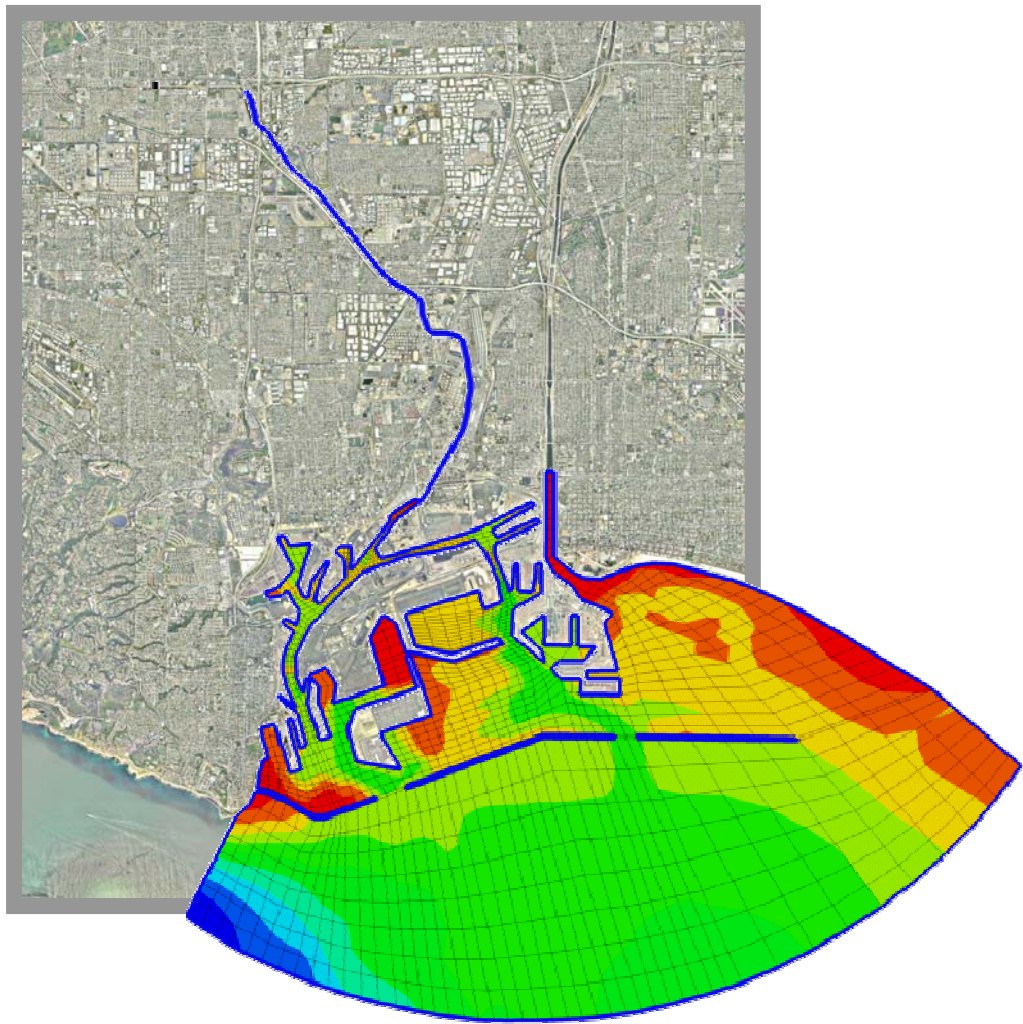


Dominguez Channel Estuary Model Study

DCEM User's Manual



Prepared for:
Port of Los Angeles

Prepared by:
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August, 2006

DOMINGUEZ CHANNEL ESTUARY MODEL

USER'S MANUAL

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1. INTRODUCTION

1.1 BACKGROUND

In November 2003, the California State Water Resources Control Board awarded a Proposition 13 Grant to the Port of Los Angeles (Port) to conduct the Dominguez Channel Hydrodynamic and Water Quality Study now known as the Dominguez Channel Estuary Model Study (DCEMS). In December 2003, the Port issued a request for proposals and performed an extensive consultant selection process that was completed in July 2004. In August 2004, the Port retained a team of consultants lead by Everest International Consultants, Inc. (Everest) to conduct the DCEMS. The purpose of the DCEMS was to develop a hydrodynamic and water quality model that can be used to accurately predict water elevations, velocities, and pollutant transport in the estuarine and marine portions of the Dominguez Channel. The study produced a calibrated Dominguez Channel Estuary Model (DCEM) using the EFDC (Environmental Fluid Dynamics Code) numerical model.

The DCEM is a three-dimensional model that is setup to simulate hydrodynamics, salinity, dye, cohesive sediment, noncohesive sediment, chromium, copper, lead, and zinc. The calibration of the DCEM focused on the estuary portion of the Dominguez Channel and harbor, which extends from the tidally influence portion of the Dominguez Channel (at Vermont Avenue) down to the upstream portion of the Consolidated Slip (see Figure 1). However, the model domain covers a much larger area including the entire Los Angeles and Long Beach Harbor Areas (Harbor Area). The model domain is shown in the insert at the upper left corner of Figure 1.

1.2 OVERVIEW OF DCEM MANUAL

The purpose of this manual is to document the features, calibrated parameters, as well as the input/output files of the DCEM such that an experienced modeler can use the model for future TMDL developments. However, it must be emphasized that this document is not intended to be a user's manual for using EFDC; hence, modifications to the DCEM simulations should be conducted by users with experience using EFDC. Documentations for EFDC are provided in Section 2.2.

Section 2 contains background information on EFDC. A summary of the overall file configuration of the DCEM is provided in Section 3. Modifications to model grid files are summarized in Section 4. Modifications of initial conditions, time series inputs and boundary conditions, and output options are then discussed in Sections 5 through 7, respectively.

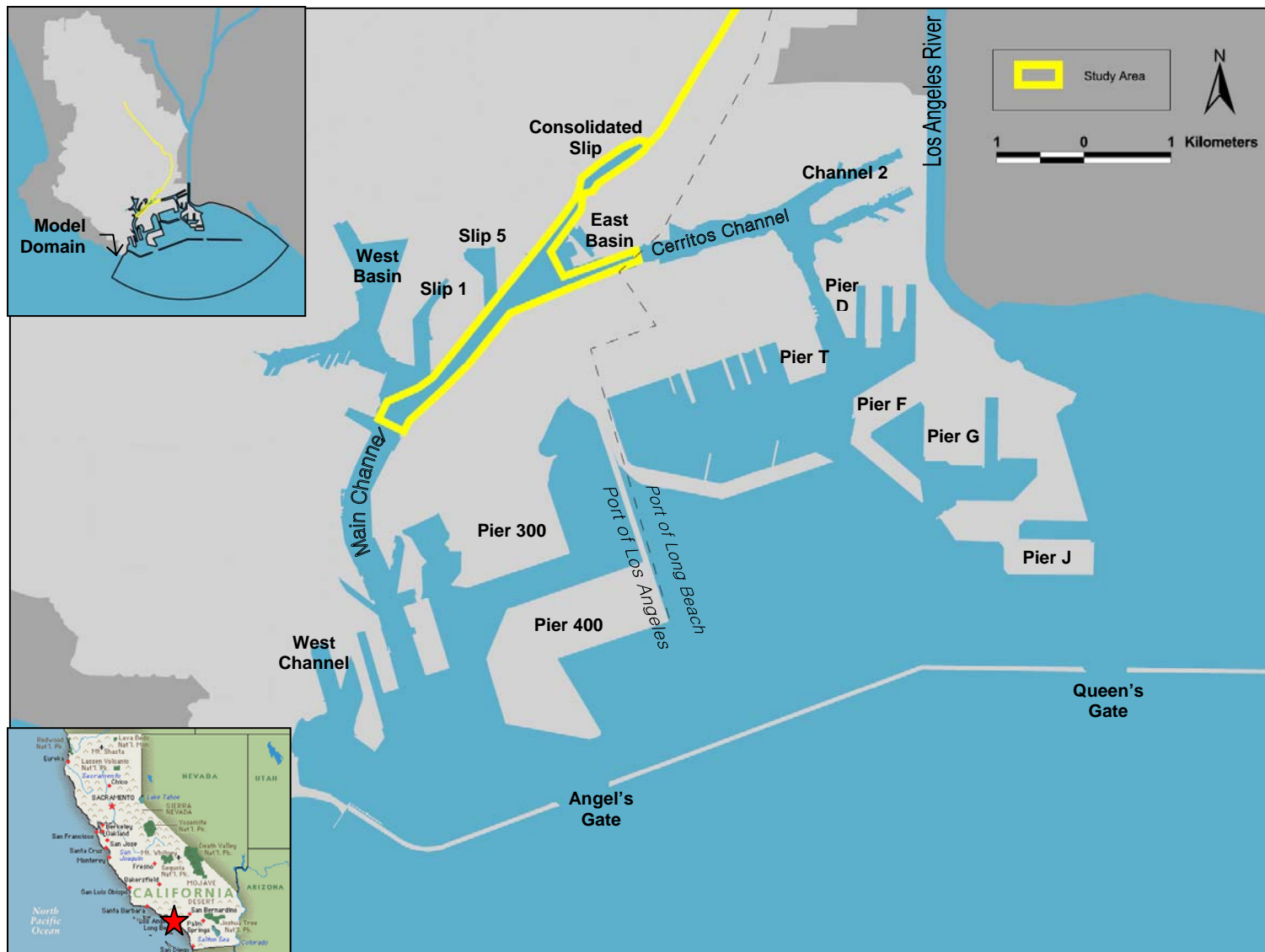


Figure 1. Dominguez Channel Estuary Model (DCEM) Study Area

2. EFDC

2.1 BACKGROUND

EFDC is a 1-, 2-, or 3-D hydrodynamic and water quality model that has been used by EPA for TMDL developments in river, lake, estuary, wetland, and coastal regions in the US. The model was originally developed by Dr. John Hamrick at the Virginia Institute of Marine Science and currently is maintained by Tetra Tech, Inc. for the EPA. EFDC has three primary components – hydrodynamics, sediment-toxic transport and fate, and water quality (eutrophication) integrated into a single model. The hydrodynamic component is dynamically coupled to salinity and temperature transport, as well as to sediment-toxic transport and water quality components.

The hydrodynamic component is similar to the Princeton Ocean Model (Blumberg and Mellor 1987). EFDC solves the 3-D Reynold-Averaged Navier-Stokes equations assuming incompressible flow and hydrostatic pressure distribution with dynamically coupled salinity and temperature transport, which accounts for density variations. Additional hydrodynamic features include a modified Mellor-Yamada level 2.5 turbulence closure formulation (Mellor and Yamada 1982 and Galperin et al 1988), wetting and drying, simulation of controlled flow structures, vegetation resistance, wave-current boundary layers and wave-induced currents, embedded single port buoyant jet module based on the CORMIX model for couple near-field and far-field mixing analyses, and Lagrangian particle tracking scheme.

The hydrodynamic component provides the dynamics for the sediment transport and fate; the latter, in turn, is fully linked to the toxic component for toxic or contaminant transport and fate. EFDC can simulate multiple classes of cohesive and noncohesive sediment as suspended load and bed load, including sediment deposition and resuspension (Tetra Tech 2002a). The sediment transport component can be coupled with the hydrodynamics to represent changes in bed topography and can also be coupled with a spectral wave model for wave induced resuspension. EFDC is capable of simulating an arbitrary number of toxics (e.g., metals and hydrophobic organics) and the interactions with any of the sediment-classes, dissolved organic carbon, and particulate organic carbon. The toxic transport is based on the same advection-diffusion scheme used for salinity and temperature.

The water quality component in EFDC is essentially an eutrophication model that simulates eutrophication and sediment biogeochemical (diagenesis) processes. The water quality simulation capability is based on a 21-state variable water column eutrophication model coupled with a 27-state variable sediment biogeochemical process model.

2.2 EFDC DOCUMENTATION

Further information and theoretical background on EFDC can be found in the following documents.

Hamrick, John M. "User's Manual for the Environmental Fluid Dynamics Computer Code" Special Report No. 331 in Applied Marine Science and Ocean Engineering. Virginia Institute of Marine Science School of Marine Science, College of William and Mary. January 1996.

Park, K., A.Y. Kuo, J. Shen, and J.M. Hamrick. "A Three-Dimensional Hydrodynamic-Eutrophication Model (HEM-3D): Description of Water Quality and Sediment Process Submodels" Special Report No. 327 in Applied Marine Science and Ocean Engineering. Virginia Institute of Marine Science School of Marine Science, College of William and Mary. January 1995.

Tetra Tech. "Theoretical and Computational Aspects of Sediment and Contaminant Transport in the EFDC Model" Prepared for U.S. EPA Office of Science and Technology. May 2002.

Tetra Tech. "Draft User's Manual for Environmental Fluid Dynamics Code Hydro Version (EFDC-Hydro) Release 1.00" Prepared for U.S. EPA Region 4. August 2002.

3. DCEM

3.1 STARTING UP

The enclosed CD contains the following subfolders within the folder, DCEM Files.

- DCEM Source Code – Model source code files and executable
- DCEM Grid – Model grid files
- DCEM Dry Weather Calibrated – Dry weather calibration input and output files
- DCEM Dry Weather Verified – Dry weather verification input and output files
- DCEM Wet Weather Calibrated – Wet weather input and output files

The last three subfolders - Dry Weather Calibrated, Dry Weather Verified, and Wet Weather Calibrated, contains all the input/output files for three DCEM calibration and verification simulations. Details about the calibration and verification of the DCEM are documented in a separate report prepared as part of the DCEMS (Everest 2006). EFDC uses default file names for input and output files, thus for multiple simulations the files must be contained in separate folders. Each simulation folder contains the appropriate input and output files that utilize the same EFDC file naming structure. These input files are developed for the provided source code files (in the DCEM Source Code folder) and may not work with other versions of the EFDC model.

Running one of existing simulations requires the input files and model executable file, DCEMEFDC.exe, which is provided in each simulation folder. The model itself can be executed by double-clicking on the executable file or through a MS-DOS prompt. For running a new simulation, the MS-DOS prompt option is recommended to view any error or warning messages produced by the model.

Input files include the primary control file, EFDC.INP, grid files, initial conditions files, and time series files. Output files provided with the DCEM are the default output files, time series, and vertical profile files. Full lists of the DCEM input and output files are provided in Table 1 and Table 2, respectively. Each of the three DCEM simulations contains a similar set of input and output files, with the exception for the dye input and output files, which were only simulated for the dry weather calibration.

Table 1. Input Files

INPUT FILE	TYPE	DESCRIPTION
BEDBDN.INP	Initial Conditions	Sediment bed bulk density
BEDDDN.INP	Initial Conditions	Sediment bed porosity
BEDLAY.INP	Initial Conditions	Sediment bed thickness
CELL.INP	Grid	Grid cell type
CELLLT.INP	Grid	Grid cell type
DSER.INP	Time Series	Dye
DXDY.INP	Grid	Grid cell dimensions
EFDC.INP	Control	Primary simulation control file
LXLY.INP	Grid	Grid cell orientation
PSER.INP	Time Series	Tide boundary condition
QSER.INP	Time Series	Flow
SALT.INP	Initial Conditions	Salinity concentration
SDSER.INP	Time Series	Cohesive sediment
SEDB.INP	Initial Conditions	Cohesive sediment in sediment bed
SEDW.INP	Initial Conditions	Cohesive sediment in water column
SNDB.INP	Initial Conditions	Noncohesive sediment in sediment bed
SNDW.INP	Initial Conditions	Noncohesive sediment in water column
SNSER.INP	Time Series	Noncohesive sediment
SSER.INP	Time Series	Salinity
TOXB.INP	Initial Conditions	Metals in sediment bed
TOXW.INP	Initial Conditions	Metals in water column
TXSER.INP	Time Series	Toxic
WINDMAP.INP	Initial Conditions	Wind map
WSER.INP	Time Series	Wind

Table 2. Output Files

OUTPUT FILE	FILE TYPE	DESCRIPTION
BEDINIT.POR	Default	Initial sediment bed porosity
BEDINIT.SAN	Default	Initial noncohesive sediment in bed
BEDINIT.SED	Default	Initial cohesive sediment in bed
BEDINIT.TOX	Default	Initial toxic in sediment bed
BEDINIT.VDR	Default	Initial sediment bed void ratio
BEDINIT.VRS	Default	Initial cohesive sediment bed void ratio
BEDINIT.ZHB	Default	Initial sediment bed elevation and thickness
BEDINITC.VVF	Default	Initial sediment bed properties
BEDINITF.VVF	Default	Initial sediment bed properties
BEDTSxxx.OUT	Time Series	Sediment bed properties
DYETSxxx.OUT	Time Series	Dye concentration
EFDC.OUT	Default	Input echo file
EFDCLOG.OUT	Default	Iteration information
LIJMAP.OUT	Default	Model grid cell l, i, and j indexes
NEGSEDSND.OUT	Default	Warning file for negative sed and snd
SALTSxxx.OUT	Time Series	Salinity
SBL01TSxxx.OUT	Time Series	Sediment bed load
SEDTSxxx.OUT	Time Series	Cohesive sediment
SELTSxxx.OUT	Time Series	Water surface elevation and depth
SND01TSxxx.OUT	Time Series	Noncohesive sediment
TIME.LOG	Default	Computation time log
TOX**TSxxx.OUT	Time Series	Total metal in four water column layers and four sediment bed layers
TXBC**TSxxx.OUT	Time Series	DOC complex metal in sediment bed
TXBF**TSxxx.OUT	Time Series	Dissolved metal in sediment bed
TXBP**TSxxx.OUT	Time Series	Particulate metal in sediment bed
TXBT**TSxxx.OUT	Time Series	Total metal in sediment bed
TXWC**TSxxx.OUT	Time Series	DOC complex metal in water column
TXWF**TSxxx.OUT	Time Series	Dissolved metal in water column
TXWP**TSxxx.OUT	Time Series	Particulate metal in water column
TXWT**TSxxx.OUT	Time Series	Total metal in water column
U3DTSxxx.OUT	Time Series	u-velocity for all layers
UVETSxxx.OUT	Time Series	u- and v- depth-averaged velocity
V3DTSxxx.OUT	Time Series	v-velocity for all layers
VSFP1.OUT	Vertical Profiles	Vertical concentration profiles by depth
VSFP2.OUT	Vertical Profiles	Vertical concentration profiles by layer
WATINIT.SAN	Default	Initial noncohesive sediment in water column
WATINIT.SED	Default	Initial cohesive sediment in water column
WINDSHELT.OUT	Default	Initial wind stresses

xxx = ID number of time series output location

** = ID number of toxic (e.g., chromium, copper, lead, and zinc)

3.2 SPECIFYING SIMULATION CONTROLS

Each simulation is controlled by the input file, EFDC.INP, which contains all the information needed to run a particular simulation. This file is a text file and uses metric units. Model parameters and controls are specified by control cards, which group variables using a line specific format (i.e., the model needs the parameters or variables to be on a certain line to read the information properly). Each card begins with header lines indicating the card name and number, followed by a list of card variables and descriptions, variable order, then the numeric values of the model variables. Card 6 of EFDC.INP controls what constituents are being simulated (i.e., which options are turned “on”). As an example, Figure 2 shows the Card 6 of the EFDC.INP file for the dry weather calibration simulation. On this card, the variable ISTRAN is the switch to activate the transport options (1=activate). Each line of variables corresponds to a transport option indicated by the abbreviations on the far right column. Transport options are turbulence (turb), salinity (sal), temperature (tem), dye (dye), shellfish (sfl), toxics (tox), cohesive sediment (sed), noncohesive sediment (snd), and water quality (cwq). For the dry weather calibration, turbulence, salinity, dye, toxics, cohesive sediment, and noncohesive sediment are simulated. Note in the figure that lines for all nine transport options are required even if the option is not being used.

In the DCEM, the four metals are simulated as toxics. The number of toxic contaminants is indicated by NTOX in Card 22. The number of cohesive and noncohesive sediment classes to be simulated is indicated by NSED and NSND which are also in Card 22.

3.3 CHANGING SIMULATION TIME

EFDC uses Julian days (JD) for all time related parameters (e.g., simulation start time and input time series). For the DCEM, Julian day 1.0 is midnight January 1, 2005 (UTC). The dry weather calibration and verification simulations have a 30-day spin-up period followed by a 30-day calibration/verification period. The wet weather calibration simulation also has a 30-day spin-up period but only a 17-day of calibration period. Table 3 below summarizes the dates for all the three simulations in both calendar and Julian dates.

C6	DISSOLVED AND SUSPENDED CONSTITUENT TRANSPORT SWITCHES										Control Card Header	
C6	TURB INT=0 , SAL=1 , TEM=2 , DYE=3 , SFL=4 , TOX=5 , SED=6 , SND=7 , CWQ=8											
C												
Variable Descriptions	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	Variable Order	
	1	0	0	0	0	0	0	0	0	0		
	1	1	0	0	0	0	0	0	0	0	!turb	0
	0	0	0	0	0	0	0	0	0	0	!sal	1
	1	1	0	0	0	0	0	0	0	0	!tem	2
	0	0	0	0	0	0	0	0	0	0	!dye	3
	1	0	0	1	1	0	0	0	0	0	!sfl	4
	1	1	0	1	1	0	0	0	0	0	!tox	5
	1	1	0	1	1	0	0	0	0	0	!sed	6
	1	1	0	1	1	0	0	0	0	0	!snd	7
	0	0	0	0	0	0	0	0	0	0	!cwq	8

Figure 2. EFDC.INP Control Card Example

Table 3. Simulation Periods

SIMULATION	SPIN-UP PERIOD		SIMULATION PERIOD	
	CALENDAR DATE (UTC)	JULIAN DATES	CALENDAR DATE (UTC)	JULIAN DATES
Dry Weather Calibration	Apr 17 – May 16, 2005	107 – 136	May 17 – Jun 16, 2005	137 – 167
Dry Weather Verification	Jul 19 – Aug 17, 2005	200 – 229	Aug 18 – Sep 17, 2005	230 – 260
Wet Weather Calibration	Jan 26 – Feb 26, 2006	393 – 422	Feb 27 – Mar 16, 2006	423 – 440

Simulation time controls are specified on Cards 7 and 8 in the EFDC.INP file. Cards 7 and 8 used for the Dry Weather Simulation are shown in Figure 3 as an example. The total simulation time in days is specified by NTC. The starting time in Julian day is indicated by TBEGIN. The calculation time step is set to a 6-second interval by specifying the variable NTSPTC on Card 7, which is the number of time steps per day. The simulation starting date and time period includes a 30-day spin-up time, however the output time frames are limited to the desired calibration periods, which are discussed in Section 8. A list of the pertinent time control variables is provided in Table 4.

Changing the simulation time requires replacing variables NTC and TBEGIN. Keep in mind that TBEGIN must be consistent with the input time series (e.g., tide boundary) and contain input data for the entire simulation period, as discussed in Sections 6 and 7.

Table 4. Time Controls

TIME PARAMETER	CONTROL CARD	VARIABLE	DRY WEATHER CALIBRATION	DRY WEATHER VERIFICATION	WET WEATHER CALIBRATION
Simulation Time (days)	7	NTC	60	60	47
Starting Time (Julian day)	8	TBEGIN	107	200	393
Calculation Time Step	7	NTSPTC	14400	14400	14400


```

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 NO BUOYANCY FORCING
  NTCVB:  NUMBER OF REF TIME PERIODS WITH VARIABLE BUOYANCY FORCING
  NTSMMT: 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 5s=17280,10s=8640,12s=7200,15s=5760,30s=2880,40s=2160,60s=1440,120s=720,180s=480,300s=288
C7 NTC NTSPTC NLTC NTTC NTCPP NTSTBC NTCNB NTCVB NTSMMT NFLTMT NDRYSTP IYEAR IMONTH IDAY |
   60 14400 2 2 800 4 2 2 288000 1 16 2005 1 1
-----
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 FILE efdc.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
  DTSSFAC: DYNAMIC TIME STEPPING IF 0.0.LT.DTSSFAC.LT.1.0
C JULIAN DAY 1.0 = JANUARY 1, 2005
C8 TCON TBEGIN TREF CORIOLIS ISCORV ISCCA ISCFL ISCFLM DTSSFAC
   86400. 107.0 86400. 8.1E-5 0 0 0 0 0.0
-----

```

Figure 3. EFDC.INP Time Parameters for Dry Weather Calibration

3.4 ADJUSTING MODEL PARAMETERS

The calibrated model parameters (dry and wet weather) and the respective cards for the DCEM are shown in Table 5. It is not necessary to modify these calibrated model parameters to use the model; however, a description of how to adjust these parameters is provided here if the user wants to re-calibrate the model using other data.

Table 5. DCEM Calibrated Parameters

MODEL PARAMETER	UNITS	DRY WEATHER	WET WEATHER	EFDC.INP CARD
Roughness Height – Dominguez Channel	m	0.03		11
Roughness Height – Harbor and Ocean	m	0.02		11
Horizontal Eddy Viscosity	m ² /sec	1E-6		12
Maximum Vertical Kinematic Viscosity	m ² /sec	2E-3		12
Maximum Vertical Eddy Diffusivity	m ² /sec	1E-4		12
Anti-Diffusion Correction for Hydrodynamics	--	Off		6
Anti-Diffusion Correction for Salinity	--	Off		6
Anti-Diffusion Correction for Dye	--	Off		6
Anti-Diffusion Correction for Cohesive Sediment	--	On		6
Anti-Diffusion Correction for Noncohesive Sediment	--	On		6
Anti-Diffusion Correction for Metals	--	On		6
Sediment Settling Velocity	m/sec	3E-6		39
Chromium Equilibrium Partition Coefficient	L/mg	0.9	0.44	45
Copper Equilibrium Partition Coefficient	L/mg	0.18	0.18	45
Lead Equilibrium Partition Coefficient	L/mg	2.5	2.5	45
Zinc Equilibrium Partition Coefficient	L/mg	0.13	0.03	45

A spatially varying roughness height was used and specified in the DXDY.INP file. A roughness height is specified for each cell by variable ZROUGH (column 7 of data). Additional roughness height variables are ZBRADJ and ZBRCVT in Card 11 of the EFDC.INP file. ZBRADJ is an additive factor and ZBRCVT is a scaling factor for ZROUGH in DXDY.INP. Specifying a uniform roughness height can be accomplished by setting ZBRADJ

to the constant value and ZBRCVT to zero. Any other changes can be made to the DXDY.INP file using a text editor. The format of the DXDY.INP is discussed further in Section 4.

The turbulent diffusion parameters for horizontal eddy viscosity (AHO), maximum vertical kinematic viscosity (AVO), and maximum vertical eddy diffusivity (ABO) are found on Card 12 of the EFDC.INP file.

Anti-numerical diffusion correction options are defined by variables ISADAC and ISFCT on Card 6 of the EFDC.INP. The anti-diffusion correction options are activated by setting the variable to 1. The anti-diffusion options for the dry weather calibration were shown previously in Figure 2 and are activated for toxics, cohesive sediment, and noncohesive sediment.

The cohesive sediment settling velocity is defined by variable WSEDO on Card 39. The noncohesive sediment settling velocity found on Card 41 is set to be internally computed based on the sediment grain size by variable WSNDO.

Toxic contaminants simulated in the DCEM are chromium, copper, lead, and zinc. The equilibrium partition coefficients for these metals are specified by variable TOXPARG on Card 45 of the EFDC.INP file. Card 45 contains eight lines of variables corresponding to the metal and equilibrium partition coefficient for each sediment class. The variable NTOXN indicates the toxic contaminant ID number, 1 for chromium, 2 for copper, 3 for lead, and 4 for zinc. The second variable NSEDN is the sediment class ID number, 1 for cohesive sediment and 2 for noncohesive sediment. TOXPARG is the equilibrium partition coefficient in the water column with units of L/mg. TOXPARG is the equilibrium partition coefficient in the sediment bed. For cohesive sediment associated parameters, TOXPARG was set at one-tenth of water column equilibrium partition coefficient TOXPARG. No association was specified for noncohesive sediment.

Other general model parameters are found in the EFDC.INP control file. The DCEM uses a three time level integration, as specified by ITIMSOL on Card 1A. Diagnostic options are found on Card 2. Grid parameters are located on Cards 9 through 11 (discussed in Section 4). The turbulence closure option is defined by ISSTAB on Card 12A. The coriolis parameter is $8.1\text{E-}5$ /sec defined by CORIOLIS on Card 8. Buoyancy and temperature parameters are found on Card 46. Sediment parameters are located on Cards 36 through 42A and toxic parameters on Cards 43 – 45D. Inputs related to concentration boundary conditions are on Cards 47 through 66. Output options are located on Cards 70 through 90.

3.5 RECOMPILING EXECUTABLE FILE

The DCEM executable file, DCEMEFDC.exe, is provided in each simulation folder and can be used directly or through a MS-DOS prompt. It takes about 19 hours 30 minutes for a 60-day simulation (dry weather calibration and verification) and about 8 hours and 30 minutes for a 47-day simulation (wet weather simulation) using a Personal Computer (PC) with a CPU speed of 3.8 GHz.

The DCEM executable has been compiled using Intel Fortran and parameters have been adjusted to accommodate the DCEM requirements. The DCEM executable file provided was compiled in release mode and does not contain debugging features. This requires the user to ensure that all model input parameters are within the allowable limits summarized in Table 6.

Table 6. Limitation in Parameter File

PARAMETER TYPE	MODEL INPUT	EFDC.PAR VARIABLE	LIMIT
Grid	i cell index in cell.inp	ICM	80
	j cell index in cell.inp	JCM	320
	Number of vertical layers	KCM	10
	Number of sediment bed layers	KBM	10
	Number of water grid cells	LCM	5,000
Time Series	Number of concentration time series of any concentration variable	NCSERM	35
	Number of data points in the longest time series	NDQSER	100,000
	Number of south open surface elevation boundaries	NPBSM	60
	Number of surface elevation time series	NPSERM	4
	Number of volumetric source-sinks	NQSIJM	720
	Number of flow time series	NQSERM	60
	Number of data points in withdraw-return time series	NDQWRSR	2,000
	Number of wind time series	NWSERM	
	Number of data points in wind time series	NDWSER	80,000
Sediment	Number of cohesive sediment classes	NSCM	1
	Number of noncohesive sediment classes	NSNM	4
Toxic	Number of toxic constituents	NTXM	4
Output	Time series output locations	MLTMSRM	99
	Depths for vertical profiles	MDVSM	200
	Number of vertical profiles	MTVSM	1,200

The EFDC source code files listed below are provided for the user to recompile the executable files as needed. For most applications (e.g. changing the simulation periods, adjusting the calibrated parameters, or using different initial conditions), the user does not need to recompile the DCEM executable. The user needs to recompile the DCEM only if the parameter limits shown in Table 6 are exceeded. An example would be if the user wants to simulate five toxics instead of four, then NTXM in the EFDC.PAR has to be changed to 5 from 4. In this case, the user needs to recompile the model.

- DCEMEFDC.exe – EFDC executable
- EFDC.f – f77 source code
- EFDC.com – common block file
- EFDC.par – parameter file

Compiling of the source code files requires a Fortran 95 compiler, such as:

- Absoft Pro-Fortran MP
- Compaq Visual Fortran 6.0
- Intel Fortran (used to compile DCEM executable file)
- Lahey-Fujitsu F95 Express
- PGI Fortran

4. DCEM GRID

4.1 SETTING UP THE GRID

The primary focus of the DCEM is the estuary portion, which extends from the tidally influence portion of the Dominguez Channel (at Vermont Avenue) down through the Consolidated Slip to the Main Channel of the Port. However, the model domain extends beyond the Estuary to include the entire Harbor Area since the hydrodynamics of the Estuary are dynamically linked to the Harbor Area. The DCEM 3-D grid setup consisted of defining both the horizontal and vertical model domains.

The grid files for the DCEM are CELL.INP, CELLLT.INP, DXDY.INP, and LXLY.INP. These files were generated using an auxiliary program GEFDC.exe, which is provided in the DCEM Grid folder. The folder contains the input and output files needed to regenerate the model grid files. Details pertaining to using GEFDC.exe can be found in Tetra Tech 2002b.

Horizontal Grid

The horizontal model domain of the DCEM is a curvilinear, orthogonal grid in the UTM 11 meters coordinate system and is shown in Figure 4. The estuary portion of the grid, Dominguez Channel, Consolidated Slip, and Cerritos Channel areas, are defined with three cells across the channel. The model grid was designed with a higher resolution (i.e., smaller grid cells) in the estuary portion with progressively larger cells in the Harbor Area and beyond the breakwaters. The model grid contains a total of 2,031 horizontal cells. Horizontal grid parameters are specified on Card 9 in the EFDC.INP file.

The grid files CELL.INP, CELLLT.INP, DXDY.INP, and LXLY.INP contain information for the horizontal model domain. Each model cell is identified by an l-index, i-index, and j-index. The DCEM grid can be reduced to a row and column format of water, land, and boundary cells, which is stored in the CELL.INP file. The l-index is a sequential numbering of all the cells starting at 2 and provides the order of the cells used in the input files. The i- and j-indexes are the column and row numbers of the cells in the CELL.INP file, respectively. CELLLT.INP is a duplicate copy of the CELL.INP that is required, but not used. Additional information on these grid files can be found in Tetra Tech 2002b.

The DXDY.INP file contains the grid cell dimensions (x, y, and z), as well as roughness height, bottom elevation, and initial water depth. Data for each cell specified in sequential

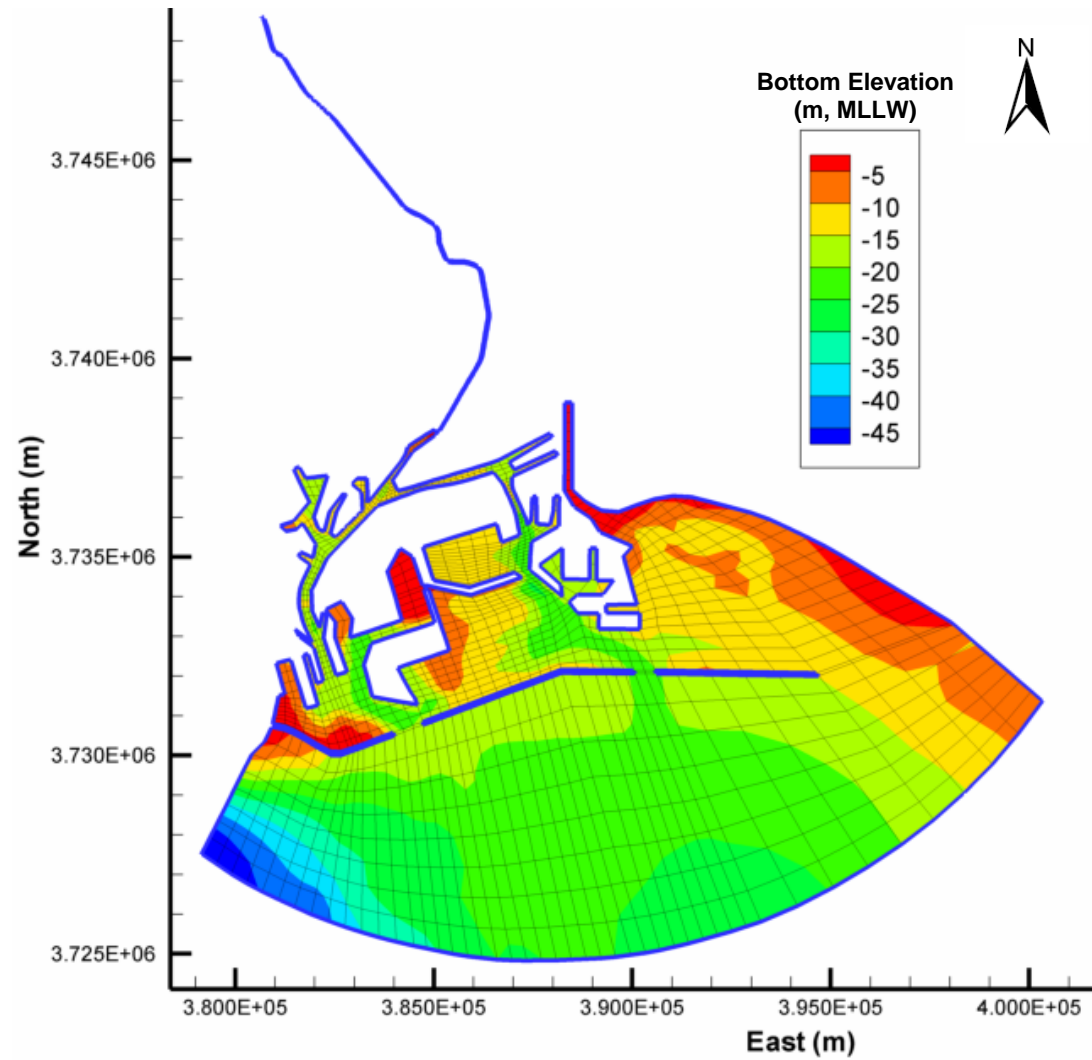


Figure 4. DCEM Model Grid and Bathymetry

order by the l-index, i-index, j-index, dx, dy, initial depth, bottom elevation, roughness height, and vegetation type. The LXLY.INP file stores the grid cell location and alignment.

Vertical Grid

EFDC uses a stretched or sigma vertical coordinate. In other words, each model grid cell is divided into the same number of vertical layers regardless of the water depth. The DCEM was specified with five, equally-spaced vertical layers in the water column. For example, a cell with a water depth of 5 meters is represented by five 1-m layers and a cell with a water depth of 20 meters is represented by five 4-m layers. The vertical grid specifications are found in Cards 9A and 10 in EFDC.INP by variables KC, K, and DZC. KC is the number of vertical layers, K is the layer number, and DZC is the dimensionless layer thickness. The bottom layer is specified as the first layer (K=1) and the surface layer as the last layer (K=5).

Sediment Bed

The sediment bed layers are defined using Cards 36 through 38 in the EFDC.INP, as well as additional input files, BEDBDN.INP, BEDDDN.INP, and BEDLAY.INP, which are used to set up the initial sediment bed. BEDBDN.INP contains the initial bed bulk density in kg/m^3 . The porosity of the sediment layers is contained in the BEDDDN.INP file, which was specified uniformly as 0.3. BEDLAY.INP contains the sediment layer thickness in meters that was specified with four uniform bed layers.

To modify the sediment bed layers, the three initial sediment bed files, BEDBDN.INP, BEDDDN.INP, and BEDLAY.INP, can be edited using a text editor. Each file contains eight comment lines followed by a header line with three variables. The third variable indicates the number of sediment bed layers. Increasing or decreasing the number of bed layers requires providing the necessary data for the new number of layers, in turn requires making changes to the initial sediment and toxic concentrations in the bed, which is discussed later in Section 5.

4.2 UPDATING BATHYMETRY

Bathymetry data for the DCEM were a composite of data from various sources. As shown in Figure 5, bathymetry data for the Dominguez Channel were from a POLA March 2006 survey. The U.S. Army Corps of Engineers (USACE) survey data for the Los Angeles Channel Deepening Project conducted in 2005 were used for the Main Channel and parts of the Los Angeles Harbor. The rest of the model domain was based on the 2004 NOAA Charts (Numbers 18749 and 18751), supplemented by other survey data conducted by USACE in 2001.

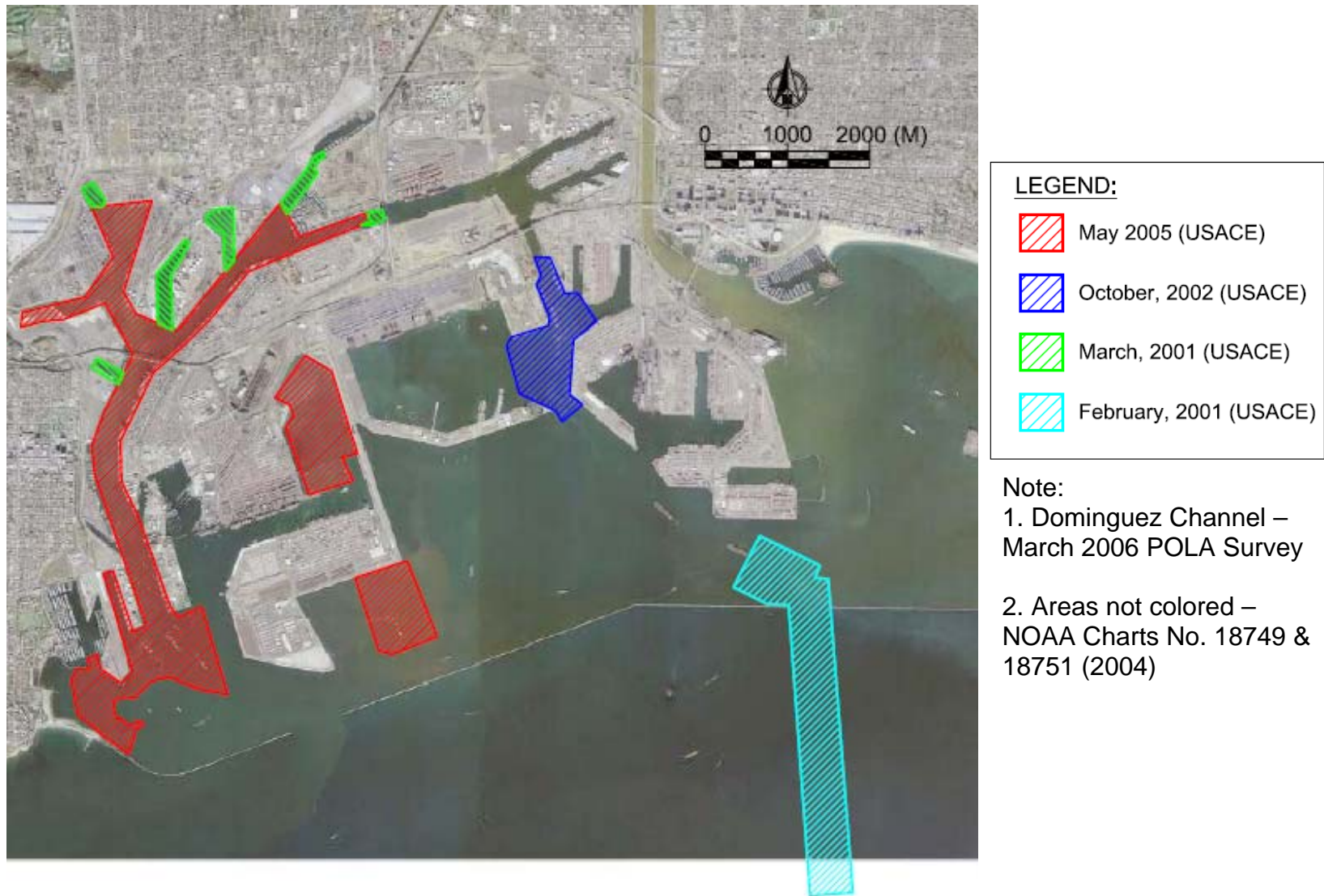


Figure 5. Bathymetry Data Sources

Updating the bathymetry requires regenerating the DXDY.INP file, which contains the bottom elevation and initial water depth of the grid cells, using the auxiliary program GEFDC.exe. Bathymetry data (x,y,z format) are contained in the file, DEPDAT.INP. Prior to adding new bathymetry data, data points in the original file contained within the area of the new data must be removed from the dataset. The GEFDC.exe control file GEFDC.INP also must be updated by specifying the new number of data points in variable NDEPDAT on Card 11.

4.3 ADDING AND REMOVING FLOW LOCATIONS

Flows and loadings from Dominguez Channel Watershed are represented by 19 inflow locations as shown in Figure 6. However, inflow time series were specified at 21 locations because the Vermont Avenue inflow was specified across three channel cells. A list the storm drains simulated in the DCEM, the drainage areas, and the corresponding grid cell locations are provided in Table 7.

Table 7. Storm Drain Inflows for DCEM

STORM DRAIN	DRAINAGE AREA (km ²)	INPUT CELL (i,j)
Vermont Avenue	103.36	18, 300 19, 300 20, 300
Victoria Street	15.19	20, 280
Gladwick Street	11.77	20, 240
213 th Street	30.32	18, 215
223 rd Street	8.11	20, 182
Johns Manville Street	5.90	20, 156
Sepulveda	4.34	18, 137
PCH	2.07	20, 110
Anaheim Street	5.14	20, 90
Blinn Avenue	4.60	18, 70
Slip 5	1.60	14, 53
Slip 1	1.46	16, 45
West Basin	66.99	12, 48
Battery Street	15.27	12, 40
Main Channel	1.07	18, 31
West Channel	14.29	12, 22
Channel No. 2	3.34	42, 57
Pier 300 & Pier T	0.71	40, 50
Pier D - J	1.10	14, 51

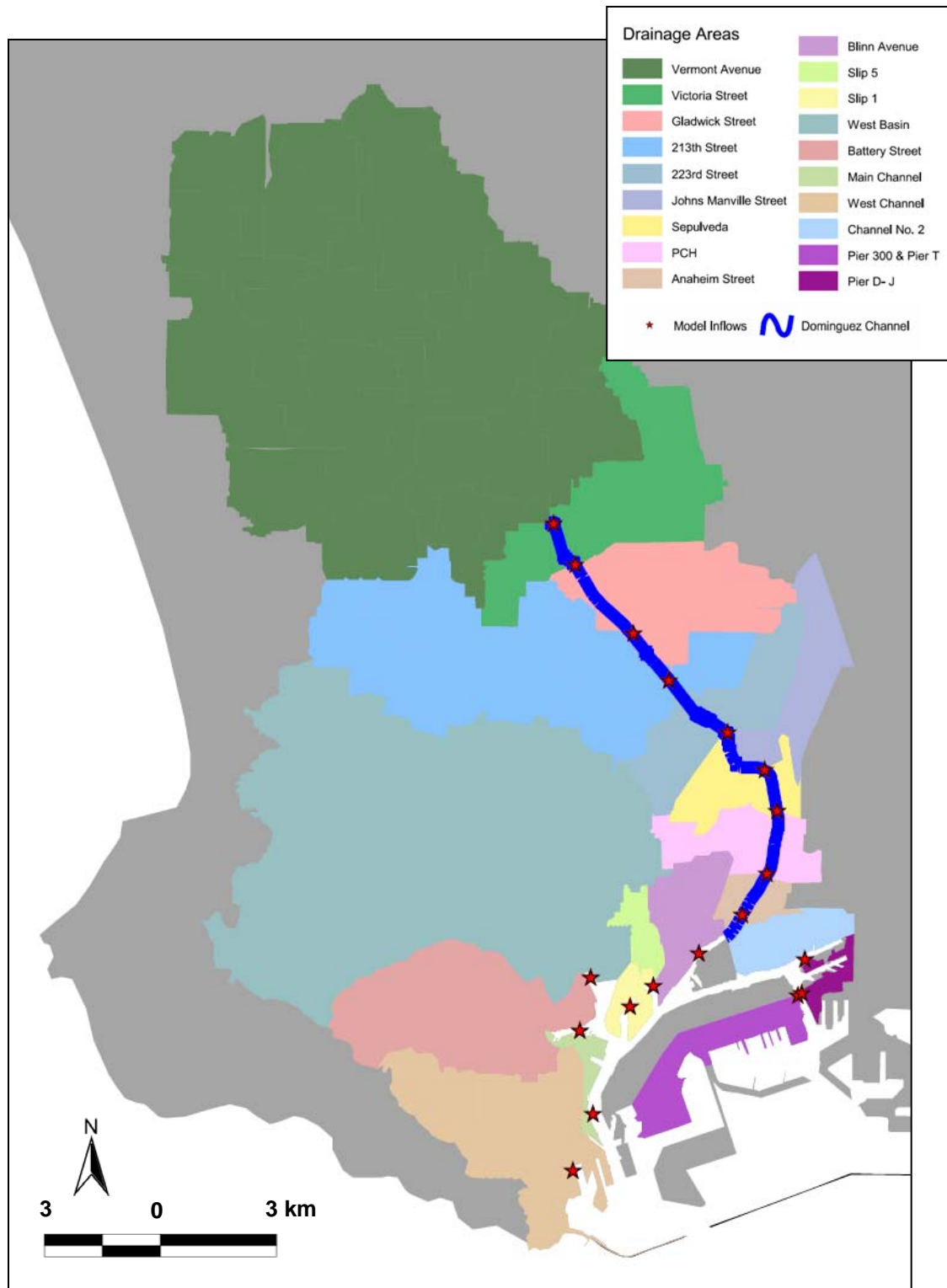


Figure 6. Storm Drain Drainage Areas and Model Inflow Locations

For the dry weather calibration, the dye simulation required specifying an inflow with a corresponding dye concentration. An additional 19 inflows were specified, one for the dye release and 18 for the two dye patches. Details about the dye release locations can be found in a separate report prepared for DCEMS (Everest 2006).

In the EFDC.INP control file, the total number of flow locations is specified with NQSIJ on Card 23. The input locations (cell i- and j-index) are then listed in Card 24.

Adding or removing flow locations requires modifying Cards 23 through 26 in the EFDC.INP file. The new number of flow locations is specified on Card 23 (NQSIJ). The flow location should be added or removed from Card 24. Likewise, the number of data lines on Cards 25 and 26 should be equal to the number of flow locations.

4.4 ADJUSTING POWER STATION FLOW

The Harbor Generating Station is the only power station currently operating in the Harbor Area that requires cooling water for a steam turbine (Unit 5). The Harbor Generating Station draws cooling water from the northwest corner of Slip 5 and discharges in the northeast corner of the West Basin. This was simulated as a withdraw-return flow using the design flow rate of 4.73 m³/sec (108 MGD).

The number of withdraw-return flows is specified by variable NQWR on Card 23 of the EFDC.INP file. The cell location and constant flow rate are then specified using Card 33. The flow rate can be adjusted by the variable QWRE. To remove the Harbor Generating Station flow, set NQWR on Card 23 to zero and delete the values for Card 33.

5. INITIAL CONDITIONS

5.1 ESTABLISHING INITIAL CONDITIONS

Initial conditions for water depth, salinity, dye, sediment, and metals must be specified in DCEM. For the initial concentration in the water column, uniform concentrations were specified. This is why, for all the simulations, a 30-day “spin-up” period was simulated prior to the calibration/verification simulations such that an initial salinity gradient could be developed. Refer to the model calibration report (Everest 2006) for more discussions on choosing a 30-day spin-up period.

This section summarizes the input files that define the initial conditions and explains how these initial conditions can be modified.

5.2 CHANGING INITIAL WATER DEPTH

The initial water depth is defined based on the tide elevation at the start of the simulation. The starting tide elevation of the three simulations is presented in Table 8. The initial water depth is contained in the input file DXDY.INP. The initial water depth is specified in column 5 of the DXDY.INP file for all model cells and is calculated as the difference between the initial water elevation and the cell bottom elevation. Changing the initial water depth may be required for a different simulation period because the initial tide elevation can be different than those listed in Table 8.

Table 8. Initial Tide Elevations

DCEM SIMULATION	SIMULATION STARTING TIME (JULIAN DAY)	INITIAL TIDE ELEVATION (M, MLLW)
Dry Weather Calibration	107	0.972
Dry Weather Verification	200	1.712
Wet Weather Calibration	393	-0.232

Changing the initial water depth can be done by directly editing the DXDY.INP file using a text editor. Another option is to re-create the DXDY.INP using the grid generation auxiliary program, GEFDC.exe. The initial water elevation is specified by the variable SURFELV in Card 11 of the GEFDC.INP file.

5.3 ADJUSTING INITIAL SALINITY CONCENTRATION

A uniform initial salinity concentration of 33.5 PSU is specified in the file SALT.INP. The file contains the initial salinity concentration in each layer of all water cells. A portion of the SALT.INP file is shown in Figure 7. The format requires data of I-cell index, i-cell index, j-cell index, and salinity concentrations in layers 1 through 5 for each grid cell. This format is used for all initial concentration files. Modifications of the initial salinity concentrations can be done by directly editing the values with a text editor.

5.4 CHANGING INITIAL DYE CONCENTRATION

The dry weather calibration included a dye simulation, which requires defining an initial dye concentration. The initial dye concentration was specified as zero in the DYE.INP file, which contains the initial dye concentrations. The file uses the same format as the initial salinity. Modifications to the initial dye concentrations can be done by directly editing the values using a text editor.

5.5 MODIFYING INITIAL SEDIMENT CONCENTRATIONS

Water Column

An initial concentration of 3.9 mg/L for cohesive sediment was specified in the file, SEDW.INP. The constant initial concentration of 0 mg/L for noncohesive sediment is found in the SNDW.INP file. Both files use the same format as the initial salinity and dye. Modifications to the initial sediment concentrations can be done by directly editing the values using a text editor.

Sediment Bed

The sediment composition of the sediment bed is defined by the files, SEDB.INP and SNDB.INP. As mentioned previously, the sediment bed was setup with four layers. For the surface layer of the sediment bed, the initial sediment composition was specified by the fractions of cohesive and noncohesive sediments. Bed sediment fractions of 70% sands and

Header Lines			Initial Concentrations for 5 layers				
DOMINGUEZ CHANNEL ESTUARY MODEL			INITIAL SALINITY CONCENTRATION				
1							
2	11	3	33.5	33.5	33.5	33.5	33.5
3	12	3	33.5	33.5	33.5	33.5	33.5
4	13	3	33.5	33.5	33.5	33.5	33.5
5	14	3	33.5	33.5	33.5	33.5	33.5
6	15	3	33.5	33.5	33.5	33.5	33.5
7	16	3	33.5	33.5	33.5	33.5	33.5
8	17	3	33.5	33.5	33.5	33.5	33.5
9	18	3	33.5	33.5	33.5	33.5	33.5
10	19	3	33.5	33.5	33.5	33.5	33.5
11	20	3	33.5	33.5	33.5	33.5	33.5
12	21	3	33.5	33.5	33.5	33.5	33.5
13	22	3	33.5	33.5	33.5	33.5	33.5
14	23	3	33.5	33.5	33.5	33.5	33.5
15	24	3	33.5	33.5	33.5	33.5	33.5
16	25	3	33.5	33.5	33.5	33.5	33.5
17	26	3	33.5	33.5	33.5	33.5	33.5
18	27	3	33.5	33.5	33.5	33.5	33.5
19	28	3	33.5	33.5	33.5	33.5	33.5
20	29	3	33.5	33.5	33.5	33.5	33.5
21	30	3	33.5	33.5	33.5	33.5	33.5
22	31	3	33.5	33.5	33.5	33.5	33.5
23	32	3	33.5	33.5	33.5	33.5	33.5
24	33	3	33.5	33.5	33.5	33.5	33.5
25	34	3	33.5	33.5	33.5	33.5	33.5
26	35	3	33.5	33.5	33.5	33.5	33.5
27	36	3	33.5	33.5	33.5	33.5	33.5
28	37	3	33.5	33.5	33.5	33.5	33.5
29	38	3	33.5	33.5	33.5	33.5	33.5
30	39	3	33.5	33.5	33.5	33.5	33.5
31	40	3	33.5	33.5	33.5	33.5	33.5
32	41	3	33.5	33.5	33.5	33.5	33.5
33	42	3	33.5	33.5	33.5	33.5	33.5
34	43	3	33.5	33.5	33.5	33.5	33.5
35	44	3	33.5	33.5	33.5	33.5	33.5
36	45	3	33.5	33.5	33.5	33.5	33.5
37	46	3	33.5	33.5	33.5	33.5	33.5
38	47	3	33.5	33.5	33.5	33.5	33.5
39	48	3	33.5	33.5	33.5	33.5	33.5
40	49	3	33.5	33.5	33.5	33.5	33.5
41	50	3	33.5	33.5	33.5	33.5	33.5
42	51	3	33.5	33.5	33.5	33.5	33.5
43	52	3	33.5	33.5	33.5	33.5	33.5
44	53	3	33.5	33.5	33.5	33.5	33.5
45	54	3	33.5	33.5	33.5	33.5	33.5
46	55	3	33.5	33.5	33.5	33.5	33.5
47	56	3	33.5	33.5	33.5	33.5	33.5
48	11	4	33.5	33.5	33.5	33.5	33.5
49	12	4	33.5	33.5	33.5	33.5	33.5
50	13	4	33.5	33.5	33.5	33.5	33.5
51	14	4	33.5	33.5	33.5	33.5	33.5
52	15	4	33.5	33.5	33.5	33.5	33.5
53	16	4	33.5	33.5	33.5	33.5	33.5
54	17	4	33.5	33.5	33.5	33.5	33.5
55	18	4	33.5	33.5	33.5	33.5	33.5
56	19	4	33.5	33.5	33.5	33.5	33.5
57	20	4	33.5	33.5	33.5	33.5	33.5

Figure 7. Initial Concentration Example – SALT.INP

30% fines were used for the Dominguez Channel. The sediment bed in the Consolidated Slip was specified as 10% sands and 90% fines, while the Cerritos Channel was set at 30% sands and 70% fines. For the rest of the model domain, the sediment bed surface layer was specified as 100% sands. The remaining three sediment layers were also specified as 100% sands. The initial sediment composition can be modified by directly editing the values using a text editor.

5.6 MODIFYING INITIAL METAL CONCENTRATIONS

Water Column

Initial metal concentrations in the water column are specified for chromium, copper, lead, and zinc in the file TOXW.INP. The file format is similar to other initial conditions files. However initial concentrations are repeated for each metal, which corresponds to the order listed on Card 43 of the EFDC.INP file. Uniform initial conditions of 1.8, 1.7, 1.1, and 10.2 µg/L were specified for chromium, copper, lead, and zinc, respectively. Modifications to the initial metal concentrations can be done by directly editing the values using a text editor.

Sediment bed

For the sediment bed, metal concentrations were only specified in the surface layer, but spatially varied. The initial metal concentrations in the sediment bed are specified in the file TOXB.INP, which has a similar format as the initial metal concentrations for the water column. The initial metal concentrations in the Dominguez Channel, which are cells with a j-index ranging between 79 and 300, were 67.91, 95.33, 179.25, and 384.06 µg/L for chromium, copper, lead, and zinc, respectively. For the Consolidated Slip, the initial metal concentrations in the sediment bed were 245.68, 408.36, 360.22, and 1137.33 µg/L for chromium, copper, lead, and zinc, respectively. For the rest of the model domain including the other three sediment bed layers, the sediment bed was specified with metal concentrations of essentially zero (EFDC does not allow initial metal concentrations in the bed to be numerically zero). Modifications to the initial sediment bed metal concentrations are done by directly editing the values using a text editor.

6. BOUNDARY CONDITIONS

6.1 SPECIFYING TIDE BOUNDARY

The DCEM was set up with an open, surface elevation boundary on the south face of the model domain, as shown in Figure 8. The tidal water elevations obtained from the NOAA Los Angeles Outer Harbor gage (9410660) was used to specify water elevations at this south boundary. The total number of cells on the south boundary of 46 is specified by variable NPBS on Card 18. Variable NPSE on Card 18 indicates the number of surface elevation time series found in the tide file, PSER.INP. The cells of the south boundary, which are the cells with a j-index of 3, are listed on Card 18 of the EFDC.INP file. Variable NPSEs on Card 18 corresponds to the surface elevation time series for that boundary cell.

Changing the tide boundary condition requires changing the time series in the PSER.INP file using a text editor. The time series uses time in Julian days and water elevation consistent with the bathymetry data. Changes in the starting tide elevation of a simulation also require updating the initial water depth, as previously discussed.

6.2 SPECIFYING CONCENTRATION BOUNDARY

Concentration boundary conditions (e.g., salinity) are also required for the open boundary specified on the south face of the model domain (i.e., tide ocean boundary). The total number of cells on the south boundary (46) is defined by variable NCBS on Card 46 in the EFDC.INP file. The cells of the south boundary are then listed on Card 47 of the EFDC.INP file, which are the same cells defined for the tide boundary. For each cell, the time series ID number for the transported concentration are listed, which are discussed in Section 7. Data for the 46 boundary cells are also required on Cards 48 through 51, but were set at zero, since time series concentration boundaries were used.

The dry weather calibration requires concentration boundaries for salinity, dye, cohesive sediment, nonhesive sediment, and metals. These are also required for the dry weather verification and wet weather calibration with the exception of dye.

Modifying the locations of the concentration boundary conditions requires modifying Cards 46 through 51 in the EFDC.INP control file. Changes to the concentration boundary conditions (time series) are discussed in Section 7.

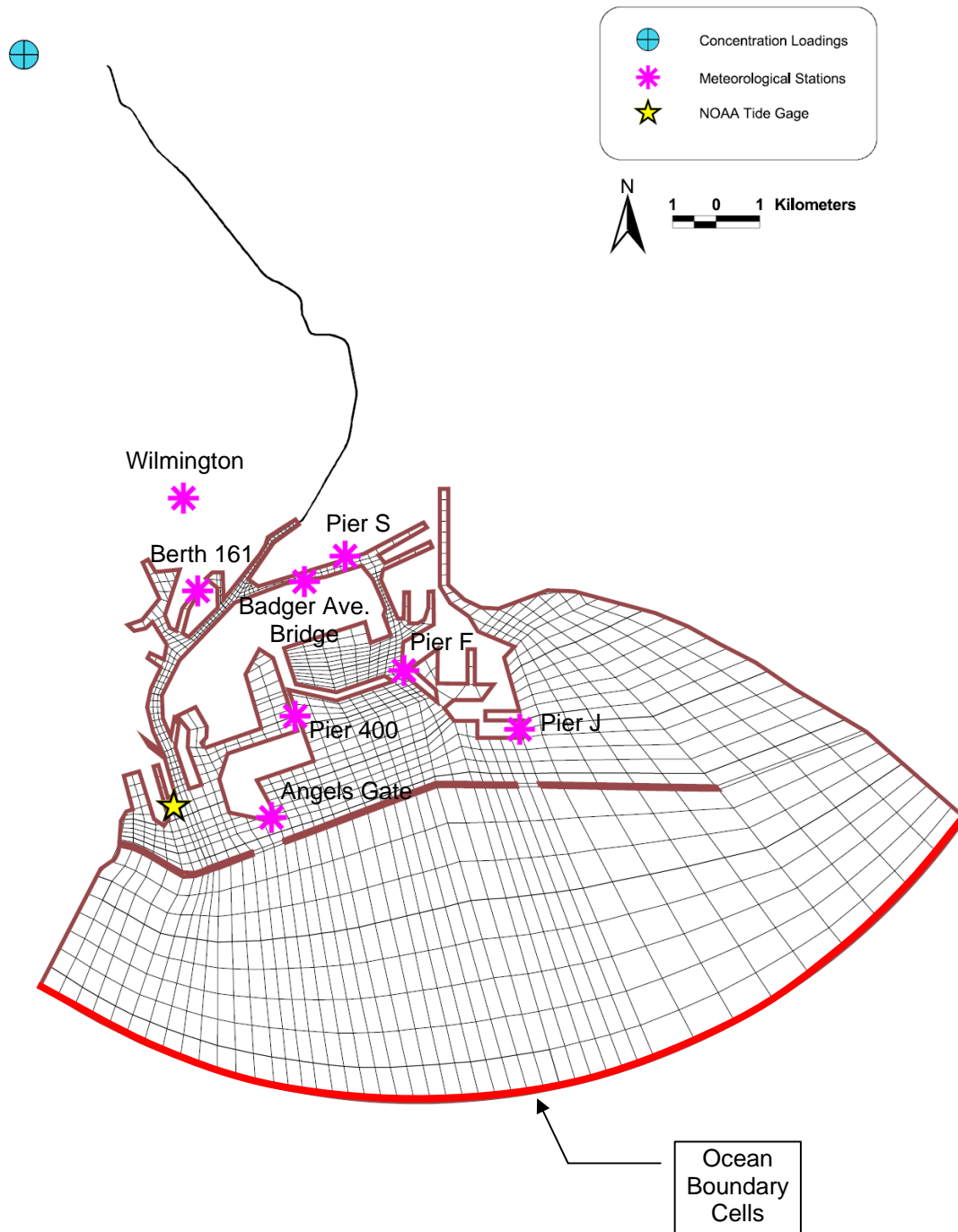


Figure 8. DCEM Boundaries

6.3 CHANGING WIND CONDITIONS

Wind conditions for the DCEM were based on wind data obtained from multiple locations shown in Figure 8. As part of the DCEMS Field Program, meteorological data was measured continuously between February 26, 2005 and March 22, 2006 in the Wilmington community, above Anaheim Street between Bayview and Neptune. Additional meteorological data were obtained from the NOAA National Ocean Service (NOS) real-time oceanographic monitoring data. The Physical Oceanographic Real-Time System (PORTS®) measures and disseminates observations and predictions of water levels and meteorological parameters.

Spatially varying wind conditions were applied based on an inverse distance weighting of eight meteorological stations. Each meteorological station was used for the model grid cells located within a 3-km radius of the station or area of influence. For model grid cells not located within the area of influence for any station, the wind conditions were based on the closest meteorological station. Details for calculating and assigning the wind conditions throughout the model domain can be found in the DCEMS Model Calibration report (Everest 2006).

The meteorological station weighting factors for each model cell are specified in the WNDMAP.INP. This file contains the l-index, i-index, j-index, and the eight weighting factors for each model cell. The order of the weighting factors correspond to the order provided in the wind time series that is summarized in Table 9. For the wet weather calibration, Pier S data were not available, thus the weighting factors were based on seven meteorological stations. Changes to the wind boundary conditions (time series) are discussed in the following section.

Table 9. Meteorological Stations

TIME SERIES ID	STATION NAME	DATA SOURCE
1	Wilmington	DCEMS Field Program
2	Angels Gate	PORTS® (m0203)
3	Badger Avenue Bridge	PORTS® (m0201)
4	Berth 161	PORTS® (m0202)
5	Pier 400	PORTS® (m0200)
6	Pier F	PORTS® (m0100)
7	Pier J	PORTS® (m0102)
8	Pier S	PORTS® (m0101)

7. TIME SERIES

7.1 MODIFYING INFLOWS

For the DCEM, dry weather inflows proportional to the drainage area were specified for the 19 simulated storm drains and are listed in Table 10. The total number of inflow time series is specified by variable NQSER in Card 23 of the EFDC.INP file. For the dry weather calibration, inflows were specified at the 19 storm drain inflows, as well as 19 inflows corresponding to the dye inputs. Each time series is numbered sequentially in the file and corresponds to the time series ID number in Card 24 (variable NQSERQ) of the control file.

Table 10. Dry Weather Storm Drain Inflows

STORM DRAIN	DRY WEATHER FLOW (m ³ /s)	TIME SERIES ID
Vermont Avenue	0.218294	1
Victoria Street	0.032094	2
Gladwick Street	0.024862	3
213 th Street	0.063952	4
223 rd Street	0.017129	5
Johns Manville Street	0.012479	6
Sepulveda	0.009161	7
PCH	0.004385	8
Anaheim Street	0.010835	9
Blinn Avenue	0.009746	10
Slip 5	0.003410	11
Slip 1	0.003107	12
West Basin	0.141312	13
Battery Street	0.032157	14
Main Channel	0.002286	15
West Channel	0.030204	16
Channel No. 2	0.007069	17
Pier 300 & Pier T	0.001491	18
Pier D - J	0.002320	19

All flow time series are contained in the input file QSER.INP. An example of the first two dry weather time series for the Vermont Avenue and Victoria Street storm drains is shown in Figure 9a. This flow time series file starts with 14 comment lines, which are required but not used by the model. Then each time series is listed, containing two header lines followed by the time series data. The first heading line contains seven variables and a text description of the inflow. The second heading line contains the weighting factors for each vertical layer. For the dry weather calibration and verification simulations, the storm drain inflows used a constant flow for each storm drain.

For wet weather, all inflows were scaled based on the inflow at Vermont Avenue. The QSER.INP contains only one time series. The flows at the 19 storm drains are then scaled using the variable QSFACTOR on Card 24 of the EFDC.INP file, as shown Figure 9b.

7.2 MODIFYING LOADINGS

Loadings associated with the inflows are assigned using concentration time series ID numbers on Card 24 of the EFDC.INP file. The concentration time series ID numbers are specified with variables NSSERQ, NDSERQ, NTXSERQ, NSDSERQ, and NSNSERQ for salinity, dye, toxic, cohesive sediment, and noncohesive sediment, respectively. An example of Card 24 is shown in Figure 9b.

The input concentration time series files are summarized in Table 11. These files contain concentration time series for both loadings, as well as time series used for boundary conditions. The total number of time series contained in each input file is specified in Card 22 of the EFDC.INP file.

All input time series files begin with 15 comments lines that are required, but not used by the model. Similar to the flow time series, each concentration time series contains two header lines followed by the time series data. The exception to this format is the toxic or metals time series in TXSER.INP. Each time series data point contains values for each metal being simulated. As an example, the TXSER.INP file for dry weather is shown in Figure 10.

Table 11. Input Concentration Time Series Files

CONCENTRATION TIME SERIES	INPUT FILE	CARD 22 VARIABLE
Salinity	SSER.INP	NSSER
Dye	DSER.INP	NDSER
Cohesive Sediment	SDSER.INP	NSDSER
Noncohesive Sediment	SNSER.INP	NSNSER
Toxics (Metals)	TXSER.INP	NTXSER

```

C qser.inp file, in free format across line, repeats nqser times, stailw
C
C ISTYP MQSER(NS) TCQSER(NS) TAQSER(NS) RMULADJ(NS) ADDADJ(NS)
C
C if istyp.eq.1 then read depth weights and single value of QSER
C
C (WKQ(K),K=1,KC)
C
C TQSER(M,NS) QSER(M,1,NS) !(mqser(ns) pairs for ns=1,nqser series)
C
C else read a value of qser for each layer
C
C TQSER(M,NS) (QSER(M,K,NS),K=1,KC) !(mqser(ns) pairs)
C DCEMS DRY WEATHER FLOW FOR MAJOR STORM DRAINS (FROM UPSTREAM TO DOWNSTREAM)
1 5 86400. 0. 1.0 0. 0 ! 1-VERMONT AVE
0.0 0.0 0.0 0.0 1.0
-1000.0 0.218294
0.0 0.218294
100.0 0.218294
1000.0 0.218294
10000.0 0.218294
1 5 86400. 0. 1.0 0. 0 ! 2-VICTORIA ST
0.0 0.0 0.0 0.0 1.0
-1000.0 0.032094
0.0 0.032094
100.0 0.032094
1000.0 0.032094
10000.0 0.032094

```

a) QSER.INP – Dry Weather

```

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 VOLUM 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 COHESIVE SEDIMENT CONC TIME SERIES
NSNSERQ: ID NUMBER OF ASSOCIATED NONCOHESIVE SED CONC TIME SERIES
QSFACTOR: FRACTION OF TIME SERIES FLOW NQSERQ ASSIGNED TO THIS CELL
C
C24 IQS JQS QSSE NQSMUL NQSMFF NQSERQ NS- NT- ND- NSF- NTX- NSD- NSN- qsfactor
18 300 0. 0 0 1 2 0 0 0 1 1 1 0.333 !'1-VERMONT'
19 300 0. 0 0 1 2 0 0 0 1 1 1 0.334 !'1-VERMONT'
20 300 0. 0 0 1 2 0 0 0 1 1 1 0.333 !'1-VERMONT'
20 280 0. 0 0 1 2 0 0 0 4 4 1 0.147 !'2-VICTORIA ST'
20 240 0. 0 0 1 2 0 0 0 4 4 1 0.114 !'3-GLADWICK ST'
18 215 0. 0 0 1 2 0 0 0 5 5 1 0.293 !'4-213TH ST'
20 182 0. 0 0 1 2 0 0 0 4 4 1 0.078 !'5-223RD ST'
20 156 0. 0 0 1 2 0 0 0 4 4 1 0.057 !'6-JOHNS MANVILLE'
18 137 0. 0 0 1 2 0 0 0 4 4 1 0.042 !'7-SEPULVEDA'
20 110 0. 0 0 1 2 0 0 0 4 4 1 0.020 !'8-PCH'
20 90 0. 0 0 1 2 0 0 0 4 4 1 0.050 !'9-ANAHEIM ST'
18 70 0. 0 0 1 2 0 0 0 4 4 1 0.044 !'10-BLINN AVE'
14 53 0. 0 0 1 2 0 0 0 4 4 1 0.015 !'11-SLIP 5'
16 45 0. 0 0 1 2 0 0 0 4 4 1 0.014 !'12-SLIP 1'
12 48 0. 0 0 1 2 0 0 0 4 4 1 0.648 !'13-WEST BASIN'
12 40 0. 0 0 1 2 0 0 0 4 4 1 0.148 !'14-BATTERY ST'
18 31 0. 0 0 1 2 0 0 0 4 4 1 0.010 !'15-MAIN CHANNEL'
12 22 0. 0 0 1 2 0 0 0 4 4 1 0.138 !'16-WEST CHANNEL'
42 57 0. 0 0 1 2 0 0 0 4 4 1 0.032 !'17-POLB CHANNEL 2'
40 50 0. 0 0 1 2 0 0 0 4 4 1 0.007 !'18-POLB PIER 300&T'
41 51 0. 0 0 1 2 0 0 0 4 4 1 0.011 !'19-POLB PIER D-J'

```

b) EFDC.INP Card 24 – Wet Weather

Figure 9. Example Flow Time Series

```

C TXSER.INP FILE
C REPEATS NC SER(6) TIMES
C
C InType MCSER(NS,6) TCCSER(NS,6) TACSER(NS,6) RMULADJ(NS,6) ADDADJ(NS,6)
C
C IF InType.EQ.1 THEN READ DEPTH WEIGHTS AND SINGLE VALUE OF CSER (WKQ(K),K=1,KC)
C TC SER(M,NS,6) CSER(M,NS,6) ! (MCSER(NS,6) PAIRS FOR NS=6,NC SER(6) SERIES)
C ELSE READ A VALUE OF SEDIMENT FOR EACH LAYER
C
C DRY WEATHER WATER QUALITY CALIBRATION (5/17/05) - METALS
C CHROMIUM,COPPER,LEAD,ZINC
C
C TC SER(M,NS,6) (CSER(M,K,NS,6),K=1,KC) ! (MCSER(NS,6) PAIRS)
C
C 1 5 86400. 0.0 1.0 0 ! STORM DRAIN SOURCE
C 0.0 0.0 0.0 0.0 1.0
C -1000.0 2.6
C 8.2
C 0.3
C 20.8
C 0.0 2.6
C 8.2
C 0.3
C 20.8
C 100.0 2.6 Chromium
C 8.2 Copper
C 0.3 Lead
C 20.8 Zinc
C 1000.0 2.6
C 8.2
C 0.3
C 20.8
C 10000.0 2.6
C 8.2
C 0.3
C 20.8
C 1 5 86400. 0.0 1.0 0 ! NO LOADING
C 0.0 0.0 0.0 0.0 1.0
C -1000.0 0.0
C 0.0
C 0.0
C 0.0
C 0.0
C 0.0
C 100.0 0.0
C 0.0
C 0.0
C 0.0
C 1000.0 0.0
C 0.0
C 0.0
C 0.0
C 10000.0 0.0
C 0.0
C 0.0
C 0.0
C 0.0
C 1 5 86400. 0.0 1.0 0 ! OCEAN BOUNDARY
C 1.0 1.0 1.0 1.0 1.0
C -1000.0 1.8
C 1.7
C 1.1
C 10.2
C 0.0 1.8
C 1.7
C 1.1
C 10.2
C 100.0 1.8
C 1.7
C 1.1
C 10.2
C 1000.0 1.8
C 1.7
C 1.1
C 10.2
C 10000.0 1.8
C 1.7
C 1.1
C 10.2

```

Figure 10. Example Metals Time Series

8. OUTPUT OPTIONS

8.1 CHANGING OUTPUT LOCATIONS

The output time series controls are found on Cards 84 through 87 in the EFDC.INP file. Output time series files provided are for the six ADP and/or CTD locations that were used for the model calibration, which are shown in Figure 11. The number of locations to generate time series results is specified by MLTMSR and the output frequency by NWTMSR on Card 84.

The start and stop times to write to the time series files are controlled by TSSTRT and TSSTOP on Card 86. Output time frames excluded the 30-day spin up. Time series output locations (cell i- and j-index) are specified on Card 87 of the EFDC.INP file. Adding or removing output locations requires changing the number of output locations (NLTMSR on Card 84) and adding or removing the cell location information on Card 87.

8.2 SELECTING OUTPUT TIME SERIES

Card 87 contains switches to indicate what type of output time series files to generate (activate=1) for each output location. Output files were generated for surface elevation (MTSP), transported concentration variables (e.g., salinity, dye, sediment, and metals) (MTSC), depth-averaged velocity (MTSUE), and velocity vector components (MTSU). The variable CLTS (contained in single quotes) is text description that is reproduced in the output file comment header. The output file names are automatically defined based on the output type and output location. The output location ID is a three-digit number in sequential order listed in Card 87. This ID corresponds to the 'xxx' notation in the list of output files shown previously in Table 2. For the metal concentration time series files, an additional ID in the file name is used to indicate the toxic ID number. This ID corresponds to the '**' notation in the list of output files shown previously in Table 2.

8.3 SPECIFYING VERTICAL PROFILE OUTPUTS

Vertical profile output controls are found on Cards 88 through 90 that can be set to output vertical profile results at a particular simulation time for a specified location. The output file VSFP1.OUT contains vertical profiles based on user-defined depths and VSFP2.OUT contains vertical profiles using each layer depth. The number of user defined depths is indicated by MDVSFP in Card 88. The user defined depths are then listed in Card 89.

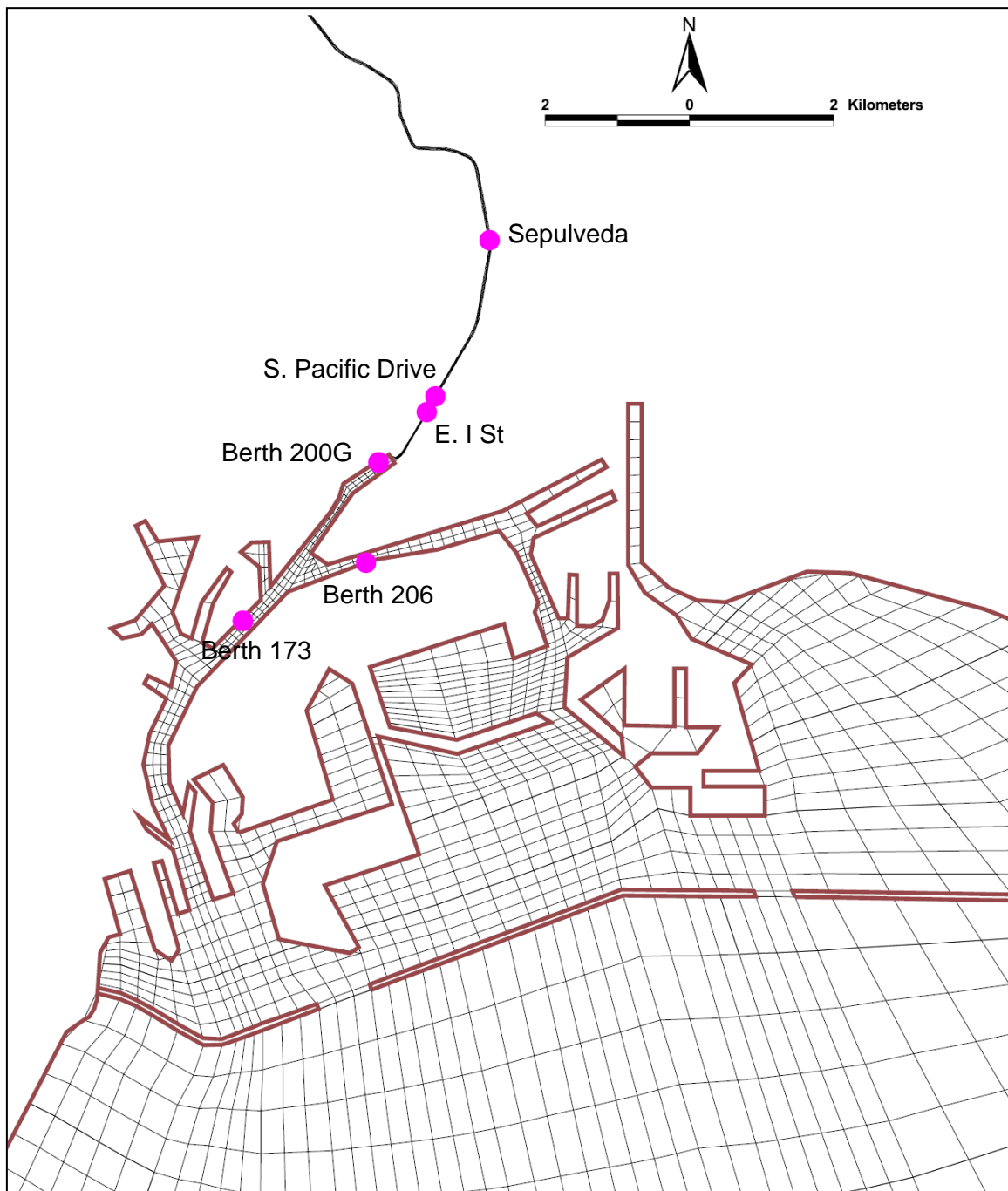


Figure 11. DCEM Time Series Output Locations

Variable MLVSFP on Card 88 is the number of space-time location pairs used to generate the vertical profiles. The time in Julian days and cell location (i- and j-index) are then listed in Card 90.

8.4 CHANGING OUTPUT OPTIONS

Output control options are found on Cards 70 through 90 in the EFDC.INP file. EFDC has other output options as well. Results for the entire model domain can be stored in dump files. Horizontal and vertical contour plots, as well as 3D field outputs can also be generated.

9. REFERENCES

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