CE-QUAL-W2: A Two-Dimensional, Laterally Averaged, Hydrodynamic and Water Quality Model, Version 4.5

User Manual:
Part 5 – Model Utilities

Edited by
Scott A. Wells
Professor
Department of Civil and Environmental Engineering
Portland State University
Portland, OR 97207-0751

Department of Civil and Environmental Engineering
Portland State University
Portland, OR 97207-0751

December 2023

Contents

List of Figures

List of Tables

Preface

This manual documents the two-dimensional, laterally averaged, hydrodynamic and water quality model CE-QUAL-W2. As in all complex models, there have been many contributors. This re-write of the User Manual was based on prior User Manuals: Environmental and Hydraulic Laboratories (1986), Cole and Buchak (1995) Version 2, and Cole and Wells (2000) Version 3.0 through Cole and Wells (2019) Version 4.1. Hence, one can think of the primary author as merely an editor of past documents, rather than reflecting one person's sole authorship. This updated User Manual contains numerous corrections, new figures, new sections, additional documentation, and improvements in organization and presentation of information compared to Cole and Wells (2019).

This section of the User Manual Part 5 documents the model utilities used in supporting the model, the model release notes and a detailed list of bug fixes.

The other sections of the User Manual are divided into multiple sections for ease of updating and editing:

- User Manual Part 1: Introduction to CE-QUAL-W2, Model download package, how to run the model, model versions, changes between model versions
- User Manual Part 2: Theoretical basis for CE-QUAL-W2: hydrodynamics and water quality, particle transport and numerical scheme
- User Manual Part 3: Model input and output file descriptions and input/output file examples
- User Manual Part 4: Model examples
- User Manual Part 5: Release notes, bug fixes, differences in model versions, history of bug fixes, and other user manuals such as for the GUI interface, the water balance algorithm, and other external codes.

This report should be cited as follows:

Wells, S. A., editor (2023) "CE-QUAL-W2: A two-dimensional, laterally averaged, hydrodynamic and water quality model, version 4.5, user manual part 5, model utilities and release notes," Department of Civil and Environmental Engineering, Portland State University, Portland, OR.

Or for a specific section:

Cole, Tom (2023) "Water Balance Utility," in "CE-QUAL-W2: A two-dimensional, laterally averaged, hydrodynamic and water quality model, version 4.5, user manual part 5, model utilities and release notes," ed. S. Wells, Department of Civil and Environmental Engineering, Portland State University, Portland, OR.

1. Introduction

Several useful CE-QUAl-W2 model utilities are available for editing the control file, post-processing model results, and setting up model input files. A description of these utilities is included in this part of the User Manual.

Also, this document shows model changes and bug fixes, model changes between versions, and a history of bug fixes in earlier versions.

Hence, this section of the User Manual includes the following sections:

- Model utilities
    - Water balance utility
    - Converter utility from w2_con.npt control file to Excel version
    - GUI control file editor and bathymetry viewer for Versions 3.7-4.22
    - Post-processor provided by DSI, Inc. including a bathymetry viewer
    - Excel macro utility for writing out input files for CE-QUAL-W2
- Model release notes
    - Current Bug fixes
    - Model Know Limitations
    - Model changes between versions
    - Model bug fixes between versions

2. Water Balance Utility

Primary author: Tom Cole

How to use the water balance utility GUI application

Running the water balance program

When the executable is run, a window appears that allows the following inputs (note that the executable runs under the Windows operating system only) as shown in Figure 1.

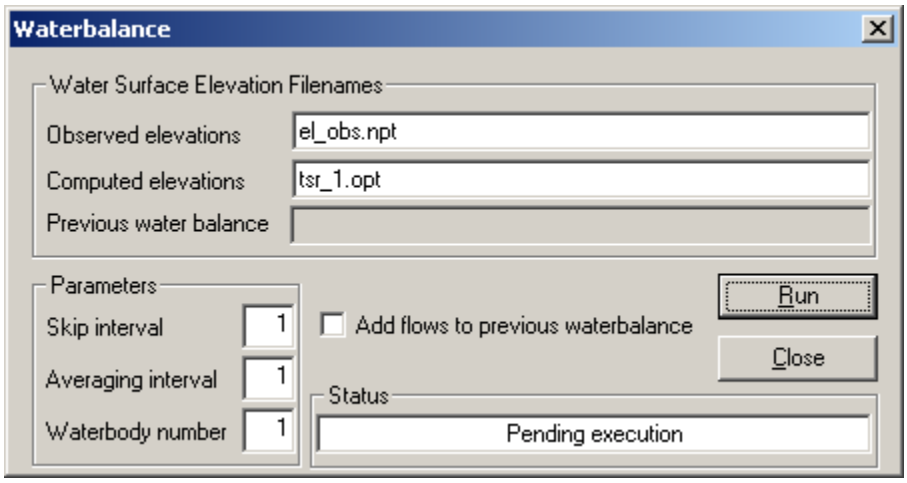


Figure 1. Dialog box for water balance utility.

:

When the dialog box first appears, default values populate the edit boxes. The user can then edit each one if the default values are not correct. Selecting Run will run the waterbalance utility to completion as shown in the following dialog box (Figure 2).

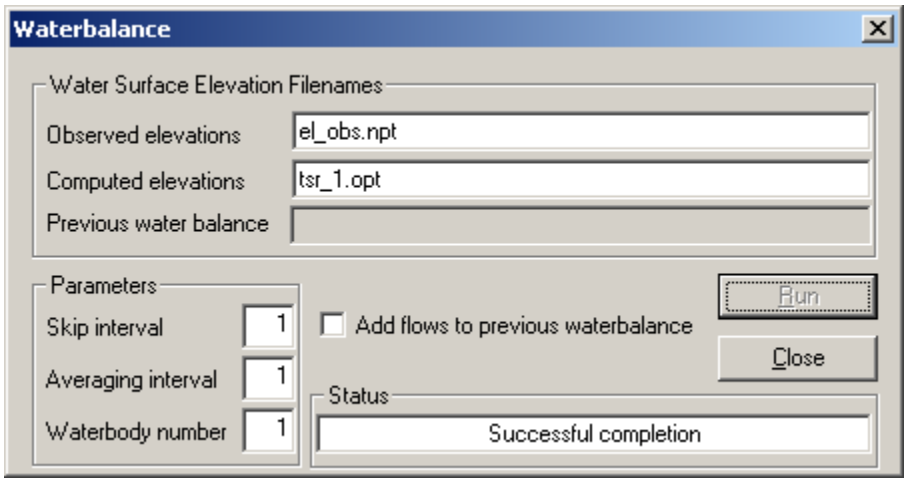


Figure 2. Dialog box for water balance utility if successful completion.

Observed elevations filename. This file consists of a Julian day and observed elevation as in the following example:

```
2000-2001 Oologah Reservoir observed water surface elevations

    JDAY     ELO
  90.792 195.453
  90.833 195.456
  90.875 195.459
  90.917 195.441
  90.958 195.444
  91.000 195.450
  91.042 195.441
```

```
91.083 195.441
91.125 195.447
91.167 195.441
91.208 195.444
91.250 195.438
91.292 195.432
```

This example skips the first 3 lines and is of a similar format to all other CE-QUAL-W2 time-varying inputs with a fixed format with eight columns each for the JDAY and ELO values. However, the utility will read in values using variable field lengths so long as the JDAY and ELO values are separated by a space. Data need not be at regular intervals that might cause a repeat of the same values. Sometimes better results have been obtained if the same values that repeat over a time interval are not included (such as the water surface elevation at day 91.083 above).

Also note that the degree of accuracy in the observed elevations can have an impact on the computed flows. It is up to the user to decide the necessary precision used in the observed water surface elevations.

Computed elevations filename. The following shows an example output file from a time series file (the columns to the right have not been shown):

```
   JDAY,       DLT,      ELWS, ..............................
 92.000,    456.39,    195.37, ..............................
 93.000,    952.28,    195.28, ..............................
 94.000,    494.28,    195.27, ..............................
 95.000,     34.43,    195.17, ..............................
 96.000,    170.88,   195.08, ............................
 97.000,    211.93,    194.99, ..............................
 98.000,    255.11,    194.92, ..............................
 99.000,   1459.08,    194.78, ..............................
```

The water balance utility reads in the [JDAY] and [ELWS] values and uses these in the water balance computations. The user must turn on time series output in the model control file and specify the segment at which the water surface elevation values are output (typically the segment next to the dam for reservoirs). Information on how to accomplish this is given in the User's Manual under the Time Series output file discussion.

Add to previous water balance . For various reasons, the water balance utility may not perfectly close the water balance the first time through the computations. Depending upon the discrepancies between computed and observed elevations, the utility may need to be used iteratively by rerunning the model using output from the first run of the water balance utility and then rerunning the water balance utility on the water surface elevations output in the new time series file. For a system with multiple branches, each iteration of the utility and the resulting output file can be saved as a separate file that is then incorporated as a distributed tributary for branch 2, then branch 3, etc. In the case of a system with only one branch, this approach cannot be used. Rather, the new flows generated at the second iteration need to be added to the previously computed flows and incorporated as an "improved" distributed tributary inflow file. This option allows the user to continue adding flows to the same inflow file.

The computed flows are contained in the "**qwb.opt**" file. For most simulations, these flows will generate water surface elevations sufficiently close to the observed elevations such that further refinement is unnecessary. However, as mentioned above, the solution may need to be iterated. Rarely, manual adjustment of the generated flows may be required. This is usually only needed when observed water surface elevations change significantly over a short time period.

Previous water balance filename. If the "Add to previous water balance" option is used, you must specify the existing water balance output file for the computed flows to be added to.

Skip interval. Some reservoirs have a lot of noise in the observed water surface elevation data, such as in peaking hydropower operations, and this option allows the user to specify how many observed elevations are ignored when computing the flows between observed elevations. For example, if water surface elevations are available on an hourly interval, the resulting flows generated by the water balance utility can have large + and – flows that are completely unrealistic as opposed to using observed elevations on a daily basis taken during periods of no hydropower generation. In order to smooth out the computed flows, a skip factor of 24 would result in computed flows being output on a daily basis with all of the "noise" generated by hydropower operations ignored over the 24-hour period.

Averaging interval. This option computes a running average of the water surface elevation based on the input value. This is an additional aid to smooth out water surface elevation "noise". For example, consider the case in which there is no inflow/outflow to the system, but there is considerable wind seiching. The water balance utility would compute alternating inflows and outflows from the system that, depending on the amount of seiching, could be very large when in reality there should not be any flows added to or subtracted from the system. Using a running average alone or in combination with skipping over a number of observed elevations specified in (4) can help alleviate many of the problems caused by an automated water balance computation.

Waterbody number. In the case of multiple waterbodies each of which has a separate bathymetry input file, the user must specify which waterbody (and thus which bathymetry file) the water balance is being computed for. This capability is necessary for modeling systems with multiple reservoirs.

Incorporating the computed flows into the simulation

The water balance utility can be used for lakes and reservoirs in which water surface elevations are a function of inflows and controlled outflows from the system. The utility computes the flows necessary to match observed water surface elevations (typically taken at the dam) and outputs them to the "**qwb.opt**" file. This file is composed of a Julian date and an inflow (m^3 sec^{-1}). The flows can be either positive or negative. Temperatures and/or constituent concentrations must also be provided in the corresponding temperature and constituent concentration input files if the computed flows are incorporated as inflows to the system. ***The water balance utility does not provide this information***, but this information needs to be provided by the user depending upon how the computed flows are incorporated into the simulation. Considerable thought should go into how best to incorporate temperature and constituent concentrations and is discussed in more detail below.

Note that negative flows use temperatures/concentrations in the waterbody when calculating the impact on the system of these flows rather than the temperatures/concentrations in the corresponding inflow temperature and constituent concentration files. This ensures that negative flows generate no change in temperature or constituent concentrations. However, positive flows can impact simulation results and care must be taken as to how the flows are incorporated into the simulation.

The flows required to complete the water balance are computed as a step function. If they are incorporated into the model as an additional inflow or outflow whose current values are being linearly interpolated, such as a branch inflow, then the resulting water balance will not be correct. Typically, the flows in the qwb.opt file are first included as a distributed tributary inflow assigned to the mainstem branch and interpolation [DTRIC] is turned "OFF". The corresponding distributed tributary inflow temperatures are

usually set to air temperatures in the qdt_br1.npt file. When running water quality, care must be taken as to what constituents should be included in the corresponding inflow constituent concentration file. Typically, only DO values are included if the distributed tributary option of incorporation is used, and they are set to saturated values corresponding to the observed air temperatures. Keep in mind that if the water balance flows are incorporated as branch inflows, then the mass loading of organic matter and nutrients will be increased as well.

The branch corresponding to the distributed tributary inflow is usually assigned to the mainstem branch of a reservoir. Using a distributed tributary minimizes the impact of the flow, temperature, and/or water quality associated with the distributed tributary by distributing the flow throughout all segments in a branch weighted by surface area. Be aware that large flows as a result of large errors in inflow/outflow measurements can and have had a significant impact on temperature and water quality calibration in the surface layers. Usually, this is not a problem, but sensitivity analyses should be conducted to see if the flow and associated temperature/constituent concentrations have an impact on the simulation results. If so, then the following discussion is of particular relevance.

As emphasized previously, a great deal of thought should go into how the flows generated from the water balance utility are incorporated into the simulation. As discussed previously, these are typically incorporated as distributed tributary inflows so as to minimize the impact of the flows on the simulation. However, this may not always be the best, most accurate, or most realistic method. For example, suppose that the water balance flows are consistently negative. This would indicate that either inflows are consistently overestimated or outflows are consistently underestimated. Obviously, incorporating the flows as a positive increase in the outflows as opposed to subtracting them from the inflows can potentially have a very significant impact on simulation results. In this case, sensitivity analyses should be conducted to determine which method improves the simulation results. If, say, hypolimnetic temperatures are consistently being underestimated, then incorporating the flows into a hypolimnetic outflow could improve the simulation results. Conversely, if hypolimnetic temperatures were being overpredicted, then the inflows should probably be reduced. The key point to keep in mind is that there are a number of different ways to incorporate the computed flows, and they generally should all be tested to determine the best way to incorporate the computed flows into the simulation.

As another example, consider the case in which the generated flows are consistently positive and a branch in which sometimes significant inflows are ungauged. In this case, a sensitivity analyses should be performed to determine if incorporating the flows or a portion of the flows into the ungauged branch inflow improves model results. Oftentimes, the model can be used as a guide as to how best to incorporate the computed flows into the simulation.

Example from Tom Cole

Walter F. George is a U.S. Army Corps of Engineer reservoir located on the Chattahoochee River in Alabama. The reservoir is operated as a peaking hydropower facility. During calibration, the model consistently underpredicted hypolimnetic temperatures by 0.5-1ºC. Wind sheltering could be adjusted to increase hypolimnetic temperatures, but this adjustment always adversely impacted thermocline depth. After considerable thought, it was concluded that including possible seepage at the dam might improve hypolimnetic temperature predictions. A portion of the distributed tributary flows were incorporated as an additional outflow at the bottom of the dam. The final value used was 5 m^3 sec^{-1}, which was less than 1% of the average outflows and brought hypolimnetic temperatures into almost exact agreement with observed temperatures. Further investigation of the outflows revealed that during times of no power generation, an additional flow of 5.1 m^3 sec^{-1} was specified in a file that was not originally sent as part of

the outflow data. Thus, the model pointed the way as to how best to incorporate the computed flows and was a surprisingly accurate indicator of what was occurring in the prototype.

How to use the water balance utility console application

A console application that reads an input file is also available to perform the waterbalance. This new console version of the water balance code provides the following updates:

1. This is not a windows dialog box driven code so it can easily be used in batch files.
2. There is now an input file for model parameters for the water balance utility and an output file for model errors.
3. There are several enhancements: one has more flexibility over file naming, the number of header lines to skip in input files, and the number of waterbodies to use in the analysis.

Input File: "WatBal.npt"

The new input file, "WatBal.npt" has the following format:

```
Water Balance input file for Console Application
"el_obs.npt"       , file for observations, time and water level time series in 2 columns
"tsr_8_seg36.opt"  , tsr file for model predictions-assuming only one line skipped in
file header
"qwb1.npt"         , Output file name
1                  , NSKIPS - number of skips of data
1                  , NAV - averaging interval, number of data points to average
1,1      , waterbody to perform water balance: JW1:STARTWB,JW2:ENDWB:1,2=WB1&2;1,1==WB1
ONLY
3        , number of lines to skip in the header for the water level data file
0               , past water balance PWB file: Yes==1, No==0
"qwb.npt"        , Previous Water Balance file name
```

The explanations of each line are shown in the example file above. If performing over multiple waterbodies, keep in mind that all waterbodies must have the same grid (i.e., ELBOT and vertical spacing must be the same). Currently all the flow correction is given to only 1 water balance file. A later option will be for multiple WB files so that one can distribute them across several waterbodies.

Output File: "WatBal_Errors.opt"

If there are errors, any errors will be shown in this text file. If no errors, then this file will not be written to the disk.

An example of the error file output is shown below:

```
Could not open simulated elevations file tsr_8_seg39.opt
```

Output File: "el_stats.opt"

This output file displays model error statistics of the water level and average flow rate in the qwb output file. Typical output from this program are shown below:

```
       N   Mean Error  Absolute ME    RMS Error
     238         0.00         0.00         0.00

Average water balance flow correction = .00 m^3/s for period covering Julian day 1.04 to
239.94
```

Output File from water balance

The main output file from the water balance utility is a time series of flows necessary to match the water level.

A typical output file is shown below:

```
Computed flow to complete water balance
       1       1
    JDAY     QWB
   1.040    0.00
   2.000   24.34
   3.000    2.33
   4.000    2.34
   5.000    3.72
   6.000    2.33
   7.000    4.67
   8.000    2.34
   9.000    3.71
  10.000    3.29
  11.000    4.66
  12.000    2.34
  13.000    3.69
  14.000    2.34
  15.000    3.32
  16.000    3.31
  17.000    3.49
```

How to Run the Console Water Balance Utility

The water balance utility is run by executing the exe file for 32 (**WBconsole32.exe**) or 64 bit (**WBconsole64.exe**) Windows operating system. One also needs the input file **WatBal.npt** in the directory of the executable.

3. Control File Converter for CE-QUAL-W2

This section outlines the steps required to convert a legacy application control file, **w2_con.npt**, and its companion **graph.npt** file into the Excel version of the control file or to convert a w2_con.csv file from 4.1 or 4.22 to 4.5.

This is a relatively simple process that involves these steps:

1. Copy **ConverterControlFile.exe** into the directory of a legacy application or copy the three files read by the program (w2_con.npt, graph.npt, and the bathymetry file) into a directory with the executable. If you are just converting a 4.1 or 4.22 w2_con.csv file to the new format, just copy w2_con.csv and the bathymetry file into a new directory. After execution (double click the converter executable), the following files are written to the directory:
    a. **w2_con45.csv** – this is a csv file format of the control file. This will then need to be copied into a Version 4.5 example **w2_con.xlsm** template.
    b. A csv form of the bathymetry file (if the bathymetry file was not already in csv format). The output bathymetry file is named **bthX.csv,** where X is the waterbody number. This new format is much easier for editing and analysis than the older file format. The file name in the **w2_con.csv** is also changed to **bthX.csv**.
2. Copy **w2_con.csv** into an existing Version 4.5 example file ***.xlsm** from another application (you can use one from the W2 Model Examples) by following these steps:
    a. Open the file **w2_con.xlsm** (or it may have a different descriptive name, such as **w2_con_DeGray.xslm)** from an existing example problem supplied in the CE-QUAL-W2 example problems.

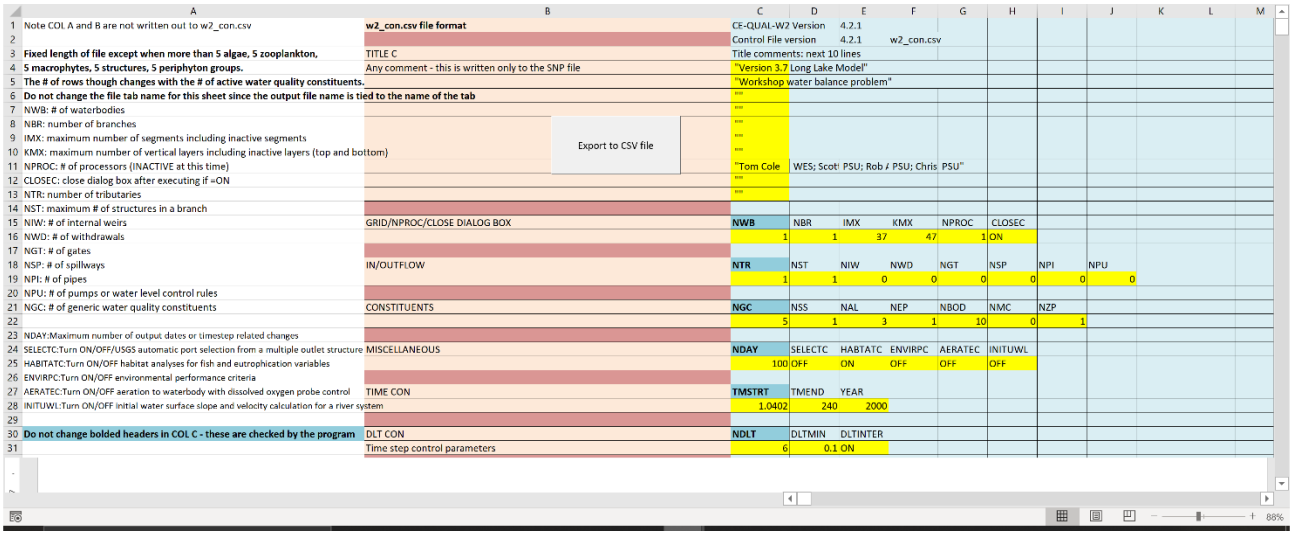
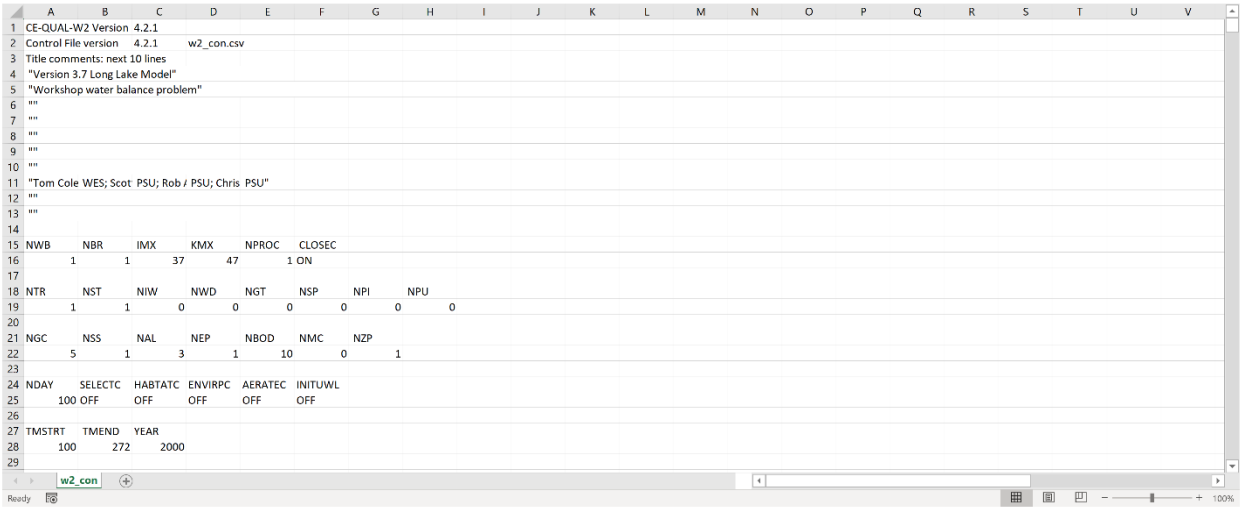


Figure 3. An example of an existing w2_con.xlsm file. Columns A and B are not used in the control file and we will be pasting the w2_con45.csv into column C1, not A1.

    i. The easiest option is to open the file **w2_con45.csv** from the converter utility in Excel. Select the columns and rows with data. Do not select the entire sheet

since you cannot copy and paste these into Cell C1 in **w2_con.xlsm**. Select the rows and columns necessary to select all the data. Be careful you select all the columns – especially for the SOD specification per segment. You will need to select as many columns as the # of segments (IMX).

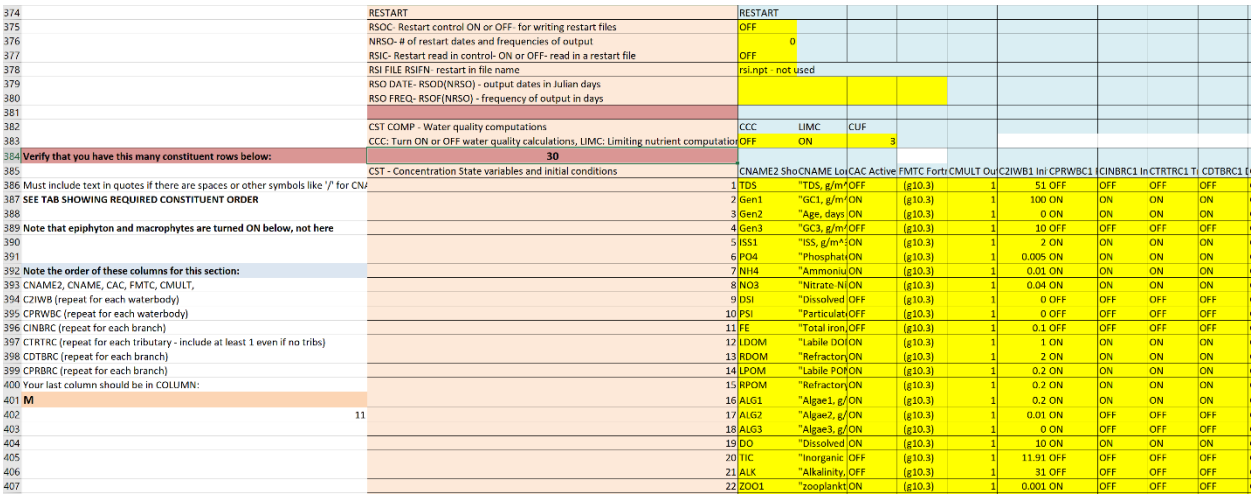


	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	CE-QUAL-W2 Version	4.2.1																				
2	Control File version	4.2.1	w2_con.csv																			
3	Title comments: next 10 lines																					
4	"Version 3.7 Long Lake Model"																					
5	"Workshop water balance problem"																					
6	""																					
7	""																					
8	""																					
9	""																					
10	""																					
11	"Tom Cole WES; Scot PSU; Rob / PSU; Chris PSU"																					
12	""																					
13	""																					
14																						
15	NWB	NBR	IMX	KMX	NPROC	CLOSEC																
16	1	1	37	47	1	ON																
17																						
18	NTR	NST	NIW	NWD	NGT	NSP	NPI	NPU														
19	1	1	0	0	0	0	0	0														
20																						
21	NGC	NSS	NAL	NEP	NBOD	NMC	NZP															
22	5	1	3	1	10	0	1															
23																						
24	NDAY	SELECTC	HABTATC	ENVIRPC	AERATEC	INITUWL																
25	100	OFF	OFF	OFF	OFF	OFF																
26																						
27	TMSTRT	TMEND	YEAR																			
28	100	272	2000																			
29																						

Figure 4. An example of the w2_con45.csv file from the converter utility.

ii. Then Copy the selected cells from **w2_con45.csv** and paste to **w2_con.xlsm** cell C1 using *Paste Values and Number Formatting* so that the colors and other formatting are preserved in the original document.

b. The next step is to adjust rows for the number of constituents. The template file you used **w2_con.xlsm** had an assumed number of water quality constituents that may be different from the number you will use. Go to approximately row 384 as shown below and delete or add cells ***in only column A and B*** only to match the specified number in the formula. So, if you need to add cells, then select the correct number of cells in column A and B, right click your mouse and choose 'Insert', then 'shift cells down.' If you need to delete cells, then select the correct number of cells in column A and B, right click your mouse, choose 'Delete', then select 'move cells up'. Now the information in column A and B should line up with what is written in Column C.

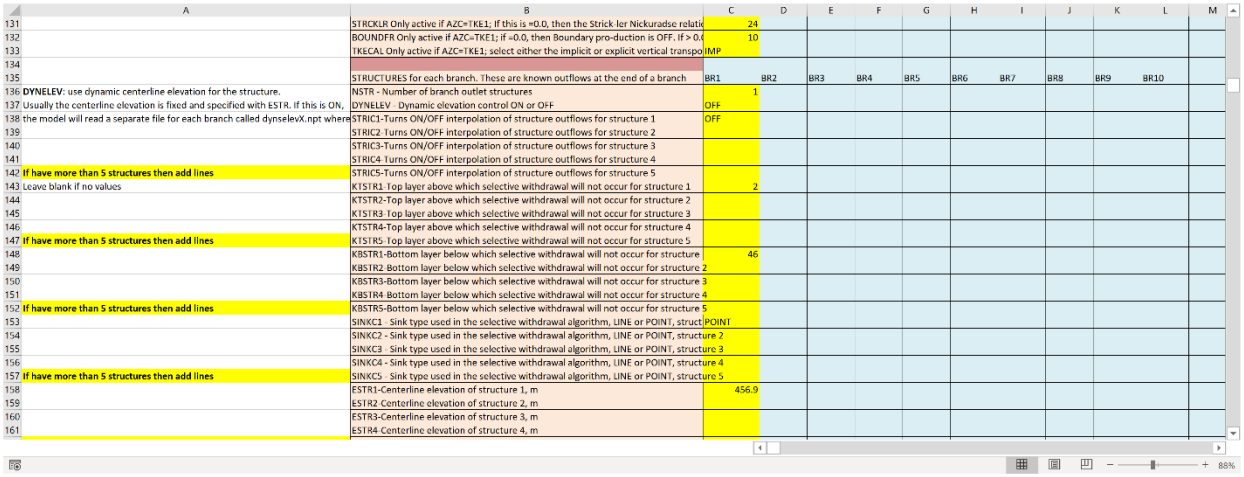


374		RESTART	RESTART											
375		RSOC- Restart control ON or OFF- for writing restart files	OFF											
376		NRSO- # of restart dates and frequencies of output	0											
377		RSIC- Restart read in control- ON or OFF- read in a restart file	OFF											
378		RSI FILE RSIFN- restart in file name	rsi.npt - not used											
379		RSO DATE- RSOD(NRSO) - output dates in Julian days												
380		RSO FREQ- RSOF(NRSO) - frequency of output in days												
381														
382		CST COMP - Water quality computations	CCC	LIMC	CUF									
383		CCC: Turn ON or OFF water quality calculations, LIMC: Limiting nutrient computation	OFF	ON	3									
384	Verify that you have this many constituent rows below:	30												
385		CST - Concentration State variables and initial conditions		CNAME2 Sho	CNAME Lo	CAC Active	FMTC Fortr	CMULT Ou	C2IWB1 Ini	CPRWBC1	CINBRC1 In	CTRTRC1 T	CDTBRC1	
386	Must include text in quotes if there are spaces or other symbols like '/' for CN		1	TDS	"TDS, g/m^	OFF	(g10.3)	1	51 OFF	OFF	OFF	OFF		
387	SEE TAB SHOWING REQUIRED CONSTITUENT ORDER		2	Gen1	"GC1, g/m^	ON	(g10.3)	1	100 ON	ON	ON	ON		
388			3	Gen2	"Age, days	ON	(g10.3)	1	0 ON	ON	ON	ON		
389	Note that epiphyton and macrophytes are turned ON below, not here		4	Gen3	"GC3, g/m^	OFF	(g10.3)	1	10 OFF	OFF	OFF	OFF		
390			5	ISS1	"ISS, g/m^3	ON	(g10.3)	1	2 ON	ON	ON	ON		
391			6	PO4	"Phosphat	ON	(g10.3)	1	0.005 ON	ON	ON	ON		
392	Note the order of these columns for this section:		7	NH4	"Ammoniu	ON	(g10.3)	1	0.01 ON	ON	ON	ON		
393	CNAME2, CNAME, CAC, FMTC, CMULT,		8	NO3	"Nitrate-Ni	ON	(g10.3)	1	0.04 ON	ON	ON	ON		
394	C2IWB (repeat for each waterbody)		9	DSI	"Dissolved	OFF	(g10.3)	1	0 OFF	OFF	OFF	OFF		
395	CPRWBC (repeat for each waterbody)		10	PSI	"Particulat	OFF	(g10.3)	1	0 OFF	OFF	OFF	OFF		
396	CINBRC (repeat for each branch)		11	FE	"Total iron	OFF	(g10.3)	1	0.1 OFF	OFF	OFF	OFF		
397	CTRTRC (repeat for each tributary - include at least 1 even if no tribs)		12	LDOM	"Labile DO	ON	(g10.3)	1	1 ON	ON	ON	ON		
398	CDTBRC (repeat for each branch)		13	RDOM	"Refractor	ON	(g10.3)	1	2 ON	ON	ON	ON		
399	CPRBRC (repeat for each branch)		14	LPOM	"Labile POI	ON	(g10.3)	1	0.2 ON	ON	ON	ON		
400	Your last column should be in COLUMN:		15	RPOM	"Refractor	ON	(g10.3)	1	0.2 ON	ON	ON	ON		
401	M		16	ALG1	"Algae1, g/	ON	(g10.3)	1	0.2 ON	ON	ON	ON		
402	11		17	ALG2	"Algae2, g/	ON	(g10.3)	1	0.01 ON	OFF	OFF	OFF		
403			18	ALG3	"Algae3, g/	ON	(g10.3)	1	0 ON	OFF	OFF	OFF		
404			19	DO	"Dissolved	ON	(g10.3)	1	10 ON	ON	ON	ON		
405			20	TIC	"Inorganic	OFF	(g10.3)	1	11.91 OFF	OFF	OFF	OFF		
406			21	ALK	"Alkalinity,	OFF	(g10.3)	1	31 OFF	OFF	OFF	OFF		
407			22	ZOO1	"zooplankt	ON	(g10.3)	1	0.001 ON	OFF	OFF	OFF		

Figure 5. Location in Excel template where the constituent order is shown. In this example, the required number of constituents is 30. This is a formula computed in the Excel sheet. Make sure that you have that same number in the list that follows. There is guidance on another tab in the Excel file on the required order based on your dimensioning of number of algal groups, BOD groups, macrophyte groups, periphyton groups, suspended solids groups, and generic constituent groups. Also note that in column A, guidance is given on setting the number of columns needed in this section.

c. If you have more than 5 structures, 5 epiphyton/periphyton groups, 5 algae groups, 5 macrophyte groups, or 5 zooplankton groups, you will have to add additional rows where necessary only in columns A and B. You can search in Column A for "increase # of rows" for where these areas are located.

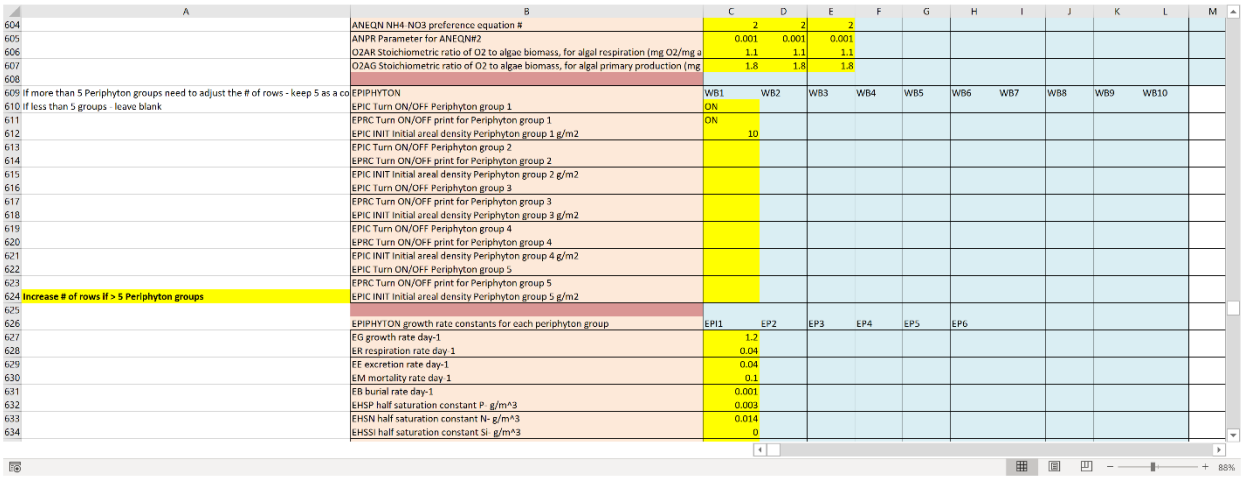
   i. For structures, look at rows 136-165 – there are notes in Col A and B describing where to add rows if more than 5 structures.



	A	B	C	D	E	F	G	H	I	J	K	L	M
131		STRCKLR Only active if AZC=TKE1; If this is =0.0, then the Strick ler Nickuradse relati	24										
132		BOUNDFR Only active if AZC=TKE1; if =0.0, then Boundary pro-duction is OFF. If > 0.(	10										
133		TKECAL Only active if AZC=TKE1; select either the implicit or explicit vertical transpo	IMP										
134													
135		STRUCTURES for each branch. These are known outflows at the end of a branch	BR1	BR2	BR3	BR4	BR5	BR6	BR7	BR8	BR9	BR10	
136	DYNELEV: use dynamic centerline elevation for the structure.	NSTR - Number of branch outlet structures	1										
137	Usually the centerline elevation is fixed and specified with ESTR. If this is ON,	DYNELEV - Dynamic elevation control ON or OFF	OFF										
138	the model will read a separate file for each branch called dynselevX.npt where	STRIC1-Turns ON/OFF interpolation of structure outflows for structure 1	OFF										
139		STRIC2-Turns ON/OFF interpolation of structure outflows for structure 2											
140		STRIC3-Turns ON/OFF interpolation of structure outflows for structure 3											
141		STRIC4-Turns ON/OFF interpolation of structure outflows for structure 4											
142	If have more than 5 structures then add lines	STRIC5-Turns ON/OFF interpolation of structure outflows for structure 5											
143	Leave blank if no values	KTSTR1-Top layer above which selective withdrawal will not occur for structure 1	2										
144		KTSTR2-Top layer above which selective withdrawal will not occur for structure 2											
145		KTSTR3-Top layer above which selective withdrawal will not occur for structure 3											
146		KTSTR4-Top layer above which selective withdrawal will not occur for structure 4											
147	If have more than 5 structures then add lines	KTSTR5-Top layer above which selective withdrawal will not occur for structure 5											
148		KBSTR1-Bottom layer below which selective withdrawal will not occur for structure	46										
149		KBSTR2-Bottom layer below which selective withdrawal will not occur for structure 2											
150		KBSTR3-Bottom layer below which selective withdrawal will not occur for structure 3											
151		KBSTR4-Bottom layer below which selective withdrawal will not occur for structure 4											
152	If have more than 5 structures then add lines	KBSTR5-Bottom layer below which selective withdrawal will not occur for structure 5											
153		SINKC1 - Sink type used in the selective withdrawal algorithm, LINE or POINT, struct	POINT										
154		SINKC2 - Sink type used in the selective withdrawal algorithm, LINE or POINT, structure 2											
155		SINKC3 - Sink type used in the selective withdrawal algorithm, LINE or POINT, structure 3											
156		SINKC4 - Sink type used in the selective withdrawal algorithm, LINE or POINT, structure 4											
157	If have more than 5 structures then add lines	SINKC5 - Sink type used in the selective withdrawal algorithm, LINE or POINT, structure 5											
158		ESTR1-Centerline elevation of structure 1, m	456.9										
159		ESTR2-Centerline elevation of structure 2, m											
160		ESTR3-Centerline elevation of structure 3, m											
161		ESTR4-Centerline elevation of structure 4, m											

Figure 6. Location in Excel file where the number of rows needs to be increased in case there are more than 5 structures.

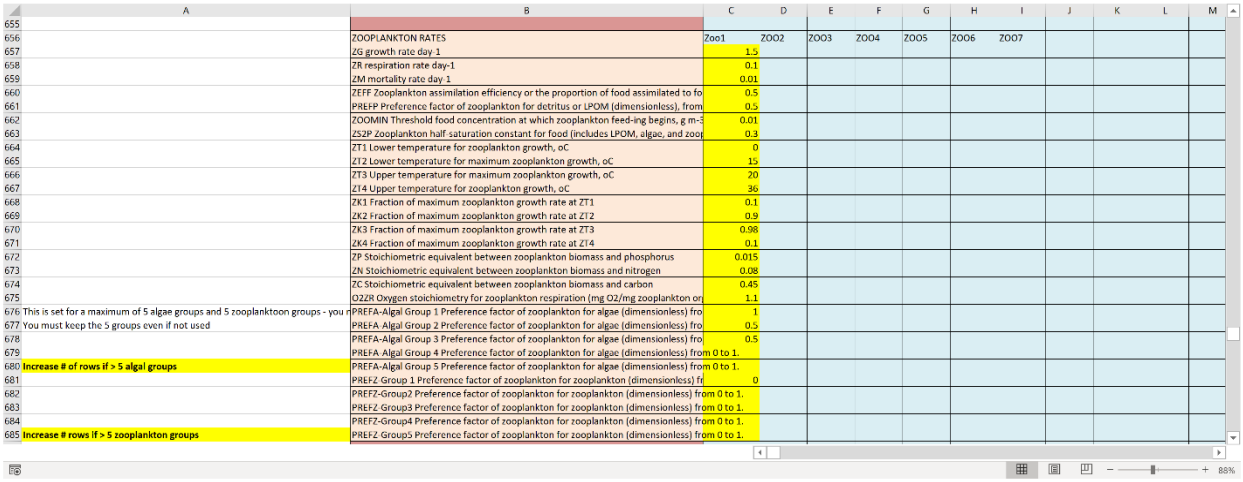
   ii. For more than 5 epiphyton/periphyton groups, look in the epiphyton section (search for epiphyton).



	A	B	C	D	E	F	G	H	I	J	K	L	M
604		ANEQN NH4 NO3 preference equation #	2	2	2								
605		ANPR Parameter for ANEQN#2	0.001	0.001	0.001								
606		O2AR Stoichiometric ratio of O2 to algae biomass, for algal respiration (mg O2/mg a	1.1	1.1	1.1								
607		O2AG Stoichiometric ratio of O2 to algae biomass, for algal primary production (mg	1.8	1.8	1.8								
608													
609	If more than 5 Periphyton groups need to adjust the # of rows - keep 5 as a co	EPIPHYTON	WB1	WB2	WB3	WB4	WB5	WB6	WB7	WB8	WB9	WB10	
610	If less than 5 groups - leave blank	EPIC Turn ON/OFF Periphyton group 1	ON										
611		EPRC Turn ON/OFF print for Periphyton group 1	ON										
612		EPIC INIT Initial areal density Periphyton group 1 g/m2	10										
613		EPIC Turn ON/OFF Periphyton group 2											
614		EPRC Turn ON/OFF print for Periphyton group 2											
615		EPIC INIT Initial areal density Periphyton group 2 g/m2											
616		EPIC Turn ON/OFF Periphyton group 3											
617		EPRC Turn ON/OFF print for Periphyton group 3											
618		EPIC INIT Initial areal density Periphyton group 3 g/m2											
619		EPIC Turn ON/OFF Periphyton group 4											
620		EPRC Turn ON/OFF print for Periphyton group 4											
621		EPIC INIT Initial areal density Periphyton group 4 g/m2											
622		EPIC Turn ON/OFF Periphyton group 5											
623		EPRC Turn ON/OFF print for Periphyton group 5											
624	**Increase # of rows if > 5 Periphyton groups**	EPIC INIT Initial areal density Periphyton group 5 g/m2											
625													
626		EPIPHYTON growth rate constants for each periphyton group	EP1	EP2	EP3	EP4	EP5	EP6					
627		EG growth rate day-1	1.2										
628		ER respiration rate day-1	0.04										
629		EE excretion rate day-1	0.04										
630		EM mortality rate day-1	0.1										
631		EB burial rate day-1	0.001										
632		EHSP half saturation constant P- g/m^3	0.003										
633		EHSN half saturation constant N- g/m^3	0.014										
634		EHSSi half saturation constant Si- g/m^3	0										

Figure 7. Location in Excel file where the number of rows needs to be increased in case there are more than 5 epiphyton/periphyton groups..

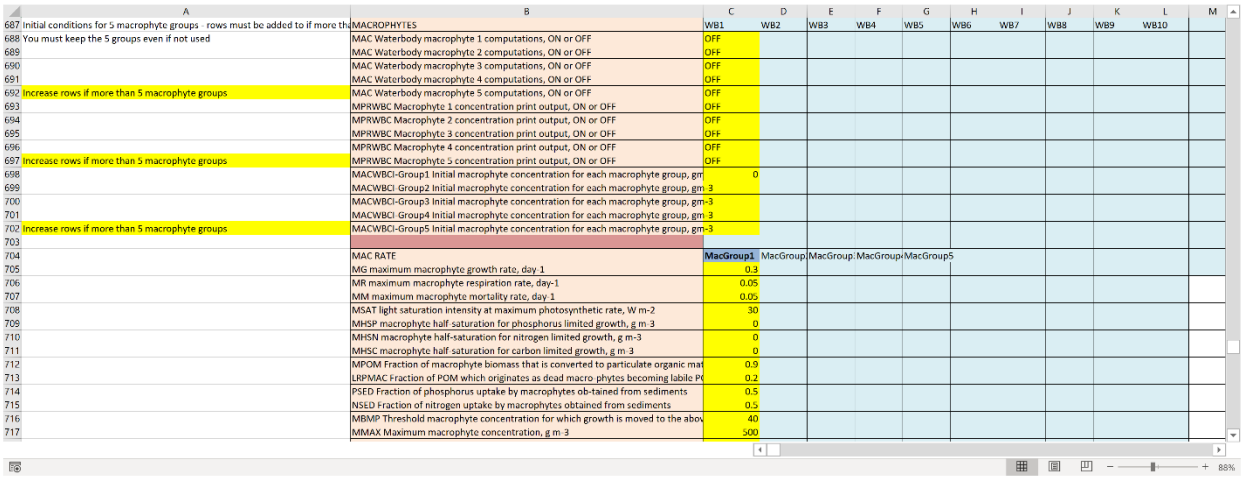
iii. For more than 5 algae and 5 zooplankton groups, look in the zooplankton section (search for zooplankton).



	A	B	C	D	E	F	G	H	I	J	K	L	M
655													
656		ZOOPLANKTON RATES	Zoo1	ZOO2	ZOO3	ZOO4	ZOO5	ZOO6	ZOO7				
657		ZG growth rate day-1	1.5										
658		ZR respiration rate day-1	0.1										
659		ZM mortality rate day-1	0.01										
660		ZEFF Zooplankton assimilation efficiency or the proportion of food assimilated to fo	0.5										
661		PREFP Preference factor of zooplankton for detritus or LPOM (dimensionless), from	0.5										
662		ZOOMIN Threshold food concentration at which zooplankton feed-ing begins, g m-3	0.01										
663		ZS2P Zooplankton half-saturation constant for food (includes LPOM, algae, and zoop	0.3										
664		ZT1 Lower temperature for zooplankton growth, oC	0										
665		ZT2 Lower temperature for maximum zooplankton growth, oC	15										
666		ZT3 Upper temperature for maximum zooplankton growth, oC	20										
667		ZT4 Upper temperature for zooplankton growth, oC	36										
668		ZK1 Fraction of maximum zooplankton growth rate at ZT1	0.1										
669		ZK2 Fraction of maximum zooplankton growth rate at ZT2	0.9										
670		ZK3 Fraction of maximum zooplankton growth rate at ZT3	0.98										
671		ZK4 Fraction of maximum zooplankton growth rate at ZT4	0.1										
672		ZP Stoichiometric equivalent between zooplankton biomass and phosphorus	0.015										
673		ZN Stoichiometric equivalent between zooplankton biomass and nitrogen	0.08										
674		ZC Stoichiometric equivalent between zooplankton biomass and carbon	0.45										
675		O2ZR Oxygen stoichiometry for zooplankton respiration (mg O2/mg zooplankton or	1.1										
676	This is set for a maximum of 5 algae groups and 5 zooplanktoon groups - you r	PREFA-Algal Group 1 Preference factor of zooplankton for algae (dimensionless) fro	1										
677	You must keep the 5 groups even if not used	PREFA-Algal Group 2 Preference factor of zooplankton for algae (dimensionless) fro	0.5										
678		PREFA-Algal Group 3 Preference factor of zooplankton for algae (dimensionless) fro	0.5										
679		PREFA-Algal Group 4 Preference factor of zooplankton for algae (dimensionless) from 0 to 1.											
680	**Increase # of rows if > 5 algal groups**	PREFA-Algal Group 5 Preference factor of zooplankton for algae (dimensionless) from 0 to 1.											
681		PREFZ Group 1 Preference factor of zooplankton for zooplankton (dimensionless) fr	0										
682		PREFZ-Group2 Preference factor of zooplankton for zooplankton (dimensionless) from 0 to 1.											
683		PREFZ-Group3 Preference factor of zooplankton for zooplankton (dimensionless) from 0 to 1.											
684		PREFZ-Group4 Preference factor of zooplankton for zooplankton (dimensionless) from 0 to 1.											
685	**Increase # rows if > 5 zooplankton groups**	PREFZ-Group5 Preference factor of zooplankton for zooplankton (dimensionless) from 0 to 1.											

Figure 8. Location in Excel file where the number of rows needs to be increased in case there are more than 5 zooplankton groups.

iv. For more than 5 macrophyte groups, look in the macrophyte section (search for macrophyte).



	A	B	C	D	E	F	G	H	I	J	K	L	M
687	Initial conditions for 5 macrophyte groups - rows must be added to if more th	MACROPHYTES	WB1	WB2	WB3	WB4	WB5	WB6	WB7	WB8	WB9	WB10	
688	You must keep the 5 groups even if not used	MAC Waterbody macrophyte 1 computations, ON or OFF	OFF										
689		MAC Waterbody macrophyte 2 computations, ON or OFF	OFF										
690		MAC Waterbody macrophyte 3 computations, ON or OFF	OFF										
691		MAC Waterbody macrophyte 4 computations, ON or OFF	OFF										
692	Increase rows if more than 5 macrophyte groups	MAC Waterbody macrophyte 5 computations, ON or OFF	OFF										
693		MPRWBC Macrophyte 1 concentration print output, ON or OFF	OFF										
694		MPRWBC Macrophyte 2 concentration print output, ON or OFF	OFF										
695		MPRWBC Macrophyte 3 concentration print output, ON or OFF	OFF										
696		MPRWBC Macrophyte 4 concentration print output, ON or OFF	OFF										
697	Increase rows if more than 5 macrophyte groups	MPRWBC Macrophyte 5 concentration print output, ON or OFF	OFF										
698		MACWBCI-Group1 Initial macrophyte concentration for each macrophyte group, gm	0										
699		MACWBCI-Group2 Initial macrophyte concentration for each macrophyte group, gm-3											
700		MACWBCI-Group3 Initial macrophyte concentration for each macrophyte group, gm-3											
701		MACWBCI-Group4 Initial macrophyte concentration for each macrophyte group, gm-3											
702	Increase rows if more than 5 macrophyte groups	MACWBCI-Group5 Initial macrophyte concentration for each macrophyte group, gm-3											
703													
704		MAC RATE	MacGroup1	MacGroup2	MacGroup3	MacGroup4	MacGroup5						
705		MG maximum macrophyte growth rate, day-1	0.3										
706		MR maximum macrophyte respiration rate, day-1	0.05										
707		MM maximum macrophyte mortality rate, day-1	0.05										
708		MSAT light saturation intensity at maximum photosynthetic rate, W m-2	30										
709		MHSP macrophyte half-saturation for phosphorus limited growth, g m-3	0										
710		MHSN macrophyte half-saturation for nitrogen limited growth, g m-3	0										
711		MHSC macrophyte half saturation for carbon limited growth, g m-3	0										
712		MPOM Fraction of macrophyte biomass that is converted to particulate organic mat	0.9										
713		LRPMAC Fraction of POM which originates as dead macro phytes becoming labile P	0.2										
714		PSED Fraction of phosphorus uptake by macrophytes ob-tained from sediments	0.5										
715		NSED Fraction of nitrogen uptake by macrophytes obtained from sediments	0.5										
716		MBMP Threshold macrophyte concentration for which growth is moved to the abo	40										
717		MMAX Maximum macrophyte concentration, g m-3	500										

Figure 9. Location in Excel file where the number of rows needs to be increased in case there are more than 5 macrophyte groups.

d. You will need to put quotes around the **TITLE** field, **HNAME** field, **CNAME** field, and **CDNAME** field. This can be done by setting up a formula using the existing cells as '=char(34)&[CELLREF]&char(34)' where CELLREF is the cell reference number of the original text. Then paste the ***values*** with the double quotes to the locations in the control file. ***If anyone figures out an easier way to do this let me know! Frustratingly, Excel drops the double quotes on importing them.***

e. The **w2_con.xlsm** file should now be working. As edits are made in this file, you will push the button on the top of the file in Column B to export it to **w2_con.csv**, which is read in by the W2 model. The preprocessor will 'yell' at you in case there is an error in the set up.

4. GUI Interface for CE-QUAL-W2 for Versions 3.7-4.20

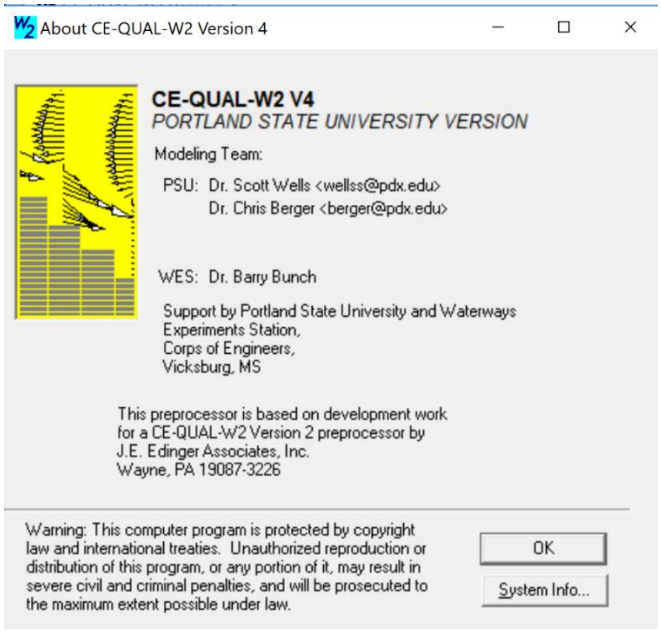


Figure 10. About W2 Control GUI preprocessor.

Introduction

This section describes the GUI interface that is released with CE-QUAL-W2. This works with the old version of the control file, **w2_con.npt (only up to Version 4.2)** but does work with the Excel version of the control file (**w2_con.csv**). The w2_post program shown in the next section has a bathymetry viewer that can be used with the **w2_con.csv** control file.

The manual describes the uses of the GUI for editing the control file (**w2_con.npt**) and the bathymetry file (user-defined filename, typically called **bth.npt** or **bth.csv**). Please note that the model files can be edited using a text editor or in Excel, and the GUI is therefore not required to run the model. The GUI though may be very helpful for the new CE-QUAL-W2 user as is the Excel version of the control file. The bathymetry editor is very useful in viewing the model grid and making changes to the grid (e.g., grid refinement). The bathymetry editor though does not assist in setting up the bathymetry. The model user must have already developed the bathymetry file using other programs. The bathymetry editor only edits an existing bathymetry file. Often the bathymetry is developed using GIS software or programs like SURFER or other 3-D contour plotting software packages.

Installing the GUI Interface

After downloading the GUI interface setup files and unzipping them, from Windows Explorer double-click on ‘setup.exe’ to guide you in the set-up process.

Opening the GUI Interface

By double-clicking on the W2 icon from the Desktop or from Windows Explorer, the user is presented with the following screen:

Figure 11. Dialog box menu.

This interface is meant to be simple and uncomplicated.

Menus

The user has 3 menus: File, Window, and Help. The File menu controls which control file to open and to save. The user can only open a CE-QUAL-W2 control file – such as w2_con.npt. Opening any other file type will result in an error. The File save button and file open buttons and menu items only affect the control file and the associated files (bathymetry and graph files). Note that when you save a file, you overwrite the original file with which you started. The GUI program though copies the original output file to a similar name but with a number designator. This allows the user always to go back and track changes made over time to the control file or bathymetry files.

Button Bar

The buttons become active as the user opens the files that affect the buttons. For example, once the bathymetry file is opened, the 4 grid viewing options are then displayed (see more information below). The open file button opens the w2_con.npt file or another file that is in the format of the control file. The save button becomes active once a file is opened and changes are made. The print button prints the current screen (I would not use this since it is not a very useful print out. It is much more convenient to just print the text file directly from Notepad or other text editor.) The next buttons are described below.

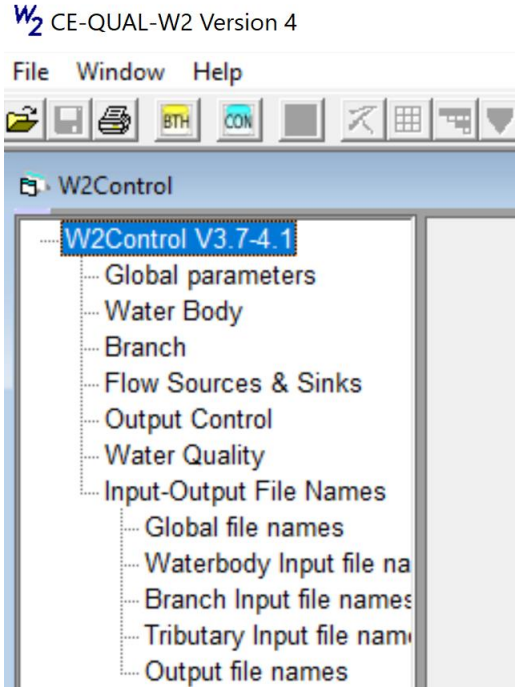


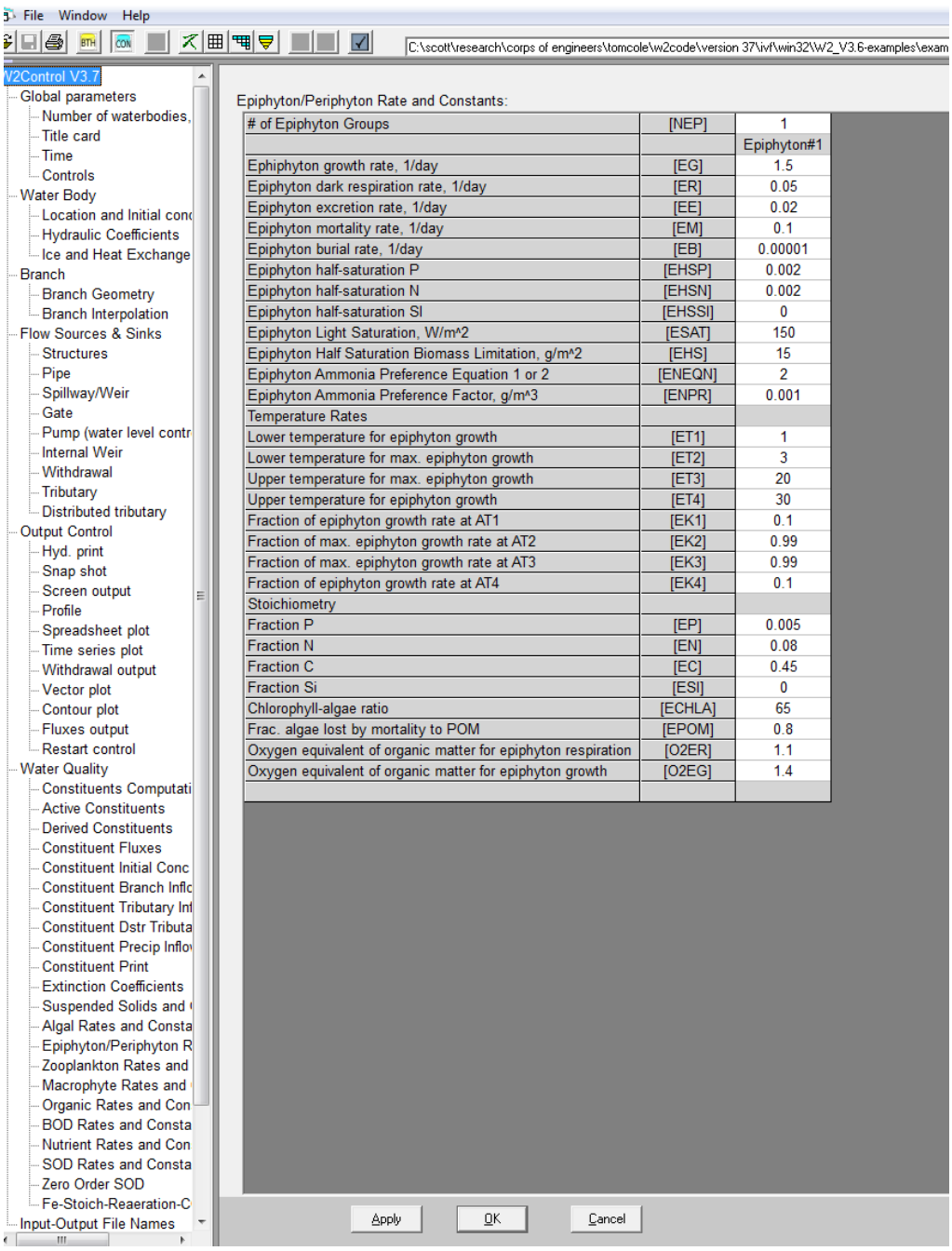
Figure 12. Menu of w2control.

Editing the Control File

Once you have chosen a control file to open (w2_con.npt), open it and adjust the window so that the window options are visible. If the file does not open there may be serious formatting errors in the file or you may have not chosen a CE-QUAL-W2 control file. Check the file for errors using the CE-QUAL-W2 preprocessor (a separate program released with W2).

You will notice that the BTH button is now active, meaning that you can also open the bathymetry file. The left pane now has 7 headings – each subheadings that can be shown by double-clicking on the main heading. For example, several of the subheadings have been expanded, as shown to your right.

By double-clicking on a subheading, the user can edit the information in a cell. Information about each model parameter is shown in Appendix C in the User Manual.



# of Epiphyton Groups	[NEP]	1
		Epiphyton#1
Ephiphyton growth rate, 1/day	[EG]	1.5
Epiphyton dark respiration rate, 1/day	[ER]	0.05
Epiphyton excretion rate, 1/day	[EE]	0.02
Epiphyton mortality rate, 1/day	[EM]	0.1
Epiphyton burial rate, 1/day	[EB]	0.00001
Epiphyton half-saturation P	[EHSP]	0.002
Epiphyton half-saturation N	[EHSN]	0.002
Epiphyton half-saturation SI	[EHSSI]	0
Epiphyton Light Saturation, W/m^2	[ESAT]	150
Epiphyton Half Saturation Biomass Limitation, g/m^2	[EHS]	15
Epiphyton Ammonia Preference Equation 1 or 2	[ENEQN]	2
Epiphyton Ammonia Preference Factor, g/m^3	[ENPR]	0.001
Temperature Rates		
Lower temperature for epiphyton growth	[ET1]	1
Lower temperature for max. epiphyton growth	[ET2]	3
Upper temperature for max. epiphyton growth	[ET3]	20
Upper temperature for epiphyton growth	[ET4]	30
Fraction of epiphyton growth rate at AT1	[EK1]	0.1
Fraction of max. epiphyton growth rate at AT2	[EK2]	0.99
Fraction of max. epiphyton growth rate at AT3	[EK3]	0.99
Fraction of epiphyton growth rate at AT4	[EK4]	0.1
Stoichiometry		
Fraction P	[EP]	0.005
Fraction N	[EN]	0.08
Fraction C	[EC]	0.45
Fraction Si	[ESI]	0
Chlorophyll-algae ratio	[ECHLA]	65
Frac. algae lost by mortality to POM	[EPOM]	0.8
Oxygen equivalent of organic matter for epiphyton respiration	[O2ER]	1.1
Oxygen equivalent of organic matter for epiphyton growth	[O2EG]	1.4

Figure 13. Example of w2control menu.

Once you have edited the cells (either by changing a number or changing a menu parameter), there are 2 buttons at the bottom of the page as shown below.

The Apply button is used to set the parameters of the table. For example above, the # of epiphyton groups is '1". If one wanted to change this to "2". One would enter 2 in the cell for NEP and then press "Apply". The table will be re-drawn as shown below.

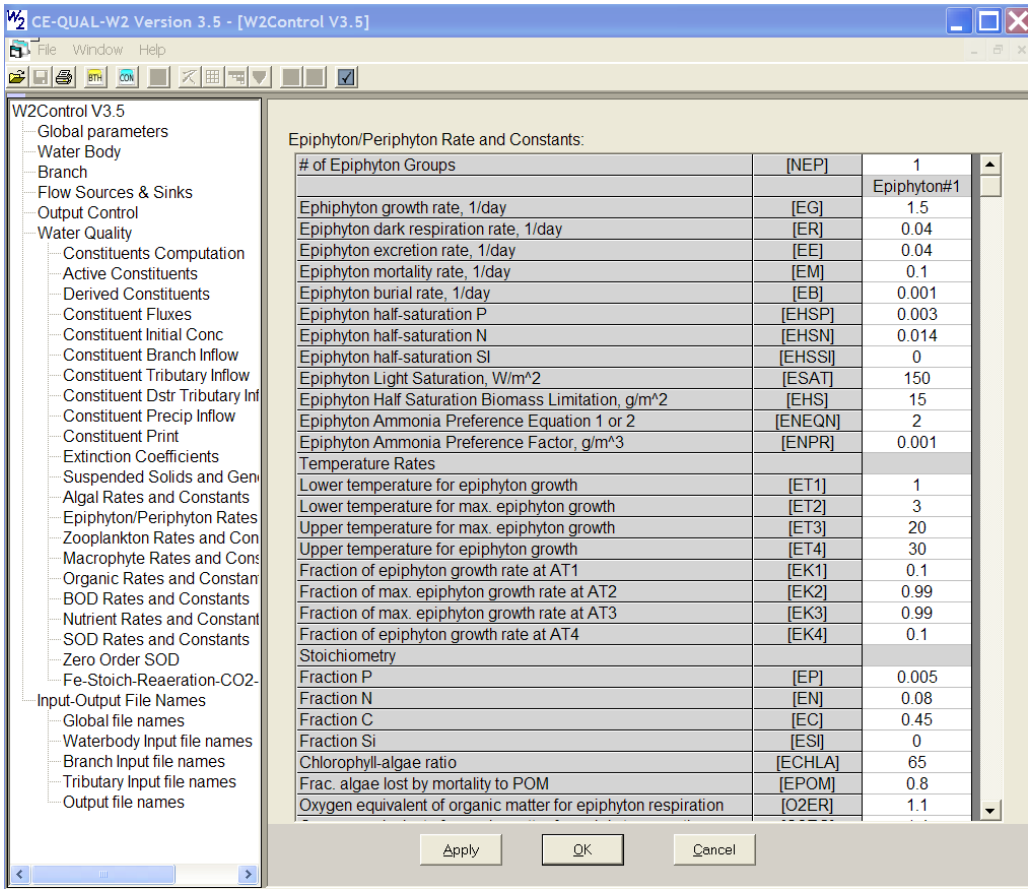


Figure 14. Dialog box example.

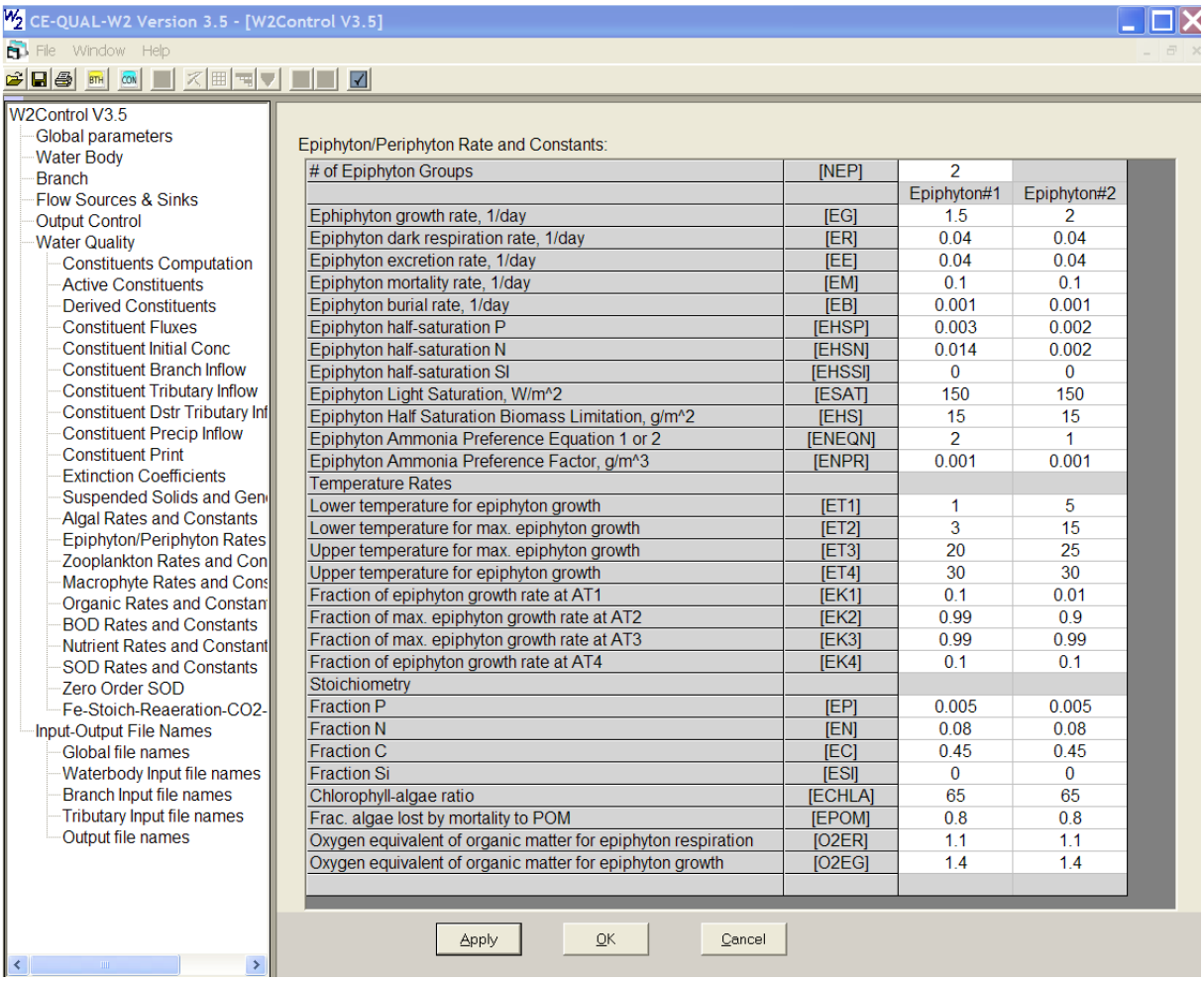


Figure 15. Dialog box example.

Then after making changes, the OK button MUST be pressed. But this does not SAVE the file to the hard disk. The User must also then press the SAVE button on the button bar above (or the menu FILE/SAVE file) to save these changes to the disk. The save button will be highlighted after a selection is changed.

Editing the Bathymetry File

After opening the control file, the bathymetry file can be opened by clicking the BTH button. Note that the bathymetry file name is under the 'INPUT-OUTPUT FILE NAMES' Menu and the submenu 'WATERBODY INPUT FILE NAMES'. At this point there are 4 views that become active: Side View, Top View, Data View, End View.

The buttons on the top allow one to toggle between the different bathymetric views. By expanding the Top View, one can enlarge the view by holding down the left mouse button and scrolling from right to left (see example below). To decrease the image size, hold down the left mouse button and scroll from right to left.

To change the active segment and layer, you must place the mouse cursor in the Data View at a segment and layer of interest and click the 'Refresh View' button. This affects which segment is shown in the End View and which segment is highlighted in the Side View.

To edit the bathymetry, click on the variable and change its value. Then the user must click the 'OK' button to accept these changes. Using the SAVE button saves all the user files.

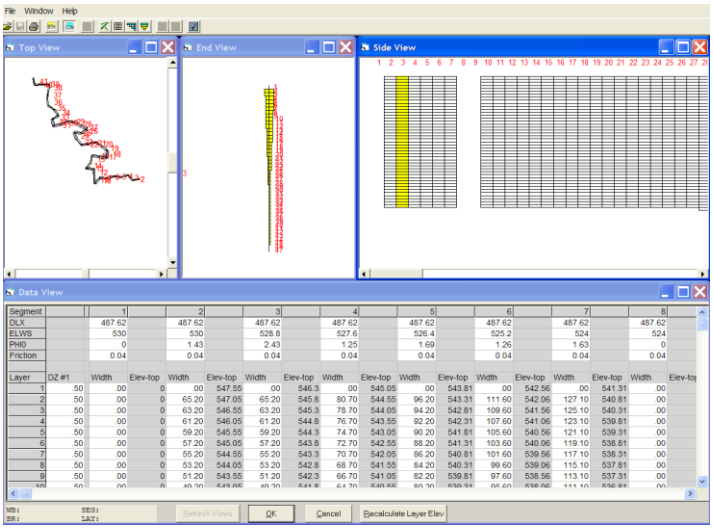


Figure 16. Bathymetry dialog box example.

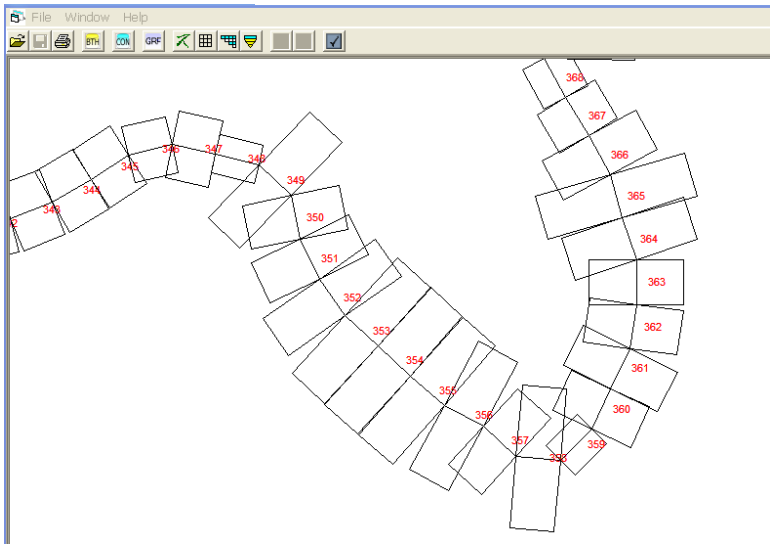


Figure 17. Segments of a model dialog box.

Merging or Splitting Segments or Layers

In order to perform this operation, open the Data View and select the range of layers and/or segments to merge or split by highlighting them with the mouse. You will notice in the left hand corner a box shows what segments and layers have been selected.

In the example below I have selected layers 5-14 and segments 2 and 3. You will also now notice that the layer and segment merge/split buttons are now active. To merge or split segments, click on the Merge/Split segment button. A small dialog box will come up with options for merging or splitting the segments (see below). You then have the option to merge the 2 segments or split them into many more segments. The control file (w2_con.npt) will automatically adjust segment numbers when using this option. But keep in

mind that the following files will need to be edited to adjust them for changes in the number of model segments: the wind sheltering coefficient file (wsc.npt) and the shading file (shade.npt).

A similar process is followed for merging or splitting layers.

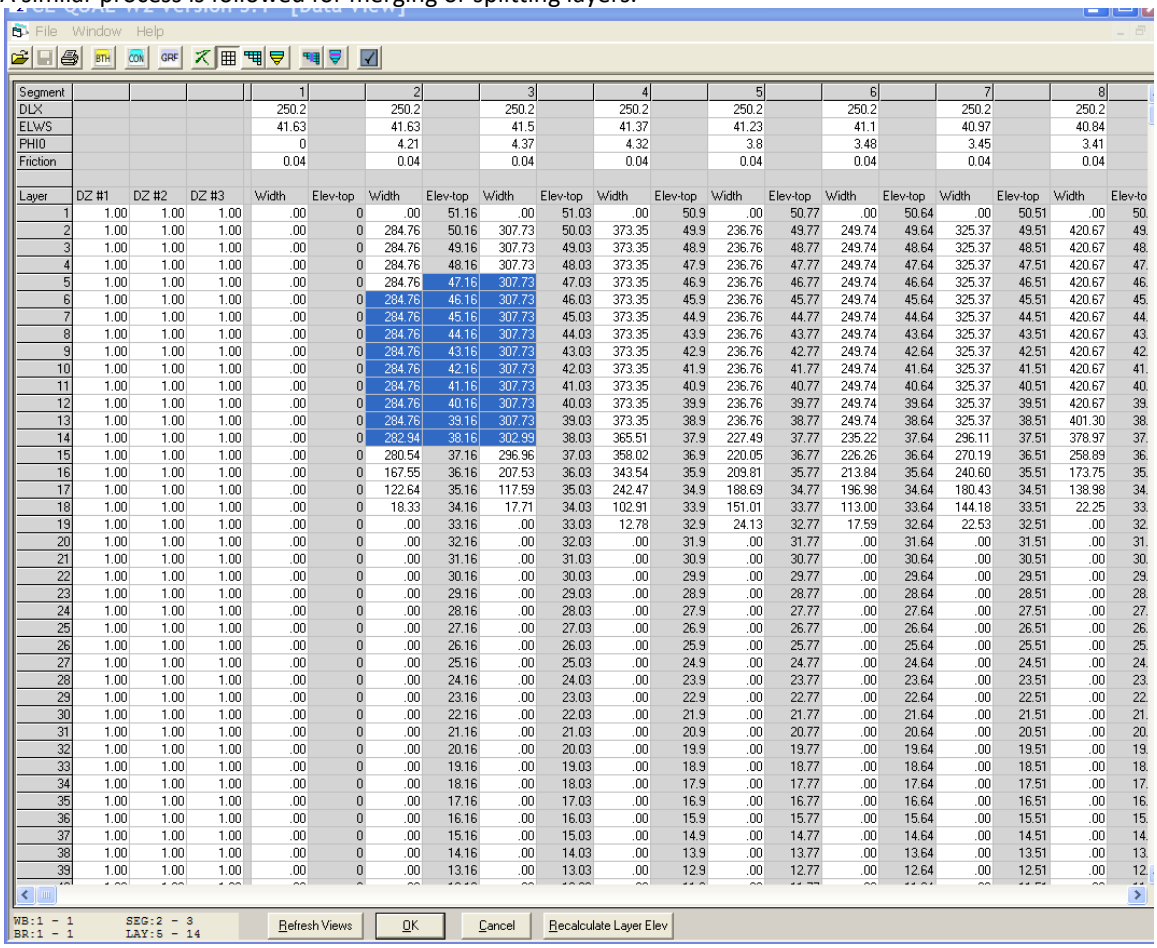


Figure 18. Splitting or merging layers example.

Note that in the bottom left corner of the above screen shot, the layers and segments that were selected is shown.

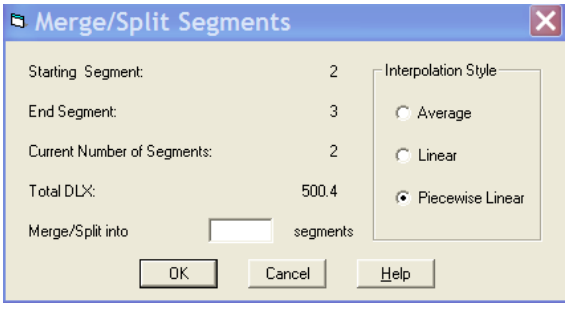


Figure 19. Merge/split dialog box.

Running the Preprocessor within the GUI

The preprocessor which checks all input files can be executed from within the GUI by clicking on the CHECK button. At which point a dialogue box will pop up with information about running the preprocessor. The preprocessor executable must be in the root directory with the input files.

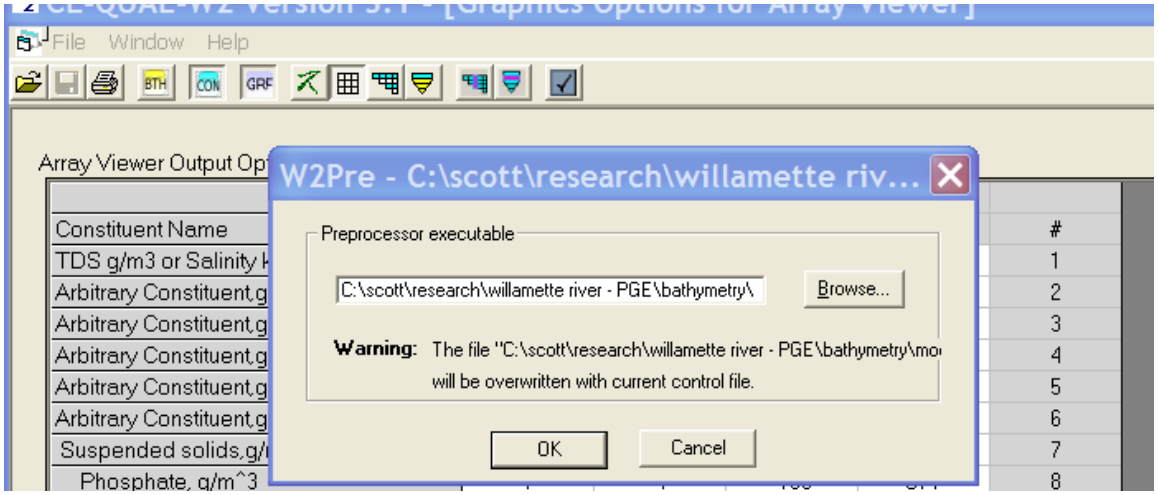


Figure 20. Running dialog box within w2control.

A Note on Saving Files

The GUI interface makes a backup copy of each file opened during a session. It will add an integer number to the files opened. This integer is based on whether previous backup files have been created or not. For example, the 1st time the GUI opens the files, w2_con.npt, graph.npt, and bth.npt; the program will write as backup copies of the unaltered original files: w2_con.npt2, graph.npt2, and bth.npt2. The next time the program opens these files, the files w2_con.npt3, graph.npt3, and bth.npt3 will be created (if you have already deleted the *.*2 files from your hard disk, the GUI will again use the integer '2' rather than '3').

Typical Errors with the GUI

Sometimes the GUI cannot read a control file because of the format of the text. UNIX/Linux systems often use a line-feed at the end of a line, while Windows text files include a carriage-return and a line-feed. You must convert the file to a Windows text file for the GUI to work properly. In a text editor you can view all the characters and verify you have the proper Windows format if the GUI is having problems reading the file. Many text editors automatically convert files from one type to the other (such as the text editor 'Note-pad ++').

It is recommended that you use the W2 preprocessor to catch errors in the set-up files first before using the GUI. The W2 preprocessor though will not catch the line-feed error noted above and will read the files correctly whether in UNIX/Linux or Windows format.

Command Line Processing

The GUI also can be controlled by command line passing of the working directory and file. In a batch program or from the command line in a DOS box you can execute the GUI as follows:

"C:\scott\research\corps of engineers\tomcole\w2code\GUI36\w2control\w2control4.exe"
C:\scott\w2workshop\2009 workshop\waterqual\problem1\w2_con.npt

The first string in quotes executes the GUI (this shows the path to the GUI – your path to the GUI will be different). The command line argument is NOT in quotes. This program was developed in VB6 and does not take quotes around the command line. Note that this is different than the FORTRAN command line argument. So the above command will open the GUI and load the control file automatically from the directory "C:\scott\w2workshop\2009 workshop\waterqual\problem1".

Using the GUI W2Control on Touchscreen Laptops and Monitors

The software, W2Control, is a GUI preprocessor for the W2 model. It works fine on non-touch enabled monitors. But for touch screen monitors, like many of the latest laptops, the opening "treeview" menu does not work because of a software incompatibility with VB6, the source code. W2Control can though be used on a touch screen laptop by doing the following:

Go to Services by typing 'Services' in the command line or Cortana line. In the list choose 'Touch keyboard and Handwriting Panel Service'. Right click your mouse and choose Properties and change 'Automatic' to 'Disabled'. Then click STOP in the Service Status to stop the service. Click APPLY. The W2Control then works as expected.

5. Post-Processor for CE-QUAL-W2 by DSI, Inc.

Paul Craig at DSI, Inc. has generously provided a software system for evaluating model results. There is a short user's manual produced by DSI that documents the software utility and this is a separate pdf file download. This post-processor currently works for Version 3.7 to the current version. This post-processor, as shown in Figure 21 and Figure 22, allows the user to look at model bathymetry, show time series, profile plots, contour plots, velocity vectors, and animations with up to 4 simultaneous state variables.

Dynamic Solutions International LLC

Quick Guide for the
CE-QUAL-W2 Post Processor
W2_Post

July 2012 Updates June 2016

W2_Post

A post-processor for CE-QUAL-W2 Version3/4 that provides the user with a broad range of visualization and analyses of the model results. W2_Post provides for rapid visualization and assessment of W2 model results. W2_Post uses a binary file generated by the CE-QUAL-W2 (i.e. the "W2L" file extension) for all of its model data analysis. No need to output multiple types of output from W2. The post-processor provides extensive model calibration / measured data comparison tools and statistics. The following are summaries of each major type of post-processing available.

Figure 21. Splash screen for W2_Post.

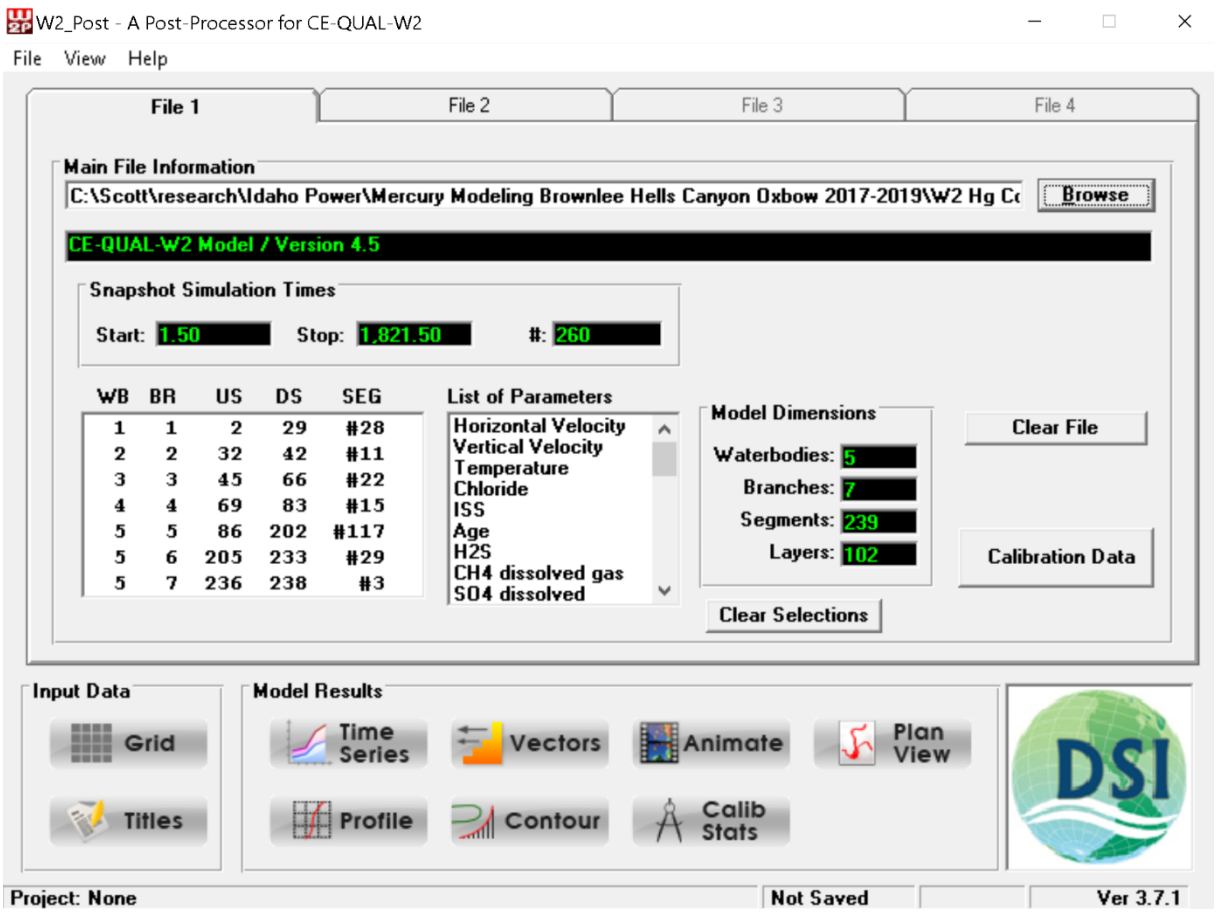


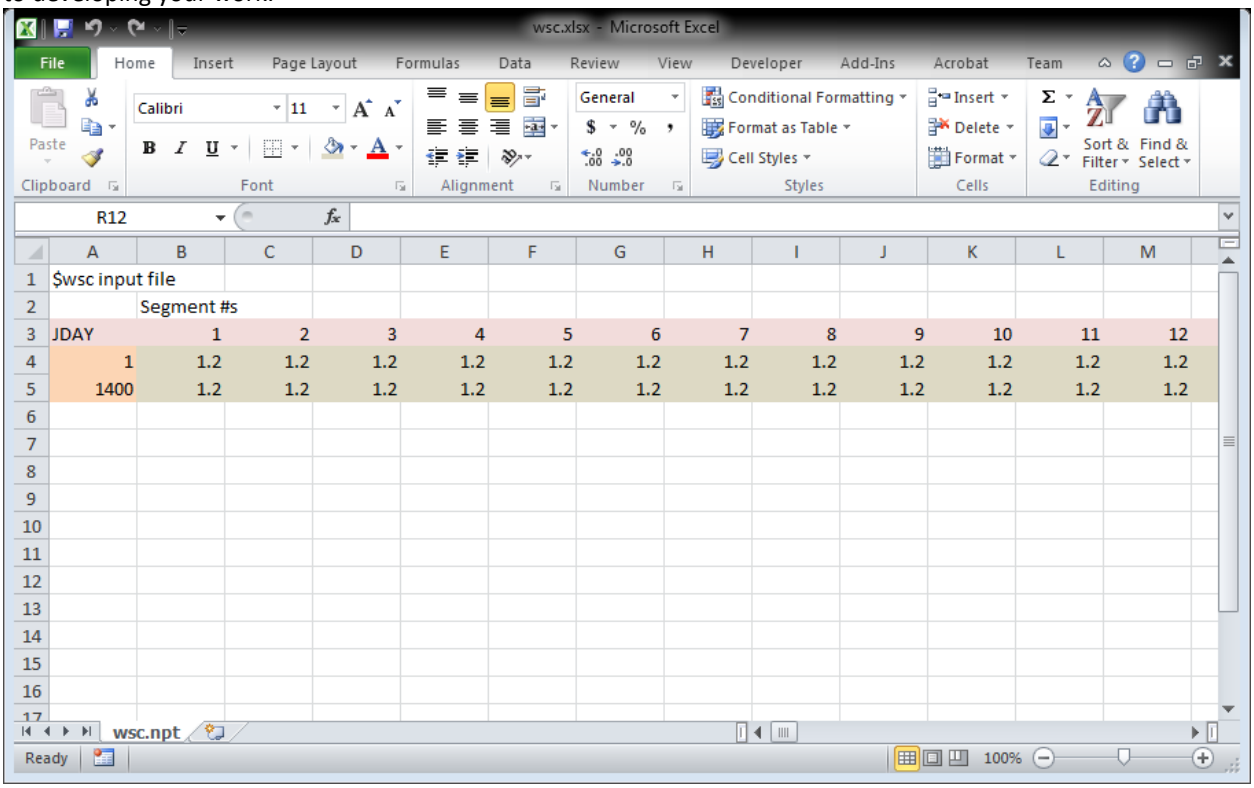
Figure 22. Menu for w2_post.exe post-processing tool from DSI.

6. Excel Macro Utility for CE-QUAL-W2

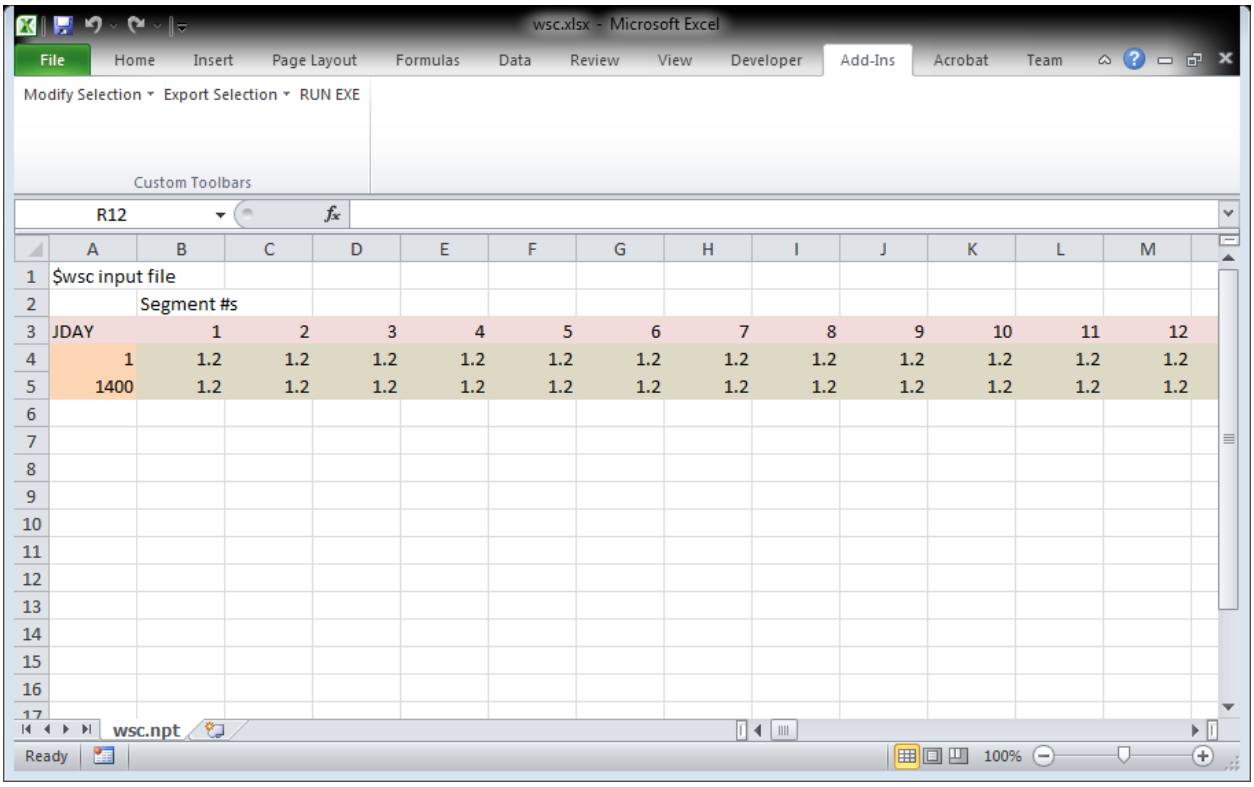
This Excel macro was written by Jeffrey Gregory, P.E., Civil Engineer, USACE, Nashville District and updated by Scott Wells, PSU.

The Excel macro, “w2tools_examples.xlsm”, can be used to develop and write out input files for the CE-QUAL-W2 model. This can be especially useful if the model user develops an Excel workbook with separate tabs for the different input files for the model.

For example, consider the input file for wind sheltering using the new free format (or csv) formatting option. You develop a workbook for this as shown below. The coloring in the workbook is optional and is just an aid to developing your work.



Now one opens “w2tools_examples2.xlsm” and ‘Enables Macros”. Once this file is opened, the user will notice that the sheet now has a header termed “Add-Ins”. Clicking this header one obtains the following options as shown below: “Modify Selection”, “Export Selection”, or “Run EXE”.



The user then selects by highlighting the portion of the file to export or modify. By selecting "Export Selection" then "Any selection to csv format". The file is written as a free-format csv file with the file name based on the worksheet name, i.e. in this case "wsc.npt". There are many other export file formats that can be used that are compatible with CE-QUAL-W2. Also, the worksheets in the "w2tools_examples.xlsm" generally show how to use the different macro features. These sheets are only used to show examples of the use of the Add-In macros.

This set of tools also allow you to modify a selection by multiplying, adding, interpolating data gaps, rounding, and transposing. Select the area of the spreadsheet that you want to modify, then select Add-Ins, Modify Selection, and one of the tools, such as Interpolate (either the X column or the Y column of a 2 column selection).

7. W2 V4.5 Bug Fixes, Enhancements, and User Manual Changes

Table 1 shows a list of model bug fixes since the release of CE-QUAL-W2 Version 4.5.

Table 1. List of bug fixes and enhancement code changes since CE-QUAL-W2 Version 4.5 was released. Note that shaded areas toggle between release versions.

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
1	W2/PREW2	Release	Initial code release	7/26/2021
2	W2/PREW2	Update	Re-release fixing minor read error in sediment diagenesis	7/30/2021
3	W2	Sediment diagenesis bug fix – critical fix	The sediment temperature for the aerobic layer and anaerobic layers were re-written. There were a couple mistakes in the earlier version since Version 4.0. These have been tested and are working fine now. Also 2 diagenesis files are now produced showing the model temperature in the aerobic layer and the anaerobic layers over time and segment.	8/30/2021
4	Converter	Bug fix	The converter utility output formats were adjusted to avoid character overflow in the output file and a bug in reading the w2_con.npt file was corrected in case epiphyton were set to zero.	8/30/2021
5	W2	Withdrawal.f90	A parentheses error was found by Stewart Rounds that has been corrected. Old code: IF ((WSEL-EL(KBOT,ID)-ELR) /= 0.0) THEN Updated code: IF (WSEL-(EL(KBOT,ID)-ELR) /= 0.0) THEN This code error would not have affected any simulation with zero slope which includes all lakes and reservoirs.	11/19/2021
6	W2	Sediment diagenesis	More output files were added to evaluate the computations within the sediment diagenesis model, these include porewater concentrations of NO3, NH3, PO4, and SO4 in both aerobic and anaerobic layers. The user manual was also updated.	11/19/2021
7	Converter	Bug fix	There was a bug fix for older bathymetry file formats. This has been fixed.	12/17/2021

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
8	W2	C vs Organic matter	The input variables when all organics are in terms of C basis was adjusted in the code to mimic the existing organic matter decay paths. Some of the additional functionality of this will be added in a subsequent release when the organic matter and C species are done similarly.	12/17/2021
9	Waterbalance	Csv file type output	A few minor changes were made to prevent spurious error messages and changing the GUI version to write out csv files rather than fixed format. Also, the console version had a couple errors that were fixed in variable type.	12/20/2021
10	PreW2	Preprocessor water balance	An error was fixed in the output for pre.opt file showing the waterbalance flows if there were multiple withdrawals and tributaries	12/28/2021
11	W2	Gates	There was no bug fix, just a refinement in the gate algorithm when the gamma variable was set equal to zero in the rating curve. In this case the rating curve is similar to a spillway rather than a gate where the term B raised to the gamma power is assumed to be '1'. In the code this was forced to '1' rather than being calculated from the exponentiation. This avoids a problem if the gate opening is zero raised to the zero power. Fortran will equate this to zero, not 1.	12/28/2021

12	W2	ICE=ONWB	When Ice=ONWB, the volume balance calculation was not correct in the SNP output and in the last column of the flowbalance.csv output file. Changed line of code for ice balance from temperature subroutine to main program code since it apples to the next rather than current time step:
			
			`!VolIce(jb)=VolIce(jb)+iceqss(i)*dlt`
			`! since this flow is not exercised until the next time step - moved code to main program calculation of qss`
				1/13/2022

13	W2	DO for gates and spillways	Added another option for DO at gates and spillways. Reaeration is increased by a fraction of the input dissolved oxygen. In many cases dams have turbine venting or other processes that introduce air into the turbine discharge. The model user can specify when this occurs by submitting a time series file of fractions that are multiplied by the incoming dissolved oxygen concentrations. The W2 code, preprocessor and User Manual has been updated.	1/18/2022

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
14	Prew2	pre.opt	More variables were output to pre.opt such as the gate and spillway gas equations to allow for a more thorough review of input variables.	1/18/2022
15	W2	Restart	Restart input files may have had an incorrect Julian day if the number was greater than 8 digits. That has been fixed for all restart time series.	2/15/2022
16	W2	Restart with ONH	A variable was not initialized properly for cases where the WITHDRAWAL OUTPUT file was set to ONH implying hourly or ONS implying seconds for the output frequency.	3/12/2022
17	W2	Sediment Diagenesis	Fixed output for PO4 and SO4 from sediment diagenesis output files. Also, added new output files for reduced Fe, Mn, and CH4 in the aerobic and anaerobic layers.	5/24/2022
18	W2	CH4	The sediment model had CH4 in O2 equivalents while the water column model had CH4 in as C units. The water column concentrations were adjusted to a more common reporting unit of mg/l as CH4 and the link between the sediment and water column was fixed.	5/24/2022
19	W2	Lowering layer output of SED in TSR file	The model has an algorithm to create a deep slot in a segment in case the water layer is too low. This keeps the segment hydrated during low flow events. When using the first order sediment model in a shallow stream, the values of SED, SEDC, SEDP, and SEDN were set to zero for this new lower layer. The output for SED in the tsr file was updated using the value for the current bottom layer rather than the fictious lower layer.	5/26/2022
20	W2	Constriction	The input file User Manual description was inconsistent. Fixed code and User Manual to agree with spreadsheet template for constriction.	7/12/2022
21	W2	Water Quality	The Generic constituent's new feature of release based on SOD was not implemented correctly. This was fixed. The MNII reduction computation used the FeII reduction rate rather than the MnII reduction rate. This was fixed. Many thanks to Cory McDonald at Hydros in Boulder for finding those!	7/21/2022
22	W2	W2_POST	Post-processing using W2_post has been enhanced. Now all derived variables are able to be viewed as time-series, profiles, contours, and animations. Prior to this, only state variables were able to be viewed.	10/13/2022

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
28	PreW2	Water balance	The water balance summary in pre.opt had a bug in computing and displaying the tributary and withdrawal flows. This has been fixed.	10/13/2022
29	W2	ENVR performance	The Environmental performance Julian day range was implemented as a yearly criterion implying that if one chose JD 20-60 over a multiple year scenario, it would use JD 20-60 each year to compile statistics. Now the user can specify yearly or a discrete set of Julian days. The User Manual has been updated. Now the Julian day range is only applied to the given range. If the first Julian day is negative, it is applied yearly.	10/13/2022
30	W2	PARTP	A bug has been fixed in the PARTP algorithm where P sorbs onto inorganic SS. This fix will somewhat reduce the P loss since it was overestimated before. This may result in using a higher value of PARTP to get similar loss of Pas in the earlier model.	10/13/2022
31	W2	Example problems	The Excel macro for writing out the example problems was updated to account for systems where the estimated number of columns was under-estimated. For each example, the Excel macro input file macro code was updated.	10/13/2022

32	W2	Sediment Diagenesis	The updated sediment diagenesis code was called – not every time step – but every CUF time steps. The Time for the sediment diagenesis model was computed as
			`SD_tc = dlt*CUF/DAY`
			Which is the time step in days for the sediment diagenesis algorithm. This is approximately correct, but not exact since the time step can vary over time and is not constant. The exact time between calls for Update Kinetics was computed from
			`SD_tc=JDAY-JDAY_INIT`
			Where JDAY_INIT was the JDAY at the beginning of the last call to Update Kinetics.
				10/15/0222

33	W2	Flux output	The columns for flux output for DOEP (epiphyton production) and DOAR (algae respiration) were accidentally switched from the order in the control file. This has been fixed.	10/20/2022

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
34	W2	Tsr output	If the tsr output with derived concentration variables followed an 'Add Layer' event, the derived variables in the output were often zero or incorrectly initialized in the layer add subroutine. All state variables were correctly initialized. On the next time step the model recomputed derived variables correctly. This only affected output.	11/10/2022
35	W2	TSR output	Further improvements for #34. APLIM, ANLIM output fixed also for special output conditions.	11/17/2022
36	W2	FLX output file	The flux output file similar to the SNP file had a limitation of 200 segments output. That has been corrected to 2000 in case one has more than 200 active segments defined in one waterbody.	1/12/2023
37	W2	Sediment Diagenesis: Fe and Mn	The Fe and Mn routines were re-written. The prior routines did not interact with the water column (oops!). These have been corrected as well as adding temperature effects for oxidation and reduction in the sediments and water column using an Arrhenius approach with a theta value of 1.05.	1/12/2023
38	W2	Sediment Diagenesis output	More sediment diagenesis output files are now written out including the transfer velocity (m/d) for each sediment layer.	1/12/2023
39	W2	Sediment Diagenesis temperature	Another term has been added to the sediment diagenesis input file – at the end – that tells the diagenesis model to either compute temperature of the aerobic and anaerobic layers dynamically or use adjacent water temperature for aerobic and anaerobic layers.	1/12/2023
40	W2	Habitat output	The model user can now use a new control, DOVOL, to specify the output of volume below 1 mg/l over time. See the User Manual Part 3 on Habitat volume.	2/1/2023
41	W2	Deallocate variables for restart	Many new model variables needed to be deallocated to have restart to work properly.	4/13/2023
42	W2	Manual updates	Several minor manual updates were made	4/13/2023
43	W2	Preprocessor	Additional checks added	4/13/2023
44	W2	Gates	Added functionality for gates. User Manual updated. Gates now can specify FLOW_ZGT where both a flow rate and a variable elevation can be entered.	4/13/2023

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
45	W2	CUF	CUF is an integer that the user can use to delay updates of the kinetic rates and WQ source/sink terms for simulating water-quality constituents. It skips the hydrodynamic time step by CUF time steps. In order to have more control over the update frequency of water quality kinetics, CUF will now be a real number. If it is positive it will have the same functionality as before (skipping CUF time steps between kinetic updates). If CUF is negative, then this is the Julian day interval for updating kinetics. Hence, a value of -0.02 means that the kinetics will be updated only every 0.01 days or every 14.4 min. This allows more precise control of the interval.	7/2/2023
46	W2	New output file	If one uses Stewart Rounds new post-processor W2Anim, **https://github.com/sa-rounds/w2anim/releases/latest**, the W2 model automatically outputs a file for viewing the outlet dynamics (flow, temperature and water quality) for any outflow. The output file is written out whenever there is a WDO (withdrawal output) specified.	7/2/2023
47	W2	Diagenesis	Updated and added another transfer velocity output file from sediment diagenesis model.	7/7/2023
48	W2	WDO	Withdrawal output for cwo and dwo files now reads the format specifier in the w2_con.csv file. Earlier this format only applied to the SNP output file.	7/7/2023
49	User Manual	Part 2	Updated heat transfer section adding longwave atmospheric formula which were missing from the text.	7/10/2023
50	W2	SPR	Spreadsheet output format precision has been improved as well as names and units of state and derived variables.	7/27/2023
51	W2	SPR	Added horizontal velocity and horizontal layer flow to the SPR output; revised User Manual	8/2/2023
52	W2	Withdrawal output	Added code to prevent gaps in withdrawal output files after a model restart	8/10/2023
53	W2	Auto-port	The number of elevations for a multiple structure withdrawal was increased from 11 to 100. Revised User Manual.	8/16/2023

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added

54	W2	Input file	A series of minor updates for the code were made for reading the input file, one of which had switched one of the inputs for BACT (bacteria). The old code had:
			`READ (CON,*)  (BACTLDK(JW),  JW=1,NWB)`
			`READ (CON,*)  (BACTS(JW),  JW=1,NWB)`
			But this order was not consistent with the Excel template nor the User manual. This was changed to
			`READ (CON,*)  (BACTS(JW),  JW=1,NWB)`
			`READ (CON,*)  (BACTLDK(JW),  JW=1,NWB)`
			Also, if one still used the w2_con.npt text file, there were errors in reading that file which have been corrected. Also, the pH-buffering input file input warning was fixed. Thanks to Stewart Rounds for finding these issues.
				9/7/2023

55	W2	Silica and Epiphyton	The variable PSIEM in was not initialized to zero causing it to increase each time step.
			Added `PSIEM(:,IU:ID) = 0.0` to Particulate_Silica subroutine in water_quality.f90. Also, there was a minor issue in computing Epiphyton decay due to an incorrect subscript for the variable H1:
			Old code:
			`EGR(K,I,J)`
			`= MIN(ETRM(K,I,J)*EG(J)*LIMIT*BLIM,FDPO4(K,I)*PO4(K,I)/(EP(J)*DLT*EPD(K,I,J)/H1(KT,I)+NONZERO),`
			`&`
			`(NH4(K,I)+NO3(K,I))/(EN(J)*DLT*EPD(K,I,J)/H1(K,I)+NONZERO))`
			
			New code:
			`EGR(K,I,J)`
			`= MIN(ETRM(K,I,J)*EG(J)*LIMIT*BLIM,FDPO4(K,I)*PO4(K,I)/(EP(J)*DLT*EPD(K,I,J)/H1(K,I)+NONZERO),`
			`&`
			`(NH4(K,I)+NO3(K,I))/(EN(J)*DLT*EPD(K,I,J)/H1(K,I)+NONZERO))`
			Thanks again to Stewart Rounds for finding these issues!
				9/7/2023

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added

56	W2	Density when below zero	Currently the density computation for water goes below zero making the water lighter and lighter. As suggested by Stewart Rounds, perhaps the density for water should be computed at 0°C rather than at negative temperature values. The W2 model without ICE cover can compute negative temperatures as the water keeps losing heat. Turning Ice ON helps keep water temperatures above 0°C. Hence, an IF test was added to make the density for temperatures below 0°C to be at 0°C. Fix below:
			`REAL(R8) FUNCTION DENSITY (T,TDS,SS)`
			`  use PREC`
			`  USE LOGICC, ONLY: SUSP_SOLIDS, FRESH_WATER, SALT_WATER; USE GLOBAL, ONLY:JW`
			`  IMPLICIT NONE`
			`  REAL(R8) :: T,TDS,SS`
			`  IF(T < 0.0) T = 0.0  ! Suggested by Stewart Rounds`
				9/7/2023

57	W2	W2 Error Dump file	Another output variable to show whether a segment was active or not was added to the "W2Errordump.csv" output file to help interpret the error dump file information. This suggestion was made by Stewart Rounds.	9/7/2023
58	W2	SNP file	Some updates to the format of the SNP file were implemented following suggestions from Stewart Rounds. The branch inflows and distributed tributaries are identified as INACTIVE if they are not active.	9/7/2023
59	W2	Layer Add Sub	Stewart Rounds suggested many code improvements to improve the robustness of the code. Many of these have been implemented.	9/7/2023
60	W2	WDO output	The wdo output files did not allow a subdirectory specification even though the User Manual said there was one. This has been fixed now. Hence, if the wdo file specification is '.\wdofiles\wdo.csv' then all the wdo files will be written to the subdirectory off the working directory of 'wdofiles' with a file suffix of '.csv'.	9/18/2023
61	W2	Restart	Restart was broken if one used Sediment Diagenesis based on earlier enhancements. Restart was fixed. [A later fix, see #69, fixed this if one used the dialog box restart.]	9/20.2023
62	W2	USGS Selective	The USGS selective routine had several bugs that were fixed by Stewart Rounds.	10/1/2023

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
63	W2	TSR and Epiphyton	The TSR output did not list the limiting nutrient for epiphyton. This output was added for each epiphyton group near the limiting nutrient for algae. This already was shown in the SNP output file if the print control was ON for epiphyton.	11/2/2023
64	W2	NH3 volatilization	The wind speed used to compute the water vapor transfer rate for NH3 volatilization was changed from 0.5 X Wind at 2 m to the wind at 2 m effectively doubling the gas transfer rate. This occurred as a result of uncertainty in the wind speed height in the original formulation for water vapor gas transfer as it affects ammonia volatilization. (See User Manual Part 3 under Ammonium where the equation has been updated.)	11/8/2023
65	W2	WDO output	The qwo and two files for the mixed flow and temperatures did not have all the flows or temperatures in columns to the right of the total flow when there was a mix of downstream outflows and lateral outflows. This has been fixed.	11/14/2023
66	W2	DZMAX	During periods of density instabilities in W2, the code used a value of DZ=DZMAX which was hardwired at 1000 m2/s. This is incredibly high. There is a possibility that this could lead to too fast mixing that could carry up through a hypolimnion. Now DZMAX is an input variable to check if the temperature regime is sensitive to this and if stability issues may arise. This may be more often an issue if there is sediment bed heating of the water column. If DZMAX is entered as a positive value, it is used directly as the value of DZ when there is an instability. If entered as a negative number, it is a multiplier on the actual value of DZ. Hence if the user enters '-100'. Then during an instability the value of DZ=DZ(computed) X 100. This has led to smoother and not so dramatic changes in density when there are instabilities in the hypolimnion. The User Manual has Part 3 been updated and is found on the MISCELLANEOUS input row starting with NDAY in the Excel macro (search for DZMAX).	11/20/2023

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
67	PreW2	pre.opt +pre.wrn	Several additional variables were output to the pre.opt file; several more checks were made for common issues; moved the error for cloud cover below 10% to a warning; the error for light extinction below 0.25 m-1 was moved to a warning; the code was updated for the new variable DZMAX mentioned above (#66); several code fixes were made as suggested by Stewart Rounds for using the text file control file and a couple other variable fixes.	12/14/2023
68	W2	Met data	A model enhancement has been added for reading variable meteorological data in regions of segments rather than tied to waterbodies. This allows a reservoir to be one waterbody and add different meteorological conditions on different parts of the reservoir. A new tab has been added to the master Excel spreadsheet and checks have been added to the preprocessor. The User Manual has also been updated.	12/14/2023
69	W2	Restart	Restart was fixed by making sure some new variables were properly deallocated when a restart was performed from the dialog box. Also, similar bugs were fixed with Sediment Diagenesis restart using the dialog box.	12/14/2023
70	W2	Input/output	Several updates to output files were made allowing for a subdirectory specification for diagenesis files (updated User Manual since there is a new input variable in the sediment diagenesis file), consistent format for habitat output files, and cleaned up snp.opt file (eliminating code for line printers!). These are courtesy of Dr. Zhong who is setting up HDF5 output.	12/28/2023
71	W2	W2	Stewart Rounds found a few bugs in the initial conditions that may have affected the first time step if you have a constriction, output variables DEPTHM and DEPTHB (used in model output) for sloping sections, and computation of the current upper layer in case the water surface was exactly equal to the top of a grid elevation (extremely rare). A few other assorted bugs were fixed for waterbody-waterbody connections. A big shout out to Stewart for going through the code!!	1/17/2024

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
72	W2	PCO2	Partial pressure of CO2 gas in the atmosphere was computed incorrectly for years prior to 1980 because of an integer overflow. Many thanks to Cory McDonald of Hydros for pointing that out. Old Code: PCO2 = (0.000041392*REAL(YEAR*YEAR*YEAR) - 0.231409975*REAL(YEAR*YEAR) + 430.804190829*REAL(YEAR) - 266735.857433224)*PALT(DS(BE(1)))*1.0E-6 New Code: PCO2 = (0.000041392*REAL(YEAR)*real(YEAR)*real(YEAR) - 0.231409975*REAL(YEAR)*real(YEAR) + 430.804190829*REAL(YEAR) - 266735.857433224)*PALT(DS(BE(1)))*1.0E-6	2/29/2024

8. Frequently Asked Questions

This is a list of common questions and answers for debugging your model applications.

Question topic	Question	Response
Numerical Stability	I'm modeling a canal system with high flows (~80 cms) that has a series of gates and pumps to control the flows. I don't have flow rating data on the gates, so I'm using structures to control the flows. I have data on flow rates at the pumps and infer flows at the gates. At higher flows, the model gets unstable and crashes. Is there something withing the structure algorithms that would cause a crash or would you infer that it's just a model construct?	I would force DLTMAX lower during the high velocity period – there is no way a priori to exactly predict the numerical stability for a non-linear PDE – it is just an estimate. Also make sure you don't set all inflows to be placed by density (PQC) and use the implicit turbulence closure scheme rather than explicit (AZSLC).

9. W2 Known Code Limitations

Table 2 shows known bugs and issues with the current release of the code:

Table 2. Known bugs in code.

#	Item	Description
1	Water levels in a "bowl"	If water levels decrease in a waterbody shaped like a "bowl", the removal of model layers as the water level decreases will cause the model to bomb if an upstream segment dries up.
2	Pipes under high head	The pipes algorithm does not handle well high-head, high-speed, dynamic flow conditions in a pipe as a result of numerical stability.
3	Time step limitation in a complex system model	The time step for stability in a system model is governed by the lowest time step for numerical stability. If you have a very dynamic river with several reservoirs, the time step for the river will control. This can result in very long run times. One can still break apart the model and run the pieces separately using the WDOUT files to provide boundary conditions for downstream waterbodies.
4	Partitioning	The partitioning coefficient for sorption is currently constant for all organic and inorganic compartments
5	Internal weir at a Dam segment	Putting an internal weir at a Dam segment does not affect the outflow from the selective withdrawal structure. One must limit selective withdrawal rather than use an internal weir at the dam segment. Remember the internal weir works for the right-hand-face of a model layer.
6	W2 multiple file error check	If the model user accidentally enters duplicate file names for an input file, the w2 executable will "bomb" because it will try to read the file in more than once. The first use of the file will lock its availability for the second instance. The W2 error message that comes on the screen (traceback error) should mention the file name that has problems. The W2 preprocessor should catch this potential error.
7	Raising level of spillway/weir above grid	The preprocessor will say there is an error if the user raises the weir, spillway, gate, water level control or any other hydraulic element above the current top-of-the-grid. The w2 code will still run properly though. But more correctly, the model user should increase the DZ of the upper-most layer to a value that would eliminate this problem. Keep in mind that the segment widths from the top layer then extend upward at that same width.

#	Item	Description
8	Internal weirs	The internal weir algorithm does not work when all vertical layers of a segment are blocked by the weir.
9	Multiple dams into one downstream reach	Currently, the code will allow one dam inflow to a downstream branch by a user-specified outflow file. The code though does allow multiple dams inflowing to a common downstream branch if the outflow is specified as a hydraulic structure.
10	Problems reading file in GUI or in W2 pre-processor of in W2 model	Sometimes the control file or bathymetry file or an input file cannot be read properly. This can be a result of the text editor used to produce the file or file conversions that occur when transferring files from workstations running Linux or from email. There may be a problem with the end of line character in the file. For Windows files, the standard end of line is a carriage return followed by a line feed: <CR><LF>. For UNIX systems it is usually only a Line Feed <LF>. To convert this from a UNIX system to a Windows system text file, use Notepad++ (a free windows text editor), go to EDIT/EOL Conversion and select Windows. Another issue common in reading text files is that the editor adds 'tabs'. All 'tabs' must be converted to 'spaces' for the file to be read properly.

10. Appendix A: Differences between CE-QUAL-W2 Versions

Differences between Version 4.22 and 4.5

In a large departure from keeping the version form almost static, Version 4.5 has many differences in the fixed format text file and the Excel xlsm file that has the w2_con.csv version of the control file.

Below are the changes in the w2_con.npt file, but comparable ones are found in the Excel input file version. Only areas with new variables are highlighted:

```
MISCELL     NDAY SELECTC HABTATC ENVIRPC AERATEC INITUWL   ORGCC   SEDIAG
             100     OFF      ON      ON     OFF     OFF     OFF      OFF


Eliminated the unused variables UQB and DQB:
BRANCH G      US      DS     UHS     DHS   NLMIN   SLOPE  SLOPEC
BR1            2      31       0       0       2 0.00000   0.000


TSR SEG     ITSR    ITSR    ITSR    ITSR    ITSR    ITSR    ITSR    ITSR    ITSR
              31

TSR LAYE    ETSR    ETSR    ETSR    ETSR    ETSR    ETSR    ETSR    ETSR    ETSR
         0.00000

WLOUT        WLC  WLFREQ
              ON     0.5

FLOWBAL   FLOWBC  FBFREQ
              ON     7.0

NPBAL     NPBALC NPBFREQ
              ON     7.0

WITH OUT    WDOC    NWDO   NIWDO
              ON       1       1



RSO FREQ    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF


CST COMP     CCC    LIMC     CUF  CO2PPM CO2YRLY
              ON      ON       3    400.      ON

ATMDEP    ATMDPC ATMDPIN
WB1          OFF      ON

CST ACTIVE   CAC
TDS           ON
Gen1          ON
Gen2          ON
```

```
CST ACTIVE   CAC
TDS           ON
Gen1          ON
Gen2          ON
Gen3          ON
ISS1          ON
WATERAGE     OFF
BACTERIA     OFF
DGP          OFF
N2           OFF
H2S          OFF
CH4          OFF
SO4          OFF
FEII         OFF
FEOOH        OFF
MNII         OFF
MNO2         OFF
PO4           ON
NH4           ON
NO3           ON
DSI          OFF
PSI          OFF
FE            ON
LDOM          ON
RDOM          ON
LPOM          ON
RPOM         OFF
ALG1          ON
DO            ON
TIC           ON
ALK           ON
ZOO1         OFF
LDOM_P       OFF
RDOM_P       OFF
LPOM_P       OFF
RPOM_P       OFF
LDOM_N       OFF
RDOM_N       OFF
LPOM_N       OFF
RPOM_N       OFF
MICROCY      OFF
CYLINDR      OFF
ANATOXIN     OFF
SAXITOXN     OFF

CST DERI   CDWBC   CDWBC   CDWBC   CDWBC   CDWBC   CDWBC   CDWBC   CDWBC   CDWBC
DOC          OFF
POC          OFF
TOC           ON
DON          OFF
PON          OFF
TON          OFF
TKN          OFF
TN            ON
NH3           ON
DOP          OFF
POP          OFF
TOP          OFF
TP           OFF
APR          OFF
CHLA         OFF
ATOT         OFF
%DO          OFF
TDG           ON
TURBIDITY    OFF
TSS          OFF
```

```
TISS          OFF
CBOD          OFF
pH            OFF
CO2           OFF
HCO3          OFF
CO3           OFF
SECCHI        OFF

CST FLUX    CFWBC    CFWBC    CFWBC    CFWBC    CFWBC    CFWBC    CFWBC    CFWBC    CFWBC
TISSIN        OFF
TISSOUT       OFF
PO4AR         OFF
PO4AG         OFF
PO4AP         OFF
PO4ER         OFF
PO4EG         OFF
PO4EP         OFF
PO4POM        OFF
PO4DOM        OFF
PO4OM         OFF
PO4SED        OFF
PO4SOD        OFF
PO4SET        OFF
NH4NITR       OFF
NH4AR         OFF
NH4AG         OFF
NH4AP         OFF
NH4ER         OFF
NH4EG         OFF
NH4EP         OFF
NH4POM        OFF
NH4DOM        OFF
NH4OM         OFF
NH4SED        OFF
NH4SOD        OFF
NH3GAS         ON
NO3DEN        OFF
NO3AG         OFF
NO3EG         OFF
NO3SED        OFF
DSIAG         OFF
DSIEG         OFF
DSIPIS        OFF
DSISED        OFF
DSISOD        OFF
DSISET        OFF
PSIAM         OFF
PSINET        OFF
PSIDK         OFF
LDOMDK        OFF
LRDOM         OFF
RDOMDK        OFF
LDOMAP        OFF
LDOMEP        OFF
LPOMDK        OFF
LRPOM         OFF
RPOMDK        OFF
LPOMAP        OFF
LPOMEP        OFF
LPOMSET       OFF
RPOMSET       OFF
CBODDK        OFF
DOAP          OFF
DOEP          OFF
DOAR          OFF
DOER          OFF
DOPOM         OFF
DODOM         OFF
```

```
DOOM          OFF
DONITR        OFF
DOCBOD        OFF
DOREAR         ON
DOSED          ON
DOSOD         OFF
TICAG         OFF
TICEG         OFF
SEDDK         OFF
SEDAS         OFF
SEDLPOM       OFF
SEDSET        OFF
SODDK         OFF

CST ICON    C2IWB    C2IWB    C2IWB    C2IWB    C2IWB    C2IWB    C2IWB    C2IWB    C2IWB
TDS       51.0000
Gen1      100.000
Gen2      0.00000
Gen3      10.0000
ISS1      2.00000
WATERAGE       0.0
BACTERIA       0.0
DGP            0.0
N2             0.0
H2S            0.0
CH4            0.0
SO4            0.0
FEII           0.0
FEOOH          0.0
MNII           0.0
MNO2           0.0
PO4       0.00100
NH4       0.00200
NO3       0.14000
DSI       0.00000
PSI       0.00000
LDOM      0.70000
RDOM      2.02200
LPOM      0.10000
RPOM      0.00000
ALG1      -1.0000
DO        -1.0000
TIC       11.9100
ALK       31.0000
ZOO1       0.1000
LDOM_P     0.0005
RDOM_P     0.0005
LPOM_P     0.0005
RPOM_P     0.0005
LDOM_N     0.0080
RDOM_N     0.0080
LPOM_N     0.0080
RPOM_N     0.0080
MICROCYS       0.0
CYLINDRO       0.0
ANATOXIN       0.0
SAXITOXN       0.0

CST PRIN   CPRWBC   CPRWBC   CPRWBC   CPRWBC   CPRWBC   CPRWBC   CPRWBC   CPRWBC   CPRWBC
TDS            ON
Gen1           ON
Gen2          OFF
Gen3          OFF
ISS1           ON
WATERAGE      OFF
BACTERIA      OFF
DGP           OFF
```

```
N2              OFF
H2S             OFF
CH4             OFF
SO4             OFF
FEII            OFF
FEOOH           OFF
MNII            OFF
MNO2            OFF
PO4              ON
NH4              ON
NO3              ON
DSI             OFF
PSI             OFF
LDOM             ON
RDOM             ON
LPOM             ON
RPOM            OFF
ALG1             ON
DO               ON
TIC             OFF
ALK             OFF
ZOO1            OFF
LDOM_P          OFF
RDOM_P          OFF
LPOM_P          OFF
RPOM_P          OFF
LDOM_N          OFF
RDOM_N          OFF
LPOM_N          OFF
RPOM_N          OFF
MICROCYSTIN     OFF
CYLINDROSP      OFF
ANATOXIN        OFF
SAXITOXIN       OFF

CIN CON    CINBRC  CINBRC  CINBRC  CINBRC  CINBRC  CINBRC  CINBRC  CINBRC  CINBRC
TDS              ON
Gen1             ON
Gen2            OFF
Gen3             ON
ISS1             ON
WATERAGE        OFF
BACTERIA        OFF
DGP             OFF
N2              OFF
H2S             OFF
CH4             OFF
SO4             OFF
FEII            OFF
FEOOH           OFF
MNII            OFF
MNO2            OFF
PO4              ON
NH4              ON
NO3              ON
DSI             OFF
PSI             OFF
LDOM             ON
RDOM             ON
LPOM             ON
RPOM            OFF
ALG1             ON
DO               ON
TIC              ON
ALK              ON
ZOO1            OFF
LDOM_P          OFF
RDOM_P          OFF
```

```
LPOM_P        OFF
RPOM_P        OFF
LDOM_N        OFF
RDOM_N        OFF
LPOM_N        OFF
RPOM_N        OFF
MICROCYSTIN   OFF
CYLINDROSP    OFF
ANATOXIN      OFF
SAXITOXIN     OFF

CTR CON    CTRTRC   CTRTRC   CTRTRC   CTRTRC   CTRTRC   CTRTRC   CTRTRC   CTRTRC   CTRTRC
TDS            ON       OFF
Gen1           ON       OFF
Gen2          OFF       OFF
Gen3           ON       OFF
ISS1           ON       OFF
WATERAGE      OFF       OFF
BACTERIA      OFF       OFF
DGP           OFF       OFF
N2            OFF       OFF
H2S           OFF       OFF
CH4           OFF       OFF
SO4           OFF       OFF
FEII          OFF       OFF
FEOOH         OFF       OFF
MNII          OFF       OFF
MNO2          OFF       OFF
PO4            ON       OFF
NH4            ON       OFF
NO3            ON       OFF
DSI           OFF       OFF
PSI           OFF       OFF
LDOM           ON       OFF
RDOM           ON       OFF
LPOM           ON       OFF
RPOM          OFF       OFF
ALG1           ON       OFF
DO             ON       OFF
TIC            ON       OFF
ALK            ON       OFF
ZOO1          OFF       OFF
LDOM_P        OFF       OFF
RDOM_P        OFF       OFF
LPOM_P        OFF       OFF
RPOM_P        OFF       OFF
LDOM_N        OFF       OFF
RDOM_N        OFF       OFF
LPOM_N        OFF       OFF
RPOM_N        OFF       OFF
MICROCYSTIN   OFF       OFF
CYLINDROSP    OFF       OFF
ANATOXIN      OFF       OFF
SAXITOXIN     OFF       OFF

CDT CON    CDTBRC   CDTBRC   CDTBRC   CDTBRC   CDTBRC   CDTBRC   CDTBRC   CDTBRC   CDTBRC
TDS            ON       OFF
Gen1           ON       OFF
Gen2          OFF       OFF
Gen3           ON       OFF
ISS1           ON       OFF
WATERAGE      OFF       OFF
BACTERIA      OFF       OFF
DGP           OFF       OFF
N2            OFF       OFF
H2S           OFF       OFF
CH4           OFF       OFF
```

```
SO4             OFF      OFF
FEII            OFF      OFF
FEOOH           OFF      OFF
MNII            OFF      OFF
MNO2            OFF      OFF
PO4              ON      OFF
NH4              ON      OFF
NO3              ON      OFF
DSI             OFF      OFF
PSI             OFF      OFF
LDOM             ON      OFF
RDOM             ON      OFF
LPOM             ON      OFF
RPOM            OFF      OFF
ALG1             ON      OFF
DO               ON      OFF
TIC              ON      OFF
ALK              ON      OFF
ZOO1            OFF      OFF
LDOM_P          OFF      OFF
RDOM_P          OFF      OFF
LPOM_P          OFF      OFF
RPOM_P          OFF      OFF
LDOM_N          OFF      OFF
RDOM_N          OFF      OFF
LPOM_N          OFF      OFF
RPOM_N          OFF      OFF
MICROCYSTIN     OFF      OFF
CYLINDROSP      OFF      OFF
ANATOXIN        OFF      OFF
SAXITOXIN       OFF      OFF

CPR CON    CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC
TDS              ON       ON
Gen1             ON      OFF
Gen2            OFF      OFF
Gen3             ON      OFF
ISS1             ON      OFF
WATERAGE        OFF      OFF
BACTERIA        OFF      OFF
DGP             OFF      OFF
N2              OFF      OFF
H2S             OFF      OFF
CH4             OFF      OFF
SO4             OFF      OFF
FEII            OFF      OFF
FEOOH           OFF      OFF
MNII            OFF      OFF
MNO2            OFF      OFF
PO4              ON      OFF
NH4              ON      OFF
NO3              ON      OFF
DSI             OFF      OFF
PSI             OFF      OFF
LDOM             ON      OFF
RDOM             ON      OFF
LPOM             ON      OFF
RPOM            OFF      OFF
ALG1             ON      OFF
DO               ON      OFF
TIC              ON      OFF
ALK              ON      OFF
ZOO1            OFF      OFF
LDOM_P          OFF      OFF
RDOM_P          OFF      OFF
LPOM_P          OFF      OFF
RPOM_P          OFF      OFF
LDOM_N          OFF      OFF
```

```
RDOM_N        OFF      OFF
LPOM_N        OFF      OFF
RPOM_N        OFF      OFF
MICROCYSTIN   OFF      OFF
CYLINDROSP    OFF      OFF
ANATOXIN      OFF      OFF
SAXITOXIN     OFF      OFF

GENERIC     CGQ10    CG0DK    CG1DK     CGS    CGLDK    CGKLF     CGCS      CGR
CG 1      0.00000  0.00000  0.00000 0.00000      0.0      0.0      0.0      0.0
CG 2      0.00000 -1.0000  0.00000 0.00000      0.0      0.0      0.0      0.0
CG 3      1.04000  0.00000 1.40000 0.00000      0.0      0.0      0.0      0.0

S SOLIDS      SSS    SEDRC    TAUCR     SSCS
SS# 1     1.00000      OFF  0.00000      0.0

BACTERIA BACTQ10 BACT1DK   BACTS BACTLDK
WB1         1.025   0.100    0.00   0.050

H2S          H2SR  H2SQ10  H2S1DK    SO4R
WB1         0.005   1.04     0.10   0.050

CH4          CH4R  CH4Q10  CH41DK
WB1         0.004  1.0400    0.05

FE          FEIIR KFEOXID  KFERED  HalfSat  SetVel
WB1         0.004  1.0400    0.05     0.10    0.10

MN          MNIIR KMNOXID  KMNRED  HalfSat  SetVel
WB1         0.004  1.0400    0.05     0.10    0.10

ALGAL RATE     AG       AR       AE       AM       AS     AHSP     AHSN    AHSSI     ASAT
ALG1      2.00000  0.04000  0.04000  0.10000  0.10000  0.00300  0.01400  0.00000  100.000

ALG STOI     ALGP     ALGN     ALGC    ALGSI    ACHLA    ALPOM    ANEQN     ANPR AVERT_M
ALG1      0.00500  0.08000  0.45000  0.00000  0.06500  0.80000        1  0.00100      OFF

OM STOIC     ORGP     ORGN     ORGC    ORGSI
WB 1      0.00500  0.08000  0.45000  0.18000

OM RATE      OMT1     OMT2     OMK1     OMK2
WB 1      4.00000 30.0000  0.10000  0.99000

TURBSEC   COEFFA  COEFFB  SECCHI
WB1         1.10    0.05     1.5

CBOD         KBOD     TBOD     RBOD     CBODS
BOD 1     0.25000  1.01500  1.85000       0.0

REAERATION  TYPE     EQN#    COEF1    COEF2    COEF3    COEF4    DGPO2    MINKL
WB 1        LAKE        2  0.00000  0.00000  0.00000  0.00000    1.027      0.6


MET FILE.................................METFN.................................
WB 1     met.npt

EXT FILE.................................EXTFN.................................
WB 1     ext_1.npt

ATD FILE.................................ATDFN.................................
WB 1     atm_dep_wb1.csv

VPR FILE.................................VPRFN.................................
WB 1     vpr.npt
```

Also, there are many changes in the other input files for activating different processes in Version 4.5. See the User Manual Part 3 for the new format for these ancillary input files.

Differences between Version 4.2.2 and Version 4.2.1

Version 4.2.2 has 2 new variables, [**CO2PPM**] and [**CO2YRLY**], that were added to the main control file, **w2_con.npt** and **w2_con.csv**. The old fixed format card in **w2_con.npt** is shown below:

```
RSO DATE    RSOD    RSOD    RSOD    RSOD    RSOD    RSOD    RSOD    RSOD    RSOD


RSO FREQ    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF


CST COMP     CCC    LIMC     CUF
              ON     OFF      10

CST ACTIVE   CAC
TDS           ON
Gen1          ON
ISS1          ON
ISS2          ON
```

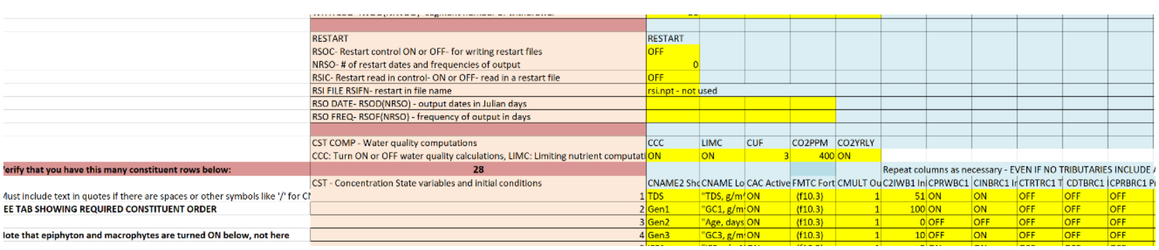
The Version 4.2.2 file, **w2_con.npt** is shown below with the changes highlighted:

```
RSO DATE    RSOD    RSOD    RSOD    RSOD    RSOD    RSOD    RSOD    RSOD    RSOD


RSO FREQ    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF    RSOF


CST COMP     CCC    LIMC     CUF  CO2PPM CO2YRLY
              ON      ON      10    400.      ON
CST ACTIVE   CAC
TDS           ON
Gen1          ON
ISS1          ON
ISS2          ON
```

In the Excel macro version, the new variables are shown below:



Differences between Version 4.2.1 and Version 4.2

Version 4.2.1 is file compatible except that the **multiple_wb.npt** format has changed. Also, a new input file, **w2_con.csv**, can be read by the model. This file is developed using the Excel file **w2_con.xslm**.

Differences between Version 4.2 and Version 4.1

Version 4.2 is file compatible with Version 4.1. There are no changes in the main control file. There are new control files though that control new processes: (1) Multiple processor simulation for cascade of waterbodies (**multiple_wb.npt**), (2) SYSTDG Total Dissolved Gas algorithm for spillways (**systdg.npt**).

Differences between Version 4.1 and Version 4.0

Version 4.1 is file compatible with Version 4.0. There are no changes in the main control file. There is only 1 new input file, '**particle.csv**', that serves as an input file to the particle tracking algorithm.

Differences between Version 4.0 and Version 3.72

Version 4 is file compatible with Version 3.72, even though there are new options in the main control file, w2_con.npt, and new input files whose presence or absence is detected by the model. For example, for ICEC control the options now include ON, ONWB, and OFF, where ONWB is a new option. New input files include a file for sediment diagenesis, 'W2_CEMA_Input.npt', and a file for the dynamic alkalinity calculation, 'pH_buffering.npt'

Control file differences are in the Generic Constituent Section of the Code where new variables were added to the control file to allow for phot-degradation and the new N2 state variable for TDG:

```
GENERIC    CGQ10   CG0DK   CG1DK     CGS    CGLDK   CGKLF     CGS
CG 1     0.00000 0.00000 0.00000 0.00000 0.00000 1.03400 -1.0000     ! TDG
CG 2     0.00000 -1.0000 0.00000 0.00000 0.00000 0.00000 0.00000
CG 3     1.04000 0.00000 1.40000 0.00000 0.00000 0.00000 0.00000
```

Differences between Version 3.72 and Version 3.71

These 2 codes are file compatible. Besides a few bug fixes since the last release of Version 3.71, Version 3.72 includes the USGS automatic port selection code. This can be activated by setting SELECTC='USGS' in the control file w2_con.npt. In Version 3.71, only 'ON' or 'OFF' were input variables for SELECTC. If one sets SELECTC='USGS', the format of the file w2_selective.npt is also changed from Version 3.71. Details of this and examples are provided in the User's Manual and on-line.

Differences between Version 3.71 and Version 3.7

There is only one change in the control file between Version 3.7 and 3.71. There is a new option for outlet structures – dynamic centerline elevation. In the control file, there is an ON/OFF option after declaring the # of structures for each branch:

```
EDDY VISC     AZC    AZSLC    AZMAX      FBC        E    ARODI STRCKLR BOUNDFR  TKECAL
WB 1          TKE      IMP 1.00000        3 9.53500 0.43100 0.00000 0.00000     IMP

N STRUC      NSTR DYNELEV
BR1            17       ON
BR2             0      OFF
BR3             0      OFF

STR INT     STRIC    STRIC    STRIC    STRIC    STRIC    STRIC    STRIC    STRIC    STRIC
```

If these fields are missing the model will assume that DYNELEV=OFF.

Differences between Version 3.7 and Version 3.6

Even though there are some cases where a Version 3.7 executable will run Version 3.6 and Version 3.5 files fine, there are updates required to the w2_con.npt file that need to be made. The preprocessor will catch these errors.

Control file changes: w2_con.npt

The main changes to the W2 control file are additional flags to turn ON/OFF new control file options and the addition of new state variables for water quality, BOD-N and BOD-P for each BOD group.

Below is a list of changes in the control file with the card image header for each line changed (highlighted options are new in V3.7). Descriptions of these new features are in the W2 User's Manual.

1. MISCELL

```
MISCELL      NDAY SELECTC HABTATC ENVIRPC AERATEC INITUWL
               100     OFF       ON       ON       ON     OFF
```

Five new variables, SELECTC, HABITATC, ENVIRPC, AERATEC, and INITUWL, are 5 new control variables that turn ON/OFF the use of automatic selective withdrawal, fish habitat volumes, environmental performance criteria, artificial aeration, and the initial water surface and velocity computations, respectively. If

using an old Version 3.6 control file, all of these would default to 'OFF' if they were left blank. Also the model preprocessor would flag these are missing variables.

2. DLT CON

```
DLT CON       NDT  DLTMIN DLTINTR
                1 1.00000     OFF
```

where DLTINTR is a control for interpolating the the time step DLTMAX and DLTF rather than use as a step function

3. BRANCH G

```
BRANCH G      US      DS     UHS     DHS     UQB     DQB   NLMIN   SLOPE  SLOPEC
Br 1           2      59       0       0       0       0       1     0.0     0.0
```

where SLOPEC is the hydraulic equivalent slope for a river channel that affects the momentum equation.

4. GATE WEIR

```
GATE WEIR   GTA1    GTB1    GTA2    GTB2  DYNVAR    GTIC
Gate1    1.00000 1.50000 1.00000 1.50000    FLOW      ON
```

where GTIC is an interpolation control for the specified DYNVAR for the GATE-WEIR.

5. Dynamic pipe

```
PIPES       IUPI    IDPI    EUPI    EDPI     WPI   DLXPI     FPI  FMINPI  LATPIC DYNPIPE
Pi 1          24      28    28.0    27.0     0.5   230.0   0.065     0.1    DOWN      ON
```

where DYNPIPE controls whether the pipe is controlled by time series of an ON/OFF or partially open gate

6. Dynamic pump

```
PUMPS 1     IUPU    IDPU     EPU  STRTPU   ENDPU   EONPU  EOFFPU     QPU   WTHLC DYNPUMP
              111       0    440.    1.00    366.   441.0   435.0     1.0    DOWN      ON
```

where DYNPUMP controls the EPU, EONPU, EOFFPU, and QPU over time by reading in a time series file

7. INIT CND

```
INIT CND   TEMPI    ICEI  WTYPEC   GRIDC
WB 1     -1.0000 0.00000   FRESH    RECT
```

where GRIDC controls whether the grid is interpreted as rectangular in depth or trapezoidal.

8. CST ACTIVE [Note that this change only appears if NBOD>0]

```
CST ACTIVE   CAC
```

```
TDS             ON
Gen1            ON
Gen2           OFF
Gen3           OFF
Gen4           OFF
Gen5           OFF
ISS1            ON
PO4             ON
NH4             ON
NO3             ON
DSI            OFF
PSI            OFF
FE             OFF
LDOM            ON
RDOM            ON
LPOM            ON
RPOM            ON
1CBOD           ON
2CBOD           ON
3CBOD           ON
4CBOD           ON
5CBOD           ON
6CBOD           ON
7CBOD           ON
8CBOD           ON
9CBOD           ON
10CBOD          ON
1CBODP          ON
2CBODP          ON
3CBODP          ON
4CBODP          ON
5CBODP          ON
6CBODP          ON
7CBODP          ON
8CBODP          ON
9CBODP          ON
10CBODP         ON
1CBODN          ON
2CBODN          ON
3CBODN          ON
4CBODN          ON
5CBODN          ON
6CBODN          ON
7CBODN          ON
8CBODN          ON
9CBODN          ON
10CBODN         ON
ALG1            ON
ALG2            ON
ALG3            ON
DO              ON
TIC             ON
ALK             ON
ZOO1           OFF
LDOM_P          ON
RDOM_P          ON
LPOM_P          ON
RPOM_P          ON
LDOM_N          ON
RDOM_N          ON
LPOM_N          ON
RPOM_N          ON
```

9. CST ICON, CST PRIN, CIN CON,CTR CON, CDT CON and CPR CON

```
CST ICON    C2IWB    C2IWB    C2IWB    C2IWB    C2IWB    C2IWB    C2IWB    C2IWB    C2IWB
```

```
TDS          0.0
AGE          0.0
TRACER       0.0
COL1         0.0
Conduct      0.0
Chlorine     0.0
ISS1         0.0
PO4         0.03
NH4         0.01
NOx          0.3
DSi          0.0
PSi          0.0
TFe          0.0
LDOM         0.1
RDOM         0.1
LPOM         0.1
RPOM         0.1
1CBOD        0.0
2CBOD        0.0
3CBOD        0.0
4CBOD        0.0
5CBOD        0.0
6CBOD        0.0
7CBOD        0.0
8CBOD        0.0
9CBOD        0.0
10CBOD       0.0
1CBODP       0.0
2CBODP       0.0
3CBODP       0.0
4CBODP       0.0
5CBODP       0.0
6CBODP       0.0
7CBODP       0.0
8CBODP       0.0
9CBODP       0.0
10CBODP      0.0
1CBODN       0.0
2CBODN       0.0
3CBODN       0.0
4CBODN       0.0
5CBODN       0.0
6CBODN       0.0
7CBODN       0.0
8CBODN       0.0
9CBODN       0.0
10CBODN      0.0
ALG1         0.1
ALG2         0.1
ALG3         0.1
DO          12.0
TIC          5.0
ALK         19.8
ZOO1         0.0
LDOM_P    0.0005
RDOM_P    0.0005
LPOM_P    0.0005
RPOM_P    0.0005
LDOM_N    0.0080
RDOM_N    0.0080
LPOM_N    0.0080
RPOM_N    0.0080

CST PRIN  CPRWBC  CPRWBC  CPRWBC  CPRWBC  CPRWBC  CPRWBC  CPRWBC  CPRWBC  CPRWBC
TDS           ON
AGE           ON
TRACER        ON
```

```
COL1          ON
Conduct       ON
Chlorine      ON
ISS1          ON
PO4           ON
NH4           ON
NOx           ON
DSi          OFF
PSi          OFF
TFe          OFF
LDOM          ON
RDOM          ON
LPOM          ON
RPOM          ON
1CBOD         ON
2CBOD         ON
3CBOD         ON
4CBOD         ON
5CBOD         ON
6CBOD         ON
7CBOD         ON
8CBOD         ON
9CBOD         ON
10CBOD        ON
1CBODP        ON
2CBODP        ON
3CBODP        ON
4CBODP        ON
5CBODP        ON
6CBODP        ON
7CBODP        ON
8CBODP        ON
9CBODP        ON
10CBODP       ON
1CBODN        ON
2CBODN        ON
3CBODN        ON
4CBODN        ON
5CBODN        ON
6CBODN        ON
7CBODN        ON
8CBODN        ON
9CBODN        ON
10CBODN       ON
ALG1          ON
ALG2          ON
ALG3          ON
DO            ON
TIC           ON
ALK           ON
ZOO1         OFF
LDOM_P        ON
RDOM_P        ON
LPOM_P        ON
RPOM_P        ON
LDOM_N        ON
RDOM_N        ON
LPOM_N        ON
RPOM_N        ON

CIN CON   CINBRC  CINBRC  CINBRC  CINBRC  CINBRC  CINBRC  CINBRC  CINBRC  CINBRC
TDS           ON      ON
AGE          OFF     OFF
TRACER       OFF     OFF
COL1         OFF     OFF
Conduct       ON      ON
Chlorine     OFF     OFF
ISS1          ON      ON
```

```
PO4             ON      ON
NH4             ON      ON
NOx             ON      ON
DSi            OFF     OFF
PSi            OFF     OFF
TFe            OFF     OFF
LDOM            ON      ON
RDOM            ON      ON
LPOM            ON      ON
RPOM            ON      ON
1CBOD           ON      ON
2CBOD           ON      ON
3CBOD           ON      ON
4CBOD           ON      ON
5CBOD           ON      ON
6CBOD           ON      ON
7CBOD           ON      ON
8CBOD           ON      ON
9CBOD           ON      ON
10CBOD          ON      ON
1CBODP          ON      ON
2CBODP          ON      ON
3CBODP          ON      ON
4CBODP          ON      ON
5CBODP          ON      ON
6CBODP          ON      ON
7CBODP          ON      ON
8CBODP          ON      ON
9CBODP          ON      ON
10CBODP         ON      ON
1CBODN          ON      ON
2CBODN          ON      ON
3CBODN          ON      ON
4CBODN          ON      ON
5CBODN          ON      ON
6CBODN          ON      ON
7CBODN          ON      ON
8CBODN          ON      ON
9CBODN          ON      ON
10CBODN         ON      ON
ALG1            ON      ON
ALG2            ON      ON
ALG3            ON      ON
DO              ON      ON
TIC             ON      ON
ALK             ON      ON
ZOO1           OFF     OFF
LDOM_P          ON      ON
RDOM_P          ON      ON
LPOM_P          ON      ON
RPOM_P          ON      ON
LDOM_N          ON      ON
RDOM_N          ON      ON
LPOM_N          ON      ON
RPOM_N          ON      ON

CTR CON    CTRTRC  CTRTRC  CTRTRC  CTRTRC  CTRTRC  CTRTRC  CTRTRC  CTRTRC  CTRTRC
TDS             ON      ON
AGE            OFF     OFF
TRACER          ON      ON
COL1            ON      ON
Conduct         ON      ON
Chlorine        ON      ON
ISS1            ON      ON
PO4             ON      ON
NH4             ON      ON
NOx             ON      ON
```

```
DSi           OFF     OFF
PSi           OFF     OFF
TFe           OFF     OFF
LDOM           ON      ON
RDOM           ON      ON
LPOM           ON      ON
RPOM           ON      ON
1CBOD          ON      ON
2CBOD          ON      ON
3CBOD          ON      ON
4CBOD          ON      ON
5CBOD          ON      ON
6CBOD          ON      ON
7CBOD          ON      ON
8CBOD          ON      ON
9CBOD          ON      ON
10CBOD         ON      ON
1CBODP         ON      ON
2CBODP         ON      ON
3CBODP         ON      ON
4CBODP         ON      ON
5CBODP         ON      ON
6CBODP         ON      ON
7CBODP         ON      ON
8CBODP         ON      ON
9CBODP         ON      ON
10CBODP        ON      ON
1CBODN         ON      ON
2CBODN         ON      ON
3CBODN         ON      ON
4CBODN         ON      ON
5CBODN         ON      ON
6CBODN         ON      ON
7CBODN         ON      ON
8CBODN         ON      ON
9CBODN         ON      ON
10CBODN        ON      ON
ALG1           ON      ON
ALG2           ON      ON
ALG3           ON      ON
DO             ON      ON
TIC            ON      ON
ALK            ON      ON
ZOO1          OFF     OFF
LDOM_P         ON      ON
RDOM_P         ON      ON
LPOM_P         ON      ON
RPOM_P         ON      ON
LDOM_N         ON      ON
RDOM_N         ON      ON
LPOM_N         ON      ON
RPOM_N         ON      ON

CDT CON   CDTBRC  CDTBRC  CDTBRC  CDTBRC  CDTBRC  CDTBRC  CDTBRC  CDTBRC  CDTBRC
TDS            ON      ON
AGE           OFF     OFF
TRACER         ON      ON
COL1           ON      ON
Conduct        ON      ON
Chlorine       ON      ON
ISS1           ON      ON
PO4            ON      ON
NH4            ON      ON
NOx            ON      ON
DSi           OFF     OFF
PSi           OFF     OFF
TFe           OFF     OFF
LDOM           ON      ON
```

```
RDOM           ON      ON
LPOM           ON      ON
RPOM           ON      ON
1CBOD          ON      ON
2CBOD          ON      ON
3CBOD          ON      ON
4CBOD          ON      ON
5CBOD          ON      ON
6CBOD          ON      ON
7CBOD          ON      ON
8CBOD          ON      ON
9CBOD          ON      ON
10CBOD         ON      ON
1CBODP         ON      ON
2CBODP         ON      ON
3CBODP         ON      ON
4CBODP         ON      ON
5CBODP         ON      ON
6CBODP         ON      ON
7CBODP         ON      ON
8CBODP         ON      ON
9CBODP         ON      ON
10CBODP        ON      ON
1CBODN         ON      ON
2CBODN         ON      ON
3CBODN         ON      ON
4CBODN         ON      ON
5CBODN         ON      ON
6CBODN         ON      ON
7CBODN         ON      ON
8CBODN         ON      ON
9CBODN         ON      ON
10CBODN        ON      ON
ALG1           ON      ON
ALG2           ON      ON
ALG3           ON      ON
DO             ON      ON
TIC            ON      ON
ALK            ON      ON
ZOO1          OFF     OFF
LDOM_P         ON      ON
RDOM_P         ON      ON
LPOM_P         ON      ON
RPOM_P         ON      ON
LDOM_N         ON      ON
RDOM_N         ON      ON
LPOM_N         ON      ON
RPOM_N         ON      ON

CPR CON    CPRBRC  CPRBRC  CPRBRC  CPRBRC  CPRBRC  CPRBRC  CPRBRC  CPRBRC  CPRBRC
TDS            ON      ON
AGE           OFF     OFF
TRACER         ON      ON
COL1           ON      ON
Conduct        ON      ON
Chlorine       ON      ON
ISS1           ON      ON
PO4            ON      ON
NH4            ON      ON
NOx            ON      ON
DSi           OFF     OFF
PSi           OFF     OFF
TFe           OFF     OFF
LDOM           ON      ON
RDOM           ON      ON
LPOM           ON      ON
RPOM           ON      ON
```

```
1CBOD           ON       ON
2CBOD           ON       ON
3CBOD           ON       ON
4CBOD           ON       ON
5CBOD           ON       ON
6CBOD           ON       ON
7CBOD           ON       ON
8CBOD           ON       ON
9CBOD           ON       ON
10CBOD          ON       ON
1CBODP          ON       ON
2CBODP          ON       ON
3CBODP          ON       ON
4CBODP          ON       ON
5CBODP          ON       ON
6CBODP          ON       ON
7CBODP          ON       ON
8CBODP          ON       ON
9CBODP          ON       ON
10CBODP         ON       ON
1CBODN          ON       ON
2CBODN          ON       ON
3CBODN          ON       ON
4CBODN          ON       ON
5CBODN          ON       ON
6CBODN          ON       ON
7CBODN          ON       ON
8CBODN          ON       ON
9CBODN          ON       ON
10CBODN         ON       ON
ALG1            ON       ON
ALG2            ON       ON
ALG3            ON       ON
DO              ON       ON
TIC             ON       ON
ALK             ON       ON
ZOO1           OFF      OFF
LDOM_P          ON       ON
RDOM_P          ON       ON
LPOM_P          ON       ON
RPOM_P          ON       ON
LDOM_N          ON       ON
RDOM_N          ON       ON
LPOM_N          ON       ON
RPOM_N          ON       ON
```

New control files

Based on the options the user turns ON or OFF, new control files are required. These new control files are named:

1. w2_selective.npt – new variables controlling the selective withdrawal algorithm to select temperature targets
2. w2_habitat.npt – new variables controlling fish habitat limits for temperature and dissolved oxygen and surface and segment volume weighted eutrophication state variables
3. w2_envirpf.npt – new variables controlling setting environmental performance criteria
4. w2_aerate.npt – variables describing use of dissolved oxygen addition to enhance dissolved oxygen levels through diffusers

Details of these new control files are in the CE-QUAL-W2 User Manual.

Differences between Version 3.6 and Version 3.5

Version 3.6 can be run without changing any of the input files, even though the preprocessor will identify errors in the control file because of missing variables. Below is a highlighted list of locations in the file w2_con.npt where additional variables have been added. There are no other changes in the input files for Version 3.6.

The TKE algorithm has been updated with new algorithms that match experimental tank data for kinetic energy and dissipation. This is based on a Master's degree project by Sam Gould at Portland State University. A new user option is the TKE1 algorithm, in add addition to the legacy algorithm TKE. This results in several new input variables on the following line of the w2_con.npt file that are only active if TKE1 is chosen for AZC:

```
EDDY VISC     AZC    AZSLC    AZMAX      FBC        E    ARODI STRCKLR BOUNDFR  TKECAL
WB 1           W2      IMP 1.00000        3    9.535    0.430    24.0   10.00     IMP
```

The roughness height of the water for correction of the vertical velocity wind profile is now a user-defined input, z_0. Prior to this the model had hardwired the value of z_0=0.003 m for wind speed correction at 2m (for evaporation where wind height at 2 m is typical) and z_0=0.01 m for wind at 10 m (for shear stress calculations where wind height of 10 m is typical). For consistency, both conversions now use the same value of roughness height. If the user does not specify the value of z_0 (for example if he/she leaves the spaces blank for z_0 using a V3.5 control file), the code uses 0.001 m.

```
HYD COEF       AX       DX     CBHE     TSED       FI    TSEDF    FRICC       Z0
WB 1      1.00000 1.00000 0.30000 11.5000 0.01000 1.00000     MANN    0.001
```

A new option for output is in the format required for TECPLOT. For TECPLOT animation there is only a flag in the CPL output line. This allows for easy model animation of the variables U, W, T, RHO, and all active constituents at the frequency specified by the CPL file as a function of distance and elevation.

```
CPL PLOT     CPLC     NCPL TECPLOT
WB 1           ON        1      ON
```

A new variable for determining the fraction of NO3-N that is diffused into the sediments that becomes organic matter, or SED-N was introduced. According to one study, only about 37% of NO_3-N that diffuses into the sediments becomes incorporated into organic matter in the sediments. The rest is denitrified.

```
   NITRATE     NO3DK     NO3S FNO3SED
   Wb 1         0.05      0.0     0.37
   Wb 2         0.05      0.0     0.37
```

In V3.5 the model computed an average decay coefficient of the sediments based on what was deposited. The user now has the option to dynamically compute that decay rate or to have it fixed and controlled by the model user. A new variable was introduced called DYNSEDK which is either ON/OFF to allow or not allow dynamic computation of the sediment decay rate.

```
   SEDIMENT     SEDC    PRNSC    SEDCI     SEDK     SEDS     FSOD     FSED    SEDBR DYNSEDK
```

```
Wb 1          ON      ON      0.0     0.1     0.0     1.0     1.0   0.001     OFF
Wb 2          ON      ON      0.0     0.1     0.0     1.0     1.0   0.001     OFF
```

The User can now specify the # of processors to use on the host computer. Most users find that setting NPROC=2 gets the best results. Sometimes setting this greater than 2 results in slower model performance. Also, the CLOSEC control closes the windows dialog box after the model completes its simulation. This is useful in using the windows version of the release code in batch simulations. These are specified in the control file as follows:

```
GRID          NWB      NBR      IMX      KMX    NPROC   CLOSEC
                1        4       66      117        2       ON
```

Differences between Version 3.2 and Version 3.5

The differences in V3.5 and V3.2 input files are found in the control file: **w2_con.npt** and in the **graph.npt** file. All other files are the same between the 2 versions.

w2_con.npt

Below is an example of parts of the control file from V3.5 where all new variables are highlighted. Most of these changes have to do with the new zooplankton, macrophyte, and new state variables added to the model. See the User Manual for a list of changes between V3.2 and V 3.5 in the version history. Also there were some deletions from the V3.2 w2_con.npt file. These are shown below.

New variables added to the control file are highlighted

```
.
.
IN/OUTFL      NTR      NST      NIW      NWD      NGT      NSP      NPI      NPU
                1        1        0        0        0        0        0        0

CONSTITU      NGC      NSS      NAL      NEP     NBOD      NMC      NZP
                5        1        1        1        5        0        1

MISCELL      NDAY
               100
.
.
CST COMP      CCC     LIMC      CUF
                ON       ON       10

CST ACTIVE    CAC
TDS           OFF
Gen1           ON
Gen2          OFF
Gen3          OFF
Gen4          OFF
Gen5          OFF
ISS1          OFF
PO4           OFF
NH4           OFF
NO3           OFF
DSI           OFF
PSI           OFF
FE            OFF
LDOM          OFF
RDOM          OFF
LPOM          OFF
RPOM          OFF
BOD1          OFF
BOD2          OFF
BOD3          OFF
BOD4          OFF
BOD5          OFF
ALG1          OFF
DO            OFF
TIC           OFF
ALK           OFF
ZOO1          OFF
LDOM_P        OFF
```

RDOM_P	OFF
LPOM_P	OFF
RPOM_P	OFF
LDOM_N	OFF
RDOM_N	OFF
LPOM_N	OFF
RPOM_N	OFF

CST DERI	CDWBC	CDWBC	CDWBC	CDWBC	CDWBC	CDWBC	CDWBC	CDWBC	CDWBC
DOC	OFF								
POC	OFF								
TOC	OFF								
DON	OFF								
PON	OFF								
TON	OFF								
TKN	OFF								
TN	OFF								
DOP	OFF								
POP	OFF								
TOP	OFF								
TP	OFF								
APR	OFF								
CHLA	OFF								
ATOT	OFF								
%DO	OFF								
TSS	OFF								
TISS	OFF								
CBOD	OFF								
pH	OFF								
CO2	OFF								
HCO3	OFF								
CO3	OFF								

CST FLUX	CFWBC	CFWBC	CFWBC	CFWBC	CFWBC	CFWBC	CFWBC	CFWBC	CFWBC
TISSIN	OFF								
TISSOUT	OFF								
PO4AR	OFF								
PO4AG	OFF								
PO4AP	OFF								
PO4ER	OFF								
PO4EG	OFF								
PO4EP	OFF								
PO4POM	OFF								
PO4DOM	OFF								
PO4OM	OFF								
PO4SED	OFF								
PO4SOD	OFF								
PO4SET	OFF								
NH4NITR	OFF								
NH4AR	OFF								
NH4AG	OFF								
NH4AP	OFF								
NH4ER	OFF								
NH4EG	OFF								
NH4EP	OFF								
NH4POM	OFF								
NH4DOM	OFF								
NH4OM	OFF								
NH4SED	OFF								
NH4SOD	OFF								
NO3DEN	OFF								
NO3AG	OFF								
NO3EG	OFF								
NO3SED	OFF								
DSIAG	OFF								
DSIEG	OFF								
DSIPIS	OFF								
DSISED	OFF								

```
DSISOD       OFF
DSISET       OFF
PSIAM        OFF
PSINET       OFF
PSIDK        OFF
FESET        OFF
FESED        OFF
LDOMDK       OFF
LRDOM        OFF
RDOMDK       OFF
LDOMAP       OFF
LDOMEP       OFF
LPOMDK       OFF
LRPOM        OFF
RPOMDK       OFF
LPOMAP       OFF
LPOMEP       OFF
LPOMSET      OFF
RPOMSET      OFF
CBODDK       OFF
DOAP         OFF
DOAR         OFF
DOEP         OFF
DOER         OFF
DOPOM        OFF
DODOM        OFF
DOOM         OFF
DONITR       OFF
DOCBOD       OFF
DOREAR       OFF
DOSED        OFF
DOSOD        OFF
TICAG        OFF
TICEG        OFF
SEDDK        OFF
SEDAS        OFF
SEDLPOM      OFF
SEDSET       OFF
SODDK        OFF

CST ICON   C2IWB   C2IWB   C2IWB   C2IWB   C2IWB   C2IWB   C2IWB   C2IWB   C2IWB
TDS      0.00000
Gen1     0.00000
Gen2     0.00000
Gen3     0.00000
Gen4     0.00000
Gen5     0.00000
ISS1     0.00000
PO4      0.03000
NH4      0.01000
NO3      0.30000
DSI      0.00000
PSI      0.00000
FE       0.00000
LDOM     0.10000
RDOM     0.10000
LPOM     0.10000
RPOM     0.10000
BOD1     0.00000
BOD2     0.00000
BOD3     0.00000
BOD4     0.00000
BOD5     0.00000
ALG1     0.10000
DO       12.0000
TIC      5.00000
ALK      19.8000
```

```
ZOO1        0.1000
LDOM_P      0.0005
RDOM_P      0.0005
LPOM_P      0.0005
RPOM_P      0.0005
LDOM_N      0.0080
RDOM_N      0.0080
LPOM_N      0.0080
RPOM_N      0.0080

CST PRIN   CPRWBC   CPRWBC   CPRWBC   CPRWBC   CPRWBC   CPRWBC   CPRWBC   CPRWBC   CPRWBC
TDS           OFF
Gen1           ON
Gen2          OFF
Gen3          OFF
Gen4          OFF
Gen5          OFF
ISS1          OFF
PO4           OFF
NH4           OFF
NO3           OFF
DSI           OFF
PSI           OFF
FE            OFF
LDOM          OFF
RDOM          OFF
LPOM          OFF
RPOM          OFF
BOD1          OFF
BOD2          OFF
BOD3          OFF
BOD4          OFF
BOD5          OFF
ALG1          OFF
DO            OFF
TIC           OFF
ALK           OFF
ZOO1          OFF
LDOM_P        OFF
RDOM_P        OFF
LPOM_P        OFF
RPOM_P        OFF
LDOM_N        OFF
RDOM_N        OFF
LPOM_N        OFF
RPOM_N        OFF

CIN CON    CINBRC   CINBRC   CINBRC   CINBRC   CINBRC   CINBRC   CINBRC   CINBRC   CINBRC
TDS            ON
Gen1          OFF
Gen2           ON
Gen3           ON
Gen4           ON
Gen5           ON
ISS1           ON
PO4            ON
NH4            ON
NO3            ON
DSI           OFF
PSI           OFF
FE            OFF
LDOM           ON
RDOM           ON
LPOM           ON
RPOM           ON
BOD1           ON
BOD2           ON
BOD3           ON
```

```
BOD4            ON
BOD5            ON
ALG1            ON
DO              ON
TIC             ON
ALK             ON
ZOO1           OFF
LDOM_P         OFF
RDOM_P         OFF
LPOM_P         OFF
RPOM_P         OFF
LDOM_N         OFF
RDOM_N         OFF
LPOM_N         OFF
RPOM_N         OFF

CTR CON    CTRTRC  CTRTRC  CTRTRC  CTRTRC  CTRTRC  CTRTRC  CTRTRC  CTRTRC  CTRTRC
TDS             ON      ON
Gen1           OFF     OFF
Gen2            ON      ON
Gen3            ON      ON
Gen4            ON      ON
Gen5            ON      ON
ISS1            ON      ON
PO4             ON      ON
NH4             ON      ON
NO3             ON      ON
DSI            OFF     OFF
PSI            OFF     OFF
FE             OFF     OFF
LDOM            ON      ON
RDOM            ON      ON
LPOM            ON      ON
RPOM            ON      ON
BOD1            ON      ON
BOD2            ON      ON
BOD3            ON      ON
BOD4            ON      ON
BOD5            ON      ON
ALG1            ON      ON
DO              ON      ON
TIC             ON      ON
ALK             ON      ON
ZOO1           OFF     OFF
LDOM_P         OFF     OFF
RDOM_P         OFF     OFF
LPOM_P         OFF     OFF
RPOM_P         OFF     OFF
LDOM_N         OFF     OFF
RDOM_N         OFF     OFF
LPOM_N         OFF     OFF
RPOM_N         OFF     OFF

CDT CON    CDTBRC  CDTBRC  CDTBRC  CDTBRC  CDTBRC  CDTBRC  CDTBRC  CDTBRC  CDTBRC
TDS             ON
Gen1           OFF
Gen2            ON
Gen3            ON
Gen4            ON
Gen5            ON
ISS1            ON
PO4             ON
NH4             ON
NO3             ON
DSI            OFF
PSI            OFF
FE             OFF
```

```
LDOM            ON
RDOM            ON
LPOM            ON
RPOM            ON
BOD1            ON
BOD2            ON
BOD3            ON
BOD4            ON
BOD5            ON
ALG1            ON
DO              ON
TIC             ON
ALK             ON
ZOO1           OFF
LDOM_P         OFF
RDOM_P         OFF
LPOM_P         OFF
RPOM_P         OFF
LDOM_N         OFF
RDOM_N         OFF
LPOM_N         OFF
RPOM_N         OFF

CPR CON    CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC   CPRBRC
TDS             ON
Gen1           OFF
Gen2            ON
Gen3            ON
Gen4            ON
Gen5            ON
ISS1            ON
PO4             ON
NH4             ON
NO3             ON
DSI            OFF
PSI            OFF
FE             OFF
LDOM            ON
RDOM            ON
LPOM            ON
RPOM            ON
BOD1            ON
BOD2            ON
BOD3            ON
BOD4            ON
BOD5            ON
ALG1            ON
DO              ON
TIC             ON
ALK             ON
ZOO1           OFF
LDOM_P         OFF
RDOM_P         OFF
LPOM_P         OFF
RPOM_P         OFF
LDOM_N         OFF
RDOM_N         OFF
LPOM_N         OFF
RPOM_N         OFF

EX COEF     EXH2O     EXSS     EXOM     BETA      EXC     EXIC
WB 1      0.45000 0.01000 0.40000 0.45000      OFF      OFF

ALG EX        EXA      EXA      EXA      EXA      EXA      EXA
          0.10000

ZOO EX        EXZ      EXZ      EXZ      EXZ      EXZ      EXZ
              0.2      0.2      0.2
```

```
MACRO EX      EXM      EXM      EXM      EXM      EXM      EXM
           0.0100

GENERIC     CGQ10    CG0DK    CG1DK      CGS
CG 1      0.00000 -1.0000 0.00000 0.00000
CG 2      0.00000 0.00000 0.00000 0.00000
CG 3      1.04000 0.00000 0.50000 0.00000
CG 4      0.00000 0.00000 0.00000 0.00000
CG 5      0.00000 0.00000 0.00000 0.00000

S SOLIDS      SSS    SEDRC    TAUCR
SS1       1.50000      OFF     0.00

ALGAL RATE     AG       AR       AE       AM       AS     AHSP     AHSN    AHSSI     ASAT
ALG1      2.00000 0.12000 0.02000 0.05000 0.04000 0.00500 0.00500 0.00000 50.0000

ALGAL TEMP   AT1      AT2      AT3      AT4      AK1      AK2      AK3      AK4
ALG1      5.00000 12.0000 20.0000 30.0000 0.10000 0.99000 0.99000 0.10000

ALG STOI     ALGP     ALGN     ALGC    ALGSI    ACHLA    ALPOM    ANEQN     ANPR
ALG1      0.00500 0.08000 0.45000 0.00000 65.0000 0.80000        1 0.00100

EPIPHYTE     EPIC     EPIC     EPIC     EPIC     EPIC     EPIC     EPIC     EPIC     EPIC
EPI1          OFF

EPI PRIN     EPRC     EPRC     EPRC     EPRC     EPRC     EPRC     EPRC     EPRC     EPRC
EPI1          OFF

EPI INIT    EPICI    EPICI    EPICI    EPICI    EPICI    EPICI    EPICI    EPICI    EPICI
EPI1      10.0000

EPI RATE       EG       ER       EE       EM       EB     EHSP     EHSN    EHSSI
EPI1      2.00000 0.05000 0.02000 0.05000 0.01000 0.00200 0.00200 0.00000

EPI HALF     ESAT      EHS    ENEQN     ENPR
EPI1      50.0000 40.0000        2 0.00200

EPI TEMP      ET1      ET2      ET3      ET4      EK1      EK2      EK3      EK4
EPI1      2.00000 5.00000 20.0000 30.0000 0.10000 0.99000 0.99000 0.10000

EPI STOI       EP       EN       EC      ESI    ECHLA     EPOM
EPI1      0.00500 0.08000 0.45000 0.00000 65.0000 0.80000

ZOOP RATE      ZG       ZR       ZM     ZEFF    PREFP   ZOOMIN     ZS2P
Zoo1         1.50     0.10    0.010     0.50     0.50   0.0100     0.30

ZOOP ALGP   PREFA    PREFA    PREFA    PREFA    PREFA    PREFA    PREFA    PREFA    PREFA
Zoo1         1.00     0.50     0.50

ZOOP ZOOP   PREFZ    PREFZ    PREFZ    PREFZ    PREFZ    PREFZ    PREFZ    PREFZ    PREFZ
Zoo1         0.00     0.00     0.00

ZOOP TEMP     ZT1      ZT2      ZT3      ZT4      ZK1      ZK2      ZK3      ZK4
              0.0     15.0     20.0     36.0      0.1      0.9     0.98    0.100

ZOOP STOI      ZP       ZN       ZC
          0.01500 0.08000 0.45000

MACROPHYT MACWBC   MACWBC   MACWBC   MACWBC   MACWBC   MACWBC   MACWBC   MACWBC   MACWBC
Mac1           ON      OFF      OFF

MAC PRINT MPRWBC   MPRWBC   MPRWBC   MPRWBC   MPRWBC   MPRWBC   MPRWBC   MPRWBC   MPRWBC
Mac1           ON      OFF      OFF

MAC INI   MACWBCI MACWBCI MACWBCI MACWBCI MACWBCI MACWBCI MACWBCI MACWBCI MACWBCI
Mac1      0.00000        0.1      0.5
```

```
MAC RATE       MG       MR       MM     MSAT     MHSP     MHSN     MHSC     MPOM   LRPMAC
Mac 1        0.30     0.05     0.05     30.0      0.0      0.0      0.0      0.9      0.2

MAC SED      PSED     NSED
MAC 1         0.5      0.5

MAC DIST     MBMP     MMAX
Mac 1        40.0    500.0

MAC DRAG   CDSTEM      DWV     DMSA    ANORM
Mac 1         2.0      7e4     8.00     0.80

MAC TEMP       MT1      MT2      MT3      MT4      MK1      MK2      MK3      MK4
Mac 1          7.0     15.0     24.0     34.0      0.1     0.99     0.99     0.01

MAC STOICH     MP       MN       MC
Mac 1       0.005     0.08     0.45

DOM         LDOMDK   RDOMDK   LRDDK
WB 1       0.10000 0.00100 0.00100

POM         LPOMDK   RPOMDK   LRPDK     POMS
WB 1       0.08000 0.00100 0.00100 0.10000

OM STOIC     ORGP     ORGN     ORGC    ORGSI
WB 1       0.00500 0.08000 0.45000 0.18000

OM RATE      OMT1     OMT2     OMK1     OMK2
WB 1       4.00000 30.0000 0.10000 0.99000

CBOD          KBOD     TBOD     RBOD    CBODS
BOD 1      0.04180 1.01470 1.00000      0.0
BOD 2      0.13020 1.01470 1.00000      0.0
BOD 3      0.04690 1.01470 1.00000      0.0
BOD 4      0.08800 1.01470 1.00000      0.0
BOD 5      0.05000 1.01470 1.00000      0.0

CBOD STOIC   BODP     BODN     BODC
BOD 1      0.00500 0.08000 0.45000
BOD 2      0.00500 0.08000 0.45000
BOD 3      0.00500 0.08000 0.45000
BOD 4      0.00500 0.08000 0.45000
BOD 5      0.00500 0.08000 0.45000

PHOSPHOR     PO4R    PARTP
WB 1       0.00100 0.00000

AMMONIUM     NH4R    NH4DK
WB 1       0.00100 0.50000

NH4 RATE    NH4T1    NH4T2    NH4K1    NH4K2
WB 1       5.00000 25.0000 0.10000 0.99000

NITRATE     NO3DK     NO3S
WB 1       0.05000 0.00000

NO3 RATE    NO3T1    NO3T2    NO3K1    NO3K2
WB 1       5.00000 25.0000 0.10000 0.99000

SILICA       DSIR     PSIS    PSIDK   PARTSI
WB 1       0.10000 0.00000 0.30000 0.20000

IRON          FER      FES
WB 1       0.10000 0.00000

SED CO2      CO2R
WB 1       0.10000
```

```
STOICH 1   O2NH4    O2OM
WB 1     4.57000 1.40000

STOICH 2    O2AR    O2AG
ALG1     1.10000 1.40000

STOICH 3    O2ER    O2EG
EPI1     1.10000 1.40000

STOICH 4    O2ZR
ZOO1     1.10000

STOICH 5    O2MR    O2MG
MAC1          1.1     1.4

O2 LIMIT     KDO
         0.10000

SEDIMENT    SEDC  SEDPRC   SEDCI    SEDK     SEDS    FSOD    FSED    SEDBR
WB 1          ON      ON 0.00000 0.10000      0.1 1.00000 1.00000      0.2

SOD RATE   SODT1   SODT2   SODK1   SODK2
WB 1     4.00000 30.0000 0.10000 0.99000

S DEMAND     SOD     SOD     SOD     SOD     SOD     SOD     SOD     SOD     SOD
             0.6     0.6     0.6     0.6     0.6     0.6     0.6     0.6     0.6
             0.6     0.6     0.6     0.6     0.6     0.6     0.6     0.6     0.6
             0.6     0.6     0.6     0.6     0.6     0.6     0.6     0.6     0.6
             0.6     0.6     0.6     0.6     0.6     0.6     0.6     0.6     0.6
             0.6

REAERATION  TYPE    EQN#   COEF1   COEF2   COEF3   COEF4
WB1         LAKE       6
```

<u>Lines removed from the V3.2 control file:</u> These are a result of eliminating the pumpback and line printer settings.

Here is the part of the V3.2 control file that was deleted:

```
DST TRIB    DTRC
Br 1          ON
Br 2          ON
Br 3         OFF
Br 4         OFF
Br 5         OFF

PUMPBACK     JBG     KTG     KBG     JBP     KTP     KBP
               0

PRINTER      LJC
              IV

HYD PRINT HPRWBC  HPRWBC  HPRWBC  HPRWBC  HPRWBC  HPRWBC  HPRWBC  HPRWBC  HPRWBC
NVIOL        OFF     OFF
U             ON      ON
```

<u>Graph.npt file changes.</u> These changes are a result of the new state variables in W2 and are highlighted below.

```
Hydrodynamic, constituent, and derived constituent names, formats, multipliers, and array
viewer controls

.....................HNAME...................     FMTH    HMULT    HMIN    HMAX    HPLTC
#
```

```
Timestep violations [NVIOL]                    (I10)     1.0    -1.0     1.0     OFF
1
Horizontal velocity [U], m/s                (1PE10.1)     1.0  -.1000    0.15     OFF
2
Vertical velocity [W], m/s                  (1PE10.1)     1.0  -.1E-6   -0.01     OFF
3
Temperature [T1], <o/>C                       (F10.2)     1.0   -10.0   -26.0      ON
4
Density [RHO], g/m^3                          (F10.3)     1.0   997.0  1005.0     OFF
5
Vertical eddy viscosity [AZ], m^2/s           (F10.3)     1.0  -1E-08    0.01     OFF
6
Velocity shear stress [SHEAR], 1/s^2          (F10.3)     1.0  -1E-08    0.01     OFF
7
Internal shear [ST], m^3/s                    (F10.3)     1.0  -1E-08    0.01     OFF
8
Bottom shear [SB], m^3/s                      (F10.3)     1.0  -1E-08    0.01     OFF
9
Longitudinal momentum [ADMX], m^3/s           (F10.3)     1.0  -1E-08    0.01     OFF
10
Longitudinal momentum [DM], m^3/s             (F10.3)     1.0  -1E-08    0.01     OFF
11
Horizontal density gradient [HDG], m^3/s      (F10.3)     1.0  -1E-08    0.01     OFF
12
Vertical momentum [ADMZ], m^3/s               (F10.3)     1.0  -1E-08    0.01     OFF
13
Horizontal pressure gradient [HPG], m^3/s     (F10.3)     1.0  -1E-08    10.0     OFF
14
Gravity term channel slope [GRAV], m^3/s      (F10.3)     1.0     0.0     0.0     OFF
15

.....................CNAME.....................    FMTC   CMULT    CMIN    CMAX   CPLTC
#
TDS, g/m^3                                    (F10.3)     1.0    -1.0   200.0     OFF
1
Age, days                                     (F10.3)     1.0    -1.0  -200.0      ON
2
Tracer, g/m^3                                 (F10.3)     1.0 -20.000   100.0     OFF
3
Bacteria, col/100ml                           (F10.3)     1.0 -20.000   100.0     OFF
4
Conductivity, mhos                            (F10.3)     1.0 -20.000   100.0     OFF
5
Chloride, mg/l                                (F10.3)     1.0 -20.000   100.0     OFF
6
ISS, g/m^3                                    (F10.3)     1.0 -20.000   100.0     OFF
7
Phosphate, g/m^3                              (F10.3)  1000.0    -1.0   500.0     OFF
8
Ammonium, g/m^3                               (F10.3)  1000.0 -0.1000   300.0     OFF
9
Nitrate-Nitrite, g/m^3                        (F10.3)     1.0 -0.1000     5.0     OFF
10
Dissolved silica, g/m^3                       (F10.3)     1.0    -1.0    10.0     OFF
11
Particulate silica, g/m^3                     (F10.3)     1.0 -0.2000    15.0     OFF
12
Total iron, g/m^3                             (F10.3)     1.0 -0.1000     2.0     OFF
13
Labile DOM, g/m^3                             (F10.3)     1.0 -0.1000    -3.0     OFF
14
Refractory DOM, g/m^3                         (F10.3)     1.0 -0.1000    -4.0     OFF
15
Labile POM, g/m^3                             (F10.3)     1.0 -0.1000    -3.0     OFF
16
Refractory POM, g/m^3                         (F10.3)     1.0 -0.1000    -4.0     OFF
17
```

```
CBOD1, g/m^3                                (F10.3)     1.0 -0.0100     3.0     OFF
18
CBOD2, g/m^3                                (F10.3)     1.0 -0.0100     3.0     OFF
19
CBOD3, g/m^3                                (F10.3)     1.0 -0.0100     3.0     OFF
20
CBOD4, g/m^3                                (F10.3)     1.0 -0.0100     3.0     OFF
21
CBOD5, g/m^3                                (F10.3)     1.0 -0.0100     3.0     OFF
22
Algae, g/m^3                                (F10.3)     1.0 -0.0100     3.0     OFF
23
Dissolved oxygen, g/m^3                     (F10.3)     1.0 -0.0100    -1.0     OFF
24
Inorganic carbon, g/m^3                     (F10.3)     1.0 -0.0100     3.0     OFF
25
Alkalinity, g/m^3                           (F10.3)     1.0 -0.0100     3.0     OFF
26
zooplankton1, mg/m^3                        (g10.3)  1000.0 -0.0100     1.0     OFF
27
LDOM P, mg/m^3                              (g10.3)  1000.0     0.0     1.0     OFF
28
RDOM P, mg/m^3                              (g10.3)  1000.0     0.0     1.0     OFF
29
LPOM P, mg/m^3                              (g10.3)  1000.0     0.0     1.0     OFF
30
RPOM P, mg/m^3                              (g10.3)  1000.0     0.0     1.0     OFF
31
LDOM N, mg/m^3                              (g10.3)  1000.0     0.0     1.0     OFF
32
RDOM N, mg/m^3                              (g10.3)  1000.0     0.0     1.0     OFF
33
LPOM N, mg/m^3                              (g10.3)  1000.0     0.0     1.0     OFF
34
RPOM N, mg/m^3                              (g10.3)  1000.0     0.0     1.0     OFF
35

.....................CDNAME.....................   FMTCD  CDMULT    CDMIN    CDMAX  CDPLTC
#
Dissolved organic carbon, g/m^3             (F10.3)     1.0     -1.0     25.0     OFF
1
Particulate organic carbon, g/m^3           (F10.3)     1.0     -1.0     50.0     OFF
2
Total organic carbon, g/m^3                 (F10.3)     1.0     -1.0     25.0     OFF
3
Dissolved organic nitrogen, g/m^3           (F10.3)     1.0     -1.0     25.0     OFF
4
Particulate organic nitrogen, g/m^3         (F10.3)     1.0     -1.0     25.0     OFF
5
Total organic nitrogen, g/m^3               (F10.3)     1.0     -1.0     50.0     OFF
6
Total Kheldahl Nitrogen, g/m^3              (F10.3)     1.0     -1.0     15.0     OFF
7
Total nitrogen, g/m^3                       (F10.3)     1.0     -1.0     15.0     OFF
8
Dissolved organic phosphorus, mg/m^3        (F10.3)  1000.0     -1.0     25.0     OFF
9
Particulate organic phosphorus, mg/m^3      (F10.3)  1000.0     -1.0     -1.0     OFF
10
Total organic phosphorus, mg/m^3            (F10.3)  1000.0     -1.0      5.0     OFF
11
Total phosphorus, mg/m^3                    (F10.3)  1000.0     -1.0     20.0     OFF
12
Algal production, g/m^2/day                 (F10.3)     1.0     -1.0      5.0     OFF
13
Chlorophyll a, mg/m^3                       (F10.3)     1.0     -5.0    145.0     OFF
14
```

Total algae, g/m^3	(F10.3)	1.0	-1.0	60.0	OFF
15					
Oxygen % Gas Saturation	(F10.3)	1.0	-1.0	50.0	OFF
16					
Total suspended Solids, g/m^3	(F10.3)	1.0	-1.0	5.0	OFF
17					
Total Inorganic Suspended Solids,g/m^3	(F10.3)	1.0	-1.0	20.0	OFF
18					
Carbonaceous Ultimate BOD, g/m^3	(F10.3)	1.0	5.0	9.0	OFF
19					
pH	(F10.3)	1.0	-1.0	10.0	OFF
20					
CO2	(F10.3)	1.0	-1.0	10.0	OFF
21					
HCO3	(F10.3)	1.0	-1.0	10.0	OFF
22					
CO3	(F10.3)	0.0	0.0	0.0	OFF
23					

Differences between Version 3.1 and Version 3.2

There are minor differences in 2 input files between the 2 versions: **w2_con.npt** and the **graph.npt** file. All other files are the same between the 2 versions.

w2_con.npt

The only section where there is a slight difference in the control file is in the section where the inorganic suspended solids group settling velocities are entered. In Version 3.1, this section looks like this:

```
ALG EX       EXA     EXA     EXA     EXA     EXA     EXA
         0.10000

GENERIC    CGQ10   CG0DK   CG1DK     CGS
CG 1     0.00000 -1.0000 0.00000 0.00000
CG 2     0.00000 0.00000 0.00000 0.00000
CG 3     1.04000 0.00000 0.50000 0.00000
CG 4     0.00000 0.00000 0.00000 0.00000
CG 5     0.00000 0.00000 0.00000 0.00000

S SOLIDS     SSS     SSS     SSS     SSS     SSS     SSS     SSS     SSS     SSS
         1.50000

ALGAL RATE    AG      AR      AE      AM      AS    AHSP    AHSN   AHSSI    ASAT
ALG1     2.00000 0.12000 0.02000 0.05000 0.04000 0.00500 0.00500 0.00000 50.0000
```

In Version 3.2, there is now a sediment resuspension capability for wind driven resuspension along the shores of lakes and reservoirs. The Version 3.2 control file has the following lines in this same section of the control file:

```
ALG EX       EXA     EXA     EXA     EXA     EXA     EXA
         0.10000

GENERIC    CGQ10   CG0DK   CG1DK     CGS
CG 1     0.00000 -1.0000 0.00000 0.00000
CG 2     0.00000 0.00000 0.00000 0.00000
CG 3     1.04000 0.00000 0.50000 0.00000
CG 4     0.00000 0.00000 0.00000 0.00000
CG 5     0.00000 0.00000 0.00000 0.00000

S SOLIDS     SSS   SEDRC   TAUCR
SS1      1.50000     OFF    0.00

ALGAL RATE    AG      AR      AE      AM      AS    AHSP    AHSN   AHSSI    ASAT
ALG1     2.00000 0.12000 0.02000 0.05000 0.04000 0.00500 0.00500 0.00000 50.0000
```

For Version 3.2, SSS is the settling velocity for particle group 1, SEDRC is the control which turns ON or OFF sediment resuspension, and TAUCR is the critical shear stress at which resuspension occurs. For Version 3.2, each line represents 1 SS group, while in Version 3.1, each group settling velocity is in the next 8 columns moving across the page.

graph.npt

The graph file controls output formatting and the graphing parameters used in Array Viewer (only for the PC platform). The files have been rearranged significantly. A Version 3.1 graph file is shown below:

```
Constituent, hydrodynamic, and derived constituent names, formats, multipliers, and array
viewer controls

.....................CNAME.....................   CMULT    CMIN    CMAX   CPLTC       #
TDS g/m^3 or Salinity kg/m^3                    1.00000 -1.0000 200.000     OFF       1
Generic Constituent,g/m^3, #1                   1.00000 -1.0000 -200.00      ON       2
Generic Constituent,g/m^3, #2                   1.00000 -1.0000 1000.00     OFF       3
Generic Constituent,g/m^3, #3                   1.00000 -1.0000 5.00000     OFF       4
Generic Constituent,g/m^3, #4                   1.00000 -1.0000 -300.00     OFF       5
Generic Constituent,g/m^3, #5                   1.00000 -1.0000 -3.0000     OFF       6
Suspended solids,g/m^3, #1                      1.00000 -1.0000 15.0000     OFF       7
Phosphate, g/m^3                                1000.00 -1.0000 -50.000     OFF       8
Ammonium,  g/m^3                                1000.00 -0.1000 -300.00     OFF       9
Nitrate-Nitrite, g/m^3                          1.00000 -0.1000 -5.0000     OFF      10
Dissolved silica, g/m^3                         1.00000 -1.0000 10.0000     OFF      11
Particulate silica, g/m^3                       1.00000 -0.2000 15.0000     OFF      12
Total iron, g/m^3                               1.00000 -0.1000 2.00000     OFF      13
Labile DOM, g/m^3                               1.00000 -0.1000 -3.0000     OFF      14
Refractory DOM, g/m^3                           1.00000 -0.1000 4.00000     OFF      15
Labile POM, g/m^3                               1.00000 -0.1000 3.00000     OFF      16
Refractory POM, g/m^3                           1.00000 -0.1000 4.00000     OFF      17
CBOD, g/m^3,     #1                             1.00000 -0.1000 10.0000     OFF      18
CBOD, g/m^3,     #2                             1.00000 -0.1000 10.0000     OFF      19
CBOD, g/m^3,     #3                             1.00000 -0.1000 10.0000     OFF      20
CBOD, g/m^3,     #4                             1.00000 -0.1000 10.0000     OFF      21
CBOD, g/m^3,     #5                             1.00000 -0.1000 10.0000     OFF      22
Algae,  g/m^3,      #1                          1.00000 -0.0100 -3.0000     OFF      23
Dissolved oxygen, g/m^3                         1.00000 -2.0000 15.0000     OFF      24
Inorganic carbon, g/m^3                         1.00000 -1.0000 10.0000     OFF      25
Alkalinity, g/m^3                               1.00000 -1.0000 200.000     OFF      26

.....................HNAME.....................     HFMT    HMIN    HMAX   HPLTC       #
Timestep violations [NVIOL]                     (F10.0) -1.0000  100000     OFF       1
Horizontal velocity [U], m/s                   (1PE10.1) -0.0100 0.10000      ON       2
Vertical velocity [W], m/s                     (1PE10.1)-.10E-06 0.01000     OFF       3
Temperature [T1], <o/>C                          (F10.2) -2.0000 -30.000      ON       4
Density [RHO], g/m^3                             (F10.2) 997.000 1005.00     OFF       5
Vertical eddy viscosity [AZ], m^2/s            (1PE10.1)  -1E-08 0.00100     OFF       6
Velocity shear stress [SHEAR], 1/s^2           (1PE10.1)  -1E-08 0.01000     OFF       7
Internal shear [ST], m^3/s                     (1PE10.1)  -1E-08 0.01000     OFF       8
Bottom shear [SB], m^3/s                       (1PE10.1)  -1E-08 0.01000     OFF       9
Longitudinal momentum [ADMX], m^3/s            (1PE10.1)  -1E-08 0.01000     OFF      10
Longitudinal momentum [DM], m^3/s              (1PE10.1)  -1E-08 0.01000     OFF      11
Horizontal density gradient [HDG], m^3/s       (1PE10.1)  -1E-08 0.01000     OFF      12
Vertical momentum [ADMZ], m^3/s                (1PE10.1)  -1E-08 0.01000     OFF      13
Horizontal pressure gradient [HPG], m^3/s      (1PE10.1)  -1E-08 0.01000     OFF      14
Gravity term channel slope [GRAV], m^3/s       (1PE10.1)  -1E-08 10.0000     OFF      15

.....................CDNAME.....................  CDMULT   CDMIN   CDMAX  CDPLTC       #
Dissolved organic carbon, g/m^3                 1.00000 -1.0000 3.00000     OFF       1
Particulate organic carbon, g/m^3               1.00000 -1.0000 25.0000     OFF       2
Total organic carbon, g/m^3                     1.00000 -1.0000 50.0000     OFF       3
Dissolved organic nitrogen, g/m^3               1.00000 -1.0000 25.0000     OFF       4
Particulate organic nitrogen, g/m^3             1.00000 -1.0000 25.0000     OFF       5
Total organic nitrogen, g/m^3                   1.00000 -1.0000 25.0000     OFF       6
Total Kheldahl Nitrogen, g/m^3                  1.00000 -1.0000 5.00000     OFF       7
Total nitrogen, g/m^3                           1.00000 -1.0000 50.0000     OFF       8
Dissolved organic phosphorus, mg/m^3            1000.00 -1.0000 15.0000     OFF       9
Particulate organic phosphorus, mg/m^3          1000.00 -1.0000 15.0000     OFF      10
Total organic phosphorus, mg/m^3                1000.00 -1.0000 25.0000     OFF      11
Total phosphorus, mg/m^3                        1000.00 -1.0000 -1.0000     OFF      12
Algal production, g/m^2/day                     1.00000 -1.0000 5.00000     OFF      13
```

```
Chlorophyll a, mg/m^3                          1000.00 -1.0000 -70.000     OFF      14
Total algae, g/m^3                             1.00000 -1.0000 5.00000     OFF      15
Oxygen % Gas Saturation                        1.00000 -5.0000 145.000     OFF      16
Total suspended Solids, g/m^3                  1.00000 -1.0000 60.0000     OFF      17
Total Inorganic Suspended Solids,g/m^3         1.00000 -1.0000 50.0000     OFF      18
Carbonaceous Ultimate BOD, g/m^3               1.00000 -1.0000 20.0000     OFF      19
pH                                             1.00000 6.00000 9.00000     OFF      20
CO2                                            1.00000 -1.0000 10.0000     OFF      21
HCO3                                           1.00000 -1.0000 10.0000     OFF      22
CO3                                            1.00000 -1.0000 10.0000     OFF      23
```

An example of the same graph file but for Version 3.2 is shown below:

```
Hydrodynamic, constituent, and derived constituent names, formats, multipliers, and array
viewer controls

.....................HNAME...................     FMTH    HMULT     HMIN     HMAX   HPLTC
#
Timestep violations [NVIOL]                        (I10)      1.0     -1.0      1.0     OFF
1
Horizontal velocity [U], m/s                     (Z10.8)      1.0  -.1000     0.15      ON
2
Vertical velocity [W], m/s                       (Z10.8)      1.0  -.1E-6   -0.01     OFF
3
Temperature [T1], <o/>C                          (Z10.8)      1.0   -10.0   -26.0      ON
4
Density [RHO], g/m^3                             (Z10.8)      1.0   997.0  1005.0     OFF
5
Vertical eddy viscosity [AZ], m^2/s              (Z10.8)      1.0  -1E-08    0.01     OFF
6
Velocity shear stress [SHEAR], 1/s^2             (Z10.8)      1.0  -1E-08    0.01     OFF
7
Internal shear [ST], m^3/s                       (Z10.8)      1.0  -1E-08    0.01     OFF
8
Bottom shear [SB], m^3/s                         (Z10.8)      1.0  -1E-08    0.01     OFF
9
Longitudinal momentum [ADMX], m^3/s              (Z10.8)      1.0  -1E-08    0.01     OFF
10
Longitudinal momentum [DM], m^3/s                (Z10.8)      1.0  -1E-08    0.01     OFF
11
Horizontal density gradient [HDG], m^3/s         (Z10.8)      1.0  -1E-08    0.01     OFF
12
Vertical momentum [ADMZ], m^3/s                  (Z10.8)      1.0  -1E-08    0.01     OFF
13
Horizontal pressure gradient [HPG], m^3/s        (Z10.8)      1.0  -1E-08    10.0     OFF
14
Gravity term channel slope [GRAV], m^3/s         (Z10.8)      1.0     0.0     0.0     OFF
15

.....................CNAME...................     FMTC    CMULT     CMIN     CMAX   CPLTC
#
TDS, g/m^3                                       (Z10.8)      1.0     -1.0   200.0     OFF
1
Age, days                                        (Z10.8)      1.0     -1.0  -200.0      ON
2
Tracer, g/m^3                                    (Z10.8)      1.0 -20.000   100.0     OFF
3
Bacteria, col/100ml                              (Z10.8)      1.0 -20.000   100.0     OFF
4
Conductivity, mhos                               (Z10.8)      1.0 -20.000   100.0     OFF
5
Chloride, mg/l                                   (Z10.8)      1.0 -20.000   100.0     OFF
6
ISS, g/m^3                                       (Z10.8)      1.0 -20.000   100.0     OFF
7
```

```
Phosphate, g/m^3                          (Z10.8)  1000.0    -1.0   500.0     OFF
8
Ammonium, g/m^3                           (Z10.8)  1000.0 -0.1000   300.0     OFF
9
Nitrate-Nitrite, g/m^3                    (Z10.8)     1.0 -0.1000     5.0     OFF
10
Dissolved silica, g/m^3                   (Z10.8)     1.0    -1.0    10.0     OFF
11
Particulate silica, g/m^3                 (Z10.8)     1.0 -0.2000    15.0     OFF
12
Total iron, g/m^3                         (Z10.8)     1.0 -0.1000     2.0     OFF
13
Labile DOM, g/m^3                         (Z10.8)     1.0 -0.1000    -3.0     OFF
14
Refractory DOM, g/m^3                     (Z10.8)     1.0 -0.1000    -4.0     OFF
15
Labile POM, g/m^3                         (Z10.8)     1.0 -0.1000    -3.0     OFF
16
Refractory POM, g/m^3                     (Z10.8)     1.0 -0.1000    -4.0     OFF
17
CBOD1, g/m^3                              (Z10.8)     1.0 -0.0100     3.0     OFF
18
CBOD2, g/m^3                              (Z10.8)     1.0 -0.0100     3.0     OFF
19
CBOD3, g/m^3                              (Z10.8)     1.0 -0.0100     3.0     OFF
20
CBOD4, g/m^3                              (Z10.8)     1.0 -0.0100     3.0     OFF
21
CBOD5, g/m^3                              (Z10.8)     1.0 -0.0100     3.0     OFF
22
Algae, g/m^3                              (Z10.8)     1.0 -0.0100     3.0     OFF
23
Dissolved oxygen, g/m^3                   (Z10.8)     1.0 -0.0100    -1.0     OFF
24
Inorganic carbon, g/m^3                   (Z10.8)     1.0 -0.0100     3.0     OFF
25
Alkalinity, g/m^3                         (Z10.8)     1.0 -0.0100     3.0     OFF
26

.....................CDNAME...................   FMTCD  CDMULT   CDMIN   CDMAX  CDPLTC
#
Dissolved organic carbon, g/m^3           (F10.3)     1.0    -1.0    25.0     OFF
1
Particulate organic carbon, g/m^3         (F10.3)     1.0    -1.0    50.0     OFF
2
Total organic carbon, g/m^3               (F10.3)     1.0    -1.0    25.0     OFF
3
Dissolved organic nitrogen, g/m^3         (F10.3)     1.0    -1.0    25.0     OFF
4
Particulate organic nitrogen, g/m^3       (F10.3)     1.0    -1.0    25.0     OFF
5
Total organic nitrogen, g/m^3             (F10.3)     1.0    -1.0    50.0     OFF
6
Total Kheldahl Nitrogen, g/m^3            (F10.3)     1.0    -1.0    15.0     OFF
7
Total nitrogen, g/m^3                     (F10.3)     1.0    -1.0    15.0     OFF
8
Dissolved organic phosphorus, mg/m^3      (F10.3)  1000.0    -1.0    25.0     OFF
9
Particulate organic phosphorus, mg/m^3    (F10.3)  1000.0    -1.0    -1.0     OFF
10
Total organic phosphorus, mg/m^3          (F10.3)  1000.0    -1.0     5.0     OFF
11
Total phosphorus, mg/m^3                  (F10.3)  1000.0    -1.0    20.0     OFF
12
Algal production, g/m^2/day               (F10.3)     1.0    -1.0     5.0     OFF
13
```

```
Chlorophyll a, mg/m^3                          (F10.3)     1.0    -5.0   145.0     OFF
14
Total algae, g/m^3                             (F10.3)     1.0    -1.0    60.0     OFF
15
Oxygen % Gas Saturation                        (F10.3)     1.0    -1.0    50.0     OFF
16
Total suspended Solids, g/m^3                  (F10.3)     1.0    -1.0     5.0     OFF
17
Total Inorganic Suspended Solids,g/m^3         (F10.3)     1.0    -1.0    20.0     OFF
18
Carbonaceous Ultimate BOD, g/m^3               (F10.3)     1.0     5.0     9.0     OFF
19
pH                                             (F10.3)     1.0    -1.0    10.0     OFF
20
CO2                                            (F10.3)     1.0    -1.0    10.0     OFF
21
HCO3                                           (F10.3)     1.0    -1.0    10.0     OFF
22
CO3                                            (F10.3)     0.0     0.0     0.0     OFF
23
```

In Version 3.2, the user has format control of all output variables, as well as MULT control (see User Manual). In Version 3.1, some groups had one but not the other. Also, in Version 3.2, the groups (HNAME, CNAME, CDNAME) were reordered.

11. Appendix B: BUG FIXES AND ENHANCEMENTS BETWEEN VERSIONS

There have been many updates and bug fixes between model versions. Even though some model updates have not been documented, we have tried to be diligent in outlining code updates since Version 3.7 between model versions. We have included below a series of tables with code fixes for multiple versions of CE-QUAL-W2 as a reference to earlier versions.

W2 V4.2 Bug Fixes, Enhancements, and User Manual Changes

Table 3 shows a list of model bug fixes since the prior release of CE-QUAL-W2 Version 4.1. Note that some of these fixes were documented before the first release of Version 4.2.

Table 3. List of bug fixes and enhancement code changes since CE-QUAL-W2 Version 4.2 was released. Note that shaded areas toggle between release versions.

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
1	W2	Particle tracking	Fixed a bug when a particle was in the "air" above the water surface when in a river a 'deep slot' was added to the river bathymetry to keep it hydrated. Also, fixed a reflection error off the surface for vertical movement of the particle.	12/26/2018
2	W2	Particle tracking	For file output for finalparticle.csv, adjusted header so that it would be general for any number of monitoring stations. Previously the header was hard-wired to write only 3 monitoring locations in the title. This does not affect prior model output information only the title header.	1/3/2019
3	PREW2	Pipe invert	The preprocessor gave a 'false' error for an invert elevation being below the grid in some rare cases. This has been fixed. The model was not affected.	1/21/2019
4	W2	TN	There was a bug in the calculation of TN when large concentrations of zooplankton were present. If zooplankton were not simulated or they were a small population, there would be no impact of this TN bug. Bug fixed.	1/29/2019

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
5	W2	Epiphyton periphyton burial and conversion to LPOM and sediments	The User Manual showed that the epiphyton parameter EB, burial rate, was in units of m/day. The model implemented this and also computed the cell layer burial rate as EB*EC (concentration of biomass per cell volume) * Surface area/Volume of a cell or EB*EC/H where H is the layer thickness. In reality though it should be the thickness of the periphyton layer. But that layer thickness is not predicted by the model. Hence, the decision was to change the burial rate to units of 1/day such that the loss of epiphyton by burial would follow a first order decay process (similar to the first order sediment model) as EB*EC. Hence, this burial rate is no longer a function of the grid. Also, there was the conversion of organic matter and nutrients at death to the sediment P, N and C compartments whereas they should go directly to LPOM first. Hence only burial goes directly into the sediment compartments.	3/5/2019
6	W2	Output files	Code was written to print the initial condition in output files at time t=0 at the start of the simulation.	3/5/2019
7	W2	Restart with Sediment Diagenesis	Prior to this date, the restart option did not work with sediment diagenesis turned ON. This enhancement has been coded and debugged and is now working.	7/1/2019
8	W2	Dynamic loading	This is a new feature in CE-QUAL-W2 and applies to linear waterbodies in series. For example, if one has a river system with 9 waterbodies, the model user can break the model into 9 separate models and run them all in parallel where the downstream model dynamically updates its boundary conditions as the upstream model moves forward in time. This has resulted in significant time savings for model runs (90%).	7/1/2019
9	W2	Sediment Diagenesis	Output files were updated to write csv files that can be plotted easily in Excel. The older output files for sediment diagenesis were hard to graph formatted text output files. All internal writes for warnings are now written to the W2 warning file, w2.wrn, and all errors are written to the w2.err output file.	7/1/2019
10	W2	Sediment Diagenesis	Bug fixes were made to the scour section of the model. The code had several errors based on the documentation from CEMA. These have been fixed and synchronized with the description in the CEMA sediment diagenesis report. Thanks to Lindsay Bearup at the USBR! Also, the scour model was not set-up for both Chezy and Manning's friction factors. This code was generalized.	7/1/2019
11	W2	Output files	Output files were not initialized properly for w2.wrn during a restart. This was fixed allowing the w2.wrn file to be appended to rather than over-written.	7/1/2019

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
12	W2	Code updates	Pointers were allocated memory in the ALLOCATE command. This was non-standard Fortran usage and was fixed. There were extra calls to Kinetic_Rates and Temperature_Rates subroutines that were unnecessary during layer addition and in the INIT subroutine.	7/1/2019
13	W2	TDG	A new algorithm for TDG production at spillways, SYSTDG, was implemented in Version 4.2. This is a more detailed TDG correlation equation compared with the existing algorithms in Version 4.1 and before. The primary application was for the Columbia and Snake River dams. A separate technical memo is included with the User Manual on this new process.	7/1/2019
14	W2	opt to csv	Flux output files were changed from a file type opt to csv to facilitate graphing in Excel. Structure output files for the auto port selection were changed from opt to csv.	7/1/2019
15	W2	Contour output	The Tecplot and regular Contour output was not working for cases when branches went inactive. This has been fixed.	7/1/2019
16	W2	Sediment diagenesis	The input file for sediment diagenesis has been changed from w2_CEMA_input.npt to w2_diagenesis.npt for clarity of naming files. All output files have also been changed to include 'Diagenesis' as the first word and eliminating 'CEMA'. For example the file CEMALogFile.opt was changed to DiagenesisLogFile.opt.	7/1/2019

17	W2	Withdrawal	In the withdrawal subroutine, the kt index needed to be defined twice. Below is an example of the fix in 2 places:
			(1)
			`ELR = SINA(JB)*DLX(ID)*0.5 ! CB 10/14/11`
			`WSEL = ELWS(ID)-ELR ! CB 10/14/11`
			`kt=ktwb(jw) ! cb 07/24/19`
			`CALL DOWNSTREAM_WITHDRAWAL_ESTIMATE(JSTSPLT(J,1),TEMPTOP,ESTR(JSTSPLT(J,1),TSPLTJB(J)))`
			(2)
			`WSEL = ELWS(IWD(JWD))-ELR ! CB 10/14/11`
			`I=IWD(JWD)`
			`kt=ktwb(jjw) ! cb 07/24/19`
			`CALL LATERAL_WITHDRAWAL_ESTIMATE(JSTSPLT(J,1),TEMPTOP,EWD(JSTSPLT(J,1)))`
				8/1/2019

18	W2	Branch inactive	The BR_INACTIVE flag that skips output in a branch that was inactive was dimensioned with the wrong variable for the CPL output (Tecplot output). This has been corrected.	8/27/2019
19	W2	Tecplot Branch	There is a new input file to specify what branches the user wants for Tecplot output, called TecplotBr.csv. This allows the user to only pick some of the branches rather than all of them for Tecplot output.	8/27/2019

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added

20	Prew2	False warning	A false warning was sometimes activated for pipes for DYNPIPE when in fact was ON or OFF as required. This was fixed. Below is final code fix:
			`IF ((DYNPIPE(JP) /= '  ON') .AND. (DYNPIPE(JP) /= '  OFF')) THEN`
			`CALL ERRORS`
			`WRITE (ERR,FMTI) 'Pipe DYNAMIC PIPE control [DYNPIPE='//DYNPIPE(JP)(4:8)//'] must be either "ON" or "OFF" for pipe`
				8/27/2019

21	W2	str_brX.opt	Structure output file, str_brX.opt, for automatic port selection was changed from a text delimited *.opt file to a comma delimited *.csv file	8/28/2019
22	W2	Auto Port Selection	The split algorithm for the auto port selection based on temperature now can read an input file of dynamic temperatures rather than relying on multiple rules with different fixed temperatures.	8/30/2019
23	W2	Tecplot	Tecplot output under the CPL output was not set up for restart properly. Tecplot output files now should work for cases where there are model restarts.	9/4/2019

24	W2	Water age	The code below for water age correction as a result of evaporation (a very minor adjustment) was incorrect:
			The old code was
			`IF(AERATEC == "  ON")CALL AERATEMASS`
			`IF(EVAPORATION(JW) .AND. WATER_AGE_ACTIVE)THEN  ! CORRECT WATER AGE FOR EVAPORATION SR 7/27/2017`
			`DO I=IU,ID`
			`JC=NGCS+JG_AGE-1`
			`CSSB(KT,I,JC)=CSSB(KT,I,JC)-EV(I)*CG(KT,I,JC)`
			`ENDDO`
			`ENDIF`
			
			The updated code is
			`IF(AERATEC == "  ON")CALL AERATEMASS`
			`IF(EVAPORATION(JW) .AND. WATER_AGE_ACTIVE)THEN  ! CORRECT WATER AGE FOR EVAPORATION SR 7/27/2017`
			`DO I=IU,ID`
			`JC=NGCS+JG_AGE-1`
			`CSSB(KT,I,JC)=CSSB(KT,I,JC)-EV(I)*CG(KT,I,JG_AGE)`
			`ENDDO`
			`ENDIF`
				10/17/2019

25	W2	Pipe algorithm	The pipe algorithm was revised to reduce issues with pipe algorithm instabilities. There is error trapping to reduce the prevalence of growing instabilities from a water surface slope that becomes unstable.	11/1/2019

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
26	W2	W2 fixes	Small fixes that do not affect the model user: Eliminated the unused variable PHISET and changed INTEGER*8 variables in the SYSTDG algorithm to INTEGER*4. Thanks to Stewart Rounds USGS for noting these items.	11/13/2019

27	W2	Turbidity	Turbidity can be used through the sediment diagenesis model as a derived variable. This will shortly be moved to a derived constituent in W2 and taken out of the sediment diagenesis subroutine. There was a coding error in the turbidity routine that was fixed:
			`!CellTSSValue = C1(K,SegNumI,6)`
			`!CellTSSValue = TOTSS(K,SegNumI)`
			`!SW 11/15/2019 C1(K,SegNumI,nturb) ! cb 2/18/13`
			`!C1(K,SegNumI,6) = exp(CoeffA_Turb*log(CellTSSValue) + CoeffB_Turb)`
			`!C2(K,SegNumI,6) = exp(CoeffA_Turb*log(CellTSSValue) + CoeffB_Turb)`
			`!C1(K,SegNumI,nturb) = exp(CoeffA_Turb*log(CellTSSValue) + CoeffB_Turb) ! cb 2/18/13`
			`!C2(K,SegNumI,nturb) = exp(CoeffA_Turb*log(CellTSSValue) + CoeffB_Turb)`
			`C1(K,SegNumI,nturb) = exp(CoeffA_Turb*log(TOTSS(K,SegNumI)) + CoeffB_Turb) ! cb 2/18/13`
			`C2(K,SegNumI,nturb) = C1(K,SegNumI,nturb) !exp(CoeffA_Turb*log(CellTSSValue) + CoeffB_Turb)`
				11/15/2019

28	W2	Examples and User Manual	The kinetic flux output order for DOEP and DOAR was reversed in a couple of the input files in the model example files (in w2_con.npt) and in one place in the User Manual. These were corrected.	11/15/2019

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added

29	W2	Branch Active	In the process of setting inflows to upstream inactive branches to branches that were still active, the following code was updated for complex, multi-waterbody systems: [Chris Berger]
			`IF(BR_INACTIVE(JB))THEN ! CONVERT INFLOWS TO TRIBS SET TO THE CUS(1) LOCATION`
			`JTT=JTT+1`
			`!ITR(JTT)=CUS(1) ! HARDWIRED TO FIRST BRANCH`
			`ITR(JTT)=CUS(jbdn(jw)) ! changed HARDWIRE TO JBDN BRANCH ! cb 11/20/19`
			`QTR(JTT) = QIN(JB)`
			…
			`! including tributary flows for inactive branches`
			`DO JW=1,NWB ! cb 11/20/19`
			`KT = KTWB(JW)`
			`DO JB=BS(JW),BE(JW)`
			`IF(BR_INACTIVE(JB))then`
			`IU = CUS(JB)`
			`ID = DS(JB)`
			`IF (TRIBUTARIES) THEN`
			`DO JT=1,JTT`
			`!********** Inflow fractions`
			`IF (JB == JBTR(JT)) THEN`
			`I = cus(jbdn(jw)) ! placing tributary flows in upstream end of main branch`
			`QTRF(KT:KB(I),JT) = 0.0`
			`KTTR(JT) = KT`
			`KBTR(JT) = KB(I)`
			`KTTR(JT) = MAX(KT,KTTR(JT))`
			`KBTR(JT) = MIN(KB(I),KBTR(JT))`
			`IF (KBTR(JT) < KTTR(JT)) KBTR(JT) = KTTR(JT)`
			`BHSUM = 0.0`
			`DO K=KTTR(JT),KBTR(JT)`
			`BHSUM = BHSUM+BH2(K,I)`
			`END DO`
			`DO K=KTTR(JT),KBTR(JT)`
			`QTRF(K,JT) = BH2(K,I)/BHSUM`
			`END DO`
			`DO K=KTTR(JT),KBTR(JT)`
			`QSS(K,I) = QSS(K,I)+QTR(JT)*QTRF(K,JT)`
			`END DO`
			`END IF`
			`END DO`
			`END IF`
			`end if`
			`end do`
			`end do`
				11/22/2019

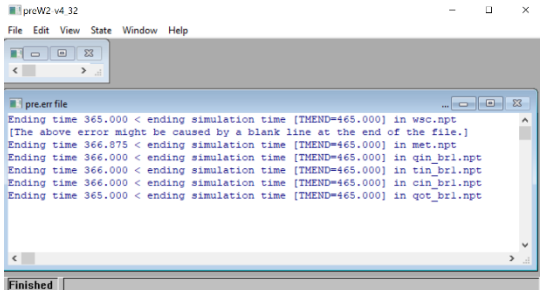
#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added

30	W2	WRN output	The warning output format was improved when there were volume balance errors – thanks to Stewart Rounds, who defies retirement to provide model improvements!!
			
			In the subroutine, balances.f90, the new code is shown below:
			`IF (VOLUME_WARNING) THEN`
			`WRITE(WRN,'(A,F0.4,/A,I0,A,I0,A,I0,3(:/A,E15.8,A))') &`
			`'COMPUTATIONAL WARNING AT JULIAN DAY = ',JDAY, &`
			`'WATERBODY=', JW, ', BRANCH=', JB, ', KT=', KT, &`
			`'SPATIAL CHANGE =', VOLSBR(JB), ' M^3', &`
			`'TEMPORAL CHANGE =', VOLTBR(JB), ' M^3', &`
			`'VOLUME ERROR =', VOLSBR(JB)-VOLTBR(JB), ' M^3'`
			`!SR 11/16/19`
			`WRITE (WRN,*) 'LAYER CHANGE:', LAYERCHANGE(JW)`
			`WRITE (WRN,*) 'SZ', SZ(CUS(JB):DS(JB)), 'Z', Z(CUS(JB):DS(JB)), 'H2KT', H2(KT,CUS(JB):DS(JB)), &`
			`'H1KT', H1(KT,CUS(JB):DS(JB)), 'WSE', ELWS(CUS(JB):DS(JB)), 'Q', Q(CUS(JB):DS(JB)), &`
			`'QC', QC(CUS(JB):DS(JB)), 'T1', T1(KT,CUS(JB):DS(JB)), 'T2', T2(KT,CUS(JB):DS(JB)), &`
			`'SUKT', SU(KT,CUS(JB):DS(JB)), 'UKT', U(KT,CUS(JB):DS(JB)), 'QIN', QINSUM(JB), &`
			`'QTR', QTR, 'QWD', QWD !SR 11/16/19`
			`WARNING_OPEN = .TRUE.`
				12/2/2019

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added

31	W2	W2 Error Dump	The W2ErrorDump.opt file output format was changed to be easier to analyze. The file was changed to W2ErrorDump .csv to facilitate opening in Excel and for general plotting. The new code is from Stewart Rounds and is found in endsimulation.f90.
			
			Old code:
			`!OPEN(W2ERR,FILE='W2Errordump.opt',status='unknown')`
			
			`!WRITE(w2err,*)'JDAY',jday,'SZ',sz,'Z',z,'H2KT',h2(kt,1:imx),'H1KT',h1(kt,1:imx),'BHR1',bhr1(kt,1:imx),'BHR2',bhr2(kt,1:imx),'WSE',elws,'Q',q,'QC',qc,'QERR',qerr,'T1',t1(kt,1:imx),'T2',t2(kt,1:imx),'SUKT',su(kt,1:imx),&`
			`!`
			`'UKT',u(kt,1:imx),'QIN',qin,'QTR',qtr,'QWD',qwd`
			
			New Code:
			`OPEN (W2ERR,FILE='W2Errordump.csv',status='unknown')`
			`WRITE (W2ERR,*) 'JDAY = ', JDAY`
			`WRITE (W2ERR,'(A,1000(",",F0.6))') 'QIN:', (QIN(J),J=1,NBR)`
			`WRITE (W2ERR,'(A,1000(",",F0.6))') 'QTR:', (QTR(J),J=1,NTRT)`
			`WRITE (W2ERR,'(A,1000(",",F0.6))') 'QDT:', (QDTR(J),J=1,NBR)`
			`WRITE (W2ERR,'(A,1000(",",F0.6))') 'QWD:', (QWD(J),J=1,NWDT)`
			`WRITE (W2ERR,'(/A)')`
			`'SEG,BRANCH,KT,WSE,SZ,Z,Q,QC,QERR,H2KT,H1KT,BHR1,BHR2,T1,T2,SUKT,UKT'`
			`DO JW=1,NWB`
			`KT = KTWB(JW)`
			`DO JB=BS(JW),BE(JW)`
			`DO I=US(JB)-1,DS(JB)+1`
			`WRITE (W2ERR,'(I0,",",I0,",",I0,14(",",F0.6))') I, JB, KT, ELWS(I), SZ(I), Z(I), Q(I), QC(I), QERR(I), H2(KT,I), H1(KT,I), BHR1(KT,I), BHR2(KT,I), T1(KT,I), T2(KT,I), SU(KT,I), U(KT,I)`
			`END DO`
			`END DO`
			`END DO`
				12/30/2019

32	W2	Multiple Waterbody	Stewart Rounds improved on the code presented in Version 4.2. Instead of writing and reading restart files, the code waited for the updates before proceeding. This led to code changes in many subroutines. Also, the downstream model can now wait for input from multiple upstream files rather than just one. This update is described in the User Manual and is part of the Version 4.2.1 model update because of a new input file format for the multiple waterbody input file.	1/2/2020

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
33	PREW2	Preprocessor	A new feature was added to the preprocessor – a new windows pops up with errors if they are present. This avoids having to open the pre.err file in a word processor in case there were errors. 	3/15/2020
34	W2	Pump	Added features were added to the pump algorithm. This allows for the flow through a pump to be controlled by the downstream water level, rather than just the upstream level. If this is the case, then a negative downstream segment number is used. This also changes the logic of ELON and ELOFF. This has been updated in the User Manual also.	3/15/2020
35	W2/PREW2	Control file	A new control file option was created in Excel using a comma delimited control file, w2_con.csv. This control file is a lot simpler to use than the text file w2_con.npt because (1) strict formatting by spaces is not required, (2) easier to cut and paste large sections withing Excel, (3) variable explanations are available in Column A, (4) the graph.npt file is no longer required and is incorporated into the Excel based input file, and (5) there is a one-button function to write the input file into csv format for reading into the W2 code. This file also has many other advantages in setting up output and more intuitive variable placement (i.e., the order of the old w2_con.npt is not strictly followed.) The only negative is that it breaks the GUI W2_Control which is not necessary other than the nice visualization bathymetry tools. But many of those are in the w2Tools post-processor. There is currently not a converter from the old format to the new one. But the model executable and preprocessor work with either control file.	4/16/2020
36	W2	TSR	TSR model output headers were improved. The P, N, and Light limitation for algae headers (APLIM, ANLIM, ALLIM) now show the algae group number rather than a generic header, such as PLIM_ALG1.	5/3/2020
37	Converter	Control file	A control file converter utility and description was added to the download package. This utility converts the control file (w2_con.npt) to a format using Excel.	5/22/2020
39	PreW2	More checks	Several additional model checks were added to the preprocessor to improve its skill set.	5/22/2020 6/15/2020

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
40	W2	Tecplot output	A new input file Tecplotbr.csv is now used to specify which branches are output to the Tecplot contour map. Before, all model branch information was output to the Tecplot file. Now the user can control this more precisely to eliminate a lot of post-processing of the data file. This is described in the User Manual.	5/22/2020
41	W2	CO2 in atmosphere	As the basis for Version 4.2.2, the CO2 gas saturation was redone. See User Manual Part 2 under TIC.	8/10/2020
42	Converter		Fixed a bug in writing out the csv format for the control file in case there were more than 1 withdrawals.	8/27/2020
43	W2	SPR ONV	Whenever the SPR was set equal to ONV for a w2_con.csv file, this output was not implemented correctly. For the input file w2_con.npt this worked as expected.	10/8/2020
44	Converter		Fixed a bug when NTR was exactly 9 (this bug also affected cases where NWB=9 or NBR=9). Also fixed some of the output formatting.	11/27/2020
45	W2	Pipe	A dimensioning bug was found when there were no pipes. This did not affect model results with the executable but did show up using the debugger in the Intel environment. This has been fixed. Many thanks to Jun Ma for noticing that!!	12/20/2020
46	W2/Pre/Converter	Csv input	When converting to the Excel macro utility for the control file and when modeling a system with no tributaries, the columns read for distributed inflows and precipitation may have been read incorrectly. This was adjusted by fixing the converter utility, the preprocessor and W2 code.	2/17/2021

47	W2	Kinetic Flux	When there are layer subtractions, the Kinetic flux in the surface layer terms can not account for the mass. This did not affect the mass balance of the constituents, just the flux variables used for output. Many thanks for Taylor Adams of Hydros for finding that error.
			
			In layeraddsubtract.f90:
			`KF(KT,I,KFCN(1:NAF(JW),JW)) = (KF(KT-1,I,KFCN(1:NAF(JW),JW))*VOL(KT-1,I)+KF(KT,I,KFCN(1:NAF(JW),JW))*VOL(KT,I))/(VOL(KT-1,I)+VOL(KT,I)) ! SW Fix suggested by Taylor Adams Hydros 25Feb2021 ! KF is in units of g/m3/s`
			`KFS(KT,I,KFCN(1:NAF(JW),JW)) = KFS(KT-1,I,KFCN(1:NAF(JW),JW))+KFS(KT,I,KFCN(1:NAF(JW),JW)) ! SW Fix suggested by Taylor Adams Hydros 25Feb2021 ! KFS is in units of g KFS=KF*VOL*DT C1(KT-1,I,CN(1:NAC)) = 0.0`
				2/25/2021

W2 V4.1 Bug Fixes, Enhancements, and User Manual Changes

Table 4. Bug fixes and enhancements for Version 4.1.

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
1	PREW2	Additional checks	Additional checks were added to the preprocessor for sediment decay temperature coefficients and stoichiometric coefficients. Concentration summaries in downstream and upstream head boundary conditions were added to the pre.opt file.	5/19/2017

2	W2	DO Saturation	The equation for computing dissolved oxygen saturation was a function of elevation and temperature. If the user set the water body type to SALT, the TDS or salinity was used to correct the dissolved oxygen saturation. The TDS correction for dissolved oxygen saturation was added to the fresh water computation also. The new code is highlighted below:
			`SATO = EXP(7.7117-1.31403*(LOG(T+45.93)))*P`
			`IF (SALT_WATER) THEN`
			`SATO = EXP(LOG(SATO)-SAL*(1.7674E-2-1.0754E1/(T+273.15)+2.1407E3/(T+273.15)**2))  ! SAL is in ppt`
			`ELSEIF(SAL > 100.)THEN`
			`SATO = EXP(LOG(SATO)-(SAL/1000.)*(1.7674E-2-1.0754E1/(T+273.15)+2.1407E3/(T+273.15)**2))  ! SAL is in mg/l`
			`ENDIF`
				5/21/2017

3	W2	Sediment diagenesis output	Another line was added to the sediment diagenesis input file for the frequency of output. Prior to this it used the TSR output frequency and wrote out duplicate results if there was more than 1 waterbody.	5/25/2017
4	W2	Initialize variables	DLVOL, VOLTBR, EVBR, and QSUM were added to the initialized variables in INIT.F90. This only affects the Fortran compiler when it is in debug model. In the release executable all variables are initialized to zero even if not explicitly set to zero.	7/24/2017

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added

5	W2	Sediment diagenesis code updates	We have deleted unused variables and array initializations. This has improved the speed of running the model with sediment diagenesis. These code areas are:
			`!SP CEMA`
			`  if(sediment_diagenesis)then`
			`    If(CEMARelatedCode .and. IncludeBedConsolidation)Call ComputeCEMARelatedSourceSinks`
			`  !  If(CEMARelatedCode .and. IncludeCEMASedDiagenesis)Call ComputeCEMADiagenesisSourceSinks  SW 6/27/2017`
			`  end if`
			`!End SP CEMA`
			
			`      !SP CEMA`
			`      !if(sediment_diagenesis)then`
			`      !  If(CEMARelatedCode .and. IncludeBedConsolidation)TSS       = 0.0  ! SW 7/27/2017`
			`      !end if`
			`      !End SP CEMA`
			
			`!SP CEMA`
			`!if(sediment_diagenesis)then`
			`!  CEMATSSCopy = TSS`
			`!end if`
			`!End SP CEMA`
				7/24/2017

6	PREW2	Sediment diagenesis	Additional error checking for the sediment diagenesis model was added to the preprocessor. In this case, whenever SOD was not set to zero, an error is displayed.	7/24/2017
7	W2	Assorted code improvements	Stewart Rounds of the USGS suggested a few minor updates: eliminated extra right-parentheses in a format description for time series output (the Intel compiler allowed them!), added WARNING_OPEN and ERROR_OPEN = .TRUE. in several cases where output is written to these files, and eliminated a situation where the derived output file at a withdrawal point was not written out if the file is empty. Also, for water age, evaporation should not concentrate the 'age'. Hence code was added to recognize water age and to eliminate the effect of evaporation on water age.	7/27/2017
8	W2	Branch active or inactive	In the W2 model, if a model branch became dehydrated, the model would not continue running. In order to allow for wide varieties of water levels, users would often have to add numerous deep fictitious layers to keep a branch hydrated. Now the model can handle branches becoming active or inactive automatically. Code was added to allow branches to become active as they fill up or to become inactive if they lose their water. Also, any branch inflows or tributaries entering inactive branches are automatically moved to the current active segment of the nearest hydrated branch.	7/27/2017

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added

9	W2	RPOMN	Stewart Rounds, USGS, found this one. The if test below used NRPOMP rather than NRPOMN. Usually both NRPOMN and NRPOMP are both 'ON', so for most applications this should not affect the model user.
			OLD Code:
			IF(CAC(NRPOMP) == ' ON')THEN
			IF(RPOM(K,I).GT.0.0)THEN
			ORGNRP(K,I)=RPOMN(K,I)/RPOM(K,I)
			NEW Code:
			IF(CAC(NRPOMN) == ' ON')THEN
			IF(RPOM(K,I).GT.0.0)THEN
			ORGNRP(K,I)=RPOMN(K,I)/RPOM(K,I)
				8/2/2017

10	W2	Screen Dialog Box	Under some unique conditions, exiting the W2 dialog box reinitializes some of the output files. Added code was inserted to STOP program execution after closing the dialog box.	8/23/2017
11	W2	Sediment Diagenesis	Flux rates for P, NH3, and NO3 were added to the MASSBAL output file from sediment diagenesis so that a complete N and P balance can be evaluated for a waterbody.	8/31/2017
12	W2	Particle Tracking	Particle tracking algorithm has been added and documentation in a separate report added to the model release	8/31/2017
13	W2	Opt to csv file	Changed flowbal.opt and massbal.opt to flowbal.csv and massbal.csv in order to facilitate opening inn Excel.	8/31/2017
14	W2	Gate file	The gate file was inadvertently not converted over to a csv format in the earlier Version 4.0 code. The 4.1 code was updated to include csv gate files.	9/26/2017

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added

15	W2	Shading	Added code to allow for a canopy shading in addition to dynamic shading. The DYNSH in the shade input file can now be a negative number between -1 and 0. This will activate dynamic shading and taking the absolute value of this number will reduce the short wave solar radiation by a fixed fraction as if some of the channel has a canopy. Of course canopy cover is more complex than this small correction since it also affects long-wave radiation transfer. New code is highlighted below:
			
			`SN = MIN (HT*ABS (SIN (ABS (PHI0(I)-AZ00)))/TAN (A0)-EDGE,BI(KT,I))`
			`SFACT = SRED*SN/BI(KT,I)`
			`100 CONTINUE`
			`SHADE(I) = MAX (0.0,1-SFACT)`
			`SHADE(I) = MIN(ABS(SHADEI(I)),SHADE(I))`
			`! SW 10/2/2017 Allows for fixed canopy cover over top of channel - only used if shade is less than shadei only valid for -0.99 and 0.0`
			
			Hence if DYNSH (or SHADEI) in the code were -0.9 and the dynamic shading algorithm computed the shade factor as 0.95 (which is a 5% reduction in short wave solar), the code would use 0.9 or a 10% reduction in short-wave solar. If the dynamic shade algorithm computes a shade greater than the fixed rate, the minimum of these is used.
				10/3/2017

16	W2	Sediment Diagenesis	Changed back to the original segment width at the bottom for sediment diagenesis so that this algorithm replicates the original CEMA sediment diagenesis algorithm. Pulled out the CellArea as a dimensioned variable computed only once rather than for each cell at each time step. Also, added a control variable to turn ON/OFF Bubbles calculation. This saves much computational time and until the Bubbles subroutine is vetted we do not recommend its use. Also several code fixes were made in the sediment diagenesis module for mistakes in the original algorithm.	10/3/2017, 10/22/2017
17	W2	User Manual	The User Manual was updated fixing minor errors and typos and adding discussion of new features of Version 4.1. This is Revision 1 of the 4.1 Manual but includes updates and fixed typos from the Version 4.0 Manual and explanations of new features.	10/3/2017

18	W2	Kinetic fluxes for ADD Layer	A bug was corrected in the Kinetic Flux layer addition code as shown below:
			`KFS(KT,I,KFCN(1:NAF(JW),JW)) = KFS(KT+1,I,KFCN(1:NAF(JW),JW))`
			`!KF(KT+1,I,KFCN(1:NAF(JW),JW)) CODE ERROR FIX SW 10/24/2017`
			This does not affect fluxes in the TSR file, only the cumulative fluxes (KFS) during an add layer event for the surface layer only.
				10/24/2017

#	Code: W2 or PREW2 or GUI	Fix or En-hancement Type	Description of Bug/Enhancement	Date Fixed or Enhance-ment added
19	W2	Header	Changed header for flux for DO reaeration from just source to source/sink which can occur during super-saturation. `KFNAME(64) = 'DO reaeration - source/sink, kg/day '`	10/24/2017

20	W2	Fluxes	In the file, kfl_wbX.opt where X is the waterbody num-ber, the fluxes are presented in the same format as a snapshot file. The headers showed fluxes in kg/d but they were in kg. This has been corrected. The fluxes in kg/d in the file kflux_wbX.opt were already in the cor-rect units of kg/d. Also, added the following code since KT would have been from the prior waterbody rather than the current waterbody:
			`DO JW=1,NWB`
			`KT = KTWB(JW) ! SW 10/25/2017`
			`IF (FLUX(JW)) CALL KINETIC_FLUXES`
			`END DO`
				10/24/2017

21	W2	Pumps	Changed some of the logic for pumps to avoid settings for older values influencing the current settings. The following code was added to hydroinout.f90:
			`ILAT = 0`
			`JWW = NWD`
			`withdrawals = jww > 0`
			`if(nwdt>nwd)qwd(nwd+1:nwdt)=0.0 ! SW 10/30/2017`
			`JTT = NTR`
			`tributaries = jtt > 0`
			`if(ntrt>ntr)qtr(ntr+1:ntrt)=0.0 ! SW 10/30/2017`
			`JSS = NSTR`
				10/30/2017

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added

22	W2	TDG at spillway	Since the new implementation of the TDG algorithm, the withdrawal.f90 algorithm at spillways had not been updated properly. This fix applies to the computation of TDG at spillways and gates. The old and new code are shown below:
			
			`!if(tdgon)then ! cb 11/6/17`
			`!cdavg(js,jb,16) = (cavg(js,jb,ndo)/exp(7.7117-1.31403*(log(tavg(js,jb)+45.93)))*palt(id))*100.0`
			`dosat=exp(7.7117-1.31403*(log(tavg(js,jb)+45.93)))*palt(id)`
			
			`cdavg(js,jb,16)=(cavg(js,jb,ndo)/dosat)*100.0`
			`IF(ngctdg /= 0)THEN`
			`EA = DEXP(2.3026D0*(7.5D0*TDEW(JW)/(TDEW(JW)+237.3D0)+0.6609D0))*0.001316 ! in mm Hg 0.0098692atm=7.5006151mmHg`
			`!cdavg(js,jb,NDC) = (cavg(js,jb,NGN2)/(1.5568D06*0.79*(PALT(ID)-EA)*(1.8816D-5 - 4.116D-7 * Tavg(js,jb) + 4.6D-9 * Tavg(js,jb)**2)))*100.0 ! SW 10/27/15`
			`n2sat=1.5568D06*0.79*(PALT(ID)-EA)*(1.8816D-5 - 4.116D-7 * Tavg(js,jb) + 4.6D-9 * Tavg(js,jb)**2)`
			`cdavg(js,jb,NDC) = 100.*(0.79*(cavg(js,jb,NGN2)/n2sat) + 0.21*(cavg(js,jb,ndo)/dosat))`
			`ENDIF`
			`!end if`
				11/8/2017

23	W2 Control	Updated GUI	A new version of W2Control has been made to account for a large number of small refinements in the control file to bring it up to Version 4.1. Otherwise, some of these changes had to be implemented by editing the text file, w2_con.npt. Also, guidance was added to the release notes how to use the GUI with a touch-screen laptop or desktop in cases where the touch screen does not work with the GUI.	3/10/2018

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added

24	W2	Csv file input for shade file	Updated reading in csv file for shade file to be compatible with preprocessor. Sometimes one needs to add an extra column of commas in a csv input file.
			
			New code:
			`IF(INFORMAT=='$')THEN`
			`READ(SHD,'(/)')`
			`DO I=1,IMX`
			`READ (SHD,*)J,SHADEI(I) ! SW 3/14/2018 ADDED TO BE COMPATIBLE WITH PREPROCESSOR`
			`IF(SHADEI(I)<0.0)THEN`
			`BACKSPACE(SHD)`
			`READ (SHD,*) J,SHADEI(I),TTLB(I),TTRB(I),CLLB(I),CLRB(I),SRLB1(I),SRLB2(I),SRRB1(I),SRRB2(I),(TOPO(I,J),J=1,IANG),SRFJD1(I),SRFJD2(I)`
			`ENDIF`
			`ENDDO`
				3/14/2018

25	W2	TSR file output	When the model user sets the elevation as a negative value, the model outputs variables at that layer only. When the water level went below that layer, the output was fixed at the old value of the variable until the water level rose into the layer. To eliminate issues with misinterpreting or having to edit out constant values, whenever the water level is below the layer, now a -99 is written out showing that there is no water in the layer specified.	4/5/2018
26	PREW2	More checks	Added checks for NaN in input files for meteorological files and flow, temperature and concentration files for inflows, distributed tributaries, precipitation, and tributaries. Previously, the preprocessor read input files even with NaN without reporting an error since this is a proper numerical value.	4/10/2018
27	W2	WDO output	The Withdrawal files are often used for downstream models. The withdrawal output frequency is in days. In order to make this more precise numerically, the output frequency can also be entered in hours and seconds. The problem was that 1 hour is 0.04167 days and due to round off error for long term runs of many years, the hourly frequency output would not be at the same hour. The variable WDOC now can be ON/OFF/ONS/ONH where ONS means the output frequency is in sec and ONH means the output frequency is in hours. The User Manual, GUI, and Preprocessor have been updated.	4/10/2018
28	Water-balance	Water-balance	A new waterbalance utility was released that is a console application and can be used in batch file processing. It also has more features than the old water balance utility allowing the use of multiple waterbodies in the calculation of flows. There is a new file directory for this application in the download section as well as executables and a User Manual for this utility.	4/10/2018

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
29	PREW2	More checks	Several more preprocessor enhancements were added to the preprocessor to check for Unix file type where an EOL is a <CR> and not the windows <CR><LF>. Also a few more descriptions were added to the error output to clarify where a problem may be.	4/18/2018
30	Water-balance	Water-balance	Some refinements to the water balance utility console application were made.	6/5/2018

31	W2	Sediment Resuspension	The sediment resuspension algorithm computed sediment resuspension in all model layers except the surface layer. The fix below adds resuspension for the surface layer (highlighted code is new).
			
			`IF (SEDIMENT_RESUSPENSION(J)) THEN`
			`FETCH = FETCHD(I,JB)`
			`IF (COS(PHI(JW)-PHI0(I)) < 0.0) FETCH = FETCHU(I,JB)`
			`FETCH = MAX(FETCH,BI(KT,I),DLX(I))`
			`U2 = WIND(JW)*WSC(I)*WIND(JW)*WSC(I)+NONZERO`
			`COEF1 = 0.53 *(G*DEPTHB(KT,I)/U2)**0.75`
			`COEF2 = 0.0125*(G*FETCH/U2)**0.42`
			`COEF3 = 0.833* (G*DEPTHB(KT,I)/U2)**0.375`
			`COEF4 = 0.077* (G*FETCH/U2)**0.25`
			`HS = 0.283*U2/G*0.283*TANH(COEF1)*TANH(COEF2/TANH(COEF1))`
			`!TS = 2.0*PI*U2/G*1.2*TANH(COEF3)*TANH(COEF4/TANH(COEF3))`
			`TS = 2.0*PI*sqrt(U2)/G*1.2*TANH(COEF3)*TANH(COEF4/TANH(COEF3)) ! cb 7/15/14`
			`L0 = G*TS*TS/(2.0*PI)`
			`L1 = L0 ! SW 6/28/2018 Allow for resuspension of surface layer`
			`L = L0*TANH(2.0*PI*DEPTHB(KT,I)/L1)`
			`DO WHILE (ABS(L-L1) > 0.001)`
			`L1 = L`
			`L = L0*TANH(2.0*PI*DEPTHB(KT,I)/L1)`
			`END DO`
			`COEF = MIN(710.0,2.0*PI*DEPTHB(KT,I)/L)`
			`UORB = PI*HS/TS*100.0/SINH(COEF)`
			`TAU = 0.003*UORB*UORB`
			`IF (TAU-TAUCR(J) > 0.0) EPSILON = MAX(0.0,0.008/49.0*(TAU-TAUCR(J))**3*10000.0/DLT)`
			`SSR = EPSILON*DLX(I)*(BI(KT,I)-BI(KT+1,I))/VOL(KT,I)`
			`END IF`
			`SSSS(KT,I,J) = -SSS(J)*SS(KT,I,J)*BI(KT,I)/BH2(KT,I)+SSR`
				6/28/2018

32	W2	Sediment Flux	Added 'RECURSIVE' to the subroutine definition as it calls itself and recent updates to the Intel compiler flagged this as an error.
			
			`RECURSIVE Subroutine CEMASedimentDiagenesis`
			`Use MAIN`
			`Use GLOBAL`
			`Use GEOMC`
			`Use SCREENC`
				6/28/2018

33	PREW2	Added checks	Assorted minor updates to error checks	7/1/2018

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added

34	PREW2	Consolidation	Update to checking code in sediment diagenesis for consolidation. New code:
			`Read(5000,*)MessageTemp, LayerAddThkFrac`
			`Read(5000,*)MessageTemp, NumConsolidRegns`
			`if(IncludeBedConsolidation .and. NumConsolidRegns == 0)then ! CB 7/9/2018 changed .or. to .and.`
			`CALL ERRORS`
				7/9/2018

35	W2	Sediment	The sediment model allows for first order sediment decay in the layers above the bottom layer. If a modeler set as an initial condition a finite value for the initial concentration of sediment, then the amount in layer kb would be there and not transfer eventually to the sediment diagenesis layer as downward sloughing occurs. Hence, if the model user sets an initial concentration of the first order sediment model and has turned on sediment diagenesis, then the code sets the value of sediment in layer kb to zero.
			
			The code fixe for SED is shown below:
			`SED(KT,I) = SED(KT,I)/H2(KT,I)`
			`If(CEMARelatedCode .and. IncludeCEMASedDiagenesis)then ! cb 07/23/18`
			`SED(KT+1:KB(I)-1,I) = SED(KT+1:KB(I)-1,I)/H2(KT+1:KB(I)-1,I)`
			`sed(kb(i),i)=0.0`
			`else`
			`SED(KT+1:KB(I),I) = SED(KT+1:KB(I),I)/H2(KT+1:KB(I),I)`
			`end if`
			`END DO`
			Similar code fixes were applied to SEDP, SEDC and SEDN.
				7/23/2018

36	W2	TSR output	When a branch goes inactive, the TSR output file continued to write output information even though the segment was not hydrated. Logic was added to skip output for a TSR file if the segment was inactive or if the fixed layer was above the surface layer.
			`DO J=1,NIKTSR`
			`I = ITSR(J)`
			`! find out if segment is inactive OR cell is inactive for fixed layer - do not write out tsr file ! SW 7/24/2018`
			`IF(BR_INACTIVE(JBTSR(J)))CYCLE`
			`IF(CUS(JBTSR(J)) > I)CYCLE`
			`DO JW=1,NWB`
			`IF (I >= US(BS(JW))-1 .AND. I <= DS(BE(JW))+1) EXIT`
			`END DO`
			`IF(ETSR(J) < 0)THEN ! SW 7/24/2018`
			`IF(INT(ABS(ETSR(J))) < KTWB(JW))CYCLE`
			`ENDIF`
				7/24/2018

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
37	W2	WRN	When a branch becomes ACTIVE, it is now written out to the WRN file (this was previously written out to the SNP file and only when INACTIVE to the WRN file).	7/24/2018
38	W2	SO4 in Sediment	The code was updated to compute SO4 in both the aerobic and anaerobic layers and to allow diffusion from the water column to the sediment. This was previously not implemented. Also, updates were made to the bed consolidation routine in the sediment diagenesis model.	8/1/2018
39	W2, PREW2	Constriction	This is a model enhancement: The model user can specify a maximum width between segments by specifying that in a new input file called 'constriction.csv'. This does not affect the volume of the segments – it only affects the right hand side face width. Whereas an internal weir blocks all the flow, this allows for a reduced area and eliminates the need to insert a short segment of small width that can cause stability and lowered time step issues. The new input file is 'consticton.csv' and has the following format: Line 1: Comment Line 2: # of constrictions Line 3: Comment Line 4: [Repeated by # of constrictions] Segment # of constriction, Maximum width in m of constriction # of Constrictions 1 Seg # Max width, m 10 115 The W2 code looks for 'constriction.csv' – if it is found, then it reads the file and applies this to the right hand side width between 2 segments. Updates were made to the User Manual, Preprocessor and W2 Executables	8/3/2018
40	W2	Restart	If there were WDO output files, the RESTART option may not have worked properly. A code fix was implemented for a RESTART with WDO output files.	8/3/2018
41	W2	Envir Perf	The environmental performance output was updated to include the descriptive terms: 'Sum of fractions' and 'Average'. The User Manual was updated.	8/6/2018
42	W2	Particle Transport	Tracking the time history of temperature, velocity and depth of particles was added to the particle transport algorithm. The file 'particle.csv' now includes information on histogram output for each particle released into the waterbody. The User Manual and Preprocessor were also updated for this new feature.	8/6/2018

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added

43	W2	Layer subtract	When the W2 model adds a deep slot in shallow rivers, the variable AVHR in layeraddsub.f90 was defined for an inactive segment incorrectly. This code was cleaned up. New code is shown below:
			`DEPTHM(KTWB(JW),I)=(H1(KTWB(JW),I)-(EL(KBI(I)+1,I)-EL(KB(I)+1,I)))*0.5 ! SW 1/23/06`
			`IF(I<=DS(JB))THEN ! SW 8/6/2018`
			`AVHR(KT,I)=(H1(KT,I)-(EL(KBI(I)+1,I)-EL(KB(I)+1,I))) +(H1(KT,I+1)-(EL(KBI(I)+1,I+1)-EL(KB(I)+1,I+1))&`
			`-H1(KT,I)+(EL(KBI(I)+1,I)-EL(KB(I)+1,I)))/(0.5*(DLX(I)+DLX(I+1)))*0.5*DLX(I)`
			`ELSE`
			`AVHR(KT,I)=AVHR(KT,I-1)`
			`ENDIF`
				8/6/2018

44	W2	Input bathymetry	If the model user in the bathymetry input file gives the water surface (or FRIC, or PHI0, or DLX) of inactive segments a '0', the code in the first time step may set the KT layer incorrectly because of using ELWS of an inactive segment. The code though fixes it on the 2nd time step. This does not really affect the model run as it gets started other than an unnecessary change in the surface layer designation. If the model user gave the inactive segments the same values as the active ones, the code ran normally from the first time step. In order to standardize this and allow the model user to keep inactive segment ELWS, DLX, FRIC, and PHI0 set to zero, these values are initialized with the neighboring segment value.
			`READ (BTH(JW),'(//(10F8.0))') (DLX(I), I=US(BS(JW))-1,DS(BE(JW))+1)`
			`READ (BTH(JW),'(//(10F8.0))') (ELWS(I), I=US(BS(JW))-1,DS(BE(JW))+1)`
			`READ (BTH(JW),'(//(10F8.0))') (PHI0(I), I=US(BS(JW))-1,DS(BE(JW))+1)`
			`READ (BTH(JW),'(//(10F8.0))') (FRIC(I), I=US(BS(JW))-1,DS(BE(JW))+1)`
			`READ (BTH(JW),'(//(10F8.0))') (H(K,JW), K=1,KMX)`
			`DO I=US(BS(JW))-1,DS(BE(JW))+1`
			`READ (BTH(JW),'(//(10F8.0))') (B(K,I), K=1,KMX)`
			`H2(:,I) = H(:,JW)`
			`END DO`
			`endif`
			`! Set water surface of inactive segments to those active cells next to them SW 8/6/2018`
			`DO JB=BS(JW),BE(JW)`
			`ELWS(US(JB)-1)=ELWS(US(JB))`
			`ELWS(DS(JB)+1)=ELWS(DS(JB))`
			`DLX(US(JB)-1)=DLX(US(JB))`
			`DLX(DS(JB)+1)=DLX(DS(JB))`
			`PHI0(US(JB)-1)=PHI0(US(JB))`
			`PHI0(DS(JB)+1)=PHI0(DS(JB))`
			`FRIC(US(JB)-1)=FRIC(US(JB))`
			`FRIC(DS(JB)+1)=FRIC(DS(JB))`
			`END DO`
				8/6/2018

45	W2	Particle	Added the ability of particles to be passed to other branches by connections of gates, pumps or spillways between upstream and downstream branches aligned linearly along a river.	8/7/2018

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added

46	W2	Flow Balance Output	The flow balance output file, flowbalance.csv, output was affected by Branches becoming active or inactive. Code was revised in balances.f90 to allow for the flow balances to properly account for cumulative flow sources/sinks.
			`IF (VOLUME_BALANCE(JW)) THEN`
			`DO JB=BS(JW),BE(JW)`
			`IF(.NOT.BR_INACTIVE(JB))THEN ! SW 8/8/2018`
			`VOLSBR(JB) = VOLSBR(JB)+DLVOL(JB)`
			`VOLTBR(JB) = VOLEV(JB)+VOLPR(JB)+VOLTRB(JB)+VOLDT(JB)+VOLWD(JB)+VOLUH(JB)+VOLDH(JB)+VOLIN(JB)+VOLOUT(JB)+VOLICE(JB)`
			`if(sediment_diagenesis)then`
			`If(CEMARelatedCode .and. IncludeBedConsolidation)Then`
			`VOLTBR(JB) = VOLTBR(JB)+ VOLCEMA(JB)`
			`End If`
			`ENDIF`
			
			`IF (ENERGY_BALANCE(JW)) THEN`
			`ESR(JW) = 0.0`
			`ETR(JW) = 0.0`
			`DO JB=BS(JW),BE(JW)`
			`IF(BR_INACTIVE(JB))CYCLE ! SW 8/8/2018`
			
			`IF (MASS_BALANCE(JW)) THEN`
			`DO JB=BS(JW),BE(JW)`
			`IF(BR_INACTIVE(JB))CYCLE ! SW 8/8/2018`
			`DO JC=1,NAC`
				8/8/2018

47	W2	Particle Transport	In the particle tracking algorithm, the depth statistics of are now based on the particle depth. Before this, the depth statistics of a particle were based on water depth not particle depth.	8/24/2018

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added

48	W2	Long Profile Output	The volume weighted temperature was added to the longitudinal profile output. The User Manual was also updated.
			`WRITE(NUNIT,'(1000(A,","))')'Seg#','ElevWaterSurf(m)','Q(m3/s)','SurfaceTemp(oC)','Depth(m)','Width(m)','VolWeighTemp(oC)',(CNAME2(CN(JC)),JC=1,NAC),(CDNAME2(CDN(JD,JW)),JD=1,NACD(JW))`
			`ELSE`
			`WRITE(NUNIT,'(1000(A,","))')'Seg#','ElevWaterSurf(m)','Q(m3/s)','SurfaceTemp(oC)','Depth(m)','Width(m)','VolWeighTemp(oC)'`
			`ENDIF`
			`DO JJ=1,NWB`
			`K=KTWB(JJ)`
			`DO JB=BS(JJ),BE(JJ)`
			`DO I=CUS(JB),DS(JB)`
			`! TEMP VOL WEIGHTED AVERAGE SW 8/30/2018`
			`TVOLAVG=0.0 ! SW 8/30/2018`
			`VOLTOT=0.0`
			`DO KK=KTWB(JW),KB(I)`
			`VOLTOT=VOLTOT+VOL(KK,I)`
			`TVOLAVG=TVOLAVG+T1(KK,I)*VOL(KK,I)`
			`ENDDO`
			`IF(KB(I)>=KTWB(JW))tvolavg=tvolavg/voltot`
			`IF(CONSTITUENTS)THEN`
			`WRITE(NUNIT,'(I5,",",100(F12.3,","))')I,ELWS(I),QC(I),T2(K,I),DEPTHB(KB(I),I),B(KTI(I),I),TVOLAVG,(C2(K,I,CN(JAC))*CMULT(CN(JAC)),JAC=1,NAC),(CD(K,I,CDN(JD,JW))*CDMULT(CDN(JD,JW)),JD=1,NACD(JW))`
			`ELSE`
			`WRITE(NUNIT,'(I5,",",100(F12.3,","))')I,ELWS(I),QC(I),T2(K,I),DEPTHB(KB(I),I),B(KTI(I),I),TVOLAVG`
				8/30/2018

49	W2	SPR output	The spreadsheet output file now has an option to output volume weighted values at the locations and times specified. If the user enters 'ONV' in the control file in the following line:
			`SPR PLOT SPRC NSPR NISPR`
			`WB 1 ONV 1 2`
			the output will include the regular SPR output and a separate file with the suffix '_volw.csv' for the volume weighted output. The User Manual has also been updated with the new feature.
				9/28/2018

50	W2	User Manual	Updated the LPOM, LPOM-P, and LPOM-N source sink equations and the LPOM source sink stencil to be in agreement with the model code. These were old and did not reflect the addition of zooplankton ingestion and excretion/mortality.	10/9/2018
51	W2	Particle Tracking	Added an enhancement to add monitoring segments that record when the particle goes by the monitor or sensor. This would be useful for comparing to a dye study in a river for example.	11/14/2018
52	W2	SPR output	A volume weighted output bug for item 49 was fixed.	11/14/2018
53	W2	TSR flux output units	If flux output was ON, the instantaneous flux values for TSR output were in the incorrect units. These units were corrected to kg/day. Thanks to Binglei Gong at Anchor! All other flux files units were not affected.	12/10/2018

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
54	W2	Volume balance	The volume balance when segments were added and subtracted because of a shallow location in the grid, caused the code to incorrectly compute the volume balance (if VBC is ON). This was corrected.	12/18/2018
55	W2	Internal solar radiation and angle of sun for shading	The internal solar radiation algorithm had a bug that if one used reference years many years from your simulation or made a simulation over 20 years, the solar maximum each year drifts. If you read in solar radiation, there are no issues or if one makes runs from 1-10 years – the drift is probably minimal. This mainly affects those who use a reference year far from the start date or run simulations over 20 years or longer while using the internal short wave solar algorithm. Fix from Dan Turner at USACE and Stewart Rounds USGS – many kudos!!	12/18/2018
56	W2	Energy and mass balance	For a simulation with an initial BRANCH INACTIVE, the energy and mass balance if ON (EBC and MBC set to ON) starts off incorrectly. The layer subtraction algorithm when segments were subtracted in some cases where there were deeper holes followed by shallows incorrectly computed the energy and constituent mass balance. Also, a couple changes were made for the heat balance and mass balance for constituents when branches were changed from active to inactive.	12/18/2018
57	W2	Particle tracking	Fixed a bug when a particle was in the “air” above the water surface when in a river a ‘deep slot’ was added to the river bathymetry to keep it hydrated. Also, fixed a reflection error off the surface for vertical movement of the particle.	12/26/2018
58	W2	Particle tracking	For file output for finalparticle.csv, adjusted header so that it would be general for any number of monitoring stations. Previously the header was hard-wired to write only 3 monitoring locations in the title. This does not affect prior model output information only the title header.	1/3/2019
59	PREW2	Pipe invert	The preprocessor gave a ‘false’ error for an invert elevation being below the grid in some rare cases. This has been fixed. The model was not affected.	1/21/2019
60	W2	TN	There was a bug in the calculation of TN when large concentrations of zooplankton were present. If zooplankton were not simulated or they were a small population, there would be no impact of this TN bug. Bug fixed.	1/29/2019

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
61	W2	Epiphyton periphyton burial and conversion to LPOM and sediments	The User Manual showed that the epiphyton parameter EB, burial rate, was in units of m/day. The model implemented this and also computed the cell layer burial rate as EB*EC(concentration of biomass per cell volume)*Surface area/Volume of a cell or EB*EC/H where H is the layer thickness. In reality though it should be the thickness of the periphyton layer. But that layer thickness is not predicted by the model. Hence, the decision was to change the burial rate to units of 1/day such that the loss of epiphyton by burial would follow a first order decay process (similar to the first order sediment model) as EB*EC. Hence, this burial rate is no longer a function of the grid. Also, there was the conversion of organic matter and nutrients at death to the sediment P, N and C compartments whereas they should go directly to LPOM first. Hence only burial goes directly into the sediment compartments.	3/5/2019
62	W2	Output files	Code was written to print the initial condition in output files at time t=0 at the start of the simulation.	3/5/2019
63	W2	Restart with Sediment Diagenesis	Prior to this date, the restart option did not work with sediment diagenesis turned ON. This enhancement has been coded and debugged and is now working.	3/5/2019
64	W2	Dynamic loading	This is a new feature in CE-QUAL-W2 and applies to linear waterbodies in series. For example, if one has a river system with 9 waterbodies, the model user can break the model into 9 separate models and run them all in parallel where the downstream model dynamically updates its boundary conditions as the upstream model moves forward in time. This has resulted in significant time savings for model runs (90%). Documentation for this will be provided shortly.	3/5/2019
65	W2	User Manual	The existing User Manual will be frozen in its current version until a newly updated user manual will be released in the next couple months. Hence, the dynamic loading described above will be described in the new User Manual.	3/5/2019

W2 V4.0 Bug Fixes, Enhancements, and User Manual Changes

Table 5. Bug fixes and enhancements for Version 4.0.

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
1	PREW2	Additional model checks	Additional model checks were added for Profile and Spreadsheet output model segments	6/7/16
2	User Manual	Updated	User Manual Rev 6 was released with many minor updates and better explanatory text	6/7/16
3	W2	Restart	Fixed restart to work for epiphyton and macrophytes. This was broken in case a model user used RESTART. Fixed restart for mass balance for nutrients output in the file massbal.opt.	6/7/16
4	W2	Location of compiler info file	Fixed location of W2 compiler information in case of using command line aware directory. File was written to the location of the model executable rather than the command line aware directory.	6/7/16
5	Waterbalance	Update for Version 4	The waterbalance utility uses a model tsr file for reading in water level over time. Since the Version 4 file format was updated with comma delimeted output files, the waterbalance utility has been updated. This utility is not compatible with earlier versions.	6/10/16
6	W2	Sediment Diagenesis	Initialized the sediment width (sedcellwidth) in subroutine `CEMASedimentDiagenesis`.	6/11/16
7	W2	Screen output	The text fields in the Windows dialog box may 'overflow' if you have more than 160 tributaries. The field size was increased to avoid this possibility. Old code: CHARACTER(1000) :: TEXT1 New code: CHARACTER(1700) :: TEXT1	6/24/16
8	W2	Profile output	The longitudinal profile output added depth at a segment as part of the longitudinal output. User Manual updated also.	7/11/2016
9	W2	Profile output	Changed file name of longitudinal file output from integer of the Julian day to Julian day in F8.2 format in case of multiple outputs on one day	7/16/2016

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
10	W2	TSR output	Changed TSR file so that the first 11 lines of header are eliminated to facilitate graphing. Also, the name of the filetype in the control file is now read and used for the output file. Hence, using the TSR FILENAME of 'tsr.csv' will produce csv files that are immediately opened in Excel for viewing again making it easier for post-processing.	8/1/2016
11	PRE	Met file checks	The preprocessor has been enhanced with more model file checks. This program now has summaries of meteorological data (min, max, average) for each waterbody in the pre.opt file as well as further logical checks on values of these averages. These summaries are another check on the correctness of the input met data file. A typical result in pre.opt is shown below: Meteorological Data Input Summary Parameter Waterbody Average Value Maximum Minimum TAIR(C) 1 10.553 37.780 -11.940 TDEW(C) 1 6.935 19.500 -17.670 WIND(m/s) 1 1.337 12.440 0.000 PHI(rad) 1 3.426 6.280 0.000 CLOUD(0-10) 1 7.367 9.720 0.000 SRO(W/m2) 1 0.000 0.000 0.000 TAIR(C) 2 10.553 37.780 -11.940 TDEW(C) 2 6.935 19.500 -17.670 WIND(m/s) 2 1.337 12.440 0.000 PHI(rad) 2 3.426 6.280 0.000 CLOUD(0-10) 2 7.367 9.720 0.000 SRO(W/m2) 2 0.000 0.000 0.000	10/30/16
12	PRE	Distributed concentration checks	Added checks for average, min, and max inflow concentrations for all distributed tributaries. These are written out to the pre.opt file	11/1/16
13	PRE	LPR input	For LPR file inputs for temperature, the preprocessor reports an error when using LPR input. The code incorrectly used KT rather than KTWB(JW). [This also affects V3.7 preprocessor.]	11/9/2016
14	W2	Model update	The model executables were updated from Intel Fortran Compiler # 14 to Intel Fortran compiler # 17. Also, the flag to initialize all variables to zero was enforced. There are many variables in the new sediment diagenesis model that need to be explicitly set to zero. These initializations will be made in the code in the future so that setting this flag will be unnecessary.	11/17/2016
15	W2 and PRE	Code updates	A couple code updates were made as a result of using the Intel Fortran Version 17 compiler. The new compiler did not like some of the older implementations. These were minor updates.	11/22/2016
16	W2	Output	Improved clarity of output headers for flux outputs, including units of kg/d in all header titles	11/28/2016

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
17	W2	Output header	The order of the flux headings in the file 'kflux_jwX.opt' were switched. The header showed DOAP, DOAR, DOEP, DOER but it should have been DOAP, DOEP, DOAR, DOER. This is determined from the order in the example problem control files and the User Manual. The example problems and User Manual have all been updated.	11/28/2016
18	W2	Example problems	Updated example problems using FIX #10 above where tsr.opt filename was changed to tsr.csv allowing tsr files to open directly in Excel.	11/28/2016

19	W2	Algae-Si	The flux of Si from dying algae was incorrectly computed. This bug has existed since Version 3.0 when the algorithm was first added to W2. Below is the code fix:
			
			`ENTRY PARTICULATE_SILICA`
			`  PSIAM(:,IU:ID) = 0.0`
			`  DO I=IU,ID`
			`    DO K=KT,KB(I)`
			`      DO JA=1,NAL`
			`      IF(ALG_CALC(JA))THEN`
			`        PSIAM(K,I) =`
			`PSIAM(K,I)+AMR(K,I,JA)*ALG(K,I,JA)*ASI(JA)      !`
			`PSI(K,I)   HA-Z  12/2016`
			`      ENDIF`
				12/5/2016

20	W2	WDO output	Enhancement: The Withdrawal output file name WDOFN was unused in the main program. Now the model reads this file and uses the file type for all WDO output files. Previously this was hard-wired to 'opt' output. Now if the user sets WDOFN to 'wdo.csv' all the files will be written with the 'csv' file type facilitating opening in Excel. The files are already in comma delimited format.	12/8/2016
21	W2	DLT INTER	There was a problem computing the interpolated value of DLTMAX and DLTF when the first value of DLTD was earlier than the start date of the model. This bug was fixed.	12/9/2016
22	User Manual	Updates	Assorted typos fixed, better explanatory text added, and added definitions and units of model parameters. This is REV8.	1/6/2017, 2/10/2017
23	W2	Output format	Output format changed for Bioenergetics output file	1/6/2017
24	W2	TECPLOT output	Added derived variables to TECPLOT output files (See Contour Plot in User Manual). User Manual updated.	1/17/2017
25	PREW2	ENVIRPC	Checks were added for the ENVIRPC input file in the preprocessor.	2/16/2017
25	W2	ENVIRPC	Fixed several minor bugs in the ENVIRPC subroutine and added an enhancement to perform a histogram analysis of water depth. The User Manual was updated to reflect this new enhancement as well as the new csv output format and file names. The example problems were updated with new w2_envirprf.npt files.	2/16/2017

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Fixed or Enhancement added
26	W2	Head BC input files	For head boundary condition input files (both upstream and downstream), the W2 code was updated to include new file formats for these boundary conditions (BCs). They include the older format, a new csv format and a new csv format in case conditions are not stratified at the BC. The User Manual was updated to show these new file formats.	3/3/2017
27	PREW2	Head BC checks	With the new file format for head BCs in #26 above, the preprocessor was updated to check these new input file formats. Also, additional checks were added to the head BCs.	3/3/2017
28	Water-balance	Bug fixes/updates	The water balance utility was updated because of the new input format of TSR output files. See fix #10. Also, a bug was fixed in this code that affected cases when the water level was above the top of the grid.	3/17/2017
29	W2	CPL Tecplot	The CPL Tecplot output sometimes did not update the month in the contour plot text files. This has been fixed – thanks to Jung Ma, Hubei University of Technology in Wuhan, for finding it!	4/4/2017
30	Water-balance	Waterbalance manual	The waterbalance manual was updated for Version 4.	4/14/2017
31	W2	TSR output	Refined the TSR output so that flux terms that were not specified are no longer written out. This cleans up the TSR output and reduces the active number of flux variables when sediment diagenesis is not on.	4/15/2017
32	W2	Derived variables	Fixed a code regression for derived variable TDG when the user stopped the code and pressed restart	4/15/2017
33	W2	Withdrawal output	When a user pressed restart and he/she specified withdrawal output files, the restarted files ignored the filetype of the WDO specification in the control file and used ‘opt’.	4/15/2017

W2 V3.7 Bug Fixes, Enhancements and User Manual Changes

Table 6. Bug fixes and enhancements for Version 3.7.

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

1	W2	Fish habitat limits	Changed temperature and DO criteria from
			`t2(k,i)<fisht-emph(ii).and.t2(k,i)>fishtempl(ii).and.o2(k,i)>fishdo(ii)`
			
			to
			`t2(k,i)<=fisht-emph(ii).and.t2(k,i)>fishtempl(ii).and.o2(k,i)>=fishdo(ii)`
			
			This update is reflected in the manual. Hence the high temperature limit and the dissolved oxygen minimum is less than or equal to given value rather than less than.
				8/7/2012

2	W2	Structure, gate, pump, pipe, withdrawal output files	Added code to ensure that if flow is '0' in an outlet structure, that the corresponding temperature and concentration in the outlet file is written as '-99.0'. Previously this was not fully implemented in the code. Code such as this was inserted in several places in the subroutine outputa2.f90:
			`IF(QGT(JS)==0.0)THEN`
			`TAVGW(JWD)=-99.0`
			`CAVGW(JWD,:)=-99.0`
			`CDAVGW(JWD,:)=-99.0`
			`ENDIF`
				8/13/2012

3	PREW2	Format updates	Several output updates were made for warnings and errors	8/16/2012
4	Resource files for W2	Compiling files	Updated some corrupted resource files that were used to compile the source code. Also, zipped up source code and compiler settings together so that file locations are correct for using the Intel compiler.	9/12/2012

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added
5	W2 and PREW2	Read csv files	By inserting the character '$' as the first character of the first line, the following files can now be read in free-format or csv format: met, lpr, vpr, wsc, met, cin, ctr, cdtr, cpre, qot, and qwd. This is described in a Word document that accompanies the download package. The preprocessor has also been updated for file checks. This is part of the Version 3.71 update.	9/12/2012

6	W2	Read input file	An input format bug was fixed for a system with more than 9 waterbodies.
			`DO JD=1,NDC`
			`!READ (CON,'(A8,(:9A8))')`
			`CDNAME2(JD),(CDWBC(JD,JW), JW=1,NWB)`
			`READ (CON,'(A8,(:9A8):/(8X,(:9A8)))')`
			`CDNAME2(JD),(CDWBC(JD,JW), JW=1,NWB)`
			`!cb 9/13/12`
			`END DO`
			`READ (CON,'(/)')`
			`! DO JF=1,NFL`
			`do jf=1,73 ! Fix this later`
			`!READ (CON,'(A8,(:9A8))')`
			`KFNAME2(JF),(KFWBC(JF,JW), JW=1,NWB)`
			`READ (CON,'(A8,(:9A8):/(8X,(:9A8)))')`
			`KFNAME2(JF),(KFWBC(JF,JW), JW=1,NWB)`
			`!cb 9/13/12`
			`END DO`
			
			This had the effect of turning OFF output for derived constituents for waterbody 10.
				9/13/2012

7	GUI	Time series elevation	The GUI read in values of ETSR as integers rather than real numbers. This was fixed.	10/30/12
8	W2	Spillways Lateral	Lateral spillways when connected to other model segments were sometimes not connecting as a tributary to the downstream segment. This has been fixed.	10/30/12
9	W2	W2Tools output	In place of the Vector Plot Output (VPL), a new output was added that allows use of the W2Tools post-processing package. This is part of the Version 3.71 update.	10/30/12
10	W2	User Manual	The User Manual has been updated with the new model features as shown in 5 and 9 above. In addition a separate user manual file shows how to use the w2tools post-processor. This is in the directory for W2tools. This is the version 3.71 update.	10/30/12

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added
11	W2	Water quality and temperature	A new calculation technique was added that eliminates calling the Tri-diagonal subroutine. These were built into the temperature and water quality subroutines. This change results in improvements in computational speed of from less than 5% to over 20% for water quality models with lots of water quality state variables.	10/30/2012
12	PREW2	More checks	Added more error trapping for input files. This is an effort for the error trapping to occur before the code bombs. Fixed a couple of regression errors as a result of this fix.	11/2/2012, 11/5/2012
13	Excel macro utility		Added an Excel macro utility to aid in writing out input files to CE-QUAL-W2	11/5/2012

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

14	W2	Withdrawal subroutine	Fixed an IF test that used the wrong variable in the dynamic port allocation algorithm. Also added code to allow the code to test for temperatures at the outlet levels specified.
			
			Deleted line of code is underlined followed by the fix.
			
			`DO J=1,NUMTSPLT !REODERING OUTLETS SO THAT HIGHEST ELEVATION STRUCTURE ON TOP (ASSUMING 2 SPLIT OUTLETS)`
			`! IF(TCNTR(J) == ' ST')THEN`
			`IF(TSPLTCNTR(J) == ' ST')THEN`
			`! cb 11/11/12`
			`IF(ESTR(JSTSPLTT(J,1),TSPLTJB(J)) < ESTR(JSTSPLTT(J,2),TSPLTJB(J)))THEN`
			`JSTSPLT(J,1)=JSTSPLTT(J,2)`
			`JSTSPLT(J,2)=JSTSPLTT(J,1)`
			`END IF`
			`! ELSE IF(TCNTR(J) == ' WD')THEN`
			`ELSE IF(TSPLTCNTR(J) == ' WD')THEN`
			`! cb 11/11/12`
			`IF(EWD(JSTSPLTT(J,1)) < EWD(JSTSPLTT(J,2)))THEN`
			
			…
			`IF(TSPLTJB(J) == JB .AND. TSPLTCNTR(J) == ' ST')THEN`
			`QALL=0.0`
			`DO JJ=1,NOUTS(J)`
			
			`QALL=QALL+QSTR(JSTSPLT(J,JJ),TSPLTJB(J)) ! SUM UP ALL THE FLOWS`
			`ELR = SINA(JB)*DLX(DS(JB))*0.5`
			`DO K=KTWB(JW),KB(DS(JB))`
			`IF (EL(K,DS(JB))-ELR < ESTR(JSTSPLT(J,JJ),TSPLTJB(J))) EXIT`
			`!SW 10/17/01`
			`END DO`
			`KSTR = K-1`
			`KSTRSPLT(JJ) = MIN(KSTR,KB(DS(JB)))`
			`ENDDO`
			`DO JJ=1,NOUTS(J) !`
			`cb 11/11/12 dividing total flow between outlets for temperature test`
			
			`QSTR(JSTSPLT(J,JJ),TSPLTJB(J)) = qall/real(nouts(j))`
			`ENDDO`
				11/13/12

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

15	W2	Reading in names of WQ variables	In case a user does not enter the units in graph.npt, the code improperly parses the WQ variable name. In this case the output name is a blank. To avoid this issue, extra code was added to preserve the variable name even if no units were added to the graph.npt list.
			
			`L1 = SCAN (CNAME(JC),',')+2`
			`IF(L1 == 2)L1=43 ! SW 12/3/2012 Implies no comma found`
			`L2 = SCAN (CNAME(JC)(L1:43),' ')+L1`
			`IF(L2 > 43)L2=43 ! SW 12/3/2012`
			`CUNIT(JC) = CNAME(JC)(L1:L2)`
			`CNAME1(JC) = CNAME(JC)(1:L1-3)`
			`CNAME3(JC) = CNAME1(JC)`
			`DO WHILE (L3 < L1-3)`
				12/3/2012

16	PREW2	SEDS and SEDK	The variable names were switched in reading the control file in the preprocessor perhaps leading to incorrect warnings/errors being tagged.
			
			The proper order was restored:
			`!READ (CON,'(/A8/(8X,2A8,6F8.0,A8))', ERR=400) AID, (SEDC(JW), PRNSC(JW), SEDCI(JW), seds(jw), SEDDK(JW), FSOD(JW), &`
			`!`
			`FSED(JW), sedbr(jw), DYNSEDK(JW), JW=1,NWB)`
			`! SW 6/1/07`
			`READ (CON,'(/A8/(8X,2A8,6F8.0,A8))', ERR=400) AID, (SEDC(JW), PRNSC(JW), SEDCI(JW), SEDDK(JW),seds(jw), FSOD(JW), &`
			
			`FSED(JW), sedbr(jw), DYNSEDK(JW), JW=1,NWB)`
			`! cb 12/30/12`
				12/30/12

17	Excel macro utility w2tool	Integer/Long variables	Some loose ends were corrected in the Visual Basic code built into the Excel macros.	1/2/2013
18	W2	TDG output	A series of code changes were made to fix some issues that arose for computing the impact of a structure on downstream TDG. These fixes were made in subroutines Withdrawal, outputa2w2tools, w2modules, and hydroinout. These affected calculation of output of dissolved gas concentration for output files for spillways or gates that had dissolved gas equation.	1/23/2013

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

19	W2	Reading in dynamic extinction coefficient	For temperature only studies, the model did not update the dynamic light extinction coefficient correctly. This has been fixed by the added code below:
			
			`DO JW=1,NWB`
			`IF (READ_EXTINCTION(JW))GAMMA(:,US(BS(JW)):DS(BE(JW))) = EXH2O(JW) ! SW 1/28/13`
			`KT = KTWB(JW)`
			`IF (.NOT. NO_HEAT(JW)) THEN`
				1/28/2013

20	W2	Input format when 9 WBs	A specific input read error occurred when 9 waterbodies were present as a result of an earlier bug fix: The new read statements occur in 2 places:
			
			`READ (CON,'(A8,9A8,/(:8X,9A8))')`
			`CDNAME2(JD),(CDWBC(JD,JW), JW=1,NWB)`
			`!cb 9/13/12 sw 2/18/13`
			
			`READ (CON,'(A8,9A8,/(:8X,9A8))')`
			`KFNAME2(JF),(KFWBC(JF,JW), JW=1,NWB)`
			`!cb 9/13/12 sw2/18/13`
				2/18/13

21	PREW2	More checks added	Additional checks were added to warn users of gaps in meteorological data when interpolation may be inappropriate.	2/20/2013
22	W2 User Manual	Updated	Updated User Manual – many small additions and edits – REV3.	2/20/2013
23	PREW2	Improved an error check	Updated an error check for choosing inactive segments for ISNP output	3/21/2013
24	PREW2	More checks added	Added checks for inflow temperature and tributary temperatures	3/28/2013

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

25	W2	Initial WL Calculation	Changed SLOPE to SLOPEC in init—u-elws.f90 routine since the normal depth should be based on SLOPEC.
			
			END IF
			FUNCVALUE=FLOW-XAREA*HRAD**0.6667*SLOPEC(JB)**0.5/FMANN
			! SW 4/5/2013
			
			RETURN
			END SUBROUTINE MANNINGS_EQN
			
			Also changed KB(I)-1 to KB(I)+1 for ELWS:
			
			IF(ABS(DX).LT.XACC .OR. FMID.EQ.0.)THEN
			ELWS(I)=RTBIS+EL(KB(I)+1,I)
			! SW 4/5/13
			RETURN
			
			Also changed KTTOP from REAL to an INTEGER:
			REAL :: XAREA, WSURF ! 4/5/13 SW
			INTEGER :: KTTOP ! 4/5/13 SW
				4/5/2013

25	W2	Output for pumps, spillways, gates	If the LAT option was chosen, the output files index for JWD was incorrect. This may have affected output temperatures and concentrations.	5/17/2013
26	PRE-W2	Mass loading calculation	There were cases where the preprocessor bombed while calculating the mass loading for output to the pre.opt file. This error has been fixed.	6/21./2013
27	W2	Assorted code updates	Minor format errors (that were ignored by compiler), update to code comments, and faster code initializations to speed up model performance were performed in several subroutines: input_PAR.f90, temperature_PAR.f90, transport_PAR.f90, update.f90, and w2_37_win.f90. An example of an initialization code speed up from temperature_PAR.f90: New code: DO K=KT,KB(I) AT(K,I) = 0.0D0; CT(K,I) = 0.0D0; VT(K,I) = 0.0D0 ! SW CODE SPEEDUP 6/15/13 ENDDO Old code AT(:,I) = 0.0D0; CT(:,I) = 0.0D0; VT(:,I) = 0.0D0	6/21/2013
28	W2 tools Excel macro	Update	More robust tools release	6/21/2013
29	PRE-W2	Label error	A label error for one spillway error was fixed. It mistakenly used 'gate'.	7/2/2013

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added
30	W2	CPL output	A slight change in output format for the 'raw' cpl output file format was made. No change was made in the tecplot output format. DO I=CUS(JB),DS(JB) WRITE (CPL(JW),'(A38/(9(F10.3,2X)))') CDNAME(CDN(JD,JW)),(CD(K,I,CDN(JD,JW))*CDMULT(CDN(JD,JW)), K=KTWB(JW),KB(I)) ! cb 6/28/13 end do !WRITE (CPL(JW),'(A38/(9(F10.3,2X)))') CDNAME(CDN(JD,JW)),((CD(K,I,CDN(JD,JW))*CDMULT(CDN(JD,JW)), & ! SW 8/12/06 !K=KTWB(JW),KB(I)),I=CUS(JB),DS(JB)) ! CB 1/03/05	7/31/13

31	W2	Read input file	A regression error that cropped up when there were 9 or greater than 10 waterbodies has been fixed. This had to do with reading in derived and flux variables in the control file.
			
			DO JD=1,NDC
			If(nwb < 10)READ (CON,'(A8,(:9A8))')
			CDNAME2(JD),(CDWBC(JD,JW), JW=1,NWB)
			If(nwb >= 10) READ
			(CON,'(A8,9A8,/(:8X,9A8))')
			CDNAME2(JD),(CDWBC(JD,JW), JW=1,NWB)
			!cb 9/13/12 sw 2/18/13 6/16/13
			END DO
			READ (CON,'(/)')
			! DO JF=1,NFL
			do jf=1,73 ! Fix this later
			If(nwb < 10)READ (CON,'(A8,(:9A8))')
			KFNAME2(JF),(KFWBC(JF,JW), JW=1,NWB)
			If(nwb >= 10) READ
			(CON,'(A8,9A8,/(:8X,9A8))')
			KFNAME2(JF),(KFWBC(JF,JW), JW=1,NWB)
			!cb 9/13/12 sw2/18/13 6/16/13
				8/13/13

32	W2	New compiler	Upgraded to the Intel XE 13.1.3.198 compiler. New W2 executables for 32 bit and 64 bit.	8/13/13

33	W2	INIT WL	An error was fixed in the initial water level computation program for rivers. The code below should have the subscript JB instead of J.
			
			DO JJW=1,NWB
			DO JJB=BS(JJW),BE(JJW)
			IF(DHS(JB) > US(JB) .AND.
			DHS(J) < DS(JJB))THEN
			JBD=JJB
			END IF
			END DO
				8/20/13

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

34	W2	INIT WL	There was an index error with gates in the initial water level computation. The old code is shown below:
			
			`IF(ELWS(ID) < WSUP)THEN`
			`IF(ELWS(IDSP(JS)) > WSUP)`
			`WSUP = ELWS(IDSP(JS)) ! CHECKING TO SEE IF DOWNSTREAM WS ELEVATION ISN'T ALREADY 'HIGH'`
			`ELWS(ID)=WSUP`
			
			The new code is
			
			`IF(ELWS(IDGT(JG)) > WSUP)`
			`WSUP = ELWS(IDGT(JG)) ! CHECKING TO SEE IF DOWNSTREAM WS ELEVATION ISN'T ALREADY 'HIGH'`
			`WX 8/21/13`
				8/21/2013

35	W2	GATE	Cleaning up some code in the gate algorithm.
			Old code:
			
			`IF (A2GT(JG) /= 0.0 .AND. IDGT(JG) /= 0.0) THEN`
			
			New code:
			
			`IF (A2GT(JG) /= 0.0 .AND. IDGT(JG) /= 0) THEN`
				8/21/2013

36	W2	TSS computation	Updated the computation for the derived variable TSS to include zooplankton and the particulate form of CBOD. A formula was added to the User Manual reflecting this change. New code includes
			
			`IF(CBODS(IBOD)>0.0)TOTSS(K,I) = TOTSS(K,I)+CBOD(K,I,IBOD)/O2OM(JW)`
			`! SW 9/5/13 Added particulate CBOD to TSS computation`
			
			`TOTSS(K,I) = TOTSS(K,I)+ZOO(K,I,JZ) ! SW 9/5/13 Added zooplankton to TSS computation`
				9/6/2013

37	W2	Spillway-LAT	When a spillway was defined with IDSP=0 and LAT, a tributary was defined incorrectly. The new code is shown below:
			
			`IF (IDSP(JS) /= 0)then ! cb 9/11/13`
			`JTT = JTT+1`
			`QTR(JTT) = QSP(JS)`
			`ITR(JTT) = IDSP(JS)`
			`PLACE_QTR(JTT) = PDSPC(JS) == 'DENSITY'`
			`SPECIFY_QTR(JTT) = PDSPC(JS) == 'SPECIFY'`
			`IF (SPECIFY_QTR(JTT)) THEN`
			`ELTRT(JTT) = ETDSP(JS)`
			`ELTRB(JTT) = EBDSP(JS)`
			`END IF`
			`JBTR(JTT) = JBD`
			`end if ! cb 9/11/13`
				9/11/2013

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added
38	W2	32 bit exe on XP	Recompiled with new settings from Visual Studio 2012 to (hopefully) run on XP systems with 32 bit OS	9/11/2013

39	W2	End Simulation	Added new close open files in the end_simulation subroutine. This is merely cleaning up the code to be consistent in closing all open files when a 'Stop' is executed. This should have no effect on the end user. Part of this new code is shown below:
			`IF(SELECTC == '  ON')then  ! SW 9/25/13 New Section on closing files`
			`ifile=1949`
			`do jb=1,nbr`
			`if(nstr(jb) > 0)then`
			`ifile=ifile+1`
			`close(ifile)`
			`endif`
			`enddo`
			`if(nwd > 0)then`
			`ifile=ifile+1`
			`close(ifile)`
			`endif`
			`endif`
			
			`IF (DOWNSTREAM_OUTFLOW) THEN`
			`JFILE=0`
			`DO JWD=1,NIWDO`
			`CLOSE(WDO(JWD,1))`
			`CLOSE(WDO(JWD,2))`
			`IF (CONSTITUENTS) THEN`
			`CLOSE (WDO(JWD,3))`
			`END IF`
			`IF (DERIVED_CALC) THEN`
			`CLOSE(WDO(JWD,4))`
			`END IF`
				9/25/13

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

40	W2	Pumps – Lateral	Fixed several sections of code in the PUMP algorithm in the hydroinout.f90 routine. Under some conditions such as specifying "Lateral", the PUMP algorithm may not have moved the water from the upstream to the downstream segment correctly. This has been fixed and tested. Part of the code changes are shown below:
			`IF (LATERAL_PUMP(JP)) THEN`
			`ELW = EL(KTWB(JWU),IUPU(JP))-Z(IUPU(JP))*COSA(JBU)`
			`! JWW = JWW+1 ! SW 9/25/13`
			`! JBWD(JWW) = JBU`
			`! IWD(JWW) = IUPU(JP)`
			`ELSE`
			`ELW = EL(KTWB(JWU),IUPU(JP))-Z(IUPU(JP))*COSA(JBU)-SINA(JBU)*DLX(IUPU(JP))*0.5`
			`! JSS(JBU) = JSS(JBU)+1 ! SW 9/25/13`
			`END IF`
			…
			`IF (PUMPON(JP)) THEN`
			`IF (LATERAL_PUMP(JP)) THEN`
			`JLAT = 1`
			`JWW = JWW+1`
			`! SW 9/25/13`
			…
			`CALL LATERAL_WITHDRAWAL ! (JWW)`
			`DO K=KTW(JWW),KBW(JWW)`
			`QSS(K,I) = QSS(K,I)-QSW(K,JWW)`
			`END DO`
			`IF (IDPU(JP) /= 0) THEN`
			`! MOVED CODE SW 9/25/13`
			`JTT = JTT+1`
			…
			`ELSE`
			`JSS(JBU) = JSS(JBU)+1 ! SW 9/25/13`
			`KTSW(JSS(JBU),JBU) = KTPU(JP)`
			…
				9/25/13

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

41	W2	Clean up memory issues	A series of minor memory issues were cleaned up. This should have no impacts on current model runs. These were usually uninitialized memory. Code changes made include:
			
			`READ (CON,'(/)')`
			`  KFNAME2='     '   ! SW 9/27/13 INITIALIZE ENTIRE ARRAY`
			`  KFWBC   ='     '   ! SW 9/27/13 INITIALIZE ENTIRE ARRAY`
			
			`READ (CON,'(//(:8X,9I8))')          (KBWD(JW), JW=1,NWD); TRC= '       '  ! SW 9/27/13 INITIALIZATION SINCE ALLOCATION IS TO NTRT`
			`  READ (CON,'(//(:8X,9A8))')          (TRC(JT), JT=1,NTR)`
			
			`    EHSN(JE),   EHSSI(JE), JE=1,NEPT)        !JE=1,NEP)  SW 9/27/13`
			`  READ (CON,'(//(8X,2F8.0,I8,F8.0))') (ESAT(JE), EHS(JE),    ENEQN(JE),  ENPR(JE), JE=1,NEPT)        !JE=1,NEP)  SW 9/27/13`
			`  READ (CON,'(//(8X,8F8.0))')         (ET1(JE), ET2(JE),    ET3(JE),    ET4(JE),    EK1(JE), EK2(JE),                          &`
			`                                       EK3(JE), EK4(JE), JE=1,NEPT)        !JE=1,NEP)  SW 9/27/13`
			`  READ (CON,'(//(8X,6F8.0))')         (EP(JE), EN(JE),     EC(JE),     ESI(JE),    ECHLA(JE), EPOM(JE),    JE=1,NEPT)        !JE=1,NEP)  SW 9/27/13`
			
			`READ (CON,'(//8X,A8,I8,A8)')         RSOC, NRSO,    RSIC; RSOD=0.0 ! SW 9/27/13 INITIALIZE SINCE ALLOCATED AS NOD BUT ONLY NRSO USED`
			`  READ (CON,'(//(:8X,9F8.0))')        (RSOD(J), J=1,NRSO)`
			
			`  READ (CON,'(//8X,I8,F8.0,a8)')         NDLT, DLTMIN, DLTINTER; DLTD=0.0  ! SW 9/28/13 INITIALIZE ARRAY TO NOD SINCE ONLY NDLT ASSIGNED`
			`  READ (CON,'(//(:8X,9F8.0))')        (DLTD(J), J =1,NDLT)`
			
			`   SINKC(1:NSTR(JB),JB) = SINKCT(1:NSTR(JB),JB)`
			`    POINT_SINK(1:NSTR(JB),JB) = SINKC(1:NSTR(JB),JB) == '   POINT'   ! SW 9/27/13`
			`  END DO`
			` ! POINT_SINK = SINKC == '   POINT'`
			
			`  COLDEP=ELWS(I)-COLB`
			`   !     MACT(J,KT,I)=MACT(J,KT+1,I)`
			`  IF(MACROPHYTE_ON)MACT(J,KT,I)=MACT(J,KT+1,I) ! SW 9/28/13`
			
			`!     SDKV(:,US(JB):DS(JB))=SDK(JW)`
			`       SDKV(:,US(JB)-1:DS(JB)+1)=SDK(JW)    ! SW 9/28/13`
				9/27/13

42	W2	CPL output	Code was added to eliminate writing out the habitat index to the CPL file for Tecplot when HABITATC is OFF.
			IF(I /= DS(JB)+1)THEN
			IF(HABTATC == ' ON')THEN
			WRITE (CPL(JW),9999)
			X1(I),ELWS(I),U(K,I),-
			W(K,I),T1(K,I),RHO(K,I),HAB(K,I),(C2(K,I,CN(JC))
			,JC=1,NAC)
			ELSE
			WRITE (CPL(JW),9999)
			X1(I),ELWS(I),U(K,I),-
			W(K,I),T1(K,I),RHO(K,I),(C2(K,I,CN(JC)),JC=1,NAC
			)
			ENDIF
			ELSE
			XDUM=-99.0
			WRITE (CPL(JW),9999)
			X1(I),ELWS(I),XDUM,XDUM,XDUM,XDUM,XDUM,(XDUM,
			JJ=1,NAC)
			ENDIF
			DO K=KTWB(JW),KMX-1
			IF(I /= DS(JB)+1 .AND. K <=
			KB(I))THEN
			IF(HABTATC == ' ON')THEN
			WRITE (CPL(JW),9999)
			X1(I),ELWS(I)-DEPTHM(K,I),U(K,I),-
			W(K,I),T1(K,I),RHO(K,I),HAB(K,I),(C2(K,I,CN(JC))
			,JC=1,NAC)
			ELSE
			WRITE (CPL(JW),9999)
			X1(I),ELWS(I)-DEPTHM(K,I),U(K,I),-
			W(K,I),T1(K,I),RHO(K,I),(C2(K,I,CN(JC)),JC=1,NAC
			)
			ENDIF
			IF(K == KB(I))THEN
			IF(HABTATC == '
			ON')THEN
			WRITE (CPL(JW),9999)
			X1(I),ELWS(I)-DEPTHB(K,I),U(K,I), -
			W(K,I),T1(K,I),RHO(K,I),HAB(K,I),(C2(K,I,CN(JC))
			,JC=1,NAC)
			ELSE
			WRITE (CPL(JW),9999)
			X1(I),ELWS(I)-DEPTHB(K,I),U(K,I), -
			W(K,I),T1(K,I),RHO(K,I),(C2(K,I,CN(JC)),JC=1,NAC
			)
			ENDIF
			WRITE (CPL(JW), *)'TITLE="CE-QUAL-W2"'
			IF(HABTATC == ' ON')THEN
			WRITE
			(CPL(JW),19233)(CNAME2(CN(JN)),JN=1,NAC)
			ELSE
			WRITE
			(CPL(JW),19234)(CNAME2(CN(JN)),JN=1,NAC)
			ENDIF ! sw 9/28/13
			19233
			FORMAT('VARIABLES="Distance, m","Elevation,
			m","U","W","T","RHO", "HABITAT"
			',<NAC>(',"',A8,'"'))
			19234 FORMAT('VARIABLES="Distance,
			m","Elevation, m","U","W","T","RHO"
			',<NAC>(',"',A8,'"')) ! sw 9/28/13
				9/28/13

43	W2	SPECIFY TRIB	In specifying the elevation between top and bottom for an inflow tributary, the code put the inflow 1 layer	10/3/2013

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

			below it should have been in many cases. This has been fixed by the additional code shown below:
			
			`IF (SPECIFY_QTR(JT)) THEN`
			`KTTR(JT) = 2`
			`! DO WHILE (EL(KTTR(JT),I) > ELTRT(JT))`
			`DO WHILE (EL(KTTR(JT),I) > ELTRT(JT) .and. EL(KTTR(JT)+1,I) > ELTRT(JT)) ! SW 10/3/13`
			`KTTR(JT) = KTTR(JT)+1`
			`END DO`	

44	W2	CWO or CWDO output	Fixed a format overflow in writing out concentrations in a withdrawal output file.
			
			`IF (QWDO(J) /= 0.0) CWDO(CN(JC),J) = CWDO(CN(JC),J)/QWDO(J)`
			`WRITE (CWDOC(CN(JC)),'(F8.3)') CWDO(CN(JC),J) ! SW 9/23/13 Changed format from G8.3 to F8.3 to avoid format overflow`
			`CWDOC(CN(JC)) = ADJUSTR(CWDOC(CN(JC)))`
			
			`IF (QWDO(J) /= 0.0) CDWDO(CDN(JD,JW),J) = CDWDO(CDN(JD,JW),J)/QWDO(J)`
			`WRITE (CDWDOC(CDN(JD,JW)),'(F8.3)') CDWDO(CDN(JD,JW),J) ! SW 9/23/13 Changed format from G8.3 to F8.3 to avoid format overflow`
			`CDWDOC(CDN(JD,JW)) = ADJUSTR(CDWDOC(CDN(JD,JW)))`
				10/4/2013

45	W2 and PREW2	Inflow, Tributary, Distributary and Shade inputs	Added csv file format as a new file input format for flow and temperature files for inflows, tributaries and distributed tributaries. Also, the shade file is now in csv file format. This enhancement includes updates to the preprocessor and W2 codes. Also several minor bug fixes were made on the Preprocessor.	7/15/14

46	W2	Resuspension of inorganic solids	A resuspension formula was corrected. See the code change below:
			
			`HS = 0.283 *U2/G*0.283*TANH(COEF1)*TANH(COEF2/TANH(COEF1))`
			`!TS = 2.0*PI*U2/G*1.2* TANH(COEF3)*TANH(COEF4/TANH(COEF3))`
			`TS = 2.0*PI*sqrt(U2)/G*1.2* TANH(COEF3)*TANH(COEF4/TANH(COEF3)) ! cb 5/9/14`
				7/15/14

47	W2	Tecplot output	When the user sets CPL output for Tecplot, the output format when HABITAC=OFF was incorrect. This has been fixed.	7/15/14

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

48	PREW2	Warnings	Fixed a name inconsistency for developing warnings for input concentrations
			
			`!    IF (NAME /= 'Residence time' .AND. NAME /= 'Water age') THEN`
			`IF (NAME /= 'Residence time' .AND. NAME /= 'AGE') THEN     ! SW 7/15/14`
			`CALL WARNINGS`
				7/15/14

49	W2	TSR filename	The filename in w2_con.npt for TSR is used for the output filenames. In order to account for complex paths that include more than one '.', the following change was made with the BACK=.TRUE. command which checks from the right-hand-side rather than left-hand-side of the character string
			
			`!       L1 = SCAN(TSRFN,'.')`
			`L1 = SCAN(TSRFN,'.',BACK=.TRUE.)`
				8/22/14

50	PREW2	Hydraulic structure warnings	Added many new hydraulic structure warnings (gates, spillways, pumps, pipes, internal weirs) for cases where KBSTR was less than KB and fixed a few error messages for these structure checks.	9/10/14
51	W2	TSR output	The time series file has added the surface heat flux terms (net, short wave solar net, long wave radiation net, back radiation heat flux, evaporation heat flux, conductive heat flux) to the output. The manual was also updated.	1/15/15

52	W2	Interpolation of wind direction	In some cases, the wind direction interpolation was incorrect. Code was added to reduce the wind direction angle to less than 2*pi before the interpolation is performed and to consider another possible interpolation case. Thanks to Wenwei Xu for pointing this out. New code is shown below:
			
			`! CONVERT PHIO AND PHINX TO LESS THAN 2*PI     SW 2/13/15`
			`DO WHILE(PHIO(JW)>2.*PI)`
			`PHIO(JW)=PHIO(JW)-2.*PI`
			`ENDDO`
			`DO WHILE(PHINX(JW)>2.*PI)`
			`PHINX(JW)=PHINX(JW)-2.*PI`
			`ENDDO`
			`IF (PHIO(JW)-PHINX(JW) > PI) THEN`
			`PHI(JW) = (1.0-RATIO)*(PHINX(JW)+2.0*PI)+RATIO*PHIO(JW)`
			`ELSEIF (PHIO(JW)-PHINX(JW) < -PI) THEN ! WX 2/13/15`
			`PHI(JW) = (1.0-RATIO)*PHINX(JW)+RATIO*(PHIO(JW) +2.0*PI)    ! WX 2/13/15`
			`ELSE`
			`PHI(JW) = (1.0-RATIO)*PHINX(JW)+RATIO*PHIO(JW)`
			`END IF`
				2/13/15

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

53	W2	Withdrawal	Stewart Rounds: Extra check to avoid divide by zero in withdrawal algorithm (this or similar code occurs in 4 subroutines in withdrawal.f90)
			
			IF ((ELSTR-HSWB) > EL(KBOT+1,ID)) THEN
			DLRHOB = ABS(RHO(KSTR,ID)-RHO(KBOT,ID))
			ELSE IF ((EL(KBOT+1,ID)-ELR) == ELSTR) THEN
			!SR 03/24/13
			DLRHOB = NONZERO
			!SR 03/24/13
			ELSE
			DLRHOB = ABS(RHO(KSTR,ID)-RHO(KBOT,ID))*HSWB/(ELSTR-(EL(KBOT+1,ID)-ELR))
				4/9/2015

54	W2	SELECTC	The USGS has developed a new automatic port selection algorithm. In the control file, w2_con.npt, one can use the new algorithm by setting SELECTC='USGS'. The old algorithm is used when this is set to SELECTC= 'ON'. There is new documentation in the User Manual for this new algorithm.	4/9/2015
55	W2	Restart output	Added code to write out a restart file (rso.opt) at the end of a run if restart_output is ON.	4/9/15
56	W2 Examples	Added example problems	Added new example problem for the Spokane River using new csv file inputs and 4 example problems for using the USGS auto-port algorithm	4/9/15

57	W2	Restart for file volume_wbX.opt	The file handler was not closed properly for volume_wbX.opt. Fixed it with additional code in endsimualtion.f90:
			`if(nwd > 0)then`
			`ifile=ifile+1`
			`close(ifile)`
			`endif`
			`do jw=1,nwb ! sw 4/20/15`
			`ifile=ifile+1 ! sw 4/20/15`
			`close(ifile) ! sw 4/20/15`
			`enddo ! sw 4/20/15`
				4/20/15

58	W2	W2selective.npt	Changed input format for critical temperatures for the output file volume_wbX.opt from a maximum of 10 waterbodies to 100. `READ(1010,'(8X,100F8.0)')(TEMPCRIT(JW,J),JW=1,NWB) ! NOTE MAX OF 100 WATERBODIES sw 4/20/15`	4/20/15
59	W2	Resuspension of SS	Changed DO loop index in suspended solids resuspension in water_quality.f90 from DO K=KT-1,KB(I)-1 to DO K=KT+1,KB(I)-1 ! cb 9/29/14	5/14/2015

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added
60	W2	Wind at 2 m	The W2 model computes the wind at a 2 m height based on the used defined measurement height of the wind for evaporation computations. The formula for computing this variable was using a step function of the wind data rather than interpolation of the wind data when the user chose to interpolate meteorological data. For meteorological input data at short time intervals this is a very minor change. For meteorological data at large time intervals (like a day), this could affect the amount of evaporation. Hence, the calculation below was moved from the TVDS routine to the main routine so that the interpolated wind would be used. `WIND2(I)=WIND(JW)*WSC(I)*DLOG(2.0D0/Z0(JW))/DLOG(WINDH(JW)/Z0(JW))`	5/21/15
61	W2	TSR output	The TSR file output now also includes a volume weighted vertical average temperature for the segment that the TSR file is located. The manual has been updated also.	6/1/15

62	W2	Writing over output files	In some intermittent cases, when the dialog box closes, the model reinitializes some of the output files (effectively deleting the output). The following line of code was adding at the beginning of the main W2 code to prevent this:
			
			`!**`
			`Task 1: Inputs`
			`**`
			`!**********...`
			
			`INTEGER(4) length,istatus`
			`character*255 dirc`
			`! call omp_set_num_threads(4) ! set # of processors to NPROC Moved to INPUT subroutine`
			`IF(END_RUN)STOP ! SW 6/26/15 Added code to prevent a thread from reinitializing output files as dialog box is closing...intermittant error`
				6/26/15

63	W2	Output order for kinetic fluxes	The output columns for DOAR and DOER were switched in the output file kflux_jw*.opt. The model code was changed to fix this. ! DOAR => KF(:,:,56); DOEP => KF(:,:,57); DOER => KF(:,:,58); DOPOM => KF(:,:,59); DODOM => KF(:,:,60) DOEP => KF(:,:,56); DOAR => KF(:,:,57); DOER => KF(:,:,58); DOPOM => KF(:,:,59); DODOM => KF(:,:,60) ! cb 9/16/2015	9/16/15

W2 V3.6 Bug Fixes, Enhancements, and User Manual Changes

Table 7. Bug fixes and enhancements for Version 3.6.

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added
1	W2	TKE1 model	The variable STRICK was incorrectly allocated as an INTEGER rather than REAL.	10/11/2008
2	W2	PIPE	Code was streamlined in the subroutine ZBRENT where calls were made directly to CDFUNC rather than through the dummy function FUNC	10/11/2008
3	W2 Manual	Z0	The User Manual had Z0 in an incorrect line in the control file (w2_con.npt). The write up and example control file in the User Manual were corrected.	10/28/2008
4	W2	Longitudinal profile input	The W2 program did not read initial constituent concentrations in the longitudinal profile file when CCC was 'OFF'. This has been fixed.	12/4/2008
5	W2	TECPLOT output	When using TECPLOT output for multiple waterbodies, the output format did not allow loading the information into TECPLOT. Fixed.	1/26/2009

6	W2	Epiphyton input	For entering vertical profile data for periphyton, there was an index error:
			OLD CODE:
			IF (VERT_EPIPHYTON(JW,JE)) EPD(:,I,JE) = EPIVP(K,JW,JE)
			NEW CODE:
			IF (VERT_EPIPHYTON(JW,JE)) EPD(:,I,JE) = EPIVP(:,JW,JE)
				5/21/2009

7	PreW2	Constituent loads	An enhancement was added to the Preprocessor to compute loads in kg/day for all inflow, tributary and distributed tributaries. Also, these are summed up for the model application. These are shown in the file “pre.opt”. These are approximate loads since the concentration data are used to set the frequency of loading update. Flow rates at the time of the concentration input data are used to compute load.	5/21/2009

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

8	W2	Gas transfer at spillways	A couple code fixes in the hydroinout.f90 subroutine:
			(1) CGAS needed to be initialized in some cases to CGAS=C2(K,ID,CN(JC)) prior to calling the subroutine TOTAL_DISSOLVED_GAS for use in the Butts and Evans (1983) equation:
			NEW CODE:
			`CGAS=C2(K,ID,CN(JC))  ! MM 5/21/2009`
			(2) Change logic in several lines from
			IF(CAC(NDO) == ' ON' to
			IF(CAC(NDO) == ' ON' .and. CN(JC)==NDO
			NEW CODE:
			`IF (CN(JC)==NDO .AND. CAC(NDO) == ' ON' .AND. GASSPC(JS) == ' ON' .AND. QSP(JS) > 0.0) THEN`
			! MM 5/21/2009
				5/21/2009

9	W2	Reaeration from dams	An error was found in the formulae from Butts and Evans (1983).
			OLD CODE:
			`DB = SAT-C`
			`DA = DB*(1.0+0.38*AGASGT(N)*BGASGT(N)*CGASGT(N)*(1.0-0.11*CGASGT(N))*(1.0+0.046*T))`
			`C = SAT-DA`
			NEW CODE:
			`DA = SAT-C`
			`! MM 5/21/2009 DA: Deficit upstream`
			`DB = DA/(1.0+0.38*AGASSP(N)*BGASSP(N)*CGASSP(N)*(1.0-0.11*CGASSP(N))*(1.0+0.046*T))`
			`! DB: deficit downstream`
			`C = SAT-DB`
				5/21/2009

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added
10	W2	Order of flux parameters	The order of flux parameters in the User Manual and output were incorrect. The control file has them in this order: RPOMSET CBODDK **DOAP** **DOAR** **DOEP** **DOER** DOPOM DODOM DOOM whereas the code assumed they were in this order: RPOMSET CBODDK **DOAP** **DOEP** **DOAR** **DOER** DOPOM DODOM DOOM This has been corrected. The User Manual and control file order is now reflected in the W2 code.	6/2/2009

11	Pre	False errors for inflow location	The preprocessor sometimes gave false errors in the pre.err for tributary, internal weirs, pipes, and other hydraulic features saying that the pipe or tributary was below the elevation of the bottom of the segment. The W2 model ran fine even with this error message given in the preprocessor. This has been fixed.
			
			Example of OLD CODE:
			`IF (EBTR(JT) < EL(KB(ITR(JT)+1),ITR(JT))) THEN`
			`CALL ERRORS`
			`WRITE (ERR,FMTFI) 'Inflow placement bottom elevation [EBTR=',EBTR(JT),'] < bottom active cell elevation for tributary ',JT`
			
			New CODE:
			`IF (EBTR(JT) < EL(KB(ITR(JT))+1,ITR(JT))) THEN`
			`CALL ERRORS`
			`WRITE (ERR,FMTFI) 'Inflow placement bottom elevation [EBTR=',EBTR(JT),'] < bottom active cell elevation for tributary ',JT`
				6/18/09

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added
12	Pre	Additional error checking	Additional error checking was added to help debug an error in the bathymetry file when the problem was in the branch connectivity specifically BS and BE. Also, a false error was given when the temperature had an isothermal initial condition, constituents were OFF, and an initial concentration was set to "-2". This was fixed.	6/22/09
13	Pre	Command line processing and working directory displayed for windows	In the windows version of the preprocessor, the user can now supply a command line argument that sets the working directory of the code. Hence, one does not need to copy the preprocessor into every directory. In a batch file, for example, one can execute the following command: `preW2_ivf.exe "C:\scott\w2workshop\2009 workshop\waterqual\problem3"` The preprocessor now uses the supplied directory (in double quotes) as the working directory for all the files. The command line argument has one blank space between the end of the executable and the first quote. Also, the working directory is now displayed at the top of the window. Additional checks were also added for checking the grid linkage.	9/12/09

14	W2	# of processors	The model user can now control the # of physical processors the model uses. At this point, dual-processor model runs have shown an improvement of about 20% over a single processor. But, QUAD processors usually are slower. It is recommended that NPROC be set to 2 in the control file. The user can experiment on his/her own system. If this is not set by the user or is left blank, the model still runs but sets it to 2 processors.
			
			`GRID  NWB  NBR  IMX  KMX  NPROC  CLOSEC`
			`1  1  23  22`
			`2  ON`
				9/12/09

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added
15	W2	Command line processing for windows	In the windows version of the w2 model, the user can now supply a command line argument that sets the working directory of the code. Hence, one does not need to copy the model executable into every directory. In a batch file, for example, one can execute the following command: `W2_ivf.exe "C:\scott\w2workshop\2009 workshop\waterqual\problem3"` The w2 model now uses the supplied directory (in double quotes) as the working directory for all the files. The command line argument has one blank space between the end of the executable and the first quote. The working directory is displayed in a text box in the window.	9/12/09

16	W2	W2 window closed at end of successful execution	At the end of a windows run, the windows dialog box waits for the user to press 'close' to exit the window. This allows the user to examine the final run parameters. In the w2_con.npt file there is now an option to close this window when the run has completed. If this option is not set, then the dialog box will stay until the user clicks 'close'.
			
			This allows for efficient batch processing of the model, especially if user in conjunction with command line processing mentioned in #15.
			
			`GRID NWB NBR IMX KMX`
			`NPROC CLOSEC`
			`1 1 23 22`
			`0 ON`
			
			When CLOSEC is set to ON, then the dialog box will disappear once the run finishes. If it is set to OFF, then the dialog box will remain until the user clicks 'close'.
				9/12/09

17	User Manual	Updates	Updates and changes to the control file (#13-#16) were reflected in an updated User Manual.	9/12/09

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added
18	GUI	Updates	The GUI was updated with the following: (1) new control file parameters NPROC and CLOSEC were added (see #14 and 16). There is also a SELECTC that will be used in V3.7 that has been included – ignore it for now. (2) The GUI also can be controlled by command line passing of the working directory and file. In a batch program or from the command line in a DOS box you can execute the GUI as follows: `"C:\scott\research\corps of engineers\tomcole\w2code\GUI36\w2control\w2control36.exe" C:\scott\w2workshop\2009 workshop\waterqual\problem1\w2_con.npt` The first string in quotes executes the GUI. The command line argument is NOT in quotes. This program was developed in VB6 and does not take quotes around the command line. Note that this is different than the FORTRAN command line argument. So the above command will open the GUI and load the control file automatically. (3) A text box now shows the file path and name of the file that you are working on (4) In file open, earlier all *.npt files were shown. Since only "w2_con.npt" files are loaded into the GUI, only the "w2_con.npt" file was shown for opening.	9/12/09

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

19	W2	Gates, spillways, pipes	Whenever DOWN was specified for a gate, spillway or pump, the model estimated the water level at the end of the segment, rather than using the branch center water level. This is important in sloping river systems where a long segment may have a water surface elevation drop between the segment center and the edge. In the past this was computed assuming the slope of the channel. This was updated to estimate the water surface elevation using linear interpolation rather than the grid slope. Below is an example of the code fix – in this case for GATES:
			
			OLD CODE:
			`ELIU=ELWS(IUGT(JG))-`
			`SINA(JBUGT(JG))*DLX(IUGT(JG))*0.5`
			
			NEW CODE:
			`ELIU= ELWS(IUGT(JG)) + (ELWS(IUGT(JG))-`
			`ELWS(IUGT(JG)-`
			`1))/(0.5*(DLX(IUGT(JG))+DLX(IUGT(JG)-`
			`1)))*DLX(IUGT(JG))*0.5
				9/25/09

20	W2	New executable	A new executable was made using a new release of Intel Version 11 compiler that corrected problems with Windows 7 applications.	9/25/09

21	W2	ICE cover algorithm	There were a couple logic errors in the ice cover algorithm. These were corrected below:
			!************** Ice thickness
			ICETH(I) = ICETH(I)+ICETHU+ICETH1+ICETH2
			IF (ICETH(I) < ICE_TOL) ICETH(I) = 0.0
			IF (WINTER .AND. (.NOT. ICE_IN(JB))) THEN
			IF (.NOT. ALLOW_ICE(I)) ICETH(I) = 0.0
			END IF
			ICE(I) = ICETH(I) > 0.0
			IF (ICE(I))THEN ! 3/27/08 SW
			ICESW(I) = 0.0
			ELSE
			ICESW(I) = 1.0
			ENDIF
			ICETHU = 0.0
			ICETH1 = 0.0
			ICETH2 = 0.0
			IF (ICETH(I) < ICE_TOL .AND. ICETH(I) > 0.0) ICETH(I) = ICE_TOL
			ELSE
			IF(TERM_BY_TERM(JW))CALL EQUILIBRIUM_TEMPERATURE ! SW 10/20/09 Must call this first otherwise ET and CSHE are 0
			HIA = 0.2367*CSHE(I)/5.65E-8
			! JM 11/08 convert SI units of m/s to English (btu/ft2/d/F) and then back to SI W/m2/C
			! ICETH(I) = MAX(0.0,ICETH(I)+DLT*((RIMT-ET(I))/(ICETH(I)/RK1+1.0/HIA)-(T2(KT,I)-RIMT))/RHOIRL1) ! OLD CODE
			ICETH(I) = MAX(0.0,ICETH(I)+DLT*((RIMT-ET(I))/(ICETH(I)/RK1+1.0/HIA)-HWI(JW)*(T2(KT,I)-RIMT))/RHOIRL1) ! SW 10/20/09 Revised missing HWI(JW)
			ICE(I) = ICETH(I) > 0.0
			ICESW(I) = 1.0
			IF (ICE(I)) THEN
			! TFLUX = 2.392E-7*(RIMT-T2(KT,I))*BI(KT,I)*DLX(I) ! OLD CODE
			TFLUX = 2.392E-7*HWI(JW)*(RIMT-T2(KT,I))*BI(KT,I)*DLX(I) ! SW 10/20/09 Revised missing HWI(JW)
			TSS(KT,I) = TSS(KT,I)+TFLUX
			TSSICE(JB) = TSSICE(JB)+TFLUX*DLT
			ICESW(I) = 0.0
			END IF
			END IF
			END DO
			END IF
			END IF
				10/20/09

22	W2	Gates output in QWD file	The following bug was found in defining which branch a gate was located. This affected the output for the	3/24/10

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

			withdrawals at a location where there were gates that were not tied to other branches.
			
			Old code:
			`JWUGT(JG) = JW`
			`IF (IDGT(JG) > 0) THEN`
			`DO JB=1,NBR`
			`IF (IDGT(JG) >= US(JB) .AND. IDGT(JG) <= DS(JB)) EXIT`
			`END DO`
			`JBDGT(JG) = JB`
			`DO JW=1,NWB`
			`IF (JB >= BS(JW) .AND. JB <= BE(JW)) EXIT`
			`END DO`
			`JWDGT(JG) = JW`
			`else ! BUG FIX 9/27/07`
			`jbdgt(jp)=1`
			`jwdgt(jp)=1`
			`END IF`
			
			New code:
			`JWUGT(JG) = JW`
			`IF (IDGT(JG) > 0) THEN`
			`DO JB=1,NBR`
			`IF (IDGT(JG) >= US(JB) .AND. IDGT(JG) <= DS(JB)) EXIT`
			`END DO`
			`JBDGT(JG) = JB`
			`DO JW=1,NWB`
			`IF (JB >= BS(JW) .AND. JB <= BE(JW)) EXIT`
			`END DO`
			`JWDGT(JG) = JW`
			`else ! BUG FIX 9/27/07`
			`jbdgt(jg)=1 ! SW 3/24/10`
			`jwdgt(jg)=1 ! SW 3/24/10`
			`END IF`	

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

23	PreW2	Reading of WSC	Reading in of the WSC file was limited to only 100 dates in the preprocessor. This limitation was fixed by the code shown below:
			`!  DO J=1,100`
			`  28995 continue  ! cb 3/26/10`
			`  READ (NPT,'(10F8.0:/(8X,9F8.0))',END=29000) SDAY,(WSC(I),I=1,IMX)`
			`  IF (SDAY <= SDAYO) THEN`
			`  CALL ERRORS`
			`  WRITE (ERR,'(3(A,F0.3))') 'Julian date ',SDAY,' <= previous date of ',SDAYO,' in '//WSCFN`
			`  END IF`
			`  DO I=1,IMX`
			`  IF(WSC(I) <= 0.0)THEN`
			`  CALL ERRORS`
			`  WRITE (ERR,'(A,F0.3,A,I4,A)') 'Julian date ',SDAY,': WSC AT SEG(I)=',I,' <= 0.0 in '//WSCFN`
			`  ENDIF`
			`  IF (WSC(I) > 2.0) THEN`
			`  CALL WARNINGS`
			`  WRITE (WRN,'(A,F0.3,A,I4,A)') 'Julian day ',SDAY,': WSC(I) AT SEG(I)=',I,' > 2.0 in '//WSCFN`
			`  END IF`
			`  IF (WSC(I) > 0.0 .and. wsc(i) < 0.5) THEN`
			`  CALL WARNINGS`
			`  WRITE (WRN,'(A,F0.3,A,I4,A)') 'Julian day ',SDAY,': WSC(I) AT SEG(I)=',I,' < 0.5 in '//WSCFN`
			`  END IF`
			`  ENDDO`
			`  SDAYO=SDAY`
			`  ! ENDDO`
			`  go to 28995  ! cb 3/26/10`
				3/26/10

24	PreW2	Check on LAT or DOWN	Added an enhancement to do a check in case a spillway, pipe, pump, or gate was specified as 'DOWN'. In all cases where 'DOWN' is specified, the segment that the hydraulic structure originates must be at the end of a branch. Additional logic was added to check for this in all the hydraulic structures.	3/26/10
25	W2 Manual	Light extinction, ice	Added more text to the section on computation of light extinction and inserted a missing reference. Revised an equation for clarity in ICE algorithm and added more explanation on how to estimate HICE.	4/13/2010
26	W2 Manual	Precipitation input file	The units of precipitation are in m/s. The example precipitation input file was changed to more realistic values.	4/14/2010

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

27	W2	ICE	Added code to account for the need to compute long wave radiation in case user chose the equilibrium temperature approach. Fixed subscript error in ice melt computation. Also, made the variable TICE double precision since it is assumed double precision in the call to Surface_terms.
			
			New code:
			`IF (ICE(I)) THEN`
			`TICE = TAIR(JW)`
			`DEL = 2.0`
			`J = 1`
			
			`if(tair(jw).ge.5.0)then ! SW 4/19/10`
			`RANLW(JW) = 5.31E-13*(273.15+TAIR(JW))**6*(1.0+0.0017*CLOUD(JW)**2)*0.97`
			`else`
			`RANLW(JW) = 5.62E-8*(273.15+TAIR(JW))**4*(1.-0.261*exp(-7.77E-4*TAIR(JW)**2))*(1.0+0.0017*CLOUD(JW)**2)*0.97`
			`endif`
			
			`RN1=SRON(JW)/(REFL*RHOWCP)*SHADE(I)*(1.0-ALBEDO(JW))*BETAI(JW)+RANLW(JW)`
			`! SW 4/19/10`
			`DO WHILE (DEL > 1.0 .AND. J < 500)`
			`CALL SURFACE_TERMS (TICE)`
			`RN(I) = RN1-RB(I)-RE(I)-RC(I) ! 4/19/10`
			`! RN(I) = SRON(JW)/(REFL*RHOWCP)*SHADE(I)*(1.0-ALBEDO(JW))*BETAI(JW)+RANLW(JW)-RB(I)-RE(JW)-RC(I) ! OLD CODE`
			`DEL = RN(I)+RK1*(RIMT-TICE)/ICETH(I)`
			`IF (ABS(DEL) > 1.0) TICE = TICE+DEL/500.0`
			`J = J+1`
			`END DO`
				4/19/10

28	W2	Evaporation	Units for EV in the SNP file were given in m/s but were actually m^3/s	4/21/10

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

29	W2	Ice	In the ice melt algorithm, SRON should not have been divided by RHOCP in computing RN1 and DEL in the DO WHILE loop should have been ABS(DEL) rather than DEL:
			
			`RN1=SRON(JW)/REFL*SHADE(I)*(1.0-ALBEDO(JW))*BETAI(JW)+RANLW(JW)`
			`! SW 4/19/10 eliminate spurious divsion of SRO by RHOCP`
			`DO WHILE (ABS(DEL) > 1.0 .AND. J < 500)`
			`! SW 4/21/10 Should have been ABS of DEL`
			`CALL SURFACE_TERMS (TICE)`
				4/21/2010

30	PRE	Constituent loading	The output from the preprocessor in the pre.opt file for constituent loading was in kg rather than the output header of kg/day. The output was updated to kg/day by adding the following lines of code:
			
			`cdtload(incdt(1:NACdt(Jb),Jb),jb)=cdtload(incdt(1:NACdt(Jb),Jb),jb)/(jday-tstart)`
			`! CB 5/10/10 Change units to kg/day`
			
			`ctrload(trcn(1:NACtr(Jt),Jt),jt)=ctrload(trcn(1:NACtr(Jt),Jt),jt)/(JDAY-TSTART)`
			`!CB 5/11/10 convert to units of kg/day`
				5/10/10

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

31	W2	Gate, spillways, pipes	In the case where the user has specified that the flow is DOWN, in the case of reverse flow, the model did not assign the flow correctly if the user had no other tributaries or withdrawals specified in the control file. For this rare event, additional code was written to account for this fact. Also, a logic error was discovered in reverse flow for spillways and gates. This was corrected.
			
			New code added to hydroinout.f90:
			
			`JWW = NWD`
			`withdrawals = jww > 0 ! 6/4/10 SW`
			`JTT = NTR`
			`tributaries = jtt > 0 ! 6/4/10 SW`
			`JSS = NSTR`
			`IF (SPILLWAY) THEN`
			…
			`END IF`
			`tributaries = jtt > 0 ! 6/4/10 SW`
			`withdrawals = jww > 0 ! 6/4/10 SW`
			
			`DO JW=1,NWB`
			`KT = KTWB(JW)`
			`DO JB=BS(JW),BE(JW)`
			
			New code in gate-spill-pipe.f90:
			
			For spillway:
			`IF (ISUB == 0) THEN`
			`DLEL = ELIU-ESP(JS)`
			`IF (ELID > ESP(JS)) DLEL = ELIU-ELID`
			`! SW 6/7/10`
			`IF (DLEL < 0.0) THEN`
			`DLEL = -DLEL`
			For gates:
			`IF (A2GT(JG) == 0.0 .AND. G2GT(JG) /= 0.0) DLEL = ELIU-G2GT(JG)`
			`IF (ELID > EGT(JG)) DLEL = ELIU-ELID`
			`! SW 6/7/10`
			`IF (DLEL < 0.0) THEN`
				6/4/10

#	Code: W2 or PREW2 or GUI	Fix or Enhancement Type	Description of Bug/Enhancement	Date Bug Fixed or Enhancement added

32	W2	Branch intersections with multiple waterbodies	In cases where there are branch intersections between waterbodies, it was possible that the variable KBI and KB were incorrectly set. Here is the fix: Move the statement defining KBI in the subroutine initgeom.f90 to the place shown below (delete the earlier reference):
			
			`IF (B(K,ID+1) == 0.0) B(K,ID+1) = B(K-1,ID+1)`
			`IF (IEXIT == 1) EXIT`
			`END IF`
			`END IF`
			`END IF`
			`END DO`
			`END DO ! SW 1/23/06`
			`END DO ! SW 1/23/06`
			`bnew=b ! SW 1/23/06`
			`KBI = KB ! SW 10/30/2010`
			
			`!**** Upstream active segment and single layer ! 1/23/06 entire section moved SW`
			`DO JW=1,NWB`
			`KT = KTWB(JW)`
			`DO JB=BS(JW),BE(JW)`
				10/30/2010

33	W2	SS resuspension	The code index was incorrect in the loop for computing resuspension. This led in some compilers to an infinite loop.
			The corrected code is shown below:
			
			`SSSS(KT,I,J) = -SSS(J)*SS(KT,I,J)*BI(KT,I)/BH2(KT,I)+SSR`
			`! DO K=KT-1,KB(I)-1`
			`DO K=KT,KB(I)-1`
			`! JP 2/3/12`
			`IF (SEDIMENT_RESUSPENSION(J)) THEN`
			
			Thanks to James Pasley for this bug report/fix.
				2/3/2012

W2 V3.5 Bug Fixes, Enhancements, and User Manual Changes

Table 8. Bug fixes and enhancements for Version 3.5.

#	Code: W2 or PREW2 or GUI	Fix or Enhance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
1	W2	Zooplank-ton-algae	Sign error in the zooplankton grazing on algae term	8/23/06
2	W2	Input/output	Format for I/O was changed to allow better decimal precision of output	8/23/06

3	W2	Sediment settling rate	The sediment settling rate was accidentally used for POM settling. This was fixed. The old and new code lines are shown below:
			OLD:
			`sedsum = sed-sum+seds(JW)*(LPOM(K,I)*lpomdk(jw)+RPOM(K,I)*rpomdk(jw))*BI(K,I)/BH2(K,I)*(1.0-BI(K+1,I)/BI(K,I))`
			NEW:
			`sedsum = sed-sum+poms(JW)*(LPOM(K,I)*lpomdk(jw)+RPOM(K,I)*rpomdk(jw))*BI(K,I)/BH2(K,I)*(1.0-BI(K+1,I)/BI(K,I)) ! cb 10/22/06`
			
			This was an issue in the SEDIMENT, SEDIMENT C, SEDIMENT P, SEDIMENT N, and SEDIMENT DECAY RATE subroutines.
				10/26/06

4	W2	Sediment burial	An algorithm was added for sediment burial. This is now a new parameter in the sediment part of the control file. An updated user manual description is forthcoming. The sediment burial rate SEDB (day^{-1}) can be specified in the "SEDIMENT" card section of the control file. A different burial rate can be specified for each water body.
			
			OLD/NEW line (example):
			`! SED(K,I) = MAX(SED(K,I)+(LPOMEP(K,I)+SEDAS(K,I)+SEDOMS(K,I)+SEDNS(K,I)-SEDD(K,I))*DLT,0.0)`
			`SED(K,I) = MAX(SED(K,I)+(sedem+SEDAS(K,I)+sedcb(k,i)+SEDOMS(K,I)+SEDNS(K,I)-SEDD(K,I)-sedbr(k,i))*DLT,0.0) ! cb 11/30/06`
				11/30/06

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
5	Control File	Add burial rate for sedi-ment model	This is the change in #4 above imple-mented in the control file. The new varia-ble SEDBR is added in f8 format after the FSED variable. SEDBR: sediment burial rate in units of per day. SEDIMENT SEDC SEDPRC SEDCI SEDK SEDS FSOD FSED SEDBR WB 1 ON ON 0.00000 0.10000 0.1 1.00000 1.00000 1.0	

6	W2	Sediment heating and sediment processes	If a model added and subtracted layers that resulted in segment addition and subtraction, there was the possibility that sediment fluxes were incorrectly com-puted.
			In the NO3 subroutine:
			Old code:
			NO3SED(K,I) = NO3(K,I)*NO3S(JW)*NO3TRM(K,I)*(BI(K,I)-BI(K+1,I))/BH2(K,I)
			New code:
			if(k == kb(i)) then
			NO3SED(K,I) = NO3(K,I)*NO3S(JW)*NO3TRM(K,I)*(BI(K,I))/BH2(K,I)
			else
			NO3SED(K,I) = NO3(K,I)*NO3S(JW)*NO3TRM(K,I)*(BI(K,I)-BI(K+1,I))/BH2(K,I)
			endif
			
			New code added in sediment routine:
			if(k == kb(i))then ! SW 4/18/07
			SODD(K,I) = SOD(I)/BH2(K,I)*SODTRM(K,I)*BI(K,I)
			else
			SODD(K,I) = SOD(I)/BH2(K,I)*SODTRM(K,I)*(BI(K,I)-BI(K+1,I))
			Endif
			New code added in suspended solids rou-tine:
			if(k == kb(i))then
			SSR = EPSILON*DLX(I)*BI(K,I)/VOL(K,I)
			else
			SSR = EPSILON*DLX(I)*(BI(K,I)-BI(K+1,I))/VOL(K,I)
			Endif
				4/18/07

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

6	W2	(see above)	New code added for heat flux to channel bottom:
			`if(kt == kb(i))then ! SW 4/18/07`
			`SROSED = SROOUT*TSEDF(JW)`
			`else`
			`SROSED = SROOUT*(1.0-BI(KT+1,I)/BI(KT,I))*TSEDF(JW)`
			`Endif`
			
			`if(k==kb(i))then ! SW 4/18/07`
			`TFLUX = CBHE(JW)/RHOWCP*(TSED(JW)-T2(K,I))*BI(K,I)*DLX(I)`
			`else`
			`TFLUX = CBHE(JW)/RHOWCP*(TSED(JW)-T2(K,I))*(BI(K,I)-BI(K+1,I))*DLX(I)`
			`endif`
			
			New code added for sediment subroutine:
			`if(k == kb(i))then ! SW 4/18/07`
			`SEDAS(K,I) = SEDAS(K,I)+MAX(AS(JA),0.0)*ALG(K,I,JA)*BI(K,I)/BH2(K,I)*(1.0-BI(K+1,I)/BI(K,I))`
			`else`
			`SEDAS(K,I) = SEDAS(K,I)+MAX(AS(JA),0.0)*ALG(K,I,JA)*BI(K,I)/BH2(K,I)*(1.0-BI(K+1,I)/BI(K,I))`
			`endif`
			`if(k == kb(i))then ! SW 4/18/07`
			`SEDOMS(K,I) = POMS(JW)*(LPOM(K,I)+RPOM(K,I))*BI(K,I)/BH2(K,I)`
			`SEDSO = POMS(JW)*SED(K,I)*BI(K+1,I)/BH2(K,I)`
			`else`
			`SEDOMS(K,I) = POMS(JW)*(LPOM(K,I)+RPOM(K,I))*BI(K,I)/BH2(K,I)*(1.0-BI(K+1,I)/BI(K,I))`
			`SEDSO = POMS(JW)*SED(K,I)*BI(K+1,I)/BH2(K,I)*(1.0-BI(K+1,I)/BI(K,I))`
			`endif`
				4/18/07

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

7	W2	Zoo-plankton fixes	Several fixes in the zooplankton routine were made. Many thanks to Dr. Kellie Vache, Institute for Landscape Ecology and Resources Management (ILR) Justus-Liebig-University Giessen Heinrich-Buff-Ring 26 35392 Giessen, Germany, for finding these which are documented below:
			`DO K=KT,KB(I)`
			`do jz = 1, nzp`
			`zgztot=0.0`
			`!kv 5/9/2007`
			`do jjz = 1,nzp`
			`! zooss(k,i,jz)=`
			`(zmu(k,i,jz)*zeff(jz)-zrt(k,i,jz)-`
			`zmt(k,i,jz))*zoo(k,i,jz) -`
			`zgz(k,i,jz,jjz)*zoo(k,i,jz) ! omniv-`
			`orous zooplankton`
			
			`zgztot=zgztot+zgz(k,i,jz,jjz)*zoo(k,i,`
			`jz) !kv`
			`5/9/2007`
			`end do`
			`zooss(k,i,jz)=`
			`(zmu(k,i,jz)*zeff(jz)-zrt(k,i,jz)-`
			`zmt(k,i,jz))*zoo(k,i,jz) - zgztot`
			`! kv 5/9/2007`
			`end do`
			
			`do jjz = 1, nzp`
			`! tgraze(k,i,jz) =`
			`tgraze(k,i,jz) +`
			`prefz(jz,jjz)*zoo(k,i,jjz)`
			`tgraze(k,i,jz) =`
			`tgraze(k,i,jz) +`
			`prefz(jjz,jz)*zoo(k,i,jjz)`
			`!cb 5/17/2007`
			`end do`
			
			`do jjz = 1,nzp ! omnivorous zooplank-`
			`ton`
			`! ZGZ(k,i,jjz,jz)`
			`=`
			`Zmu(K,I,jz)*ZOO(K,I,jz)*prefZ(jz,jjz)/`
			`tgraze(K,I,jz)`
			`ZGZ(k,i,jjz,jz)`
			`=`
			`Zmu(K,I,jz)*ZOO(K,I,jz)*prefZ(jjz,jz)/`
			`tgraze(K,I,jz) !kv 5/9/2007`
			`end do`
				5/21/07

8	PRE	More checks	Added checks for Sediment burial rate and some further checks on grid geome-try; added output on SEDS and SEDBR to the pre.opt file; fixed condition where NZP had to equal 1 to work.	6/2/2007

#	Code: W2 or PREW2 or GUI	Fix or Enhance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
9	W2	Array deallo-cation	The deallocate command on line 7557 was commented out to avoid a deallocation error when the 'STOP' button is pushed during execution on a PC. `! deallocate (sedbr,sedbrp,sedbrn,sedbrc) ! SW 6/4/07 No need to deallocate pointers`	6/4/2007

10	W2	Initialization of IUT	For code setting up an external head BC, the variable IUT was not initialized before it was used. This was fixed below:
			`!**** Boundary bottom layers`
			`! IF (UH_EXTERNAL(JB)) KB(IUT-1) = KB(IUT)`
			`IF (UH_EXTERNAL(JB)) KB(IU-1) = KB(IU) !cb 6/12/07`
			`IF (UH_INTERNAL(JB)) THEN`
			`IF (JBUH(JB) >= BS(JW) .AND. JBUH(JB) <= BE(JW)) THEN`
			`! KB(IUT-1) = MIN(KB(UHS(JB)),KB(IUT))`
			`KB(IU-1) = MIN(KB(UHS(JB)),KB(IU)) !cb 6/12/07`
			`ELSE`
			`! IF (EL(KB(IUT),IUT) >= EL(KB(UHS(JB)),UHS(JB))) THEN`
			`IF (EL(KB(IU),IU) >= EL(KB(UHS(JB)),UHS(JB))) THEN !cb 6/12/07`
			`! KB(IUT-1) = KB(IUT)`
			`KB(IU-1) = KB(IU)`
			`ELSE`
			`! DO K=KT,KB(IUT)`
			`! IF (EL(KB(UHS(JB)),UHS(JB)) >= EL(K,IUT)) THEN`
			`! KB(IUT-1) = K; EXIT`
			`DO K=KT,KB(IU) !cb 6/12/07`
			`IF (EL(KB(UHS(JB)),UHS(JB)) >= EL(K,IU)) THEN !cb 6/12/07`
			`KB(IU-1) = K; EXIT !cb 6/12/07`
			`END IF`
				6/17/2007

11	W2	CBOD set-tling	The CBOD settling rate earlier was not converted from m/d in the control file to m/s in the code. Added code: `cbods = cbods/day !cb 7/23/07`	7/23/07

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

12	W2	TSR output	The surface width was not correctly being output. Changed BI(KT) to BI(KTWB(JW)).
			
			`FIX:`
			`BI(KTWB(JW),I),SHADE(I),ICETH(I),(ADJU`
			`STR(C2CH(JAC)),JAC=1,NAC),`
			`&  ! CB 7/26/07`
				7/26/07

13	PREW2	Pumps	The pump control for DOWN or LAT was not being checked properly, also a check on IUPUC was incorrect. Fixed.	8/14/07

14	W2	Algae	The logic for negative settling velocities for algae had an error.
			Old code:
			`!  ASR(K,I,JA) = -`
			`AS(JA)*(ALG(K+1,I,JA)*B(K+1,I)/(B(K,I)`
			`*H2(K,I))-`
			`ALG(K,I,JA))*BI(K,I)/BH2(K,I)`
			New code:
			
			`ASR(K,I,JA) = -`
			`AS(JA)*(ALG(K+1,I,JA)*BI(K+1,I)/BH2(K,`
			`I)-ALG(K,I,JA)*BI(K,I)/BH2(K,I))`
			`!SP 8/27/07`
			Shwet Prakash
				8/27/07

15	GUI	NZOOP	When # of zooplankton was set equal to zero, there was an array dimensioning er-ror that caused the writing of the control file to only proceed part way. Fixed.	9/17/07

#	Code: W2 or PREW2 or GUI	Fix or Enhance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

16	W2	Open channel flow	Variable passed between subroutines had inconsistent declaration between routines.
			`! REAL, ALLOCATABLE, DIMENSION(:) :: Y, D, B, V, CAREA, TOPW, BELEV, Q, VOLD, YOLD`
			
			`REAL, ALLOCATABLE, DIMENSION(:) :: Y, B, V, CAREA, TOPW, BELEV, Q, VOLD, YOLD ! cb 10/1/07`
			
			`! ALLOCATE (Y(NN), V(NN), CAREA(NN), TOPW(NN), BELEV(NN), Q(NN), VOLD(NN), YOLD(NN), D(NN), B(NN))`
			
			`ALLOCATE (Y(NN), V(NN), CAREA(NN), TOPW(NN), BELEV(NN), Q(NN), VOLD(NN), YOLD(NN), B(NN)) ! cb 10/1/07`
			
			`! DEALLOCATE (Y, V, CAREA, TOPW, BELEV, Q, VOLD, YOLD, D, B, YT, VT, VPR, YPR, TAREA, TOPWT, RT, INDX, AL, DAA)`
			
			`DEALLOCATE (Y, V, CAREA, TOPW, BELEV, Q, VOLD, YOLD, B, YT, VT, VPR, YPR, TAREA, TOPWT, RT, INDX, AL, DAA) ! cb 10/1/07`
				10/4/07

17	W2	TKE model	The TKE algorithm had several bugs that have been fixed, these included making the loop over layers go to KBMIN (rather than KB), the original code overwrote the boundary conditions when using the Thomas algorithm, the original code overwrote vertical eddy viscosity at the bed during the averaging process, Δz_k changed to $\Delta z_{k+1/2}$, TKE array was initialized to zero, TKE was implemented in add/sub layers like AZ. Many of these fixes are a result of the work of Sam Gould (Gould, 2006) who wrote an MS project report at PSU entitled "k-e Turbulence Model." Further recommendations by Gould (2006) will be incorporated into the next version of CE-QUAL-W2.	10/4/07

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

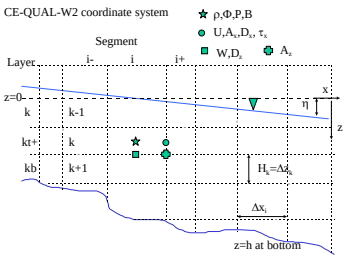
			The old code is shown below as a refer-ence to the new code in the release ver-sion.
			
			OLD CODE
			`ENTRY CALCULATE_TKE`
			`  USTAR =`
			`SQRT(1.25*CZ(I)*WIND10(I)**2/RHO(KT,I)`
			`)`
			`  IF (MANNINGS_N(JW)) THEN`
			`    HRAD = BHR1(KT,I)/(BR(KTI(I),I)-`
			`BR(KT+1,I)+2.*AVH1(KT,I))`
			`if(macrophyte_on.and.mannings_n(jw))th`
			`en`
			`      call`
			`macrophyte_friction(hrad,fric(i),effri`
			`c,kt,i)`
			`gc2=g*effric*effric/hrad**0.33333333`
			`    else`
			`if(.not.macrophyte_on.and.mannings_n(j`
			`w))then`
			`gc2=g*fric(i)*fric(i)/hrad**0.33333333`
			`    end if`
			`  ELSE`
			`    GC2 = 0.0`
			`    IF (FRIC(I) /= 0.0) GC2 =`
			`G/(FRIC(I)*FRIC(I))`
			`  END IF`
			`  USTARB      =`
			`SQRT(GC2)*ABS(0.5*(U(KT,I)+U(KT,I-1)))`
			`  TKE(KT,I,1) =`
			`0.5*(3.33*(USTAR*USTAR+USTARB*USTARB)+`
			`TKE(KT,I,1))*(BH2(KT,I)/BH1(KT,I))`
			`  TKE(KT,I,2) =`
			`0.5*(USTAR*USTAR*USTAR+USTARB*USTARB*U`
			`STARB*5.0/H1(KT,I)+TKE(KT,I,2))*(BH2(K`
			`T,I)/BH1(KT,I))`
			`  DO K=KT+1,KB(I)-1`
			`    BOUK = MAX(AZ(K,I)*G*(RHO(K+1,I)-`
			`RHO(K,I))/(H(K,JW)*RHOW),0.0)`
			`    PRDK = AZ(K,I)*(0.5*(U(K,I)+U(K,I-`
			`1)-U(K+1,I)-U(K+1,I-1))/H(K,JW))**2.0`
			`    PRHE =`
			`10.0*GC2**1.25*ABS(0.5*(U(K,I)+U(K,I-`
			`1)))**4.0/(0.5*B(K,I))**2.0`
			`      IF (MANNINGS_N(JW)) THEN`
			`! v3.5 start`
			`      HRAD = BHR(K,I)/(BR(K,I)-`
			`BR(K+1,I)+2.0*H(K,JW))`
			`!      GC2  =`
			`G*FRIC(I)*FRIC(I)/HRAD**0.333`
			
			`if(macrophyte_on.and.mannings_n(jw))th`
			`en`
			`       call`
			`macrophyte_friction(hrad,fric(i),effri`
			`c,k,i)`
			
			`gc2=g*effric*effric/hrad**0.33333333`	

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

			else if (.not.macrophyte_on.and.mannings_n(jw))then
			
			gc2=g*fric(i)*fric(i)/hrad**0.33333333
			end if
			! v3.5 end
			END IF
			PRHK = GC2/(0.5*B(K,I))*ABS(0.5*(U(K,I)+U(K,I -1)))**3.0
			UNST = PRDK-TKE(K,I,2)
			UNSE = 1.44*TKE(K,I,2)/TKE(K,I,1)*PRDK- 1.92*(TKE(K,I,2)/TKE(K,I,1)*TKE(K,I,2))
			TKE(K,I,1) = TKE(K,I,1)+DLT*(UNST+PRHK-BOUK)
			TKE(K,I,2) = TKE(K,I,2)+DLT*(UNSE+PRHE)
			END DO
			USTARB = SQRT(GC2)*ABS(0.5*(U(KB(I),I)+U(KB(I), I-1)))
			TKE(KB(I),I,1) = 0.5*(3.33*USTARB*USTARB+TKE(KB(I),I,1))
			TKE(KB(I),I,2) = 0.5*(USTARB*USTARB*USTARB*5.0/H(KB(I), JW)+TKE(KB(I),I,2))
			AT = 0.0; CT = 0.0; VT = 0.0; DT = 0.0
			DO J=1,2
			DO K=KT,KB(I)
			AT(K,I) = -DLT/BH1(K,I)*BB(K- 1,I)/SIG(J)*AZ(K-1,I)/AVH1(K-1,I)
			CT(K,I) = - DLT/BH1(K,I)*BB(K,I)/SIG(J)*AZ(K,I)/AV H1(K,I)
			VT(K,I) = 1.0-AT(K,I)-CT(K,I)
			DT(K,I) = TKE(K,I,J)
			END DO
			CALL TRIDIAG(AT(:,I),VT(:,I),CT(:,I),DT(:,I),KT,KB(I),KMX,TKE(:,I,J))
			END DO
			DO K=KT,KB(I)
			TKE(K,I,1) = MAX(TKE(K,I,1),TKEMIN1)
			TKE(K,I,2) = MAX(TKE(K,I,2),TKEMIN2)
			AZ(K,I) = 0.09*TKE(K,I,1)*TKE(K,I,1)/TKE(K,I,2)
			END DO
			! Center at cell faces
			DO K=KT,KB(I)-1
			AZ(K,I) = 0.5*(AZ(K,I)+AZ(K+1,I))
			AZ(K,I) = MAX(AZMIN,AZ(K,I))
			AZ(K,I) = MIN(AZMAX(JW),AZ(K,I))
			DZ(K,I) = MAX(DZMIN,FRAZDZ*AZ(K,I))
			END DO	

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
18	W2	Restart	Added TKE to restart variables written out and read in.	10/5/07
19	GUI	ET	The equilibrium temperature option in the drop down menu was 'EQT' rather than 'ET'. Fixed.	10/9/07
20	W2	Sediment	The SEDIMENT subroutine did not have any computational mistakes, just an error in assigning all array variables to the value at K,I. This resulted in excessive computational time. The fix is shown be-low: OLD sedbr = sedb(jw)*sed(k,i) NEW sedbr(K,I) = sedb(jw)*sed(k,i)	10/15/07

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

21	W2	TKE	Turbulence model had an improper averaging between layers. A new temporary variable was defined to temporarily store the values for AZ prior to averaging to the bottom/top of the layers and the horizontal layers. This also affected the computation of DZ. Fixed.
			
			New code defined AZT and allocated memory for it, such that
			`AZT(K,I) = 0.09*TKE(K,I,1)*TKE(K,I,1)/TKE(K,I,2)`
			and
			`AZ(K,I) = 0.5*(AZT(K,I)+AZT(K+1,I))`
			
			Similarly for the horizontal averaging and for DZ. Also, the values of DZ were fixed to be at the bottom of a cell and AZ was fixed to be at the bottom right-hand edge of a cell as shown below:
			 
			
				12/17/07

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

22	W2	SS settling	The incorrect cell width was used for SSSO. BI(KT,I) was changed to BI(K,I).
			
			OLD CODE:
			`SSSO(K,I) = (TOTSS0+FES(JW)*FPFE(K,I))*BI(KT,I)/BH2(K,I)*DO1(K,I)`
			`FPSS(K,I) = FPSS(K,I)*TISS(K,I)`
			NEW CODE:
			`SSSO(K,I) = (TOTSS0+FES(JW)*FPFE(K,I))*BI(K,I)/BH2(K,I)*DO1(K,I)`
			`FPSS(K,I) = FPSS(K,I)*TISS(K,I)`
				12/17/07

23	W2	Initial-ization of one-layer	The definition of KBMIN was not updated if the model started out in some seg-ments with only one_layer. This has been fixed.
			
			Added code highlighted:
			`DO I=IU,ID`
			`IF (KB(I)-KT < NL(JB)-1) IUT = I+1`
			`ONE_LAYER(I) = KT == KB(I)`
			`END DO`
			`CUS(JB) = IUT`
			`! reinitialize KBMIN`
			`DO I=IU-1,ID`
			`KBMIN(I) = MIN(KB(I),KB(I+1))`
			`END DO`
			`KBMIN(ID+1) = KBMIN(ID)`
			
			`!**** Areas and bottom widths`
			
			`IF (.NOT. TRAPEZOIDAL(JW)) THEN`
				12/17/07

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

24	W2	Bottom pro-cesses	This is a couple more fixes related to bug fix #6 above. The Denitrification rate and epiphyton burial rates could be affected based on unique combinations of add-ing/subtracting segments that left the value of BI in an inactive layer below KB defined incorrectly. In order to prevent the possibility of problems, the following fixes were made:
			
			Old Code:
			`sedNO3(K,I) = NO3(K,I)*NO3S(JW)*NO3TRM(K,I)*(BI(K,I) -BI(K+1,I))/BH2(K,I)`
			
			`EPM(K,I,J) = EPD(K,I,J)*(BI(K,I)- BI(K+1,I)+2.0*H1(K,I))*DLX(I)`
			
			New code:
			`if(k == kb(i)) then ! SW 12/16/07`
			`sedNO3(K,I) = NO3(K,I)*NO3S(JW)*NO3TRM(K,I)*(BI(K,I) )/BH2(K,I)`
			`else`
			`sedNO3(K,I) = NO3(K,I)*NO3S(JW)*NO3TRM(K,I)*(BI(K,I) -BI(K+1,I))/BH2(K,I)`
			`endif`
			
			`if(k == kb(i)) then ! SW 12/16/07`
			`EPM(K,I,J) = EPD(K,I,J)*(BI(K,I)+2.0*H1(K,I))*DLX(I )`
			`else`
			`EPM(K,I,J) = EPD(K,I,J)*(BI(K,I)- BI(K+1,I)+2.0*H1(K,I))*DLX(I)`
			`endif`
				12/17/2007

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

25	W2	CBODS	If the user defined particulate CBOD that settles to the bottom and had SED turned ON, the conversion from oxygen to organic matter was missing in the accumulation on the channel bottom or sides.
			
			OLD
			`do jd=1,nbod`
			`SEDcb(K,I) = SEDcb(K,I)+MAX(cbods(jd),0.0)*cbod(K,I,Jd)*BI(K,I)/BH2(K,I)*(1.0-BI(K+1,I)/BI(K,I))`
			`end do`
			NEW
			`do jd=1,nbod`
			`SEDcb(K,I) = SEDcb(K,I)+MAX(cbods(jd),0.0)*(cbod(K,I,Jd)/O2OM(JW))*BI(K,I)/BH2(K,I)*(1.0-BI(K+1,I)/BI(K,I))`
			`! 1/16/08`
			`end do`
				1/18/08

26	W2	SEDBR	Eliminated a redundant definition of SEDBR in the Sediment routine since it is already defined in the Kinetic rates sub-routine.	1/18/08

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

27	W2	SEDDK	The first order sediment decay rate is an average of the decay rates of all the in-fluxes of organic matter and their respec-tive decay rates. There was an error in computing this average decay rate for CBOD treated as particulate. Code fix is shown below:
			
			OLD
			`do jd=1,nbod`
			`sedsum = sed-sum+MAX(cbods(jd),0.0)*cbod(K,I,Jd)*BI(K,I)/BH2(K,I)*(1.0-BI(K+1,I)/BI(K,I))`
			`end do`
			
			NEW
			`do jd=1,nbod`
			`sedsum = sed-sum+MAX(cbods(jd),0.0)*cbod(K,I,Jd)*BI(K,I)/BH2(K,I)*(1.0-BI(K+1,I)/BI(K,I))*RBOD(JD)*CBODD(K,I,JD)/O2OM(JW)`
			`end do`
				1/18/08

28	W2	SRO	There are some cases when segments were added/subtracted that the value of BI was not correctly initialized. This code is a fix to prevent such occurrences:
			
			`OLD CODE:`
			`SRONET = SROIN-SROOUT`
			`SROSED = SROOUT*(1.0-BI(K+1,I)/BI(K,I))*TSEDF(JW)`
			
			`NEW CODE:`
			`SRONET = SROIN-SROOUT`
			`if(k /= kb(i))then ! SW 1/18/08`
			`SROSED = SROOUT*(1.0-BI(K+1,I)/BI(K,I))*TSEDF(JW)`
			`else`
			`SROSED = SROOUT*TSEDF(JW)`
			`endif`
				1/18/2008

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

29	W2	Water Qual-ity	Added several calls to prevent computa-tion of kinetic variables if epiphyton are defined in the control file with NEP=1 or more but is not ACTIVE or turned ON. If the kinetic expressions are non-zero and the initial concentration is given, then this could add source/sink terms to the oxygen balance.
			
			This is typical of the code changes – since several of this type were made:
			
			OLD CODE:
			DO JE=1,NEP
			PO4EG(K,I) = PO4EG(K,I)+EGR(K,I,JE)*EPC(K,I,JE)*EP(JE)
			PO4ER(K,I) = PO4ER(K,I)+ERR(K,I,JE)*EPC(K,I,JE)*EP(JE)
			END DO
			
			NEW CODE:
			IF (EPIPHYTON_CALC(JW,JE))then ! SW 1/18/2008
			PO4EG(K,I) = PO4EG(K,I)+EGR(K,I,JE)*EPC(K,I,JE)*EP(JE)
			PO4ER(K,I) = PO4ER(K,I)+ERR(K,I,JE)*EPC(K,I,JE)*EP(JE)
			endif
				1/18/2008

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

30	W2	Bottom pro-cesses	Continuation of bug fix #24 in such places as
			
			New code:
			IF(K == KB(I))THEN
			xdum=BI(K,I)/BH2(K,I) ! SW 1/18/08
			ELSE
			xdum=BI(K,I)/BH2(K,I)*(1.0-BI(K+1,I)/BI(K,I))
			ENDIF
			
			SEDAS(K,I) = SEDAS(K,I)+MAX(AS(JA),0.0)*ALG(K,I,JA) *xdum ! SW 1/18/08
			
			SEDOMS(K,I) = pomS(JW)*(LPOM(K,I)+RPOM(K,I))*xdum !sw 1/18/08 cb 10/22/06
			IF(K==KB(I))THEN ! SW 1/18/08
			SEDSO = 0.0
			ELSE
			SEDSO = sedS(JW)*SED(K,I)*BI(K+1,I)/BH2(K,I)*(1.0-BI(K+1,I)/BI(K,I))
			Endif
			
			DO K=KT,KB(I)
			IF(K == KB(I))THEN
			xdum=BI(K,I)/BH2(K,I) ! SW 1/18/08
			ELSE
			xdum=BI(K,I)/BH2(K,I)*(1.0-BI(K+1,I)/BI(K,I))
			ENDIF
			DO JA=1,NAL
			SEDASp(K,I) = SEDASp(K,I)+MAX(AS(JA),0.0)*ap(ja)*ALG(K,I,JA)*xdum ! SW 1/18/08
			END DO
			DO JE=1,NEP
			IF (EPIPHYTON_CALC(JW,JE))LPOMEPp(K,I) = LPOMEPp(K,I)+EPOM(JE)*ep(je)*(EMR(K,I,JE)*EPC(K,I,JE))
			END DO
			do jd=1,nbod
			
			This code is repeated similarly in many of the sediment routines.
				1/18/2008

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
31	W2	Add segment initial-ization	The DEPTHM and DEPTHB were not ini-tialized correctly when a segment was added – this does not affect internal com-putations, just output for SPR and SNP files. OLD CODE: BKT(I) = BH1(KT,I)/H1(KT,I) DEPTHB(K,I) = H1(KT,I) ! DEPTHM(K,I) = H1(KT,I)*0.5 NEW CODE: BKT(I) = BH1(KT,I)/H1(KT,I) DEPTHB(KT,I) = H1(KT,I) ! SW 1/27/08 DEPTHM(KT,I) = H1(KT,I)*0.5 ! SW 1/27/08	1/27/08

W2 V3.2 Bug Fixes, Enhancements, and User Manual Changes

Table 9. Bug fixes and enhancements for Version 3.2.

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
1	W2	Waterbody-waterbody connection	When there was negative velocities at a waterbody-waterbody connection, there was a possibility (dependent on the ba-thymetry of the connection at the water-body-waterbody intersection) that there could be temperature or concentration anomalies.	8/31/04

#	Code: W2 or PREW2 or GUI	Fix or Enhance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
2	W2	Lateral_ withdrawal	Added limit to the DLRHOMAX function: Old code: DLRHOMAX=MAX(DLRHOT,DLRHOB) New code: DLRHOMAX=MAX(DLRHOT,DLRHOB,1.0E-10)	1/25/05

3	W2	Branch connectivity	Logic in branch connectivity set-up was fixed
			Old code:
			IF(UHS(JB) == DS(JJJB))EXIT
			New code:
			IF(abs(UHS(JB)) == DS(JJJB))EXIT
				1/25/05

4	W2	Pumpback	Pumpback logic was corrected – this is legacy code that will probably be removed from later versions of W2
			Old code:
			DO JB=1,NBR
			IF (JB == JBP) JWBP = JW
			END DO
			New code:
			DO JW=1,NWB
			DO JB=BS(JW),BE(JW)
			IF(JB == JBP) JWBP = JW
			END DO
			END DO
				1/25/05

5	W2	CPL write	Switched order of implied DO loop on CPL write statement for output of constituents	1/25/05
6	W2	PRF write	Changed output format for PRF output for constituents from f10.2 to e13.6	1/25/05

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
7	W2	Heat balance	Added the Idso and Jackson long wave radiation equation when air temperatures are below 5C. The Swinbank model underpredicts long wave incoming radiation at low air temperatures by as much as 10%. The computation of long wave atmospheric radiation is done using the approach of Swinbank (1963) unless air temperatures are less than 5°C, when the Idso and Jackson (1969) formula is used (Wells, et al., 1982). The Swingbank formula for clear sky long wave atmospheric radiation is $\phi_{ac} = 5.31E-13(T_a + 273)^6$ where units are W/m^2,°C at 2 m height. Below 40°F (5°C) the formula of Idso and Jackson is recommended (above 10°C both equations are almost identical): $\phi_{ac} = \sigma(T_a + 273)^4\left(1 - 0.261\exp(-7.77E-4T_a^2)\right)$ where units are W/m^2 and T_a is in units of °C. The Stefan-Boltzmann constant = 5.62E-8 W/m^2/(°K)^4.	1/25/05

#	Code: W2 or PREW2 or GUI	Fix or Enhance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

7	W2	Layer addition algorithm	Mistyped subscript K instead of I:
			Old code:
			`IF (KB(I) > KBI(I)) THEN`
			`B(KB(K),I) = 0.0`
			`DX(KB(I),I) = 0.0`
			`KB(I) = KB(I)-1`
			`IF (I /= DS(JB)+1)`
			`KBMIN(I) = MIN(KB(K),KB(I+1))`
			`IF (I /= US(JB)-1)`
			`KBMIN(I-1) = MIN(KB(I-1),KB(I))`
			New Code:
			`IF (KB(I) > KBI(I)) THEN`
			`B(KB(I),I) = 0.0`
			`! SW 3/2/05`
			`DX(KB(I),I) = 0.0`
			`KB(I) = KB(I)-1`
			`IF (I /= DS(JB)+1)`
			`KBMIN(I) = MIN(KB(I),KB(I+1))`
			`! SW 3/2/05`
			`IF (I /= US(JB)-1)`
			`KBMIN(I-1) = MIN(KB(I-1),KB(I))`
				3/2/05

8	W2	Variable initialize-tion	In some cases when there was a layer subtraction and a time step violation immediately afterward, the variable SW was not initialized properly. This caused problems in the Tomas Algorithm for the water surface computation. The following line of code was added to the SUB layer algorithm:
			`SW(KT-1,IU-1:ID+1) = 0.0`
			`!TC 3/9/05`
			Also, the variable AVHR was defined in the Update variables for DS+1. The following new code was added:
			`AVHR(KT,DS(JB)+1)=H1(KT,DS(JB)+1)`
			`!SW 03/08/05`
				3/9/05

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

9	W2	Interpola-tion multipli-ers	Possible index error if there are multiple waterbodies.
			Old code:
			`RATZ(K,JW) = AVH2(K-1,I)/AVH2(K,I)`
			`CURZ1(K,JW) = 2.0*H(K,JW)**2/(AVH2(K-1,I)+AVH2(K,I))/AVH2(K-1,I)`
			`CURZ2(K,JW) = -2.0*H(K,JW)**2/(AVH2(K-1,I)*AVH2(K,I))`
			`CURZ3(K,JW) = 2.0*H(K,JW)**2/(AVH2(K-1,I)+AVH2(K,I))/AVH2(K,I)`
			`END DO`
			New code:
			`RATZ(K,JW) = AVH2(K-1,DS(BE(JW)))/AVH2(K,DS(BE(JW)))`
			`CURZ1(K,JW) = 2.0*H(K,JW)**2/(AVH2(K-1,DS(BE(JW)))+AVH2(K,DS(BE(JW))))/AVH2(K-1,DS(BE(JW)))`
			`CURZ2(K,JW) = -2.0*H(K,JW)**2/(AVH2(K-1,DS(BE(JW)))*AVH2(K,DS(BE(JW))))`
			`CURZ3(K,JW) = 2.0*H(K,JW)**2/(AVH2(K-1,DS(BE(JW)))+AVH2(K,DS(BE(JW))))/AVH2(K,DS(BE(JW)))`
				5/10/05

10	W2	Spillway and Gates	Older code in order to check if it was sub-merged or not used the elevation differ-ence relative to the channel bed on ei-ther side of the weir, rather than the weir crest. Also removed code line: `IF(ELDN>ESP(JS))DH+ELUP-ELDN`	5/10/05

11	W2	Reaeration	Corrected formula errors in Thackston and Krenkel formula:
			Old code:
			`USTAR=SQRT(ADEPTH*SLOPE(JB)*32.2)**0.5`
			`REAER(I) = 24.88*(1.0+SQRT(0.176*UAVG/SQRT(ADEPTH)))*USTAR`
			New code:
			`USTAR=SQRT(ADEPTH*SLOPE(JB)*32.2)`
			`REAER(I) = 24.88*(1.0+SQRT(0.176*UAVG/SQRT(ADEPTH)))*USTAR/ADEPTH`
			Similar changes were made to the updated Thackston model (Eqn 10)
				5/10/05

12	W2	Violations NV	The variable BI and VOL was not initial-ized properly during a time-step viola-tion.	8/25/05

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
13	W2	ADD a layer	The variable BI was not initialized properly during an ADD layer.	8/25/05
14	W2	TRIDIAG sub-routine	Insert Deallocate Statement in Tridiag SUBROUTINE TRIDIAG(A,V,C,D,S,E,N,U) USE PREC INTEGER, IN TENT(IN) :: S, E, N REAL(R8), DIMENSION(:), INTENT(IN) :: A(E),V(E),C(E),D(E) REAL, DIMENSION(:), INTENT(OUT) :: U(N) REAL(R8), ALLOCATABLE, DIMENSION(:) :: BTA, GMA ALLOCATE (BTA(N),GMA(N)) BTA(S) = V(S) GMA(S) = D(S) DO I=S+1,E BTA(I) = V(I)-A(I)/BTA(I-1)*C(I-1) GMA(I) = D(I)-A(I)/BTA(I-1)*GMA(I-1) END DO U(E) = GMA(E)/BTA(E) DO I=E-1,S,-1 U(I) = (GMA(I)-C(I)*U(I+1))/BTA(I) END DO Deallocate (BTA, GMA) <---- - ! SW 10/17/05 END SUBROUTINE TRIDIAG	10/17/05

15	W2	SUB layer	In SUB Layer/Sub Seg - eliminate parentheses which caused a sign error
			IF (.NOT. TRAPEZOIDAL(JW))
			THEN
			BI(KT,IU-1) = B(KTI(IU-
			1),I)
			H1(KT,IU-1) = H(KT,JW)-
			Z(IU-1)
			BH1(KT,IU-1) = B(KTI(IU-
			1),IU-1)*(EL(KT,IU-1)-EL(KTI(IU-1)+1,IU-
			1)-Z(IU-1)*COSA(JB))/COSA(JB) <----
			--- ! SR 10/17/05
			IF (KT >= KB(IU-1))
			BH1(KT,IU-1) = B(KT,IU-1)*H1(KT,IU-1)
			DO K=KTI(IU-1)+1,KT
			BH1(KT,IU-1) = BH1(KT,IU-
			1)+BH1(K,IU-1)
			END DO
			ELSE
				10/17/05

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

16	W2	SUB layer for shallow sys-tems	Layer SUB - improve model running in shallow segments
			
			!** Water surface minimum thickness
			DO JW=1,NWB
			KT = KTWB(JW)
			ZMIN(JW) = -1000.0
			KTMAX = 2 <----- ! SR 10/17/05
			DO JB=BS(JW),BE(JW)
			DO I=CUS(JB),DS(JB)
			IF(KB(I) > KTMAX) KTMAX = KB(I) <----- ! SR 10/17/05
			IF (Z(I) > ZMIN(JW)) THEN
			IZMIN(JW) = I
			JBIZ = JB
			END IF
			ZMIN(JW) = MAX(ZMIN(JW),Z(I))
			END DO
			END DO
			ADD_LAYER = ZMIN(JW) < -0.85*H(KT-1,JW) .AND. KT /= 2
			SUB_LAYER = ZMIN(JW) > 0.60*H(KT,JW) .AND. KT < KTMAX <----- ! SR 10/17/05
			....
			!******** Upstream active segment
			IUT = US(JB)
			IF (SLOPE(JB) /= 0.0) THEN
			DO I=US(JB)-1,DS(JB)+1
			IF (KB(I) < KT)THEN <---------- ! SR 10/17/05
			KB(I) = KT
			B(KB(I),I) = 0.000001
			DX(KB(I),I) = DXI(JW)
			...
			!****** Additional layer subtractions
			ZMIN(JW) = -1000.0
			DO JB=BS(JW),BE(JW)
			DO I=CUS(JB),DS(JB)
			ZMIN(JW) = MAX(ZMIN(JW),Z(I))
			END DO
			END DO
			SUB_LAYER = ZMIN(JW) > 0.60*H(KT,JW) .AND. KT < KTMAX <----- ! SR 10/17/05
			END DO
			END DO
			
			Also done for the initial set-up of the branch geometry:
			!**** Upstream active segment and single layer
			
			IF (SLOPE(JB) /= 0.0) THEN
			DO I=US(JB)-1,DS(JB)+1
			IF (KB(I) < KT) THEN <----- ! .AND. I /= IZMIN(JW) SW 10/17/05
			B(KT,I) = 0.000001
				10/17/05

#	Code: W2 or PREW2 or GUI	Fix or Enhance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

17	W2	Shade algo-rithm	No errors just an improvement in computational efficiency.
			Delete this from the SHADING subroutine:
			`!** Set the angles for which topographic shade data are available`
			`DO II=1,IANG`
			`ANG(II)=((II-1)*(360.0/FLOAT(IANG)))*PI/180.0`
			`END DO`
			`GAMMA = (2*PI)/IANG`
			and change the 2 occurrences of gamma to gama (only in shading subroutine):
			`ANG2 = (TOPO(I,J+1)-TOPO(I,J))/GAMA <---- ! SW 10/17/05`
			`TOPOANG = TOPO(I,J)+ANG2*ANG1`
			`ENDIF`
			`END DO`
			`IF (AZ00 > ANG(IANG) .AND. AZ00 <= 2*PI) THEN`
			`ANG1 = AZ00-ANG(IANG)`
			`ANG2 = (TOPO(I,1)-TOPO(I,IANG))/GAMA <----! SW 10/17/05`
			ADD a line to the module SHADEC:
			`MODULE SHADEC`
			`PARAMETER (IANG=18)`
			`REAL, PARAMETER :: GAMA=(3.1415926*2.)/REAL(IANG) <--- ! SW 10/17/05`
			`REAL, DIMENSION(IANG):: ANG <----! SW 10/17/05`
			`REAL, ALLOCATABLE, DIMENSION(:) ::`
			`A00, DECL, HH, TTLB, TTRB, CLLB, CLRB <------- ! SW 10/17/05`
			`REAL, ALLOCATABLE, DIMENSION(:) ::`
			`SRLB1, SRRB1, SRLB2, SRRB2, SRFJD1, SRFJD2,SHADEI`
			`REAL,ALLOCATABLE, DIMENSION(:,:) :: TOPO`
			`LOGICAL, ALLOCATABLE, DIMENSION(:) :: DYNAMIC_SHADE`
			`DATA ANG /0.00000, 0.34907, 0.69813, 1.04720, 1.39626, 1.74533, 2.09440, 2.44346,&`
			`2.79253, 3.14159, 3.49066, 3.83972, 4.18879, 4.53786, 4.88692, 5.23599, 5.58505, 5.93412/ <----- ! SW10/17/05`
			`END MODULE SHADEC`
			Delete allocation statement for ang:
			`ALLOCATE (SRLB1(IMX), SRRB1(IMX), SRLB2(IMX), SRRB2(IMX), SRFJD1(IMX), SHADEI(IMX), SRFJD2(IMX))`
			`ALLOCATE (TOPO(IMX,IANG)) <---- !SW10/17/05`
			`ALLOCATE (QSW(KMX,NWDT), CTR(NCT,NTRT), HPRWBC(NHY,NWB))`
			Delete ang from the deallocate statement:
			`DEALLOCATE(TTLB, TTRB, CLLB, SRLB1, SRRB1, SRLB2, SRRB2, SRFJD1, SHADEI,SRFJD2, TOPO, QSW, CTR) <----! SW 10/17/05`
				10/17/05

#	Code: W2 or PREW2 or GUI	Fix or Enhance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added
18	W2	Epiphyton algorithm	Several changes were made that corrected errors in shallow systems where adding and subtracting layers did not reinitialize macrophyte layers when the current KT was below KB; the epiphyton burial rate was greater than specified in the control file; epiphyton that are buried become part of the 1st order organic sediment (as before); epiphyton mortality now becomes part of the LPOM pool (based on the EPOM fraction) and is settled and transported downstream rather than going into the organic 1st order sediment model directly. Currently this is non-photosynthesizing – but we will change in the next version.	5/26/06
19	W2	ADD/SUB layers	There was a bug in addition and subtraction of layers that led to water quality variables not being initialized correctly during riverine shallow flow	5/26/06
20	User Manual	Typos corrected	The manual had a few typos that were corrected.	6/11/2006
21	W2	Waterbody-waterbody connection	The subroutine Upstream_velocity under specific conditions did not maintain flwo continuity across a waterbody-waterbody connection	6/29/2006
22	W2	SNP output	The algal limiting nutrient SNP output had a bug under specific conditions in writing out the information.	6/30/2006

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

23	W2	Sediment heating and sediment processes	If a model added and subtracted layers that resulted in segment addition and subtraction, there was the possibility that sediment fluxes were incorrectly com-puted.
			
			In the NO3 subroutine:
			Old code:
			`NO3SED(K,I) = NO3(K,I)*NO3S(JW)*NO3TRM(K,I)*(BI(K,I) -BI(K+1,I))/BH2(K,I)`
			
			New code:
			`if(k == kb(i)) then NO3SED(K,I) = NO3(K,I)*NO3S(JW)*NO3TRM(K,I)*(BI(K,I))/BH2(K,I) else NO3SED(K,I) = NO3(K,I)*NO3S(JW)*NO3TRM(K,I)*(BI(K,I)-BI(K+1,I))/BH2(K,I) endif`
			
			New code added in sediment routine:
			`if(k == kb(i))then ! SW 4/18/07 SODD(K,I) = SOD(I)/BH2(K,I)*SODTRM(K,I)*BI(K,I) else SODD(K,I) = SOD(I)/BH2(K,I)*SODTRM(K,I)*(BI(K,I)-BI(K+1,I)) Endif`
			New code added in suspended solids rou-tine:
			`if(k == kb(i))then SSR = EPSILON*DLX(I)*BI(K,I)/VOL(K,I) else SSR = EPSILON*DLX(I)*(BI(K,I)-BI(K+1,I))/VOL(K,I) Endif`
				4/18/07

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

23	W2	(see above)	New code added for heat flux to channel bottom:
			`if(kt == kb(i))then ! SW 4/18/07`
			`SROSED =`
			`SROOUT*TSEDF(JW)`
			`else`
			`SROSED =`
			`SROOUT*(1.0-`
			`BI(KT+1,I)/BI(KT,I))*TSEDF(JW)`
			`Endif`
			
			`if(k==kb(i))then ! SW`
			`4/18/07`
			`TFLUX =`
			`CBHE(JW)/RHOWCP*(TSED(JW)-`
			`T2(K,I))*BI(K,I)*DLX(I)`
			`else`
			`TFLUX =`
			`CBHE(JW)/RHOWCP*(TSED(JW)-`
			`T2(K,I))*(BI(K,I)-BI(K+1,I))*DLX(I)`
			`endif`
			
			New code added for sediment subrou-tine:
			`if(k == kb(i))then ! SW 4/18/07`
			`SEDAS(K,I) =`
			`SEDAS(K,I)+MAX(AS(JA),0.0)*ALG(K,I,JA)`
			`*BI(K,I)/BH2(K,I)*(1.0-`
			`BI(K+1,I)/BI(K,I))`
			`else`
			`SEDAS(K,I) =`
			`SEDAS(K,I)+MAX(AS(JA),0.0)*ALG(K,I,JA)`
			`*BI(K,I)/BH2(K,I)*(1.0-`
			`BI(K+1,I)/BI(K,I))`
			`endif`
			`if(k == kb(i))then ! SW 4/18/07`
			`SEDOMS(K,I) =`
			`POMS(JW)*(LPOM(K,I)+RPOM(K,I))*BI(K,I)`
			`/BH2(K,I)`
			`SEDSO =`
			`POMS(JW)*SED(K,I)*BI(K+1,I)/BH2(K,I)`
			`else`
			`SEDOMS(K,I) =`
			`POMS(JW)*(LPOM(K,I)+RPOM(K,I))*BI(K,I)`
			`/BH2(K,I)*(1.0-BI(K+1,I)/BI(K,I))`
			`SEDSO =`
			`POMS(JW)*SED(K,I)*BI(K+1,I)/BH2(K,I)*(`
			`1.0-BI(K+1,I)/BI(K,I))`
			`endif`
				4/18/07

#	Code: W2 or PREW2 or GUI	Fix or En-hance-ment Type	Description of Bug/Enhancement	Date Bug Fixed or Enhance-ment Added

24	W2	Algae	The logic for negative settling velocities for algae had an error.
			Old code:
			`! ASR(K,I,JA) = -`
			`AS(JA)*(ALG(K+1,I,JA)*B(K+1,I)/(B(K,I)`
			`*H2(K,I))-`
			`ALG(K,I,JA))*BI(K,I)/BH2(K,I)`
			New code:
			`ASR(K,I,JA) = -`
			`AS(JA)*(ALG(K+1,I,JA)*BI(K+1,I)/BH2(K,`
			`I)-ALG(K,I,JA)*BI(K,I)/BH2(K,I))`
			`!SP 8/27/07`
			Shwet Prakash
				8/27/07