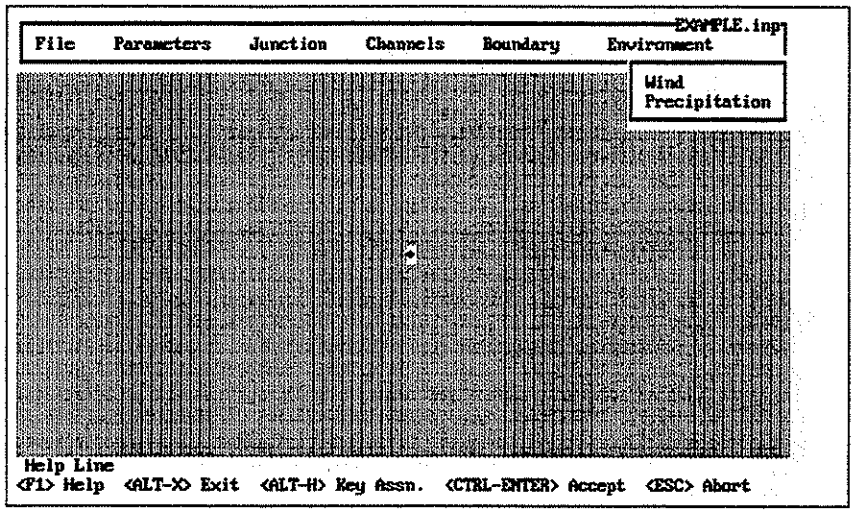


Wind/Precipitation/Evaporation Data

User specified time variable wind, precipitation/evaporation for the entire network. Wind acceleration can either enhance or oppose stream flow, depending on the relative direction of the wind . For wind blowing normal to the channel axis, cos = 0, and there is no acceleration along the axis. For wind blowing along the axis in a positive direction, cos = +1. Positive flow in the channel will be enhanced, and negative flow will be opposed. Conversely, for wind blowing along the axis in a negative direction, cos = -1. Positive flow in the channel will be opposed, and negative flow will be enhanced.

Precipitation/Evaporation

User specified time variable precipitation/evaporation for the entire network.

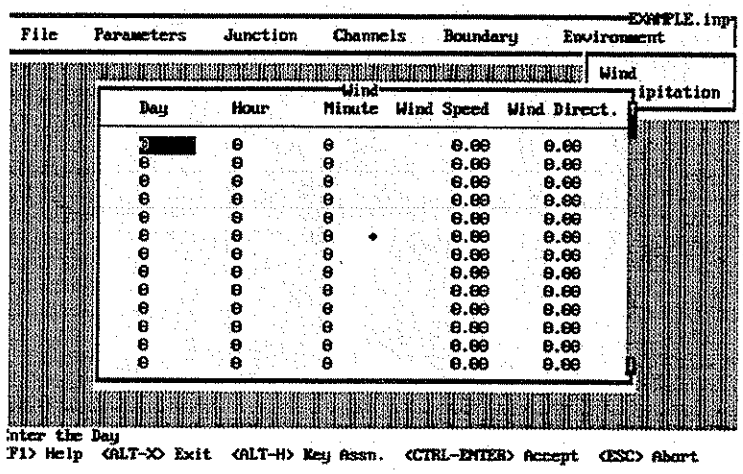


Wind Speed

Wind acceleration can either enhance or oppose stream flow, depending on the relative direction of the wind . For wind blowing normal to the channel axis, cos = 0, and there is no acceleration along the axis. For wind blowing along the axis in a positive direction, cos = +1. Positive flow in the channel will be enhanced, and negative flow will be opposed. Conversely, for wind blowing along the axis in a negative direction, cos = -1. Positive flow in the channel will be opposed, and negative flow will be enhanced.

Wind Direction

Wind speed (m/sec) and direction (degrees from true north) are measured at a point 10 meters above the water surface. This wind is to be representative for the entire water body. Values of wind speed and direction can vary with time. Piecewise linear functions of wind speed and direction versus time are specified. If the simulation extends beyond the last specified wind, the piecewise linear functions are repeated.


File Parameters Junction Channels Boundary Environment
EXAMPLE.inp
Wind
ipitation
Wind
Day Hour Minute Wind Speed Wind Direct.
0 0 0 0.00 0.00
0 0 0 0.00 0.00
0 0 0 0.00 0.00
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0 0 0 0.00 0.00
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0 0 0 0.00 0.00
nter the Day
F1> Help <ALT-X> Exit <ALT-H> Key Assn. <CTRL-ENTER> Accept <ESC> Abort

WASP Graphical Post-processor (W5DSPLY)

The interactive graphical post processor W5DSPLY allows the user to rapidly visualize the results of WASP and DYNHYD simulations. W5DSPLY and WISP is the only piece of software needed to process the large array of result files that can be produced from WASP modeling system. W5DSPLY allows the user to view the results both graphical and tabularly and has options for exporting data to spreadsheets. W5DSPLY has the capabilities to process more then one simulation result file at a time (NOTE: the files must be from the same model), and the plotting of up to four graphs on the screen simutaneously. These four plots (view ports) can be manipulated individually to show different results. As with all the programs context sensitive help is available at any time within the program, simple press the F1 for help or ALT-H for listing of the keyboard map.

Routine Execution

W5DSPLY program is executed by WISP automatically when the post process option is selected. WISP allows provides the correct file to process. If the user elects to execute W5DSPLY without WISP the following command line syntax must be observed:

W5DSPLY FILENAME.EXT C:\WASP

Note that the filename follows that of an associated WASP and DYNHYD input file. The extension can only be one of 5 available result files that can be processed by the post processor: TDF/EDF/TRN/DDF which represents the TOXI, EUTRO, WASP Transport, and DYNHYD simulation result files respectively. For example, if you had a TOXI input file called RIVER.INP, the associated WASP simulation result file would be called RIVER.TDF. To execute the post processor on this file the following syntax would be employed:

W5DSPLY RIVER.TDF C:\WASP

where W5DSPLY is the executable, RIVER.TDF is the result file to process and C:\WASP is the directory where the WASP models are installed.

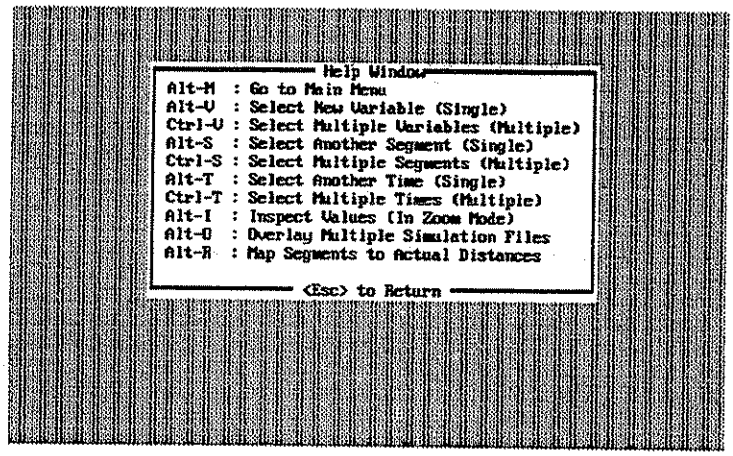
TRN file which represents the WASP transport result file can be plotted and viewed by W5DSPLY. The syntax would be as follows:

W5DSPLY RIVER.TRN C:\WASP

All other auxiliary files can be viewed by the WISP BROWSE feature.

Plotting Options

There are several graphing functions available from W5DSPLY. The simulation results files can be viewed in just about any manner imaginable. Unfortunately, with many options comes more complexity. The following illustrates the Hot-Key (press ALT-H) assignments for the post processor. Depending upon which graphing option you are using will determine the contents of the list.

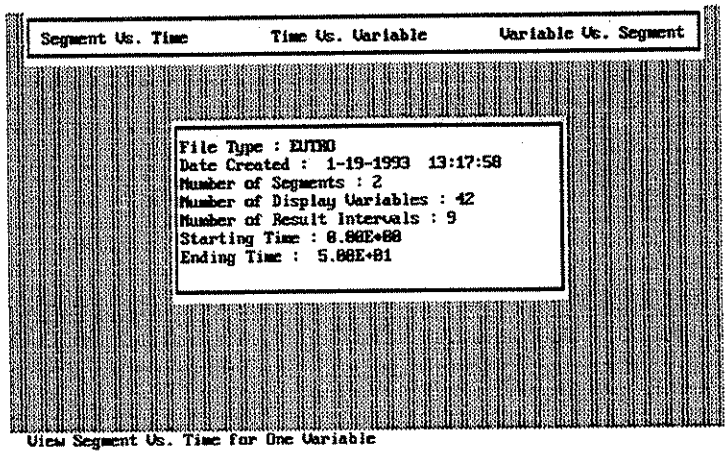


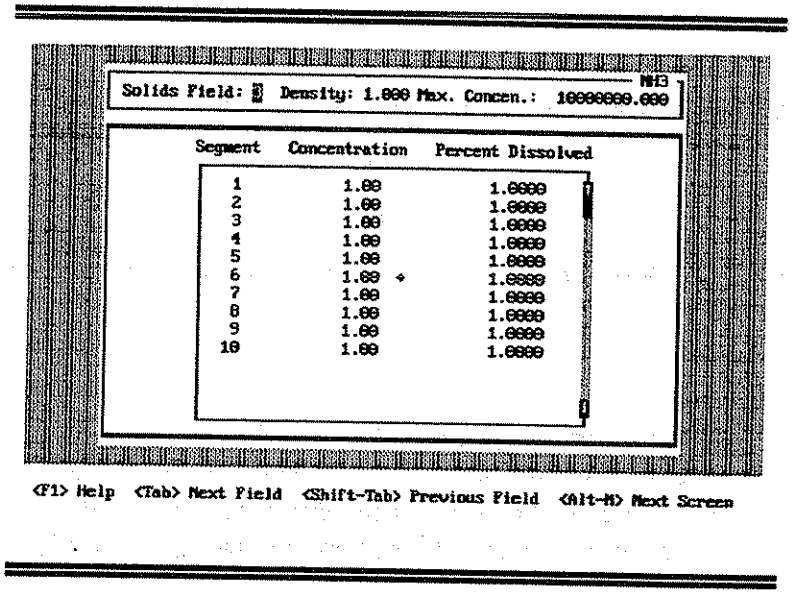
Menu Options

Initially when W5DSPLY is loaded the user is given the opportunity to select the time and space dimension of the output to view. The user is not constrained by this selection as each view port can be configured for any of the menu options simultaneously. The post processor breaks the simulation results down into three classes display variables, time intervals and spatial compartments.

1. Display Variables are the state variables and intermediators that are simulated in the models. Examples would be the constituents simulated in TOXI, EUTRO and DYNHYD.
2. Time Intervals are the discrete times at which information was written to the individual model result files. This represents the finest temporal resolution available for a given model run.
3. Spatial Compartments represent the physical dimensioning of the environment into computational elements. With WASP these represent the segments, with DYNHYD these represent the junctions.

The first option Segment vs. Time - allows the user to view up to 5 display variables versus time for a single segment over time. The second option allows the user to view Time vs. Variables from 1 to 5 segments over time. The third option allows the user to view Variable vs. Segment for 1 to 5 dump intervals. The figure below illustrates W5DSPLY main menu.



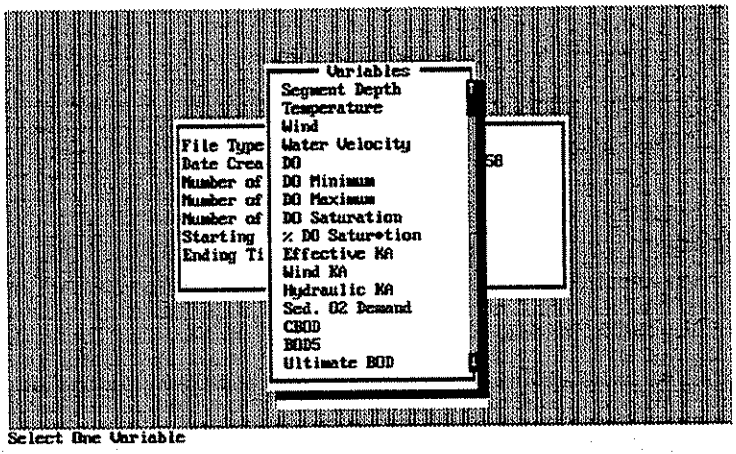


Option 1 -- Segment vs. Time

This is the function that would be used most often. It allows the user to examine the simulation results over time for individual segments. Once this option is selected the user will have to select the initial variable to display. The variable is selected by using the up/down arrow keys to select the variable of interest followed by the Enter Key. Upon the selection of a display variable four graphs will be drawn on the screen by default. These four graphs or view ports will initially display the same graph. The user can control each view port individually. To change view ports the user should use the arrow keys located on their numeric keypad. The activated view port is delineated from the others because it is surrounded by a frame. Under the first option the user can toggle through display variables by pressing the Space Bar. Once this initial graph is displayed the user has several options that have Hot Keys associated to them:

F1	--	Displays context sensitive help
ALT-H	--	displays menu of Hot Keys
ALT-V	--	Select Single Display Variable for graphing
CTRL-V	--	Select multiple variables for graphing
ALT-M	--	Display Main Menu
ALT-O	--	Overlay multiple simulation files.

The overlay multiple simulation files option will read up to 5 total WASP simulation files for plotting simutaneously. The files do not have to be the same size but, must be the same number of spatial compartments segments and display variables (i.e., you can not mix EUTRO and TOXI).



Option 2 -- Time vs. Variable

This option allows the user to examine the simulation results over time for individual display variables for up to five segments. This option is much like option 1 except the multiple variable choice here is segments for an individual display variable instead of multiple display variables for a given segment. Once this option is selected the user will have to select the initial segment to display. The segment is selected by using the up/down arrow keys followed by pressing the Enter Key. At this point all four view ports will be displayed as in option 1. The Space Bar will toggle through the segment(s) . Once this initial graph is displayed the user has several options that have Hot Keys associated with them:

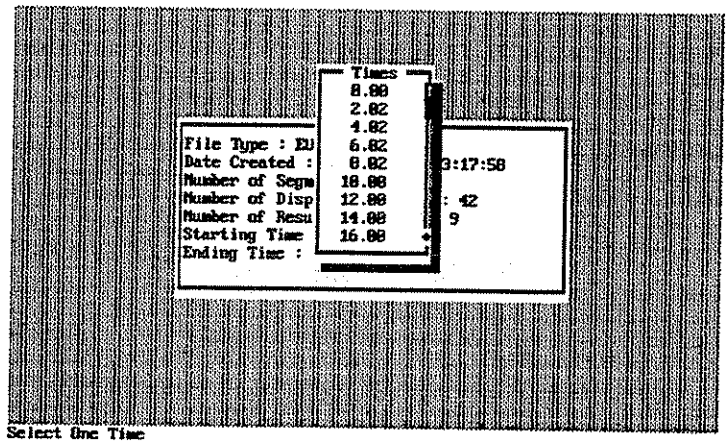
F1	--	Displays context sensitive help
ALT-H	--	Displays menu of Hot Keys
ALT-S	--	Select single segment for graphing
CTRL-S	--	Select multiple segments for graphing

ALT-M	--	Display Main Menu
ALT-O	--	Overlay multiple simulation files.

The overlay multiple simulation files option will allow reading of up to 5 WASP result files. The files do not have to be the same size, but, must be the same number of segments and display variables (i.e. you can not mix EUTRO and TOXI files).

Option – 3 Variable vs. Segment

This option allows the user to examine display variables vs. segments for up to five simulation time periods. This option allows the user to view a display variable for a given time over spatial compartments. Once this option is selected the user will have to select the initial time to display. The time is selected by using the up/down arrow keys followed by the Enter Key. The space bar will toggle through the display variables for the segments at the user selected time periods. Once this initial graph is displayed the user has several options that have Hot Keys associated with them:



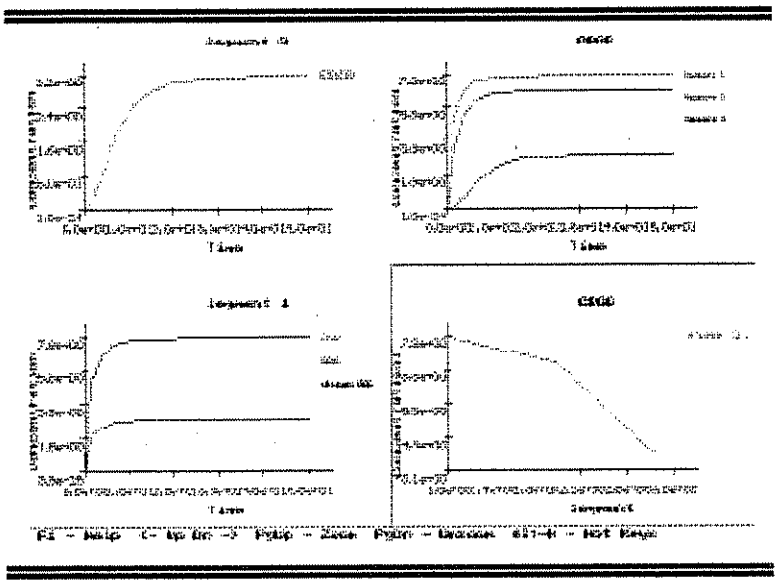
F1	--	Displays context sensitive help
ALT-H	--	Displays menu of Hot Keys
ALT-T	--	Select single time period to plot
CTRL-V	--	Select multiple time periods to plot

ALT-M	--	Display Main Menu
ALT-O	--	Overlay multiple simulation files.

The overlay multiple simulation files option will allow reading of up to 5 total WASPresult files. The files do not have to be the same size but, must have the same number of segments and display variables (i.e., you can not mix EUTRO and TOXI files).

Changing View Ports

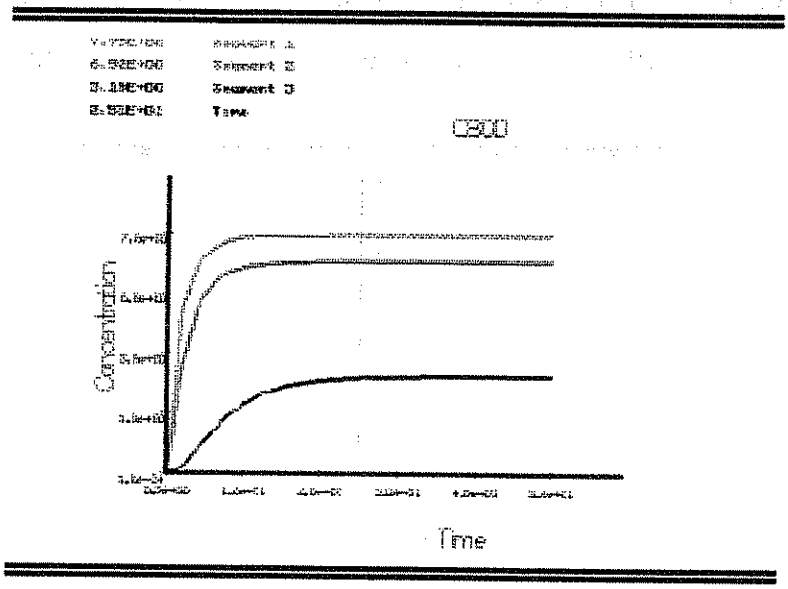
To change view ports simply press the right/left/up/down arrow keys. The active view port is the one with the white box around it. Once you have a view port active, the user has the capability to change the contents of the graph. The illustration below shows the graphic screen with the 4 view ports displayed.



Zoom Option

At any point during the viewing of the plots the user can elect to zoom the current active view port by simply pressing the Page-Down key. This will force the active view port to full screen. While in full screen mode the user still has the capability of manipulating the current graph in all the same manner as before. The user also has the capability of investigating the numbers which define the graph. By pressing ALT-I the user will toggle the investigation feature of W5DSPLY,

a vertical line will appear and a new view port will be opened in the upper left hand corner of the screen. The new view port will display the values of the lines of the simulation result curves that correspond to the intersection point with the vertical line. The user may move the vertical line by pressing the left or right arrow keys. Note that the sensitivity of the movement of the vertical line can be adjusted by pressing the space bar. Initially, the movement is set very coarse, but pressing the space bar will toggle to more sensitive movements. There are four levels of sensitivity for the investigation mode, the level can be determined from the status area at the bottom of the graph. Level indicates the current toggled sensitivity, 1 being the most sensitive and 4 being the least sensitive. Before the user can continue with further functions the user must toggle out of the investigation mode by pressing ALT-I.

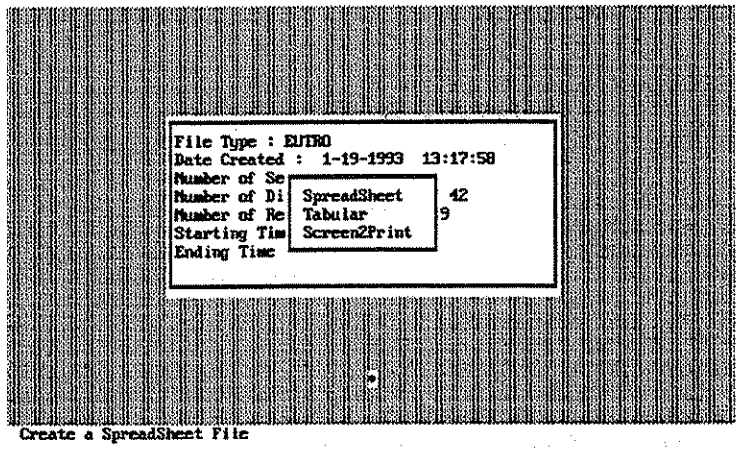


Output Options

The output options of W5DSPLY represents some of the strongest features of the post processor. Besides being able to view the documents on the screen, W5DSPLY can output the model simulation results in several usable formats. It has the ability to produce files that can be imported by most any spreadsheet programs, produce a "generic" output table or print the active graphics screen to almost any printer.

Creating Spreadsheet Files

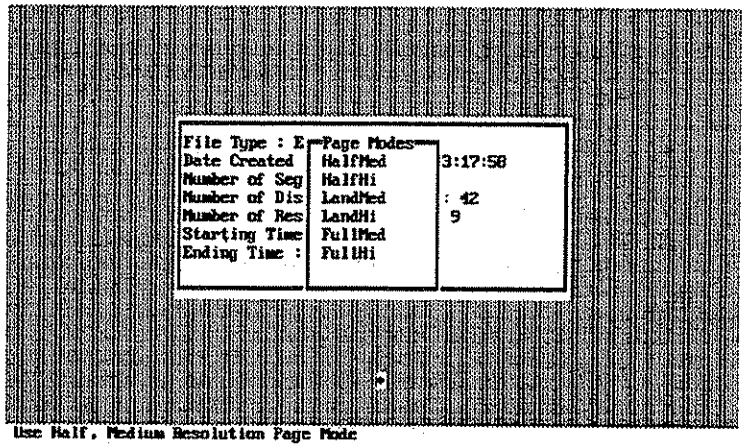
W5DSPLY has the capability to produce spreadsheet compatible files that can be imported without using a parse function. The spreadsheet files are comma delimited ASCII text files that can be directly imported. This feature is provided to the user so that publication quality graphs and statistics can be performed on the simulation results with little effort. It also allows the user to easily plot observed data versus simulated data. To create a spreadsheet file for the active view port type ALT-P. This will cause the display of a output choice menu. Select the spreadsheet option and W5DSPLY will then prompt for a filename (Note: that W5DSPLY will offer a default name of the input filename with the extension .PRN). You can offer any name you like or except the default by pressing enter. W5DSPLY will warn if a file is about to be overwritten. Upon the successful completion of creating the spreadsheet file W5DSPLY will prompt to load the spreadsheet program or not. If you elect to load the spreadsheet program W5DSPLY will unload and the user specified spreadsheet program will be loaded. Upon exit from the spreadsheet program the user will be returned to W5DSPLY.



Creating Tabular Printer Files

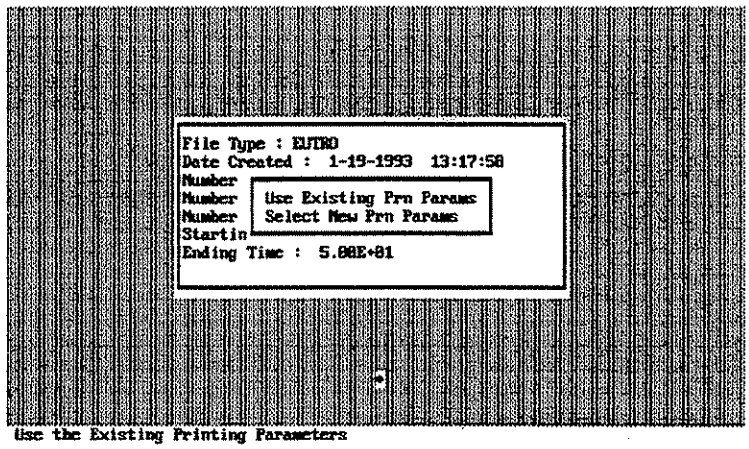
The tabular print file option is used to analyze the simulation results in a tabular fashion. The user has the option to list the information to the screen using a browser function or export the table to an ASCII file which can later be viewed, printed or imported into a document. To view and

create an table file press ALT-P and select the Tabular option. Note: only the numeric information that describes the graphs in the active view port will be written to the table file.

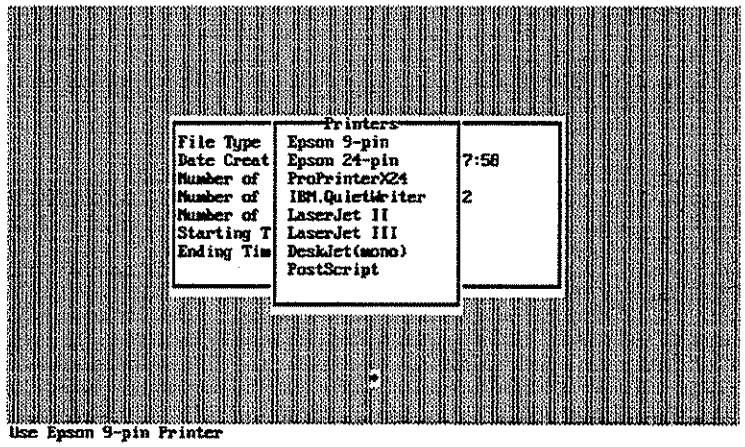


Printer/Plotter Output Options

W5DSPLY has the ability to output the graphics screens to both plotters and printers. The program supports the most common printer and plotter interfaces. The first time the user requests a printer/plotter output, W5DSPLY will have to be configured for the desired hardware. To output a figure press ALT-P, and select SCREEN2PRINT. The user will then be asked to use preexisting defaults or select them. If this is the first time using this output option you will be required to select the hardware components which best match your computer configuration. The PORT refers to the hardware address to which the output device is attached. With most printers the PORT is LPT1:, plotters can either be attached to LPT1: or a communication port COM1: . Please refer to your system installation information.

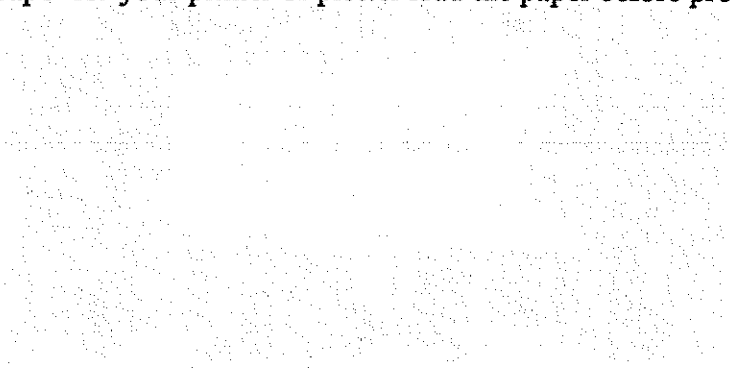


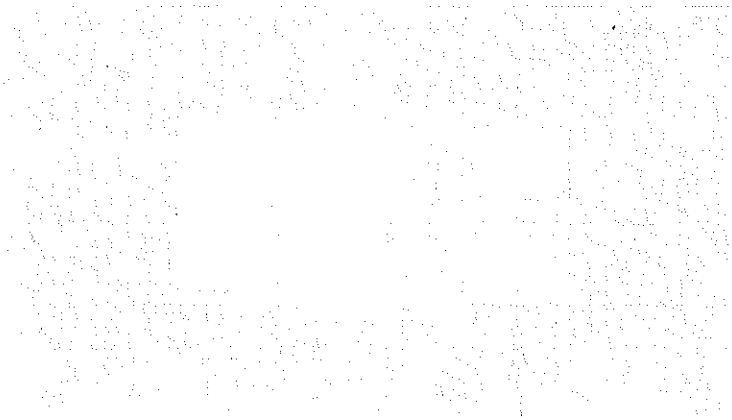
You will need to know what printer emulations your printer/plotter support if your printer is not directly supported. Below is a printer/plotter configuration screen, and you will be required to select one of the printers listed below. Some experimentation may have to take place to determine which output device best suits your hardware.



Once the hardware is configured correctly the user may print/plot any graphics displayed by simply pressing ALT-P and selecting SCREEN2PRINT. Whatever is displayed on the active graphic screen will be sent to the output device. After selecting SCREEN2PRINT the program

will return to the graphics screen and the user will have to press F7 to output the graph. If you are using single sheet paper for your printer or plotter load the paper before pressing F7.



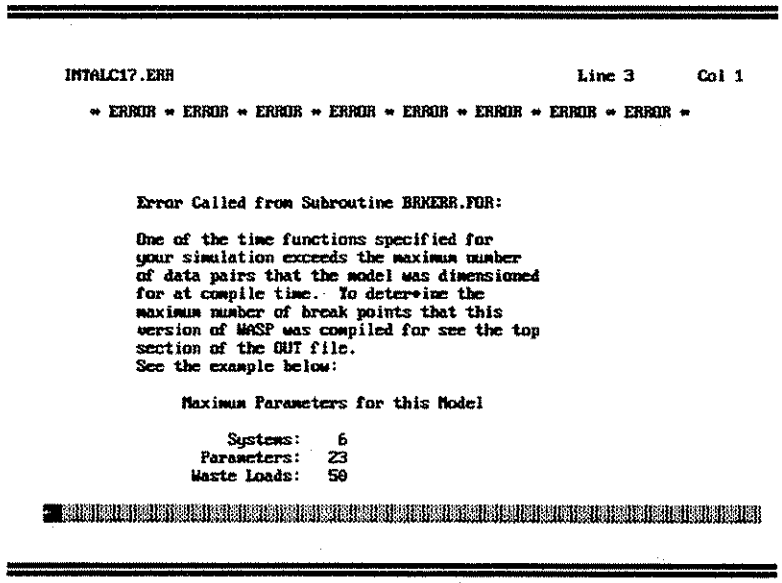


WASP -- Benthic Algorithm Enhancements

During the application of WASP version 4.32 Ecology discovered a problem with TOXI4's benthic compaction subroutine. The past coding of the subroutine required the user to have the same number of benthic layers regardless for the need or not. Based upon the request of Ecology the WASP benthic subroutine (BEDSED) was modified to allow the number of benthic layers to vary at the user's discretion. The new algortihms were tested against several benchmark datasets that had known solutions without problems. The modifications to BEDSED are illustrated in Appendix C.

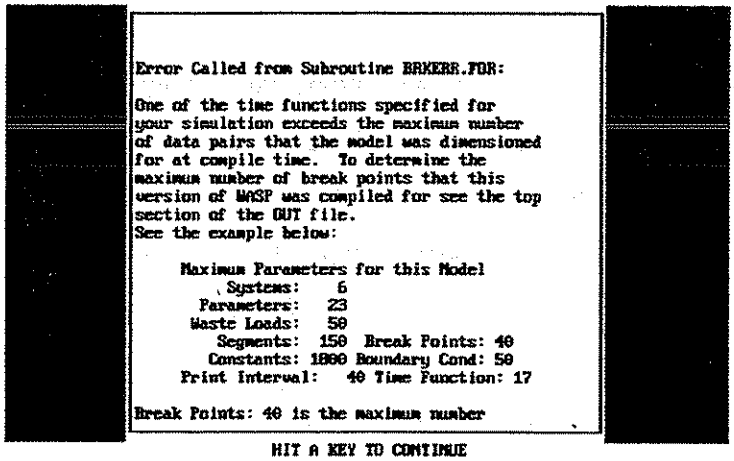
WASP Error Checking Algorithms and Code Modifications

Runtime error checking algorithms were added to aid the user in determining where and how the WASP program encounter and error. These algorithms were designed so that they could be utilized by both the TOXI and EUTRO version of WASP. The error checking/correction algorithms were designed to use the powers of WISP, but will also function properly without the aid of WISP. A new runtime message file was created (WASP.ERF), RIVER.ERR provides the specific error information to the user by looking up the file that was encountered and displays the information to the user via a file or message window on the screen. If WISP was used to execute the program WASP will create a filename with the same prefix as the input file with the extension *.ERR. For example if the input filename was called RIVER.INP and WASP encountered an error will reading the input dataset or during execution the error information would be written to this file. Upon completion of the execution of a WASP input dataset WISP checks for the occurrence of this file and if it exists WISP will display the error file in the WISP Browser.



If the input dataset was not executed using WISP, WASP will display the error message in a window before termination of the program. Either way the program is executed the *.ERR file

will exist until the input file is re-executed and can be viewed with any text editor.



Dataset Checking and Warnings

Algorithms have been added to the WASP model which will pause the program to alert the user of some exceptions that occurred during the execution of their input dataset. The information is displayed to the user along line 25. This message will give the user a brief explanation of the potential problem occurred.

1. Flow Continuity Does not Balance--this indicates that the flow continuity matrix in the flow input does not balance. See the *.OUT file for a listing of the information read by WASP.
2. Segment Depths not Entered-- a segment depth was not entered for the specified segment. If WASP is going to calculate a reaeration/volatilization rate WASP needs the depth of the segment.
3. WASP Calculated a Smaller Time Step -- This warning would be issued if the user is not using the automatic time step option and has provided a time step. WASP calculated a time step that is less then the one specified by the user, this could lead to model instability if the warning is ignored. To determine the appropriate time step to use view the *.TRN file.
4. End of File Reached on NPS File -- WASP has reached the end of the user supplied non-point source loading file. All NPS loads will be set to zero.
5. Rewinding Hydrodynamic File-- WASP has encountered the end of file of the hydrodynamic linkage file. The HYD file will be rewinded and used again.

6. Begin/End Time of Hydrodynamic Linkage File does not Match -- the time sequence between the beginning and end time of the hydrodynamic linkage file does not match that of the WASP input dataset. The WASP begin time will be adjusted automatically.

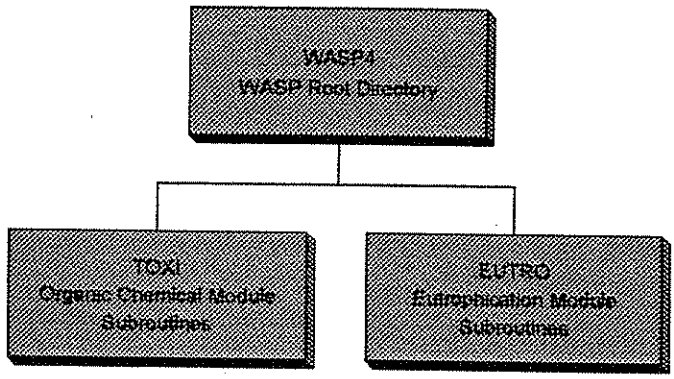
WASP Recompilation

The WASP modeling system was designed to allow users to easily modify the program and change the dimensionality of the code. This section gives detailed information on how to change the dimensionality of the WASP FORTRAN programs, compile and link the programs. This document assumes the user has all the appropriate software required to successfully compile and link the programs.

Software Overview

The WASP software has been designed to module and be shared and linked with other kinetic subroutines. The EPA version of WASP is distributed with two kinectic subroutines when compiled and linked together with the generic WASP transport code form the two models TOXI4 and EUTRO4. Because of this module design the user must take precautions in not crossing the TOXI4 FORTRAN COMMON BLOCKS with the EUTRO4 COMMON BLOCKS and vice versa. If this occurs unknown results may occur. The WASP source code is stored in the following fashion to protect from crossing COMMON Blocks.

WASP Source Location



The common blocks for each of the individual WASP models (EUTRO4 & TOXI4) are stored in the subdirectories with the source code for the kinetic sub-models.

WASP Transport Module (WASP4V4.FOR)

The file WASP4V40.FOR contains all the FORTRAN source code that is used for reading the WASP input files, performing the bookkeeping and solving the mass balance equations. This code is exactly the same for both modules of WASP. The WASP transport code gets its dimensionality from the included common blocks. To properly compile the WASP code the appropriate common block must be present at the time of compilation.

Organic Chemical Kinetic Subroutines (TOXI.FOR)

The TOXI.FOR file contains all the FORTRAN source code that comprises the organic chemical model. The organic chemical routines dimensionality comes from the WASP.CMN file and the associated *.CMN and *.EQU files located in the TOXI subdirectory. The user is discouraged from modifying any portion of the TOXI.FOR file and the associated common blocks until a good understanding of the program is achieved.

Eutrophication Kinetic Subroutines (EUTRO.FOR)

The EUTRO.FOR file contains all the FORTRAN source code that comprises the eutrophication model. Like the organic chemical model EUTRO gets its dimensionality from the WASP.CMN file.

Software Requirements

To successfully make changes to the WASP modeling system the user will need to have the following software:

1. FORTRAN Compiler -- Salford University FTN77/x86 Compiler. This includes the protected mode kernel DBOS, and LINK77 the linkage editor needed to join the machine object code into an executable.
2. Screen Graphics Library -- ISS Interacter library required during linkage to allow for the resolution of external subroutine calls.
3. An ASCII compatible text editor. The use of word processor programs are discouraged as they can enter control characters into the program source codes.

Other compilers could be used as long as the appropriate Interacter Library exist for the particular compiler.

The software should be installed in directories according to the manufacturers directions. For this example on how to recompile the WASP programs the software is assumed to be in the following paths:

FTN77	C:\FTN77
Interacter	C:\INT\LIB

Changing WASP Dimensions

All the dimensions of WASP (number of segments, number of possible exchange pairs, etc.) are parameterized in the appropriate WASP.CMN file. Appropriate is meant as the specific WASP.CMN file for each kinetic sub-program. The WASP.CMN file has a FORTRAN PARAMETER statement that is responsible assigning these values. Given below is a portion of the WASP.CMN with a detailed definition of each of the parameters. The numbers in the brackets represent the current dimension of the model for Ecology.

1. SY = Number of State Variables -- for TOXI this number is 6 and for EUTRO it is 8. It is highly unlikely this number would ever need to be changed as it would indicate that new state variables have been programmed into the model.
2. SG [150] = Number of Segments -- this parameter designates the number of spatial compartments that WASP can consider in a single simulation. This number would need to be increased if the number of segments in the user dataset is more then the number specified in the WASP.CMN file.
3. CX [1800]= Number of Kinetical Constants -- this value sets up an array to store all the chemical constants. It is unlikely that this number would ever need to be changed.
4. PR [23]= Number of Segment Parameters -- this value is used to dimension the model for the number of segment parameters (i.e., temperature, pH, etc.) that could possibly be used by the model. If the user elects to add additional segment parameters this number would need to be increased and the appropriate code added to the program.
5. BC [50]= Number of Boundary Segments -- this is the number of boundary conditions the model can consider. Depending upon the transport pattern being simulated and the number of segments this value may need to be increased if more boundaries are specified in the input dataset than is dimensioned in the WASP.CMN file. Note that WASP has a limitation of one boundary per segment.
6. WK [50]= Number of Loads -- this value sets the number of loads that can be read (excluding the non-point source loads). If the users number of loads exceeds that of the dimension in the WASP.CMN file this number should be increased. Note that WASP has a limitation of one load per segment.

7. TF [17]= Number of Env. Time Functions -- this value sets the number of environmental time functions the model can handle. If more time functions are required this number can be raised and additional code added to the model.
8. MB [400]= Maximum Number of Time Breaks for all Functions -- this value specifies the number of data points that can be entered for every time function. In other words if you have flow data for every day in a year this number would have to be greater then 365.
9. MNF [6]= Number of Flow Fields (Typically 6) -- this is the number of flow fields in the model (surface water, pore water, solids 1-3, evaporation/precipitation). It is unlikely that this number would ever change as it would entail major code modification.
10. MNI [10]= Number of Time Functions per Inflow Field -- this value indicates the dimension for the number of individual flow functions the user can have for each individual flow field.

The figure below is an actually code snippet from the TOXI WASP.CMN file. The variable names match with the descriptions given above.

```
PARAMETER (SY=6, SG=150, S2=SG*6, CX=1800, PR=23, BC=50, WK=50, TF=17, MP=40, MB=400, MD=1,
SY1=SY+1, MB1=MB+1, MNF=6,MNI=10, M30=2*BC*SY, M50=2*WK*SY, M70=S2+1, M73=2*TF, M75=2*MB)
```

Creating a New Executable

Before a new executable can be created the user must make any changes in the dimensionality of the code or code content and then run the compiler and then the linker. The compiler will generate error messages if the coding was incorrect or an object file (*.OBJ) if the file passed the compilation stage. Inorder to re-compile the TOXI4 program the user would have to pass the compiler over the WASP4V40.FOR file and the TOXI.FOR using all the common block files located in the TOXI directory. The example below gives an illustration on what exactly would need to be typed inorder to re-compile TOXI.

```
FTN77  WASP4V40 /INTL /FULLCHECK
FTN77  TOXI /INTL /FULLCHECK
LINK77
$LOAD WASP4V40
$LOAD TOXI
$LOAD C:\INT\LIB\INTPC386
```

$FILE TOXI4.EXE

The first two lines would compile the source code using the Salford FORTRAN compiler FTN77. The /INTL indicates to the compiler that long integers should be the default (i.e., Integer*4), the /FULLCHECK instructs the compiler to add code to the executable that will do full checking of array integrate as well as under and overflow checking. LINK77 executes the linkage editor, after issuing the command LINK77 the user will be given an interactive prompt $ in which the rest of the information should be provided. The LOAD command instructs the linker to load that particular object file into memory, if it returns an error file not found make sure the *.FOR file was compiled successfully. The LOAD C:\INT\LIB\INTPC386 instructs the linker to load the routines from the Interacter library that are needed by the WASP model. The last statement FILE assigns the name and causes the linker to create the new executable (*.EXE).

APPENDIX - A Browser Commands

Cursor Movement

Action	Key Assignment	Description
Left	<Left>, <CtrlS>	Scroll window left 1 column.
Right	<Right>, <CtrlD>	Scroll window right 1 column.
WordLeft	<CtrlLeft>, <CtrlA>	Scroll window left 10 columns.
WordRight	<CtrlRight>, <CtrlF>	Scroll window right 10 columns.
Home	<Home>, <CtrlQ><S>	Scroll window to column 1.
End	<End>, <CtrlQ><D>	Scroll window to left most column
Up	<Up>, <CtrlE>	Scroll window up one line.
Down	<Down>, <CtrlX>	Scroll window down one line.
PageUp	<PgUp>, <CtrlR>	Scroll window up one page.
PageDn	<PgDn>, <CtrlC>	Scroll window down one page.
TopOfFile	<CtrlPgUp>, <CtrlQ>	Scroll to beginning of file.
EndOfFile	<CtrlPgDn>, <CtrlQ>	Scroll to end of file.
JmpLine	<CtrlJ><L>	Prompts the user for a line number, then scrolls the window such that the greater than the number of lines in the file, the window will be scrolled to the end of the file.

File Commands

Action	Key Assignment	Description
NewFile	<F3>, <CtrlK><N>	Load a new file into the browser.

Block Commands

Action	Key Assignment	Description
BlkBegin	<F7>, <CtrlK><B>	Marks the line at the top of the window as the start of a block.
BlkEnd	<F8>, <CtrlK><K>	Marks the line at the top of the window as the end of a block.
BlkBottom	<CtrlB><K>	Marks the line at the bottom of the window as the end of a block.
JmpBegin	<CtrlQ><B>	Jump to the beginning of the currently marked block.
JmpEnd	<CtrlQ><K>	Jump to the end of the currently marked block.
BlkToggle	<CtrlK><H>	Toggle the display of marked blocks.
BlkWrite	<CtrlK><W>	Writes the currently marked and displayed block to a file.
BlkPrint	<CtrlK><P>	Writes the currently marked and displayed block to the printer. As with the browsed to the printer. By default, BlkPrint directs output to LPT1; to select LPT2 or LPT3, call the SetPrinter method.

Search

Action	Key Assignment	Description
Search	<CtrlQ><F>	Allows the user to search for any string of up to 30

		characters. After handled in the same fashion as the Borland editors. Valid search options are 'B' (search Backwards), 'G' (search Globally), and 'U' (ignore case). If the search string is found, the line where the text is found will be highlighted until another search operation is performed or the mode is toggled between hex and ASCII.
ReSearch	<CtrlL>	Repeat the last search operation. The string used in the last search operation operation has yet been performed, this command does nothing.

Text Markers

Action	Key Assignment	Description
SetMark0..9	<CtrlK><0>..<CtrlK><3>	Sets one of the ten text markers at the start of the line
JmpMark0..9	<CtrlQ><0>..<CtrlQ><3>	Scrolls the window such that the line associated with the specified text jumps to marker 1, etc.

Mode Toggles

Action	Key Assignment	Description

HexMode	<CtrlH>	Toggles between ASCII mode (the default) and hex mode.
StripHigh	<CtrlQ><H>	Activates or deactivates the option to suppress (strip) the eighth (high) bit characters with an ordinal value of 128 or higher (10000000 in binary).
TabExpand	<CtrlQ><T>	Enables or disables tab expansion. When this option is on, tab characters (^I) (Tab stops our every 8 columns: 1, 9, 17, etc.) This option does nothing in hex mode.

Other

Action	Key Assignment	Description
Quit	<CtrlBreak>, <Esc>	Quit browsing.
Help	<F1>, <ClickBoth>	Help.
MouseSel	<ClickLeft>	This command does nothing unless the browse window has a scroll bar or mouse

APPENDIX - B Editor Commands

Cursor Movement

Action	Key Assignment	Description
Left	<Left>, <CtrlS>	Cursor left one character.
Right	<Right>, <CtrlD>	Cursor right one character.
WordLeft	<CtrlLeft>, <CtrlA>	Cursor left one word.
WordRight	<CtrlRight>, <CtrlF>	Cursor right one word.
Home	<Home>, <CtrlQ><S>	Cursor to beginning of line.
End	<End>, <CtrlQ><D>	Cursor to end of line.
Up	<Up>, <CtrlE>	Cursor up one line.
Down	<Down>, <CtrlX>	Cursor down one line.
ScrollUp	<CtrlW>	Scroll display up one line.
ScrollDown	<CtrlZ>	Scroll display down one line.
PageUp	<PgUp>, <CtrlR>	Scroll display up one page.
PageDn	<PgDn>, <CtrlC>	Scroll display down one page.
ScreenTop	<CtrlHome>, <CtrlQ><E>	Move cursor to top of edit window.
ScreenBot	<CtrlEnd>, <CtrlQ><X>	Move cursor to bottom of edit window.
TopOfFile	<CtrlPgUp>, <CtrlQ><R>	Move cursor to beginning of file.
EndOfFile	<CtrlPgDn>, <CtrlQ><C>	Move cursor to end of file.
JmpLine	<CtrlJ><L>	Prompts the user for a line number, then moves the cursor to the specified

Insertion and Deletion

Action	Key Assignment	Description
Del	<Del>, <CtrlG>	Delete character at cursor.
Back	<Bksp>, <CtrlH>	Delete character to left of cursor.

DelLine	<CtrlY>	Delete current line.
DelEol	<CtrlQ><Y>	Delete from cursor to end of line.
DelWord	<CtrlT>	Delete word to right of cursor.
Select	<Enter>, <CtrlM>	Start a new line.
InsertLine	<CtrlN>	Insert a new line at the position of the cursor.
Tab	<Tab>, <CtrlI>	Move the cursor to the next tab stop. If insert mode is on, any text to the tab stops our at 8-column intervals (by default).
CtrlChar	<CtrlP>	Insert control character.

File Commands

Action	Key Assignment	Description
SaveFile	<F2>, <CtrlK><S>	Save the current file and continue editing.
NewFile	<F3>	Load a new file.
AbandonFile	<CtrlK><Q>	Quit editing; ignore any changes made to the text.
SaveSwitch	<CtrlK><D>	Save the current file and load a new one.
SaveNamed	<CtrlK><N>	Save the current file under a new name.
SaveExit	<CtrlK><X>	Save the current file and exit.

Block Commands

Action	Key Assignment	Description
BlkBegin	<F7>, <CtrlK><B>	Mark the beginning of a block.
BlkEnd	<F8>, <CtrlK><K>	Mark the end of a block.
BlkWord	<CtrlK><T>	Mark the current word as a block.
JmpBegin	<CtrlQ><B>	Jump to the beginning of the currently marked block.
JmpEnd	<CtrlQ><K>	Jump to the end of the block.
BlkToggle	<CtrlK><H>	Toggle the display of blocks.
BlkCopy	<CtrlK><C>	Copy the currently displayed block to the position of the cursor.
BlkMove	<CtrlK><V>	Move the currently displayed block to the position of the cursor.
BlkDelete	<CtrlK><Y>	Delete the currently displayed block.
BlkIndent	<CtrlK><I>	Indent the currently displayed block by a fixed number of spaces
BlkUnindent	<CtrlK><U>	Unindent the block.
BlkTCase	<CtrlO><O>	Toggle the case of all characters in the currently displayed block
BlkUCase	<CtrlO><U>	Like BlkTCase, but convert characters to upper case.
BlkLCase	<CtrlO><V>	Like BlkTCase, but convert characters to lower case.
BlkRead	<CtrlK><R>	Reads a file into the text buffer at the current position of the

		cursor and the buffer, a warning will be generated and no data will be read in.
BlkWrite	<CtrlK><W>	Writes the currently marked and displayed block to a file.
BlkPrint	<CtrlK><P>	Writes the currently marked and displayed block to the printer

Search and Replace

Action	Key Assignment	Description
Search	<CtrlQ><F>	Allows the user to search for any string of up to 30 characters. After include 'B' (search Backwards), 'G' (search Globally), 'L' (search Locally, within marked block), and 'U' (ignore case).
Replace	<CtrlQ><A>	Works like Search, except that the user is asked for a replacement string Search, 'N' may be used to indicate that replacements are to be made without asking for confirmation. If 'N' is not selected, each replacement must be confirmed: yes (make the replacement), no (don't make it), all (make this

		replacement and continue making replacements without further confirmation), and quit (stop the whole operation).
ReSearch	<CtrlL>	Repeat the last search or replace operation.

Text Markers

Action	Key Assignment	Description
SetMark0..9	<CtrlK><0>..<CtrlK><3>	Sets one of the ten text markers at the position of the cursor.
JmpMark0..9	<CtrlQ><0>..<CtrlQ><3>	Moves the cursor to a text marker set with one of the SetMarkX commands.
MarkToggle	<CtrlK><M>	Toggle the display of text markers.
PrevPos	<CtrlQ><P>	Jump to the last cursor position before the cursor was moved to the current

Text Formatting

Action	Key Assignment	Description
ReformatP	<CtrlB>	Reformat the current paragraph. Does nothing if word wrap is off.
ReformatG	<CtrlK><G>	Reformat the entire text buffer. Use with caution!
CenterLine	<CtrlO><C>	Center the current line between column 1 and the right margin.

Mode Toggles and Option Settings

Action	Key Assignment	Description
Ins	<Ins>, <CtrlV>	Toggle insert mode on or off. A fat cursor indicates insert mode; a thin
Indent	<CtrlO><I>	Toggle auto-indent mode on or off.
WordWrap	<CtrlO><W>	Toggle word wrap on or off.
TabToggle	<CtrlO><F>	Toggle the tab mode between smart tabs and fixed tabs.
TabSize	<CtrlO><T>	Prompts the user for the number of columns between tab stops (1-10).
RtMargin	<CtrlO><R>	Prompts the user for a new right margin.
SetIndent	<CtrlO><B>	Prompts the user for the number of spaces to indent/unindent marked blocks.

Other

Action	Key Assignment	Description
Restore	<CtrlQ><L>	Restore original contents of the current line.
Help	<F1>, <ClickBoth>	Request help.
MouseSel	<ClickLeft>	Moves the cursor to the position indicated by the mouse.