6. USING THE MODEL

6.1 Introduction

RMA-11 functions in essentially the same way as RMA-4 although the user instructions for preparation of the main input file have been modified. Similarly to RMA-4, RMA-11 can utilize a finite element grid specified directly in the main input file or in a binary geometry file created by RMA-1/RMAGEN. The velocity field can be described in the main input file or in a binary results file from RMA-2 or RMA-11. RMA-11 requires a second input file that contains the data specific to the water quality constituent relations and their mode of operation. Two additional files may be supplied by the user, an alternate input file that may be used to simplify data input and a water quality graph input file that may used to allow automatic interpolation of boundary conditions from a time based input file. The structure and formats of each of the input files are presented below.

6.2 Model Limitations

The latest version of RMA-11 is designated as release 4.0. Descriptions of recent updates to the code are included as comments at the beginning of the FORTRAN code.

The program is written in standard FORTRAN90 and has been executed on an IBM-PC under DOS, and on UNIX systems. Version 4.4 has reconstructed the model so that it operated with ALLOCATABLE arrays so that almost any size system can be configured using input parameters. It is still possible that in particular applications the some size limitations will have to be adjusted by recompilation with changed dimensions to reflect different size networks but this should no longer be expected.

It has been found that differing computer systems use different OPEN statement and have limitations on file sizes and numbers of files. SUBROUTINE ZVRS has been created with the variable IVRSID designed to be set by the user with the integer appropriate for his system. The default number supplied is IVRSID = 4 which will create a sequential file for each time the buffer in the equation solving routine is filled. This setting checks and generates file names that have the structure Qxxx.001 etc.

The following file units are required in execution of the model.

(2) Input main data file
(30) Input water quality data file
(3) Output results
(9) Scratch unit for data during equation solution (not required if buffer size is large enough
(75) Output file for diagnostic messages ("messrm11.dat")
Units **(4), (12), (51)** to **(69)** may be required if the options that permit met file input, saving of selected nodal results, geometric file input, alternate input files for boundary conditions, saving of 2 or 3-d geometry data, saving of a restart file, using a previously saved restart file or saving a binary results file are executed.

6.3 Run Time Instructions

The model operates interactively with the user requesting the file name for data input. All other files are now (Version 2.2) named in the data input file depending on the functions desired by the user. The basic input data is entered on this interactively named file and is described in section 6.4.

The following files may be activated by the model:

1. Input file containing basic input data, described in section 6.4 below. Required

2. Input water quality file containing input water quality parameters, described in section 6.8 below. Required.

3. Input meteorologic file containing meteorologic input data in time series form, described in section 6.7 below. Not required,

4. Output ASCII file used for tabulation of water column simulation results. Required

5. Output ASCII file used for tabulation of bed simulation results. Optional

6. Selective ASCII output file used for tabulation of selected nodes and constituents. Required if selected nodes are defined in main input file

7. Input geometry file (from RMA-1 or RMAGEN[1]). Not required

8. Boundary condition input file, read when the regular input file is at ENDDATA and may be reread for repeating boundary input, see section 6.5 below.

9. Input velocity file containing input velocity conditions in binary format generated in a previous RMA-2 or RMA-10 run. Not required.

10. Output 2-d binary geometry file that may be used to save the two-dimensional geometry from this run. Not required.

11. Output 3-d binary geometry file that may be used to save the three-dimensional geometry from this run. Not required.

[1]). Two file types may be used. Each binary file allows the type to be selected optionally by changing the ID line
(1) Standard UNFORMATTED, these are binary files with headers, or
(2) TRANSPARENT/BINARY, these are pure binary without headers for compatibility between different compilers.

12. Input 3-d binary geometry file that may be used for direct input of the three-dimensional geometry for this run (not recommended). Not required

13. Input binary restart file that may be used as initial conditions or to restart from a previous run. Not required.

14. Output restart file for saving results with a view to restarting. Not required.

15. Output binary save file used for storing all water quality concentrations etc. computed during each solution step. This is a binary file that may be used for post processing. Not required.

15. Input quality graph file containing water quality graph data for later interpolation, see section 6.6 below. Depending on input data this may or may not be required.

16. Output bed mass density file for accumulation of TSS. (not required)

17. Input carbon diagenesis file (not required)

18. Output time series of suspended sediment and bed sediment

6.4 Main Input File

Introduction

The initial set of data, the **FILE** block lists the files that will be used by the model. This list may be entered in any order, however it must be terminated with an **ENDFIL** data line. This is followed by the **LIMITS** block that sets limits for operation of the model. The rest of the main input file is designed to control the flow of the program, inputting a **CONTROL** block, a **PROPERTY** block and **TIMESTEP** block.

Each line of this file is entered with an identifier in cols. 1-8 (left adjusted). This identifier is essential for successful execution of the model

6.4.1 FILE BLOCK

This data block inputs the names of all files that required for the simulation

Columns	*Format*	*Name*	*Description*

Line type OUTFIL: File Name Data 1 line

01-06	A	ID	"OUTFIL"
09-40	A	FNAME	Output file name. *Required*, but maybe set to nul

Line type OUTBED: File Name Data 1 line

01-06	A	ID	"OUTBED"
09-40	A	FNAME	Output file name for bed data. *Optional,* if not defined output goes to OUTFIL. May be set to nul.

Line type R4QFIL: File Name Data 1 line

01-07	A	ID	" R4QFIL "
09-40	A	FNAME	File containing element input water quality constants *Required*.

Line type METFIL: File Name Data 1 line

01-06	A	ID	" METFIL "
09-40	A	FNAME	Input meteorological data file name. *Not required*.

Line type BCFIL: File Name Data 1 line

01-05	A	ID	" BCFIL "
09-40	A	FNAME	Boundary condition file name for appending to the end of the main input file. *Not required*.

Line type INGEO: File Name Data 1 line

01-07	A	ID	"INGEO " for type 1 “INBNGEO “ for type 2 (see earlier footnote)

09-40	A	FNAME	Input binary file name containing two-dimensional geometry (from RMA1 or RMAGEN) *Not required*.

Line type INRST: File Name Data 1 line

01-07	A	ID	"INRST " for type 1 "INBNRST " for type 2 (see earlier footnote)
09-40	A	FNAME	Input binary restart file name, for restarting from a previous run. *Not required*.

Line type OUTRST: File Name Data 1 line

01-08	A	ID	"OUTRST " for type 1 "OUTBNRST " for type 2 (see earlier footnote)
09-40	A	FNAME	Output binary file name, for creation of file to permit restarting in a subsequent run. *Not required*.

Line type OUTRES: File Name Data 1 line

01-08	A	ID	"OUTRES " for type 1 "OUTBNRES" for type 2 (see earlier footnote) "OUTBNRMA" for RMA format
09-40	A	FNAME	Output binary file name, for creation of saving results from this run. *Not required*.

Line type VELFIL: File Name Data 1 line

01-08	A	ID	"VELFIL " for type 1 "VELBNFIL" for type 2 (see earlier footnote) "VELBNRMA" for RMA format "VELSMSFL" for SMS format
09-40	A	FNAME	Input binary velocity/depth results file name generated in RMA-2 or RMA-10 *Not required*.

Line type OUT2GE: File Name Data 1 line

01-08	A	ID	"OUT2GE " for type 1 "OUTBN2GE" for type 2 (see earlier footnote)

09-40	A	FNAME	Output binary file name that will contain an updated copy of the geometry used in this run, *Not required*.

Line type OUT3GE: File Name Data 1 line

01-08	A	ID	"OUT3GE " for type 1 “OUTBN3GE“ for type 2 (see earlier footnote)
"			
09-40	A	FNAME	Output 3-d geometry file name for saving a copy of the generated 3-dimensional element structure. This file is used in post-processing programs *Not required*.

Line type IN3DGE: File Name Data 1 line

01-08	A	ID	"IN3DGE " for type 1 “INBN3DGE “ for type 2 (see earlier footnote)
09-40	A	FNAME	Input 3-d geometry file for use in place of the 2-d geometric input structure. The use of this file is not recommended *Not required*.

Line type GRPHIN: File Name Data 1 line

01-06	A	ID	"GRPHIN "
09-40	A	FNAME	File containing water quality graph data for interpolation *Not required*.

Line type OUTSPL: File Name Data 1 line

01-06	A	ID	" OUTSPL "
09-40	A	FNAME	File of ASCII results at selected nodes *Not required*.

Line type OUTDF: File Name Data 1 line

01-05	A	ID	" OUTDF "
09-40	A	FNAME	ASCII file of diffusion coefficients at selected elements *Not required*.

Line type OUTBDR: File Name Data 1 line

01-08	A	ID	"OUTBDR " for type 1 "OUTBNBDR" for type 2 (see earlier footnote)
09-40	A	FNAME	Output binary file containing mass of TSS on the bed (gm/m^2) *Not required*.

Line type INBDR: File Name Data 1 line

01-08	A	ID	"INBDR " for type 1 "INBNBDR" for type 2 (see earlier footnote)
09-40	A	FNAME	Input file containing the total sediment diagenesis rates in the bed (gm O_2/m^2-day) *Not required*.

Line type INCROS: File Name Data 1 line

01-05	A	ID	"INCROS "
09-40	A	FNAME	Input file name of an ASCII file that contains cross-section data and weighting factors for interpolation of values to the nodes. For format see section 4.11 of RMA-2 documentation *Not required*.

Line type INPUMP: File Name Data 1 line

01-05	A	ID	"INPUMP "
09-40	A	FNAME	Input file name of an ASCII file that contains pump operating data. For format see section 4.12 of RMA-2 documentation *Not required*.

Line type AMASSOUT: File Name Data 1 line

01-05	A	ID	"AMASSOUT"
09-40	A	FNAME	Output file name of an ASCII file that contains a time series of total mass of suspended sediment and bed sediment *Not required*.

Line type ENDFIL: File Name Data 1 line

01-06	A	ID	" ENDFIL "
09-40	A	FNAME	Indicator of end of file name data *Required.*

6.4.2 LIMIT BLOCK

The data lines that form the **LIMIT** block are optional and may be used with allocatable version of RMA-11 to reset limits for the buffer size and front width to assure efficient execution. If used, terminate with an ENDLIMIT data line

Columns *Format* *Name* *Description*

Line type MAXFRONT Front limit data 1 line (optional)

01-08	ID	A	"MAXFRONT"
09-16	MFW	I	Maximum allowed front size in equation solver (if not defined defaults to 425)

Line type BUFFSIZ Front limit data 1 line (optional)

01-07	ID	A	"BUFFSIZ"
09-16	NBSS	I	Buffer size for equation solver (if not defined defaults to 4,000,000)

Line type BUFFSIZ Front limit data 1 line (optional)

01-07	ID	A	"BUFFSIZ"
09-16	NBSS	I	Buffer size for equation solver (if not defined defaults to 4,000,000)

Line type MAXNOD Node limit data 1 line (optional except for 3-D cases where it is required)

01-06	ID	A	"MAXNOD"
09-16	MAXP	I	Maximum number of nodes (if not defined defaults to number in input 2-D geometry file)

Line type MAXEL Element limit data 1 line (optional except for 3-D cases where it is required)

01-05	ID	A	"MAXEL"
09-16	MAXE	I	Maximum number of elements (if not defined defaults to number in input 2-D geometry file)

Line type MAXSSLAY Suspended sediment bed layer limit data 1 line (optional)

01-08	ID	A	"MAXSSLAY"

09-16	MLAYERD	I	Maximum number of layers for suspended sediment bed. (if not defined defaults to 10)

Line type MAXMAT Element type limit data 1 line (optional)

01-06	ID	A	"MAXMAT"
09-16	MMATDM	I	Maximum number of element types. (if not defined defaults to 1000)

Line type MAXCONST Constituent limit data 1 line (optional)

01-08	ID	A	"MAXCONST"
09-16	NQLDM	I	Maximum number water quality constituent types. (if not defined defaults to number computed from R11 input file)

Line type MAXPUMP Pump limit data 1 line (optional)

01-07	ID	A	"MAXPUMP"
09-16	NMPMD	I	Maximum number data types. (if not defined defaults to 10)

Line type MAX1DCRS Cross section limit data 1 line (optional)

01-08	ID	A	"MAX1DCRS"
09-16	MCRSD	I	Maximum number of 1-d cross-sections. (if not defined defaults to 500)

Line type MAXPTS1D Cross section points limit data 1 line (optional)

01-08	ID	A	"MAXPTS1D"
09-16	MPTSD	I	Maximum number of points in any 1-D section. (if not defined defaults to 50)

Line type MAXSTEPS Time step limit data 1 line (optional)

01-08	ID	A	"MAXSTEPS"
09-16	mSTEP	I	Maximum number of time steps, water quality constituent types. (if not defined defaults to number of steps defined in input file)

Line type MAXPTLAY 2-D Node limit data 1 line (optional)

01-08	ID	A	" MAXPTLAY"
09-16	MLAY	I	Maximum number of nodes in the 2-D input file. (if not defined defaults to number of steps defined is computed from input geometry file)

Line type MAXLAYER Max layer limit data 1 line (optional)

01-08	ID	A	" MAXLAYER"
09-16	NLAYM	I	Maximum number of element layers in the 3-D geometry. (if not defined defaults to number implied by the NDP value in the R11 file or to 6)

Line type **ENDLIMIT END OF LIMIT SETTING BLOCK** 1 line (optional)

01-08	ID	A	"ENDLIMIT"

6.4.3 CONTROL BLOCK

The data lines that form the **CONTROL** block input all the variables that control the run sequence of the model

Columns	*Format*	*Name*	*Description*
Line type TI:	Title Data		1 line
01-08	A	ID	"TI "
09-80	A	TITLE	Any heading comment
Line type C0	Control Data		1 line Required
01-02	A	ID	"C0"
09-16	I	IYRR	Year to start simulation
17-24	I	DAYOFY	Julian day of year to start simulation
25-32	R	TET	Hour to start simulation
Line type C1	Control Data		1 line Required
01-08	A	ID	"C1 "
09-16	I	NQAL	Number of constituents (up to 16) (NO LONGER USED)
17-24	I	IPRT	Print option 0 = suppress node and element information 1 = print all input data and expanded form of results 2 = suppress node and element data and print short form of the results
25-32	I	MBAND	Type of velocity field: -1 = velocity field defined by single line. See line type N 0 = varying velocity field on file NIPT (RMA-10 format) 1 = constant velocity field on file NIPT (RMA-10 format) 100 = varying velocity field on file NIPT (RMA-2 format) 101 = constant velocity field on file NIPT (RMA-2 format)
33-40	I	NBT	Type of initial condition: 0 = 1 line, see line type IC 1 = multi-line, see line type IC

41-48	I	MMET	No longer used.
49-56	I	NDP	3-D layers switch. = 0 Use 2-D depth averaged approximation = 1, Read NDEP cards for all surface nodes, type LD1 = -1, Read NDEP cards at corner nodes as required, type LD2, defining proportional spacing. = +2, Read NDEP cards at corner nodes as required, type LD3. defining absolute elevations. = -N Set Number of layers to ABS(NDP) -1, provided NDP < -1.
56-64	I	IDIFF	Method of specifying diffusion coefficients, see lines type DF and DP. 0 = Values input are directly used in calculation. Nominal vertical diffusion is the input constant scaled by the RMA factor for stratified flow. 1 = Horizontal diffusion coefficients are applied in the direction of flow. For the longitudinal direction they are computed from element size and velocity magnitude, and are scaled by input values. The transverse coefficients are defined as a further factor times the longitudinal value. Nominal vertical diffusion is the input constant, scaled by the RMA factor for stratified flow. 2 = Horizontal diffusion coefficients are applied in the direction of flow. For the longitudinal direction they are computed from the input values scaled by velocity magnitude only. The transverse coefficients are defined as a further factor times the longitudinal value. Nominal vertical diffusion is the input constant times the velocity magnitude, scaled by the RMA factor for stratified flow. 3.= Horizontal diffusion coefficients. are applied in the direction of flow. For the longitudinal direction they are computed from the input values scaled by velocity magnitude only. The transverse coefficients are defined as a further factor times the longitudinal value. Nominal vertical diffusion is the input constant, scaled by the RMA factor for stratified flow. 4.= Horizontal diffusion coefficients. are applied in the direction of flow. For the longitudinal direction they are computed from the input values scaled by the element size only. The transverse coefficients are defined

			as a further factor times the longitudinal value. Vertical diffusion is computed as input nominal value scaled by the Henderson-Sellers correction for stratified flow. 5.= Horizontal diffusion coefficients. are applied in the direction of flow. For the longitudinal direction they are computed from the input values scaled by the velocity magnitude only. The transverse coefficients are defined as a further factor times the longitudinal value. Vertical diffusion is computed as input nominal value scaled by the Henderson-Sellers correction for stratified flow. 6 = Horizontal diffusion coefficients are computed using the Smagorinsky formula (see RMA-2/RMA-10 documentation) corrected by an input Prandtl-Schmidt number[2]. This option is currently only implemented for 2-D depth averaged applications.
65-72	I	ICNSV	Switch controlling formulation of governing advection diffusion equation. 0 = Use non-conservative form 1 = Use conservative form
73-80	I	INOTR	Switch controlling transformation option 0 = Transform using 3-D transformation 1 = Do not apply transformation. This option may only be used for 2-D cases.

Line type C2; Control Data 1 line Required

01-08	A	ID	"C2 "
09-16	R	ELEV	Reference elevation used in the 3-D water surface transformation, usually the mean water surface elevation (Must be supplied)
17-24	R	XSCALE	X coordinate scale factor to convert inputs to meters
25-32	R	YSCALE	Y coordinate scale factor to convert inputs to meters
33-40	R	ZSCALE	Z coordinate scale factor to convert inputs to meters

[2] The Diffusion coefficients are computed as ν/σ where ν is the computed kinematic turbulent eddy viscosity and σ is the Prandtl Schmidt number

41-48	R	USCALE	X velocity scale factor to convert inputs to m/sec
49-56	R	VSCALE	Y velocity scale factor to convert inputs to m/sec
57-64	R	WSCALE	Z velocity scale factor to convert inputs to meters
65-72	R	PCTR	Fraction of average out-flowing concentration returned on inflow, using the formula: Cin = Cs + PCTR*(Cout – Cs) where: Cin = modified specification Cs = specified concentration Cout = average outgoing concentration.

Line type C3: <u>Control Data 1 line Required</u>

01-08	I	ID	"C3 "
09-16	I	NITN	Number of iterations per dynamic solution step.
17-24	I	NSTART	Starting time step (used to skip through B.C. data for restart.
25-32	I	NCYC	Number of time steps to be simulated
33-40	I	NPRTF	Iteration frequency for printing full solution if ITSI<0. This number is time step frequency for printing full solution.
41-48	I	IDSWT	Dry node activation. Set = 0 to eliminate dry node operation or when element elimination has not been activated in RMA-2 or RMA-10. Set = 1 for use with original wetting and drying element elimination method. Set = -1 for use with marshing method where element elimination has also been activated.
49-56	I	IRSAV	Time step to start saving binary results file. 0 = same as saving from first step
57-64	I	ISAVF	Time step frequency for saving of binary results file. 0 = same as saving all steps.
49-56	I	ISAVW	Time step to start saving selected node ASCII results file. 0 = same as saving from first step

57-64	I	ISAVX	Time step frequency for saving selected node ASCII results file. 0 = same as saving all steps.

Line type C4: Control Data 1 line Required

01-08	A	ID	"C4 "
09-16	R	DSET	Depth below which nodes are dry, when drying. Active only if wetting and drying activated.
17-24	R	DSETD	Depth above which nodes are active when wetting. Active only if wetting and drying activated.
25-32	R	TSTART	Not used.
33-40	R	TCORR	Hours to be used to adjust time on input velocity file generated by RMA-2. Subtraction is positive.
41-48	R	TEND	Time of last step on input velocity file.

Line type **C5 1-D SECTION CONTROL LINE 5** 1 line (optional)

01-02	A	ID	"C5"
09-16	I	ID1DND	= 2 to activate sloping bed cross-section option (not currently available). = 3 to activate input of cross-section data from file.

Line type **EXM 1-D SECTION EXCLUSION** As many lines as needed when ID1DND =3 (optional/not required)

01-08	A	ID	"EXM"
09-80 9 @ 8	I	MDLIST	List of element types that will use the standard trapezoidal cross-section from the geometry file rather than the type 3 cross-section data from the input cross-section file.

6.4.4 PROPERTIES BLOCK

The data lines that form the **PROPERTIES** block input all the parameters and geometric data needed for the simulation. End with and ENDGEO data line.

Line Type ICE1. Ice data 1 line Optional, if not provided ice formation and influence will not be simulated.

Columns	*Format*	*Name*	*Description*
01-08	A	ID	"ICE1 "
09-16	R	ROW	Density of water (kg/m^3)
17-24	R	CHEAT	Heat capacity of water
25-32	R	TMED	Temperature at the ice/water interface (deg C). Default=0.0
33-40	R	HTR	Heat transfer coefficient between snow and air (W/m^2/deg C)
41-48	R	XLAT	Latent heat of fusion of ice (J/g). Default=333.4
49-56	R	ROSN	Density of snow (kg/m^3). Default=300
57-64	R	ROIC	Density of ice (kg/m^3) Default=917
65-72	R	TICE	Ice temperature(deg C). Default =0.5*Tair

Line Type ICE2. Ice data part 2 1 line Calibration and correction coefficients, required, if line type ICE1 is entered See appendix describing ice formation equations for more details

01-08	A	ID	"ICE2 "
09-16	R	CAL1	Calibration coefficient for ice-water transfers below critical water velocity
17-24	R	CAL2	Calibration coefficient for ice-water transfers above critical water velocity.
25-32	R	CAL3	Calibration coefficient for net heat flux in the presence of ice.
33-40	R	CAL4	Correction factor for thickness of snow cover.
41-48	R	VTR	Water velocity for transition of heat transfer formulation for ice-water heat flux

Line type SP: Selected Save Nodes Up to NQAL lines Not required. Used to define constituents and nodes that will be saved in time series form

01-08	A	ID	“SP “
09-16	I	NCONS	Constituent number
16-80	I	NNODT	Nodes selected for special output for this constituent. Up to 8 values in fields of 8.

Line type DSP: Selected Save Elements Up to 2 lines Not required. Used to define elements for which representative diffusion coefficients will be saved in time series form

01-08	A	ID	“DSP “
09-80	I	IDSAV	Element numbers for which diffusion coefficients will be saved. Up to 9 values in fields of 8.

Line type IOV Time Overlay Option (optional) When this line is entered the input time from any restart file is overlaid with the time from the control line C0

01-03	A	ID	"IOV"

Line type IDP Track Bed Change Option (optional) When this line is entered the initial thickness of the bed is saved and then when changes in bed thickness occur the apparent geometry is updated so that apparent depth and velocities are scaled.

01-03	A	ID	"IDP"
09-16	I	IDEPCH	Switch option 0 = Do not activate equivalent to omitting line 1 = Compute initial bed from initial conditions or read initial bed from restart file, then track bed changes for scaling purposes. 2 = Compute initial bed from initial conditions do not read initial bed from restart file even if available, then track bed changes for scaling purposes..

Line type **PMP PUMP CONTROL OPTION** (optional upto 10 pumps) When these lines are entered the inflows and outflows at two elements are controlled by a gate operating policy defined in the PUMP data file

01-03	A	ID	"PMP"
09-16	I	IGTP	Gate controller type 1 = nodal elevation control
17-24	I	INCC	Element number for inflow to the system
25-32	I	NOUTCC	Element number for outflow from the system
33-40	I	NCONTR	Node controlling pump operation
41-48	R	THRESH	Tolerance for shutdown of pump. This threshold is applied so that pump does not immediately shutdown if the effect of turning it on in the model is to lower the elevation at the control node.

Line type COL 3-D Collapse Switch 1 line Optional

01-02	A	ID	"COL"
09-16	R	TRA	Transition depth at which 3-dimensional elements become 2-dimensional depth integrated. If = 0.0 then the model will terminate.

Line type PWR Power station recycling option as many lines as required Optional

01-03	A	ID	"PWR"
09-16	I	NINCC	Model inflow continuity line number = power station outlet.
17-24	I	NOUTCC	Model outflow continuity line number = power station inlet
25-32	R	NCONSTIT	Constituent number
33-40	R	NSWCONST	Rule type, set =1 except for DO For DO, if NSWCONST = 1 then the applied DO is limited to the saturation concentration. If NSWCONST = 2 then the applied DO is set equal to the saturation concentration.
41-48	R	ADDTMP1	Concentration factor. Applied concentration = PAVE*(1.0+ADDTMP1) where PAVE = power station average input concentration

Line type BD: Boundary Distribution Functions Not required - defaults to a constant distribution. Up to NQAL lines Read only if NDP (line type C1) not equal zero

01-08	A	ID	"BD "
09-16	I	I	Constituent number
17-24	R	CMIN	Coefficients used to describe vertical distribution of constituent I for boundary condition input.
25-32	R	CPWR	Expression to be used is C=BCX*(CMIN+(1-CMIN)*(Z/H)**CPWR where Z (m) is the elevation above the bottom, and H (m) is the depth and BCX is input boundary value in line types BN or BC.

Line type VD: Vertical Distribution Functions Not required - defaults to a constant distribution. May be used to expand 2-d velocity files for 3-d transport simulation and to define vertical distribution coefficients for use when IDIFF =4 Read only if NDP (line type C1) not equal zero

01-08	A	ID	"VD "
09-16	R	VMIN	Expression to be used is
17-24	R	POWER	V = Vinput*(VMIN+(1-VMIN)*(Z/H)**POWER *FACT, where Z (m) is the elevation above the

			bottom, and H (m) is the depth and Vinput is input velocity value, and FACT is a normalizing factor to ensure that total flow is preserved.
25-32	R	EDD1	Coefficients used to describe vertical distribution of vertical diffusion coefficient.
33-40	R	EDD2	
41-48	R	EDD3[3]	

Line type DF: Element Type Data (IDIFF=1,5) As many lines as element types in the geometric data. (use same number of lines as for the RMA-2 simulation).

01-08	A	ID	"DF "
09-16	I	J	Element type number
17-24	R	ORT(J, 1)	If IDIFF = 0 then X-direction diffusion coefficient for element type J If IDIFF = 1,2,3,4,5 then this scale factor applied for the longitudinal direction.
25-32	R	ORT(J, 2)	If IDIFF = 0 then Y-direction diffusion coefficient for element type J If IDIFF = 1,2,3,4,5 then this scale factor applied for the lateral direction.
33-40	R	ORT(J, 3)	Z-direction diffusion coefficient for element type J.
41-48	R	CDMIN(1)	Minimum value for longitudinal diffusion.
49-56	R	CDMIN(2)	Minimum value for lateral diffusion.

Line type DP: Element Type Data (option IDIFF = 6) As many lines as element types in the geometric data. (use same number of lines as for the RMA-2/RMA-10 simulation).

01-08	A	ID	"DP "
09-16	I	J	Element type number
17-24	R	TBMIN(J)	Smagorinsky factor
25-32	R	PSM(J)	Prandtl-Schmidt number.
33-40	R	TBNMIN(J)	Minimum over-riding diffusion coefficient.

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[3] The multiplier of the vertical distribution of the vertical diffusion coefficient is given by:

DIFF = EDD1 + Z * (EDD2 + Z * (EDD3)

Line type CC1: <u>Continuity Node Data Lines types CC1 and CC2 form groups of lines. Repeat sets as needed (These line types are not required)</u>

01-08	A	ID	"CC1 "
09-80 (9 @ 8)	I	LINE(J,K)	Lists of node numbers which define line segments across which are also used generation of boundary conditions

Line type CC2: <u>Continuity Node Data (continued) Use this line type when more than 9 values are desired</u>

01-08	A	ID	"CC2 "
09-80	I	LINE(J,K)	Continuation of node numbers which define a given line .

Line type EL: <u>Element Data Use this line type to define element data not entered in the binary geometry file. (Not required)</u>

01-08	A	ID	"EL "
09-14	I	J	Element number
15-62 (8 @ 6)	I	NOP(J,K)	Up to eight node numbers for elements listed counter-clockwise around the element
63-68	I	IMAT(J)	Element type (the number entered here corresponds to the parameters specified in the ORT array, defined above)
69-76	R	ANG(J)	Principal direction of diffusion coefficient anti-clockwise +'ve (radians) from x-axis.

Line type ND: <u>Nodal Data Use this line type to define nodal data not entered in the binary geometry file (Not Required)</u>

01-08	A	ID	"ND "
09-16	I	N	Node number
17-24	R	CORD(N,1)	X coordinate input at node N
25-32	R	CORD(N,2)	Y coordinate input at node N
33-40	R	AO(N)	Bottom elevation at node N

NOTE: The coordinate values read from the above lines are multiplied by the appropriate scale factors, XSCALE and YSCALE, and should result in the proper X and Y coordinates (meters) after transformation

Line type WD: Width Data Use this line type to define width data not entered in the binary geometry file (Not Required)

01-08	A	ID	"WD "
09-16	I	J	Node number
17-24	R	WIDTH(J)	Node J channel width at zero depth
25-32	R	SS1(J)	Left side slope at node J
33-40	R	SS2(J)	Right side slope at node J
41-48	R	WIDS(J)	Storage width associated with node J at zero depth

Line type LD1 Layer Data (All Nodes) Read only if NDP=1 Repeat this line type until all 2-D nodes are entered.

01-08	A	ID	"LD1 "
09-80 (9 @ 8)	I	NDEP(J)	Number of elements in vertical direction of each node in succession. 9 values per line. (note numbers are only used for corner nodes, all mid-sides may be set to zero).

Line type LD2 Layer Data Read only if NDP=-1 Use sets of LD2 and LD2A lines to define layers at all 2-D corner nodes that will become 3-D

01-08	A	ID	"LD2 "
09-16	R	I	For node I number of elements in vertical
17-24	I	NDEP(I)	Number of elements in vertical direction at each node (values are only needed for corner nodes and for nodes with non-zero value.
25-80 (7 @ 8)	R	THLAY(I,J)	Scalar multiplier for non-uniform element spacing. 0 defaults to uniform spacing (NDEP(I)) values. Continue on LD2A line if necessary.

Line type LD2A Layer Data Read only if NDP=-1 and NDEP(I) on line type LD2 > 7 Repeat until all THLAY values are defined

01-08	A	ID	"LD2A "

09-80 (9 @ 8)	R	THLAY(I,J)	Continuation of scalar multiplier for non-uniform element spacing. 0 defaults to uniform spacing (NDEP(I)) values.

Line type LD3 Layer Data for Specified Elevations Read only if NDP = 2 Use sets of LD3 and LD3A lines to define layers at all 2-D corner nodes that will become 3-D

01-08	A	ID	"LD3 "
09-16	I	I	Node number I
17-24	I	NDEP(I)	Number of elements in vertical direction at each node (values are only needed for corner nodes and for nodes with non-zero value.
25-80 (7 @ 8)	R	THLAY(I,J)	Elevation of each non-uniformly spaced corner nodes below the surface node I.

Line type LD3A Layer Data for Specified Elevations Read only if NDP= 2 and NDEP(I) on line type LD3 > 7 Repeat until all THLAY values are defined

01-08	A	ID	"LD3A "
09-80 (9 @ 8)	R	THLAY(I,J)	Elevation of each non-uniformly spaced corner nodes below the surface node I.

Line type ENDGEO: End of geometry indicator line

01-08	A	ID	"ENDGEO "

6.4.5 INITIAL CONDITIONS BLOCK

The data lines that form the **INITIAL CONDITIONS** block input all the initial condition data data needed for the simulation.. Terminate with and ENDINIT data line. If a restart file is used values are not required.

Columns	*Format*	*Name*	*Description*

Line type IC: Initial Condition Data Not required if restart file is used.
If NBT = 0, (on line type C1) then enter one set of line types IC and optionally, IB, IT and IS data The magnitude of N in cols. 9-16 will be ignored.
If NBT = 1 then enter pairs of IC and optionally IB and IT lines for each node. Then enter optionally enter a set of IS lines for each node.

Columns	Format	Name	Description
01-08	A	ID	"IC "
09-16	I	N	If NBT = 0 ignore magnitude of N IF NBT = 1 Magnitude of N is node number If N < 0 then use a type IT line containing time derivative. Repeat type IC line with N = 0 if NQAL > 7
17-80 (8 @ 8)	R	TCON(N,L)	Initial quality concentration for either all nodes (NBT=0) or node |N| (NBT = 1) for each active constituent .

Line type IB: Initial Condition Data for Bed Not required if restart file is used.

Columns	Format	Name	Description
01-08	A	ID	"IB "
09-16	I	N	If NBT = 0 ignore magnitude of N IF NBT = 1 Magnitude of N is node number If N < 0 then use a type IT line containing time derivative. Repeat type IC line with N = 0 if NQALB > 7
17-80 (8 @ 8)	R	BCON(N,L)	Initial bed quality concentration for either all nodes (NBT=0) or node |N| (NBT = 1) for each active constituent .

Line type IT: Initial Time Derivative Data Not required if restart file is used. Read when N in IC line < 0 Repeat IT line to read additional lines if NQAL in line C1 > 7

Columns	Format	Name	Description
01-08	A	ID	"IT "
09-16	I	N	Blank
16-80	R	TDOT(N,L)	Initial time derivative of water quality

(8 @ 8)			concentration for all nodes (NBT=0) or node |N| (NBT = 1) for each active constituent.

Line type IS: Initial Sand Bed Thickness Data Not required if restart file is used. Read only if Sand is being simulated and NBT = 0 or NBT = 1

01-08	A	ID	"IS "
09-16	I	N	Blank (NBT = 0) or Node number (NBT = 1)
17-24	R	TTHICK(N)	Initial thickness of bed layer

Line type CB: Initial Cohesive Suspended Sediment Control Data Read only if cohesive suspended sediment is being simulated

01-08	A	ID	"CB "
09-16	I	IBED	= 1 read bed data line type CBD for one node and expand to all nodes = 2 read bed data line type CBD for each node.
17-24	I	IELEV	= 0 read no bed elevation data = 1 read old bed data line type CBL.

Line type CBD: Initial Cohesive Suspended Sediment Bed Data Read only if cohesive suspended sediment is being simulated and IBED =1 or 2 Repeat sets of CBD and CBL for each node if IBED = 2

01-08	A	ID	"CBD "
09-16	I	N	If IBED = 1 Ignore (values on this line will expand to all nodes) If IBED =2 Node number
17-24	I	NLA	Number of layers in old bed data. = 0 set old bed thickness to zero.
25-32	R	TEMP1	Initial mass in new bed (kg/m2)

Line type CBL: Cohesive Suspended Sediment Old Bed Data Read only if cohesive suspended sediment is being simulated, IBED =1 or 2 and NLA >0 1 data line for each layer (NLA)

01-08	A	ID	"CBL "
09-16	I	L	Layer number

17-24	R	SSTO	Critical shear stress for erosion for layer L (N/m2)
25-32	R	SMVAL	Erosion rate constant for layer L. (kg.m2/sec)
33-40	R	GBO	Bulk density for layer L kg/m3
41-48	R	THICKO	Thickness of this layer (m)

Line type IV: Initial Velocity Data — Not required if input velocity file is used. Use if MBAND = -1 on line type C1 To define values at specific nodes use one line for each node.

01-08	A	ID	"IV "
09-16	I	N	Node number for velocities, if node number = 0 then velocity data applies to all nodes (For 3-d application the velocities may be distributed using line type VD)
17-24	R	VX	Velocity in the x-direction at node N (or all nodes).
25-32	R	VY	Velocity in the y-direction at node N (or all nodes).
33-40	R	VZ	Velocity in the z-direction at node N (or all nodes).
41-48	R	WD	Depth at node N (or all nodes)
49-56	R	SVX	Salinity if needed at node N (or all nodes). Note that this value will be saved but not simulated
57-64	R	TVY	Temperature if needed at node N (or all nodes). Note that this value will be saved but not simulated
65-72	R	SVZ	Suspended sediment at node N (or all nodes). Note that this value will be saved but not simulated

Line type ENDINIT: End of initial condition data — Not required if restart file is used.

01-08	A	ID	"ENDINIT "

6.4.6 BOUNDARY CONDITIONS BLOCK

The data lines that form the **BOUNDARY CONDITIONS** block input the time step and boundary conditions data . Terminate with and ENDSTEP data line. Repeat line types DT, SV, RS, BN, BR, BNQ,BRQ, BC, BCQ, SN, SD, NL, NLL, NLQ, DL, DLL, DLQ and ENDSTEP for each set of time steps to be simulated where data values differ. For example, a single time step block may be used when the time step is constant the boundary conditions are constant or are to be input from the "Water Quality Graph File".

Columns	*Format*	*Name*	*Description*

Line type DT: Time step control. Required

01-08	A	ID	"DT "
09-16	R	DELT	Time step for this solution step (hrs). If IRESL active. The model checks for consistency between the saved value and input value. For steady state set DELT = 0.0
17-24	I	IYRR	Year to end use of this time step. Blank for steady state.
25-32	I	IDY	Julian day to end use of this time step. Blank for steady state.
33-40	R	HREND	Hour to end use of this time step. Blank for steady state.

Line type SV: Save control Data Not required - Defaults to -1

01-08	A	ID	"SV "
09-80 (9 @ 8)	I	ISAV	Resolve save switch. One value for each pass defined in line type 5 of the quality input file. Note that files may only be saved for later use in the same simulation. -1 = Do not save global matrix for resolution. Note that it may be used in subsequent iterations for this constituent. 1 = Save global matrix for resolution. Only save global matrix if identical flow regime and time steps will occur later in the simulation. 0 = Act on value of IRESL. This initiates the resolve operation.

Line type RS: Resolve Control Data Not required - Defaults to 0

01-08	A	ID	"RS "

09-80	I	IRESL	Resolve restore switch, One value for each pass defined in line type 5 of the quality input file.
(9 @ 8)			0 = Act on value of ISAV. Use RESOL only for iterations greater than one. N = Use RESOL, act on the file saved during time step N. -1 = Do not use RESOL for later iterations, always use FRONT

Line type BN/BR: Boundary Nodal Data Not required Repeat line types BN or BR with NNN blank if NQAL > 8

01-08	A	ID	"BN " or "BR " If BR is specified then the model will automatically track the outgoing average concentration and apply a fraction on return (see PCTR on line type C2)
09-16	I	NNN	Node number at which a nodal boundary condition is to be specified. Include mid-side node numbers. If NNN is entered with a minus sign, this boundary condition is applied regardless of flow direction.
16-80 (8 @ 8)	R	BCX	Up to 8 or NQAL values for specification of boundary conditions at node NNN (mg/l).

Line type BNQ/BRQ: Boundary Nodal Data to be read from a WATER QUALITY GRAPH file Not required

01-08	A	ID	"BNQ "" or "BRQ " If BRQ is specified then the model will automatically track the outgoing average concentration and apply a fraction on return (see PCTR on line type C2)
09-16	I	NNN	Node number at which a nodal boundary condition is to be computed by interpolation from the WATER QUALITY GRAPH file. Include mid-side node numbers. If NNN is entered with a minus sign, this boundary condition is applied regardless of flow direction.

Line type BC/BS: Continuity Line Boundary Data. Not required Repeat line types BC/BS with NNN blank if NQAL > 8

01-08	A	ID	"BC "" or "BS " If BS is specified then the model will automatically track the outgoing average concentration by node and apply a fraction on return (see PCTR on line type C2)
09-16	I	NNN	Continuity line number at which a nodal boundary conditions are to be specified. If NNN is entered with a minus sign, this boundary condition is applied regardless of flow direction.
16-80 (8 @ 8)	R	BCX	Up to NQAL values for specification of boundary conditions (mg/l).

Line type BCQ: Continuity Line Boundary Data to be read from a WATER QUALITY GRAPH file Not required

01-08	A	ID	"BCQ "" or "BSQ " If BSQ is specified then the model will automatically track the outgoing average concentration by node and apply a fraction on return (see PCTR on line type C2)
09-16	I	NNN	Continuity line number at which a nodal boundary conditions are to be computed from WATER QUALITY GRAPH file. If NNN is entered with a minus sign, this boundary condition is applied regardless of flow direction.

Line type SN: Special Boundary Nodal Data Not required Repeat line type SN with NNN blank if NQAL > 8 Enter this data to define specific vertical variations of constituents at a node. Repeat set of SN and SD lines for each surface node.

01-08	A	ID	"SN "
09-16	I	NNN	Surface node number at which a nodal boundary condition is to be specified. Include mid-side node numbers.
16-80 (8@8)	R	BCX	Up to 8 or NQAL values for specification of boundary conditions at node NNN (mg/l).

Line type SD: Special Boundary Nodal Data (cont.)Not required Repeat line type SD with NNN blank if NQAL > 8 Enter this data to define specific vertical variations of constituents at a below an SN node. One or possibly 2 SD lines for each node working vertically downward from the surface node

01-08	A	ID	"SD "
09-16	I	NNN	Blank - The model automatically locates the appropriate node.
16-80 (8@8)	R	BCX	Up to 8 or NQAL values for specification of boundary conditions at sub-surface node (mg/l).

NOTE: On the first time step enter type BN,BR, BNQ, BRQ, BC, BS, BCQ, BSQ, SN and SD lines for each node which may ever have a specified boundary condition. **[**In normal operation the model will eliminate boundary conditions where the advective flow is out of the system. To avoid this condition set node number or continuity line number negative for any node or continuity line where the boundary conditions will be applied regardless of direction of flow.**] NOT FULLY FUNCTIONAL AT PRESENT**

Line type NL: Nodal Load Data Not required Enter NL and optionally NLL lines for nodes where external loading is to be applied

01-08	A	ID	"NL "
09-16	I	NNN	The node number which will receive a specified mass loading.
17-24	R	QIN	Leave blank
25-80 (7 @ 8)	R	BCX	Up to NQAL or 7 values for loading rates of each constituent at node NNN, gm/sec.

Line type NLL: Nodal Load Data (cont.) Not required Enter line type NLL when NQAL > 7 and NL line used

01-08	A	ID	"NLL "
09-80 (9 @ 8)	R	BCX	Continuation up to NQAL values for loading rates of each constituent at node NNN from line type NL, gm/sec.

Line type NLQ: Nodal Load Data to be read from a WATER QUALITY GRAPH file Not required

01-08	A	ID	"NLQ "
09-16	I	NNN	The node number which will be computed from WATER QUALITY GRAPH file as a specified mass loading

Line type DL: Element Load Data Not required Enter DL and optionally DLL lines for elements where external loading is to be applied

01-08	A	ID	"DL "
09-16	I	IEL	The element which will receive the specified mass loading.
17-24	I	IELAYR	The layer in a three-dimensional sense which will receive the specified mass loading. 0 = all layers

25-32	I	NEST	Option for selecting loading units 0 = load applied as BCS in units of gm/sec regardless of QS 1 = load applied to element as QS * BCS where BCS = concentration and QS is flow/volume/area/length (as appropriate) for the element. 2 = load applied to element as QS * BCS where BCS = concentration and QS is total flow entering the element.[4]
33-40	R	QS	Element inflow as specified in RMA-2 or RMA-10. Units for QS are determined by NEST (see immediately above).
41-80 (5 @ 8)	R	BCS	Up to NQAL or 5 values for loading rates of each constituent at element IEL, gm/sec, (or mg/l see above).

Line type DLL: Element Load Data (cont.) Not required Enter line type DLL when NQAL > 5 and DL line used

01-08	A	ID	"DLL "
09-80 (9 @ 8)	R	BCX	Continuation up to NQAL values for loading rates of each constituent at element or node NNN from line type NL, gm/sec. Note units. Total load over a one- or two-dimensional element.

Line type DLQ: Element Load Data to be read from a WATER QUALITY GRAPH file Not required

01-08	A	ID	"DLQ "
09-16	I	NNN	The element for which mass loads will be computed from WATER QUALITY GRAPH file
17-24	I	IELAYR	The layer in a three-dimensional sense which will receive the specified mass loading. 0 = all layers
25-32	I	NEST	Option for selecting loading units 0 = load applied as BCS in units of gm/sec regardless of QS 1 = load applied to element as QS * BCS

4 When NEST is set negative multiple DL sets may used to accumulate loads into the element. There must be one additional and final DL set which must have a positive NEST, QS equal to the total inflow and zero concentrations.

where BCS = concentration and QS is flow/volume/area/length (as appropriate) for the element.
2 = load applied to element as QS * BCS where BCS = concentration and QS is total flow entering the element. See earlier note for the effect of sign

Line type DA: Global Element Load Data Not required Enter DA and optionally DAL lines for elements where external loading that is to be applied to all surface elements is to be entered. At present, use only for 2-D depth averaged systems

01-08	A	ID	"DA "
09-16			Leave blank
17-24	I		Leave blank
25-32	I	NEST	Set = 1 to apply load as QS * BCS where BCS = concentration and QS is flow/volume/area/length (as appropriate) for the element.
33-40	R	QS	Element inflow as specified in RMA-2 or RMA-10. Units are rainfall rates of mm/day
41-80 (5 @ 8)	R	BCS	Up to NQAL or 5 values for loading rates of each constituent (mg/l)

Line type DAL: Global Element Load Data (cont.) Not required Enter line type DAL when NQAL > 5 and DL line used

01-08	A	ID	"DAL "
09-80 (9 @ 8)	R	BCX	Continuation up to NQAL values for loading rates of each constituent.(mg/l)

Line type DAQ: Global Element Load Data to be read from a WATER QUALITY GRAPH file. It will be applied to all surface elements. At present, use only for 2-D depth averaged systems Note that flows in the graph file must be entered in mm/day Not required

01-08	A	ID	"DAQ "
09-16	I	NNN	Leave blank

17-24	I	IELAYR	Leave blank
25-32	I	NEST	Set = 1 load applied to elements as QS * BCS where BCS = concentration and QS is flow/area (as appropriate) for the elements.

Line type ENDSTEP: End Of Time Step Data Required

01-08	A	ID	"ENDSTEP "

Line type ENDDATA: Terminal data Required to end data file.

01-08	A	ID	"ENDDATA "

6.5 Boundary Condition Input File

This alternate input file may be used either to organize the input data structure or to reduce the amount of data required. The model automatically seeks this file when the main input file reads an ENDDATA line when seeking a line type DT. Data for line types DT, SV, RS, BN, BC, SN, SD, NL and ENDSTEP may entered from this file. When a line type ENDDATA is read the file is automatically rewound and read from the beginning again. It is thus possible to repeatedly read data from this file during a simulation. This is useful when time steps are constant, and the boundary conditions are either constant or input from the water quality graph input file.

6.6 Water Quality Graph Input File

The water quality graph input file may be used to allow the model to automatically interpolate value from a time history series of values for water quality boundary conditions and loadings. Currently implemented boundary conditions are: specified nodal values, specified continuity line values, element and nodal loading values. This file is automatically entered when control switches are set in the main input file using line types BNQ, BCQ and NLQ.

Multiple sets of lines type TI, QT and QD may be used to define additional water quality graphs on the same file. Terminate the entire data set with a line type ENDDATA. The file formats have the following structure:

Columns	*Format*	*Name*	*Description*

Line type TI: Title line to identify data Required

01-08	A	ID	"TI "
09-80	A	TITLE	Title line

Line type QT: Control line Required

01-08	A	ID	“QT “
09-16	I	NCLIN	Node number, element number or continuity line number depending on the data type in column 17-24. Set = 0 for global element inflows
17-24	I	JSWT	Identifier of boundary condition type = 0 Specified nodal value = 1 Specified continuity line values. = 2 Nodal loading = 3 Element loading.
25-32	I	IYDD	Starting year for data.

Line type QD: Water Quality Data As many lines as needed

01-04	A	ID	“QD “
05-08	R	DAY	Julian day of data
09-16	R	HR	Hour of data
17-24	R	CA	Parameter value This field contains as many values of CA as would be input on the corresponding line types BN, BC, NL or DL in the main input file, see the instructions for the exact parameters required. That is: NQAL values for line types BN or BC where CA is equivalent to BCX (JSWT =0 or 1) NQAL+ 1 values for line type NL or DL where CA is equivalent to QS and BCS (JSWT = 2 or 3) If QS is used flow rates are m^3/sec or m^3/sec/vol-area-length except for gobal rates when flows are mm/day

Line type ENDDATA: Terminal data Required to end data file.

01-08	I	ID	"ENDDATA "

6.7 Meteorologic Data Input File

The meteorologic input file may be used to allow the model to automatically interpolate value from a time series of values for atmospheric boundary conditions. This file is automatically entered when an input file name is defined.

Multiple sets of lines type TI, ET, EV and MET may be used to define additional water quality graphs on the same file. Terminate the entire data set with a line type ENDDATA. The file formats have the following structure:

Columns	*Format*	*Name*	*Description*
Line type TI:	Title line to identify data		Required
01-08	A	ID	"TI "
09-80	A	METITL	Title line
Line type ET:	Control line		Required
01-04	A	ID	“ET “
04-08	I	IYD	Year at start of data
09-80	I	METID	Up to 9 element type numbers associated with the meteorologic data, enter in fields of 8.
Line type EV:	Evaporation coefficients		Required
01-08	A	ID	“EV “
09-16	R	EVAPA	Coefficient “a” in evaporation equation
17-24	R	EVAPB	Coefficient “b” in evaporation equation
25-32	I	ISOL	Switch controlling source of Short wave data 0 = Compute from input data values of cloudiness etc. 1 = use input values directly.
33-40	I	IDPT	Switch controlling choice between wetbulb and dewpoint data 0 = use wetbulb data (see col 41-48) 1 = use dewpoint data.
Line type MET:	Atmospheric Data		As many lines as needed
01-04	A	ID	“MET “
05-08	R	DAY	Julian day of data.
09-16	R	HR	Hour of data
17-24	R	DAT	Atmospheric dust attenuation. Range typically 0 - 0.13

25-32	R	CL	Cloudiness.
33-40	R	TA	Dry bulb temperature (deg C)
41-48	R	TWB	If IDPT = 0 Wet bulb temperature (deg C). If IDPT = 1 Dew point temperature (deg C)
49-56	R	EA	Atmospheric pressure (millibars)
57-64	R	WIND	Wind speed (m/s)
65-72	R	SNOWD	Snow depth (m)
73-80	R	WDIR	Wind direction (radians /measured from x-axis)
81-88	R	SOLR	Solar radiation rate measured in Watts/m^2

Line type ENDDATA: Terminal data Required to end data file.

01-08	I	ID	"ENDDATA "

6.8 Carbon Diagenesis Data Input File

The carbon diagenesis data input file may be used to allow the model to automatically interpolate value from a time history series of nodal values for carbon diagenesis conditions.

Multiple sets of lines type CNTRL and DATA may be used to define the variation of carbon diagenesis over time.Terminate the entire data set with a line type ENDDATA. The file formats have the following structure:

Columns	*Format*	*Name*	*Description*
Line type TITLE:	Title line to identify data		Required
01-08	A	ID	"TITLE "
09-80	A	TITLE	Title line
Line type CNTRL:	Control line		Required
01-08	A	ID	“CNTRL “
09-16	I	IYD	Year for data set
17-24	I	DAY	Julian day for data set
25-32	R	HR	Hour for data set.
33-40	I	NPM	Number of nodes for this data set
Line type DATA: Data values			NPM lines
01-08	A	ID	“DATA “
09-16	I	N	Node number
17-24	R	CA	Carbon diagenesis for node N (gm/m^2-day)
Line type ENDDATA:	Terminal data		Required to end data file.
01-08	I	ID	"ENDDATA "

6.9 File format for the cross-section data file

Line type **TC CROSS SECTION TITLE LINE** 1 line

01-02	ID	A	"TC"
09-80	TITLE	A	Any heading comment

Repeat lines type ICS and CRS for each cross-section data set.

Line type **ICS CROSS-SECTION IDENTIFIER** 1 line

01-03	ID	A	"ICS"
09-16	IVMIL	I	Cross-section number
16-24	NRIVL	I	Number of elevations in section data

Line type **CRS CROSS SECTION DATA** NRIVL lines

01-03	ID	A	"CRS"
09-16	CRSDAT(1)	R	Elevation
17-24	CRSDAT(2)	R	Cross-section area
25-32	CRSDAT(3)	R	Cross-section surface width

Line type **CRF CROSS REFERENCE DATA** 1 line for each corner node

01-03	ID	A	"CRF"
09-16	NODE1	I	Corner node number
17-24	NRIVCR1	i	Cross-section number for weighting factor 1
25-32	WTRIVCR1	R	Weighting factor for cross-section 1
33-40	NRIVCR2	i	Cross-section number for weighting factor 2
41-48	WTRIVCR2	R	Weighting factor for cross-section 2

Note that WTRIVCR2 is not strictly needed. WTRIVCR1 and WTRIVCR2 must add to 1.0

Line type **ENDDATA END CROSS SECTION DATA FILE** 1 line (Required)

01-07	ID	A	"ENDDATA"

6.10 File format for the pumping control data file

Line type **TP PUMPING TITLE LINE** 1 line

01-02	ID	A	"TP"
09-80	TITLE	A	Any heading comment

Repeat lines type IPD and PDT for each pump data set.

Line type **IPD PUMP IDENTIFIER** 1 line

01-03	ID	A	"IPG"
09-16	IPID	I	Element number for pump extraction
17-24	IPTYP	I	Pump operation switch 0 = Use average outflow concentration as inflow 1 = Use PUMPDATA(3 etc) as a multiplier to the average outflow concentration for inflow. 2 = Use PUMPDATA(3 etc) as an addition of concentration to the average outflow concentration for inflow.

Line type **PDT PUMP DATA** As many lines as needed for more than 7 constituents and up to 10 elevation values for each pump

01-03	ID	A	"PDT"
09-16	PUMPDATA(1)	R	Elevation[5]
17-24	PUMPDATA(2)	R	Flow rate
25-32	PUMPDATA(3)	R	factor on concentration as defined
33-40	PUMPDATA(4)	R	by IPTYP
41-48	PUMPDATA(4)	R	
	etc		

Line type **ENDDATA END PUMP DATA FILE** 1 line (Required)

01-07	ID	A	"ENDDATA"

[5] Pump data are input so that when the elevation exceeds the defined value the input flow rate is initiated

6.11 Quality Input Data File

Use the TEST.R4Q file as a template for creating a quality input data file.

All words in upper case in the QINPUT.R4Q file are labels and should not be changed. Words in lower case are the names of the data items to be replaced by numerical values.

Line type 1 should be used for an 80 character title for the data file.

Line type 2 are two comment lines that must remain in the file. The numbers in the second line mark column boundaries to help align the data.

Line types 3 and 4 contain the CONSTITUENT TYPE LIST. The type list is used to create a map identifying the placement of constituent values in the constituent arrays. If Algae is simulated, Temperature must also be simulated. A maximum of six arbitrary constituents may be used. Only one of each of the other types may be simulated. Line type 3 is an overall list of constituents and line type 4 identifies an active bed constituent. IN THE PRESENT VERSION DATA FROM THIS LINE ARE ONLY USED FOR CARBON DIAGENESI INPUT.
Replace the # for the number of constituents being modeled according to the following list

1 -	Arbitrary Non-Conservative:
2 -	BOD:
3 -	DO:
4 -	Org-N:
5 -	NH3:
6 -	N02:
7 -	NO3:
8 -	Org-P:
9 -	PO4:
10 -	Algae:
11 -	Temperature:
12: -	Suspended sediment (Cohesive)[6]
13: -	Suspended sediment (Non-cohesive - sand)
14: -	Salinity
15: -	Coliform
16: -	TSS
17: -	H2SOD
18: -	Total sediment diagenesis

Line type 5 contains the CONTROLS FOR ORDER OF SOLUTION. RMA-4Q is designed to operate in a number of modes. The paragraph that follows summarizes the options and indicates how the data should be set up to achieve various objectives.

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[6] NOTE THAT COHESIVE AND NON-COHESIVE SEDIMENT ARE MODELLED USING GM/M^3 UNITS AND NOT THE STANDARD KG/M^3.

1. The most economical mode structures the equations so that all growth and decay rate terms that are dependant on the constituent itself are placed on the right hand side of the governing equations but not in the left hand side coefficients. When this option is used for all constituents a pass through the equation solver can simultaneously solve for values for each constituent. Because this is an approximation successive approximations will be required to converge on a final solution. These can however be achieved using the resolve capability after the first iteration of a time step. This method will be applied if IPASS is set to 1 for each constituents on line type 4. Note that IRESL and ISAV in the main input file may be used to reuse previous solutions even on the first iteration. These values are entered as line types P and Q in the input file and one value is required for each pass defined in line type 5.

2. If a constituent does not converge well using this process. (i.e. it is very sensitive to a growth or decay rate) The individual constituent may be singled out for a separate pass through the equation solver by defining a separate value of IPASS. If IPASS is entered with a negative sign in front, then the appropriate rate term will be set into the left hand side coefficients. (Note that this rate term will probably be of no use for other constituents and only one entry of IPASS should contain this number). As further aid to convergence, when the value of ISAV for that constituent is set to -1, the resolve capability will not be used and the left hand coefficients will be updated for each iteration. The example data file QMTEST.R4Q shows an example where temperature has been single out for repeated solution using FRONT and DO has been simulated with a rate term but then using resolve as if the rate term was fixed. Note that this type of convergence problem is not normally a found with the temperature constituent. ISAV has thus been set to -1 in QMTEST.RM4 to ensure that FRONT is entered for each iteration for the first pass but to 0 for the second pass. The remaining constituents are treated with their rate terms only on the right hand side.

Line type 6 provides convergence parameters for each constituent. Iteration will proceed until the maximum change in any given constituent is less than the entered value for that constituent

Line types 7 to 22 define the GLOBAL MODEL PARAMETERS. However, if a given constituent is not simulated, omit the data line for that constituent. Lines type 7 and 8 must be given for all simulations. Repeat arbitrary constituent lines type 15 for each arbitrary constituent simulated.

Lines type 23 to 38 define the ELEMENT VARIABLE PARAMETERS and should be given only for the constituents being simulated. The user should repeat these parameters for each ELEMENT TYPE defined in the finite element geometry.

Lines type 39 to 41 form the TIME DEPENDENT ATMOSPHERIC BOUNDARY CONDITIONS, they must be defined for a given date and time and entries made for each element type. The use of this data format is NOT RECOMMENDED, the user should input atmospheric data using the MET data files

Columns	*Format*	*Name*	*Description*
Line type 1.	TITLE	1 line	
01-03	A3	IDL	'TIT' (Optional line identifier)

01-80	20A4	QTITLE	Title

Line type 2. COMMENT LINES 2 lines to form header for constituent list Optional revised format follows Note that these lines may now be omitted

First line

01-04	A4	IDL	'LAB1'
05-80	A75	LABL	Any comment

Second line

01-04	A4	IDL	'LAB2'
05-80	A75	LABL	Any comment

Line type 3 CONSTITUENT TYPE LIST 1 or 2 lines depending on the number of constituents

01-05	A5	IDL	"TYPE " or "TYPE1" for second line
06-75	15I5	ICONST	List of active constituent numbers drawn from the following list:

1	Arbitrary Non-Conservative:
2	BOD:
3	DO:
4	Org-N:
5	NH3:
6	N02:
7	NO3:
8	Org-P:
9	PO4:
10	Algae:
11	Temperature:
12	Susp sed (cohesive):
13	Susp sed (non cohesive):
14	Salinity:
15	Coliform
16: -	TSS
17: -	H2SOD
18: -	Total sediment diagenesis

Line type 4 BED CONSTITUENT TYPE LIST 1 line

01-05	A5	IDL	"BTYPE "
06-75	15I5	ICONST	List of active bed constituent numbers drawn from the following list:

2	BOD:
3	DO:
4	Org-N:
5	NH3:
6	N02:

7	NO3:
8	Org-P:
9	PO4:
10	Algae:

Line type 5 CONTROLS FOR ORDER OF SOLUTION 1 or 2 lines depending on the number of constituents

01-05	A5	IDL	"PASS " or "PASS1" for second line
06-75	15I5	IPASS	Solution pass number for the constituent listed above. Constituents with the same pass number will be solved simultaneously. If the pass number is set negative the rate term will be included on the left hand side of the governing equations.

Line type 5a CONTROLS FOR ORDER OF SOLUTION IN BED 1 line

01-05	A5	IDL	"BPASS"
06-75	15I5	IPASS	Solution pass number for the bed constituent listed above. Constituents with the same pass number will be solved simultaneously. If the pass number is set negative the rate term will be included on the left hand side of the governing equations.

Line type 6 CONTROLS FOR WATER COLUMN CONVERGENCE OF SOLUTION 1 or 2 lines depending on the number of constituents

01-05	A5	IDL	"CONV " or "CONV1" for second line
06-75	15F5.0	CONVS	Maximum acceptable change for each water column constituent during an iteration for the model to be considered converged.

Line type 6A CONTROLS FOR BED PARAMETER CONVERGENCE OF SOLUTION 1 line

01-05	A5	IDL	"BCONV "
06-75	15F5.0	BCONV	Maximum acceptable change for each bed constituent during an iteration for the model to be considered converged.

Line type 6B CONTROLS FOR WATER COLUMN CHANGE LIMITS DURING SOLUTION 1 or 2 lines depending on the number of constituents (Optional)

01-05	A5	IDL	"LIMIT" or "LIMT1" for second line
06-75	15F5.0	CLIMIT	Maximum acceptable change for each water column constituent during an iteration. If exceeded the model will be considered unstable and stopped

Line type 6C CONTROLS FOR BED CONCENTRATION CHANGE LIMITS DURING SOLUTION 1 line (Optional)

01-05	A5	IDL	"LIMIT" or "LIMT1" for second line
06-75	15F5.0	CLIMIT	Maximum acceptable change for each bed constituent during an iteration. If exceeded the model will be considered unstable and stopped.

Line type 7 Header for GLOBAL MODEL PARAMETERS 2 lines to form header for constituent list Optional revised format follows. Note that these lines may now be omitted

First line

01-04	A4	IDL	'LAB3'
09-80	A75	LABL	Any comment

Second line

01-04	A4	IDL	'LAB4'
09-80	A75	LABL	Any comment

Line type 8 SYSTEM PARAMETERS 1 line

01-06	A6	IDL	"SYSTEM"
09-16	F8.0	ELEV	Elevation of site (m).
17-24	F8.0	LAT	Latitude of site (deg).
25-32	F8.0	LONG	Longitude of site (deg). East is positive
33-40	F8.0	STAN	Standard time at site (deg). East is positive.
41-48	F8.0		Leave blank
49-56	F8.0	STIME	Year for meteorological data.
57-64	I8	METRIC	Metric switch. 0 = English units for meteorological data 1 = Metric units for meteorological data
65-72	F8.0	EXTINC	Light Extinction coefficient, (1/m) (now used for all options.

Line type 9 ALGAE DATA 2 lines to define data for algae
Read only if algae is an active constituent

1st line

01-06	A6	IDL	"ALGAE1 "
09-16	F8.0	ALP0	Conversion factor µmg - Chla to mg - A .
17-24	F8.0	ALP1	Fraction of Algal biomass that is nitrogen
25-32	F8.0	ALP2	Fraction of algal biomass that is organic phosphorous
33-40	F8.0	ALP3	Oxygen production rate per unit of algal photosynthesis (mg-O / mg-A)
41-48	F8.0	ALP4	Oxygen uptake rate per unit of algae respired (mg-O / mg-A)
49-56	F8.0	THET1	Algal growth rate temperature factor.
57-64	F8.0	THET2	Algal respiration rate temperature factor.
65-72	F8.0	THET3	Algal settling rate temperature factor.
73-80	F8.0	PREFN	Preference for NH3 - N (0. - 1.0)

2nd line

01-06	A6	IDL	"ALGAE2 "
09-16	F8.0	KLIGHT	Light half saturation coefficient (kJ/m^2/sec). Note that upper atmosphere incoming radiation from the sun is 1.353kJ/m^2/sec.
17-24	F8.0	KNITR	Nitrogen half saturation coefficient (mg/l).
25-32	F8.0	KPHOS	PO4 half saturation coefficient (mg/l)
33-40	F8.0	LAMB0	Not used, formerly non algal portion of the light extinction coefficient (1/m) now input on SYSTEM line.
41-48	F8.0	LAMB1	Linear algal self shading coefficient (1/m mg-Chla/l)
49-56	F8.0	LAMB2	Non-linear algal self shading coefficient

Line type 9a BED ALGAE DATA 2 lines to define data for algae
Read only if bed algae is an active constituent

1st line

01-07	A7	IDL	"BALGAE1 "
09-16	F8.0	ABLP0	Conversion factor μmg - Chla to mg - A .
17-24	F8.0	ABLP1	Fraction of bed algal biomass that is nitrogen
25-32	F8.0	ABLP2	Fraction of bed algal biomass that is organic phosphorous
33-40	F8.0	ABLP3	Oxygen production rate per unit of bed algal photosynthesis (mg-O / mg-A)
41-48	F8.0	ABLP4	Oxygen uptake rate per unit of bed algae respired (mg-O / mg-A)
49-56	F8.0	BTHET1	Bed algae growth rate temperature factor.
57-64	F8.0	BTHET2	Bed algae respiration rate temperature factor.
65-72	F8.0	BTHET3	Bed algae settling rate temperature factor.
73-80	F8.0	PBREFN	Preference for NH3 - N (0. - 1.0)

2nd line

01-07	A7	IDL	"BALGAE2 "
09-16	F8.0	KBLIGHT	Light half saturation coefficient (kJ/m^2/sec). Note that upper atmosphere incoming radiation from the sun is 1.353kJ/m^2/sec.
17-24	F8.0	KBNITR	Nitrogen half saturation coefficient (mg/l).
25-32	F8.0	KBPHOS	PO4 half saturation coefficient (mg/l)
33-40	F8.0	LAMB0	Not used, formerly non algal portion of the light extinction coefficient (1/m) now input on SYSTEM line.
41-48	F8.0	LAMB1	Linear algal self shading coefficient (1/m mg-Chla/l)
49-56	F8.0	LAMB2	Non-linear algal self shading coefficient

Line type 10 NITROGEN DATA 1 line to define data for nitrogen.
Read only if nitrogen is an active constituent

01-05	A5	IDL	"NITRO "

09-16	F8.0	ALP5	Oxygen uptake rate per unit of ammonia nitrogen oxidation (mg-O / mg-N)
17-24	F8.0	ALP6	Oxygen uptake rate per unit of nitrite nitrogen oxidation (mg-O / mg-N)
25-32	F8.0	THET4	Temperature coefficient for bed organic nitrogen decay.
33-40	F8.0	THET5	Temperature coefficient for bed organic nitrogen settling.
41-48	F8.0	THET6	Temperature coefficient for bed ammonia nitrogen decay.
49-56	F8.0	THET7	Temperature coefficient for bed ammonia nitrogen benthic sources.
57-64	F8.0	THET8	Temperature coefficient for bed nitrite nitrogen decay.
65-72	F8.0	KNINH	First order bed nitrification inhibition coefficient. $(mg/l)^{-1}$

Line type 10a BED NITROGEN DATA 1 line to define data for bed nitrogen. Read only if bed nitrogen is an active constituent

01-06	A6	IDL	“BNITRO “
09-16	F8.0	ABLP5	Oxygen uptake rate per unit of ammonia nitrogen oxidation (mg-O / mg-N)
17-24	F8.0	ABLP6	Oxygen uptake rate per unit of nitrite nitrogen oxidation (mg-O / mg-N)
25-32	F8.0	BTHET4	Temperature coefficient for bed organic nitrogen decay.
33-40	F8.0	BTHET5	Temperature coefficient for bed organic nitrogen settling.
41-48	F8.0	BTHET6	Temperature coefficient for bed ammonia nitrogen decay.
49-56	F8.0	BTHET7	Temperature coefficient for bed ammonia nitrogen benthic sources.
57-64	F8.0	BTHET8	Temperature coefficient for bed nitrite nitrogen decay.
65-72	F8.0	KBNINH	First order bed nitrification inhibition coefficient. $(mg/l)^{-1}$

Line type 10 DISSOLVED PHOSPHOROUS DATA 1 line to define data for dissolved phosphorous.
Read only if dissolved phosphorous is an active constituent

01-04	A4	IDL	“PHOS “
09-16	F8.0	THET9	Temperature coefficient for organic phosphorous decay.
17-24	F8.0	THET0	Temperature coefficient for organic phosphorous settling
25-32	F8.0	THET11	Temperature coefficient for phosphate benthic sources.

Line type 10a BED DISSOLVED PHOSPHOROUS DATA 1 line to define data for dissolved phosphorous.
Read only if dissolved phosphorous is an active constituent

01-05	A5	IDL	“BPHOS “
09-16	F8.0	BTHET9	Temperature coefficient for organic phosphorous decay.

Line type 11 REAERATION DATA 1 line to define options for reaeration of dissolved oxygen (DO). Read only if DO is an active constituent

01-05	A5	IDL	“REAER “
09-16	I8	IREAER	Option switch for reaeration computation 0 = Use Churchill formula 1 = Use Liss and Merlivat (1986) wind speed based formula (suitable for open water environments) 2 = Use minimum reaeration rate input in the DO data as a constant. 3 = Use Churchill formula but also set a lower limit using the input value in the DO data. 4 = Use O’Connor-Dobbins (1958) formula, applying the value input on the DO data line as a lower bound.

Line type 12 DISSOLVED OXYGEN DATA1 line to define data for dissolved oxygen (DO) and bio-chemical oxygen demand.
Read only if (DO or BOD) are active constituents

01-06	A6	IDL	“DO-BOD “
09-16	F8.0	THET12	Temperature coefficient for BOD decay.
17-24	F8.0	THET13	Temperature coefficient for BOD settling.
25-32	F8.0	THET14	Temperature coefficient for DO benthic demand.

33-40	F8.0	THET15	Temperature coefficient for DO reaeration rate.

Line type 12a BED DISSOLVED OXYGEN DATA 1 line to define data for dissolved oxygen (DO) and bio-chemical oxygen demand.
Read only if (DO or BOD) are active constituents

01-07	A7	IDL	"BDO-BOD "
09-16	F8.0	BTHET12	Temperature coefficient for BOD decay.

Line type 13 COLIFORM DATA 1 lines

01-05	A5	IDL	"COLIF"
09-16	F8.0	THET17	Temperature coefficient for coliforms decay.
17-24	F8.0	THET18	Temperature coefficient for coliforms settling.
25-32	I8	ICOLOPT	Switch controlling coliform modelling option 0 = use light sensitive formulation for daylight decay 1 = use constant coefficient for daylight decay.

Line type 14 SUSPENDED SEDIMENT (COHESIVE) Read only if cohesive susp sediment is an active constituent

01-04	A4	IDL	"CSS1"
09-16	I8	ISVL	Control type for settling velocity data 1 = Set all settling velocities for time step ITS to a VSST 2 = Calculate settling velocities using parameters of this data line.
17-24	F8.0	VSST	Constant settling velocity used for all nodes, use when ISVL = 1 (m/s)
25-32	F8.0	CRCON1	Settling velocity parameter #1 see below. Use when ISVL = 2 (gm/m^3)
33-40	F8.0	VSS1	Settling velocity parameter #2 see below. Use when ISVL = 2 (m/sec)
41-48	F8.0	CRCON2	Settling velocity parameter #3 see below. Use when ISVL = 2 (gm/m^3)
49-56	F8.0	EXP2	Settling velocity parameter #4 see below. Use when ISVL = 2

Settling velocity computation:

V = VSS1	C < CRCON1
V = VSK*C	CRCON1 < C < CRCON2
V = VSS2	C > CRCON2

where VSK and VSS2 are computed values computed to assure continuity

Line type 15 SUSPENDED SEDIMENT (COHESIVE) Read only if cohesive susp sediment is an active constituent

01-04	A4	IDL	"CSS2"
09-16	F8.0	VK	Von Karman's Constant = 0.0 defaults to 0.4
17-24	F8.0	RKS	Bed height roughness (m) for Rouse distribution calculation. = 0.0 implies smooth bed.

Line type 16 SUSPENDED SEDIMENT (COHESIVE) Read only if cohesive susp sediment is an active constituent

01-04	A4	IDL	"CSS3"
09-16	I8	NLAYT	Number of layers of new deposits formed
17-24	F8.0	TAUCD	Critical shear stress for deposition of new layer (N/m^2)
25-32	F8.0	GAW	Density of suspending water - (kg/m^3)
33-40	F8.0	GAB	Bulk density of top layer - (kg/m^3)
41-48	F8.0	TTLAY	Full thickness of top layer - (m)
49-56	F8.0	GAC	Density of sediment material - (kg/m^3)
57-64	F8.0	ERC	Erosion rate constant for bottom layer - $kg/(m^2$ sec). All other layers erode en masse in time Δt.
65-72	F8.0	UN	Kinematic viscosity of suspending water - m /sec (=1.16x10 m /sec at 15 C)

Line type 17 SUSPENDED SEDIMENT (COHESIVE) Read only if cohesive susp sediment is an active constituent Read one data line for each layer defined above

01-04	A4	IDL	"CSS4"
09-16	I8	I	Layer number

17-24	F8.0	SS(I)	Critical shear stress of layer I - (N/m^2)
25-32	F8.0	GB(I)	Bulk density of layer I (kg/m^3)
33-40	F8.0	THLAY(I)	Layer thickness (m). Optional, if set = 0 then thickness calculated to match same weight as top layer
25-32	F8.0	EROS(I)	Layer erosion rate constant kg/(m^2 sec) Optional if set = 0 then erosion occurs en masse when critical shear stress is reached If set non zero then particle erosion formulae are applied

<u>**Line type 18** WIND DATA FOR WAVE SHEAR (COHESIVE) Read only if cohesive susp sediment is an active constituent/optional Read one data line for each element type</u>

01-05	A5	IDL	"WAVED"
09-16	I8	I	Element type number
17-24	F8.0	WINDSPDM	Wind speed (m/s)
25-32	F8.0	FETCHM	Fetch (m)
33-40	F8.0	MANN	Manning coefficient applied in wind wave shear computation

<u>**Line type 19** SUSPENDED SEDIMENT (NON COHESIVE) DATA 2 lines Read only if non-cohesive susp sediment is an active constituent</u>

01-05	A5	IDL	"SAND1 " or "SAND " in old format
09-16	F8.0	SACLL	Minimum grain size (mm)
17-24	F8.0	SACUL	Maximum grain size (mm).
25-32	F8.0	ASACI	Number of grain size classes (presently only one size allowed)
33-40	F8.0	SGSA	Specific gravity of sediment
41-48	F8.0	GSF	Grain shape factor.
49-56	F8.0	CLDE	Characteristic length factor/time for deposition (typically 1.0 or 0.05 depending on ICHART)[7]

[7] ICHART = 0 is based on STUDH., it treats the time step as a limiting value when determining the net settling process = $\frac{C - C_{eq}}{t_c}$.. It is formulated as follows:

57-64	F8.0	CLER	Characteristic length factor for erosion (typically 10.0 or 0.05 depending on ICHART)[8].
65-72	F8.0	VSAND	Fall velocity for sediment (m/sec)[9].
73-80	F8.0	AMANN	Manning coefficient used to calculate U*

2nd line

01-05	A5	IDL	"SAND2 "
09-16	F8.0	D35	D35 grain size (mm)
17-24	F8.0	D50	D50 grain size (mm)

$$t_c = \text{larger of } CLDE^* \frac{\text{depth}}{\text{Settling velocity}} \text{ or } \Delta t$$

where: CLDE = Coefficient for deposition,(typical value 1.0).
Δt = Computation time step, (s)

ICHART = 1 is an alternate formulation. It uses an input characteristic time as a limiting value and is thus independent of Δt. It is formulated as follows

$$t_c = \text{larger of } \frac{\text{depth}}{\text{Settling velocity}} \text{ or } 3600^*CLDE$$

where: CLDE = An input characteristic time for deposition,(typical value 0.05 hrs).

[8] ICHART = 0 on the following line follows the methodology of STUDH, it treats the time step as a limiting value when determining erosion rate = $\frac{C_{eq} - C}{t_c}$. The expression used for tc is:

$$t_c = \text{larger of } CLER^* \frac{\text{depth}}{\text{near bed water velocity}} \text{ or } \Delta t$$

where: CLER = Coefficient for erosion,(typical value 10.0).

ICHART = 1 is an alternate formulation. It uses an input characteristic time as a limiting value and is thus independent of Δt. It is formulated as follows:

$$t_c = \text{larger of } \frac{\text{depth}}{\text{near bed water velocity}} \text{ or } 3600^*CLER$$

where CLER is now an input characteristic time for erosion, (typical value 0.05 hrs).

[9] Note that if the fall velocity is set equal to 0.0 then the settling velocity is computed according to the following formula:

$$V_S = 10.^*\nu/(0.8^*\, d_{50})\ ^*\ ([1.+ 0.01^*(sg_s - 1.)^*g^*(0.8^*d_{50})^3 / \nu^2]^{0.5} - 1)$$

Where Vs = Settling velocity of non-cohesive sediment (m/s)
ν = Kinematic viscosity of water (m/s)
d_{50} = 50th percentile grain size (m)
sg_s = Specific gravity of sand

25-32	F8.0	D90	D90 grain size (mm)
33-40	I8	ISMODE	Switch controlling choice of transport method 1 = Ackers and White" 2 = Van Rijn" 3 = Brownlie 4 = Use Modified Van Rijn (1989) 5 = use 1993 Van Rijn method
41-48	I8	ICHART	Switch controlling choice of treatment of CLDE and CLER on the first line. 0 = use standard STUDH method 1 = use revised method (see footnotes on CLDE and CLER

Line type 20 ARBITRARY NON CONSERVATIVE CONSTITUENT DATA
2 lines to define data for each arbitrary non conservative constituent.
(ARB) Read only if there are active constituents.

1st line

01-08	A8	IDL	"ARB1CON1"[10] or "ARB-CON1" in old format
09-16	A8	NAME	Name for this constituent
17-24	I8	NUMCPL	Number of coupled constituents.
25-32	I8	IC1	1st coupled constituent (may be self).
33-40	I8	IC2	2nd coupled constituent.
41-48	I8	IC3	3rd coupled constituent.
49-56	I8	IC4	4th coupled constituent.
56-64	I8	IC5	5th coupled constituent.
65-72	I8	IC6	6th coupled constituent.

2nd line

01-08	A8	IDL	"ARB2CON1" or "ARB-CON2" in old format
09-16	F8.0	THETS	Temperature coefficient for settling
17-24	F8.0	THETB	Temperature coefficient for benthic demand.
25-32	F8.0	THETR1	Temperature coefficient for coupled const. 1.
33-40	F8.0	THETR2	Temperature coefficient for coupled const. 2.
41-48	F8.0	THETR3	Temperature coefficient for coupled const 3.
49-56	F8.0	THETR4	Temperature coefficient for coupled const 4.
57-64	F8.0	THETR5	Temperature coefficient for coupled const 5.
65-72	F8.0	THETR6	Temperature coefficient for coupled const 6.

Line type 21 TSS DATA 1 line to define data for total suspended solids (TSS)
Read only if TSS is an active constituent

01-03	A3	IDL	"TSS "
09-16	F8.0	THET16	Temperature coefficient for TSS settling.

[10] Note that the final 1 in these ID's refers to the arbitrary constituent number. If needed these pairs can be repeated for 6 constituents with initial line ID's of the form ARB1CON1, ARB1CON2, ARB1CON3 etc. and 2nd line ID's of the form ARB2CON1, ARB2CON2, ARB2CON3 etc.

Line type 22 HYDROGEN SULFIDE OXYGEN DEMAND DATA 1 line to define data for H2S oxygen demand.
Read only if H2SOD is an active constituent

01-05	A5	IDL	"H2SOD "
09-16	F8.0	THET19	Temperature coefficient for H2SOD reaction rate.
17-24	F8.0	THET20	Temperature coefficient for H2SOD settling.

ELEMENT VARIABLE DATA. **Line type 23** **is a header.** **Line types 24 to 36 should be repeated for each element type.**

Line type 23 Header for ELEMENT VARIABLE PARAMETERS 2 lines to form header for constituent list Optional revised format follows Note that these lines may now be omitted

First line

01-04	A4	IDL	'LAB5'
09-80	A75	LABL	Any comment

Second line

01-04	A4	IDL	'LAB6'
09-80	A75	LABL	Any comment

Line type 24 ELEMENT TYPE IDENTIFIER 1 line

01-08	A8	IDL	"ELEMTYPE"
09-80	I8	K1	Element type numbers with properties below. Up to 9 entries in fields of 8.

Line type 25 ALGAE RATE DATA 1 line

01-06	A6	IDL	"ALGAEE "
09-16	F8.0	MUMAX	Nominal algae growth rate (1/day)
17-24	F8.0	RESP	Algal respiration rate (1/day)
25-32	F8.0	SIG1	Algal settling rate (m/day)
33-40	F8.0	XEXTINC	Element type sensitive non-algae extinction coefficient over-rides LAMB0 on ALGAE2 line if coefficient is to be element type sensitive (Optional).
41-48	F8.0	AGMAX	Limit value for algae growth rate (1/day)
49-56	F8.0	ARMAX	Limit value for algae respiration rate (1/day)

Line type 25a BED ALGAE RATE DATA 1 line

01-07	A7	IDL	"BALGAEE "
09-16	F8.0	MUMAX	Nominal bed algae growth rate (1/day)
17-24	F8.0	RESP	Bed algae respiration rate (1/day)

25-40			Leave blank
41-48	F8.0	AGMAX	Limit value for bed algae growth rate (1/day)
49-56	F8.0	ARMAX	Limit value for bed algae respiration rate (1/day)

Line type 26 ORGANIC NITROGEN RATE DATA 1 line

01-05	A5	IDL	"ORG-N "
09-16	F8.0	BET3	Organic N to ammonia N conversion rate (1/day)
17-24	F8.0	SIG4	Organic N settling rate (m/day)

Line type 26a BED ORGANIC NITROGEN RATE DATA 1 line

01-06	A6	IDL	"BORG-N "
09-16	F8.0	BET3	Organic N to ammonia N conversion rate (1/day)

Line type 27 AMMONIA RATE DATA 1 line

01-03	A3	IDL	"NH3 "
09-16	F8.0	BET1	Ammonia N to nitrite N conversion rate (1/day)
17-24	F8.0	SIG3	Benthos source rate for ammonia N (mg/ m2/day).
25-32	F8.0	XN	Michaelis Menton coefficient for low DO inhibition of oxidation (mg/l)

Line type 27a BED AMMONIA RATE DATA1 line

01-04	A4	IDL	"BNH3 "
09-16	F8.0	BBET1	Bed Ammonia N to nitrite N conversion rate (1/day)
17-24	F8.0	BSIG3	Bed Benthos source rate for ammonia N (mg/ m2/day).
25-32	F8.0	XBN	Michaelis Menton coefficient for low DO inhibition of oxidation (mg/l)

Line type 28 NITRITE RATE DATA 1 line

01-03	A3	IDL	“NO2 ”
09-16	F8.0	BET2	Nitrite N to nitrate N conversion rate (1/day)

Line type 28a BED NITRITE RATE DATA 1 line

01-04	A4	IDL	“BNO2 ”
09-16	F8.0	BBET2	Bed Nitrite N to nitrate N conversion rate (1/day)

Line type 29 NITRATE RATE DATA 1 line

01-08	A3	IDL	“NO3 ”

Line type 30 ORGANIC PHOSPHOROUS RATE DATA 1 line

01-05	A5	IDL	“ORG-P ”
09-16	F8.0	BET4	Organic phosphorous decay rate (1/day)
17-24	F8.0	SIG5	Organic phosphorous settling rate (m/day)

Line type 31 PHOSPHATE RATE DATA 1 line

01-03	A3	IDL	“PO4 ”
09-16	F8.0	SIG2	Benthos source rate for phosphate P (mg/ m^2/day).
17-24	F8.0	BET5	Phosphate P decay rate (1/day)

Line type 32 BOD RATE DATA 1 line

01-03	A3	IDL	“BOD ”
09-16	F8.0	K1	Decay rate for BOD (1/day)
17-24	F8.0	SIG6	BOD settling rate (m/day)
25-32	F8.0	XB	Michaelis Menton coefficient for low DO inhibition of oxidation (mg/l)

Line type 32a BED BOD RATE DATA 1 line

01-08			“BBOD ”
09-16	F8.0	K1	Decay rate for bed BOD (1/day)

25-32	F8.0	XB	Michaelis Menton coefficient for low DO inhibition of oxidation (mg/l)

Line type 33 DO RATE DATA 1 line

01-02	A2	IDL	"DO "
09-16	F8.0	K4	Oxygen demand rate for sediment (mg/m2/day)
17-24	F8.0		Reaeration rate – as applied value for IREAER option 2 (units m/day), as lower bound for IREAER options 3 and 4 (units 1/day), as lower bound for IREAER option 1 (units m/day).
25-32	F8.0	XJN	NH3 oxygenation velocity for sediment oxygen demand (m/day)
33-40	F8.0	XJS	H2S oxygenation velocity for sediment oxygen demand (m/day)

Line type 34 COLIFORM RATE DATA 1 line

01-06	A6	IDL	"COLIFE" or"COLIF " in old format.
09-16	F8.0	XEXTINC	Settling rate for coliforms (m/day)
17-24	F8.0	T90_DARK	90% decay time for darkness(hr)
25-32	F8.0	XLIGHTCOEF	ICOLPT = 0 Light Coef. (hr.[MJ/(m^{2}hr)]$^{0.7}$) ICOLPT = 1 90% decay time for daytime (hr)
33-40	F8.0	XLAMBCOLIF	ICOLPT = 0 Light extinction coef. (1/m) ICOLPT = 1 Not used

Line type 35 ARBITRARY CONSTITUENT RATE DATA 1 line for each arbitrary constituent Change the final 1 to the appropriate constituent number for each arbitrary constituent.

01-08	A8	IDL	"ARBECON1" or"ARBCON1" in old format.
09-16	F8.0	SIGS	Settling rate for arbitrary constituent (m/day)
17-24	F8.0	SIGB	Benthic source rate for arbitrary constituent (m/m^2/day)
25-32	F8.0	RATE1	1st order growth rate coupled to constituent IC1 - may be self (1/day)
33-40	F8.0	RATE2	1st order growth rate coupled to constituent IC2 (1/day)

41-48	F8.0	RATE3	1st order growth rate coupled to constituent IC3 (1/day)
49-56	F8.0	RATE4	1st order growth rate coupled to constituent IC4 (1/day)
57-64	F8.0	RATE5	1st order growth rate coupled to constituent IC5 (1/day)
65-72	F8.0	RATE6	1st order growth rate coupled to constituent IC6 (1/day)

Line type 36 TSS RATE DATA 1 line

01-04	A4	ID	"TSSE" or "TSS " in old format
09-16	F8.0	SIG6	TSS settling rate (m/day)

Line type 37 H2SOD RATE DATA 1 line

01-06	A6	IDL	"H2SODE" or "H2SOD " in old format.
09-16	F8.0	K1	Decay rate for H2SOD (1/day)
17-24	F8.0	SIG6	H2SOD settling rate (m/day)
25-32	F8.0	XB	Michaelis Menton coefficient for low DO inhibition of oxidation (mg/l)

Line type 38 END INDICATOR 1 line

01-08			"ENDELEM "

ATMOSPHERIC BOUNDARY CONDITION DATA. Line types 39-41 should be repeated for each date and time where atmospheric data is available. This is an out of date method provided only for backward compatibility. Met data files are the recommended method.

Line type 39 DATE AND TIME DATA. 1 line

01-07			"DAT/TIM"
09-16	F8.0	DATE	Julian day of the year.
17-24	F8.0	TETV	Hour of the day.

Line type 40 ELEMENT TYPE IDENTIFIER 1 line

01-08			"ELEMTYPE"
09-16	F8.0	JDAY	Element type number

Line type 41 ATMOSPHERIC BOUNDARY CONDITIONS 1 line of for each element type.

01-08			"ATMS-BCC"
09-16	F8.0	DAT	Atmospheric dust attenuation. Range typically 0 - 0.13
17-24	F8.0	CL	Cloudiness.
25-32	F8.0	TA	Dry bulb temperature (deg C)
33-40	F8.0	TWB	Wet bulb temperature (deg C).
41-48	F8.0	EA	Atmospheric pressure (millibars)
49-56	F8.0	WIND	Wind speed (m/s)
57-64	F8.0	EVAPA	Coefficient "a" in evaporation equation
65-72	F8.0	EVAPB	Coefficient "b" in evaporation equation

Line type 42 END FILE INDICATOR 1 line

01-08	"ENDDATA "

6.12 Results File Format

The RMA format results file contains the same 1000 character header as RMA-2 with the exception that the label is now RMA11. For every time step that is output, data is written to the file. The exact write statement depends on the constituents modeled.

In order to plot RMA-11 results, RMAPLT has been designed to allow for 5 preceding constituents in the results file, so that when the user selects constituent (1) the first water quality constituent is plotted. Indeed if constituent (0) is selected water surface elevation is plotted.

6.12.1 STANDARD FORMAT

The standard format for constituents other than sand or cohesive sediments and with no ice activity is:

```
                 WRITE(IRMAFM) TETT,NQAL+5,NP,IYRR,
     +          ((VEL(K,J),J=1,NP),K=1,3), (wd(j),j=1,np),
     +              (wsel(j),j=1,np),
     &              ((TCON(K,J),J=1,NP),K=1,NQAL)
```

Note that all three velocity components are written (VEL) in addition to depth (WD) and water surface elevation (WSEL). The constituents are contained within TCON. The value NQAL+5 is set to record the actual number of blocks of data written. That is 3 velocities plus depth plus water surface elevation plus the number of constituents.

6.12.2 ICE FORMATION FORMAT

If ice formation is simulated then ice thickness is written as an extra component:

```
                 WRITE(IRMAFM) TETT,NQAL+6,NP,IYRR,
     +          ((VEL(K,J),J=1,NP),K=1,3), (wd(j),j=1,np),
     +              (wsel(j),j=1,np),
     &              ((TCON(K,J),J=1,NP),K=1,NQAL)
     +             , (icethk(j),j=1,np)
```

Thus ice thickness is the next constituent after the last standard constituent.

6.12.3 SAND RESULTS FORMAT

If sand is simulated additional constituents are written but the same basic form is maintained.

```
  +       WRITE(IRMAFM) TETT,NQAL+8,NP,IYRR,
  +         ((VEL(K,J),J=1,NP),K=1,3), (wd(j),j=1,np),
  +              (wsel(j),j=1,np),
  +         ((TCON(K,J),J=1,NP),K=1,NQAL),
  + (DELBED(J)*1.e6,J=1,NP),(srate(j),j=1,np),(gpbsav(j),j=1,np)
```

The three extra constituents are:

NQAL+1	Bed change scaled to be in microns,
NQAL+2	Bed shear stress.
NQAL+3	Water column potential.

6.12.4 COHESIVE SEDIMENT RESULTS FORMAT

If cohesive sediment is simulated then the write statement is:

```
     +         WRITE(IRMAFM) TETT,NQAL+7+NLAYT,NP,IYRR,
     +        ((VEL(K,J),J=1,NP),K=1,3), (wd(j),j=1,np),
     +           (wsel(j),j=1,np),
     +          ((TCON(K,J),J=1,NP),K=1,NQAL)
     +           ,(bshear(j)*10**3,j=1,np),
     +         (totthick(j)*10**6,j=1,np)
     +         ,((THICK(I,J)*10**6,I=1,NP),J=1,NLAYT)
```

The extra constituents are:

NQAL+1	Bed shear scaled by 1000,
NQAL+2	Total bed thickness scaled to be in microns.
NQAL+3 etc	Individual layer thicknesses also scaled to be in microns.