APPENDIX A: GEMSS THEORY, ASSUMPTIONS AND APPLICABILITY

GEMSS® uses many models written in FORTRAN code that computes time-varying velocities, water surface elevations, and water quality constituent concentrations in rivers, lakes, reservoirs, estuaries, and coastal waterbodies. The computations are done on a horizontal and vertical grid that represents the waterbody bounded by its water surface, shoreline, and bottom. The water surface elevations are computed simultaneously with the velocity components. The water quality constituent concentrations are computed from the velocity components and elevations. Included in the computations are boundary condition formulations for friction, wind shear, turbulence, inflow, outflow, surface heat exchange, and water quality kinetics.

The flow and constituent fields are discretized in time, and the computation marches forward in time steps of 100 s to 900 s, computing the dependent variables throughout the grid at each of these steps. To march the calculations through time, boundary condition data consisting of meteorological data; inflow rates, temperatures, and constituent concentrations; and outflow rates are required. These boundary conditions data are assembled as separate input files.

The theoretical basis of the three dimensional model was first presented in Edinger and Buchak (1980) and subsequently in Edinger and Buchak (1985) under the previous name called GLLVHT. It provides three-dimensional, time-varying simulations of rivers, lakes, impoundments, estuaries and coastal water bodies. GEMSS has been peer reviewed and published (Edinger and Buchak, 1995; Edinger, et al., 1994 and 1997). The fundamental computations are an extension of the well known longitudinal-vertical transport model that was developed by J. E. Edinger Associates, Inc. beginning in 1974 and summarized in Buchak and Edinger (1984). This model forms the hydrodynamic and transport basis of the Corps of Engineers' water quality model CE-QUAL-W2 (U. S. Army Engineer Waterways Experiment Station, 1986).

The hydrodynamic and transport relationships used in the GLLVHT are developed from the horizontal momentum balance, continuity, constituent transport and the equation of state. The basic relationships are given in Edinger and Buchak (1980, 1985 and 1995). These relationships have six unknowns (U, V, W - velocities in x, y and z directions, respectively, η - water surface elevation, ρ - density, C_n - constituent n) in six equations with the momentum and constituent dispersion coefficients (A_x, A_y, A_z, D_x, D_y, D_z) evaluated from velocities and the density structure.

In the x and y momentum balances, the forcing terms are the barotropic or water surface slope, the baroclinic or density gravity slope, the Coriolis acceleration, the advection of momentum in each of the three coordinate directions, the dispersion of momentum in each of the coordinate directions and the specific momentum as would apply to a high velocity discharge. The baroclinic and barotropic slopes are arrived at from the hydrostatic approximation to vertical momentum and horizontal differentiation of the density-pressure integral by Leibnitz' rule. The baroclinic slope is seen to be the vertical integral of the horizontal density gradient and becomes the major driving force for density-induced flows due to discharge buoyancy.

The hydrodynamic equations are semi-implicit in time. The semi-implicit integration procedure has the advantage that computational stability is not limited by the Courant condition that $\Delta x/\Delta t$, $\Delta y/\Delta t < (gh_m)^{1/2}$ where h_m is the maximum water depth that can lead to inefficiently small time

steps of integration. Since the solutions are semi-implicit (for example, explicit in the constituent transport and the time lagged momentum terms) the stability is controlled by the Torrence condition ($U\Delta t/\Delta x$, $V\Delta t/\Delta y < 1$; Δx and Δy are grid sizes in x and y directions, respectively). Hence, the integration time step can be chosen to realistically represent the details of the boundary data which is about 15 minutes for tides and up to one hour for meteorological data.

The vertical momentum dispersion coefficient and vertical shear is presently (but not limited to) evaluated from a Von Karman relationship modified by the local Richardson number, Ri, which is defined as the ratio of vertical buoyant acceleration to vertical momentum transfer (Leendertse, 1989). Higher order turbulence closure schemes (two equations k-ω second moment closure model by Mellor and Yamada, 1982) are also included in the module. The longitudinal and lateral dispersion coefficients are scaled to the dimensions of the grid cell using the dispersion relationships developed by Okubo and modified to include the velocity gradients of the velocity field using Smagorinsky relationship. The wind stress and bottom shear stress are computed using quadratic relationships with appropriate friction coefficients.

A summary of the hydrodynamic model characteristics is given in Table 1.

Table 1 Features of GEMSS-HDM

Property	Description	Advantage
ΔX, ΔY, ΔZ	Variable from cell to cell. Curvilinear	Fit shorelines precisely, provide more refined grid detail where needed. Each cell has its own orientation for accurate orientation of winds
Layer/ cell addition subtraction	Yes	Allows adding and subtracting layers over large water surface elevation changes. Flooding and drying of tidal flats and marshes.
Interior Boundaries	Yes	Representation of interior structures such as breakwaters, marinas, underflow/overflow curtain walls.
Vertical momentum	Included. Relaxes Hydrostatic Approx.	Important for draw down at outflow structures, mixing devices, and accurate representation of water surfaces in regions of large horizontal velocity changes.
Discharge Momentum	All three directions	Used for proper representation of high velocity discharges.
Time Stepping Solution	Implicit solution over all space on each time step.	Not limited by the Courant wave speed criterion of $\Delta t < \Delta x/(gHmax)^{0.5}$. Typical time step for 3-D baroclinic circulation is approximately 15 minutes
Coriolis Acceleration	Variable with latitude. Incorporated in implicit part of the time step computations.	Can do large water bodies with large time steps.
Transport Scheme	Quickest, Ultimate	Better prediction of constituent profiles in regions of sharp changes
Turbulence Closure	Higher Order Schemes	Better description of turbulence in regions of rapid changes in bathymetry and around structures. Also at density interfaces.
Wind Speed	Variable through time and across grid	Realistic representation of wind events on a water body.

Property	Description	Advantage
Surface Heat Exchange	Time varying term by term heat budget	Accurate representation of diurnal variations in heat exchange.
Linkage to Water Quality Models	Coupled with water quality models of different levels of complexity	More realistic representation of processes taking place.
Other Supported Routines and Processes	Sediment transport Spill Model Toxics Model Intake Entrainment Model.	Additional routines can be included in a modular fashion and run directly in GLLVHT on a real time basis.

The model is built to accept a large number of transport constituents and constituent relationships depending on the water quality model being used. The list of transport variables available in GLLVHT to analyze flushing, entrainment, thermal pollution, boundary exchange, etc. is given below.

- Temperature
- Salinity
- Excess Temperature
- Instantaneous Tracer Dye
- Continuous Tracer Dye

1. MATHEMATICAL FORMULATION

1.1 MODEL DESCRIPTION

The hydrodynamic and transport relationships used in the GLLVHT are developed from the horizontal momentum balance, continuity, constituent transport and the equation of state. The horizontal momentum balances for the horizontal velocity components, U and V in the x- and y-coordinate horizontal directions, with z taken positive downward are

$$\partial U/\partial t = g\,\partial z'/\partial x - g/\rho \int_{z'}^{z} (\partial \rho/\partial x)\,\partial z + fV - \partial UU/\partial x - \partial VU/\partial y - \partial WU/\partial z + SM_x + \partial A_x(\partial U/\partial x)/\partial x + \partial A_y(\partial U/\partial y)/\partial y + \partial A_z(\partial U/\partial z)/\partial z \quad \text{(A-1)}$$

$$\partial V/\partial t = g\partial z'/\partial y - g/\rho \int_{z'}^{z} (\partial\rho/\partial y)\partial z - fU - \partial UV/\partial x - \partial VV/\partial y - \partial WV/\partial z + SM_y + \partial A_x(\partial V/\partial x)/\partial x + \partial A_y(\partial V/\partial y)/\partial y + \partial A_z(\partial W/\partial z)/\partial z \quad \text{(A-2)}$$

Local continuity for the vertical velocity component W is

$$\partial W/\partial z = - \partial U/\partial x - \partial V/\partial y \quad \text{(A-3)}$$

Vertically integrated continuity for the surface elevation, z', is

$$\partial z'/\partial t = - \int_{z}^{h} (\partial U/\partial x)\,dz - \int_{z}^{h} (\partial V/\partial y)\,dz \quad \text{(A-4)}$$

The constituent transport relationship for n number of constituents (for example, salinity, dye and sediment) is

$$\partial C_n/\partial t = -\partial UC_n/\partial x - \partial VC_n/\partial y - \partial WC_n/\partial z + \partial(D_x\partial C_n/\partial x)/\partial x$$

$$+ \partial(D_y\partial C_n/\partial y)/\partial y + \partial(D_z\partial C_n/\partial z)/\partial z + H_n \quad \text{(A-5)}$$

And, the equation of state relating density, r, to constituents is

$$\rho = f(C_1, C_2, \ldots, C_n) \quad \text{(A-6)}$$

These relationships have six unknowns (U, V, W, z', r, C_n) in six equations, assuming that the momentum and constituent dispersion coefficients (A_x, A_y, A_z, D_x, D_y, D_z) can be evaluated from velocities and the density structure.

In the x and y momentum balances, the right-hand terms are successively the barotropic or water surface slope, the baroclinic or density gravity slope, the Coriolis acceleration, the advection of momentum in each of the three coordinate directions, the dispersion of momentum in each of the coordinate directions and the specific momentum as would apply to a high velocity discharge.

The baroclinic and barotropic slopes are arrived at from the hydrostatic approximation to vertical momentum and horizontal differentiation of the density-pressure integral by Leibnitz' rule. The baroclinic slope is seen to be the vertical integral of the horizontal density gradient and becomes the major driving force for density-induced flows due to discharge buoyancy.

The specific momentum terms, SM_x and SM_y, are evaluated from the velocity and flow rate of a discharge into a model cell as Udis*Qdis/(Dx*Dy*Dz) where Dx, Dy and Dz are the model cell dimensions. The specific momentum is directed vectorially parallel to the direction of the discharge velocity.

1.2 NUMERICAL SCHEME

The hydrodynamic relationships are integrated numerically, implicitly forward in time, by evaluating the horizontal momentum balances as

$$\partial U/\partial t = g\partial z'/\partial x + F_x \quad \text{(A-7)}$$

$$\partial V/\partial t = g\partial z'/\partial y + F_y \quad \text{(A-8)}$$

where U, V and z' are taken simultaneously forward in time and all the other terms are incorporated in the forcing functions F_x and F_y and are lagged in time. Equations (A-7) and (A-8) are substituted (either by cross-differentiation or algebraically from the finite difference forms) into vertically integrated continuity to give the surface wave equation of

$$\partial^2 z'/\partial t^2 + g\partial(H\partial z'/\partial x)/\partial x + g\partial(H\partial z'/\partial y)/\partial y = \partial/\partial x(\int_{z'}^{h} F_x \partial z) + \partial/\partial y(\int_{z'}^{h} F_y \partial z) \quad \text{(A-9)}$$

where z' is the surface displacement and H is the total water column depth. The surface wave equation has second order derivative in time which makes solving of Equation (A-9) quite cumbersome. So, the second order time derivative is converted to first order by expanding $\delta^2 z'/\delta t^2$ using Equation (A-4).

The computational steps in GLLVHT on each time step of integration are: (1) to evaluate F_x and F_y from U, V, W, r known from the previous time step; (2) to solve the surface wave equation for new z' for the spatial grid using a modified form of Gauss-Jordan elimination by back substitution; (3) to solve for new U and V using Equations (A-7) and (A-8); (4) to solve for W using Equation (A-3); (5) to re-evaluate z' from Equation (A-4) for precision; and, (6) to solve the constituent relationships, Equations (A-5).

The semi-implicit integration procedure has the advantage that computational stability is not limited by the Courant condition that Dx/Dt, Dy/Dt $< (gh_m)^{1/2}$ where h_m is the maximum water depth that can lead to inefficiently small time steps of integration. Since the solutions are semi-implicit (for example, explicit in the constituent transport and the time lagged momentum terms) the stability is controlled by the Torrence condition (UDt/Dx, VDt/Dy < 1). Hence, the integration time step can be chosen to realistically represent the details of the boundary data which is about 15 minutes for tides and up to one hour for meteorological data.

There are a number of auxiliary relationships which enter the computations. First, the vertical momentum dispersion coefficient and vertical shear is presently (but not limited to) evaluated from a Von Karman relationship modified by the local Richardson number, Ri, (the ratio of vertical buoyant acceleration to vertical momentum transfer) as

$$A_z = kLm^2/2[(\partial U/\partial z)^2 + (\partial V/\partial z)^2]^{1/2}\mathrm{Exp}(-1.5Ri) \quad \text{(A-10)}$$

where k is the Von Karman constant; Lm is a mixing length that can be a function of depth; and, Ri is the local Richardson number. The Richardson number function is from Leendertse and Liu (1975). The longitudinal and lateral dispersion coefficients are scaled to the dimensions of the grid cell using the dispersion relationships developed by Okubo (1971) of

$$D_l = 5.84 \times 10^{-4}(L_l)^{1.1} \quad \text{(A-11)}$$

where D_l is the longitudinal or lateral dispersion coefficient in square meters per second and L_l is the longitudinal or lateral cell dimension in meters.
Wind surface stress enters the relationships for each of the coordinate directions as

$$A_z\partial U/\partial z \,|_{z'} = WS_x \quad \text{(A-12)}$$

and,

$$A_z\partial V/\partial z \,|_{z'} = WS_y \quad \text{(A-13)}$$

where $W(W_x)$ and $W(W_y)$ are surface shear functions of wind speed.
Bottom friction enters the computations through a Chezy friction relationship as

$$A_z \partial U/\partial z \mid_h = (g/C_h^2)U^2 \qquad \text{(A-13)}$$
$$A_z \partial V/\partial z \mid_h = (g/C_h^2)V^2$$

where C_h is the local Chezy friction coefficient and h is the bottom elevation at which bottom friction is evaluated.

Transport computation is explicit in time. It is developed so that transport coefficients can be computed once and used for all constituents during that time step at a given "n", "k" location. The solution time is not too sensitive to the number of constituents being examined. Constituent computations are performed using a higher order transport scheme. This scheme uses second order upwind differencing following the method of Mei and Plotkin (1985). The scheme includes an adjustment factor to account for "undershoots" and "overshoots" that normally occurs in any higher order scheme in the presence of sharp gradients. The adjustment factor is computed using local second order and first order gradients similar to ULTIMATE (1988).

The model is built to accept a large number of transport constituents and constituent relationships. The basic parameter obtained from the water quality model is the constituent flux, H(n,k,nc). For example H(n,k,4) = -KR_4*C(n,k,4)*dxdydz for the decay of constituent 4. Dxdydz is the volume of the grid cell and KR_4 is the decay constant).

2. NUMERICAL CONFIGURATION

2.1 GRID AND COORDINATE TRANSFORMATIONS

Rectilinear (quasi-curvilinear) grid for mapping to different detail in different parts of a waterbody is used in GEMSS. Horizontal grid dimensions changing with depth is also used. The model domain is a space staggered finite difference grid with elevations and constituent concentrations computed at cell centers and velocities through cell interfaces. This scheme facilitates implementation of control volume approach resulting in perfect water balance.

Both Z-level and sigma level methods are used for gridding in the vertical direction. Z-level allows the use of variable layer thicknesses in the vertical direction and facilitates implementation of the layer cell add and subtract algorithm for modeling tidal flats; It also allows the use thicker layers in deeper water. Sigma level model is described in Section 7.

The curvilinear model grid is obtained using GridGen tool of GEMSS. GridGen is an automated grid generation tool which is a menu and mouse driven graphical software that allows the user to develop rectilinear as well as curvilinear coordinates from digitized maps containing shorelines and bathymetric soundings, transects and contours. These maps are loaded in GEMSS using widely used shaped file format (.shp, .dbf, .shx, .sbn, .sbx, .prj files) of ESRI. For applications where no digital maps are available, GEMSS has a unique format .GShp which can be used to draw waterbodies and specify depths for subsequent gridding. This format is normally used to set up some simple waterbodies such as rectangular basin etc.

2.2 WETTING AND DRYING

The basic model variable for water surface elevation, Z, is relative to a local datum at the top of a fixed horizontal layer, KT. When the water surface rises so that it enters a new layer, the current thick layer is divided into two, Z is modified and KT is decremented by 1. The reverse action is taken on falling water surface. When the rising surface floods dry cells, they are also activated (and deactivated when dried again). Wetting and drying is important to account for tidal flats and wetlands.

2.3 ARRAY STRUCTURE

Hydrodynamic variables identified by surface cell number "n" and vertical layer "k" as for example U(n,k), V(n,k), W(n,k), Az(n,k). Constituent and water quality variables identified with a water quality constituent number, "nc", as C(n,k,nc). This approach reduces array storage and simplifies computational loops.

2.4 SOLUTION METHOD

HDM used a family of fully implicit schemes, either the banded matrix solver (small grids) or the preconditioned conjugate gradient, successive over relaxation, or modified strongly implicit methods (large grids). After performing a series of numerical experiments on conventional problems as well as real world applications, the preconditioned conjugate gradient method is the ultimate solution method used in HDM because of its less computer storage, CPU time and high convergence speed.

2.5 SOURCES, SINKS AND SPECIFIC MOMENTUM

Discharges/Intakes (e.g. river inflows, outfalls, marine disposals, thermal intakes and discharges etc.) are introduced as sources/sinks to the continuity and transport equations; in addition, sub grid scale jet discharge can be accommodated using a source term for the momentum equations as discussed in the description section. Sources and sinks for continuity equation are applied using the flow rate variable Q(n,k) and for transport equations using the constituent flux variable, H(n,k,nc). Constituent fluxes are also computed from water quality routines.

3. PROGRAM STRUCTURE

3.1 MODEL DESIGN

The unique design of GEMSS gives the user the power of writing adaptation routines to introduce different initial conditions, time variant boundary conditions, replace existing algorithms for source and sink computations related to water quality, sediment transport etc. and nonstandard features or customize the output. In this scheme GEMSS-HDM behaves like a black box. Efficient routines for specifying input time varying data to the model such as meteorological data, inflows, discharge loads, time series boundary data using standards formats (e.g., Microsoft Excel csv format). Separate control switches and input "cards" for hydrodynamics and water quality constituents. Examples of input cards for hydrodynamics include specifying time of beginning and ending computations; types of outputs and their starting and ending times and frequencies; location and characteristics of inflows, discharges and intakes including recirculation coupling; control cards for water quality routines include in addition specification of rate parameters and specifying different combinations of constituents that might be required for a particular simulation.

3.2 Interface to other models

The design structure of GLLVHT is very flexible to accommodate different three dimensional water quality models. Examples include 1) EPA's EUTRO and the Corps' CE-QUAL-ICM (Integrated Compartment Model), sources of water quality kinetics routines.

3.3 Programming Language and Operating System

GEMSS numerical models are written in FORTRAN 90 and developed on Compaq's Visual Fortran compiler that runs on Windows NT and XP operating systems. We have also developed add-on tools for GEMSS that takes advantage of multi language programming (e.g. linking Visual Basic or Visual C++ with FORTRAN) available in Visual Fortran.

4. Boundary Conditions

The model handles a wide variety of boundary conditions through the use of control file generator module of GEMSS and they are listed below.

1. Fresh water inflows and outflows.
2. Outfall discharges.
3. Water intakes.
4. Powerplant intake and discharges. Specific discharge momentum for high velocity discharges.
5. Instantaneous dye releases; useful for flushing and each water parcel residence time computations.
6. Continuous dye releases; useful for dilution computations for wastewater discharges; screening tool for design scenarios.
7. Intantaneous and continuous oil, chemical and sewage spills.
8. Forced open boundary; option for different types of distribution along the boundary, tidal elevation amplification factor, tidal elevation lag time.
9. Free open boundary; use of first and higher order derivations of elevation, velocity and constituents.
10. Radiation boundary; used for elevation, velocity and constituents.
11. Slugging different regions of water body.
12. Interior boundaries for representation of interior structures such as breakwaters, marinas, weirs, gates, culverts, underflow/overflow curtain walls.
13. Surface precipitation/exchange.
14. Bottom deposition/releases.
15. Re-circulation boundary.
16. Entrainment source and target; used for larval and bio-organisms entrainment computations in water intakes.
17. Velocity boundary; used when no information is available other than field data from current meters.
18. Bubblers;
19. Distributed flows; used for representing non-point sources.
20. Grid cell activation/non-activation; quick way to alter the grid pattern.

5. TRANSPORT SCHEMES

The transport module in GEMSS-SHWET is capable of running in fully explicit to fully implicit mode in vertical direction while performing explicit computations in the horizontal direction. A Finite difference scheme is based on control volume (cv) approach. Let's assume transport in 1-D as shown in figure 1.

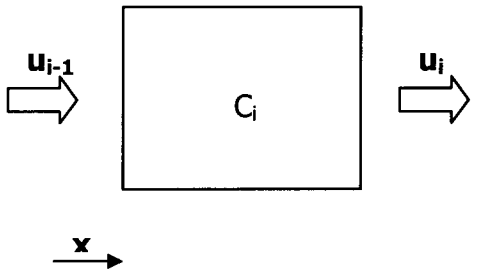

Figure 1 1-D transport schematic

The mass balance based on the CV approach can be written as:

$$C^{n+1} = C^n - (Mass)_{in} + (Mass)_{out} \quad (1)$$

$$Mass_{in} = (adv)_w + (Dif)_w \quad (2)$$

$$Mass_{out} = (adv)_E + (Dif)_E \quad (3)$$

$$(Adv)_w = Cour_w * C_{fw} \quad (4)$$

$$(Adv)_E = Cour_E * C_{fE} \quad (5)$$

$$Cour_E = \frac{u_E * dt}{dx} \quad (6)$$

Where, C_{fw} and C_{fE} are the face concentration values at the west and east cell faces respectively. $Cour_w$ and $Cour_E$ are the courant numbers defined at the west and the east cell faces respectively. Unlike velocities, concentrations are defined at the cell centers in GEMSS and thus interpolation needs to be done in order to calculate the required face concentrations. The various transport schemes used in GEMSS differ in the interpolation scheme used to calculate these face concentration.

The transport scheme can also be Explicit or Implicit. In a fully explicit scheme, all the terms used to calculate the face concentrations are from the current time step while in a fully implicit scheme the face concentrations are calculated based on the concentrations at the next time step. Implicit formulation requires solving matrix and thus is computationally expensive. On the other hand implicit formulation relaxes the time step constraints. In GEMSS, the vertical transport can

be solved using the implicit scheme. It also allows for different combinations (weightage) of Explicit-Implicit formulation. This weightage can be specified in the form of two parameters θ_a and θ_d. The variable θ_a specifies the contribution of implicit formulation for advective transport in the vertical direction and the variable θ_d specifies the contribution of implicit formulation for diffusive transport. The transport equation in 3 -dimension with implicit and explicit formulation can thus be written as

$$\frac{C_i^{n+1} - C_i^n}{\Delta t} = (Adv)_{EX} + (Adv)_{EY} + (Dif)_{EX} + (Dif)_{EX} + (1-\theta_a)(Adv)_{EZ} + \theta_a(Adv)_{IZ} + (1-\theta_d)(Dif)_{EZ} + \theta_d(Dif)_{IZ} \quad (7)$$

Where, $(Adv)_{EX}$, $(Adv)_{EY}$ and $(Adv)_{EZ}$ are the explicit part of the advective fluxes in the x, y and z directions respectively and $(Dif)_{EX}$, $(Dif)_{EY}$ and $(Dif)_{EZ}$ are the explicit part of the diffusive fluxes in the x, y and z directions respectively. $(Adv)_{IZ}$ and $(Dif)_{IZ}$ are the implicit part of the advective and diffusive fluxes in the z direction.

When $\theta_a = \theta_d = 0$, then the transport equation is completely explicit and when $\theta_a = \theta_d = 1$, then the transport equation is completely implicit in the z direction. Note that the transport in x and y are always solved explicitly. When $\theta_a = \theta_d = 0.55$, then the transport scheme is called Crank-Nicholson in the z direction.

The explicit transport schemes used in GEMSS are:

a) Upwind
b) QUICKEST
c) QUICKEST + ULTIMATE

5.1 UPWIND SCHEME

Upwind is the simplest transport scheme of first order with the upstream bias. That is it assumes that the concentration at the face is equal to the concentration of the grid upstream of the face. So, if the velocity at the right face is positive (left to right) then the concentration at the right face is C_i and if the velocity at the right face is negative then the concentration at the right face will be C_{i+1}. Figure 2 shows the choice of these concentration values.

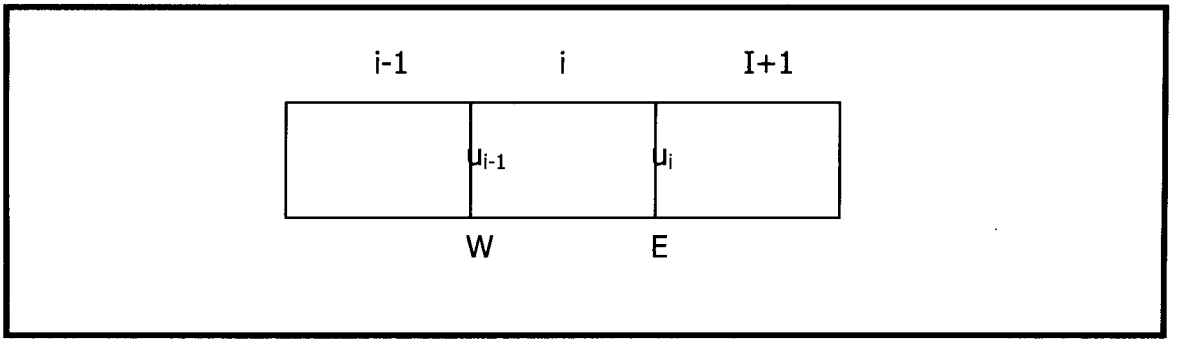

Figure 2 1-D transport schematic with face values for UPWIND scheme

For the East face (E),

If $u_i \geq 0$ then,
$C_{fe} = C_i$

If $u_i \leq 0$ then,
$C_{fe} = C_{i+1}$

For the West face (W)

If $u_{i-1} \geq 0$ then,
$C_{fw} = C_{i-1}$

If $u_{i-1} \leq 0$ then,
$C_{fw} = C_i$

Using these face values, the advective flux is calculated. For the diffusive flux, central differencing at the cell face is applied. This gives, for the east face, the following expression for diffusion:

$$(Dif)_E = a_E(C_{i+1} - C_i) \tag{8}$$

$$a_E = \frac{D_x * dt}{(\Delta x)^2} \tag{9}$$

where D_x is the horizontal diffusion coefficients in x –direction.

5.2 QUICKEST SCHEME

The QUICKEST (Quadratic Upstream Interpolation for Convective Kinematics with Estimated Streaming Terms) scheme originally developed by Leonard (1979) has been extended to three dimensions and incorporated in GEMSS. Unlike upwind scheme, it is third order accurate and performs well for sharp gradients. Both advection and diffusion are solved using the QUICKEST algorithm with the diffusion flux calculation based on Spasojevic et. al. (1994). QUICKEST

employs a three point upstream biased interpolation scheme to calculate the face concentrations for the cell. The selection of Upstream (**U**), Current(**C**) and Downstream (**D**) cells is according to the following figure 3

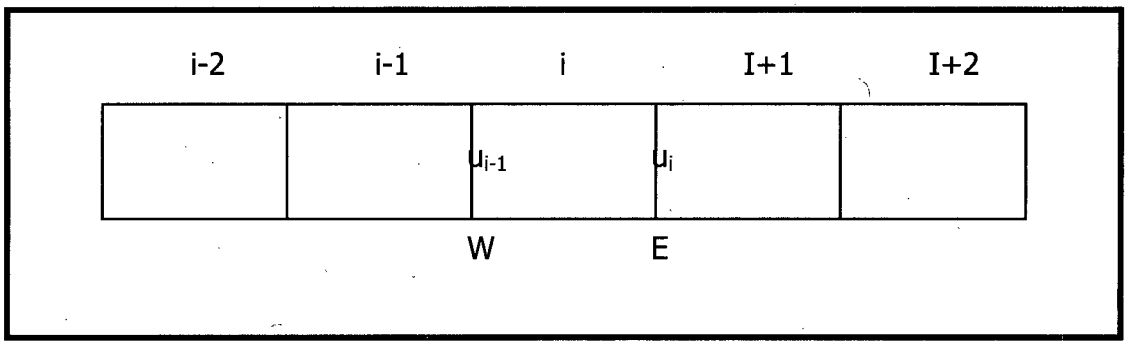

Figure 3 1-D transport schematic with face values for QUICKEST scheme

For the East face (E),

If $u_i \geq 0$ then,
U = i-1, **C** = i and **D** = i+1

If $u_i \leq 0$ then,
U = i+2, **C** = i+1 and **D** = i
For the West face (W)

If $u_{i-1} \geq 0$ then,
U = i-2, **C** = i-1 and **D** = i

If $u_{i-1} \leq 0$ then,
U = i-1, **C** = i and **D** = i+1

Using this nomenclature, the concentrations are defined as C_U, C_C and C_D for the upstream, current and the downstream cell respectively. Then the face concentration for west face is written, using QUICKEST interpolation, as

$$C_{fw} = \frac{C_i + C_{i-1}}{2} + \frac{Cour_w}{2}(C_i - C_{i-1}) - \frac{1}{6}(1 - Cour_w^2)(C_U - 2*C_C + C_D) \quad (10)$$

Similarly for the east face the concentration is,

$$C_{fe} = \frac{C_i + C_{i+1}}{2} + \frac{Cour_e}{2}(C_{i+1} - C_i) - \frac{1}{6}(1 - Cour_e^2)(C_U - 2*C_C + C_D) \quad (11)$$

Using these face concentration, the advective fluxes are calculated in all the three directions. The diffusive fluxes are given in the form of following equations 12 and 13

$$(Dif)_w = a_w\left[(C_i - C_{i-1}) - \frac{Cour_w}{2}(C_U - 2*C_C + C_D)\right] \quad (12)$$

$$(Dif)_E = a_E\left[(C_{i+1} - C_i) - \frac{Cour_w}{2}(C_U - 2*C_C + C_D)\right] \quad (13)$$

5.3 QUICKEST WITH ULTIMATE

The QUICKEST scheme is not monotonous, i.e., it produces overshoots and undershoots. Thus in order to avoid these oscillations, a universal limiter based on Leonard's work (1991) can also be applied. This limiter is called ULTIMATE (Universal Limiter for Transient Interpolation Modeling of the Advective Transport Equation) and is applied to each cell faces individually. The algorithm requires the calculation of the CURV and DEL as defined in the equations 14 and 15

$$CURV = C_D + C_U - 2*C_C \quad (14)$$
$$DEL = C_D - C_U \quad (15)$$

Depending on the values of CURV and DEL, the ULTIMATE limiter is applied to maintain it monotonic.

- If $|CURV| \leq 0.6\ |DEL|$, then the face concentration calculated by QUICKEST is used.
- If $|CURV| \geq |DEL|$, then $C_f = C_c$.
- Otherwise C_{REF} is computed according to the equation 16

$$C_{REF} = C_U + \frac{C_C - C_U}{Cour_f} \quad (17)$$

If DEL > 0, chose C_f so that $C_C < C_f < \min [C_{REF}, C_D]$
If DEL < 0, chose C_f so that $\max [C_{REF}, C_D] < C_f < C_C$

5.4 EXAMPLE APPLICATION

In order to further illustrate the difference in these algorithms consider a 2-D problem. The following results are obtained for a simplified reservoir problem with transport only in x and Z direction. The grid sizes are uniform. The reservoir is subjected to meteorology data and the results were plotted for different combination of explicit-implicit transport schemes. The results shown here are for the three explicit schemes with three different combinations of θ_a and θ_d. The chosen values for θ_a (=θ_d) are 0.00, 0.55 and 1.00. A schematic of the reservoir is shown in figure 4.

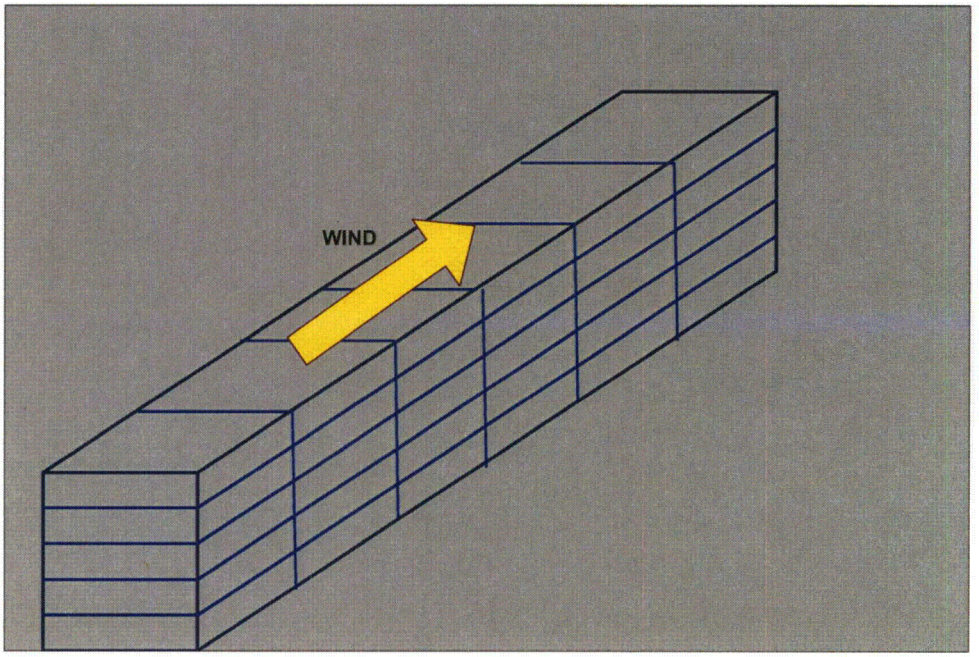

Figure 4 Schematic of 2-D transport problem to illustrate the difference between various transport schemes

The results for this problem are shown in Figures 5 through 7 using the three transport schemes and 3 different values of implicit weighting. It is expected that the reservoir will be stratified and the formation of this stratification (temperature vertical profile) is more realistic when higher order schemes, QUICKEST or QUICKEST+ULTIMATE, are used.

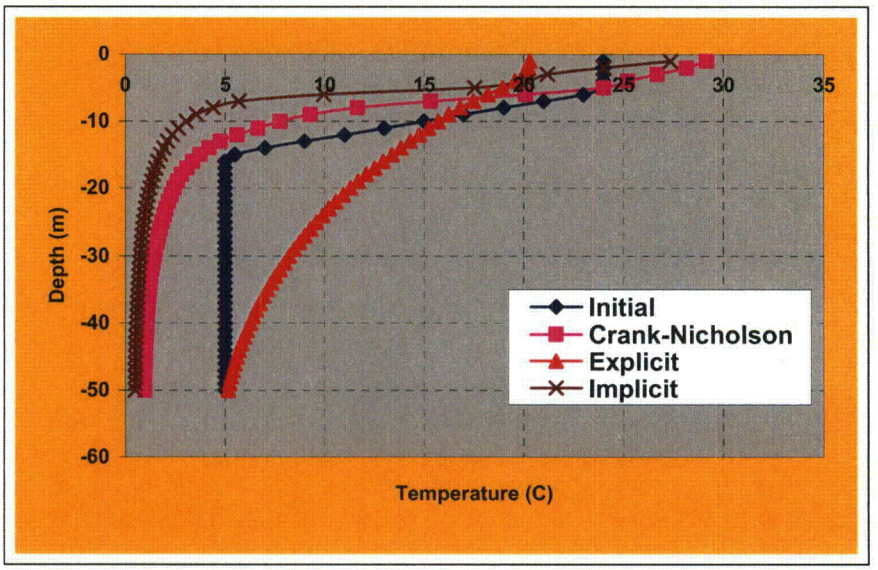

Figure 5 Vertical profile of temperature using UPWIND

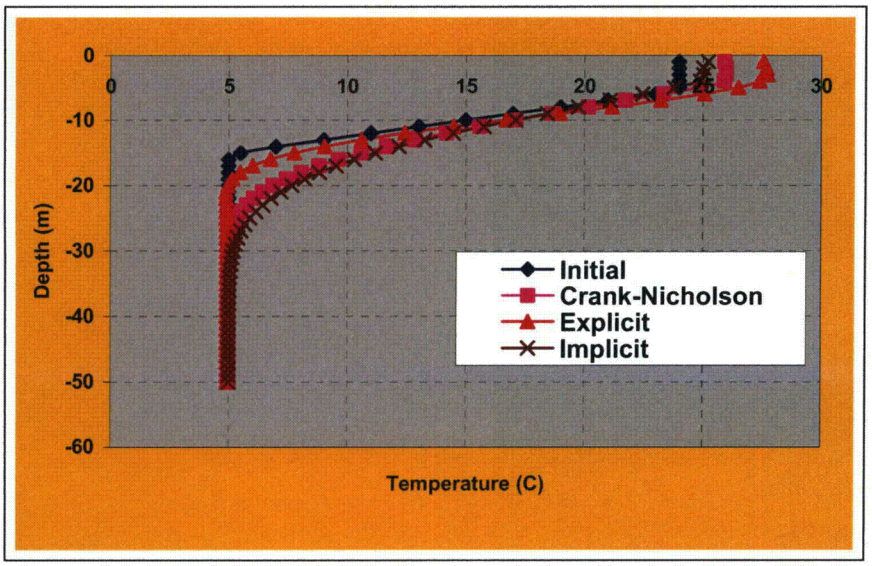

Figure 5 Vertical profile of temperature using QUICKEST

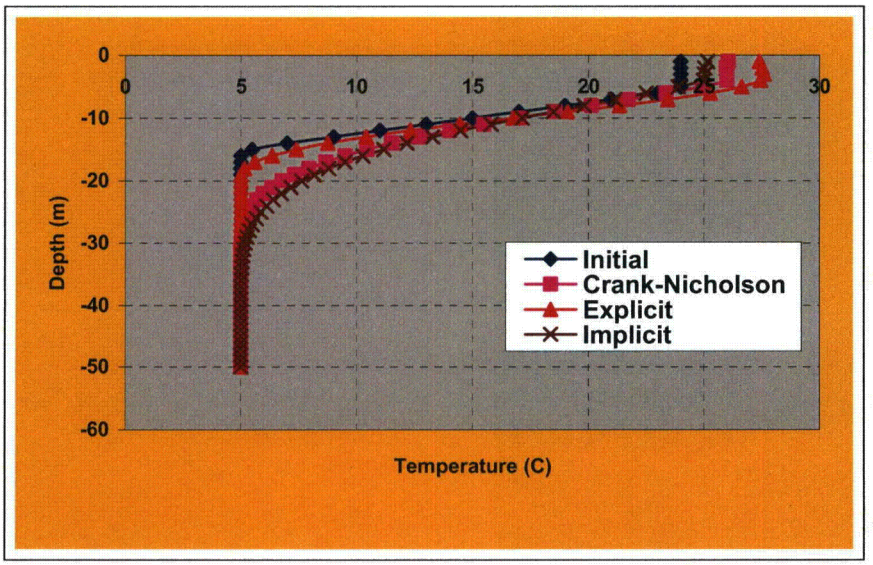

Figure 5 Vertical profile of temperature using QUICKEST with ULTIMATE

The scheme selection should be problem and goal specific. When the focus is on computational efficiency UPWIND can be used. This computational efficiency is compromised when the higher order schemes are adopted but they result in much better stratification and also QUICKEST+ULTIMATE smoothes out any computational overshoots/undershoots.

6. HORIZONTAL DIFFUSIVITY

The hydrodynamic model in GEMSS solves the turbulence time average Reynolds momentum equations in the three dimensions. These momentum equations are in the form of Equation-1.

$$\frac{\partial U_i}{\partial t} + U_j \frac{\partial U_i}{\partial x_j} = \frac{\partial}{\partial x_j}\left(K_H \frac{\partial U_i}{\partial x_j} - \overline{u_i u_j} \right) + F \tag{1}$$

K_H is the horizontal dispersion which includes molecular diffusion along with the small scale transport (scalar as well as momentum) which is not solved by the coarse numerical grid resolution. Thus the dispersion coefficient is estimated based on the horizontal resolution adopted and, in some cases, local velocity shear. GEMSS provides two options to estimate the horizontal dispersion based on these approaches. The two options, Okubo and Smagorinsky, are discussed here.

6.1 OKUBO

When this option is chosen, the horizontal diffusion in both x and y directions are estimated separately based on the resolution in the respective directions. The horizontal diffusion in this case is computed using equation 2 (Okubo, 1971).

$$K_x = C_x * (\Delta x)^n \tag{2}$$

$$K_y = C_y * (\Delta y)^n \tag{3}$$

Thus the dispersion decreases as horizontal resolution increases and approaches zero when the grid sizes are infinitesimally small. A zero diffusion in this case means that the all transport can be modeled as advection at such small length scale.

6.2 SMAGORINSKY

This option is based on the work of Smagorinsky (1963). Using this approach the horizontal dispersion is estimated as

$$K_H = C_H (\Delta x * \Delta y)\left[\left(\frac{\partial u}{\partial x}\right)^2 + \left(\frac{\partial v}{\partial y}\right)^2 + \frac{1}{2}\left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\right)^2 \right] \tag{4}$$

Note that the diffusion increases with increasing local turbulence (velocity shear) and decreases with increasing horizontal resolution. The diffusion is same in both x and y direction and is referred to as horizontal diffusion. The constant C_H works well in the range of 0.1 to 0.5.

6.3 EXAMPLE APPLICATION

To illustrate the difference between the two approaches consider the case of Jobos Bay, Puerto Rico. A heated water discharge plume analysis was performed by JEEAI for Jobos Bay. The location of this discharge and the model domain are shown in Figure 1.

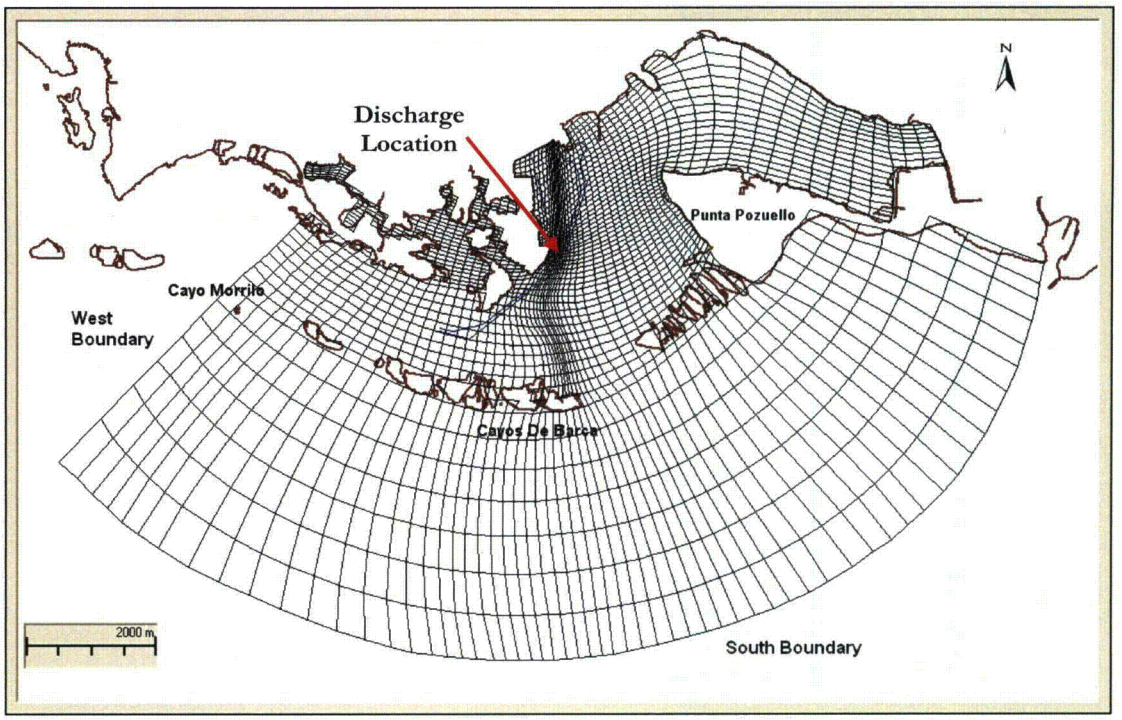

Figure 1 Model grid for Jobos Bay, Puerto Rico

The heated water is released at 1000cfs (450 000gpm) into the bay which creates a local turbulence. This small scale turbulence is responsible for increased mixing in the vicinity. Thus it is very important to account for this mixing. When Okubo approach is used, only the horizontal grid resolution is used but Smagorinsky approach also accounts for the localized turbulent mixing. Figures 2 and 3 show the discharge plume using the two approaches. It can be seen that higher temperature exists in the case of Okubo which is not present when Smagorinsky is used. Smagorinsky formulation, in this case, allows more localized dispersion. With Smagorinsky, the plume is at a lower temperature but with wider extent while with Okubo, the plume is at higher temperature with smaller extent.

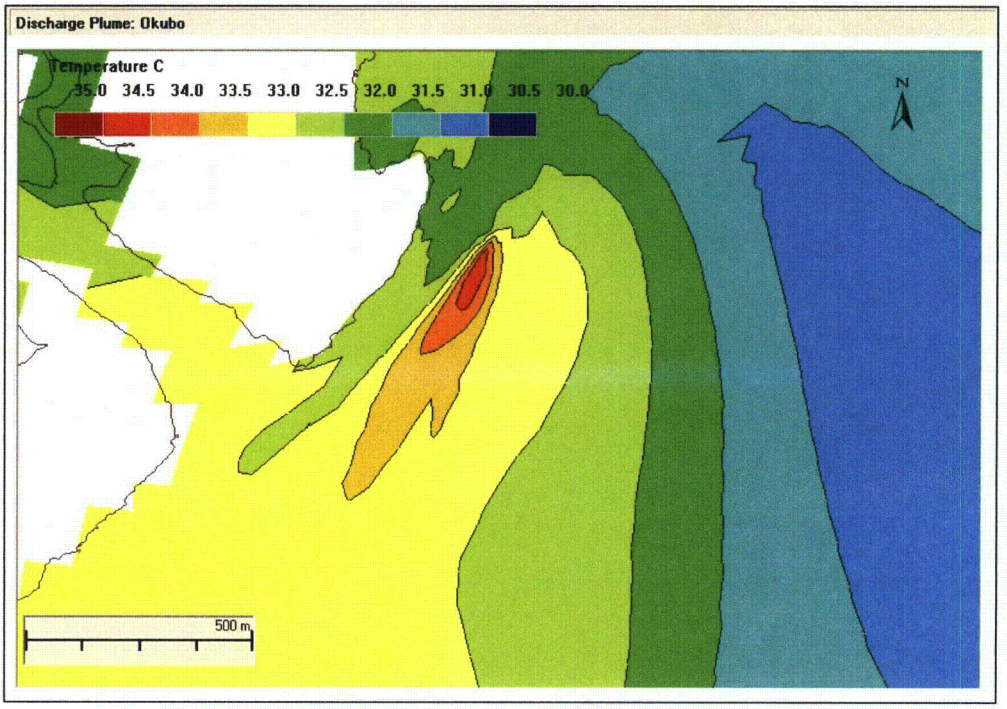

Figure 2 Thermal discharge plume using Okubo formulation for horizontal diffusivity

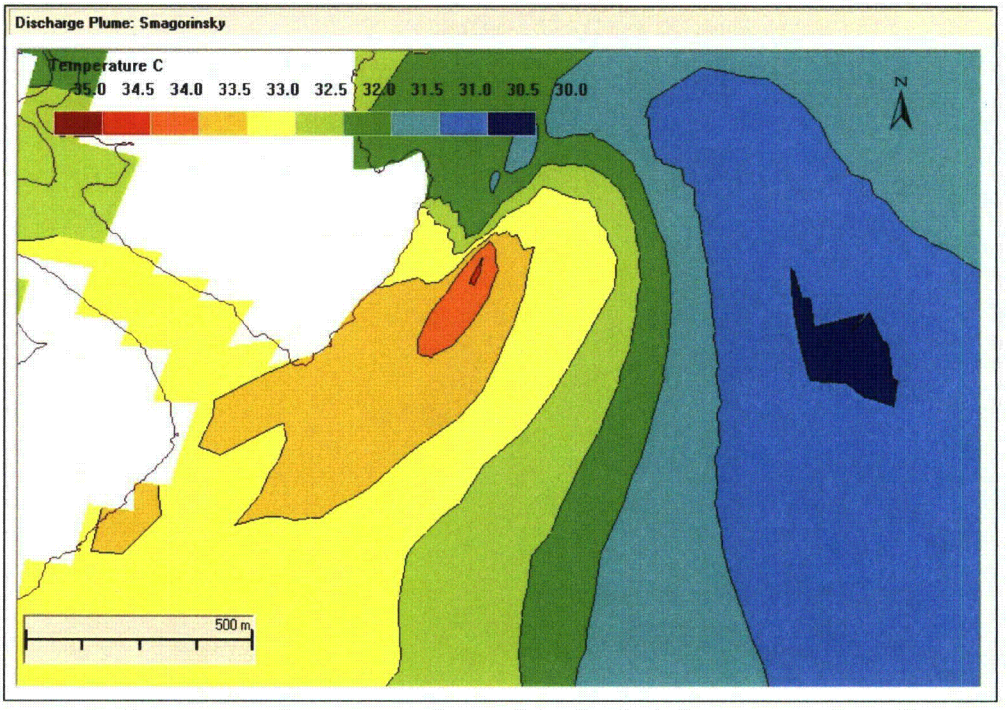

Figure 3 Thermal discharge plume using Smagorinsky formulation for horizontal diffusivity

7. GEMSS SIGMA VERSION

GEMSS can be run as both z-grid and sigma grid (σ-grid) in the vertical direction. The Hydrodynamic model along with the Transport and Water-quality model allows the σ-stretching for applications that deal with rapidly changing bathymetry.

7.1 THEORETICAL BACKGROUND

The σ-stretching is obtained by transforming the vertical direction in to the σ-coordinate system. This σ-coordinate system is defined as follows so the free water surface is always at σ = 0 and the bottom is always at σ = -1. This transformation allows the same number of vertical layers throughout the model domain and can be written as:

$$\sigma = \frac{z - \eta}{H + \eta} \tag{1}$$

Where η = Free Surface Elevation and is measured positive upwards

H = Bottom depth and is measured negative downwards

Also, let D (= H + η) be the total water column depth.

Thus, when z = η, σ = 0 and when z = -H, σ = -1.

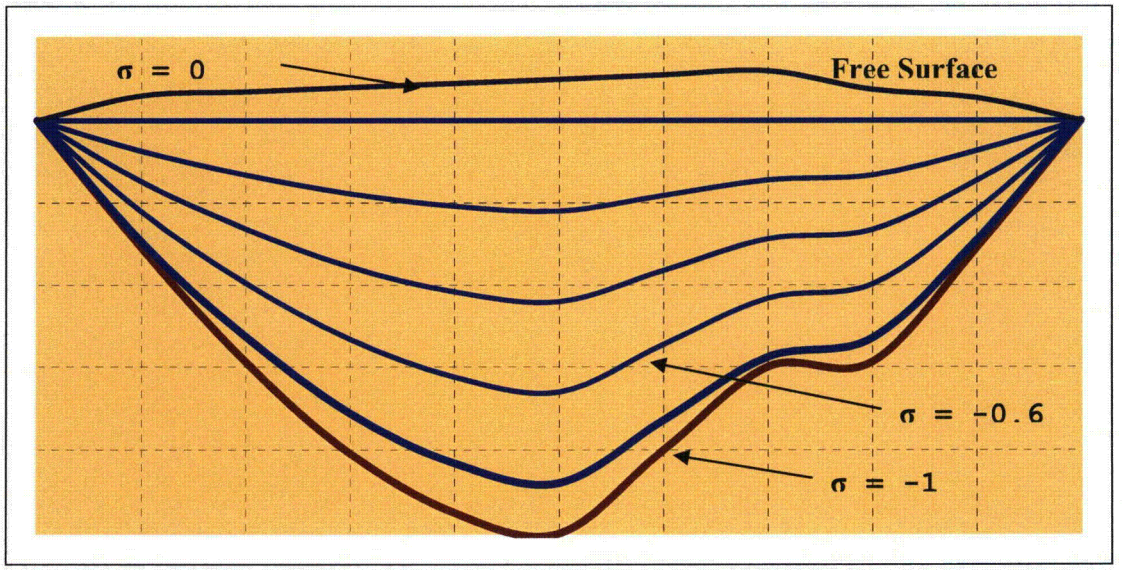

Figure 4 Schematic showing Sigma Stretching in GEMSS

The σ-coordinate transformation equations are

Continuity:

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{1}{D}\frac{\partial \omega}{\partial \sigma} + \frac{1}{D}\frac{\partial \eta}{\partial t} = 0 \tag{2}$$

Momentum Equation:

$$\frac{\partial u}{\partial t}+\frac{\partial uu}{\partial x}+\frac{\partial uv}{\partial y}+\frac{1}{D}\frac{\partial uw}{\partial \sigma}-fv+g\frac{\partial \eta}{\partial x}+\frac{gD}{\rho_0}\int_{\sigma}^{0}\left[\frac{\partial \rho}{\partial x}-\frac{\sigma}{D}\frac{\partial D}{\partial x}\frac{\partial \rho}{\partial \sigma}\right]d\sigma=\frac{1}{D}\frac{\partial}{\partial \sigma}\left[\frac{K_M}{D}\frac{\partial U}{\partial \sigma}\right]+F_x \quad (3)$$

$$\frac{\partial v}{\partial t}+\frac{\partial uv}{\partial x}+\frac{\partial vv}{\partial y}+\frac{1}{D}\frac{\partial vw}{\partial \sigma}-fu+g\frac{\partial \eta}{\partial y}+\frac{gD}{\rho_0}\int_{\sigma}^{0}\left[\frac{\partial \rho}{\partial y}-\frac{\sigma}{D}\frac{\partial D}{\partial y}\frac{\partial \rho}{\partial \sigma}\right]d\sigma=\frac{1}{D}\frac{\partial}{\partial \sigma}\left[\frac{K_M}{D}\frac{\partial V}{\partial \sigma}\right]+F_y \quad (4)$$

Temperature Equation:

$$\frac{\partial T}{\partial t}+\frac{\partial Tu}{\partial x}+\frac{\partial Tv}{\partial y}+\frac{1}{D}\frac{\partial Tw}{\partial \sigma}=\frac{1}{D}\frac{\partial}{\partial \sigma}\left[\frac{K_H}{D}\frac{\partial T}{\partial \sigma}\right]+F_T \quad (5)$$

Salinity Equation:

$$\frac{\partial S}{\partial t}+\frac{\partial Su}{\partial x}+\frac{\partial Sv}{\partial y}+\frac{1}{D}\frac{\partial Sw}{\partial \sigma}=\frac{1}{D}\frac{\partial}{\partial \sigma}\left[\frac{K_H}{D}\frac{\partial S}{\partial \sigma}\right]+F_S \quad (6)$$

Where ω is the velocity component normal to sigma surface and can be transformed back to true vertical velocity using the following equation:

$$W=\omega+u\left[\sigma\frac{\partial D}{\partial x}+\frac{\partial \eta}{\partial x}\right]+v\left[\sigma\frac{\partial D}{\partial y}+\frac{\partial \eta}{\partial y}\right]+\sigma\frac{\partial D}{\partial t}+\frac{\partial \eta}{\partial t} \quad (7)$$

The F_x etc., terms are horizontal diffusion terms and are defined as follows:

$$F_x=\frac{\partial}{\partial x}\left(A_x\frac{\partial u}{\partial x}\right)+\frac{\partial}{\partial y}\left(A_y\frac{\partial u}{\partial y}\right)$$

$$F_y=\frac{\partial}{\partial x}\left(A_x\frac{\partial v}{\partial x}\right)+\frac{\partial}{\partial y}\left(A_y\frac{\partial v}{\partial y}\right)$$

$$F_T=\frac{\partial}{\partial x}\left(D_x\frac{\partial T}{\partial x}\right)+\frac{\partial}{\partial y}\left(D_y\frac{\partial T}{\partial y}\right)$$

$$F_S=\frac{\partial}{\partial x}\left(D_x\frac{\partial S}{\partial x}\right)+\frac{\partial}{\partial y}\left(D_y\frac{\partial S}{\partial y}\right)$$

7.2 IMPLEMENTATION

Setting up of Sigma stretching in GEMSS is easy but requires some caveats. To run GEMSS with the σ-grid, a σ layering should be adopted first. There is no limit to the maximum or minimum number of layers and the number should be adopted based on the level of vertical resolution desired. Since the number of verticals grids do no change throughout the model

domain, time considerations are usually an important factor to consider while choosing the number of layers. Once the desired number of layers is chosen, the user needs to provide the sigma level information to GEMSS. These sigma levels divide the sigma layers and are equal to the total number of layers + 1. For instance, if 4 layers are required with a uniform distribution then the sigma levels will be 0, -0.25, -0.5, -0.75 and -1.0. This is the only user input required by the user to setup the sigma stretching and can be supplied through the control file editor.

When sigma stretching is used some limitations need to be remembered while setting up the output. Sigma model requires the specification of a vertical datum. This vertical datum is the same as the initial elevation supplied by the user in the control file editor under the grid tab. This initial datum refers to the surface layer 'kt'. All other layers (up to the maximum number of sigma layers) are referred to as 'k' layers under kt. Thus if the user needs the output for the top two sigma layers then in any output setting, planes 'kt' and '1 layers under kt' should be chosen.

7.3 Example Application

To further illustrate the gridding and display the results of a GEMSS-Sigma stretching simulation please consider the case of Susquehanna River, PA. Figure 2 shows the 3-D render of the river and Figure 3 shows the horizontal river grid. The river bathymetry along an East-West plane as shown in figure 3 is shown in figure 4.

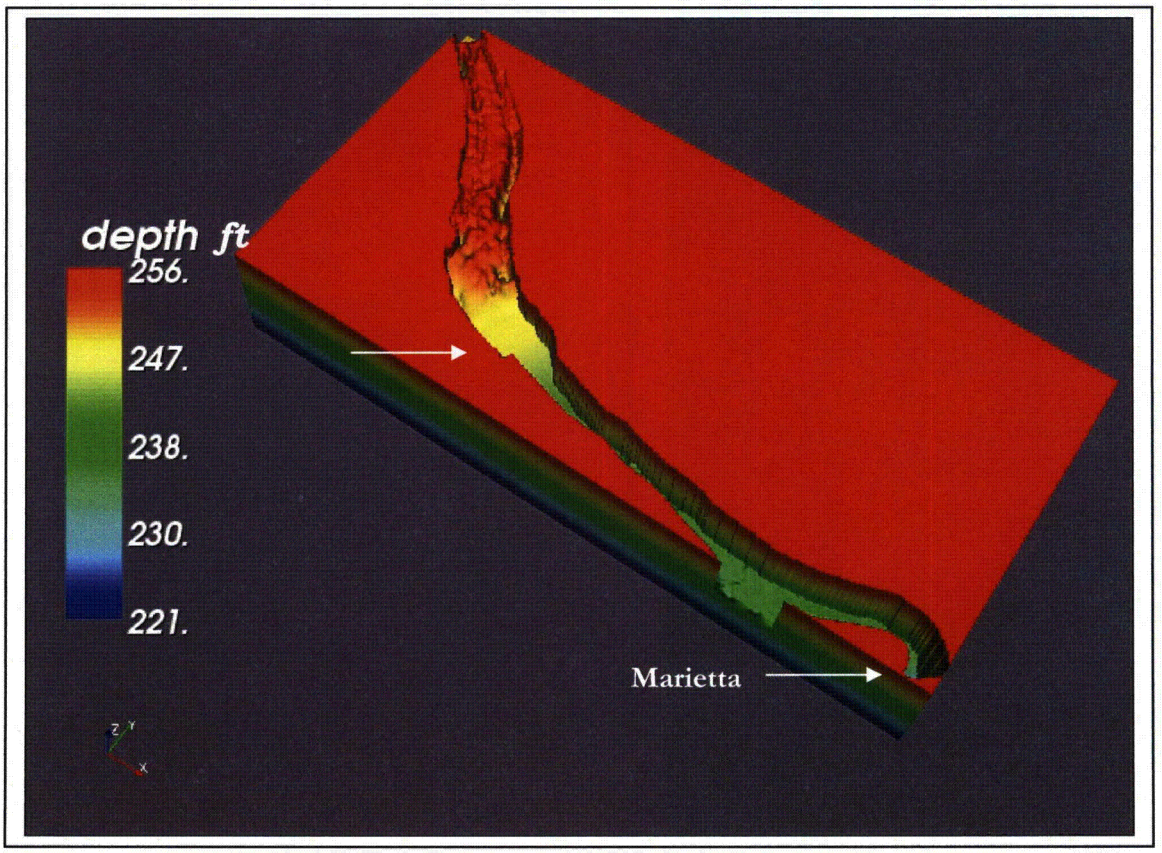

Figure 5 3-D render of Susquehanna River bathymetry

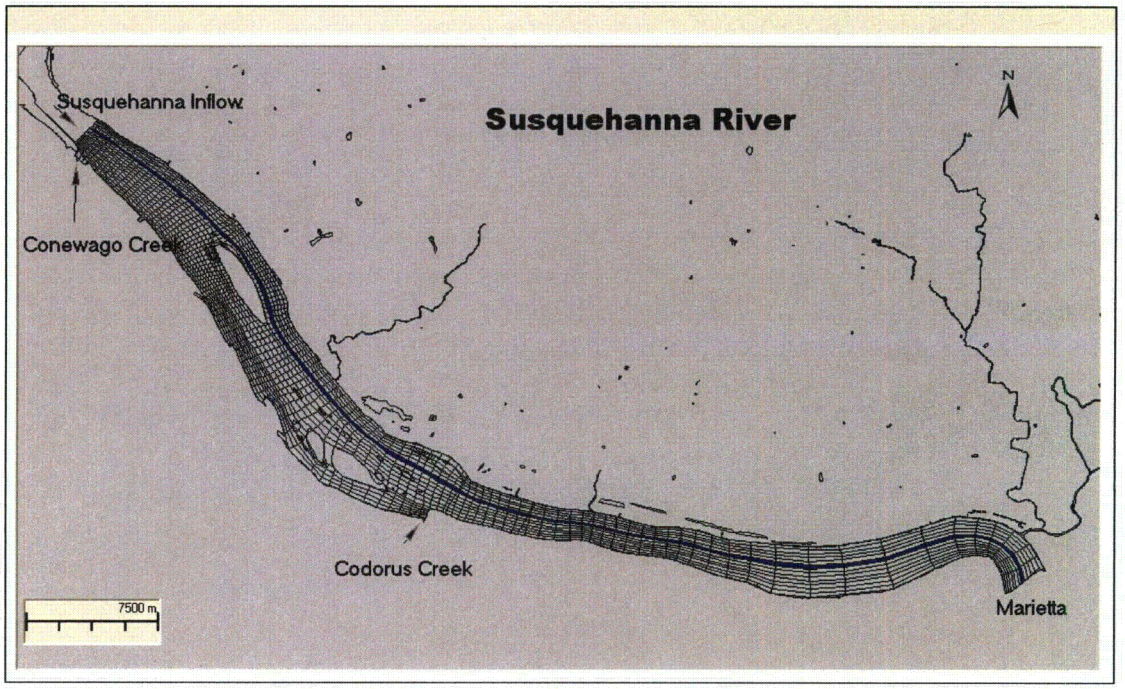

Figure 6 Susquehanna River horizontal grid

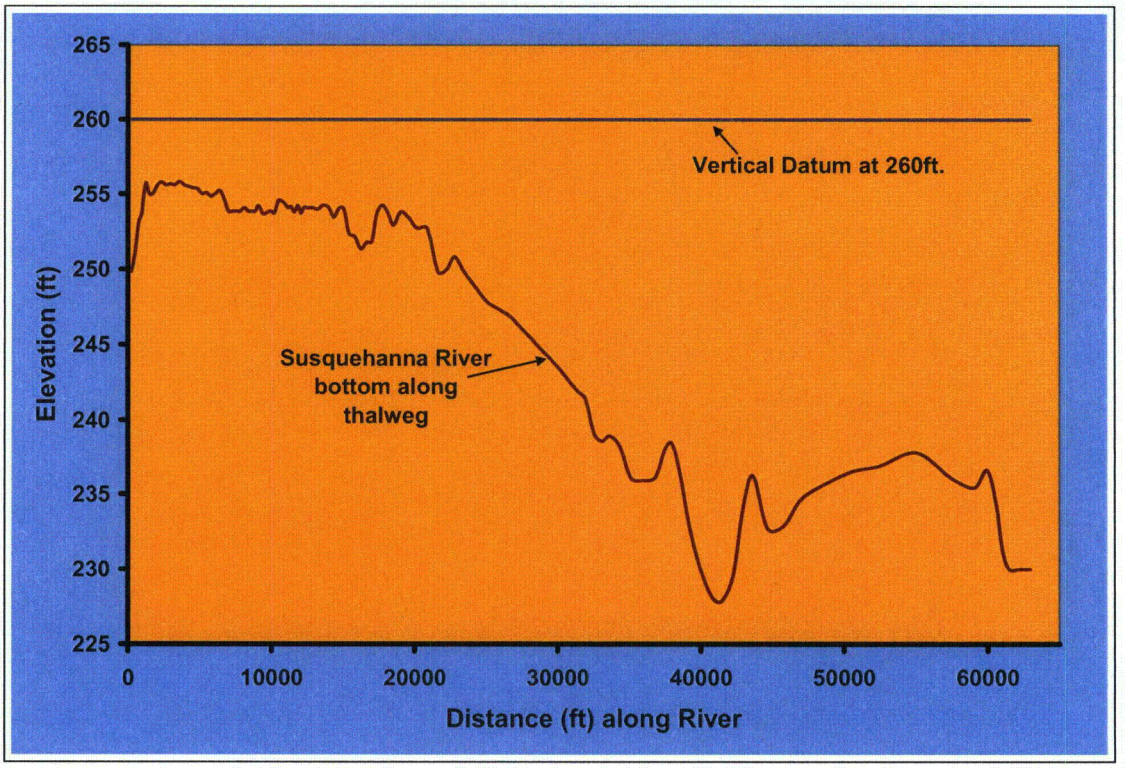

Figure 7 Susquehanna River bathymetry along thalweg (blue line in Figure 3)

Over the course of a year, Susquehanna River experiences several storms and low flow periods. The gauge at the downstream end (Marietta) shows the water surface elevation to be ranging between 240ft to 254ft (73.15m to 77.42m). Also, the river section between 20000ft and 30000ft there is a very sharp gradient in the bottom bathymetry. During normal and low flows, there is a formation of riffles in this section. Thus due to the high water surface variation and the presence of sharp bottom gradients a highly resolved z-grid is not possible. GEMSS was run with z-grid layering of 10ft (3.05m) to successfully model the river but the vertical resolution was less than desired. The z-grid is shown in figure 5. To model the river with a better vertical resolution, sigma stretching was adopted. With sigma stretching the vertical resolution ranged from 0.66ft (0.2m) to 4.6ft (1.4m) from the shallowest water column depth (low flow) to deepest water column depth (storm events). A typical water surface elevation profile during normal flow period is shown in figure 6. The Sigma layering with 5 layers is also shown for the water column.

Figure 8 **Susquehanna River vertical z-grid**

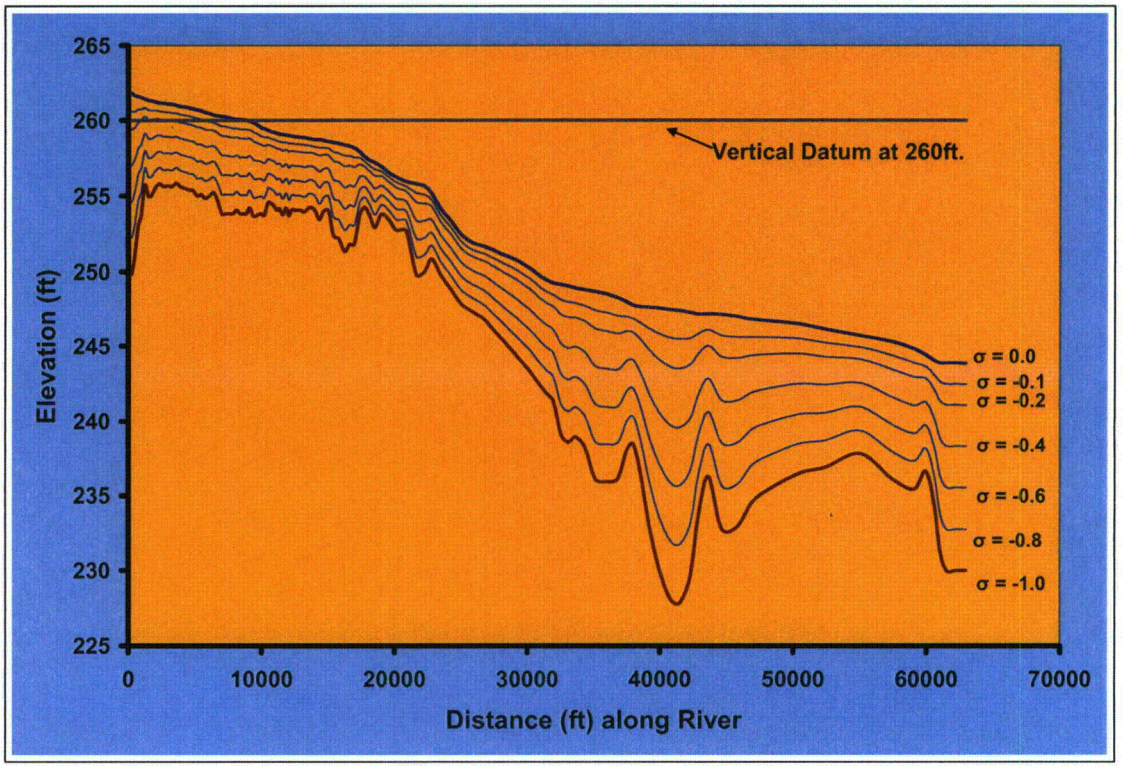

Figure 9 **Susquehanna River Water Surface Elevation and Sigma layering**

8. VERTICAL DIFFUSIVITY

The hydrodynamic model in GEMSS solves the turbulence time average Reynolds momentum equations in the three dimensions. These momentum equations are in the form of Equation-1.

$$\frac{\partial U_i}{\partial t} + U_j \frac{\partial U_i}{\partial x_j} = \frac{\partial}{\partial x_j}\left(\nu \frac{\partial U_i}{\partial x_j} - \overline{u_i u_j} \right) + F \qquad \textit{(Equation 1)}$$

The **F** terms represents the pressure gradient and baroclinic terms. The term $-\overline{u_i u_j}$ represents the turbulence time averaging and when multiplied by ϱ_0 is called Reynolds stresses. For computational purposes Reynolds stress is assumed to be proportional to the mean-velocity gradients as shown in Equation-2.

$$-\overline{u_i u_j} = \nu_t \left(\frac{\partial U_i}{\partial x_j} + \frac{\partial U_j}{\partial x_i} \right) - \frac{2}{3} k \delta_{ij} \qquad \textit{(Equation 2)}$$

ν_t is called the turbulent viscosity and is not a fluid property like the molecular viscosity ν. The turbulent viscosity is a property of the flow and thus may vary considerably from one point in the flow to the other. This provides the basis of a conceptual turbulence model which requires estimation of this turbulence viscosity by parameterizing the turbulence in the flow.

There are several models in the literature that parameterize the turbulence to estimate the eddy viscosity. Some of these models estimate them by relating them to the mean velocity distribution (0-Equation) or a constant value provided by trial and error. Other models account for the transport of turbulence quantities by solving transport equations (1-Equation or 2-Equation) for them. GEMSS allows the use of all the three turbulence models discussed and the correct choice of a particular model depends on the problem considered and flow properties.

8.1 0-EQUATION

The first choice of a turbulence model is the 0-Equation model and is the simplest and most time efficient model. The model is based on *Prandtl's mixing length* approach that attributes the eddy viscosity to mean fluctuating velocity and mixing length (L_m). This mean fluctuating velocity ($\bar{U}$), he then postulated, is equal to the product of the mean velocity gradient and the mixing length. Thus we get

$$\overline{U} = L_m \left| \frac{\partial U}{\partial z} \right| \qquad \textit{(Equation 3)}$$

$$\nu_t = \overline{U} L_m = L_m^2 \left| \frac{\partial U}{\partial z} \right| \qquad \textit{(Equation 4)}$$

The mixing length approach has been and can be applied with great success and computational efficiency for relatively simple flows. Since the mixing length (L_m) can specified by a simple empirical formula, 0-Equation models are very computationally efficient as compared to 1-/2- Equation models that require solution of transport equations. GEMSS allows user to select various possible mixing length relationships. All of these available empirical relationships are shown here.

8.2 PRANDTL

The mixing length is estimated as a function of the layer width and is given by Equation-5 below.

$$L_m = \kappa * z \qquad \textit{(Equation 5)}$$

Where κ (=0.4) is the von Karman constant and z is the vertical layer width.

8.3 PARABOLIC

Introduced by Engelund (1978) the mixing length has a parabolic distribution over the depth of the channel and is given by Equation-6 below.

$$L_m = \kappa * z * \left(1 - \frac{z}{H}\right) \qquad \textit{(Equation 6)}$$

Where z is the distance of layer from the bottom wall and H is the total depth of the channel.

8.4 NIKURADSE

The mixing length is given by the Equation-7 below (Rodi, 1993).

$$L_m = H\left[0.14 - 0.08\left(1-\frac{z}{H}\right)^2 - 0.06\left(1-\frac{z}{H}\right)^4\right] \qquad \textit{(Equation 7)}$$

RNG (RE NORMALIZATION GROUP)

Based on the RNG model of Yakohot and Orszag (1986) the turbulent viscosity is calculated using the Equation-8 below.

$$\nu_t = \nu\left[1 + MAX\left\{3*\kappa^4\left(\frac{z*u_*}{\nu}\right)^3 * \left(1-\frac{z}{H}\right)^3 - C_1\right\}\right]^{1/3} \qquad \textit{(Equation 8)}$$

8.5 1-EQUATION

The next level of turbulence models solves transport equation for the turbulence quantities. This requires sacrificing the simple direct link between the fluctuating velocity scale and solving a more rigorous transport equation which is time consuming. The eddy viscosity concept is still used for this model but its estimation is no more done using a mixing length. The velocity fluctuation and thus the turbulent mixing can then be characterized by the seemingly most appropriate scale of turbulence, the turbulent kinetic energy (k) per unit mass. 'k' is a direct measure of the intensity of turbulent fluctuations and is used according to the Equation-9 for the calculation of turbulent eddy viscosity.

$$\nu_t = S_m * \sqrt{k}L \qquad \textit{(Equation 9)}$$

Where S is computed based on Richardson number (G_H) and L is the turbulence macro-scale. They are defined as shown in Equation-10 to Equation-11.

$$L = \left[0.14 - 0.14\left(\frac{z}{H}\right)^2\right]H \qquad \textit{(Equation 10)}$$

$$S_m = \frac{B_1^{-1/3} - A_1A_2G_H\left[\left(B_2 - 3A_2\right)\left(1-\frac{6A_1}{B_1}\right) - 3C_1\left(B_2 + 6A_1\right)\right]}{\left[1 - 3A_2G_H\left(6A_1 + B_2\right)\right]\left(1 - 9A_1A_2G_H\right)} \qquad \textit{(Equation 11)}$$

$$G_H = \left(\frac{L^2}{k}\right)\left(\frac{g}{\rho_0}\frac{\partial\rho}{\partial z}\right) \qquad \textit{(Equation 12)}$$

The turbulent kinetic energy (k) is solved using the transport Equation-13 which requires additional parameters D_q and D_H given by Equation-14 to Equation-16.

$$\frac{\partial k}{\partial t}+U\frac{\partial k}{\partial x}+V\frac{\partial k}{\partial y}+W\frac{\partial k}{\partial z}=\frac{\partial}{\partial z}\left(D_q\frac{\partial k}{\partial z}\right)+2\nu_t\left(\frac{\partial U}{\partial z}\right)^2+2\nu_t\left(\frac{\partial V}{\partial z}\right)^2+\frac{2g}{\rho_0}D_H\frac{\partial \rho}{\partial z}-\frac{2k^{3/2}}{B_1 L}$$

(Equation 13)

$$D_q = S_q * \sqrt{k}L \qquad \text{and} \qquad D_H = S_H * \sqrt{k}L \qquad \textit{(Equation 14)}$$

$$S_m=\frac{\left[1-\frac{6A_1}{B_1}\right]A_2}{\left[1-3A_2G_H\left(6A_1+B_2\right)\right]\left(1-9A_1A_2G_H\right)} \qquad \textit{(Equation 15)}$$

The constants used in the equations are according to Mellor Yamada (1982) as (A_1, A_2, B_1, B_2, C_1, E_1, E_2, S_q) = (0.92, 0.74, 16.6, 10.1, 0.08, 1.8, 1.33, 0.2).

8.6 2-EQUATION

The next level of turbulence models solves transport equation for the turbulent kinetic energy along with a length-scale unlike the 1-Equation model. The length-scale is subject to transport processes in a similar manner as the energy. The length-scale equation does not have to contain only L but can be any combination of $k_a L_b$. The 2-Equation model used in GEMSS is based on Generic Length Scale (GLS) model proposed by Umlauf and Burchard (2003); Warner *et. al.* (2005). The first equation in GLS approach is a standard equation of transport of k (equation 16), but the second equation is for the generic length scale ψ (equation 17).

$$\frac{\partial k}{\partial t}+U\frac{\partial k}{\partial x}+V\frac{\partial k}{\partial y}+W\frac{\partial k}{\partial z}=\frac{\partial}{\partial z}\left(D_q\frac{\partial k}{\partial z}\right)+2\nu_t\left(\frac{\partial U}{\partial z}\right)^2+2\nu_t\left(\frac{\partial V}{\partial z}\right)^2+\frac{2g}{\rho_0}D_H\frac{\partial \rho}{\partial z}-\varepsilon$$

(Equation 17)

where Є is the dissipation and is given by the following relationship

$$\varepsilon=(C_\mu^0)^{3+p/n}k^{3/2+m/n}\psi^{-1/n}$$

$$\frac{\partial \psi}{\partial t}+U\frac{\partial \psi}{\partial x}+V\frac{\partial \psi}{\partial y}+W\frac{\partial \psi}{\partial z}=\frac{\partial}{\partial z}\left(D_q\frac{\partial \psi}{\partial z}\right)+2\nu_t c_1\frac{\psi}{k}\left(\frac{\partial U}{\partial z}\right)^2+2\nu_t c_1\frac{\psi}{k}\left(\frac{\partial V}{\partial z}\right)^2$$

$$+c_2\frac{g}{\rho_0}\frac{\psi}{k}D_H\frac{\partial \rho}{\partial z}-\frac{\psi}{k}c_3\varepsilon F_{wall}$$

(Equation 17)

Where c_3 takes the value of c^-_3 in stably stratified flows and c^+_3 in unstable flows. The generic length scale is defined as

$$\psi = (C_\mu^0)^p k^m \psi^n$$

The advantage of a GLS scheme is that it can be used to formulate existing 2-equation turbulence models or new closures with different values of parameters such as p, m, n, c_1 etc. In GEMSS three explicit turbulence models are formulated (can be chosen from the dropdown menu) along with a general model with user specified parameter values. The three explicit formulations are Mellor-Yamada 2.5 order turbulence closure (or *k-kl*; Mellor and Yamada 1974), Jones-Launder model (or *k-Є*; Jones and Launder 1972) and Kolmogorov model (or *k-ω*; Kolmogorov 1942, Saffman 1970).

The solution of Equation-16 in conjunction with Equation-17 gives the values of *k* and ψ which are used in the same fashion as in 1-Equation models to obtain the turbulence viscosity and vertical diffusivities for scalar quantities.

Results

Results obtained from a simplified 2-dimensional (width averaged) flow problem and an estuarine system using the three different options for vertical diffusivity are shown in figure 1 and 2 respectively.

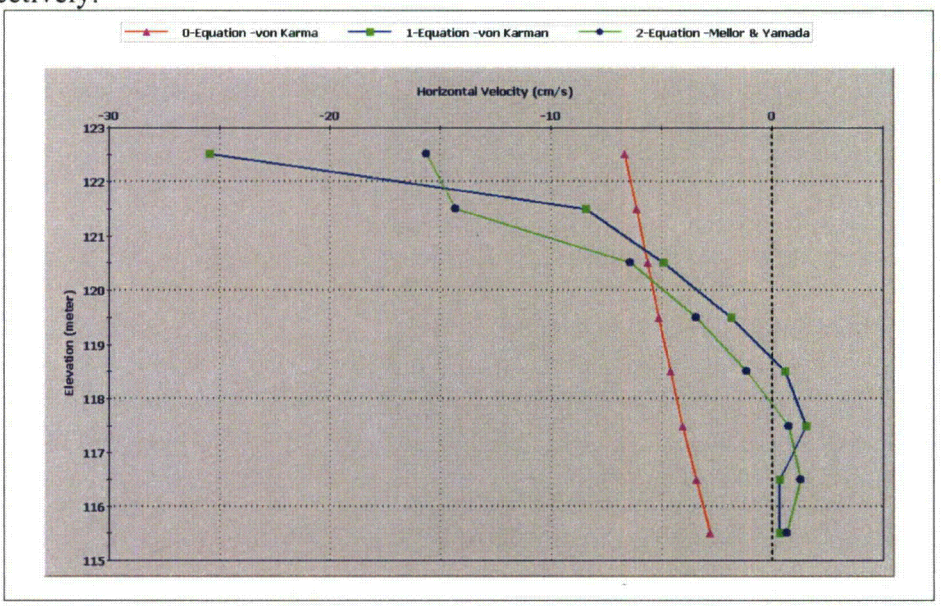

Figure 1: Horizontal velocity in a width average flow system with inflow at upstream and head boundary at downstream

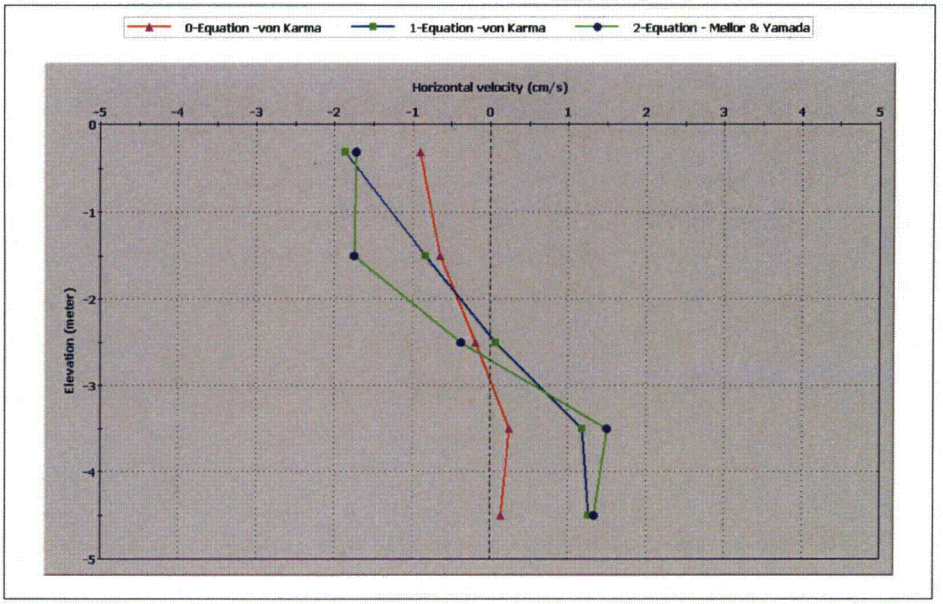

Figure 2: Horizontal velocity in an estuarine system with river discharge at upstream and head boundary at open sea

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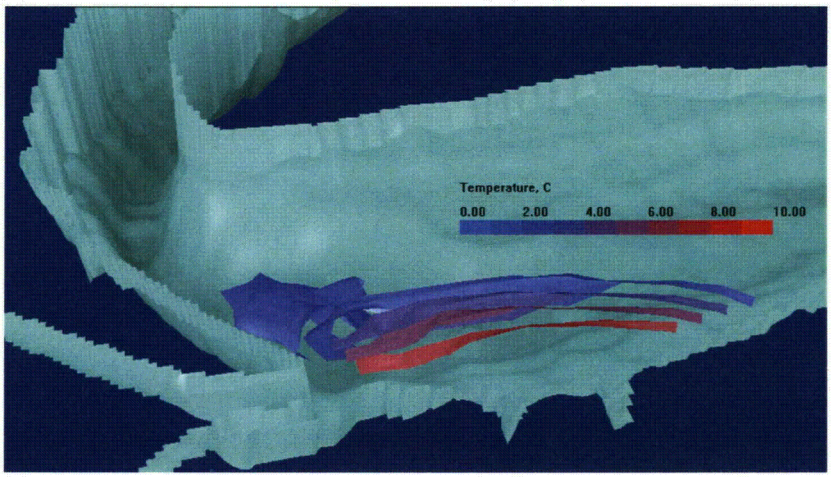
10. AGENCY - REVIEWED APPLICATIONS

Facility and waterbody	Application	Review agency	Date
Chattahoochie River, GA	Temperature	Georgia EPD	1975
Kootenay River, British Columbia, Canada	Temperature	Environment Canada	1984
Nechako River, British Columbia, Canada	Temperature	Nechako Fisheries Conservation Project	1987
Ocmulgee River, GA	BOD and Dissolved Oxygen	Georgia EPD	1990
Pigeon River, NC	Temperature	North Carolina	1992
East Branch Perkiomen Creek, PA	Temperature	Pennsylvania Fish Commission and Pennsylvania DER	1992
Maggie Creek/Humboldt River, NV	Temperature	Bureau of Land Management	1993
L'Etang Estuary, N.B., Canada	Papermill discharge dilution	Environment New Brunswick	1994
Port Arthur canal system, TX	Temperature, nitrates, dissolved oxygen, algae	Texas Natural Resources Conservation Commission	1994
Battle River Reservoir, Alta., Canada	Temperature	Alberta Environment	1981
Monongahela River, PA	Temperature	Pennsylvania DER	1982

Facility and waterbody	Application	Review agency	Date
Patuxent River Estuary, MD	Temperature, dissolved oxygen and fish larvae	Maryland Power Plant Siting Commission	1986
Budd Inlet on Puget Sound, WA	Temperature, salinity and nutrient cycles	Washington Department of Ecology	1986
Coosa River and Weiss Reservoir, GA	Temperature	Georgia EPD	1986
Nechako Reservoir, British Columbia, Canada	Temperature	Nechako Fisheries Conservation Project, British Columbia Power Commission	1988, 1994
Lake Sinclair, GA	Temperature and dissolved oxygen	Georgia EPD	1990
Clinton Lake, IL	Temperature	Illinois Water Pollution Control Board	1993
Chaleur Bay, New Brunswick, Canada	Temperature and salinity	Environment Canada	1988
Cooper River, SC	Temperature, salinity and dilutions	South Carolina Fisheries Commission	1988
Nechako Reservoir, British Columbia, Canada	Temperature	Nechako Fisheries Conservation Project	1988
Delaware River Estuary, DE	Temperature and salinity	Delaware DNRC	1989
East Waterway on Puget Sound, WA	Temperature, salinity and dilution	Washington Department of Ecology	1989
Webber Cove on Malpeque Bay, P.E.I., Canada	Temperature, salinity, coliforms, dissolved oxygen	Environment Canada	1991
Safe Shutdown Impoundment	Temperature	US NRC	1992
Garden State Paper facility on the Passaic River, NJ	Temperature, chlorine	New Jersey DEP	1996
San Diego Gas and Electric	Temperature	EPA Region IX	1995

Facility and waterbody	Application	Review agency	Date
Encina generating station, Pacific coast, CA			
Cogeneration facilitate at the Brooklyn Navy Yard basin, NY	Temperature	NY State Department of Environmental Conservation	1994
Plant Branch, Lake Sinclair, GA	temperature	Georgia Department of Environmental Conservation	1996
Wagner Generating Station on Baltimore Harbor, MD	Temperature, larvae	Maryland Power Plant Siting Agency	1994
Courtney Bay, N.B., Canada	Temperature, salinity, dissolved oxygen, dilution, metals	Environment New Brunswick	1994



GLLVHT model predicted thermal plume in an estuary.
The picture was obtained using Qual View.

APPENDIX B: CORMIX DATA AND RESULTS

CORMIX Input

Scenario 01

```
CORMIX2 PREDICTION FILE:
2222222222222222222222222222222222222222222222222222222222222222222222222222
222
                        CORMIX MIXING ZONE EXPERT SYSTEM
          Subsystem CORMIX2:  Multiport Diffuser Discharges
                             CORMIX Version 5.0GT
                          HYDRO2 Version 5.0.1.0 December 2007
------------------------------------------------------------------------------
---
------------------------------------------------------------------------------
---
CASE DESCRIPTION
 Site name/label:   Bell Bend
 Design case:       Scenario 01
 FILE NAME:         C:\...PPS\Susquehanna 3\CORMIX\Proposed\Scenario
01.prd
 Time stamp:        Tue Apr 29 16:11:41 2008

ENVIRONMENT PARAMETERS (metric units)
 Bounded section
 BS     =    228.60  AS     =     801.29  QA     =     123.23  ICHREG= 1
 HA     =      3.51  HD     =       3.51
 UA     =     0.154  F      =      0.005 USTAR =0.3908E-02
 UW     =     0.000 UWSTAR=0.0000E+00
 Uniform density environment
 STRCND=  U         RHOAM =  995.5560

DIFFUSER DISCHARGE PARAMETERS (metric units)
 Diffuser type:     DITYPE= unidirectional_perpendicular
 BANK   =  RIGHT    DISTB =      81.08  YB1    =      64.62  YB2    =
97.54
 LD     =     32.92  NOPEN =    72       SPAC   =       0.46
 D0     =     0.102  A0     =      0.008 H0     =       0.00  SUB0   =
3.51
 Nozzle/port arrangement:   unidirectional_without_fanning
 GAMMA =      90.00  THETA =      45.00  SIGMA =       0.00  BETA   =
90.00
 U0     =     1.207  Q0     =      0.705       =0.7048E+00
 RHO0   =  994.9540  DRHO0 =0.6019E+00  GP0    =0.5929E-02
 C0     =0.3460E+01  CUNITS=  deg.F
 IPOLL =  3         KS     =0.5873E-05  KD     =0.0000E+00

FLUX VARIABLES - PER UNIT DIFFUSER LENGTH (metric units)
 q0     =0.2141E-01  m0     =0.2585E-01  j0     =0.1269E-03  SIGNJ0=      1.0
 Associated 2-d length scales (meters)
 lQ=B   =      0.018 lM     =      10.21  lm     =       1.09
 lmp    =  99999.00  lbp    =  99999.00  la     =  99999.00

FLUX VARIABLES - ENTIRE DIFFUSER (metric units)
 Q0     =0.7048E+00  M0     =0.8510E+00  J0     =0.4179E-02
 Associated 3-d length scales (meters)
 LQ     =      0.09  LM     =      13.71  Lm     =       6.00  Lb     =
1.15
                                          Lmp    =  99999.00  Lbp    =
99999.00

NON-DIMENSIONAL PARAMETERS
 FR0    =    117.76  FRD0   =      49.20  R      =       7.85  PL     =      1.
 (slot)             (port/nozzle)

RECOMPUTED SOURCE CONDITIONS FOR RISER GROUPS:
 Properties of riser group with  1 ports/nozzles each:
 U0     =     1.207  D0     =      0.102 A0     =       0.008 THETA =
45.00
 FR0    =    117.76  FRD0   =      49.20  R      =       7.85
 (slot)             (riser group)

FLOW CLASSIFICATION
 22222222222222222222222222222222222222222
 2  Flow class (CORMIX2)      =     MU2    2
 2  Applicable layer depth HS =      3.51  2
 22222222222222222222222222222222222222222

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0     =0.3460E+01  CUNITS=  deg.F
 NTOX   =  0
```

```
 NSTD  =  1          CSTD  =0.9000E+02
 REGMZ =  0
 XINT  =   3048.00  XMAX  =   3048.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and the diffuser mid-point:
        81.08 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  50 display intervals per module

NOTE on dilution/concentration values for this HEATED DISCHARGE (IPOLL=3):
   S  = hydrodynamic dilutions, include buoyancy (heat) loss effects, but
        provided plume has surface contact
   C  = corresponding temperature values (always in "degC"!),
        include heat loss, if any
-------------------------------------------------------------------------------
---
-------------------------------------------------------------------------------
---
BEGIN MOD201: DIFFUSER DISCHARGE MODULE

 Due to complex near-field motions:  EQUIVALENT SLOT DIFFUSER (2-D)
GEOMETRY

 Profile definitions:
   BV = Gaussian 1/e (37%) half-width, in vertical plane normal to
trajectory
   BH = top-hat half-width, in horizontal plane normal to trajectory
   S  = hydrodynamic centerline dilution
   C  = centerline concentration (includes reaction effects, if any)

       X        Y        Z        S        C        BV       BH
    0.00     0.00     0.00      1.0 0.346E+01   0.01    16.46
** WATER QUALITY STANDARD OR CCC HAS BEEN FOUND **
 The pollutant concentration in the plume falls below water quality
standard
   or CCC value of 0.900E+02 due to mixing in this control volume.
 The actual extent of the zone at whose boundary the water quality
   standard or the CCC is exceeded will be smaller than the control
   volume outflow values predicted below.


END OF MOD201: DIFFUSER DISCHARGE MODULE
-------------------------------------------------------------------------------
---
-------------------------------------------------------------------------------
---
BEGIN MOD271: ACCELERATION ZONE OF UNIDIRECTIONAL CO-FLOWING DIFFUSER

 In this laterally contracting zone the diffuser plume becomes VERTICALLY
FULLY
  MIXED over the entire layer depth (HS =    3.51m).
   Full mixing is achieved after a plume distance of about five
   layer depths from the diffuser.

 Profile definitions:
   BV = layer depth (vertically mixed)
   BH = top-hat half-width, in horizontal plane normal to trajectory
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)

       X        Y        Z        S        C        BV       BH
    0.00     0.00     0.00      1.0 0.346E+01   0.01    16.46
    0.33     0.00     0.04      4.8 0.724E+00   0.08    16.35
    0.66     0.00     0.07      6.3 0.546E+00   0.15    16.25
    0.99     0.00     0.11      7.5 0.459E+00   0.21    16.16
    1.32     0.00     0.14      8.6 0.405E+00   0.28    16.07
    1.65     0.00     0.18      9.4 0.366E+00   0.35    15.99
    1.98     0.00     0.21     10.2 0.338E+00   0.42    15.91
    2.30     0.00     0.25     11.0 0.315E+00   0.49    15.83
    2.63     0.00     0.28     11.7 0.296E+00   0.56    15.76
    2.96     0.00     0.32     12.3 0.281E+00   0.63    15.70
    3.29     0.00     0.35     12.9 0.267E+00   0.70    15.63
    3.62     0.00     0.39     13.5 0.256E+00   0.77    15.57
    3.95     0.00     0.42     14.1 0.246E+00   0.84    15.52
    4.28     0.00     0.46     14.6 0.237E+00   0.91    15.46
    4.61     0.00     0.49     15.1 0.229E+00   0.98    15.41
    4.94     0.00     0.53     15.6 0.221E+00   1.05    15.36
    5.27     0.00     0.56     16.1 0.215E+00   1.12    15.32
    5.60     0.00     0.60     16.6 0.209E+00   1.19    15.27
    5.93     0.00     0.63     17.0 0.203E+00   1.26    15.23
```

```
     6.25     0.00    0.67    17.5 0.198E+00   1.33    15.19
     6.58     0.00    0.70    17.9 0.193E+00   1.40    15.15
     6.91     0.00    0.74    18.3 0.189E+00   1.47    15.11
     7.24     0.00    0.77    18.7 0.185E+00   1.54    15.08
     7.57     0.00    0.81    19.1 0.181E+00   1.61    15.04
     7.90     0.00    0.84    19.5 0.177E+00   1.68    15.01
     8.23     0.00    0.88    19.9 0.174E+00   1.75    14.98
     8.56     0.00    0.91    20.3 0.171E+00   1.82    14.95
     8.89     0.00    0.95    20.6 0.168E+00   1.89    14.92
     9.22     0.00    0.98    21.0 0.165E+00   1.96    14.89
     9.55     0.00    1.02    21.3 0.162E+00   2.03    14.87
     9.88     0.00    1.05    21.7 0.160E+00   2.10    14.85
    10.20     0.00    1.09    22.0 0.157E+00   2.17    14.82
    10.53     0.00    1.12    22.4 0.155E+00   2.24    14.80
    10.86     0.00    1.16    22.7 0.152E+00   2.31    14.78
    11.19     0.00    1.19    23.0 0.150E+00   2.38    14.77
    11.52     0.00    1.23    23.3 0.148E+00   2.45    14.75
    11.85     0.00    1.26    23.7 0.146E+00   2.52    14.74
    12.18     0.00    1.30    24.0 0.144E+00   2.59    14.72
    12.51     0.00    1.33    24.3 0.143E+00   2.66    14.71
    12.84     0.00    1.37    24.6 0.141E+00   2.73    14.70
    13.17     0.00    1.40    24.9 0.139E+00   2.80    14.69
    13.50     0.00    1.44    25.2 0.137E+00   2.87    14.68
    13.83     0.00    1.47    25.5 0.136E+00   2.94    14.67
    14.15     0.00    1.51    25.8 0.134E+00   3.01    14.67
    14.48     0.00    1.54    26.0 0.133E+00   3.08    14.66
    14.81     0.00    1.58    26.3 0.131E+00   3.15    14.66
    15.14     0.00    1.61    26.6 0.130E+00   3.22    14.66
    15.47     0.00    1.65    26.9 0.129E+00   3.29    14.65
    15.80     0.00    1.68    27.2 0.127E+00   3.36    14.65
    16.13     0.00    1.72    27.4 0.126E+00   3.44    14.65
    16.46     0.00    1.75    27.7 0.125E+00   3.51    14.65
 Cumulative travel time =         83.3886 sec
   Plume centerline may exhibit slight discontinuities in transition
     to subsequent far-field module.

END OF MOD271: ACCELERATION ZONE OF UNIDIRECTIONAL CO-FLOWING DIFFUSER
--------------------------------------------------------------------------
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--------------------------------------------------------------------------
---
```

Scenario 02

```
CORMIX2 PREDICTION FILE:
2222222222222222222222222222222222222222222222222222222222222222222222
222
                      CORMIX MIXING ZONE EXPERT SYSTEM
          Subsystem CORMIX2:  Multiport Diffuser Discharges
                        CORMIX Version 5.0GT
                    HYDRO2 Version 5.0.1.0 December 2007
--------------------------------------------------------------------------
---
--------------------------------------------------------------------------
---
CASE DESCRIPTION
 Site name/label:   Bell Bend
 Design case:       Scenario 02
 FILE NAME:         C:\...PPS\Susquehanna 3\CORMIX\Proposed\Scenario
02.prd
 Time stamp:        Tue Apr 29 16:15:34 2008

ENVIRONMENT PARAMETERS (metric units)
 Bounded section
 BS    =    207.26  AS    =    631.74  QA    =     31.85  ICHREG= 1
 HA    =      3.05  HD    =      3.05
 UA    =     0.050  F     =     0.005 USTAR =0.1311E-02
 UW    =     0.000 UWSTAR=0.0000E+00
 Uniform density environment
 STRCND=  U         RHOAM =  995.5560

DIFFUSER DISCHARGE PARAMETERS (metric units)
 Diffuser type:     DITYPE= unidirectional_perpendicular
 BANK  =  RIGHT     DISTB =     81.08  YB1   =     64.62  YB2   =
97.54
 LD    =     32.92  NOPEN =   72       SPAC  =      0.46
 D0    =      0.102 A0    =     0.008 H0    =      0.00  SUB0  =
3.05
 Nozzle/port arrangement:   unidirectional_without_fanning
 GAMMA =     90.00  THETA =     45.00  SIGMA =      0.00  BETA  =
90.00
```

```
 U0    =      1.207 Q0    =      0.705       =0.7048E+00
 RHO0  =  994.9540  DRHO0 =0.6019E+00  GP0   =0.5929E-02
 C0    =0.3460E+01  CUNITS=  deg.F
 IPOLL =  3         KS    =0.5873E-05  KD    =0.0000E+00

FLUX VARIABLES - PER UNIT DIFFUSER LENGTH (metric units)
 q0    =0.2141E-01  m0    =0.2585E-01  j0    =0.1269E-03  SIGNJ0=      1.0
 Associated 2-d length scales (meters)
 lQ=B  =      0.018 lM    =     10.21  lm    =     10.17
 lmp   =  99999.00  lbp   =  99999.00  la    =  99999.00

FLUX VARIABLES - ENTIRE DIFFUSER (metric units)
 Q0    =0.7048E+00  M0    =0.8510E+00  J0    =0.4179E-02
 Associated 3-d length scales (meters)
 LQ    =      0.09  LM    =     13.71  Lm    =     18.30  Lb    =
32.60
                                       Lmp   =  99999.00  Lbp   =
99999.00

NON-DIMENSIONAL PARAMETERS
 FR0   =    117.76  FRD0  =     49.20  R     =     23.95  PL    =      1.
 (slot)             (port/nozzle)

RECOMPUTED SOURCE CONDITIONS FOR RISER GROUPS:
 Properties of riser group with  1 ports/nozzles each:
 U0    =      1.207 D0    =      0.102 A0    =      0.008 THETA =
45.00
 FR0   =    117.76  FRD0  =     49.20  R     =     23.95
 (slot)             (riser group)

FLOW CLASSIFICATION
 22222222222222222222222222222222222222222222
 2  Flow class (CORMIX2)     =    MU2    2
 2  Applicable layer depth HS =     3.05  2
 22222222222222222222222222222222222222222222

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.3460E+01  CUNITS=  deg.F
 NTOX  =  0
 NSTD  =  1         CSTD  =0.9000E+02
 REGMZ =  0
 XINT  =   3048.00  XMAX  =   3048.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and the diffuser mid-point:
        81.08 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  50 display intervals per module

NOTE on dilution/concentration values for this HEATED DISCHARGE (IPOLL=3):
   S  = hydrodynamic dilutions, include buoyancy (heat) loss effects, but
        provided plume has surface contact
   C  = corresponding temperature values (always in "degC"!),
        include heat loss, if any
-------------------------------------------------------------------------
---
-------------------------------------------------------------------------
---
BEGIN MOD201: DIFFUSER DISCHARGE MODULE

 Due to complex near-field motions:  EQUIVALENT SLOT DIFFUSER (2-D)
GEOMETRY

 Profile definitions:
   BV = Gaussian 1/e (37%) half-width, in vertical plane normal to
trajectory
   BH = top-hat half-width, in horizontal plane normal to trajectory
   S  = hydrodynamic centerline dilution
   C  = centerline concentration (includes reaction effects, if any)

       X        Y        Z        S        C        BV       BH
    0.00     0.00     0.00     1.0 0.346E+01   0.01    16.46
** WATER QUALITY STANDARD OR CCC HAS BEEN FOUND **
 The pollutant concentration in the plume falls below water quality
standard
   or CCC value of 0.900E+02 due to mixing in this control volume.
 The actual extent of the zone at whose boundary the water quality
   standard or the CCC is exceeded will be smaller than the control
   volume outflow values predicted below.
```

END OF MOD201: DIFFUSER DISCHARGE MODULE

BEGIN MOD271: ACCELERATION ZONE OF UNIDIRECTIONAL CO-FLOWING DIFFUSER

In this laterally contracting zone the diffuser plume becomes VERTICALLY FULLY
MIXED over the entire layer depth (HS = 3.05m).
Full mixing is achieved after a plume distance of about five
layer depths from the diffuser.

Profile definitions:
BV = layer depth (vertically mixed)
BH = top-hat half-width, in horizontal plane normal to trajectory
S = hydrodynamic average (bulk) dilution
C = average (bulk) concentration (includes reaction effects, if any)

X	Y	Z	S	C	BV	BH
0.00	0.00	0.00	1.0	0.346E+01	0.01	16.46
0.33	0.00	0.03	2.6	0.134E+01	0.08	16.14
0.66	0.00	0.06	3.2	0.107E+01	0.15	15.84
0.99	0.00	0.09	3.7	0.926E+00	0.21	15.56
1.32	0.00	0.12	4.2	0.832E+00	0.28	15.29
1.65	0.00	0.15	4.5	0.763E+00	0.34	15.04
1.98	0.00	0.18	4.9	0.711E+00	0.41	14.81
2.30	0.00	0.21	5.2	0.668E+00	0.48	14.58
2.63	0.00	0.24	5.5	0.633E+00	0.54	14.37
2.96	0.00	0.27	5.7	0.603E+00	0.61	14.17
3.29	0.00	0.30	6.0	0.577E+00	0.67	13.98
3.62	0.00	0.34	6.2	0.555E+00	0.74	13.80
3.95	0.00	0.37	6.5	0.535E+00	0.80	13.63
4.28	0.00	0.40	6.7	0.517E+00	0.87	13.47
4.61	0.00	0.43	6.9	0.501E+00	0.94	13.32
4.94	0.00	0.46	7.1	0.486E+00	1.00	13.17
5.27	0.00	0.49	7.3	0.473E+00	1.07	13.03
5.60	0.00	0.52	7.5	0.460E+00	1.13	12.89
5.93	0.00	0.55	7.7	0.449E+00	1.20	12.76
6.25	0.00	0.58	7.9	0.439E+00	1.27	12.64
6.58	0.00	0.61	8.1	0.429E+00	1.33	12.52
6.91	0.00	0.64	8.2	0.420E+00	1.40	12.41
7.24	0.00	0.67	8.4	0.411E+00	1.46	12.31
7.57	0.00	0.70	8.6	0.403E+00	1.53	12.20
7.90	0.00	0.73	8.7	0.396E+00	1.59	12.11
8.23	0.00	0.76	8.9	0.389E+00	1.66	12.01
8.56	0.00	0.79	9.1	0.382E+00	1.73	11.92
8.89	0.00	0.82	9.2	0.376E+00	1.79	11.84
9.22	0.00	0.85	9.4	0.370E+00	1.86	11.76
9.55	0.00	0.88	9.5	0.364E+00	1.92	11.68
9.88	0.00	0.91	9.7	0.358E+00	1.99	11.61
10.20	0.00	0.94	9.8	0.353E+00	2.06	11.55
10.53	0.00	0.98	9.9	0.348E+00	2.12	11.49
10.86	0.00	1.01	10.1	0.343E+00	2.19	11.43
11.19	0.00	1.04	10.2	0.339E+00	2.25	11.38
11.52	0.00	1.07	10.3	0.334E+00	2.32	11.33
11.85	0.00	1.10	10.5	0.330E+00	2.38	11.28
12.18	0.00	1.13	10.6	0.326E+00	2.45	11.24
12.51	0.00	1.16	10.7	0.322E+00	2.52	11.21
12.84	0.00	1.19	10.9	0.318E+00	2.58	11.18
13.17	0.00	1.22	11.0	0.315E+00	2.65	11.15
13.50	0.00	1.25	11.1	0.311E+00	2.71	11.12
13.83	0.00	1.28	11.2	0.308E+00	2.78	11.10
14.15	0.00	1.31	11.4	0.305E+00	2.85	11.08
14.48	0.00	1.34	11.5	0.301E+00	2.91	11.07
14.81	0.00	1.37	11.6	0.298E+00	2.98	11.05
15.14	0.00	1.40	11.7	0.295E+00	3.04	11.04
15.47	0.00	1.43	11.8	0.292E+00	3.05	11.03
15.80	0.00	1.46	11.9	0.290E+00	3.05	11.03
16.13	0.00	1.49	12.1	0.287E+00	3.05	11.02
16.46	0.00	1.52	12.2	0.284E+00	3.05	11.02

Cumulative travel time = 110.0015 sec
Plume centerline may exhibit slight discontinuities in transition
to subsequent far-field module.

END OF MOD271: ACCELERATION ZONE OF UNIDIRECTIONAL CO-FLOWING DIFFUSER

Scenario 03

```
CORMIX2 PREDICTION FILE:
2222222222222222222222222222222222222222222222222222222222222222222222222
222
                        CORMIX MIXING ZONE EXPERT SYSTEM
          Subsystem CORMIX2:  Multiport Diffuser Discharges
                             CORMIX Version 5.0GT
                          HYDRO2 Version 5.0.1.0 December 2007
------------------------------------------------------------------------------
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------------------------------------------------------------------------------
---
CASE DESCRIPTION
 Site name/label:   Bell Bend
 Design case:       Scenario 03
 FILE NAME:         C:\...PPS\Susquehanna 3\CORMIX\Proposed\Scenario
03.prd
 Time stamp:        Tue Apr 29 16:17:57 2008

ENVIRONMENT PARAMETERS (metric units)
 Bounded section
 BS    =    240.79  AS    =   1012.83  QA    =    350.02  ICHREG= 1
 HA    =      4.21  HD    =      4.21
 UA    =     0.346  F     =     0.005 USTAR =0.8520E-02
 UW    =     0.000 UWSTAR=0.0000E+00
 Uniform density environment
 STRCND=  U         RHOAM =  999.8640

DIFFUSER DISCHARGE PARAMETERS (metric units)
 Diffuser type:     DITYPE= unidirectional_perpendicular
 BANK  =  RIGHT     DISTB =     81.08  YB1   =     64.62  YB2   =
97.54
 LD    =     32.92  NOPEN =   72       SPAC  =      0.46
 D0    =     0.102  A0    =     0.008 H0    =      0.00  SUB0  =
4.21
 Nozzle/port arrangement:   unidirectional_without_fanning
 GAMMA =     90.00  THETA =     45.00  SIGMA =      0.00  BETA  =
90.00
 U0    =     1.207  Q0    =     0.705       =0.7048E+00
 RHO0  =  998.4484  DRHO0 =0.1416E+01  GP0   =0.1388E-01
 C0    =0.3381E+02  CUNITS=  deg.F
 IPOLL =  3         KS    =0.3274E-05  KD    =0.0000E+00

FLUX VARIABLES - PER UNIT DIFFUSER LENGTH (metric units)
 q0    =0.2141E-01  m0    =0.2585E-01  j0    =0.2973E-03  SIGNJ0=      1.0
 Associated 2-d length scales (meters)
 lQ=B  =     0.018  lM    =      5.79  lm    =      0.22
 lmp   =  99999.00  lbp   =  99999.00  la    =  99999.00

FLUX VARIABLES - ENTIRE DIFFUSER (metric units)
 Q0    =0.7048E+00  M0    =0.8510E+00  J0    =0.9785E-02
 Associated 3-d length scales (meters)
 LQ    =     0.09   LM    =      8.96  Lm    =      2.67  Lb    =
0.24
                                        Lmp   =  99999.00  Lbp   =
99999.00

NON-DIMENSIONAL PARAMETERS
 FR0   =     76.96  FRD0  =     32.15  R     =      3.49  PL    =      1.
 (slot)             (port/nozzle)

RECOMPUTED SOURCE CONDITIONS FOR RISER GROUPS:
 Properties of riser group with  1 ports/nozzles each:
 U0    =     1.207  D0    =     0.102  A0    =     0.008 THETA =
45.00
 FR0   =     76.96  FRD0  =     32.15  R     =      3.49
 (slot)             (riser group)

FLOW CLASSIFICATION
 22222222222222222222222222222222222222
 2  Flow class (CORMIX2)       =    MU2    2
.2  Applicable layer depth HS =     4.21  2
 22222222222222222222222222222222222222

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.3381E+02  CUNITS=  deg.F
 NTOX  =  0
 NSTD  =  1         CSTD  =0.9000E+02
 REGMZ =  0
 XINT  =   3048.00  XMAX  =   3048.00
```

```
X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and the diffuser mid-point:
        81.08 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  50 display intervals per module

NOTE on dilution/concentration values for this HEATED DISCHARGE (IPOLL=3):
   S  = hydrodynamic dilutions, include buoyancy (heat) loss effects, but
        provided plume has surface contact
   C  = corresponding temperature values (always in "degC"!),
        include heat loss, if any
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BEGIN MOD201: DIFFUSER DISCHARGE MODULE

 Due to complex near-field motions:  EQUIVALENT SLOT DIFFUSER (2-D)
GEOMETRY

 Profile definitions:
   BV = Gaussian 1/e (37%) half-width, in vertical plane normal to
trajectory
   BH = top-hat half-width, in horizontal plane normal to trajectory
   S  = hydrodynamic centerline dilution
   C  = centerline concentration (includes reaction effects, if any)

       X        Y        Z        S        C        BV       BH
    0.00     0.00     0.00      1.0 0.338E+02   0.01    16.46
** WATER QUALITY STANDARD OR CCC HAS BEEN FOUND **
 The pollutant concentration in the plume falls below water quality
standard
   or CCC value of 0.900E+02 due to mixing in this control volume.
 The actual extent of the zone at whose boundary the water quality
   standard or the CCC is exceeded will be smaller than the control
   volume outflow values predicted below.


END OF MOD201: DIFFUSER DISCHARGE MODULE
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BEGIN MOD271: ACCELERATION ZONE OF UNIDIRECTIONAL CO-FLOWING DIFFUSER

 In this laterally contracting zone the diffuser plume becomes VERTICALLY
FULLY
  MIXED over the entire layer depth (HS =    4.21m).
   Full mixing is achieved after a plume distance of about five
   layer depths from the diffuser.

 Profile definitions:
   BV = layer depth (vertically mixed)
   BH = top-hat half-width, in horizontal plane normal to trajectory
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)

       X        Y        Z        S        C        BV       BH
    0.00     0.00     0.00      1.0 0.338E+02   0.01    16.46
    0.33     0.00     0.04     10.6 0.318E+01   0.08    16.44
    0.66     0.00     0.08     14.6 0.231E+01   0.17    16.41
    0.99     0.00     0.13     17.7 0.191E+01   0.25    16.39
    1.32     0.00     0.17     20.3 0.167E+01   0.34    16.37
    1.65     0.00     0.21     22.5 0.150E+01   0.42    16.36
    1.98     0.00     0.25     24.6 0.137E+01   0.50    16.34
    2.30     0.00     0.29     26.5 0.128E+01   0.59    16.32
    2.63     0.00     0.34     28.2 0.120E+01   0.67    16.31
    2.96     0.00     0.38     29.9 0.113E+01   0.76    16.29
    3.29     0.00     0.42     31.5 0.107E+01   0.84    16.28
    3.62     0.00     0.46     32.9 0.103E+01   0.93    16.27
    3.95     0.00     0.50     34.4 0.984E+00   1.01    16.25
    4.28     0.00     0.55     35.7 0.946E+00   1.09    16.24
    4.61     0.00     0.59     37.0 0.913E+00   1.18    16.23
    4.94     0.00     0.63     38.3 0.883E+00   1.26    16.22
    5.27     0.00     0.67     39.5 0.855E+00   1.35    16.21
    5.60     0.00     0.72     40.7 0.830E+00   1.43    16.20
    5.93     0.00     0.76     41.9 0.808E+00   1.51    16.19
    6.25     0.00     0.80     43.0 0.787E+00   1.60    16.18
    6.58     0.00     0.84     44.1 0.767E+00   1.68    16.17
    6.91     0.00     0.88     45.1 0.749E+00   1.77    16.17
    7.24     0.00     0.93     46.2 0.732E+00   1.85    16.16
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   7.57     0.00    0.97    47.2 0.716E+00   1.93    16.15
   7.90     0.00    1.01    48.2 0.702E+00   2.02    16.14
   8.23     0.00    1.05    49.2 0.688E+00   2.10    16.14
   8.56     0.00    1.09    50.1 0.675E+00   2.19    16.13
   8.89     0.00    1.14    51.0 0.662E+00   2.27    16.12
   9.22     0.00    1.18    52.0 0.651E+00   2.36    16.12
   9.55     0.00    1.22    52.9 0.640E+00   2.44    16.11
   9.88     0.00    1.26    53.8 0.629E+00   2.52    16.11
  10.20     0.00    1.30    54.6 0.619E+00   2.61    16.10
  10.53     0.00    1.35    55.5 0.609E+00   2.69    16.10
  10.86     0.00    1.39    56.3 0.600E+00   2.78    16.09
  11.19     0.00    1.43    57.2 0.591E+00   2.86    16.09
  11.52     0.00    1.47    58.0 0.583E+00   2.94    16.09
  11.85     0.00    1.51    58.8 0.575E+00   3.03    16.08
  12.18     0.00    1.56    59.6 0.567E+00   3.11    16.08
  12.51     0.00    1.60    60.4 0.560E+00   3.20    16.08
  12.84     0.00    1.64    61.1 0.553E+00   3.28    16.08
  13.17     0.00    1.68    61.9 0.546E+00   3.36    16.07
  13.50     0.00    1.72    62.7 0.539E+00   3.45    16.07
  13.83     0.00    1.77    63.4 0.533E+00   3.53    16.07
  14.15     0.00    1.81    64.2 0.527E+00   3.62    16.07
  14.48     0.00    1.85    64.9 0.521E+00   3.70    16.07
  14.81     0.00    1.89    65.6 0.515E+00   3.79    16.07
  15.14     0.00    1.93    66.3 0.510E+00   3.87    16.07
  15.47     0.00    1.98    67.0 0.504E+00   3.95    16.07
  15.80     0.00    2.02    67.7 0.499E+00   4.04    16.06
  16.13     0.00    2.06    68.4 0.494E+00   4.12    16.06
  16.46     0.00    2.10    69.1 0.489E+00   4.21    16.06
 Cumulative travel time =         45.3349 sec
   Plume centerline may exhibit slight discontinuities in transition
     to subsequent far-field module.

END OF MOD271: ACCELERATION ZONE OF UNIDIRECTIONAL CO-FLOWING DIFFUSER
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Scenario 04

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CORMIX2 PREDICTION FILE:
2222222222222222222222222222222222222222222222222222222222222222222222222
222
                      CORMIX MIXING ZONE EXPERT SYSTEM
          Subsystem CORMIX2:  Multiport Diffuser Discharges
                          CORMIX Version 5.0GT
                     HYDRO2 Version 5.0.1.0 December 2007
------------------------------------------------------------------------
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CASE DESCRIPTION
 Site name/label:   Bell Bend
 Design case:       Scenario 04
 FILE NAME:         C:\...PPS\Susquehanna 3\CORMIX\Proposed\Scenario
04.prd
 Time stamp:        Tue Apr 29 16:20:04 2008

ENVIRONMENT PARAMETERS (metric units)
 Bounded section
 BS    =    219.46  AS    =    722.41  QA    =     77.22  ICHREG= 1
 HA    =      3.29  HD    =      3.29
 UA    =     0.107  F     =     0.005 USTAR =0.2745E-02
 UW    =     0.000 UWSTAR=0.0000E+00
 Uniform density environment
 STRCND=  U         RHOAM =  999.8640

DIFFUSER DISCHARGE PARAMETERS (metric units)
 Diffuser type:     DITYPE= unidirectional_perpendicular
 BANK  =  RIGHT     DISTB =     81.08  YB1   =     64.62  YB2   =
97.54
 LD    =     32.92  NOPEN =   72       SPAC  =      0.46
 D0    =     0.102  A0    =     0.008 H0    =      0.00  SUB0  =
3.29
 Nozzle/port arrangement:   unidirectional_without_fanning
 GAMMA =     90.00  THETA =     45.00  SIGMA =      0.00  BETA  =
90.00
 U0    =     1.207  Q0    =     0.705       =0.7048E+00
 RHO0  =  998.4484  DRHO0 =0.1416E+01  GP0   =0.1388E-01
 C0    =0.3381E+02  CUNITS=  deg.F
 IPOLL =  3         KS    =0.3274E-05  KD    =0.0000E+00
```

```
FLUX VARIABLES - PER UNIT DIFFUSER LENGTH (metric units)
 q0    =0.2141E-01  m0    =0.2585E-01  j0    =0.2973E-03  SIGNJ0=      1.0
 Associated 2-d length scales (meters)
 lQ=B  =      0.018 lM    =      5.79  lm    =      2.26
 lmp   =  99999.00  lbp   =  99999.00  la    =  99999.00

FLUX VARIABLES - ENTIRE DIFFUSER (metric units)
 Q0    =0.7048E+00  M0    =0.8510E+00  J0    =0.9785E-02
 Associated 3-d length scales (meters)
 LQ    =      0.09  LM    =      8.96  Lm    =      8.63  Lb    =
8.01
                                       Lmp   =  99999.00  Lbp   =
99999.00

NON-DIMENSIONAL PARAMETERS
 FR0   =     76.96  FRD0  =     32.15  R     =     11.30  PL    =      1.
 (slot)             (port/nozzle)

RECOMPUTED SOURCE CONDITIONS FOR RISER GROUPS:
 Properties of riser group with  1 ports/nozzles each:
 U0    =      1.207 D0    =      0.102 A0    =      0.008 THETA =
45.00
 FR0   =     76.96  FRD0  =     32.15  R     =     11.30
 (slot)             (riser group)

FLOW CLASSIFICATION
 22222222222222222222222222222222222222222
 2  Flow class (CORMIX2)      =    MU2    2
 2  Applicable layer depth HS =     3.29  2
 22222222222222222222222222222222222222222

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.3381E+02  CUNITS=  deg.F
 NTOX  =  0
 NSTD  =  1         CSTD  =0.9000E+02
 REGMZ =  0
 XINT  =   3048.00  XMAX  =   3048.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and the diffuser mid-point:
        81.08 m  from the RIGHT bank/shore.
    X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP =  50 display intervals per module

NOTE on dilution/concentration values for this HEATED DISCHARGE (IPOLL=3):
   S  = hydrodynamic dilutions, include buoyancy (heat) loss effects, but
        provided plume has surface contact
   C  = corresponding temperature values (always in "degC"!),
        include heat loss, if any
------------------------------------------------------------------------
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---
BEGIN MOD201: DIFFUSER DISCHARGE MODULE

 Due to complex near-field motions:  EQUIVALENT SLOT DIFFUSER (2-D)
GEOMETRY

 Profile definitions:
   BV = Gaussian 1/e (37%) half-width, in vertical plane normal to
trajectory
   BH = top-hat half-width, in horizontal plane normal to trajectory
   S  = hydrodynamic centerline dilution
   C  = centerline concentration (includes reaction effects, if any)

       X        Y        Z        S        C        BV       BH
    0.00     0.00     0.00      1.0 0.338E+02   0.01    16.46
** WATER QUALITY STANDARD OR CCC HAS BEEN FOUND **
 The pollutant concentration in the plume falls below water quality
standard
   or CCC value of 0.900E+02 due to mixing in this control volume.
 The actual extent of the zone at whose boundary the water quality
   standard or the CCC is exceeded will be smaller than the control
   volume outflow values predicted below.


END OF MOD201: DIFFUSER DISCHARGE MODULE
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BEGIN MOD271: ACCELERATION ZONE OF UNIDIRECTIONAL CO-FLOWING DIFFUSER

 In this laterally contracting zone the diffuser plume becomes VERTICALLY
FULLY
  MIXED over the entire layer depth (HS =    3.29m).
   Full mixing is achieved after a plume distance of about five
   layer depths from the diffuser.

 Profile definitions:
   BV = layer depth (vertically mixed)
   BH = top-hat half-width, in horizontal plane normal to trajectory
   S  = hydrodynamic average (bulk) dilution
   C  = average (bulk) concentration (includes reaction effects, if any)

      X        Y        Z        S        C        BV       BH
   0.00     0.00     0.00      1.0 0.338E+02   0.01    16.46
   0.33     0.00     0.03      3.7 0.926E+01   0.08    16.28
   0.66     0.00     0.07      4.8 0.712E+01   0.15    16.12
   0.99     0.00     0.10      5.6 0.604E+01   0.21    15.97
   1.32     0.00     0.13      6.3 0.536E+01   0.28    15.82
   1.65     0.00     0.16      6.9 0.488E+01   0.34    15.68
   1.98     0.00     0.20      7.5 0.451E+01   0.41    15.55
   2.30     0.00     0.23      8.0 0.422E+01   0.48    15.43
   2.63     0.00     0.26      8.5 0.398E+01   0.54    15.31
   2.96     0.00     0.30      9.0 0.377E+01   0.61    15.20
   3.29     0.00     0.33      9.4 0.360E+01   0.67    15.10
   3.62     0.00     0.36      9.8 0.345E+01   0.74    15.00
   3.95     0.00     0.40     10.2 0.332E+01   0.80    14.91
   4.28     0.00     0.43     10.6 0.320E+01   0.87    14.82
   4.61     0.00     0.46     10.9 0.309E+01   0.94    14.73
   4.94     0.00     0.49     11.3 0.300E+01   1.00    14.65
   5.27     0.00     0.53     11.6 0.291E+01   1.07    14.58
   5.60     0.00     0.56     11.9 0.283E+01   1.13    14.50
   5.93     0.00     0.59     12.3 0.276E+01   1.20    14.43
   6.25     0.00     0.63     12.6 0.269E+01   1.27    14.36
   6.58     0.00     0.66     12.9 0.263E+01   1.33    14.30
   6.91     0.00     0.69     13.2 0.257E+01   1.40    14.24
   7.24     0.00     0.72     13.4 0.252E+01   1.46    14.18
   7.57     0.00     0.76     13.7 0.246E+01   1.53    14.12
   7.90     0.00     0.79     14.0 0.242E+01   1.59    14.07
   8.23     0.00     0.82     14.3 0.237E+01   1.66    14.02
   8.56     0.00     0.86     14.5 0.233E+01   1.73    13.97
   8.89     0.00     0.89     14.8 0.229E+01   1.79    13.92
   9.22     0.00     0.92     15.0 0.225E+01   1.86    13.88
   9.55     0.00     0.95     15.3 0.221E+01   1.92    13.84
   9.88     0.00     0.99     15.5 0.218E+01   1.99    13.80
  10.20     0.00     1.02     15.8 0.214E+01   2.06    13.76
  10.53     0.00     1.05     16.0 0.211E+01   2.12    13.73
  10.86     0.00     1.09     16.2 0.208E+01   2.19    13.70
  11.19     0.00     1.12     16.5 0.205E+01   2.25    13.67
  11.52     0.00     1.15     16.7 0.203E+01   2.32    13.64
  11.85     0.00     1.19     16.9 0.200E+01   2.38    13.62
  12.18     0.00     1.22     17.1 0.197E+01   2.45    13.60
  12.51     0.00     1.25     17.4 0.195E+01   2.52    13.58
  12.84     0.00     1.28     17.6 0.192E+01   2.58    13.56
  13.17     0.00     1.32     17.8 0.190E+01   2.65    13.54
  13.50     0.00     1.35     18.0 0.188E+01   2.71    13.53
  13.83     0.00     1.38     18.2 0.186E+01   2.78    13.52
  14.15     0.00     1.42     18.4 0.184E+01   2.85    13.51
  14.48     0.00     1.45     18.6 0.182E+01   2.91    13.50
  14.81     0.00     1.48     18.8 0.180E+01   2.98    13.49
  15.14     0.00     1.51     19.0 0.178E+01   3.04    13.49
  15.47     0.00     1.55     19.2 0.176E+01   3.11    13.48
  15.80     0.00     1.58     19.4 0.174E+01   3.17    13.48
  16.13     0.00     1.61     19.6 0.173E+01   3.24    13.48
  16.46     0.00     1.65     19.8 0.171E+01   3.29    13.47
 Cumulative travel time =          97.9689 sec
   Plume centerline may exhibit slight discontinuities in transition
     to subsequent far-field module.

END OF MOD271: ACCELERATION ZONE OF UNIDIRECTIONAL CO-FLOWING DIFFUSER
------------------------------------------------------------------------
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------------------------------------------------------------------------
---
```

Scenario 05

CORMIX2 PREDICTION FILE:

```
2222222222222222222222222222222222222222222222222222222222222222222222222
222
                        CORMIX MIXING ZONE EXPERT SYSTEM
          Subsystem CORMIX2:  Multiport Diffuser Discharges
                             CORMIX Version 5.0GT
                          HYDRO2 Version 5.0.1.0 December 2007
------------------------------------------------------------------------------
---
------------------------------------------------------------------------------
---
CASE DESCRIPTION
 Site name/label:   Bell Bend
 Design case:       Scenario 05
 FILE NAME:         C:\...PPS\Susquehanna 3\CORMIX\Proposed\Scenario
05.prd
 Time stamp:        Wed Jun  4 12:00:46 2008

ENVIRONMENT PARAMETERS (metric units)
 Bounded section
 BS    =    240.79  AS    =   1012.83  QA    =    359.03  ICHREG= 1
 HA    =      4.21  HD    =      4.21
 UA    =     0.354  F     =     0.005 USTAR =0.8739E-02
 UW    =     0.000 UWSTAR=0.0000E+00
 Uniform density environment
 STRCND=  U         RHOAM =  999.8640

DIFFUSER DISCHARGE PARAMETERS (metric units)
 Diffuser type:     DITYPE= unidirectional_perpendicular
 BANK  =  RIGHT     DISTB =     81.08  YB1   =     64.62  YB2   =
97.54
 LD    =     32.92  NOPEN =   72       SPAC  =      0.46
 D0    =     0.102 A0    =      0.008 H0    =      0.00  SUB0  =
4.21
 Nozzle/port arrangement:   unidirectional_without_fanning
 GAMMA =     90.00  THETA =     45.00  SIGMA =      0.00  BETA  =
90.00
 U0    =     1.207 Q0    =     0.705       =0.7048E+00
 RHO0  =  998.4484  DRHO0 =0.1416E+01  GP0   =0.1388E-01
 C0    =0.3381E+02  CUNITS=  deg.F
 IPOLL =  3         KS    =0.3274E-05  KD    =0.0000E+00

FLUX VARIABLES - PER UNIT DIFFUSER LENGTH (metric units)
 q0    =0.2141E-01  m0    =0.2585E-01  j0    =0.2973E-03  SIGNJ0=      1.0
 Associated 2-d length scales (meters)
 lQ=B  =      0.018 lM    =      5.79  lm    =      0.21
 lmp   =  99999.00  lbp   =  99999.00  la    =  99999.00

FLUX VARIABLES - ENTIRE DIFFUSER (metric units)
 Q0    =0.7048E+00  M0    =0.8510E+00  J0    =0.9785E-02
 Associated 3-d length scales (meters)
 LQ    =      0.09  LM    =      8.96  Lm    =      2.60  Lb    =
0.22
                                        Lmp   =  99999.00  Lbp   =
99999.00

NON-DIMENSIONAL PARAMETERS
 FR0   =     76.96  FRD0  =     32.15  R     =      3.41  PL    =      1.
 (slot)             (port/nozzle)

RECOMPUTED SOURCE CONDITIONS FOR RISER GROUPS:
 Properties of riser group with  1 ports/nozzles each:
 U0    =     1.207 D0    =     0.102 A0    =     0.008 THETA =
45.00
 FR0   =     76.96  FRD0  =     32.15  R     =      3.41
 (slot)             (riser group)

FLOW CLASSIFICATION
 22222222222222222222222222222222222222
 2  Flow class (CORMIX2)      =    MU2    2
 2  Applicable layer depth HS =     4.21  2
 22222222222222222222222222222222222222

MIXING ZONE / TOXIC DILUTION / REGION OF INTEREST PARAMETERS
 C0    =0.3381E+02  CUNITS=  deg.F
 NTOX  =  0
 NSTD  =  1         CSTD  =0.9000E+02
 REGMZ =  0
 XINT  =   3048.00  XMAX  =   3048.00

X-Y-Z COORDINATE SYSTEM:
    ORIGIN is located at the bottom and the diffuser mid-point:
```

81.08 m from the RIGHT bank/shore.
X-axis points downstream, Y-axis points to left, Z-axis points upward.
NSTEP = 50 display intervals per module

NOTE on dilution/concentration values for this HEATED DISCHARGE (IPOLL=3):
S = hydrodynamic dilutions, include buoyancy (heat) loss effects, but provided plume has surface contact
C = corresponding temperature values (always in "degC"!), include heat loss, if any

---

BEGIN MOD201: DIFFUSER DISCHARGE MODULE

Due to complex near-field motions: EQUIVALENT SLOT DIFFUSER (2-D) GEOMETRY

Profile definitions:
BV = Gaussian 1/e (37%) half-width, in vertical plane normal to trajectory
BH = top-hat half-width, in horizontal plane normal to trajectory
S = hydrodynamic centerline dilution
C = centerline concentration (includes reaction effects, if any)

X	Y	Z	S	C	BV	BH
0.00	0.00	0.00	1.0	0.338E+02	0.01	16.46

** WATER QUALITY STANDARD OR CCC HAS BEEN FOUND **
The pollutant concentration in the plume falls below water quality standard
or CCC value of 0.900E+02 due to mixing in this control volume.
The actual extent of the zone at whose boundary the water quality standard or the CCC is exceeded will be smaller than the control volume outflow values predicted below.

END OF MOD201: DIFFUSER DISCHARGE MODULE

BEGIN MOD271: ACCELERATION ZONE OF UNIDIRECTIONAL CO-FLOWING DIFFUSER

In this laterally contracting zone the diffuser plume becomes VERTICALLY FULLY
MIXED over the entire layer depth (HS = 4.21m).
Full mixing is achieved after a plume distance of about five layer depths from the diffuser.

Profile definitions:
BV = layer depth (vertically mixed)
BH = top-hat half-width, in horizontal plane normal to trajectory
S = hydrodynamic average (bulk) dilution
C = average (bulk) concentration (includes reaction effects, if any)

X	Y	Z	S	C	BV	BH
0.00	0.00	0.00	1.0	0.338E+02	0.01	16.46
0.33	0.00	0.04	10.9	0.311E+01	0.08	16.44
0.66	0.00	0.08	15.0	0.226E+01	0.17	16.42
0.99	0.00	0.13	18.1	0.187E+01	0.25	16.40
1.32	0.00	0.17	20.7	0.163E+01	0.34	16.38
1.65	0.00	0.21	23.1	0.146E+01	0.42	16.36
1.98	0.00	0.25	25.2	0.134E+01	0.50	16.34
2.30	0.00	0.29	27.1	0.125E+01	0.59	16.33
2.63	0.00	0.34	28.9	0.117E+01	0.67	16.31
2.96	0.00	0.38	30.6	0.110E+01	0.76	16.30
3.29	0.00	0.42	32.2	0.105E+01	0.84	16.29
3.62	0.00	0.46	33.8	0.100E+01	0.93	16.28
3.95	0.00	0.50	35.2	0.960E+00	1.01	16.26
4.28	0.00	0.55	36.6	0.924E+00	1.09	16.25
4.61	0.00	0.59	37.9	0.891E+00	1.18	16.24
4.94	0.00	0.63	39.2	0.862E+00	1.26	16.23
5.27	0.00	0.67	40.5	0.835E+00	1.35	16.22
5.60	0.00	0.72	41.7	0.811E+00	1.43	16.21
5.93	0.00	0.76	42.9	0.788E+00	1.51	16.20
6.25	0.00	0.80	44.0	0.768E+00	1.60	16.20
6.58	0.00	0.84	45.2	0.749E+00	1.68	16.19
6.91	0.00	0.88	46.3	0.731E+00	1.77	16.18
7.24	0.00	0.93	47.3	0.715E+00	1.85	16.17
7.57	0.00	0.97	48.4	0.699E+00	1.93	16.16
7.90	0.00	1.01	49.4	0.685E+00	2.02	16.16

8.23	0.00	1.05	50.4	0.671E+00	2.10	16.15
8.56	0.00	1.09	51.4	0.658E+00	2.19	16.15
8.89	0.00	1.14	52.3	0.646E+00	2.27	16.14
9.22	0.00	1.18	53.3	0.635E+00	2.36	16.13
9.55	0.00	1.22	54.2	0.624E+00	2.44	16.13
9.88	0.00	1.26	55.1	0.614E+00	2.52	16.12
10.20	0.00	1.30	56.0	0.604E+00	2.61	16.12
10.53	0.00	1.35	56.9	0.595E+00	2.69	16.12
10.86	0.00	1.39	57.7	0.586E+00	2.78	16.11
11.19	0.00	1.43	58.6	0.577E+00	2.86	16.11
11.52	0.00	1.47	59.4	0.569E+00	2.94	16.10
11.85	0.00	1.51	60.2	0.561E+00	3.03	16.10
12.18	0.00	1.56	61.1	0.554E+00	3.11	16.10
12.51	0.00	1.60	61.9	0.546E+00	3.20	16.10
12.84	0.00	1.64	62.7	0.540E+00	3.28	16.09
13.17	0.00	1.68	63.5	0.533E+00	3.36	16.09
13.50	0.00	1.72	64.2	0.526E+00	3.45	16.09
13.83	0.00	1.77	65.0	0.520E+00	3.53	16.09
14.15	0.00	1.81	65.8	0.514E+00	3.62	16.09
14.48	0.00	1.85	66.5	0.508E+00	3.70	16.09
14.81	0.00	1.89	67.2	0.503E+00	3.79	16.09
15.14	0.00	1.93	68.0	0.497E+00	3.87	16.08
15.47	0.00	1.98	68.7	0.492E+00	3.95	16.08
15.80	0.00	2.02	69.4	0.487E+00	4.04	16.08
16.13	0.00	2.06	70.1	0.482E+00	4.12	16.08
16.46	0.00	2.10	70.8	0.477E+00	4.21	16.08

Cumulative travel time = 44.3011 sec
Plume centerline may exhibit slight discontinuities in transition to subsequent far-field module.

END OF MOD271: ACCELERATION ZONE OF UNIDIRECTIONAL CO-FLOWING DIFFUSER

APPENDIX C: GEMSS DATA AND RESULTS

GEMSS® Input

Scenario 01

```
$GEMSSModelResults,32
$GEMSS-SHWETControlFile,4.24
$Creation Date: 4/16/2008
$Waterbody Name: Susquehanna 3
$Modeler Name: SP
#########################################################################
# 1:     Scenario variables,
#########################################################################
"IntGDS,","Option to use GEMSS data structure,", 1
"Scenario,","Scenario file path and name,","C:\GEMSS\APPS\Susquehanna
3\Output\Scenario 01_01 NC,"
"DoText2MDBConversion,","Use Scenario Output Direct Database
converion,",1,1
"ZipOutputFile,","Zip text output files after creating the database,",0,0
"DoCompUsingGEMSSOutput,","Run Model Using Existing GEMSS Contour Output
Text Files,", 0
"GEMSSHDMInputFile,","Existing GEMSS Contour Output Header Text
Files,","","
#########################################################################
# 2:     Grid variables,
#########################################################################
"igrid,","Switch to read grid data from a file,",1,1
"GridFile,","Grid file name,","C:\GEMSS\APPS\Susquehanna
3\Grid\Susquehanna River 05 474Min.g3g,","4/23/2008 12:36:08
PM,","4/28/2008 12:20:10 PM,"
"InputHDatumUnit,","Input grid data is in geographic coordinate system
switch,",0
"UseLinearConversionIn,","Use linear conversion for input grid data,",1
"cstypeIn,","Input coordinate conversion mode,",0
"cscodeIn,","Input coordinate conversion zone number,",0,None
"csdatumIn,","Input UTM datum,",0
"InputVDatumUnit,","Input grid data is in geographic coordinate system
switch,",0
"OutputHDatumUnit,","Output grid data is in geographic coordinate system
switch,",0
"UseLinearConversionOut,","Use linear conversion for output grid data,",1
"cstypeOut,","Output coordinate conversion mode,",0
"cscodeOut,","Output coordinate conversion zone number,",0,None
"csdatumOut,","Output UTM datum,",0
"OutputVDatumUnit,","Output grid data is in geographic coordinate system
switch,",0
"iupmgrid,","Switch to set up different k layers,",0
"km_p,","Vertical array size,",-99
"nzds,","Number of vertical layer domains,",-99
"nzdstr,","Starting vertical layer number for each domain,",-99
"nzend,","Ending vertical layer number for each domain,",-99
"dzd,","Layer thickness in each domain,",-99
"igpsfmt,","Switch to write grid file gps format for use in ArcView,",0
"elioption,","switch to Use TVD From Boundary Condition File or Initial
elevation,", 0
"eli,","Initial elevation,",487.5
"iwbs,","Waterbody switches,", 1
"eldatum,","Reference elevation of 3rd layer in meters,",0
"UseSigmaStretching,","Switch to Use Sigma stretching,",0
"NSLevel,","Number of Sigma Levels,",0
"SigDistType,","Sigma Layer Distribution type,",0
"Slevel,","User Defined Sigma Distribution,",0.0
"ZtoSigmaBCDepthTransform,","Use BC Depth Transformation from Vertical to
Sigma Level,",0
"SmoothBathy,","Switch to Perform Bathymetry Smoothening,",0
"SlpMax,","Maximum  Allowable Slope for bathymetry smoothening,",0
"NSmoothCycle,","Number of Smoothening Cycles,",0
#########################################################################
#3:     Meteorological variables,
#########################################################################
"MetDataType,","Switch to use Meteorological time varying data; VB Use
verion; Number of Meteorology variables,",0,2.2,14
"metss,","Use Meteorological data in current simulation status,",1
"Metfile1,","Meteorological time varying data input file
name,","No_Data_File,"
"metinterp,","Switch to perform interpolation on met data,",0
"ievap;EvapScaleFactor,","Switch for evaporation;Evaporation scale
facotr,",1,1
"iwndhyd,","Use wind in hydrodynamics computations,",0
"ta,","temperature of air C,",21,0
"td,","Dew point temperature C,",13,0
```

```
"twb,","Wet bulb temperature C,",13,0
"rt,","response temperature C,",20,0
"phi,","Wind direction degrees,",90
"wad,","Wind speed m/sec,",5, 0
"cc,","Cloud coverage Octal,",2
"solrad,","Solar radiation W/m^2,",120,0
"ps,","Atmoshpheric pressure mm of Hg,",760
"ishe,","Surace heat exchange method,",1
"KEMethod,","Method to Compute K and E,",0
"cshe,","Coefficient of surface heat exchange w/m2/C,",24.59
"te,","Equlibrium temperature C,",85,1
"secchi,","Secchi depth; light transmission depth m,",-99
"rsts,","Vegetative and Topographic Shading Factor; 0 to 1.0,",-99
"wscoef,","Wind sheltering coefficient; 0 to 1.0,",-99
"iwsf,","Wind speed function,",1
"MetInterpolationMethod,","Met Interpolation Method,",0
"IDWPOW,","Exponent value for inverse weighting scheme,",0
"MetVarInterpSwitch;MetVarInterp,","Met Individuall interpolatey switch
and interpolation methods,",0
*************************************************************************
*  Meteorological Scale Factor Variables,
*************************************************************************
"UseMetRegionSF;MetRegionSFSS,","Met factor switch,",0,0
*************************************************************************
*  Meteorological Dynamic Shading Variables,
*************************************************************************
"UseDSHDRegionSF;DSHDRegionSFSS,","Met dynamic shading switch,",0,0
*************************************************************************
*  Icel Growth Model Variables,
*************************************************************************
"UseIGModel;UseIGModelStatus,","Switch to control the use of ice growth
model and status,",0,0
*************************************************************************
*  Wave Model Variables,
*************************************************************************
"iwvc;iwvcss,","Wave model activation switch and status,",0,0
#########################################################################
# 4:     Constituents,
#########################################################################
"itrc,","Transport switch; computation status; number of variables,",1,1,5
"iwqc,","Water quality model type; computation status; number of
variables,",0,0,0
"iwqaddc,","Water quality ADD model switch; computations status; number of
variables,",0,0,0
"iGAMc,","Algae model computations; status,",0,0
"nGAMs,","Number of algae,",0,1
"UseGAMInsideWQM,","Use Generalized Algae Model inside Water Quality
Model,",0
"isnec,","Sediment nutrient exchange computations,",0,0
"iPTM,","Particle transport model computations,",0,0
"istc,","Sediment transport model computations,",0,0
"nstcs,","Number of sediment transport type,",0,1
"ientc,","Entrainment computations,",0,0
"nezones,","Number of entrainment zones,",0,1
"iatc,","Optional to add more constituents,",0,0
"natc,","Number of additional constituents,",0,1
"icfmc,","Coliform Bacteria Model computations,",0,0
"ncfmcs,","Number of coliform bacteria type,",0
"iCKMc;iCKMcss,","Chlorine kinetics Model computations and status,",0,0
"nCKMc,","Number of chlorine kinetics type,",0
"iMGM;iMGMss,","Macrophyte grouth model computations and status,",0,0
"nMGMs,","Number of macrophyte type,",0,1
"UseMGMInsideWQM,","Use Macrophyte Grouth Model inside Water Quality
Model,",0
"WriteTransportOutput,","Write TRM model internal variables to GEMSS
output output,",0
"WriteWQMOutput,","Write WQM model internal variables to GEMSS output
output,",0
"WriteSFMOutput,","Write SFM model internal variables to GEMSS output
output,",0
"WriteWQADDOutput,","Write WQADD model internal variables to GEMSS output
output,",0
"WriteGAMOutput,","Write GAM model internal variables to GEMSS output
output,",0
"WriteENMOutput,","Write ENM model internal variables to GEMSS output
output,",0
"WriteUDCOutput,","Write UDM model internal variables to GEMSS output
output,",0
"WriteCFMOutput,","Write CFM model internal variables to GEMSS output
output,",0
```

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"WriteSTMOutput,","Write STM model internal variables to GEMSS output
output,",0
"WriteMGMOutput,","Write MGM model internal variables to GEMSS output
output,",0
"WriteCKMOutput,","Write CKM model internal variables to GEMSS output
output,",0
"WritePTMOutput,","Write PTM model internal variables to GEMSS output
output,",0
"cnum,","Number of Constituents,",5
"Index,","Model Name,","Identifier; Cannot be Modified,","User Given
Name,","Activity of Constituent,","Output Time,","Units,","Transport
Switch,"
"C0,","Transport,",I_Temp,"I_Temp,",1,1,1,1
"C1,","Transport,",I_Saln,"I_Saln,",1,1,0,1
"C2,","Transport,",I_lDye,"I_lDye,",1,1,0,1
"C3,","Transport,",I_CDye,"I_CDye,",1,1,0,1
"C4,","Transport,",I_Exst,"I_Exst,",1,1,1,1
#########################################################################
# 5:     Model switches,
#########################################################################
"Use3DModel,","Switch to control 3D model simulations,",1,3.7
"issflw,","switch on/off ssflow input data that is available in the
sscontrol.csv,",1
"itrcs,","transport computation algorithm switch,",1
"udwtf,","advection theta in z-direction,",0
"vdwft,","diffusion theta in z-direction,",0
"HOTSIniTime,","HOTS initization time period,",-99
"itrbs,","Turbulence scheme,",1
"itrbsm,","Turbulence sub model,",1
"itrbparam,","Turbulence parameters,",0,1,1,2.44,2.44,0.9,0.5,1,2.53
"imxls,","Mixing length scheme,",1
"ihmdcx,","momentum diffusion coefficient scheme selector in x-
direction,",2
"ihmdcy,","momentum diffusion coefficient scheme selector in y-
direction,",2
"hmdcx,","momentum diffusion coefficient in x-direction
m2/sec,",0.00584,1.1
"hmdcy,","momentum diffusion coefficient in y-direction
m2/sec,",0.00584,1.1
"prnm,","Prandtl number,",10
"ihtdcx,","transport diffusion coefficient scheme in x-direction,",3
"ihtdcy,","transport diffusion coefficient scheme in y-direction,",3
"htdcx,","transport diffusion coefficient in x-direction m2/sec,",,
"htdcy,","transport diffusion coefficient in y-direction m2/sec,",,
"idnf,","Density function selector,",2
"ideep,","Compressibility usage,",1
"ichezy,","Chezy coefficient selector,",0
"ilchezy,","Limiting Chezy selector,",0
"chezy,","Chezy coefficient; Czo;do;n,",40,,
"WSCoeffType,","Wind stress coefficient type,",0
"WSConstA,","Wind stress constant A,",0.8
"WSConstB,","Wind stress constant B,",0.065
"icors,","Coriolis force selector,",0
"RefLatOption;RefLat,","Referene Latitude Option; Reference Latitude
Value,",0,40
"ivaterms,","Vertical acceleration terms,",0
"idbg,","Debug switch,",0
"tvdscheck,","time varying data consistency check,",0
"iWDLayers,","Use wetting and drying of layers,",1
"lraddthk,","Layer addition thickness m,",0.8
"lrsubthk,","Layer subtraction thickness m,",0.8
"StabilizeInversionFlag,","StabilizeInversionFlag,",0
"InvCoeff,","InvCoeff,",-99
"iUsed1DModel,","Switch to use 1D model; Switch grid has 1D model,",0,0,1
"ComputeStat,","Statisdtical method to output variables,",0
"StatFreq;StatUnit,","Statisdtical frequency and unit to write output
variables,",0,0
"StatStartTime,","Start time for statistical computations,",39539
"StatEndTime,","End time for statistical computations,",39543
"ReturnTime1DDn,","Return time,",0
"UseZCheck,","Control z calculations,",0
"ZStabilityFactor,","Stability factor for z,",0
"CheckTimeStepUsingNewValues,","Redo computations using new time step
values,",0
"UseWindRamp,","Use time ramp function for larger wind speeds,",0
"NumWindRampLevels,","Number of time step intervale for the wind ramp
function,",1
"RampLimitWindSpeed,","Limiting wind speed for the usege of time ramp
function,",0
"WriteBCTVD,","Write boundary condition time varying data files in time
Series output files,",0
```

```
"WriteBCLoads,","Write boundary condition data as loads in time series
output files,",0
"WriteSDTVD,","Write sediment data time varying data files in time series
outoput files,",0
"SSDataType,","Source and sinks data type for use in boundary conditon
data writing procedure,",1
"iDo1DHDM,","Do 1D hydrodynamics,",1
"iSetdt1DAsdt,","Set 1D model time step same as 3D model,",0
"ZAmplificationFactor,","Z amplification factor for stability checks,",4
"CGCLimit1,","Conjugate Gradient Computation Error Limit 1,",1,-7
"CGCLimit2,","Conjugate Gradient Computation Error Limit 2,",1,-9
"UseRampFlowFunction,","Use ramp flow function to stabilize the model
simulation,",0
"NumRampFlowBCs,","Number of ramp flow boundary conditions,",0,
"SaveCSDataInArray,","Convert cross-section data to depth vs width
array,",0
"DelHforCS,","Depth interval for depth vs width array computations,",0.1
"HDMVersionNumber,","Use far-field/near-field modeling approach,",0
"CapitolLakeVarsSwi,","Switch for Capitol lake variables,",0,0
########################################################################
# 6:      Simulation time variables,
########################################################################
"stryear,","Model start time year,",2008
"strmonth,","Model srart time month,",4
"strday,","Model start time day,",1
"strhour,","Model start hour,",0
"strmin,","Model start minutes,",0
"endyear,","Model end time year,",2008
"endmonth,","Model end month year,",4
"endday,","Model end day,",21
"endhour,","Model end hour,",0
"endmin,","Model end minutes,",0
"MaxTimeSlots,","Maximun number of output time slots used in outputs,",2
"idltt,","Time step control switch,",0,1
"dltminm,","Minimum time step,",60
"dltlimit,","Start Up time step,",60
"omega,","Time step under relaxation factor,",0.75
########################################################################
# 7:      Derived variables,
########################################################################
"idv,","Option to use derived variables computations,",0
########################################################################
# 8:      Probability Plume variables,
########################################################################
"ComputeProPlume,","Computation of Probability Plume,",0
########################################################################
# 9:      Snapshot output variables,
########################################################################
"isnp,","Snapshot output selector,",1,2.2
"isnpss,","Ouput status,",1
"snpfile,","Snapshot output file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 01_01 NC.snp,"
"iMetInfo,","Switch to write meteorology to snapshot output,",0
"iVolumeBalance,","Volume Balance switch,",1
"iMassBalance,","Mass Balance switch,",0
"nsnp,","Number of snapshot output times,",2
"snpyear,","Snapshot output year,",2008,2008
"snpmonth,","Snapshot output month,",4,4
"snpday,","Snapshot output day,",1,3
"snphour,","Snapshot output hour,",0,0
"snpmin,","Snapshot output minutes,",0,0
"snpfrequ,","Snapshot output frequency unit,",1,2
"snpfreq,","Snapshot output frequency value,",1,1
"nsnpkpk;kpk,","Number of snapshot output K planes; output K plane
values,",1,51
"nsnpkpkv;kpv,","Number of snapshot output variables for selected K
planes; output variable ID values,",6,1,19,20,21,22,23
"nsnpjpj;jpj,","Number of snapshot output J planes; output J plane
values,",0
"nsnpjpjv;jpv,","Number of snapshot outputvariables for selected J planes;
output variable ID values,",0
"nsnpipi;ipi,","Number of snapshot output I planes; output I plane
values,",0
"nsnpipiv;ipv,","Number of snapshot output variables for selected I
planes; output variable ID values,",0
"nsnpijpij,","Number of snapshot output I J points,",0
"snpijpi;snpijpj;snpijpnm,","Snapshot output
information,",ICell,JCell,Location names
"nsnpijpv;ijpv,","Snapshot output number of output variables for all
selected IJ cells; output variable IDs for all selected IJ cells,",0
```

```
"HydVar,","Hydrodynamic constituent name,",Surface Elevation,U -
velocity,V - Velocity,W - Velocity,Density,Momentum Diffusivity,Chezy,Flow
Rate
"hdunits,","Constituent unit type,",0,0,0,0,0,0,0,0
"hdamp,","Scaling factor,",100,1,1,1,1,10000,1,1
"hddigits,","Number of digits to print in the snapshot,",2,2,2,2,2,2,2,2
Scaling factor, No. of digits, ConstituentID, Constituent name, Output
Type, Units
1,2,I_Temp,I_Temp,1 : Concentration,0 : C
1,2,I_Saln,I_Saln,1 : Concentration,0 : ppt
1,2,I_lDye,I_lDye,1 : Concentration,0 : mg/l
1,2,I_CDye,I_CDye,1 : Concentration,0 : mg/l
1,2,I_Exst,I_Exst,1 : Concentration,0 : deg C
"Stat3DSnapShot,","Do stat analysis for 3D SnapShot,",0
"DV3DSnapShot,","Derived Variables for 3D ShapShot,",0
"ProbPlumeSnapshotStatus,","Status to write probability plume data to the
snapshot output,",0
"WriteMetSnapshot,","Switch to write meteorology variable output to
snapshot,",0
"SnpOutputMetVars,","Numberof meteorology variables;Output meteorology
variable ID to snapshot,",0
"WriteICESnapshot,","Write ice growth model output Variables,",0
"WriteWaveSnapshot,","Write wave model output Variables,",0
"WriteTransportSnapshot,","Write TRM model internal variables to snapshot
output,",0
"WriteWQMSnapshot,","Write WQM model internal variables to snapshot
output,",0
"WriteSFMSnapshot,","Write SFM model internal variables to snapshot
output,",0
"WriteWQADDSnapshot,","Write WQADD model internal variables to snapshot
output,",0
"WriteGAMSnapshot,","Write GAM model internal variables to snapshot
output,",0
"WriteENMSnapshot,","Write ENM model internal variables to snapshot
output,",0
"WriteUDCSnapshot,","Write UDM model internal variables to snapshot
output,",0
"WriteCFMSnapshot,","Write CFM model internal variables to snapshot
output,",0
"WriteSTMSnapshot,","Write STM model internal variables to snapshot
output,",0
"WriteMGMSnapshot,","Write MGM model internal variables to snapshot
output,",0
"WriteCKMSnapshot,","Write CKM model internal variables to snapshot
output,",0
"WritePTMSnapshot,","Write PTM model internal variables to snapshot
output,",0
#########################################################################
# 10:      Console output variables,
#########################################################################
"icle,","Console output selector,",1,1.1
"icless,","Ouput status,",1
"ncle,","Number of console ouput times,",2
"cleyear,","Console output year,",2008,2008
"clemonth,","Console output month,",4,4
"cleday,","Console output day,",1,1
"clehour,","Console output hour,",0,2
"clemin,","Console output minutes,",0,0
"clefrequ,","Console output frequency unit,",0,1
"clefreq,","Console output frequency value,",1,1
"nclep,","Number of Console output I J points,",1
"clei;clej;clenm;clenijpk;clenijpv,","Console output
information,",ICell,JCell,Location names,Number of K, Number of Variables
"cleP1,","Point 1,",119,17,"C1,",1,1
"clek1,","Console output number of K values and K layer values for point
1,",1,30
"clev1,","Console output number of output variables and variable IDs for
point 1,",1,1
"Stat3DConsole,","Do stat analysis for 3D Console,",0
"DV3DConsole,","Derived Variables for 3D Console,",0
"WriteICEConsole,","Write ice growth model output Variables,",0
"WriteWaveConsole,","Write wave model output Variables,",0
"WriteTransportConsole,","Write TRM model internal variables to console
output,",0
"WriteWQMConsole,","Write WQM model internal variables to console
output,",0
"WriteSFMConsole,","Write SFM model internal variables to console
output,",0
"WriteWQADDConsole,","Write WQADD model internal variables to console
output,",0
```

```
"WriteGAMConsole,","Write GAM model internal variables to console
output,",0
"WriteENMConsole,","Write ENM model internal variables to console
output,",0
"WriteUDCConsole,","Write UDM model internal variables to console
output,",0
"WriteCFMConsole,","Write CFM model internal variables to console
output,",0
"WriteSTMConsole,","Write STM model internal variables to console
output,",0
"WriteMGMConsole,","Write MGM model internal variables to console
output,",0
"WriteCKMConsole,","Write CKM model internal variables to console
output,",0
"WritePTMConsole,","Write PTM model internal variables to console
output,",0
##########################################################################
# 11:     Diagnostic output variables,
##########################################################################
"idgn,","Diagnostic output selector,",0
##########################################################################
# 12:     Restart output variables,
##########################################################################
"irst,","Restart output selector,",0
##########################################################################
# 13:     Time series output variables,
##########################################################################
"itsr,","Time series output selector,",1,4.2
"itsrss,","Ouput status,",1
"tsrfile,","Time series output file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 01_01 NC_TSM.txt,"
"ntsr,","Number of time steries output times,",1
"tsryear,","Time series output year,",2008
"tsrmonth,","Time series output month,",4
"tsrday,","Time series output day,",1
"tsrhour,","Time series output hour,",0
"tsrmin,","Time series output minutes,",0
"tsrfrequ,","Time series output frequency unit,",1
"tsrfreq,","Time series output frequency value,",1
"ntsrp,","Number of time series output points,",11
"tsri;tsrj;tsrnm;tsrnijpk;tsrnijpv,","Time series output
information,",ICell,JCell,Location names,Number of K, Number of Variables
"tsP1,","Point 1,",172,27,"T1,",30,0
"tsP2,","Point 2,",166,26,"T2,",0,0
"tsP3,","Point 3,",159,25,"T3,",0,0
"tsP4,","Point 4,",155,25,"T4,",0,0
"tsP5,","Point 5,",151,25,"T5,",0,0
"tsP6,","Point 6,",148,25,"T6,",0,0
"tsP7,","Point 7,",144,23,"T7,",0,0
"tsP8,","Point 8,",140,23,"T8,",0,0
"tsP9,","Point 9,",136,21,"T9,",0,0
"tsP10,","Point 10,",128,25,"T11,",0,0
"tsP11,","Point 11,",126,20,"T12,",0,0
"tsrk1,","Time series output number of K values and K layer values for
point
1,",30,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,2
6,27,28,29,30
"tsrk2,","Time series output number of K values and K layer values for
point 2,",0
"tsrk3,","Time series output number of K values and K layer values for
point 3,",0
"tsrk4,","Time series output number of K values and K layer values for
point 4,",0
"tsrk5,","Time series output number of K values and K layer values for
point 5,",0
"tsrk6,","Time series output number of K values and K layer values for
point 6,",0
"tsrk7,","Time series output number of K values and K layer values for
point 7,",0
"tsrk8,","Time series output number of K values and K layer values for
point 8,",0
"tsrk9,","Time series output number of K values and K layer values for
point 9,",0
"tsrk10,","Time series output number of K values and K layer values for
point 10,",0
"tsrk11,","Time series output number of K values and K layer values for
point 11,",0
"tsrv1,","Time series output number of output variables and variable IDs
for point 1,",0
"tsrv2,","Time series output number of output variables and variable IDs
for point 2,",0
```

```
"tsrv3,","Time series output number of output variables and variable IDs
for point 3,",0
"tsrv4,","Time series output number of output variables and variable IDs
for point 4,",0
"tsrv5,","Time series output number of output variables and variable IDs
for point 5,",0
"tsrv6,","Time series output number of output variables and variable IDs
for point 6,",0
"tsrv7,","Time series output number of output variables and variable IDs
for point 7,",0
"tsrv8,","Time series output number of output variables and variable IDs
for point 8,",0
"tsrv9,","Time series output number of output variables and variable IDs
for point 9,",0
"tsrv10,","Time series output number of output variables and variable IDs
for point 10,",0
"tsrv11,","Time series output number of output variables and variable IDs
for point 11,",0
"Stat3DTimeSeries,","Do stat analysis for 3D time series,",0
"DV3DTimeSeries,","Derived Variables for 3D time series,",0
"ProbPlumeTimeSeriesStatus,","Status to write probability plume data to
the time series output,",0
"WriteMetTimeSeries,","Switch to write meteorology variable output to time
series,",0
"TSOutputMetVars,","Numberof meteorology variables;Output meteorology
variable ID to time series,",0
"WriteICETimeSeries,","Write ice growth model output Variables,",0
"WriteWaveTimeSeries,","Write wave model output Variables,",0
"WriteTransportTimeSeries,","Write TRM model internal variables to time
series output,",0
"WriteWQMTimeSeries,","Write WQM model internal variables to time series
output,",0
"WriteSFMTimeSeries,","Write SFM model internal variables to time series
output,",0
"WriteWQADDTimeSeries,","Write WQADD model internal variables to time
series output,",0
"WriteGAMTimeSeries,","Write GAM model internal variables to time series
output,",0
"WriteENMTimeSeries,","Write ENM model internal variables to time series
output,",0
"WriteUDCTimeSeries,","Write UDM model internal variables to time series
output,",0
"WriteCFMTimeSeries,","Write CFM model internal variables to time series
output,",0
"WriteSTMTimeSeries,","Write STM model internal variables to time series
output,",0
"WriteMGMTimeSeries,","Write MGM model internal variables to time series
output,",0
"WriteCKMTimeSeries,","Write CKM model internal variables to time series
output,",0
"WritePTMTimeSeries,","Write PTM model internal variables to time series
output,",0
"itrn,","Time series transport output selector,",0
########################################################################
# 14:      Vertical profile output variables,
########################################################################
"ivpf,","Vertical profile output selector,",0,4
########################################################################
# 15:      GPP contour output variables,
########################################################################
"igpp,","GPP output selector,",1,2.2
"igppss,","Ouput status,",1
"gppctmfile,","Contour output contour file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 01_01 NC_CTM.txt,"
"gpphdmfile,","Contour output header file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 01_01 NC_HDM.txt,"
"gppgrdfile,","Contour output element file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 01_01 NC_GRD.txt,"
"WritegppAtAllSurfaces,","Option to write output at all surface and
cells,", 1
"ngppkpk;gppkpk,","Number of GPP contour output K planes; output K plane
values,",0
"ngppjpj;gppjpj,","Number of GPP contour output J planes; output J plane
values,",0
"ngppipi;gppipi,","Number of GPP contour output I planes; output I plane
values,",0
"ngpp,","Number of GPP contour output times,",1
"gppyear,","GPP contour output year,",2008
"gppmonth,","GPP contour output month,",4
"gppday,","GPP contour output day,",1
"gpphour,","GPP contour output hour,",0
```

```
"gppmin,","GPP contour output minutes,",0
"gppfrequ,","GPP contour output frequency unit,",1
"gppfreq,","GPP contour output frequency value,",6
"ngppv; gppv,","GPP contour output number of  output variables for all
selected IJ cells; GPP contour output variable IDs for selected
location,",8,1,2,3,4,19,21,22,23
"Stat3DContour,","Do stat analysis for 3D contour,",0
"DV3DContour,","Derived Variables for 3D contour,",0
"ProbPlumeContourStatus,","Status to write probability plume data to the
contour output,",0
"WriteMetContour,","Switch to write meteorology variable output to GPP
contour,",0
"gppOutputMetVars,","Numberof meteorology variables;Output meteorology
variable ID to GPP contour,",0
"WriteICEContour,","Write ice growth model output variables,",0
"WriteWaveContour,","Write wave model output variables,",0
"WriteTransportContour,","Write TRM model internal variables to contour
output,",0
"WriteWQMContour,","Write WQM model internal variables to contour
output,",0
"WriteSFMContour,","Write SFM model internal variables to contour
output,",0
"WriteWQADDContour,","Write WQADD model internal variables to contour
output,",0
"WriteGAMContour,","Write GAM model internal variables to contour
output,",0
"WriteENMContour,","Write ENM model internal variables to contour
output,",0
"WriteUDCContour,","Write UDM model internal variables to contour
output,",0
"WriteCFMContour,","Write CFM model internal variables to contour
output,",0
"WriteSTMContour,","Write STM model internal variables to contour
output,",0
"WriteMGMContour,","Write MGM model internal variables to contour
output,",0
"WriteCKMContour,","Write CKM model internal variables to contour
output,",0
"WritePTMContour,","Write PTM model internal variables to contour
output,",0
##########################################################################
# 16:      QualView velocity field output variables,
##########################################################################
"icvf,","Velocity field output for Qual View selector,",0
##########################################################################
# 17:      QualView contour output variables,
##########################################################################
"icnt,","Qual View contour output selector,",0
##########################################################################
# 18:      Current meter type output variables,
##########################################################################
"idcm,","Current meter type output selector,",0
##########################################################################
# 19:      TMDL Output Variables,
##########################################################################
"iTML,","TML output selector,",0,1.1
##########################################################################
# 20:      Oil Spil output variables,
##########################################################################
"iSVF,","Oil Spill output selector,",0
##########################################################################
#21:      User defined output variables 1,
##########################################################################
"iudo1,","User defined variable output selector1,",0
##########################################################################
#22:      User defined output variables 2,
##########################################################################
"iudo2,","User defined variable output selector2,",0
##########################################################################
#23:      User defined output variables 3,
##########################################################################
"iudo3,","User defined variable output selector3,",0
##########################################################################
#24:      User defined output variables 4,
##########################################################################
"iudo4,","User defined variable output selector4,",0
##########################################################################
#25:      User defined output variables 5,
##########################################################################
"iudo5,","User defined variable output selector5,",0
##########################################################################
```

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# 26:     NCF NETCDF output variables,
#########################################################################
"iNCF,","NETCDF output selector,",0
#########################################################################
# 27: CFD output variables,
#########################################################################
"WriteCFDOutput;WriteCFDOutputS,","Switch to Turn on CFD output; Ouput
status,",0,0
#########################################################################
# 28:     Initial conditions; constant and spatial data,
#########################################################################
"iicff,","Initial condition far field file use,",0,2.5,27
"icffile,","Initial condition far field file,","No_Data_File,"
"icDoSTInterpolate,","Do Spatial and Temporal Interpolation,",0
"RestartToleranceTime,","Time toloerance for using restart file,",0
"AdjustICData,","Adjust initial conditoin data using data before the model
simulation time,",1
"NumInterpSerarchCycles,","Number of smoothening cycles,",1
"DoFourByFourSearch,","Switch to activate 4 nearby cells approach,",1
"DoEightByEightSearch,","Switch to activate 8 nearby cells approach,",1
"SmoothCoefficient,","Factor to control parent cell dependency,",0
"IPIStart,","Interpolation starting I cell index,",1
"IPIEnd,","Interpolation ending I cell index,",250
"IPJStart,","Interpolation starting J cell index,",1
"IPJEnd,","Interpolation ending J cell index,",50
"DoRecursiveSmoothening,","Do recursive smoothening on all cells,",0
"ICInterpolationScheme,","Initial condition interpolation scheme,",0
"IDWPOW,","Power for interpolation,",2
"ICGeoFileStatus,","Initial Condition Geo File Status,",0
"ICGeoFileName,","Initial Condition Geo File Name,","No_Data_File,"
"WFNorth,","Weighting factor in the north direction ,",1
"WFSouh,","Weighting factor in the south direction ,",1
"WFWest,","Weighting factor in the west direction ,",1
"WFEast,","Weighting factor in the east direction ,",1
"WFNorthWest,","Weighting factor in the north west direction ,",1
"WFNorthEast,","Weighting factor in the north east direction ,",1
"WFSouthWest,","Weighting factor in the sout westh direction ,",1
"WFSouthEast,","Weighting factor in the south east direction ,",1
"ICGeoStnFileStatus,","Use field data stations look up file,",0
"ICGeoStnFileName,","Field data station look up file
name,","No_Data_File,"
"UseRT,","Use response temperature for background temperature,",1
"UseStnBGTemp,","Use field data station for setting up background
temperature,",0
"QuadInterpolationType,","Interpolation method for quadrilateral shape,",1
"DoPointInterpolation,","Use field station location for point
interpolation method,",1
"UseConstituentData,","Use constituent data only from restart file,",0
"UseOnlyVelocities,","Use only velocities and elevation,",0
"ConstituentStartTime,","Constituent start time from restart file,",39554
"FieldDataDepthType,","Field data depth measurement type,",1
"VBUseNumConstituents,","Number of constituents,",0
"UseTVICData,","Use time varying initial condition data,",0
"nicp,","Number of initial conditon points,", 2
"icpnm,","Constituent name; User does not change the name or the
order,",I_Temp,I_Saln
"icpid,","Initial condition id,",1,2
"ict,","Initial condition data type,",4,4
"icdsg,","SSFlow station number to be used for the specific
constituent,",1,1
"icifn,","File name for using it when ict value is set to 2,",
"icifn_1,","File name for using it for initial condition
1,","No_Data_File,"
"icifn_2,","File name for using it for initial condition
2,","No_Data_File,"
"icv,","Initial condition constituent value,",-99,-99
"icu,","Initial condition constituent unit when ict is set to 1,",-99,-99
"icstd,","Initial condition start date,","04/01/2008,","04/01/2008,"
"icstt,","Initial condition start time,","00:00,","00:00,"
"icxst,","Initial condition x starting location specified as I index,",1,1
"icxend,","Initial condition x ending location specified as I
index,",250,250
"icjst,","Initial condition y starting location specified as j index,",1,1
"icjend,","Initial condition y ending location specified as j
index,",50,50
"ickst,","Initial condition z starting location specified as k
index,",999,999
"ickend,","Initial condition z ending location specified as k index,",-
999,-999
"icswtype,","Initial condition type,",0,0
"ictvtype,","Initial condition time varying type,",0,0
```

```
#########################################################################
# 28:     Initial conditions, Profile data,
#########################################################################
"kmax,","number of k layers,", 50
"504.066,","Profile value at k = 1,",-99,-99
"503.066,","Profile value at k = 2,",-99,-99
"502.066,","Profile value at k = 3,",-99,-99
"501.066,","Profile value at k = 4,",-99,-99
"500.066,","Profile value at k = 5,",-99,-99
"499.066,","Profile value at k = 6,",-99,-99
"498.066,","Profile value at k = 7,",-99,-99
"497.066,","Profile value at k = 8,",-99,-99
"496.066,","Profile value at k = 9,",-99,-99
"495.066,","Profile value at k = 10,",-99,-99
"494.066,","Profile value at k = 11,",-99,-99
"493.066,","Profile value at k = 12,",-99,-99
"492.066,","Profile value at k = 13,",-99,-99
"491.066,","Profile value at k = 14,",-99,-99
"490.066,","Profile value at k = 15,",-99,-99
"489.066,","Profile value at k = 16,",-99,-99
"488.066,","Profile value at k = 17,",-99,-99
"487.066,","Profile value at k = 18,",-99,-99
"486.066,","Profile value at k = 19,",-99,-99
"485.066,","Profile value at k = 20,",-99,-99
"484.066,","Profile value at k = 21,",-99,-99
"483.066,","Profile value at k = 22,",-99,-99
"482.066,","Profile value at k = 23,",-99,-99
"481.066,","Profile value at k = 24,",-99,-99
"480.066,","Profile value at k = 25,",-99,-99
"479.066,","Profile value at k = 26,",-99,-99
"478.066,","Profile value at k = 27,",-99,-99
"477.066,","Profile value at k = 28,",-99,-99
"476.066,","Profile value at k = 29,",-99,-99
"475.066,","Profile value at k = 30,",-99,-99
"474.066,","Profile value at k = 31,",-99,-99
"473.066,","Profile value at k = 32,",-99,-99
"472.066,","Profile value at k = 33,",-99,-99
"471.066,","Profile value at k = 34,",-99,-99
"470.066,","Profile value at k = 35,",-99,-99
"469.066,","Profile value at k = 36,",-99,-99
"468.066,","Profile value at k = 37,",-99,-99
"467.066,","Profile value at k = 38,",-99,-99
"466.066,","Profile value at k = 39,",-99,-99
"465.066,","Profile value at k = 40,",-99,-99
"464.066,","Profile value at k = 41,",-99,-99
"463.066,","Profile value at k = 42,",-99,-99
"462.066,","Profile value at k = 43,",-99,-99
"461.066,","Profile value at k = 44,",-99,-99
"460.066,","Profile value at k = 45,",-99,-99
"459.066,","Profile value at k = 46,",-99,-99
"458.066,","Profile value at k = 47,",-99,-99
"457.066,","Profile value at k = 48,",-99,-99
"456.066,","Profile value at k = 49,",-99,-99
"455.066,","Profile value at k = 50,",-99,-99
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Boundary conditions,
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"ndsg,","Number of ssflows,",6
"ndsgdtr,","Number of Distributed Networks,",0
"vbuse1,","Number of Boundary Conditions; Number of Fixed Variables and
Total Number of Variables,",6,52,67,1.9,37
"vbuse2,","Number of ssFlows for Current Boundary; BC Index,",1, 1
"vbuse3,","boundary condition mode,","Discharge,",Discharge
"dsgm,","Boundary Condition Mode,",0,0 : Discharge
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","Upstream,",Upstream
"dsgdt(1),","Input Data Type for Hydrodynamics,",1,1 : Constant
"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
Constant
"dsgifn(1),","TVD Input File Name for
Hydrodynamics,","No_Data_File,",No_Data_File
"dsgifn(2),","TVD Input File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
"dsgqfnst,","Use Qualifier File for Transport and Water Quality,",0,0
"dsgqfn,","Qualifier File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
"dsgip(1),","Time Varying Input Data Interpolation Scheme for H,",0,0 : No
Interpolation
"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
Interpolation
"dsgdc,","Grid Domain Type,",3,3 : 3D Model
```

```
"dsgwd,","Write Boundary Condition Data to Snapshot Output F,",1,1
"dsgstd,","Boundary Condition Start Date,","04/01/2008,",04/01/2008
"dsgstt,","Boundary Condition Start Time,","00:00,",00:00
"dsgendd,","Boundary Condition End Date,","04/21/2008,",04/21/2008
"dsgendt,","Boundary Condition End Time,","00:00,",00:00
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"dsgvf,","Specific Momentum Amplification Factor,",1,1
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"fdsgd,","Hydrodynamic Flow Direction,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",1,1 : cfs
"fdsgv,","Hydrodynamic Mode Value,",4473,4473
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"wdsg,","Intake Conduit Width,",-99,Not Applicable
"dsgnp,","Number of Ports in the Discharge Conduit,",-99,Not Applicable
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
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"dsgstructureu,","Structure Width Units,",-99,Not Applicable
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"dsgFlowCoeff,","Flow Coefficient,",-99,Not Applicable
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Struc,",-99,Not Applicable
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"dsgv(I_Temp),","Temperature Value,",86.54,86.54
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"dsgv(I_Saln),","Salinity Value,",0.2,0.2
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Concentration
"dsgvu(I_IDye),","Instantaneous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_IDye),","Instantaneous Dye Value,",0,0
"dsgrc(I_CDye),","Continuous Dye Data Type,",0,0 : (I_CDye) Concentration
"dsgvu(I_CDye),","Continuous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_CDye),","Continuous Dye Value,",0,0
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Concentration
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"dsgv(I_Exst),","Excess Temperature Value,",0,0
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Withdrawal
"dsgm,","Boundary Condition Mode,",1,1 : Intake and Withdrawal
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","Downstream,",Downstream
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"dsgqfn,","Qualifier File Name for Transport and Water
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Interpolation
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Interpolation
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"dsgvf,","Specific Momentum Amplification Factor,",1,1
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Withdrawal
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"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",1,1 : cfs
"fdsgv,","Hydrodynamic Mode Value,",4351.83,4351.83
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"wdsg,","Intake Conduit Width,",-99,Not Applicable
"dsgnp,","Number of Ports in the Discharge Conduit,",-99,Not Applicable
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
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"dsgstructureu,","Structure Width Units,",-99,Not Applicable
"dsgFlowExp,","Flow Exponent,",-99,Not Applicable
"dsgFlowCoeff,","Flow Coefficient,",-99,Not Applicable
"dsgFlowDir,","Hydrodynamic Flow Direction,",-99,Not Applicable
"dsgFlowMode,","Hydrodynamic Mode,",-99,Not Applicable
"dsgFlowUnit,","Hydrodynamic Mode Unit,",-99,Not Applicable
"dsgFlowValue,","Hydrodynamic Mode Value,",-99,Not Applicable
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"dsgFlowHeadDiffFWUnits,","Heade Difference Units for Flow Withdrawal,",-
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Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
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"dsgrt,","Hydrodynamic Mode Value Adjustment Factor,",-99,Not Applicable
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"dsgv(I_Temp),","Temperature Value,",-99,Not Applicable
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"dsgv(I_Saln),","Salinity Value,",-99,Not Applicable
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Concentration
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"dsgv(I_IDye),","Instantaneous Dye Value,",-99,Not Applicable
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"dsgvu(I_CDye),","Continuous Dye Unit / Status,",-99,Not Applicable
"dsgv(I_CDye),","Continuous Dye Value,",-99,Not Applicable
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Concentration
"dsgvu(I_Exst),","Excess Temperature  Unit / Status,",-99,Not Applicable
"dsgv(I_Exst),","Excess Temperature Value,",-99,Not Applicable
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"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","SSES_In,",SSES_In
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Interpolation
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"dsgrangess,","Selected Region Display Status,",1,1
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"dsgvf,","Specific Momentum Amplification Factor,",1,1
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Withdrawal
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"fdsgu,","Hydrodynamic Mode Unit,",3,3 : gpm
"fdsgv,","Hydrodynamic Mode Value,",42300,42300
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"wdsg,","Intake Conduit Width,",-99,Not Applicable
"dsgnp,","Number of Ports in the Discharge Conduit,",-99,Not Applicable
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
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"dsgstructureu,","Structure Width Units,",-99,Not Applicable
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Struc,",-99,Not Applicable
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"dsgv(I_Saln),","Salinity Value,",-99,Not Applicable
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Concentration
"dsgvu(I_IDye),","Instantaneous Dye Unit / Status,",-99,Not Applicable
"dsgv(I_IDye),","Instantaneous Dye Value,",-99,Not Applicable
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"dsgvu(I_CDye),","Continuous Dye Unit / Status,",-99,Not Applicable
"dsgv(I_CDye),","Continuous Dye Value,",-99,Not Applicable
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Concentration
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"vbuse3,","boundary condition mode,","Discharge,",Discharge
"dsgm,","Boundary Condition Mode,",0,0 : Discharge
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","SSES_Ou,",SSES_Ou
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"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
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"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
Interpolation
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"fdsgd,","Hydrodynamic Flow Direction,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",3,3 : gpm
"fdsgv,","Hydrodynamic Mode Value,",11200,11200
"sdsg,","Intake Conduit Shape,",1,1 : Circular
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"tdsg,","Intake Conduit Angle from Positive x-Axis,",270,270
"ldsg,","Intake Conduit Length in Meters,",0.1016,0.1016
"wdsg,","Intake Conduit Width,",0.1016,0.1016
"dsgnp,","Number of Ports in the Discharge Conduit,",72,72
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
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"dsgstructureu,","Structure Width Units,",-99,Not Applicable
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99,Not Applicable
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"dsgv(I_Temp),","Temperature Value,",12.5,12.5
"dsgrc(I_Saln),","Salinity Data Type,",0,0 : (I_Saln) Concentration
"dsgvu(I_Saln),","Salinity  Unit / Status,",0,0 : ppt
"dsgv(I_Saln),","Salinity Value,",0.4,0.4
"dsgrc(I_IDye),","Instantaneous Dye Data Type,",0,0 : (I_IDye)
Concentration
"dsgvu(I_IDye),","Instantaneous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_IDye),","Instantaneous Dye Value,",100,100
"dsgrc(I_CDye),","Continuous Dye Data Type,",0,0 : (I_CDye) Concentration
"dsgvu(I_CDye),","Continuous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_CDye),","Continuous Dye Value,",0,0
"dsgrc(I_Exst),","Excess Temperature Data Type,",0,0 : (I_Exst)
Concentration
"dsgvu(I_Exst),","Excess Temperature  Unit / Status,",1,1 : deg F
"dsgv(I_Exst),","Excess Temperature Value,",12.5,12.5
"vbuse2,","Number of ssFlows for Current Boundary; BC Index,",1, 5
"vbuse3,","boundary condition mode,","Intake and Withdrawal,",Intake and
Withdrawal
"dsgm,","Boundary Condition Mode,",1,1 : Intake and Withdrawal
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","BBNPP_In,",BBNPP_In
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Qualit,","No_Data_File,",No_Data_File
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"dsgvf,","Specific Momentum Amplification Factor,",1, 1
"hdsgm,","Method of Flow Withdrawal from Layers,",1,1 : Area Based Flow
Withdrawal
"fdsgd,","Hydrodynamic Flow Direction,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",3,3 : gpm
"fdsgv,","Hydrodynamic Mode Value,",34458, 34458
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"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
99,Not Applicable
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"dsgvu(I_Temp),","Temperature Unit / Status,",-99,Not Applicable
"dsgv(I_Temp),","Temperature Value,",-99,Not Applicable
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"dsgvu(I_Saln),","Salinity  Unit / Status,",-99,Not Applicable
"dsgv(I_Saln),","Salinity Value,",-99,Not Applicable
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Concentration
"dsgvu(I_IDye),","Instantaneous Dye Unit / Status,",-99,Not Applicable
"dsgv(I_IDye),","Instantaneous Dye Value,",-99,Not Applicable
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"dsgvu(I_CDye),","Continuous Dye Unit / Status,",-99,Not Applicable
"dsgv(I_CDye),","Continuous Dye Value,",-99,Not Applicable
"dsgrc(I_Exst),","Excess Temperature Data Type,",0,0 : (I_Exst)
Concentration
"dsgvu(I_Exst),","Excess Temperature  Unit / Status,",-99,Not Applicable
"dsgv(I_Exst),","Excess Temperature Value,",-99,Not Applicable
"vbuse2,","Number of ssFlows for Current Boundary; BC Index,",1, 6
"vbuse3,","boundary condition mode,","Discharge,",Discharge
"dsgm,","Boundary Condition Mode,",0,0 : Discharge
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","BBnPP_Ou,",BBnPP_Ou
"dsgdt(1),","Input Data Type for Hydrodynamics,",1,1 : Constant
"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
Constant
"dsgifn(1),","TVD Input File Name for
Hydrodynamics,","No_Data_File,",No_Data_File
```

```
"dsgifn(2),","TVD Input File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
"dsgqfnst,","Use Qualifier File for Transport and Water Quality,",0,0
"dsgqfn,","Qualifier File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
"dsgip(1),","Time Varying Input Data Interpolation Scheme for H,",0,0 : No
Interpolation
"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
Interpolation
"dsgdc,","Grid Domain Type,",3,3 : 3D Model
"dsgwd,","Write Boundary Condition Data to Snapshot Output F,",1,1
"dsgstd,","Boundary Condition Start Date,","04/01/2008,",04/01/2008
"dsgstt,","Boundary Condition Start Time,","00:00,",00:00
"dsgendd,","Boundary Condition End Date,","04/21/2008,",04/21/2008
"dsgendt,","Boundary Condition End Time,","00:00,",00:00
"idsgst,","Starting Grid Cell Index in x-Direction,",166,166
"idsgend,","Ending Grid Cell Index in x-Direction,",166,166
"jdsgst,","Starting Grid Cell Index in y-Direction,",25,25
"jdsgend,","Ending Grid Cell Index in y-Direction,",27,27
"kdsgst,","Starting Vertical Layer Number in z-Direction,",-999,-999 : KB
"kdsgend,","Ending Vertical Layer Number in z-Direction,",-999,-999 : KB
"dsgcolor,","Selected Region Color,",12829149,12829149
"dsgrangess,","Selected Region Display Status,",1,1
"dsgdr,","Hydrodynamic Mode Value Adjustment Factor,",5,5 : BBNPP_In
"dsgvf,","Specific Momentum Amplification Factor,",1,1
"hdsgm,","Method of Flow Withdrawal from Layers,",0,0
"fdsgd,","Hydrodynamic Flow Direction,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",3,3 : gpm
"fdsgv,","Hydrodynamic Mode Value,",11172,11172
"sdsg,","Intake Conduit Shape,",1,1 : Circular
"pdsg,","Intake Conduit Angle from Positive z-Axis,",135,135
"tdsg,","Intake Conduit Angle from Positive x-Axis,",270,270
"ldsg,","Intake Conduit Length in Meters,",0.1016,0.1016
"wdsg,","Intake Conduit Width,",0.1016,0.1016
"dsgnp,","Number of Ports in the Discharge Conduit,",72,72
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
"dsgstructurew,","Structure Width,",-99,Not Applicable
"dsgstructureu,","Structure Width Units,",-99,Not Applicable
"dsgFlowExp,","Flow Exponent,",-99,Not Applicable
"dsgFlowCoeff,","Flow Coefficient,",-99,Not Applicable
"dsgFlowDir,","Hydrodynamic Flow Direction,",-99,Not Applicable
"dsgFlowMode,","Hydrodynamic Mode,",-99,Not Applicable
"dsgFlowUnit,","Hydrodynamic Mode Unit,",-99,Not Applicable
"dsgFlowValue,","Hydrodynamic Mode Value,",-99,Not Applicable
"dsgFlowHeadDiffFW,","Head Difference for Flow Withdrawal Using the
Stru,",-99,Not Applicable
"dsgFlowHeadDiffFWUnits,","Heade Difference Units for Flow Withdrawal,",-
99,Not Applicable
"dsgFlowHeadDiffFD,","Head Difference for Flow Discharge Using the
Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
99,Not Applicable
"dsgrt,","Hydrodynamic Mode Value Adjustment Factor,",1,1
"dsgrc(I_Temp),","Temperature Data Type,",1,1 : (I_Exst) Concentration
"dsgvu(I_Temp),","Temperature Unit / Status,",1,1 : deg F
"dsgv(I_Temp),","Temperature Value,",3.46,3.46
"dsgrc(I_Saln),","Salinity Data Type,",0,0 : (I_Saln) Concentration
"dsgvu(I_Saln),","Salinity  Unit / Status,",0,0 : ppt
"dsgv(I_Saln),","Salinity Value,",0.4,0.4
"dsgrc(I_IDye),","Instantaneous Dye Data Type,",0,0 : (I_IDye)
Concentration
"dsgvu(I_IDye),","Instantaneous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_IDye),","Instantaneous Dye Value,",0,0
"dsgrc(I_CDye),","Continuous Dye Data Type,",0,0 : (I_CDye) Concentration
"dsgvu(I_CDye),","Continuous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_CDye),","Continuous Dye Value,",100,100
"dsgrc(I_Exst),","Excess Temperature Data Type,",0,0 : (I_Exst)
Concentration
"dsgvu(I_Exst),","Excess Temperature  Unit / Status,",1,1 : deg F
"dsgv(I_Exst),","Excess Temperature Value,",3.46,3.46
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-WQM,
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iwqc,","Water Quality Model Type ID; Name; Number of parameters; number
of regions; number of variables,",0,"Not Used",0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-SFM,
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"isnec,","Sediment Model Type ID; Name; Number of parameters; Number of
regions; number of variables,",0,"Not Used",0,0,0
```

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$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-WQADD
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iwqaddc,","Water Quality ADD switch; number of variables; Number of
parameters; Number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-GAM
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iGAM,","Algae Model: Switch; Number of Algae; Number of Variables for
Each Algae; number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-CFM
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iCFM,","Bacteria Model: Switch; Number of Bacterias; Number of parameters
for Each Bacteria; Number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-UDF
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iUDC,","User Defined Model: Switch; Number of variables; Number of
parameters for Each Coliform; Number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-ENT
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iENT,","Entrainment Model: Switch; Number of Entrainments; Number of
Paraments for Each Variables; Number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-STM
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"istc,","Sediment Transport Model Computations: Switch; Number of
Entrainments; Number of Paraments for Each Variables; Number of
regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-MGM
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iMGM,","Macrophytes Model: Switch; Number of Macrophytes; Number of
Variables for Each Macrophytes; number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for Chlorine Kinetics module-CKM
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iCKM,","Chlorine Kinetics Module: Module tpe; Number of variables; Number
of parameters for each variable; Number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Particle Transport Variables for GEMSS-PTM,
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iPTM,","particle transport model computations,",0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Miscellaneous data,
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"vbusel,","Number of columns and rows,",4,0
```

Scenario 02

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$GEMSSModelResults,14
$GEMSS-SHWETControlFile,4.24
$Creation Date: 4/16/2008
$Waterbody Name: Susquehanna 3
$Modeler Name: SP
#############################################################################
# 1:     Scenario variables,
#############################################################################
"IntGDS,","Option to use GEMSS data structure,", 1
"Scenario,","Scenario file path and name,","C:\GEMSS\APPS\Susquehanna
3\Output\Scenario 02_01 NC,"
"DoText2MDBConversion,","Use Scenario Output Direct Database
converion,",1,1
"ZipOutputFile,","Zip text output files after creating the database,",0,0
"DoCompUsingGEMSSOutput,","Run Model Using Existing GEMSS Contour Output
Text Files,", 0
"GEMSSHDMInputFile,","Existing GEMSS Contour Output Header Text
Files,","","
#############################################################################
# 2:     Grid variables,
#############################################################################
"igrid,","Switch to read grid data from a file,",1,1
"GridFile,","Grid file name,","C:\GEMSS\APPS\Susquehanna
3\Grid\Susquehanna River 05 474Min.g3g,","4/23/2008 12:36:08
PM,","4/28/2008 12:20:10 PM,"
"InputHDatumUnit,","Input grid data is in geographic coordinate system
switch,",0
"UseLinearConversionIn,","Use linear conversion for input grid data,",1
"cstypeIn,","Input coordinate conversion mode,",0
```

```
"cscodeIn,","Input coordinate conversion zone number,",0,None
"csdatumIn,","Input UTM datum,",0
"InputVDatumUnit,","Input grid data is in geographic coordinate system
switch,",0
"OutputHDatumUnit,","Output grid data is in geographic coordinate system
switch,",0
"UseLinearConversionOut,","Use linear conversion for output grid data,",1
"cstypeOut,","Output coordinate conversion mode,",0
"cscodeOut,","Output coordinate conversion zone number,",0,None
"csdatumOut,","Output UTM datum,",0
"OutputVDatumUnit,","Output grid data is in geographic coordinate system
switch,",0
"iupmgrid,","Switch to set up different k layers,",0
"km_p,","Vertical array size,",-99
"nzds,","Number of vertical layer domains,",-99
"nzdstr,","Starting vertical layer number for each domain,",-99
"nzend,","Ending vertical layer number for each domain,",-99
"dzd,","Layer thickness in each domain,",-99
"igpsfmt,","Switch to write grid file gps format for use in ArcView,",0
"elioption,","switch to Use TVD From Boundary Condition File or Initial
elevation,", 0
"eli,","Initial elevation,",486
"iwbs,","Waterbody switches,", 1
"eldatum,","Reference elevation of 3rd layer in meters,",0
"UseSigmaStretching,","Switch to Use Sigma stretching,",0
"NSLevel,","Number of Sigma Levels,",0
"SigDistType,","Sigma Layer Distribution type,",0
"Slevel,","User Defined Sigma Distribution,",0.0
"ZtoSigmaBCDepthTransform,","Use BC Depth Transformation from Vertical to
Sigma Level,",0
"SmoothBathy,","Switch to Perform Bathymetry Smoothening,",0
"SlpMax,","Maximum  Allowable Slope for bathymetry smoothening,",0
"NSmoothCycle,","Number of Smoothening Cycles,",0
######################################################################
#3:      Meteorological variables,
######################################################################
"MetDataType,","Switch to use Meteorological time varying data; VB Use
verion; Number of Meteorology variables,",0,2.2,14
"metss,","Use Meteorological data in current simulation status,",1
"Metfile1,","Meteorological time varying data input file
name,","No_Data_File,"
"metinterp,","Switch to perform interpolation on met data,",0
"ievap;EvapScaleFactor,","Switch for evaporation;Evaporation scale
facotr,",1,1
"iwndhyd,","Use wind in hydrodynamics computations,",0
"ta,","temperature of air C,",21,0
"td,","Dew point temperature C,",13,0
"twb,","Wet bulb temperature C,",13,0
"rt,","response temperature C,",20,0
"phi,","Wind direction degrees,",90
"wad,","Wind speed m/sec,",5, 0
"cc,","Cloud coverage Octal,",2
"solrad,","Solar radiation W/m^2,",120,0
"ps,","Atmoshpheric pressure mm of Hg,",760
"ishe,","Surace heat exchange method,",1
"KEMethod,","Method to Compute K and E,",0
"cshe,","Coefficient of surface heat exchange w/m2/C,",24.59
"te,","Equlibrium temperature C,",85,1
"secchi,","Secchi depth; light transmission depth m,",-99
"rsts,","Vegetative and Topographic Shading Factor; 0 to 1.0,",-99
"wscoef,","Wind sheltering coefficient; 0 to 1.0,",-99
"iwsf,","Wind speed function,",1
"MetInterpolationMethod,","Met Interpolation Method,",0
"IDWPOW,","Exponent value for inverse weighting scheme,",0
"MetVarInterpSwitch;MetVarInterp,","Met Individuall interpolatey switch
and interpolation methods,",0
**********************************************************************
*  Meteorological Scale Factor Variables,
**********************************************************************
"UseMetRegionSF;MetRegionSFSS,","Met factor switch,",0,0
**********************************************************************
*  Meteorological Dynamic Shading Variables,
**********************************************************************
"UseDSHDRegionSF;DSHDRegionSFSS,","Met dynamic shading switch,",0,0
**********************************************************************
*  Icel Growth Model Variables,
**********************************************************************
"UseIGModel;UseIGModelStatus,","Switch to control the use of ice growth
model and status,",0,0
**********************************************************************
*  Wave Model Variables,
```

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**********************************************************************
"iwvc;iwvcss,","Wave model activation switch and status,",0,0
######################################################################
# 4:     Constituents,
######################################################################
"itrc,","Transport switch; computation status; number of variables,",1,1,5
"iwqc,","Water quality model type; computation status; number of
variables,",0,0,0
"iwqaddc,","Water quality ADD model switch; computations status; number of
variables,",0,0,0
"iGAMc,","Algae model computations; status,",0,0
"nGAMs,","Number of algae,",0,1
"UseGAMInsideWQM,","Use Generalized Algae Model inside Water Quality
Model,",0
"isnec,","Sediment nutrient exchange computations,",0,0
"iPTM,","Particle transport model computations,",0,0
"istc,","Sediment transport model computations,",0,0
"nstcs,","Number of sediment transport type,",0,1
"ientc,","Entrainment computations,",0,0
"nezones,","Number of entrainment zones,",0,1
"iatc,","Optional to add more constituents,",0,0
"natc,","Number of additional constituents,",0,1
"icfmc,","Coliform Bacteria Model computations,",0,0
"ncfmcs,","Number of coliform bacteria type,",0
"iCKMc;iCKMcss,","Chlorine kinetics Model computations and status,",0,0
"nCKMc,","Number of chlorine kinetics type,",0
"iMGM;iMGMss,","Macrophyte grouth model computations and status,",0,0
"nMGMs,","Number of macrophyte type,",0,1
"UseMGMInsideWQM,","Use Macrophyte Grouth Model inside Water Quality
Model,",0
"WriteTransportOutput,","Write TRM model internal variables to GEMSS
output output,",0
"WriteWQMOutput,","Write WQM model internal variables to GEMSS output
output,",0
"WriteSFMOutput,","Write SFM model internal variables to GEMSS output
output,",0
"WriteWQADDOutput,","Write WQADD model internal variables to GEMSS output
output,",0
"WriteGAMOutput,","Write GAM model internal variables to GEMSS output
output,",0
"WriteENMOutput,","Write ENM model internal variables to GEMSS output
output,",0
"WriteUDCOutput,","Write UDM model internal variables to GEMSS output
output,",0
"WriteCFMOutput,","Write CFM model internal variables to GEMSS output
output,",0
"WriteSTMOutput,","Write STM model internal variables to GEMSS output
output,",0
"WriteMGMOutput,","Write MGM model internal variables to GEMSS output
output,",0
"WriteCKMOutput,","Write CKM model internal variables to GEMSS output
output,",0
"WritePTMOutput,","Write PTM model internal variables to GEMSS output
output,",0
"cnum,","Number of Constituents,",5
"Index,","Model Name,","Identifier; Cannot be Modified,","User Given
Name,","Activity of Constituent,","Output Time,","Units,","Transport
Switch,"
"C0,","Transport,",I_Temp,"I_Temp,",1,1,1,1
"C1,","Transport,",I_Saln,"I_Saln,",1,1,0,1
"C2,","Transport,",I_lDye,"I_lDye,",1,1,0,1
"C3,","Transport,",I_CDye,"I_CDye,",1,1,0,1
"C4,","Transport,",I_Exst,"I_Exst,",1,1,1,1
######################################################################
# 5:     Model switches,
######################################################################
"Use3DModel,","Switch to control 3D model simulations,",1,3.7
"issflw,","switch on/off ssflow input data that is available in the
sscontrol.csv,",1
"itrcs,","transport computation algorithm switch,",1
"udwtf,","advection theta in z-direction,",0
"vdwft,","diffusion theta in z-direction,",0
"HOTSIniTime,","HOTS initization time period,",-99
"itrbs,","Turbulence scheme,",1
"itrbsm,","Turbulence sub model,",1
"itrbparam,","Turbulence parameters,",0,1,1,2.44,2.44,0.9,0.5,1,2.53
"imxls,","Mixing length scheme,",1
"ihmdcx,","momentum diffusion coefficient scheme selector in x-
direction,",2
"ihmdcy,","momentum diffusion coefficient scheme selector in y-
direction,",2
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"hmdcx,","momentum diffusion coefficient in x-direction
m2/sec,",0.00584,1.1
"hmdcy,","momentum diffusion coefficient in y-direction
m2/sec,",0.00584,1.1
"prnm,","Prandtl number,",10
"ihtdcx,","transport diffusion coefficient scheme in x-direction,",3
"ihtdcy,","transport diffusion coefficient scheme in y-direction,",3
"htdcx,","transport diffusion coefficient in x-direction m2/sec,",,
"htdcy,","transport diffusion coefficient in y-direction m2/sec,",,
"idnf,","Density function selector,",2
"ideep,","Compressibility usage,",1
"ichezy,","Chezy coefficient selector,",0
"ilchezy,","Limiting Chezy selector,",0
"chezy,","Chezy coefficient; Czo;do;n,",40,,
"WSCoeffType,","Wind stress coefficient type,",0
"WSConstA,","Wind stress constant A,",0.8
"WSConstB,","Wind stress constant B,",0.065
"icors,","Coriolis force selector,",0
"RefLatOption;RefLat,","Referene Latitude Option; Reference Latitude
Value,",0,40
"ivaterms,","Vertical acceleration terms,",0
"idbg,","Debug switch,",0
"tvdscheck,","time varying data consistency check,",0
"iWDLayers,","Use wetting and drying of layers,",1
"lraddthk,","Layer addition thickness m,",0.8
"lrsubthk,","Layer subtraction thickness m,",0.8
"StabilizeInversionFlag,","StabilizeInversionFlag,",0
"InvCoeff,","InvCoeff,",-99
"iUsed1DModel,","Switch to use 1D model; Switch grid has 1D model,",0,0,1
"ComputeStat,","Statisdtical method to output variables,",0
"StatFreq;StatUnit,","Statisdtical frequency and unit to write output
variables,",0,0
"StatStartTime,","Start time for statistical computations,",39539
"StatEndTime,","End time for statistical computations,",39543
"ReturnTime1DDn,","Return time,",0
"UseZCheck,","Control z calculations,",0
"ZStabilityFactor,","Stability factor for z,",0
"CheckTimeStepUsingNewValues,","Redo computations using new time step
values,",0
"UseWindRamp,","Use time ramp function for larger wind speeds,",0
"NumWindRampLevels,","Number of time step intervale for the wind ramp
function,",1
"RampLimitWindSpeed,","Limiting wind speed for the usege of time ramp
function,",0
"WriteBCTVD,","Write boundary condition time varying data files in time
Series output files,",0
"WriteBCLoads,","Write boundary condition data as loads in time series
output files,",0
"WriteSDTVD,","Write sediment data time varying data files in time series
outoput files,",0
"SSDataType,","Source and sinks data type for use in boundary conditon
data writing procedure,",1
"iDo1DHDM,","Do 1D hydrodynamics,",1
"iSetdt1DAsdt,","Set 1D model time step same as 3D model,",0
"ZAmplitication Factor,","Z amplification factor for stability checks,",4
"CGCLimit1,","Conjugate Gradient Computation Error Limit 1,",1,-7
"CGCLimit2,","Conjugate Gradient Computation Error Limit 2,",1,-9
"UseRampFlowFunction,","Use ramp flow function to stabilize the model
simulation,",0
"NumRampFlowBCs,","Number of ramp flow boundary conditions,",0,
"SaveCSDataInArray,","Convert cross-section data to depth vs width
array,",0
"DelHforCS,","Depth interval for depth vs width array computations,",0.1
"HDMVersionNumber,","Use far-field/near-field modeling approach,",0
"CapitolLakeVarsSwi,","Switch for Capitol lake variables,",0,0
########################################################################
# 6:      Simulation time variables,
########################################################################
"stryear,","Model start time year,",2008
"strmonth,","Model srart time month,",4
"strday,","Model start time day,",1
"strhour,","Model start hour,",0
"strmin,","Model start minutes,",0
"endyear,","Model end time year,",2008
"endmonth,","Model end month year,",4
"endday,","Model end day,",21
"endhour,","Model end hour,",0
"endmin,","Model end minutes,",0
"MaxTimeSlots,","Maximun number of output time slots used in outputs,",2
"idltt,","Time step control switch,",0,1
"dltminm,","Minimum time step,",60
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"dltlimit,","Start Up time step,",60
"omega,","Time step under relaxation factor,",0.75
##########################################################################
# 7:     Derived variables,
##########################################################################
"idv,","Option to use derived variables computations,",0
##########################################################################
# 8:     Probability Plume variables,
##########################################################################
"ComputeProPlume,","Computation of Probability Plume,",0
##########################################################################
# 9:     Snapshot output variables,
##########################################################################
"isnp,","Snapshot output selector,",1,2.2
"isnpss,","Ouput status,",1
"snpfile,","Snapshot output file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 02_01 NC.snp,"
"iMetInfo,","Switch to write meteorology to snapshot output,",0
"iVolumeBalance,","Volume Balance switch,",1
"iMassBalance,","Mass Balance switch,",0
"nsnp,","Number of snapshot output times,",2
"snpyear,","Snapshot output year,",2008,2008
"snpmonth,","Snapshot output month,",4,4
"snpday,","Snapshot output day,",1,3
"snphour,","Snapshot output hour,",0,0
"snpmin,","Snapshot output minutes,",0,0
"snpfrequ,","Snapshot output frequency unit,",1,2
"snpfreq,","Snapshot output frequency value,",1,1
"nsnpkpk;kpk,","Number of snapshot output K planes; output K plane
values,",1,51
"nsnpkpkv;kpv,","Number of snapshot output variables for selected K
planes; output variable ID values,",6,1,19,20,21,22,23
"nsnpjpj;jpj,","Number of snapshot output J planes; output J plane
values,",0
"nsnpjpjv;jpv,","Number of snapshot outputvariables for selected J planes;
output variable ID values,",0
"nsnpipi;ipi,","Number of snapshot output I planes; output I plane
values,",0
"nsnpipiv;ipv,","Number of snapshot output variables for selected I
planes; output variable ID values,",0
"nsnpijpij,","Number of snapshot output I J points,",0
"snpijpi;snpijpj;snpijpnm,","Snapshot output
information,",ICell,JCell,Location names
"nsnpijpv;ijpv,","Snapshot output number of output variables for all
selected IJ cells; output variable IDs for all selected IJ cells,",0
"HydVar,","Hydrodynamic constituent name,",Surface Elevation,U -
velocity,V - Velocity,W - Velocity,Density,Momentum Diffusivity,Chezy,Flow
Rate
"hdunits,","Constituent unit type,",0,0,0,0,0,0,0,0
"hdamp,","Scaling factor,",100,1,1,1,1,10000,1,1
"hddigits,","Number of digits to print in the snapshot,",2,2,2,2,2,2,2,2
Scaling factor, No. of digits, ConstituentID, Constituent name, Output
Type, Units
1,2,I_Temp,I_Temp,1 : Concentration,0 : C
1,2,I_Saln,I_Saln,1 : Concentration,0 : ppt
1,2,I_lDye,I_lDye,1 : Concentration,0 : mg/l
1,2,I_CDye,I_CDye,1 : Concentration,0 : mg/l
1,2,I_Exst,I_Exst,1 : Concentration,0 : deg C
"Stat3DSnapShot,","Do stat analysis for 3D SnapShot,",0
"DV3DSnapShot,","Derived Variables for 3D ShapShot,",0
"ProbPlumeSnapshotStatus,","Status to write probability plume data to the
snapshot output,",0
"WriteMetSnapshot,","Switch to write meteorology variable output to
snapshot,",0
"SnpOutputMetVars,","Numberof meteorology variables;Output meteorology
variable ID to snapshot,",0
"WriteICESnapshot,","Write ice growth model output variables,",0
"WriteWaveSnapshot,","Write wave model output variables,",0
"WriteTransportSnapshot,","Write TRM model internal variables to snapshot
output,",0
"WriteWQMSnapshot,","Write WQM model internal variables to snapshot
output,",0
"WriteSFMSnapshot,","Write SFM model internal variables to snapshot
output,",0
"WriteWQADDSnapshot,","Write WQADD model internal variables to snapshot
output,",0
"WriteGAMSnapshot,","Write GAM model internal variables to snapshot
output,",0
"WriteENMSnapshot,","Write ENM model internal variables to snapshot
output,",0
```

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"WriteUDCSnapshot,","Write UDM model internal variables to snapshot
output,",0
"WriteCFMSnapshot,","Write CFM model internal variables to snapshot
output,",0
"WriteSTMSnapshot,","Write STM model internal variables to snapshot
output,",0
"WriteMGMSnapshot,","Write MGM model internal variables to snapshot
output,",0
"WriteCKMSnapshot,","Write CKM model internal variables to snapshot
output,",0
"WritePTMSnapshot,","Write PTM model internal variables to snapshot
output,",0
#########################################################################
# 10:      Console output variables,
#########################################################################
"icle,","Console output selector,",1,1.1
"icless,","Ouput status,",1
"ncle,","Number of console ouput times,",2
"cleyear,","Console output year,",2008,2008
"clemonth,","Console output month,",4,4
"cleday,","Console output day,",1,1
"clehour,","Console output hour,",0,2
"clemin,","Console output minutes,",0,0
"clefrequ,","Console output frequency unit,",0,1
"clefreq,","Console output frequency value,",1,1
"nclep,","Number of Console output I J points,",1
"clei;clej;clenm;clenijpk;clenijpv,","Console output
information,",ICell,JCell,Location names,Number of K, Number of Variables
"cleP1,","Point 1,",119,17,"C1,",1,1
"clek1,","Console output number of K values and K layer values for point
1,",1,30
"clev1,","Console output number of output variables and variable IDs for
point 1,",1,1
"Stat3DConsole,","Do stat analysis for 3D Console,",0
"DV3DConsole,","Derived Variables for 3D Console,",0
"WriteICEConsole,","Write ice growth model output Variables,",0
"WriteWaveConsole,","Write wave model output Variables,",0
"WriteTransportConsole,","Write TRM model internal variables to console
output,",0
"WriteWQMConsole,","Write WQM model internal variables to console
output,",0
"WriteSFMConsole,","Write SFM model internal variables to console
output,",0
"WriteWQADDConsole,","Write WQADD model internal variables to console
output,",0
"WriteGAMConsole,","Write GAM model internal variables to console
output,",0
"WriteENMConsole,","Write ENM model internal variables to console
output,",0
"WriteUDCConsole,","Write UDM model internal variables to console
output,",0
"WriteCFMConsole,","Write CFM model internal variables to console
output,",0
"WriteSTMConsole,","Write STM model internal variables to console
output,",0
"WriteMGMConsole,","Write MGM model internal variables to console
output,",0
"WriteCKMConsole,","Write CKM model internal variables to console
output,",0
"WritePTMConsole,","Write PTM model internal variables to console
output,",0
#########################################################################
# 11:      Diagnostic output variables,
#########################################################################
"idgn,","Diagnostic output selector,",0
#########################################################################
# 12:      Restart output variables,
#########################################################################
"irst,","Restart output selector,",0
#########################################################################
# 13:      Time series output variables,
#########################################################################
"itsr,","Time series output selector,",1,4.2
"itsrss,","Ouput status,",1
"tsrfile,","Time series output file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 02_01 NC_TSM.txt,"
"ntsr,","Number of time steries output times,",1
"tsryear,","Time series output year,",2008
"tsrmonth,","Time series output month,",4
"tsrday,","Time series output day,",1
"tsrhour,","Time series output hour,",0
```

```
"tsrmin,","Time series output minutes,",0
"tsrfrequ,","Time series output frequency unit,",1
"tsrfreq,","Time series output frequency value,",1
"ntsrp,","Number of time series output points,",1
"tsri;tsrj;tsrnm;tsrnijpk;tsrnijpv,","Time series output
information,",ICell,JCell,Location names,Number of K, Number of Variables
"tsP1,","Point 1,",119,17,"T1,",1,1
"tsrk1,","Time series output number of K values and K layer values for
point 1,",1,30
"tsrv1,","Time series output number of output variables and variable IDs
for point 1,",1,1
"Stat3DTimeSeries,","Do stat analysis for 3D time series,",0
"DV3DTimeSeries,","Derived Variables for 3D time series,",0
"ProbPlumeTimeSeriesStatus,","Status to write probability plume data to
the time series output,",0
"WriteMetTimeSeries,","Switch to write meteorology variable output to time
series,",0
"TSOutputMetVars,","Numberof meteorology variables;Output meteorology
variable ID to time series,",0
"WriteICETimeSeries,","Write ice growth model output Variables,",0
"WriteWaveTimeSeries,","Write wave model output Variables,",0
"WriteTransportTimeSeries,","Write TRM model internal variables to time
series output,",0
"WriteWQMTimeSeries,","Write WQM model internal variables to time series
output,",0
"WriteSFMTimeSeries,","Write SFM model internal variables to time series
output,",0
"WriteWQADDTimeSeries,","Write WQADD model internal variables to time
series output,",0
"WriteGAMTimeSeries,","Write GAM model internal variables to time series
output,",0
"WriteENMTimeSeries,","Write ENM model internal variables to time series
output,",0
"WriteUDCTimeSeries,","Write UDM model internal variables to time series
output,",0
"WriteCFMTimeSeries,","Write CFM model internal variables to time series
output,",0
"WriteSTMTimeSeries,","Write STM model internal variables to time series
output,",0
"WriteMGMTimeSeries,","Write MGM model internal variables to time series
output,",0
"WriteCKMTimeSeries,","Write CKM model internal variables to time series
output,",0
"WritePTMTimeSeries,","Write PTM model internal variables to time series
output,",0
"itrn,","Time series transport output selector,",0
########################################################################
# 14:      Vertical profile output variables,
########################################################################
"ivpf,","Vertical profile output selector,",0,4
########################################################################
# 15:      GPP contour output variables,
########################################################################
"igpp,","GPP output selector,",1,2.2
"igppss,","Ouput status,",1
"gppctmfile,","Contour output contour file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 02_01 NC_CTM.txt,"
"gpphdmfile,","Contour output header file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 02_01 NC_HDM.txt,"
"gppgrdfile,","Contour output element file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 02_01 NC_GRD.txt,"
"WritegppAtAllSurfaces,","Option to write output at all surface and
cells,", 1
"ngppkpk;gppkpk,","Number of GPP contour output K planes; output K plane
values,",0
"ngppjpj;gppjpj,","Number of GPP contour output J planes; output J plane
values,",0
"ngppipi;gppipi,","Number of GPP contour output I planes; output I plane
values,",0
"ngpp,","Number of GPP contour output times,",1
"gppyear,","GPP contour output year,",2008
"gppmonth,","GPP contour output month,",4
"gppday,","GPP contour output day,",1
"gpphour,","GPP contour output hour,",0
"gppmin,","GPP contour output minutes,",0
"gppfrequ,","GPP contour output frequency unit,",1
"gppfreq,","GPP contour output frequency value,",6
"ngppv; gppv,","GPP contour output number of  output variables for all
selected IJ cells; GPP contour output variable IDs for selected
location,",8,1,2,3,4,19,21,22,23
"Stat3DContour,","Do stat analysis for 3D contour,",0
```

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"DV3DContour,","Derived Variables for 3D contour,",0
"ProbPlumeContourStatus,","Status to write probability plume data to the
contour output,",0
"WriteMetContour,","Switch to write meteorology variable output to GPP
contour,",0
"gppOutputMetVars,","Numberof meteorology variables;Output meteorology
variable ID to GPP contour,",0
"WriteICEContour,","Write ice growth model output Variables,",0
"WriteWaveContour,","Write wave model output Variables,",0
"WriteTransportContour,","Write TRM model internal variables to contour
output,",0
"WriteWQMContour,","Write WQM model internal variables to contour
output,",0
"WriteSFMContour,","Write SFM model internal variables to contour
output,",0
"WriteWQADDContour,","Write WQADD model internal variables to contour
output,",0
"WriteGAMContour,","Write GAM model internal variables to contour
output,",0
"WriteENMContour,","Write ENM model internal variables to contour
output,",0
"WriteUDCContour,","Write UDM model internal variables to contour
output,",0
"WriteCFMContour,","Write CFM model internal variables to contour
output,",0
"WriteSTMContour,","Write STM model internal variables to contour
output,",0
"WriteMGMContour,","Write MGM model internal variables to contour
output,",0
"WriteCKMContour,","Write CKM model internal variables to contour
output,",0
"WritePTMContour,","Write PTM model internal variables to contour
output,",0
##########################################################################
# 16:      QualView velocity field output variables,
##########################################################################
"icvf,","Velocity field output for Qual View selector,",0
##########################################################################
# 17:      QualView contour output variables,
##########################################################################
"icnt,","Qual View contour output selector,",0
##########################################################################
# 18:      Current meter type output variables,
##########################################################################
"idcm,","Current meter type output selector,",0
##########################################################################
# 19:      TMDL Output Variables,
##########################################################################
"iTML,","TML output selector,",0,1.1
##########################################################################
# 20:     Oil Spil output variables,
##########################################################################
"iSVF,","Oil Spill output selector,",0
##########################################################################
#21:      User defined output variables 1,
##########################################################################
"iudo1,","User defined variable output selector1,",0
##########################################################################
#22:      User defined output variables 2,
##########################################################################
"iudo2,","User defined variable output selector2,",0
##########################################################################
#23:      User defined output variables 3,
##########################################################################
"iudo3,","User defined variable output selector3,",0
##########################################################################
#24:      User defined output variables 4,
##########################################################################
"iudo4,","User defined variable output selector4,",0
##########################################################################
#25:      User defined output variables 5,
##########################################################################
"iudo5,","User defined variable output selector5,",0
##########################################################################
# 26:     NCF NETCDF output variables,
##########################################################################
"iNCF,","NETCDF output selector,",0
##########################################################################
# 27: CFD output variables,
##########################################################################
```

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"WriteCFDOutput;WriteCFDOutputS,","Switch to Turn on CFD output; Ouput
status,",0,0
#########################################################################
# 28:     Initial conditions; constant and spatial data,
#########################################################################
"iicff,","Initial condition far field file use,",0,2.5,27
"icffile,","Initial condition far field file,","No_Data_File,"
"icDoSTInterpolate,","Do Spatial and Temporal Interpolation,",0
"RestartToleranceTime,","Time toloerance for using restart file,",0
"AdjustICData,","Adjust initial conditoin data using data before the model
simulation time,",1
"NumInterpSerarchCycles,","Number of smoothening cycles,",1
"DoFourByFourSearch,","Switch to activate 4 nearby cells approach,",1
"DoEightByEightSearch,","Switch to activate 8 nearby cells approach,",1
"SmoothCoefficient,","Factor to control parent cell dependency,",0
"IPIStart,","Interpolation starting I cell index,",1
"IPIEnd,","Interpolation ending I cell index,",250
"IPJStart,","Interpolation starting J cell index,",1
"IPJEnd,","Interpolation ending J cell index,",50
"DoRecursiveSmoothening,","Do recursive smoothening on all cells,",0
"ICInterpolationScheme,","Initial condition interpolation scheme,",0
"IDWPOW,","Power for interpolation,",2
"ICGeoFileStatus,","Initial Condition Geo File Status,",0
"ICGeoFileName,","Initial Condition Geo File Name,","No_Data_File,"
"WFNorth,","Weighting factor in the north direction ,",1
"WFSouh,","Weighting factor in the south direction ,",1
"WFWest,","Weighting factor in the west direction ,",1
"WFEast,","Weighting factor in the east direction ,",1
"WFNorthWest,","Weighting factor in the north west direction ,",1
"WFNorthEast,","Weighting factor in the north east direction ,",1
"WFSouthWest,","Weighting factor in the sout westh direction ,",1
"WFSouthEast,","Weighting factor in the south east direction ,",1
"ICGeoStnFileStatus,","Use field data stations look up file,",0
"ICGeoStnFileName,","Field data station look up file
name,","No_Data_File,"
"UseRT,","Use response temperature for background temperature,",1
"UseStnBGTemp,","Use field data station for setting up background
temperature,",0
"QuadInterpolationType,","Interpolation method for quadrilateral shape,",1
"DoPointInterpolation,","Use field station location for point
interpolation method,",1
"UseConstituentData,","Use constituent data only from restart file,",0
"UseOnlyVelocities,","Use only velocities and elevation,",0
"ConstituentStartTime,","Constituent start time from restart file,",39554
"FielDataDepthType,","Field data depth measurement type,",1
"VBUseNumConstituents,","Number of constituents,",0
"UseTVICData,","Use time varying initial condition data,",0
"nicp,","Number of initial conditon points,", 2
"icpnm,","Constituent name; User does not change the name or the
order,",I_Temp,I_Saln
"icpid,","Initial condition id,",1,2
"ict,","Initial condition data type,",4,4
"icdsg,","SSFlow station number to be used for the specific
constituent,",1,1
"icifn,","File name for using it when ict value is set to 2,",
"icifn_1,","File name for using it for initial condition
1,","No_Data_File,"
"icifn_2,","File name for using it for initial condition
2,","No_Data_File,"
"icv,","Initial condition constituent value,",-99,-99
"icu,","Initial condition constituent unit when ict is set to 1,",-99,-99
"icstd,","Initial condition start date,","04/01/2008,","04/01/2008,"
"icstt,","Initial condition start time,","00:00,","00:00,"
"icxst,","Initial condition x starting location specified as I index,",1,1
"icxend,","Initial condition x ending location specified as I
index,",250,250
"icjst,","Initial condition y starting location specified as j index,",1,1
"icjend,","Initial condition y ending location specified as j
index,",50,50
"ickst,","Initial condition z starting location specified as k
index,",999,999
"ickend,","Initial condition z ending location specified as k index,",-
999,-999
"icswtype,","Initial condition type,",0,0
"ictvtype,","Initial condition time varying type,",0,0
#########################################################################
# 28:     Initial conditions, Profile data,
#########################################################################
"kmax,","number of k layers,", 50
"504.066,","Profile value at k = 1,",-99,-99
"503.066,","Profile value at k = 2,",-99,-99
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"502.066,","Profile value at k = 3,",-99,-99
"501.066,","Profile value at k = 4,",-99,-99
"500.066,","Profile value at k = 5,",-99,-99
"499.066,","Profile value at k = 6,",-99,-99
"498.066,","Profile value at k = 7,",-99,-99
"497.066,","Profile value at k = 8,",-99,-99
"496.066,","Profile value at k = 9,",-99,-99
"495.066,","Profile value at k = 10,",-99,-99
"494.066,","Profile value at k = 11,",-99,-99
"493.066,","Profile value at k = 12,",-99,-99
"492.066,","Profile value at k = 13,",-99,-99
"491.066,","Profile value at k = 14,",-99,-99
"490.066,","Profile value at k = 15,",-99,-99
"489.066,","Profile value at k = 16,",-99,-99
"488.066,","Profile value at k = 17,",-99,-99
"487.066,","Profile value at k = 18,",-99,-99
"486.066,","Profile value at k = 19,",-99,-99
"485.066,","Profile value at k = 20,",-99,-99
"484.066,","Profile value at k = 21,",-99,-99
"483.066,","Profile value at k = 22,",-99,-99
"482.066,","Profile value at k = 23,",-99,-99
"481.066,","Profile value at k = 24,",-99,-99
"480.066,","Profile value at k = 25,",-99,-99
"479.066,","Profile value at k = 26,",-99,-99
"478.066,","Profile value at k = 27,",-99,-99
"477.066,","Profile value at k = 28,",-99,-99
"476.066,","Profile value at k = 29,",-99,-99
"475.066,","Profile value at k = 30,",-99,-99
"474.066,","Profile value at k = 31,",-99,-99
"473.066,","Profile value at k = 32,",-99,-99
"472.066,","Profile value at k = 33,",-99,-99
"471.066,","Profile value at k = 34,",-99,-99
"470.066,","Profile value at k = 35,",-99,-99
"469.066,","Profile value at k = 36,",-99,-99
"468.066,","Profile value at k = 37,",-99,-99
"467.066,","Profile value at k = 38,",-99,-99
"466.066,","Profile value at k = 39,",-99,-99
"465.066,","Profile value at k = 40,",-99,-99
"464.066,","Profile value at k = 41,",-99,-99
"463.066,","Profile value at k = 42,",-99,-99
"462.066,","Profile value at k = 43,",-99,-99
"461.066,","Profile value at k = 44,",-99,-99
"460.066,","Profile value at k = 45,",-99,-99
"459.066,","Profile value at k = 46,",-99,-99
"458.066,","Profile value at k = 47,",-99,-99
"457.066,","Profile value at k = 48,",-99,-99
"456.066,","Profile value at k = 49,",-99,-99
"455.066,","Profile value at k = 50,",-99,-99
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Boundary conditions,
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"ndsg,","Number of ssflows,",6
"ndsgdtr,","Number of Distributed Networks,",0
"vbuse1,","Number of Boundary Conditions; Number of Fixed Variables and
Total Number of Variables,",6,52,67,1.9,37
"vbuse2,","Number of ssFlows for Current Boundary; BC Index,",1, 1
"vbuse3,","boundary condition mode,","Discharge,",Discharge
"dsgm,","Boundary Condition Mode,",0,0 : Discharge
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","Upstream,",Upstream
"dsgdt(1),","Input Data Type for Hydrodynamics,",1,1 : Constant
"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
Constant
"dsgifn(1),","TVD Input File Name for
Hydrodynamics,","No_Data_File,",No_Data_File
"dsgifn(2),","TVD Input File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
"dsgqfnst,","Use Qualifier File for Transport and Water Quality,",0,0
"dsgqfn,","Qualifier File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
"dsgip(1),","Time Varying Input Data Interpolation Scheme for H,",0,0 : No
Interpolation
"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
Interpolation
"dsgdc,","Grid Domain Type,",3,3 : 3D Model
"dsgwd,","Write Boundary Condition Data to Snapshot Output F,",1,1
"dsgstd,","Boundary Condition Start Date,","04/01/2008,",04/01/2008
"dsgstt,","Boundary Condition Start Time,","00:00,",00:00
"dsgendd,","Boundary Condition End Date,","04/21/2008,",04/21/2008
"dsgendt,","Boundary Condition End Time,","00:00,",00:00
"idsgst,","Starting Grid Cell Index in x-Direction,",210,210
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"idsgend,","Ending Grid Cell Index in x-Direction,",210,210
"jdsgst,","Starting Grid Cell Index in y-Direction,",11,11
"jdsgend,","Ending Grid Cell Index in y-Direction,",35,35
"kdsgst,","Starting Vertical Layer Number in z-Direction,",999,999 : KT
"kdsgend,","Ending Vertical Layer Number in z-Direction,",-999,-999 : KB
"dsgcolor,","Selected Region Color,",12977694,12977694
"dsgrangess,","Selected Region Display Status,",1,1
"dsgdr,","Recirculation Boundary Condition Number,",0,0 : No Recirculation
"dsgvf,","Specific Momentum Amplification Factor,",1,1
"hdsgm,","Use Momentum Distribution for Vertical Discharge,",0,0
"fdsgd,","Hydrodynamic Flow / Load,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",1,1 : cfs
"fdsgv,","Hydrodynamic Mode Value,",1246,1246
"sdsg,","Discharge Conduit Shape,",-99,-99 : Not Used
"pdsg,","Discharge Conduit Angle from Positive z-Axis,",-99,Not Applicable
"tdsg,","Discharge Conduit Angle from Positive x-Axis,",-99,Not Applicable
"ldsg,","Discharge Conduit Length in meters,",-99,Not Applicable
"wdsg,","Discharge Conduit Width in meters,",-99,Not Applicable
"dsgnp,","Number of Ports in the Discharge Conduit,",-99,Not Applicable
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
"dsgstructurew,","Structure Width,",-99,Not Applicable
"dsgstructureu,","Structure Width Units,",-99,Not Applicable
"dsgFlowExp,","Flow Exponent,",-99,Not Applicable
"dsgFlowCoeff,","Flow Coefficient,",-99,Not Applicable
"dsgFlowDir,","Hydrodynamic Flow Direction,",-99,Not Applicable
"dsgFlowMode,","Hydrodynamic Mode,",-99,Not Applicable
"dsgFlowUnit,","Hydrodynamic Mode Unit,",-99,Not Applicable
"dsgFlowValue,","Hydrodynamic Mode Value,",-99,Not Applicable
"dsgFlowHeadDiffFW,","Head Difference for Flow Withdrawal Using the
Stru,",-99,Not Applicable
"dsgFlowHeadDiffFWUnits,","Heade Difference Units for Flow Withdrawal,",-
99,Not Applicable
"dsgFlowHeadDiffFD,","Head Difference for Flow Discharge Using the
Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
99,Not Applicable
"dsgrt,","Hydrodynamic Mode Value Adjustment Factor,",1,1
"dsgrc(I_Temp),","Temperature Data Type,",0,0 : (I_Temp) Concentration
"dsgvu(I_Temp),","Temperature Unit / Status,",1,1 : F
"dsgv(I_Temp),","Temperature Value,",86.54,86.54
"dsgrc(I_Saln),","Salinity Data Type,",0,0 : (I_Saln) Concentration
"dsgvu(I_Saln),","Salinity  Unit / Status,",0,0 : ppt
"dsgv(I_Saln),","Salinity Value,",0.2,0.2
"dsgrc(I_IDye),","Instantaneous Dye Data Type,",0,0 : (I_IDye)
Concentration
"dsgvu(I_IDye),","Instantaneous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_IDye),","Instantaneous Dye Value,",0,0
"dsgrc(I_CDye),","Continuous Dye Data Type,",0,0 : (I_CDye) Concentration
"dsgvu(I_CDye),","Continuous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_CDye),","Continuous Dye Value,",0,0
"dsgrc(I_Exst),","Excess Temperature Data Type,",0,0 : (I_Exst)
Concentration
"dsgvu(I_Exst),","Excess Temperature  Unit / Status,",0,0 : deg C
"dsgv(I_Exst),","Excess Temperature Value,",0,0
"vbuse2,","Number of ssFlows for Current Boundary; BC Index,",1, 2
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Withdrawal
"dsgm,","Boundary Condition Mode,",1,1 : Intake and Withdrawal
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","Downstream,",Downstream
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"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
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"dsgifn(2),","TVD Input File Name for Transport and Water
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"dsgqfnst,","Use Qualifier File for Transport and Water Quality,",0,0
"dsgqfn,","Qualifier File Name for Transport and Water
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Interpolation
"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
Interpolation
"dsgdc,","Grid Domain Type,",3,3 : 3D Model
"dsgwd,","Write Boundary Condition Data to Snapshot Output F,",1,1
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"dsgstt,","Boundary Condition Start Time,","00:00,",00:00
"dsgendd,","Boundary Condition End Date,","04/21/2008,",04/21/2008
"dsgendt,","Boundary Condition End Time,","00:00,",00:00
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"dsgvf,","Specific Momentum Amplification Factor,",1,1
"hdsgm,","Use Momentum Distribution for Vertical Discharge,",1,1 : Area
Based Flow Withdrawal
"fdsgd,","Hydrodynamic Flow / Load,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",1,1 : cfs
"fdsgv,","Hydrodynamic Mode Value,",1125,1125
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"tdsg,","Discharge Conduit Angle from Positive x-Axis,",-99,Not Applicable
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"wdsg,","Discharge Conduit Width in meters,",-99,Not Applicable
"dsgnp,","Number of Ports in the Discharge Conduit,",-99,Not Applicable
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
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"dsgstructureu,","Structure Width Units,",-99,Not Applicable
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"dsgFlowCoeff,","Flow Coefficient,",-99,Not Applicable
"dsgFlowDir,","Hydrodynamic Flow Direction,",-99,Not Applicable
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"dsgFlowUnit,","Hydrodynamic Mode Unit,",-99,Not Applicable
"dsgFlowValue,","Hydrodynamic Mode Value,",-99,Not Applicable
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"dsgFlowHeadDiffFWUnits,","Heade Difference Units for Flow Withdrawal,",-
99,Not Applicable
"dsgFlowHeadDiffFD,","Head Difference for Flow Discharge Using the
Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
99,Not Applicable
"dsgrt,","Hydrodynamic Mode Value Adjustment Factor,",-99,Not Applicable
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"dsgvu(I_Temp),","Temperature Unit / Status,",-99,Not Applicable
"dsgv(I_Temp),","Temperature Value,",-99,Not Applicable
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"dsgv(I_Saln),","Salinity Value,",-99,Not Applicable
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Concentration
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"dsgv(I_IDye),","Instantaneous Dye Value,",-99,Not Applicable
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"dsgvu(I_CDye),","Continuous Dye Unit / Status,",-99,Not Applicable
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Interpolation
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Interpolation
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"dsgrangess,","Selected Region Display Status,",1,1
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"dsgvf,","Specific Momentum Amplification Factor,",1,1
"hdsgm,","Use Momentum Distribution for Vertical Discharge,",1,1 : Area
Based Flow Withdrawal
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"fdsgu,","Hydrodynamic Mode Unit,",3,3 : gpm
"fdsgv,","Hydrodynamic Mode Value,",42300,42300
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"wdsg,","Discharge Conduit Width in meters,",-99,Not Applicable
"dsgnp,","Number of Ports in the Discharge Conduit,",-99,Not Applicable
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"dsgFlowHeadDiffFD,","Head Difference for Flow Discharge Using the
Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
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"dsgrt,","Hydrodynamic Mode Value Adjustment Factor,",-99,Not Applicable
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"dsgv(I_CDye),","Continuous Dye Value,",-99,Not Applicable
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"dsgm,","Boundary Condition Mode,",0,0 : Discharge
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","SSES_Ou,",SSES_Ou
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Interpolation
"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
Interpolation
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"dsgrangess,","Selected Region Display Status,",1,1
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"fdsgd,","Hydrodynamic Flow / Load,",0,0 : Along x-Direction
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"fdsgu,","Hydrodynamic Mode Unit,",3,3 : gpm
"fdsgv,","Hydrodynamic Mode Value,",11200,11200
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"tdsg,","Discharge Conduit Angle from Positive x-Axis,",270,270
"ldsg,","Discharge Conduit Length in meters,",0.1016,0.1016
"wdsg,","Discharge Conduit Width in meters,",0.1016,0.1016
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"dsgFlowUnit,","Hydrodynamic Mode Unit,",-99,Not Applicable
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"dsgFlowHeadDiffFWUnits,","Heade Difference Units for Flow Withdrawal,",-
99,Not Applicable
"dsgFlowHeadDiffFD,","Head Difference for Flow Discharge Using the
Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
99,Not Applicable
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"dsgv(I_Temp),","Temperature Value,",12.5,12.5
"dsgrc(I_Saln),","Salinity Data Type,",0,0 : (I_Saln) Concentration
"dsgvu(I_Saln),","Salinity  Unit / Status,",0,0 : ppt
"dsgv(I_Saln),","Salinity Value,",0.4,0.4
"dsgrc(I_IDye),","Instantaneous Dye Data Type,",0,0 : (I_IDye)
Concentration
"dsgvu(I_IDye),","Instantaneous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_IDye),","Instantaneous Dye Value,",100,100
"dsgrc(I_CDye),","Continuous Dye Data Type,",0,0 : (I_CDye) Concentration
"dsgvu(I_CDye),","Continuous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_CDye),","Continuous Dye Value,",0,0
"dsgrc(I_Exst),","Excess Temperature Data Type,",0,0 : (I_Exst)
Concentration
"dsgvu(I_Exst),","Excess Temperature  Unit / Status,",1,1 : deg F
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"vbuse2,","Number of ssFlows for Current Boundary; BC Index,",1, 5
"vbuse3,","boundary condition mode,","Intake and Withdrawal,",Intake and
Withdrawal
"dsgm,","Boundary Condition Mode,",1,1 : Intake and Withdrawal
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","BBNPP_In,",BBNPP_In
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"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
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Interpolation
"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
Interpolation
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"dsgrangess,","Selected Region Display Status,",1,1
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"dsgvf,","Specific Momentum Amplification Factor,",1,1
"hdsgm,","Use Momentum Distribution for Vertical Discharge,",1,1 : Area
Based Flow Withdrawal
"fdsgd,","Hydrodynamic Flow / Load,",0,0 : Along x-Direction
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"fdsgu,","Hydrodynamic Mode Unit,",3,3 : gpm
"fdsgv,","Hydrodynamic Mode Value,",34458,34458
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"tdsg,","Discharge Conduit Angle from Positive x-Axis,",-99,Not Applicable
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"wdsg,","Discharge Conduit Width in meters,",-99,Not Applicable
"dsgnp,","Number of Ports in the Discharge Conduit,",-99,Not Applicable
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"dsgstructureu,","Structure Width Units,",-99,Not Applicable
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99,Not Applicable
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Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
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Concentration
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"dsgvu(I_CDye),","Continuous Dye Unit / Status,",-99,Not Applicable
"dsgv(I_CDye),","Continuous Dye Value,",-99,Not Applicable
"dsgrc(I_Exst),","Excess Temperature Data Type,",0,0 : (I_Exst)
Concentration
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"dsgv(I_Exst),","Excess Temperature Value,",-99,Not Applicable
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"vbuse3,","boundary condition mode,","Discharge,",Discharge
"dsgm,","Boundary Condition Mode,",0,0 : Discharge
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","BBnPP_Ou,",BBnPP_Ou
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"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
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Interpolation
"dsgdc,","Grid Domain Type,",3,3 : 3D Model
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"fdsgd,","Hydrodynamic Flow / Load,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",3,3 : gpm
"fdsgv,","Hydrodynamic Mode Value,",11172,11172
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"tdsg,","Discharge Conduit Angle from Positive x-Axis,",270,270
"ldsg,","Discharge Conduit Length in meters,",0.1016,0.1016
"wdsg,","Discharge Conduit Width in meters,",0.1016,0.1016
"dsgnp,","Number of Ports in the Discharge Conduit,",72,72
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Stru,",-99,Not Applicable
"dsgFlowHeadDiffFWUnits,","Heade Difference Units for Flow Withdrawal,",-
99,Not Applicable
"dsgFlowHeadDiffFD,","Head Difference for Flow Discharge Using the
Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
99,Not Applicable
"dsgrt,","Hydrodynamic Mode Value Adjustment Factor,",1,1
"dsgrc(I_Temp),","Temperature Data Type,",1,1 : (I_Exst) Concentration
"dsgvu(I_Temp),","Temperature Unit / Status,",1,1 : deg F
"dsgv(I_Temp),","Temperature Value,",3.46,3.46
"dsgrc(I_Saln),","Salinity Data Type,",0,0 : (I_Saln) Concentration
"dsgvu(I_Saln),","Salinity  Unit / Status,",0,0 : ppt
"dsgv(I_Saln),","Salinity Value,",0.4,0.4
"dsgrc(I_IDye),","Instantaneous Dye Data Type,",0,0 : (I_IDye)
Concentration
"dsgvu(I_IDye),","Instantaneous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_IDye),","Instantaneous Dye Value,",0,0
"dsgrc(I_CDye),","Continuous Dye Data Type,",0,0 : (I_CDye) Concentration
"dsgvu(I_CDye),","Continuous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_CDye),","Continuous Dye Value,",100,100
"dsgrc(I_Exst),","Excess Temperature Data Type,",0,0 : (I_Exst)
Concentration
"dsgvu(I_Exst),","Excess Temperature  Unit / Status,",1,1 : deg F
"dsgv(I_Exst),","Excess Temperature Value,",3.46,3.46
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-WQM,
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iwqc,","Water Quality Model Type ID; Name; Number of parameters; number
of regions; number of variables,",0,"Not Used",0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-SFM,
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"isnec,","Sediment Model Type ID; Name; Number of parameters; Number of
regions; number of variables,",0,"Not Used",0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-WQADD
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iwqaddc,","Water Quality ADD switch; number of variables; Number of
parameters; Number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-GAM
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iGAM,","Algae Model: Switch; Number of Algae; Number of Variables for
Each Algae; number of regions,",0,0,0,0
```

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$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-CFM
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iCFM,","Bacteria Model: Switch; Number of Bacterias; Number of parameters
for Each Bacteria; Number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-UDF
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iUDC,","User Defined Model: Switch; Number of variables; Number of
parameters for Each Coliform; Number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-ENT
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iENT,","Entrainment Model: Switch; Number of Entrainments; Number of
Paraments for Each Variables; Number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-STM
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"istc,","Sediment Transport Model Computations: Switch; Number of
Entrainments; Number of Paraments for Each Variables; Number of
regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-MGM
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iMGM,","Macrophytes Model: Switch; Number of Macrophytes; Number of
Variables for Each Macrophytes; number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for Chlorine Kinetics module-CKM
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iCKM,","Chlorine Kinetics Module: Module tpe; Number of variables; Number
of parameters for each variable; Number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Particle Transport Variables for GEMSS-PTM,
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iPTM,","particle transport model computations,",0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Miscellaneous data,
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"vbusel,","Number of columns and rows,",4,0
```

Scenario 03

```
$GEMSSModelResults,32
$GEMSS-SHWETControlFile,4.24
$Creation Date: 4/16/2008
$Waterbody Name: Susquehanna 3
$Modeler Name: SP
########################################################################
# 1:     Scenario variables,
########################################################################
"IntGDS,","Option to use GEMSS data structure,", 1
"Scenario,","Scenario file path and name,","C:\GEMSS\APPS\Susquehanna
3\Output\Scenario 03_01 NC,"
"DoText2MDBConversion,","Use Scenario Output Direct Database
converion,",1,1
"ZipOutputFile,","Zip text output files after creating the database,",0,0
"DoCompUsingGEMSSOutput,","Run Model Using Existing GEMSS Contour Output
Text Files,", 0
"GEMSSHDMInputFile,","Existing GEMSS Contour Output Header Text
Files," ","
########################################################################
# 2:     Grid variables,
########################################################################
"igrid,","Switch to read grid data from a file,",1,1
"GridFile,","Grid file name,","C:\GEMSS\APPS\Susquehanna
3\Grid\Susquehanna River 05 474Min.g3g,","4/23/2008 12:36:08
PM,","4/28/2008 12:20:10 PM,"
"InputHDatumUnit,","Input grid data is in geographic coordinate system
switch,",0
"UseLinearConversionIn,","Use linear conversion for input grid data,",1
"cstypeIn,","Input coordinate conversion mode,",0
"cscodeIn,","Input coordinate conversion zone number,",0,None
"csdatumIn,","Input UTM datum,",0
"InputVDatumUnit,","Input grid data is in geographic coordinate system
switch,",0
"OutputHDatumUnit,","Output grid data is in geographic coordinate system
switch,",0
"UseLinearConversionOut,","Use linear conversion for output grid data,",1
"cstypeOut,","Output coordinate conversion mode,",0
"cscodeOut,","Output coordinate conversion zone number,",0,None
"csdatumOut,","Output UTM datum,",0
```

```
"OutputVDatumUnit,","Output grid data is in geographic coordinate system
switch,",0
"iupmgrid,","Switch to set up different k layers,",0
"km_p,","Vertical array size,",-99
"nzds,","Number of vertical layer domains,",-99
"nzdstr,","Starting vertical layer number for each domain,",-99
"nzend,","Ending vertical layer number for each domain,",-99
"dzd,","Layer thickness in each domain,",-99
"igpsfmt,","Switch to write grid file gps format for use in ArcView,",0
"elioption,","switch to Use TVD From Boundary Condition File or Initial
elevation,", 0
"eli,","Initial elevation,",489.8
"iwbs,","Waterbody switches,", 1
"eldatum,","Reference elevation of 3rd layer in meters,",0
"UseSigmaStretching,","Switch to Use Sigma stretching,",0
"NSLevel,","Number of Sigma Levels,",0
"SigDistType,","Sigma Layer Distribution type,",0
"Slevel,","User Defined Sigma Distribution,",0.0
"ZtoSigmaBCDepthTransform,","Use BC Depth Transformation from Vertical to
Sigma Level,",0
"SmoothBathy,","Switch to Perform Bathymetry Smoothening,",0
"SlpMax,","Maximum  Allowable Slope for bathymetry smoothening,",0
"NSmoothCycle,","Number of Smoothening Cycles,",0
########################################################################
#3:      Meteorological variables,
########################################################################
"MetDataType,","Switch to use Meteorological time varying data; VB Use
verion; Number of Meteorology variables,",0,2.2,14
"metss,","Use Meteorological data in current simulation status,",1
"Metfile1,","Meteorological time varying data input file
name,","No_Data_File,"
"metinterp,","Switch to perform interpolation on met data,",0
"ievap;EvapScaleFactor,","Switch for evaporation;Evaporation scale
facotr,",1,1
"iwndhyd,","Use wind in hydrodynamics computations,",0
"ta,","temperature of air C,",21,0
"td,","Dew point temperature C,",13,0
"twb,","Wet bulb temperature C,",13,0
"rt,","response temperature C,",20,0
"phi,","Wind direction degrees,",90
"wad,","Wind speed m/sec,",5, 0
"cc,","Cloud coverage Octal,",2
"solrad,","Solar radiation W/m^2,",120,0
"ps,","Atmoshpheric pressure mm of Hg,",760
"ishe,","Surace heat exchange method,",1
"KEMethod,","Method to Compute K and E,",0
"cshe,","Coefficient of surface heat exchange w/m2/C,",13.71
"te,","Equlibrium temperature C,",34,1
"secchi,","Secchi depth; light transmission depth m,",-99
"rsts,","Vegetative and Topographic Shading Factor; 0 to 1.0,",-99
"wscoef,","Wind sheltering coefficient; 0 to 1.0,",-99
"iwsf,","Wind speed function,",1
"MetInterpolationMethod,","Met Interpolation Method,",0
"IDWPOW,","Exponent value for inverse weighting scheme,",0
"MetVarInterpSwitch;MetVarInterp,","Met Individuall interpolatey switch
and interpolation methods,",0
**************************************************************************
*  Meteorological Scale Factor Variables,
**************************************************************************
"UseMetRegionSF;MetRegionSFSS,","Met factor switch,",0,0
**************************************************************************
*  Meteorological Dynamic Shading Variables,
**************************************************************************
"UseDSHDRegionSF;DSHDRegionSFSS,","Met dynamic shading switch,",0,0
**************************************************************************
*  Icel Growth Model Variables,
**************************************************************************
"UseIGModel;UseIGModelStatus,","Switch to control the use of ice growth
model and status,",0,0
**************************************************************************
*  Wave Model Variables,
**************************************************************************
"iwvc;iwvcss,","Wave model activation switch and status,",0,0
########################################################################
# 4:     Constituents,
########################################################################
"itrc,","Transport switch; computation status; number of variables,",1,1,5
"iwqc,","Water quality model type; computation status; number of
variables,",0,0,0
"iwqaddc,","Water quality ADD model switch; computations status; number of
variables,",0,0,0
```

```
"iGAMc,","Algae model computations; status,",0,0
"nGAMs,","Number of algae,",0,1
"UseGAMInsideWQM,","Use Generalized Algae Model inside Water Quality
Model,",0
"isnec,","Sediment nutrient exchange computations,",0,0
"iPTM,","Particle transport model computations,",0,0
"istc,","Sediment transport model computations,",0,0
"nstcs,","Number of sediment transport type,",0,1
"ientc,","Entrainment computations,",0,0
"nezones,","Number of entrainment zones,",0,1
"iatc,","Optional to add more constituents,",0,0
"natc,","Number of additional constituents,",0,1
"icfmc,","Coliform Bacteria Model computations,",0,0
"ncfmcs,","Number of coliform bacteria type,",0
"iCKMc;iCKMcss,","Chlorine kinetics Model computations and status,",0,0
"nCKMc,","Number of chlorine kinetics type,",0
"iMGM;iMGMss,","Macrophyte grouth model computations and status,",0,0
"nMGMs,","Number of macrophyte type,",0,1
"UseMGMInsideWQM,","Use Macrophyte Grouth Model inside Water Quality
Model,",0
"WriteTransportOutput,","Write TRM model internal variables to GEMSS
output output,",0
"WriteWQMOutput,","Write WQM model internal variables to GEMSS output
output,",0
"WriteSFMOutput,","Write SFM model internal variables to GEMSS output
output,",0
"WriteWQADDOutput,","Write WQADD model internal variables to GEMSS output
output,",0
"WriteGAMOutput,","Write GAM model internal variables to GEMSS output
output,",0
"WriteENMOutput,","Write ENM model internal variables to GEMSS output
output,",0
"WriteUDCOutput,","Write UDM model internal variables to GEMSS output
output,",0
"WriteCFMOutput,","Write CFM model internal variables to GEMSS output
output,",0
"WriteSTMOutput,","Write STM model internal variables to GEMSS output
output,",0
"WriteMGMOutput,","Write MGM model internal variables to GEMSS output
output,",0
"WriteCKMOutput,","Write CKM model internal variables to GEMSS output
output,",0
"WritePTMOutput,","Write PTM model internal variables to GEMSS output
output,",0
"cnum,","Number of Constituents,",5
"Index,","Model Name,","Identifier; Cannot be Modified,","User Given
Name,","Activity of Constituent,","Output Time,","Units,","Transport
Switch,"
"C0,","Transport,",I_Temp,"I_Temp,",1,1,1,1
"C1,","Transport,",I_Saln,"I_Saln,",1,1,0,1
"C2,","Transport,",I_lDye,"I_lDye,",1,1,0,1
"C3,","Transport,",I_CDye,"I_CDye,",1,1,0,1
"C4,","Transport,",I_Exst,"I_Exst,",1,1,1,1
#########################################################################
# 5:     Model switches,
#########################################################################
"Use3DModel,","Switch to control 3D model simulations,",1,3.7
"issflw,","switch on/off ssflow input data that is available in the
sscontrol.csv,",1
"itrcs,","transport computation algorithm switch,",1
"udwtf,","advection theta in z-direction,",0
"vdwft,","diffusion theta in z-direction,",0
"HOTSIniTime,","HOTS initization time period,",-99
"itrbs,","Turbulence scheme,",1
"itrbsm,","Turbulence sub model,",1
"itrbparam,","Turbulence parameters,",0,1,1,2.44,2.44,0.9,0.5,1,2.53
"imxls,","Mixing length scheme,",1
"ihmdcx,","momentum diffusion coefficient scheme selector in x-
direction,",2
"ihmdcy,","momentum diffusion coefficient scheme selector in y-
direction,",2
"hmdcx,","momentum diffusion coefficient in x-direction
m2/sec,",0.00584,1.1
"hmdcy,","momentum diffusion coefficient in y-direction
m2/sec,",0.00584,1.1
"prnm,","Prandtl number,",10
"ihtdcx,","transport diffusion coefficient scheme in x-direction,",3
"ihtdcy,","transport diffusion coefficient scheme in y-direction,",3
"htdcx,","transport diffusion coefficient in x-direction m2/sec,",,
"htdcy,","transport diffusion coefficient in y-direction m2/sec,",,
"idnf,","Density function selector,",2
```

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"ideep,","Compressibility usage,",1
"ichezy,","Chezy coefficient selector,",0
"ilchezy,","Limiting Chezy selector,",0
"chezy,","Chezy coefficient; Czo;do;n,",40,,
"WSCoeffType,","Wind stress coefficient type,",0
"WSConstA,","Wind stress constant A,",0.8
"WSConstB,","Wind stress constant B,",0.065
"icors,","Coriolis force selector,",0
"RefLatOption;RefLat,","Referene Latitude Option; Reference Latitude
Value,",0,40
"ivaterms,","Vertical acceleration terms,",0
"idbg,","Debug switch,",0
"tvdscheck,","time varying data consistency check,",0
"iWDLayers,","Use wetting and drying of layers,",1
"lraddthk,","Layer addition thickness m,",0.8
"lrsubthk,","Layer subtraction thickness m,",0.8
"StabilizeInversionFlag,","StabilizeInversionFlag,",0
"InvCoeff,","InvCoeff,",-99
"iUsed1DModel,","Switch to use 1D model; Switch grid has 1D model,",0,0,1
"ComputeStat,","Statisdtical method to output variables,",0
"StatFreq;StatUnit,","Statisdtical frequency and unit to write output
variables,",0,0
"StatStartTime,","Start time for statistical computations,",39539
"StatEndTime,","End time for statistical computations,",39543
"ReturnTime1DDn,","Return time,",0
"UseZCheck,","Control z calculations,",0
"ZStabilityFactor,","Stability factor for z,",0
"CheckTimeStepUsingNewValues,","Redo computations using new time step
values,",0
"UseWindRamp,","Use time ramp function for larger wind speeds,",0
"NumWindRampLevels,","Number of time step intervale for the wind ramp
function,",1
"RampLimitWindSpeed,","Limiting wind speed for the usege of time ramp
function,",0
"WriteBCTVD,","Write boundary condition time varying data files in time
Series output files,",0
"WriteBCLoads,","Write boundary condition data as loads in time series
output files,",0
"WriteSDTVD,","Write sediment data time varying data files in time series
outoput files,",0
"SSDataType,","Source and sinks data type for use in boundary conditon
data writing procedure,",1
"iDo1DHDM,","Do 1D hydrodynamics,",1
"iSetdt1DAsdt,","Set 1D model time step same as 3D model,",0
"ZAmplicationFactor,","Z amplification factor for stability checks,",4
"CGCLimit1,","Conjugate Gradient Computation Error Limit 1,",1,-7
"CGCLimit2,","Conjugate Gradient Computation Error Limit 2,",1,-9
"UseRampFlowFunction,","Use ramp flow function to stabilize the model
simulation,",1
"NumRampFlowBCs,","Number of ramp flow boundary conditions,",6,
"BCNum1,","Ramp flow values for boundary condition
number1,",1,"Upstream",1,12482,1,6,1
"BCNum2,","Ramp flow values for boundary condition
number2,",2,"Downstream",1,12361,1,6,1
"BCNum3,","Ramp flow values for boundary condition
number3,",3,"SSES_In",0,0,0,0,1
"BCNum4,","Ramp flow values for boundary condition
number4,",4,"SSES_Ou",0,0,0,0,1
"BCNum5,","Ramp flow values for boundary condition
number5,",5,"BBNPP_In",0,0,0,0,1
"BCNum6,","Ramp flow values for boundary condition
number6,",6,"BBnPP_Ou",0,0,0,0,1
"SaveCSDataInArray,","Convert cross-section data to depth vs width
array,",0
"DelHforCS,","Depth interval for depth vs width array computations,",0.1
"HDMVersionNumber,","Use far-field/near-field modeling approach,",0
"CapitolLakeVarsSwi,","Switch for Capitol lake variables,",0,0
#########################################################################
# 6:      Simulation time variables,
#########################################################################
"stryear,","Model start time year,",2008
"strmonth,","Model srart time month,",4
"strday,","Model start time day,",1
"strhour,","Model start hour,",0
"strmin,","Model start minutes,",0
"endyear,","Model end time year,",2008
"endmonth,","Model end month year,",4
"endday,","Model end day,",21
"endhour,","Model end hour,",0
"endmin,","Model end minutes,",0
"MaxTimeSlots,","Maximun number of output time slots used in outputs,",2
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"idltt,","Time step control switch,",0,1
"dltminm,","Minimum time step,",10
"dltlimit,","Start Up time step,",60
"omega,","Time step under relaxation factor,",0.75
##########################################################################
# 7:     Derived variables,
##########################################################################
"idv,","Option to use derived variables computations,",0
##########################################################################
# 8:     Probability Plume variables,
##########################################################################
"ComputeProPlume,","Computation of Probability Plume,",0
##########################################################################
# 9:     Snapshot output variables,
##########################################################################
"isnp,","Snapshot output selector,",1,2.2
"isnpss,","Ouput status,",1
"snpfile,","Snapshot output file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 03_01 NC.snp,"
"iMetInfo,","Switch to write meteorology to snapshot output,",0
"ivolumeBalance,","Volume Balance switch,",1
"iMassBalance,","Mass Balance switch,",0
"nsnp,","Number of snapshot output times,",2
"snpyear,","Snapshot output year,",2008,2008
"snpmonth,","Snapshot output month,",4,4
"snpday,","Snapshot output day,",1,3
"snphour,","Snapshot output hour,",0,0
"snpmin,","Snapshot output minutes,",0,0
"snpfrequ,","Snapshot output frequency unit,",1,2
"snpfreq,","Snapshot output frequency value,",1,1
"nsnpkpk;kpk,","Number of snapshot output K planes; output K plane
values,",1,51
"nsnpkpkv;kpv,","Number of snapshot output variables for selected K
planes; output variable ID values,",6,1,19,20,21,22,23
"nsnpjpj;jpj,","Number of snapshot output J planes; output J plane
values,",0
"nsnpjpjv;jpv,","Number of snapshot outputvariables for selected J planes;
output variable ID values,",0
"nsnpipi;ipi,","Number of snapshot output I planes; output I plane
values,",0
"nsnpipiv;ipv,","Number of snapshot output variables for selected I
planes; output variable ID values,",0
"nsnpijpij,","Number of snapshot output I J points,",0
"snpijpi;snpijpj;snpijpnm,","Snapshot output
information,",ICell,JCell,Location names
"nsnpijpv;ijpv,","Snapshot output number of output variables for all
selected IJ cells; output variable IDs for all selected IJ cells,",0
"HydVar,","Hydrodynamic constituent name,",Surface Elevation,U -
velocity,V - Velocity,W - Velocity,Density,Momentum Diffusivity,Chezy,Flow
Rate
"hdunits,","Constituent unit type,",0,0,0,0,0,0,0,0
"hdamp,","Scaling factor,",100,1,1,1,1,10000,1,1
"hddigits,","Number of digits to print in the snapshot,",2,2,2,2,2,2,2,2
Scaling factor, No. of digits, ConstituentID, Constituent name, Output
Type, Units
1,2,I_Temp,I_Temp,1 : Concentration,0 : C
1,2,I_Saln,I_Saln,1 : Concentration,0 : ppt
1,2,I_lDye,I_lDye,1 : Concentration,0 : mg/l
1,2,I_CDye,I_CDye,1 : Concentration,0 : mg/l
1,2,I_Exst,I_Exst,1 : Concentration,0 : deg C
"Stat3DSnapShot,","Do stat analysis for 3D SnapShot,",0
"DV3DSnapShot,","Derived Variables for 3D ShapShot,",0
"ProbPlumeSnapshotStatus,","Status to write probability plume data to the
snapshot output,",0
"WriteMetSnapshot,","Switch to write meteorology variable output to
snapshot,",0
"SnpOutputMetVars,","Numberof meteorology variables;Output meteorology
variable ID to snapshot,",0
"WriteICESnapshot,","Write ice growth model output Variables,",0
"WriteWaveSnapshot,","Write wave model output Variables,",0
"WriteTransportSnapshot,","Write TRM model internal variables to snapshot
output,",0
"WriteWQMSnapshot,","Write WQM model internal variables to snapshot
output,",0
"WriteSFMSnapshot,","Write SFM model internal variables to snapshot
output,",0
"WriteWQADDSnapshot,","Write WQADD model internal variables to snapshot
output,",0
"WriteGAMSnapshot,","Write GAM model internal variables to snapshot
output,",0
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"WriteENMSnapshot,","Write ENM model internal variables to snapshot
output,",0
"WriteUDCSnapshot,","Write UDM model internal variables to snapshot
output,",0
"WriteCFMSnapshot,","Write CFM model internal variables to snapshot
output,",0
"WriteSTMSnapshot,","Write STM model internal variables to snapshot
output,",0
"WriteMGMSnapshot,","Write MGM model internal variables to snapshot
output,",0
"WriteCKMSnapshot,","Write CKM model internal variables to snapshot
output,",0
"WritePTMSnapshot,","Write PTM model internal variables to snapshot
output,",0
########################################################################
# 10:      Console output variables,
########################################################################
"icle,","Console output selector,",1,1.1
"icless,","Ouput status,",1
"ncle,","Number of console ouput times,",2
"cleyear,","Console output year,",2008,2008
"clemonth,","Console output month,",4,4
"cleday,","Console output day,",1,1
"clehour,","Console output hour,",0,2
"clemin,","Console output minutes,",0,0
"clefrequ,","Console output frequency unit,",0,0
"clefreq,","Console output frequency value,",1,10
"nclep,","Number of Console output I J points,",1
"clei;clej;clenm;clenijpk;clenijpv,","Console output
information,",ICell,JCell,Location names,Number of K, Number of Variables
"cleP1,","Point 1,",119,17,"C1,",1,1
"clek1,","Console output number of K values and K layer values for point
1,",1,30
"clev1,","Console output number of output variables and variable IDs for
point 1,",1,1
"Stat3DConsole,","Do stat analysis for 3D Console,",0
"DV3DConsole,","Derived Variables for 3D Console,",0
"WriteICEConsole,","Write ice growth model output Variables,",0
"WriteWaveConsole,","Write wave model output Variables,",0
"WriteTransportConsole,","Write TRM model internal variables to console
output,",0
"WriteWQMConsole,","Write WQM model internal variables to console
output,",0
"WriteSFMConsole,","Write SFM model internal variables to console
output,",0
"WriteWQADDConsole,","Write WQADD model internal variables to console
output,",0
"WriteGAMConsole,","Write GAM model internal variables to console
output,",0
"WriteENMConsole,","Write ENM model internal variables to console
output,",0
"WriteUDCConsole,","Write UDM model internal variables to console
output,",0
"WriteCFMConsole,","Write CFM model internal variables to console
output,",0
"WriteSTMConsole,","Write STM model internal variables to console
output,",0
"WriteMGMConsole,","Write MGM model internal variables to console
output,",0
"WriteCKMConsole,","Write CKM model internal variables to console
output,",0
"WritePTMConsole,","Write PTM model internal variables to console
output,",0
########################################################################
# 11:      Diagnostic output variables,
########################################################################
"idgn,","Diagnostic output selector,",0
########################################################################
# 12:      Restart output variables,
########################################################################
"irst,","Restart output selector,",0
########################################################################
# 13:      Time series output variables,
########################################################################
"itsr,","Time series output selector,",1,4.2
"itsrss,","Ouput status,",1
"tsrfile,","Time series output file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 03_01 NC_TSM.txt,"
"ntsr,","Number of time steries output times,",1
"tsryear,","Time series output year,",2008
"tsrmonth,","Time series output month,",4
```

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"tsrday,","Time series output day,",1
"tsrhour,","Time series output hour,",0
"tsrmin,","Time series output minutes,",0
"tsrfrequ,","Time series output frequency unit,",1
"tsrfreq,","Time series output frequency value,",1
"ntsrp,","Number of time series output points,",11
"tsri;tsrj;tsrnm;tsrnijpk;tsrnijpv,","Time series output
information,",ICell,JCell,Location names,Number of K, Number of Variables
"tsP1,","Point 1,",172,27,"T1,",30,0
"tsP2,","Point 2,",166,26,"T2,",0,0
"tsP3,","Point 3,",159,25,"T3,",0,0
"tsP4,","Point 4,",155,25,"T4,",0,0
"tsP5,","Point 5,",151,25,"T5,",0,0
"tsP6,","Point 6,",148,25,"T6,",0,0
"tsP7,","Point 7,",144,23,"T7,",0,0
"tsP8,","Point 8,",140,23,"T8,",0,0
"tsP9,","Point 9,",136,21,"T9,",0,0
"tsP10,","Point 10,",128,25,"T11,",0,0
"tsP11,","Point 11,",126,20,"T12,",0,0
"tsrk1,","Time series output number of K values and K layer values for
point
1,",30,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,2
6,27,28,29,30
"tsrk2,","Time series output number of K values and K layer values for
point 2,",0
"tsrk3,","Time series output number of K values and K layer values for
point 3,",0
"tsrk4,","Time series output number of K values and K layer values for
point 4,",0
"tsrk5,","Time series output number of K values and K layer values for
point 5,",0
"tsrk6,","Time series output number of K values and K layer values for
point 6,",0
"tsrk7,","Time series output number of K values and K layer values for
point 7,",0
"tsrk8,","Time series output number of K values and K layer values for
point 8,",0
"tsrk9,","Time series output number of K values and K layer values for
point 9,",0
"tsrk10,","Time series output number of K values and K layer values for
point 10,",0
"tsrk11,","Time series output number of K values and K layer values for
point 11,",0
"tsrv1,","Time series output number of output variables and variable IDs
for point 1,",0
"tsrv2,","Time series output number of output variables and variable IDs
for point 2,",0
"tsrv3,","Time series output number of output variables and variable IDs
for point 3,",0
"tsrv4,","Time series output number of output variables and variable IDs
for point 4,",0
"tsrv5,","Time series output number of output variables and variable IDs
for point 5,",0
"tsrv6,","Time series output number of output variables and variable IDs
for point 6,",0
"tsrv7,","Time series output number of output variables and variable IDs
for point 7,",0
"tsrv8,","Time series output number of output variables and variable IDs
for point 8,",0
"tsrv9,","Time series output number of output variables and variable IDs
for point 9,",0
"tsrv10,","Time series output number of output variables and variable IDs
for point 10,",0
"tsrv11,","Time series output number of output variables and variable IDs
for point 11,",0
"Stat3DTimeSeries,","Do stat analysis for 3D time series,",0
"DV3DTimeSeries,","Derived Variables for 3D time series,",0
"ProbPlumeTimeSeriesStatus,","Status to write probability plume data to
the time series output,",0
"WriteMetTimeSeries,","Switch to write meteorology variable output to time
series,",0
"TSOutputMetVars,","Numberof meteorology variables;Output meteorology
variable ID to time series,",0
"WriteICETimeSeries,","Write ice growth model output Variables,",0
"WriteWaveTimeSeries,","Write wave model output Variables,",0
"WriteTransportTimeSeries,","Write TRM model internal variables to time
series output,",0
"WriteWQMTimeSeries,","Write WQM model internal variables to time series
output,",0
"WriteSFMTimeSeries,","Write SFM model internal variables to time series
output,",0
```

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"WriteWQADDTimeSeries,","Write WQADD model internal variables to time
series output,",0
"WriteGAMTimeSeries,","Write GAM model internal variables to time series
output,",0
"WriteENMTimeSeries,","Write ENM model internal variables to time series
output,",0
"WriteUDCTimeSeries,","Write UDM model internal variables to time series
output,",0
"WriteCFMTimeSeries,","Write CFM model internal variables to time series
output,",0
"WriteSTMTimeSeries,","Write STM model internal variables to time series
output,",0
"WriteMGMTimeSeries,","Write MGM model internal variables to time series
output,",0
"WriteCKMTimeSeries,","Write CKM model internal variables to time series
output,",0
"WritePTMTimeSeries,","Write PTM model internal variables to time series
output,",0
"itrn,","Time series transport output selector,",0
########################################################################
# 14:      Vertical profile output variables,
########################################################################
"ivpf,","Vertical profile output selector,",0,4
########################################################################
# 15:      GPP contour output variables,
########################################################################
"igpp,","GPP output selector,",1,2.2
"igppss,","Ouput status,",1
"gppctmfile,","Contour output contour file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 03_01 NC_CTM.txt,"
"gpphdmfile,","Contour output header file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 03_01 NC_HDM.txt,"
"gppgrdfile,","Contour output element file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 03_01 NC_GRD.txt,"
"WritegppAtAllSurfaces,","Option to write output at all surface and
cells,", 1
"ngppkpk;gppkpk,","Number of GPP contour output K planes; output K plane
values,",0
"ngppjpj;gppjpj,","Number of GPP contour output J planes; output J plane
values,",0
"ngppipi;gppipi,","Number of GPP contour output I planes; output I plane
values,",0
"ngpp,","Number of GPP contour output times,",1
"gppyear,","GPP contour output year,",2008
"gppmonth,","GPP contour output month,",4
"gppday,","GPP contour output day,",1
"gpphour,","GPP contour output hour,",0
"gppmin,","GPP contour output minutes,",0
"gppfrequ,","GPP contour output frequency unit,",1
"gppfreq,","GPP contour output frequency value,",6
"ngppv; gppv,","GPP contour output number of  output variables for all
selected IJ cells; GPP contour output variable IDs for selected
location,",8,1,2,3,4,19,21,22,23
"Stat3DContour,","Do stat analysis for 3D contour,",0
"DV3DContour,","Derived Variables for 3D contour,",0
"ProbPlumeContourStatus,","Status to write probability plume data to the
contour output,",0
"WriteMetContour,","Switch to write meteorology variable output to GPP
contour,",0
"gppOutputMetVars,","Numberof meteorology variables;Output meteorology
variable ID to GPP contour,",0
"WriteICEContour,","Write ice growth model output Variables,",0
"WriteWaveContour,","Write wave model output Variables,",0
"WriteTransportContour,","Write TRM model internal variables to contour
output,",0
"WriteWQMContour,","Write WQM model internal variables to contour
output,",0
"WriteSFMContour,","Write SFM model internal variables to contour
output,",0
"WriteWQADDContour,","Write WQADD model internal variables to contour
output,",0
"WriteGAMContour,","Write GAM model internal variables to contour
output,",0
"WriteENMContour,","Write ENM model internal variables to contour
output,",0
"WriteUDCContour,","Write UDM model internal variables to contour
output,",0
"WriteCFMContour,","Write CFM model internal variables to contour
output,",0
"WriteSTMContour,","Write STM model internal variables to contour
output,",0
```

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"WriteMGMContour,","Write MGM model internal variables to contour
output,",0
"WriteCKMContour,","Write CKM model internal variables to contour
output,",0
"WritePTMContour,","Write PTM model internal variables to contour
output,",0
#########################################################################
# 16:       QualView velocity field output variables,
#########################################################################
"icvf,","Velocity field output for Qual View selector,",0
#########################################################################
# 17:       QualView contour output variables,
#########################################################################
"icnt,","Qual View contour output selector,",0
#########################################################################
# 18:       Current meter type output variables,
#########################################################################
"idcm,","Current meter type output selector,",0
#########################################################################
# 19:       TMDL Output Variables,
#########################################################################
"iTML,","TML output selector,",0,1.1
#########################################################################
# 20:       Oil Spil output variables,
#########################################################################
"iSVF,","Oil Spill output selector,",0
#########################################################################
#21:       User defined output variables 1,
#########################################################################
"iudo1,","User defined variable output selector1,",0
#########################################################################
#22:       User defined output variables 2,
#########################################################################
"iudo2,","User defined variable output selector2,",0
#########################################################################
#23:       User defined output variables 3,
#########################################################################
"iudo3,","User defined variable output selector3,",0
#########################################################################
#24:       User defined output variables 4,
#########################################################################
"iudo4,","User defined variable output selector4,",0
#########################################################################
#25:       User defined output variables 5,
#########################################################################
"iudo5,","User defined variable output selector5,",0
#########################################################################
# 26:       NCF NETCDF output variables,
#########################################################################
"iNCF,","NETCDF output selector,",0
#########################################################################
# 27: CFD output variables,
#########################################################################
"WriteCFDOutput;WriteCFDOutputS,","Switch to Turn on CFD output; Ouput
status,",0,0
#########################################################################
# 28:       Initial conditions; constant and spatial data,
#########################################################################
"iicff,","Initial condition far field file use,",0,2.5,27
"icffile,","Initial condition far field file,","No_Data_File,"
"icDoSTInterpolate,","Do Spatial and Temporal Interpolation,",0
"RestartToleranceTime,","Time toloerance for using restart file,",0
"AdjustICData,","Adjust initial conditoin data using data before the model
simulation time,",1
"NumInterpSerarchCycles,","Number of smoothening cycles,",1
"DoFourByFourSearch,","Switch to activate 4 nearby cells approach,",1
"DoEightByEightSearch,","Switch to activate 8 nearby cells approach,",1
"SmoothCoefficient,","Factor to control parent cell dependency,",0
"IPIStart,","Interpolation starting I cell index,",1
"IPIEnd,","Interpolation ending I cell index,",250
"IPJStart,","Interpolation starting J cell index,",1
"IPJEnd,","Interpolation ending J cell index,",50
"DoRecursiveSmoothening,","Do recursive smoothening on all cells,",0
"ICInterpolationScheme,","Initial condition interpolation scheme,",0
"IDWPOW,","Power for interpolation,",2
"ICGeoFileStatus,","Initial Condition Geo File Status,",0
"ICGeoFileName,","Initial Condition Geo File Name,","No_Data_File,"
"WFNorth,","Weighting factor in the north direction ,",1
"WFSouh,","Weighting factor in the south direction ,",1
"WFWest,","Weighting factor in the west direction ,",1
"WFEast,","Weighting factor in the east direction ,",1
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"WFNorthWest,","Weighting factor in the north west direction ,",1
"WFNorthEast,","Weighting factor in the north east direction ,",1
"WFSouthWest,","Weighting factor in the sout westh direction ,",1
"WFSouthEast,","Weighting factor in the south east direction ,",1
"ICGeoStnFileStatus,","Use field data stations look up file,",0
"ICGeoStnFileName,","Field data station look up file
name,","No_Data_File,"
"UseRT,","Use response temperature for background temperature,",1
"UseStnBGTemp,","Use field data station for setting up background
temperature,",0
"QuadInterpolationType,","Interpolation method for quadrilateral shape,",1
"DoPointInterpolation,","Use field station location for point
interpolation method,",1
"UseConstituentData,","Use constituent data only from restart file,",0
"UseOnlyVelocities,","Use only velocities and elevation,",0
"ConstituentStartTime,","Constituent start time from restart file,",39554
"FieldDataDepthType,","Field data depth measurement type,",1
"VBUseNumConstituents,","Number of constituents,",0
"UseTVICData,","Use time varying initial condition data,",0
"nicp,","Number of initial conditon points,", 2
"icpnm,","Constituent name; User does not change the name or the
order,",I_Temp,I_Saln
"icpid,","Initial condition id,",1,2
"ict,","Initial condition data type,",4,4
"icdsg,","SSFlow station number to be used for the specific
constituent,",1,1
"icifn,","File name for using it when ict value is set to 2,",
"icifn_1,","File name for using it for initial condition
1,","No_Data_File,"
"icifn_2,","File name for using it for initial condition
2,","No_Data_File,"
"icv,","Initial condition constituent value,",-99,-99
"icu,","Initial condition constituent unit when ict is set to 1,",-99,-99
"icstd,","Initial condition start date,","04/01/2008,","04/01/2008,"
"icstt,","Initial condition start time,","00:00,","00:00,"
"icxst,","Initial condition x starting location specified as I index,",1,1
"icxend,","Initial condition x ending location specified as I
index,",250,250
"icjst,","Initial condition y starting location specified as j index,",1,1
"icjend,","Initial condition y ending location specified as j
index,",50,50
"ickst,","Initial condition z starting location specified as k
index,",999,999
"ickend,","Initial condition z ending location specified as k index,",-
999,-999
"icswtype,","Initial condition type,",0,0
"ictvtype,","Initial condition time varying type,",0,0
######################################################################
# 28:     Initial conditions, Profile data,
######################################################################
"kmax,","number of k layers,", 50
"504.066,","Profile value at k = 1,",-99,-99
"503.066,","Profile value at k = 2,",-99,-99
"502.066,","Profile value at k = 3,",-99,-99
"501.066,","Profile value at k = 4,",-99,-99
"500.066,","Profile value at k = 5,",-99,-99
"499.066,","Profile value at k = 6,",-99,-99
"498.066,","Profile value at k = 7,",-99,-99
"497.066,","Profile value at k = 8,",-99,-99
"496.066,","Profile value at k = 9,",-99,-99
"495.066,","Profile value at k = 10,",-99,-99
"494.066,","Profile value at k = 11,",-99,-99
"493.066,","Profile value at k = 12,",-99,-99
"492.066,","Profile value at k = 13,",-99,-99
"491.066,","Profile value at k = 14,",-99,-99
"490.066,","Profile value at k = 15,",-99,-99
"489.066,","Profile value at k = 16,",-99,-99
"488.066,","Profile value at k = 17,",-99,-99
"487.066,","Profile value at k = 18,",-99,-99
"486.066,","Profile value at k = 19,",-99,-99
"485.066,","Profile value at k = 20,",-99,-99
"484.066,","Profile value at k = 21,",-99,-99
"483.066,","Profile value at k = 22,",-99,-99
"482.066,","Profile value at k = 23,",-99,-99
"481.066,","Profile value at k = 24,",-99,-99
"480.066,","Profile value at k = 25,",-99,-99
"479.066,","Profile value at k = 26,",-99,-99
"478.066,","Profile value at k = 27,",-99,-99
"477.066,","Profile value at k = 28,",-99,-99
"476.066,","Profile value at k = 29,",-99,-99
"475.066,","Profile value at k = 30,",-99,-99
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"474.066,","Profile value at k = 31,",-99,-99
"473.066,","Profile value at k = 32,",-99,-99
"472.066,","Profile value at k = 33,",-99,-99
"471.066,","Profile value at k = 34,",-99,-99
"470.066,","Profile value at k = 35,",-99,-99
"469.066,","Profile value at k = 36,",-99,-99
"468.066,","Profile value at k = 37,",-99,-99
"467.066,","Profile value at k = 38,",-99,-99
"466.066,","Profile value at k = 39,",-99,-99
"465.066,","Profile value at k = 40,",-99,-99
"464.066,","Profile value at k = 41,",-99,-99
"463.066,","Profile value at k = 42,",-99,-99
"462.066,","Profile value at k = 43,",-99,-99
"461.066,","Profile value at k = 44,",-99,-99
"460.066,","Profile value at k = 45,",-99,-99
"459.066,","Profile value at k = 46,",-99,-99
"458.066,","Profile value at k = 47,",-99,-99
"457.066,","Profile value at k = 48,",-99,-99
"456.066,","Profile value at k = 49,",-99,-99
"455.066,","Profile value at k = 50,",-99,-99
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Boundary conditions,
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"ndsg,","Number of ssflows,",6
"ndsgdtr,","Number of Distributed Networks,",0
"vbuse1,","Number of Boundary Conditions; Number of Fixed Variables and
Total Number of Variables,",6,52,67,1.9,37
"vbuse2,","Number of ssFlows for Current Boundary; BC Index,",1, 1
"vbuse3,","boundary condition mode,","Discharge,",Discharge
"dsgm,","Boundary Condition Mode,",0,0 : Discharge
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","Upstream,",Upstream
"dsgdt(1),","Input Data Type for Hydrodynamics,",1,1 : Constant
"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
Constant
"dsgifn(1),","TVD Input File Name for
Hydrodynamics,","No_Data_File,",No_Data_File
"dsgifn(2),","TVD Input File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
"dsgqfnst,","Use Qualifier File for Transport and Water Quality,",0,0
"dsgqfn,","Qualifier File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
"dsgip(1),","Time Varying Input Data Interpolation Scheme for H,",0,0 : No
Interpolation
"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
Interpolation
"dsgdc,","Grid Domain Type,",3,3 : 3D Model
"dsgwd,","Write Boundary Condition Data to Snapshot Output F,",1,1
"dsgstd,","Boundary Condition Start Date,","04/01/2008,",04/01/2008
"dsgstt,","Boundary Condition Start Time,","00:00,",00:00
"dsgendd,","Boundary Condition End Date,","04/21/2008,",04/21/2008
"dsgendt,","Boundary Condition End Time,","00:00,",00:00
"idsgst,","Starting Grid Cell Index in x-Direction,",210,210
"idsgend,","Ending Grid Cell Index in x-Direction,",210,210
"jdsgst,","Starting Grid Cell Index in y-Direction,",11,11
"jdsgend,","Ending Grid Cell Index in y-Direction,",35,35
"kdsgst,","Starting Vertical Layer Number in z-Direction,",999,999 : KT
"kdsgend,","Ending Vertical Layer Number in z-Direction,",-999,-999 : KB
"dsgcolor,","Selected Region Color,",12977694,12977694
"dsgrangess,","Selected Region Display Status,",1,1
"dsgdr,","Recirculation Boundary Condition Number,",0,0 : No Recirculation
"dsgvf,","Specific Momentum Amplification Factor,",1,1
"hdsgm,","Use Momentum Distribution for Vertical Discharge,",0,0
"fdsgd,","Hydrodynamic Flow / Load,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",1,1 : cfs
"fdsgv,","Hydrodynamic Mode Value,",12482,12482
"sdsg,","Discharge Conduit Shape,",-99,-99 : Not Used
"pdsg,","Discharge Conduit Angle from Positive z-Axis,",-99,Not Applicable
"tdsg,","Discharge Conduit Angle from Positive x-Axis,",-99,Not Applicable
"ldsg,","Discharge Conduit Length in meters,",-99,Not Applicable
"wdsg,","Discharge Conduit Width in meters,",-99,Not Applicable
"dsgnp,","Number of Ports in the Discharge Conduit,",-99,Not Applicable
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
"dsgstructurew,","Structure Width,",-99,Not Applicable
"dsgstructureu,","Structure Width Units,",-99,Not Applicable
"dsgFlowExp,","Flow Exponent,",-99,Not Applicable
"dsgFlowCoeff,","Flow Coefficient,",-99,Not Applicable
"dsgFlowDir,","Hydrodynamic Flow Direction,",-99,Not Applicable
"dsgFlowMode,","Hydrodynamic Mode,",-99,Not Applicable
"dsgFlowUnit,","Hydrodynamic Mode Unit,",-99,Not Applicable
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"dsgFlowValue,","Hydrodynamic Mode Value,",-99,Not Applicable
"dsgFlowHeadDiffFW,","Head Difference for Flow Withdrawal Using the
Stru,",-99,Not Applicable
"dsgFlowHeadDiffFWUnits,","Heade Difference Units for Flow Withdrawal,",-
99,Not Applicable
"dsgFlowHeadDiffFD,","Head Difference for Flow Discharge Using the
Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
99,Not Applicable
"dsgrt,","Hydrodynamic Mode Value Adjustment Factor,",1,1
"dsgrc(I_Temp),","Temperature Data Type,",0,0 : (I_Temp) Concentration
"dsgvu(I_Temp),","Temperature Unit / Status,",1,1 : F
"dsgv(I_Temp),","Temperature Value,",32,32
"dsgrc(I_Saln),","Salinity Data Type,",0,0 : (I_Saln) Concentration
"dsgvu(I_Saln),","Salinity  Unit / Status,",0,0 : ppt
"dsgv(I_Saln),","Salinity Value,",0.2,0.2
"dsgrc(I_IDye),","Instantaneous Dye Data Type,",0,0 : (I_IDye)
Concentration
"dsgvu(I_IDye),","Instantaneous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_IDye),","Instantaneous Dye Value,",0,0
"dsgrc(I_CDye),","Continuous Dye Data Type,",0,0 : (I_CDye) Concentration
"dsgvu(I_CDye),","Continuous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_CDye),","Continuous Dye Value,",0,0
"dsgrc(I_Exst),","Excess Temperature Data Type,",0,0 : (I_Exst)
Concentration
"dsgvu(I_Exst),","Excess Temperature  Unit / Status,",0,0 : deg C
"dsgv(I_Exst),","Excess Temperature Value,",0,0
"vbuse2,","Number of ssFlows for Current Boundary; BC Index,",1, 2
"vbuse3,","boundary condition mode,","Intake and Withdrawal,",Intake and
Withdrawal
"dsgm,","Boundary Condition Mode,",1,1 : Intake and Withdrawal
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","Downstream,",Downstream
"dsgdt(1),","Input Data Type for Hydrodynamics,",1,1 : Constant
"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
Constant
"dsgifn(1),","TVD Input File Name for
Hydrodynamics,","No_Data_File,",No_Data_File
"dsgifn(2),","TVD Input File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
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"dsgqfn,","Qualifier File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
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Interpolation
"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
Interpolation
"dsgdc,","Grid Domain Type,",3,3 : 3D Model
"dsgwd,","Write Boundary Condition Data to Snapshot Output F,",1,1
"dsgstd,","Boundary Condition Start Date,","04/01/2008,",04/01/2008
"dsgstt,","Boundary Condition Start Time,","00:00,",00:00
"dsgendd,","Boundary Condition End Date,","04/21/2008,",04/21/2008
"dsgendt,","Boundary Condition End Time,","00:00,",00:00
"idsgst,","Starting Grid Cell Index in x-Direction,",119,119
"idsgend,","Ending Grid Cell Index in x-Direction,",119,119
"jdsgst,","Starting Grid Cell Index in y-Direction,",17,17
"jdsgend,","Ending Grid Cell Index in y-Direction,",35,35
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"kdsgend,","Ending Vertical Layer Number in z-Direction,",-999,-999 : KB
"dsgcolor,","Selected Region Color,",6374311,6374311
"dsgrangess,","Selected Region Display Status,",1,1
"dsgdr,","Recirculation Boundary Condition Number,",1,1
"dsgvf,","Specific Momentum Amplification Factor,",1,1
"hdsgm,","Use Momentum Distribution for Vertical Discharge,",1,1 : Area
Based Flow Withdrawal
"fdsgd,","Hydrodynamic Flow / Load,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",1,1 : cfs
"fdsgv,","Hydrodynamic Mode Value,",12361,12361
"sdsg,","Discharge Conduit Shape,",-99,-99 : Not Used
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"tdsg,","Discharge Conduit Angle from Positive x-Axis,",-99,Not Applicable
"ldsg,","Discharge Conduit Length in meters,",-99,Not Applicable
"wdsg,","Discharge Conduit Width in meters,",-99,Not Applicable
"dsgnp,","Number of Ports in the Discharge Conduit,",-99,Not Applicable
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
"dsgstructurew,","Structure Width,",-99,Not Applicable
"dsgstructureu,","Structure Width Units,",-99,Not Applicable
"dsgFlowExp,","Flow Exponent,",-99,Not Applicable
"dsgFlowCoeff,","Flow Coefficient,",-99,Not Applicable
"dsgFlowDir,","Hydrodynamic Flow Direction,",-99,Not Applicable
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"dsgFlowValue,","Hydrodynamic Mode Value,",-99,Not Applicable
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"dsgFlowHeadDiffFWUnits,","Heade Difference Units for Flow Withdrawal,",-
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"dsgFlowHeadDiffFD,","Head Difference for Flow Discharge Using the
Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
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"dsgrt,","Hydrodynamic Mode Value Adjustment Factor,",-99,Not Applicable
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"dsgv(I_Temp),","Temperature Value,",-99,Not Applicable
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"dsgvu(I_Saln),","Salinity  Unit / Status,",-99,Not Applicable
"dsgv(I_Saln),","Salinity Value,",-99,Not Applicable
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Concentration
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"dsgv(I_IDye),","Instantaneous Dye Value,",-99,Not Applicable
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"dsgvu(I_CDye),","Continuous Dye Unit / Status,",-99,Not Applicable
"dsgv(I_CDye),","Continuous Dye Value,",-99,Not Applicable
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Concentration
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"dsgv(I_Exst),","Excess Temperature Value,",-99,Not Applicable
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Withdrawal
"dsgm,","Boundary Condition Mode,",1,1 : Intake and Withdrawal
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","SSES_In,",SSES_In
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"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
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"dsgifn(2),","TVD Input File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
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"dsgqfn,","Qualifier File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
"dsgip(1),","Time Varying Input Data Interpolation Scheme for H,",0,0 : No
Interpolation
"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
Interpolation
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"dsgendt,","Boundary Condition End Time,","00:00,",00:00
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"dsgrangess,","Selected Region Display Status,",1,1
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"dsgvf,","Specific Momentum Amplification Factor,",1,1
"hdsgm,","Use Momentum Distribution for Vertical Discharge,",1,1 : Area
Based Flow Withdrawal
"fdsgd,","Hydrodynamic Flow / Load,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",3,3 : gpm
"fdsgv,","Hydrodynamic Mode Value,",42300,42300
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"tdsg,","Discharge Conduit Angle from Positive x-Axis,",-99,Not Applicable
"ldsg,","Discharge Conduit Length in meters,",-99,Not Applicable
"wdsg,","Discharge Conduit Width in meters,",-99,Not Applicable
"dsgnp,","Number of Ports in the Discharge Conduit,",-99,Not Applicable
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
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"dsgstructureu,","Structure Width Units,",-99,Not Applicable
"dsgFlowExp,","Flow Exponent,",-99,Not Applicable
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"dsgFlowCoeff,","Flow Coefficient,",-99,Not Applicable
"dsgFlowDir,","Hydrodynamic Flow Direction,",-99,Not Applicable
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"dsgFlowValue,","Hydrodynamic Mode Value,",-99,Not Applicable
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"dsgFlowHeadDiffFWUnits,","Heade Difference Units for Flow Withdrawal,",-
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Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
99,Not Applicable
"dsgrt,","Hydrodynamic Mode Value Adjustment Factor,",-99,Not Applicable
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"dsgv(I_Temp),","Temperature Value,",-99,Not Applicable
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"dsgvu(I_CDye),","Continuous Dye Unit / Status,",-99,Not Applicable
"dsgv(I_CDye),","Continuous Dye Value,",-99,Not Applicable
"dsgrc(I_Exst),","Excess Temperature Data Type,",0,0 : (I_Exst)
Concentration
"dsgvu(I_Exst),","Excess Temperature  Unit / Status,",-99,Not Applicable
"dsgv(I_Exst),","Excess Temperature Value,",-99,Not Applicable
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"vbuse3,","boundary condition mode,","Discharge,",Discharge
"dsgm,","Boundary Condition Mode,",0,0 : Discharge
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","SSES_Ou,",SSES_Ou
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"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
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Qualit,","No_Data_File,",No_Data_File
"dsgip(1),","Time Varying Input Data Interpolation Scheme for H,",0,0 : No
Interpolation
"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
Interpolation
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"dsgstt,","Boundary Condition Start Time,","00:00,",00:00
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"kdsgend,","Ending Vertical Layer Number in z-Direction,",-999,-999 : KB
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"dsgrangess,","Selected Region Display Status,",1,1
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"dsgvf,","Specific Momentum Amplification Factor,",1,1
"hdsgm,","Use Momentum Distribution for Vertical Discharge,",0,0
"fdsgd,","Hydrodynamic Flow / Load,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",3,3 : gpm
"fdsgv,","Hydrodynamic Mode Value,",11200,11200
"sdsg,","Discharge Conduit Shape,",1,1 : Circular
"pdsg,","Discharge Conduit Angle from Positive z-Axis,",135,135
"tdsg,","Discharge Conduit Angle from Positive x-Axis,",270,270
"ldsg,","Discharge Conduit Length in meters,",0.1016,0.1016
"wdsg,","Discharge Conduit Width in meters,",0.1016,0.1016
"dsgnp,","Number of Ports in the Discharge Conduit,",72,72
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
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"dsgstructureu,","Structure Width Units,",-99,Not Applicable
"dsgFlowExp,","Flow Exponent,",-99,Not Applicable
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"dsgFlowHeadDiffFWUnits,","Heade Difference Units for Flow Withdrawal,",-
99,Not Applicable
"dsgFlowHeadDiffFD,","Head Difference for Flow Discharge Using the
Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
99,Not Applicable
"dsgrt,","Hydrodynamic Mode Value Adjustment Factor,",1,1
"dsgrc(I_Temp),","Temperature Data Type,",1,1 : (I_Exst) Concentration
"dsgvu(I_Temp),","Temperature Unit / Status,",1,1 : deg F
"dsgv(I_Temp),","Temperature Value,",31,31
"dsgrc(I_Saln),","Salinity Data Type,",0,0 : (I_Saln) Concentration
"dsgvu(I_Saln),","Salinity  Unit / Status,",0,0 : ppt
"dsgv(I_Saln),","Salinity Value,",0.4,0.4
"dsgrc(I_IDye),","Instantaneous Dye Data Type,",0,0 : (I_IDye)
Concentration
"dsgvu(I_IDye),","Instantaneous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_IDye),","Instantaneous Dye Value,",100,100
"dsgrc(I_CDye),","Continuous Dye Data Type,",0,0 : (I_CDye) Concentration
"dsgvu(I_CDye),","Continuous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_CDye),","Continuous Dye Value,",0,0
"dsgrc(I_Exst),","Excess Temperature Data Type,",0,0 : (I_Exst)
Concentration
"dsgvu(I_Exst),","Excess Temperature  Unit / Status,",1,1 : deg F
"dsgv(I_Exst),","Excess Temperature Value,",31,31
"vbuse2,","Number of ssFlows for Current Boundary; BC Index,",1, 5
"vbuse3,","boundary condition mode,","Intake and Withdrawal,",Intake and
Withdrawal
"dsgm,","Boundary Condition Mode,",1,1 : Intake and Withdrawal
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","BBNPP_In,",BBNPP_In
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"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
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Interpolation
"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
Interpolation
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"jdsgend,","Ending Grid Cell Index in y-Direction,",35,35
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"dsgrangess,","Selected Region Display Status,",1,1
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"dsgvf,","Specific Momentum Amplification Factor,",1,1
"hdsgm,","Use Momentum Distribution for Vertical Discharge,",1,1 : Area
Based Flow Withdrawal
"fdsgd,","Hydrodynamic Flow / Load,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",3,3 : gpm
"fdsgv,","Hydrodynamic Mode Value,",34458,34458
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"tdsg,","Discharge Conduit Angle from Positive x-Axis,",-99,Not Applicable
"ldsg,","Discharge Conduit Length in meters,",-99,Not Applicable
"wdsg,","Discharge Conduit Width in meters,",-99,Not Applicable
"dsgnp,","Number of Ports in the Discharge Conduit,",-99,Not Applicable
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
"dsgstructurew,","Structure Width,",-99,Not Applicable
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Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
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"dsgrt,","Hydrodynamic Mode Value Adjustment Factor,",-99,Not Applicable
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Concentration
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"dsgv(I_IDye),","Instantaneous Dye Value,",-99,Not Applicable
"dsgrc(I_CDye),","Continuous Dye Data Type,",0,0 : (I_Cdye) Concentration
"dsgvu(I_CDye),","Continuous Dye Unit / Status,",-99,Not Applicable
"dsgv(I_CDye),","Continuous Dye Value,",-99,Not Applicable
"dsgrc(I_Exst),","Excess Temperature Data Type,",0,0 : (I_Exst)
Concentration
"dsgvu(I_Exst),","Excess Temperature  Unit / Status,",-99,Not Applicable
"dsgv(I_Exst),","Excess Temperature Value,",-99,Not Applicable
"vbuse2,","Number of ssFlows for Current Boundary; BC Index,",1, 6
"vbuse3,","boundary condition mode,","Discharge,",Discharge
"dsgm,","Boundary Condition Mode,",0,0 : Discharge
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","BBnPP_Ou,",BBnPP_Ou
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"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
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"dsgrangess,","Selected Region Display Status,",1,1
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"hdsgm,","Use Momentum Distribution for Vertical Discharge,",0,0
"fdsgd,","Hydrodynamic Flow / Load,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",3,3 : gpm
"fdsgv,","Hydrodynamic Mode Value,",11172,11172
"sdsg,","Discharge Conduit Shape,",1,1 : Circular
"pdsg,","Discharge Conduit Angle from Positive z-Axis,",135,135
"tdsg,","Discharge Conduit Angle from Positive x-Axis,",270,270
"ldsg,","Discharge Conduit Length in meters,",0.1016,0.1016
"wdsg,","Discharge Conduit Width in meters,",0.1016,0.1016
"dsgnp,","Number of Ports in the Discharge Conduit,",72,72
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
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"dsgFlowHeadDiffFD,","Head Difference for Flow Discharge Using the
Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
99,Not Applicable
"dsgrt,","Hydrodynamic Mode Value Adjustment Factor,",1,1
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"dsgrc(I_Saln),","Salinity Data Type,",0,0 : (I_Saln) Concentration
"dsgvu(I_Saln),","Salinity  Unit / Status,",0,0 : ppt
"dsgv(I_Saln),","Salinity Value,",0.4,0.4
"dsgrc(I_IDye),","Instantaneous Dye Data Type,",0,0 : (I_IDye)
Concentration
"dsgvu(I_IDye),","Instantaneous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_IDye),","Instantaneous Dye Value,",0,0
"dsgrc(I_CDye),","Continuous Dye Data Type,",0,0 : (I_CDye) Concentration
"dsgvu(I_CDye),","Continuous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_CDye),","Continuous Dye Value,",100,100
"dsgrc(I_Exst),","Excess Temperature Data Type,",0,0 : (I_Exst)
Concentration
"dsgvu(I_Exst),","Excess Temperature  Unit / Status,",1,1 : deg F
"dsgv(I_Exst),","Excess Temperature Value,",33.81,33.81
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-WQM,
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iwqc,","Water Quality Model Type ID; Name; Number of parameters; number
of regions; number of variables,",0,"Not Used",0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-SFM,
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"isnec,","Sediment Model Type ID; Name; Number of parameters; Number of
regions; number of variables,",0,"Not Used",0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-WQADD
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iwqaddc,","Water Quality ADD switch; number of variables; Number of
parameters; Number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-GAM
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iGAM,","Algae Model: Switch; Number of Algae; Number of Variables for
Each Algae; number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-CFM
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iCFM,","Bacteria Model: Switch; Number of Bacterias; Number of parameters
for Each Bacteria; Number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-UDF
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iUDC,","User Defined Model: Switch; Number of variables; Number of
parameters for Each Coliform; Number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-ENT
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iENT,","Entrainment Model: Switch; Number of Entrainments; Number of
Paraments for Each Variables; Number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-STM
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"istc,","Sediment Transport Model Computations: Switch; Number of
Entrainments; Number of Paraments for Each Variables; Number of
regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-MGM
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iMGM,","Macrophytes Model: Switch; Number of Macrophytes; Number of
Variables for Each Macrophytes; number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for Chlorine Kinetics module-CKM
```

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$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iCKM,","Chlorine Kinetics Module: Module tpe; Number of variables; Number
of parameters for each variable; Number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Particle Transport Variables for GEMSS-PTM,
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iPTM,","particle transport model computations,",0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Miscellaneous data,
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"vbusel,","Number of columns and rows,",4,0
```

Scenario 04

```
$GEMSSModelResults,32
$GEMSS-SHWETControlFile,4.24
$Creation Date: 4/16/2008
$Waterbody Name: Susquehanna 3
$Modeler Name: SP
#########################################################################
# 1:     Scenario variables,
#########################################################################
"IntGDS,","Option to use GEMSS data structure,", 1
"Scenario,","Scenario file path and name,","C:\GEMSS\APPS\Susquehanna
3\Output\Scenario 04_01 NC,"
"DoText2MDBConversion,","Use Scenario Output Direct Database
converion,",1,1
"ZipOutputFile,","Zip text output files after creating the database,",0,0
"DoCompUsingGEMSSOutput,","Run Model Using Existing GEMSS Contour Output
Text Files,", 0
"GEMSSHDMInputFile,","Existing GEMSS Contour Output Header Text
Files,","","
#########################################################################
# 2:     Grid variables,
#########################################################################
"igrid,","Switch to read grid data from a file,",1,1
"GridFile,","Grid file name,","C:\GEMSS\APPS\Susquehanna
3\Grid\Susquehanna River 05 474Min.g3g,","4/23/2008 12:36:08
PM,","4/28/2008 12:20:10 PM,"
"InputHDatumUnit,","Input grid data is in geographic coordinate system
switch,",0
"UseLinearConversionIn,","Use linear conversion for input grid data,",1
"cstypeIn,","Input coordinate conversion mode,",0
"cscodeIn,","Input coordinate conversion zone number,",0,None
"csdatumIn,","Input UTM datum,",0
"InputVDatumUnit,","Input grid data is in geographic coordinate system
switch,",0
"OutputHDatumUnit,","Output grid data is in geographic coordinate system
switch,",0
"UseLinearConversionOut,","Use linear conversion for output grid data,",1
"cstypeOut,","Output coordinate conversion mode,",0
"cscodeOut,","Output coordinate conversion zone number,",0,None
"csdatumOut,","Output UTM datum,",0
"OutputVDatumUnit,","Output grid data is in geographic coordinate system
switch,",0
"iupmgrid,","Switch to set up different k layers,",0
"km_p,","Vertical array size,",-99
"nzds,","Number of vertical layer domains,",-99
"nzdstr,","Starting vertical layer number for each domain,",-99
"nzend,","Ending vertical layer number for each domain,",-99
"dzd,","Layer thickness in each domain,",-99
"igpsfmt,","Switch to write grid file gps format for use in ArcView,",0
"elioption,","Switch to Use TVD From Boundary Condition File or Initial
elevation,", 0
"eli,","Initial elevation,",486.80
"iwbs,","Waterbody switches,", 1
"eldatum,","Reference elevation of 3rd layer in meters,",0
"UseSigmaStretching,","Switch to Use Sigma stretching,",0
"NSLevel,","Number of Sigma Levels,",0
"SigDistType,","Sigma Layer Distribution type,",0
"Slevel,","User Defined Sigma Distribution,",0.0
"ZtoSigmaBCDepthTransform,","Use BC Depth Transformation from Vertical to
Sigma Level,",0
"SmoothBathy,","Switch to Perform Bathymetry Smoothening,",0
"SlpMax,","Maximum  Allowable Slope for bathymetry smoothening,",0
"NSmoothCycle,","Number of Smoothening Cycles,",0
#########################################################################
#3:     Meteorological variables,
#########################################################################
"MetDataType,","Switch to use Meteorological time varying data; VB Use
verion; Number of Meteorology variables,",0,2.2,14
```

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"metss,","Use Meteorological data in current simulation status,",1
"Metfile1,","Meteorological time varying data input file
name,","No_Data_File,"
"metinterp,","Switch to perform interpolation on met data,",0
"ievap;EvapScaleFactor,","Switch for evaporation;Evaporation scale
facotr,",1,1
"iwndhyd,","Use wind in hydrodynamics computations,",0
"ta,","temperature of air C,",21,0
"td,","Dew point temperature C,",13,0
"twb,","Wet bulb temperature C,",13,0
"rt,","response temperature C,",20,0
"phi,","Wind direction degrees,",90
"wad,","Wind speed m/sec,",5, 0
"cc,","Cloud coverage Octal,",2
"solrad,","Solar radiation W/m^2,",120,0
"ps,","Atmoshpheric pressure mm of Hg,",760
"ishe,","Surace heat exchange method,",1
"KEMethod,","Method to Compute K and E,",0
"cshe,","Coefficient of surface heat exchange w/m2/C,",13.71
"te,","Equlibrium temperature C;",34,1
"secchi,","Secchi depth; light transmission depth m,",-99
"rsts,","Vegetative and Topographic Shading Factor; 0 to 1.0,",-99
"wscoef,","Wind sheltering coefficient; 0 to 1.0,",-99
"iwsf,","Wind speed function,",1
"MetInterpolationMethod,","Met Interpolation Method,",0
"IDWPOW,","Exponent value for inverse weighting scheme,",0
"MetVarInterpSwitch;MetVarInterp,","Met Individuall interpolatey switch
and interpolation methods,",0
*************************************************************************
*  Meteorological Scale Factor Variables,
*************************************************************************
"UseMetRegionSF;MetRegionSFSS,","Met factor switch,",0,0
*************************************************************************
*  Meteorological Dynamic Shading Variables,
*************************************************************************
"UseDSHDRegionSF;DSHDRegionSFSS,","Met dynamic shading switch,",0,0
*************************************************************************
*  Icel Growth Model Variables,
*************************************************************************
"UseIGModel;UseIGModelStatus,","Switch to control the use of ice growth
model and status,",0,0
*************************************************************************
*  Wave Model Variables,
*************************************************************************
"iwvc;iwvcss,","Wave model activation switch and status,",0,0
#########################################################################
# 4:     Constituents,
#########################################################################
"itrc,","Transport switch; computation status; number of variables,",1,1,5
"iwqc,","Water quality model type; computation status; number of
variables,",0,0,0
"iwqaddc,","Water quality ADD model switch; computations status; number of
variables,",0,0,0
"iGAMc,","Algae model computations; status,",0,0
"nGAMs,","Number of algae,",0,1
"UseGAMInsideWQM,","Use Generalized Algae Model inside Water Quality
Model,",0
"isnec,","Sediment nutrient exchange computations,",0,0
"iPTM,","Particle transport model computations,",0,0
"istc,","Sediment transport model computations,",0,0
"nstcs,","Number of sediment transport type,",0,1
"ientc,","Entrainment computations,",0,0
"nezones,","Number of entrainment zones,",0,1
"iatc,","Optional to add more constituents,",0,0
"natc,","Number of additional constituents,",0,1
"icfmc,","Coliform Bacteria Model computations,",0,0
"ncfmcs,","Number of coliform bacteria type,",0
"iCKMc;iCKMcss,","Chlorine kinetics Model computations and status,",0,0
"nCKMc,","Number of chlorine kinetics type,",0
"iMGM;iMGMss,","Macrophyte grouth model computations and status,",0,0
"nMGMs,","Number of macrophyte type,",0,1
"UseMGMInsideWQM,","Use Macrophyte Grouth Model inside Water Quality
Model,",0
"WriteTransportOutput,","Write TRM model internal variables to GEMSS
output output,",0
"WriteWQMOutput,","Write WQM model internal variables to GEMSS output
output,",0
"WriteSFMOutput,","Write SFM model internal variables to GEMSS output
output,",0
"WriteWQADDOutput,","Write WQADD model internal variables to GEMSS output
output,",0
```

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"WriteGAMOutput,","Write GAM model internal variables to GEMSS output
output,",0
"WriteENMOutput,","Write ENM model internal variables to GEMSS output
output,",0
"WriteUDCOutput,","Write UDM model internal variables to GEMSS output
output,",0
"WriteCFMOutput,","Write CFM model internal variables to GEMSS output
output,",0
"WriteSTMOutput,","Write STM model internal variables to GEMSS output
output,",0
"WriteMGMOutput,","Write MGM model internal variables to GEMSS output
output,",0
"WriteCKMOutput,","Write CKM model internal variables to GEMSS output
output,",0
"WritePTMOutput,","Write PTM model internal variables to GEMSS output
output,",0
"cnum,","Number of Constituents,",5
"Index,","Model Name,","Identifier; Cannot be Modified,","User Given
Name,","Activity of Constituent,","Output Time,","Units,","Transport
Switch,"
"C0,","Transport,",I_Temp,"I_Temp,",1,1,1,1
"C1,","Transport,",I_Saln,"I_Saln,",1,1,0,1
"C2,","Transport,",I_lDye,"I_lDye,",1,1,0,1
"C3,","Transport,",I_CDye,"I_CDye,",1,1,0,1
"C4,","Transport,",I_Exst,"I_Exst,",1,1,1,1
#########################################################################
# 5:     Model switches,
#########################################################################
"Use3DModel,","Switch to control 3D model simulations,",1,3.7
"issflw,","switch on/off ssflow input data that is available in the
sscontrol.csv,",1
"itrcs,","transport computation algorithm switch,",1
"udwtf,","advection theta in z-direction,",0
"vdwft,","diffusion theta in z-direction,",0
"HOTSIniTime,","HOTS initization time period,",-99
"itrbs,","Turbulence scheme,",1
"itrbsm,","Turbulence sub model,",1
"itrbparam,","Turbulence parameters,",0,1,1,2.44,2.44,0.9,0.5,1,2.53
"imxls,","Mixing length scheme,",1
"ihmdcx,","momentum diffusion coefficient scheme selector in x-
direction,",2
"ihmdcy,","momentum diffusion coefficient scheme selector in y-
direction,",2
"hmdcx,","momentum diffusion coefficient in x-direction
m2/sec,",0.00584,1.1
"hmdcy,","momentum diffusion coefficient in y-direction
m2/sec,",0.00584,1.1
"prnm,","Prandtl number,",10
"ihtdcx,","transport diffusion coefficient scheme in x-direction,",3
"ihtdcy,","transport diffusion coefficient scheme in y-direction,",3
"htdcx,","transport diffusion coefficient in x-direction m2/sec,",,
"htdcy,","transport diffusion coefficient in y-direction m2/sec,",,
"idnf,","Density function selector,",2
"ideep,","Compressibility usage,",1
"ichezy,","Chezy coefficient selector,",0
"ilchezy,","Limiting Chezy selector,",0
"chezy,","Chezy coefficient; Czo;do;n,",40,,
"WSCoeffType,","Wind stress coefficient type,",0
"WSConstA,","Wind stress constant A,",0.8
"WSConstB,","Wind stress constant B,",0.065
"icors,","Coriolis force selector,",0
"RefLatOption;RefLat,","Referene Latitude Option; Reference Latitude
Value,",0,40
"ivaterms,","Vertical acceleration terms,",0
"idbg,","Debug switch,",0
"tvdscheck,","time varying data consistency check,",0
"iWDLayers,","Use wetting and drying of layers,",1
"lraddthk,","Layer addition thickness m,",0.8
"lrsubthk,","Layer subtraction thickness m,",0.8
"StabilizeInversionFlag,","StabilizeInversionFlag,",0
"InvCoeff,","InvCoeff,",-99
"iUsed1DModel,","Switch to use 1D model; Switch grid has 1D model,",0,0,1
"ComputeStat,","Statisdtical method to output variables,",0
"StatFreq;StatUnit,","Statisdtical frequency and unit to write output
variables,",0,0
"StatStartTime,","Start time for statistical computations,",39539
"StatEndTime,","End time for statistical computations,",39543
"ReturnTime1DDn,","Return time,",0
"UseZCheck,","Control z calculations,",0
"ZStabilityFactor,","Stability factor for z,",0
```

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"CheckTimeStepUsingNewValues,","Redo computations using new time step
values,",0
"UseWindRamp,","Use time ramp function for larger wind speeds,",0
"NumWindRampLevels,","Number of time step intervale for the wind ramp
function,",1
"RampLimitWindSpeed,","Limiting wind speed for the usege of time ramp
function,",0
"WriteBCTVD,","Write boundary condition time varying data files in time
Series output files,",0
"WriteBCLoads,","Write boundary condition data as loads in time series
output files,",0
"WriteSDTVD,","Write sediment data time varying data files in time series
outoput files,",0
"SSDataType,","Source and sinks data type for use in boundary conditon
data writing procedure,",1
"iDo1DHDM,","Do 1D hydrodynamics,",1
"iSetdt1DAsdt,","Set 1D model time step same as 3D model,",0
"ZAmplitication Factor,","Z amplification factor for stability checks,",4
"CGCLimit1,","Conjugate Gradient Computation Error Limit 1,",1,-7
"CGCLimit2,","Conjugate Gradient Computation Error Limit 2,",1,-9
"UseRampFlowFunction,","Use ramp flow function to stabilize the model
simulation,",0
"NumRampFlowBCs,","Number of ramp flow boundary conditions,",0,
"SaveCSDataInArray,","Convert cross-section data to depth vs width
array,",0
"DelHforCS,","Depth interval for depth vs width array computations,",0.1
"HDMVersionNumber,","Use far-field/near-field modeling approach,",0
"CapitolLakeVarsSwi,","Switch for Capitol lake variables,",0,0
#########################################################################
# 6:       Simulation time variables,
#########################################################################
"stryear,","Model start time year,",2008
"strmonth,","Model srart time month,",4
"strday,","Model start time day,",1
"strhour,","Model start hour,",0
"strmin,","Model start minutes,",0
"endyear,","Model end time year,",2008
"endmonth,","Model end month year,",4
"endday,","Model end day,",21
"endhour,","Model end hour,",0
"endmin,","Model end minutes,",0
"MaxTimeSlots,","Maximun number of output time slots used in outputs,",2
"idltt,","Time step control switch,",0,1
"dltminm,","Minimum time step,",60
"dltlimit,","Start Up time step,",60
"omega,","Time step under relaxation factor,",0.75
#########################################################################
# 7:      Derived variables,
#########################################################################
"idv,","Option to use derived variables computations,",0
#########################################################################
# 8:      Probability Plume variables,
#########################################################################
"ComputeProPlume,","Computation of Probability Plume,",0
#########################################################################
# 9:      Snapshot output variables,
#########################################################################
"isnp,","Snapshot output selector,",1,2.2
"isnpss,","Ouput status,",1
"snpfile,","Snapshot output file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 04_01 NC.snp,"
"iMetInfo,","Switch to write meteorology to snapshot output,",0
"iVolumeBalance,","Volume Balance switch,",1
"iMassBalance,","Mass Balance switch,",0
"nsnp,","Number of snapshot output times,",2
"snpyear,","Snapshot output year,",2008,2008
"snpmonth,","Snapshot output month,",4,4
"snpday,","Snapshot output day,",1,3
"snphour,","Snapshot output hour,",0,0
"snpmin,","Snapshot output minutes,",0,0
"snpfrequ,","Snapshot output frequency unit,",1,2
"snpfreq,","Snapshot output frequency value,",1,1
"nsnpkpk;kpk,","Number of snapshot output K planes; output K plane
values,",1,51
"nsnpkpkv;kpv,","Number of snapshot output variables for selected K
planes; output variable ID values,",6,1,19,20,21,22,23
"nsnpjpj;jpj,","Number of snapshot output J planes; output J plane
values,",0
"nsnpjpjv;jpv,","Number of snapshot outputvariables for selected J planes;
output variable ID values,",0
```

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"nsnpipi;ipi,","Number of snapshot output I planes; output I plane
values,",0
"nsnpipiv;ipv,","Number of snapshot output variables for selected I
planes; output variable ID values,",0
"nsnpijpij,","Number of snapshot output I J points,",0
"snpijpi;snpijpj;snpijpnm,","Snapshot output
information,",ICell,JCell,Location names
"nsnpijpv;ijpv,","Snapshot output number of output variables for all
selected IJ cells; output variable IDs for all selected IJ cells,",0
"HydVar,","Hydrodynamic constituent name,",Surface Elevation,U -
velocity,V - Velocity,W - Velocity,Density,Momentum Diffusivity,Chezy,Flow
Rate
"hdunits,","Constituent unit type,",0,0,0,0,0,0,0,0
"hdamp,","Scaling factor,",100,1,1,1,1,10000,1,1
"hddigits,","Number of digits to print in the snapshot,",2,2,2,2,2,2,2,2
Scaling factor, No. of digits, ConstituentID, Constituent name, Output
Type, Units
1,2,I_Temp,I_Temp,1 : Concentration,0 : C
1,2,I_Saln,I_Saln,1 : Concentration,0 : ppt
1,2,I_lDye,I_lDye,1 : Concentration,0 : mg/l
1,2,I_CDye,I_CDye,1 : Concentration,0 : mg/l
1,2,I_Exst,I_Exst,1 : Concentration,0 : deg C
"Stat3DSnapShot,","Do stat analysis for 3D SnapShot,",0
"DV3DSnapShot,","Derived Variables for 3D ShapShot,",0
"ProbPlumeSnapshotStatus,","Status to write probability plume data to the
snapshot output,",0
"WriteMetSnapshot,","Switch to write meteorology variable output to
snapshot,",0
"SnpOutputMetVars,","Numberof meteorology variables;Output meteorology
variable ID to snapshot,",0
"WriteICESnapshot,","Write ice growth model output variables,",0
"WriteWaveSnapshot,","Write wave model output variables,",0
"WriteTransportSnapshot,","Write TRM model internal variables to snapshot
output,",0
"WriteWQMSnapshot,","Write WQM model internal variables to snapshot
output,",0
"WriteSFMSnapshot,","Write SFM model internal variables to snapshot
output,",0
"WriteWQADDSnapshot,","Write WQADD model internal variables to snapshot
output,",0
"WriteGAMSnapshot,","Write GAM model internal variables to snapshot
output,",0
"WriteENMSnapshot,","Write ENM model internal variables to snapshot
output,",0
"WriteUDCSnapshot,","Write UDM model internal variables to snapshot
output,",0
"WriteCFMSnapshot,","Write CFM model internal variables to snapshot
output,",0
"WriteSTMSnapshot,","Write STM model internal variables to snapshot
output,",0
"WriteMGMSnapshot,","Write MGM model internal variables to snapshot
output,",0
"WriteCKMSnapshot,","Write CKM model internal variables to snapshot
output,",0
"WritePTMSnapshot,","Write PTM model internal variables to snapshot
output,",0
########################################################################
# 10:      Console output variables,
########################################################################
"icle,","Console output selector,",1,1.1
"icless,","Ouput status,",1
"ncle,","Number of console ouput times,",2
"cleyear,","Console output year,",2008,2008
"clemonth,","Console output month,",4,4
"cleday,","Console output day,",1,1
"clehour,","Console output hour,",0,2
"clemin,","Console output minutes,",0,0
"clefrequ,","Console output frequency unit,",0,1
"clefreq,","Console output frequency value,",1,1
"nclep,","Number of Console output I J points,",1
"clei;clej;clenm;clenijpk;clenijpv,","Console output
information,",ICell,JCell,Location names,Number of K, Number of Variables
"cleP1,","Point 1,",119,17,"C1,",1,1
"clek1,","Console output number of K values and K layer values for point
1,",1,30
"clev1,","Console output number of output variables and variable IDs for
point 1,",1,1
"Stat3DConsole,","Do stat analysis for 3D Console,",0
"DV3DConsole,","Derived Variables for 3D Console,",0
"WriteICEConsole,","Write ice growth model output variables,",0
"WriteWaveConsole,","Write wave model output variables,",0
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"WriteTransportConsole,","Write TRM model internal variables to console
output,",0
"WriteWQMConsole,","Write WQM model internal variables to console
output,",0
"WriteSFMConsole,","Write SFM model internal variables to console
output,",0
"WriteWQADDConsole,","Write WQADD model internal variables to console
output,",0
"WriteGAMConsole,","Write GAM model internal variables to console
output,",0
"WriteENMConsole,","Write ENM model internal variables to console
output,",0
"WriteUDCConsole,","Write UDM model internal variables to console
output,",0
"WriteCFMConsole,","Write CFM model internal variables to console
output,",0
"WriteSTMConsole,","Write STM model internal variables to console
output,",0
"WriteMGMConsole,","Write MGM model internal variables to console
output,",0
"WriteCKMConsole,","Write CKM model internal variables to console
output,",0
"WritePTMConsole,","Write PTM model internal variables to console
output,",0
##########################################################################
# 11:     Diagnostic output variables,
##########################################################################
"idgn,","Diagnostic output selector,",0
##########################################################################
# 12:     Restart output variables,
##########################################################################
"irst,","Restart output selector,",0
##########################################################################
# 13:     Time series output variables,
##########################################################################
"itsr,","Time series output selector,",1,4.2
"itsrss,","Ouput status,",1
"tsrfile,","Time series output file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 04_01 NC_TSM.txt,"
"ntsr,","Number of time steries output times,",1
"tsryear,","Time series output year,",2008
"tsrmonth,","Time series output month,",4
"tsrday,","Time series output day,",1
"tsrhour,","Time series output hour,",0
"tsrmin,","Time series output minutes,",0
"tsrfrequ,","Time series output frequency unit,",1
"tsrfreq,","Time series output frequency value,",1
"ntsrp,","Number of time series output points,",11
"tsri;tsrj;tsrnm;tsrnijpk;tsrnijpv,","Time series output
information,",ICell,JCell,Location names,Number of K, Number of Variables
"tsP1,","Point 1,",172,27,"T1,",30,0
"tsP2,","Point 2,",166,26,"T2,",0,0
"tsP3,","Point 3,",159,25,"T3,",0,0
"tsP4,","Point 4,",155,25,"T4,",0,0
"tsP5,","Point 5,",151,25,"T5,",0,0
"tsP6,","Point 6,",148,25,"T6,",0,0
"tsP7,","Point 7,",144,23,"T7,",0,0
"tsP8,","Point 8,",140,23,"T8,",0,0
"tsP9,","Point 9,",136,21,"T9,",0,0
"tsP10,","Point 10,",128,25,"T11,",0,0
"tsP11,","Point 11,",126,20,"T12,",0,0
"tsrk1,","Time series output number of K values and K layer values for
point
1,",30,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,2
6,27,28,29,30
"tsrk2,","Time series output number of K values and K layer values for
point 2,",0
"tsrk3,","Time series output number of K values and K layer values for
point 3,",0
"tsrk4,","Time series output number of K values and K layer values for
point 4,",0
"tsrk5,","Time series output number of K values and K layer values for
point 5,",0
"tsrk6,","Time series output number of K values and K layer values for
point 6,",0
"tsrk7,","Time series output number of K values and K layer values for
point 7,",0
"tsrk8,","Time series output number of K values and K layer values for
point 8,",0
"tsrk9,","Time series output number of K values and K layer values for
point 9,",0
```

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"tsrk10,","Time series output number of K values and K layer values for
point 10,",0
"tsrk11,","Time series output number of K values and K layer values for
point 11,",0
"tsrv1,","Time series output number of output variables and variable IDs
for point 1,",0
"tsrv2,","Time series output number of output variables and variable IDs
for point 2,",0
"tsrv3,","Time series output number of output variables and variable IDs
for point 3,",0
"tsrv4,","Time series output number of output variables and variable IDs
for point 4,",0
"tsrv5,","Time series output number of output variables and variable IDs
for point 5,",0
"tsrv6,","Time series output number of output variables and variable IDs
for point 6,",0
"tsrv7,","Time series output number of output variables and variable IDs
for point 7,",0
"tsrv8,","Time series output number of output variables and variable IDs
for point 8,",0
"tsrv9,","Time series output number of output variables and variable IDs
for point 9,",0
"tsrv10,","Time series output number of output variables and variable IDs
for point 10,",0
"tsrv11,","Time series output number of output variables and variable IDs
for point 11,",0
"Stat3DTimeSeries,","Do stat analysis for 3D time series,",0
"DV3DTimeSeries,","Derived Variables for 3D time series,",0
"ProbPlumeTimeSeriesStatus,","Status to write probability plume data to
the time series output,",0
"WriteMetTimeSeries,","Switch to write meteorology variable output to time
series,",0
"TSOutputMetVars,","Numberof meteorology variables;Output meteorology
variable ID to time series,",0
"WriteICETimeSeries,","Write ice growth model output Variables,",0
"WriteWaveTimeSeries,","Write wave model output Variables,",0
"WriteTransportTimeSeries,","Write TRM model internal variables to time
series output,",0
"WriteWQMTimeSeries,","Write WQM model internal variables to time series
output,",0
"WriteSFMTimeSeries,","Write SFM model internal variables to time series
output,",0
"WriteWQADDTimeSeries,","Write WQADD model internal variables to time
series output,",0
"WriteGAMTimeSeries,","Write GAM model internal variables to time series
output,",0
"WriteENMTimeSeries,","Write ENM model internal variables to time series
output,",0
"WriteUDCTimeSeries,","Write UDM model internal variables to time series
output,",0
"WriteCFMTimeSeries,","Write CFM model internal variables to time series
output,",0
"WriteSTMTimeSeries,","Write STM model internal variables to time series
output,",0
"WriteMGMTimeSeries,","Write MGM model internal variables to time series
output,",0
"WriteCKMTimeSeries,","Write CKM model internal variables to time series
output,",0
"WritePTMTimeSeries,","Write PTM model internal variables to time series
output,",0
"itrn,","Time series transport output selector,",0
#########################################################################
# 14:      Vertical profile output variables,
#########################################################################
"ivpf,","Vertical profile output selector,",0,4
#########################################################################
# 15:      GPP contour output variables,
#########################################################################
"igpp,","GPP output selector,",1,2.2
"igppss,","Ouput status,",1
"gppctmfile,","Contour output contour file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 04_01 NC_CTM.txt,"
"gpphdmfile,","Contour output header file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 04_01 NC_HDM.txt,"
"gppgrdfile,","Contour output element file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 04_01 NC_GRD.txt,"
"WritegppAtAllSurfaces,","Option to write output at all surface and
cells,", 1
"ngppkpk;gppkpk,","Number of GPP contour output K planes; output K plane
values,",0
```

```
"ngppjpj;gppjpj,","Number of GPP contour output J planes; output J plane
values,",0
"ngppipi;gppipi,","Number of GPP contour output I planes; output I plane
values,",0
"ngpp,","Number of GPP contour output times,",1
"gppyear,","GPP contour output year,",2008
"gppmonth,","GPP contour output month,",4
"gppday,","GPP contour output day,",1
"gpphour,","GPP contour output hour,",0
"gppmin,","GPP contour output minutes,",0
"gppfrequ,","GPP contour output frequency unit,",1
"gppfreq,","GPP contour output frequency value,",6
"ngppv; gppv,","GPP contour output number of  output variables for all
selected IJ cells; GPP contour output variable IDs for selected
location,",8,1,2,3,4,19,21,22,23
"Stat3DContour,","Do stat analysis for 3D contour,",0
"DV3DContour,","Derived Variables for 3D contour,",0
"ProbPlumeContourStatus,","Status to write probability plume data to the
contour output,",0
"WriteMetContour,","Switch to write meteorology variable output to GPP
contour,",0
"gppOutputMetVars,","Numberof meteorology variables;Output meteorology
variable ID to GPP contour,",0
"WriteICEContour,","Write ice growth model output variables,",0
"WriteWaveContour,","Write wave model output variables,",0
"WriteTransportContour,","Write TRM model internal variables to contour
output,",0
"WriteWQMContour,","Write WQM model internal variables to contour
output,",0
"WriteSFMContour,","Write SFM model internal variables to contour
output,",0
"WriteWQADDContour,","Write WQADD model internal variables to contour
output,",0
"WriteGAMContour,","Write GAM model internal variables to contour
output,",0
"WriteENMContour,","Write ENM model internal variables to contour
output,",0
"WriteUDCContour,","Write UDM model internal variables to contour
output,",0
"WriteCFMContour,","Write CFM model internal variables to contour
output,",0
"WriteSTMContour,","Write STM model internal variables to contour
output,",0
"WriteMGMContour,","Write MGM model internal variables to contour
output,",0
"WriteCKMContour,","Write CKM model internal variables to contour
output,",0
"WritePTMContour,","Write PTM model internal variables to contour
output,",0
##########################################################################
# 16:      QualView velocity field output variables,
##########################################################################
"icvf,","Velocity field output for Qual View selector,",0
##########################################################################
# 17:      QualView contour output variables,
##########################################################################
"icnt,","Qual View contour output selector,",0
##########################################################################
# 18:      Current meter type output variables,
##########################################################################
"idcm,","Current meter type output selector,",0
##########################################################################
# 19:      TMDL Output Variables,
##########################################################################
"iTML,","TML output selector,",0,1.1
##########################################################################
# 20:      Oil Spil output variables,
##########################################################################
"iSVF,","Oil Spill output selector,",0
##########################################################################
#21:      User defined output variables 1,
##########################################################################
"iudo1,","User defined variable output selector1,",0
##########################################################################
#22:      User defined output variables 2,
##########################################################################
"iudo2,","User defined variable output selector2,",0
##########################################################################
#23:      User defined output variables 3,
##########################################################################
"iudo3,","User defined variable output selector3,",0
```

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##########################################################################
#24:      User defined output variables 4,
##########################################################################
"iudo4,","User defined variable output selector4,",0
##########################################################################
#25:      User defined output variables 5,
##########################################################################
"iudo5,","User defined variable output selector5,",0
##########################################################################
# 26:     NCF NETCDF output variables,
##########################################################################
"iNCF,","NETCDF output selector,",0
##########################################################################
# 27: CFD output variables,
##########################################################################
"WriteCFDOutput;WriteCFDOutputS,","Switch to Turn on CFD output; Ouput
status,",0,0
##########################################################################
# 28:     Initial conditions; constant and spatial data,
##########################################################################
"iicff,","Initial condition far field file use,",0,2.5,27
"icffile,","Initial condition far field file,","No_Data_File,"
"icDoSTInterpolate,","Do Spatial and Temporal Interpolation,",0
"RestartToleranceTime,","Time toloerance for using restart file,",0
"AdjustICData,","Adjust initial conditoin data using data before the model
simulation time,",1
"NumInterpSerarchCycles,","Number of smoothening cycles,",1
"DoFourByFourSearch,","Switch to activate 4 nearby cells approach,",1
"DoEightByEightSearch,","Switch to activate 8 nearby cells approach,",1
"SmoothCoefficient,","Factor to control parent cell dependency,",0
"IPIStart,","Interpolation starting I cell index,",1
"IPIEnd,","Interpolation ending I cell index,",250
"IPJStart,","Interpolation starting J cell index,",1
"IPJEnd,","Interpolation ending J cell index,",50
"DoRecursiveSmoothening,","Do recursive smoothening on all cells,",0
"ICInterpolationScheme,","Initial condition interpolation scheme,",0
"IDWPOW,","Power for interpolation,",2
"ICGeoFileStatus,","Initial Condition Geo File Status,",0
"ICGeoFileName,","Initial Condition Geo File Name,","No_Data_File,"
"WFNorth,","Weighting factor in the north direction ,",1
"WFSouh,","Weighting factor in the south direction ,",1
"WFWest,","Weighting factor in the west direction ,",1
"WFEast,","Weighting factor in the east direction ,",1
"WFNorthWest,","Weighting factor in the north west direction ,",1
"WFNorthEast,","Weighting factor in the north east direction ,",1
"WFSouthWest,","Weighting factor in the sout westh direction ,",1
"WFSouthEast,","Weighting factor in the south east direction ,",1
"ICGeoStnFileStatus,","Use field data stations look up file,",0
"ICGeoStnFileName,","Field data station look up file
name,","No_Data_File,"
"UseRT,","Use response temperature for background temperature,",1
"UseStnBGTemp,","Use field data station for setting up background
temperature,",0
"QuadInterpolationType,","Interpolation method for quadrilateral shape,",1
"DoPointInterpolation,","Use field station location for point
interpolation method,",1
"UseConstituentData,","Use constituent data only from restart file,",0
"UseOnlyVelocities,","Use only velocities and elevation,",0
"ConstituentStartTime,","Constituent start time from restart file,",39554
"FielDataDepthType,","Field data depth measurement type,",1
"VBUseNumConstituents,","Number of constituents,",0
"UseTVICData,","Use time varying initial condition data,",0
"nicp,","Number of initial conditon points,", 2
"icpnm,","Constituent name; User does not change the name or the
order,",I_Temp,I_Saln
"icpid,","Initial condition id,",1,2
"ict,","Initial condition data type,",4,4
"icdsg,","SSFlow station number to be used for the specific
constituent,",1,1
"icifn,","File name for using it when ict value is set to 2,",
"icifn_1,","File name for using it for initial condition
1,","No_Data_File,"
"icifn_2,","File name for using it for initial condition
2,","No_Data_File,"
"icv,","Initial condition constituent value,",-99,-99
"icu,","Initial condition constituent unit when ict is set to 1,",-99,-99
"icstd,","Initial condition start date,","04/01/2008,","04/01/2008,"
"icstt,","Initial condition start time,","00:00,","00:00,"
"icxst,","Initial condition x starting location specified as I index,",1,1
"icxend,","Initial condition x ending location specified as I
index,",250,250
```

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"icjst,","Initial condition y starting location specified as j index,",1,1
"icjend,","Initial condition y ending location specified as j
index,",50,50
"ickst,","Initial condition z starting location specified as k
index,",999,999
"ickend,","Initial condition z ending location specified as k index,",-
999,-999
"icswtype,","Initial condition type,",0,0
"ictvtype,","Initial condition time varying type,",0,0
######################################################################
# 28:     Initial conditions, Profile data,
######################################################################
"kmax,","number of k layers,", 50
"504.066,","Profile value at k = 1,",-99,-99
"503.066,","Profile value at k = 2,",-99,-99
"502.066,","Profile value at k = 3,",-99,-99
"501.066,","Profile value at k = 4,",-99,-99
"500.066,","Profile value at k = 5,",-99,-99
"499.066,","Profile value at k = 6,",-99,-99
"498.066,","Profile value at k = 7,",-99,-99
"497.066,","Profile value at k = 8,",-99,-99
"496.066,","Profile value at k = 9,",-99,-99
"495.066,","Profile value at k = 10,",-99,-99
"494.066,","Profile value at k = 11,",-99,-99
"493.066,","Profile value at k = 12,",-99,-99
"492.066,","Profile value at k = 13,",-99,-99
"491.066,","Profile value at k = 14,",-99,-99
"490.066,","Profile value at k = 15,",-99,-99
"489.066,","Profile value at k = 16,",-99,-99
"488.066,","Profile value at k = 17,",-99,-99
"487.066,","Profile value at k = 18,",-99,-99
"486.066,","Profile value at k = 19,",-99,-99
"485.066,","Profile value at k = 20,",-99,-99
"484.066,","Profile value at k = 21,",-99,-99
"483.066,","Profile value at k = 22,",-99,-99
"482.066,","Profile value at k = 23,",-99,-99
"481.066,","Profile value at k = 24,",-99,-99
"480.066,","Profile value at k = 25,",-99,-99
"479.066,","Profile value at k = 26,",-99,-99
"478.066,","Profile value at k = 27,",-99,-99
"477.066,","Profile value at k = 28,",-99,-99
"476.066,","Profile value at k = 29,",-99,-99
"475.066,","Profile value at k = 30,",-99,-99
"474.066,","Profile value at k = 31,",-99,-99
"473.066,","Profile value at k = 32,",-99,-99
"472.066,","Profile value at k = 33,",-99,-99
"471.066,","Profile value at k = 34,",-99,-99
"470.066,","Profile value at k = 35,",-99,-99
"469.066,","Profile value at k = 36,",-99,-99
"468.066,","Profile value at k = 37,",-99,-99
"467.066,","Profile value at k = 38,",-99,-99
"466.066,","Profile value at k = 39,",-99,-99
"465.066,","Profile value at k = 40,",-99,-99
"464.066,","Profile value at k = 41,",-99,-99
"463.066,","Profile value at k = 42,",-99,-99
"462.066,","Profile value at k = 43,",-99,-99
"461.066,","Profile value at k = 44,",-99,-99
"460.066,","Profile value at k = 45,",-99,-99
"459.066,","Profile value at k = 46,",-99,-99
"458.066,","Profile value at k = 47,",-99,-99
"457.066,","Profile value at k = 48,",-99,-99
"456.066,","Profile value at k = 49,",-99,-99
"455.066,","Profile value at k = 50,",-99,-99
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Boundary conditions,
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"ndsg,","Number of ssflows,",6
"ndsgdtr,","Number of Distributed Networks,",0
"vbuse1,","Number of Boundary Conditions; Number of Fixed Variables and
Total Number of Variables,",6,52,67,1.9,37
"vbuse2,","Number of ssFlows for Current Boundary; BC Index,",1, 1
"vbuse3,","boundary condition mode,","Discharge,",Discharge
"dsgm,","Boundary Condition Mode,",0,0 : Discharge
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","Upstream,",Upstream
"dsgdt(1),","Input Data Type for Hydrodynamics,",1,1 : Constant
"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
Constant
"dsgifn(1),","TVD Input File Name for
Hydrodynamics,","No_Data_File,",No_Data_File
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"dsgifn(2),","TVD Input File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
"dsgqfnst,","Use Qualifier File for Transport and Water Quality,",0,0
"dsgqfn,","Qualifier File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
"dsgip(1),","Time Varying Input Data Interpolation Scheme for H,",0,0 : No
Interpolation
"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
Interpolation
"dsgdc,","Grid Domain Type,",3,3 : 3D Model
"dsgwd,","Write Boundary Condition Data to Snapshot Output F,",1,1
"dsgstd,","Boundary Condition Start Date,","04/01/2008,",04/01/2008
"dsgstt,","Boundary Condition Start Time,","00:00,",00:00
"dsgendd,","Boundary Condition End Date,","04/21/2008,",04/21/2008
"dsgendt,","Boundary Condition End Time,","00:00,",00:00
"idsgst,","Starting Grid Cell Index in x-Direction,",210,210
"idsgend,","Ending Grid Cell Index in x-Direction,",210,210
"jdsgst,","Starting Grid Cell Index in y-Direction,",11,11
"jdsgend,","Ending Grid Cell Index in y-Direction,",35,35
"kdsgst,","Starting Vertical Layer Number in z-Direction,",999,999 : KT
"kdsgend,","Ending Vertical Layer Number in z-Direction,",-999,-999 : KB
"dsgcolor,","Selected Region Color,",12977694,12977694
"dsgrangess,","Selected Region Display Status,",1,1
"dsgdr,","Hydrodynamic Mode Value Adjustment Factor,",0,0 : No
Recirculation
"dsgvf,","Specific Momentum Amplification Factor,",1,1
"hdsgm,","Method of Flow Withdrawal from Layers,",0,0
"fdsgd,","Hydrodynamic Flow Direction,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",1,1 : cfs
"fdsgv,","Hydrodynamic Mode Value,",2848,2848
"sdsg,","Intake Conduit Shape,",-99,-99 : Not Used
"pdsg,","Intake Conduit Angle from Positive z-Axis,",-99,Not Applicable
"tdsg,","Intake Conduit Angle from Positive x-Axis,",-99,Not Applicable
"ldsg,","Intake Conduit Length in Meters,",-99,Not Applicable
"wdsg,","Intake Conduit Width,",-99,Not Applicable
"dsgnp,","Number of Ports in the Discharge Conduit,",-99,Not Applicable
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
"dsgstructurew,","Structure Width,",-99,Not Applicable
"dsgstructureu,","Structure Width Units,",-99,Not Applicable
"dsgFlowExp,","Flow Exponent,",-99,Not Applicable
"dsgFlowCoeff,","Flow Coefficient,",-99,Not Applicable
"dsgFlowDir,","Hydrodynamic Flow Direction,",-99,Not Applicable
"dsgFlowMode,","Hydrodynamic Mode,",-99,Not Applicable
"dsgFlowUnit,","Hydrodynamic Mode Unit,",-99,Not Applicable
"dsgFlowValue,","Hydrodynamic Mode Value,",-99,Not Applicable
"dsgFlowHeadDiffFW,","Head Difference for Flow Withdrawal Using the
Stru,",-99,Not Applicable
"dsgFlowHeadDiffFWUnits,","Heade Difference Units for Flow Withdrawal,",-
99,Not Applicable
"dsgFlowHeadDiffFD,","Head Difference for Flow Discharge Using the
Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
99,Not Applicable
"dsgrt,","Hydrodynamic Mode Value Adjustment Factor,",1,1
"dsgrc(I_Temp),","Temperature Data Type,",0,0 : (I_Temp) Concentration
"dsgvu(I_Temp),","Temperature Unit / Status,",1,1 : F
"dsgv(I_Temp),","Temperature Value,",32,32
"dsgrc(I_Saln),","Salinity Data Type,",0,0 : (I_Saln) Concentration
"dsgvu(I_Saln),","Salinity  Unit / Status,",0,0 : ppt
"dsgv(I_Saln),","Salinity Value,",0.2,0.2
"dsgrc(I_IDye),","Instantaneous Dye Data Type,",0,0 : (I_IDye)
Concentration
"dsgvu(I_IDye),","Instantaneous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_IDye),","Instantaneous Dye Value,",0,0
"dsgrc(I_CDye),","Continuous Dye Data Type,",0,0 : (I_CDye) Concentration
"dsgvu(I_CDye),","Continuous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_CDye),","Continuous Dye Value,",0,0
"dsgrc(I_Exst),","Excess Temperature Data Type,",0,0 : (I_Exst)
Concentration
"dsgvu(I_Exst),","Excess Temperature  Unit / Status,",0,0 : deg C
"dsgv(I_Exst),","Excess Temperature Value,",0,0
"vbuse2,","Number of ssFlows for Current Boundary; BC Index,",1, 2
"vbuse3,","boundary condition mode,","Intake and Withdrawal,",Intake and
Withdrawal
"dsgm,","Boundary Condition Mode,",1,1 : Intake and Withdrawal
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","Downstream,",Downstream
"dsgdt(1),","Input Data Type for Hydrodynamics,",1,1 : Constant
"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
Constant
```

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"dsgifn(1),","TVD Input File Name for
Hydrodynamics,","No_Data_File,",No_Data_File
"dsgifn(2),","TVD Input File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
"dsgqfnst,","Use Qualifier File for Transport and Water Quality,",0,0
"dsgqfn,","Qualifier File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
"dsgip(1),","Time Varying Input Data Interpolation Scheme for H,",0,0 : No
Interpolation
"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
Interpolation
"dsgdc,","Grid Domain Type,",3,3 : 3D Model
"dsgwd,","Write Boundary Condition Data to Snapshot Output F,",1,1
"dsgstd,","Boundary Condition Start Date,","04/01/2008,",04/01/2008
"dsgstt,","Boundary Condition Start Time,","00:00,",00:00
"dsgendd,","Boundary Condition End Date,","04/21/2008,",04/21/2008
"dsgendt,","Boundary Condition End Time,","00:00,",00:00
"idsgst,","Starting Grid Cell Index in x-Direction,",119,119
"idsgend,","Ending Grid Cell Index in x-Direction,",119,119
"jdsgst,","Starting Grid Cell Index in y-Direction,",17,17
"jdsgend,","Ending Grid Cell Index in y-Direction,",35,35
"kdsgst,","Starting Vertical Layer Number in z-Direction,",999,999 : KT
"kdsgend,","Ending Vertical Layer Number in z-Direction,",-999,-999 : KB
"dsgcolor,","Selected Region Color,",6374311,6374311
"dsgrangess,","Selected Region Display Status,",1,1
"dsgdr,","Hydrodynamic Mode Value Adjustment Factor,",1,1
"dsgvf,","Specific Momentum Amplification Factor,",1,1
"hdsgm,","Method of Flow Withdrawal from Layers,",1,1 : Area Based Flow
Withdrawal
"fdsgd,","Hydrodynamic Flow Direction,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",1,1 : cfs
"fdsgv,","Hydrodynamic Mode Value,",2727,2727
"sdsg,","Intake Conduit Shape,",-99,-99 : Not Used
"pdsg,","Intake Conduit Angle from Positive z-Axis,",-99,Not Applicable
"tdsg,","Intake Conduit Angle from Positive x-Axis,",-99,Not Applicable
"ldsg,","Intake Conduit Length in Meters,",-99,Not Applicable
"wdsg,","Intake Conduit Width,",-99,Not Applicable
"dsgnp,","Number of Ports in the Discharge Conduit,",-99,Not Applicable
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
"dsgstructurew,","Structure Width,",-99,Not Applicable
"dsgstructureu,","Structure Width Units,",-99,Not Applicable
"dsgFlowExp,","Flow Exponent,",-99,Not Applicable
"dsgFlowCoeff,","Flow Coefficient,",-99,Not Applicable
"dsgFlowDir,","Hydrodynamic Flow Direction,",-99,Not Applicable
"dsgFlowMode,","Hydrodynamic Mode,",-99,Not Applicable
"dsgFlowUnit,","Hydrodynamic Mode Unit,",-99,Not Applicable
"dsgFlowValue,","Hydrodynamic Mode Value,",-99,Not Applicable
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Stru,",-99,Not Applicable
"dsgFlowHeadDiffFWUnits,","Heade Difference Units for Flow Withdrawal,",-
99,Not Applicable
"dsgFlowHeadDiffFD,","Head Difference for Flow Discharge Using the
Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
99,Not Applicable
"dsgrt,","Hydrodynamic Mode Value Adjustment Factor,",-99,Not Applicable
"dsgrc(I_Temp),","Temperature Data Type,",0,0 : (I_Temp) Concentration
"dsgvu(I_Temp),","Temperature Unit / Status,",-99,Not Applicable
"dsgv(I_Temp),","Temperature Value,",-99,Not Applicable
"dsgrc(I_Saln),","Salinity Data Type,",0,0 : (I_Saln) Concentration
"dsgvu(I_Saln),","Salinity  Unit / Status,",-99,Not Applicable
"dsgv(I_Saln),","Salinity Value,",-99,Not Applicable
"dsgrc(I_IDye),","Instantaneous Dye Data Type,",0,0 : (I_IDye)
Concentration
"dsgvu(I_IDye),","Instantaneous Dye Unit / Status,",-99,Not Applicable
"dsgv(I_IDye),","Instantaneous Dye Value,",-99,Not Applicable
"dsgrc(I_CDye),","Continuous Dye Data Type,",0,0 : (I_Cdye) Concentration
"dsgvu(I_CDye),","Continuous Dye Unit / Status,",-99,Not Applicable
"dsgv(I_CDye),","Continuous Dye Value,",-99,Not Applicable
"dsgrc(I_Exst),","Excess Temperature Data Type,",0,0 : (I_Exst)
Concentration
"dsgvu(I_Exst),","Excess Temperature  Unit / Status,",-99,Not Applicable
"dsgv(I_Exst),","Excess Temperature Value,",-99,Not Applicable
"vbuse2,","Number of ssFlows for Current Boundary; BC Index,",1, 3
"vbuse3,","boundary condition mode,","Intake and Withdrawal,",Intake and
Withdrawal
"dsgm,","Boundary Condition Mode,",1,1 : Intake and Withdrawal
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","SSES_In,",SSES_In
"dsgdt(1),","Input Data Type for Hydrodynamics,",1,1 : Constant
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"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
Constant
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Qualit,","No_Data_File,",No_Data_File
"dsgqfnst,","Use Qualifier File for Transport and Water Quality,",0,0
"dsgqfn,","Qualifier File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
"dsgip(1),","Time Varying Input Data Interpolation Scheme for H,",0,0 : No
Interpolation
"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
Interpolation
"dsgdc,","Grid Domain Type,",3,3 : 3D Model
"dsgwd,","Write Boundary Condition Data to Snapshot Output F,",1,1
"dsgstd,","Boundary Condition Start Date,","04/01/2008,",04/01/2008
"dsgstt,","Boundary Condition Start Time,","00:00,",00:00
"dsgendd,","Boundary Condition End Date,","04/21/2008,",04/21/2008
"dsgendt,","Boundary Condition End Time,","00:00,",00:00
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"idsgend,","Ending Grid Cell Index in x-Direction,",182,182
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"jdsgend,","Ending Grid Cell Index in y-Direction,",35,35
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"dsgrangess,","Selected Region Display Status,",1,1
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"dsgvf,","Specific Momentum Amplification Factor,",1,1
"hdsgm,","Method of Flow Withdrawal from Layers,",1,1 : Area Based Flow
Withdrawal
"fdsgd,","Hydrodynamic Flow Direction,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",3,3 : gpm
"fdsgv,","Hydrodynamic Mode Value,",42300,42300
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"tdsg,","Intake Conduit Angle from Positive x-Axis,",-99,Not Applicable
"ldsg,","Intake Conduit Length in Meters,",-99,Not Applicable
"wdsg,","Intake Conduit Width,",-99,Not Applicable
"dsgnp,","Number of Ports in the Discharge Conduit,",-99,Not Applicable
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
"dsgstructurew,","Structure Width,",-99,Not Applicable
"dsgstructureu,","Structure Width Units,",-99,Not Applicable
"dsgFlowExp,","Flow Exponent,",-99,Not Applicable
"dsgFlowCoeff,","Flow Coefficient,",-99,Not Applicable
"dsgFlowDir,","Hydrodynamic Flow Direction,",-99,Not Applicable
"dsgFlowMode,","Hydrodynamic Mode,",-99,Not Applicable
"dsgFlowUnit,","Hydrodynamic Mode Unit,",-99,Not Applicable
"dsgFlowValue,","Hydrodynamic Mode Value,",-99,Not Applicable
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"dsgFlowHeadDiffFWUnits,","Heade Difference Units for Flow Withdrawal,",-
99,Not Applicable
"dsgFlowHeadDiffFD,","Head Difference for Flow Discharge Using the
Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
99,Not Applicable
"dsgrt,","Hydrodynamic Mode Value Adjustment Factor,",-99,Not Applicable
"dsgrc(I_Temp),","Temperature Data Type,",0,0 : (I_Temp) Concentration
"dsgvu(I_Temp),","Temperature Unit / Status,",-99,Not Applicable
"dsgv(I_Temp),","Temperature Value,",-99,Not Applicable
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"dsgvu(I_Saln),","Salinity  Unit / Status,",-99,Not Applicable
"dsgv(I_Saln),","Salinity Value,",-99,Not Applicable
"dsgrc(I_IDye),","Instantaneous Dye Data Type,",0,0 : (I_IDye)
Concentration
"dsgvu(I_IDye),","Instantaneous Dye Unit / Status,",-99,Not Applicable
"dsgv(I_IDye),","Instantaneous Dye Value,",-99,Not Applicable
"dsgrc(I_CDye),","Continuous Dye Data Type,",0,0 : (I_Cdye) Concentration
"dsgvu(I_CDye),","Continuous Dye Unit / Status,",-99,Not Applicable
"dsgv(I_CDye),","Continuous Dye Value,",-99,Not Applicable
"dsgrc(I_Exst),","Excess Temperature Data Type,",0,0 : (I_Exst)
Concentration
"dsgvu(I_Exst),","Excess Temperature  Unit / Status,",-99,Not Applicable
"dsgv(I_Exst),","Excess Temperature Value,",-99,Not Applicable
"vbuse2,","Number of ssFlows for Current Boundary; BC Index,",1, 4
"vbuse3,","boundary condition mode,","Discharge,",Discharge
"dsgm,","Boundary Condition Mode,",0,0 : Discharge
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","SSES_Ou,",SSES_Ou
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"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
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Qualit,","No_Data_File,",No_Data_File
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"dsgqfn,","Qualifier File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
"dsgip(1),","Time Varying Input Data Interpolation Scheme for H,",0,0 : No
Interpolation
"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
Interpolation
"dsgdc,","Grid Domain Type,",3,3 : 3D Model
"dsgwd,","Write Boundary Condition Data to Snapshot Output F,",1,1
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"dsgstt,","Boundary Condition Start Time,","00:00,",00:00
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"dsgendt,","Boundary Condition End Time,","00:00,",00:00
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"jdsgend,","Ending Grid Cell Index in y-Direction,",27,27
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"kdsgend,","Ending Vertical Layer Number in z-Direction,",-999,-999 : KB
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"dsgrangess,","Selected Region Display Status,",1,1
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"dsgvf,","Specific Momentum Amplification Factor,",1,1
"hdsgm,","Method of Flow Withdrawal from Layers,",0,0
"fdsgd,","Hydrodynamic Flow Direction,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",3,3 : gpm
"fdsgv,","Hydrodynamic Mode Value,",11200,11200
"sdsg,","Intake Conduit Shape,",1,1 : Circular
"pdsg,","Intake Conduit Angle from Positive z-Axis,",135,135
"tdsg,","Intake Conduit Angle from Positive x-Axis,",270,270
"ldsg,","Intake Conduit Length in Meters,",0.1016,0.1016
"wdsg,","Intake Conduit Width,",0.1016,0.1016
"dsgnp,","Number of Ports in the Discharge Conduit,",72,72
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
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"dsgstructureu,","Structure Width Units,",-99,Not Applicable
"dsgFlowExp,","Flow Exponent,",-99,Not Applicable
"dsgFlowCoeff,","Flow Coefficient,",-99,Not Applicable
"dsgFlowDir,","Hydrodynamic Flow Direction,",-99,Not Applicable
"dsgFlowMode,","Hydrodynamic Mode,",-99,Not Applicable
"dsgFlowUnit,","Hydrodynamic Mode Unit,",-99,Not Applicable
"dsgFlowValue,","Hydrodynamic Mode Value,",-99,Not Applicable
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Stru,",-99,Not Applicable
"dsgFlowHeadDiffFWUnits,","Heade Difference Units for Flow Withdrawal,",-
99,Not Applicable
"dsgFlowHeadDiffFD,","Head Difference for Flow Discharge Using the
Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
99,Not Applicable
"dsgrt,","Hydrodynamic Mode Value Adjustment Factor,",1,1
"dsgrc(I_Temp),","Temperature Data Type,",1,1 : (I_Exst) Concentration
"dsgvu(I_Temp),","Temperature Unit / Status,",1,1 : deg F
"dsgv(I_Temp),","Temperature Value,",31,31
"dsgrc(I_Saln),","Salinity Data Type,",0,0 : (I_Saln) Concentration
"dsgvu(I_Saln),","Salinity  Unit / Status,",0,0 : ppt
"dsgv(I_Saln),","Salinity Value,",0.4,0.4
"dsgrc(I_IDye),","Instantaneous Dye Data Type,",0,0 : (I_IDye)
Concentration
"dsgvu(I_IDye),","Instantaneous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_IDye),","Instantaneous Dye Value,",100,100
"dsgrc(I_CDye),","Continuous Dye Data Type,",0,0 : (I_CDye) Concentration
"dsgvu(I_CDye),","Continuous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_CDye),","Continuous Dye Value,",0,0
"dsgrc(I_Exst),","Excess Temperature Data Type,",0,0 : (I_Exst)
Concentration
"dsgvu(I_Exst),","Excess Temperature  Unit / Status,",1,1 : deg F
"dsgv(I_Exst),","Excess Temperature Value,",31,31
"vbuse2,","Number of ssFlows for Current Boundary; BC Index,",1, 5
"vbuse3,","boundary condition mode,","Intake and Withdrawal,",Intake and
Withdrawal
"dsgm,","Boundary Condition Mode,",1,1 : Intake and Withdrawal
"dsgss,","Boundary Condition Status,",1,1
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"dsgnm,","Boundary Condition Name,","BBNPP_In,",BBNPP_In
"dsgdt(1),","Input Data Type for Hydrodynamics,",1,1 : Constant
"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
Constant
"dsgifn(1),","TVD Input File Name for
Hydrodynamics,","No_Data_File,",No_Data_File
"dsgifn(2),","TVD Input File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
"dsgqfnst,","Use Qualifier File for Transport and Water Quality,",0,0
"dsgqfn,","Qualifier File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
"dsgip(1),","Time Varying Input Data Interpolation Scheme for H,",0,0 : No
Interpolation
"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
Interpolation
"dsgdc,","Grid Domain Type,",3,3 : 3D Model
"dsgwd,","Write Boundary Condition Data to Snapshot Output F,",1,1
"dsgstd,","Boundary Condition Start Date,","04/01/2008,",04/01/2008
"dsgstt,","Boundary Condition Start Time,","00:00,",00:00
"dsgendd,","Boundary Condition End Date,","04/21/2008,",04/21/2008
"dsgendt,","Boundary Condition End Time,","00:00,",00:00
"idsgst,","Starting Grid Cell Index in x-Direction,",173,173
"idsgend,","Ending Grid Cell Index in x-Direction,",173,173
"jdsgst,","Starting Grid Cell Index in y-Direction,",35,35
"jdsgend,","Ending Grid Cell Index in y-Direction,",35,35
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"dsgrangess,","Selected Region Display Status,",1,1
"dsgdr,","Hydrodynamic Mode Value Adjustment Factor,",1, 1
"dsgvf,","Specific Momentum Amplification Factor,",1, 1
"hdsgm,","Method of Flow Withdrawal from Layers,",1,1 : Area Based Flow
Withdrawal
"fdsgd,","Hydrodynamic Flow Direction,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",3,3 : gpm
"fdsgv,","Hydrodynamic Mode Value,",34458, 34458
"sdsg,","Intake Conduit Shape,",-99,-99 : Not Used
"pdsg,","Intake Conduit Angle from Positive z-Axis,",-99,Not Applicable
"tdsg,","Intake Conduit Angle from Positive x-Axis,",-99,Not Applicable
"ldsg,","Intake Conduit Length in Meters,",-99,Not Applicable
"wdsg,","Intake Conduit Width,",-99,Not Applicable
"dsgnp,","Number of Ports in the Discharge Conduit,",-99,Not Applicable
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
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"dsgstructureu,","Structure Width Units,",-99,Not Applicable
"dsgFlowExp,","Flow Exponent,",-99,Not Applicable
"dsgFlowCoeff,","Flow Coefficient,",-99,Not Applicable
"dsgFlowDir,","Hydrodynamic Flow Direction,",-99,Not Applicable
"dsgFlowMode,","Hydrodynamic Mode,",-99,Not Applicable
"dsgFlowUnit,","Hydrodynamic Mode Unit,",-99,Not Applicable
"dsgFlowValue,","Hydrodynamic Mode Value,",-99,Not Applicable
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"dsgFlowHeadDiffFWUnits,","Heade Difference Units for Flow Withdrawal,",-
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"dsgFlowHeadDiffFD,","Head Difference for Flow Discharge Using the
Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
99,Not Applicable
"dsgrt,","Hydrodynamic Mode Value Adjustment Factor,",-99,Not Applicable
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"dsgvu(I_Temp),","Temperature Unit / Status,",-99,Not Applicable
"dsgv(I_Temp),","Temperature Value,",-99,Not Applicable
"dsgrc(I_Saln),","Salinity Data Type,",0,0 : (I_Saln) Concentration
"dsgvu(I_Saln),","Salinity  Unit / Status,",-99,Not Applicable
"dsgv(I_Saln),","Salinity Value,",-99,Not Applicable
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Concentration
"dsgvu(I_IDye),","Instantaneous Dye Unit / Status,",-99,Not Applicable
"dsgv(I_IDye),","Instantaneous Dye Value,",-99,Not Applicable
"dsgrc(I_CDye),","Continuous Dye Data Type,",0,0 : (I_Cdye) Concentration
"dsgvu(I_CDye),","Continuous Dye Unit / Status,",-99,Not Applicable
"dsgv(I_CDye),","Continuous Dye Value,",-99,Not Applicable
"dsgrc(I_Exst),","Excess Temperature Data Type,",0,0 : (I_Exst)
Concentration
"dsgvu(I_Exst),","Excess Temperature  Unit / Status,",-99,Not Applicable
"dsgv(I_Exst),","Excess Temperature Value,",-99,Not Applicable
"vbuse2,","Number of ssFlows for Current Boundary; BC Index,",1, 6
"vbuse3,","boundary condition mode,","Discharge,",Discharge
"dsgm,","Boundary Condition Mode,",0,0 : Discharge
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"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","BBnPP_Ou,",BBnPP_Ou
"dsgdt(1),","Input Data Type for Hydrodynamics,",1,1 : Constant
"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
Constant
"dsgifn(1),","TVD Input File Name for
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"dsgifn(2),","TVD Input File Name for Transport and Water
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"dsgqfnst,","Use Qualifier File for Transport and Water Quality,",0,0
"dsgqfn,","Qualifier File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
"dsgip(1),","Time Varying Input Data Interpolation Scheme for H,",0,0 : No
Interpolation
"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
Interpolation
"dsgdc,","Grid Domain Type,",3,3 : 3D Model
"dsgwd,","Write Boundary Condition Data to Snapshot Output F,",1,1
"dsgstd,","Boundary Condition Start Date,","04/01/2008,",04/01/2008
"dsgstt,","Boundary Condition Start Time,","00:00,",00:00
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"jdsgend,","Ending Grid Cell Index in y-Direction,",27,27
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"dsgrangess,","Selected Region Display Status,",1,1
"dsgdr,","Hydrodynamic Mode Value Adjustment Factor,",5,5 : BBNPP_In
"dsgvf,","Specific Momentum Amplification Factor,",1,1
"hdsgm,","Method of Flow Withdrawal from Layers,",0,0
"fdsgd,","Hydrodynamic Flow Direction,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",3,3 : gpm
"fdsgv,","Hydrodynamic Mode Value,",11172,11172
"sdsg,","Intake Conduit Shape,",1,1 : Circular
"pdsg,","Intake Conduit Angle from Positive z-Axis,",135,135
"tdsg,","Intake Conduit Angle from Positive x-Axis,",270,270
"ldsg,","Intake Conduit Length in Meters,",0.1016,0.1016
"wdsg,","Intake Conduit Width,",0.1016,0.1016
"dsgnp,","Number of Ports in the Discharge Conduit,",72,72
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
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"dsgstructureu,","Structure Width Units,",-99,Not Applicable
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"dsgFlowHeadDiffFWUnits,","Heade Difference Units for Flow Withdrawal,",-
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"dsgFlowHeadDiffFD,","Head Difference for Flow Discharge Using the
Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
99,Not Applicable
"dsgrt,","Hydrodynamic Mode Value Adjustment Factor,",1,1
"dsgrc(I_Temp),","Temperature Data Type,",1,1 : (I_Exst) Concentration
"dsgvu(I_Temp),","Temperature Unit / Status,",1,1 : deg F
"dsgv(I_Temp),","Temperature Value,",33.81,33.81
"dsgrc(I_Saln),","Salinity Data Type,",0,0 : (I_Saln) Concentration
"dsgvu(I_Saln),","Salinity  Unit / Status,",0,0 : ppt
"dsgv(I_Saln),","Salinity Value,",0.4,0.4
"dsgrc(I_IDye),","Instantaneous Dye Data Type,",0,0 : (I_IDye)
Concentration
"dsgvu(I_IDye),","Instantaneous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_IDye),","Instantaneous Dye Value,",0,0
"dsgrc(I_CDye),","Continuous Dye Data Type,",0,0 : (I_CDye) Concentration
"dsgvu(I_CDye),","Continuous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_CDye),","Continuous Dye Value,",100,100
"dsgrc(I_Exst),","Excess Temperature Data Type,",0,0 : (I_Exst)
Concentration
"dsgvu(I_Exst),","Excess Temperature  Unit / Status,",1,1 : deg F-
"dsgv(I_Exst),","Excess Temperature Value,",33.81,33.81
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-WQM,
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
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"iwqc,","Water Quality Model Type ID; Name; Number of parameters; number
of regions; number of variables,",0,"Not Used",0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-SFM,
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"isnec,","Sediment Model Type ID; Name; Number of parameters; Number of
regions; number of variables,",0,"Not Used",0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-WQADD
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iwqaddc,","Water Quality ADD switch; number of variables; Number of
parameters; Number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-GAM
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iGAM,","Algae Model: Switch; Number of Algae; Number of Variables for
Each Algae; number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-CFM
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iCFM,","Bacteria Model: Switch; Number of Bacterias; Number of parameters
for Each Bacteria; Number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-UDF
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iUDC,","User Defined Model: Switch; Number of variables; Number of
parameters for Each Coliform; Number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-ENT
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iENT,","Entrainment Model: Switch; Number of Entrainments; Number of
Paraments for Each Variables; Number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-STM
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"istc,","Sediment Transport Model Computations: Switch; Number of
Entrainments; Number of Paraments for Each Variables; Number of
regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-MGM
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iMGM,","Macrophytes Model: Switch; Number of Macrophytes; Number of
Variables for Each Macrophytes; number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for Chlorine Kinetics module-CKM
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iCKM,","Chlorine Kinetics Module: Module tpe; Number of variables; Number
of parameters for each variable; Number of regions,",0,0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Particle Transport Variables for GEMSS-PTM,
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iPTM,","particle transport model computations,",0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Miscellaneous data,
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"vbuse1,","Number of columns and rows,",4,0
```

Scenario 05

```
$GEMSSModelResults,32
$GEMSS-SHWETControlFile,4.24
$Creation Date: 4/16/2008
$Waterbody Name: Susquehanna 3
$Modeler Name: SP
#########################################################################
# 1:     Scenario variables,
#########################################################################
"IntGDS,","Option to use GEMSS data structure,", 1
"Scenario,","Scenario file path and name,","C:\GEMSS\APPS\Susquehanna
3\Output\Scenario 05_01 NC,"
"DoText2MDBConversion,","Use Scenario Output Direct Database
converion,",1,1
"ZipOutputFile,","Zip text output files after creating the database,",0,0
"DoCompUsingGEMSSOutput,","Run Model Using Existing GEMSS Contour Output
Text Files,", 0
"GEMSSHDMInputFile,","Existing GEMSS Contour Output Header Text
Files,","","
#########################################################################
# 2:     Grid variables,
#########################################################################
"igrid,","Switch to read grid data from a file,",1,1
```

```
"GridFile,","Grid file name,","C:\GEMSS\APPS\Susquehanna
3\Grid\Susquehanna River 05 474Min.g3g,","4/23/2008 12:36:08
PM,","4/28/2008 12:20:10 PM,"
"InputHDatumUnit,","Input grid data is in geographic coordinate system
switch,",0
"UseLinearConversionIn,","Use linear conversion for input grid data,",1
"cstypeIn,","Input coordinate conversion mode,",0
"cscodeIn,","Input coordinate conversion zone number,",0,None
"csdatumIn,","Input UTM datum,",0
"InputVDatumUnit,","Input grid data is in geographic coordinate system
switch,",0
"OutputHDatumUnit,","Output grid data is in geographic coordinate system
switch,",0
"UseLinearConversionOut,","Use linear conversion for output grid data,",1
"cstypeOut,","Output coordinate conversion mode,",0
"cscodeOut,","Output coordinate conversion zone number,",0,None
"csdatumOut,","Output UTM datum,",0
"OutputVDatumUnit,","Output grid data is in geographic coordinate system
switch,",0
"iupmgrid,","Switch to set up different k layers,",0
"km_p,","Vertical array size,",-99
"nzds,","Number of vertical layer domains,",-99
"nzdstr,","Starting vertical layer number for each domain,",-99
"nzend,","Ending vertical layer number for each domain,",-99
"dzd,","Layer thickness in each domain,",-99
"igpsfmt,","Switch to write grid file gps format for use in ArcView,",0
"elioption,","Switch to Use TVD From Boundary Condition File or Initial
elevation,", 0
"eli,","Initial elevation,",489.8
"iwbs,","Waterbody switches,", 1
"eldatum,","Reference elevation of 3rd layer in meters,",0
"UseSigmaStretching,","Switch to Use Sigma stretching,",0
"NSLevel,","Number of Sigma Levels,",0
"SigDistType,","Sigma Layer Distribution type,",0
"Slevel,","User Defined Sigma Distribution,",0.0
"ZtoSigmaBCDepthTransform,","Use BC Depth Transformation from Vertical to
Sigma Level,",0
"SmoothBathy,","Switch to Perform Bathymetry Smoothening,",0
"SlpMax,","Maximum  Allowable Slope for bathymetry smoothening,",0
"NSmoothCycle,","Number of Smoothening Cycles,",0
######################################################################
#3:      Meteorological variables,
######################################################################
"MetDataType,","Switch to use Meteorological time varying data; VB Use
verion; Number of Meteorology variables,",0,2.2,14
"metss,","Use Meteorological data in current simulation status,",1
"Metfile1,","Meteorological time varying data input file
name,","No_Data_File,"
"metinterp,","Switch to perform interpolation on met data,",0
"ievap;EvapScaleFactor,","Switch for evaporation;Evaporation scale
facotr,",1,1
"iwndhyd,","Use wind in hydrodynamics computations,",0
"ta,","temperature of air C,",21,0
"td,","Dew point temperature C,",13,0
"twb,","Wet bulb temperature C,",13,0
"rt,","response temperature C,",20,0
"phi,","Wind direction degrees,",90
"wad,","Wind speed m/sec,",5, 0
"cc,","Cloud coverage Octal,",2
"solrad,","Solar radiation W/m^2,",120,0
"ps,","Atmoshpheric pressure mm of Hg,",760
"ishe,","Surace heat exchange method,",1
"KEMethod,","Method to Compute K and E,",0
"cshe,","Coefficient of surface heat exchange w/m2/C,",13.71
"te,","Equlibrium temperature C,",34,1
"secchi,","Secchi depth; light transmission depth m,",-99
"rsts,","Vegetative and Topographic Shading Factor; 0 to 1.0,",-99
"wscoef,","Wind sheltering coefficient; 0 to 1.0,",-99
"iwsf,","Wind speed function,",1
"MetInterpolationMethod,","Met Interpolation Method,",0
"IDWPOW,","Exponent value for inverse weighting scheme,",0
"MetVarInterpSwitch;MetVarInterp,","Met Individuall interpolatey switch
and interpolation methods,",0
**********************************************************************
*  Meteorological Scale Factor Variables,
**********************************************************************
"UseMetRegionSF;MetRegionSFSS,","Met factor switch,",0,0
**********************************************************************
*  Meteorological Dynamic Shading Variables,
**********************************************************************
"UseDSHDRegionSF;DSHDRegionSFSS,","Met dynamic shading switch,",0,0
```

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**********************************************************************
*  Icel Growth Model Variables,
**********************************************************************
"UseIGModel;UseIGModelStatus,","Switch to control the use of ice growth
model and status,",0,0
**********************************************************************
*  Wave Model Variables,
**********************************************************************
"iwvc;iwvcss,","Wave model activation switch and status,",0,0
######################################################################
# 4:     Constituents,
######################################################################
"itrc,","Transport switch; computation status; number of variables,",1,1,5
"iwqc,","Water quality model type; computation status; number of
variables,",0,0,0
"iwqaddc,","Water quality ADD model switch; computations status; number of
variables,",0,0,0
"iGAMc,","Algae model computations; status,",0,0
"nGAMs,","Number of algae,",0,1
"UseGAMInsideWQM,","Use Generalized Algae Model inside Water Quality
Model,",0
"isnec,","Sediment nutrient exchange computations,",0,0
"iPTM,","Particle transport model computations,",0,0
"istc,","Sediment transport model computations,",0,0
"nstcs,","Number of sediment transport type,",0,1
"ientc,","Entrainment computations,",0,0
"nezones,","Number of entrainment zones,",0,1
"iatc,","Optional to add more constituents,",0,0
"natc,","Number of additional constituents,",0,1
"icfmc,","Coliform Bacteria Model computations,",0,0
"ncfmcs,","Number of coliform bacteria type,",0
"iCKMc;iCKMcss,","Chlorine kinetics Model computations and status,",0,0
"nCKMc,","Number of chlorine kinetics type,",0
"iMGM;iMGMss,","Macrophyte grouth model computations and status,",0,0
"nMGMs,","Number of macrophyte type,",0,1
"UseMGMInsideWQM,","Use Macrophyte Grouth Model inside Water Quality
Model,",0
"WriteTransportOutput,","Write TRM model internal variables to GEMSS
output output,",0
"WriteWQMOutput,","Write WQM model internal variables to GEMSS output
output,",0
"WriteSFMOutput,","Write SFM model internal variables to GEMSS output
output,",0
"WriteWQADDOutput,","Write WQADD model internal variables to GEMSS output
output,",0
"WriteGAMOutput,","Write GAM model internal variables to GEMSS output
output,",0
"WriteENMOutput,","Write ENM model internal variables to GEMSS output
output,",0
"WriteUDCOutput,","Write UDM model internal variables to GEMSS output
output,",0
"WriteCFMOutput,","Write CFM model internal variables to GEMSS output
output,",0
"WriteSTMOutput,","Write STM model internal variables to GEMSS output
output,",0
"WriteMGMOutput,","Write MGM model internal variables to GEMSS output
output,",0
"WriteCKMOutput,","Write CKM model internal variables to GEMSS output
output,",0
"WritePTMOutput,","Write PTM model internal variables to GEMSS output
output,",0
"cnum,","Number of Constituents,",5
"Index,","Model Name,","Identifier; Cannot be Modified,","User Given
Name,","Activity of Constituent,","Output Time,","Units,","Transport
Switch,"
"C0,","Transport,",I_Temp,"I_Temp,",1,1,1,1
"C1,","Transport,",I_Saln,"I_Saln,",1,1,0,1
"C2,","Transport,",I_lDye,"I_lDye,",1,1,0,1
"C3,","Transport,",I_CDye,"I_CDye,",1,1,0,1
"C4,","Transport,",I_Exst,"I_Exst,",1,1,1,1
######################################################################
# 5:     Model switches,
######################################################################
"Use3DModel,","Switch to control 3D model simulations,",1,3.7
"issflw,","switch on/off ssflow input data that is available in the
sscontrol.csv,",1
"itrcs,","transport computation algorithm switch,",1
"udwtf,","advection theta in z-direction,",0
"vdwft,","diffusion theta in z-direction,",0
"HOTSIniTime,","HOTS initization time period,",-99
"itrbs,","Turbulence scheme,",1
```

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"itrbsm,","Turbulence sub model,",1
"itrbparam,","Turbulence parameters,",0,1,1,2.44,2.44,0.9,0.5,1,2.53
"imxls,","Mixing length scheme,",1
"ihmdcx,","momentum diffusion coefficient scheme selector in x-
direction,",2
"ihmdcy,","momentum diffusion coefficient scheme selector in y-
direction,",2
"hmdcx,","momentum diffusion coefficient in x-direction
m2/sec,",0.00584,1.1
"hmdcy,","momentum diffusion coefficient in y-direction
m2/sec,",0.00584,1.1
"prnm,","Prandtl number,",10
"ihtdcx,","transport diffusion coefficient scheme in x-direction,",3
"ihtdcy,","transport diffusion coefficient scheme in y-direction,",3
"htdcx,","transport diffusion coefficient in x-direction m2/sec,",,
"htdcy,","transport diffusion coefficient in y-direction m2/sec,",,
"idnf,","Density function selector,",2
"ideep,","Compressibility usage,",1
"ichezy,","Chezy coefficient selector,",0
"ilchezy,","Limiting Chezy selector,",0
"chezy,","Chezy coefficient; Czo;do;n,",40,,
"WSCoeffType,","Wind stress coefficient type,",0
"WSConstA,","Wind stress constant A,",0.8
"WSConstB,","Wind stress constant B,",0.065
"icors,","Coriolis force selector,",0
"RefLatOption;RefLat,","Referene Latitude Option; Reference Latitude
Value,",0,40
"ivaterms,","Vertical acceleration terms,",0
"idbg,","Debug switch,",0
"tvdscheck,","time varying data consistency check,",0
"iWDLayers,","Use wetting and drying of layers,",1
"lraddthk,","Layer addition thickness m,",0.8
"lrsubthk,","Layer subtraction thickness m,",0.8
"StabilizeInversionFlag,","StabilizeInversionFlag,",0
"InvCoeff,","InvCoeff,",-99
"iUsed1DModel,","Switch to use 1D model; Switch grid has 1D model,",0,0,1
"ComputeStat,","Statisdtical method to output variables,",0
"StatFreq;StatUnit,","Statisdtical frequency and unit to write output
variables,",0,0
"StatStartTime,","Start time for statistical computations,",39539
"StatEndTime,","End time for statistical computations,",39543
"ReturnTime1DDn,","Return time,",0
"UseZCheck,","Control z calculations,",0
"ZStabilityFactor,","Stability factor for z,",0
"CheckTimeStepUsingNewValues,","Redo computations using new time step
values,",0
"UseWindRamp,","Use time ramp function for larger wind speeds,",0
"NumWindRampLevels,","Number of time step intervale for the wind ramp
function,",1
"RampLimitWindSpeed,","Limiting wind speed for the usege of time ramp
function,",0
"WriteBCTVD,","Write boundary condition time varying data files in time
Series output files,",0
"WriteBCLoads,","Write boundary condition data as loads in time series
output files,",0
"WriteSDTVD,","Write sediment data time varying data files in time series
outoput files,",0
"SSDataType,","Source and sinks data type for use in boundary conditon
data writing procedure,",1
"iDo1DHDM,","Do 1D hydrodynamics,",1
"iSetdt1DAsdt,","Set 1D model time step same as 3D model,",0
"ZAmplitication Factor,","Z amplification factor for stability checks,",4
"CGCLimit1,","Conjugate Gradient Computation Error Limit 1,",1,-7
"CGCLimit2,","Conjugate Gradient Computation Error Limit 2,",1,-9
"UseRampFlowFunction,","Use ramp flow function to stabilize the model
simulation,",1
"NumRampFlowBCs,","Number of ramp flow boundary conditions,",6,
"BCNum1,","Ramp flow values for boundary condition
number1,",1,"Upstream",1,12800,1,6,1
"BCNum2,","Ramp flow values for boundary condition
number2,",2,"Downstream",1,12679,1,6,1
"BCNum3,","Ramp flow values for boundary condition
number3,",3,"SSES_In",0,0,0,0,1
"BCNum4,","Ramp flow values for boundary condition
number4,",4,"SSES_Ou",0,0,0,0,1
"BCNum5,","Ramp flow values for boundary condition
number5,",5,"BBNPP_In",0,0,0,0,1
"BCNum6,","Ramp flow values for boundary condition
number6,",6,"BBnPP_Ou",0,0,0,0,1
"SaveCSDataInArray,","Convert cross-section data to depth vs width
array,",0
```

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"DelHforCS,","Depth interval for depth vs width array computations,",0.1
"HDMVersionNumber,","Use far-field/near-field modeling approach,",0
"CapitolLakeVarsSwi,","Switch for Capitol lake variables,",0,0
########################################################################
# 6:      Simulation time variables,
########################################################################
"stryear,","Model start time year,",2008
"strmonth,","Model srart time month,",4
"strday,","Model start time day,",1
"strhour,","Model start hour,",0
"strmin,","Model start minutes,",0
"endyear,","Model end time year,",2008
"endmonth,","Model end month year,",4
"endday,","Model end day,",21
"endhour,","Model end hour,",0
"endmin,","Model end minutes,",0
"MaxTimeSlots,","Maximun number of output time slots used in outputs,",2
"idltt,","Time step control switch,",0,1
"dltminm,","Minimum time step,",10
"dltlimit,","Start Up time step,",60
"omega,","Time step under relaxation factor,",0.75
########################################################################
# 7:      Derived variables,
########################################################################
"idv,","Option to use derived variables computations,",0
########################################################################
# 8:      Probability Plume variables,
########################################################################
"ComputeProPlume,","Computation of Probability Plume,",0
########################################################################
# 9:      Snapshot output variables,
########################################################################
"isnp,","Snapshot output selector,",1,2.2
"isnpss,","Ouput status,",1
"snpfile,","Snapshot output file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 05_01 NC.snp,"
"iMetInfo,","Switch to write meteorology to snapshot output,",0
"iVolumeBalance,","Volume Balance switch,",1
"iMassBalance,","Mass Balance switch,",0
"nsnp,","Number of snapshot output times,",2
"snpyear,","Snapshot output year,",2008,2008
"snpmonth,","Snapshot output month,",4,4
"snpday,","Snapshot output day,",1,3
"snphour,","Snapshot output hour,",0,0
"snpmin,","Snapshot output minutes,",0,0
"snpfrequ,","Snapshot output frequency unit,",1,2
"snpfreq,","Snapshot output frequency value,",1,1
"nsnpkpk;kpk,","Number of snapshot output K planes; output K plane
values,",1,51
"nsnpkpkv;kpv,","Number of snapshot output variables for selected K
planes; output variable ID values,",6,1,19,20,21,22,23
"nsnpjpj;jpj,","Number of snapshot output J planes; output J plane
values,",0
"nsnpjpjv;jpv,","Number of snapshot outputvariables for selected J planes;
output variable ID values,",0
"nsnpipi;ipi,","Number of snapshot output I planes; output I plane
values,",0
"nsnpipiv;ipv,","Number of snapshot output variables for selected I
planes; output variable ID values,",0
"nsnpijpij,","Number of snapshot output I J points,",0
"snpijpi;snpijpj;snpijpnm,","Snapshot output
information,",ICell,JCell,Location names
"nsnpijpv;ijpv,","Snapshot output number of output variables for all
selected IJ cells; output variable IDs for all selected IJ cells,",0
"HydVar,","Hydrodynamic constituent name,",Surface Elevation,U -
velocity,V - Velocity,W - Velocity,Density,Momentum Diffusivity,Chezy,Flow
Rate
"hdunits,","Constituent unit type,",0,0,0,0,0,0,0,0
"hdamp,","Scaling factor,",100,1,1,1,1,10000,1,1
"hddigits,","Number of digits to print in the snapshot,",2,2,2,2,2,2,2,2
Scaling factor, No. of digits, ConstituentID, Constituent name, Output
Type, Units
1,2,I_Temp,I_Temp,1 : Concentration,0 : C
1,2,I_Saln,I_Saln,1 : Concentration,0 : ppt
1,2,I_lDye,I_lDye,1 : Concentration,0 : mg/l
1,2,I_CDye,I_CDye,1 : Concentration,0 : mg/l
1,2,I_Exst,I_Exst,1 : Concentration,0 : deg C
"Stat3DSnapShot,","Do stat analysis for 3D SnapShot,",0
"DV3DSnapShot,","Derived Variables for 3D ShapShot,",0
"ProbPlumeSnapshotStatus,","Status to write probability plume data to the
snapshot output,",0
```

```
"WriteMetSnapshot,","Switch to write meteorology variable output to
snapshot,",0
"SnpOutputMetVars,","Numberof meteorology variables;Output meteorology
variable ID to snapshot,",0
"WriteICESnapshot,","Write ice growth model output variables,",0
"WriteWaveSnapshot,","Write wave model output variables,",0
"WriteTransportSnapshot,","Write TRM model internal variables to snapshot
output,",0
"WriteWQMSnapshot,","Write WQM model internal variables to snapshot
output,",0
"WriteSFMSnapshot,","Write SFM model internal variables to snapshot
output,",0
"WriteWQADDSnapshot,","Write WQADD model internal variables to snapshot
output,",0
"WriteGAMSnapshot,","Write GAM model internal variables to snapshot
output,",0
"WriteENMSnapshot,","Write ENM model internal variables to snapshot
output,",0
"WriteUDCSnapshot,","Write UDM model internal variables to snapshot
output,",0
"WriteCFMSnapshot,","Write CFM model internal variables to snapshot
output,",0
"WriteSTMSnapshot,","Write STM model internal variables to snapshot
output,",0
"WriteMGMSnapshot,","Write MGM model internal variables to snapshot
output,",0
"WriteCKMSnapshot,","Write CKM model internal variables to snapshot
output,",0
"WritePTMSnapshot,","Write PTM model internal variables to snapshot
output,",0
#########################################################################
# 10:      Console output variables,
#########################################################################
"icle,","Console output selector,",1,1.1
"icless,","Ouput status,",1
"ncle,","Number of console ouput times,",2
"cleyear,","Console output year,",2008,2008
"clemonth,","Console output month,",4,4
"cleday,","Console output day,",1,1
"clehour,","Console output hour,",0,2
"clemin,","Console output minutes,",0,0
"clefrequ,","Console output frequency unit,",0,0
"clefreq,","Console output frequency value,",1,10
"nclep,","Number of Console output I J points,",1
"clei;clej;clenm;clenijpk;clenijpv,","Console output
information,",ICell,JCell,Location names,Number of K, Number of Variables
"cleP1,","Point 1,",119,17,"C1,",1,1
"clek1,","Console output number of K values and K layer values for point
1,",1,30
"clev1,","Console output number of output variables and variable IDs for
point 1,",1,1
"Stat3DConsole,","Do stat analysis for 3D Console,",0
"DV3DConsole,","Derived Variables for 3D Console,",0
"WriteICEConsole,","Write ice growth model output variables,",0
"WriteWaveConsole,","Write wave model output variables,",0
"WriteTransportConsole,","Write TRM model internal variables to console
output,",0
"WriteWQMConsole,","Write WQM model internal variables to console
output,",0
"WriteSFMConsole,","Write SFM model internal variables to console
output,",0
"WriteWQADDConsole,","Write WQADD model internal variables to console
output,",0
"WriteGAMConsole,","Write GAM model internal variables to console
output,",0
"WriteENMConsole,","Write ENM model internal variables to console
output,",0
"WriteUDCConsole,","Write UDM model internal variables to console
output,",0
"WriteCFMConsole,","Write CFM model internal variables to console
output,",0
"WriteSTMConsole,","Write STM model internal variables to console
output,",0
"WriteMGMConsole,","Write MGM model internal variables to console
output,",0
"WriteCKMConsole,","Write CKM model internal variables to console
output,",0
"WritePTMConsole,","Write PTM model internal variables to console
output,",0
#########################################################################
# 11:     Diagnostic output variables,
```

```
##########################################################################
"idgn,","Diagnostic output selector,",0
##########################################################################
# 12:     Restart output variables,
##########################################################################
"irst,","Restart output selector,",0
##########################################################################
# 13:     Time series output variables,
##########################################################################
"itsr,","Time series output selector,",1,4.2
"itsrss,","Ouput status,",1
"tsrfile,","Time series output file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 05_01 NC_TSM.txt,"
"ntsr,","Number of time steries output times,",1
"tsryear,","Time series output year,",2008
"tsrmonth,","Time series output month,",4
"tsrday,","Time series output day,",1
"tsrhour,","Time series output hour,",0
"tsrmin,","Time series output minutes,",0
"tsrfrequ,","Time series output frequency unit,",1
"tsrfreq,","Time series output frequency value,",1
"ntsrp,","Number of time series output points,",11
"tsri;tsrj;tsrnm;tsrnijpk;tsrnijpv,","Time series output
information,",ICell,JCell,Location names,Number of K, Number of Variables
"tsP1,","Point 1,",172,27,"T1,",30,0
"tsP2,","Point 2,",166,26,"T2,",0,0
"tsP3,","Point 3,",159,25,"T3,",0,0
"tsP4,","Point 4,",155,25,"T4,",0,0
"tsP5,","Point 5,",151,25,"T5,",0,0
"tsP6,","Point 6,",148,25,"T6,",0,0
"tsP7,","Point 7,",144,23,"T7,",0,0
"tsP8,","Point 8,",140,23,"T8,",0,0
"tsP9,","Point 9,",136,21,"T9,",0,0
"tsP10,","Point 10,",128,25,"T11,",0,0
"tsP11,","Point 11,",126,20,"T12,",0,0
"tsrk1,","Time series output number of K values and K layer values for
point
1,",30,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,2
6,27,28,29,30
"tsrk2,","Time series output number of K values and K layer values for
point 2,",0
"tsrk3,","Time series output number of K values and K layer values for
point 3,",0
"tsrk4,","Time series output number of K values and K layer values for
point 4,",0
"tsrk5,","Time series output number of K values and K layer values for
point 5,",0
"tsrk6,","Time series output number of K values and K layer values for
point 6,",0
"tsrk7,","Time series output number of K values and K layer values for
point 7,",0
"tsrk8,","Time series output number of K values and K layer values for
point 8,",0
"tsrk9,","Time series output number of K values and K layer values for
point 9,",0
"tsrk10,","Time series output number of K values and K layer values for
point 10,",0
"tsrk11,","Time series output number of K values and K layer values for
point 11,",0
"tsrv1,","Time series output number of output variables and variable IDs
for point 1,",0
"tsrv2,","Time series output number of output variables and variable IDs
for point 2,",0
"tsrv3,","Time series output number of output variables and variable IDs
for point 3,",0
"tsrv4,","Time series output number of output variables and variable IDs
for point 4,",0
"tsrv5,","Time series output number of output variables and variable IDs
for point 5,",0
"tsrv6,","Time series output number of output variables and variable IDs
for point 6,",0
"tsrv7,","Time series output number of output variables and variable IDs
for point 7,",0
"tsrv8,","Time series output number of output variables and variable IDs
for point 8,",0
"tsrv9,","Time series output number of output variables and variable IDs
for point 9,",0
"tsrv10,","Time series output number of output variables and variable IDs
for point 10,",0
"tsrv11,","Time series output number of output variables and variable IDs
for point 11,",0
```

```
"Stat3DTimeSeries,","Do stat analysis for 3D time series,",0
"DV3DTimeSeries,","Derived Variables for 3D time series,",0
"ProbPlumeTimeSeriesStatus,","Status to write probability plume data to
the time series output,",0
"WriteMetTimeSeries,","Switch to write meteorology variable output to time
series,",0
"TSOutputMetVars,","Numberof meteorology variables;Output meteorology
variable ID to time series,",0
"WriteICETimeSeries,","Write ice growth model output Variables,",0
"WriteWaveTimeSeries,","Write wave model output Variables,",0
"WriteTransportTimeSeries,","Write TRM model internal variables to time
series output,",0
"WriteWQMTimeSeries,","Write WQM model internal variables to time series
output,",0
"WriteSFMTimeSeries,","Write SFM model internal variables to time series
output,",0
"WriteWQADDTimeSeries,","Write WQADD model internal variables to time
series output,",0
"WriteGAMTimeSeries,","Write GAM model internal variables to time series
output,",0
"WriteENMTimeSeries,","Write ENM model internal variables to time series
output,",0
"WriteUDCTimeSeries,","Write UDM model internal variables to time series
output,",0
"WriteCFMTimeSeries,","Write CFM model internal variables to time series
output,",0
"WriteSTMTimeSeries,","Write STM model internal variables to time series
output,",0
"WriteMGMTimeSeries,","Write MGM model internal variables to time series
output,",0
"WriteCKMTimeSeries,","Write CKM model internal variables to time series
output,",0
"WritePTMTimeSeries,","Write PTM model internal variables to time series
output,",0
"itrn,","Time series transport output selector,",0
########################################################################
# 14:      Vertical profile output variables,
########################################################################
"ivpf,","Vertical profile output selector,",0,4
########################################################################
# 15:      GPP contour output variables,
########################################################################
"igpp,","GPP output selector,",1,2.2
"igppss,","Ouput status,",1
"gppctmfile,","Contour output contour file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 05_01 NC_CTM.txt,"
"gpphdmfile,","Contour output header file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 05_01 NC_HDM.txt,"
"gppgrdfile,","Contour output element file path and
name,","C:\GEMSS\APPS\Susquehanna 3\Output\Scenario 05_01 NC_GRD.txt,"
"WritegppAtAllSurfaces,","Option to write output at all surface and
cells,", 1
"ngppkpk;gppkpk,","Number of GPP contour output K planes; output K plane
values,",0
"ngppjpj;gppjpj,","Number of GPP contour output J planes; output J plane
values,",0
"ngppipi;gppipi,","Number of GPP contour output I planes; output I plane
values,",0
"ngpp,","Number of GPP contour output times,",1
"gppyear,","GPP contour output year,",2008
"gppmonth,","GPP contour output month,",4
"gppday,","GPP contour output day,",1
"gpphour,","GPP contour output hour,",0
"gppmin,","GPP contour output minutes,",0
"gppfrequ,","GPP contour output frequency unit,",1
"gppfreq,","GPP contour output frequency value,",6
"ngppv; gppv,","GPP contour output number of  output variables for all
selected IJ cells; GPP contour output variable IDs for selected
location,",8,1,2,3,4,19,21,22,23
"Stat3DContour,","Do stat analysis for 3D contour,",0
"DV3DContour,","Derived Variables for 3D contour,",0
"ProbPlumeContourStatus,","Status to write probability plume data to the
contour output,",0
"WriteMetContour,","Switch to write meteorology variable output to GPP
contour,",0
"gppOutputMetVars,","Numberof meteorology variables;Output meteorology
variable ID to GPP contour,",0
"WriteICEContour,","Write ice growth model output Variables,",0
"WriteWaveContour,","Write wave model output Variables,",0
"WriteTransportContour,","Write TRM model internal variables to contour
output,",0
```

```
"WriteWQMContour,","Write WQM model internal variables to contour
output,",0
"WriteSFMContour,","Write SFM model internal variables to contour
output,",0
"WriteWQADDContour,","Write WQADD model internal variables to contour
output,",0
"WriteGAMContour,","Write GAM model internal variables to contour
output,",0
"WriteENMContour,","Write ENM model internal variables to contour
output,",0
"WriteUDCContour,","Write UDM model internal variables to contour
output,",0
"WriteCFMContour,","Write CFM model internal variables to contour
output,",0
"WriteSTMContour,","Write STM model internal variables to contour
output,",0
"WriteMGMContour,","Write MGM model internal variables to contour
output,",0
"WriteCKMContour,","Write CKM model internal variables to contour
output,",0
"WritePTMContour,","Write PTM model internal variables to contour
output,",0
#########################################################################
# 16:      QualView velocity field output variables,
#########################################################################
"icvf,","Velocity field output for Qual View selector,",0
#########################################################################
# 17:      QualView contour output variables,
#########################################################################
"icnt,","Qual View contour output selector,",0
#########################################################################
# 18:      Current meter type output variables,
#########################################################################
"idcm,","Current meter type output selector,",0
#########################################################################
# 19:      TMDL Output Variables,
#########################################################################
"iTML,","TML output selector,",0,1.1
#########################################################################
# 20:      Oil Spil output variables,
#########################################################################
"iSVF,","Oil Spill output selector,",0
#########################################################################
#21:      User defined output variables 1,
#########################################################################
"iudo1,","User defined variable output selector1,",0
#########################################################################
#22:      User defined output variables 2,
#########################################################################
"iudo2,","User defined variable output selector2,",0
#########################################################################
#23:      User defined output variables 3,
#########################################################################
"iudo3,","User defined variable output selector3,",0
#########################################################################
#24:      User defined output variables 4,
#########################################################################
"iudo4,","User defined variable output selector4,",0
#########################################################################
#25:      User defined output variables 5,
#########################################################################
"iudo5,","User defined variable output selector5,",0
#########################################################################
# 26:      NCF NETCDF output variables,
#########################################################################
"iNCF,","NETCDF output selector,",0
#########################################################################
# 27: CFD output variables,
#########################################################################
"WriteCFDOutput;WriteCFDOutputS,","Switch to Turn on CFD output; Ouput
status,",0,0
#########################################################################
# 28:      Initial conditions; constant and spatial data,
#########################################################################
"iicff,","Initial condition far field file use,",0,2.5,27
"icffile,","Initial condition far field file,","No_Data_File,"
"icDoSTInterpolate,","Do Spatial and Temporal Interpolation,",0
"RestartToleranceTime,","Time toloerance for using restart file,",0
"AdjustICData,","Adjust initial conditoin data using data before the model
simulation time,",1
"NumInterpSerarchCycles,","Number of smoothening cycles,",1
```

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"DoFourByFourSearch,","Switch to activate 4 nearby cells approach,",1
"DoEightByEightSearch,","Switch to activate 8 nearby cells approach,",1
"SmoothCoefficient,","Factor to control parent cell dependency,",0
"IPIStart,","Interpolation starting I cell index,",1
"IPIEnd,","Interpolation ending I cell index,",250
"IPJStart,","Interpolation starting J cell index,",1
"IPJEnd,","Interpolation ending J cell index,",50
"DoRecursiveSmoothening,","Do recursive smoothening on all cells,",0
"ICInterpolationScheme,","Initial condition interpolation scheme,",0
"IDWPOW,","Power for interpolation,",2
"ICGeoFileStatus,","Initial Condition Geo File Status,",0
"ICGeoFileName,","Initial Condition Geo File Name,","No_Data_File,"
"WFNorth,","Weighting factor in the north direction ,",1
"WFSouh,","Weighting factor in the south direction ,",1
"WFWest,","Weighting factor in the west direction ,",1
"WFEast,","Weighting factor in the east direction ,",1
"WFNorthWest,","Weighting factor in the north west direction ,",1
"WFNorthEast,","Weighting factor in the north east direction ,",1
"WFSouthWest,","Weighting factor in the sout westh direction ,",1
"WFSouthEast,","Weighting factor in the south east direction ,",1
"ICGeoStnFileStatus,","Use field data stations look up file,",0
"ICGeoStnFileName,","Field data station look up file
name,","No_Data_File,"
"UseRT,","Use response temperature for background temperature,",1
"UseStnBGTemp,","Use field data station for setting up background
temperature,",0
"QuadInterpolationType,","Interpolation method for quadrilateral shape,",1
"DoPointInterpolation,","Use field station location for point
interpolation method,",1
"UseConstituentData,","Use constituent data only from restart file,",0
"UseOnlyVelocities,","Use only velocities and elevation,",0
"ConstituentStartTime,","Constituent start time from restart file,",39554
"FielDataDepthType,","Field data depth measurement type,",1
"VBUseNumConstituents,","Number of constituents,",0
"UseTVICData,","Use time varying initial condition data,",0
"nicp,","Number of initial conditon points,", 2
"icpnm,","Constituent name; User does not change the name or the
order,",I_Temp,I_Saln
"icpid,","Initial condition id,",1,2
"ict,","Initial condition data type,",4,4
"icdsg,","SSFlow station number to be used for the specific
constituent,",1,1
"icifn,","File name for using it when ict value is set to 2,",
"icifn_1,","File name for using it for initial condition
1,","No_Data_File,"
"icifn_2,","File name for using it for initial condition
2,","No_Data_File,"
"icv,","Initial condition constituent value,",-99,-99
"icu,","Initial condition constituent unit when ict is set to 1,",-99,-99
"icstd,","Initial condition start date,","04/01/2008,","04/01/2008,"
"icstt,","Initial condition start time,","00:00,","00:00,"
"icxst,","Initial condition x starting location specified as I index,",1,1
"icxend,","Initial condition x ending location specified as I
index,",250,250
"icjst,","Initial condition y starting location specified as j index,",1,1
"icjend,","Initial condition y ending location specified as j
index,",50,50
"ickst,","Initial condition z starting location specified as k
index,",999,999
"ickend,","Initial condition z ending location specified as k index,",-
999,-999
"icswtype,","Initial condition type,",0,0
"ictvtype,","Initial condition time varying type,",0,0
######################################################################
# 28:     Initial conditions, Profile data,
######################################################################
"kmax,","number of k layers,", 50
"504.066,","Profile value at k = 1,",-99,-99
"503.066,","Profile value at k = 2,",-99,-99
"502.066,","Profile value at k = 3,",-99,-99
"501.066,","Profile value at k = 4,",-99,-99
"500.066,","Profile value at k = 5,",-99,-99
"499.066,","Profile value at k = 6,",-99,-99
"498.066,","Profile value at k = 7,",-99,-99
"497.066,","Profile value at k = 8,",-99,-99
"496.066,","Profile value at k = 9,",-99,-99
"495.066,","Profile value at k = 10,",-99,-99
"494.066,","Profile value at k = 11,",-99,-99
"493.066,","Profile value at k = 12,",-99,-99
"492.066,","Profile value at k = 13,",-99,-99
"491.066,","Profile value at k = 14,",-99,-99
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"490.066,","Profile value at k = 15,",-99,-99
"489.066,","Profile value at k = 16,",-99,-99
"488.066,","Profile value at k = 17,",-99,-99
"487.066,","Profile value at k = 18,",-99,-99
"486.066,","Profile value at k = 19,",-99,-99
"485.066,","Profile value at k = 20,",-99,-99
"484.066,","Profile value at k = 21,",-99,-99
"483.066,","Profile value at k = 22,",-99,-99
"482.066,","Profile value at k = 23,",-99,-99
"481.066,","Profile value at k = 24,",-99,-99
"480.066,","Profile value at k = 25,",-99,-99
"479.066,","Profile value at k = 26,",-99,-99
"478.066,","Profile value at k = 27,",-99,-99
"477.066,","Profile value at k = 28,",-99,-99
"476.066,","Profile value at k = 29,",-99,-99
"475.066,","Profile value at k = 30,",-99,-99
"474.066,","Profile value at k = 31,",-99,-99
"473.066,","Profile value at k = 32,",-99,-99
"472.066,","Profile value at k = 33,",-99,-99
"471.066,","Profile value at k = 34,",-99,-99
"470.066,","Profile value at k = 35,",-99,-99
"469.066,","Profile value at k = 36,",-99,-99
"468.066,","Profile value at k = 37,",-99,-99
"467.066,","Profile value at k = 38,",-99,-99
"466.066,","Profile value at k = 39,",-99,-99
"465.066,","Profile value at k = 40,",-99,-99
"464.066,","Profile value at k = 41,",-99,-99
"463.066,","Profile value at k = 42,",-99,-99
"462.066,","Profile value at k = 43,",-99,-99
"461.066,","Profile value at k = 44,",-99,-99
"460.066,","Profile value at k = 45,",-99,-99
"459.066,","Profile value at k = 46,",-99,-99
"458.066,","Profile value at k = 47,",-99,-99
"457.066,","Profile value at k = 48,",-99,-99
"456.066,","Profile value at k = 49,",-99,-99
"455.066,","Profile value at k = 50,",-99,-99
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Boundary conditions,
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"ndsg,","Number of ssflows,",6
"ndsgdtr,","Number of Distributed Networks,",0
"vbuse1,","Number of Boundary Conditions; Number of Fixed Variables and
Total Number of Variables,",6,52,67,1.9,37
"vbuse2,","Number of ssFlows for Current Boundary; BC Index,",1, 1
"vbuse3,","boundary condition mode,","Discharge,",Discharge
"dsgm,","Boundary Condition Mode,",0,0 : Discharge
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","Upstream,",Upstream
"dsgdt(1),","Input Data Type for Hydrodynamics,",1,1 : Constant
"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
Constant
"dsgifn(1),","TVD Input File Name for
Hydrodynamics,","No_Data_File,",No_Data_File
"dsgifn(2),","TVD Input File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
"dsgqfnst,","Use Qualifier File for Transport and Water Quality,",0,0
"dsgqfn,","Qualifier File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
"dsgip(1),","Time Varying Input Data Interpolation Scheme for H,",0,0 : No
Interpolation
"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
Interpolation
"dsgdc,","Grid Domain Type,",3,3 : 3D Model
"dsgwd,","Write Boundary Condition Data to Snapshot Output F,",1,1
"dsgstd,","Boundary Condition Start Date,","04/01/2008,",04/01/2008
"dsgstt,","Boundary Condition Start Time,","00:00,",00:00
"dsgendd,","Boundary Condition End Date,","04/21/2008,",04/21/2008
"dsgendt,","Boundary Condition End Time,","00:00,",00:00
"idsgst,","Starting Grid Cell Index in x-Direction,",210,210
"idsgend,","Ending Grid Cell Index in x-Direction,",210,210
"jdsgst,","Starting Grid Cell Index in y-Direction,",11,11
"jdsgend,","Ending Grid Cell Index in y-Direction,",35,35
"kdsgst,","Starting Vertical Layer Number in z-Direction,",999,999 : KT
"kdsgend,","Ending Vertical Layer Number in z-Direction,",-999,-999 : KB
"dsgcolor,","Selected Region Color,",12977694, 12977694
"dsgrangess,","Selected Region Display Status,",1,1
"dsgdr,","Hydrodynamic Mode Value Adjustment Factor,",0,0 : No
Recirculation
"dsgvf,","Specific Momentum Amplification Factor,",1, 1
"hdsgm,","Method of Flow Withdrawal from Layers,",0,0
"fdsgd,","Hydrodynamic Flow Direction,",0,0 : Along x-Direction
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"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",1,1 : cfs
"fdsgv,","Hydrodynamic Mode Value,",12800, 12800
"sdsg,","Intake Conduit Shape,",-99,-99 : Not Used
"pdsg,","Intake Conduit Angle from Positive z-Axis,",-99,Not Applicable
"tdsg,","Intake Conduit Angle from Positive x-Axis,",-99,Not Applicable
"ldsg,","Intake Conduit Length in Meters,",-99,Not Applicable
"wdsg,","Intake Conduit Width,",-99,Not Applicable
"dsgnp,","Number of Ports in the Discharge Conduit,",-99,Not Applicable
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
"dsgstructurew,","Structure Width,",-99,Not Applicable
"dsgstructureu,","Structure Width Units,",-99,Not Applicable
"dsgFlowExp,","Flow Exponent,",-99,Not Applicable
"dsgFlowCoeff,","Flow Coefficient,",-99,Not Applicable
"dsgFlowDir,","Hydrodynamic Flow Direction,",-99,Not Applicable
"dsgFlowMode,","Hydrodynamic Mode,",-99,Not Applicable
"dsgFlowUnit,","Hydrodynamic Mode Unit,",-99,Not Applicable
"dsgFlowValue,","Hydrodynamic Mode Value,",-99,Not Applicable
"dsgFlowHeadDiffFW,","Head Difference for Flow Withdrawal Using the
Stru,",-99,Not Applicable
"dsgFlowHeadDiffFWUnits,","Heade Difference Units for Flow Withdrawal,",-
99,Not Applicable
"dsgFlowHeadDiffFD,","Head Difference for Flow Discharge Using the
Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
99,Not Applicable
"dsgrt,","Hydrodynamic Mode Value Adjustment Factor,",1, 1
"dsgrc(I_Temp),","Temperature Data Type,",0,0 : (I_Temp) Concentration
"dsgvu(I_Temp),","Temperature Unit / Status,",1,1 : F
"dsgv(I_Temp),","Temperature Value,",32, 32
"dsgrc(I_Saln),","Salinity Data Type,",0,0 : (I_Saln) Concentration
"dsgvu(I_Saln),","Salinity  Unit / Status,",0,0 : ppt
"dsgv(I_Saln),","Salinity Value,",0.2, 0.2
"dsgrc(I_IDye),","Instantaneous Dye Data Type,",0,0 : (I_IDye)
Concentration
"dsgvu(I_IDye),","Instantaneous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_IDye),","Instantaneous Dye Value,",0, 0
"dsgrc(I_CDye),","Continuous Dye Data Type,",0,0 : (I_CDye) Concentration
"dsgvu(I_CDye),","Continuous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_CDye),","Continuous Dye Value,",0, 0
"dsgrc(I_Exst),","Excess Temperature Data Type,",0,0 : (I_Exst)
Concentration
"dsgvu(I_Exst),","Excess Temperature  Unit / Status,",0,0 : deg C
"dsgv(I_Exst),","Excess Temperature Value,",0, 0
"vbuse2,","Number of ssFlows for Current Boundary; BC Index,",1, 2
"vbuse3,","boundary condition mode,","Intake and Withdrawal,",Intake and
Withdrawal
"dsgm,","Boundary Condition Mode,",1,1 : Intake and Withdrawal
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","Downstream,",Downstream
"dsgdt(1),","Input Data Type for Hydrodynamics,",1,1 : Constant
"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
Constant
"dsgifn(1),","TVD Input File Name for
Hydrodynamics,","No_Data_File,",No_Data_File
"dsgifn(2),","TVD Input File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
"dsgqfnst,","Use Qualifier File for Transport and Water Quality,",0,0
"dsgqfn,","Qualifier File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
"dsgip(1),","Time Varying Input Data Interpolation Scheme for H,",0,0 : No
Interpolation
"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
Interpolation
"dsgdc,","Grid Domain Type,",3,3 : 3D Model
"dsgwd,","Write Boundary Condition Data to Snapshot Output F,",1,1
"dsgstd,","Boundary Condition Start Date,","04/01/2008,",04/01/2008
"dsgstt,","Boundary Condition Start Time,","00:00,",00:00
"dsgendd,","Boundary Condition End Date,","04/21/2008,",04/21/2008
"dsgendt,","Boundary Condition End Time,","00:00,",00:00
"idsgst,","Starting Grid Cell Index in x-Direction,",119,119
"idsgend,","Ending Grid Cell Index in x-Direction,",119,119
"jdsgst,","Starting Grid Cell Index in y-Direction,",17,17
"jdsgend,","Ending Grid Cell Index in y-Direction,",35,35
"kdsgst,","Starting Vertical Layer Number in z-Direction,",999,999 : KT
"kdsgend,","Ending Vertical Layer Number in z-Direction,",-999,-999 : KB
"dsgcolor,","Selected Region Color,",6374311, 6374311
"dsgrangess,","Selected Region Display Status,",1,1
"dsgdr,","Hydrodynamic Mode Value Adjustment Factor,",1, 1
"dsgvf,","Specific Momentum Amplification Factor,",1, 1
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"hdsgm,","Method of Flow Withdrawal from Layers,",1,1 : Area Based Flow
Withdrawal
"fdsgd,","Hydrodynamic Flow Direction,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",1,1 : cfs
"fdsgv,","Hydrodynamic Mode Value,",12679, 12679
"sdsg,","Intake Conduit Shape,",-99,-99 : Not Used
"pdsg,","Intake Conduit Angle from Positive z-Axis,",-99,Not Applicable
"tdsg,","Intake Conduit Angle from Positive x-Axis,",-99,Not Applicable
"ldsg,","Intake Conduit Length in Meters,",-99,Not Applicable
"wdsg,","Intake Conduit Width,",-99,Not Applicable
"dsgnp,","Number of Ports in the Discharge Conduit,",-99,Not Applicable
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
"dsgstructurew,","Structure Width,",-99,Not Applicable
"dsgstructureu,","Structure Width Units,",-99,Not Applicable
"dsgFlowExp,","Flow Exponent,",-99,Not Applicable
"dsgFlowCoeff,","Flow Coefficient,",-99,Not Applicable
"dsgFlowDir,","Hydrodynamic Flow Direction,",-99,Not Applicable
"dsgFlowMode,","Hydrodynamic Mode,",-99,Not Applicable
"dsgFlowUnit,","Hydrodynamic Mode Unit,",-99,Not Applicable
"dsgFlowValue,","Hydrodynamic Mode Value,",-99,Not Applicable
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Stru,",-99,Not Applicable
"dsgFlowHeadDiffFWUnits,","Heade Difference Units for Flow Withdrawal,",-
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"dsgFlowHeadDiffFD,","Head Difference for Flow Discharge Using the
Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
99,Not Applicable
"dsgrt,","Hydrodynamic Mode Value Adjustment Factor,",-99,Not Applicable
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"dsgvu(I_Temp),","Temperature Unit / Status,",-99,Not Applicable
"dsgv(I_Temp),","Temperature Value,",-99,Not Applicable
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"dsgvu(I_Saln),","Salinity  Unit / Status,",-99,Not Applicable
"dsgv(I_Saln),","Salinity Value,",-99,Not Applicable
"dsgrc(I_IDye),","Instantaneous Dye Data Type,",0,0 : (I_IDye)
Concentration
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"dsgv(I_IDye),","Instantaneous Dye Value,",-99,Not Applicable
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"dsgvu(I_CDye),","Continuous Dye Unit / Status,",-99,Not Applicable
"dsgv(I_CDye),","Continuous Dye Value,",-99,Not Applicable
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Concentration
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"dsgv(I_Exst),","Excess Temperature Value,",-99,Not Applicable
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"vbuse3,","boundary condition mode,","Intake and Withdrawal,",Intake and
Withdrawal
"dsgm,","Boundary Condition Mode,",1,1 : Intake and Withdrawal
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","SSES_In,",SSES_In
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"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
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"dsgqfn,","Qualifier File Name for Transport and Water
Qualit,","No_Data_File,",No_Data_File
"dsgip(1),","Time Varying Input Data Interpolation Scheme for H,",0,0 : No
Interpolation
"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
Interpolation
"dsgdc,","Grid Domain Type,",3,3 : 3D Model
"dsgwd,","Write Boundary Condition Data to Snapshot Output F,",0,0
"dsgstd,","Boundary Condition Start Date,","04/01/2008,",04/01/2008
"dsgstt,","Boundary Condition Start Time,","00:00,",00:00
"dsgendd,","Boundary Condition End Date,","04/21/2008,",04/21/2008
"dsgendt,","Boundary Condition End Time,","00:00,",00:00
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"idsgend,","Ending Grid Cell Index in x-Direction,",182,182
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"jdsgend,","Ending Grid Cell Index in y-Direction,",35,35
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"dsgcolor,","Selected Region Color,",7993779,7993779
"dsgrangess,","Selected Region Display Status,",1,1
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"dsgvf,","Specific Momentum Amplification Factor,",1,1
"hdsgm,","Method of Flow Withdrawal from Layers,",1,1 : Area Based Flow
Withdrawal
"fdsgd,","Hydrodynamic Flow Direction,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",3,3 : gpm
"fdsgv,","Hydrodynamic Mode Value,",42300,42300
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"tdsg,","Intake Conduit Angle from Positive x-Axis,",-99,Not Applicable
"ldsg,","Intake Conduit Length in Meters,",-99,Not Applicable
"wdsg,","Intake Conduit Width,",-99,Not Applicable
"dsgnp,","Number of Ports in the Discharge Conduit,",-99,Not Applicable
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
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"dsgstructureu,","Structure Width Units,",-99,Not Applicable
"dsgFlowExp,","Flow Exponent,",-99,Not Applicable
"dsgFlowCoeff,","Flow Coefficient,",-99,Not Applicable
"dsgFlowDir,","Hydrodynamic Flow Direction,",-99,Not Applicable
"dsgFlowMode,","Hydrodynamic Mode,",-99,Not Applicable
"dsgFlowUnit,","Hydrodynamic Mode Unit,",-99,Not Applicable
"dsgFlowValue,","Hydrodynamic Mode Value,",-99,Not Applicable
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"dsgFlowHeadDiffFWUnits,","Heade Difference Units for Flow Withdrawal,",-
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"dsgFlowHeadDiffFD,","Head Difference for Flow Discharge Using the
Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
99,Not Applicable
"dsgrt,","Hydrodynamic Mode Value Adjustment Factor,",-99,Not Applicable
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"dsgvu(I_Temp),","Temperature Unit / Status,",-99,Not Applicable
"dsgv(I_Temp),","Temperature Value,",-99,Not Applicable
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"dsgvu(I_Saln),","Salinity  Unit / Status,",-99,Not Applicable
"dsgv(I_Saln),","Salinity Value,",-99,Not Applicable
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Concentration
"dsgvu(I_IDye),","Instantaneous Dye Unit / Status,",-99,Not Applicable
"dsgv(I_IDye),","Instantaneous Dye Value,",-99,Not Applicable
"dsgrc(I_CDye),","Continuous Dye Data Type,",0,0 : (I_Cdye) Concentration
"dsgvu(I_CDye),","Continuous Dye Unit / Status,",-99,Not Applicable
"dsgv(I_CDye),","Continuous Dye Value,",-99,Not Applicable
"dsgrc(I_Exst),","Excess Temperature Data Type,",0,0 : (I_Exst)
Concentration
"dsgvu(I_Exst),","Excess Temperature  Unit / Status,",-99,Not Applicable
"dsgv(I_Exst),","Excess Temperature Value,",-99,Not Applicable
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"vbuse3,","boundary condition mode,","Discharge,",Discharge
"dsgm,","Boundary Condition Mode,",0,0 : Discharge
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","SSES_Ou,",SSES_Ou
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"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
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Interpolation
"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
Interpolation
"dsgdc,","Grid Domain Type,",3,3 : 3D Model
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"dsgstt,","Boundary Condition Start Time,","00:00,",00:00
"dsgendd,","Boundary Condition End Date,","04/21/2008,",04/21/2008
"dsgendt,","Boundary Condition End Time,","00:00,",00:00
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"idsgend,","Ending Grid Cell Index in x-Direction,",170,170
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"jdsgend,","Ending Grid Cell Index in y-Direction,",27,27
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"kdsgend,","Ending Vertical Layer Number in z-Direction,",-999,-999 : KB
"dsgcolor,","Selected Region Color,",12829149, 12829149
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"dsgvf,","Specific Momentum Amplification Factor,",1, 1
"hdsgm,","Method of Flow Withdrawal from Layers,",0,0
"fdsgd,","Hydrodynamic Flow Direction,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",3,3 : gpm
"fdsgv,","Hydrodynamic Mode Value,",11200, 11200
"sdsg,","Intake Conduit Shape,",1,1 : Circular
"pdsg,","Intake Conduit Angle from Positive z-Axis,",135, 135
"tdsg,","Intake Conduit Angle from Positive x-Axis,",270, 270
"ldsg,","Intake Conduit Length in Meters,",0.1016, 0.1016
"wdsg,","Intake Conduit Width,",0.1016,0.1016
"dsgnp,","Number of Ports in the Discharge Conduit,",72, 72
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
"dsgstructurew,","Structure Width,",-99,Not Applicable
"dsgstructureu,","Structure Width Units,",-99,Not Applicable
"dsgFlowExp,","Flow Exponent,",-99,Not Applicable
"dsgFlowCoeff,","Flow Coefficient,",-99,Not Applicable
"dsgFlowDir,","Hydrodynamic Flow Direction,",-99,Not Applicable
"dsgFlowMode,","Hydrodynamic Mode,",-99,Not Applicable
"dsgFlowUnit,","Hydrodynamic Mode Unit,",-99,Not Applicable
"dsgFlowValue,","Hydrodynamic Mode Value,",-99,Not Applicable
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Stru,",-99,Not Applicable
"dsgFlowHeadDiffFWUnits,","Heade Difference Units for Flow Withdrawal,",-
99,Not Applicable
"dsgFlowHeadDiffFD,","Head Difference for Flow Discharge Using the
Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
99,Not Applicable
"dsgrt,","Hydrodynamic Mode Value Adjustment Factor,",1, 1
"dsgrc(I_Temp),","Temperature Data Type,",1,1 : (I_Exst) Concentration
"dsgvu(I_Temp),","Temperature Unit / Status,",1,1 : deg F
"dsgv(I_Temp),","Temperature Value,",31, 31
"dsgrc(I_Saln),","Salinity Data Type,",0,0 : (I_Saln) Concentration
"dsgvu(I_Saln),","Salinity  Unit / Status,",0,0 : ppt
"dsgv(I_Saln),","Salinity Value,",0.4, 0.4
"dsgrc(I_IDye),","Instantaneous Dye Data Type,",0,0 : (I_IDye)
Concentration
"dsgvu(I_IDye),","Instantaneous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_IDye),","Instantaneous Dye Value,",100, 100
"dsgrc(I_CDye),","Continuous Dye Data Type,",0,0 : (I_CDye) Concentration
"dsgvu(I_CDye),","Continuous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_CDye),","Continuous Dye Value,",0, 0
"dsgrc(I_Exst),","Excess Temperature Data Type,",0,0 : (I_Exst)
Concentration
"dsgvu(I_Exst),","Excess Temperature  Unit / Status,",1,1 : deg F
"dsgv(I_Exst),","Excess Temperature Value,",31, 31
"vbuse2,","Number of ssFlows for Current Boundary; BC Index,",1, 5
"vbuse3,","boundary condition mode,","Intake and Withdrawal,",Intake and
Withdrawal
"dsgm,","Boundary Condition Mode,",1,1 : Intake and Withdrawal
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","BBNPP_In,",BBNPP_In
"dsgdt(1),","Input Data Type for Hydrodynamics,",1,1 : Constant
"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
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Qualit,","No_Data_File,",No_Data_File
"dsgip(1),","Time Varying Input Data Interpolation Scheme for H,",0,0 : No
Interpolation
"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
Interpolation
"dsgdc,","Grid Domain Type,",3,3 : 3D Model
"dsgwd,","Write Boundary Condition Data to Snapshot Output F,",0,0
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"dsgrangess,","Selected Region Display Status,",1,1
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"dsgvf,","Specific Momentum Amplification Factor,",1,1
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Withdrawal
"fdsgd,","Hydrodynamic Flow Direction,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",3,3 : gpm
"fdsgv,","Hydrodynamic Mode Value,",34458,34458
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"tdsg,","Intake Conduit Angle from Positive x-Axis,",-99,Not Applicable
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"wdsg,","Intake Conduit Width,",-99,Not Applicable
"dsgnp,","Number of Ports in the Discharge Conduit,",-99,Not Applicable
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
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"dsgstructureu,","Structure Width Units,",-99,Not Applicable
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"dsgFlowDir,","Hydrodynamic Flow Direction,",-99,Not Applicable
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"dsgFlowHeadDiffFD,","Head Difference for Flow Discharge Using the
Struc,",-99,Not Applicable
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"dsgrt,","Hydrodynamic Mode Value Adjustment Factor,",-99,Not Applicable
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"dsgv(I_Temp),","Temperature Value,",-99,Not Applicable
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"dsgvu(I_Saln),","Salinity  Unit / Status,",-99,Not Applicable
"dsgv(I_Saln),","Salinity Value,",-99,Not Applicable
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"dsgv(I_IDye),","Instantaneous Dye Value,",-99,Not Applicable
"dsgrc(I_CDye),","Continuous Dye Data Type,",0,0 : (I_Cdye) Concentration
"dsgvu(I_CDye),","Continuous Dye Unit / Status,",-99,Not Applicable
"dsgv(I_CDye),","Continuous Dye Value,",-99,Not Applicable
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Concentration
"dsgvu(I_Exst),","Excess Temperature  Unit / Status,",-99,Not Applicable
"dsgv(I_Exst),","Excess Temperature Value,",-99,Not Applicable
"vbuse2,","Number of ssFlows for Current Boundary; BC Index,",1, 6
"vbuse3,","boundary condition mode,","Discharge,",Discharge
"dsgm,","Boundary Condition Mode,",0,0 : Discharge
"dsgss,","Boundary Condition Status,",1,1
"dsgnm,","Boundary Condition Name,","BBnPP_Ou,",BBnPP_Ou
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"dsgdt(2),","Input Data Type for Transport and  Water Quality,",1,1 :
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"dsgip(2),","Time Varying Input Data Interpolation Scheme for W,",0,0 : No
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"dsgvf,","Specific Momentum Amplification Factor,",1,1
"hdsgm,","Method of Flow Withdrawal from Layers,",0,0
"fdsgd,","Hydrodynamic Flow Direction,",0,0 : Along x-Direction
"fdsgm,","Hydrodynamic Mode,",2,2 : Flow Rate
"fdsgu,","Hydrodynamic Mode Unit,",3,3 : gpm
"fdsgv,","Hydrodynamic Mode Value,",11172,11172
"sdsg,","Intake Conduit Shape,",1,1 : Circular
"pdsg,","Intake Conduit Angle from Positive z-Axis,",135,135
"tdsg,","Intake Conduit Angle from Positive x-Axis,",270,270
"ldsg,","Intake Conduit Length in Meters,",0.1016,0.1016
"wdsg,","Intake Conduit Width,",0.1016,0.1016
"dsgnp,","Number of Ports in the Discharge Conduit,",72,72
"qdsg,","Value to be Used for Flow Rate,",0,0 : Use Existing Flow Rate
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Struc,",-99,Not Applicable
"dsgFlowHeadDiffFDUnits,","Head Difference Units for Flow Discharge,",-
99,Not Applicable
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"dsgv(I_Temp),","Temperature Value,",33.81,33.81
"dsgrc(I_Saln),","Salinity Data Type,",0,0 : (I_Saln) Concentration
"dsgvu(I_Saln),","Salinity  Unit / Status,",0,0 : ppt
"dsgv(I_Saln),","Salinity Value,",0.4,0.4
"dsgrc(I_IDye),","Instantaneous Dye Data Type,",0,0 : (I_IDye)
Concentration
"dsgvu(I_IDye),","Instantaneous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_IDye),","Instantaneous Dye Value,",0,0
"dsgrc(I_CDye),","Continuous Dye Data Type,",0,0 : (I_CDye) Concentration
"dsgvu(I_CDye),","Continuous Dye Unit / Status,",0,0 : mg/l
"dsgv(I_CDye),","Continuous Dye Value,",100,100
"dsgrc(I_Exst),","Excess Temperature Data Type,",0,0 : (I_Exst)
Concentration
"dsgvu(I_Exst),","Excess Temperature  Unit / Status,",1,1 : deg F
"dsgv(I_Exst),","Excess Temperature Value,",33.81,33.81
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-WQM,
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
"iwqc,","Water Quality Model Type ID; Name; Number of parameters; number
of regions; number of variables,",0,"Not Used",0,0,0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$  Rates and Constants for GEMSS-SFM,
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"isnec,","Sediment Model Type ID; Name; Number of parameters; Number of
regions; number of variables,",0,"Not Used",0,0,0
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$  Rates and Constants for GEMSS-WQADD
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"iwqaddc,","Water Quality ADD switch; number of variables; Number of
parameters; Number of regions,",0,0,0,0
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3.1 ENSURING SURVEY OF HABITAT AT RISK TO BE DEWATERED

[illegible]

3.2 SEMI-QUANTITATIVE SURVEY (TIMED SEARCH)

[illegible]

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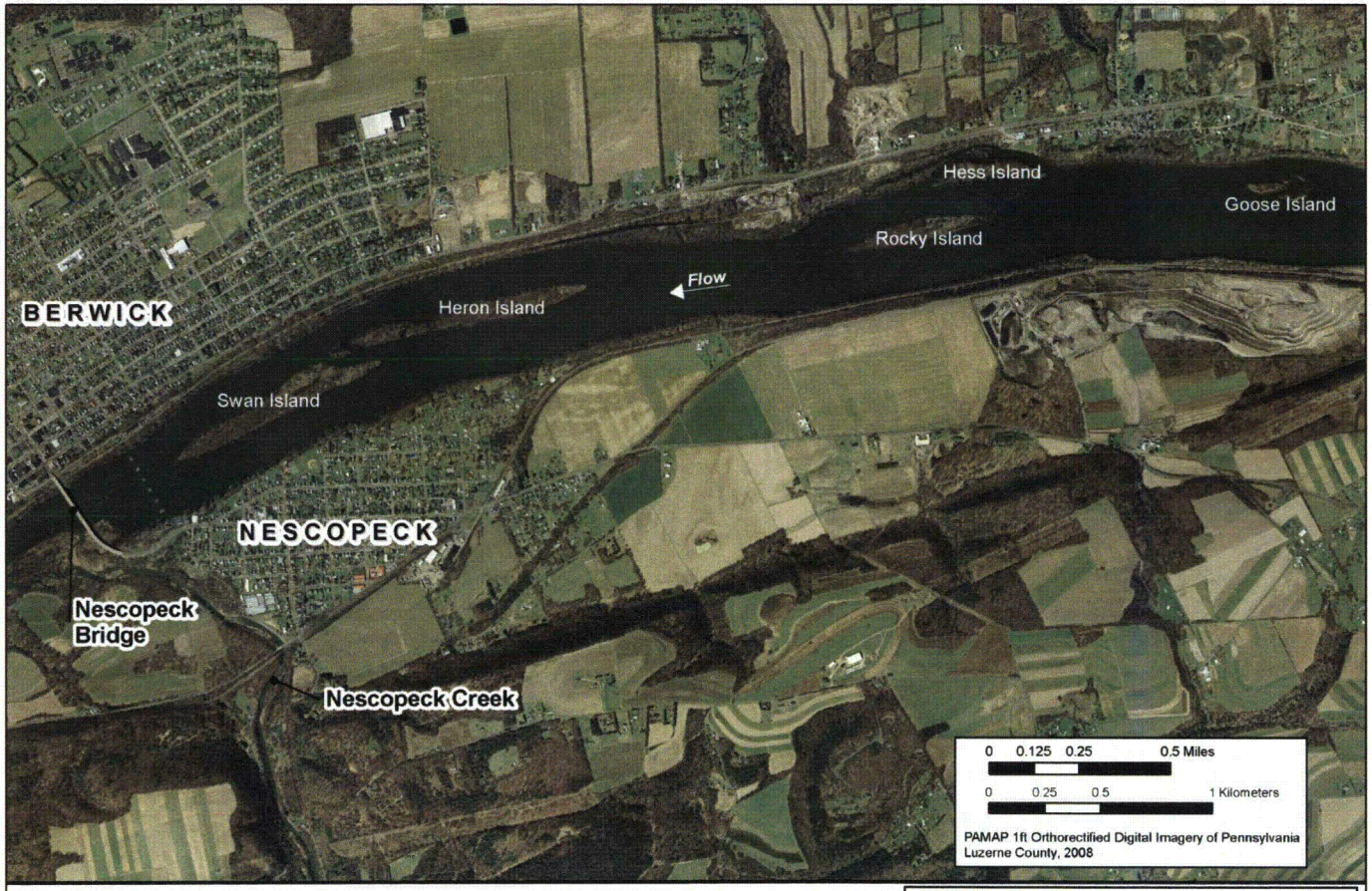

Figure 1.
Susquehanna River Mussel Survey Reach at Berwick, PA.

Figure 1 Susquehanna River Mussel Survey Reach at Berwick, Pa.

APPENDIX

DONALD P. MASON

Aquatic Ecologist

Mr. Mason has over 25 years' experience assessing the effects of habitat alteration on aquatic ecosystems. His specialties include evaluating the effects of hazardous substances, hydropower, and commercial development on fish and benthic macroinvertebrate communities. Mr. Mason has conducted and managed studies using freshwater macroinvertebrates as pollution indicators, assessed the impacts of road and highway construction on aquatic communities, and searched for rare, threatened, or endangered mussels and other aquatic species.

EDUCATION

M.S. 1982, Entomology, University of New Hampshire
B.A. 1976, Biology, Plymouth State College

PROFESSIONAL EXPERIENCE

1985-Present Normandeau Associates
1983-1985 Battelle New England Marine Research Laboratory
1982-1983 Normandeau Associates
1982 Charles T. Main, Inc.

PROFESSIONAL AFFILIATIONS

North American Benthological Society
New England Association of Environmental Biologists
Freshwater Mollusk Conservation Society

SELECTED PROJECT EXPERIENCE

Delaware River Joint Toll Bridge Commission (2010-Present) – Delaware River (PA/NJ) Scour Remediation Mussel Survey; Led a team of SCUBA divers to search for Rare, Threatened and Endangered (RTE) freshwater mussels near bridges that were scheduled for scour remediation. Since scour remediation efforts may adversely affect freshwater mussels near the rehabilitated piers, state-listed RTE mussel species were relocated to suitable habitat outside of the areas of impact. Responsible for obtaining and collecting permits; conducting the mussel search; relocating listed species to unaffected areas; and submitting reports to the PA Fish and Boat Commission and to the NJ Department of Environmental Protection, all on an expedited two month schedule.

Environmental Solutions and Innovations, Inc. (2010) – Delaware River Dwarf Wedgemussel Survey (PA/NJ); Provided technical expertise for a dwarf wedgemussel (*Alasmidonta heterodon*) survey for a proposed pipeline crossing over the Delaware River. The client was required by Pennsylvania Fish and Boat Commission and the U.S. Fish and Wildlife Service New Jersey Field Office to have a certified dwarf wedgemussel surveyor on the survey crew. Responsible for providing certified dwarf wedgemussel surveyor expertise.

Exelon (2010) – Susquehanna River Mussel Survey (MD); Provided freshwater mussel survey expertise for a survey downstream of Conowingo Dam on the Susquehanna River for the Conowingo Hydroelectric Relicensing Project. Field Biologist.

Florida Power and Light (2008-Present) – Fort Halifax Dam Removal Fish and Mussel Relocation Project (ME); Led a crew of 20 staff and volunteers to search for yellow lampmussel (*Lampsilis cariosa*) and tidewater mucket (*Leptodea ochracea*) as the Fort Halifax Dam was removed and the upstream impoundment was dewatered. Both of these species are threatened in the State of Maine. A total of 10,221 threatened mussels were relocated with less than one percent mortality. Project Manager.

Massena Electric Department (2007-2010) – Grasse River Benthic Macroinvertebrate and Mussel Survey (NY); Conducted seasonal benthic macroinvertebrate sampling throughout the Grasse River from Louisville to Massena, NY using kick nets (qualitative) and Ponar grabs (quantitative). Also, worked with SCUBA divers to qualitatively and quantitatively survey freshwater mussels (Unionidae) throughout the Grasse River during 2007, 2008, and 2009. A total of nine mussel species were identified. Technical Director.

UPPL Resources, IncU. (2006) – Assessment of fly ash spill impacts to the mussel and periphyton communities in the Delaware River at Martins Creek Generating Station. The survey included search for mussels in shallow wadeable habitats and in deep pools with SCUBA at locations upstream and downstream of the fly ash entry point. Field Biologist.

Secor International Incorporated (2005-2006) - Baseline Investigation of the Little Mississinewa River (IN); Sediment in the Little Mississinewa River, Randolph County, IN is contaminated with PCBs from a former electrical manufacturer. Sediments at several locations along seven miles of the river will be dredged and replaced with clean material as remediation. Fish tissue and benthic macroinvertebrate community data were collected to establish baseline conditions prior to remediation. Principal Investigator.

South Shore Tri-Town Development Corporation (2001-Present) - Tri-Town Wildlife Surveys; This site, located on the former South Weymouth Naval Air Station property (MA), has areas contaminated with petrochemicals and demolition debris. Sampled the west branch of French's Stream to search for three species included on the Massachusetts Natural Heritage and Endangered Species Program list, the Mystic Valley Amphipod (*Crangonyx aberrans*), the Spatterdock (or Spring Blue) Darner (*Aeshna mutata*), and the Mocha Emerald (*Somatochlora linearis*). Specimens of the Mystic Valley Amphipod were collected on site, however neither of the dragonflies was found. Responsible for data collection and report preparation. Principal Investigator.

Beazer Homes Corp. (2006) - Andover Junction Brook Habitat Assessment and Mussel Survey (NJ); Assessed the aquatic habitat and conducted a freshwater mussel survey along 3,000 feet of streambed in Andover Junction Brook and an unnamed tributary stream, both located on a proposed planned unit development property in Andover Borough, NJ. This study was conducted to determine the species composition and relative abundance of the on-site mussel community and to determine whether Dwarf Wedge Mussel (*Alasmidonta heterodon*), a freshwater mussel included on the Federal List of Endangered Species, was present on the property. Project Manager.

Fryeburg Aquifer Resource Committee. (2006) - Baseline Investigation of Aquatic Biota in Wards Brook and Lovewell Pond (ME); Potential impacts associated with proposed additional water withdrawals from the Wards Brook aquifer, for commercial bottling, on the ecology of Wards Brook and Lovewell Pond was studied. Two of the primary ecological concerns addressed in this study included 1) the paucity of baseline information on the aquatic biota (fish, mussels, invertebrates) in Wards Brook and Lovewell Pond and, 2) impacts of groundwater withdrawal on these biota and water quality. Principal Investigator.

Upper Peninsula Power Company (2004) – Assessment of the Silver Lake Dam Breach on Downstream Mussel Fauna (MI); Led a crew of six investigators to assess the effects of the Silver Lake Dam breach on downstream mussel fauna. The survey was conducted along 32 miles of the river from Silver Lake to the river mouth at Lake Superior and included assessments of mussel habitat quality, species composition, and population density. A total of five mussel species were found throughout the study area, including cylindrical papershell (*Anodontoides ferussacianus*), giant floater (*Pyganodon grandis*), fatmucket (*Lampsilis siliquoidea*), eastern elliptio (*Elliptio complanata*), and white heelsplitter (*Lasmigona complanata*). Project Manager.

Vanasse Hangen Brustlin, Inc. (2003-2004) - Missisquoi Bay Bridge Project, Lake Champlain (VT) Freshwater Mussel Survey and Relocation; Surveyed and relocated Vermont state-listed threatened and endangered freshwater mussels that would potentially be impacted during construction of a bridge to

replace the Route 78 causeway/bridge. A total of 418 mussels, including two Vermont state-listed endangered species, the Fragile Papershell (*Leptodea fragilis*) and the Pink Heelsplitter (*Potamilus alatus*), and one state-listed threatened species, the Giant Floater (*Pyganodon grandis*), were relocated using SCUBA divers to areas outside of the influence of construction activities. Responsible for leading the field crew and report preparation. Program Manager.

Vanasse Hangen Brustlin, Inc. (2000-2004) - Missisquoi Bay Bridge Project, Lake Champlain (VT); This multi-faceted study included studies on the movements of the state threatened spiny-soft shell turtle (*Trionyx spiniferus*) using radiotelemetry, a fish habitat and creel survey, and a state-listed freshwater mussel survey and relocation (see above) in relation to an existing causeway and a proposed new bridge. Responsible for data collection and report preparation. Crew Leader/Program Manager.

Public Service Company of New Hampshire (2003) - Merrimack River (NH) Brook Floater Survey; Surveyed 24 river miles using SCUBA divers, to search for populations of Brook Floater mussels (*Alasmidonta varicosa*), a NH state-listed endangered species. This study was conducted to evaluate the susceptibility of this species to impacts associated with hydroelectric generation and was the most extensive survey ever conducted for this species in the New Hampshire portion of the Merrimack River. This survey established several new records on the extent and location of brook floater populations in the Merrimack River. Responsible for leading the field crew and preparing the final report. Project Manager.

City of Manchester (CT) (1994, 1996, 1998) - A bioassessment of the fish and benthic macroinvertebrate communities in the Hockanum River was conducted as part of the discharge permit application for the Manchester, CT Sanitary Landfill and sewage treatment plant. Benthic communities were sampled using artificial substrate (rock basket) samples and kick samples, then analyzed separately using EPA's Rapid Bioassessment Protocol level 3 (RBP III). Fish data were analyzed using RBP level 5. Responsible for data collection, analysis, and report preparation. Aquatic Communities Technical Director.

Dexter Corporation (CT) (1997) - Surveyed 300 ft of streambed in Stony Brook (CT), near an aqueduct proposed for reconstruction, to look for Dwarf Wedge Mussels (*Alasmidonta heterodon*). *A. heterodon* is a federally listed endangered species that is sensitive to sedimentation and would have been adversely affected by construction activities. Responsible for conducting the field survey and report preparation. Project Manager.

New Hampshire DOT (1997) - Supervised a dive team that searched a section of the Johns River (NH), crossed by a bridge proposed for reconstruction, to look for Dwarf Wedge Mussels (*Alasmidonta heterodon*). *A. heterodon* is a federally listed endangered species which would have been adversely affected by construction activities. Responsible for project management, field data collection, and report preparation. Project Manager.

Smith College (1997) - Paradise Pond (MA) Dredging Mitigation Project; Worked closely with the client as well as State and Federal regulatory personnel to develop mitigation plans to alleviate impacts of dredging operations on a downstream population of Dwarf Wedge Mussel (*Alasmidonta heterodon*), a federally-listed endangered species. Technical Director.

City of Brockton (MA) (1997) - Supervised a dive team that surveyed the shoreline of Silver Lake, MA in search of two freshwater mussels included in the Massachusetts list of species of special concern, Eastern Pond Mussel (*Ligumia nasuta*) and Tidewater Mucket (*Leptodea ochracea*). Responsible for supervising the field crew and report preparation. Project Manager.

Northeast Maritime (1997) - Conducted a freshwater mussel search and evaluated mussel habitats in several streams that would be crossed by a gas pipeline in central Maine. The main purpose of this study was to identify habitats and populations of state and Federally listed rare, threatened, and endangered mussel species, primarily Dwarf Wedge Mussel (*Alasmidonta heterodon*), Brook Floater Mussel (*A. varicosa*), Yellow Lamp Mussel (*Lampsilis cariosa*) and Tidewater Mucket (*Leptodea ochracea*). Project Biologist.

SE Technologies, Inc. (1997) - Collected benthic macroinvertebrate data using EPA's Rapid Bioassessment Protocols level 2 (RBP II) and conducted an endangered aquatic species search near a closed electroplating facility to determine whether groundwater or surface runoff from the site was adversely affecting the aquatic biological community in Fivemile River (CT). Responsible for data collection, analysis, and report preparation. Project Manager.

SPECIAL TRAINING

OSHA 40-Hour Safety Certification

OSHA 8-Hour Safety Certification Refresher (Current)

Rapid Bioassessment Protocols (RBP)

Hazardous Material Supervisors Training (OSHA 29 CFR 1910.120)

First Aid and CPR

Habitat Evaluation Procedures (HEP)

SELECTED PRESENTATIONS

Mason, D.P. Survey for the Presence of Dwarf Wedge Mussels (*Alasmidonta heterodon*) in the Paulins Kill River, NJ. Presented to the 24th Annual Meeting of the New England Association of Environmental Biologists, March 2000, Jackson, NH.

Mason, D.P. and W.E. Hearn. Effects of fluctuating flows on benthic communities. Presented to the 37th Annual Meeting of the North American Benthological Society, May 1989, Guelph, Ontario, Canada.

Mason, D.P., S.L. Radke, K.T. Tracewski, and P.C. Johnson. Eclosion of gypsy moth (Lepidoptera: Lymantriidae) egg masses held under constant conditions as a function of sampling date. Presented to the 52nd Annual Meeting of the Eastern Branch of the Entomological Society of America, September 1980, Baltimore, MD.

SELECTED PEER-REVIEWED ARTICLES AND PUBLICATIONS

Haney, J.F., T.R. Beaulieu, R.P. Berry, D.P. Mason, C.R. Miner, E.S. McLean, K.L. Price, M.A. Trout, R.A. Vinton, and S.J. Weiss. 1983. Light intensity and relative light change as factors regulating stream drift. Archiv fur Hydrobiologie 97(1):73-88.

Mason, D.P. 1982. Physical and hydrochemical effects on stream insect communities in the White Mountain National Forest of New Hampshire. M.S. Thesis, University of New Hampshire, Durham, New Hampshire. 106 pp.

STUDY PLAN TO COLLECT SUPPLEMENTAL DATA TO ASSESS THE POTENTIAL EFFECTS OF THE BELL BEND PROJECT ON WATER QUALITY OF BACKWATER AREAS USED BY FRY AND YOUNG-OF-THE-YEAR SMALLMOUTH BASS

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Exton, PA 19341

21665.001-SMB1

REV 0, 1 APRIL 2012

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ABBREVIATIONS

Abbreviation	Meaning
°F or °C	Degrees Fahrenheit or Celsius (water temperature)
7Q10	Seven-day, consecutive low flow once on average every ten years.
ACOE	U.S. Army Corps of Engineers
ADCP	Acoustic Doppler Current Profiler, instrument to measure velocity at varying depths
ADF	Average Daily Flow computed on an annual basis
AMD	Abandoned Mine Drainage
BBNPP	Bell Bend Nuclear Power Plant
BBNPP ER	Bell Bend Nuclear Power Plant Environmental Report submitted to the Nuclear Regulatory Commission
cfs	Cubic feet per second; 1 cfs = 0.646 mgd
COLA	Combined Construction and Operating License Application
CORMIX	Cornell Mixing Zone Expert System, mixing zone model
DO	Dissolved oxygen
EFDC	Environmental Fluid Dynamics Code, 3-D hydrodynamic and water quality model
EMA	Eastern Middle Anthracite Fields
ERM	Environmental Resources Management, Inc.
GEMSS®	Generalized Environmental Modeling System for Surfacewater, 3-D hydrodynamic and water quality model
HSC	Habitat Suitability Curve, index used to indicate fish preferences for microhabitat variables (e.g., water velocity, depth, substrate/cover);expressed on a scale of 0 (least suitable) to 1 (optimum)
IFIM	Instream Flow Incremental Methodology, habitat-based methodology to estimate available aquatic habitat under changing flow conditions; based on the premise that stream-dwelling organisms prefer a certain range of microhabitats (velocity,depth,and substrate/cover)
mgd	Million gallons per day; 1 mgd = 1.55 cfs
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
PADEP	Pennsylvania Department of Environmental Protection
PFBC	Pennsylvania Fish and Boat Commission
PHABSIM	Physical Habitat Simulation, model integrates outputs of hydraulic model(s) and species micro-habitat preferences (depth, velocity, and substrate/cover)
PLS	Professional Land Surveyor
PPL Bell Bend	PPL Bell Bend, LLC; sponsor of the BBNPP project
RHABSIM	Customized version of PHABSIM
Sonde	Device that measures DO, temperature, pH and conductivity; French for "probe"
SRAFRC	Susquehanna River Anadromous Fish Restoration Commission
SRBC	Susquehanna River Basin Commission
SSES	Susquehanna Steam Electric Station
TMDL	Total Maximum Daily Load
TRPA	Thomas R. Payne and Associates
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WUA	Weighted Usable Area, an index of available habitat

1. INTRODUCTION

PPL submitted a report to the SRBC entitled, *"Potential Effects of the Bell Bend Project on Aquatic Resources and Downstream Users, Proposed Bell Bend Nuclear Power Plant Site, Luzerne County, Pennsylvania,* dated June, 2011. Subsequent to the submittal of that report, SRBC provided comments in a letter dated December 21, 2011 to Mr. Michael J. Caverly, VP-Financial Nuclear Development. In that correspondence, SRBC provided a number of comments with the following primary concerns:

1. There is a need for additional sampling of backwater and shoreline areas for dissolved oxygen (DO) and water temperature where fry (≤25 mm) and young smallmouth bass (YOY SMB) are known to occupy so that a more complete evaluation of the effects of consumptive use can be made.
2. Shallow inshore locations are critical habitats for YOY SMB and are the primary focus of concern.
3. The study should determine the size and location of these areas at low flow conditions.
4. Since lowest DO levels were recorded at Sonde #1 at Goose Island, additional data are required to determine the extent and magnitude of the low DO levels.
5. Data are required from other backwater areas such as the backwater areas in the Rocky Island vicinity.

This study plan has been developed in light of these comments with a primary focus on obtaining additional water quality data from backwater and shoreline areas.

1.1. OBJECTIVE

The objective of this study is to assess the potential impact associated with reduced river flow and stage due to BBNPP (Figure 1-1) consumptive use on dissolved oxygen (DO) and temperature, primarily focusing on backwater and shoreline areas that may be occupied by YOY SMB.

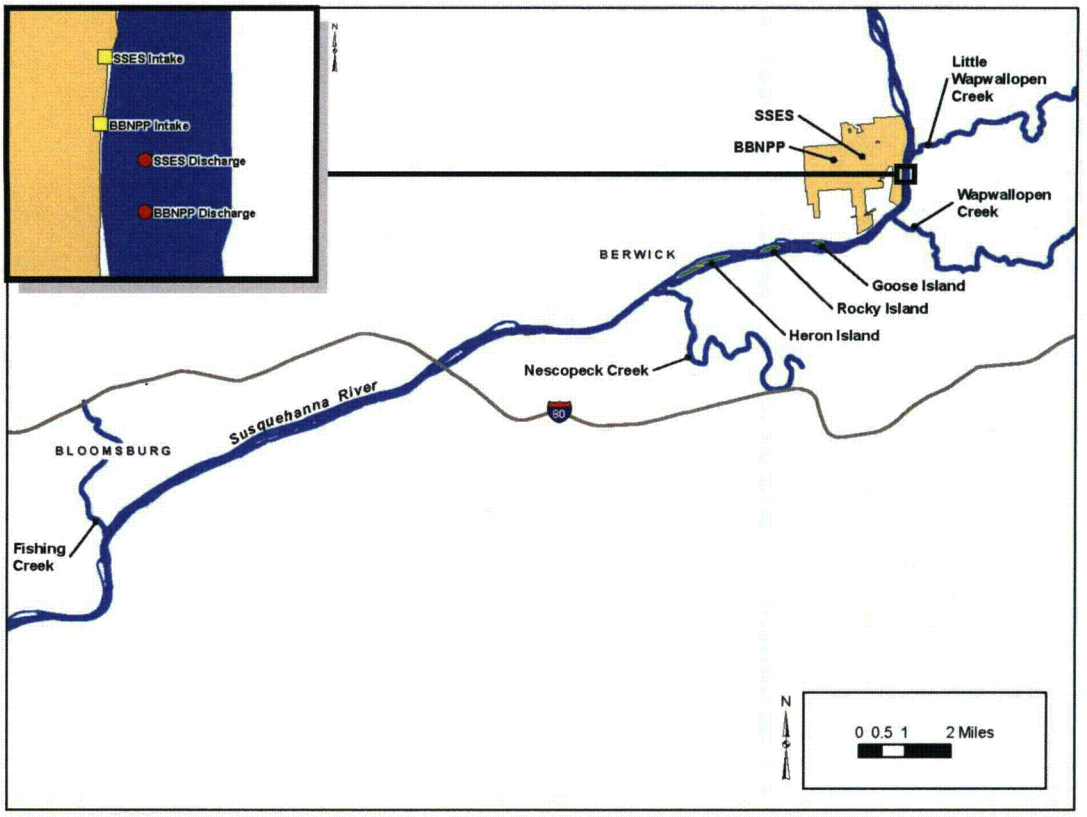

Figure 1-1 Map showing intake and discharge locations for the proposed Bell Bend Nuclear Power Plant (BBNPP) on the Susquehanna River, Luzerne County, PA (source Normandeau Associates, *et al.* 2011)

The 2012 data gathering and analysis will provide a comprehensive data base for a more complete evaluation of these areas. The study reach for this data collection is approximately 2.6 mi between the upper tip of Goose Island and the lower tip of Heron Island; the upper tip of Goose Island is approximately 2.5 mi downstream of the proposed BBNPP discharge location.

1.2. PLANNED FIELD WORK AND ANALYSIS

The work will consist of collecting additional observations on SMB spawning activity (nesting, fry emergence, rearing, and nursery), DO, water temperature, pH, and depths data at six backwater and shoreline areas including the portion of the Susquehanna River near Rocky Island. Continuous depth measurements were not collected during 2010. The plan assumes that there is sufficient flexibility to respond to changing and/or prevailing hydrological and meteorological conditions.

The data collection is proposed to cover the period from mid-April to mid-August 2012. A temperature impact analysis will be conducted in a manner similar to that performed on the 2010 data. The 2010 temperature impact analysis was evaluated using a 0-dimension Temperature Calculation module of the Generalized Environmental Modeling System for Surface Waters (GEMSS®) software package. This method uses hourly meteorological data to develop temperature change (ΔT) based on the maximum induced depth change as calculated by the flow analysis. The changes in temperature are then applied to the sonde data.

For the 2012 analysis, the data will be assessed for event frequency and duration using the same methodology as the 2010 analysis. The thermal model will also be applied using the 2012 data and corresponding hourly meteorological data and ΔTs reported on an hourly basis with the same diagnostics and summaries as with the 2010 data. In addition, the 2012 data collection will also include a depth transducer that will collect depth data on an hourly basis. This will allow for a direct comparison of depth to flow. Based on data analysis, a correlation or regression analysis can be completed to determine the existence of a possible statistically significant relationship and the strength of any relationship. The hourly measurements are expected to provide a large sample size for these types of analyses.

PPL Bell Bend intends to submit a study report by September 6, 2012. The sections below provide details of the study plan along with the specific objectives.

2. *RELEVANT DATA AND PRIOR STUDIES*

This section of the study plan summarizes relevant and readily available hydrologic and water quality data. Relevant data sources and reports are outlined in Table 2-1.

Table 2-1 Summary of Relevant Prior Studies and Data

Source	Reports and Data
Ecology III	Currently conducts quarterly water quality sampling at five sites; measures daily temperature and water surface elevation; performs electrofishing and seining. Macro-invertebrate, mussel, and impingement/entrainment investigations were also conducted. Annual reports are available beginning in 1971 with occasional special studies (e.g., thermal plume surveys) published separately. Reports include summary of water quality parameters (pH, DO, temperature, alkalinity, conductance, hardness, TDS, nutrients and metals).
EPA	Published two TMDL's (Susquehanna River and Nescopeck Creek) which summarize water quality data (pH, alkalinity and metals: aluminum, iron and manganese). Primary source of data are the sampling done in support of TMDL's (AMD-related TMDL for both Susquehanna River reach upstream of the BBNPP and Nescopeck Creek, and PCB-related TMDL for the Susquehanna River).
PPL Bell Bend	Published the BBNPP Environmental Report which is not a primary source, but contains a summary of available water quality parameters (pH, DO, temperature, alkalinity, conductance, hardness, TDS, nutrients and metals). Primary source of data are two SSES sampling locations used since 1968 and additional sampling performed during 2008.
USGS	Measures stage and discharge on various streams and the Susquehanna River itself. Several water quality parameters (pH, nutrients, metals, minerals, hydrocarbons and TDS) measured at USGS station near Hunlock Creek and Danville.
Normandeau Associates, et al., 2011	Potential Effects of the Bell Bend Project on Aquatic Resources and Downstream Users Proposed Bell Bend Nuclear Power Plant Site, Luzerne County, Pennsylvania

2.1. *HYDROLOGY*

This section presents background information on flows in the Susquehanna River relevant to this study.

2.1.1. USGS Gaging Sites and Records

The USGS gaging sites of importance to this study are shown in Table 2-2, below.

Table 2-2 USGS gaging sites

Location	USGS No.	Drainage Area (sq. mi)	Period of Record
Susquehanna River at Wilkes-Barre	01536500	9,960	Daily discharge, 4/1899-present
Susquehanna River at Danville	01540500	11,220	Daily discharge, 4/1905-present
Nescopeck Creek at Nescopeck	01538600	171	Periodic measurements since 1949

The Wilkes-Barre river gage is the nearest river gage upstream from the study reach; the study reach encompasses an area between the upper tip of Goose Island and the lower tip of Heron

Island. River flow data from this gaging site were used for all previous calculations of habitat flow relationships (Normandeau Associates, *et al.* 2011).

The drainage area at SSES/BBNPP is 2.8% greater than at the Wilkes-Barre gage. Wapwallopen Creek at Wapwallopen is the only active gage on a stream entering the river between the Wilkes-Barre gage and SSES/BBNPP; the Wapwallopen Creek gage has a drainage area of only 43.8 square miles. For the purposes of this supplemental data collection study, river flow as measured and recorded at the Wilkes-Barre gage will be considered to represent the flow in the study reach. Recorded daily river flows at Wilkes-Barre for the period April 1899 (beginning of record) through March 2011 will be used to evaluate the occurrence of the potential impacts of BBNPP consumptive water use[1]. Table 2-3 presents selected statistics of the daily river flow at Wilkes-Barre from April 1899 through March 2011.

Table 2-3 Selected daily river flow statistics at Wilkes-Barre (USGS gage # 01536500), April 1899 - March 2011

	Daily flow (cfs)			
Month/season[2]	Minimum	Median	Average (mean)	Maximum
Jan	1,010	9,100	14,500	210,000
Feb	1,060	8,800	14,900	179,000
Mar	2,100	22,100	30,400	229,000
Apr	5,210	24,000	31,000	206,000
May	2,000	12,000	16,300	206,000
Jun	1,350	5,775	9,400	329,000
Jul	787	3,480	5,600	142,000
Aug	716	2,440	4,200	95,300
Sep	532	2,290	4,600	244,000
Oct	658	3,360	7,200	151,000
Nov	627	7,540	11,500	123,000
Dec	860	10,200	14,500	184,000
Annual	532	7,400	13,700	329,000
Jan-Mar	1,010	12,100	20,100	229,000
Apr-Jun	1,350	13,000	18,900	329,000
Jul-Sep	532	2,670	4,800	244,000
Aug-Oct[3]	532	2,570	5,400	244,000
Oct-Dec	627	6,720	11,100	184,000

[1]SRBC has requested that daily river flows for the entire period of record be used for this study. (Pers. Communication with A. Dehoff.)

[2]Other "seasons" (e.g., May-June) may be appropriate for evaluation of potential habitat loss for certain species-life stage combinations.

2.2. WATER QUALITY

This section of the study plan describes the water quality of the Susquehanna River in the vicinity of the BBNPP.

2.2.1.Susquehanna River Water Quality

Susquehanna River water quality has been monitored by the Susquehanna SES Environmental Laboratory from 1971 through the present, with modifications to the program over the years. Table 2-4 summarizes the sampling periods, frequency, locations, and programs.

Table 2-4 Ecology III Susquehanna River water quality monitoring program

Year	Sample period	Sample frequency	Sample locations	Programs
1971	Aug-Dec	Twice a month	6-9 locations Falls, PA to Berwick, PA	
1972	Apr-Dec	Daily	SSES	Various analyses
		Monthly	SSES	Diurnal
		Semimonthly	Falls to Berwick	River Run
		Quarterly	SSES to Columbia	Extended River Run
1973	Jan-Dec	Daily	SSES	Various analyses
		Monthly	SSES	Diurnal
		Semimonthly	Falls to Berwick	River Run
		Quarterly	SSES to Columbia	Extended River Run
1974	Jan-Dec	Semi-weekly	SSES, Bell Bend	Various analyses
		Mar, May, Jul, Sep	SSES	Diurnal
		Feb, May, Jul, Sep, Dec	Falls to Berwick	River Run
1975	Jan-Dec	Weekly (Jan-Feb)	SSES, SSES-A[4]	Various analyses
		Weekly (Mar-Dec)	SSES-A	Various analyses
		Apr, May, Jun, Jul, Aug, Sep	SSES-A	Diurnal
1976	Mar, Oct-Dec	Semimonthly	SSES-A	Various analyses
	Apr-Jun	Semiweekly		
	Jul-Sep	Weekly		
1977	Apr-Sep	Semiweekly	SSES-A	Various analyses
	Jan-Mar, Oct-Dec	Semimonthly		
1978-1985	Apr-Sep	Semiweekly	SSES**, Bell Bend	Various analyses
	Jan-Mar, Oct-Dec	Weekly		
1986-2004	Apr-Sep	Weekly	SSES, Bell Bend, Bell Bend I	Various analyses
	Jan-Mar, Oct-Dec	Semimonthly		
2005-present		Quarterly	SSES, Bell Bend	Various analyses
1974-present	Constant monitor for river level and river temperature			

Ecology III has measured water temperatures 1,620 feet upstream of the SSES intake structure on the west bank of the Susquehanna River daily since 1974 (Ecology III, Inc. 2008). A maximum water temperature of 86.5°F was recorded on 15 Aug 1988 and on 4 Aug 2007. A minimum water temperature of 32.0°F was recorded numerous times in January. Other statistical summaries, for example, monthly mean and maximum temperatures, can be developed from this daily record. The Susquehanna River adjacent to the BBNPP is designated as a Warm Water Fishery (WWF). Specific water quality criteria (Pa. Code, Chapter 93.Water Quality Standards, § 93.7.Specific water quality criteria) for DO and pH are as follows:

> "DO (applicable to WWF): Minimum daily average 5.0 mg/l; minimum instantaneous 4.0 mg/l."

[4]Same sampling location from 1975 to present. SSES-A was renamed SSES.

"pH (applicable to WWF): range between 6.0 and 9.0 inclusive"

Pennsylvania provides the following criteria for temperature (Pa. Code, Chapter 93. Water Quality Standards, §93.7. Specific water quality criteria):

> "Maximum temperatures in the receiving water body resulting from heated waste sources are regulated under Chapters 92, 96 and other sources where temperature limits are necessary to protect designated and existing uses. Additionally, these wastes may not result in a change by more than 2°F during a 1-hour period."

Table 2-5 summarizes the temperature limits by "critical use period" applicable to WWF streams. These values represent the maximum allowable water temperatures (cross-sectional average) at an unspecified distance downstream of the discharge where fully-mixed conditions occur.

Table 2-5 Temperature limits applicable to Warm Water Fishery streams

Source: Pa Code, Chapter 93, § 93.7

Critical Use Period:	Temperature (°F)
January1-31	40
February1-29	40
March1-31	46
April1-15	52
April16-30	58
May1-15	64*
May16-31	72*
June1-15	80*
June16-30	84*
July1-31	87*
August1-15	87**
August16-30	87**
September1-15	84
September16-30	78
October1-15	72
October16-31	66
November1-15	58
November16-30	50
December1-31	42

* Critical Period for Fry per Chaplin (2009)
**Additional Period to be evaluated by this Study

A search of USGS records for recent dissolved oxygen measurements in Susquehanna River shows that Hunlock Creek (USGS No. 01537700) is the nearest water quality station upstream of SSES and that Danville (USGS No. 01540500) is the nearest water quality station downstream of SSES. There were 76 samples taken at Danville and 15 samples at Hunlock Creek since January 2001. DO values for all samples were within the range of 7 mg/l to 15 mg/l. The DO values were consistently above the applicable DO criterion (DO_2). The pH values ranged from 6.4 to 8.9. The pH values were consistently within the required standard.

The water quality of the Susquehanna River upstream of the BBNPP has also been studied as part of two TMDL investigations. The first TMDL study (PADEP 1999; USEPA, 1999) focused on polychlorinated biphenyls (PCBs). The second TMDL (PADEP 2009; USEPA 2009) focused on mine drainage-affected segments for metals (iron, aluminum, and manganese), pH, and alkalinity. These Susquehanna River TMDL studies provide measured water quality parameters (pH, alkalinity and metals: iron, aluminum, and manganese).

3. *WATER QUALITY ASSESSMENT OF BACKWATER AREAS USED BY FRY (≤25 MM LONG) AND YOUNG-OF-THE-YEAR SMALLMOUTH BASS (YOY SMB)*

"Diseased" YOY SMB have been observed by Ecology III staff biologists in the river during the summers of 2005 and 2010, periods of low river flow and high water temperature (Brian Mangan, personal communication). The summer of 2005 was also the period when the Pennsylvania Fish & Boat Commission biologists first observed mortality of YOY SMB with lesions but apparently not in the area near the BBNPP site. A recent report by Chaplin *et al.* (2009) postulated that sub-optimal dissolved oxygen (DO), particularly during the nighttime and in combination with relatively warm temperatures in habitats of YOY SMB, may have played a role in predisposing the fish to the bacterial infections. The bacterium (*Flavobacterium columnare*) is common in soil and water and causes secondary infections in stressed fish (PFBC 2005).

Microhabitats in which such sub-optimal DO and warm temperatures may occur are typically in side channels or backwaters and are characterized by relatively low velocities (<0.1 ft./sec) and shallow depths (<2 ft.) compared to the main river channel. These microhabitats, occupied by YOY SMB, can be subject to wide fluctuations in DO and elevated water temperature. For illustrative purposes, an example photo of a backwater area from the southeast shore of Goose Island on the Susquehanna River with abundant aquatic vegetation is provided as Figure 3-1; it shows a shallow, low velocity area away from the main river channel.

Figure 3-1 Example of backwater habitat at Southeast shore of Goose Island on the Susquehanna River with abundant aquatic vegetation. Photo taken in July 2010.

Shallow areas are more susceptible to heating by solar radiation than the main channel of the Susquehanna River and also may show larger fluctuations in DO over a 24-hour period. Backwaters are relatively calm, shallow areas or channels around islands that are cut off from the dominant flow of a river, particularly in late spring and summer as seasonal low flow approaches. This period may coincide with fish rearing and nursery activities. YOY SMB utilizing these habitats during a sustained extreme low river flow may be subject to potentially stressful, low DO concentrations at night and elevated water temperature during the day.

3.1. FIELD DATA COLLECTION

A program of continuous monitoring of DO, pH, water temperature, and depth in off-channel habitats, combined with visual observations (hydrological conditions permitting) of potential SMB spawning areas along the shore lines will be conducted. Six sondes will be deployed in the vicinity of Goose, Hess, and Rocky Islands for 17 weeks from 15 April through 15 August, meteorological and hydrological conditions permitting. Two back-up sondes will be available in case of any malfunctions with the field units. If spawning activity is observed or emerging (black) fry are noted, the frequency of depth measurements and visual observations will be increased in these areas. These observations may also be used to adjust the locations of the continuous monitoring locations described below. Also, water quality and depth data will be

collected at various locations within the SRBC designated study reach (between the upper tip of Goose Island and lower tip of Rocky Island) when conditions deem necessary. A copy of the Field Data Sheet (Attachment 1) and the Sonde Calibration Form (Attachment 2) that will be used during the study are provided as well.

To supplement the above data, periodic electrofishing surveys[5] will be conducted primarily to examine YOY SMB for symptoms of disease (e.g., lesions, open wounds/injury, etc.), particularly in August when the bacterial disease has been reported to be most prevalent.

Continuous monitoring of DO, water temperature, depth, and pH in backwater areas near Rocky Island, Hess Island, and Goose Island (Figure 3-2) will be conducted during a period likely to coincide with high water temperature and low nighttime DO values and recommended by SRBC. All these locations are at least 2.5 mi downstream of the proposed BBNPP discharge and cover both shorelines. This period would also coincide with the SMB spawning, rearing, and nursery in backwater areas. This monitoring program will document whether stressful water quality conditions occur during the critical nursery and rearing times of fry and YOY SMB and the extent of these conditions.

The locations were selected for accessibility, ease of servicing, and representativeness of potential backwater habitat and a main channel location near Goose Island. The proposed sampling scheme utilizes a total of six locations to be monitored. Five of the six field sondes will be positioned near-shoreline and backwater locations at and around the two islands. These locations will provide data in areas with the potential of having stressful water quality conditions for YOY SMB. One backwater location is a repeat at Goose Island backwater area and another within the vicinity of Goose Island in the main channel to be used as a reference site (Figure 3.2). The third location is the backwater area between Goose Island and the west shoreline. The other locations will include a suitable microhabitat within the riffle area located near Rocky Island as well as near the southern tip of Rocky Island. The other suitable microhabitat location will be near the southern tip of Hess Island.

Unlike the Chaplin *et al.* (2009) and Normandeau Associates *et al* (2011) studies where paired sondes were deployed in both a backwater area and a corresponding main channel location to monitor DO and water temperature, this proposed study is designed to sample water quality parameters (water temperature, DO, pH, and depth) at five low velocity and/or backwater areas and one main channel habitat near Goose Island (Figure 3-2); the latter will be used as a reference location. Again these locations, particularly low velocity areas, are selected based on where YOY SMB occur and can become susceptible to the bacterium (*Flavobacterium columnare*) within the SRBC designated study reach.

[5]PFBC has offered to coordinate with PPL Bell Bend to perform YOY SMB electrofishing in the study area in August in order to determine the incidence of disease.

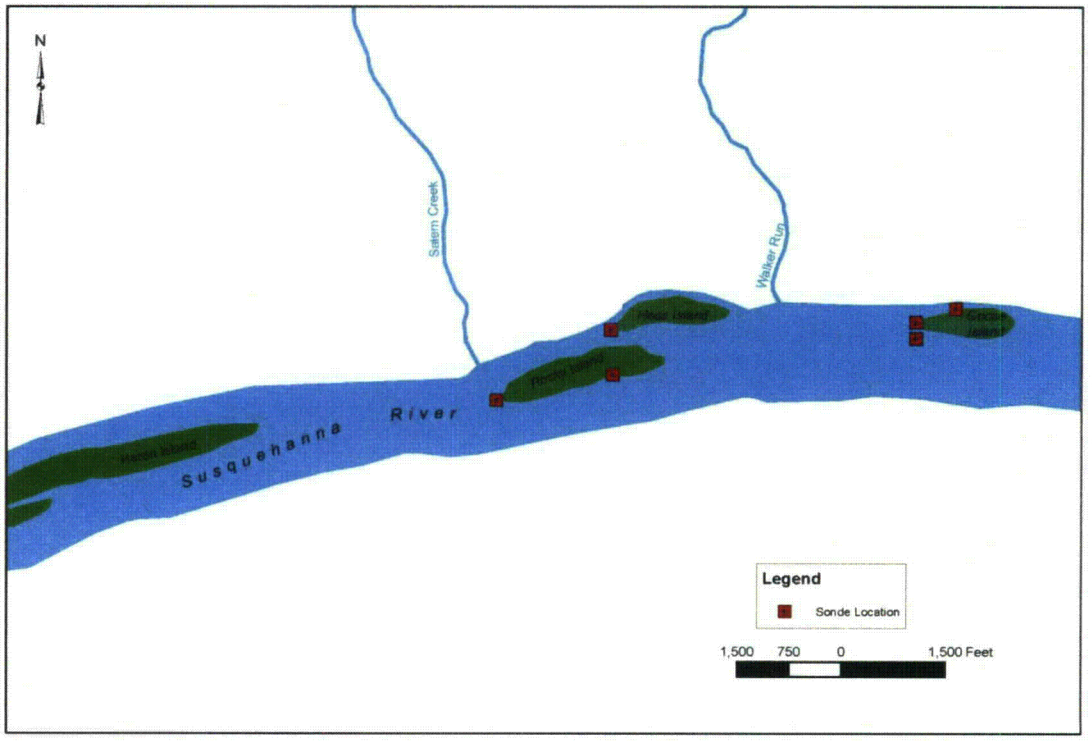

Figure 3-2 Proposed sampling locations of backwater temperature and DO in the study area. One (lower) of the two sondes at Goose Island is positioned in the main channel to serve as a reference location.

3.2. QA/QC OF SONDE PERFORMANCE

Personnel will utilize boat(s) to service the sondes and calibration will be done either in the field or at the Susquehanna SES Environmental Laboratory, approximately 4 miles upriver from the islands. Meteorological and hydrological conditions permitting, the sondes will be serviced once a week during the monitoring period to allow corrective action in a timely fashion. Should some continuous data collection be interrupted, manual measurements will be taken, particularly during nighttime low DO periods.

Continuous water quality data will be collected at continuous monitoring locations with a HACH Hydrolab DS5X data sonde equipped with sensors to measure temperature, DO, pH, and depth. The temperature sensors are set at the factory and all other parameter sensors will be calibrated per manufacturer's requirements on a weekly basis. The DO sensor will employ the luminescence dissolved oxygen (LDO) technology which uses blue and red light-emitting diodes (LEDs) to measure DO in water. The LDO sensor was chosen over traditional techniques out of concern that passive fouling (*e.g.*, algae growth on sensor) could occur. The LDO sensor does

not consume oxygen so passive fouling will not affect DO readings. The luminescence dissolved oxygen (LDO) technology is specifically designed for long term continuous monitoring; any incidental algae or biological growth on the meter will not affect the accuracy of the sensor. The continuous monitor probes will be visually inspected for biological growth weekly and cleaned as necessary.

QA/QC measures will include regular (weekly) downloads and calibration of the continuous monitors per manufacturer's instructions. The LDO sensor will be equipped with a self-cleaning wiper to decrease the potential for fouling by debris or algae. Calibration records for the continuous monitors will be kept and provided in the report. Performance of the sondes will be checked against a calibrated field DO and temperature meter according to the procedures developed by Ecology III.

As in the Chaplin *et al.* (2009) study, freshly calibrated water quality meters will be positioned with the deployed sonde to collect side-by-side measurements of DO and water temperature. The deployed sonde will be cleaned and returned to the river and a second set of side-by-side readings will be recorded. Following these checks, the deployed sondes will be retrieved and the data downloaded to a field data logger. The recorded sonde measurements will be adjusted for any drifts between the two side-by-side readings. Dissolved oxygen (DO), water temperature, pH, and depth data averaged for hourly parameter values will be collected for 17 weeks (15 April-15 August), meteorological and hydrological conditions permitting.

The LDO, pH, and depth sensors on the continuous monitors will be calibrated prior to deployment, per manufacturer's specifications and on a weekly basis thereafter. In-river DO, water temperature, and pH will be checked against the continuous monitor using calibrated portable instruments; these values will be recorded on data sheets as performance check measurements. Once the continuous data is retrieved, the performance check measurements will be compared to the continuous monitor data set for accuracy. The raw data collected from the continuous monitor will be reviewed and approved by field scientists prior to reporting. Spurious and other data that is considered inconsistent or unreasonable based on observed trends will be highlighted for exclusion from further analysis.

3.3. Smallmouth Bass (SMB) Spawning Activity, Fry (≤25 mm long), and Young of the Year (YOY) Monitoring

Observations on initiation of smallmouth bass spawning activity and emergence of fry with subsequent development into YOY life stage will begin in mid-April 2012 or earlier if the river water temperature warms to 50°F. An attempt will be made to document the time and location of pre-spawning activity as was observed in early spring of 2010. For 2012, an approximation of the size of the area where spawning activity is observed will also be documented. This shore-line schooling behavior of adult SMB gives a good indication of where spawning will actually occur. The observations will be centered where sondes have been deployed in the vicinity of Goose, Hess, and Rocky Islands (Figure 3-2). Once spawning begins around the first week in May, weekly observations will be made to try to locate nests and subsequent schools of SMB fry.

In 2010, SMB fry were seen hatching from nests and swimming directly into the shoreline to seek cover from the river current.

A portable sonde will be used to record river water temperature; DO, pH, and depth at the location of fry schools, particularly if they are not near a sonde. These instantaneous measurements will not take the place of the continuous sonde data, but they should provide some information about habitat preference. As fry grow into YOY, their location and habitat will also be noted weekly. Photographs will be taken to document the habitat of both fry and YOY SMB along with depth and current measurements. Some backpack electrofishing and seining is planned in July, provided river conditions are suitable, to document possible habitat changes of YOY SMB (see footnote 5 on page 11).

3.4. DATA ANALYSIS

The water quality analysis will focus on the relationship among flow, depth, temperature, dissolved oxygen (DO) and possibly pH. The previous 2010 data were limited by time frame since the deployment of the sondes occurred in late June, so actual data from the beginning of the SRBC period of interest beginning May 1, were not available. The sonde data did, however, capture the highest temperature period of the year and the data supports that it captured all events above the 84°F thermal threshold. The 2012 data collection season is scheduled to begin mid-April and continue to mid-August, fully capturing the pre-spawning, fry and juvenile activity periods.

3.4.1.Smallmouth Bass Prespawning and Fry Period 2012

When field observations indicate that the fry period is over, the collected 2012 data will be analyzed. Initially, the data will be assessed for event frequency and duration similar to the 2010 data.

Unlike the 2010 data collection, the 2012 data collection will also include a depth transducer that will gather depth data on an hourly basis with corresponding water quality data. This will allow a direct comparison of depth, and thus flow variation and if temperature is statistically related to flow. Based again on diagnostics, a correlation or regression analysis will be completed to determine the existence of a statistically significant relationship and the strength of any relationship. It may also allow evaluation of the relationship on an hourly basis, again based on the data diagnostics. If the depth analysis is inconclusive we will then apply the thermal model used for the 2010 data analysis using the 2012 data and corresponding hourly meteorological data and ΔTs reported on an hourly basis with the same diagnostics and summaries as with the 2010 data.

3.4.2. YOY SMB Period 2012

Once the full data collection event is complete, all the data will be assessed using the same procedural outline as for the pre-spawning and fry period described above. At this time, the data will also be assessed to determine if any other, particularly statistical analyses, will be useful.

The scope and nature of those assessments cannot be determined until all the data are available and have been evaluated.

The final data will be used to evaluate the strength of any potential relationship between depth, temperature, DO, and flow. If a relationship exists, it will be used to analyze those parameters at lower flows than 7Q10 if they were to occur in the USGS record adjusted for the sonde location during the study period.

3.4.3. Dissolved Oxygen and pH 2012

Since thermal changes can affect dissolved oxygen, the analysis will include an analysis of the dissolved oxygen data to assess dissolved oxygen concentration effects based on a threshold concentration of 4.0 mg/l. All the analyses will be based on hourly data and hourly increment analysis, consistent with the time step used in data collection and will include frequency and duration of events below 4 mg/l. This will be a complex analysis and the nature of the data will dictate the details and direction of the analysis. The main reason this analysis is so complex lies primarily in the strong diurnal signal that is dominated by photosynthetic activity, which drives DO into high super-saturation conditions into the mid- to late afternoon with corresponding nighttime lows in dissolved oxygen. As part of weekly observations, the type of aquatic vegetation will be visually identified and its density estimated as well as any impact it may have on impairing flow or creating a flow occlusion in and or around the microhabitats. The statistical analyses of dissolved oxygen and pH will be presented in tabular and graphical form.

Chaplin *et al* 2009, as well as other references on *Flavobacterium columnare,* discuss factors such as pH on the potential virulence of the bacteria. A parallel assessment of other parameters (temperature and DO) shall compare incremental effects of flow reduction on those parameters. This portion of the analysis will have certain limitations based on the time step available for historical flow data (daily averages) which we will attempt to reconcile with the hourly sonde and meteorological data.

4. REPORTING AND SCHEDULE

The fry period data analysis will be complete by the end of July or early August 2012, depending on when the end of fry activity is noted in the field. The final comprehensive analysis will be completed approximately 2 weeks after the end of data collection, and compiled in the study report at the end of the first week of September 2012.

An electronic database will accompany the report. This database will provide all data sources used in the analysis, photographs from site visits, documentation of sampled locations with time and dates, and computer model inputs and outputs.

Table 4-1 below describes the planned schedule for this project. The tasks shown are those that relate directly to deliverables to agencies and the expected review cycles on work products.

Table 4-1 Proposed Schedule

Submit to SRBC for Review	Fri 4/6/12
Hold Agency Meeting	Wed 4/11/12
Finalize Scope	Wed 4/18/12
Undertake Additional Data Collection as Needed	Thu 9/6/12
Prepare and Submit Report * Assumes no additional data collection is necessary.	Thu 9/6/12*

LITERATURE CITED

Chaplin,J.J., J.K. Crawford, and R.A. Brightbill.2009. Water quality monitoring in 2008 in response to young-of-the-year smallmouth bass (*Micropterus dolomieui*) mortality in the Susquehanna River and major tributaries, Pennsylvania, U.S. Geological Survey, Reston, VA.

Ecology III, Inc. 2008. Environmental studies in the vicinity of the Susquehanna Steam Electric Station. Annual Report prepared for PPL LLC, Allentown, PA.

Ecology III, Inc. 2008."River temperature method of analysis, 1974-2008".804 Salem Blvd., Berwick, PA 18603. Prepared for PPL LLC, Allentown, PA.

Normandeau Associates Inc., Ecology III, and T. R. Payne Associates. 2011. Potential effects of the Bell Bend Project on aquatic resources and downstream users. Proposed Bell Bend Nuclear Plant Site, Luzerne County, Pennsylvania. Draft for agency review. Prepared for PPL Bell Bend, LLC, Allentown, PA.

Pennsylvania Department of Environmental Protection., 2009. Final Susquehanna River metals TMDL Luzerne County. February.

USEPA. 2009. Decision Rationale Total Maximum Daily Loads For Acid Mine Drainage Affected Segments Susquehanna River Luzerne County, Pennsylvania.

USGS. 2010. Stream Stats online at http://water.usgs.gov/osw/streamstats/pennsylvania.html

ATTACHMENTS

Attachment 1

Bell Bend Backwater Water Quality Project
DS5X LDO MONITOR CALIBRATION & CHECK FIELD SHEET

LOCATION: _____ **Investigator :** _____

DATE ☐☐☐☐☐☐ (m m d d y y)

PURPOSE ☐
1 = Calibrate & Download monitor (complete Sec 1-7 below)
2 = Performance check (complete Sections 1, 2, 3 & 7)
3 = Retrieve for data download & maintenance (complete Sections 1, 2, 3, 4 & 7)

Weather Code ☐
1=Clear 2=P. Cloudy 3=Overcast 4=Lt.Rain 5= H. Rain 6=Fog/Haze

1 River Flow : _____ **River Level** _____

As Measured at Susquehanna Environmental Laboratory

2 PRE-RETRIEVAL "CAL END POINT" OR PERFORMANCE CHECK VALUES (at DO monitor location):

Time	DO / pH Meter		DS5X Monitor	
☐☐☐☐ (24 hr)*	Temp ☐☐.☐	°F	Temp _____	°F**
	DO ☐☐.☐	mg/l	DO _____	mg/l **
	pH ☐☐.☐	su	pH _____	su **
	Cond _____	µS/cm**	Cond _____	µS/cm**
	Depth	feet	Depth	feet

4 MONITOR RETRIEVAL FOR DATA DOWNLOAD & MAINTENANCE:

Time retrieved (taken out of service) ☐☐☐☐ (prevailing, 24 hr) *

Data Download Location: _____ (**Lab** or **Onsite**) **Time of Download:** ☐☐☐☐ (24 hr) *

Applicable Maintenance Performed: _____
1 = None required; **2** = Sensors cleaned; **3** = pH electrolyte replaced; **4** = Batteries replaced; **5** = Other (_____)

5 MONITOR CALIBRATION: **Barometric pressure =** _____

DO Calibration* ** **Method Used:** ☐ 1 = LDO 100% SAT; **2** = Aerated Water; **3** = Other _____

Cal Temp _____ **(°F)** >> °F from hand thermometer; YSI; or Sonde thermistor for Method 2

Cal DO ☐☐.☐ **(mg/l)** >> DO value (from solubility table) for Method 2

pH Calibration *** @ 7.00 _____ @ 4.00 _____ @ 10.00 _____ (Record **OK** for buffer(s) used)

Conductivity Calibration*** @ 0 µS/cm _____ @ 147 µS/cm _____ @ 1412 µS/cm _____

Time that the monitor was redeployed in the Backwater ☐☐☐☐ (prevailing, 24 hr) *

6 MONITOR REDEPLOYMENT "CAL BEGIN POINT" MEASUREMENTS (at monitor location):

Time	DO / pH Meter		DS5X Monitor	
☐☐☐☐ (24 hr)*	Temp ☐☐.☐	°F	Temp _____	°F**
	DO ☐☐.☐	mg/l	DO _____	mg/l**
	pH ☐☐.☐	su	pH _____	su **
	Cond _____	µS/cm**	Cond _____	µS/cm**
	Depth	feet	Depth	feet

7 Air Temperature _____ **°F** **Wind Conditions** (Circle one): Calm Light Moderate Gusty Strong

Wind Direction: _____

Other Sampling Notes: _____

* Use 24 hour clock; e.g., 3 AM = 0300 hr 3 PM = 1500 hr

** Record values later from downloaded data at the corresponding time of portable meter measurements.

*** May be done in Lab or Field just prior to deployment, experience to dictate location.

Bell Bend Backwater SMB Project
SUSQUEHANNA SES ENVIRONMENTAL LABORATORY

CALIBRATION / MAINTENANCE LOG
YSI SONDE 650 MDS – PROBE 600 XL

SERIAL NUMBER _____ PROBE NUMBER _____

Instrument put in service: Date _____ Time _____

Attachment 2

Date	Time	DO (mg/l) Found	DO (mg/l) After Cal	Barom. (mmHG)	Cond.147 (µmhos/cm)	Cond.1412 (µmhos/cm)	pH 4	pH 7	pH 10	Initials	Remarks

BELL BEND NUCLEAR POWER PLANT			
	MILESTONE	SCHEDULED DATE	ACTUAL DATE
1	Bell Bend COL Application Submitted by PPL		10/10/08
2	Bell Bend COL Application Docketed by NRC		12/15/08
3	SRBC Withdrawal/Consumptive Water Use Application Submitted		05/13/09
4	NPDES Permit Application Submitted		11/12/10
5	FEMA Floodplain Analysis Submitted		05/15/11
6	ACOE/DEP Joint Permit Application Submitted		06/29/11
7	Air Operating Permit for Construction Submitted		07/18/11
8	NPDES Rev. 1 Submitted		09/19/11
9	DEP Air Conformity Analysis Submitted		10/07/11
10	ACOE/DEP Joint Permit Application Revision Submitted		11/12/11
11	SRBC Groundwater Withdrawal Application Submitted		01/05/12
12	SRBC Approval-By-Rule Application		03/21/12
13	NRC ER Revision 3 Submitted		03/30/12
14	DEP Issues 401 Water Quality Certification	12/17/12	
15	DEP Issues NPDES Stormwater Permit	01/23/13	
16	DEP Issues Section 105 Encroachment Permit	01/23/13	
17	NRC Issues Draft Environmental Impact Statement	03/31/13	
18	SRBC Approves All Withdrawal and Consumptive Water Use Permits	03/31/13	
19	NRC Issues Final Environmental Impact Statement	05/30/14	
20	ACOE Issues 404 Wetlands Permit	09/30/14	
21	NRC Approves Bell Bend COL	03/31/15	
22	Complete Construction	12/19/22	
23	Commercial Operation Date	06/16/23	

SRBC Applications Index

PPL Bell Bend

Surface Water Withdrawal and Consumptive Use Applications

Name	Transmittal Date	Subject
BNP-2009-073	5/13/2009	Application for Groundwater Withdrawal, Application for Surface Water Withdrawal, Application for Consumptive Water Use
BNP-2009-307	10/9/2009	Supplemental Information for Application for Surface Water Withdrawal, Application for Consumptive Water Use
BNP-2011-005	1/14/2011	Application for Surface Water Withdrawal, Application for Consumptive Water Use (Revised Max Withdrawal and Consumptive Use)

Groundwater Withdrawal

Name	Transmittal Date	Subject
BNP-2011-125	6/28/2011	Application for Aquifer Test Plan Waiver
BNP-2012-007	1/5/2012	Application for Groundwater Withdrawal

Approval by Rule Application

Name	Transmittal Date	Subject
BNP-2012-058	3/21/2012	Approval by Rule Application for Groundwater Withdrawal

PPL Generation

Other Applications

Name	Transmittal Date	Subject
PPL-2011-216	11/21/2011	Rushton Mine Application for Aquifer Test Plan Waiver
PPL-2011-238	12/22/2011	Rushton Mine Ground-Water Withdrawal Application
PPL-2012-076	3/9/2012	Holtwood Hydroelectric Station Application to Provide Consumptive Water Use Mitigation

T. L. Harpster
VP-Bell Bend Project-Development

PPL Bell Bend, LLC
38 Bomboy Lane, Suite 2
Berwick, PA 18603
Tel. 570.802.8111 FAX 570.802.8119
tlharpster@pplweb.com

May 13, 2009

Project Review Coordinator
Susquehanna River Basin Commission
1721 North Front Street
Harrisburg, PA 17102-2391

ATTN: Paula B. Ballaron, Regulatory Program Director

BELL BEND NUCLEAR POWER PLANT
APPLICATION FOR GROUNDWATER WITHDRAWAL
APPLICATION FOR SURFACE WATER WITHDRAWAL
APPLICATION FOR CONSUMPTIVE WATER USE
BNP-2009-073

Dear Ms. Ballaron:

Enclosed for the Susquehanna River Basin Commission's review and approval please find the following applications for water withdrawal and use at the proposed Bell Bend Nuclear Power Plant (BBNPP), to be located in Salem Township, Luzerne County, PA:

- Application for groundwater withdrawal up to a maximum 30-day average of 3.3 million gallons per day (mgd);
- Application for surface water withdrawal up to a maximum of 44 mgd (peak day); and
- Application for consumptive water use up to a maximum of 31 mgd (peak day).

BBNPP is owned and will be operated by PPL Bell Bend, LLC (PPL BB). PPL BB is owned by PPL Bell Bend Holdings, LLC which in turn is an indirect subsidiary of PPL Corporation. PPL BB will be the licensed operator of BBNPP.

General Information

BBNPP will be a single-unit nuclear power plant with a net electrical output of approximately 1,600 megawatts. BBNPP will be located southwest of and adjacent to the Susquehanna Steam Electric Station (SSES). BBNPP will employ a U.S. Evolutionary Power Reactor, which is a pressurized water reactor expected to have a life of at least 60 years. PPL BB expects to receive a license from the U.S. Nuclear Regulatory Commission (NRC) for an initial period of 40 years.

The primary water source for BBNPP will be the Susquehanna River. The BBNPP river intake will be located approximately 300 ft. downstream from the SSES river intake. The river intake will contain six river pumps: three pumps (each rated at 13,100 gpm) will be components of the Circulating Water System Makeup Water System (CWSMWS); and three pumps (each rated at 2,900 gpm) will be components of the Raw Water Supply System (RWSS). The RWSS will provide water to the Essential Service Water Emergency Makeup System (ESWEMS) and several relatively minor uses. Two CWSMWS pumps and one RWSS pump will provide sufficient water supply during normal plant operation.

The CWSMWS will provide turbine condenser cooling and will have two natural draft evaporative cooling towers (the "Main" cooling towers). The ESWEMS will provide water for cooling the reactor core and other plant components during both normal and emergency conditions. The ESWEMS will have eight mechanical forced draft evaporative cooling towers; during normal plant operation only two ESWEMS cooling towers will be in service at any given time. Blowdown from both the CWSMWS and ESWEMS cooling towers will be discharged to the Combined Waste Water Retention Basin and thence to the River via a common discharge line, with a submerged diffuser in the river. The BBNPP discharge diffuser will be located approximately 680 ft. downstream from the BBNPP river intake and approximately 380 ft. downstream from the SSES discharge diffuser.

On October 10, 2008 PPL BB submitted a Combined License Application (COLA) for the construction and operation of BBNPP to the NRC. On December 19, 2008 the NRC accepted the COLA for docketing. The COLA may be viewed on the NRC website at:

http://www.nrc.gov/reactors/new-reactors/col/bell-bend.html

Mobilization and site preparation activities are currently scheduled to begin during the third quarter 2011, and initial commercial operation of BBNPP is currently scheduled for December 2018. PPL BB will advise the Commission of any substantive changes to these dates.

Application for Groundwater Withdrawal

PPL BB is applying for approval of groundwater withdrawal of up to 3.3 mgd as a 30-day average. It is expected that groundwater will be withdrawn only during construction. The sole purpose of the withdrawal will be to dewater the area in which the reactor building and ESWEMS structures will be constructed. A slurry wall will be installed along the perimeter of the area to be dewatered. The dewatering system will consist of approximately 30 wells located inside of and along the length of the slurry wall. The maximum rate of groundwater withdrawal will occur during a two- to three-month period early in construction to draw down the groundwater level within the area enclosed by the slurry wall. Following drawdown, groundwater withdrawal will be continued in order to maintain dry conditions for excavation and foundation construction. On-site withdrawal of groundwater is expected to cease completely prior to plant operation.

Some of the groundwater withdrawn during construction is expected to be used for construction purposes. Most or all of the use of groundwater during construction is expected to be consumptive. The consumptive use of groundwater is included in the application for consumptive water use.

The daily amount of groundwater withdrawal will be monitored and reported by PPL BB in accordance with a monitoring plan approved by the Commission.

Application for Surface Water Withdrawal

PPL BB is applying for approval of surface water withdrawal from the Susquehanna River of up to 44 mgd (peak day). Water will be withdrawn from the River only during plant operation (not during construction). Except for potable/sanitary water to be supplied by the local water purveyor, all water used during plant operation will be withdrawn from the River.

The primary use of surface water will be for the CWSMWS and ESWEMS, predominately cooling tower loss (evaporation and drift) and blowdown. The consumptive use of surface water is included in the application for consumptive water use.

The daily amount of surface water withdrawal will be monitored and reported by PPL BB in accordance with a monitoring plan approved by the Commission.

Application for Consumptive Water Use

PPL BB is applying for approval of consumptive water use of up to 31 mgd (peak day). Cooling tower evaporation represents more than 99 percent of the estimated peak day consumptive water use. The maximum (peak day) consumptive water use during construction is estimated to be approximately 0.12 mgd; consumptive use of groundwater is expected to cease prior to plant operation.

The daily amount of consumptive water use will be estimated and reported by PPL BB in accordance with a monitoring plan approved by the Commission.

Mitigation for Consumptive Water Use

PPL BB will reimburse the Commission for the Commission's costs of water supply storage, in accordance with the Commission's consumptive water use regulations, for the consumptive water use attributable to the project. In addition, PPL BB will continue to work closely with the Commission and other stakeholders to attempt to identify potential sources of mitigation acceptable to the Commission and to PPL BB that could be used in lieu of all or part of the monetary reimbursement. As the Commission is aware, the potential use of mine pools as sources of replacement water to provide mitigation is being evaluated.

Commission's Passby Flow Policy

PPL BB believes the Commission's "Guidelines for Using and Determining Passby Flows and Conservation Releases for Surface-Water and Groundwater Withdrawal Approvals" dated November 8, 2002 are intended to preserve flow to protect fisheries in small streams and therefore should not apply to BBNPP. However, even if the Commission considers the Guidelines in its review of the proposed BBNPP surface water withdrawal, the proposed surface water withdrawal is "minimal" as defined in the Guidelines.

The proposed BBNPP surface water withdrawal and discharge, and the existing SSES surface water withdrawal and discharge, all occur within the same pool in the River. The enclosed report "River Evaluation in the Vicinity of the SSES River Water Intake and River Diffuser and the Proposed BBNPP Intake and Diffuser" describes the pool and the prospective net effect of the two plants' withdrawals and discharges on the pool level. As explained in the report, the aggregate net withdrawal of SSES and BBNPP will not significantly affect water levels in the river pool and the upstream-to-downstream sequence of withdrawal and discharge has minimal effect on local aquatic habitat.

Request for Extension of Term of Approval

While PPL BB understands the Commission's need for flexibility in project approvals to meet potentially changing hydrologic or environmental conditions, it is PPL BB's opinion that the 15-year term of approval cited in Section 806.31 of the Commission's regulations is inappropriately short for a major electric generating unit, given the project's size, complexity and cost. PPL BB respectfully requests that the term(s) of the Commission's docket approval(s) for BBNPP surface water withdrawal and consumptive water use extend to the expiration date of the 40-year combined license (COL) expected to be issued by the NRC, while reserving the

Commission's right to reasonably revise docket conditions after appropriate notice and opportunity for hearing.
The following explanation of a COL is excerpted from the NRC's website:

> By issuing a [COL], the [NRC] authorizes the licensee to construct and (with specified conditions) operate a nuclear power plant at a specific site, in accordance with established laws and regulations. A COL is valid for 40 years from the date of the Commission finding, under Title 10, Section 52.103 (g), of the *Code of Federal Regulations* [10 CFR 52.103(g)], that the acceptance criteria in the combined license are met.

Request for Extension of Time to Commence Water Use

PPL BB respectfully requests that any docket(s) approving the groundwater withdrawal, the surface water withdrawal and the consumptive water use applied for herein grant a five-year period to commence the respective withdrawals and consumptive water use. In accordance with the project schedule, the three-year period stated in Section 806.31(b) of the Commission's regulations will probably allow insufficient time for commencement of water use related to plant operation and possibly even for commencement of water use related to plant construction. Also, PPL BB wishes to reserve the right to request an extension of the five-year period should such extension become necessary.

Project Review Fees

Based on the Commission's Project Fee Schedule effective through December 31, 2009 the respective fees associated with the applications submitted herewith are:

Groundwater withdrawal (3.3 mgd, 30-day average)	$ 8,825
Surface water withdrawal (44 mgd, peak day)	177,410
Consumptive water use (31 mgd, peak day)	44,100
Total Project Review Fee	$ 230,335

PPL BB elects the option to pay the surface water withdrawal fee and the consumptive water use fee in three consecutive equal annual installments with interest, as offered in the Project Fee Schedule. Accordingly, concurrent with this application, PPL BB is submitting by electronic transfer to the Commission's account an amount of $82,662 representing the total of the groundwater withdrawal fee, one-third of the surface water withdrawal fee, and one-third of the consumptive water use fee.

Public Notice of Applications

PPL BB is proceeding to issue public notice of these applications in accordance with the Commission's regulations. Notifications will be made to Luzerne County, the Luzerne County Planning Commission, Salem Township, a local newspaper, and owners of properties contiguous to the BBNPP site.

PPL BB respectfully requests the Commission's approval within two years of the date of receipt of the enclosed applications. Representatives of PPL BB will be available to provide further information to support the review process. Should you or your Staff have any questions, please contact Tinku Khanwalkar at 610.774.5466 or akhanwalkar@pplweb.com.

We look forward to working with your Staff in this matter.

Respectfully,

Terry L. Harpster

Attachment 1: Report: "River Evaluation in the Vicinity of the SSES River Water Intake and River Diffuser and the Proposed BBNPP Intake and Diffuser," Ecology III, Inc., September 12, 2008 (Revised May 6, 2009)
Attachment 2: Groundwater Withdrawal Application
Attachment 3: Surface Water Withdrawal Application
Attachment 4: Consumptive Water Use Application

cc: (w/o attachment)

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