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Oakland Bay Study

A dye and modeling study in an enclosed estuary with a high degree of refluxing

May 2004

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A dye and modeling study in an enclosed estuary with a high degree of refluxing

by
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Abstract

The city of Shelton is growing in population and is considering the possibility of increasing their wastewater discharge via an outfall that straddles two (sanitary) lines, which define a shellfish closure zone in Oakland Bay and Hammersley Inlet.

The Washington State Department of Ecology was approached to develop a model to help the Washington State Department of Health evaluate conditions at these sanitary lines, in response to Shelton's needs for possible wastewater treatment plant expansion.

We developed the Hammersley Oakland Bay Oceanographic (HOBO) model based on the Environmental Fluid Dynamics Code (EFDC), a three-dimensional hydrodynamic computer primitive equation model (Hamrick, 1992, 1996). HOBO is driven by real data acquired at its boundaries. The air-sea boundary conditions were generally provided from the nearby airport, Sanderson Field. The open sea boundary conditions were recorded near Libby Point as a part of the overall study. We used the HOBO model to simulate various discharge scenarios and to determine consequences at the two sanitary lines during periods specified by the Washington State Department of Health.

Ecology also participated in a dye study to determine the far-field dilution factor at the sanitary lines at a specific time, April 2003, and to validate the model.

Model results show that extending the diffuser horizontally across Hammersley Inlet can be very effective in controlling the far-field dilution at the sanitary line, although releasing effluent further north toward Munson and away from Eagle Point can cause problems on the east end of the Oakland Bay sanitary line. Holding back effluent at slack tide is another very effective method for controlling initial dilution at the sanitary lines. Controlling the vertical plume trapping depth is not very effective as a control method since there is a substantial amount of vertical mixing in this estuary, and the plume gets mixed anyway by the time it gets to either sanitary line.

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Executive Summary

The Washington State Department of Ecology was approached to develop a computer model of Hammersley Inlet and Oakland Bay for the City of Shelton.

The driving force for this work was a desire by the City of Shelton, Port of Shelton, Washington State Department of Corrections, and other regional partners to possibly expand the city's wastewater treat plant (WWTP) output into Oakland Bay and Hammersley Inlet without compromising shellfish harvest areas defined by two sanitary lines fore and aft of its discharge diffuser. The model was used to run and test various discharge scenarios of the WWTP.

The Washington State Department of Health (WDOH) maintains these sanitary lines, which are important to many commercial and tribal aquaculture interests in the area. The adverse condition for far-field dilution at the upstream sanitary line (Oakland Bay) is the flood tide after ebb, such that the sum of effluent accumulated during the ebb as well as low slack tide advects over the line shortly after the onset of the flood. Conversely, the adverse condition for far-field dilution at the downstream sanitary line in Hammersley Inlet is the ebb following a flood tide.

Oakland Bay is connected to the remainder of South Puget Sound by a long narrow entrance channel with a high degree of tidal-refluxing. Refluxing in an estuary refers to the quantity of outflowing water in a mixing zone that returns into the estuary over many tidal cycles. Refluxing occurs throughout the model domain, and there is ample justification for using dye to study circulation whereas drogues and drifters would likely be stranded on the jagged shoreline. To complement the understanding of a dye study instigated by the Federal Drug Administration (FDA), the Washington State Department of Ecology created a three-dimensional hydrodynamic model of the embayment using a sigma-coordinate primitive equation model called the Environmental Fluid Dynamics Code, or EFDC (Hamrick, 1992, 1996). We show that the model can be tuned to recreate the dye experiment, and then we use it to investigate various proposed discharge scenarios.

Model results show that the initial dilution of effluent released at the WDOH effluent criteria of 46,300 fecal coliform bacteria units per 100/ml (fcbs) would satisfactorily dilute to the Class A water quality standard of 14 fcbs crossing the sanitary lines when discharge is set at 2.6 million gallons per day (mgd). At 6.7 mgd, the satisfactory dilution did not occur. At intermediate levels between 4 and 4.6 mgd, success was dependent on diffuser configuration and discharge timing relative to the tide.

The model results also indicate that extending the diffuser horizontally across Hammersley Inlet can be very effective in controlling the far-field dilution at the sanitary line, although releasing effluent further north toward Munson and away from Eagle Point can cause problems on the east end of the Oakland Bay sanitary line. Holding back effluent at slack tide is another very effective method for controlling initial dilution at the sanitary lines. Controlling the vertical plume trapping depth is not very effective as a control method since there is a substantial amount of vertical mixing in this estuary, and the plume gets mixed anyway by the time it gets to either sanitary line.

This study does not recommend a decision on the future of discharge in the Oakland Bay system, but can be an aid to WDOH and the Regional Wastewater Task Force in making that decision on a timely and scientific basis. Ecology is planning an additional study based on the Clean Water Act-based 303(d) list that identifies impaired segments and prioritizes them for development of Total Maximum Daily Load (TMDL) studies.

Introduction

In 2002 the Food and Drug Administration (FDA) offered to send a team of specialists to Washington State to help the Washington State Department of Health (WDOH) conduct dye work at wastewater treatment plant (WWTP) outfalls. Two WWTPs were selected by WDOH for assessment: Hartstene Pointe and Shelton. This assessment was to be conducted during wintertime conditions, in order to assess higher discharge flows from these plants.

1. The Hartstene Pointe WWTP releases effluent in batch discharges, and was selected in order to compare measured plume dilutions with predicted Cornell Mixing Zone Models (CORMIX) model dilutions. These results were considered essential in determining the impact of various potential outfall configurations on nearby geoduck resources.

2. The Shelton WWTP was selected for assessment due to a proposal to expand the plant and discharge into Oakland Bay, which could impact its shellfish industry. The WDOH will not allow the existing shellfish closure zone for the Shelton WWTP outfall to expand in future flows. Therefore it was essential to measure effluent dilutions on the adverse tidal conditions that could have the most impact to the shellfish growing area. These results were then used to develop and calibrate a predictive three-dimensional computer model for the Shelton WWTP into these waters.

The Washington Department of Ecology (Ecology), in addition to being the agency responsible for administrating National Pollution Discharge Elimination System (NPDES) permits, maintains an oceanographic capability in its Environmental Assessment Program at Olympia. This program already had a functional 3D model of Puget Sound called the South Puget Sound Synthesis Area Model and in it had noted a high degree of refluxing in Hammersley Inlet, adjacent to Oakland Bay. Refluxing in an estuary refers to the quantity of outflowing water in a mixing zone that returns into the estuary over many tidal cycles. Despite a large barotropic (pressure-driven) tidal exchange, tidally-averaged residual (or net) outflows were very weak and seasonal. Weak residual flow can imply a high degree of refluxing.

WDOH asked that Ecology apply the EFDC model to the Oakland Bay – Hammersley Inlet site. The City of Shelton partially funded the work described here. There was also interest in this project from the shellfish industry and the Squaxin Tribe. During this work, we consulted with all of these parties and worked interactively with the Cosmopolitan Engineering Group of Tacoma (Cosmopolitan), the consultant for the City of Shelton.

In order to frame further understanding of water circulation in this system, we summarize a series of motivating questions in Table 1.

Table 1. Five central question sets pertinent to flushing contaminants in Oakland Bay seaward:

1. What is the initial dilution (near and far-field) of outfall effluent at two sanitary lines that enclose this discharge and demark a shellfish harvest closure zone? Are there exceedances of simulated fecal coliform bacteria tracers under specific discharge scenarios?
2. Once a tracer is diluted throughout the bay, how long will it take to flush out (steady-state solution)?
3. Where does the tracer go after leaving Hammersley Inlet seaward? (We can only use the complete South Puget Sound Synthesis Area Model to address this; no data were collected seaward of Libby Point in this study.)
4. How clean is the incoming water from Puget Sound?
5. What about other seasons? What is the significance of doing this work in April?

Questions 1 and 2 were addressed by the actual dye release experiment, but only for the specific conditions of mid-April 2003 and at specific locations where data were recorded. We can use the model, once validated against these real data, to address questions 3-5 and to provide a more comprehensive view (filling in data gaps along an entire sanitary line that would be impractical to gather sufficient data across). The South Puget Sound Synthesis Area Model and its larger-scale counterpart at the University of Washington, Puget Sound Regional Synthesis Model (PRISM), lacked the small-scale resolution necessary to address the questions surrounding the Shelton WWTP but would be required for questions 1, 2, and 5. WDOH wanted a resolution approaching 50 m in the vicinity of the outfall, hence the need for the Hammersley Oakland Bay Oceanographic (HOBO) model. Regarding question 4, we do not know how clean the receiving water is. We assumed that incoming water was perfectly clean and devoid of fecal coliform bacteria for these model runs. In order to make an assessment, we would need to have the full South Puget Sound Synthesis Area Model with all known fecal loadings and decay in South Puget Sound included.

Physical Setting

Oakland Bay (Fig.1) is a broad shallow estuary connected by the narrow channel of Hammersley Inlet to outer Puget Sound. Creeks include Goldsborough, Johns, Cranberry, Shelton, Deer, Uncle Johns, Mill, Malaney, Campbell, and Creek A.

A volume of 7.9×10^7 m^3 of water enters Oakland Bay during a typical flood tide, which only has a volume of 8.7×10^7 m^3 (Oakland Bay and Hammersley Inlet combined are about 14.8×10^7 m^3). A simple tidal prism calculation results in a flushing time of slightly over a day. This is a very poor estimate because much of the same water returns (refluxes) on each subsequent flood tide, as we will demonstrate in this study.

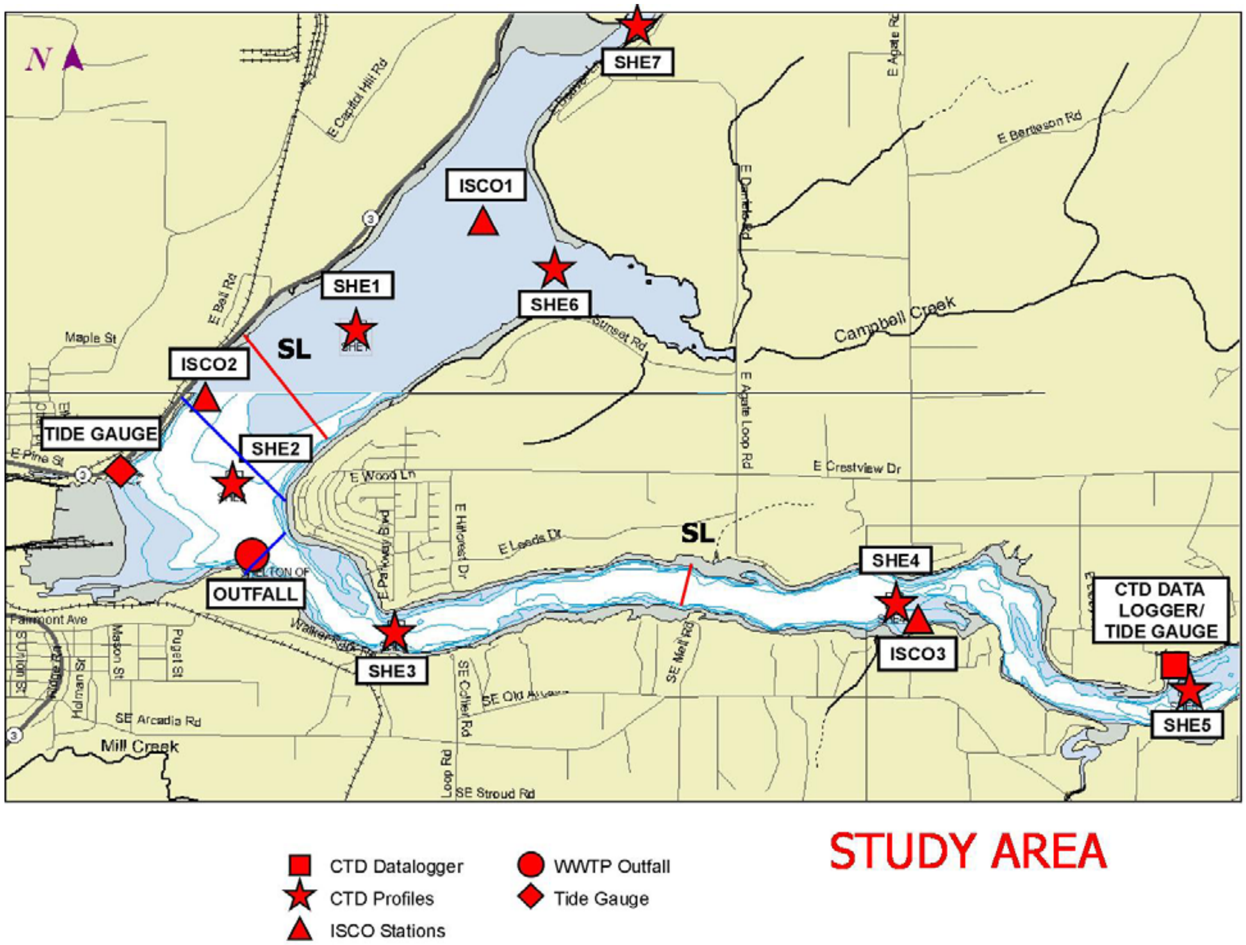

Figure 1. The Oakland Bay – Hammersley Inlet study area.

“SL” indicates a sanitary line location.

The outfall location is indicated with a circle, the sanitary lines (Oakland Bay and Hammersley Inlet) demarking the closure zones for shellfish harvesting are indicated as red lines on either side of the outfall, and ADCP transects are shown with blue lines.

ISCO samplers for dye collection are shown with triangles; boundary conditions were collected at 15-m intervals at the square, and a limited number of vertical CTD casts were collected at the stars.

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Hydrology and Hydrodynamics

Hydrology of the Oakland Bay system is typical of midsize estuaries, with higher river and stream flows occurring in the late fall through late spring, and low flows occurring in the summer and early fall. From a hydrodynamic perspective, Oakland Bay is one of the more energetic estuaries in Puget Sound with two-meter tidal ranges and strong tidal currents in the navigational channel. During the high river flow portion of the year, the combination of energetic tidal mixing and fresh water flushing of the tributary rivers lessens the accumulation of material in the system and fortunately, this is deemed by WDOH the more likely time for an upset event at the WWTP to occur. However, if there were an incident in the summer or early fall, the lower river flow conditions into Oakland Bay would cause any introduced material to be retained for a longer time. For example, for an overflow event resulting in an effluent concentration of C_o in the estuary, the first-order, well-mixed rate-of-change would be:

$$dC/dt + C(Q/V_o) = 0 \qquad (1)$$

where V_o = mean volume of the bay
C = effluent concentration in the bay
Q = freshwater inflow volume = net seaward transport (well-mixed)

The solution of this differential equation demonstrates that the concentration would be inversely proportional to the net seaward transport.

$$C(t) = C_o\, e^{-t/\tau} \qquad (2)$$

where τ = flushing time of the estuary = V_o/Q
t = time
C_0 = initial concentration
$C(t)$ = concentration versus time

Thus in summer and early fall, when Q is lowest, there is a higher retention of effluent in the estuary. This time period was not chosen for the dye experiment because of the low risk of a release event at the Shelton plant. These equations address question 2 in Table 1.

From a hydrodynamic modeling perspective, Oakland Bay exhibits sufficient three-dimensional features to warrant a three-dimensional modeling approach. In the estuary proper, the combination of a narrow, deep navigation channel bordered by wider shallow areas requires both horizontal resolution to properly represent the channel and vertical resolution to represent the predominance of landward transport of saltier water along the channel and seaward transport over the shallow areas. Although during portions of the year, stratification may not be significant and a depth-averaged model might be appropriate, depth-averaged models are not capable of representing circulation associated with wind. For this reason, a minimum two-layer vertical resolution is desirable.

Purpose and Scope of Project

This project was called for by regional partners (e.g., The City of Shelton, Port of Shelton, Washington Corrections Center) tasked with trying to evaluate the future wastewater collection, treatment, and discharge needs within the region. The population in this coastal area is expected to continue to increase, thereby increasing wastewater production from residential, commercial, and industrial sources. Ecology, through its NPDES permitting process, must approve new or expanded wastewater discharges. Typically, Ecology uses water quality models to evaluate the impacts of new or expanding discharges, and then sets NPDES permit limits reflecting minimum federal and state guidelines or more restrictive levels when they are needed to protect water quality standards in the receiving water.

The primary purpose of the HOBO model is to address the farfield dilution cited under Table 1, question 1. However, this study will also address aspects of questions 2 and 3. The model could also be used predicatively for periods with wetter or drier conditions, with and without wind. Although the late summer period is not a likely time for a sewage event to occur, it is the worst time of the year for flushing in the system, due to the low river flow (buoyancy forcing), lower kinetic energy from calmer wind, and smaller average tidal exchanges near the equinox in September. We could also use the model to look at the effects of seasonal and inter-annual variability.

The resulting modeling analyses provide the City/County, WDOH, and Ecology with scientific information previously unavailable for evaluating impacts on fecal coliform bacteria counts in Oakland Bay and Hammersley Inlet. Given the model results and corresponding reliability, local and state officials should be able to use the modeling analyses to provide a scientific and technically-sound basis for altering the WWTP discharge. Additionally, the modeling results can be used to guide further water-quality model development to support Ecology's long-term goal of establishing a TMDL for the estuary.

Scope and Approach for the Modeling Project

We selected the Environmental Fluid Dynamics Code (EFDC) model (Hamrick 1992, 1996) for this application. EFDC is an open-source, public domain, surface water modeling system incorporating fully integrated hydrodynamic, water quality, and sediment-contaminant simulation capabilities. EFDC is very versatile and can be used for 1, 2, or 3-dimensional simulation of rivers, lakes, estuaries, coastal regions, and wetlands. EFDC can be used with a water quality component that is based on water quality kinetics from the Chesapeake Bay Water Quality model or CE-QUAL-ICM (Cerco and Cole, 1994).

The justification for three-dimensional modeling stems from vertical stratification evident in Ecology's historical monitoring data in Oakland Bay (station OAK004), although less is known about lateral gradients. We would require a minimum of two layers to characterize this stratification, but four were chosen to allow for surface and bottom boundary layers.

Calibration and validation of the EFDC model was achieved using available information, plus data obtained during the Rhodamine dye release study performed by the FDA, Cosmopolitan, WDOH, and Ecology in mid April of 2003. Residence time was established with a variety of methods and compared with that of the model.

Future uses of the HOBO model may include evaluating potential alternatives to the existing outfall structure, if modeling indicated that redesign or relocation could enhance mixing in the receiving waters. Results of one such tactic, a diversion of effluent at slack tide, is included in this report.

Figure 2. The Rhodamine dye was visible at the surface around low slack on 15 April 2003. The divers discover that there is no end cap on the diffuser.

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Methods

Overall Synopsis

Ecology created the HOBO model by coupling the open-source, public domain EFDC source and executable code, with specific input (.INP) files we created that relate to its specific bathymetry, shoreline, river, and stream configuration. In April 2003, we experimentally determined the flushing characteristics of Oakland Bay by three experimental methods (Cosmopolitan, 2003a): repeated ADCP transects, paired-tide gauges, and most directly with a Rhodamine dye release (Fig. 2).

FDA injected dye at the outfall of the WWTP for one full tidal cycle (24.8 h) starting at 0505 on 15 April 2003. We measured its dilution during this period at several fixed points via ISCO samplers fixed on moorings that took a sample every hour for subsequent analysis by a laboratory fluorometer (Fig. 1). We then validated the calibrated model, driven by real boundary data, against these experimental results before solving for the dilution factors for the various plant operation proposals.

Fecal coliform bacteria are indicative of organisms from the intestinal tract of humans and other animals and are used as an indicator bacteria as a measure of public health (Thomann and Mueller, 1987). In the present model, fecal coliform bacteria are interchangeable with dye and do not interact with other state variables (no die-off). These bacteria are the same as a completely conservative dye tracer, but with units that are significant to fecal bacteria levels in real situations. The critical level, established by WDOH, for longer duration simulations is 14 fecal coliform units per 100 ml. Future TMDL work will address a realistic die-off rate and other sources of fecal coliform bacteria.

Model Development

HOBO is a three-dimensional, hydrodynamic, sigma-coordinate model similar to the Princeton Ocean Model that solves the primitive equations for a curvilinear grid of water cells that each have uniform properties throughout (i.e., a finite resolution). The model solves the Newtonian laws of fluid mechanics. Boundary conditions for the model were provided by using real observational data. Solutions are found by time-integrating the equations of motion (finite-differencing). Details are available in Hamrick, 1992.

The location of the CTD that acquired the boundary conditions of temperature and salinity determined the seaward boundary of HOBO. Effluent advects passed this location on a typical flood tide, which makes measured versus model dye results diverge with time since some dye is regrettably lost over each tidal cycle in the model.

The general procedure for the applying the EFDC model to the Oakland Bay system followed a sequence of steps beginning with model set-up or configuration. Model configuration involved the construction of a horizontal grid of the waterbody (Fig. 3) and interpolation of bathymetric data to the grid, construction of EFDC input files, and compilation of the source code with appropriate parameter specification of array dimensions. The EFDC input files include the master input file, efdc.inp; files specifying the grid and bathymetry, cell.inp, celllt.inp, dxdy.inp, lxly.inp; an atmospheric forcing file, aser.inp; an inflow-outflow file, qser.inp; salinity boundary condition files, sser.inp; an initial salinity file, salt.inp; temperature boundary condition files tser.inp; an initial temperature file, temp.inp; and dye initial conditions (DYE.INP) and time series inputs (DSER.INP) (see Appendices A and B).

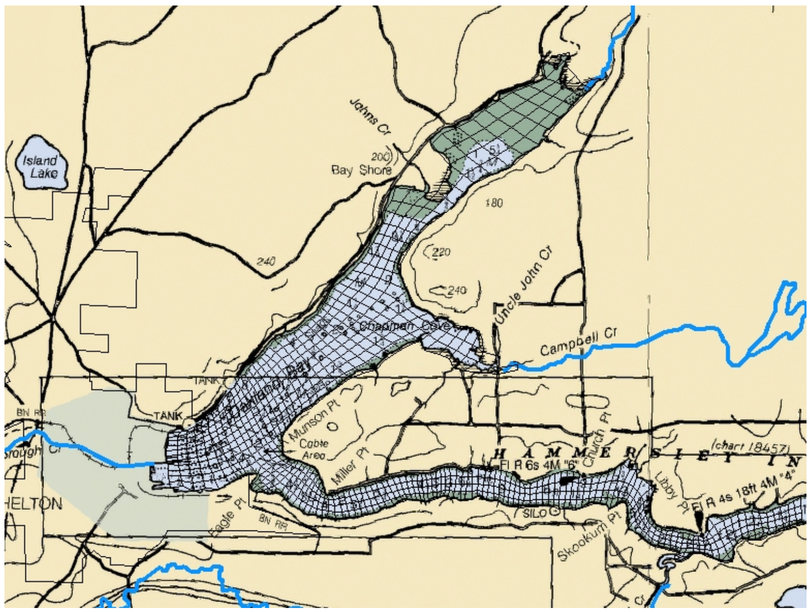


Figure 3. HOBO model grid.

The outfall location from Shelton's WWTP was measured with differential GPS to be 47^o 12.537' N x 123^o 04.398'W. This is closest to South Puget Sound Synthesis Area Model cell I=54, J=14 and HOBO cell I=19, J=11.

Data Observations to Support Modeling

Numerous agencies have collected data that pertain to the Oakland Bay system. These information sources have been drawn upon extensively to set up, calibrate, and validate the 3-D HOBO model (Fig. 4). We describe uses of specific data in detail in the subsequent sections of this report where they are applied. An overview of the data sources and types is as follows:

- National Oceanic and Atmospheric Administration – digital bathymetry and tide data
- National Weather Service – atmospheric data including observations of wind speed, wind direction, barometric pressure, air temperature, rainfall, and cloud cover from the automated station at Sanderson Field (Shelton Airport Automated Surface Observing System (ASOS))
- U.S. Geological Survey – daily river flow data for river data used to adjust small stream data
- Pacific Shellfish Growers and Cosmopolitan Engineering – ungaged stream data

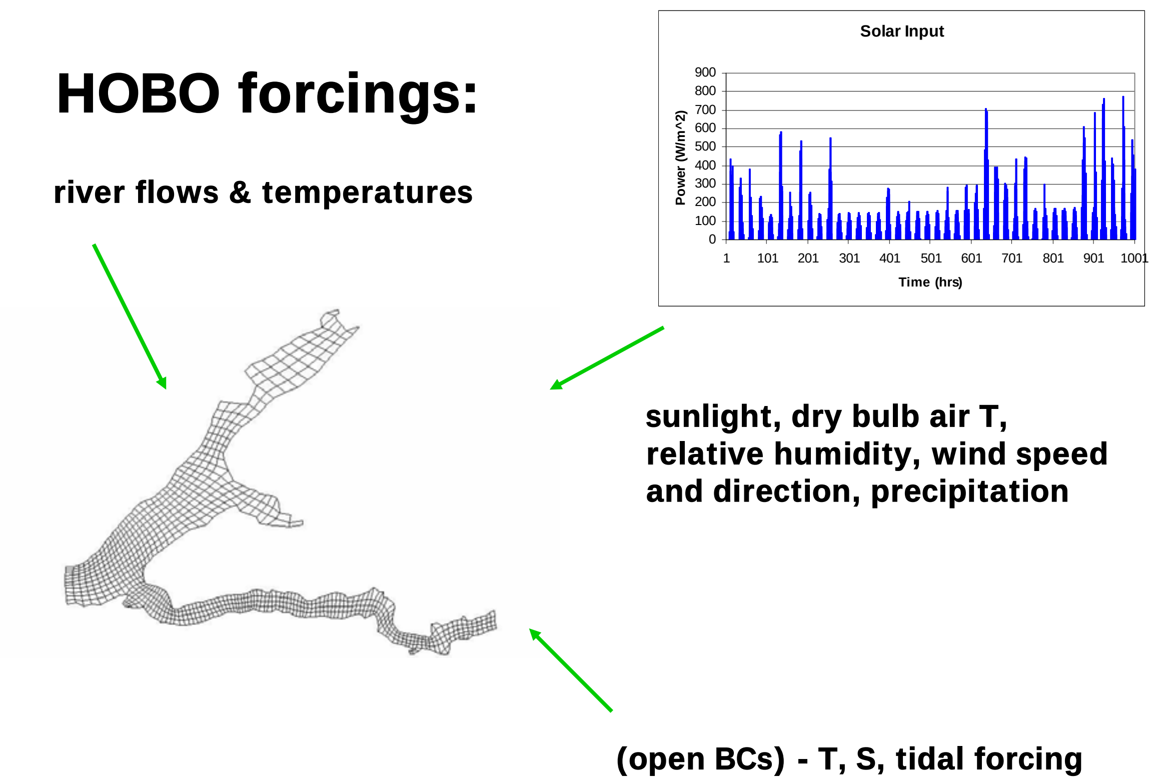


Figure 4. HOBO forcing functions.

Model Configuration for the Oakland Bay System

The horizontal grid constructed for the HOBO uses curvilinear horizontal grid cells and was constructed using the GEFDC grid generation code based on an orthogonal mapping procedure (Ryskin and Leal, 1983). The horizontal grid was constructed using NOAA Chart 18457, published in 1997, for the main estuarine regions. The horizontal cell distribution was sketched on the NOAA chart and printed copies of the tributary shoreline plots. Horizontal cell vertices along land-water boundaries were digitized and processed by GEFDC to create the complete grid. Figure 3 shows the horizontal grid.

Model Calibration and Validation

After the model was spatially defined and gridded, and the input and run conditions were set, we conducted initial runs to evaluate its performance. These preliminary results led to refinements that allowed HOBO to produce results more comparable to the experimental data sets we collected. The HOBO model was calibrated to National Ocean Service tide gauge and validated against temperature, salinity, and dye data collected in support of its development.

Discharge Dilution Analysis

We applied the calibrated and validated hydrodynamic model to evaluate initial dilution (mixing and transport) of the Shelton WWTP effluents. Our dilution calculations quantify the degree of mixing and transport of the effluent in the Oakland Bay system. For each model run, we introduced a tracer having a concentration of 46,300 fecal coliform bacteria colonies per 100 ml into the plant effluent. The Rhodamine dye we used in the mid-April experiment mimicked this concentration with a 2.954-ppm average concentration of dye. Since both tracers are conservative, all model fecal coliform bacteria results scale proportionally to the dye study. We used the hydrodynamic and transport model to simulate the distribution of the tracer in the system for a two-month period encompassing March and April 2003. HOBO was spun-up for 45 days from March 1 to April 15 before the simulated dye releases began. Model runs terminated at day 60, which was at the end of April.

Near-field Dilution

Cosmopolitan Engineering performed the near-field dilution analysis. We transferred dilution data from this analysis for input into HOBO to calculate far-field dilution. Near-field dilution refers to the mixing and diffusion of the effluents in the immediate vicinity of the plant discharge (30-60 meters). Cosmopolitan ran these analyses with the Lagrangian formulation used in the Updated Merge (UM) two-dimensional diffuser formulation of EPA's PLUMES model (Baumgartner, Frick, and Roberts, 1994). Results were summarized in a Cosmopolitan Technical Memorandum (Cosmopolitan, 2003b).

The outfall discharge is located in a high-energy region of the inlet where tidal mixing dominates the dilution process. The three configurations used for the near-field dilution consisted of the original as-designed diffuser, the as-found condition with the end-cap missing and acting like a single port discharge, and finally an extended diffuser design. The extended diffuser design simply spreads effluent over one additional column of HOBO cells in the horizontal.

Table 2 illustrates inflows that correspond to the near-field dilutions over a tidal cycle calculated, with a specific simulation (2.6 mgd, ebb/flood condition with no end cap) listed in Table 3. The initial and final outfall flows are set to zero. Because this is an upset event, we do not need to concern ourselves with adding zero-concentration outfall flows before and after the upset event. We hold the effluent concentration constant at 46,300 fecal coliform bacteria per 100 ml, vary the flow rate, and layer distribution according to the near-field dilution and plume trapping depths calculated by PLUMES.

Table 2. Outfall flow, Q, for each of the sigma depth layers of the HOBO model over the tidal cycle. At each time-step during the injection, flow across four layers sum to 0.1138 m^3/s (2.6 mgd). Outfall effluent concentration, C, is constant at 46,300 fecal coliform units per 100 ml. The total injection rate is Q * C.

depth day	layer1 (deep)	layer2	layer3	layer4 (shallow)	tide
45.2113	0.	0.	0.	0.	
45.2114	0.	0.0569	0.0569	0.	high
45.2844	0.	0.0569	0.0569	0.	
45.2845	0.	0.0569	0.0569	0.	
45.3573	0.	0.0569	0.0569	0.	
45.3574	0.	0.0569	0.0569	0.	ebb
45.4302	0.	0.0569	0.0569	0.	
45.4303	0.	0.	0.0569	0.0569	
45.5031	0.	0.	0.0569	0.0569	
45.5032	0.	0.	0.	0.1138	low
45.5676	0.	0.	0.	0.1138	
45.5677	0.	0.	0.0569	0.0569	
45.6235	0.	0.	0.0569	0.0569	
45.6236	0.	0.0569	0.0569	0.	flood
45.6794	0.	0.0569	0.0569	0.	
45.6795	0.	0.0569	0.0569	0.	
45.7353	0.	0.0569	0.0569	0.	
45.7354	0.	0.0569	0.0569	0.	high
45.7531	0.	0.0569	0.0569	0.	
45.7532	0.	0.	0.	0.	
∞	0.	0.	0.	0.	

Far-field Dilution

The far-field dilution of the WWTP discharge was determined in HOBO after initializing it with the near-field dilution calculated in PLUMES (Cosmopolitan, 2003b). We ran most of the aforementioned diffuser configurations for three distinct discharge flow rates, 2.6 mgd, 4.0 mgd, and 6.7 mgd. Adverse condition simulations were made for both the Hammersley Inlet (flood-ebb) and Oakland Bay (ebb-flood) sanitary lines. Conditions for the 15 original HOBO model runs are summarized in Table 3.

Table 3. Conditions for the 15 original HOBO model runs.

Run	Flow rate	Tide sequence	Diffuser configuration
1	2.6 mgd = 0.1138 m^3/s	ebb/flood	no end cap
2	2.6 mgd = 0.1138 m^3/s	ebb/flood	diffuser
3	4.0 mgd = 0.1750 m^3/s	ebb/flood	diffuser
4	6.7 mgd = 0.2931 m^3/s	ebb/flood	diffuser
5	2.6 mgd = 0.1138 m^3/s	ebb/flood	extended diffuser
6	4.0 mgd = 0.1750 m^3/s	ebb/flood	extended diffuser
7	6.7 mgd = 0.2931 m^3/s	ebb/flood	extended diffuser
8	2.6 mgd = 0.1138 m^3/s	flood/ebb	diffuser
9	4.0 mgd = 0.1750 m^3/s	flood/ebb	diffuser
10	6.7 mgd = 0.2931 m^3/s	flood/ebb	diffuser
11	2.6 mgd = 0.1138 m^3/s	flood/ebb	extended diffuser
12	4.0 mgd = 0.1750 m^3/s	flood/ebb	extended diffuser
13	6.7 mgd = 0.2931 m^3/s	flood/ebb	extended diffuser
14	2.6 mgd = 0.0.1138 m^3/s	flood/ebb	no end cap
15	2.6 mgd = 0.0.1138 m^3/s	ebb/flood/ebb	no end cap

Results

Model Calibration and Validation

Our initial model results (Fig. 5) demonstrated acceptable heat and salt flux performance when tidal and wind forcing were turned off, and river flow and open boundary conditions were gradually increased to tune the grid and stabilize it. We then applied a radiative-separative condition for tidal forcing at the open eastern boundary in Hammersley Inlet. By iteratively adjusting the amplitudes and phase angles for five primary tidal constituents (M2, S2, N2, K1, and O1), we achieved a calibrated known tidal time series at an interior point (Fig. 6).

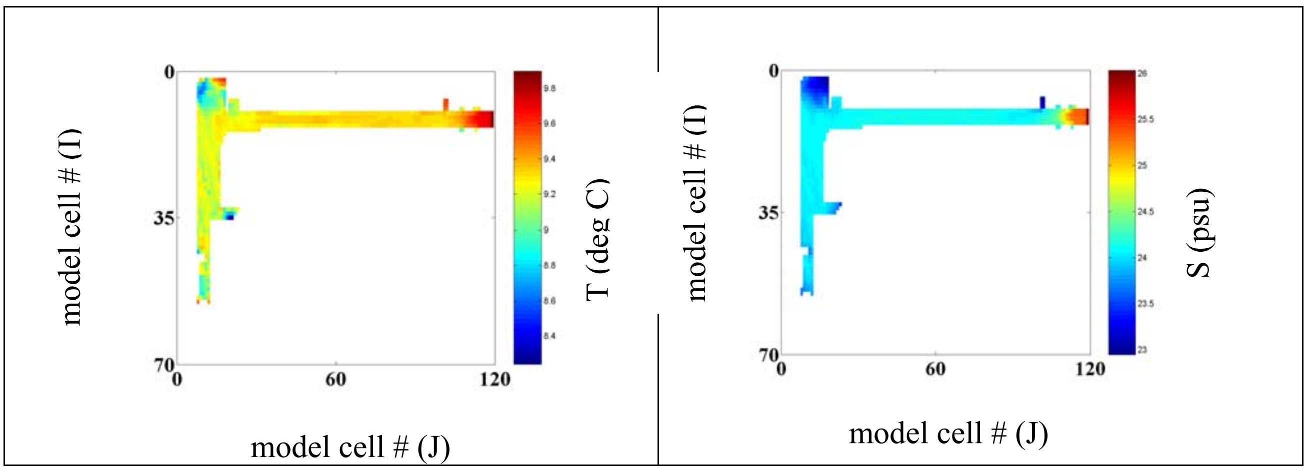


Figure 5. Surface-layer temperature and salinity on computational plane prior to adding tides in HOBO.

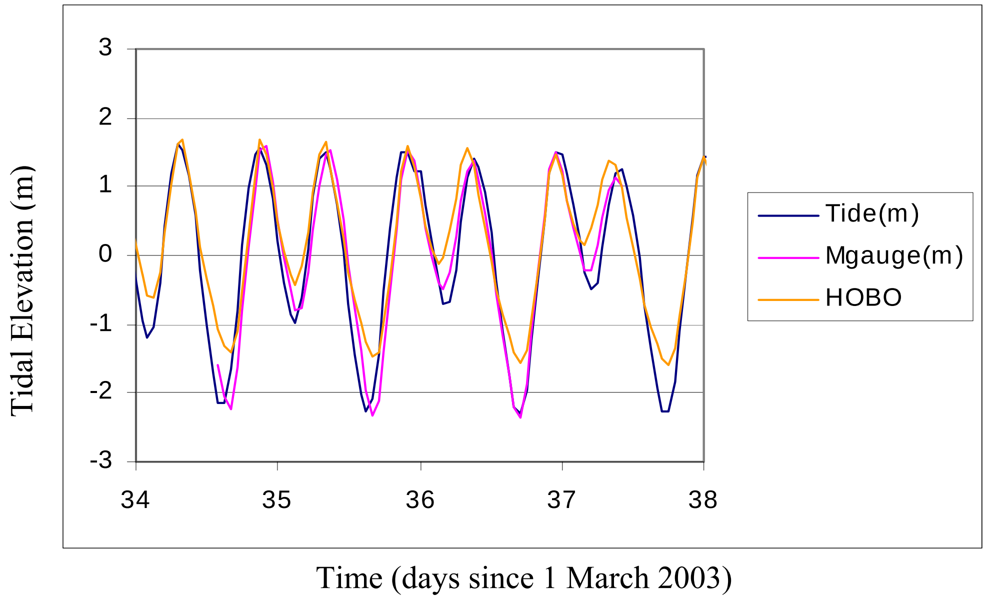


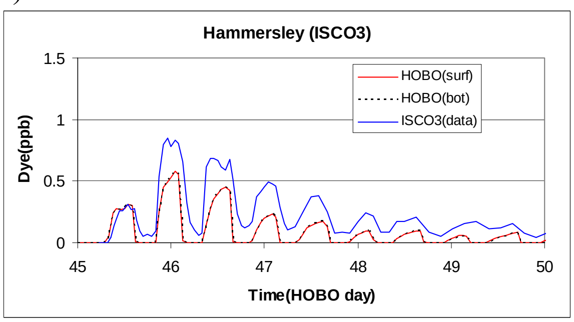
Figure 6. Calibration results for HOBO model tidal elevations.

Shown is the HOBO model output (orange) achieved after mathematical iterations against a fully-submerged pressure transducer tide-gauge (red) at an interior point. NOAA tide predictions (blue) are included for comparison.

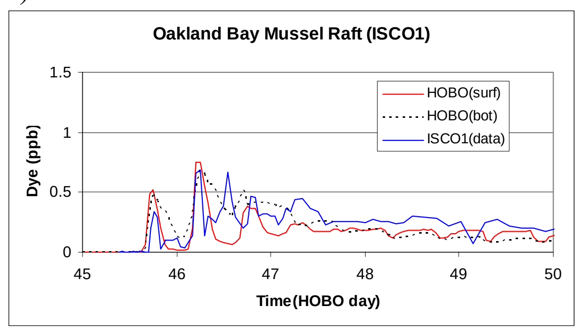
Tidal parameters for HOBO are included in Appendix A (EFDC.INP, card 17).

Validation can be defined as the application of the calibrated model to simulate an entirely different set of prototype conditions with model performance satisfying criteria similar to those specified for calibration. Validation results between the hydrodynamic model and the dye data from the FDA injection of Rhodamine are shown in Figure 7. For the most part, the general trends between HOBO and the experiment are the same during the initial phase, which is our primary interest. The widening gap between HOBO and the experimental data is due to the fact that HOBO loses some dye out of its open boundary during each tidal cycle. Future use of HOBO (e.g., the upcoming TMDL study at Ecology) could remedy this problem by extending the model boundary closer to Pickering Passage and collecting boundary condition data (temperature and salinity) at that location (beyond the point at which injected dye advects on the ebb tide). Large log booms noted in the area (Fig. 7d) might account for the measured dye spike at the Oakland Bay mussel raft ISCO sampler due to retention of surface water (Fig. 7b, HOBO day 46.5).

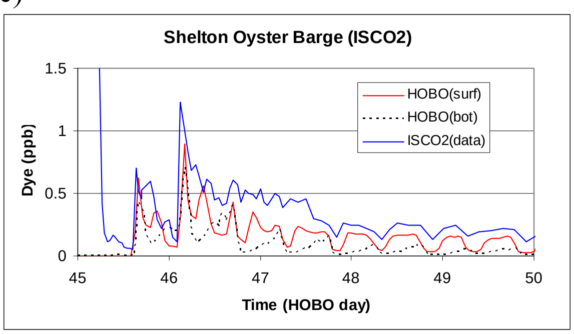
a)



b)



c)



d)

Figure 7. HOBO model duplication of experimental results in a) Hammersley Inlet (ISCO3), b) Oakland Bay at the mussel raft (ISCO1), and c) Oakland Bay at the Shelton oyster barge (ISCO2). Red represents HOBO's near-surface sigma-layer, blue represents experimental surface data. The black dashed line represents HOBO's near-bottom sigma-layer to give some idea of vertical variability. A picture of the log boom on the day of the experiment is in d).

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Residence Time Estimation

As an overall indication of how well the model is performing, we seek to compare flushing (residence) time estimates between HOBO and several experimental methods at our disposal. We can make the best estimate of residence time for a specific date from the data collected with the dye study.

The Dye Study

Regarding question 2 in Table 1: Every ebb tide removed approximately 8% of the well-mixed dye (and water) from the east end of Hammersley Inlet, but every flood tide returned 92% of it. The dilution factor was such that after four days, half of the dye still remained. In addition to accurately determining the flushing characteristics of the bay for this specific time period, we also used these data to validate HOBO.

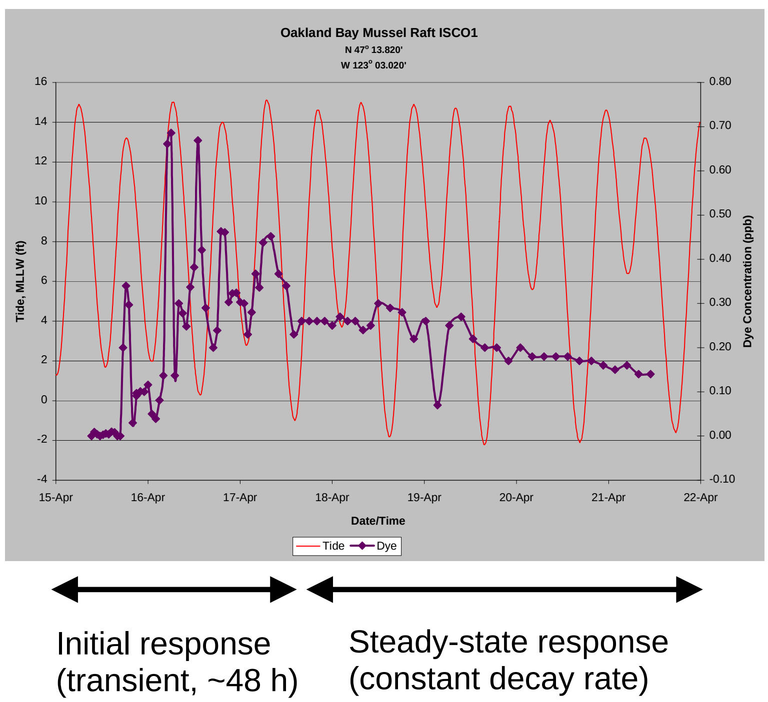

Figure 8. Time series of measured dye concentration at the Oakland Bay mussel raft (Fig. 1) on 15 Apr 2004. The concentration of effluent (bold) during the initial response phase of release is highly dependent on the initial conditions of the tide (light). During the steady-state phase, the response exhibits first-order (exponential) decay.

We need to make distinctions between the initial near-field (first 0.5 hr), initial far-field (1-48 hr), and steady-state (after 48 hr) phases of dilution (Fig. 8). Using EPA PLUMES software, Cosmopolitan Engineering determined the initial near-field dilution and trapping depth of the plume. HOBO's resolution was still too coarse in the vertical at four sigma layers to do this precisely. To determine the far-field dilution (e.g., at the sanitary lines or an ISCO sampler), the near-field results from PLUMES had to be entered into the appropriate grid cells in HOBO, and these changed with tidal stage. In the experiment we can clearly see the chaotic initial phase during the first 48 hours where the dye concentration at a fixed point in Oakland Bay is sensitive to the initial conditions (i.e., what tide phase the dye is released).

Determination of the steady-state phase (question 2 in Table 1) is possible because the total dye injected over the 24.8-h injection period used in the experiment was high enough to saturate the bay with an observable concentration of dye. If the total dye input were uniformly dissolved throughout the volume of the bay, the dye concentration would be:

$$\frac{(2.954\,ppm)(9{,}728m\text{^}3/day)(24.84h)}{(24h/day)(8.7x10\text{^}7m\text{^}3)} = 0.34 \text{ ppb}$$

This initial value of 0.34 ppb plots agreeably along a best-fit, first-order exponential decay curve ($C(t) = C_o\, e^{-t/\tau}$) of dye concentration at the two ISCO locations within Oakland Bay (Fig. 9). The solution of the time constant, τ (e-folding time), for these curves are 5.5 days (1/0.182 d^{-1}) and 6 days (1/0.165 d^{-1}), which agree well with each other because Oakland Bay is well-mixed over this timescale. Solving for how long it would take to flush out half the injected contamination (t_{50}) in April 2003, we get about four days. We add a day to this result to account for the time lost between the end of the dye injection and start of the constant decay rate period. Perhaps we should add even more time because decay starts even before the end of the injection period. Therefore, we estimate from this approach that it takes over five days to flush out half of the total dye injected at the time of the experiment.

How long does it take to flush half the dye seaward?
Dye Study: ~4 days

Shelton Oyster Barge:

Dye = 0.3315 $e^{-0.182\ t}$
For 0.5 dye, t = 3.8d

Oakland Bay Raft:

Dye = 0.3615 $e^{-0.165\ t}$
For 0.5 dye, t = 4.2d

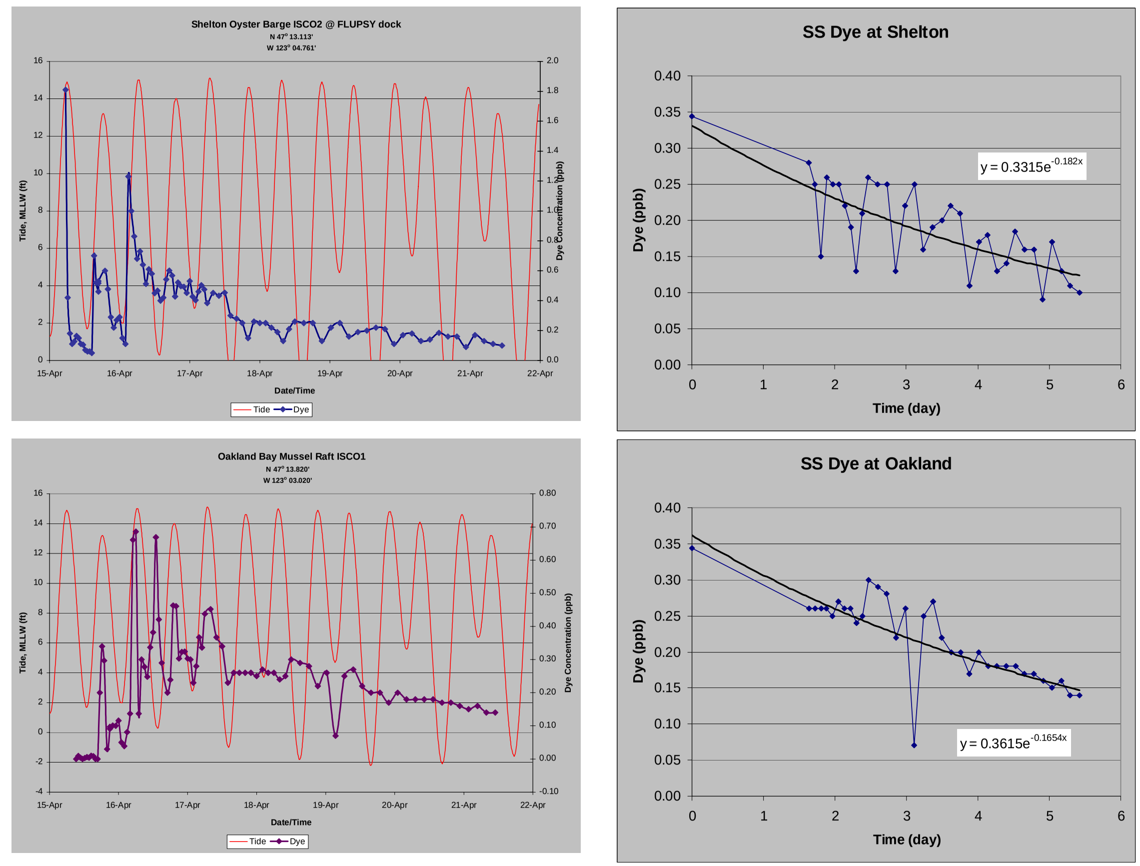

Figure 9. Dye concentration results from two stations in Oakland Bay used to estimate flushing times. Dye (bold) and tides (light) versus time as in Figure 8.

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Twin Tide Gauges

We also used the two tide gauge stations (Fig. 1) to make an estimation of flushing, assuming that the absolute pressure readings and timing information is correct at both stations. By assuming that Hammersley Inlet can be idealized as a perfect straight channel with a uniform friction factor, we can solve a simplified hydrodynamic equation by directly integrating it with Euler's method (e.g., within Excel in VBA after Steve Chapra (Chapra, 2000).

$$\partial u / dt = -g\, \partial \eta / \partial x + (f / 8h) \quad \bar{u}\, \|\bar{u}\| \tag{3}$$

where u = along-channel velocity
x = along-channel distance
h = mean channel depth, f = friction factor
η = surface elevation due to tide
g = gravity, t = time

Hence, we take a time series of sea-surface elevation changes (η) over the channel's length (x) and estimate acceleration, velocity, and displacement of a particle released at the outfall with an initial velocity of 0 m/s (Fig. 10). We can calculate the average channel depth, h, but must determine the friction factor f. We iterated f until we achieved velocities similar to those measured with our ADCP in Hammersley Inlet (Fig. 1).

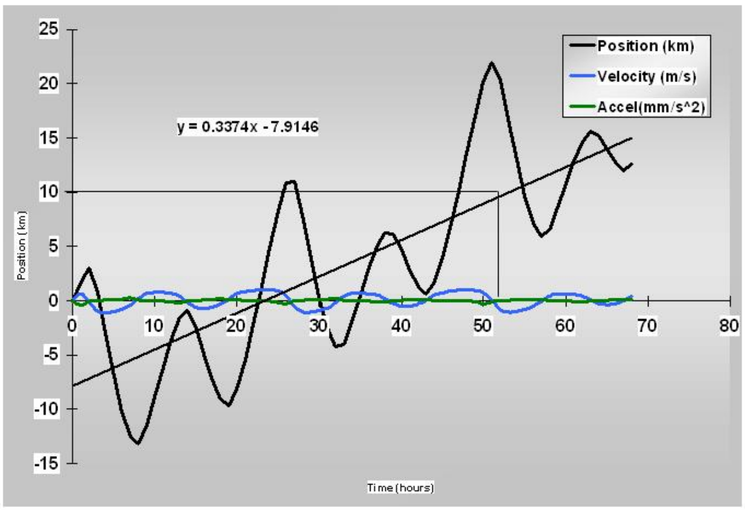

Figure 10. Approximate solution for a perfect channel with friction.
f = 0.025 N-s/m (kg/s), h = 6.8 m, dx (distance between gauges) = 8.1488 km).

It takes over 50 hours (flushing time = two days) for a "drifter" released at the outfall location at time zero to make it 10 km past the model boundary. Not surprisingly, this method under predicts the flushing time as compared with the dye release approach, because the real channel is not ideal (straight and with uniform friction).

Acoustic Doppler Current Profiler (ACDP) Velocity

We repeated two ADCP transects (Fig. 1) every 1.5 hours over the tidal cycle and published the results in a recent data report (Cosmopolitan, 2003a). It is possible to calculate the approximate mean residual flow from these data and get an idea of the net flushing time of the estuary (Fig. 11).

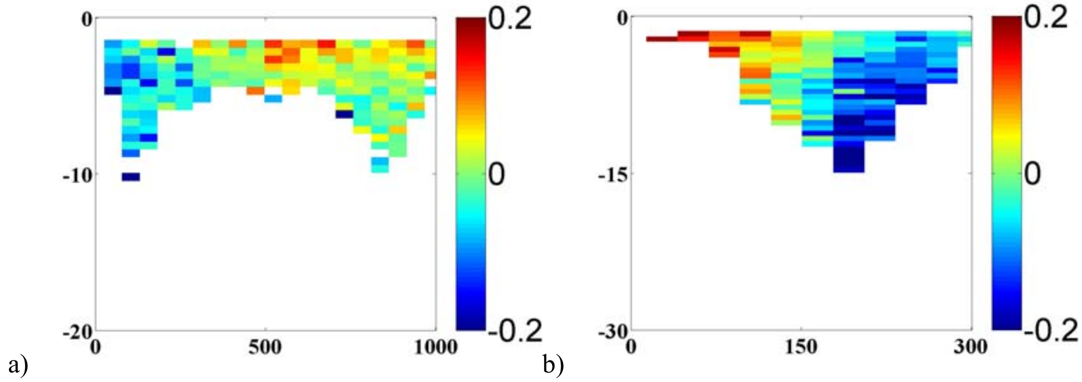

Figure 11. Residual flow as calculated by averaging eight ADCP transects on 16 April 2003 across a) Oakland Bay and b) Hammersley Inlet.

The residual exchange flow was highest in Oakland Bay at about 5,000 m^3/s and lowest at the western end of Hammersley Inlet (750 m^3/s). This translates into a flushing time of (750 m^3/s) / (8.7 x 10^7 m^3), which is 116,000 s or about 1.3 day, 2.6 day for half the volume.

This method under-predicts the flushing time due to a too vigorous exchange flow. This is likely because the amount of refluxing changes throughout the inlet by location. In a vertical estuary (net flow out at the surface, net flow in at depth), exchange flow generally increases from the head of the estuary toward the mouth. As rivers enter Oakland Bay on its seaward journey, the strength of the two-layered, upstream-downstream net transport is approximately proportional to the local salinity gradient.

The lowered exchange flow in Hammersley Inlet is due to the active mixing and refluxing in the inlet and is associated with a weaker salinity gradient. A similar phenomenon occurs in Tacoma Narrows where the residual mean flow is about ten percent that of the Nisqually Reach. The ADCP data, crude as the 8-cycle averaging over 13h is, shows more residual flow on our landward Oakland Bay transect and less on our seaward Hammersley Inlet transect (backwards for a vertical estuary). It is reasonable to expect that ADCP transects further east in Hammersley Inlet would produce an even smaller residual flow getting closer to the 4-5 day flushing time observed with the dye injections. This worthwhile estimate is closer to the simplistic tidal prism calculation and the tide gauge approach but once again is not as realistic as the dye value. A month-long, bottom-mounted deployment would yield better results.

Model-Derived Net Flow

The velocity outputs from a north-to-south transect in Hammersley Inlet at the sanitary line (I=58) over four depth layers can be tidally-averaged over a lunar day. We calculated the time it takes to flush half the volume from Oakland Bay as a moving average (Fig. 12). We use the average of net surface outflow, and the near-bottom inflow. Note the presence of the fortnightly neap/spring cycle due to this short 25-hour averaging period. The residence time predicted on 15 April 2004 was about five days, which is in very good agreement with the dye experiment. The slight decrease in the trend line may be indicative of drier weather as the season proceeds.

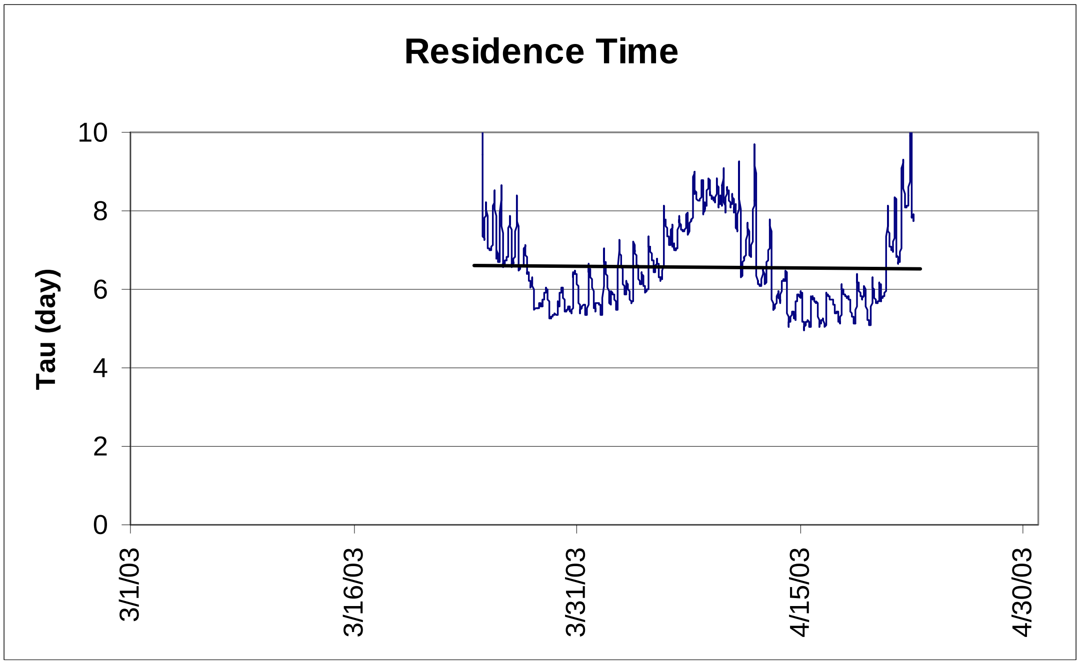

Figure 12. The calculated net-flow residence times from HOBO output across Hammersley Inlet (I=58). Results are for below the depth-of-no-motion using a 24.8-h moving average. The trend line is a linear best fit.

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Model Output

The distinguishing characteristic of each simulation in Table 3 is the variation in discharge rate and timing of that discharge. The outfall discharge rate, Q, changes with time and which cell or cells it affects (see Table 2). Outfall effluent concentration, C, is constant at 46,300 fecal coliform units per 100 ml so that the total injection rate is Q * C.

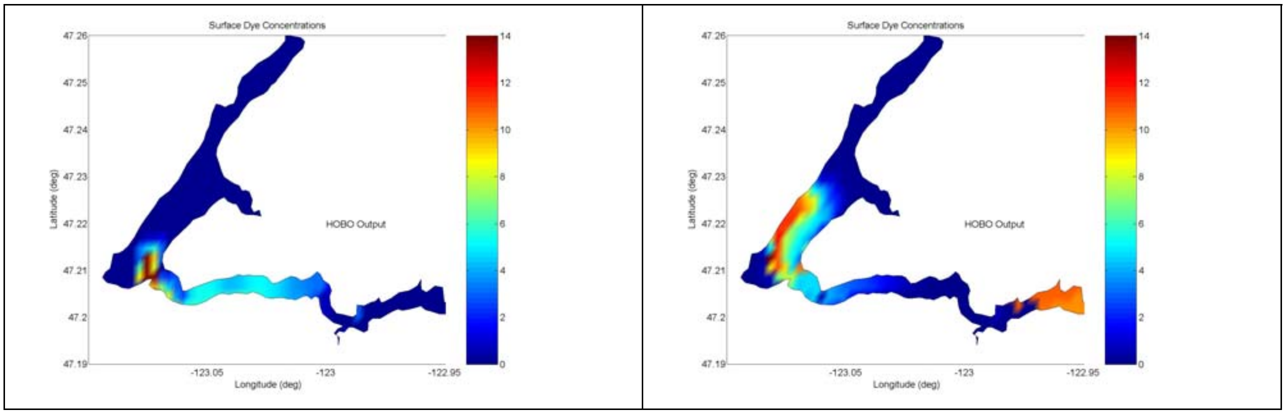


Figure 13. Plan view of the adverse condition (ebb tide after flood) for the Oakland Bay sanitary line from HOBO run approximating actual dye-release conditions (run 15): a) time = 45.479 days, b) time = 45.531 days.

In the model output for the 15 runs, effluent generally works its way to west of the center line in Oakland Bay on the flood tide (Fig. 13b). There is, however, the potential for a large concentration on the east side of the Oakland Bay sanitary line if the release point for the effluent is too far north across Hammersley Inlet (Fig. 13a).

The location of ISCO sampler(s) used to validate HOBO were often canted off to the side because of logistics. The location of the ISCO nearest the Oakland Bay sanitary line (ISCO2) was west of the most concentrated part of the plume (Fig. 14) but closer to the outfall than the line.

In general, the Oakland Bay sanitary line was the more critical location (Fig. 14) where there was more likely to be an exceedance of the 14 fecal coliform bacteria / 100 ml criteria than along the well-mixed sanitary line in Hammersley Inlet, which could probably be moved closer to the outfall. Repositioning the sanitary lines would call for interactive HOBO runs to resolve the optimal location.

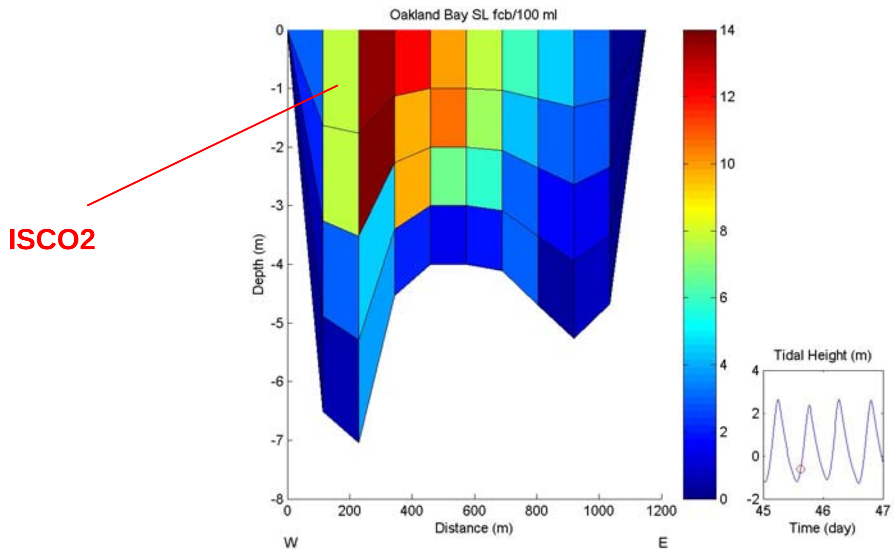
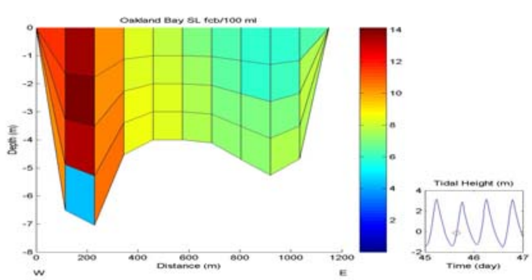


Figure 14. HOBO simulated maximum dye concentrations across the Oakland Bay sanitary line from run 15. Note that the ISCO2 sampler is positioned west of the peak concentrations, although it is closer to the outfall than the sanitary line being modeled (see Fig. 1).



time(2162) = 45.645830 (3:30PM)

11.61	13.53	10.27	8.35	7.77	6.89	6.24	5.86	5.80	6.39
11.38	14.15	10.36	8.39	8.12	7.44	6.60	5.87	6.06	7.62
10.94	13.39	10.48	8.46	8.28	7.58	6.93	7.02	6.92	7.80
10.38	4.35	10.72	8.54	8.39	7.70	7.11	7.12	7.73	7.69

Figure 15. Fecal bacteria counts (# organisms per 100 ml) per cell for run 6 (4.0 mgd for 13 hours; ebb then flood with extended diffuser). This is the time step containing the peak concentration for the Oakland Bay sanitary line during this simulation.

The tabular results and graphic mappings of tracer concentrations for all 15 runs are included in Appendix C and are summarized in Table 4.

Table 4. Maximum fecal coliform concentrations for all 16 HOBO model runs at both sanitary lines.

Run	Oakland Bay		Hammersley Inllet	
	Total number exceedances	Maximum value (colonies per 100 ml)	Total number exceedances	Maximum value (colonies per 100 ml)
1 - 2.6 mgd no end cap, e/f	0	13	0	7
2 - 2.6 mgd diffuser, e/f	0	13	0	6
3 - 4.0 mgd diffuser, e/f	6	**19**	0	9
4 - 6.7 mgd diffuser, e/f	**17**	**33**	**25**	**16**
5 - 2.6 mgd x-diffuser, e/f	0	9	0	6
6 - 4.0 mgd x-diffuser, e/f	1	14	0	9
7 - 6.7 mgd x-diffuser, e/f	8	**24**	**25**	**16**
8 - 2.6 mgd diffuser, f/e	0	10	0	9
9 - 4.0 mgd diffuser, f/e	3	**15**	0	13
10 - 6.7 mgd diffuser, f/e	**15**	**26**	**29**	**22**
11 - 2.6 mgd x-diffuser, f/e	0	8	0	9
12 - 4.0 mgd x-diffuser, f/e	0	13	0	13
13 - 6.7 mgd x-diffuser, f/e	11	**21**	**29**	**22**
14 - 2.6 mgd no end cap, f/e	0	12	0	9
15 - 1&14 combined, e/f/e	0	13	0	9
16 - 4.6 mgd diffuser, e/f (90-m hold at low slack)	3	**15**	n/a	n/a

Runs 1-14 were made with a 13-h dye injection. Run 15 was made with conditions as close as possible to those of the actual experiment using a 24.84-h dye, to compare model output with field experimental results (e.g., Fig. 7).

After completing the original 15 runs, a 16th run (Table 5) was made to test the effects of holding back effluent at low slack tide to decrease concentrations at the Oakland Bay sanitary line. We also used a slightly higher effluent flow rate of 4.6 mgd than run 3. All the effluent held back during the 1.5-h slack tide was re-released during the remaining injection period.

Results for the 16th run showed fewer exceedances at the Oakland Bay sanitary line than in run 3. HOBO showed a maximum concentration of 15 fcbs/ 100 ml at the Oakland Bay line. As shown in Figure 2, effluent discharged during the low slack water period is poorly diluted compared to all other tidal stages. It is this poorly-diluted pool of effluent that is transported across the sanitary line at high concentrations as shown in Figure 13.

Table 5. Near-field outfall flow model input for run 16 at 4.6 mgd. Note that effluent is diverted at low slack tide and pumped out at a higher flow rate during the remainder of the tidal cycle to make up the difference. Outfall effluent concentration is again fixed at 46,300 fecal coliform units per 100 ml.

depth day	layer1 (deep)	layer2	layer3	layer4 (shallow)	tide
45.2113	0.	0.	0.	0.	
45.2114	0.	0.0654	0.0654	0.	high
45.2844	0.	0.0654	0.0654	0.	
45.2845	0.	0.0654	0.0654	0.	
45.3573	0.	0.0654	0.0654	0.	
45.3574	0.	0.0654	0.0654	0.	ebb
45.4302	0.	0.0654	0.0654	0.	
45.4303	0.	0.	0.0654	0.0654	
45.5031	0.	0.	0.0654	0.0654	
45.5032	0.	0.	0.	0.0	low
45.5676	0.	0.	0.	0.0	
45.5677	0.	0.	0.0818	0.0818	
45.6235	0.	0.	0.0818	0.0818	
45.6236	0.	0.0818	0.0818	0.	flood
45.6794	0.	0.0818	0.0818	0.	
45.6795	0.	0.0818	0.0818	0.	
45.7353	0.	0.0818	0.0818	0.	
45.7354	0.	0.0818	0.0818	0.	high
45.7531	0.	0.0818	0.0818	0.	
45.7532	0.	0.	0.	0.	
∞	0.	0.	0.	0.	

Conclusions

The present 2.6 mgd flow rate was generally acceptable in all HOBO simulations using it, although fecal coliform bacteria values were approaching 13 organisms per 100 ml at the Oakland Bay sanitary line (Table 4; runs 1, 2, and 15). The 6.7 mgd flow rate has multiple exceedances of the standard at both sanitary lines. The initial dilution can be greatly aided either by extending the diffuser horizontally across the inlet (runs 5-7 and 11-13), or by holding back injection at slack tide so that the tidal mixing can have more effect on it when released later (run 16). Extending the diffuser across the channel works well to a point; if it is extended too far from Eagle Point toward Munson Point, there is a danger of obtaining high counts on the east side of the Oakland Bay sanitary line (see Fig. 13a). Effluent injected too far north will potentially wrap around with poor dilution on to the east side of the Oakland Bay sanitary line. The sanitary line on Hammersley Inlet could possibly be moved further west.

Residence time estimates varied from a low of two days (tide gauge method and a straight channel) to five days (dye release and HOBO model). The least accurate method we used was the tide gauge method because the real channel is more complex than the rectangular geometry assumed for its solution of two days. The most accurate method was the dye release experiment, but it is only valid for the date of testing. The ADCP method was intermediate and would have been more accurate if multiple bottom-mounted instruments had been deployed for a longer period of time.

Conclusions regarding the WWTP's alternatives are not made here, but this report will be given to WDOH for their interpretation and recommendations. There are several considerations regarding the interpretation of these results. Oakland Bay has high refluxing, low flushing, and a naturally high retention rate. We still do not know how tainted the incoming replacement waters are with other fecal sources from elsewhere in South Puget Sound, so we have assumed none exist. We also do not know Oakland Bay's behavior in other seasons or years. In winter, there is more discharge potential but the estuary also flushes faster due to wind and rain action from storms. In late summer, the estuary flushing is particularly slow but there is also little chance for discharge. If there were an "accident" in September, anything that goes in the water would likely remain for a very long time.

A probabilistic or Monte Carlo type investigation of the system with HOBO could be undertaken. It appears that effluent from the Oakland Bay system would eventually head out Dana Passage (Fig. 16), but we need to verify this South Puget Sound Synthesis Area Model result experimentally. Some investigators have suggested that inlets to the west of Hope Island discharge to northern Case Inlet via Pickering Passage instead (Ebbesmeyer, 1997). We see a continued need for a comprehensive regional model (South Puget Sound Synthesis Area Model) to address large-scale management issues for the entire South Puget Sound basin.

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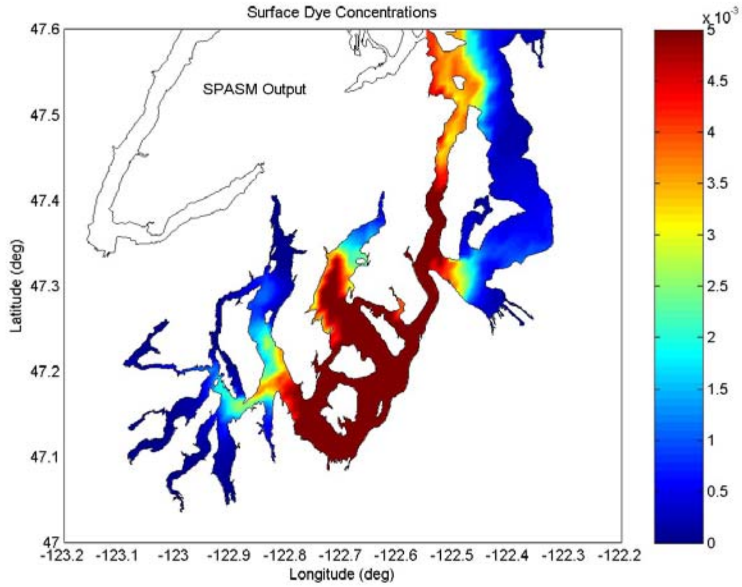

Figure 16. Apparent fate and transport of Oakland Bay effluent seaward according to the South Puget Sound Synthesis Area Model.

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Appendix A

Model input file
for Oakland Bay (EFDC.INP)

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******************************************************************************
*                                                                            *
*   WELCOME TO THE ENVIRONMENTAL FLUID DYNAMICS COMPUTER CODE SERIES          *
*   DEVELOPED BY JOHN M. HAMRICK.                                            *
*                                                                            *
*   THIS IS THE MASTER INPUT FILE efdc.inp, AND SHOULD BE USED WITH THE      *
*   15 AUGUST 1998 OR LATER VERSION OF efdc.f DIRECTLY RELEASED BY DEVELOPER  *
*                                                                            *
*   THIS FILE IS SELF DOCUMENTED WITH DEFINITIONS AND GUIDENCE FOR EACH      *
*   INPUT VARIABLE CONTAINED IN ITS CARD IMAGE SECTION. REFER TO USERS MAN   *
*   AVAILABLE FROM DEVELOPER AT ham@visi.net FOR ADDTIONAL DOCUMENTATION     *
*                                                                            *
******************************************************************************
C1  TITLE FOR RUN                                                            |
C                                                                            |
      TITLE OR IDENTIFIER FOR THIS INPUT FILE AND RUN                        |
C                                                                            |
C1  (LIMIT TO 80 CHARACTERS LENGTH)                                          |
    'HOBO - Hammersley Oakland Bay Oceanographic model'
------------------------------------------------------------------------------
C2  RESTART, GENERAL CONTROL AND AND DIAGNOSTIC SWITCHES                      |
C                                                                            |
      ISRESTI: 1 FOR READING INITIAL CONDITIONS FROM FILE  restart.inp       |
              -1 AS ABOVE BUT ADJUST FOR CHANGING BOTTOM ELEVATION           |
               2 INTIALIZES A KC LAYER RUN FROM A KC/2 LAYER RUN FOR KC.GE.4 |
              10 FOR READING IC'S FROM restart.inp WRITTEN BEFORE 8 SEPT 92  |
      ISRESTO:-1 FOR WRITING RESTART FILE restart.out AT END OF RUN          |
               N INTEGER.GE.0 FOR WRITING restart.out EVERY N REF TIME PERIODS|
      ISRESTR: 1 FOR WRITING RESIDUAL TRANSPORT FILE restran.out             |
      ISLOG:   1 FOR WRITING LOG FILE efdc.log                               |
      ISPAR:   0 FOR EXECUTION OF CODE ON A SINGLE PROCESSOR MACHINE         |
               1 FOR PARALLEL EXECUTION, PARALLELIZING PRIMARILY OVER LAYERS |
               2 FOR PARALLEL EXECUTION, PARALLELIZING PRIMARILY OVER        |
                 NDM HORIZONTAL GRID SUBDOMAINS, SEE CARD CARD C9            |
      ISDIVEX: 1 FOR WRITING EXTERNAL MODE DIVERGENCE TO SCREEN              |
      ISNEGH:  1 FOR SEARCHING FOR NEGATIVE DEPTHS AND WRITING TO SCREEN     |
      ISMMC:   1 FOR WRITING MIN AND MAX VALUES OF SALT AND DYE              |
                 CONCENTRATION TO SCREEN                                     |
      ISBAL:   1 FOR ACTIVATING MASS, MOMENTUM AND ENERGY BALANCES AND       |
                 WRITING RESULTS TO FILE bal.out                             |
      ISHP:    1 FOR CALLING HP 9000 S700 VERSIONS OF CERTAIN SUBROUTINES    |
      ISH0W:   1 TO SHOW PUV&S ON SCREEN, SEE INSTRUCTIONS FOR FILE show.inp |
C                                                                            |
C2  ISRESTI ISRESTO ISRESTR ISPAR ISLOG ISDIVEX ISNEGH ISMMC ISBAL ISHP ISHOW |
    0       -1       0       0     2      0       2      0     0     0    1
------------------------------------------------------------------------------
C3  EXTERNAL MODE SOLUTION OPTION PARAMETERS AND SWITCHES                    |
C                                                                            |
      RP:        OVER RELAXATION PARAMETER                                   |
      RSQM:      TRAGET SQUARE RESIDUAL OF ITERATIVE SOLUTION SCHEME         |
      ITERM:     MAXIMUN NUMBER OF ITERARTIONS                               |
      IRVEC:   0 STANDARD RED-BLACK SOR SOLUTION                             |
               1 MORE VECTORIZABLE RED-BLACK SOR (FOR RESEARCH PURPOSES)     |
               2 RED-BLACK ORDERED CONJUGATE GRADIENT SOLUTION               |
               3 REDUCED SYSTEM R-B CONJUGATE GRADIENT SOLUTION              |
               9 NON-DRYING CON GRADIENT SOLUTION WITH MAXIMUM DIAGNOSTICS   |
      RPADJ:     RELAXATION PARAMETER FOR AUXILLARY POTENTIAL ADJUSTME       |
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                 OF THE MEAN MASS TRANSPORT ADVECTION FIELD                  |
                 (FOR RESEARCH PURPOSES)                                     |
      RSQMADJ:   TRAGET SQUARED RESIDUAL ERROR FOR ADJUSTMENT                |
                 (FOR RESEARCH PURPOSES)                                     |
      ITRMADJ:   MAXIMUM ITERARTIONS FOR ADJUSTMENT(FOR RESEARCH PURPOSES)   |
      ITERHPM:   MAXIMUM ITERATIONS FOR STRONGLY NONLINER DRYING AND WETTING |
                 SCHEME (ISDRY=3 OR OR 4)  ITERHPM.LE.4                      |
      IDRYCK:    ITERATIONS PER DRYING CHECK (ISDRY.GE.1)  2.LE.IDRYCK.LE.20 |
      ISDSOLV: 1 TO WRITE DIAGNOSTICS FILES FOR EXTERNAL MODE SOLVER         |
         FILT:   FILTER COEFFICIENT FOR 3 TIME LEVEL EXPLICIT ( 0.0625 )     |
C       1.E-3                                                                |
C3  RP   RSQM  ITERM IRVEC RPADJ RSQMADJ ITRMADJ ITERHPM IDRYCK ISDSOLV  FILT |
   1.8  1.E-5  20000 9     1.8   1.E-16  1500    0       20     0       0.0625
-------------------------------------------------------------------------------
C4  LONGTERM MASS TRANSPORT INTEGRATION ONLY SWITCHES                         |
C                                                                            |
      ISLTMT:  1 FOR LONG-TERM MASS TRANSPORT ONLY (FOR RESEARCH PURPOSES)   |
      ISSSMMT: 0 WRITES MEAN MASS TRANSPORT TO restran.out AFTER EACH        |
                 AVERAGING PERIOD  (FOR RESEARCH PURPOSES)                   |
               1 WRITES MEAN MASS TRANSPORT TO restran.out AFTER LAST        |
                 AVERAGING PERIOD  (FOR RESEARCH PURPOSES)                   |
      ISLTMTS: 0 ASSUMES LONG-TERM TRANSPORT SOLUTION IS TRANSIENT           |
                 (FOR RESEARCH PURPOSES)                                     |
               1 ASSUMES LONG-TERM TRANSPORT SOLUTION IS ITERATED TOWARD     |
                 STEADY STATE (FOR RESEARCH PURPOSES)                        |
      ISIA:    1 FOR IMPLICIT LONG-TERM ADVECTION INTEGRATION FOR ZEBRA      |
                 VERTICAL LINE R-B SOR (FOR RESEARCH PURPOSES)               |
      RPIA:      RELAXATION PARAMETER FOR ZEBRA SOR(FOR RESEARCH PURPOSES)   |
      RSQMIA:    TRAGET RESIDUAL ERROR FOR ZEBRA SOR (FOR RESEARCH PURPOSES) |
      ITRMIA:    MAXIMUM ITERATIONS FOR ZEBRA SOR (FOR RESEARCH PURPOSES)    |
C                                                                            |
C4  ISLTMT  ISSSMMT ISLTMTS  ISIA  RPIA  RSQMIA   ITRMIA                     |
    0       1       0        0     1.8   1.E-10   100
-------------------------------------------------------------------------------
C5   MOMENTUM ADVEC AND HORIZ DIFF SWITCHES AND MISC SWITCHES                |
C                                                                            |
      ISCDMA:  1 FOR CENTRAL DIFFERENCE MOMENTUM ADVECTION                   |
               0 FOR UPWIND DIFFERENCE MOMENTUM ADVECTION                    |
               2 FOR EXPERIMENTAL UPWIND DIFF MOM ADV (FOR RESEACH PURPOSES) |
      ISHDMF:  1 TO ACTIVE HORIZONTAL MOMENTUM DIFFUSION                     |
      ISDISP:  1 CALCULATE MEAN HORIZONTAL SHEAR DISPERSION TENSOR OVER LAST |
                 MEAN MASS TRANSPORT AVERAGING PERIOD                        |
      ISWASP: 4 or 5 TO WRITE FILES FOR WASP4 or WASP5 MODEL LINKAGE         |
      ISDRY:     GREATER THAN 0 TO ACTIVE WETTING & DRYING OF SHALLOW AREAS  |
               1 CONSTANT WETTING DEPTH SPECIFIED BY HWET ON CARD 11         |
                 WITH NONLINEAR ITERATIONS SPECIFIED BY ITERHPM ON CARD C3   |
               2 VARIABLE WETTING DEPTH CALCULATED INTERNALLY IN CODE        |
                 WITH NONLINEAR ITERATIONS SPECIFIED BY ITERHPM ON CARD C3   |
              11 SAME AS 1, WITHOUT NONLINEAR ITERATION                      |
              12 SAME AS 2, WITHOUT NONLINEAR ITERATION                      |
               3 DIFFUSION WAVE APPROX, CONSTANT WETTING DEPTH (NOT ACTIVE)  |
               4 DIFFUSION WAVE APPROX, VARIABLE WETTING DEPTH (NOT ACTIVE)  |
      ISQQ:    1 TO USE STANDARD TURBULENT INTENSITY ADVECTION SCHEME        |
      ISRLID:  1 TO RUN IN RIGID LID MODE (NO FREE SURFACE)                  |
      ISVEG:   1 TO IMPLEMENT VEGETATION RESISTANCE                          |
               2 IMPLEMENT WITH DIAGNOSTICS TO FILE cbot.log                 |
      ISVEGL:  1 TO INCLUDE LAMINAR FLOW OPTION IN VEGETATION RESISTANCE     |
```

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      ISITB:   1 FOR IMPLICIT BOTTOM & VEGETATION RESISTANCE IN EXTERNAL MODE |
                 FOR SINGLE LAYER APPLICATIONS (KC=1) ONLY                     |
      ISEVER:  1 TO DEFAULT TO EVERGLADES HYDRO SOLUTION OPTIONS               |
C                                 11                                           |
C5   ISCDMA ISHDMF ISDISP ISWASP ISDRY ISQQ ISRLID ISVEG ISVEGL ISITB ISEVER  |
     0      0      0      0      0     1    0      0     0      0     0
-------------------------------------------------------------------------------
C6   DISSOLVED AND SUSPENDED CONSTITUENT TRANSPORT SWITCHES                    |
C6   TURB INT=0,SAL=1,TEM=2,DYE=3,SFL=4,TOX=5,SED=6,SND=7,CWQ=8                |
C                                                                              |
      ISTRAN:  1 OR GREATER TO ACTIVATE TRANSPORT                              |
      ISTOPT:    NONZERO FOR TRANSPORT OPTIONS, SEE USERS MANUAL               |
      ISCDCA:  0 FOR STANDARD DONOR CELL UPWIND DIFFERENCE ADVECTION           |
               1 FOR CENTRAL DIFFERENCE ADVECTION FOR THREE TIME LEVEL STEPS   |
               2 FOR EXPERIMENTAL UPWIND DIFFERENCE ADVECTION (FOR RESEARCH)   |
      ISADAC:  1 TO ACTIVATE ANTI-NUMERICAL DIFFUSION CORRECTION TO            |
                 STANDARD DONOR CELL SCHEME                                    |
      ISFCT:   1 TO ADD FLUX LIMITING TO ANTI-NUMERICAL DIFFUSION CORRECTION   |
      ISPLIT:  1 TO OPERATOR SPLIT HORIZONTAL AND VERTICAL ADVECTION           |
                 (FOR RESEARCH PURPOSES)                                       |
      ISADAH:  1 TO ACTIVATE ANTI-NUM DIFFUSION CORRECTION TO HORIZONTAL       |
                 SPLIT ADVECTION STANDARD DONOR CELL SCHEME (FOR RESEARCH)     |
      ISADAV:  1 TO ACTIVATE ANTI-NUM DIFFUSION CORRECTION TO VERTICAL         |
                 SPLIT ADVECTION STANDARD DONOR CELL SCHEME (FOR RESEARCH)     |
      ISCI:    1 TO READ CONCENTRATION FROM FILE restart.inp                   |
      ISCO:    1 TO WRITE CONCENTRATION TO FILE restart.out                    |
C                                                                              |
C6   ISTRAN ISTOPT ISCDCA ISADAC ISFCT ISPLIT ISADAH ISADAV ISCI ISCO          |
     1      0      0      0      0      0      0      0      0    0    !turb 0
     1      1      0      1      1      0      0      0      1    1    !sal  1
     1      1      0      1      1      0      0      0      1    1    !tem  2
     1      1      0      1      1      0      0      0      1    1    !dye  3
     0      0      0      1      1      0      0      0      0    0    !sfl  4
     0      0      0      1      1      0      0      0      0    0    !tox  5
     0      0      0      1      1      0      0      0      0    0    !sed  6
     0      0      0      1      1      0      0      0      0    0    !snd  7
     0      0      0      1      1      0      0      0      0    0    !cwq  8
-------------------------------------------------------------------------------
C7  TIME-RELATED INTEGER PARAMETERS                                            |
C                                                                              |
      NTC:     NUMBER OF REFERENCE TIME PERIODS IN RUN                         |
      NTSPTC:  NUMBER OF TIME STEPS PER REFERENCE TIME PERIOD                  |
      NLTC:    NUMBER OF LINEARIZED REFERENCE TIME PERIODS                     |
      NLTC:    NUMBER OF TRANSITION REF TIME PERIODS TO FULLY NONLINEAR        |
      NTCPP:   NUMBER OF REFERENCE TIME PERIODS BETWEEN FULL PRINTED OUTPUT    |
               TO FILE efdc.out                                                |
      NTSTBC:  NUMBER OF REFERENCE TIME PERIODS BETWEEN TWO TIME LEVEL         |
               TRAPEZOIDAL CORRECTION TIME STEP                                |
      NTCNB:   NUMBER OF REFERENCE TIME PERIODS WITH N0 BUOYANCY FORCING       |
      NTCVB:   NUMBER OF REF TIME PERIODS WITH VARIABLE BUOYANCY FORCING       |
      NTCMMT:  NUMBER OF NUMBER OF REF TIME TO AVERAGE OVER TO OBTAIN          |
               RESIDUAL OR MEAN MASS TRANSPORT VARIABLES                       |
      NFLTMT:  USE 1 (FOR RESEARCH PURPOSES)                                   |
      NDRYSTP: MIN NO. OF TIME STEPS A CELL REMAINS DRY AFTER INTIAL DYRING    |
C                                                                              |
C7  NTC  NTSPTC NLTC NTTC NTCPP NTSTBC NTCNB NTCVB NTSMMT NFLTMT NDRYSTP       |
    30   8640    0    0    30    4      0     0    29   1      16
```

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------------------------------------------------------------------------------
C8  TIME-RELATED REAL PARAMETERS                                              |
C                                                                             |
      TCON:     CONVERSION MULTIPLIER TO CHANGE TBEGIN TO SECONDS             |
      TBEGIN:   TIME ORIGIN OF RUN                                            |
      TREF:     REFERENCE TIME PERIOD IN SEC (ie 44714.16s or 86400s)         |
      CORIOLIS: CONSTANT CORIOLIS PARAMETER IN 1/SEC                          |
      ISCORV:   1 TO READ VARIABLE CORIOLIS COEFFICIENT FROM lxly.inp FILE    |
      ISCCA:    WRITE DIAGNOSTICS FOR MAX CORIOLIS-CURV ACCEL TO FILEefdc.log |
      ISCFL:    1 WRITE DIAGNOSTICS OF MAX THEORETICAL TIME STEP TO cfl.out   |
                GT 1  TIME STEP ONLY AT INTERVAL ISCFL FOR ENTIRE RUN         |
      ISCFLM:   1  TO MAP LOCATIONS OF MAX TIME STEPS OVER ENTIRE RUN         |
C          1247.125/1186.125/1171.1250/1096.125                               |
C8   TCON     TBEGIN    TREF       CORIOLIS   ISCORV  ISCCA  ISCFL  ISCFLM    |
     86400.    23.125  86400.     1.1E-4     0       0        0     0
------------------------------------------------------------------------------
C9  SPACE-RELATED AND SMOOTHING  PARAMETERS                                   |
C                                                                             |
      KC:      NUMBER OF VERTICAL LAYER                                       |
      IC:      NUMBER OF CELLS IN I DIRECTION                                 |
      JC:      NUMBER OF CELLS IN J DIRECTION                                 |
      LC:      NUMBER OF ACTIVE CELLS IN HORIZONTAL + 2                       |
      LVC:     NUMBER OF VARIABLE SIZE HORIZONTAL CELLS                       |
      ISCO:    1 FOR CURVILINEAR-ORTHOGONAL GRID (LVC=LC-2)                   |
      NDM:     NUMBER OF DOMAINS FOR HORIZONTAL DOMAIN DECOMPOSITION          |
               ( NDM=1, FOR MODEL EXECUTION ON A SINGLE PROCESSOR SYSTEM OR   |
                 NDM=MM*NCPUS, WHERE MM IS AN INTEGER AND NCPUS IS THE NUMBER |
                 OF AVAILABLE CPU's FOR MODEL EXECUTION ON A PARALLEL         |
                 MULTIPLE PROCESSOR SYSTEM )                                  |
      LDW:     NUMBER OF WATER CELLS PER DOMAIN                               |
               ( LDW=(LC-2)/NDM, FOR MULTIPE VECTOR PROCESSORS, LWD MUST BE   |
                 AN INTEGER MULTIPLE OF THE VECTOR LENGTH OR STRIDE NVEC      |
                 THUS CONSTRAINING LC-2 TO BE AN INTEGER MULTIPLE OF NVEC )   |
      ISMASK:  1 FOR MASKING WATER CELL TO LAND OR ADDING THIN BARRIERS       |
                USING INFORMATION IN FILE mask.inp                            |
      ISPGNS:  1 FOR IMPLEMENTING A PERIODIC GRID IN COMP N-S DIRECTION OR    |
                CONNECTING ARBITRATY CELLS USING INFO IN FILE mappgns.inp     |
      NSHMAX:  NUMBER OF DEPTH SMOOTHING PASSES                               |
      NSBMAX:  NUMBER OF INITIAL SALINITY FIELD SMOOTHING PASSES              |
      WSMH:    DEPTH SMOOTHING WEIGHT                                         |
      WSMB:    SALINITY SMOOTHING WEIGHT                                      |
C                                                                             |
C9 KC IC  JC   LC  LVC ISCO NDM LDW ISMASK ISPGNS NSHMX NSBMX   WSMH    WSMB  |
   4  120 70   868 866 1    1   866  0     0      1     1    0.0625  0.0625
------------------------------------------------------------------------------
C10 LAYER THICKNESS IN VERTICAL                                               |
C                                                                             |
      THICKNESS OF EACH VERTICAL LAYER, 1 = BOTTOM                            |
      LAYER THICKNESSES MUST SUM TO 1.0                                       |
C                                                                             |
C10 LAYER NUMBER   DIMESIONLESS LAYER THICKNESSS                              |
        1          0.25
        1          0.25
        1          0.25
        1          0.25
```

```
-------------------------------------------------------------------------------
C11 GRID, ROUGHNESS AND DEPTH PARAMETERS                                       |
C                                                                              |
      DX:        CARTESIAN CELL LENGTH IN X OR I DIRECTION                     |
      DY:        CARTESION CELL LENGHT IN Y OR J DIRECTION                     |
      DXYCVT:    MULTIPLY DX AND DY BY TO OBTAIN METERS                        |
      IMD:       GREATER THAN 0 TO READ MODDXDY.INP FILE                       |
      ZBRADJ:    LOG BDRY LAYER CONST OR VARIABLE ROUGH HEIGHT ADJ IN METERS   |
      ZBRCVRT:   LOG BDRY LAYER VARIABLE ROUGHNESS HEIGHT CONVERT TO METERS    |
      HMIN:      MINIMUM DEPTH OF INPUTS DEPTHS IN METERS                      |
      HADJ:      ADJUCTMENT TO DEPTH FIELD IN METERS                           |
      HCVRT:     CONVERTS INPUT DEPTH FIELD TO METERS                          |
      HDRY:      DEPTH AT WHICH CELL OR FLOW FACE BECOMES DRY                  |
      HWET:      DEPTH AT WHICH CELL OR FLOW FACE BECOMES WET                  |
      BELADJ:    ADJUCTMENT TO BOTTOM BED ELEVATION FIELD IN METERS            |
      BELCVRT:   CONVERTS INPUT BOTTOM BED ELEVATION FIELD TO METERS           |
C                                                                              |
C11 DX  DY DXYCVT IMD  ZBRADJ ZBRCVT HMIN HADJ HCVT HDRY  HWET  BELADJ BELCVT |
    1.  1.  1.    0    0.005  0.0    0.5  0.2  1.0  0.11  0.16  -0.2   1.00
-------------------------------------------------------------------------------
C12 TURBULENT DIFFUSION PARAMETERS                                             |
C                                                                              |
      AHO:      CONSTANT HORIZONTAL MOMENTUM AND MASS DIFFUSIVITY M*M/S        |
      AHD:      DIMESIONLESS HORIZONTAL MOMENTUM DIFFUSIVITY                   |
      AVO:      BACKGROUND, CONSTANT OR MOLECULAR KINEMATIC VISCOSITY M*M/S    |
      ABO:      BACKGROUND, CONSTANT OR MOLECULAR DIFFUSIVITY M*M/S            |
      AVMN:     MINIMUM KINEMATIC EDDY VISCOSITY M*M/S                         |
      ABMN:     MINIMUM EDDY DIFFUSIVITY M*M/S                                 |
      AVBCON:   EQUALS ZERO FOR CONSTANT VERTICAL VISCOSITY AND DIFFUSIVITY    |
                  WHICH ARE SET EQUAL TO AVO AND ABO OTHERWISE SET TO 1.0      |
      ISAVBMN: SET TO 1 TO ACTIVATE MIN VIS AND DIFF OF AVMN AND ABMN          |
      ISFAVB:   SET TO 1 OR 2 TO AVG OR SQRT FILTER AVV AND AVB                |
      ISINWV:   SET TO 1 TO ACTIVATE PARAMETERIZATION OF INTERNAL WAVE         |
                  GENERATED TURBULENCE                                         |
C                 1.E-6  1.E-9  1.E-6  1.E-9                                   |
C12  AHO   AHD   AVO    ABO    AVMN   ABMN   AVBCON  ISAVBMN ISFAVB  ISINWV   |
     0.0   0.0   1.E-6  1.E-8  1.E-6  1.E-8  1.0     0       1       0
-------------------------------------------------------------------------------
C13 TURBULENCE CLOSURE PARAMETERS                                              |
C                                                                              |
      VKC:    VON KARMAN CONSTANT                                              |
      CTURB1: TURBULENT CONSTANT (UNIVERSAL)                                   |
      CTURB2: TURBULENT CONSTANT (UNIVERSAL)                                   |
      CTE1:   TURBULENT CONSTANT (UNIVERSAL)                                   |
      CTE2:   TURBULENT CONSTANT (UNIVERSAL)                                   |
      CTE3:   TURBULENT CONSTANT (UNIVERSAL)                                   |
      QQMIN:  MINIMUM TURBULENT INTENSITY SQUARED                              |
      QQLMIN: MINIMUM TURBULENT INTENSITY SQUARED TIME MACRO-SCALE             |
      DMLMIN: MINIMUM DIMENSIONLESS MACRO-SCALE                                |
C                                                1.E-8   1.E-12   1.E-4        |
C13 VKC   CTURB1  CTURB2   CTE1   CTE2   CTE3   QQMIN   QQLMIN   DMLMIN       |
    0.4   16.6    10.1     1.8    1.33   0.53   1.E-8   1.E-12   1.E-4
-------------------------------------------------------------------------------
C14 TIDAL & ATMOSPHERIC FORCING, GROUND WATER AND SUBGRID CHANNEL PARAMETERS   |
C                                                                              |
      MTIDE:    NUMBER OF PERIOD (TIDAL) FORCING CONSTITUENTS                  |
      NWSER:    NUMBER OF WIND TIME SERIES (0 SETS WIND TO ZERO)               |
```

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      NASER :  NUMBER OF ATMOSPHERIC CONDITION TIME SERIES (0 SETS ALL  ZERO) |
      ISGWI:   1 TO ACTIVATE SOIL MOISTURE BALANCE WITH DRYING AND WETTING    |
      ISCHAN:  1 ACTIVATE SUBGRID CHANNEL MODEL AND READ MODCHAN.INP          |
      ISWAVE   1 FOR WAVE CURRENT BOUNDARY LAYER  REQUIRES FILE wave.inp      |
               2 FOR WCBL AND WAVE INDUCED CURRENTS REQUIRES FILE wave.inp    |
C                                                                             |
C14 MTIDE  NWSER  NASER   ISGWI  ISCHAN  ISWAVE  ITIDASM                      |
    5      1      1       0      0       0          0
-------------------------------------------------------------------------------
C15 PERIODIC FORCING (TIDAL) CONSTITUENT SYMBOLS AND PERIODS                   |
C                                                                             |
      SYMBOL:  FORCING SYMBOL (CHARACTER VARIABLE) FOR TIDES, THE NOS SYMBOL  |
      PERIOD:  FORCING PERIOD IN SECONDS                                      |
C                                                                             |
C15 SYMBOL   PERIOD                                                           |
     'M2'     44714.1643936   1
     'S2'     43200.0000000   2
     'N2'     45570.0536814   3
     'K1'     86164.0907615   4
     'O1'     92949.6299931   5
-------------------------------------------------------------------------------
C16 SURFACE ELEVATION OR PRESSURE BOUNDARY CONDITION PARAMETERS                |
C                                                                             |
      NPBS:  NUMBER OF SURFACE ELEVATION OR PRESSURE BOUNDARY CONDITIONS      |
             CELLS ON SOUTH OPEN BOUNDARIES                                   |
      NPBW:  NUMBER OF SURFACE ELEVATION OR PRESSURE BOUNDARY CONDITIONS      |
             CELLS ON WEST OPEN BOUNDARIES                                    |
      NPBE:  NUMBER OF SURFACE ELEVATION OR PRESSURE BOUNDARY CONDITIONS      |
             CELLS ON EAST OPEN BOUNDARIES                                    |
      NPBN:  NUMBER OF SURFACE ELEVATION OR PRESSURE BOUNDARY CONDITIONS      |
             CELLS ON NORTH OPEN BOUNDARIES                                   |
      NPFOR: NUMBER OF HARMONIC FORCINGS                                      |
      NPSER: NUMBER OF TIME SERIES FORCINGS                                   |
      PDGINIT: ADD THIS CONSTANT ADJUSTMENT GLOBALLY TO THE SURFACE ELEVATION |
C                                                                             |
C16  NPBS NPBW NPBE NPBN  NPFOR  NPSER  PDGINIT                                |
      0    0   4    0     1      0      0.0
-------------------------------------------------------------------------------
C17 PERIODIC FORCING (TIDAL) SURF ELEV OR PRESSURE BOUNDARY COND. FORCINGS     |
C                                                                             |
      NPFOR:      FORCING NUMBER                                              |
      SYMBOL:     FORCING SYMBOL (FOR REFERENCE HERE ONLY)                    |
      AMPLITUDE:  AMPLITUDE IN M (PRESSURE DIVIDED BY RHO*G)                  |
      PHASE:      FORCING PHASE RELATIVE TO TBEGIN IN SECONDS                 |
C                                                                             |
C17 NPFOR    SYMBOL     AMPLITUDE      PHASE                                  |
   1        'M2'        1.60           14638.
   1        'S2'        0.65           21000.
   1        'N2'        0.35           27100.
   1        'K1'        0.80           22000.
   1        'O1'        0.61           41000.
-------------------------------------------------------------------------------
C18 PERIODIC FORCING (TIDAL) SURF ELEV OR PRESSURE ON SOUTH OPEN BOUNDARIES    |
C                                                                             |
      IPBS:      I CELL INDEX OF BOUNDARY CELL                                |
      JPBS:      J CELL INDEX OF BOUNDARY CELL                                |
      ISPBS:   1 FOR RADIATION-SEPARATION CONDITION                           |
```

```
                0 FOR ELEVATION SPECIFIED                                        |
      NPFORS:    APPLY HARMONIC FORCING NUMBER NPFORS                            |
      NPSERS:    APPLY TIME SERIES FORCING NUMBER NPSERS                         |
C                                                                                |
C18 IPBS     JPBS   ISPBS    NPFORS  NPSERS                                      |
-------------------------------------------------------------------------------
C19 PERIODIC FORCING (TIDAL) SURF ELEV OR PRESSURE ON WEST OPEN BOUNDARIES       |
C                                                                                |
      IPBW:   SEE CARD 19                                                        |
      JPBW:                                                                      |
      ISPBW:                                                                     |
      NPFORW:                                                                    |
      NPSERW:                                                                    |
C                                                                                |
C19 IPBW     JPBW   ISPBW    NPFORW  NPSERW                                      |
-------------------------------------------------------------------------------
C20 PERIODIC FORCING (TIDAL) SURF ELEV OR PRESSURE ON EAST OPEN BOUNDARIES       |
C                                                                                |
      IPBE:   SEE CARD 19                                                        |
      JPBE:                                                                      |
      ISPBE:                                                                     |
      NPFORE:                                                                    |
      NPSERE:                                                                    |
C                                                                                |
C20 IPBE     JPBE   ISPBE    NPFORE  NPSERE                                      |
     119      10     0          1       0
     119      11     0          1       0
     119      12     0          1       0
     119      13     0          1       0
-------------------------------------------------------------------------------
C21 PERIODIC FORCING (TIDAL) SURF ELEV OR PRESSURE ON NORTH OPEN BOUNDARIES      |
C                                                                                |
      IPBN:   SEE CARD 19                                                        |
      JPBN:                                                                      |
      ISPBN:                                                                     |
      NPFORN:                                                                    |
      NPSERN:                                                                    |
C                                                                                |
C21 IPBN     JPBN   ISPBN    NPFORN  NPSERN                                      |
-------------------------------------------------------------------------------
C22 SPECIFY NUM OF SEDIMENT AMD TOXICS AND NUM OF CONCENTRATION TIME SERIES       |
C                                                                                |
      NTOX:   NUMBER OF TOXIC CONTAMINANTS (DEFAULT = 1)                         |
      NSED:   NUMBER OF COHESIVE SEDIMENT SIZE CLASSES (DEFAULT = 1)             |
      NSND:   NUMBER OF NON-COHESIVE SEDIMENT SIZE CLASSES (DEFAULT = 1)         |
      NSSER:  NUMBER OF SALINITY TIME SERIES                                     |
      NTSER:  NUMBER OF TEMPERATURE TIME SERIES                                  |
      NDSER:  NUMBER OF DYE CONCENTRATION TIME SERIES                            |
      NSFSER: NUMBER OF SHELLFISH LARVAE CONCENTRATION TIME SERIES               |
      NTXSER: NUMBER OF TOXIC CONTAMINANT CONCENTRATION TIME SERIES              |
              EACH TIME SERIES MUST HAVE DATA FOR NTOX TOXICICANTS               |
      NSDSER: NUMBER OF COHESIVE SEDIMENT CONCENTRATION TIME SERIES              |
              EACH TIME SERIES MUST HAVE DATA FOR NSED COHESIVE SEDIMENTS        |
      NSNSER: NUMBER OF NONCOHESIVE SEDIMENT CONCENTRATION TIME SERIES           |
              EACH TIME SERIES MUST HAVE DATA FOR NSND NON-COHESIVE SEDIMENTS    |
      ISDBAL: SET TO 1 FOR SEDIENT MASS BALANCE                                  |
C                                                                                |
```

```
C22  NTOX NSED  NSND  NSSER NTSER NDSER NSFSER NTXSER NSDSER NSNSER ISSBAL    |
     1    1     1     2     2     1     0      0      0      0      0
------------------------------------------------------------------------------
C23 VELOCITY, VOLUMN SOURCE/SINK, FLOW CONTROL, AND WITHDRAWAL/RETURN DATA    |
C                                                                             |
      NVBS:   NUMBER OF VELOCITY BC'S ON SOUTH OPEN BOUNDARIES                |
      NUBW:   NUMBER OF VELOCITY BC'S ON WEST OPEN BOUNDARIES                 |
      NUBE:   NUMBER OF VELOCITY BC'S ON EAST OPEN BOUNDARIES                 |
      NVBN:   NUMBER OF VELOCITY BC'S ON NORTH OPEN BOUNDARIES                |
      NQSIJ:  NUMBER OF CONSTANT AND/OR TIME SERIES SPECIFIED SOURCE/SINK     |
              LOCATIONS (RIVER INFLOWS,ETC)             .                     |
      NQJPIJ: NUMBER OF CONSTANT AND/OR TIME SERIES SPECIFIED SOURCE          |
              LOCATIONS TREATED AS JETS/PLUMES          .                     |
      NQSER:  NUMBER OF VOLUMN SOURCE/SINK TIME SERIES                        |
      NQCTL:  NUMBER OF PRESSURE CONTROLED WITHDRAWAL/RETURN PAIRS            |
      NQCTLT: NUMBER OF PRESSURE CONTROLED WITHDRAWAL/RETURN TABLES           |
      NQWR:   NUMBER OF CONSTANT OR TIME SERIES SPECIFIED WITHDRAWL/RETURN    |
              PAIRS                                                           |
      NQWRSR: NUMBER OF TIME SERIES SPECIFYING WITHDRAWL,RETURN AND           |
              CONCENTRATION RISE SERIES                                       |
      ISDIQ:  SET TO 1 TO WRITE DIAGNOSTIC FILE, diaq.out                     |
C                                                                             |
C23 NVBS NUBW NUBE NVBN NQSIJ NQJPIJ NQSER NQCTL NQCTLT NQWR NQWRSR  ISDIQ    |
    0    0    0    0    12    0      12     0     0      0    0       0
------------------------------------------------------------------------------
C24 VOLUMETRIC SOURCE/SINK LOCATIONS, MAGNITUDES, AND CONCENTRATION SERIES    |
C                                                                             |
      IQS:      I CELL INDEX OF VOLUME SOURCE/SINK                            |
      JQS:      J CELL INDEX OF VOLUME SOURCE/SINK                            |
      QSSE:     CONSTANT INFLOW/OUTFLOW RATE IN M*M*M/S                       |
      NQSMUL:   MULTIPLIER SWITCH FOR CONSTANT AND TIME SERIES VOL S/S        |
                = 0  MULT BY 1. FOR NORMAL IN/OUTFLOW (L*L*L/T)               |
                = 1  MULT BY DY FOR LATERAL IN/OUTFLOW (L*L/T) ON U FACE      |
                = 2  MULT BY DX FOR LATERAL IN/OUTFLOW (L*L/T) ON V FACE      |
                = 3  MULT BY DX+DY FOR LATERAL IN/OUTFLOW (L*L/T) ON U&V FACES|
      NQSMFF:   IF NON ZERO ACCOUNT FOR VOL S/S MOMENTUM FLUX                 |
                = 1  MOMENTUM FLUX ON NEG U FACE                              |
                = 2  MOMENTUM FLUX ON NEG V FACE                              |
                = 3  MOMENTUM FLUX ON POS U FACE                              |
                = 4  MOMENTUM FLUX ON POS V FACE                              |
      NQSERQ:   ID NUMBER OF ASSOCIATED VOLUMN FLOW TIME SERIES               |
      NSSERQ:   ID NUMBER OF ASSOCIATED SALINITY TIME SERIES                  |
      NTSERQ:   ID NUMBER OF ASSOCIATED TEMPERATURE TIME SERIES               |
      NDSERQ:   ID NUMBER OF ASSOCIATED DYE CONC TIME SERIES                  |
      NSFSERQ:  ID NUMBER OF ASSOCIATED SHELL FISH LARVAE RELEASE TIME SERIES |
      NTXSERQ:  ID NUMBER OF ASSOCIATED TOXIC CONTAMINANT CONC TIME SERIES    |
      NSDSERQ:  ID NUMBER OF ASSOCIATED COHEASIVE SEDIMENT CONC TIME SERIES   |
      NSNSERQ:  ID NUMBER OF ASSOCIATED NONCOHEASIVE SED CONC TIME SERIES     |
C                                                                             |
C24 IQS  JQS   QSSE  NQSMUL NQSMFF NQSERQ NS- NT- ND- NSF- NTX- NSD- NSN-     |
     18    2   0.0    0      0        1    2   2   0   0    0    0    0
GOLDSBOROUGH CREEK
     11   44   0.0    0      0        2    2   2   0   0    0    0    0    JOHNS
CREEK
      8   55   0.0    0      0        3    2   2   0   0    0    0    0    CRANBERRY
CREEK
```

```
      8    2   0.0    0      0        4    2   2   0   0    0    0    0    SHELTON
CREEK
     12   55   0.0    0      0        5    2   2   0   0    0    0    0    DEER
CREEK
     22   34   0.0    0      0        6    2   2   0   0    0    0    0    UNCLE
JOHNS CREEK
    102   10   0.0    0      0        7    2   2   0   0    0    0    0    MILL
CREEK
     12   48   0.0    0      0        8    2   2   0   0    0    0    0    MALANEY
CREEK
     23   33   0.0    0      0        9    2   2   0   0    0    0    0    CAMPBELL
CREEK
     20   33   0.0    0      0       10    2   2   0   0    0    0    0    CREEK A
     19   11   0.0    0      0       11    0   0   1   0    0    0    0    OUTFALL
     19   12   0.0    0      0       12    0   0   1   0    0    0    0    X-OUTFALL
-------------------------------------------------------------------------------
C25 TIME CONSTANT INFLOW CONCENTRATIONS FOR TIME CONSTANT VOLUMETRIC SOURCES  |
C                                                                            |
      SAL:  SALT CONCENTRATION CORRESPONDING TO INFLOW ABOVE                 |
      TEM:  TEMPERATURE CORRESPONDING TO INFLOW ABOVE                        |
      DYE:  DYE CONCENTRATION CORRESPONDING TO INFLOW ABOVE                  |
      SFL:  SHELL FISH LARVAE CONCENTRATION CORRESPONDING TO INFLOW ABOVE    |
      TOX:  NTOX TOXIC CONTAMINANT CONCENTRATIONS CORRESPONDING TO           |
            INFLOW ABOVE  WRITTEN AS TOXC(N), N=1,NTOX A SINGLE DEFAULT      |
            VALUE IS REQUIRED EVEN IF TOXIC TRANSPORT IS NOT ACTIVE          |
C                                                                            |
C25 SAL TEM     DYE   SFL  TOX1-20                                           |
     0.  10.     0.    0.    0.
     0.  10.     0.    0.    0.
     0.  10.     0.    0.    0.
     0.  10.     0.    0.    0.
     0.  10.     0.    0.    0.
     0.  10.     0.    0.    0.
     0.  10.     0.    0.    0.
     0.  10.     0.    0.    0.
     0.  10.     0.    0.    0.
     0.  10.     0.    0.    0.
     0.  10.     0.    0.    0.
     0.  10.     0.    0.    0.
-------------------------------------------------------------------------------
C26 TIME CONSTANT INFLOW CONCENTRATIONS FOR TIME CONSTANT VOLUMETRIC SOURCES  |
C                                                                            |
      SED:  NSED COHESIVE SEDIMENT CONCENTRATIONS CORRESPONDING TO           |
            INFLOW ABOVE  WRITTEN AS SEDC(N), N=1,NSED. I.E., THE FIRST      |
            NSED VALUES ARE COHESIVE A SINGLE DEFAULT VALUE IS REQUIRED      |
            EVEN IF COHESIVE SEDIMENT TRANSPORT IS INACTIVE                  |
      SND:  NSND NON-COHESIVE SEDIMENT CONCENTRATIONS CORRESPONDING TO       |
            INFLOW ABOVE  WRITTEN AS SND(N), N=1,NSND. I.E., THE LAST        |
            NSND VALUES ARE NON-COHESIVE. A SINGLE DEFAULT VALUE IS          |
            REQUIRED EVEN IF NON-COHESIVE SEDIMENT TRANSPORT IS INACTIVE     |
C                                                                            |
C26 SED1  SND1                                                               |
     0.    0.
     0.    0.
     0.    0.
     0.    0.
     0.    0.
```

```
     0.    0.
     0.    0.
     0.    0.
     0.    0.
     0.    0.
     0.    0.
     0.    0.
-------------------------------------------------------------------------------
C27 JET/PLUME SOURCE LOCATIONS, GEOMETRY AND ENTRAINMENT PARAMETERS            |
C                                                                              |
        ID:  ID COUNTER FOR JET/PLUME                                          |
      ICAL:  1 ACTIVE, 0 BYPASS                                                |
      IQJP:  I CELL INDEX OF JET/PLUME                                         |
      JQJP:  J CELL INDEX OF JET/PLUME                                         |
      KQJP:  K CELL INDEX OF JET/PLUME (DEFAULT, QJET=0 OR JET COMP DIVERGES)  |
      XJET:  LOCAL EAST JET LOCATION RELATIVE TO DISCHARGE CELL CENTER (M)     |
      YJET:  LOCAL NORTH JET LOCATION RELATIVE TO DISCHARGE CELL CENTER (M)    |
      ZJET:  ELEVATION OF DISCHARGE (M)                                        |
     PHJET:  VERTICAL JET ANGLE POSITIVE FROM HORIZONTAL (DEGREES)             |
     THJET:  HORIZONTAL JET ANGLE POS COUNTER CLOCKWISE FROM EAST (DEGREES)    |
      DJET:  DIAMETER OF DISCHARGE PORT (M)                                    |
      CFRD:  ADJUSTMENT FACTOR FOR FROUDE NUMBER                               |
     DJPER:  ENTRAINMENT ERROR CRITERIA                                        |
C                                                                              |
C27 ID ICAL IQJP JQJP KQJP  XJET  YJET   ZJET  PHJET THJET DJET  CFRD  DJPER   |
-------------------------------------------------------------------------------
C28 JET/PLUME SOLUTION CONTROL AND OUTPUT CONTROL PARAMETERS                   |
C                                                                              |
        ID:   ID COUNTER FOR JET/PLUME                                         |
      NJEL:   MAXIMUM NUMBER OF ELEMENTS ALONG JET/PLUME LENGTH                |
     NJPMX:   MAXIMUM NUMBER OF ITERATIONS                                     |
     ISENT:   0 USE MAXIMUM OF SHEAR AND FORCED ENTRAINMENT                    |
              1 USE SUM OF SHEAR AND FORCED ENTRAINMENT                        |
     ISTJP:   0 STOP AT SPECIFIED NUMBER OF ELEMENTS                           |
              1 STOP WHEN CENTERLINE PENETRATES BOTTOM OR SURFACE              |
              2 STOP WITH BOUNDARY PENETRATES BOTTOM OR SURFACE                |
     NUDJP:  FREQUENCY FOR UPDATING JET/PLUME (NUMBER OF TIME STEPS)           |
      IOJP:  1 FOR FULL ASCII, 2 FOR COMPACT ASCII OUTPUT AT EACH UPDATE       |
             3 FOR FULL AND COMPACT ASCII OUTPUT, 4 FOR BINARY OUTPUT          |
      IPJP:  NUMBER OF SPATIAL PRINT/SAVE POINT IN VERTICAL                    |
     ISDJP:  1 WRITE DIAGNOSTIS TO jplog__.out                                 |
C                                                                              |
C28 ID   NJEL    NJPMX  ISENT ISTJP  NUDJP  IOJP IPJP  ISDJP                   |
-------------------------------------------------------------------------------
C29 JET/PLUME SOURCE PARAMETERS AND DISCHARGE/CONCENTRATION SERIES IDS         |
C                                                                              |
           ID:  ID COUNTER FOR JET/PLUME                                       |
         QQJP:  CONSTANT JET/PLUME FLOW RATE IN M*M*M/S                        |
      NQSERJP:  ID NUMBER OF ASSOCIATED VOLUMN FLOW TIME SERIES                |
      NSSERJP:  ID NUMBER OF ASSOCIATED SALINITY TIME SERIES                   |
      NTSERJP:  ID NUMBER OF ASSOCIATED TEMPERATURE TIME SERIES                |
      NDSERJP:  ID NUMBER OF ASSOCIATED DYE CONC TIME SERIES                   |
      NSFSERJP: ID NUMBER OF ASSOCIATED SHELL FISH LARVAE RELEASE TIME SERIES  |
      NTXSERJP: ID NUMBER OF ASSOCIATED TOXIC CONTAMINANT CONC TIME SERIES     |
      NSDSERJP: ID NUMBER OF ASSOCIATED COHEASIVE SEDIMENT CONC TIME SERIES    |
      NSNSERJP: ID NUMBER OF ASSOCIATED NONCOHEASIVE SED CONC TIME SERIES      |
C                10                                                            |
```

```
C29  ID   QQJP   NQSERJP NS-  NT-  ND-  NSF-  NTX-  NSD-  NSN-                 |
-------------------------------------------------------------------------------
C30 TIME CONSTANT INFLOW CONCENTRATIONS FOR TIME CONSTANT JET/PLUME SOURCES    |
C                                                                              |
      SAL:  SALT CONCENTRATION CORRESPONDING TO INFLOW ABOVE                   |
      TEM:  TEMPERATURE CORRESPONDING TO INFLOW ABOVE                          |
      DYE:  DYE CONCENTRATION CORRESPONDING TO INFLOW ABOVE                    |
      SFL:  SHELL FISH LARVAE CONCENTRATION CORRESPONDING TO INFLOW ABOVE      |
      TOX:  NTOX TOXIC CONTAMINANT CONCENTRATIONS CORRESPONDING TO             |
            INFLOW ABOVE  WRITTEN AS TOXC(N), N=1,NTOX A SINGLE DEFAULT        |
            VALUE IS REQUIRED EVEN IF TOXIC TRANSPORT IS NOT ACTIVE            |
C                                                                              |
C30 SAL  TEM   DYE   SFL  TOX1-20                                              |
-------------------------------------------------------------------------------
C31 TIME CONSTANT INFLOW CONCENTRATIONS FOR TIME CONSTANT JET/PLUME SOURCES    |
C                                                                              |
      SED:  NSED COHESIVE SEDIMENT CONCENTRATIONS CORRESPONDING TO             |
            INFLOW ABOVE  WRITTEN AS SEDC(N), N=1,NSED. I.E., THE FIRST        |
            NSED VALUES ARE COHESIVE A SINGLE DEFAULT VALUE IS REQUIRED        |
            EVEN IF COHESIVE SEDIMENT TRANSPORT IS INACTIVE                    |
      SND:  NSND NON-COHESIVE SEDIMENT CONCENTRATIONS CORRESPONDING TO         |
            INFLOW ABOVE  WRITTEN AS SND(N), N=1,NSND. I.E., THE LAST          |
            NSND VALUES ARE NON-COHESIVE. A SINGLE DEFAULT VALUE IS            |
            REQUIRED EVEN IF NON-COHESIVE SEDIMENT TRANSPORT IS INACTIVE       |
C                                                                              |
C31 SED1  SND1  SND2   SND3                                                    |
-------------------------------------------------------------------------------
C32 SURFACE ELEV OR PRESSURE DEPENDENT FLOW INFORMATION                         |
C                                                                              |
      IQCTLU:   I INDEX OF UPSTREAM OR WITHDRAWAL CELL                         |
      JQCTLU:   J INDEX OF UPSTREAM OR WITHDRAWAL CELL                         |
      IQCTLD:   I INDEX OF DOWNSTREAM OR RETURN CELL                           |
      JQCTLD:   J INDEX OF DOWNSTREAM OR RETURN CELL                           |
      NQCTYP:   FLOW CONTROL TYPE                                              |
                = 0  HYDRAULIC STRUCTURE: INSTANT FLOW DRIVEN BY ELEVATION     |
                     OR PRESSURE DIFFERCENCE TABLE                             |
                = 1  ACCELERATING FLOW THROUGH TIDAL INLET                     |
      NQCTLQ:   ID NUMBER OF CONTROL CHARACTERIZATION TABLE                    |
      NQCMUL:   MULTIPLIER SWITCH FOR FLOWS FROM UPSTREAM CELL                 |
                = 0  MULT BY 1. FOR CONTROL TABLE IN (L*L*L/T)                 |
                = 1  MULT BY DY FOR CONTROL TABLE IN (L*L/T) ON U FACE         |
                = 2  MULT BY DX FOR CONTROL TABLE IN (L*L/T) ON V FACE         |
                = 3  MULT BY DX+DY FOR CONTROL TABLE IN (L*L/T) ON U&V FACES   |
      NQCMFU:   IF NON ZERO ACCOUNT FOR FLOW MOMENTUM FLUX IN UPSTREAM CELL    |
                = 1  MOMENTUM FLUX ON NEG U FACE                               |
                = 2  MOMENTUM FLUX ON NEG V FACE                               |
                = 3  MOMENTUM FLUX ON POS U FACE                               |
                = 4  MOMENTUM FLUX ON POS V FACE                               |
      NQCMFD:  IF NON ZERO ACCOUNT FOR FLOW MOMENTUM FLUX IN DOWNSTREAM CELL   |
                = 1  MOMENTUM FLUX ON NEG U FACE                               |
                = 2  MOMENTUM FLUX ON NEG V FACE                               |
                = 3  MOMENTUM FLUX ON POS U FACE                               |
                = 4  MOMENTUM FLUX ON POS V FACE                               |
      BQCMFU:   UPSTREAM MOMENTUM FLUX WIDTH (M)                               |
      BQCMFD:   DOWNSTREAM MOMENTUM FLUX WIDTH (M)                             |
C                                                                              |
C32 IQCTLU JQCTLU IQCTLD JQCTLD NQCTYP NQCTLQ NQCMUL NQC_U NQC_D BQC_U  BQC_D |
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C33 FLOW WITHDRAWAL, HEAT OR MATERIAL ADDITION, AND RETURN DATA                 |
C                                                                               |
      IWRU:     I INDEX OF UPSTREAM OR WITHDRAWAL CELL                          |
      JWRU:     J INDEX OF UPSTREAM OR WITHDRAWAL CELL                          |
      KWRU:     K INDEX OF UPSTREAM OR WITHDRAWAL LAYER                         |
      IWRD:     I INDEX OF DOWNSTREAM OR RETURN CELL                            |
      JWRD:     J INDEX OF DOWNSTREAM OR RETURN CELL                            |
      KWRD:     J INDEX OF DOWNSTREAM OR RETURN LAYER                           |
      QWRE:       CONSTANT VOLUME FLOW RATE FROM WITHDRAWAL TO RETURN           |
      NQWRSERQ: ID NUMBER OF ASSOCIATED VOLUMN WITHDRAWAL-RETURN FLOW AND       |
                   CONCENTRATION RISE TIME SERIES                               |
      NQWRMFU:  IF NON ZERO ACCOUNT FOR WITHDRAWAL FLOW MOMENTUM FLUX           |
                = 1  MOMENTUM FLUX ON NEG U FACE                                |
                = 2  MOMENTUM FLUX ON NEG V FACE                                |
                = 3  MOMENTUM FLUX ON POS U FACE                                |
                = 4  MOMENTUM FLUX ON POS V FACE                                |
      NQWRMFD:   IF NON ZERO ACCOUNT FOR RETURN FLOW MOMENTUM FLUX              |
                = 1  MOMENTUM FLUX ON NEG U FACE                                |
                = 2  MOMENTUM FLUX ON NEG V FACE                                |
                = 3  MOMENTUM FLUX ON POS U FACE                                |
                = 4  MOMENTUM FLUX ON POS V FACE                                |
      BQWRMFU:  UPSTREAM MOMENTUM FLUX WIDTH (M)                                |
      BQWRMFD:  UPSTREAM MOMENTUM FLUX WIDTH (M)                                |
C                                   23.1                                        |
C33 IWRU JWRU KWRU IWRD JCWRD KWRD  QWRE NQW_RQ NQWR_U NQWR_D BQWR_U BQWR_D      |
--------------------------------------------------------------------------------
C34 TIME CONSTANT WITHDRAWAL AND RETURN CONCENTRATION RISES                     |
C                                                                               |
      SAL:   SALTINITY RISE                                                     |
      TEM:   TEMPERATURE RISE                                                   |
      DYE:   DYE CONCENTRATION RISE                                             |
      SFL:   SHELLFISH LARVAE CONCENTRATION RISE                                |
      TOX#:  NTOX TOXIC CONTAMINANT CONCENTRATION RISES                         |
C                                                                               |
C34 SALT  TEMP  DYEC  SFLC  TOX1                                                |
--------------------------------------------------------------------------------
C35 TIME CONSTANT WITHDRAWAL AND RETURN CONCENTRATION RISES                     |
C                                                                               |
      SED#:    NSEDC COHESIVE SEDIMENT CONCENTRATION RISE                       |
      SND#:    NSEDN NONCOHESIVE SEDIMENT CONCENTRATION RISE                    |
C                                                                               |
C35 SED1  SND1  SND2                                                            |
--------------------------------------------------------------------------------
C36 SEDIMENT INITIALIZATION AND WATER COLUMN/BED REPRESENTATION OPTIONS         |
C   DATA REQUIRED EVEN IF ISTRAN(6) AND ISTRAN(7) ARE 0                         |
C                                                                               |
     ISEDINT: 0 FOR CONSTANT INITIAL CONDITIONS                                 |
              1 FOR SPATIALLY VARIABLE WATER COLUMN INITIAL CONDITIONS          |
                FROM sedw.inp AND sndw.inp                                      |
              2 FOR SPATIALLY VARIABLE BED INITIAL CONDITIONS                   |
                FROM sedb.inp AND sndb.inp                                      |
              3 FOR SPATIALLY VARIABLE WATER COL AND BED INITIAL CONDITIONS     |
    ISEDBINT: 0 FOR SPATIALLY VARYING BED INITIAL CONDITIONS IN MASS/AREA       |
              1 FOR SPATIALLY VARYING BED INITIAL CONDITIONS IN MASS FRACTION   |
                OF TOTAL SEDIMENT MASS (REQUIRES BED LAYER THICKNESS            |
                FILE bedlay.inp)                                                |
```

```
      ISEDWC: 0 COHESIVE SED WC/BED EXCHANGE BASED ON BOTTOM LAYER CONDITIONS |
              1 COHESIVE SED WC/BED EXCHANGE BASED ON WAVE/CURRENT/SEDIMENT   |
                BOUNDARY LAYERS EMBEDDED IN BOTTOM LAYER                      |
       ISMUD: 1 INCLUDE COHESIVE FLUID MUD VISCOUS EFFECTS USING EFDC         |
                FUNCTION CSEDVIS(SEDT)                                        |
      ISNDWC: 0 NONCOH SED WC/BED EXCHANGE BASED ON BOTTOM LAYER CONDITIONS   |
              1 NONCOH SED WC/BED EXCHANGE BASED ON WAVE/CURRENT/SEDIMENT     |
                BOUNDARY LAYERS EMBEDDED IN BOTTOM LAYER                      |
      ISEDVW: 0 FOR CONSTANT OR SIMPLE CONCENTRATION DEPENDENT                |
                COHESIVE SEDIMENT SETTLING VELOCITY                           |
             >1 CONCENTRATION AND/OR SHEAR/TURBULENCE DEPENDENT COHESIVE      |
                SEDIMENT SETTLING VELOCITY. VALUE INDICATES OPTION TO BE USED |
                IN EFDC FUNCTION CSEDSET(SED,SHEAR,ISEDVWC)                   |
              1 HUANG AND METHA - LAKE OKEECHOBEE                             |
              2 SHRESTA AND ORLOB - FOR KRONES SAN FRANCISCO BAY DATA         |
              3 ZIEGLER AND NESBIT  - FRESH WATER                             |
      ISNDVW: 0 USE CONSTANT SPECIFIED NONCHOESIVE SED SETTLING VELOCITIES    |
                OR CALCULATE FOR CLASS DIAMETER IS SPECIFIED VALUE IS NEG     |
             >1 FOLLOW OPTION 0 PROCEDURE BUT APPLY HINDERED SETTLING         |
                CORRECTION. VALUE INDICATES OPTION TO BE USED WITH EFDC       |
                FUNCTION CSNDSET(SND,SDEN,ISNDVW) VALUE OF ISNDVW INDICATES   |
                EXPONENTIAL IN CORRECT (1-SDEN(NS)*SND(NS)**ISNDVW            |
          KB:   MAXIMUM NUMBER OF BED LAYERS (EXCLUDING ACTIVE LAYER)         |
      ISEDAL: 1 TO ACTIVATE STATIONARY COHESIVE MUD ACTIVE LAYER              |
      ISNDAL: 1 TO ACTIVATE NONCOHESIVE ARMORING LAYER ACTIVE LAYER           |
C     3                                                                       |
C36 ISEDINT ISEDBINT ISEDWC ISMUD ISNDWC ISEDVW ISNDVW  KB ISEDAL ISNDAL      |
      0       0      0      0     0      0      0       1    0      0
------------------------------------------------------------------------------
C37 BED MECHANICAL PROPERTIES PARAMETER SET 1                                 |
C   DATA REQUIRED EVEN IF ISTRAN(6) AND ISTRAN(7) ARE 0                       |
C                                                                             |
      IBMECH: 0 TIME INVARIANT CONSTANT BED MECHANICAL PROPERITES             |
              1 SIMPLE CONSOLIDATION CALCULATION WITH CONSTANT COEFFICIENTS   |
              2 SIMPLE CONSOLIDATION WITH VARIABLE COEFFICIENTS DETERMINED    |
                EFDC FUNCTIONS CSEDCON1,2,3(IBMECH)                           |
              3 COMPLEX CONSOLIDATION WITH VARIABLE COEFFICIENTS DETERMINED   |
                EFDC FUNCTIONS CSEDCON1,2,3(IBMECH). IBMECH > 0 SETS THE      |
                C38 PARAMETER ISEDBINT=1 AND REQUIRES INITIAL CONDITIONS      |
                FILES bedlay.inp, bedbdn.inp and bedddn.in                    |
      IMORPH: 0 CONSTANT BED MORPHOLOGY (IBMECH=0, ONLY)                      |
              1 ACTIVE BED MORPHOLOGY: NO WATER ENTRAIN/EXPULSION EFFECTS     |
              2 ACTIVE BED MORPHOLOGY: WITH WATER ENTRAIN/EXPULSION EFFECTS   |
     HBEDMAX:   TOP BED LAYER THICKNESS (M) AT WHICH NEW LAYER IS ADDED OR IF |
                KBT(I,J)=KB, NEW LAYER ADDED AND LOWEST TWO LAYERS COMBINED   |
     BEDPORC:   CONSTANT BED POROSITY (IBMECH=0, OR NSED=0)                   |
                ALSO USED AS POROSITY OF DEPOSITIN NONCOHESIVE SEDIMENT       |
     SEDMDMX:   MAXIMUM FLUID MUD COHESIVE SEDIMENT CONCENTRATION (mg/l)      |
     SEDMDMN:   MINIMUM FLUID MUD COHESIVE SEDIMENT CONCENTRATION (mg/l)      |
     SEDVDRD:   VOID RATIO OF DEPOSITING COHESIVE SEDIMENT                    |
     SEDVDRM:   MINIMUM COHESIVE SEDIMENT BED VOID RATIO (IBMECH > 0)         |
     SEDVDRT:   BED CONSOLODATION RATED CONSTANT (1/SEC) (IBMECH = 1,2)       |
C                                                                             |
C37 IBMECH IMORPH  HBEDMAX  BEDPORC SEDMDMX SEDMDMN SEDVDRD SEDVDRM SEDVRDT   |
       0     0       2.0      0.5    1.1E5   4000.    20.      4.    1.E-5
```

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-------------------------------------------------------------------------------
C38 BED MECHANICAL PROPERTIES PARAMETER SET 2                                  |
C   DATA REQUIRED EVEN IF ISTRAN(6) AND ISTRAN(7) ARE 0                        |
C                                                                              |
     BMECH1:   BED MECHANICS FUNCTION COEFFICIENT                              |
     BMECH2:   BED MECHANICS FUNCTION COEFFICIENT                              |
     BMECH3:   BED MECHANICS FUNCTION COEFFICIENT                              |
     BMECH4:   BED MECHANICS FUNCTION COEFFICIENT                              |
     BMECH5:   BED MECHANICS FUNCTION COEFFICIENT                              |
     BMECH6:   BED MECHANICS FUNCTION COEFFICIENT                              |
C                                                                              |
C38   BMECH1 BMECH2 BMECH3 BMECH4 BMECH5 BMECH6                                |
      0.0     0.     0.     0.      0.      0.
-------------------------------------------------------------------------------
C39 COHESIVE SEDIMENT PARAMETER SET 1 REPEAT DATA LINE NSED TIMES              |
C   DATA REQUIRED EVEN IF ISTRAN(6) AND ISTRAN(7) ARE 0                        |
C                                                                              |
      SEDO:    CONSTANT INITIAL COHESIVE SEDIMENT CONC IN WATER COLUMN         |
                (mg/liter=gm/m**3)                                             |
      SEDBO:   CONSTANT INITIAL COHESIVE SEDIMENT IN BED PER UNIT AREA         |
                (gm/sq meter)  IE 1CM THICKNESS BED WITH SSG=2.5 AND           |
                N=.6,.5 GIVES SEDBO 1.E4, 1.25E4                               |
      SDEN:    SEDIMENT SPEC VOLUME (IE 1/2.25E6 m**3/gm)                      |
      SSG:     SEDIMENT SPECIFIC GRAVITY                                       |
      WSEDO:   CONSTANT OR REFERENCE SEDIMENT SETTLING VELOCITY                |
               IN FORMULA WSED=WSEDO*( (SED/SEDSN)**SEXP )                     |
      SEDSN:   NORMALIZING SEDIMENT CONC (COHESIVE SED TRANSPORT) (gm/m**3)    |
      SEXP:    EXPONENTIAL (COHESIVE SED TRANSPORT)                            |
      TAUD:    BOUNDARY STRESS BELOW WHICH DEPOSITION TAKES PLACE ACCORDING    |
               TO (TAUD-TAU)/TAUD                                              |
   ISEDSCOR: 1 TO CORRECT BOTTOM LAYER CONCENTRATION TO NEAR BED CONC          |
C                                                                              |
C39  SEDO   SEDBO     SDEN    SSG    WSEDO   SEDSN   SEXP   TAUD    ISEDSCOR   |
     0.0   1.0E4     1.E-12   2.25   0.0     1.0     0.     1.E+6      0
-------------------------------------------------------------------------------
C40 COHESIVE SEDIMENT PARAMETER SET 2 REPEAT DATA LINE NSED TIMES              |
C   DATA REQUIRED EVEN IT ISTRAN(6) AND ISTRAN(7) ARE 0                        |
C                                                                              |
      IWRSP: 0 USE RESUSPENSION RATE AND CRITICAL STRESS BASED ON PARAMETERS   |
               ON THIS DATA LINE                                               |
            >1 USE BED PROPERTIES DEPENDEDNT RESUSPENSION RATE AND CRITICAL    |
               STRESS GIVEN BY EFDC FUNCTIONS CSEDRESS,CSEDTAUS,CSEDTAUB       |
               FUNCTION ARGUMENSTS ARE (BDENBED,IWRSP)                         |
             1 HWANG AND METHA - LAKE OKEECHOBEE                               |
      WRSPO:   REF SURFACE EROSION  RATE IN FORMULA                            |
               WRSP=WRSP0*( ((TAU-TAUR)/TAUN)**TEX ) (gm/m**2-sec)             |
      TAUR:    BOUNDARY STRESS ABOVE WHICH SURFACE EROSION OCCURS (m/s)**2     |
      TAUN:    NORMALIZING STRESS (EQUAL TO TAUR FOR COHESIVE SED TRANS)       |
      TEXP:    EXPONENTIAL (COH SED)                                           |
C      0    0.01     4.E-4    4.E-4     1.                                     |
C40  IWRSP  WRSPO    TAUR     TAUN      TEXP                                   |
       0    0.00     1.E+6    1.E+6     1.
-------------------------------------------------------------------------------
C41 NONCOHESIVE SEDIMENT PARAMETER SET 1 REPEAT DATA LINE NSND TIMES           |
C   DATA REQUIRED EVEN IT ISTRAN(6) AND ISTRAN(7) ARE 0                        |
C                                                                              |
      SNDO:    CONSTANT INITIAL NONCOHESIVE SEDIMENT CONC IN WATER COLUMN      |
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                (mg/liter=gm/m**3)                                             |
       SNDBO:   CONSTANT INITIAL NONCOHESIVE SEDIMENT IN BED PER UNIT AREA     |
                (gm/sq meter)  IE 1CM THICKNESS BED WITH SSG=2.5 AND           |
                N=.6,.5 GIVES SNDBO 1.E4, 1.25E4                               |
       SDEN:    SEDIMENT SPEC VOLUME (IE 1/2.65E6 m**3/gm)                     |
       SSG:     SEDIMENT SPECIFIC GRAVITY                                      |
       SNDDIA:  REPRESENTATIVE DIAMETER OF SEDIMENT CLASS                      |
       WSNDO:   CONSTANT OR REFERENCE SEDIMENT SETTLING VELOCITY               |
       SNDN:    MAX MASS/TOT VOLUME IN BED (NONCOHESIVE SED TRANS) (gm/m**3)   |
       SEXP:    DIMENSIONLESS RESUSPENSION PARAMETER GAMMA ZERO                |
       TAUD:    DUNE BREAK POINT STRESS  (m/s)**2                              |
    ISNDSCOR: 1 TO CORRECT BOTTOM LAYER CONCENTRATION TO NEAR BED CONC         |
 C                                                                             |
 C41 SNDO  SNDBO   SDEN    SSG   SNDDIA  WSNDO  SNDN   SEXP   TAUD   ISNDSCOR  |
     0.0    1.E4   1.E-12   2.65  1.8E-4   0.00  1.E6   1.E-3  7.E-5    0      ! fine
sand
-------------------------------------------------------------------------------
 C42 NONCOHESIVE SEDIMENT PARAMETER SET 2 REPEAT DATA LINE NSND TIMES          |
 C   DATA REQUIRED EVEN IT ISTRAN(6) AND ISTRAN(7) ARE 0                       |
 C                                                                             |
      ISNDEQ: >1 CALCULATE ABOVE BED REFERENCE NONCHOHESIVE SEDIMENT           |
                EQUILIBRIUM CONCENTRATION USING EFDC FUNCTION                  |
                CSNDEQC(SNDDIA,SSG,WS,TAUR,TAUB,SIGPHI,SNDDMX,IOTP)            |
                WHICH IMPLEMENT FORMULATIONS OF                                |
              1 GRACIA AND PARKER                                              |
              2 SMITH AND MCLEAN                                               |
              3 VAN RIJN                                                       |
       TAUR:    CRITICAL SHIELDS STRESS IN (m/s)**2   (ISNDEQ=2)               |
       TAUN:    EQUAL TO TAUR FOR NONCHOESIVE SED TRANS  (ISNDEQ=2)            |
       TEXP:    CRITICAL SHIELDS PARAMETER  (ISNDEQ=2)                         |
 C                                                                             |
 C42  ISNDEQ   TAUR     TAUN     TEXP                                          |
        0      1.E+6    1.E+6    0.2
-------------------------------------------------------------------------------
 C43 TOXIC CONTAMINANT INITIAL CONDITIONS AND PARAMETERS                       |
 C   USER MAY CHANGE UNITS OF WATER AND SED PHASE TOX CONCENTRATION            |
 C   AND PARTIATION COEFFICIENT ON C44 - C46 BUT CONSISTENT UNITS MUST         |
 C   MUST BE USED FOR MEANINGFUL RESULTS                                       |
 C   DATA REQUIRED EVEN IT ISTRAN(5) IS 0                                      |
 C                                                                             |
       NTOXN:   TOXIC CONTAMINANT NUMBER ID (1 LINE OF DATA BY DEFAULT)        |
      ITXINT:   0 FOR SPATIALLY CONSTANT WATER COL AND BED INITIAL CONDITIONS  |
                1 FOR SPATIALLY VARIABLE WATER COLUMN INITIAL CONDITIONS       |
                2 FOR SPATIALLY VARIABLE BED INITIAL CONDITIONS                |
                3 FOR SPATIALLY VARIABLE WATER COL AND BED INITIAL CONDITION   |
     ITXBDUT:   SET TO 0 FOR CONST INITIAL BED GIVEN BY TOTAL TOX (ugm/litr)   |
                SET TO 1 FOR CONST INITIAL BED GIVEN BY                        |
                 SORBED MASS TOX/MASS SED(mg/kg)                               |
     TOXINTW:   INIT WATER COLUNM TOT TOXIC VARIABLE CONCENTRATION (ugm/litr)  |
     TOXINTB:   INIT SED BED TOXIC CONC SEE ITXBDUT                            |
      RKTOXW:   FIRST ORDER WATER COL DECAY RATE FOR TOX VARIABLE IN 1/SEC     |
      TKTOXW:   REF TEMP FOR 1ST ORDER WATER COL DECAY DEG C                   |
      RKTOXB:   FIRST ORDER SED BED DECAY RATE FOR TOX VARIABLE IN 1/SEC       |
      TKTOXB:   REF TEMP FOR 1ST ORDER SED BED DECAY DEG C                     |
 C                       ck blw kevin uses 6.0                                 |
 C43 NTOXN ITXINT ITXBDUT TOXINTW TOXINTB RKTOXW TKTOXW RKTOXB TRTOXB COMMENTS |
       1     0      0       1.      1.       0.    0.     0.      0.    DUMMY
```

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-------------------------------------------------------------------------------
C44 ADDITIONAL TOXIC CONTAMINANT PARAMETERS                                    |
C   DATA REQUIRED EVEN IT ISTRAN(5) IS 0                                       |
C                                                                              |
      NTOXN:   TOXIC CONTAMINANT NUMBER ID (1 LINE OF DATA BY DEFAULT)         |
     VOLTOX:   WATER SURFACE VOLITIALIZATION RATE MULTIPLIER (0. OR 1.)        |
     RMOLTX:   MOLECULAR WEIGHT FOR DETERMINING VOLATILIZATION RATE            |
     RKTOXP:   REFERENCE PHOTOLOYSIS DECAY RATE 1/SEC                          |
     SKTOXP:   REFERENCE SOLAR RADIATION FOR PHOTOLOYSIS (WATTS/M**2)          |
     DIFTOX:   DIFFUSION COEFF FOR TOXICANT IN SED BED PORE WATER (M**2/S)     |
C                                                                              |
C44  NTOXN VOLTOX RMOLTX RKTOXP SKTOXP DIFTOX  COMMENTS                        |
      1     0.     0.     0.      0.   1.E-9    DUMMY
-------------------------------------------------------------------------------
C45 TOXIC CONTAMINANT SEDIMENT INTERACTION PARAMETERS                          |
C   2 LINES OF DATA REQUIRED EVEN IT ISTRAN(5) IS 0                            |
C                                                                              |
     NTOXC: TOXIC CONTAMINANT NUMBER ID.  NSEDC+NSEDN LINES OF DATA            |
              FOR EACH TOXIC CONTAMINANT (DEFAULT = 2)                         |
  NSEDN/NSNDN: FIRST NSED LINES COHESIVE, NEXT NSND LINES NON-COHESIVE.        |
            REPEATED FOR EACH CONTAMINANT                                      |
   ITXPARW: EQUAL 1 FOR SOLIDS DEPENDENT PARTITIONING (WC) GIVEN BY            |
            TOXPAR=PARO*(CSED**CONPAR)                                         |
   TOXPARW: WATER COLUMN PARO (ITXPARW=1) OR EQUIL TOX CON PART COEFF BETWEEN  |
            EACH TOXIC IN WATER AND ASSOCIATED SEDIMENT PHASES (liters/mg)     |
   CONPARW: EXPONENT IN  TOXPAR=PARO*(CSED**CONPARW) IF ITXPARW=1              |
   ITXPARB: EQUAL 1 FOR SOLIDS DEPENDENT PARTITIONING (BED)                    |
   TOXPARB: SEDIMENT BED PARO (ITXPARB=1) OR EQUIL TOX CON PART COEFF BETWEEN  |
            EACH TOXIC IN WATER AND ASSOCIATED SEDIMENT PHASES (liters/mg)     |
   CONPARB: EXPONENT IN  TOXPAR=PARO*(CSED**CONPARB) IF ITXPARB=1              |
C               1       0.8770  -0.943         0.025                           |
C45 NTOXN NSEDN ITXPARW TOXPARW CONPARW ITXPARB TOXPARB CONPARB  COMMENTS      |
      1     1     0       1.      0.      0       1.      0.     DUMMY FOR NSED=1
      1     2     0       1.      0.      0       1.      0.     DUMMY FOR NSND=1
-------------------------------------------------------------------------------
C46  BUOYANCY, TEMPERATURE, DYE DATA AND CONCENTRATION BC DATA                 |
C                                                                              |
      BSC:    BUOYANCY INFLUENCE COEFFICIENT 0 TO 1, BSC=1. FOR REAL PHYSICS   |
      TEMO:   REFERENCE, INITIAL, EQUILIBRUM AND/OR ISOTHERMAL TEMP IN DEG C   |
      HEQT:   EQUILIBRUM TEMPERTURE TRANSFER COEFFICIENT M/SEC                 |
      RKDYE:  FIRST ORDER DECAY RATE FOR DYE VARIABLE IN 1/SEC                 |
      NCBS:   NUMBER OF CONCENTRATION BOUNDARY CONDITIONS ON SOUTH OPEN        |
              BOUNDARIES                                                       |
      NCBW:   NUMBER OF CONCENTRATION BOUNDARY CONDITIONS ON WEST OPEN         |
              BOUNDARIES                                                       |
      NCBE:   NUMBER OF CONCENTRATION BOUNDARY CONDITIONS ON EAST OPEN         |
              BOUNDARIES                                                       |
      NCBN:   NUMBER OF CONCENTRATION BOUNDARY CONDITIONS ON NORTH OPEN        |
              BOUNDARIES                                                       |
C          26.9                                                                |
C46   BSC  TEMO  HEQT   RKDYE  NCBS  NCBW  NCBE  NCBN                          |
      1.0  10.0  1.E-6  0.      0    0     4     0
-------------------------------------------------------------------------------
C47  LOCATION OF CONC BC'S ON SOUTH BOUNDARIES                                 |
C                                                                              |
      ICBS:    I CELL INDEX                                                    |
      JCBS:    J CELL INDEX                                                    |
```

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      NTSCRS:  NUMBER OF TIME STEPS TO RECOVER SPECIFIED VALUES ON CHANGE     |
               TO INFLOW FROM OUTFLOW                                         |
      NSSERS:  SOUTH BOUNDARY CELL SALINITY TIME SERIES ID NUMBER             |
      NTSERS:  SOUTH BOUNDARY CELL TEMPERATURE TIME SERIES ID NUMBER          |
      NDSERS:  SOUTH BOUNDARY CELL DYE CONC TIME SERIES ID NUMBER             |
      NSFSERS: SOUTH BOUNDARY CELL SHELLFISH LARVAE TIME SERIES ID NUMBER     |
      NTXSERS: SOUTH BOUNDARY CELL TOXIC CONTAMINANT CONC TIME SERIES ID NUM. |
      NSDSERS: SOUTH BOUNDARY CELL COHESIVE SED CONC TIME SERIES ID NUMBER    |
      NSNSERS: SOUTH BOUNDARY CELL NONCOHESIVE SED CONC TIME SERIES ID NUMBER |
C                                                                             |
C47 IBBS  JBBS  NTSCRS NSSERS NTSERS NDSERS NSFSERS NTXSERS NSDSERS NSNSERS   |
-------------------------------------------------------------------------------
C48 TIME CONSTANT BOTTOM CONC ON SOUTH CONC BOUNDARIES                        |
C                                                                             |
      SAL:  ULTIMATE INFLOWING BOTTOM LAYER SALINITY                          |
      TEM:  ULTIMATE INFLOWING BOTTOM LAYER TEMPERATURE                       |
      DYE:  ULTIMATE INFLOWING BOTTOM LAYER DYE CONCENTRATION                 |
      SFL:  ULTIMATE INFLOWING BOTTOM LAYER SHELLFISH LARVAE CONCENTRAION     |
      TOX:  NTOX ULTIMATE INFLOWING BOTTOM LAYER TOXIC CONTAMINANT            |
            CONCENTRATIONS NTOX VALUES TOX(N), N=1,NTOX                       |
C                                                                             |
C48 SAL   TEM   DYE   SFL    TOX1                                             |
-------------------------------------------------------------------------------
C49 TIME CONSTANT BOTTOM CONC ON SOUTH CONC BOUNDARIES                        |
C                                                                             |
      SED:  NSED ULTIMATE INFLOWING BOTTOM LAYER COHESIVE SEDIMENT            |
            CONCENTRAIONS  FIRST NSED VALUES SED(N), N=1,NSND                 |
      SND:  NSND ULTIMATE INFLOWING BOTTOM LAYER NONCOHESIVE SEDIMENT         |
            CONCENTRATIONS LAST NSND VALUES SND(N), N=1,NSND                  |
C                                                                             |
C49 SED1  SND1  SND2   SND3                                                   |
-------------------------------------------------------------------------------
C50 TIME CONSTANT SURFACE CONC ON SOUTH CONC BOUNDARIES                       |
C                                                                             |
      SAL:  ULTIMATE INFLOWING SURFAC LAYER SALINITY                          |
      TEM:  ULTIMATE INFLOWING SURFAC LAYER TEMPERATURE                       |
      DYE:  ULTIMATE INFLOWING SURFAC LAYER DYE CONCENTRATION                 |
      SFL:  ULTIMATE INFLOWING SURFAC LAYER SHELLFISH LARVAE CONCENTRAION     |
      TOX:  NTOX ULTIMATE INFLOWING SURFAC LAYER TOXIC CONTAMINANT            |
            CONCENTRATIONS NTOX VALUES TOX(N), N=1,NTOX                       |
C                                                                             |
C50 SAL   TEM   DYE   SFL    TOX1                                             |
-------------------------------------------------------------------------------
C51 TIME CONSTANT SURFACE CONC ON SOUTH CONC BOUNDARIES                       |
C                                                                             |
      SED:  NSED ULTIMATE INFLOWING SURFAC LAYER COHESIVE SEDIMENT            |
            CONCENTRAIONS  FIRST NSED VALUES SED(N), N=1,NSND                 |
      SND:  NSND ULTIMATE INFLOWING SURFAC LAYER NONCOHESIVE SEDIMENT         |
            CONCENTRATIONS LAST NSND VALUES SND(N), N=1,NSND                  |
C                                                                             |
C51 SED1  SND1  SND2   SND3                                                   |
-------------------------------------------------------------------------------
C52 LOCATION OF CONC BC'S ON WEST BOUNDARIES AND SERIES IDENTIFIERS           |
C                                                                             |
      ICBW:    I CELL INDEX                                                   |
      JCBW:    J CELL INDEX                                                   |
      NTSCRW:  NUMBER OF TIME STEPS TO RECOVER SPECIFIED VALUES ON CHANGE     |
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               TO INFLOW FROM OUTFLOW                                        |
      NSSERW:  WEST BOUNDARY CELL SALINITY TIME SERIES ID NUMBER             |
      NTSERW:  WEST BOUNDARY CELL TEMPERATURE TIME SERIES ID NUMBER          |
      NDSERW:  WEST BOUNDARY CELL DYE CONC TIME SERIES ID NUMBER             |
      NSFSERW: WEST BOUNDARY CELL SHELLFISH LARVAE TIME SERIES ID NUMBER     |
      NTXSERW: WEST BOUNDARY CELL TOXIC CONTAMINANT CONC TIME SERIES ID NUM. |
      NSDSERW: WEST BOUNDARY CELL COHESIVE SED CONC TIME SERIES ID NUMBER    |
      NSNSERW: WEST BOUNDARY CELL NONCOHESIVE SED CONC TIME SERIES ID NUMBER |
C                                                                            |
C52 IBBW  JBBW  NTSCRW NSSERW NTSERW NDSERW NSFSERW NTXSERW NSDSERW NSNSERW  |
-------------------------------------------------------------------------------
C53 TIME CONSTANT BOTTOM CONC ON WEST CONC BOUNDARIES                        |
C                                                                            |
      SAL:  ULTIMATE INFLOWING BOTTOM LAYER SALINITY                         |
      TEM:  ULTIMATE INFLOWING BOTTOM LAYER TEMPERATURE                      |
      DYE:  ULTIMATE INFLOWING BOTTOM LAYER DYE CONCENTRATION                |
      SFL:  ULTIMATE INFLOWING BOTTOM LAYER SHELLFISH LARVAE CONCENTRAION    |
      TOX:  NTOX ULTIMATE INFLOWING BOTTOM LAYER TOXIC CONTAMINANT           |
            CONCENTRATIONS NTOX VALUES TOX(N), N=1,NTOX                      |
C                                                                            |
C53 SAL   TEM   DYE   SFL    TOX1                                            |
-------------------------------------------------------------------------------
C54 TIME CONSTANT BOTTOM CONC ON WEST CONC BOUNDARIES                         |
C                                                                            |
      SED:  NSED ULTIMATE INFLOWING BOTTOM LAYER COHESIVE SEDIMENT           |
            CONCENTRAIONS  FIRST NSED VALUES SED(N), N=1,NSND                |
      SND:  NSND ULTIMATE INFLOWING BOTTOM LAYER NONCOHESIVE SEDIMENT        |
            CONCENTRATIONS LAST NSND VALUES SND(N), N=1,NSND                 |
C                                                                            |
C54  SED1  SND1                                                              |
-------------------------------------------------------------------------------
C55 TIME CONSTANT SURFACE CONC ON WEST CONC BOUNDARIES                        |
C                                                                            |
      SAL:  ULTIMATE INFLOWING SURFAC LAYER SALINITY                         |
      TEM:  ULTIMATE INFLOWING SURFAC LAYER TEMPERATURE                      |
      DYE:  ULTIMATE INFLOWING SURFAC LAYER DYE CONCENTRATION                |
      SFL:  ULTIMATE INFLOWING SURFAC LAYER SHELLFISH LARVAE CONCENTRAION    |
      TOX:  NTOX ULTIMATE INFLOWING SURFAC LAYER TOXIC CONTAMINANT           |
            CONCENTRATIONS NTOX VALUES TOX(N), N=1,NTOX                      |
C                                                                            |
C55 SAL   TEM   DYE   SFL    TOX1                                            |
-------------------------------------------------------------------------------
C56 TIME CONSTANT SURFACE CONC ON WEST CONC BOUNDARIES                        |
C                                                                            |
      SED:  NSED ULTIMATE INFLOWING SURFAC LAYER COHESIVE SEDIMENT           |
            CONCENTRAIONS  FIRST NSED VALUES SED(N), N=1,NSND                |
      SND:  NSND ULTIMATE INFLOWING SURFAC LAYER NONCOHESIVE SEDIMENT        |
            CONCENTRATIONS LAST NSND VALUES SND(N), N=1,NSND                 |
C                                                                            |
C56  SED1  SND1                                                              |
-------------------------------------------------------------------------------
C57 LOCATION OF CONC BC'S ON EAST BOUNDARIES AND SERIES IDENTIFIERS           |
C                                                                            |
      ICBE:    I CELL INDEX                                                  |
      JCBE:    J CELL INDEX                                                  |
      NTSCRE:  NUMBER OF TIME STEPS TO RECOVER SPECIFIED VALUES ON CHANGE    |
               TO INFLOW FROM OUTFLOW                                        |
```

```
      NSSERE:  EAST BOUNDARY CELL SALINITY TIME SERIES ID NUMBER                |
      NTSERE:  EAST BOUNDARY CELL TEMPERATURE TIME SERIES ID NUMBER             |
      NDSERE:  EAST BOUNDARY CELL DYE CONC TIME SERIES ID NUMBER                |
      NSFSERE: EAST BOUNDARY CELL SHELLFISH LARVAE TIME SERIES ID NUMBER        |
      NTXSERE: EAST BOUNDARY CELL TOXIC CONTAMINANT CONC TIME SERIES ID NUM.    |
      NSDSERE: EAST BOUNDARY CELL COHESIVE SED CONC TIME SERIES ID NUMBER       |
      NSNSERE: EAST BOUNDARY CELL NONCOHESIVE SED CONC TIME SERIES ID NUMBER    |
C                                                                               |
C57 IBBE  JBBE  NTSCRE NSSERE NTSERE NDSERE NSFSERE NTXSERE NSDSERE NSNSERE     |
     119   10   24     1      1      0      0        0       0       0
     119   11   24     1      1      0      0        0       0       0
     119   12   24     1      1      0      0        0       0       0
     119   13   24     1      1      0      0        0       0       0
-------------------------------------------------------------------------------
C58 TIME CONSTANT BOTTOM CONC ON EAST CONC BOUNDARIES                           |
C                                                                               |
      SAL:  ULTIMATE INFLOWING BOTTOM LAYER SALINITY                            |
      TEM:  ULTIMATE INFLOWING BOTTOM LAYER TEMPERATURE                         |
      DYE:  ULTIMATE INFLOWING BOTTOM LAYER DYE CONCENTRATION                   |
      SFL:  ULTIMATE INFLOWING BOTTOM LAYER SHELLFISH LARVAE CONCENTRAION       |
      TOX:  NTOX ULTIMATE INFLOWING BOTTOM LAYER TOXIC CONTAMINANT              |
            CONCENTRATIONS NTOX VALUES TOX(N), N=1,NTOX                         |
C                                                                               |
C58 SAL   TEM   DYE   SFL    TOX1                                              |
     0.    0.   0.    0.     0.
     0.    0.   0.    0.     0.
     0.    0.   0.    0.     0.
     0.    0.   0.    0.     0.
-------------------------------------------------------------------------------
C59 TIME CONSTANT BOTTOM CONC ON EAST CONC BOUNDARIES                           |
C                                                                               |
      SED:  NSED ULTIMATE INFLOWING BOTTOM LAYER COHESIVE SEDIMENT              |
            CONCENTRAIONS  FIRST NSED VALUES SED(N), N=1,NSND                   |
      SND:  NSND ULTIMATE INFLOWING BOTTOM LAYER NONCOHESIVE SEDIMENT           |
            CONCENTRATIONS LAST NSND VALUES SND(N), N=1,NSND                    |
C                                                                               |
C59  SED1  SND1                                                                 |
     0.    0.     0.
     0.    0.     0.
     0.    0.     0.
     0.    0.     0.
-------------------------------------------------------------------------------
C60 TIME CONSTANT SURFACE CONC ON EAST CONC BOUNDARIES                          |
C                                                                               |
      SAL:  ULTIMATE INFLOWING SURFAC LAYER SALINITY                            |
      TEM:  ULTIMATE INFLOWING SURFAC LAYER TEMPERATURE                         |
      DYE:  ULTIMATE INFLOWING SURFAC LAYER DYE CONCENTRATION                   |
      SFL:  ULTIMATE INFLOWING SURFAC LAYER SHELLFISH LARVAE CONCENTRAION       |
      TOX:  NTOX ULTIMATE INFLOWING SURFAC LAYER TOXIC CONTAMINANT              |
            CONCENTRATIONS NTOX VALUES TOX(N), N=1,NTOX                         |
C                                                                               |
C60 SAL   TEM   DYE   SFL    TOX1                                              |
     0.    0.   0.    0.     0.
     0.    0.   0.    0.     0.
     0.    0.   0.    0.     0.
     0.    0.   0.    0.     0.
-------------------------------------------------------------------------------
```

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C61 TIME CONSTANT SURFACE CONC ON EAST CONC BOUNDARIES                          |
C                                                                               |
      SED:  NSED ULTIMATE INFLOWING SURFAC LAYER COHESIVE SEDIMENT              |
            CONCENTRAIONS  FIRST NSED VALUES SED(N), N=1,NSND                   |
      SND:  NSND ULTIMATE INFLOWING SURFAC LAYER NONCOHESIVE SEDIMENT           |
            CONCENTRATIONS LAST NSND VALUES SND(N), N=1,NSND                    |
C                                                                               |
C61  SED1  SND1                                                                 |
     0.    0.     0.
     0.    0.     0.
     0.    0.     0.
     0.    0.     0.
--------------------------------------------------------------------------------
C62 LOCATION OF CONC BC'S ON NORTH BOUNDARIES AND SERIES IDENTIFIERS            |
C                                                                               |
      ICBN:    I CELL INDEX                                                     |
      JCBN:    J CELL INDEX                                                     |
      NTSCRN:  NUMBER OF TIME STEPS TO RECOVER SPECIFIED VALUES ON CHANGE       |
               TO INFLOW FROM OUTFLOW                                           |
      NSSERN:  NORTH BOUNDARY CELL SALINITY TIME SERIES ID NUMBER               |
      NTSERN:  NORTH BOUNDARY CELL TEMPERATURE TIME SERIES ID NUMBER            |
      NDSERN:  NORTH BOUNDARY CELL DYE CONC TIME SERIES ID NUMBER               |
      NSFSERN: NORTH BOUNDARY CELL SHELLFISH LARVAE TIME SERIES ID NUMBER       |
      NTXSERN: NORTH BOUNDARY CELL TOXIC CONTAMINANT CONC TIME SERIES ID NUM.   |
      NSDSERN: NORTH BOUNDARY CELL COHESIVE SED CONC TIME SERIES ID NUMBER      |
      NSNSERN: NORTH BOUNDARY CELL NONCOHESIVE SED CONC TIME SERIES ID NUMBER   |
C                                                                               |
C62 IBBN  JBBN  NTSCRN NSSERN NTSERN NDSERN NSFSERN NTXSERN NSDSERN NSNSERN     |
--------------------------------------------------------------------------------
C63 TIME CONSTANT BOTTOM CONC ON NORTH CONC BOUNDARIES                          |
C                                                                               |
      SAL:  ULTIMATE INFLOWING BOTTOM LAYER SALINITY                            |
      TEM:  ULTIMATE INFLOWING BOTTOM LAYER TEMPERATURE                         |
      DYE:  ULTIMATE INFLOWING BOTTOM LAYER DYE CONCENTRATION                   |
      SFL:  ULTIMATE INFLOWING BOTTOM LAYER SHELLFISH LARVAE CONCENTRAION       |
      TOX:  NTOX ULTIMATE INFLOWING BOTTOM LAYER TOXIC CONTAMINANT              |
            CONCENTRATIONS NTOX VALUES TOX(N), N=1,NTOX                         |
C                                                                               |
C63 SAL  TEM  DYE SFL TOX1-20                                                   |
--------------------------------------------------------------------------------
C64 TIME CONSTANT BOTTOM CONC ON NORTH CONC BOUNDARIES                          |
C                                                                               |
      SED:  NSED ULTIMATE INFLOWING BOTTOM LAYER COHESIVE SEDIMENT              |
            CONCENTRAIONS  FIRST NSED VALUES SED(N), N=1,NSND                   |
      SND:  NSND ULTIMATE INFLOWING BOTTOM LAYER NONCOHESIVE SEDIMENT           |
            CONCENTRATIONS LAST NSND VALUES SND(N), N=1,NSND                    |
C                                                                               |
C64  SED1  SED2  SND1  SND2  SND3                                               |
--------------------------------------------------------------------------------
C65 TIME CONSTANT SURFACE CONC ON NORTH CONC BOUNDARIES                         |
C                                                                               |
      SAL:  ULTIMATE INFLOWING SURFAC LAYER SALINITY                            |
      TEM:  ULTIMATE INFLOWING SURFAC LAYER TEMPERATURE                         |
      DYE:  ULTIMATE INFLOWING SURFAC LAYER DYE CONCENTRATION                   |
      SFL:  ULTIMATE INFLOWING SURFAC LAYER SHELLFISH LARVAE CONCENTRAION       |
      TOX:  NTOX ULTIMATE INFLOWING SURFAC LAYER TOXIC CONTAMINANT              |
            CONCENTRATIONS NTOX VALUES TOX(N), N=1,NTOX                         |
```

```
C                                                                          |
C65 SAL  TEM  DYE SFL TOX1-20                                              |
-------------------------------------------------------------------------------
C66 TIME CONSTANT SURFACE CONC ON NORTH CONC BOUNDARIES                    |
C                                                                          |
      SED:  NSED ULTIMATE INFLOWING SURFAC LAYER COHESIVE SEDIMENT         |
            CONCENTRAIONS  FIRST NSED VALUES SED(N), N=1,NSND              |
      SND:  NSND ULTIMATE INFLOWING SURFAC LAYER NONCOHESIVE SEDIMENT      |
            CONCENTRATIONS LAST NSND VALUES SND(N), N=1,NSND               |
C                                                                          |
C66  SED1  SED2  SND1  SND2  SND3                                          |
-------------------------------------------------------------------------------
C66a CONCENTRATION DATA ASSIMILATION                                       |
C                                                                          |
      NLCDA:  NUMBER OF HORIZONTAL LOCATIONS FOR DATA ASSIMILATION         |
      TSCDA:  WEIGHTING FACTOR, 0.-1., 1. = FULL ASSIMILATION              |
      ISCDA:  1 FOR CONCENTRATION DATA ASSIMILATION (NC=1.7 VALUES)        |
C                                                                          |
C66A  NLCDA  TSCDA   ISCDA                                                 |
       0      0.5      0    0    0    0    0     0     0
-------------------------------------------------------------------------------
C66B CONCENTRATION DATA ASSIMILATION                                       |
C                                                                          |
      ICDA:  1 FOR CONCENTRATION DATA ASSIMILATION                         |
      JCDA:  NUMBER OF HORIZONTAL LOCATIONS FOR DATA ASSIMILATION          |
      NS:    WEIGHTING FACTOR, 0.-1., 1. = FULL ASSIMILATION               |
C                                                                          |
C66B  ICDA  JCDA   NS  NT  ND  NSF  NTX  NSD  NSN                          |
-------------------------------------------------------------------------------
C67 DRIFTER DATA (FIRST 4 PARAMETER FOR SUB DRIFER, SECOND 6 FOR SUB LAGRES) |
C                                                                          |
      ISPD:   1 TO ACTIVE SIMULTANEOUS RELEASE AND LAGRANGIAN TRANSPORT OF |
                NEUTRALLY BUOYANT PARTICLE DRIFTERS AT LOCATIONS INPUT ON C44 |
      NPD:      NUMBER OF PARTICLE DIRIFERS                                |
      NPDRT:    TIME STEP AT WHICH PARTICLES ARE RELEASED                  |
      NWPD:     NUMBER OF TIME STEPS BETWEEN WRITING TO TRACKING FILE      |
                drifter.out                                                |
      ISLRPD: 1 TO ACTIVATE CALCULATION OF LAGRANGIAN MEAN VELOCITY OVER TIME |
                INTERVAL TREF AND SPATIAL INTERVAL ILRPD1<I<ILRPD2,        |
                JLRPD1<J<JLRPD2, 1<K<KC, WITH MLRPDRT RELEASES.  ANY AVERGE |
                OVER ALL RELEASE TIMES IS ALSO CALCULATED                  |
              2 SAME BUT USES A HIGER ORDER TRAJECTORY INTEGRATION         |
      ILRPD1    WEST BOUNDARY OF REGION                                    |
      ILRPD2    EAST BOUNDARY OF REGION                                    |
      JLRPD1    NORTH BOUNDARY OF REGION                                   |
      JLRPD2    SOUTH BOUNDARY OF REGION                                   |
      MLRPDRT   NUMBER OF RELEASE TIMES                                    |
      IPLRPD    1,2,3 WRITE FILES TO PLOT ALL,EVEN,ODD HORIZ LAG VEL VECTORS |
C                                                                          |
C67 ISPD NPD NPDRT NWPD ISLRPD ILRPD1 ILRPD2 JLRPD1  JLRPD2  MLRPDRT IPLRPD |
    0     0   0    12    0     6      19     11      19      11     1
-------------------------------------------------------------------------------
C68 INITIAL DRIFTER POSITIONS (FOR USE WITH SUB DRIFTER)                   |
C                                                                          |
      RI:  I CELL INDEX IN WHICH PARTICLE IS RELEASED IN                   |
      RJ:  J CELL INDEX IN WHICH PARTICLE IS RELEASED IN                   |
      RK:  K CELL INDEX IN WHICH PARTICLE IS RELEASED IN                   |
```

```
C                                                                                |
C68   RI   RJ   RK                                                               |
---------------------------------------------------------------------------------
C69 CONSTANTS FOR CARTESION GRID CELL CENTER LONGITUDE AND LATITUDE              |
C                                                                                |
      CDLON1:  6 CONSTANTS TO GIVE CELL CENTER LAT AND LON OR OTHER              |
      CDLON2:    COORDINATES FOR CARTESIAN GRIDS USING THE FORMULAS              |
      CDLON3:    DLON(L)=CDLON1+(CDLON2*FLOAT(I)+CDLON3)/60.                     |
      CDLAT1:    DLAT(L)=CDLAT1+(CDLAT2*FLOAT(J)+CDLAT3)/60.                     |
      CDLAT2:                                                                    |
      CDLAT3:                                                                    |
C                                                                                |
C69 CDLON1  CDLON2   CDLON3   CDLAT1  CDLAT2   CDLAT3                            |
      0.0   0.0      0.0      0.0     0.0      0.0
---------------------------------------------------------------------------------
C70 CONTROLS FOR WRITING ASCII OR BINARY DUMP FILES                              |
C                                                                                |
    ISDUMP: GREATER THAN 0 TO ACTIVATE                                           |
            1 SCALED ASCII INTERGER (0<VAL<65535)                                |
            2 SCALED 16BIT BINARY INTEGER (0<VAL<65535) OR (-32768<VAL<32767)    |
            3 UNSCALED ASCII FLOATING POINT                                      |
            4 UNSCALED BINARY FLOATING POINT                                     |
    ISADMP: GREATER THAN 0 TO APPEND EXISTING DUMP FILES                         |
    NSDUMP: NUMBER OF TIME STEPS BETWEEN DUMPS                                   |
    TSDUMP: STARTING TIME FOR DUMPS (NO DUMPS BEFORE THIS TIME)                   |
    TEDUMP: ENDING TIME FOR DUMPS (NO DUMPS AFTER THIS TIME)                      |
    ISDMPP: GREATER THAN 0 FOR WATER SURFACE ELEVATION DUMP                      |
    ISDMPU: GREATER THAN 0 FOR HORIZONTAL VELOCITY DUMP                          |
    ISDMPW: GREATER THAN 0 FOR VERTICAL VELOCITY DUMP                            |
    ISDMPT: GREATER THAN 0 FOR TRANSPORTED VARIABLE DUMPS                        |
   IADJDMP: 0 FOR SCALED BINARY INTEGERS (0<VAL<65535)                           |
            -32768 FOR SCALED BINARY INTEGERS (-32768<VAL<32767)                 |
C                                                                                |
C70 ISDUMP ISADMP NSDUMP TSDUMP TEDUMP ISDMPP ISDMPU ISDMPW ISDMPT IADJDMP        |
    0      0      288    0.     45.    0       0      0      1      -32768
---------------------------------------------------------------------------------
C71 CONTROLS FOR HORIZONTAL PLANE SCALAR FIELD CONTOURING                        |
C                                                                                |
      ISSPH:  1 TO WRITE FILE FOR SCALAR FIELD CONTOURING IN HORIZONTAL PLANE    |
      NPSPH:    NUMBER OF WRITES PER REFERENCE TIME PERIOD                       |
      ISRSPH: 1 TO WRITE FILE FOR RESIDUAL SALINITY PLOTTING IN                  |
                HORIZONTAL                                                       |
      ISPHXY: 0 DOES NOT WRITE I,J,X,Y IN ***cnh.out and r***cnh.out FILES       |
              1 WRITES I,J ONLY IN ***cnh.out and r***cnh.out FILES              |
              2 WRITES I,J,X,Y  IN ***cnh.out and r***cnh.out FILES              |
      DATA LINE REPEATS 7 TIMES FOR SAL,TEM,DYE,SFL,TOX,SED,SND                  |
C                                                                                |
C71 ISSPH   NPSPH   ISRSPH   ISPHXY                                              |
    0        1      0          1      !SAL
    0        1      0          1      !TEM
    1       96      0          1      !DYE
    0       24      0          1      !SFL
    0       24      0          1      !TOX
    0       24      0          1      !SED
    0       24      0          1      !SND
```

```
----------------------------------------------------------------------------------
C72 CONTROLS FOR HORIZONTAL SURFACE ELEVATION OR PRESSURE CONTOURING               |
C                                                                                  |
      ISPPH:  1 TO WRITE FILE FOR SURFACE ELEVATION OR PRESSURE CONTOURING         |
                IN HORIZONTAL PLANE                                                |
      NPPPH:    NUMBER OF WRITES PER REFERENCE TIME PERIOD                         |
      ISRPPH: 1 TO WRITE FILE FOR RESIDUAL SURFACE ELEVATION  CONTOURNG IN         |
                HORIZONTAL PLANE                                                   |
C                                                                                  |
C72 ISPPH   NPPPH   ISRPPH                                                         |
    0       6       0
----------------------------------------------------------------------------------
C73 CONTROLS FOR HORIZONTAL PLANE VELOCITY VECTOR PLOTTING                         |
C                                                                                  |
      ISVPH:  1 TO WRITE FILE FOR VELOCITY PLOTTING IN HORIZONTAL PLANE            |
      NPVPH:    NUMBER OF WRITES PER REFERENCE TIME PERIOD                         |
      ISRVPH: 1 TO WRITE FILE FOR RESIDUAL VELOCITY PLOTTIN IN                     |
                HORIZONTAL PLANE                                                   |
C                                                                                  |
C73 ISVPH   NPVPH   ISRVPH                                                         |
    1       96      0
----------------------------------------------------------------------------------
C74 CONTROLS FOR VERTICAL PLANE SCALAR FIELD CONTOURING                            |
C                                                                                  |
      ISECSPV:  N AN INTEGER NUMBER OF VERTICAL SECTIONS (N.LE.9) TO WRITE         |
                  N FILES FOR SCALAR  FIELD CONTOURING                             |
      NPSPV:      NUMBER OF WRITES PER REFERENCE TIME PERIOD                       |
      ISSPV:    1 TO ACTIVATE INSTANTANEOUS SCALAR FIELDS                          |
      ISRSPV:   1 TO ACTIVATE FOR RESIDUAL SCALAR FIELDS                           |
      ISHPLTV:  1 FOR VERTICAL PLANE PLOTTING FOR MSL DATUMS, ZERO OTHERWISE       |
      DATA LINE REPEATS 7 TIMES FOR SAL,TEM,DYE,SFL,TOX,SED,SND                    |
      ISECSPV IS DETERMINED FOR ALL 7 VARIABLES BY VALUE ON FIRST DATA LINE        |
C                                                                                  |
C74 ISECSPV   NPSPV  ISSPV  ISRSPV  ISHPLTV                                        |
    0          6      0      0       1          !SAL
    0          6      0      0       1          !TEM
    0          6      0      0       1          !DYE
    0          6      0      0       1          !SFL
    0          6      0      0       1          !TOX
    0          6      0      0       1          !SED
    0          6      0      0       1          !SND
----------------------------------------------------------------------------------
C75 MORE CONTROLS FOR VERTICAL PLANE SCALAR FIELD CONTOURING                       |
C                                                                                  |
      ISECSPV:  SECTION NUMBER                                                     |
      NIJSPV:   NUMBER OF CELLS OR I,J PAIRS IN SECTION                            |
      SEC ID:   CHARACTER FORMAT SECTION TITLE                                     |
C                                                                                  |
C75 ISECSPV NIJSPV  SEC ID                                                         |
----------------------------------------------------------------------------------
C76 I,J LOCATIONS FOR VERTICAL PLANE SCALAR FIELD CONTOURING                       |
C                                                                                  |
      ISECSPV: SECTION NUMBER                                                      |
      ISPV:    I CELL                                                              |
      JSPV:    J CELL                                                              |
C                                                                                  |
C76 ISECSPV ISPV    JSPV                                                           |
```

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-------------------------------------------------------------------------------
C77 CONTROLS FOR VERTICAL PLANE VELOCITY VECTOR PLOTTING                       |
C                                                                              |
      ISECVPV:  N AN INTEGER NUMBER (N.LE.9) OF VERTICAL SECTIONS              |
                  TO WRITE N FILES FOR VELOCITY PLOTTING                       |
      NPVPV:      NUMBER OF WRITES PER REFERENCE TIME PERIOD                   |
      ISVPV:    1 TO ACTIVATE INSTANTANEOUS VELOCITY                           |
      ISRSPV:   1 TO ACTIVATE FOR RESIDUAL VELOCITY                            |
C                                                                              |
C77 ISECVPV   NPVPV  ISVPV  ISRSPV                                             |
    0         6      0      0
-------------------------------------------------------------------------------
C78 MORE CONTROLS FOR VERTICAL PLANE VELOCITY VECTOR PLOTTING                  |
C                                                                              |
      ISCEVPV:  SECTION NUMBER                                                 |
      NIJVPV:   NUMBER IS CELLS OR I,J PAIRS IN SECTION                        |
      ANGVPV:   CCW POSITIVE ANGLE FROM EAST TO SECTION NORMAL                 |
      SEC ID:   CHARACTER FORMAT SECTION TITLE                                 |
C                                                                              |
C78 ISECVPV   NIJVPV  ANGVPV  SEC ID                                           |
-------------------------------------------------------------------------------
C79 CONTROLS FOR VERTICAL PLANE VELOCITY PLOTTING                              |
C                                                                              |
      ISECVPV:  SECTION NUMBER (REFERENCE USE HERE)                            |
      IVPV:     I CELL INDEX                                                   |
      JVPV:     J CELL INDEX                                                   |
C                                                                              |
C79 ISECVPV IVPV    JVPV                                                       |
-------------------------------------------------------------------------------
C80 CONTROLS FOR 3D FIELD OUTPUT                                               |
C                                                                              |
      IS3DO:  1 TO WRITE TO 3D ASCI INTEGER FORMAT FILES, JS3Dvar.LE.2     SEE|
              1 TO WRITE TO 3D ASCI FLOAT POINT FORMAT FILES, JS3Dvar.EQ.3 C57|
              2 TO WRITE TO 3D CHARACTER ARRAY FORMAT FILES (NOT ACTIVE)      |
              3 TO WRITE TO 3D HDF IMAGE FORMAT FILES (NOT ACTIVE)            |
              4 TO WRITE TO 3D HDF FLOATING POINT FORMAT FILES (NOT ACTIVE)   |
      ISR3DO:   SAME AS IS3DO EXCEPT FOR RESIDUAL VARIABLES                   |
      NP3DO:    NUMBER OF WRITES PER LAST REF TIME PERIOD FOR INST VARIABLES  |
      KPC:      NUMBER OF UNSTRETCHED PHYSICAL VERTICAL LAYERS                |
      NWGG:     IF NWGG IS GREATER THAN ZERO, NWGG DEFINES THE NUMBER OF !2877|
                WATER CELLS IN CARTESIAN 3D GRAPHICS GRID OVERLAY OF THE      |
                CURVILINEAR GRID. FOR NWGG>0 AND EFDC RUNS ON A CURVILINEAR   |
                GRID, I3DMI,I3DMA,J3DMI,J3DMA REFER TO CELL INDICES ON THE    |
                ON THE CARTESIAN GRAPHICS GRID OVERLAY DEFINED BY FILE        |
                gcell.inp.  THE FILE gcell.inp IS NOT USED BY EFDC, BUT BY    |
                THE COMPANION GRID GENERATION CODE GEFDC.F.  INFORMATION      |
                DEFINING THE OVERLAY IS READ BY EFDC.F FROM THE FILE          |
                gcellmp.inp. IF NWGG EQUALS 0, I3DMI,I3DMA,J3DMI,J3DMA REFER  |
                TO INDICES ON THE EFDC GRID DEFINED BY cell.inp.              |
                ACTIVATION OF THE REWRITE OPTION I3DRW=1 WRITES TO THE FULL   |
                GRID DEFINED BY cell.inp AS IF cell.inp DEFINES A CARTESIAN   |
                GRID.  IF NWGG EQ 0 AND THE EFDC COMP GRID IS CO, THE REWRITE |
                OPTION IS NOT RECOMMENDED AND A POST PROCESSOR SHOULD BE USED |
                TO TRANSFER THE SHORT FORM, I3DRW=0, OUTPUT TO AN APPROPRIATE |
                FORMAT FOR VISUALIZATION. CONTACT DEVELOPER FOR MORE DETAILS  |
      I3DMI:    MINIMUM OR BEGINNING I INDEX FOR 3D ARRAY OUTPUT              |
      I3DMA:    MAXIMUM OR ENDING I INDEX FOR 3D ARRAY OUTPUT                 |
```

```
      J3DMI:    MINIMUM OR BEGINNING J INDEX FOR 3D ARRAY OUTPUT                |
      J3DMA:    MAXIMUM OR ENDING J INDEX FOR 3D ARRAY OUTPUT                   |
      I3DRW:  0 FILES WRITTEN FOR ACTIVE CO WATER CELLS ONLY                    |
              1 REWRITE FILES TO CORRECT ORIENTATION DEFINED BY gcell.inp       |
                AND gcellmp.inp FOR CO WITH NWGG.GT.O OR BY cell.inp IF THE     |
                COMPUTATIONAL GRID IS CARTESIAN AND NWGG.EQ.0                   |
      SELVMAX:  MAXIMUM SURFACE ELEVATION FOR UNSTRETCHING (ABOVE MAX SELV )    |
      BELVMIN:  MINIMUM BOTTOM ELEVATION FOR UNSTRETCHING (BELOW MIN BELV)      |
C                                                                               |
C80 IS3DO ISR3DO NP3DO KPC NWGG I3DMI I3DMA J3DMI J3DMA I3DRW SELVMAX BELVMIN |
    0     0      0     1   0    1     120   1     70    0     15.0     -315.
-------------------------------------------------------------------------------
C81 OUTPUT ACTIVATION AND SCALES FOR 3D FIELD OUTPUT                            |
C                                                                               |
      VARIABLE:      DUMMY VARIBLE ID (DO NOT CHANGE ORDER)                     |
      IS3(VARID):  1 TO ACTIVATE THIS VARIBLES                                  |
      JS3(VARID):  0 FOR NO SCALING OF THIS VARIABLE                            |
                   1 FOR AUTO SCALING OF THIS VARIABLE OVER RANGE 0<VAL<255     |
                     AUTO SCALES FOR EACH FRAME OUTPUT IN FILES out3d.dia AND   |
                     rout3d.dia  OUTPUT IN I4 FORMAT                            |
                   2 FOR SCALING SPECIFIED IN NEXT TWO COLUMNS WITH OUTPUT      |
                     DEFINED OVER RANGE  0<VAL<255 AND WRITTEN IN I4 FORMAT     |
                   3 FOR MULTIPLIER SCALING BY MAX SCALE VALUE WITH OUTPUT      |
                     WRITTEN IN F7.1 FORMAT (IS3DO AND ISR3DO MUST BE 1)        |
C                                                                               |
C81 VARIABLE    IS3D(VARID)  JS3D(VARID)   MAX SCALE VALUE  MIN SCALE VALUE    |
    'U VEL'     1            3               100.0            -1.0
    'V VEL'     1            3               100.0            -1.0
    'W VEL'     0            0              1000.0         -1.0E-3
    'SALINITY'  1            3                 1.0             0.0
    'TEMP'      1            3                 1.0            10.0
    'DYE'       0            0              1000.0             0.0
    'COH SED'   1            3              1000.0             0.0
    'NCH SED'   1            3              1000.0             0.0
    'TOX CON'   1            3              1000.0             0.0
-------------------------------------------------------------------------------
C82 INPLACE HARMONIC ANALYSIS PARAMETERS                                        |
C                                                                               |
      ISLSHA:  1 FOR IN PLACE LEAST SQUARES HARMONIC ANALYSIS                   |
      MLLSHA:  NUMBER OF LOCATIONS FOR LSHA                                     |
      NTCLSHA: LENGTH OF LSHA IN INTEGER NUMBER OF REFERENCE TIME PERIODS       |
      ISLSTR:  1 FOR TREND REMOVAL                                              |
      ISHTA :  1 FOR SINGLE TREF PERIOD SURFACE ELEV ANALYSIS                   |
C                    90                                                         |
C82 ISLSHA  MLLSHA   NTCLSHA  ISLSTR  ISHTA                                     |
    1       2        29       0       0
-------------------------------------------------------------------------------
C83 HARMONIC ANALYSIS LOCATIONS AND SWITCHES                                    |
C                                                                               |
      ILLSHA:   I CELL INDEX                                                    |
      JLLSHA:   J CELL INDEX                                                    |
      LSHAP:  1 FOR ANALYSIS OF SURFACE ELEVATION                               |
      LSHAB:  1 FOR ANALYSIS OF SALINITY                                        |
      LSHAUE: 1 FOR ANALYSIS OF EXTERNAL MODE HORIZONTAL VELOCITY               |
      LSHAU:  1 FOR ANALYSIS OF HORIZONTAL VELOCITY IN EVERY LAYER              |
      CLSL:     LOCATION AS A CHARACTER VARIALBLE                               |
C                                                                               |
```

```
C83 ILLSHA   JLLSHA   LSHAP  LSHAB  LSHAUE LSHAU  CLSL                          |
       8      6       1      0      0      0     'Flupsy      '   ! 1
     108     11       1      0      0      0     'SHE5        '   ! 2
-------------------------------------------------------------------------------
C84 CONTROLS FOR WRITING TO TIME SERIES FILES                                   |
C                                                                               |
      ISTMSR:  1 OR 2 TO WRITE TIME SERIES OF SURF ELEV, VELOCITY, NET          |
               INTERNAL AND EXTERNAL MODE VOLUME SOURCE-SINKS, AND              |
               CONCENTRATION VARIABLES,  2 APPENDS EXISTING TIME SERIES FILES   |
      MLTMSR:  NUMBER HORIZONTAL LOCATIONS TO WRITE TIME SERIES OF SURF ELEV,   |
               VELOCITY, AND CONCENTRATION VARIABLES,  MAXIMUM LOCATIONS = 9    |
      NBTMSR:  TIME STEP TO BEGIN WRITING TO TIME SERIES FILES                  |
      NSTMSR:  TIME STEP TO STOP WRITING TO TIME SERIES FILES                   |
      NWTSER:  WRITE INTERVAL FOR WRITING TO TIME SERIES FILES                  |
     NTSSTSP:  NUMBER OF TIME SERIES START-STOP SCENARIOS,  1 OR GREATER        |
      TCTMSR:  UNIT CONVERSION FOR TIME SERIES TIME.  FOR SECONDS, MINUTES,     |
               HOURS,DAYS USE 1.0, 60.0, 3600.0, 86400.0 RESPECTIVELY           |
        IDUM:  2 DUMMY INTEGER VARIABLES REQUIRED, BOTH = 0                     |
C           13                      1728                                        |
C84 ISTMSR  MLTMSR  NBTMSR  NSTMSR  NWTMSR  NTSSTSP  TCTMSR   IDUM  IDUM         |
    1       28      1      2000000   90     1        86400.   0     0
-------------------------------------------------------------------------------
C85 CONTROLS FOR WRITING TO TIME SERIES FILES                                   |
C                                                                               |
     ITSSS:    START-STOP SCENARIO NUMBER 1.GE.ISSS.LE.NTSSTSP                  |
   MTSSTSP:    NUMBER OF STOP-START PAIRS FOR SCENARIO ISSS                     |
C                                                                               |
C85 ITSSS  MTSSTSP                                                              |
      1      1    !FULL SAVE
-------------------------------------------------------------------------------
C86 CONTROLS FOR WRITING TO TIME SERIES FILES                                   |
C                                                                               |
     ITSSS:    START-STOP SCENARIO NUMBER 1.GE.ISSS.LE.NTSSTSP                  |
     MTSSS:    NUMBER OF STOP-START PAIRS FOR SCENARIO ISSS                     |
    TSSTRT:    STARTING TIME FOR SCENARIO ITSSS, SAVE INTERVAL MTSSS            |
    TSSTOP:    STOPING TIME FOR SCENARIO ITSSS, SAVE INTERVAL MTSSS             |
C                   -1000.                                                      |
C86 ISSS   MTSSS    TSSTRT    TSSTOP     USER COMMENT                           |
      1      1      -1000.    10000.     ! FULL SAVE
-------------------------------------------------------------------------------
C87 CONTROLS FOR WRITING TO TIME SERIES FILES                                   |
C                                                                               |
      ILTS:    I CELL INDEX                                                     |
      JLTS:    J CELL INDEX                                                     |
    NTSSSS:    WRITE SCENARIO FOR THIS LOCATION                                 |
      MTSP:  1 FOR TIME SERIES OF SURFACE ELEVATION                             |
      MTSC:  1 FOR TIME SERIES OF TRANSPORTED CONCENTRATION VARIABLES           |
      MTSA:  1 FOR TIME SERIES OF EDDY VISCOSITY AND DIFFUSIVITY                |
      MTSUE: 1 FOR TIME SERIES OF EXTERNAL MODE HORIZONTAL VELOCITY             |
      MTSUT: 1 FOR TIME SERIES OF EXTERNAL MODE HORIZONTAL TRANSPORT            |
      MTSU:  1 FOR TIME SERIES OF HORIZONTAL VELOCITY IN EVERY LAYER            |
      MTSQE: 1 FOR TIME SERIES OF NET EXTERNAL MODE VOLUME SOURCE/SINK          |
      MTSQ:  1 FOR TIME SERIES OF NET EXTERNAL MODE VOLUME SOURCE/SINK          |
      CLTS:    LOCATION AS A CHARACTER VARIALBLE                                |
C                                                                               |
C87 ILTS JLTS NTSSSS MTSP MTSC MTSA MTSUE MTSUT MTSU MTSQE MTSQ  CLTS            |
    108  11    1     1    1    0     0     0    0    0     0    'She5   '        1
```

```
      58  13    1     1    1    0     0     0    0    0     0    'HSLNor1'        2
      58  12    1     1    1    0     0     0    0    0     0    'HSL2   '        3
      58  11    1     1    1    0     0     0    0    0     0    'HSL3   '        4
      58  10    1     1    1    0     0     0    0    0     0    'HSLSou4'        5
      83  11    1     1    1    0     0     0    0    0     0    'She4I3 '        6
      33  11    1     1    1    0     0     0    0    0     0    'She3   '        7
      19  11    1     1    1    1     1     1    1    1     1    'Outfall'        8
      14  14    1     1    1    0     0     0    0    0     0    'She2   '        9
       8   6    1     1    1    0     0     0    0    0     0    'Flupsy '       10
       8  16    1     1    1    0     0     0    0    0     0    'OSLWest'       11
       9  16    1     1    1    0     0     0    0    0     0    'ISCO2  '       12
      10  16    1     1    1    0     0     0    0    0     0    'OSL3   '       13
      11  16    1     1    1    0     0     0    0    0     0    'OSL4   '       14
      12  16    1     1    1    0     0     0    0    0     0    'OSL5   '       15
      13  16    1     1    1    0     0     0    0    0     0    'OSL6   '       16
      14  16    1     1    1    0     0     0    0    0     0    'OSL7   '       17
      15  16    1     1    1    0     0     0    0    0     0    'OSL8   '       18
      16  16    1     1    1    0     0     0    0    0     0    'OSL9   '       19
      17  16    1     1    1    0     0     0    0    0     0    'OSLEast'       20
      12  27    1     1    1    0     0     0    0    0     0    'She1   '       21
      15  34    1     1    1    0     0     0    0    0     0    'She6   '       22
      10  35    1     1    1    0     0     0    0    0     0    'ISCO1  '       23
      12  27    1     1    1    0     0     0    0    0     0    'She7   '       24
     119  13    1     1    1    0     0     0    0    0     0    'BLNorth'       25
     119  12    1     1    1    0     0     0    0    0     0    'BL12   '       26
     119  11    1     1    1    0     0     0    0    0     0    'BL11   '       27
     119  10    1     1    1    0     0     0    0    0     0    'BLSouth'       28
-------------------------------------------------------------------------------
C88 CONTROLS FOR EXTRACTING INSTANTANEOUS VERTICAL SCALAR FIELD PROFILES       |
C                                                                             |
      ISVSFP: 1 FOR EXTRACTING INSTANTANEOUS VERTICAL FIELD PROFILES          |
      MDVSFP:   MAXIMUM NUMBER OF DEPTHS FOR SAMPLING VALUES                  |
      MLVSFP:   NUMBER OF HORIZONTAL SPACE-TIME LOCATION PAIRS TO BE SAMPLED  |
      TMVSFP:   MULTIPLIER TO CONVERT SAMPLING TIMES TO SECONDS               |
      TAVSFP:   ADDITIVE ADJUSTMENT TO SAMPLING TIME BEFORE CONVERSION TO SEC |
C          200max   1600max                                                   |
C88 ISVSFP  MDVSFP  MLVSFP  TMVSFP  TAVSFP                                     |
      0       0     0       86400.  0.0
-------------------------------------------------------------------------------
C89 SAMPLING DEPTHS FOR EXTRACTING INST VERTICAL SCALAR FIELD PROFILES        |
C                                                                             |
      MMDVSFP:  Mth SAMPLING DEPTH                                            |
      DMSFP:    SAMPLING DEPTH BELOW SURFACE, IN METERS                       |
C                                                                             |
C89 MMDVSFP  DMVSFP                                                           |
-------------------------------------------------------------------------------
C90 HORIZONTAL SPACE-TIME LOCATIONS FOR SAMPLING                               |
C                                                                             |
      MMLVSFP:  Mth SPACE TIME SAMPLING LOCATION                              I
      TIMVSFP:  SAMPLING TIME                                                 |
      IVSFP:    I HORIZONTAL LOCATON INDEX                                    |
      JVSFP:    J HORIZONTAL LOCATON INDEX                                    |
C                                                                             |
C90 MMLVSFP  TIMVSFP  IVSFP  JVSFP                                            |
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Appendix B

Computational plane
for Oakland Bay system (CELL.INP)

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C cell.inp file, i columns and j rows, for Oakland Bay, WA
C         1         2         3         4         5         6         7         8         9        10        11        12
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C
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 3 000000955555555555900000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
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 1 000000999999999999900000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000
C cell.inp file, i columns and j rows, for Oakland Bay, WA
C          1         2         3         4         5         6         7         8         9        10        11        12
C   123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890
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Appendix C

Model run output

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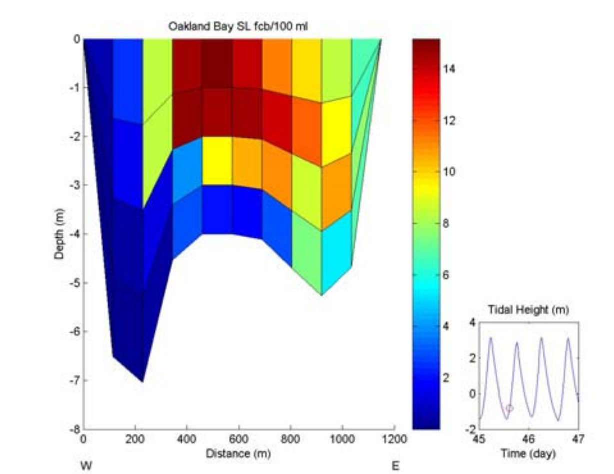
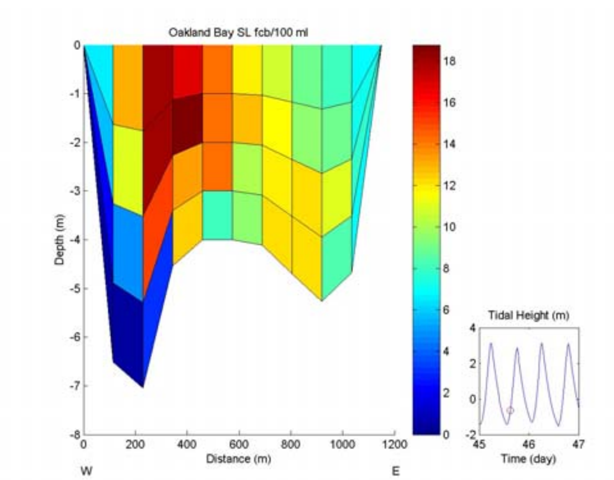
Tabular and select graphic output from all time-steps at which an exceedance occurred on the *Oakland Bay* sanitary line:

Run3: 4.0 mgd for 13 hours; ebb then flood with diffuser:



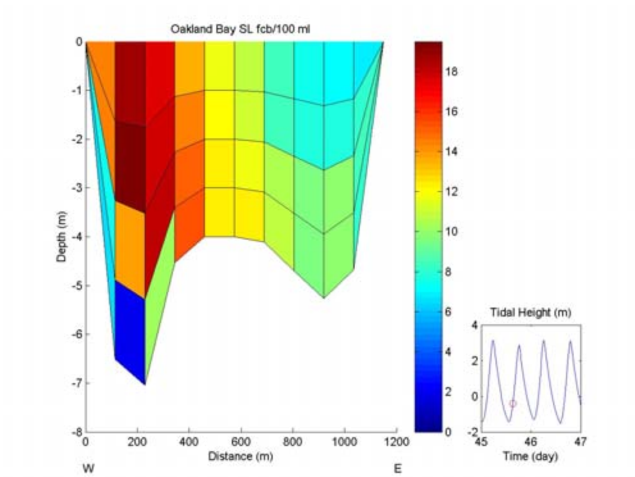
time(2159) = 45.614580

0.52	2.40	8.41	14.66	15.17	14.10	11.34	9.78	8.47	6.77
0.28	1.65	8.34	14.77	14.48	14.49	13.94	11.62	9.42	6.52
0.08	0.33	1.31	3.86	9.28	10.64	10.96	8.66	10.73	7.68
0.05	0.07	0.46	3.06	2.04	1.81	3.07	7.38	5.23	6.87



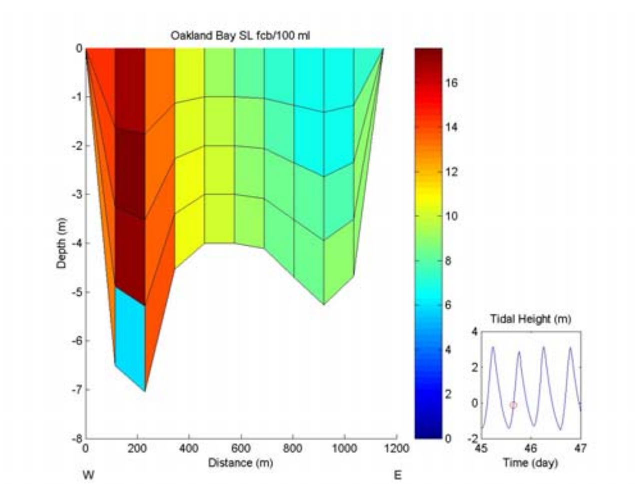
time(2160) = 45.625000 (3:00PM)

6.72	13.17	18.11	16.96	14.18	11.88	10.58	8.97	8.00	7.01
5.86	10.90	17.96	18.77	14.31	12.81	11.61	9.68	8.93	7.18
2.28	4.95	15.11	13.23	14.27	10.14	12.00	12.17	10.89	7.73
0.45	0.39	3.07	12.61	7.95	9.46	12.19	12.05	8.39	6.85



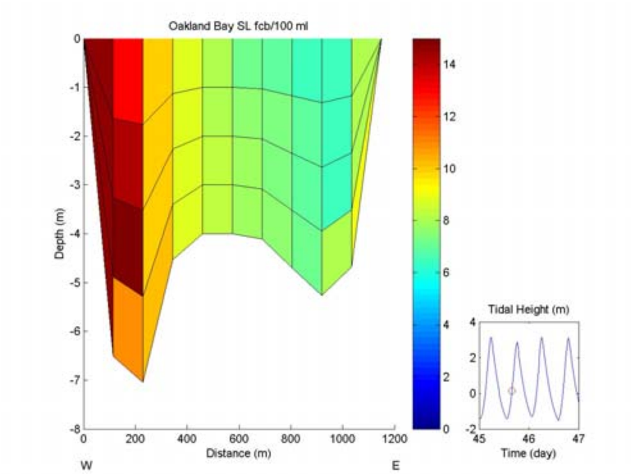
time(2161) =   45.635420

14.41	18.75	17.56	13.64	11.73	10.68	8.31	7.46	7.02	6.89
14.59	19.49	17.94	14.59	11.95	11.19	8.36	7.90	7.73	8.01
7.33	13.81	17.98	14.94	12.22	11.84	10.53	9.48	9.96	8.43
6.66	1.99	10.26	15.27	12.37	12.25	10.82	9.65	10.01	8.03



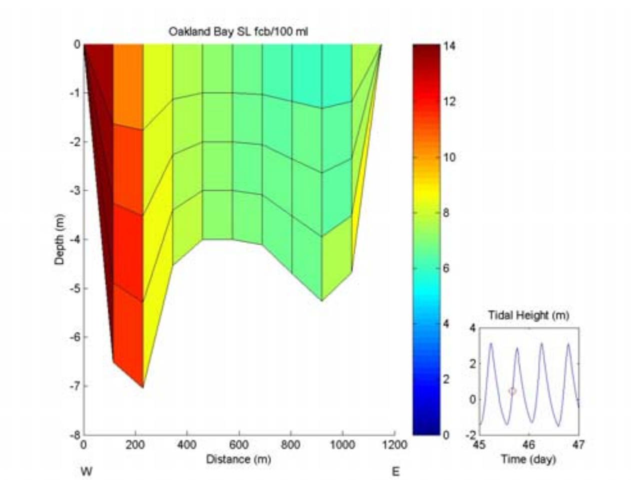
time(2162) =   45.645830 (3:30PM)

14.38	16.81	13.30	10.32	9.32	8.11	7.18	6.68	6.66	7.34
14.15	17.56	13.43	10.41	9.77	8.86	7.71	6.62	6.69	8.60
13.70	17.16	13.61	10.53	9.97	9.04	8.23	8.12	7.89	8.87
13.11	5.92	13.92	10.65	10.11	9.19	8.48	8.25	9.05	8.99



time(2163) = 45.656250

14.74	12.96	9.94	8.73	8.07	7.25	6.82	6.52	6.45	8.07
14.72	14.21	9.93	8.75	8.16	7.70	7.33	6.79	6.44	7.98
14.67	14.99	9.98	8.79	8.24	7.80	7.48	6.95	6.45	8.03
14.61	10.81	10.12	8.83	8.32	7.88	7.59	7.05	8.07	8.95



time(2164) = 45.666670

13.60	10.38	8.35	7.58	7.05	6.67	6.35	6.08	6.12	7.52
13.73	11.29	8.34	7.64	7.07	6.74	6.54	6.64	6.52	7.41
13.90	11.86	8.38	7.69	7.10	6.80	6.61	6.68	6.59	7.68
14.07	11.48	8.48	7.75	7.15	6.86	6.67	6.76	7.58	8.59

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Run4: 6.7 mgd for 13 hours; ebb then flood with diffuser:

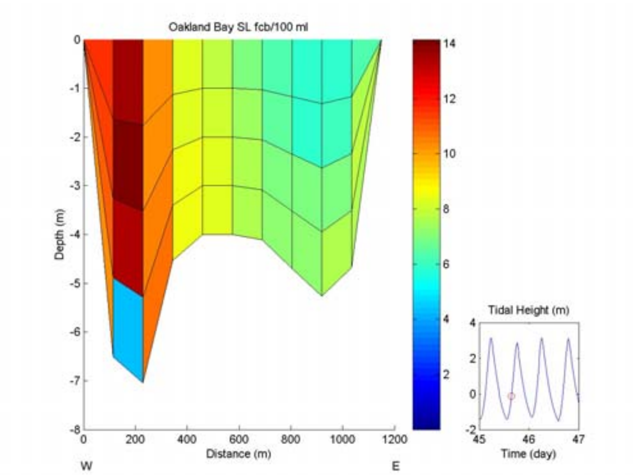
```
time(2158) =      45.604170
  0.04    0.18    1.39    5.47   10.03   13.36   15.03   15.09   13.95   11.07
  0.03    0.08    0.60    2.20    5.67    9.60   14.04   15.82   14.81   10.63
  0.04    0.04    0.19    0.84    1.95    4.63    9.88   12.96   14.90   10.29
  0.05    0.05    0.10    0.71    1.19    2.19    2.87    3.29    5.01   10.01


time(2159) =      45.614580
  0.89    4.07   14.20   24.61   25.39   23.55   19.00   16.41   14.24   11.44
  0.47    2.80   14.08   24.80   24.11   24.18   23.15   19.32   15.77   11.01
  0.13    0.55    2.19    6.46   15.57   17.70   18.19   14.35   17.72   12.80
  0.08    0.11    0.78    5.13    3.40    3.00    5.10   12.25    8.63   11.43


time(2160) =      45.625000 (3:00PM)
 11.33   22.17   30.40   28.45   23.79   19.97   17.78   15.10   13.43   11.78
  9.87   18.33   30.15   31.43   24.00   21.46   19.46   16.28   15.05   12.06
  3.84    8.28   25.34   22.14   23.92   16.86   20.06   20.30   18.16   12.98
  0.75    0.65    5.14   21.10   13.27   15.76   20.36   20.08   13.84   11.38


time(2161) =      45.635420
 24.23   31.51   29.49   22.87   19.66   17.91   13.94   12.52   11.76   11.54
 24.58   32.75   30.12   24.49   20.03   18.77   14.02   13.23   12.94   13.41
 12.19   23.14   30.19   25.08   20.48   19.85   17.65   15.86   16.62   14.10
 11.09    3.34   17.20   25.62   20.73   20.53   18.15   16.12   16.57   13.31


time(2162) =      45.645830 (3:30PM)
 24.15   28.21   22.30   17.29   15.59   13.57   12.03   11.19   11.15   12.29
 23.75   29.46   22.52   17.45   16.36   14.83   12.92   11.06   11.16   14.35
 22.96   28.74   22.82   17.64   16.69   15.13   13.76   13.55   13.13   14.74
 21.95    9.90   23.34   17.85   16.93   15.39   14.17   13.76   15.08   14.92


time(2163) =      45.656250
 24.70   21.73   16.66   14.63   13.52   12.15   11.43   10.93   10.80   13.46
 24.67   23.79   16.63   14.66   13.66   12.87   12.26   11.37   10.77   13.30
 24.60   25.10   16.72   14.72   13.79   13.05   12.52   11.63   10.78   13.36
 24.49   18.09   16.95   14.78   13.92   13.17   12.70   11.78   13.46   14.87


time(2164) =      45.666670
 22.82   17.41   14.00   12.69   11.80   11.18   10.63   10.19   10.24   12.55
 23.04   18.93   13.98   12.79   11.83   11.29   10.95   11.10   10.90   12.35
 23.31   19.88   14.05   12.87   11.89   11.39   11.07   11.18   11.02   12.82
 23.59   19.23   14.22   12.97   11.97   11.49   11.16   11.30   12.65   14.26


time(2165) =      45.677080
 18.60   12.86   10.05    8.96    8.27    7.87    7.69    7.69    8.09   11.27
 19.04   14.91   10.06    9.21    8.47    7.93    7.53    7.47    8.05   11.28
 19.53   16.57   10.15    9.31    8.56    8.07    7.84    7.91    8.38   12.52
 19.99   17.13   10.32    9.43    8.67    8.21    7.97    7.98    8.41   13.27
```

```
time(2166) =      45.687500
 12.79   9.01   6.67   6.00   5.68   5.47   5.35   5.33   5.53  10.28
 16.27   9.34   5.58   5.45   4.95   4.78   4.86   4.99   5.35  10.35
 16.62  10.97   5.62   5.51   5.04   5.02   4.93   4.78   5.03  10.45
 16.99  11.40   5.73   5.58   5.12   5.07   4.97   4.84   5.08  12.11


time(2183) =      45.864580
 14.78  12.33  11.00  10.77  11.06  11.69  11.51  10.83   9.67   7.75
 14.69  11.00  11.46  11.25  10.80  11.42  12.19  10.59   8.14   5.43
 10.60   5.01   8.21   7.68   7.28   7.01   6.80   5.42   4.87   4.52
  5.92   5.08   5.78   5.24   4.85   4.79   4.80   4.29   4.96   4.54


time(2184) =      45.875000
 14.75  12.45  10.99  10.59  10.99  11.66  11.59  11.04  10.06   8.21
 14.77  11.85  12.23  12.20  11.55  12.16  12.36  11.07   8.93   5.87
 11.43   5.01   9.09   9.11   8.22   7.62   7.42   6.13   5.58   4.85
  6.33   5.24   6.03   5.76   5.17   4.94   5.00   4.29   5.48   4.88


time(2187) =      45.906250
  9.56   9.33   8.71   8.56   8.86   9.42  10.50  11.10  10.82   9.95
 11.83  12.03  12.58  10.71   9.58  10.25  10.50  12.42  10.94   7.73
 13.36   5.44  11.29  11.99  13.39  14.34  12.38  10.94   8.60   5.73
  8.11   5.75   5.67   7.54   7.07   6.58   7.16   5.32   5.88   5.69


time(2188) =      45.916670
  7.39   7.58   7.29   7.19   7.51   8.10   9.16  10.31  10.59  10.16
  9.06  12.06  10.78   8.91   8.23   9.07   9.19  12.08  11.25   8.72
 12.69   5.60  12.23  12.64  13.68  14.33  13.03  12.83  10.04   6.13
  8.58   5.98   5.99   8.41   7.88   7.41   7.97   6.33   5.45   5.74


time(2189) =      45.927080
  5.33   6.13   6.02   5.96   6.22   6.77   7.75   9.02   9.85   9.84
  6.66  11.22   8.83   7.05   7.07   7.66   8.45  12.28  11.30   9.54
 12.19   5.66  11.47  11.91  12.60  14.26  12.52  13.86  10.44   6.94
  8.99   6.24   6.25   9.21   8.55   8.15   8.63   7.46   4.80   5.04


time(2190) =      45.937500
  4.07   5.20   5.16   5.03   5.16   5.58   6.46   7.62   8.77   9.01
  5.59   9.75   7.50   5.88   6.08   6.55   7.45  11.73  11.00   9.37
 11.86   5.75  10.31  10.30  11.63  13.12  11.91  14.29  10.41   7.51
  9.33   6.51   6.68   9.62   8.97   8.58   9.15   8.21   4.91   4.81


time(2191) =      45.947920
  3.61   4.73   4.73   4.44   4.43   4.69   5.38   6.29   7.55   7.93
  5.67   8.69   6.78   5.64   5.74   5.98   6.65  10.91  10.50   8.61
 11.43   5.80   9.34   9.07  11.40  11.95  11.86  14.33  10.08   7.99
  9.57   6.76   7.05   9.71   9.24   8.64   9.49   8.65   5.18   4.83
```

time(2192) = 45.958330

3.40	4.38	4.44	4.11	4.00	4.13	4.59	5.21	6.38	6.88
5.16	8.32	6.70	5.59	5.56	5.72	6.17	9.60	9.50	7.64
10.67	5.80	8.58	8.53	10.60	11.00	12.60	14.13	9.66	8.36
9.75	6.99	7.23	9.59	9.47	8.54	9.80	8.84	5.44	5.23

Run6: 4.0 mgd for 13 hours; ebb then flood with extended diffuser:



time(2162) = 45.645830 (3:30PM)

11.61	13.53	10.27	8.35	7.77	6.89	6.24	5.86	5.80	6.39
11.38	14.15	10.36	8.39	8.12	7.44	6.60	5.87	6.06	7.62
10.94	13.39	10.48	8.46	8.28	7.58	6.93	7.02	6.92	7.80
10.38	4.35	10.72	8.54	8.39	7.70	7.11	7.12	7.73	7.69

Run7: 6.7 mgd for 13 hours; ebb then flood with extended diffuser:

time(2159) = 45.614580

0.47	2.20	8.01	14.70	16.31	16.22	13.75	12.45	11.25	9.26
0.26	1.53	7.93	14.78	15.59	16.75	17.89	16.26	13.73	8.90
0.08	0.33	1.35	3.93	10.02	12.05	13.06	11.33	15.49	11.38
0.05	0.07	0.50	3.13	2.30	2.12	3.61	9.41	7.19	10.09

time(2160) = 45.625000 (3:00PM)

6.99	14.02	20.22	20.85	18.42	16.05	14.58	12.67	11.24	9.84
6.01	11.44	19.97	22.51	18.67	17.74	15.82	13.90	13.22	10.02
2.35	5.30	16.61	15.06	18.35	12.40	15.87	16.71	16.14	11.29
0.46	0.41	3.33	14.18	9.40	11.55	16.00	16.39	11.66	10.00

time(2161) = 45.635420

17.25	23.28	22.35	17.91	15.85	14.82	11.79	10.75	10.14	9.82
17.29	23.27	22.80	18.97	16.14	15.60	11.94	11.48	11.42	11.59
8.35	16.54	22.80	19.34	16.45	16.51	15.19	13.99	14.78	12.35
7.56	2.30	12.42	19.68	16.60	17.04	15.58	14.04	13.95	11.46

```
time(2162) =      45.645830 (3:30PM)
 19.47  22.67  17.18  13.99  13.03  11.56  10.46   9.81   9.69  10.62
 19.10  23.69  17.31  14.04  13.61  12.47  11.05   9.82  10.09  12.64
 18.38  22.39  17.52  14.15  13.86  12.70  11.62  11.76  11.49  12.91
 17.47   7.30  17.90  14.29  14.04  12.90  11.91  11.93  12.83  12.70


time(2163) =      45.656250
 21.65  18.20  13.52  12.72  11.88  10.91  10.35   9.82   9.57  11.82
 21.59  19.61  13.44  12.75  11.94  11.30  10.97  10.21   9.58  11.82
 21.49  20.32  13.47  12.77  12.01  11.39  11.14  10.42   9.58  11.81
 21.35  13.59  13.61  12.78  12.08  11.45  11.26  10.54  11.74  12.74


time(2164) =      45.666670
 21.19  16.35  12.95  11.86  11.11  10.58  10.07   9.55   9.39  11.17
 21.34  17.09  12.94  11.90  11.13  10.65  10.32  10.37  10.18  11.09
 21.53  17.35  12.99  11.95  11.17  10.72  10.41  10.44  10.28  11.40
 21.73  15.52  13.12  12.01  11.22  10.78  10.48  10.53  11.54  12.35


time(2165) =      45.677080
 19.16  14.08  10.50   9.53   8.89   8.40   8.01   7.72   7.66  10.20
 19.39  14.61  10.36   9.27   8.42   7.60   7.20   6.95   7.27  10.21
 19.68  15.30  10.37   9.29   8.46   7.69   7.40   7.29   7.70  11.16
 19.97  15.62  10.47   9.35   8.55   7.80   7.51   7.37   7.73  11.65


time(2166) =      45.687500
 16.41  12.08   8.46   7.25   6.63   6.14   5.73   5.42   5.28   9.38
 17.06  10.46   5.83   5.60   4.89   4.72   4.60   4.59   4.79   9.42
 17.24  10.90   5.88   5.60   4.89   4.70   4.57   4.39   4.58   9.47
 17.46  11.16   5.98   5.63   4.93   4.73   4.60   4.44   4.63  10.70
```

Run9: 4.0 mgd for 13 hours; flood then ebb with diffuser:

```
time(2160) =      45.625000 (3:00PM)
  6.02  11.57  15.14  12.12   9.19   6.35   5.24   3.58   2.93   2.77
  5.34   9.73  15.13  14.40   9.59   7.90   7.30   4.34   3.91   3.16
  2.09   4.45  13.04  11.31  10.18   8.86   8.75   8.63   7.84   4.10
  0.39   0.33   2.81  10.98   6.67   8.39   9.16   9.08   7.92   5.76


time(2161) =      45.635420
 11.60  13.70  11.11   7.23   5.40   4.18   2.19   1.67   1.58   2.00
 11.78  15.23  11.51   8.49   5.84   4.59   2.25   1.85   2.13   3.26
  6.38  10.78  11.65   8.96   6.40   5.23   4.61   3.81   5.94   4.03
  5.83   1.62   7.80   9.38   6.85   5.67   4.93   4.64   8.35   6.70


time(2208) =      46.125000
  3.17   6.31  10.59  12.31  12.05  11.76  11.35  10.75  10.28   9.25
  3.45   5.94  10.56  13.75  12.27  12.97  12.72  11.70  11.59   9.70
  3.46   5.65  10.01  10.00  11.78  10.65  12.08  14.80  13.16  12.31
  3.45   3.86   4.27   9.72   6.99   7.99  12.05  14.42  12.63  10.24
```

Run10: 6.7 mgd for 13 hours; flood then ebb with diffuser:

```
time(2158) =      45.604170
  0.02   0.16   1.36   5.39   9.81  12.90  14.22  13.86  12.32   9.16
  0.00   0.07   0.59   2.18   5.57   9.36  13.50  14.86  13.26   8.84
  0.00   0.02   0.17   0.80   1.89   4.49   9.55  12.38  13.94   8.94
  0.00   0.00   0.09   0.67   1.13   2.09   2.75   3.15   4.67   8.74


time(2159) =      45.614580
  0.84   3.91  13.54  22.96  22.48  19.90  14.35  11.40   9.01   6.62
  0.44   2.69  13.43  23.21  22.19  20.67  19.33  15.18  11.15   6.85
  0.09   0.51   2.13   6.24  14.98  16.90  16.95  13.08  15.83   9.97
  0.01   0.05   0.74   4.97   3.27   2.84   4.85  11.43   8.15   9.51


time(2160) =      45.625000 (3:00PM)
 10.19  19.51  25.45  20.31  15.38  10.64   8.78   6.01   4.91   4.63
  9.03  16.42  25.43  24.09  16.04  13.19  12.18   7.25   6.52   5.29
  3.53   7.47  21.90  18.97  17.03  14.74  14.56  14.31  12.94   6.82
  0.66   0.55   4.71  18.42  11.16  14.02  15.24  15.06  12.98   9.48


time(2161) =      45.635420
 19.51  23.03  18.61  12.09   9.03   6.99   3.67   2.79   2.63   3.33
 19.79  25.57  19.27  14.20   9.77   7.67   3.76   3.09   3.54   5.41
 10.76  18.07  19.49  14.98  10.68   8.73   7.68   6.36   9.80   6.68
  9.81   2.72  13.06  15.68  11.43   9.45   8.22   7.76  13.76  11.03


time(2162) =      45.645830 (3:30PM)
 17.64  17.13  10.91   6.90   5.52   3.67   2.38   1.74   1.84   3.62
 17.46  18.23  11.07   7.22   6.44   5.12   3.53   1.88   2.55   5.46
 17.07  19.38  11.30   7.42   6.82   5.45   4.66   4.41   6.75   7.26
 16.54   7.00  11.73   7.59   7.09   5.72   5.18   4.62   9.49  11.70


time(2163) =      45.656250
 15.96  10.70   6.30   4.80   3.75   2.63   1.96   1.54   1.55   4.80
 16.03  12.09   6.28   4.88   3.88   3.48   2.83   2.11   2.12   4.93
 16.12  13.76   6.32   4.97   4.00   3.68   3.08   2.34   2.14   6.29
 16.20  10.91   6.46   5.06   4.11   3.82   3.26   2.46   5.62  10.28


time(2206) =      46.104170
  3.05   3.10   3.42   4.72   6.29   7.94   9.49  10.53  11.17  10.62
  3.75   4.41   3.67   4.74   5.82   7.72  10.21  12.76  14.02  10.34
  4.78   6.63   4.41   4.93   6.46   7.92  11.09  14.29  17.43  13.30
  6.48   6.47   5.35   4.89   6.14   6.77   6.84   7.38   8.77  10.90


time(2207) =      46.114580
  3.27   4.09   7.16  12.51  15.40  17.13  16.62  16.16  15.61  13.58
  3.73   4.93   7.11  12.53  15.49  17.32  19.88  21.54  19.89  12.80
  5.12   6.10   5.57   8.46  13.31  16.56  19.84  20.25  20.03  16.00
  6.53   6.34   5.70   7.57   7.44   7.23   7.92  11.35  13.44  15.54
```

```
time(2208) =      46.125000
  5.30  10.56  17.73  20.62  20.20  19.70  19.02  18.01  17.22  15.50
  5.77   9.93  17.68  23.00  20.58  21.72  21.30  19.59  19.41  16.26
  5.80   9.45  16.69  16.73  19.77  17.84  20.23  24.81  22.09  20.67
  5.78   6.44   7.17  16.27  11.74  13.41  20.20  24.17  21.21  17.14


time(2209) =      46.135420
 11.59  17.85  20.01  20.24  19.98  19.11  17.58  17.26  17.17  17.23
 13.93  19.13  18.92  20.81  20.26  20.12  17.59  18.08  18.71  20.03
  9.14  16.43  18.63  21.03  20.53  21.33  21.74  20.98  22.80  21.54
  8.93   6.87  18.05  21.04  20.72  22.01  22.09  21.56  21.27  19.33


time(2210) =      46.145830
 14.46  18.59  19.51  17.90  17.58  17.12  16.88  16.64  16.70  18.41
 14.06  19.65  19.65  17.88  17.80  17.45  17.05  16.67  17.08  20.86
 13.44  19.49  19.80  17.95  17.96  18.40  17.09  17.29  18.13  21.49
 12.84  12.55  20.04  18.06  18.06  18.61  17.16  17.38  18.30  20.49


time(2211) =      46.156250
 16.15  17.52  17.11  16.70  16.63  16.35  16.24  16.09  16.12  19.50
 15.84  18.33  17.11  16.70  16.67  16.40  16.49  16.47  16.35  19.78
 15.57  18.63  17.15  16.70  16.71  16.44  16.56  16.56  16.85  19.85
 15.33  15.52  17.25  16.71  16.76  16.47  16.62  16.65  16.88  19.90


time(2212) =      46.166670
 16.83  16.21  15.67  15.34  14.98  14.63  14.40  14.43  14.84  18.46
 16.88  16.74  15.69  15.41  15.06  14.91  14.82  14.88  15.34  19.10
 16.92  16.86  15.74  15.48  15.14  15.01  14.88  14.94  15.44  19.07
 16.95  16.31  15.83  15.55  15.22  15.09  14.96  15.02  15.52  19.15


time(2213) =      46.177080
 14.87  12.82  11.61  10.61   9.99   9.76   9.77  10.05  10.94  16.50
 15.24  14.17  11.72  10.74   9.71   8.94   8.72   9.30  10.41  17.24
 15.58  14.49  11.88  10.90   9.80   9.00   8.60   8.63   9.91  18.45
 15.86  14.86  12.11  11.09   9.96   9.14   8.70   8.77  10.00  18.58


time(2214) =      46.187500
  9.80   7.80   6.26   5.88   5.76   5.71   5.76   5.95   6.63  14.02
 11.33   7.94   5.18   4.59   3.87   3.97   4.36   4.73   5.73  14.05
 11.92   8.16   5.25   4.58   3.77   3.38   3.00   3.30   4.38  16.66
 12.31   8.42   5.39   4.64   3.77   3.34   3.04   3.36   4.38  16.65
```

Run13: 6.7 mgd for 13 hours; flood then ebb with extended diffuser:

```
time(2160) =      45.625000 (3:00PM)
  5.72  11.11  14.93  12.56   9.95   6.94   5.92   4.09   3.39   3.40
  5.05   9.31  14.91  14.98  10.50   9.35   8.57   5.22   5.24   3.97
  2.01   4.37  12.85  11.63  11.08  10.02  10.23  10.88  10.85   5.34
  0.38   0.33   2.84  11.25   7.17   9.49  10.82  11.27  10.67   7.91
```

```
time(2161) =      45.635420
 12.15  14.45  11.47   7.37   5.62   4.46   2.29   1.87   1.92   2.53
 12.18  15.75  11.92   8.86   6.20   5.00   2.40   2.17   2.84   4.31
  6.56  11.19  12.08   9.40   6.92   5.81   5.46   4.74   8.03   5.40
  5.97   1.66   8.11   9.88   7.49   6.37   5.87   5.82  10.94   8.99


time(2206) =      46.104170
  2.20   2.25   2.51   3.55   4.77   5.99   7.11   7.79   8.20   7.74
  2.75   3.41   2.74   3.63   4.53   5.98   7.77   9.67  10.57   7.66
  3.62   5.36   3.45   3.88   5.17   6.42   8.96  11.58  14.19  11.06
  5.07   5.31   4.35   3.85   4.93   5.56   5.77   6.20   7.57   9.19


time(2207) =      46.114580
  2.37   3.10   5.73  10.15  12.48  13.75  13.20  12.71  12.19  10.43
  2.74   3.76   5.68  10.16  12.48  13.91  15.96  17.37  16.03   9.80
  3.98   4.86   4.43   6.82  10.80  13.51  16.18  16.72  16.84  13.64
  5.10   5.26   4.59   6.10   6.11   6.09   6.66   9.29  11.39  13.22


time(2208) =      46.125000
  4.39   9.40  15.81  18.24  17.65  17.08  16.29  15.18  14.33  12.48
  4.82   8.68  15.77  20.33  17.84  18.83  18.21  16.48  16.05  13.32
  4.52   8.01  14.80  14.33  17.20  15.34  17.45  21.23  18.87  17.64
  4.49   5.22   5.93  13.91  10.00  11.60  17.39  20.49  17.94  14.79


time(2209) =      46.135420
 11.28  17.56  19.32  19.13  18.72  17.67  15.82  15.21  14.86  14.45
 13.13  18.60  18.13  19.52  18.98  18.81  15.89  16.03  16.49  16.94
  8.31  15.78  17.70  19.47  19.23  20.03  20.22  19.47  20.12  18.55
  8.05   5.57  16.87  19.38  19.36  20.72  20.55  19.69  18.30  16.71


time(2210) =      46.145830
 15.36  19.10  19.39  17.20  16.59  15.79  15.34  14.80  14.68  15.75
 14.92  20.45  19.57  17.27  17.02  16.40  15.84  14.86  15.28  18.21
 13.80  20.04  19.74  17.39  17.25  17.66  15.96  16.23  16.94  19.05
 12.96  11.77  20.01  17.53  17.41  17.94  16.09  16.40  17.08  18.02


time(2211) =      46.156250
 17.01  17.54  16.24  15.79  15.58  15.19  14.98  14.65  14.49  17.10
 16.67  18.67  16.22  15.79  15.61  15.24  15.31  15.21  15.11  17.69
 16.35  19.13  16.26  15.80  15.65  15.27  15.39  15.30  15.87  18.20
 16.08  15.63  16.37  15.80  15.71  15.30  15.44  15.40  15.96  18.21


time(2212) =      46.166670
 17.45  16.10  14.99  14.68  14.30  13.95  13.64  13.52  13.71  16.42
 17.51  16.52  14.98  14.74  14.36  14.20  14.08  14.12  14.37  17.39
 17.56  16.63  15.02  14.80  14.42  14.29  14.15  14.19  14.50  17.62
 17.60  16.09  15.09  14.85  14.48  14.36  14.22  14.27  14.57  17.68
```

```
time(2213) =      46.177080
 15.56  13.10  11.50  10.44   9.75   9.44   9.34   9.50  10.18  14.83
 15.92  14.16  11.58  10.53   9.44   8.61   8.31   8.73   9.75  15.72
 16.26  14.45  11.72  10.68   9.53   8.68   8.24   8.27   9.48  17.01
 16.55  14.81  11.93  10.86   9.69   8.82   8.35   8.40   9.56  17.12


time(2214) =      46.187500
 10.63   8.28   6.37   5.88   5.68   5.57   5.54   5.63   6.17  12.70
 12.00   8.08   5.10   4.44   3.71   3.77   4.09   4.41   5.28  12.73
 12.53   8.28   5.16   4.43   3.61   3.22   2.85   3.11   4.08  15.29
 12.90   8.53   5.29   4.49   3.62   3.18   2.89   3.16   4.08  15.28
```

Tabular output from all time-steps at which an exceedance occurred on the *Hammersley Inlet* sanitary line:

Run4: 6.7 mgd for 13 hours; ebb then flood with diffuser:

```
time(2131) =      45.322920
  4.44   6.45  10.50  14.38
  4.42   6.11  10.52  14.46
  4.41   5.91  10.40  14.46
  4.39   5.77  10.28  14.46


time(2132) =      45.333330
  4.54   6.16  10.48  14.42
  4.56   5.96  10.52  14.46
  4.58   5.80  10.42  14.46
  4.59   5.68  10.30  14.46


time(2133) =      45.343750
  4.05   5.56   9.99  14.19
  4.09   5.35   9.96  14.46
  4.12   5.17   9.81  14.46
  4.15   5.04   9.65  14.46


time(2134) =      45.354170
  3.30   5.83  10.87  14.44
  3.33   5.61  10.88  14.46
  3.35   5.42  10.71  14.46
  3.38   5.28  10.51  14.46


time(2135) =      45.364580
  2.97   5.65  10.92  14.50
  2.96   5.49  10.92  14.50
  2.96   5.33  10.76  14.50
  2.98   5.20  10.57  14.50
```

```
time(2136) =      45.375000
  2.79   5.68  10.90  14.50
  2.78   5.50  10.90  14.50
  2.78   5.32  10.74  14.50
  2.79   5.18  10.54  14.50


time(2137) =      45.385420
  2.73   6.02  11.21  14.50
  2.69   5.86  11.22  14.50
  2.67   5.69  11.08  14.50
  2.67   5.55  10.90  14.50


time(2138) =      45.395830
  2.80   6.20  11.16  14.50
  2.76   6.07  11.18  14.50
  2.73   5.91  11.06  14.50
  2.71   5.78  10.91  14.50


time(2139) =      45.406250
  2.95   6.31  11.17  14.50
  2.91   6.19  11.21  14.50
  2.87   6.04  11.09  14.50
  2.85   5.92  10.95  14.50


time(2140) =      45.416670
  3.09   6.50  11.15  14.46
  3.08   6.39  11.18  14.50
  3.05   6.24  11.08  14.50
  3.03   6.12  10.96  14.50


time(2141) =      45.427080
  3.16   6.79  11.39  14.39
  3.14   6.69  11.42  14.50
  3.12   6.55  11.32  14.50
  3.09   6.43  11.20  14.50


time(2142) =      45.437500
  3.25   7.24  11.71  14.39
  3.23   7.13  11.75  14.50
  3.20   6.98  11.64  14.50
  3.17   6.85  11.52  14.50


time(2143) =      45.447920
  3.45   7.90  12.31  14.43
  3.42   7.79  12.35  14.50
  3.39   7.64  12.25  14.50
  3.35   7.51  12.13  14.50
```

```
time(2144) =      45.458330
  3.73   8.49  12.62  14.45
  3.70   8.38  12.65  14.50
  3.66   8.23  12.55  14.50
  3.61   8.10  12.44  14.50


time(2145) =      45.468750
  4.08   9.23  13.07  14.34
  4.04   9.12  13.09  14.50
  3.98   8.97  12.97  14.50
  3.92   8.83  12.85  14.50


time(2146) =      45.479170
  4.50   9.63  13.16  14.09
  4.42   9.53  13.17  14.49
  4.33   9.38  13.07  14.50
  4.26   9.26  12.98  14.50


time(2147) =      45.489580
  4.93  10.02  13.16  13.70
  4.82   9.87  13.14  14.29
  4.71   9.69  13.01  14.33
  4.62   9.54  12.89  14.39


time(2149) =      45.510420
  5.74  11.28  14.10  13.10
  5.59  11.16  14.09  13.11
  5.44  10.98  13.96  13.22
  5.31  10.85  13.84  13.30


time(2150) =      45.520830
  6.05  11.68  14.59  13.46
  5.92  11.52  14.54  13.17
  5.75  11.31  14.35  13.14
  5.61  11.14  14.18  13.14


time(2151) =      45.531250
  6.47  12.23  15.22  13.86
  6.34  12.11  15.21  13.38
  6.16  11.90  14.99  13.15
  6.00  11.72  14.79  13.15


time(2152) =      45.541670
  6.94  12.31  15.55  14.39
  6.81  12.22  15.55  13.79
  6.60  12.02  15.26  13.15
  6.39  11.86  15.02  13.15
```

```
time(2153) =      45.552080
  7.74  12.45  15.72  14.91
  7.54  12.29  15.74  14.91
  7.09  11.93  15.21  13.41
  6.57  11.70  14.75  13.27


time(2154) =      45.562500
  9.71  13.17  15.78  15.51
  9.27  12.93  15.59  15.54
  8.48  11.95  14.38  15.06
  6.51  11.21  13.80  14.07


time(2155) =      45.572920
 11.61  13.83  14.63  14.91
 10.57  12.82  13.61  14.79
  7.88  10.73  12.46  14.90
  6.89   9.57  12.73  14.94


time(2156) =      45.583330
 10.96  13.18  13.32  14.27
  8.51  12.27  12.27  14.24
  8.43  10.91  11.40  14.19
  8.38  10.90  11.49  14.15
```

Run10: 6.7 mgd for 13 hours; flood then ebb with diffuser:

```
time(2180) =      45.833330
  4.94   9.36  14.25  14.31
  4.87   9.25  14.19  13.68
  4.83   9.09  13.96  13.46
  4.80   8.92  13.65  12.81


time(2181) =      45.843750
  6.71  10.31  15.65  19.15
  6.70  10.02  15.70  19.31
  6.68   9.81  15.58  19.32
  6.66   9.65  15.44  19.32


time(2182) =      45.854170
  7.49  10.13  15.44  19.30
  7.50   9.84  15.47  19.32
  7.50   9.62  15.33  19.32
  7.50   9.47  15.16  19.32


time(2183) =      45.864580
  7.22   9.57  15.03  19.48
  7.24   9.29  14.99  19.74
  7.26   9.06  14.79  19.75
  7.28   8.90  14.58  19.74
```

```
time(2184) =      45.875000
  6.61  10.09  16.31  20.33
  6.61   9.78  16.32  20.39
  6.63   9.51  16.09  20.39
  6.66   9.30  15.81  20.39


time(2185) =      45.885420
  6.39   9.99  16.39  20.48
  6.36   9.78  16.38  20.51
  6.34   9.56  16.17  20.51
  6.34   9.39  15.94  20.51


time(2186) =      45.895830
  6.37  10.12  16.63  20.75
  6.33   9.89  16.62  20.90
  6.32   9.66  16.41  20.90
  6.32   9.47  16.16  20.90


time(2187) =      45.906250
  6.36  10.56  17.32  20.98
  6.32  10.35  17.34  20.99
  6.29  10.11  17.15  20.99
  6.28   9.92  16.92  20.99


time(2188) =      45.916670
  6.43  11.06  17.64  21.08
  6.37  10.87  17.64  21.22
  6.33  10.64  17.46  21.22
  6.31  10.45  17.25  21.22


time(2189) =      45.927080
  6.49  11.38  18.09  21.35
  6.42  11.22  18.13  21.37
  6.37  11.01  17.97  21.37
  6.35  10.83  17.76  21.37


time(2190) =      45.937500
  6.58  11.80  18.44  21.37
  6.50  11.63  18.49  21.37
  6.44  11.41  18.33  21.37
  6.42  11.23  18.14  21.37


time(2191) =      45.947920
  6.71  12.32  18.73  21.52
  6.63  12.16  18.75  21.68
  6.57  11.96  18.59  21.68
  6.53  11.77  18.40  21.68
```

```
time(2192) =      45.958330
  6.87  13.02  19.45  21.79
  6.81  12.87  19.50  21.81
  6.74  12.67  19.35  21.81
  6.70  12.48  19.16  21.81


time(2193) =      45.968750
  7.14  13.83  20.06  21.81
  7.10  13.69  20.12  21.81
  7.02  13.48  19.98  21.81
  6.96  13.29  19.80  21.81


time(2194) =      45.979170
  7.54  14.62  20.42  21.81
  7.51  14.49  20.47  21.81
  7.45  14.30  20.33  21.81
  7.37  14.11  20.17  21.81


time(2195) =      45.989580
  7.99  15.53  20.81  21.79
  7.94  15.40  20.84  21.81
  7.87  15.20  20.70  21.81
  7.79  15.01  20.54  21.81


time(2196) =      46.000000
  8.53  16.31  21.02  21.46
  8.46  16.21  21.05  21.77
  8.37  16.02  20.92  21.79
  8.28  15.85  20.78  21.81


time(2197) =      46.010420
  9.13  16.74  20.89  20.64
  9.03  16.62  20.90  21.17
  8.91  16.44  20.77  21.20
  8.79  16.28  20.64  21.66


time(2198) =      46.020830
  9.76  17.16  20.85  20.00
  9.60  17.01  20.83  20.11
  9.44  16.80  20.68  20.13
  9.29  16.64  20.53  21.08


time(2199) =      46.031250
 10.44  17.79  21.25  19.79
 10.20  17.55  21.22  19.72
  9.96  17.28  20.99  19.72
  9.76  17.08  20.77  20.66
```

```
time(2200) =       46.041670
 11.35  18.52  21.67  19.91
 10.93  18.20  21.68  19.72
 10.47  17.86  21.38  19.72
 10.17  17.63  21.07  20.35


time(2201) =       46.052080
 12.95  19.23  21.95  20.43
 12.34  18.80  21.98  19.86
 11.19  18.21  21.47  19.77
 10.07  17.90  20.92  19.97


time(2202) =       46.062500
 16.10  20.12  22.07  21.41
 15.10  19.53  21.97  20.91
 12.89  18.19  20.57  20.89
  9.34  17.17  19.90  20.62


time(2203) =       46.072920
 18.40  20.58  20.57  21.04
 17.50  19.63  19.30  21.09
 14.02  16.36  18.04  21.15
 10.09  14.19  18.23  21.21


time(2204) =       46.083330
 16.48  19.42  19.36  20.32
 13.15  19.24  18.52  20.29
 12.99  16.45  17.84  20.24
 12.90  16.37  17.93  20.20


time(2205) =       46.093750
 15.59  18.17  19.15  19.43
 15.44  18.17  19.07  19.32
 15.33  15.11  16.11  19.10
 15.20  14.74  15.66  18.93


time(2206) =       46.104170
 16.02  16.87  18.11  19.34
 16.02  15.71  17.63  19.30
 15.98  15.18  16.41  19.20
 15.92  14.92  16.16  19.11


time(2207) =       46.114580
 15.09  15.40  16.90  18.80
 15.09  15.36  16.99  18.82
 15.09  15.37  17.06  18.81
 15.10  15.41  17.14  18.80
```

```
time(2208) =       46.125000
 14.53  13.09  13.23  17.22
 14.54  13.13  13.35  17.23
 14.52  13.18  13.49  17.20
 14.50  13.25  13.68  17.16
```