# DSM2 Tutorial

An introduction to the Delta Simulation Model II (DSM2)
for simulation of hydrodynamics and water quality of the Sacramento-San Joaquin Delta

California Department of Water Resources
Office of State Water Project Planning
Modeling Support Branch
Delta Modeling Section

DRAFT

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# FOREWARD

This document is an introductory tutorial to the Delta Simulation Model II (DSM2). Please note that many of the input files used in this tutorial have been greatly simplified for illustrative purposes. This tutorial was written by Jamie Anderson and Michael Mierzwa under the supervision of Bob Suits and Paul Hutton.

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# 1 Welcome

This document provides an introductory tutorial on how to use the Delta Simulation Model II (DSM2) developed by the California Department of Water Resources (DWR). Additional information on DSM2 can be found on the DWR Modeling Support Branch website at **http://modeling.water.ca.gov/**.



# 2 Tutorial Introduction

This tutorial includes complete file sets for historical HYDRO and QUAL simulations of October of 1996. Additional exercises will extend the simulations through November 1996. This tutorial will teach you how to run historical simulations for both HYDRO and QUAL. The provided text input files for each simulation will be explained. Exercises are provided to learn how to make common changes to the input files. This tutorial is intended as an introduction to DSM2. See the complete DSM2 documentation for guidance on advanced usage of DSM2

**Tutorial Goals**

- **Run HYDRO and QUAL historical simulation**
- **Understand text input files**
- **Learn how to make common changes to input files**

## 2.1 Download Tutorial Files

The complete set of tutorial files can be downloaded from the site **http://modeling.water.ca.gov/ delta/models/dsm2/**. The tutorial text is available in PDF format, and the tutorial files are available in a zip file.

# 3 DSM2 Overview

## 3.1 DSM2 Overview

**DSM2 Modules**

- **HYDRO**
- **QUAL**
- **PTM**

The Delta Simulation Model II (DSM2) is a one-dimensional mathematical model for dynamic simulation of one-dimensional hydrodynamics, water quality and particle tracking in a network of riverine or estuarine channels. DSM2 can calculate stages, flows, velocities, mass transport processes for conservative and non-conservative constituents including salts, water temperature, dissolved oxygen, and trihalomethane formation potential, and transport of individual particles. DSM2 thus provides a powerful simulation package for analysis of complex hydrodynamic, water quality, and ecological conditions in riverine and estuarine systems.

DSM2 consists of three modules: HYDRO, QUAL, and PTM. The relationship between HYDRO, QUAL and PTM is shown in Figure 3-1. HYDRO simulates one-dimensional hydrodynamics including flows, velocities, depth, and water surface elevations. HYDRO provides the flow input for QUAL and PTM. QUAL simulates one-dimensional fate and transport of conservative and non-conservative water quality constituents given a flow field simulated by HYDRO. PTM simulates pseudo 3-D transport of neutrally buoyant particles based on the flow field simulated by HYDRO. PTM has multiple applications ranging from visualization of flow patterns to simulation of discrete organisms such as fish eggs and larvae.

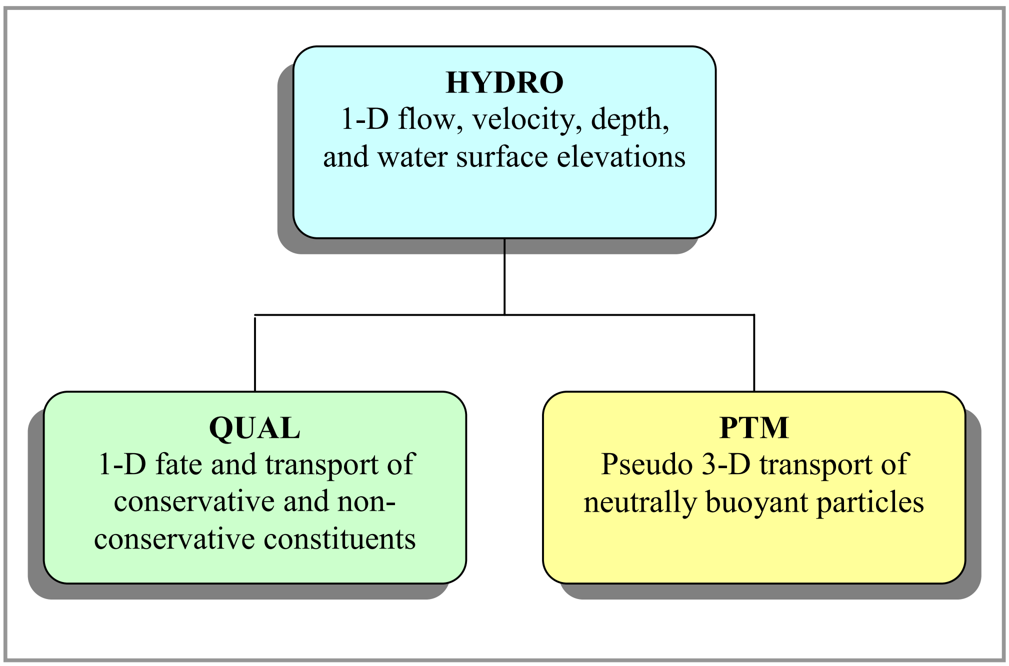



**Figure 3-1: Schematic of DSM2 Modules**

**Only PC based use of DSM2 is covered in this document.**

Although DSM2 can be run on both PC and Unix platforms, this documentation only describes use of DSM2 on the PC platform. This documentation provides an introduction to use of HYDRO and QUAL. Information on the particle tracking module, PTM, can be found on the internet at **http://modeling.water.ca.gov/delta/models/dsm2/ptm/index.shtml**.

## 3.2 DSM2 Study Types

**DSM2**
**Study Types**
- **Historical**
- **Forecasting**
- **Planning**

DSM2 is usually used for three kids of Delta simulations: historic conditions, forecasting future conditions (real-time), and planning studies (Figure 3-2 and Table 3-1). Each type of DSM2 study is briefly described below

**Recreate Historic Conditions**

Historical simulations replicate past operations, hydrologic conditions, water quality and Delta configurations. These historical simulations enable calibration and validation of the model by comparison of simulation results and field data. Historical simulations also augment available field data to provide a more spatially and temporally complete representation of the hydrodynamic and water quality conditions for that time period.

**Forecast Future Conditions**

Forecasting simulations, also known as real-time simulations, use recent field data and forecast data to project Delta conditions into the near future (typically one to ten weeks). Recently collected historical data provide current conditions for the Delta. Recent tidal elevations at Martinez are used with an astronomical tide forecast to project the Martinez tide into the near future. Corresponding hydrodynamic and water quality conditions in the Delta are then simulated. Forecasting simulations can assist State Water Project operations decisions. Additional information on forecast (real-time) simulations can be obtained from the website **http://modeling.water.ca.gov/delta/real-time/index.html**.

**Planning Studies of Hypothetical Conditions**

Delta planning studies evaluate how hypothetical changes to factors such as hydrologic regimes, water quality standards, system operations, and Delta configurations may impact Delta conditions. To explore the impacts of a given scenario under various hydrologic conditions, DSM2 planning studies are typically run under a 16-year sequence of Delta inflows and exports derived from statewide water transfer and storage simulations using CALSIM[1]. Planning simulations can use historical or astronomical tidal data which incorporate influences of the spring-neap tidal cycle or simulations can use an average repeating tide (typically the 19-year mean tide). Planning simulations typically assess impacts of proposed changes to Delta operations or configuration such as modified reservoir releases or dredging of channels. Planning study may also investigate impacts of hypothesized changes in the natural environment such as sea level rise.

[1] More information on CALSIM can be found on the internet at **http://modeling.water.ca.gov/hydro/model/index.html**.

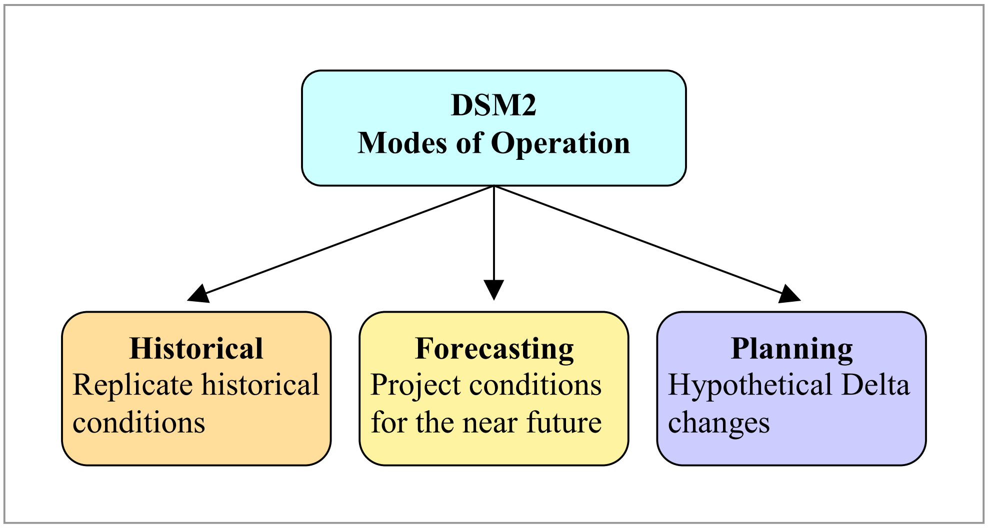



**Figure 3-2: DSM2 Modes of Operation**

**Table 3-1: Parameter Descriptions for Three Modes of DSM2 Application**

| **Simulation Parameter** | **Replicate Historic Conditions** | **Forecasting Future Conditions** | **Planning Studies for Hypothetical Conditions** |
|---|---|---|---|
| Boundary Tide | Historic or astronomical tide | Historic and projected astronomical forecast tide | Historic, astronomical, or 19-year mean tide |
| Input Data | Historic inflows and exports<br>Average Delta consumptive use | Recent and current inflows and exports<br>Average Delta consumptive use | CALSIM statewide operations studies provide inflows and exports<br>Average Delta consumptive use |
| Simulation Period | 1990-2001 are currently possible | 1-10 weeks into the future | 1976-1991 sequence from CALSIM statewide operations studies |

## 3.3 HYDRO and QUAL Data

A general overview of input and output data for DSM2 is provided below. Additional description of the input data will be provided during the course of the tutorial.

### 3.3.1 Input Data

Inputs and outputs for HYDRO and QUAL are summarized in Figure 3-3. HYDRO and QUAL require specifications of various input parameters. Geometry data for the Delta channels (cross sections, channel length, etc) are specified. The input geometry data are utilized to create the computational grid that represents the Delta. Locations of gates, barriers, and other flow control structures may also be specified.

**Initial conditions**

Initial conditions for flow and stage for a HYDRO simulation can be specified by one of two methods: 1) using a restart file that uses the simulation results from the final time step of a previous simulation as the initial conditions for a new simulation, or 2) using the initial conditions provided in the regular-xsects.inp file. If a restart file is not used, DSM2 defaults to using the values specified for stage and flow in the regular-xsects.inp file. The regular-xsect.inp file is discussed in further detail in the HYDRO tutorial.

**HYDRO Initial Conditions**
- **Restart**
- **regular-xsects.inp**

Initial conditions for constituent concentrations for a QUAL simulation can be specified by one of three methods: 1) using a restart file that uses the simulation results from the final time step of a previous simulation as the initial conditions for a new simulation, 2) specifying initial concentrations in each channel in a user created input file (referred to as a "warm-start"), or 3) running a simulation that starts with a single concentration throughout the system as an initial condition and running DSM2 until the simulated concentrations throughout the Delta are reasonable (referred to as a "cold-start").

**QUAL Initial Conditions**
- **Restart**
- **Warm-start**
- **Cold-start**

**Boundary conditions**

Boundary conditions such as flow rates, water levels, or constituent source/sinks may be specified as constant values, regular time series, or irregular time series. Time series data may be provided to the model in text files or in DSS (U. S. Army Corps' Hydrologic Engineering Center **D**ata **S**torage **S**ystem) format. Boundary condition data may be obtained from historical data, simulation results from DSM2 or CALSIM, or boundary condition data may be created to represent hypothetical conditions. Output from HYDRO simulations can be used as input in QUAL to describe the hydrodynamic conditions of the Delta (Figure 3-3).

**Boundary Conditions**
- **Flow**
- **Water level**
- **Constituent concentrations**

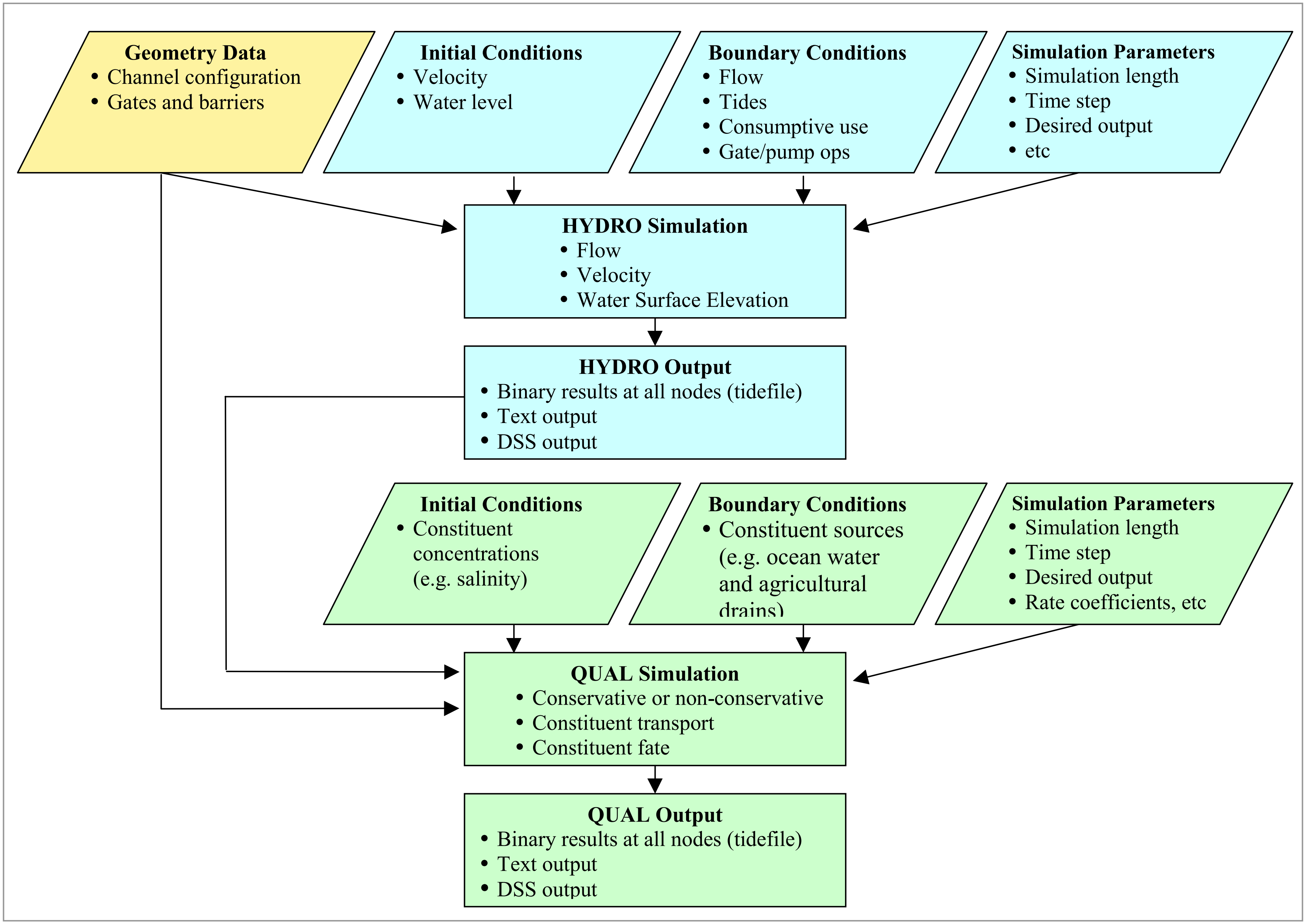



**Figure 3-3: Flow Chart of HYDRO and QUAL Inputs and Outputs**

**Simulation parameters**

DSM2 also requires designation of several simulation parameters. Among simulation characteristics defined by these parameters are length of the simulation, the length of the computational time step, tolerance for numerical solution convergence, definition of constants, the desired output.

### 3.3.2 Output Data

HYDRO provides simulated flows, velocities, and water levels at designated locations throughout the Delta (Figure 3-3). QUAL provides simulated constituent concentrations at designation locations. Output time series can be specified at each computational time step (referred to as instantaneous results) or output data can be averaged over specified time intervals (15 minute, one hour, one day, etc). Output data can be provided in text or DSS format.

**Output**

- **Text**
- **DSS**

## 3.4 HYDRO and QUAL Files

A general overview of input and output files for DSM2 is provided below. Descriptions of specific input and output files will be provided during the course of the tutorial.

### 3.4.1 Input Files

DSM2's input structure is flexible, inputs are not required to be in a specific order. Input files are read in the order that they are specified in the main input file (dsm2.inp). If sections are repeated in the same file or in multiple input files, the information read last will supercede (overwrite) previously specified information. This allows the user to create a base set of files and overwrite only that information which changes for a particular simulation.

In order to make processing and checking input data easier, the input data are typically specified in several different files. Input files are currently in text format. Time series input data can also be specified in DSS format (U. S. Army Corps' Hydrologic Engineering Center **D**ata **S**torage **S**ystem). Future modifications to DSM2 will provide input through a data base structure. This documentation reviews the text and DSS formats for DSM2 input.

**Input File Formats**

- **Text**
- **DSS for time varying data**
- **Database (under development)**

The beginning of each section in a text input file is indicated by a keyword. For most sections, the second line of the section will be the field keywords, which tell the input system what data appears in which fields. The field keywords act as column headings for the data that follow. The data itself follows in the order indicated by the field keywords. Data are provided on as many lines as are necessary. The columns of data do not need to appear as columns on the screen. DSM2 will read the first value and associate it with the first keyword, the second value with the second keyword, etc. However, it may be easier for the user to interpret the input file if values are listed directly under the keyword with which they are associated. Sections must be closed by a line containing only the keyword END. Keywords and variable names may be upper or lower case. Blank lines and comments may appear anywhere in the input files. Blank lines are often utilized to separate sections of the input file to make them easier for the user to read. Comment lines are indicated by the pound sign (#) and continue from the pound sign to the end of the line. Section keywords, field keywords, and input variables used in the tutorial input files will be defined later in this documentation. Additional section and field keyword descriptions are provided in chapter five of the 1998 Delta Modeling annual report titled "*Methodologies for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh*". The report can be accessed on the internet at **http://modeling.water.ca.gov/delta/reports/annrpt/1998/index.html**

**DSM2 Text Input**

- **Input sections defined by Section Keywords**
- **Input data defined by Field Keywords**
- **Sections end with the word END**
- **Keywords can be upper or lower case**
- **Blank lines may be used anywhere in the file**
- **Comment lines are indicated by #**
- **Data spacing is not important**

The main DSM2 input file (dsm2.inp) provides a list of additional input files used in a particular simulation. DSM2 does not specify which input data should appear in which files. Thus the user has the flexibility to organize the files in a variety of manners. For this documentation, a DSM2 input file structure will be specified for illustration purposes.

### 3.4.2 Output Files

Output from DSM2 can be generated in text and/or DSS format. Specifying an output file name with the extension *.dss will automatically generate output in DSS format. Specifying an output file name with any other extension will result in text output from DSM2.

# 4 HYDRO Tutorial

This tutorial will guide you through a historical HYDRO simulation for October 1996.

## 4.1 HYDRO Tutorial File Structure

The file structure for the HYDRO tutorial is summarized in Figure 4-1. Brief descriptions of each file and folder are provided in section 4.2.

- dsm2demo
  - bin
    - ***hydro.exe***
    - ***qual.exe***
  - data
    - grid
      - ***channels.inp***
      - ***irregular_xsects.inp***
      - ***list.inp***
      - ***regular_xsects.inp***
      - ***reservoirs.inp***
      - ***translations.inp***
      - ***type.inp***
      - irreg
        - ***1_0.24018.txt***
        - ***1_0.95336.txt***
        - ⋮
        - ***99_0.44676.txt***
    - timeseries
      - ***dicu.dss***
      - ***gates.dss***
      - ***hydro.dss***
      - ***quality.dss***
  - study
    - ***hydro.bat***
    - ***qual.bat***
    - input
      - hydro
        - ***boundary.inp***
        - ***dsm2.inp***
        - ***gates.inp***
        - ***input-ag.inp***
        - ***io.inp***
        - ***output.inp***
        - ***runtime.inp***
        - ***scalar.inp***
      - qual
        - Files in this folder are described in Figure 5-1.
    - output
      - ***hydro-oct96.htf***
      - ***hydro-oct96.dss***
      - ***hydro-oct96.out***
      - ***hydro-flow-oct96.txt***
      - ***hydro-stage-oct96.txt***
      - ***hydro-restart-oct96.out***
      - QUAL output files located in this folder are described in Figure 5-1.

**Figure 4-1: DSM2 HYDRO Tutorial File Structure**

## 4.2 Overview of the HYDRO Tutorial Files and Folders

The following are descriptions of the tutorial files and folders listed in Figure 4-1. The following symbols are used to indicate the type of item being described:

- 🗀 folder
- ☐ executable file
- 🗎 text file
- 🗐 DSS database file
- ⊠ binary file

| File Type Legend |
|---|
| 🗀 folder |
| ☐ executable file |
| 🗎 text file |
| 🗐 DSS database file |
| ⊠ binary file |

🗀 **dsm2demo:** folder that contains all of the files for the DSM2-HYDRO and QUAL demos

🗀 **bin:** folder that contains executable files

| | |
|---|---|
| ☐ *hydro.exe*: | DSM2-HYDRO executable file |
| ☐ *qual.exe*: | DSM2-QUAL executable file |

🗀 **data:** folder that contains input data for DSM2 simulations

🗀 **grid:** folder that contains input files that define the DSM2 computational grid of the Delta. These files are used for both HYDRO and QUAL.

| | |
|---|---|
| 🗎 *channels.inp*: | text input file that defines DSM2 grid channels, provides channel/node connectivity, and specifies values for constants |
| 🗎 *irregular_xsects.inp*: | text input file that defines locations where irregular cross sections are specified and indicates names of input files that describe each irregular cross section |
| 🗎 *list.inp*: | text input file that lists the channel numbering sequence |
| 🗎 *regular_xsects.inp*: | text input file that provides regular cross sectional data from DSM1. Default stage values for use if there is no restart file are also specified in this file. |
| 🗎 *reservoirs.inp*: | text input file that defines reservoir names and characteristics |

**File Type Legend**

- folder
- executable file
- text file
- DSS database file
- binary file

*translations.inp*: text input file that correlates text strings with locations (nodes, channels, etc) in the DSM2 grid. For example the San Joaquin River at Vernalis located at node 17 is correlated to (translates to) the text string "vernalis".

*type.inp*: text input file that defines certain text strings as representing diversions, exports, RIM flows (boundary inflows), drains, seepage, etc. Corrections for flow signs are also specified in this file.

**irreg**: folder that contains irregular cross sectional data

*1_0.24018.txt*
*1_0.95336.txt*
•
•
•
*99_0.44676.txt*

text files that define irregular cross sections

**timeseries**: folder that contains input time series data[2]

*dicu.dss*: Time series data for Delta Island Consumptive Use (DICU)

*gates.dss*: Time series data for gate operations

*hydro.dss*: Time series data for flow and stage boundary conditions

*quality.dss*: Time series data for constituent concentration boundary conditions

**study:** folder that contains files specific to particular DSM2 simulation or set of simulations. In this tutorial, the study is a historical simulation of October 1996.

*hydro.bat*: text batch file used for running HYDRO

*qual.bat*: text batch file used for running QUAL

**input**: folder that contains input files for the study

**hydro**: folder that contains input files for the HYDRO simulation for the study

[2] ***Note:*** If *.dsc and *.dsd files are present in this directory, those files were created when the *.dss files were viewed in VISTA.

*boundary.inp*: text input file that specified flow and stage boundary conditions

*dsm2.inp*: main DMS2 text input file where the other HYDRO input files are specified and environment variables and titles are defined

*gates.inp*: text input file that specifies types of operations to be used for each gate

*input-ag.inp*: text input file that specified agricultural drainage, seepage, and return flows (Delta Island Consumptive Use-DICU)

*io.inp*: text input file that lists the names of the HYDRO output files

*output.inp*: text input file that designates the type of simulation results and locations of the simulation results to be written to the designated output files

*runtime.inp*: text input file that designates the starting and ending times for the simulation

*scalar.inp*: text input file that sets various simulation parameters such as amount of screen output, values for constants, tolerance levels for convergence of the numerical solution, the computational time step, etc.

**qual**: folder that contains input files for the QUAL simulation for the study

Input files in the QUAL directory are described in section 5.2.

**output**: folder that contains the output files generated by DSM2 for the study. These files will be created in the tutorial.

*hydro-oct96.htf*: binary HYDRO transfer file (htf – also referred to as a HYDRO tide file) that records simulation results at every time step for every node. This file provides the hydrodynamic input for QUAL.

*hydro-oct96.dss*: DSS database file that contains time series of simulation results at specified locations. The data stored in this file is specified in output.inp.

*hydro-oct96.out*: Text file that echoes screen output

**File Type Legend**

- folder
- executable file
- text file
- DSS database file
- binary file

*hydro-flow-oct96.txt*: text output file that contains flow data for specified locations. The data stored in this file is specified in output.inp.

*hydro-stage-oct96.txt*: text output file that contains stage data for specified locations. The data stored in this file is specified in output.inp.

*hydro-restart-oct96.out*: text restart file that contains simulation results for each node for the last time step of the simulation. This file can be used to provide initial conditions for an additional simulation for a time period immediately after the current simulation period. For example a the restart file for a simulation run for October 1996 could be used to provide initial conditions for a simulation of November 1996.

**File Type Legend**

- folder
- executable file
- text file
- DSS database file
- binary file

Detailed descriptions of each of these input files follows in sections 4.3. to 4.19. The main DSM2 input file dsm2.inp is discussed first. The other files in the directory ***dsm2demo/study/input/hydro*** are described next, followed by the rest of the files in the order that they are listed above. Additional section and field keyword descriptions are provided in chapter five of the 1998 Delta Modeling annual report titled "*Methodologies for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh*". Only section and field keywords that appear in the tutorial input files are described in this documentation. Instructions on running HYDRO are located in section 4.20.

**Skipping Ahead to Running HYDRO:**

**Instructions for running HYDRO are in Section 4.20.**

## 4.3 dsm2.inp: Main HYDRO input file

The main HYDRO input file is the dsm2.inp file. For this tutorial, the dsm2.inp file is located in the directory ***dsm2demo/study/input/hydro***. This file contains the names of the other input files utilized by HYDRO. Environment variables can be declared in this file. (The concept of environmental variables is reviewed in Appendix A in section 6.1). Three sections are typically contained in a HYDRO dsm2.inp file: ENVVARS (Environment Variables), TITLES, and INP_FILES (Input Files). Each section starts with a section keyword and ends with the word END. These sections are described below. The sample dsm2.inp file used in this tutorial is shown in Figure 4-2. Typically a new dsm2.inp file is created for each simulation.

**dsm2.inp Sections**

- **ENVVARS**
- **TITLES**
- **INP_FILES**

### 4.3.1 ENVVARS: Environment Variables

Section Keyword: ENVVARS Environment variable section

| | | |
|---|---|---|
| Field keywords: | NAME | Name of environment variable |
| | VALUE | Value assigned to environment variable |
| Required: | | No |
| Overwrites: | | |
| Description: | Environment variables are user defined variables typically used to represent long computer paths for input and output files or to represent text that will change from simulation to simulation such as file extensions that refer to the name of the study. See section 6.1 for more information on Environment Variables. | |

Example:

```
ENVVARS
NAME            VALUE
RUN             oct96
GRID            ./../data/grid
TIMESERIES      ./../data/timeseries
IRREG           $GRID/irreg
DSSOUT          ./output/hydro-${RUN}.dss
FLOWTXTOUT      ./output/hydro-flow-${RUN}.txt
STAGETXTOUT     ./output/hydro-stage-${RUN}.txt
END
```

Use in tutorial:
Environment variables RUN, GRID, TIMESERIES, IRREG, DSSOUT, FLOWTXTOUT, and STAGETXTOUT are declared. The variable RUN is set equal to the text string "oct96" to indicate that the simulation represents the time period of October 1996. This environment variable is used to designate the simulation when output file names are created (see io.inp).

**RUN:** The environment variable RUN is a text string that describes the simulation. In this case the text string "oct96" indicates a historical simulation of October 1996.

**GRID:** The environment variable GRID indicates that the file related to the DSM2 grid are located in the directory indicated by the relative path ***./../data/grid***. In this path name, the "./" indicates to start in the current directory. Since the batch file for running HYDRO is located in the ***dsm2demo/study*** directory (Figure 4-1), that is the "starting point" for the relative path referenced by the "./" symbol. The "../" part of the path means to go up one directory. In this case since we are starting in the directory ***dsm2demo/study***, going up one directory would put us in the ***dsm2demo*** directory. The "data/grid" part of the path refers to the subdirectory grid located in the data directory. Thus, the relative path ***./../data/grid*** refers to the directory ***/dsm2demo/data/grid***.

> **Current directory**
> **<u>"./" definition</u>**
> **For this tutorial "./" in a pathname refers to the directory *dsm2demo/study***

```
# DSM2-HYDRO input file.
# Grid: 2.0
# UPDATED: 1-31-02 jamiea
# >>DEMO ONLY<<

# This is the main input file; other input files
# are specified here.

# Environment variable declarations
ENVVARS
NAME          VALUE
RUN           oct96
GRID          ./../data/grid
TIMESERIES    ./../data/timeseries
IRREG         $GRID/irreg
DSSOUT        ./output/hydro-${RUN}.dss
FLOWTXTOUT    ./output/hydro-flow-${RUN}.txt
STAGETXTOUT   ./output/hydro-stage-${RUN}.txt
END

# Simulation title
TITLES
   Full Sacramento-San Joaquin Delta network
END


# List of additional input files
INP_FILES
# files that would tend to change for each run
./input/hydro/boundary.inp # boundary flow and stage input
./input/hydro/scalar.inp   # other scalar data, constants
./input/hydro/gates.inp    # gate info
./input/hydro/runtime.inp  # DSM2-HYDRO runtime

# files that would not be changed often
./input/hydro/input-ag.inp # ag diversion and return input
./input/hydro/io.inp       # names of restart,output & hydro-transfer files
./input/hydro/output.inp   # lists desired output types and locations
$GRID/channels.inp         # channel/node connectivity & coefficients
$GRID/irregular_xsects.inp # irregular channel cross-sections
$GRID/regular_xsects.inp   # rectangular cross-sections from DSM1
$GRID/list.inp             # list channel numbering sequence
$GRID/reservoirs.inp       # reservoir info
$GRID/translations.inp     # input name translations
$GRID/type.inp             # correct for improper sign, assign types
END
```

Comment Lines
Section Keyword →
Field Keywords →
Environment Variable Declarations
Section END →
Section Keyword →
Title text →
Section END →
Section Keyword →
Input files that typically change
Input files that typically do not change
Section END →

**Figure 4-2: Sample HYDRO Main Input File-dsm2.inp**

**TIMESERIES:** The environment variable TIMESERIES is defined as the relative path ***./../data/timeseries***. This relative path refers to the directory ***/dsm2demo/data/timeseries***.

**IRREG:** The environment variable IRREG uses the environment variable in its definition, ***$GRID/irreg***. This path name would be represent the directory grid located in the pathname indicated by the environment variable grid. Thus this pathname refers to the directory ***/dsm2demo/data/grid/irreg***.

**DSSOUT:** The environment variable DSSOUT defines a path and file name for the DSS output as ***./output/hydro-${RUN}.dss***. Substituting the definition of the environment variable RUN into this path name gives the path and file name for the DSS output file as ***dsm2demo/study/output/hydro-oct96.dss***.

**FLOWTXTOUT:** The environment variable FLOWTXTOUT defines the path and file name for the text DSM2 flow output as ***./output/hydro-flow-${RUN}.txt*** which refers to the path and file name ***dsm2demo/study/output/hydro-flow-oct96.txt***.

**STATETXTOUT:** The environment variable STAGETXTOUT defines the path and file name for the text DSM2 stage output as ***./output/hydro-stage-${RUN}.txt*** which refers to the path and file name ***dsm2demo/study/output/hydro-stage-oct96.txt***.

### 4.3.2 TITLES

Section Keyword: TITLES Titles section

Field keywords: none

Required: no

Overwrites: no

Description: Each line in the Title section is used as a title or header for later printouts. Typically the user would enter a description of the simulation in this section.

Example:

```
TITLES
   Full Sacramento-San Joaquin Delta network
END
```

Use in tutorial:
The title was set to the text string “Full Sacramento-San Joaquin Delta network”.

### 4.3.3 **INP_FILES:** Include Input Files

Section Keyword: INP_FILES    Input file section

Field keywords: none

Required: no

Overwrites:

Description: Each line in the Include Input Files section is a filename (either full pathname or relative to the simulation directory) which directs the input system to read in that file and process it as part of the input system. This allows different sections to be in different files for convenience and clarity. Also, for many sections, the same section can be read in multiple times, subsequent values overwriting previous values.

Example:

```
INP_FILES
# files that would tend to change for each run
./input/hydro/boundary.inp    # boundary flow and stage input
./input/hydro/scalar.inp      # other scalar data, constants
./input/hydro/gates.inp       # gate info
./input/hydro/runtime.inp     # DSM2-HYDRO runtime

# files that would not be changed often
./input/hydro/input-ag.inp    # ag diversion and return input
./input/hydro/io.inp          # names of restart,output & hydro-transfer files
./input/hydro/output.inp      # lists desired output types and locations
$GRID/channels.inp            # channel/node connectivity & coefficients
$GRID/irregular_xsects.inp    # irregular channel cross-sections
$GRID/regular_xsects.inp      # rectangular cross-sections from DSM1
$GRID/list.inp                # list channel numbering sequence
$GRID/reservoirs.inp          # reservoir info
$GRID/translations.inp        # input name translations
$GRID/type.inp                # correct for improper sign, assign types
END
```

Use in tutorial:
The file pathnames listed in this example correspond to the tutorial directory structure. The first seven files listed in the INP_FILES sections refer to the text input files boundary.inp, scalar.inp, gates.inp, runtime.inp, input-ag.inp, io.inp, and output.inp located in the directory ***dsm2demo/study/input/hydro***. The next seven files listed are text input files related to the geometry located in the directory ***/dsm2demo/data/grid.*** The geoemetry files are named channels.inp, irregular_xsects.inp, regular_xsects.inp, list.inp, reservoirs.inp, translations.inp, and type.inp.

## 4.4 boundary.inp: Flow and stage boundary condition input file

Flow and stage boundary conditions (Figure 4-3) are located in the input file boundary.inp. For this tutorial, the boundary.inp file is located in the directory ***dsm2demo/study/input/hydro***. The sample boundary.inp file used in this tutorial is shown in Figure 4-4. Since the flow boundary conditions represent flows that occur around the edges or "rim" of the Delta, these flows are sometimes referred to as "rim flows". The boundary condition input file contains two sections: INPUTPATHS and JUNCTIONS. The path names corresponding to the input files that contain the boundary condition time series data are specified in the INPUTPATHS section. For this tutorial, the input paths correspond to DSS file pathnames. A review of DSS pathnames is found in section 6.2. The node corresponding to the stage boundary condition at Martinez is identified in the JUNCTIONS section. Each of these sections is described below. Typically a new boundary.inp file is created for each simulation.

> **boundary.inp**
> **Sections**
> - **INPUTPATHS**
> - **JUNCTIONS**

### 4.4.1 INPUTPATHS: Input Path Specification for Time-Varying Data

| | | |
|---|---|---|
| Section keyword: | INPUTPATHS | Each line in the INPUTPATHS section specifies the location or "path[3]" that corresponds to the desired input data time series. |
| Field keywords: | NAME | Location name. The node number to which the location name corresponds must be specified, typically in a translations input file. |
| | A_PART | DSS A part. Typically a text string that may indicate information such as the type of data or the scenario associate with the data. Must be IDENTICAL to the pathname in the input DSS file. |
| | B_PART | DSS B part. Typically a location name, node number, or channel number. Must be IDENTICAL to the pathname in the input DSS file. |

> **DSS Pathnames**
> **References to DSS pathnames (A, B, C, E, and F parts) must be IDENTICAL to the text specified in that part of the DSS file.**

[3] Each line in the INPUTPATHS section specifies the location or "path" that corresponds to the desired input data time series. In this tutorial the input paths in the boundary.inp file correspond to DSS pathnames.

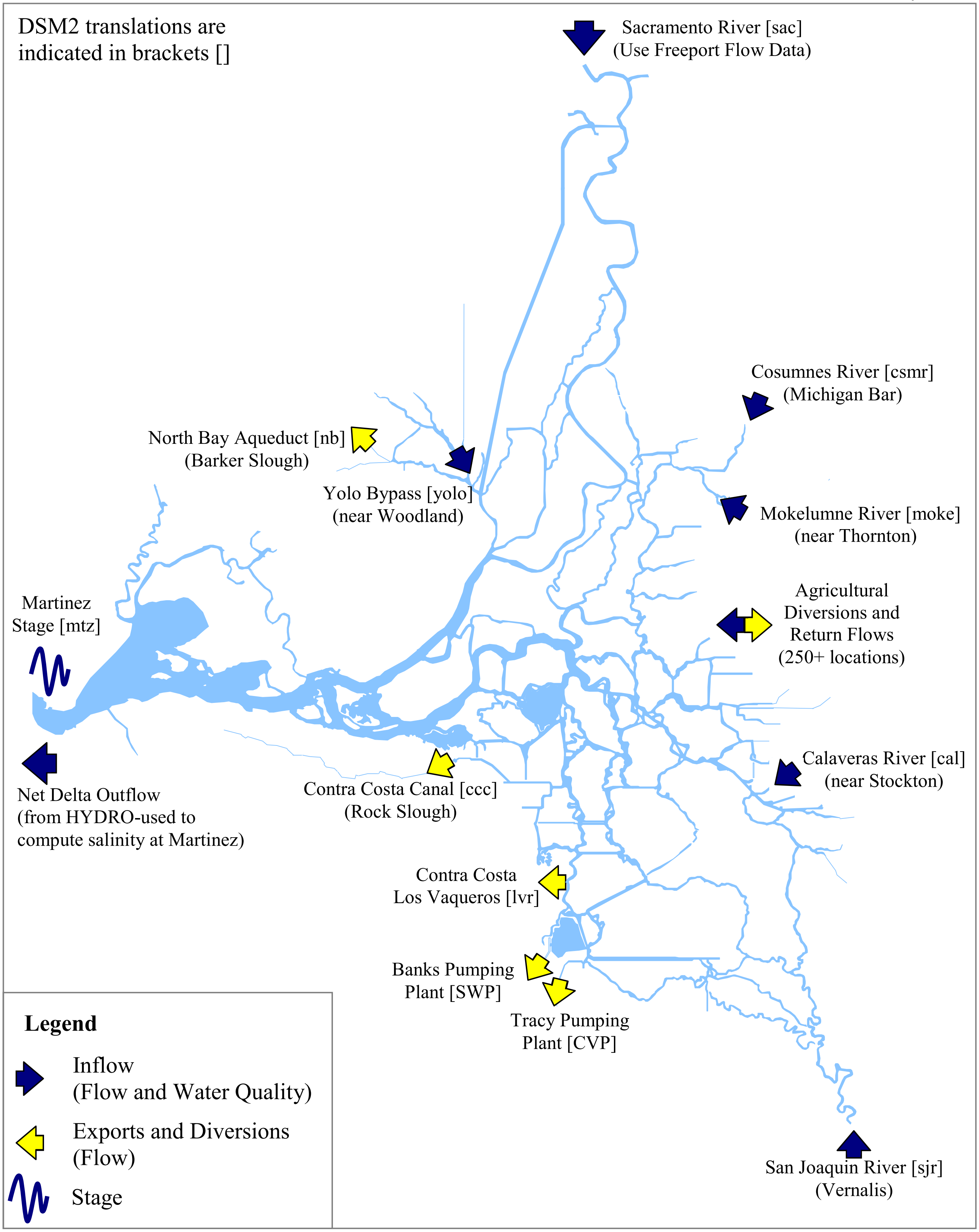



**Figure 4-3: Map of Typical DSM2 Boundary Conditions**

```
# Time-varying input
# Grid: v2.0
# Updated: 2002.01.08, mmierzwa
# >>DEMO ONLY<<

INPUTPATHS
NAME  A_PART    B_PART    C_PART              E_PART F_PART            FILLIN PRIORITY FILENAME

# Data for the Calaveras River is available starting in Jan. 2000
#cal  FILL+CHAN RCAL009   FLOW                1HOUR  DWR-DMS           last   0        $TIMESERIES/hydro.dss
ccc   HIST+CHAN CHCCC006  FLOW-DIVERSION      1DAY   CCWD              last   0        $TIMESERIES/hydro.dss
# Data for the CCWD Los Vaqueros Reservoir is available starting in Nov. 1997
#lvr  HIST+CHAN ROLD034   FLOW-DIVERSION      1DAY   CCWD              last   0        $TIMESERIES/hydro.dss
csmr  HIST+CHAN RCSM075   FLOW                1HOUR  USGS-RIM          last   0        $TIMESERIES/hydro.dss
cvp   HIST+CHAN CHDMC004  FLOW-EXPORT         1DAY   USBR-CVO          last   0        $TIMESERIES/hydro.dss
moke  HIST+CHAN RMKL070   FLOW                1DAY   EBMUD             last   0        $TIMESERIES/hydro.dss
nb    HIST+CHAN SLBAR002  FLOW-EXPORT         1DAY   DWR-OM-DFD        last   0        $TIMESERIES/hydro.dss
sac   HIST+CHAN RSAC155   FLOW                1HOUR  USGS              last   0        $TIMESERIES/hydro.dss
sjr   HIST+CHAN RSAN112   FLOW                1DAY   USGS-RIM          last   0        $TIMESERIES/hydro.dss
swp   HIST+CHAN CHSWP003  FLOW                1HOUR  DWR-OM-JOC+CALC   last   0        $TIMESERIES/hydro.dss
yolo  HIST+CHAN BYOLO040  FLOW                1DAY   DWR-DAYFLOW       last   0        $TIMESERIES/hydro.dss
mtz   FILL+CHAN RSAC054   STAGE               15MIN  UCB-ELI           interp 0        $TIMESERIES/hydro.dss
END

# Downstream stage boundary condition
JUNCTIONS
NODE  BOUNDARY
361   STAGE
END
```

Annotations:

Section Keyword → INPUTPATHS
Field Keywords → NAME … FILENAME
Data RKI* → B_PART
Type of BC → C_PART
Data interval → E_PART
Data source → F_PART
Missing data fillin method → FILLIN
Data path priority → PRIORITY
DSS input file name → FILENAME
Location names that are defined in the translations.inp input file. They are also shown in Figure 4-3.
Section END → END
Information from DSS file
Section Keyword → JUNCTIONS
Field Keywords → NODE BOUNDARY
Stage BC node → 361
Section END → END

*RKI = River Kilometer Index
BC = Boundary Condition
DSS = Data Storage System

**Figure 4-4: Sample HYDRO Boundary Condition Input File-boundary.inp**

| | |
|---|---|
| C_PART | DSS C part. Typically indicates the type of data: FLOW, STAGE, FLOW-DIVERSION, FLOW-EXPORT, GATE, EC, TDS, etc. Must be IDENTICAL to the pathname in the input DSS file. |
| E_PART | DSS E part. Typically indicates the time interval of time series data: 15MIN, 1HOUR, 1DAY, 1MON, IR-DECADE. Must be IDENTICAL to the pathname in the input DSS file. |
| F_PART | DSS F part. Typically a text string that indicates the study name or the source of the data. Must be IDENTICAL to the pathname in the input DSS file. |
| FILLIN | LAST , INTERP, or DATA. If LAST is indicated, then the last data value will be used when a value is not specified for a given time. When INTERP is indicated, values will be interpolated if a value is not specified for a given time. If DATA is indicated, the model will automatically use the last value if the time series is period averaged or the model will interpolate if the time series is instantaneous. |
| PRIORITY | Optional priority of the input data represented by this path specified as an integer between 0 and N. Lower numbers indicate higher priority data paths, for example a “1” indicates the first priority data path and a “2” indicates the second priority data path. Data from higher priority (lower number) input paths are used first. When data are missing from a higher priority input data path, data are filled in with data from the next lower priority (next higher number) data path. A priority of 0 means ignore the priority system and always use the specified path. If no data are specified in any input data path for a specific time during the model simulation, |

**DSM2 Definitions**

- **Diversions- water transferred out of Delta that will eventually return to the Delta**
- **Exports- water permanently removed from the Delta**

| | | |
|---|---|---|
| | | DSM2 will crash. See section 6.3 and Figure 6-5 for additional information on input path priorities. |
| | FILENAME | DSS filename that contains the desired time series data. |
| Required: | yes | |
| Overwrites: | no | |
| Description: | Provides information to locate time-varying data (flows, stages, gate operations, water quality, etc.) in DSS during the simulation. All time-varying input for HYDRO and QUAL must come from DSS files. Locations corresponding to the time-varying input are specified by either a node number or a name that translates to a node number. | |

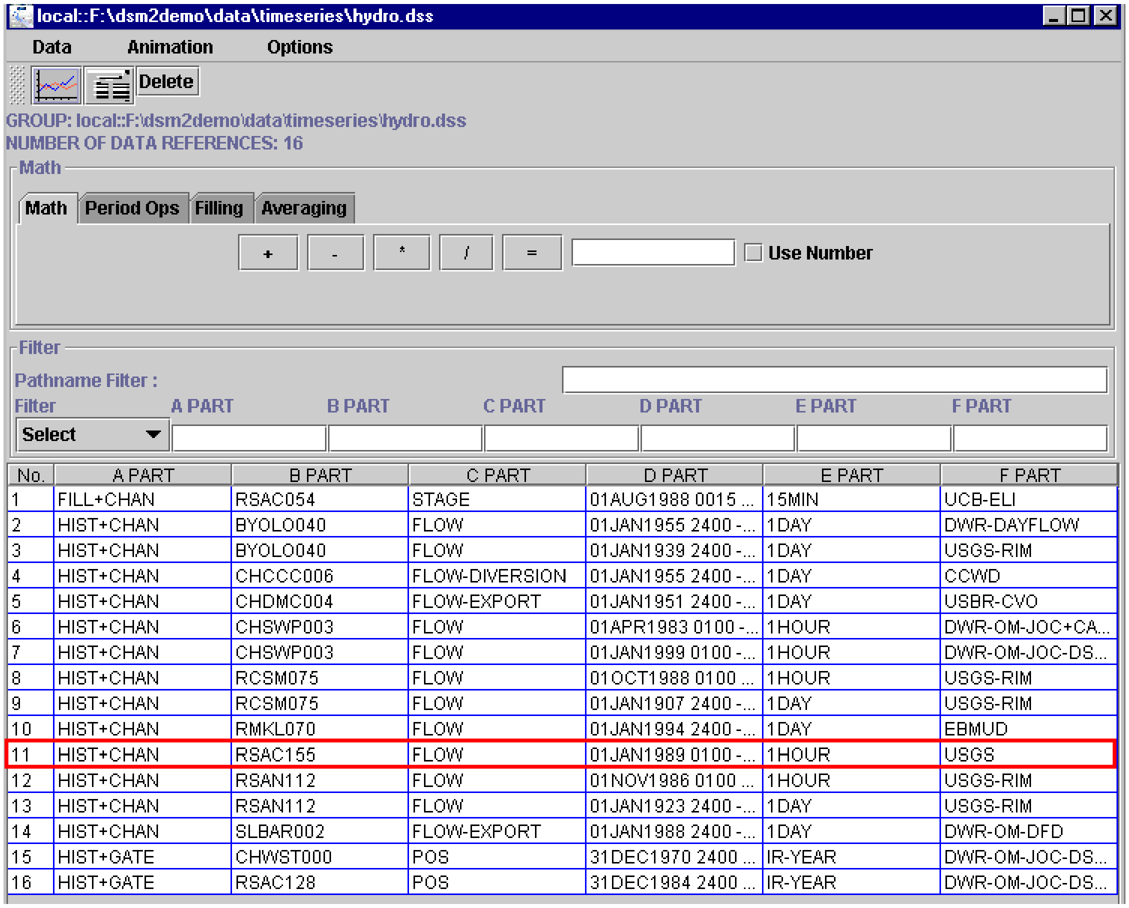
Example:

```
INPUTPATHS
NAME A_PART    B_PART  C_PART E_PART F_PART FILLIN PRIORITY FILENAME
sac  HIST+CHAN RSAC155 FLOW   1HOUR  USGS   last   0        $TIMESERIES/hydro.dss
END
```

Use in tutorial:
This sample input path above refers to time series data for the Sacramento River located in the file ***/dsm2demo/data/timeseries/hydro.dss***. A view of the DSS file as it would appear in Vista (see section 6.4 for information on VISTA) is shown in Figure 4-5. The path that corresponds to the Sacramento has been highlighted in red. Note that the path information in the INPUTPATHS section is identical to the path information in the DSS file. All of the input paths used in the boundary.inp file shown in Figure 4-4 are identical to the paths shown in Figure 4-5 for the hydro.dss file.

The boundary conditions listed in the boundary.inp file (Figure 4-4) include flows for the Sacramento River (sac), San Joaquin River (sjr), Cosumnes River (csmr), Mokelumne River (moke), State Water Project (swp) and the Yolo Bypass. Flows for the Calaveras River have been commented out and are not used in this simulation. There is a flow diversion for Contra Costa Canal at Rock Slough. The flow diversion for Contra Costa Los Vaqueros Intake has been commented out. Exports for the Central Valley Project and for the North Bay Aqueduct are also included in this file.

Note: In DSM2 a flow ***diversion*** withdraws water from the Delta that will eventually returns to the Delta, whereas a flow ***export*** permanently removes the water form the Delta system.




| No. | A PART | B PART | C PART | D PART | E PART | F PART |
|---|---|---|---|---|---|---|
| 1 | FILL+CHAN | RSAC054 | STAGE | 01AUG1988 0015 ... | 15MIN | UCB-ELI |
| 2 | HIST+CHAN | BYOLO040 | FLOW | 01JAN1955 2400 -... | 1DAY | DWR-DAYFLOW |
| 3 | HIST+CHAN | BYOLO040 | FLOW | 01JAN1939 2400 -... | 1DAY | USGS-RIM |
| 4 | HIST+CHAN | CHCCC006 | FLOW-DIVERSION | 01JAN1955 2400 -... | 1DAY | CCWD |
| 5 | HIST+CHAN | CHDMC004 | FLOW-EXPORT | 01JAN1951 2400 -... | 1DAY | USBR-CVO |
| 6 | HIST+CHAN | CHSWP003 | FLOW | 01APR1983 0100 -... | 1HOUR | DWR-OM-JOC+CA... |
| 7 | HIST+CHAN | CHSWP003 | FLOW | 01JAN1999 0100 -... | 1HOUR | DWR-OM-JOC-DS... |
| 8 | HIST+CHAN | RCSM075 | FLOW | 01OCT1988 0100 ... | 1HOUR | USGS-RIM |
| 9 | HIST+CHAN | RCSM075 | FLOW | 01JAN1907 2400 -... | 1DAY | USGS-RIM |
| 10 | HIST+CHAN | RMKL070 | FLOW | 01JAN1994 2400 -... | 1DAY | EBMUD |
| 11 | HIST+CHAN | RSAC155 | FLOW | 01JAN1989 0100 -... | 1HOUR | USGS |
| 12 | HIST+CHAN | RSAN112 | FLOW | 01NOV1986 0100 ... | 1HOUR | USGS-RIM |
| 13 | HIST+CHAN | RSAN112 | FLOW | 01JAN1923 2400 -... | 1DAY | USGS-RIM |
| 14 | HIST+CHAN | SLBAR002 | FLOW-EXPORT | 01JAN1988 2400 -... | 1DAY | DWR-OM-DFD |
| 15 | HIST+GATE | CHWST000 | POS | 31DEC1970 2400 ... | IR-YEAR | DWR-OM-JOC-DS... |
| 16 | HIST+GATE | RSAC128 | POS | 31DEC1984 2400 ... | IR-YEAR | DWR-OM-JOC-DS... |

**Figure 4-5: View of the hydro.dss File in VISTA with Data for the Sacramento River Highlighted**

### 4.4.2 **JUNCTIONS:** Specification of the Node that Corresponds to the Stage Boundary at Martinez

| | | |
|---|---|---|
| Section keyword: | JUNCTIONS | Designates which nodes have stage boundaries |
| Field keywords: | NODE | Node number corresponding to a stage boundary location. |
| | BOUNDARY | STAGE-use text string stage to indicate that the boundary is a stage boundary. Flow boundaries need not be designated in the junctions section. |
| Required: | Yes | |
| Overwrites: | Yes | |
| Description: | Description: Any junction that has a stage boundary (the stage is specified at the junction) must be listed here. Usually only one junction will have a stage boundary. Flow boundary junctions need not be listed. | |

Example:

```
JUNCTIONS
NODE  BOUNDARY
361   STAGE
END
```

Use in tutorial:
In the example boundary.inp file (Figure 4-4), Martinez (node 361) is listed as a stage boundary.

## 4.5 **gates.inp:** Gate Operations Input File

In DSM2 a gate is defined as a barrier to flow. Thus the term gate refers to devices such as weirs. In DSM2 gates are associated with nodes. A review of how gates are modeling in DSM2 is provided in Appendix A in section 6.5.

**Gate:** **In DSM2 a gate is defined as a barrier to flow.**

**Gates are assigned to DSM2 nodes.**

Gate operations are specified in the input file gates.inp. For this tutorial, the gates.inp file is located in the directory ***dsm2demo/study/input/hydro***. The sample gates.inp file used in this tutorial is shown in Figure 4-6. Sections included in the gates.inp file are GATES and INPUTPATHS. A summary of the gates modeled in this tutorial is given in Table 4-1. A new gates.inp file is created for each simulation in which the gate operations change.

**gates.inp Sections**

- **GATES**
- **INPUTPATHS**

### 4.5.1 GATES

| | | | |
|---|---|---|---|
| Section keyword: | GATES | Section that describes gate operations | |
| Field keywords: | NAME | Gate name. | |
| | OPER | Type of gate operation. Gate operations are: | |
| | | TIME | open/close times read from DSS |
| | | CALC | calculate open/close timing from operational criteria (stage difference, etc) e.g. Montezuma Sl.). |
| | | OPEN | all gates always open; use the flow coefficients given |
| | | CLOSE | always closed; set the flow coefficients to zero for no flow |
| | | IGNORE | gate not installed in initialization (same as commenting out line) |
| | | FREE | gate installed but free-flow |

**Gate Operations**

- **Time**
- **Calc**
- **Open**
- **Close**
- **Ignore**
- **Free**

Comment Lines
Descriptions of
OPER values

```
# DSM2 input file
# Grid: 2.0
# UPDATED: 2002.01.04, mmierzwa
# >>DEMO ONLY<<

# Gate specs

# allowable OPER values:
#   time - open/close times read from DSS
#   calc - open/close calculated from stage, flow (e.g. Montezuma Sl.)
#   open - always open (coeffs values are used)
#   close - always closed (coeffs are zero -- no flow)
#   ignore - gate not installed in initialization (same as commenting out line)
#   free - gate installed, free flow

# This file uses both text and dss input gate parameters, any timed gate should be
# entered into dsm2 as a time varying dss inputpath.
```

Gate on a reservoir
Commented out for
this tutorial

```
# gates on reservoirs -- the coeffs are given in the reservoir section
# commented out for demo
#GATES
#NAME     OPER   NODE
#clfct    time   72
#END
```

Section Keyword →
Field Keywords →
Designation of gates with time varying operations
Section END →

```
# gates that are time varying
GATES
NAME      CHAN   LOC    OPER
dxc       365    up     time
gl_cn     206    down   time
mid_r     134    up     time
midsco    542    down   time
mtzsl     512    down   calc
old_r     79     down   time
orhrb     54     up     time
END
```

Section Keyword →
Field Keywords →
Designation of gates with pipes and constant operations
Section END →

```
# gates that do not change
GATES
NAME       CHAN   LOC    OPER   NPIPES PIPERAD       PIPEELEV      CFPIPEDOWN    CFPIPEUP
7mil1      308    up     open   2      2.00          -7.0          0.5           0.5
7mil2      307    up     close  1      2.00          -7.0          0.0           0.0
gysoo      473    up     open   4      2.00          -3.0          0.0           0.4
midsi      537    up     open   3      2.00          -5.2          0.5           0.0
midsmo     539    down   open   3      2.00          -4.9          0.5           0.0
rrsin      529    down   open   8      2.50          -5.0          0.0           0.5
sndmd      261    up     open   2      2.75          -3.0          0.5           0.0
tpsbp      194    down   open   6      1.88          -3.5          0.0           0.6
END
```

Section Keyword →
Field Keywords →
Constant Operation Weir
Section END →

```
# weirs that do not change
GATES
NAME       CHAN   LOC    OPER   WIDTHDOWN     WIDTHUP       CRESTELEV     CFWEIRDOWN    CFWEIRUP
pcut       195    up     open   237           237           12.5          0.6           0.6
END
```

Section Keyword →
Field Keywords →
Designate 2 gates at DCC
Section END →

```
# multiple gates at a gate structure
GATES
NAME       NGATES
dxc        2
END
```

Section Keyword →
Field Keywords →
Montezuma Sl. Operations
Section END →

```
# Special Operation for Montezuma Sl. Salinity Control
GATES
NAME     DHOPEN   VELCLOSE
mtzsl    0.30     0.10
END
```

Section Keyword →
Field Keywords →
Specify Grant Line Canal parameters and time varying operations in a DSS file

```
# input paths for /HISTORICAL/ barriers with RKIs (requires OPER = time)
#
INPUTPATHS
NAME       A_PART        B_PART        C_PART        INTERVAL      ID            FILLIN PRIORITY FILENAME
#Grant Line Canal
gl_cn      hist+gate     CHGRL009      cfpipedown    ir-decade     DWR-ESO       last   0        $TIMESERIES/gates.dss
gl_cn      hist+gate     CHGRL009      cfpipeup      ir-decade     DWR-ESO       last   0        $TIMESERIES/gates.dss
gl_cn      hist+gate     CHGRL009      cfweirdown    ir-decade     DWR-ESO       last   0        $TIMESERIES/gates.dss
gl_cn      hist+gate     CHGRL009      cfweirup      ir-decade     DWR-ESO       last   0        $TIMESERIES/gates.dss
gl_cn      hist+gate     CHGRL009      crestelev     ir-decade     DWR-ESO       last   0        $TIMESERIES/gates.dss
gl_cn      hist+gate     CHGRL009      npipes        ir-decade     DWR-ESO       last   0        $TIMESERIES/gates.dss
gl_cn      hist+gate     CHGRL009      pipeelev      ir-decade     DWR-ESO       last   0        $TIMESERIES/gates.dss
gl_cn      hist+gate     CHGRL009      piperad       ir-decade     DWR-ESO       last   0        $TIMESERIES/gates.dss
gl_cn      hist+gate     CHGRL009      pos           ir-decade     DWR-ESO       last   0        $TIMESERIES/gates.dss
gl_cn      hist+gate     CHGRL009      widthdown     ir-decade     DWR-ESO       last   0        $TIMESERIES/gates.dss
gl_cn      hist+gate     CHGRL009      widthup       ir-decade     DWR-ESO       last   0        $TIMESERIES/gates.dss
```

Note: DCC and DXC both stand for Delta Cross Channel

Specify Middle River near Tracy parameters and time varying operations in a DSS file

Specify Old River near Tracy parameters and time varying operations in a DSS file

Specify Old River at Head of SJR parameters and time varying operations in a DSS file

Section END →

```
#
#Middle River near Tracy Blvd
mid_r     hist+gate    RMID027    cfpipedown   ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
mid_r     hist+gate    RMID027    cfpipeup     ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
mid_r     hist+gate    RMID027    cfweirdown   ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
mid_r     hist+gate    RMID027    cfweirup     ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
mid_r     hist+gate    RMID027    crestelev    ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
mid_r     hist+gate    RMID027    npipes       ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
mid_r     hist+gate    RMID027    pipeelev     ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
mid_r     hist+gate    RMID027    piperad      ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
mid_r     hist+gate    RMID027    pos          ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
mid_r     hist+gate    RMID027    widthdown    ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
mid_r     hist+gate    RMID027    widthup      ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
#
#Old River at Tracy
old_r     hist+gate    ROLD046    cfpipedown   ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
old_r     hist+gate    ROLD046    cfpipeup     ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
old_r     hist+gate    ROLD046    cfweirdown   ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
old_r     hist+gate    ROLD046    cfweirup     ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
old_r     hist+gate    ROLD046    crestelev    ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
old_r     hist+gate    ROLD046    npipes       ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
old_r     hist+gate    ROLD046    pipeelev     ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
old_r     hist+gate    ROLD046    piperad      ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
old_r     hist+gate    ROLD046    pos          ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
old_r     hist+gate    ROLD046    widthdown    ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
old_r     hist+gate    ROLD046    widthup      ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
#
#Old River at Head of SJR
orhrb     hist+gate    ROLD074    cfpipedown   ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
orhrb     hist+gate    ROLD074    cfpipeup     ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
orhrb     hist+gate    ROLD074    cfweirdown   ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
orhrb     hist+gate    ROLD074    cfweirup     ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
orhrb     hist+gate    ROLD074    crestelev    ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
orhrb     hist+gate    ROLD074    npipes       ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
orhrb     hist+gate    ROLD074    pipeelev     ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
orhrb     hist+gate    ROLD074    piperad      ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
orhrb     hist+gate    ROLD074    pos          ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
orhrb     hist+gate    ROLD074    widthdown    ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
orhrb     hist+gate    ROLD074    widthup      ir-decade   DWR-ESO   last  0   $TIMESERIES/gates.dss
END
```

Section Keyword →
Field Keywords →

```
# input paths for time gates with translation names (requires OPER = time)
INPUTPATHS
NAME      A_PART      C_PART      INTERVAL    ID          FILLIN FILENAME
```

Specify Delta Cross Channel parameters in a DSS file

```
dxc       hist+gate   cfweirdown  ir-decade   DWR-ESO     last   $TIMESERIES/gates.dss
dxc       hist+gate   cfweirup    ir-decade   DWR-ESO     last   $TIMESERIES/gates.dss
dxc       hist+gate   crestelev   ir-decade   DWR-ESO     last   $TIMESERIES/gates.dss
dxc       hist+gate   npipes      ir-decade   DWR-ESO     last   $TIMESERIES/gates.dss
dxc       hist+gate   widthup     ir-decade   DWR-ESO     last   $TIMESERIES/gates.dss
dxc       hist+gate   widthdown   ir-decade   DWR-ESO     last   $TIMESERIES/gates.dss
```

Specify Marrow Is. C-line parameters and time varying operations in a DSS file

```
midsco    hist+gate   cfpipedown  ir-decade   DWR-ESO     last   $TIMESERIES/gates.dss
midsco    hist+gate   cfpipeup    ir-decade   DWR-ESO     last   $TIMESERIES/gates.dss
midsco    hist+gate   npipes      ir-decade   DWR-ESO     last   $TIMESERIES/gates.dss
midsco    hist+gate   pipeelev    ir-decade   DWR-ESO     last   $TIMESERIES/gates.dss
midsco    hist+gate   piperad     ir-decade   DWR-ESO     last   $TIMESERIES/gates.dss
midsco    hist+gate   pos         ir-decade   DWR-ESO     last   $TIMESERIES/gates.dss
```

Montezuma Sl parameters and time varying operations in a DSS file

```
mtzsl     hist+gate   cfweirdown  ir-decade   DWR-ESO     last   $TIMESERIES/gates.dss
mtzsl     hist+gate   cfweirup    ir-decade   DWR-ESO     last   $TIMESERIES/gates.dss
mtzsl     hist+gate   crestelev   ir-decade   DWR-ESO     last   $TIMESERIES/gates.dss
mtzsl     hist+gate   pos         ir-decade   DWR-ESO     last   $TIMESERIES/gates.dss
mtzsl     hist+gate   widthdown   ir-decade   DWR-ESO     last   $TIMESERIES/gates.dss
mtzsl     hist+gate   widthup     ir-decade   DWR-ESO     last   $TIMESERIES/gates.dss
```

Section END →

```
END
```

Note: Clifton Court and Delta Cross Channel operations are complicated, so they are specified in a separate file (hydro.dss instead of gates.dss). Clifton Court operations are not included in this tutorial.

Section Keyword →
Field Keywords →

```
# gate timing from other dss files
INPUTPATHS
NAME      A_PART      B_PART      C_PART E_PART      F_PART            FILLIN PRIORITY FILENAME
```

Clifton Court ops
Delta Cross Chan ops
Section END →

```
#clfct    hist+gate   CHWST000    POS    IR-YEAR     DWR-OM-JOC-DSM2   last   0        $TIMESERIES/hydro.dss
dxc       hist+gate   RSAC128     POS    IR-YEAR     DWR-OM-JOC-DSM2   last   0        $TIMESERIES/hydro.dss
END
```

**Figure 4-6: Sample HYDRO Gate Operations Input File-gates.inp**

**Table 4-1: Summary of Gates Modeled in DSM2 Tutorial**

| Gate/Barrier | Name in DSM2 | RKI* | DSM2 Representation | Type of Operations |
|---|---|---|---|---|
| Clifton Court Forebay** | clfct | CHWST000 | Gate on a reservoir | Time varying |
| Delta Cross Channel | dxc | RSAC128 | 2 identical weirs | Time varying |
| Grant Line Canal | gl_cn | CHGRL009 | Weir with 0 or 6 pipes | Time varying |
| Middle River near Tracy Blvd | mid_r | RMID027 | Weir with 0 or 6 pipes | Time varying |
| Morrow Island Distribution System C-Line Outfall at Grizzly Bay | midsco | - | Weir with 1 or 2 pipes | Time varying |
| Montezuma Slough Salinity Control Gates | mtzls | - | Weir with special operations based on head differences and velocities | Calculated |
| Old River at Tracy | old_r | ROLD046 | Weir with 0 or 9 pipes | Time varying |
| Old River at head of San Joaquin River | orhrb | ROLD074 | Weir with 0, 2, 3, 4, or 6 pipes. | Time varying |
| Seven Mile Slough-Three Mile Slough | 7mil1 | - | Weir with 2 pipes | Constant-open |
| Seven Mile Slough-San Joaquin River | 7mil2 | - | Weir with 1 pipe | Constant-closed |
| Goodyear Slough | gysoo | - | Weir with 4 pipes | Constant-open |
| Morrow Island Distribution System Intake | midsi | - | Weir with 3 pipes | Constant-open |
| Morrow Island Distribution System M-Line Outfall at Suisun Slough | midsmo | - | Weir with 3 pipes | Constant-open |
| Roaring River | rrsin | - | Weir with 8 pipes | Constant-open |
| Sand Mound Slough | sndmd | - | Weir with 2 pipes | Constant-open |
| Tom Paine Slough | tpsbp | - | Weir with 6 pipes | Constant-open |
| Paradise Cut | pcut | - | Weir | Constant-open |

*RKI = River Kilometer Index

**For illustration purposes, input lines for Clifton Court Forebay are included in the gates.inp file. However since additional data processing is required to use the time series associated with this gate, the lines have been commented out in the gates.inp file.

| | |
|---|---|
| NODE | Node number if gate is a reservoir gate |
| CHAN | DSM2 channel number in which the gate is located |
| LOC | Gate location in a channel; UP or DOWN[4]<br>UP — gate located in the upstream end of the channel<br>DOWN — gate located in the downstream end of the channel |
| NGATES | Number of identical gate openings for a weir-type gate |
| WIDTHUP | Width of gate in the upstream direction[4]; WIDTHUP = width of the entire channel if the gate is a weir spanning the entire width of the channel; WIDTHUP = width of the weir opening for a notched weir[5]. |
| WIDTHDOWN | Width of gate in the downstream direction[4]; WIDTHDOWN = width of the entire channel if the gate is a weir spanning the entire width of the channel; WIDTHDOWN = width of the weir opening for a notched weir[5]. |
| CRESTELEV | Crest elevation of the weir in feet relative to the datum (NGVD 1929) [5]. |
| NPIPES | Number of identical pipes (culverts) in the barrier |
| PIPERAD | Radius of each pipe, feet (all pipes have the same radius) |
| PIPEELEV | Pipe invert elevation in feet relative to the datum (NGVD 1929) [5]. |
| CFWEIRUP | Flow coefficient for weirs when flow is in the upstream direction[4]; values are between 0 (no flow) and 1 (fully open). |

**Gate Location**
- **UP- upstream end of the channel**
- **DOWN- downstream end of the channel**

**Gate Width**
**WIDTHUP should be set equal to WIDTHDOWN**

**Pipe: In DSM2 a pipe is defined as a conduit (culvert) that allows flow to pass through a barrier (gate).**

[4] The upstream and downstream ends of the channel are designated in the ***dsm2demo/data/grid/channels.inp*** input file.
[5] See section 6.5 for more information

| | | |
|---|---|---|
| | CFWEIRDOWN | Flow coefficient for weirs when flow is in the downstream direction[4]; values are between 0 (no flow) and 1 (fully open). |
| | CFPIPEUP | Flow coefficient for pipes when flow is in the upstream direction[4]; values are between 0 (no flow) and 1 (fully open); all pipes have the same value |
| | CFPIPEDOWN | Flow coefficient for pipes when flow is in the downstream direction[4]; values are between 0 (no flow) and 1 (fully open); all pipes have the same value |
| | DHOPEN | Change in elevation criteria for opening the gate. When the gate is closed and the change in water surface elevation at the gate exceeds DHOPEN, the gate is opened; used for Montezuma Slough Salinity Control gates. |
| | VELCLOSE | Water velocity criteria for closing the gate. When the gate is open and the velocity at the gate exceeds VELCLOSE, the gate is closed; used for Montezuma Slough Salinity Control gates. |
| | POS | Gate position variable specified in DSS C_PART; used when OPER=TIME<br>-10 Calculate the gate operation<br>0 Gate if fully closed<br>1 One gate is fully open<br>2 Two gates are fully open<br>10 Remove gate from the channel, allow free flow |
| Required: | no | |
| Overwrites: | yes | Overwrites by NAME |

**Flow Coefficients for Weirs or Pipes**
- **0 = no flow**
- **1 = fully open**

**Special Operations Criteria**
- **Open gate when change in water surface elevation criteria is met**
- **Close gate when maximum water velocity criteria is met**

**POS gate operations values in DSS file when OPER=TIME**

**-10 = Calculate**
**0 = Closed**
**1 = 1 gate open**
**2 = 2 gates open**
**10 = Remove gate from channel**

Description

Describes the gates (flow barriers) to be used in a HYDRO simulation. Weirs and pipes (culverts) can be used in the same gate. The number of identical gate (weir-type) openings at a specific location is specified using NGATES and defaults to one. Multiple types of gates are not allowed at the same location. If the number of gates is greater than one (NGATES>1), all of the gates must have the same configuration. For example one gate can not be a notched weir and the other gate a full width weir with several pipes. However, multiple identical gates (with or without pipes) are allowed at the same location (NGATES>1). If multiple identical gates are used at the same location, the gates can be operated independently. All gates can be open, all gates can be closed, or a combination of open and closed gates is allowed. The number of gates open or closed at any time can be controlled during the simulation from DSS values. The OPER value should be set equal to TIME if it is desired to read the gate operations from a DSS file.

If the OPER value is TIME, the operations of the gate are specified in a DSS file. In the DSS file the gate operations are specified by the following codes referred to in DSS as the POS (gate position) values:

| | |
|---|---|
| -10 | Calculate the gate operation |
| 0 | Gate if fully closed |
| 1 | One gate is fully open |
| 2 | Two gates are fully open |
| 10 | Remove gate from the channel, allow free flow |

The Delta Cross Channel can be used as an example. The Delta Cross Channel is represented in DSM2 as two gates, so NGATES equals 2. The operations of the gates are time varying, so OPER equals TIME. Possible values from DSS should be 0 (all gates closed; no flow), 1 (one gate open, one gate closed), or 2 (both gates open). In addition, a value of 10 means to activate the 'free-flow' regime, which leaves the gate installed but with no flow impediment. Tests show this produces a very similar flow to leaving the gate out entirely. Consequently, gates can be installed and uninstalled during a single model run.

Examples:

```
GATES
# gates on reservoirs--the coeffs are given in the
# reservoir section
NAME OPER NODE
clfct time 72
END

# gates that are weirs with constant operations
# Paradise Cut
GATES
NAME   CHAN   LOC  OPER  WIDTHDOWN  WIDTHUP  CRESTELEV  CFWEIRDOWN  CFWEIRUP
pcut   195    up   open  237        237      12.5       0.6         0.6
END

# gates that are pipes with constant operations
# Seven Mile Slough-at Three Mile Slough (7mil1) and at SJR (7mil2)
GATES
NAME   CHAN  LOC  OPER   NPIPES  PIPERAD  PIPEELEV  CFPIPEDOWN CFPIPEUP
7mil1  308   up   open   2       2.00     -7.0          0.5    0.5
7mil2  307   up   close  1       2.00     -7.0          0.0    0.0
END

# gates that are both weirs and pipes with constant operations
GATES
NAME  OPER   CHAN LOC WIDTHDOWN WIDTHUP CRESTELEV CFWEIRDOWN CFWEIRUP NPIPES PIPERAD
PIPEELEV CFPIPEDOWN CFPIPEUP
mid_r ignore 134  up  140.00    140.00  -3.00     0.8        0.8      6      2.00
-4.00    0.00       0.60
# Field keywords and value lines above are actually one long line each

# Each line has wrapped to two lines in the display
END

# multiple gate openings at a gate structure
GATES
NAME   NGATES
dxc    2
END
```

Use in tutorial:

The gates.inp file used in this tutorial (Figure 4-6) contains operations for several types of gates. Clifton Court Forebay is specified as a gate on a reservoir, however for this tutorial, that gate has been commented out due to the complexity of the data associated with that gate. In the next section, six gates are designated as having time varying operations (Delta Cross Channel, Grant Line Canal, Middle River near Tracy Blvd, Morrow Island Distribution System C-Line Outfall, Old River at Tracy, and Old River at the head of the San Joaquin River), and one gate has calculated operations (Montezuma Slough Salinity Control Gates). In the next section, eight gates with pipes and constant operations are specified (Seven Mile Slough at Three Mile Slough, Seven Mile Slough at the San Joaquin River, Goodyear Slough, Morrow Island Distribution System Intake, Morrow Island Distribution System M-Line Outfall, Roaring River, Sand Mound Slough, and Tom Paine Slough). All of these gates have open pipes, except for Seven Mile Slough at the San Joaquin River. The next section designated Paradise Cut as an constantly operating weir that is open. The next section indicates that two gates represent the Delta Cross Channel. The next section indicates the operation criteria for the Montezuma Slough Salinity Control Gates. The next section provides the DSS pathnames in the file gates.dss for the variables describing and the operations data for Grant Line Canal, Middle River near Tracy Blvd, Old River at Tracy, and Old River at the head of the San Joaquin River. The next section gives the DSS paths in the file gates.dss for the variables describing the Delta Cross Channel and for the description and operations data for the Morrow Island Distribution System C-Line Outfall and the Montezuma Slough Salinity Control Gates. The last section contains DSS pathnames in the file hydro.dss for the operations data for Clifton Court and the Delta Cross Channel. For this tutorial, the operations of Clifton Court have been commented out (not included in the simulation).

**Gate Operation**
**DSS files**

- **gates.dss**
- **hydro.dss**

**Files are located in the directory *dsm2demo/data/timeseries***

## 4.6 **input-ag.inp:** Agricultural Drainage and Return Flow Input File

Agricultural drainage and return flows are specified in the input file input-ag.inp. For this tutorial, the input-ag.inp file is located in the directory ***dsm2demo/study/input/hydro***. The sample input-ag.inp file used in this tutorial is shown in Figure 4-7. The input-ag.inp file includes the section INPUTPATHS. A new input-ag.inp file is only created for a new simulation if the level of consumptive use changes.

**input-ag.inp**
**Sections**

- **INPUTPATHS**

### 4.6.1 INPUTPATHS[6]

| | | |
|---|---|---|
| Section keyword: | INPUTPATHS | Each line in the INPUTPATHS section specifies the location or "path[7]" that corresponds to the desired input data time series. |
| Field keywords: | NAME | Location name. The node number to which the location name corresponds must be specified, typically in a translations input file. |

**Locations associated with DSS data may be specified by:**

- **NAME or**
- **NODE**

[6] This section is identical to the INPUTPATHS description in section 4.4.1 with the addition of the NODE field keyword.

[7] Each line in the INPUTPATHS section specifies the location or "path" that corresponds to the desired input data time series. In this tutorial the input paths in the input-ag.inp file correspond to DSS pathnames.

| | |
|---|---|
| NODE | Node number corresponding to the location associated with the data. |

Section Keyword →
Field Keywords →
Byron Bethany ID Consumptive Use
Section END →
Section Keyword →
Field Keywords →
Diversion Data
Seepage Data
Drainage Data
Section END →

```
# DSM2 input file

# Input paths for historic-based DICU data

INPUTPATHS
NAME   A_PART           B_PART   C_PART        E_PART   F_PART    FILLIN  PRIORITY  FILENAME
# Byron-Bethany Irrigation Distric
bbid   DICU-HIST+RSVR   BBID     DIV-FLOW      1MON     DWR-OSP   LAST    1         $TIMESERIES/dicu.dss
bbid   DICU-HIST+RSVR   BBID     DRAIN-FLOW    1MON     DWR-OSP   LAST    1         $TIMESERIES/dicu.dss
bbid   DICU-HIST+RSVR   BBID     SEEP-FLOW     1MON     DWR-OSP   LAST    1         $TIMESERIES/dicu.dss
END

INPUTPATHS
NODE   A_PART           B_PART   C_PART        E_PART   F_PART    FILLIN  PRIORITY  FILENAME
1      DICU-HIST+NODE   1        DIV-FLOW      1MON     DWR-OSP   LAST    1         $TIMESERIES/dicu.dss
3      DICU-HIST+NODE   3        DIV-FLOW      1MON     DWR-OSP   LAST    1         $TIMESERIES/dicu.dss
                 ••• Several lines omitted for illustration purposes •••
354    DICU-HIST+NODE   354      DIV-FLOW      1MON     DWR-OSP   LAST    1         $TIMESERIES/dicu.dss
355    DICU-HIST+NODE   355      DIV-FLOW      1MON     DWR-OSP   LAST    1         $TIMESERIES/dicu.dss

1      DICU-HIST+NODE   1        SEEP-FLOW     1MON     DWR-OSP   LAST    1         $TIMESERIES/dicu.dss
3      DICU-HIST+NODE   3        SEEP-FLOW     1MON     DWR-OSP   LAST    1         $TIMESERIES/dicu.dss
                 ••• Several lines omitted for illustration purposes •••
354    DICU-HIST+NODE   354      SEEP-FLOW     1MON     DWR-OSP   LAST    1         $TIMESERIES/dicu.dss
355    DICU-HIST+NODE   355      SEEP-FLOW     1MON     DWR-OSP   LAST    1         $TIMESERIES/dicu.dss

1      DICU-HIST+NODE   1        DRAIN-FLOW    1MON     DWR-OSP   LAST    1         $TIMESERIES/dicu.dss
3      DICU-HIST+NODE   3        DRAIN-FLOW    1MON     DWR-OSP   LAST    1         $TIMESERIES/dicu.dss
                 ••• Several lines omitted for illustration purposes •••
354    DICU-HIST+NODE   354      DRAIN-FLOW    1MON     DWR-OSP   LAST    1         $TIMESERIES/dicu.dss
355    DICU-HIST+NODE   355      DRAIN-FLOW    1MON     DWR-OSP   LAST    1         $TIMESERIES/dicu.dss
END
```

Note: The node numbers listed in the input paths are not necessarily sequentially numbered.

**Figure 4-7: Sample HYDRO Agricultural Drainage and Return Flow Input File-input-ag.inp**

| | |
|---|---|
| A_PART | DSS A part. Typically a text string that may indicate information such as the type of data or the scenario associate with the data. Must be IDENTICAL to the pathname in the input DSS file. |
| B_PART | DSS B part. Typically a location name, node number, or channel number. Must be IDENTICAL to the pathname in the input DSS file. |
| C_PART | DSS C part. Typically indicates the type of data: DIV-FLOW, DRAIN-FLOW, SEEP-FLOW, etc. Must be IDENTICAL to the pathname in the input DSS file. |
| E_PART | DSS E part. Typically indicates the time interval of time series data: 15MIN, 1HOUR, 1DAY, 1MON, IR-DECADE. Must be IDENTICAL to the pathname in the input DSS file. |
| F_PART | DSS F part. Typically a text string that indicates the study name or the source of the data. Must be IDENTICAL to the pathname in the input DSS file. |
| FILLIN | LAST , INTERP, or DATA. If LAST is indicated, then the last data value will be used when a value is not specified for a given time. When INTERP is indicated, values will be interpolated if a value is not specified for a given time. If DATA is indicated, the model will automatically use the last value if the time series is period averaged or the model will interpolate if the time series is instantaneous. |
| PRIORITY | Optional priority of the input data represented by this path specified as an integer between 0 and N. Lower numbers indicate higher priority data paths, for example a "1" indicates the first priority data path and a "2" indicates the second priority data path. Data from higher priority (lower |

**DSS Pathnames**

**References to DSS pathnames (A, B, C, E, and F parts) must be IDENTICAL to the text specified in that part of the DSS file.**

**Types of Consumptive Use**

- **Diversions-water transferred out of Delta that will eventually return to the Delta (sink)**
- **Drainage-water leaving a Delta island and entering a Delta channel including rainfall and agricultural runoff (source)**
- **Seepage-water that is lost from Delta channels by seepage through levees onto islands (sink)**

| | |
|---|---|
| | number) input paths are used first. When data are missing from a higher priority input data path, data are filled in with data from the next lower priority (next higher number) data path. A priority of 0 means ignore the priority system and always use the specified path. If no data are specified in any input data path for a specific time during the model simulation, DSM2 will crash. See section 6.3 and Figure 6-5 for additional information on input path priorities. |
| FILENAME | DSS filename that contains the desired time series data. |

Required: yes

Overwrites: no

Description: Provides information to locate time-varying data (flows, stages, gate operations, water quality, etc.) in DSS during the simulation. All time-varying input for HYDRO and QUAL must come from DSS files. Locations corresponding to the time-varying input are specified by either a node number or a name that translates to a node number.

Example:

```
INPUTPATHS
NAME A_PART         B_PART  C_PART     E_PART F_PART  FILLIN PRIORITY FILENAME
1    DICU-HIST+NODE 1       DIV-FLOW   1MON   DWR-OSP LAST   1        $TIMESERIES/dicu.dss
1    DICU-HIST+NODE 1       SEEP-FLOW  1MON   DWR-OSP LAST   1        $TIMESERIES/dicu.dss
1    DICU-HIST+NODE 1       DRAIN-FLOW 1MON   DWR-OSP LAST   1        $TIMESERIES/dicu.dss
END
```

Use in tutorial:
The first section of the input-ag.inp file (Figure 4-7) provides the DSS pathnames for the file dicu.dss for the diversion, seepage, and drainage (return) flows associated with Byron Bethany Irrigation District. The second section of the input-ag.inp file lists the DSS pathnames for the file dicu.dss for the diversion, seepage, and drainage (return) flows associated with various locations indicated by their node number in the DSM2 grid.

**Consumptive Use <u>DSS file</u>**

- **dicu.dss**

**File is located in the directory *dsm2demo/data/ timeseries***

## 4.7 **io.inp:** Input File that Specifies Output File Names

Names of output files are specified in the input file io.inp. For this tutorial, the io.inp file is located in the directory ***dsm2demo/study/input/hydro***. The sample io.inp file used in this tutorial is shown in Figure 4-8. The io.inp file includes the section IO_FILES. If environment variables are used to distinguish files from different simulations, a new io.inp file may not be needed for each simulation.

**io.inp Sections**

- **IO_FILES**

### 4.7.1 INPUTPATHS

| | | | |
|---|---|---|---|
| Section keyword: | IO_FILES | Section where input and output file names are specified | |
| Field keywords: | MODEL | Model for which input/output is desired: | |
| | | HYDRO | input to or output from HYDRO |
| | | QUAL | input to or output from QUAL |
| | | OUTPUT | used to indicate that a text file echoing screen output is desired |
| | TYPE | Type of input/output file: | |
| | | NONE | Used when there is no choice in file format |
| | | RESTART | ASCII restart file |
| | | BINARY | Binary file (used for recording simulation results at every node at the specified interval) |
| | IO | Designation of whether file is an input or an output file | |
| | | IN | Input file that will be read |
| | | OUT | Output file that will be written |
| | | NONE | Used when MODEL equals OUTPUT |

```
# DSM2 input file

# I/O files

IO_FILES
MODEL  TYPE     IO   INTERVAL FILENAME
hydro  binary   out  15min    ./output/hydro-${RUN}.htf
hydro  restart  out  1day     ./output/hydro-restart-${RUN}.out
output none     none none     ./output/hydro-${RUN}.out
END
```

Section Keyword →
Field Keywords →
Output file specifications
Section END →

**Figure 4-8: Sample HYDRO Output File Name Specification Input File-io.inp**

| | | |
|---|---|---|
| | INTERVAL | Time interval for which data are to be written to the file; NONE, or a time interval (15 min, 1 hour, 1 day, etc.) |
| | FILENAME | Name of the input/output file |
| Required: | no | |
| Overwrites: | yes | By: MODEL+TYPE+IO |
| Description: | This section specifies the filenames of input/output files. If filenames are given for restart and binary input or output file, listing the filename in this section turns on processing for those files (general echo output is always on). | |

Example:

```
IO_FILES
MODEL   TYPE    IO    INTERVAL FILENAME
hydro   binary  out   15min    ./output/hydro-${RUN}.htf
hydro   restart out   1day     ./output/hydro-restart-${RUN}.out
output  none    none  none     ./output/hydro-${RUN}.out
END
```

Use in tutorial:
In the sample io.inp file (Figure 4-8) three output files are specified. The output file names use the environment variable RUN. Referring to the dsm2.inp file in Figure 4-2, RUN is the text string “oct96”. Thus, the three output files generated in the directory dsm2demo/study/output are:

- hydro-oct96.htf - binary file that saves HYDRO results every 15 minutes
- hydro-restart-oct96.out – an ASCII restart file
- hydro-oct96.out – an ASCII file that echoes screen output

**Output Files**

- **hydro-oct96.htf**
- **hydro-restart-oct96.out**
- **hydro-oct96.out**

## 4.8 **output.inp:** Input File that Specifies Desired Output

Desired output is specified in the input file output.inp. For this tutorial, the output.inp file is located in the directory ***dsm2demo/study/input/hydro***. The sample output.inp file used in this tutorial is shown in Figure 4-9. The output.inp file includes the section OUTPUTPATHS. For the purpose of the tutorial, output is only requested at four locations. A new output.inp file is created for each simulation in which different output types and/or locations are desired.

**output.inp Sections**

- **OUTPUTPATHS**

Section Keyword →
Field Keywords →
DSS & text output for Rio Vista specified by channel and distance
Section END →
Section Keyword →
Field Keywords →
DSS and text output specified by RKI for Antioch, SJR Brandt Bridge, and Old River at Clifton Court Ferry
Section END →

```
# DSM2 Output location file
# Grid v2.0
# Updated: 1-31-02, jamiea
# >>DEMO ONLY<<

# Output paths specified by channel number and distance
OUTPUTPATHS
CHAN     DIST   TYPE      INTERVAL  PERIOD   FILENAME
# Sac River@Rio Vista
430      9684   FLOW      1HOUR     INST     $DSSOUT
430      9684   FLOW      1HOUR     INST     $FLOWTXTOUT
430      9684   STAGE     1HOUR     INST     $DSSOUT
430      9684   STAGE     1HOUR     INST     $STAGETXTOUT
END

# Output paths specified RKI (River Kilometer Index)
OUTPUTPATHS
NAME     TYPE   INTERVAL  PERIOD   FILENAME
#Antioch
rsan007          flow      15min  inst   $DSSOUT
rsan007  flow   15min     inst     $FLOWTXTOUT
rsan007          stage     15min  inst   $DSSOUT
rsan007  stage  15min     inst     $STAGETXTOUT
#San Joaquin River at Brandt Bridge
rsan072  flow   15min     inst     $DSSOUT
rsan072  flow   15min     inst     $FLOWTXTOUT
rsan072  stage  15min     inst     $DSSOUT
rsan072  stage  15min     inst     $STAGETXTOUT
#Old River at Clifton Court Ferry
rold040  flow   15min     inst     $DSSOUT
rold040  flow   15min     inst     $FLOWTXTOUT
rold040  stage  15min     inst     $DSSOUT
rold040  stage  15min     inst     $STAGETXTOUT
END
```

**Figure 4-9: Sample HYDRO Desired Output Input File-output.inp**

### 4.8.1 OUTPUTPATHS

| | | |
|---|---|---|
| Section keyword: | OUTPUTPATHS | Section where desired output is specified |
| Field keywords: | CHAN | Channel number. If CHAN is used, also use DIST and don't use NAME. |
| | DIST | Distance from the upstream node downstream along channel in feet; Alternatively if it is desired to use the downstream location along the entire length of the channel, use the word LENGTH instead of a numerical distance. Use DIST with CHAN. |
| | NAME | Location name. The node number to which the location name corresponds must be specified, typically in a translations input file. Used for DSS B part. If NAME is used, don't use CHAN and DIST. |
| | TYPE | Type of data (FLOW, STAGE, FLOW-EXPORT, FLOW-DIVERSION, GATE, EC, TDS, etc.) Used for DSS C part. |
| | INTERVAL | Time interval of time series output data: 15MIN, 1HOUR, 1DAY, 1MON, IR-DECADE. Used for DSS E part. |
| | PERIOD | Period for which data are to be written:<br>INST — write instantaneous values to the output file<br>AVE — write values averaged over the interval specified under the keyword INTERVAL, e.g. daily or monthly averages, etc. |

| | |
|---|---|
| FILENAME | Name of output file to be written to, if the file name ends with the extension *.dss the output will be written to that file in DSS format, otherwise the output will be a text file. |

Required: no

Overwrites: no

Description: Time-varying text and DSS output is specified in this section.

Example:

Output specified by channel number and distance:

```
OUTPUTPATHS
CHAN DIST   TYPE   INTERVAL  PERIOD   FILENAME
# Sac River@Rio Vista
430  9684   FLOW   1HOUR     INST     $DSSOUT
430  9684   FLOW   1HOUR     INST     $TXTOUT
430  9684   STAGE  1HOUR     INST     $DSSOUT
430  9684   STAGE  1HOUR     INST     $TXTOUT
END
```

Output specified by name [in this case RKI -River Kilometer Index]:

```
OUTPUTPATHS
NAME    TYPE   INTERVAL  PERIOD   FILENAME
#Antioch
   rsan007          flow      15min  inst   $DSSOUT
rsan007  flow   15min     inst    $TXTOUT
   rsan007          stage     15min  inst   $DSSOUT
rsan007  stage  15min     inst    $TXTOUT
END
```

Use in tutorial:

The sample output.inp file (Figure 4-9) specifies flow and stage output at four locations (Figure 4-11). Output is requested in both text and DSS formats. One DSS file will be created and separate text output files will be created for flow and stage data. The environment variable definitions for the output file names are located in the dsm2.inp file (Figure 4-2). The first section specifies hourly output for the Sacramento River at Rio Vista using channel number and distance references. The second section specifies 15-minute output for Antioch, the San Joaquin River at Brandt Bridge, and Old River at Clifton Court Ferry using the NAME field keyword. The names for each of the locations are defined in the ***dsm2demo/data/grid/translations.inp*** file. A sample file listing output for locations throughout the Delta can be found in the file ***dsm2demo/study/input/hydro/additional_sample_ files/ output_full_delta.inp***. To use this file instead of the output.inp file, replace the output.inp pathname in the dsm2.inp file with the pathname for the output_full_delta.inp file.

**Output Files**

- **hydro-oct96.dss**
- **hydro-flow-oct96.txt**
- **hydro-stage-oct96.txt**

## 4.9 **runtime.inp:** Simulation Time Period Input File

**runtime.inp**
**Sections**
- **SCALAR**

The simulation time period is specified in the input file runtime.inp. For this tutorial, the runtime.inp file is located in the directory ***dsm2demo/study/input/hydro***. The sample runtime.inp file used in this tutorial is shown in Figure 4-10. The runtime.inp file includes the section SCALAR. A new runtime.inp file is created for each simulation with a different simulation period.

### 4.9.1 **SCALAR:** Runtime scalar variables

| | | |
|---|---|---|
| Section keyword: | SCALAR | |
| Field keywords: | none | |
| Required: | yes | |
| Overwrites: | yes | by scalar name |
| Description: | This section is used to input the values of single variables (scalars) to DSM2. Each line in the scalars section consists of two fields: the variable name and the value (in that order). | |
| | run_start_date | Date of simulation start (ddmonyyyy, e.g. 01jun1994 or restart or tidefile). If use an actual date, also define the variable run_start_time. If value is set equal to “restart” then simulation will start from the time in the restart file, and the variable run_start_time does not need to be defined. If value is set equal to “tidefile”, the simulation will start from the time in the tide file, and the variable run_start_time does not need to be defined. |
| | run_start_time | Hour of simulation start (HHHH, e.g. 0000 or 2400). Used with run_start_date when run_start_date is specified as a date. |
| | run_end_date | Date of end of simulation (ddmonyyy, e.g. 31aug1994). Used with run_end_time. If run_end_date is used, comment out run_length. |
| | run_end_time | Hour of the end of the simulation (HHHH, e.g.1500). Used with run_end_date. |

Section Keyword➔ (SCALAR)

Simulation period Oct 1, 1996 0:00 to Oct 31, 1999 24:00 (run_start_date through #comment line)

Section END➔ (END)

```
# DSM2 input file
# Simulation run time Oct 1, 1996-Oct 31, 1996
# File Modified: 1-31-02 jamiea

# Run start and end times
SCALAR
run_start_date   01OCT1996
run_start_time   0000
run_end_date     31OCT1996 # if used, comment out run_length
run_end_time     2400
#run_length      # not used
#comment out run_end date and time if you use run_length
END
```

**Figure 4-10: Sample HYDRO Simulation Time Period Input File-runtime.inp**

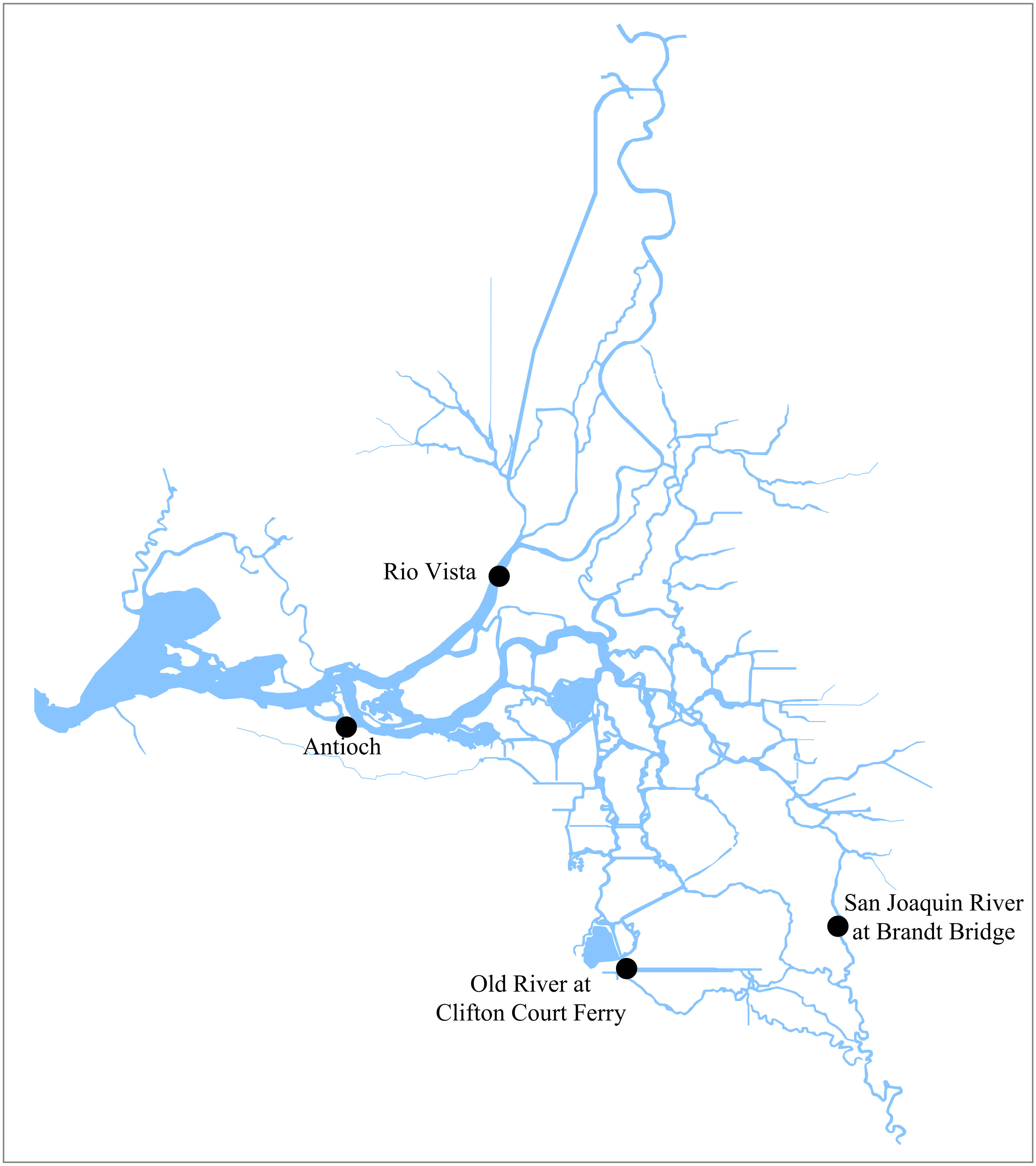



**Figure 4-11: Map of Output Locations**

| | |
|---|---|
| run_length | Length of simulation in days and hours (##DAY_##HOUR, e.g. 91DAY_15HOUR). If run_length is used, comment out or omit run_end_date and run_end_time. |

Example:

```
SCALAR
run_start_date 01OCT1996
run_start_time 0000
run_end_date   31OCT1996
run_end_time   2400
END
```

Use in tutorial:
The sample runtime.inp file (Figure 4-10) specifies the simulation time period. In this case, the simulation starts on October 1, 1996 at midnight (hour 0:00) and runs through October 31, 1996 at midnight (hour 24:00).

**Simulation Period**

**October 1, 1996 0:00 to October 31, 1996 24:00**

## 4.10 **scalar.inp:** Scalar Variable Input File

Scalar variables are defined in the input file scalar.inp. For this tutorial, the scalar.inp file is located in the directory ***dsm2demo/study/input/hydro***. The sample scalar.inp file used in this tutorial is shown in Figure 4-12. The scalar.inp file includes the section SCALAR. Typically the tidal representation (historical/realistic or repeating) and the time step are the only variables that are changed in the scalar.inp file from simulation to simulation.

**scalar.inp Sections**

- **SCALAR**

### 4.10.1 **SCALAR:** DSM2 scalar variables

| | | |
|---|---|---|
| Section keyword: | SCALAR | |
| Field keywords: | none | |
| Required: | yes | |
| Overwrites: | yes | by scalar name |
| Description: | This section is used to input the values of single variables (scalars) to DSM2. Each line in the scalars section consists of two fields: the variable name and the value (in that order). (Note: The flush_output interval should be kept at one day or greater; less than one day will result in long times to write to DSS files at the end of a run.) | |

Section Keyword → SCALAR

Miscellaneous scalar variables

Data checking and warning scalar variables

Print level scalar variable

HYDRO scalar variables

Section END → END

```
# DSM2 scalar variable input file

# Various single-argument options (constants, coefficients, ...)
SCALAR
flush_output     1day     # interval to flush output
display_intvl    6hour    # how often to display model time progress
checkdata        false    # check input data w/o simulation

# Note: all cont_* scalars are "true" or "false".
cont_unchecked   true     # continue on unchecked data (use data value)
cont_question    false    # continue on questionable data (use data value)
cont_missing     false    # continue on missing data (use previous value)
cont_bad         false    # continue on bad data (use previous value)

warn_unchecked   false    # warn about unchecked data
warn_question    false    # warn about questionable data
warn_missing     true     # warn about missing data

printlevel       0        # amount of printing, 0 to 9, increasing with number.

# following all Hydro variables
repeating_tide   f        # t = repeating tide run, f = real tide run
hydro_time_step  15min    # time step, in minutes
deltax           5000     # spatial discretization, feet
levee_slope      0.33     # used for cross-section top width extrapolation
#max_tides       15       # maximum number of tide cycles to repeat
#tide_length     25hour   # tide length
#toler_stage     0.0010   # tolerance for error in sum of repeated stages
#toler_flow      0.0020   # tolerance for error in indiv of repeated flows
terms            dyn      # Terms: dynamic, diffusion, kinematic
vardensity       f        # f = constant density, t = variable density.
varsinuosity     f        # f = constant sinuosity, t = variable sinuosity.
gravity          32.2     # acceleration due to gravity.
theta            0.6      # time-weighting factor.
maxiter          50       #(low)  # maximum number of iterations per time step.
luinc            1        # interval for complete forward eliminations.
toleranceq       0.001    #(high)  # tolerance for closure on discharge.
tolerancez       0.0008   # tolerance for closure on water-surface elevation.
END
```

**Figure 4-12: Sample HYDRO Scalar Variable Input File-scalar.inp**

| | |
|---|---|
| flush_output | Interval to flush output, (e.g. 5day). The flush_output interval should be kept at one day or greater; less than one day will result in long times to write to DSS files at the end of a run. |
| display_intvl | How often to display model time progress (e.g. 1hour) |
| checkdata | Check input data without simulation, true or false |
| cont_unchecked | Continue simulation when data flagged as unchecked are encountered, true or false. If true, use data, if false end simulation if data flagged as unchecked are encountered. |
| cont_question | Continue simulation when data flagged as questionable are encountered, true or false. If true, use data, if false end simulation if data flagged as questionable are encountered. |
| cont_missing | Continue simulation when missing data are encountered, true or false. If true, DSM2 uses the previous value when missing data are encountered and continues with the simulation. If false, DSM2 ends the simulation. |
| cont_bad | Continue simulation when data flagged as bad are encountered, true or false. If true, use data, if false end simulation if data flagged as bad are encountered. |
| warn_unchecked | Print a warning to the screen when data flagged as unchecked are encountered. |
| warn_question | Print a warning to the screen when data flagged as questionable are encountered. |
| warn_missing | Print a warning to the screen when data flagged as questionable are encountered. |

| | |
|---|---|
| printlevel | Amount of printing of screen output, 0 to 9. Amount of information printed increases with increasing number. |
| repeating_tide | Flag to indicate repeating or "realistic" tide simulation, t or f. t = repeating tide simulation and f = realistic tide simulation. |
| hydro_time_step | Computational time step length (e.g. 5min, 15min) |
| deltax | Spatial discretization, feet (e.g., 5000) |
| levee_slope | Levee slope used for cross-section top width extrapolation (e.g., 0.33) |
| max_tides | Maximum number of tide cycles to repeat (e.g. 15). Used only if repeating_tide = t. |
| tide_length | Length of repeating tidal cycle in hours (e.g. 25 hours). Used only if repeating_tide = t. |
| toler_stage | Tolerance for error in sum of repeated stages (e.g. 0.0010). Used only if repeating_tide = t. |
| toler_flow | Tolerance for error in repeated flows (e.g. 0.0020). Used only if repeating_tide = t. |
| terms | Terms to be included in the momentum equation. Currently this is always set equal to DYN for dynamic wave. |
| vardensity | Variable density flag, f or t. f = constant density and t = variable density. |
| varsinuosity | Variable sinuosity flag, f or t. f = constant sinuosity and t = variable sinuosity. |
| gravity | Acceleration due to gravity ft/sec$^2$ (e.g. 32.02). |
| theta | Time-weighting factor (e.g. 0.6). |

| | |
|---|---|
| maxiter | Maximum number of iterations per time step (e.g. 9) |
| luinc | Interval for complete forward eliminations (e.g. 1, 2). |
| toleranceq | Tolerance for closure on discharge (e.g. 0.5) |
| tolerancez | Tolerance for closure on water surface elevation (e.g. 0.005) |

Use in tutorial:

The sample scalar.inp file (Figure 4-12) defines variables that don't change with time (scalars). The first several sets of variables define display, printing, and data checking options. A historical tide is specified by setting the variable repeating_tide = f. The computational time step is set equal to 15 minutes. The spatial discretization is 5000 feet, and the levee slope for cross section top width interpolation is 0.33. The variables max_tides, tide_length, toler_stage, and toler_flow are commented out since this is a historical tide simulation. Those variables are related to repeating tide simulations. If the repeating tide variables are not commented out for a historical/realistic tide simulation, they are ignored by DSM2. The simulation uses a dynamic wave approximation (all terms of the momentum equation are included) with constant density and sinuosity. The acceleration due to gravity is 32.2 ft/s$^2$. The time weight factor is set equal to 0.6. Fifty is the maximum number of iterations per computational time step. Additional computational variables include a forward elimination interval of 1 and tolerances for closure of 0.001 for flow and of 0.0008 for stage.

**Scalar Values**

- **historical tide**
- **15-minute time step**

## 4.11 **channels.inp:** Channel Connectivity Input File

Channels in the DSM2 computational grid are defined in the input file channels.inp. For this tutorial, the channels.inp file is located in the directory ***dsm2demo/data/grid***. The sample channels.inp file used in this tutorial is shown in Figure 4-13. The channels.inp file includes the section CHANNELS. The channels.inp file does not change from simulation to simulation unless the new simulation includes physical changes to the configuration of the Delta. This tutorial uses the DSM2 version 2.0 grid. Additional information can be found on the internet at **http://modeling.water.ca.gov/delta/models/dsm2/data/grid/index.html.**

**channels.inp**
**Sections**

- **CHANNELS**

**This tutorial uses the DSM2 grid v 2.0.**

### 4.11.1 **CHANNELS**

| | | |
|---|---|---|
| Section keyword: | CHANNELS | Section that lists channel connectivity |
| Field keywords: | CHAN | DSM2 channel number |
| | LENGTH | Channel length (feet) |

```
# DSM2 grid v2.0
CHANNELS
CHAN LENGTH MANNING DISP   DOWNNODE UPNODE XSECT DIST XSECT DIST
  1  19500  0.0350  0.3000   2        1       1  0       2  19500
  2  14000  0.0280  0.3000   3        2       3  0       4  14000
  3  13000  0.0280  0.3000   4        3       5  0       6  13000
  4  14050  0.0280  0.3000   5        4       7  0       8  14050
  5  12350  0.0280  0.3000   6        5       9  0      10  12350
  6   9878  0.0280  0.3000   7        6      11  0      12   9878
  7   8796  0.0280  0.3000   8        7      13  0      14   8796
  8  11625  0.0300  0.3000   9        8      15  0      16  11625
  9  10497  0.0300  0.3000  10        9      17  0      18  10497
 10   9400  0.0300  0.3000  11       10      19  0      20   9400
         ••• Several lines omitted for illustration purposes •••
450  10000  0.0220  1.5000 227      238     839  0     840  10000
443  11500  0.0220  0.8000 362      357     827  0     828  11500
575  13000  0.0220  1.5000 357      328    1027  0    1028  13000
195   3045  0.0300  0.3000 162        5    1301  0    1302   3045
378  20000  0.0220  0.3000 300      299     701  0     702  12734
379   3300  0.0240  0.3000 300      339    1308  0    1308   3300
380   9200  0.0240  0.3000 301      300     703  0     704   9200
418  16047  0.0330  0.3000 339      338     779  0     780  16047
419   8273  0.0280  0.3000 340      339     781  0     782   8273
END
```

Section Keyword → (CHANNELS)
Field Keywords → (CHAN LENGTH MANNING ...)
Channel connectivity information (data rows)
Section END → (END)
Cross section and distance for upstream node (first XSECT DIST)
Cross section and distance for downstream node (second XSECT DIST)

**Figure 4-13: Sample Channel Connectivity Input File-channels.inp**

| | |
|---|---|
| MANNING | Manning's n for that channel |
| DISP | Dispersion coefficient for that channel |
| DOWNNODE | Downstream node of the channel |
| UPNODE | Upstream node of the channel |
| XSECT | Cross section associated with either the upstream or the downstream node. In this tutorial the first XSECT listed is associated with the upstream node and the second one listed is associated with the downstream node. |
| DIST | Distance to the cross section location measured downstream along the channel from the upstream end. In this tutorial the first DIST listed is associated with the upstream node (distance = 0) and the second one listed (distance = channel length) is associated with the downstream node. |

Required: yes

Overwrites: yes

Description: This section is used to define the channels in the DSM2 grid. The orientation of each channel is determined by which node is indicated as an upstream node and which node is designated as the downstream node. In general the node that is upstream during a flood (incoming) tide has been designated as the upstream node.

Example:

```
CHANNELS
CHAN LENGTH MANNING DISP   DOWNNODE UPNODE XSECT DIST XSECT DIST
  1  19500  0.0350  0.3000   2        1       1  0       2  19500
END
```

Use in tutorial:
The sample channels.inp file (Figure 4-13) contains the channel connectivity information for the DSM2 grid version 2.0.

## 4.12 **irregular_xsects.inp:** Irregular Cross Section Input File

**irregular_xsects.inp**
**Sections**
- **IRREG_GEOM**

Locations of irregular (non-rectangular) cross sections in the DSM2 computational grid are defined in the input file irregular_xsects.inp. The input file that describes each irregular cross section is also listed in the irregular_xsects.inp file. For this tutorial, the irregular_xsects.inp file is located in the directory ***dsm2demo/data/grid***. The sample irregular_xsects.inp file used in this tutorial is shown in Figure 4-14. The irregular_xsects.inp file includes the section IRREG_GEOM. The irregular_xsects.inp file does not change from simulation to simulation unless the new simulation includes physical changes to the configuration of the Delta.

### 4.12.1 **IRREG_GEOM:** Irregular Geometry Information

| | | |
|---|---|---|
| Section keyword: | IRREG_GEOM | Section that lists locations and files describing irregular cross sections |
| Field keywords: | CHAN | DSM2 channel number |
| | DIST | Distance downstream from upstream end, normalized between zero and one. The actual distance will be calculated internally, multiplying the normalized distance here with the channel length in the CHANNELS section (see section 4.11.1). Note that DIST in IRREG_GEOM section is a normalized distance and DIST in the CHANNELS section is an actual distance downstream from the upstream end of the channel. In DSM2 a DIST=0 is the location of the upstream node and DIST=length is the location of the downstream node. |
| | FILENAME | Name of the the input file that describes the irregular cross section characteristics such as cross-sectional area, wetted perimeter, top width, etc. The individual irregular cross section files are created using CSDP[8]. |
| Required: | yes | |
| Overwrites: | yes | by CHAN and DIST |
| Description: | This section lists the irregular cross sections. Only irregular cross sections are specified in this section; rectangular cross-sections are given in the file regular_xsects.inp. | |

**DIST Values**

- **Normalized between 0 and 1**
- **0 = upstream end of channel**
- **length = downstream end of channel**

Example:

```
IRREG_GEOM
CHAN     DIST       FILENAME
   1     0.24018    $IRREG/1_0.24018.txt
END
```

```
# Irregular Cross Sections as Generated by CSDP[8]
# DSM2 grid v2.0
# modified: 2001.01.01, mmierzwa
#
IRREG_GEOM
CHAN     DIST       FILENAME
   1     0.24018    $IRREG/1_0.24018.txt
   1     0.95336    $IRREG/1_0.95336.txt
   2     0.18901    $IRREG/2_0.18901.txt
   2     0.72606    $IRREG/2_0.72606.txt
   3     0.38266    $IRREG/3_0.38266.txt
   3     0.82150    $IRREG/3_0.82150.txt
••• Several lines omitted for illustration purposes •••
 574     0.04698    $IRREG/574_0.04698.txt
 574     0.30360    $IRREG/574_0.30360.txt
 574     0.54282    $IRREG/574_0.54282.txt
 574     0.77623    $IRREG/574_0.77623.txt
 575     0.11091    $IRREG/575_0.11091.txt
 575     0.40390    $IRREG/575_0.40390.txt
 575     0.61393    $IRREG/575_0.61393.txt
 575     0.80824    $IRREG/575_0.80824.txt
END

# taken from irregular_xsects_copy.inp file
# Irregular Cross Section Modifications
# modified: 2000.12.07, mmierzwa
IRREG_GEOM
CHAN   DIST          FILENAME
84     length        $IRREG/85_0.07884.txt
218    0             $IRREG/217_0.57846.txt
220    0             $IRREG/219_0.82392.txt
222    0             $IRREG/219_0.82392.txt
••• Several lines omitted for illustration purposes •••
84     0             $IRREG/85_0.07884.txt
84     length        $IRREG/85_0.07884.txt
227    0             $IRREG/228_0.00525.txt
227    length        $IRREG/228_0.00525.txt
# to eliminate rectangular xsect in upper Elk slough.
375    0             $IRREG/377_0.93784.txt
376    0             $IRREG/377_0.93784.txt
# for T-shaped sherman lake
281    0             $IRREG/281_upstream.txt
281    0.06061       $IRREG/281_200ft.txt # ~ 200 ft from upstream end
281    length        $IRREG/281_200ft.txt
END

# Taken from old irregular_xsects_copy_nosjr.inp file.
IRREG_GEOM
CHAN   DIST          FILENAME
327    0             $IRREG/327_0.44122.txt
327    length        $IRREG/327_0.44122.txt
366    0             $IRREG/366_0.54505.txt
366    length        $IRREG/366_0.54505.txt
422    0             $IRREG/422_0.88014.txt
END
```

Section Keyword →
Field Keywords →
Irregular cross section locations and names of files describing each cross section.
Section END →

Section Keyword →
Field Keywords →
Irregular cross section locations and names of files describing each cross section.
Section END →

DIST Values
0 = upstream end of channel
length= downstream end of channel

Section Keyword →
Field Keywords →
Irregular cross section locations
Section END →

**Figure 4-14: Sample Irregular Cross Section Input File-irregular_xsects.inp**

[8] CSDP = Cross Section Development Program
http://modeling.water.ca.gov/delta/models/dsm2/tools/csdp/index.html

Use in tutorial:
The sample irregular_xsects.inp file (Figure 4-14) defines irregular cross sections for the DSM2 grid version 2.0.

## 4.13 list.inp: Channel Connectivity List Input File

A list of channel numbers required by DSM2 is provided in the input file list.inp. For this tutorial, the list.inp file is located in the directory ***dsm2demo/data/grid***. The sample list.inp file used in this tutorial is shown in Figure 4-15. The list.inp file includes the section LIST_CHAN. The list.inp file does not change from simulation to simulation unless the new simulation includes physical changes to the configuration of the Delta.

**list.inp Sections**
- **LIST_CHAN**

### 4.13.1 LIST_CHAN: Channel List

Section keyword: LIST_CHAN Section that lists channels in the DSM2 grid

Field keywords: none

Required: yes

Overwrites:

Description: Listing of channels defining the Delta grid.

Example:

```
LIST_CHAN
17
1
2
3
```

••• Several lines omitted for illustration purposes •••

```
479
480
481
END
```

Use in tutorial:
The sample list.inp file (Figure 4-15) list the channels for the DSM2 grid version 2.0.

Section Keyword →

List of channel numbers

Section END →

```
# New Grid Channel List, Grid v2.0, Updated: MM, 2000.12.20

LIST_CHAN
17
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
169
170
171
16
560
561
18
19
20
••• Several lines omitted for illustration purposes •••
537
539
542
543
544
455
456
467
468
469
474
470
475
457
476
477
478
479
480
481
END
```

**Figure 4-15: Sample Channel Connectivity List Input File-list.inp**

## 4.14 **regular_xsects.inp:** Regular Cross Section Input File

Regular cross sections for the DSM2 grid are provided in the input file regular_xsects.inp. For this tutorial, the regular_xsects.inp file is located in the directory ***dsm2demo/data/grid***. The sample regular_xsects.inp file used in this tutorial is shown in Figure 4-16. The regular_xsects.inp file includes the section XSECTS. The regular_xsects.inp file does not change from simulation to simulation unless the new simulation includes physical changes to the configuration of the Delta.

**regular_xsects.inp**
**Sections**
- **XSECTS**

### 4.14.1 **XSECTS:** Regular Cross Sections

| | | |
|---|---|---|
| Section keyword: | XSECTS | Section that lists regular cross sections for the DSM2 grid |
| Field keywords: | XSECT | DSM2 cross section number |
| | WIDTH | Width in feet of rectangular section |
| | BOTELV | bottom elevation of rectangular section with respect to NGVD 1929 |
| | INIT-STAGE | Initial stage in feet with respect to NGVD 1929 |
| | INIT-FLOW | Initial flow, cubic feet per second |
| Required: | yes | |
| Overwrites: | yes | by XSECT |
| Description: | The cross sections given in the CHANNELS section are listed here. Only rectangular cross sections are specified in this section; irregular cross-sections are given in Irregular Cross-Sections. Initial stages and flows at the cross section are given; these can be overwritten with a restart file. | |

Example:

```
LIST_CHAN
17
1
2
```

••• Several lines omitted for illustration purposes •••

```
479
480
481
END
```

Use in tutorial:
The sample regular_xsects.inp file (Figure 4-16) defines regular cross sections for the DSM2 grid version 2.0.

Section Keyword →
Field Keywords →
Regular cross section descriptions
Section END →

```
# Rectangular Cross Section Info (NGVD)
# DSM2 Grid v2.0
# Modified: 2000.12.07, mmierzwa
XSECTS
 XSECT  WIDTH    BOTELV    INIT-STAGE INIT-FLOW
   1    612.0    -1.20       7.0000      0.00
   2    612.0    -1.20       6.0000      0.00
   3    672.0    -1.49       6.0000      0.00
   4    672.0    -1.49       5.0000      0.00
   5    456.0    -1.75       5.0000      0.00
   6    456.0    -1.75       4.0000      0.00
   7    400.0    -3.35       4.0000      0.00
   8    400.0    -3.35       3.0000      0.00
   9    370.0    -4.74       3.0000      0.00
   10   370.0    -4.74       2.0000      0.00
   11   355.0    -11.53      2.0000      0.00
   12   355.0    -11.53      2.0000      0.00
   13   376.0    -8.11       2.0000      0.00
   14   376.0    -8.11       2.0000      0.00
   15   234.0    -7.83       2.0000      0.00
   16   234.0    -7.83       2.0000      0.00
   17   144.0    -6.74       2.0000      0.00
   18   144.0    -6.74       2.0000      0.00
   19   157.0    -9.44       2.0000      0.00
   20   157.0    -9.44       2.0000      0.00
   21   160.0    -9.16       2.0000      0.00
   22   160.0    -9.16       2.0000      0.00
   23   173.0    -9.10       2.0000      0.00
   24   173.0    -9.10       2.0000      0.00
   25   231.0    -9.56       2.0000      0.00
••• Several lines omitted for illustration purposes •••
  1290  2250.0    -6.1        2.0000      0.00
  1291   273.0   -15.0        2.0000      0.00
  1292   273.0   -15.0        2.0000      0.00
  1297   841.0   -20.0        2.0000      0.00
  1298   841.0   -20.0        2.0000      0.00
  1293    81.0   -23.06       2.0000      0.00
  1294    81.0   -23.06       2.0000      0.00
  1295   920.0    -3.795      2.0000      0.00
  1296   920.0    -3.795      2.0000      0.00
  1299    73.0   -15.458      2.0000      0.00
  1300    73.0   -15.458      2.0000      0.00
  1301   122.0    -3.85       3.0000      0.00
  1302   122.0    -3.85       3.0000      0.00
  1303  2250.0    -7.1        2.0000      0.00
  1304  2250.0    -5.1        2.0000      0.00
  1305  2500.0    -3.0        2.0000      0.00
  1306   162.0   -15.5        2.0000      0.00
  1307  2000.0    -7.9        2.0000      0.00
  1308   143.0   -18.10       4.197       0.00
  1310  4500      -5.1        2.0000      0.00
END
```

**Figure 4-16: Sample Regular Cross Section Input File-regular_xsects.inp**

## 4.15 **reservoirs.inp:** Reservoir Input File

Reservoirs to be used in a simulation are defined in the input file reservoirs.inp. For this tutorial, the reservoirs.inp file is located in the directory ***dsm2demo/data/grid***. The sample reservoirs.inp file used in this tutorial is shown in Figure 4-17. The reservoirs.inp file includes the section XSECTS. The reservoirs.inp file typically does not change for a new simulation unless that simulation includes new reservoirs.

**reservoirs.inp**
**Sections**
- **RESERVOIRS**

### 4.15.1 **RESERVIORS**

| | | |
|---|---|---|
| Section keyword: | RESERVOIRS | Section that lists reservoirs to be used in a simulation |
| Field keywords: | NAME | DSM2 reservoir name |
| | AREA | Reservoir Surface area, million square feet |
| | STAGE | Initial stage in feet relative to NGVD 1929 |
| | BOTELV | Bottom elevation in feet relative to NGVD 1929 |
| | NODE | Node number the reservoir is connected to |
| | COEFF2RES | Flow coefficient from channel to reservoir |
| | COEFF2CHAN | Flow coefficient to channel from reservoir |
| Required: | no | |
| Overwrites: | yes | by NAME |
| Description: | Describes the reservoirs to be used in the simulation. | |

These three keywords may be repeated for as many nodes the reservoir is connected to

**Reservoirs defined in this tutorial**
- **Clifton Court**
- **Mildred Island**
- **Bethel Tract**
- **Frank's Tract**
- **Discovery Bay**

Example:
```
RESERVOIRS
NAME      AREA      STAGE  BOTELV NODE  COEFF2RES  COEFF2CHAN NODE COEFF2RES
COEFF2CHAN NODE  COEFF2RES  COEFF2CHAN  NODE COEFF2RES COEFF2CHAN
CLFCT     91.86800  2.50   -10.1    72    1800.        0.
MILDRED   42.29960  2.00   -14.1   127    2000.        2000.     129 2000.
2000. 130 2000. 2000. 136 2000. 2000.
END
```
} wrapped keywords

} wrapped text

In the example above, the text on two lines is longer than the width of the page, so the text has been wrapped around to the following line. The NODE, COEFF2RES and COEFF2CHAN keywords and corresponding values have been color coded to indicate which values correspond to which set of keywords. Recall that spacing is not important in DSM2 input files.

```
# DSM2 Reservoir Input File
# Stage is relative to NGVD
# created: 2001.01.01, mmierzwa

# Reservoir Grid Map Info:
# 1. Clifton Court Forebay (CLFCT)
# 2. Mildred Island (MILDRED)
# 3. Bethel Tract (BETHEL)
# 4. Franks Tract (FRANKS)
# 5. Discovery Bay (DISCOVRY)
# 6. Northern San Pablo Bay (SANPAB1)
# 7. NorthWest San Pablo Bay (SANPAB2)
# 8. South Bay #1 (SBAY1)
# 9. South Bay #2 (SBAY2)

RESERVOIRS
NAME      AREA      STAGE BOTELV NODE   COEFF2RES   COEFF2CHAN NODE COEFF2RES COEFF2CHAN NODE   COEFF2RES   COEFF2CHAN
NODE COEFF2RES COEFF2CHAN NODE COEFF2RES COEFF2CHAN NODE COEFF2RES COEFF2CHAN NODE COEFF2RES COEFF2CHAN
CLFCT     91.86800  2.50   -10.1   72     1800.       0.
MILDRED   42.29960  2.00   -14.1  127     2000.       2000.    129 2000. 2000. 130 2000. 2000. 136 2000. 2000.
BETHEL    15.50310  2.50    -8.1  220     2000.       2000.
FRANKS   141.78640  2.50   -10.1  219     2000.       2000.    225 2000. 2000. 216 2000. 2000. 103 3000. 3000. 232
3000. 3000. 224 3000. 3000.
DISCOVRY 19.63200  1.50   -16.0  198     1500.       1500.  197 1500
# These reservoirs are used only for the SF Bay DSM2 extension
#SANPAB1   48.58877  X.XX    -4.9   499    2000.       2000. 500 2000. 2000. 503 2000. 2000.
#SANPAB2   99.85006  X.XX    -4.9   499    2000.       2000. 503 2000. 2000. 508 2000. 2000. 515 2000. 2000. 516
2000. 2000.
#SBAY1     74.63527  X.XX   -12.9   535    3000.       3000. 536 3000. 3000.
#SBAY2    312.92297  X.XX    -9.9   549    3000.       3000. 555 3000. 3000.
END
```

- Reservoir name definitions
- Section Keyword →
- Field Keywords →
- Field Keywords →
- Reservoir descriptions
- Reservoirs for SF Bay DSM2 extension
- Section END →
- Note: Field keywords and FRANKS reservoir information wrap onto two lines
- } wrapped text
- } wrapped text

**Figure 4-17: Sample Reservoir Input File-reservoirs.inp**

Note: The NODE, COEFF2RES and COEFF2CHAN keywords and corresponding values have been color coded to indicate which values correspond to which set of keywords. In this file there is an extra set of NODE, COEFF2RES and COEFF2CHAN keywords. This will not affect the DSM2 simulation.

Use in tutorial:
The sample reservoirs.inp file (Figure 4-17) defines five reservoirs for the simulation: Clifton Court Forebay, Mildred Island, Bethel Tract, Frank's Tract, and Discovery Bay.

## 4.16 translations.inp: Text String Translations Input File

Text strings are associated with DSM2 grid locations or reservoirs in the input file translations.inp. For example, the text string SJR (an abbreviation for the San Joaquin River) can be associated with node 17. For this tutorial, the translations.inp file is located in the directory ***dsm2demo/data/grid***. The sample translations.inp file used in this tutorial is shown in Figure 4-18. The translations.inp file includes the section TRANSLATION. The translations.inp file typically does not change for a new simulation unless it is desired to associate a new text string with a DSM2 grid location.

**translations.inp**
**Sections**
- **TRANSLATION**

### 4.16.1 TRANSLATION

| | | |
|---|---|---|
| Section keyword: | TRANSLATION | Section that associates (translates) text strings with DSM2 grid locations |
| Field keywords: | NAME | Text string to be associated with a DSM2 grid location, typically a location name |
| | CHAN | DSM2 channel number. If CHAN is used, also use DIST. Do not use NODE and RESERVOIR. |
| | DIST | distance downstream along channel; LENGTH means to use channel length from the upstream node to the downstream node. If DIST is used, also use CHAN. Do not use NODE and RESERVOIR. |
| | NODE | DSM2 node number. If NODE is used, do not use CHAN, DIST and RESERVOIR. |
| | RESERVOIR | DSM2 reservoir name. If RESERVOIR is used, do not use CHAN, DIST and NODE. |
| Required: | no | |
| Overwrites: | yes | by NAME |

```
# Model Location Translations for Grid v2.0
# Modified: 2002.01.04, mmierzwa

# Unique translation for Delta-wide values (e.g. meteorlogical values)
# Arbitrarily assign to node one so the input system doesn't complain,
# however, these values are not input to node one in the model.
TRANSLATION
NODE          NAME
1             Delta
END

# Translations for Clifton Court Forebay & SWP
TRANSLATION
NAME          RESERVOIR
swp           clfct
bbid          clfct
bankspp       clfct
END

# Translations from common name to node number
# These can be used for inputs, or outputs for stage and
# concentration.
TRANSLATION
NODE   NAME
17     sjr           # San Joaquin River at Vernalis
17     vernalis      # San Joaquin River at Vernalis
181    cvp           # CVP pumping
••• Several lines omitted for illustration purposes •••
21     cal           # Calaveras River, near Stockton
93     rock          # Enterance to Rock Slough on Old River
END

TRANSLATION
NODE    CHAN   DIST    NAME
361     441    length  tide
END

# Translations for IEP RKI observation stations

## Translations' new RKIs are computed using a temporary irregular_xsects.inp
## file, generated using CSDP, and the channels.inp file to be used in
## dsm2.  They represent approximate locations, they are not exact.
## Please keep the translations in alphabetical order to permit easy searching
## and updating.
##
## PROCEDURE:
## irregular_xsects.inp --> normalized distance
## channels.inp         --> channel length
##
## translation dist = normalized distance * channel length

##  Several inputs needed channel translations, but their rki stations were not
##  close to channels.  They were estimated to have a distance of 0 or length.

TRANSLATION
NAME          CHAN   DIST          # Common Name
BYOLO040      399    0             # Yolo Bypass
CFTRN000      172    727           # Turner Cut
••• Several lines omitted for illustration purposes •••
SLTMP017      185    0             # Tom Pain Sl.
SLTRM004      310    540           # Three Mile Sl. @ SJR
END
```

Annotations (left margin, top to bottom):

- Section Keyword → TRANSLATION; Field Keywords → NODE NAME; Node 1="Delta" → 1 Delta; Section END → END
- Section Keyword → TRANSLATION; Field Keywords → NAME RESERVOIR; Associate 3 names with Clifton Ct reservoir (swp, bbid, bankspp); Section END → END
- Section Keyword → TRANSLATION; Field Keywords → NODE NAME; Associate nodes with text names; Section END → END
- Section Keyword → TRANSLATION; Field Keywords → NODE CHAN DIST NAME; Define name "tide" → 361 441 length tide; Section END → END
- Comment lines that explain the procedure for determining translations for data stations in the Delta. These stations are referred to by their RKI - River Kilometer Index.
- Section Keyword → TRANSLATION; Field Keywords → NAME CHAN DIST; Associate RKI names with DSM2 grid locations; Section END → END

**Figure 4-18: Sample Translations Input File-translations.inp**

Description: This section translates between place names and node or channel-distance. It allows the use of place names in input and output sections. (Note: provide either CHAN and DIST, or NODE, or RESERVOIR.)

Examples:

Associate a name (Delta) with a node number (1):

```
TRANSLATION
NODE      NAME
1         Delta
END
```

Associate a name (swp) with a reservoir (Clifton Court):

```
TRANSLATION
NAME      RESERVOIR
swp       clfct
END
```

Associate a name (BYOLO040) with a channel number (399) and distance (0):

```
TRANSLATION
NAME      CHAN   DIST   # Common Name
BYOLO040  399    0      # Yolo Bypass
END
```

Use in tutorial:
The sample translations.inp file (Figure 4-18) provides associations between text strings (names) and locations in the DSM2 grid version 2.0.

## 4.17 **type.inp:** Flow Type Input File

Flow types (inflows, diversions, drainage, exports, seepage, etc) are designated in the input file type.inp. For this tutorial, the type.inp file is located in the directory ***dsm2demo/data/grid***. The sample type.inp file used in this tutorial is shown in Figure 4-19. The type.inp file includes the section TYPE. The type.inp file typically does not change for a new simulation unless a new water source or sink is included in the simulation.

**type.inp Sections**
- **TYPE**

### 4.17.1 **TYPE:** Flow Type

| | | |
|---|---|---|
| Section keyword: | TYPE | Section that associates text strings or flow accounting labels with a flow type (inflows, diversions, drainage, exports, seepage, etc) and designates water sources and sinks |
| Field keywords: | STRING | Text string in pathname or label name to be matched and associated with a flow type or source/sink sign |

Section Keyword →

Field Keywords →

Designate the flow type associated with text strings and DSS parts

Section END →

```
# DSM2 input file
# DEMO ONLY#

# Set flow accounting names for input paths

TYPE
# string - string in pathname to match
# part - part of pathname to match (b=name; c=type; e=interval; f=modifier
#         L=label)
# match - an exact match, or just a substring
# type - the kind of flow (diversion, pumping, seepage, etc.)

# OSP style names
STRING       PART   MATCH  ACCOUNT
CCC          L      exact  DIV
SWP          L      exact  EXPORT
BANKSPP      L      exact  EXPORT
CVP          L      exact  EXPORT
VALLEJO      L      exact  EXPORT
SAC          L      exact  RIM
FRPRT        L      exact  RIM
GREENS       L      exact  RIM
SJR          L      exact  RIM
VERNALIS     L      exact  RIM
CAL          L      exact  RIM
MTZ          L      exact  BND
E03290       L      exact  RIM
CSMR         L      exact  RIM
MOKE         L      exact  RIM
NB           L      exact  DIV
YOLO         L      exact  RIM
EASTSIDE     L      exact  RIM
DICU-IRR     F      sub    DIV
DICU-DRN     F      sub    DRAIN
DICU-SEEP    F      sub    SEEP

# IEP style names
RSAC155      B      exact  RIM    # sac
RSAN112      B      exact  RIM    # sjr
RMKL070      B      exact  RIM    # moke
RCSM075      B      exact  RIM    # csmr
RCAL009      B      exact  RIM    # cal
SLRCK005     B      exact  DIV    # ccc
ROLD039      B      exact  DIV    # ccc - old r.
ROLD034      B      sub    EXPORT # ccc - old r.
CHDMC004     B      exact  EXPORT # cvp
CHSWP003     B      exact  EXPORT # swp
SLBAR002     B      exact  DIV    # nb
BYOLO040     B      exact  RIM    # yolo
RCAL007      B      exact  RIM    # cal
DIV          C      sub    DIV    # irrigation diversions
DRAIN        C      sub    DRAIN  # irrigation drainages
SEEP         C      sub    SEEP   # channel-to-island seepage

END
```

```
# get proper sign convention for flows
# i.e. pumping stored as a positive number in DSS
# must be negative in DSM2

# sign - make a negative (sink) or positive (source) value

# this is redundant, given the sign change using
# accounting labels (below)
TYPE                                  <- Section Keyword
STRING        PART   MATCH  SIGN      <- Field Keywords
CCC           B      exact  -         } Designate text
SWP           B      exact  -         } strings as sinks
CVP           B      exact  -         }
END                                   <- Section END

# sign convention for flows, using accounting labels
TYPE                                  <- Section Keyword
ACCOUNT       SIGN                    <- Field Keywords
DIV           -                       }
PUMP          -                       } Designate
EXPORT               -                } accounting labels
SEEP          -                       } as sources or sinks
DRAIN         +                       }
END                                   <- Section END
```

**Figure 4-19: Sample Flow Type Input File-type.inp**

| | |
|---|---|
| PART | Part of pathname or label to match:<br>a = A part<br>b = name or B part<br>c = measurement type or C part<br>e = interval or E part<br>f = modifier or F part<br>l = name label<br>p = entire pathname. |
| MATCH | Designates whether the text string match has to be exact or if only a substring of the designated part needs to be matched<br>exact = exact match<br>sub = match substring |
| SIGN | Designate the matching pathname as being associated with a source (+) or a sink (-)<br>+ = source<br>- = sink |
| ACCOUNT | Assign an accounting code to the match |

Required: no

Overwrites: no

Description: This section assigns accounting types to matching pathnames, for later use in Qual and PTM; changes the sign of specified time-series input values; and can change the incoming value itself. DSM2-Hydro requires that sinks (flows out of nodes and reservoirs) be negative and that sources be positive. Often sinks will be stored in a DSS file as a positive number (e.g. pumping values); the SIGN field will change the sign internally in DSM2 without changing the database. The ACCOUNT field can be used to assign a type to matching pathnames which can later be used by Qual and PTM for accounting purposes in the output.

Examples:

Associate a string with a flow accounting label

```
TYPE
STRING    PART   MATCH  ACCOUNT
CCC       L      exact  DIV
RSAC155   B      exact  RIM    # sac
END
```

Designate a string as a source or a sink

```
TYPE
STRING     PART   MATCH  SIGN
CCC        B      exact  -
SWP        B      exact  -
CVP        B      exact  -
END
```

Designate a flow accounting label as a source or a sink

```
TYPE
ACCOUNT    SIGN
DIV        -
PUMP       -
   EXPORT          -
SEEP       -
DRAIN      +
END
```

Use in tutorial:
The sample type.inp file (Figure 4-19) provides associations between text strings and flow accounting labels and flow types (inflows, diversions, drainage, exports, seepage, etc). The text strings and flow accounting labels are also designated as sources or sinks. The accounting labels used in this tutorial are summarized in Table 4-2.

**Table 4-2: Summary of Flow Accounting Labels**

| Flow Accounting Label | Source | Sink | Description |
|---|---|---|---|
| BND | ● | | **Stage boundary**-designate water surface elevations at Martinez to represent tidal inflow into the Delta |
| DIV | | ● | **Diversion**-water that is withdrawn from the Delta that will eventually be returned to the Delta |
| DRAIN | ● | | **Drainage**-water that enters the Delta as runoff from islands; includes both rainfall and agricultural runoff |
| EXPORT | | ● | **Exports**-water that is withdrawn from the system that permanently leaves the legal boundaries of the Delta |
| RIM | ● | | **Inflows**-water that flows into the system, typically at the edges or RIM of the system |
| SEEP | | ● | **Seepage**-water that is lost from Delta channels through seepage through levees onto Delta islands |

## 4.18 Individual Irregular Cross Section Input Files

For this tutorial, individual irregular cross section input files are located in the directory ***dsm2demo/data/grid/irreg***. A sample irregular cross section input file 1_0.24018.txt is shown in Figure 4-20. Characteristics of the points that define the irregular cross section are listed in tabular format in the individual irregular cross section input files. The individual irregular cross section files typically does not change for a new simulation unless a physical change to the Delta is being simulated.

**Individual irregular cross section files are located in the directory**

***dsm2demo/data/grid/irreg***

Use in tutorial:
The sample individual irregular cross section files located in the directory ***dsm2demo/data/grid/irreg*** describe the irregular cross sections for the DSM2 grid version 2.0.

## 4.19 DSS Data Time Series Input Files

For this tutorial, DSS time series data input files are located in the directory ***dsm2demo/data/timeseries***. The DSS files used by HYDRO are:

- dicu.dss – Delta Island Consumptive Use data
- gates.dss – Gate operations Data
- hydro.dss - Flow and stage boundary condition data

These input files are changed from simulation to simulation if the consumptive use, gate operations, or boundary flows change.

**DSS data time series files used by HYDRO are located in the directory**

***dsm2demo/data/timeseries***

- **dicu.dss**
- **gates.dss**
- **hydro.dss**

```
Cross-section:  1_0.24018
Elev(NGVD)        A          P          W         Rh         Xc         Zc
==========================================================================
   36.1   19710.7      973.6      970.3       20.2     1016.9       27.6
  32.97   16724.9      939.9      936.8       17.7     1007.1       24.7
  25.34   10088.4      805.2      803.1       12.5      974.5       17.2
   3.62     103.6      116.5      116.4        0.8      838.8        3.0
   1.85       0.0        0.0        0.0        0.0        0.0        0.0

station:  595.3947 808.19366 912.47675 1450.6578 1565.7894
elevation:32.97468 1.8505338 3.6298933 25.346535 36.10561
```

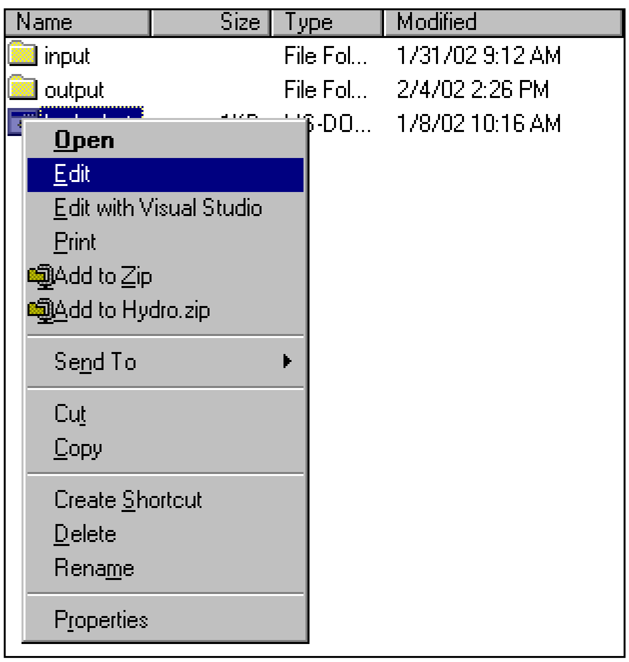
**Figure 4-20: Sample Individual Irregular Cross Section Input File-1_0.24018.txt**

## 4.20 Running HYDRO

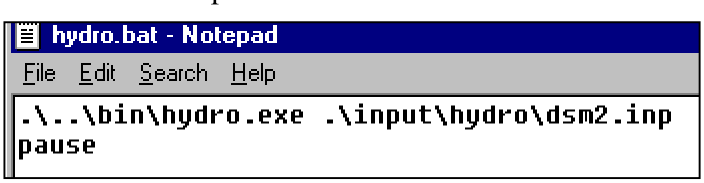
Now the adventures begin, and we will run HYDRO using the input files described in the sections 4.3 through 4.19.

### 4.20.1 Steps for Running the HYDRO Tutorial

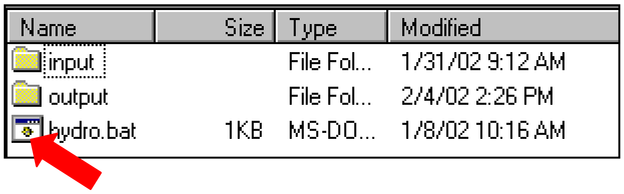
1. Obtain the tutorial files if you have not already done so (see section 2.1 for instructions on how to download the files).
2. On your PC, go to the directory ***dsm2demo/study***.
3. [Optional step] The hydro.bat batch file is used to run HYDRO. To view the contents of the batch file, right click on the hydro.bat icon and select Edit. Note: If you select Open, it will run the batch file instead of opening it so that the contents can be viewed.



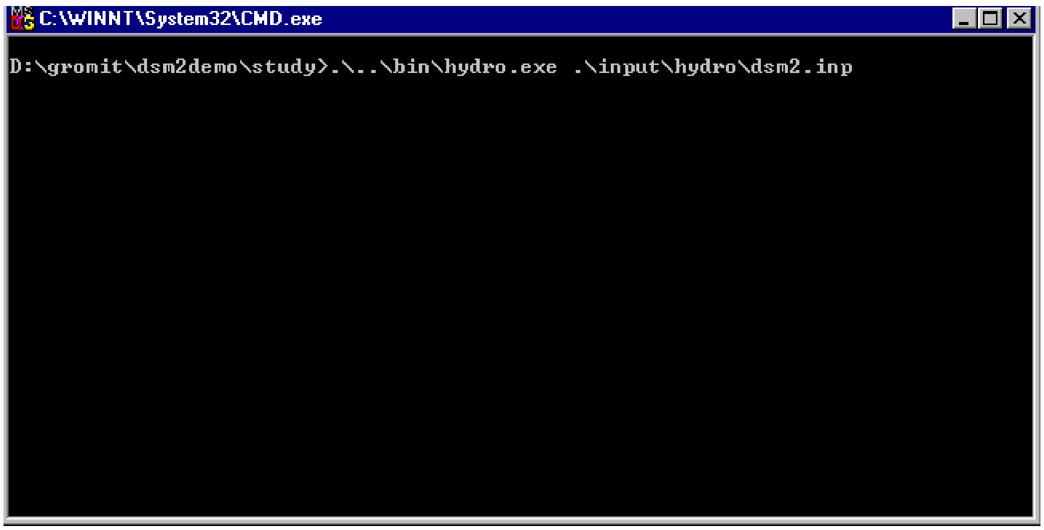

A notepad file will open with the contents of the batch file as shown below. The first line of the batch file runs HYDRO in a DOS window. The second line of the batch file causes HYDRO to pause at the end so that the user can read the final screen output. The user must then press any key to close the DOS window. Without the pause statement, HYDRO would close the DOS window and the user would not be able to read the final screen output.



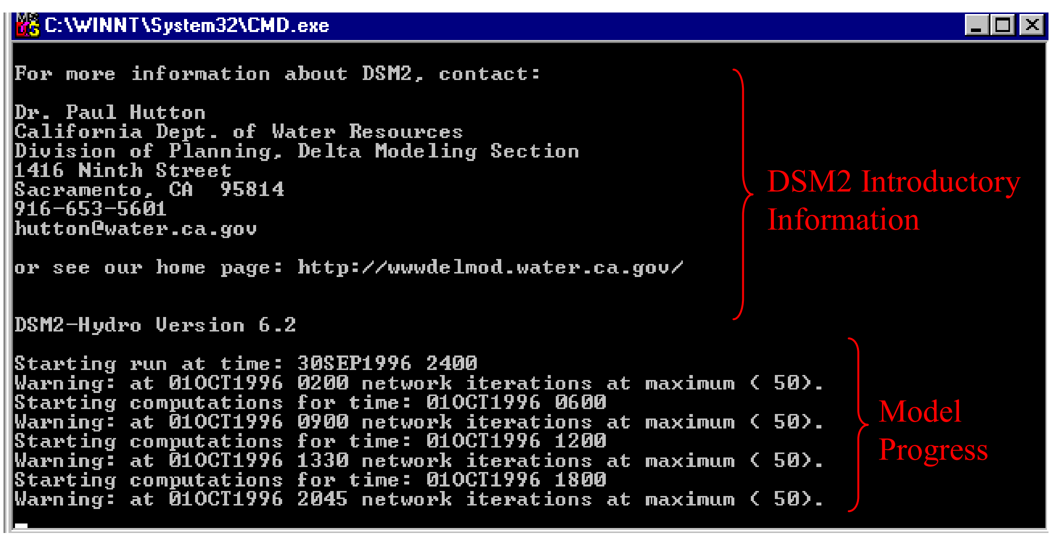
4. To run HYDRO, double click on the hydro.bat icon.



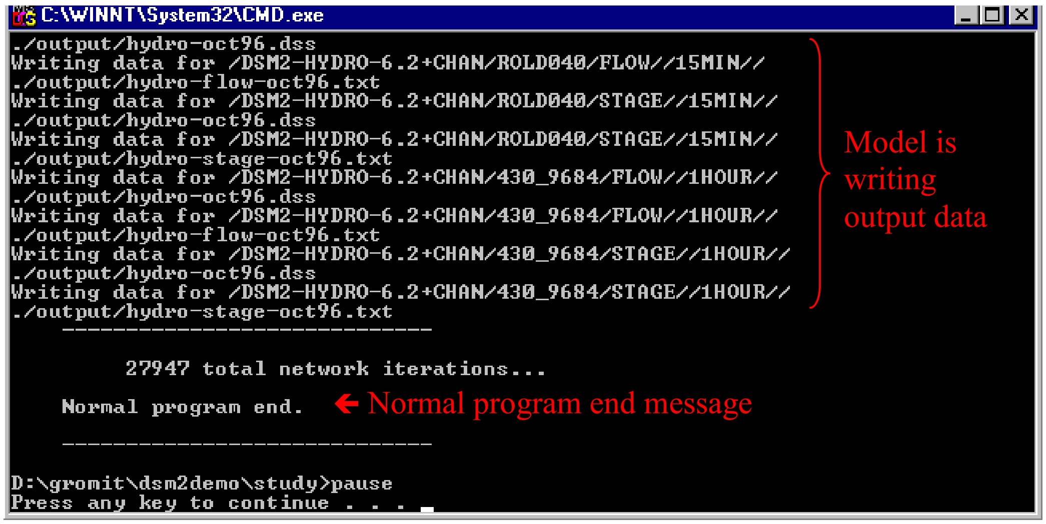

A DOS shell will open and the first line will echo the command to run HYDRO that is listed in the batch file.




Some introductory information on DSM2 will scroll across the screen. Then text indication the progress of the simulation will appear. Don't worry about the network iterations at a maximum warning. On a dual processor PC with 930Mhz chips and 512MB of RAM, a one-month historical simulation for October 1996 takes approximately 9 minutes.



5. When a HYDRO simulation finishes, the DOS prompt window remains open due to the pause command in the batch file. If the simulation ran correctly, a Normal program end message will appear near the bottom of the DOS window. Press any key to exit the DOS window.




6. Congratulations, you just completed a successful HYDRO run.

### 4.20.2 Examining Output from the HYDRO Tutorial Simulation

To examine the output from the HYDRO simulation for October 1996:

1. On your PC, go to the directory ***dsm2demo/study/output***.
2. Notice that the output files created were:
   - hydro-oct96.htf — Binary results output file (tidefile)
   - hydro-oct96.dss — DSS flow and stage time series output file
   - hydro-oct96.out — Screen output file
   - hydro-flow-oct96.txt — Text flow output file
   - hydro-restart-oct96.out — Text restart file
   - hydro-stage-oct96.txt — Text stage output file
3. To view the text output for simulated flows, double click on the hydro-flow-oct96.txt icon. A sample of the text flow output file is shown in Figure 4-21. Data are listed in a single column. DSS style pathname headings separate the data from the various output locations. For this tutorial, output are provided at four locations (Antioch, Rio Vista, San Joaquin River at Brandt Bridge and Old River at Clifton Court Ferry - Figure 4-11). The simulated flows have been plotted in Excel and are shown in Figure 4-22. Red lines indicate 25 hour running averages which estimate average values over the 24hr 50min tidal cycle.

```
/DSM2-HYDRO-6.2+CHAN/RSAN007/FLOW//15MIN//   ← DSS style pathname that indicates location, type of data, and data interval
CFS        ← Data units
INST-VAL   ← Data are instantaneous values
30SEP1996 2400   0.00
01OCT1996 0015  1.359E+03
01OCT1996 0030  3.140E+03
01OCT1996 0045  1.129E+04
01OCT1996 0100  3.435E+04     Antioch 15-minute flow data
• • •  Several lines omitted for illustration purposes • • •
31OCT1996 2300  1.471E+05
31OCT1996 2315  1.463E+05
31OCT1996 2330  1.452E+05
31OCT1996 2345  1.439E+05
31OCT1996 2400  1.423E+05
01NOV1996 0015   0.00
/DSM2-HYDRO-6.2+CHAN/RSAN072/FLOW//15MIN//   ← DSS style pathname that indicates location, type of data, and data interval
CFS        ← Data units
INST-VAL   ← Data are instantaneous values
30SEP1996 2400   0.00
01OCT1996 0015   3.31
01OCT1996 0030   18.0
01OCT1996 0045   98.2     SJR at Brandt Bridge 15-minute flow data
01OCT1996 0100   310.
• • •  Several lines omitted for illustration purposes • • •
31OCT1996 2300  2.593E+03
31OCT1996 2315  2.611E+03
31OCT1996 2330  2.618E+03
31OCT1996 2345  2.621E+03
31OCT1996 2400  2.627E+03
01NOV1996 0015   0.00
/DSM2-HYDRO-6.2+CHAN/ROLD040/FLOW//15MIN//   ← DSS style pathname that indicates location, type of data, and data interval
CFS        ← Data units
INST-VAL   ← Data are instantaneous values
30SEP1996 2400   0.00
01OCT1996 0015   -685.
01OCT1996 0030 -2.495E+03
01OCT1996 0045 -3.640E+03
01OCT1996 0100 -3.184E+03     Old R at CC Ferry 15-minute flow data
• • •  Several lines omitted for illustration purposes • • •
31OCT1996 2300 -1.371E+03
31OCT1996 2315   -431.
31OCT1996 2330   325.
31OCT1996 2345   844.
31OCT1996 2400  1.143E+03
01NOV1996 0015   0.00
/DSM2-HYDRO-6.2+CHAN/430_9684/FLOW//1HOUR//   ← DSS style pathname that indicates location, type of data, and data interval
CFS        ← Data units
INST-VAL   ← Data are instantaneous values
30SEP1996 2400   0.00
01OCT1996 0100   863.
01OCT1996 0200  5.244E+04
01OCT1996 0300  5.966E+04     Rio Vista 1 hour flow data
• • •  Several lines omitted for illustration purposes • • •
31OCT1996 2100  7.018E+04
31OCT1996 2200  6.281E+04
31OCT1996 2300  5.579E+04
31OCT1996 2400  4.946E+04
```

**Figure 4-21: Sample Text from the Output File hydro-flow-oct96.txt**

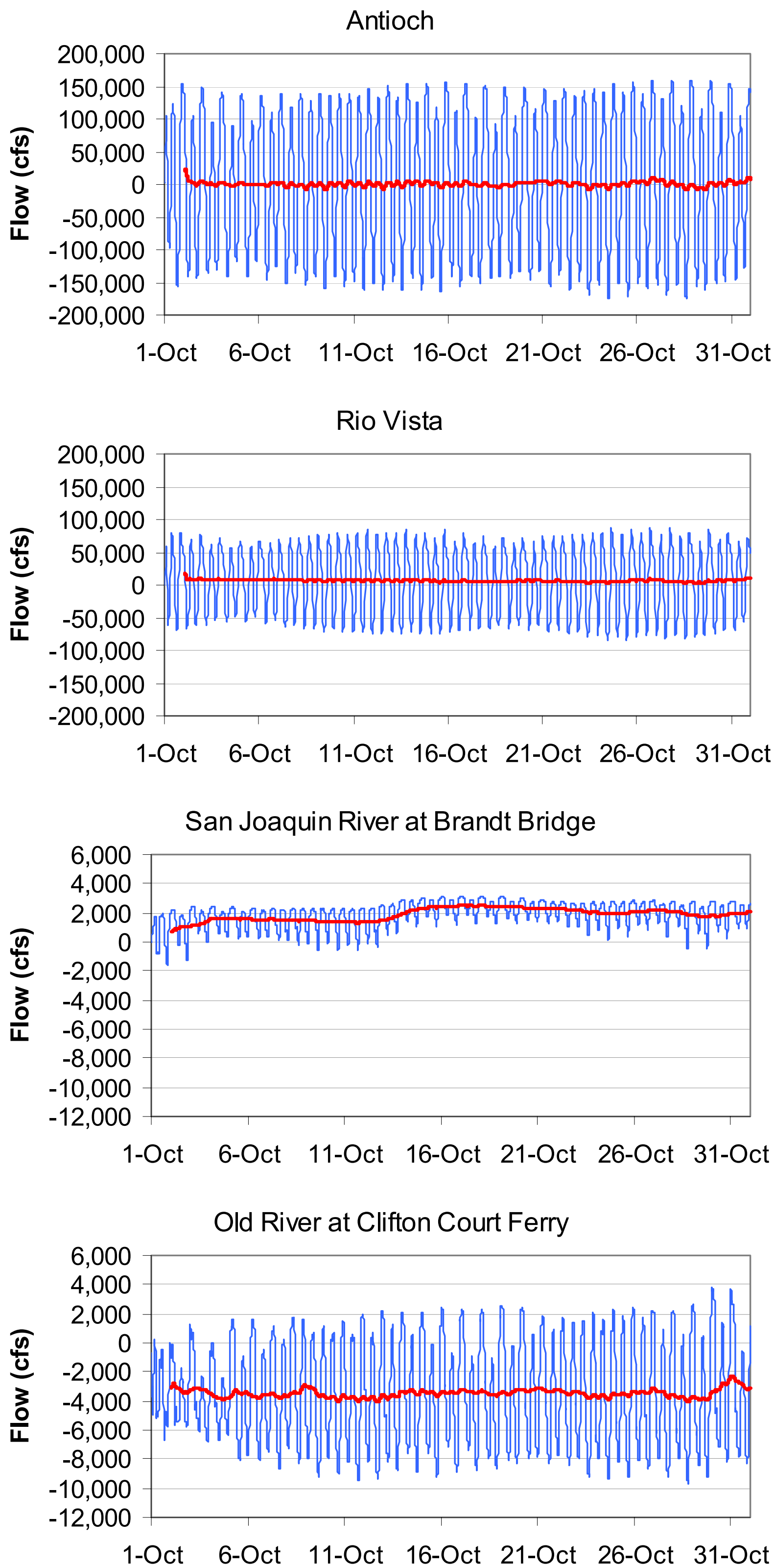
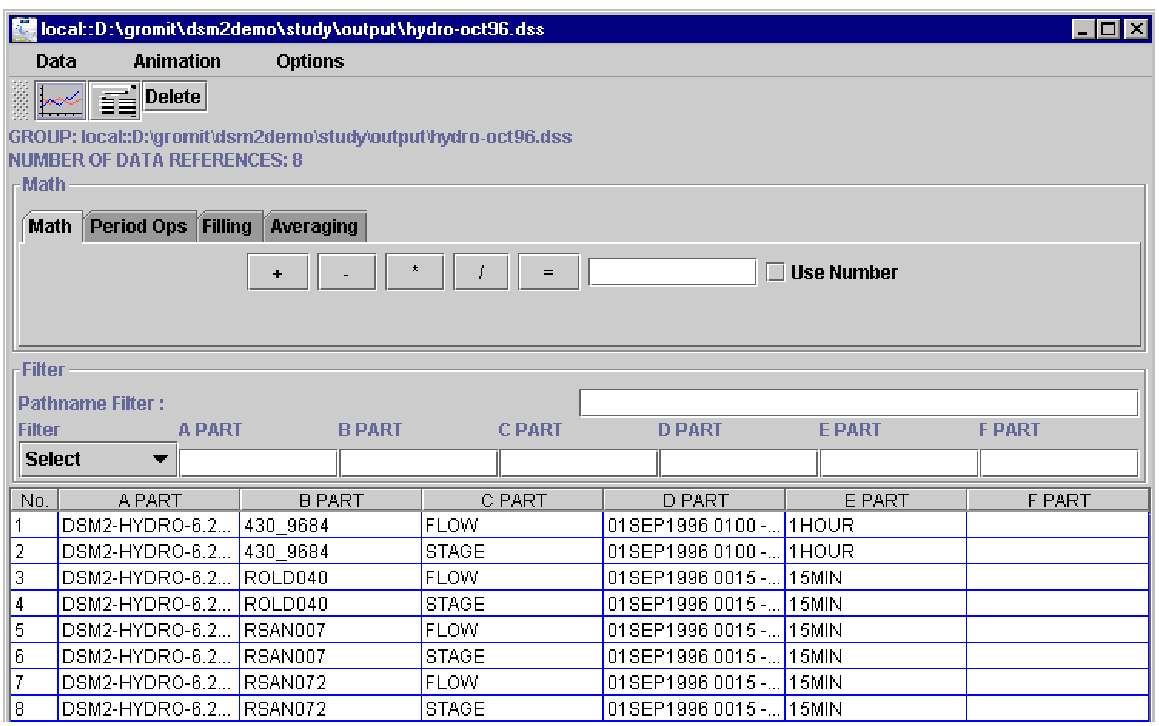



**Figure 4-22: Simulated Flows for October 1996**

Red lines indicate 25hr running averages.

4. To view the text output for simulated stages, double click on the hydro-stage-oct96.txt icon. A sample of the text stage output file is shown in Figure 4-23. Data are listed in a single column. DSS style pathname headings separate the data from the various output locations. For this tutorial, output are provided at four locations (Antioch, Rio Vista, San Joaquin River at Brandt Bridge and Old River at Clifton Court Ferry - Figure 4-11). The simulated stages have been plotted in Excel and are shown in Figure 4-24.

5. Although use of VISTA for analysis of DSS files is beyond the scope of this tutorial, an image of the VISTA window displaying the pathnames from the hydro-oct96.dss file for the flow and stage data for the four output locations used in this tutorial are shown below. Recall that data were saved on a one-hour interval for Rio Vista and on a 15-minute interval for the other four locations. The B Part of the DSS pathname reflects the locations name given in the output.inp file. Since Rio Vista was referred to by a channel number and distance, its name is represented as channel#_distance (430_9684 in this case). The other locations are referred to by their names, which correspond to RKI (River Kilometer Index) values in this case.



```
/DSM2-HYDRO-6.2+CHAN/RSAN007/STAGE//15MIN//  ← DSS style pathname
FEET      ← Data units                         that indicates location, type
INST-VAL  ← Data are instantaneous values      of data, and data interval
30SEP1996 2400   2.00
01OCT1996 0015   2.01
01OCT1996 0030   1.99
01OCT1996 0045   1.90
01OCT1996 0100   1.71   Antioch 15 minute stage data
• • •  Several lines omitted for illustration purposes • • •
31OCT1996 2300 -0.740
31OCT1996 2315 -0.890
31OCT1996 2330  -1.04
31OCT1996 2345  -1.18
31OCT1996 2400  -1.31
01NOV1996 0015   0.00
/DSM2-HYDRO-6.2+CHAN/RSAN072/STAGE//15MIN//  ← DSS style pathname
FEET      ← Data units                         that indicates location, type
INST-VAL  ← Data are instantaneous values      of data, and data interval
30SEP1996 2400   2.00
01OCT1996 0015   1.99
01OCT1996 0030   2.00
01OCT1996 0045   2.02   SJR at Brandt Bridge 15 minute stage data
01OCT1996 0100   2.08
• • •  Several lines omitted for illustration purposes • • •
31OCT1996 2300   2.18
31OCT1996 2315   2.09
31OCT1996 2330   2.01
31OCT1996 2345   1.94
31OCT1996 2400   1.88
01NOV1996 0015   0.00
/DSM2-HYDRO-6.2+CHAN/ROLD040/STAGE//15MIN//  ← DSS style pathname
FEET      ← Data units                         that indicates location, type
INST-VAL  ← Data are instantaneous values      of data, and data interval
30SEP1996 2400   2.00
01OCT1996 0015   1.94
01OCT1996 0030   1.80
01OCT1996 0045   1.74
01OCT1996 0100   1.80   Old R at CC Ferry 15 minute stage data
• • •  Several lines omitted for illustration purposes • • •
31OCT1996 2300   1.27
31OCT1996 2315   1.19
31OCT1996 2330   1.10
31OCT1996 2345   1.00
31OCT1996 2400  0.900
01NOV1996 0015   0.00
/DSM2-HYDRO-6.2+CHAN/430_9684/STAGE//1HOUR//← DSS style pathname
FEET      ← Data units                         that indicates location, type
INST-VAL  ← Data are instantaneous values      of data, and data interval
30SEP1996 2400   2.00
01OCT1996 0100   1.98
01OCT1996 0200   1.15
01OCT1996 0300  0.540   Rio Vista 1 hour stage data
• • •  Several lines omitted for illustration purposes • • •
31OCT1996 2100  0.860
31OCT1996 2200  8.000E-02
31OCT1996 2300 -0.600
31OCT1996 2400  -1.22
```

**Figure 4-23: Sample Text from the Output File hydro-stage-oct96.txt**

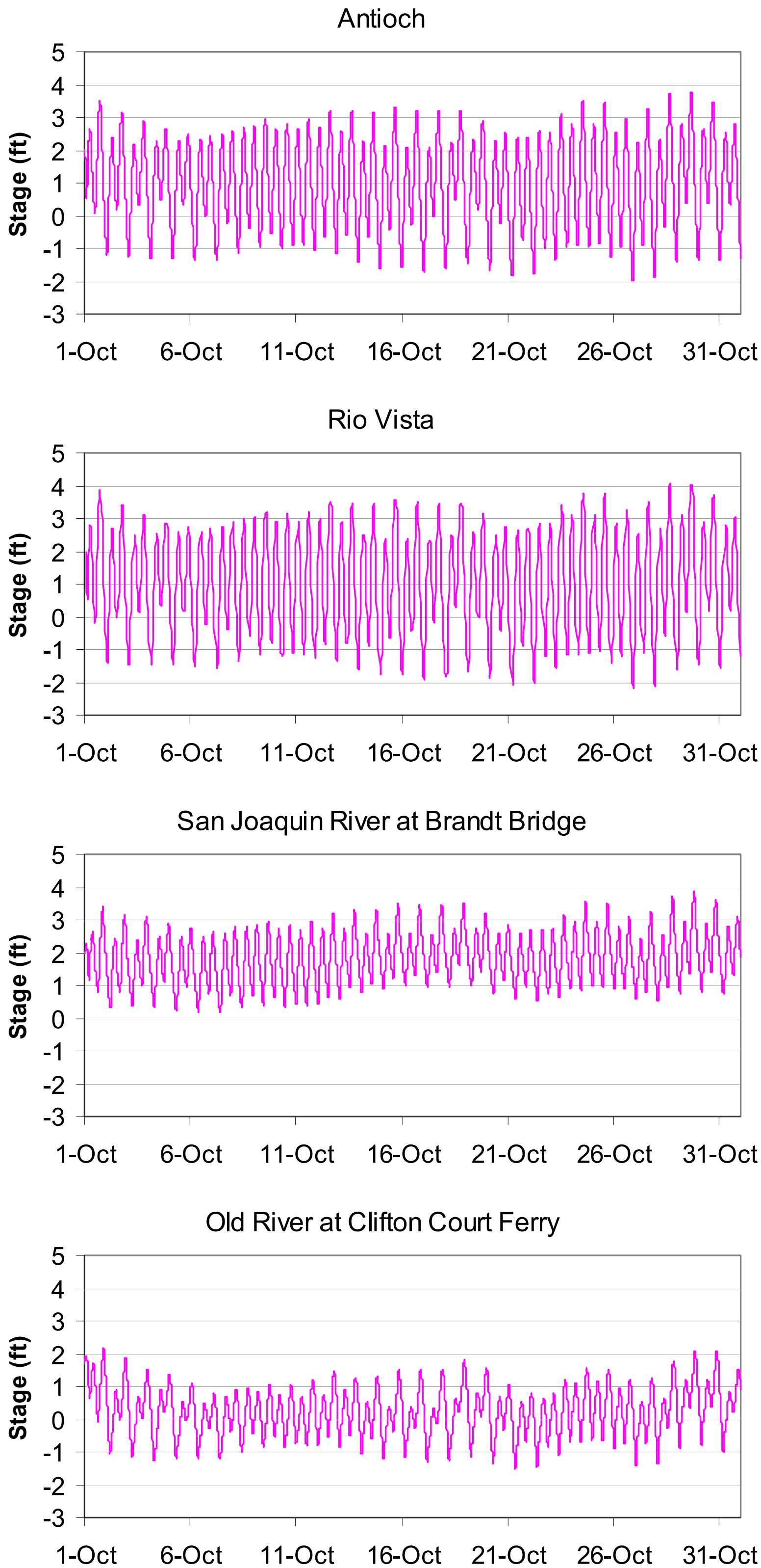



**Figure 4-24: Simulated Stages for October 1996**

## 4.21 Exercises for Modifying the HYDRO Simulation

This section contains exercises that cover some of the common changes made to DSM2 input files. These exercises involve modifying the input files from the October 1996 simulation. For reference, a complete set of input files is provided for each tutorial.

### 4.21.1 Changing the Simulation Period in HYDRO

**Exercises to change the simulation period from Oct96 to Nov96**

- **Cold start**
- **Warm start**

For this exercise, we will change the simulation period used in the tutorial from October 1996 to November 1996. Two different methods for running November 1996 will be illustrated in this exercise. In the first method, the simulation period will be changed to November 1996 and the model will be run from a "cold start" (i.e. no initial conditions are provided). For the second method, the restart file from the October 1996 simulation will be used to provide the initial conditions, termed a "warm start". For this exercise, the following files will be modified:

- dsm2demo/study/input/hydro/dsm2.inp (cold and warm start)
- dsm2demo/study/input/hydro/runtime.inp (cold and warm start)
- dsm2demo/study/input/hydro/io.inp (warm start only)

**<u>Files to be changed</u>**

- **dsm2.inp**
- **runtime.inp**
- **io.inp**

**Method 1: Cold Start**

1. On your PC, go to the directory ***dsm2demo/study/input/hydro***
2. [Optional step]. If desired, make backup copies of the files that will be modified during this exercise: dsm2.inp and runtime.inp.
3. Open the dsm2.inp file.
4. Change the value of the environment variable run from oct96 to nov96cs (November 1996 cold start).

```
# DSM2-HYDRO input file.
# Grid: 2.0
# UPDATED: 1-31-02 jamiea
# >>DEMO ONLY<<

# This is the main input file; other input files
# are specified here.

# Environment variable declarations
ENVVARS
NAME          VALUE
RUN           nov96cs
GRID          ./../data/grid
TIMESERIES    ./../data/timeseries
IRREG         $GRID/irreg
DSSOUT        ./output/hydro-${RUN}.dss
FLOWTXTOUT        ./output/hydro-flow-${RUN}.txt
STAGETXTOUT   ./output/hydro-stage-${RUN}.txt
END
• • •  Rest of the file omitted for illustration purposes • • •
```

5. Save and close the dsm2.inp file.
6. Open the file runtime.inp.
7. Change run_start_date to 01NOV1996 and change run_end_date to 30NOV1996.

```
# DSM2 input file
# Simulation run time Nov 1, 1996-Nov 30, 1996
# File Modified: 1-31-02 jamiea

# Run start and end times
SCALAR
run_start_date  01NOV1996
run_start_time  0000
run_end_date    30NOV1996  # if used, comment out run_length
run_end_time    2400
#run_length     # not used, comment out run_end date and
time if you change this
END
```

8. Save and close the runtime.inp file.
9. On your PC, go to the directory ***dsm2demo/study***.
10. To run HYDRO, double click on the hydro.bat icon.
11. Notice on the screen that the simulation starts on 31OCT1996 2400 (which is the same as 01NOV1996 000).
12. When a HYDRO simulation finishes, press any key to exit the DOS window.
13. On your PC, go to the directory ***dsm2demo/study/output***. The newly created output files are:
    - hydro-nov96cs.htf Binary output file (tidefile)
    - hydro-nov96cs.dss DSS time series output file
    - hydro-nov96cs.out Screen output file
    - hydro-flow-nov96cs.txt Text flow output file
    - hydro-restart-nov96cs.out Text restart file
    - hydro-stage-nov96cs.txt Text stage output file
14. The simulation results in the text output files can be put in Excel and plotted. The simulated flows and stages are shown in Figure 4-25 and Figure 4-26 respectively. These simulation results can be compared to the results from October 1996 (Figure 4-22 and Figure 4-24)

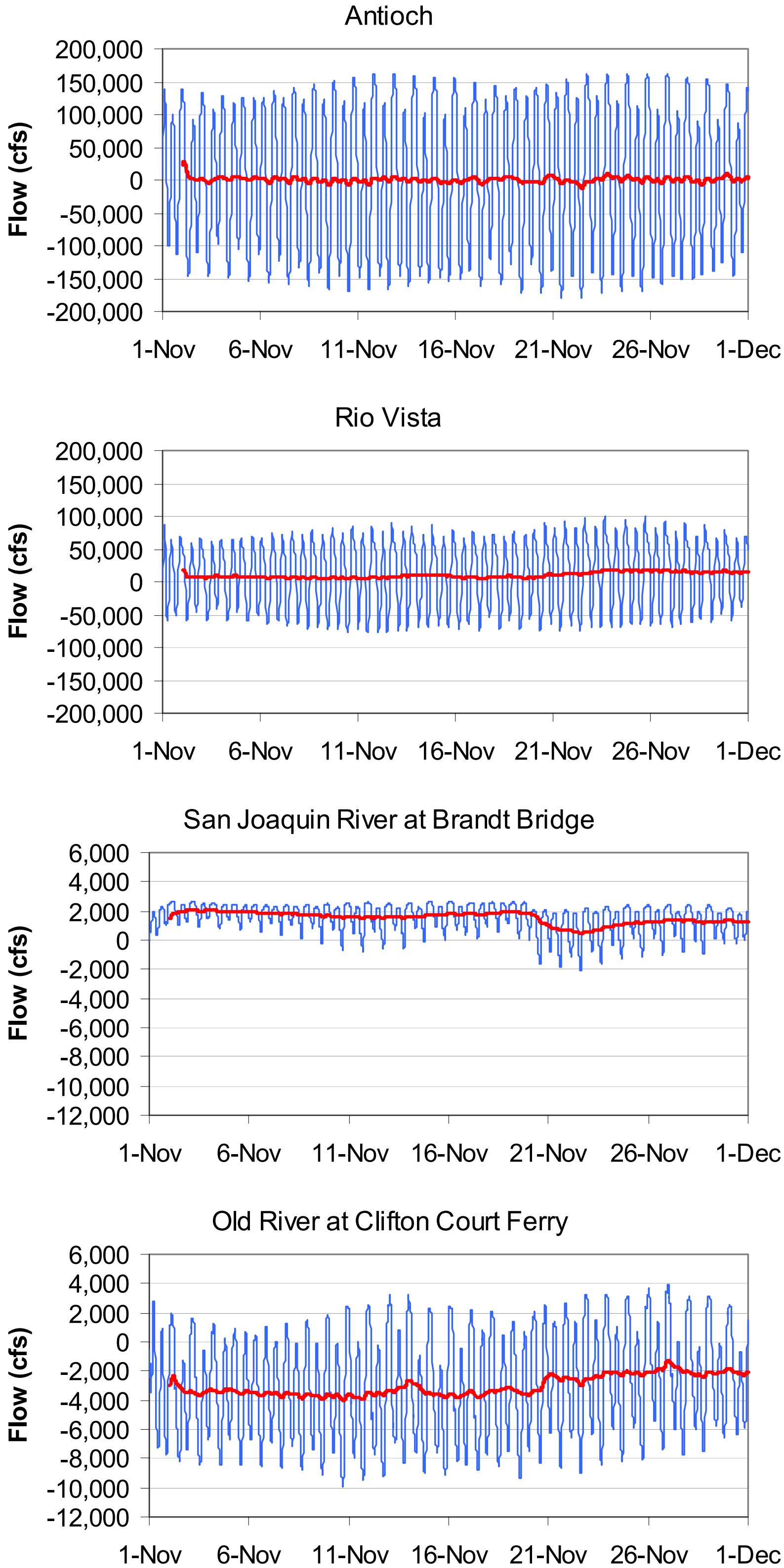



**Figure 4-25: Simulated Flows for November 1996-Cold Start**

Red lines indicate 25hr running averages.

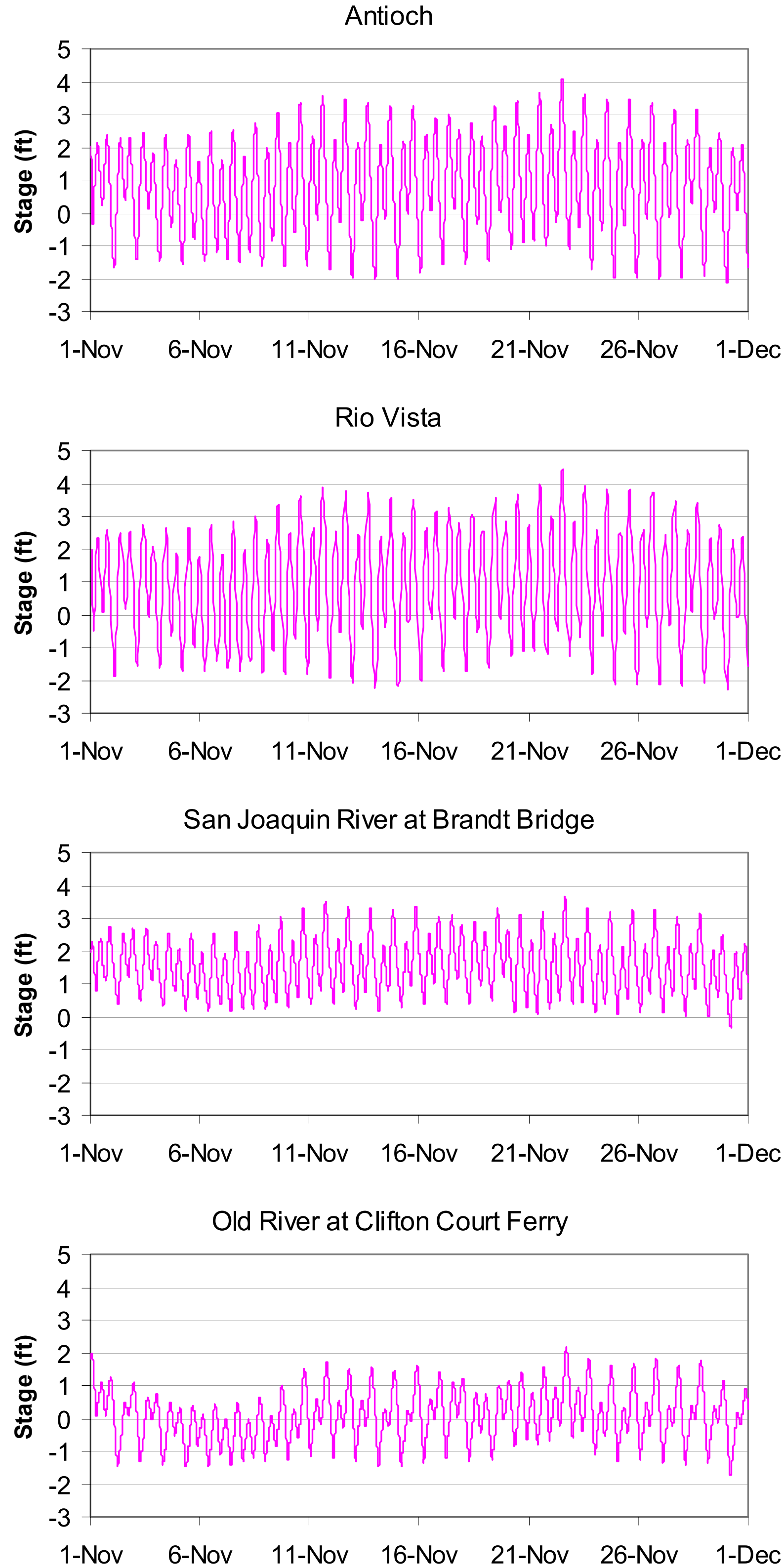



**Figure 4-26: Simulated Stages for November 1996-Cold Start**

**Method 2: Warm Start-Using a Restart File**

1. On your PC, go to the directory ***dsm2demo/study/input/hydro***
2. [Optional step]. If desired, make backup copies of the files that will be modified during this exercise: dsm2.inp, io.inp and runtime.inp.
3. Open the dsm2.inp file.
4. Change the value of the environment variable run from oct96 to nov96ws (November 1996 warm start). Add an environment variable named RESTARTRUN and define the value of the variable as oct96.

```
# DSM2-HYDRO input file.
# Grid: 2.0
# UPDATED: 1-31-02 jamiea
# >>DEMO ONLY<<

# This is the main input file; other input files
# are specified here.

# Environment variable declarations
ENVVARS
NAME          VALUE
RUN           nov96ws
RESTARTRUN    oct96
GRID          ./../data/grid
TIMESERIES    ./../data/timeseries
IRREG         $GRID/irreg
DSSOUT        ./output/hydro-${RUN}.dss
FLOWTXTOUT        ./output/hydro-flow-${RUN}.txt
STAGETXTOUT   ./output/hydro-stage-${RUN}.txt
END
• • •  Rest of the file omitted for illustration purposes • • •
```

5. Save and close the dsm2.inp file.
6. Open the file io.inp.
7. Add a new line with the variables defined as follows: MODEL=hydro, TYPE=restart, IO=in, INTERVAL=none, FILENAME=./output/hydro-restart-{RESTARTRUN}.out. In the dsm2.inp file, RESTARTRUN was defined as oct96, therefore the input restart file's name ./output/hydro-restart-${RESTARTRUN}.out would be interpreted as ./output/hydro-restart-oct96.out

```
# DSM2 input file

# I/O files

IO_FILES
MODEL  TYPE    IO   INTERVAL  FILENAME
hydro  binary  out  15min     ./output/hydro-${RUN}.htf
hydro  restart out  1day      ./output/hydro-restart-${RUN}.out
hydro  restart in   none      ./output/hydro-restart-${RESTARTRUN}.out
output none    none none      ./output/hydro-${RUN}.out
END
```

8. Save and close the io.inp file.
9. Open the file runtime.inp.
10. Change run_start_date to 01NOV1996 and change run_end_date to 30NOV1996. [The changes to the runtime.inp file are identical to those for the cold start exercise.]

```
# DSM2 input file
# Simulation run time Nov 1, 1996-Nov 30, 1996
# File Modified: 1-31-02 jamiea

# Run start and end times
SCALAR
run_start_date      01NOV1996
run_start_time      0000
run_end_date        30NOV1996    # if used, comment out run_length
run_end_time        2400
#run_length   # not used, comment out run_end date and time
if you change this
END
```

11. Save and close the runtime.inp file.
12. On your PC, go to the directory ***dsm2demo/study***.
13. To run HYDRO, double click on the hydro.bat icon.
14. Notice on the screen that the simulation starts on 31OCT1996 2400 (which is the same as 01NOV1996 000).
15. When a HYDRO simulation finishes, press any key to exit the DOS window.
16. On your PC, go to the directory ***dsm2demo/study/output***. The newly created output files are:
    - hydro-nov96ws.htf — Binary output file (tidefile)
    - hydro-nov96ws.dss — DSS time series output file
    - hydro-nov96ws.out — Screen output file
    - hydro-flow-nov96ws.txt — Text flow output file
    - hydro-restart-nov96ws.out — Text restart file
    - hydro-stage-nov96ws.txt — Text stage output file
17. The simulation results in the text output files can be put in Excel and plotted. The simulated flows and stages are shown in Figure 4-27 and Figure 4-28 respectively. These simulation results can be compared to the results from October 1996 (Figure 4-22 and Figure 4-24) and the November 1996 cold start simulations (Figure 4-25 and Figure 4-26)

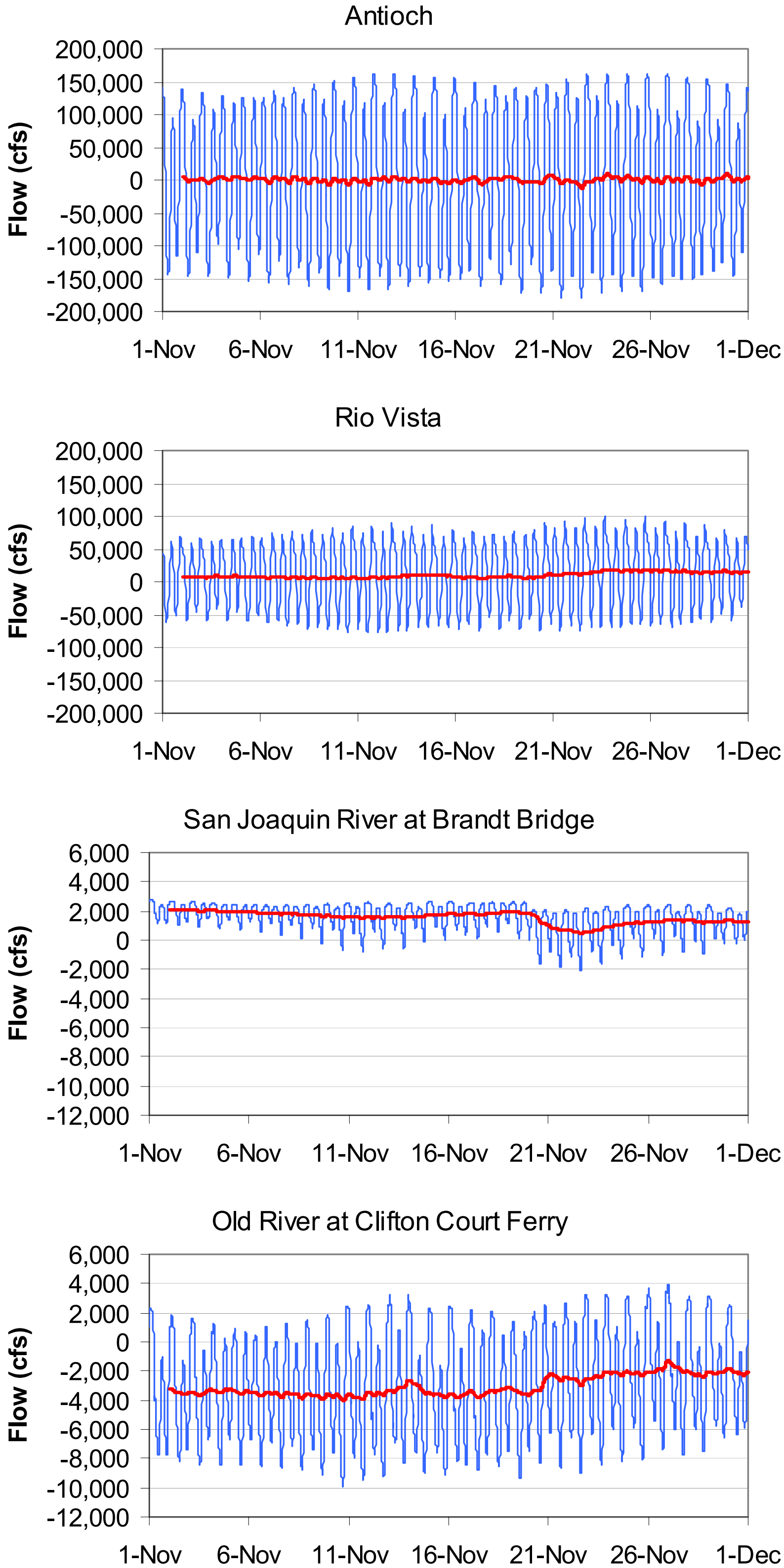



**Figure 4-27: Simulated Flows for November 1996-Warm Start**

Red lines indicate 25hr running averages.

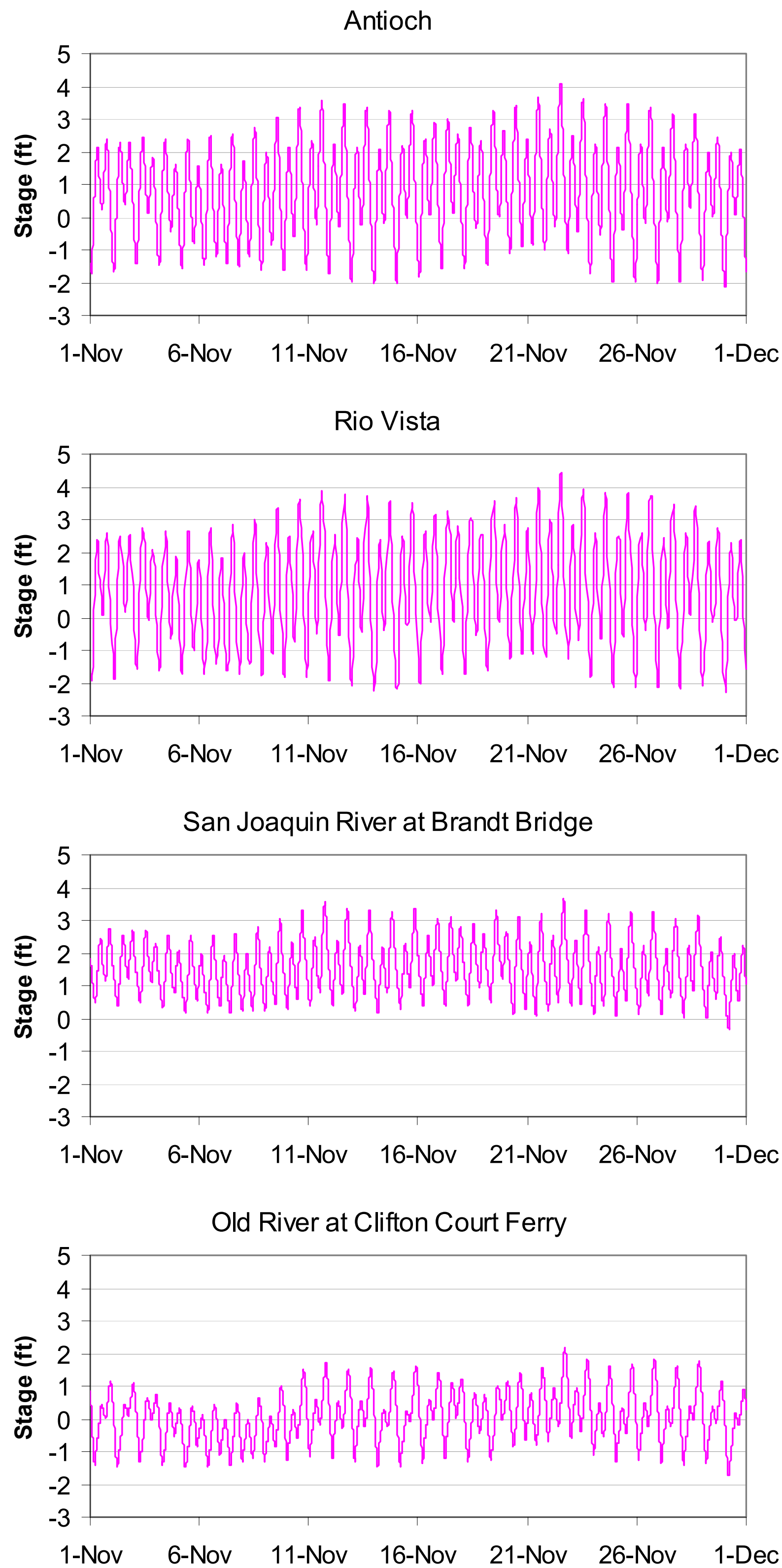



**Figure 4-28: Simulated Stages for November 1996-Warm Start**

**Comparison of simulation results**
The simulation results from text output files for the cold and warm start exercises can be plotted in Excel and compared. For comparison purposes, the cold start results were subtracted from the warm start results. Flow and stage differences for the four output locations are shown in Figure 4-29 and Figure 4-30 respectively. Note that significant differences in the simulation results only occur for approximately the first two days of the simulation. Thus, when running HYDRO from a cold start, the first few days of the simulation may be excluded when the simulation results are analyzed. Since the simulation results were basically the same after two days, it is not critical in HYDRO whether a cold start or a warm start is used. In the QUAL tutorial, it will be shown that this is not the case with water quality results. Water quality results require a longer time to reach appropriate values than hydrodynamic results.

### 4.21.2 Changing the Output Locations in HYDRO

In this exercise, we request HYDRO output from three additional locations (Figure 4-31). Additional output locations were selected at locations where field data are collected. Output locations to be added to the October 1996 simulation are:

- Middle River at Tracy Road (RMID027)
- North Fork of the Mokelumne River near Georgiana Slough (RMKL005)
- Sacramento River above the Delta Cross Channel (RSAC128)

**Exercise to add output locations**
- **RMID027**
- **RMKL005**
- **RSAC128**

For this exercise, the following files will be modified:

- dsm2demo/study/input/hydro/dsm2.inp
- dsm2demo/study/input/hydro/output.inp

**Files to be changed**
- **dsm2.inp**
- **output.inp**

**Add Output Locations**

1. On your PC, go to the directory ***dsm2demo/study/input/hydro***
2. Use the input files for the October 1996 simulation.
3. [Optional step]. If desired, make backup copies of the files that will be modified during this exercise: dsm2.inp and output.inp.
4. Open the dsm2.inp file.

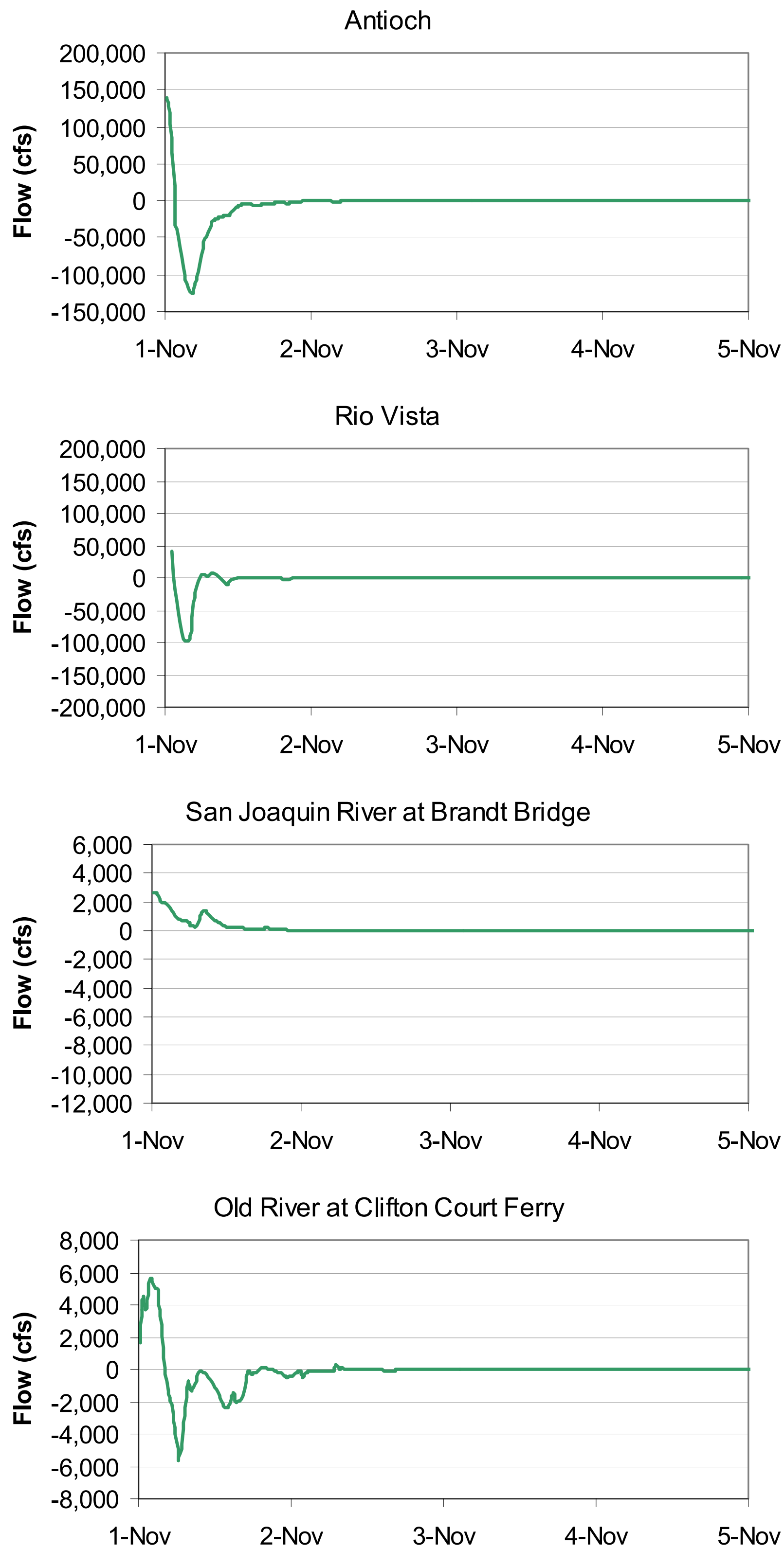



**Figure 4-29: Differences in Simulated Flows for November 1996- Warm Start Minus Cold Start**

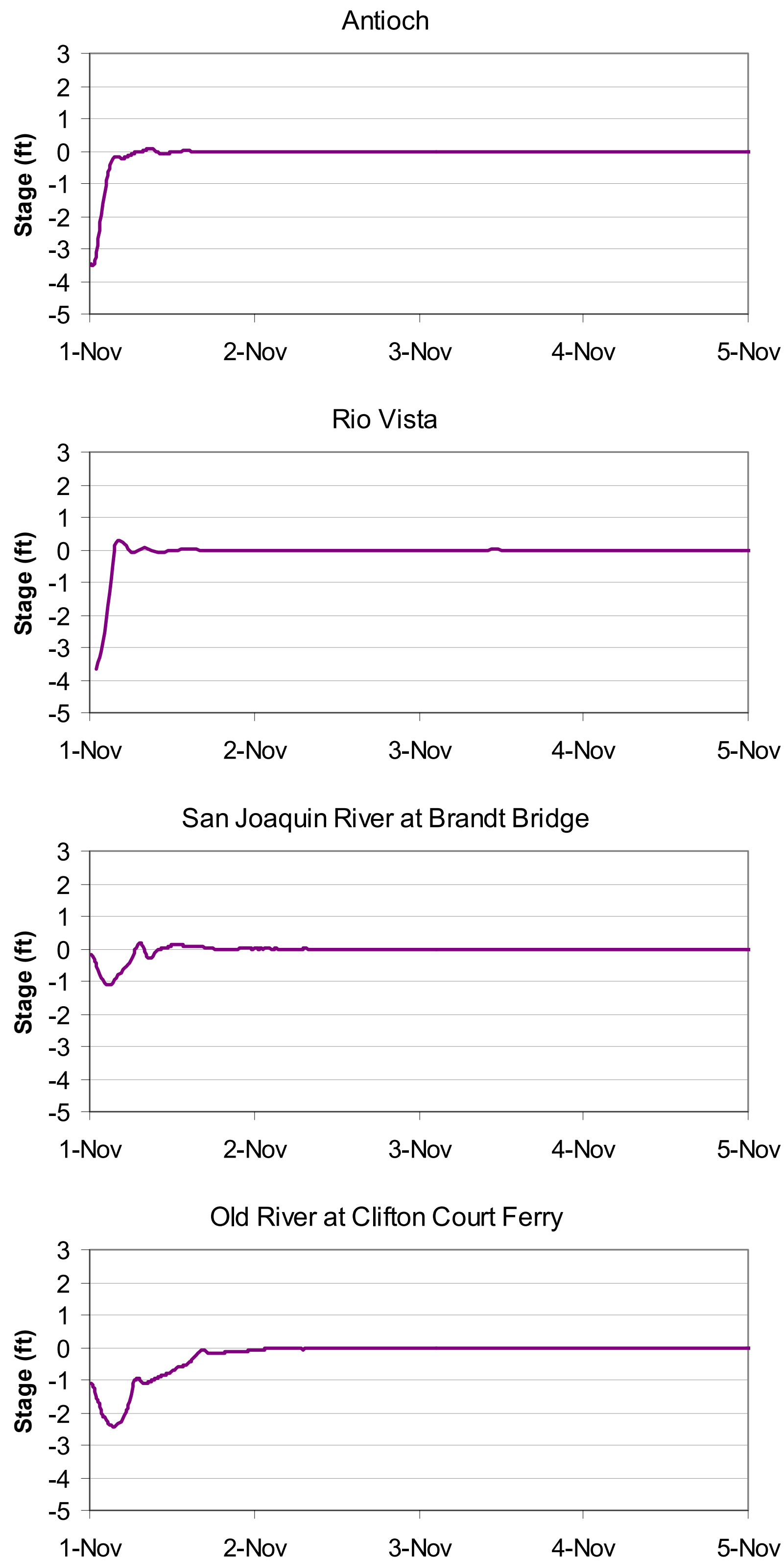



**Figure 4-30: Differences in Simulated Stages for November 1996-
Warm Start Minus Cold Start**

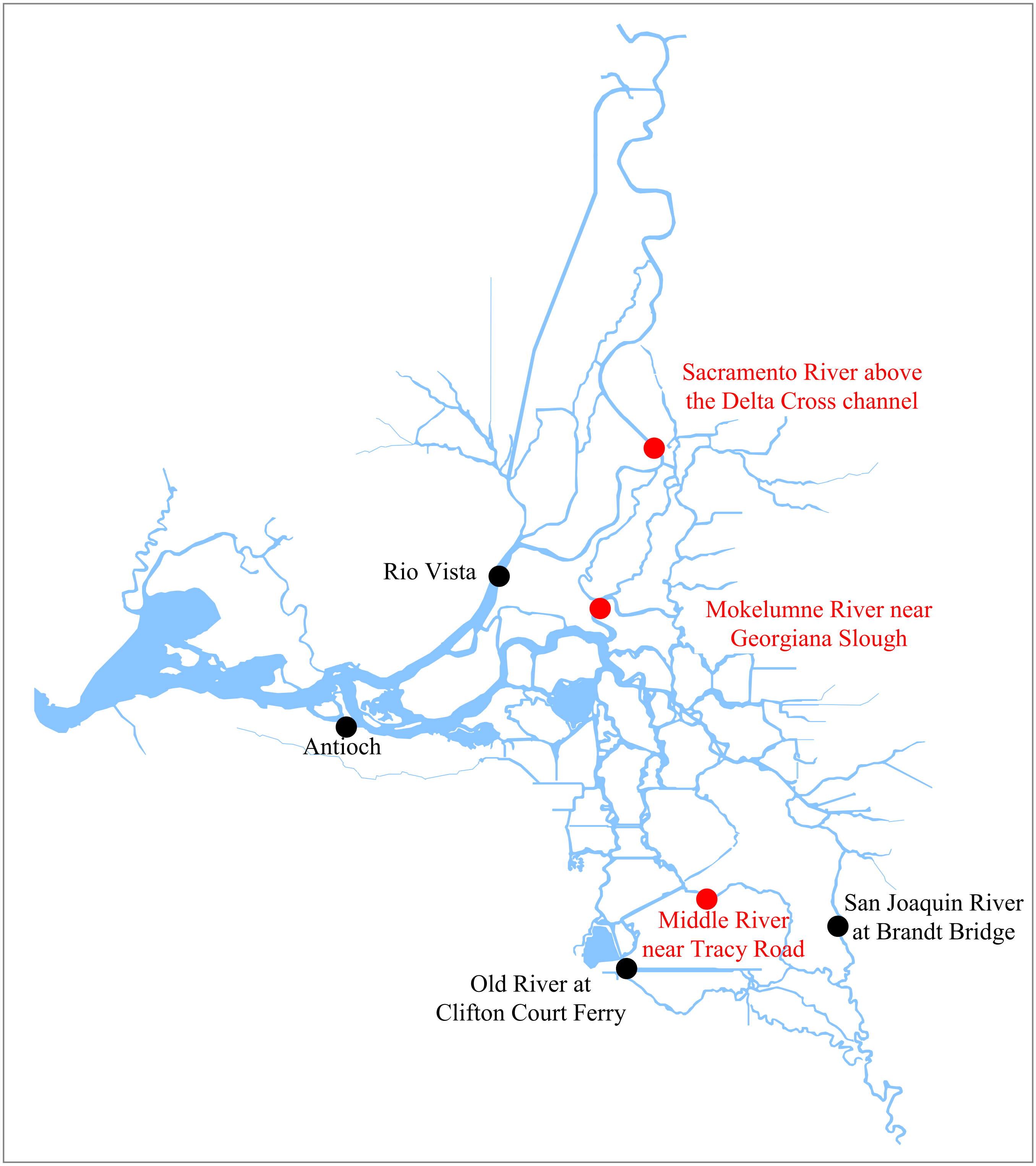



**Figure 4-31: Map of Additional Output Locations**

5. Change the value of the environment variable run from oct96 to oct96a (to distinguish this simulation from the October 1996 simulation that was run earlier in this tutorial).

```
# DSM2-HYDRO input file.
# Grid: 2.0
# UPDATED: 1-31-02 jamiea
# >>DEMO ONLY<<

# This is the main input file; other input files
# are specified here.

# Environment variable declarations
ENVVARS
NAME          VALUE
RUN           oct96a
GRID          ./../data/grid
TIMESERIES    ./../data/timeseries
IRREG         $GRID/irreg
DSSOUT        ./output/hydro-${RUN}.dss
FLOWTXTOUT        ./output/hydro-flow-${RUN}.txt
STAGETXTOUT   ./output/hydro-stage-${RUN}.txt
END
• • •  Rest of the file omitted for illustration purposes • • •
```

6. Save and close the dsm2.inp file.
7. In order to put the output locations in the output.inp file, we need to know the DSM2 name that has been assigned to that location. To look up the DSM2 names for each location, open the file dsm2demo/data/grid/translations.inp.
8. Search for the location names in this file to find the DSM2 name assigned to that location (the names are the RKI references in this case).

```
# Model Location Translations for Grid v2.0
# Modified: 2002.01.04, mmierzwa
••• Several lines omitted for illustration purposes •••

TRANSLATION
NAME          CHAN   DIST          # Common Name
••• Several lines omitted for illustration purposes •••
RMID027       133    3641          # Middle River @ Tracy Blvd
••• Several lines omitted for illustration purposes •••
RMKL005       374    5030          # North Fork Moke. River (Georgiana Sl.)
••• Several lines omitted for illustration purposes •••
RSAC128       421    8585          # Sac above DCC
••• Several lines omitted for illustration purposes •••
END
```

9. In the dsm2demo/study/input/hydro directory, open the file output.inp.
10. For each of the four locations,

- Add a comment line indicating the location
- Add a line requesting flow output in DSS format
- Add a line requesting flow output in text format
- Add a line requesting stage output in DSS format
- Add a line requesting stage output in text format

```
# DSM2 Output location file
# Grid v2.0
# Updated: 1-31-02, jamiea
# >>DEMO ONLY<<

# Output paths specified by channel number and distance
OUTPUTPATHS
CHAN        DIST      TYPE   INTERVAL      PERIOD FILENAME
# Sac River@Rio Vista
430         9684      FLOW   1HOUR         INST   $DSSOUT
430         9684      FLOW   1HOUR         INST   $FLOWTXTOUT
430         9684      STAGE  1HOUR         INST   $DSSOUT
430         9684      STAGE  1HOUR         INST   $STAGETXTOUT
END

# Output paths specified RKI (River Kilometer Index)
OUTPUTPATHS
NAME          TYPE   INTERVAL      PERIOD   FILENAME
#Antioch
rsan007       flow   15min         inst      $DSSOUT
rsan007       flow   15min         inst      $FLOWTXTOUT
rsan007       stage  15min         inst      $DSSOUT
rsan007       stage  15min         inst      $STAGETXTOUT
#San Joaquin River at Brandt Bridge
rsan072       flow   15min         inst      $DSSOUT
rsan072       flow   15min         inst      $FLOWTXTOUT
rsan072       stage  15min         inst      $DSSOUT
rsan072       stage  15min         inst      $STAGETXTOUT
#Old River at Clifton Court Ferry
rold040       flow   15min         inst      $DSSOUT
rold040       flow   15min         inst      $FLOWTXTOUT
rold040       stage  15min         inst      $DSSOUT
rold040       stage  15min         inst      $STAGETXTOUT
#Middle River at Tracy Road
rmid027       flow   15min         inst      $DSSOUT
rmid027       flow   15min         inst      $FLOWTXTOUT
rmid027       stage  15min         inst      $DSSOUT
rmid027       stage  15min         inst      $STAGETXTOUT
#Mokelumne River at Georgiana Slough
rmkl005       flow   15min         inst      $DSSOUT
rmkl005       flow   15min         inst      $FLOWTXTOUT
rmkl005       stage  15min         inst      $DSSOUT
rmkl005       stage  15min         inst      $STAGETXTOUT
#Sacramento River above the Delta Cross Channel
rsac128       flow   1hour         inst      $DSSOUT
rsac128       flow   1hour         inst      $FLOWTXTOUT
rsac128       stage  1hour         inst      $DSSOUT
rsac128       stage  1hour         inst      $STAGETXTOUT

END
```

15 minute output were requested all locations except Sac River above DCC where 1 hour data were requested

11. Save and close the output.inp file.
12. On your PC, go to the directory ***dsm2demo/study***.

13. To run HYDRO, double click on the hydro.bat icon.
14. When a HYDRO simulation finishes, press any key to exit the DOS window.
15. On your PC, go to the directory ***dsm2demo/study/output***. The newly created output files are:
    - hydro-oct96a.htf Binary output file (tidefile)
    - hydro-oct96a.dss DSS time series output file
    - hydro-oct96a.out Screen output file
    - hydro-flow-oct96a.txt Text flow output file
    - hydro-restart-oct96a.out Text restart file
    - hydro-stage-oct96a.txt Text stage output file
16. The simulation results in the text output files can be put in Excel and plotted. The simulated flows and stages are shown in Figure 4-32 and Figure 4-33 respectively. These simulation results can be compared to the results from the original four output locations for October 1996 (Figure 4-22 and Figure 4-24)

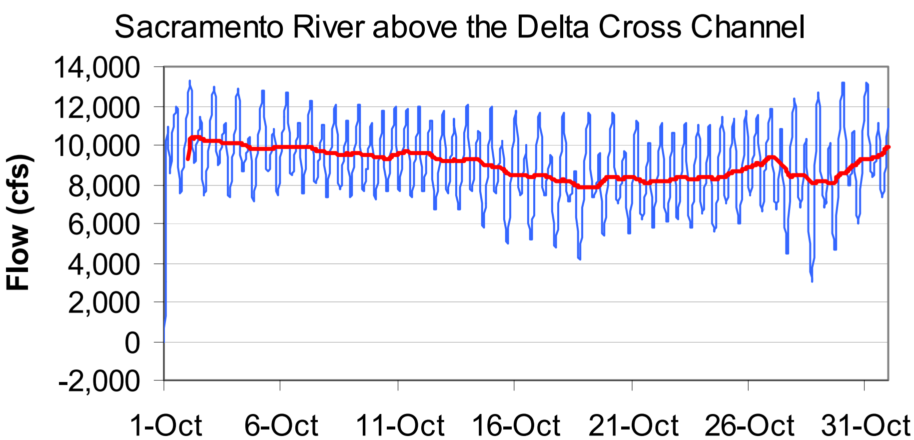
### 4.21.3 Advanced Exercise: Comparing HYDRO Simulation Results to Field Data

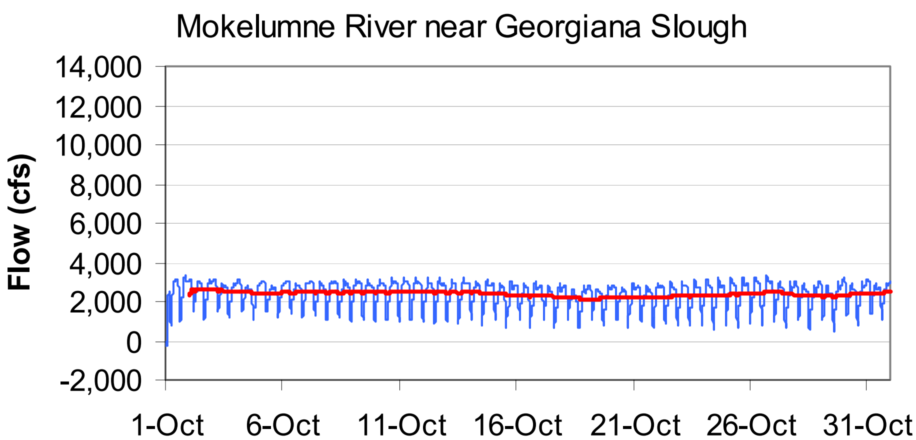
In order to determine if a computer model provides an acceptable representation of the physical system, simulation results can be compared to field data. Typically various state and federal agencies collect field data. One resource for available field data in the Delta is the Interagency Ecological Program (IEP) website **http://www.iep.water.ca.gov/dss/all/**.

**Compare Simulation Results to Field Data**

1. On your PC, go to the website **http://www.iep.water.ca.gov/dss/all/.**

2. You will see a map of the Delta with various regions highlighted in yellow as shown in Figure 4-34. Click on any desired region in the Delta to see what data are available. For the example shown here, the Delta Region highlighted in Figure 4-34 was selected.


Sacramento River above the Delta Cross Channel
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
-2,000
Flow (cfs)
1-Oct
6-Oct
11-Oct
16-Oct
21-Oct
26-Oct
31-Oct


Mokelumne River near Georgiana Slough
Flow (cfs)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
-2,000
1-Oct
6-Oct
11-Oct
16-Oct
21-Oct
26-Oct
31-Oct

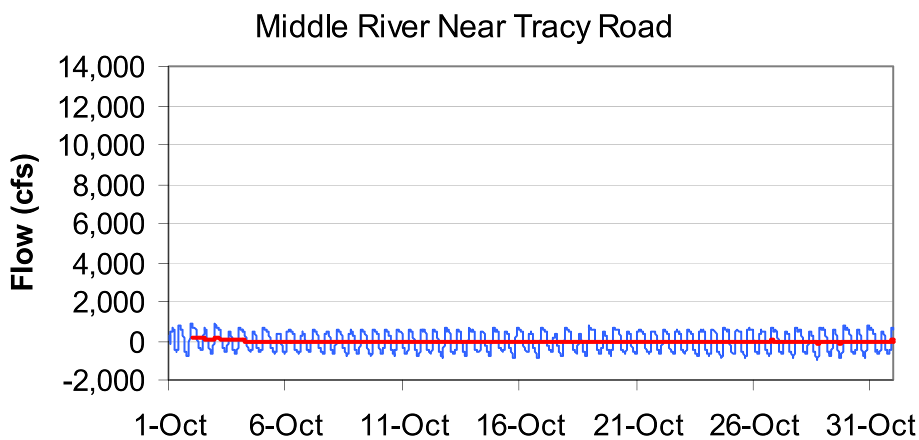
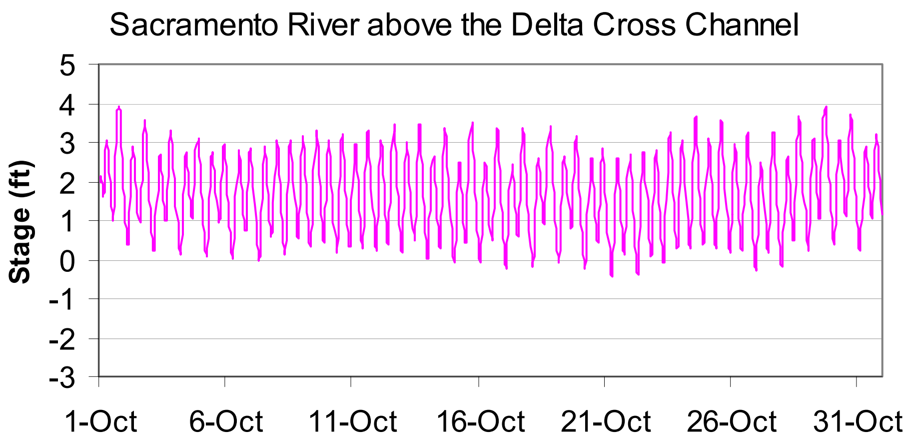
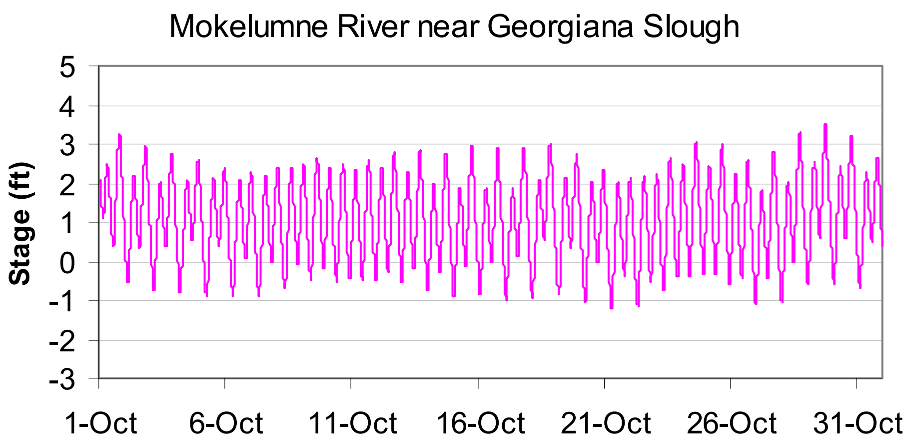



**Figure 4-32: Simulated Flows for October 1996-Additional Output Locations**

Red lines indicate 25hr running averages.


Sacramento River above the Delta Cross Channel
Stage (ft)
5
4
3
2
1
0
-1
-2
-3
1-Oct
6-Oct
11-Oct
16-Oct
21-Oct
26-Oct
31-Oct


Mokelumne River near Georgiana Slough
Stage (ft)
5
4
3
2
1
0
-1
-2
-3
1-Oct
6-Oct
11-Oct
16-Oct
21-Oct
26-Oct
31-Oct

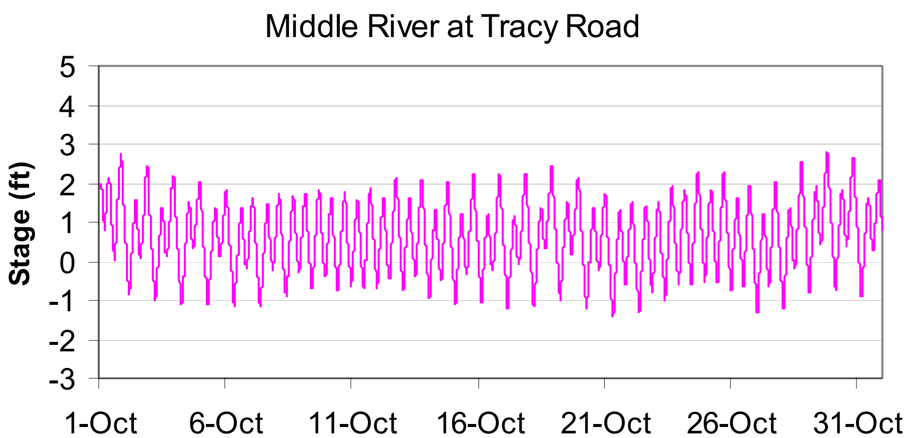
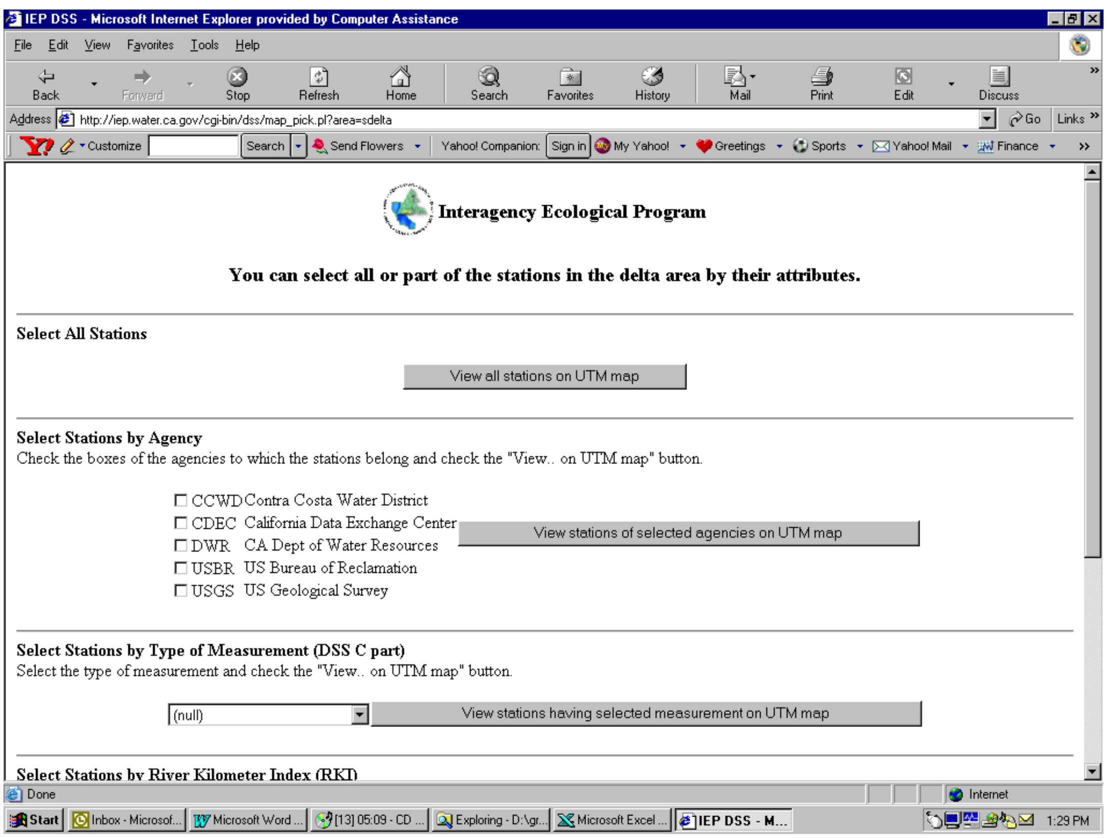


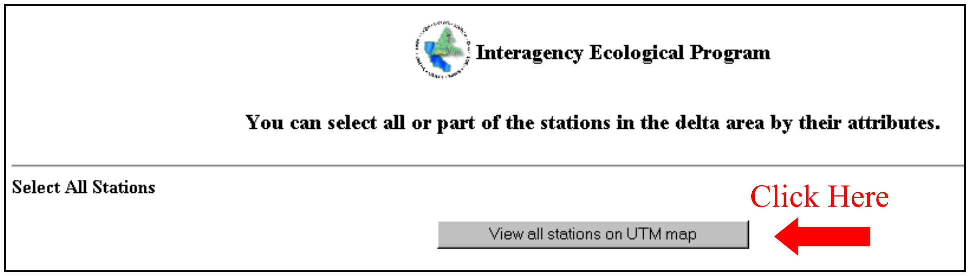

**Figure 4-33: Simulated Stages for October 1996-Additional Output Locations**


**Figure 4-34: Delta Data Regions from the IEP Website**

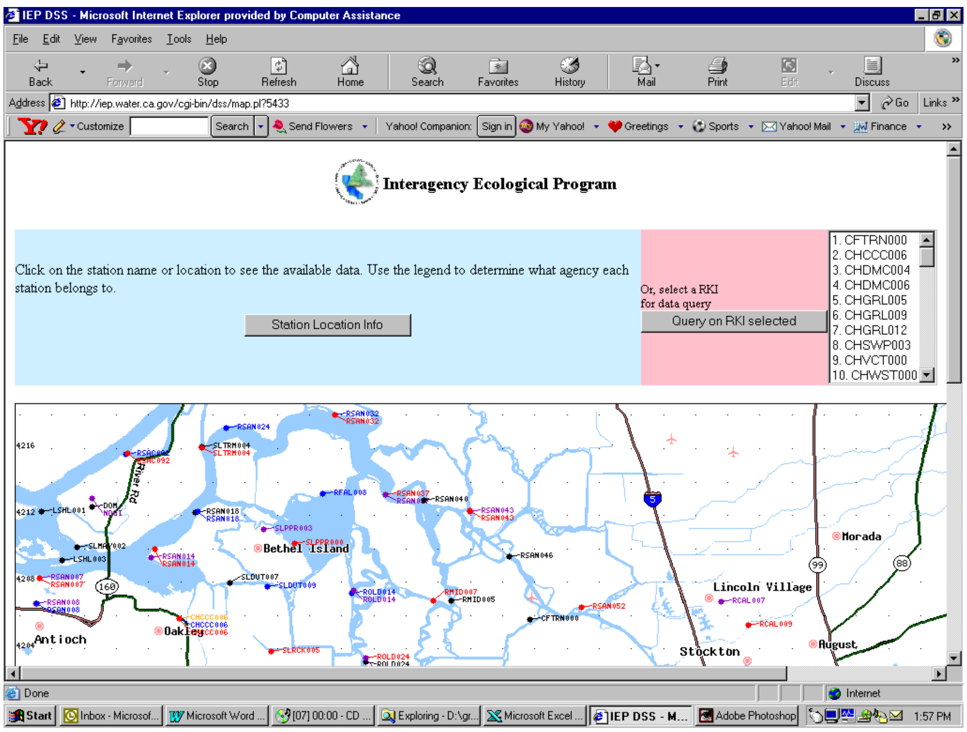
3. The screen shown below will appear after clicking on the Delta Region. Several options are provided for looking for data._Scroll down to view additional options.


IEP DSS - Microsoft Internet Explorer provided by Computer Assistance
http://iep.water.ca.gov/cgi-bin/dss/map_pick.pl?area=sdelta
Interagency Ecological Program
You can select all or part of the stations in the delta area by their attributes.
Select All Stations
View all stations on UTM map
Select Stations by Agency
Check the boxes of the agencies to which the stations belong and check the "View.. on UTM map" button.
CCWD Contra Costa Water District
CDEC California Data Exchange Center
DWR CA Dept of Water Resources
USBR US Bureau of Reclamation
USGS US Geological Survey
View stations of selected agencies on UTM map
Select Stations by Type of Measurement (DSS C part)
Select the type of measurement and check the "View.. on UTM map" button.
(null)
View stations having selected measurement on UTM map
Select Stations by River Kilometer Index (RKI)

4. At the top of the screen, select view all stations on a UTM map.__




5. The screen shown below will appear. You can use the scroll bars to navigate the page and see additional sections of the map. To the right of the pink box, you can select the RKI label for the data site and request data for that site. Alternatively, you can click on a station shown on the map.__




6. Play with this website. Obtain data for various locations. Data can be shown on the screen in graphical or ASCII format. Data can be downloaded in DSS format. Compare the data to the simulation results found in the previous exercises.

**************************************************************

**Congratulations!** You have now mastered the basic skills for HYDRO.

# 5 QUAL Tutorial

This tutorial will guide you through a historical QUAL simulation for October 1996.

## 5.1 QUAL Tutorial File Structure

The file structure for the QUAL tutorial is summarized in Figure 5-1. Brief descriptions of each file and folder are provided in section 5.2.

## 5.2 Overview of the QUAL Tutorial Files and Folders

The following are descriptions of the tutorial files and folders listed in Figure 5-1. The files in the bin and data folders are the same files that were used in the HYDRO tutorial. The following symbols are used to indicate the type of item being described:

- folder
- executable file
- text file
- DSS database file
- binary file

**dsm2demo:** folder that contains all of the files for the DSM2-HYDRO and QUAL demos

**bin:** folder that contains executable files

- *hydro.exe*: DSM2-HYDRO executable file
- *qual.exe*: DSM2-QUAL executable file

**data:** folder that contains input data for DSM2 simulations

- **grid:** folder that contains input files that define the DSM2 computational grid of the Delta. These files are used for both HYDRO and QUAL.
  - *channels.inp*: text input file that defines DSM2 grid channels, provides channel/node connectivity, and specifies values for constants

**File Type Legend**

- folder
- executable file
- text file
- DSS database file
- binary file

- dsm2demo
  - bin
    - ***hydro.exe***
    - ***qual.exe***
  - data
    - grid
      - ***channels.inp***
      - ***irregular_xsects.inp***
      - ***list.inp***
      - ***regular_xsects.inp***
      - ***reservoirs.inp***
      - ***translations.inp***
      - ***type.inp***
      - irreg
        - ***1_0.24018.txt***
        - ***1_0.95336.txt***
        - •
        - •
        - •
        - ***99_0.44676.txt***
    - timeseries
      - ***dicu.dss***
      - ***gates.dss***
      - ***hydro.dss***
      - ***quality.dss***
  - study
    - ***hydro.bat***
    - ***qual.bat***
    - input
      - hydro
        - Files in this folder are described in Figure 4-1.
      - qual
        - ***boundary.inp***
        - ***dsm2.inp***
        - ***input-ag.inp***
        - ***io.inp***
        - ***output.inp***
        - ***runtime.inp***
        - ***scalar.inp***
        - ***tide.inp***
    - output
      - HYDRO output files located in this folder are described in Figure 4-1
      - ***hydro-oct96.htf***
      - ***qual-daily-oct96.txt***
      - ***qual-hourly-oct96.txt***
      - ***qual-oct4.rst***
      - ***qual-oct96.dss***
      - ***qual-oct96.out***
      - ***qual-rst-oct96.out***

**Figure 5-1: DSM2 QUAL Tutorial File Structure**

**File Type Legend**

- folder
- executable file
- text file
- DSS database file
- binary file

*irregular_xsects.inp*: text input file that defines locations where irregular cross sections are specified and indicates names of input files that describe each irregular cross section

*list.inp*: text input file that lists the channel numbering sequence

*regular_xsects.inp*: text input file that provides regular cross sectional data from DSM1. Default stage values for use if there is no restart file are also specified in this file.

*reservoirs.inp*: text input file that defines reservoir names and characteristics

*translations.inp*: text input file that correlates text strings with locations (nodes, channels, etc) in the DSM2 grid. For example the San Joaquin River at Vernalis located at node 17 is correlated to (translates to) the text string "vernalis".

*type.inp*: text input file that defines certain text strings as representing diversions, exports, RIM flows (boundary inflows), drains, seepage, etc. Corrections for flow signs are also specified in this file.

**irreg**: folder that contains irregular cross sectional data

*1_0.24018.txt*
*1_0.95336.txt*
•
•
•
*99_0.44676.txt*

} text files that define irregular cross sections

**timeseries**: folder that contains input time series data[9]

*dicu.dss*: Time series data for Delta Island Consumptive Use (DICU)

*gates.dss*: Time series data for gate operations

*hydro.dss*: Time series data for flow and stage boundary conditions

*quality.dss*: Time series data for constituent concentration boundary conditions

[9] ***Note:*** If *.dsc and *.dsd files are present in this directory, those files were created when the *.dss files were viewed in VISTA.

**study:** folder that contains files specific to particular DSM2 simulation or set of simulations. In this tutorial, the study is a historical simulation of October 1996.

- *hydro.bat*: text batch file used for running HYDRO
- *qual.bat*: text batch file used for running QUAL
- **input**: folder that contains input files for the study
  - **hydro**: folder that contains input files for the HYDRO simulation for the study

    Input files in the HYDRO directory are described in section 4.2.
  - **qual**: folder that contains input files for the QUAL simulation for the study
    - *boundary.inp*: text input file that specified water quality boundary conditions
    - *dsm2.inp*: main DMS2 text input file where the other QUAL input files are specified and environment variables and titles are defined
    - *input-ag.inp*: text input file that specifies the quality of agricultural drainage
    - *io.inp*: text input file that lists the names of the QUAL output files
    - *output.inp*: text input file that designates the type of simulation results and locations of the simulation results to be written to the designated output files
    - *runtime.inp*: text input file that designates the starting and ending times for the simulation
    - *scalar.inp*: text input file that sets various simulation parameters such as amount of screen output, values for constants, the computational time step, etc.
    - *tide.inp*: text input file that specifies the binary HYDRO transfer file (htf – also referred to as a HYDRO tide file) that provides hydrodynamic input to QUAL

**File Type Legend**

- folder
- executable file
- text file
- DSS database file
- binary file

**File Type Legend**

- 🗀 folder
- executable file
- text file
- DSS database file
- binary file

**output**: folder that contains the output files generated by DSM2 for the study

| | |
|---|---|
| *hydro-oct96.htf*: | binary HYDRO transfer file (htf – also referred to as a HYDRO tide file) that records simulation results at every time step for every node. This file provides the hydrodynamic input for QUAL. This file was created during the HYDRO tutorial. |
| *qual-daily-oct96.txt*: | text output file that contains daily average water quality concentrations for specified locations. The data stored in this file is specified in output.inp. |
| *qual-hourly-oct96.txt*: | text output file that contains hourly or 15-minute water quality concentrations for specified locations. The data stored in this file is specified in output.inp. |
| *qual-oct4.rst.*: | text restart file that contains water quality initial conditions for October 4$^{th}$, 1996. This file was provided as one of the tutorial input files. Creation of this file will be discussed in the exercises at the end of this tutorial. |
| *qual-oct96.dss*: | DSS database file that contains time series of simulation results at specified locations. The data stored in this file is specified in output.inp. |
| *qual-oct96.out*: | text file that echoes screen output |
| *qual-rst-oct96.out*: | text restart file that contains simulation results for each node for the last time step of the simulation. This file can be used to provide initial conditions for an additional simulation for a time period immediately after the current simulation period. For example a the restart file for a simulation run for October 1996 could be used to provide initial conditions for a simulation of November 1996. |

Detailed descriptions of each of these input files follows in sections 5.3 to 5.11. The main DSM2 input file dsm2.inp is discussed first. The other files in the directory ***dsm2demo/study/input/qual*** are described next, followed by the rest of the files in the order that they are listed above. Additional section and field keyword descriptions are provided in chapter five of the 1998 Delta Modeling annual report titled "*Methodologies for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Marsh*". Only section and field keywords that appear in the tutorial input files are described in this documentation. Instructions on running QUAL are located in section 5.12.

**Skipping Ahead to Running QUAL:**

**Instructions for running HYDRO are in Section 5.12.**

## 5.3 dsm2.inp: Main QUAL input file

The main QUAL input file is the dsm2.inp file. For this tutorial, the dsm2.inp file is located in the directory ***dsm2demo/study/input/qual***. This file contains the names of the other input files utilized by QUAL. Environment variables can be declared in this file. (The concept of environmental variables is reviewed in Appendix A in section 6.1). Three sections are typically contained in a QUAL dsm2.inp file: ENVVARS (Environment Variables), TITLES, and INP_FILES (Input Files). Each section starts with a section keyword and ends with the word END. These sections are described below. The sample dsm2.inp file used in this tutorial is shown in Figure 5-2. Typically a new dsm2.inp file is created for each simulation.

**dsm2.inp Sections**

- **ENVVARS**
- **TITLES**
- **INP_FILES**

### 5.3.1 ENVVARS: Environment Variables

| | | |
|---|---|---|
| Section Keyword: | ENVVARS | Environment variable section |
| Field keywords: | NAME | Name of environment variable |
| | VALUE | Value assigned to environment variable |
| Required: | | No |
| Overwrites: | | |
| Description: | Environment variables are user defined variables typically used to represent long computer paths for input and output files or to represent text that will change from simulation to simulation such as file extensions that refer to the name of the study. See section 6.1 for more information on Environment Variables. | |

Comment Lines
Section Keyword →
Field Keywords →
Environment Variable Declarations
Section END →
Section Keyword →
Title text →
Section END →
Section Keyword →
Input files that typically change
Input files that typically do not change
Section END →

```
# DSM2-QUAL input file.
# Grid: 2.0
# UPDATED: 2-14-2002, jamiea
# >>DEMO ONLY<<

# This is the main input file; other input files
# are specified here.

ENVVARS
NAME          VALUE
RUN           oct96
GRID          ./../data/grid
TIMESERIES    ./../data/timeseries
IRREG         $GRID/irreg
DSSOUT        ./output/qual-$RUN.dss
HRTXTOUT      ./output/qual-hourly-$RUN.txt
DAYTXTOUT     ./output/qual-daily-$RUN.txt
END

TITLES
Historical QUAL simulation.
END

INP_FILES
# files that would tend to change for each run
./input/qual/runtime.inp          # runtime control
./input/qual/tide.inp             # Hydro tidefile names
./input/qual/io.inp               # i/o filenames
./input/qual/scalar.inp           # other scalar data, constants
./input/qual/boundary.inp         # boundary water quality concentrations
./input/qual/output.inp           # desired output specifications

# files that would not be changed often
./input/qual/input-ag.inp         # ag return water quality concentrations
$GRID/channels.inp
$GRID/irregular_xsects.inp
$GRID/regular_xsects.inp
$GRID/list.inp
$GRID/reservoirs.inp
$GRID/translations.inp            # input name translations
$GRID/type.inp                    # correct for improper signs
END
```

**Figure 5-2: Sample QUAL Main Input File-dsm2.inp**

Example:

```
ENVVARS
NAME                VALUE
RUN                 oct96
GRID                ./../data/grid
TIMESERIES          ./../data/timeseries
IRREG               $GRID/irreg
DSSOUT              ./output/qual-$RUN.dss
HRTXTOUT            ./output/qual-hourly-$RUN.txt
DAYTXTOUT           ./output/qual-daily-$RUN.txt
END
```

Use in tutorial:
Environment variables RUN, GRID, TIMESERIES, IRREG, DSSOUT, HRTXTOUT, and DAYTXTOUT are declared. The variable RUN is set equal to the text string "oct96" to indicate that the simulation represents the time period of October 1996. This environment variable is used to designate the simulation when output file names are created (see io.inp).

**RUN:** The environment variable RUN is a text string that describes the simulation. In this case the text string "oct96" indicates a historical simulation of October 1996.

**GRID:** The environment variable GRID indicates that the file related to the DSM2 grid are located in the directory indicated by the relative path ***./../data/grid***. In this path name, the "./" indicates to start in the current directory. Since the batch file for running QUAL is located in the ***dsm2demo/study*** directory (Figure 5-1), that is the "starting point" for the relative path referenced by the "./" symbol. The "../" part of the path means to go up one directory. In this case since we are starting in the directory ***dsm2demo/study***, going up one directory would put us in the ***dsm2demo*** directory. The "data/grid" part of the path refers to the subdirectory grid located in the data directory. Thus, the relative path ***./../data/grid*** refers to the directory ***/dsm2demo/data/grid***.

> **Current directory**
> **"./" definition**
>
> **For this tutorial "./" in a pathname refers to the directory *dsm2demo/study***

**TIMESERIES:** The environment variable TIMESERIES is defined as the relative path ***./../data/timeseries***. This relative path refers to the directory ***/dsm2demo/data/timeseries***.

**IRREG:** The environment variable IRREG uses the environment variable in its definition, ***$GRID/irreg***. This path name would be represent the directory grid located in the pathname indicated by the environment variable grid. Thus this pathname refers to the directory ***/dsm2demo/data/grid/irreg***.

**DSSOUT:** The environment variable DSSOUT defines a path and file name for the DSS output as ***`./output/qual-${RUN}.dss`***. Substituting the definition of the environment variable RUN into this path name gives the path and file name for the DSS output file as ***dsm2demo/study/output/qual-oct96.dss***.

**HRTXTOUT:** The environment variable HRTXTOUT defines the path and file name for the text DSM2 output file for hourly or 15-minute simulation results as ***`./output/qual-hourly-${RUN}.txt`*** which refers to the path and file name ***dsm2demo/study/output/qual-hourly-oct96.txt***.

**DAYTXTOUT:** The environment variable DAYTXTOUT defines the path and file name for the text DSM2 output file for daily average simulation results as ***`./output/qual-daily-${RUN}.txt`*** which refers to the path and file name ***dsm2demo/study/output/qual-daily-oct96.txt***.

### 5.3.2 TITLES

Section Keyword: TITLES Titles section

Field keywords: none

Required: no

Overwrites: no

Description: Each line in the Title section is used as a title or header for later printouts. Typically the user would enter a description of the simulation in this section.

Example:

```
TITLES
Historical QUAL simulation.
END
```

Use in tutorial:
The title was set to the text string "Historical QUAL simulation".

### 5.3.3 INP_FILES: Include Input Files

Section Keyword: INP_FILES Input file section

Field keywords: none

Required: no

Overwrites:

Description: Each line in the Include Input Files section is a filename (either full pathname or relative to the simulation directory) which directs the input system to read in that file and process it as part of the input system. This allows different sections to be in different files for convenience and clarity. Also, for many sections, the same section can be read in multiple times, subsequent values overwriting previous values.

Example:

```
INP_FILES
# files that would tend to change for each run
./input/qual/runtime.inp      # runtime control
./input/qual/tide.inp         # Hydro tidefile names
./input/qual/io.inp           # i/o filenames
./input/qual/scalar.inp       # other scalar data, constants
./input/qual/boundary.inp     # boundary water quality concentrations
./input/qual/output.inp       # desired output specifications

# files that would not be changed often
./input/qual/input-ag.inp     # ag return water quality concentrations
$GRID/channels.inp
$GRID/irregular_xsects.inp
$GRID/regular_xsects.inp
$GRID/list.inp
$GRID/reservoirs.inp
$GRID/translations.inp        # input name translations
$GRID/type.inp                # correct for improper signs
END
```

Use in tutorial:
The file pathnames listed in this example correspond to the tutorial directory structure. The first six files listed in the INP_FILES sections refer to the text input files runtime.inp, tide.inp, io.inp, scalar.inp, boundary.inp, and output.inp located in the directory ***dsm2demo/study/input/qual.*** These six files typically change from simulation to simulation.

The next set of files listed are files that do not typically change from simulation to simulation. The first file listed in this section is the text input file input-ag.inp in the ***dsm2demo/study/input/qual*** directory. The next seven files listed are text input files related to the geometry located in the directory ***/dsm2demo/data/grid.*** The geoemetry files are named channels.inp, irregular_xsects.inp, regular_xsects.inp, list.inp, reservoirs.inp, translations.inp, and type.inp.

## 5.4 **boundary.inp:** Water quality boundary condition input file

**boundary.inp**
**Sections**
- **INPUTPATHS**

Water quality boundary conditions (Figure 4-3) are located in the input file boundary.inp. For this tutorial, the boundary.inp file is located in the directory ***dsm2demo/study/input/qual***. The sample boundary.inp file used in this tutorial is shown in Figure 5-3. The water quality boundary condition input file contains two INPUTPATHS sections which specify the path names corresponding to the input files that contain the boundary condition time series data. For this tutorial, the input paths correspond to DSS file pathnames. A review of DSS pathnames is found in section 6.2. The INPUTPATHS section is described below. Typically a new boundary.inp file is created for each simulation.

### 5.4.1 **INPUTPATHS:** Input Path Specification for Time-Varying Data

| | | |
|---|---|---|
| Section keyword: | INPUTPATHS | Each line in the INPUTPATHS section specifies the location or "path[10]" that corresponds to the desired input data time series. |
| Field keywords: | NAME | Location name. The node number to which the location name corresponds must be specified, typically in a translations input file. |
| | MEAS_TYPE | Type of data: EC, TDS, etc. Used for DSS C part. Must be IDENTICAL to the DSS pathname if input is from a DSS file. MEAS_TYPE is not needed if you use the C_PART keyword. MEAS_TYPE can be used when specifying a constant value instead of time series input. |

[10] Each line in the INPUTPATHS section specifies the location or "path" that corresponds to the desired input data time series. In this tutorial the input paths in the boundary.inp file correspond to DSS pathnames.

Data RKI* Type of BC Data interval Data source Missing data fill in method Data path priority DSS input file name

Section Keyword →
Field Keywords →
Location names from translations.inp.
Section END →

```
INPUTPATHS
name     a_part     b_part  c_part e_part f_part fillin priority     filename
mtz   FILL+CHAN  RSAC054 EC      1HOUR   DWR-DMS   LAST    0        $TIMESERIES/quality.dss
sjr   HIST+CHAN  RSAN112 EC      1DAY    USBR-CVO  LAST    1        $TIMESERIES/quality.dss
sac   HIST+CHAN  RSAC139 EC      1DAY    USBR-CVO  LAST    1        $TIMESERIES/quality.dss
END
```

Information from DSS file

Section Keyword →
Field Keywords →
Location names from translations.inp. They are also shown in Figure 4-3.
Section END →

```
INPUTPATHS
NAME     MEAS_TYPE INTERVAL   ID   FILLIN PRIORITY   VALUE
sac   EC        1day       xx   last   2          150.
sjr   EC        1day       xx   last   2          550.
yolo  EC        1day       xx   last   0          275.
moke  EC        1day       xx   last   0          150.
csmr  EC        1day       xx   last   0          150.
END
```

Type of BC Data interval Study ID Missing data fill in method Data path priority Constant value for data

San Joaquin River (SJR) priorities
Sacramento River (Sac) priorities
Use time series values for EC from the file quality.dss (priority=1) unless data are missing, in which case use constant values of 150 for Sac and 550 for SJR (priority=2)

*RKI = River Kilometer Index
BC = Boundary Condition
DSS = Data Storage System

**Figure 5-3: Sample QUAL Boundary Condition Input File-boundary.inp**

| | |
|---|---|
| INTERVAL | Time interval of time series data: 15MIN, 1HOUR, 1DAY, 1MON, IR-DECADE. Used for DSS E part. Must be IDENTICAL to the DSS pathname if input is from a DSS file. INTERVAL is not needed if you use the E_PART keyword. INTERVAL can be used when specifying a constant value instead of time series input. |
| A_PART | DSS A part. Typically a text string that may indicate information such as the type of data or the scenario associate with the data. Must be IDENTICAL to the pathname in the input DSS file. |
| B_PART | DSS B part. Typically a location name, node number, or channel number. Must be IDENTICAL to the pathname in the input DSS file. |
| C_PART | DSS C part. Typically indicates the type of data: EC, TDS, etc. Must be IDENTICAL to the pathname in the input DSS file. Not used if use MEAS_TYPE. |
| E_PART | DSS E part. Typically indicates the time interval of time series data: 15MIN, 1HOUR, 1DAY, 1MON, IR-DECADE. Must be IDENTICAL to the pathname in the input DSS file. Not used if use INTERVAL. |
| F_PART | DSS F part. Typically a text string that indicates the study name or the source of the data. Must be IDENTICAL to the pathname in the input DSS file. Not used if use ID. |
| ID | Identification, study name, etc. Used for DSS F part. Must be IDENTICAL to the pathname in the input DSS file. Not needed if use F_PART keyword. ID can be used when specifying a constant value instead of time series input. |

**DSS Pathnames**

**References to DSS pathnames (A, B, C, E, and F parts) must be IDENTICAL to the text specified in that part of the DSS file.**

| | |
|---|---|
| FILLIN | LAST, INTERP, or DATA. If LAST is indicated, then the last data value will be used when a value is not specified for a given time. When INTERP is indicated, values will be interpolated if a value is not specified for a given time. If DATA is indicated, the model will automatically use the last value if the time series is period averaged or the model will interpolate if the time series is instantaneous. |
| PRIORITY | Optional priority of the input data represented by this path specified as an integer between 0 and N. Lower numbers indicate higher priority data paths, for example a "1" indicates the first priority data path and a "2" indicates the second priority data path. Data from higher priority (lower number) input paths are used first. When data are missing from a higher priority input data path, data are filled in with data from the next lower priority (next higher number) data path. A priority of 0 means ignore the priority system and always use the specified path. If no data are specified in any input data path for a specific time during the model simulation, DSM2 will crash. See section 6.3 and Figure 6-5 for additional information on input path priorities. |
| FILENAME | DSS filename that contains the desired time series data. |

| | |
|---|---|
| VALUE | Numeric value to use as constant input value for the entire simulation instead of specifying an input time series. If the keyword VALUE is used, the keywords FILENAME, A_PART, and F_PART are not used. However the keywords B_PART, C_PART, and E_PART **or** the keywords MEAS_TYPE, INTERVAL, and ID. |

Required: yes

Overwrites: no

Description: Provides information to locate time-varying data (flows, stages, gate operations, water quality, etc.) in DSS during the simulation. All time-varying input for HYDRO and QUAL must come from DSS files. Locations corresponding to the time-varying input are specified by either a node number or a name that translates to a node number.

Example:

Input time series water quality data from a DSS file:

```
INPUTPATHS
      name             a_part    b_part c_part e_part f_part fillin
                       priority  filename
mtz  FILL+CHAN RSAC054 EC       1HOUR   DWR-DMS  LAST    0         $TIMESERIES/quality.dss
sjr  HIST+CHAN RSAN112 EC       1DAY    USBR-CVO LAST    1         $TIMESERIES/quality.dss
sac  HIST+CHAN RSAC139 EC       1DAY    USBR-CVO LAST    1         $TIMESERIES/quality.dss
END
```

Input constant water quality data:

```
INPUTPATHS
      NAME             MEAS_TYPE INTERVAL      ID     FILLIN PRIORITY
                       VALUE
sac    EC         1day      xx   last    2         150.
sjr    EC         1day      xx   last    2         550.
yolo   EC         1day      xx   last    0         275.
moke   EC         1day      xx   last    0         150.
csmr   EC         1day      xx   last    0         150.
END
```

Use in tutorial:
The first set of sample input paths above refer to time series water quality data located in the file ***/dsm2demo/data/timeseries/quality.dss***. A view of the DSS file as it would appear in Vista (see section 6.4 for information on VISTA) is shown in Figure 5-4. Note that the path information in the INPUTPATHS section is identical to the path information in the DSS file. The second set of input paths specifies constant EC boundary conditions.

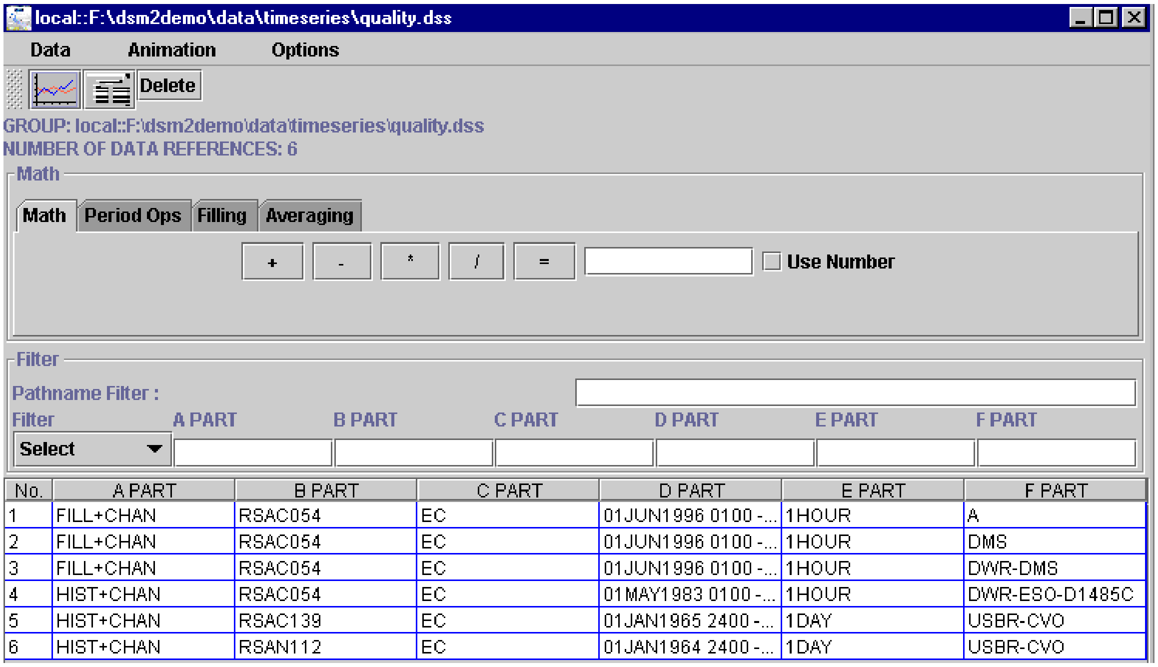



**Figure 5-4: Vista View for quality.dss File**

The boundary conditions listed in the boundary.inp file (Figure 4-4) include time series EC data for Martinez (mtz), the Sacramento River (sac) and the San Joaquin River (sjr). Constant EC values are specified for the Yolo Bypass (yolo), the Mokelumne River (moke) and the Cosumnes River (csmr). If time series data (priority=1) are missing for the Sacramento and San Joaquin rivers, constant values (priority=2) are used. These boundary conditions are summarized in Table 5-1.

**Table 5-1 : Summary of EC Boundary Conditions**

| **Location** | **EC Boundary Condition** |
|---|---|
| Martinez (mtz) | Time series data from quality.dss |
| Sacramento River (sac) | Time series data if available in quality.dss file, if not use a constant value of 150 umhos/cm |
| San Joaquin River (sjr) | Time series data if available in quality.dss file, if not use a constant value of 550 umhos/cm |
| Yolo Bypass (yolo) | Constant value of 275 umhos/cm |
| Mokelumne River (moke) | Constant value of 150 umhos/cm |
| Cosumnes River (csmr) | Constant value of 150 umhos/cm |

## 5.5 input-ag.inp: Agricultural Drainage Quality Input File

Agricultural drainage water quality concentrations are specified in the input file input-ag.inp. For this tutorial, the input-ag.inp file is located in the directory ***dsm2demo/study/input/qual***. The sample input-ag.inp file used in this tutorial is shown in Figure 5-5. The input-ag.inp file includes the sections INPUTPATHS and TRANSLATION. A new input-ag.inp file is created for a new simulation only if the quality of the drainage changes.

**input-ag.inp**
**Sections**
- **INPUTPATHS**
- **TRANSLATION**

### 5.5.1 INPUTPATHS[11]

| | | |
|---|---|---|
| Section keyword: | INPUTPATHS | Each line in the INPUTPATHS section specifies the location or "path[12]" that corresponds to the desired input data time series. |
| Field keywords: | NAME | Location name. The node number to which the location name corresponds must be specified, typically in a translations input file. |
| | NODE | Node number corresponding to the location associated with the data. |
| | A_PART | DSS A part. Typically a text string that may indicate information such as the type of data or the scenario associate with the data. Must be IDENTICAL to the pathname in the input DSS file. |
| | B_PART | DSS B part. Typically a location name, node number, or channel number. Must be IDENTICAL to the pathname in the input DSS file. |

**Locations associated with DSS data may be specified by:**
- **NAME or**
- **NODE**

**DSS Pathnames**
**References to DSS pathnames (A, B, C, E, and F parts) must be IDENTICAL to the text specified in that part of the DSS file.**

[11] This section is identical to the INPUTPATHS description in section 5.4.1 with the addition of the field keywords NODE and SDATE.

[12] Each line in the INPUTPATHS section specifies the location or "path" that corresponds to the desired input data time series. In this tutorial the input paths in the input-ag.inp file correspond to DSS pathnames.

```
# DSM2 input file

# Input paths for historic DICU water quality data
# These correspond to drainage flows from land to channels
# used in Hydro

INPUTPATHS
NAME A_PART          B_PART C_PART   E_PART  F_PART   FILLIN   SDATE  FILENAME
# Byron-Bethany Irrigation District
bbid DICU-HIST+RSVR BBID   DRAIN-EC 1MON    DWR-OSP  LAST     SYNC   $TIMESERIES/dicu.dss
END

INPUTPATHS
NODE A_PART          B_PART C_PART   E_PART F_PART    FILLIN   SDATE  FILENAME
1    DICU-HIST+NODE 1      DRAIN-EC 1MON   DWR-OSP   LAST     SYNC   $TIMESERIES/dicu.dss
3    DICU-HIST+NODE 3      DRAIN-EC 1MON   DWR-OSP   LAST     SYNC   $TIMESERIES/dicu.dss
5    DICU-HIST+NODE 5      DRAIN-EC 1MON   DWR-OSP   LAST     SYNC   $TIMESERIES/dicu.dss
               • • •  Several lines omitted for illustration purposes • • •
354  DICU-HIST+NODE 354    DRAIN-EC 1MON   DWR-OSP   LAST     SYNC   $TIMESERIES/dicu.dss
355  DICU-HIST+NODE 355    DRAIN-EC 1MON   DWR-OSP   LAST     SYNC   $TIMESERIES/dicu.dss
END

# Translate IEP "drain-ec" to just "ec"
TRANSLATION
NAME          CONST
DRAIN-EC      EC
END
```



Note: The node numbers listed in the input paths are not necessarily sequentially numbered.

**Figure 5-5: Sample QUAL Agricultural Drainage Quality Input File-input-ag.inp**

| | |
|---|---|
| C_PART | DSS C part. Typically indicates the type of data: DRAIN-EC, etc. Must be IDENTICAL to the pathname in the input DSS file. |
| E_PART | DSS E part. Typically indicates the time interval of time series data: 15MIN, 1HOUR, 1DAY, 1MON, IR-DECADE. Must be IDENTICAL to the pathname in the input DSS file. |
| F_PART | DSS F part. Typically a text string that indicates the study name or the source of the data. Must be IDENTICAL to the pathname in the input DSS file. |
| FILLIN | LAST , INTERP, or DATA. If LAST is indicated, then the last data value will be used when a value is not specified for a given time. When INTERP is indicated, values will be interpolated if a value is not specified for a given time. If DATA is indicated, the model will automatically use the last value if the time series is period averaged or the model will interpolate if the time series is instantaneous. |
| SDATE | Optional start date, if different from model run start date (Note: If used, the data will start at the given date, regardless of the model start time. Use "GENERIC" to indicate the data starts at the standard generic time (01JAN3001 0000). Use "SYNC" to indicate that the data time should be synchronized to the model time based on the interval or e part. For instance, for a data interval of 1MON, the system will attempt to always use January data for a January model time, etc. Synchronized data must have a generic start date, and must not contain missing data.) |
| FILENAME | DSS filename that contains the desired time series data. |

**DSM2 Drainage**
**<u>Definition</u>**
**Drainage-water leaving a Delta island and entering a Delta channel including rainfall and agricultural runoff (source)**

Required: yes

Overwrites: no

Description: Provides information to locate time-varying data (flows, stages, gate operations, water quality, etc.) in DSS during the simulation. All time-varying input for HYDRO and QUAL must come from DSS files. Locations corresponding to the time-varying input are specified by either a node number or a name that translates to a node number.

Example:

```
INPUTPATHS
NODE A_PART          B_PART C_PART   E_PART F_PART  FILLIN SDATE  FILENAME
1    DICU-HIST+NODE 1      DRAIN-EC 1MON   DWR-OSP  LAST   SYNC   $TIMESERIES/dicu.dss
3    DICU-HIST+NODE 3      DRAIN-EC 1MON   DWR-OSP  LAST   SYNC   $TIMESERIES/dicu.dss
END
```

Use in tutorial:
The first section of the input-ag.inp file (Figure 5-5) provides the DSS pathnames for the file dicu.dss for the drainage (return) flow EC associated with Byron Bethany Irrigation District. The second section of the input-ag.inp file lists the DSS pathnames for the file dicu.dss for the drainage (return) flow EC associated with various locations indicated by their node number in the DSM2 grid.

### 5.5.2 **TRANSLATION**

| | | |
|---|---|---|
| Section keyword: | RESERVOIRS | Section that associates (translates) text strings with DSM2 variables (grid locations, water quality constituents, etc) |
| Field keywords: | NAME | Text string to be associated with a DSM2 variable |
| | CONST | DSM2 constituent abbreviation (e.g. EC) |
| Required: | no | |
| Overwrites: | yes | by NAME |

Description: This section translates between text strings and DSM2 variables.

Example:

```
TRANSLATION
NAME      CONST
DRAIN-EC  EC
END
```

Use in tutorial:
The sample translations.inp file (Figure 5-5) associates the text string "DRAIN-EC' with the DSM2 constituent variable "EC".

## 5.6 io.inp: Input File that Specifies Output File Names

Names of output files are specified in the input file io.inp. For this tutorial, the io.inp file is located in the directory ***dsm2demo/study/input/qual***. The sample io.inp file used in this tutorial is shown in Figure 5-6. The io.inp file includes the section IO_FILES. If environment variables are used to distinguish files from different simulations, a new io.inp file may not be needed for each simulation.

**io.inp Sections**

- **IO_FILES**

### 5.6.1 INPUTPATHS

| | | | |
|---|---|---|---|
| Section keyword: | IO_FILES | Section where input and output file names are specified | |
| Field keywords: | MODEL | Model for which input/output is desired: | |
| | | HYDRO | input to or output from HYDRO |
| | | QUAL | input to or output from QUAL |
| | | OUTPUT | used to indicate that a text file echoing screen output is desired |
| | TYPE | Type of input/output file: | |
| | | NONE | Used when there is no choice in file format |
| | | RESTART | ASCII restart file |
| | | BINARY | Binary file (used for recording simulation results at every node at the specified interval) |
| | IO | Designation of whether file is an input or an output file | |
| | | IN | Input file that will be read |
| | | OUT | Output file that will be written |
| | | NONE | Used when MODEL equals OUTPUT |

Section Keyword → IO_FILES
Field Keywords → MODEL TYPE IO INTERVAL FILENAME
Output file specifications → (lines 4–6)
Section END → END

```
# I/O filenames
IO_FILES
MODEL  TYPE    IO   INTERVAL  FILENAME
output none    none none      ./output/qual-$RUN.out
qual   restart out  1day      ./output/qual-rst-$RUN.out
qual   restart in   none      ./output/qual-oct4.rst
END
```

**Figure 5-6: Sample QUAL Output File Name Specification Input File-io.inp**

| | | |
|---|---|---|
| | INTERVAL | Time interval for which data are to be written to the file; NONE, or a time interval (15 min, 1 hour, 1 day, etc.) |
| | FILENAME | Name of the input/output file |
| Required: | no | |
| Overwrites: | yes | By: MODEL+TYPE+IO |
| Description: | This section specifies the filenames of input/output files. If filenames are given for restart and binary input or output file, listing the filename in this section turns on processing for those files (general echo output is always on). | |

Example:

```
IO_FILES
MODEL    TYPE      IO     INTERVAL  FILENAME
output   none      none   none      ./output/qual-$RUN.out
qual     restart   out    1day      ./output/qual-rst-$RUN.out
qual     restart   in     none      ./output/qual-oct4.rst
END
```

Use in tutorial:
In the sample io.inp file (Figure 5-6) three output files are specified. The output file names use the environment variable RUN. Referring to the dsm2.inp file in Figure 5-2, RUN is the text string "oct96". Thus, the two output files generated in the directory dsm2demo/study/output are:

- qual-rst-oct96.out – an ASCII restart file
- qual-oct96.out – an ASCII file that echoes screen output

**Output Files**

- **qual-rst-oct96.out**
- **qual-oct96.out**

Note: at the present time there is no file equivalent to the hydro binary output file that provides simulation results at every time step at every node.

In addition to the output files, an input restart file is specified in the io.inp file. For this simulation, the input restart file is the file dsm2demo/study/output/qual-oct4.rst. The restart file was provided as part of the tutorial package. The restart file begins on October 4th to allow for a three day warm-up period in the HYDRO simulation. See the comparison between the warm-start and cold-start results for November 1996 in the HYDRO tutorial section 4.21.1.

**Input Restart File**

- **qual-oct4.rst**

**Restart starts on Oct 4 allow a 3-day warm-up period for HYDRO**

## 5.7 **output.inp:** Input File that Specifies Desired Output

Desired output is specified in the input file output.inp. For this tutorial, the output.inp file is located in the directory ***dsm2demo/study/input/qual***. The sample output.inp file used in this tutorial is shown in Figure 5-7.

```
# DSM2 QUAL Output location file
# Grid v2.0
# Updated: 2-14-02, jamiea
# >>DEMO ONLY<<

# Output paths specified by channel number and distance
OUTPUTPATHS
CHAN        DIST     TYPE   INTERVAL     PERIOD FILENAME
# Sac River@Rio Vista
430         9684     ec     1HOUR        INST   $DSSOUT
430         9684     ec     1HOUR        INST   $HRTXTOUT
430         9684     ec     1DAY         AVE    $DSSOUT
430         9684     ec     1DAY         AVE    $DAYTXTOUT
END

# Output paths specified RKI (River Kilometer Index)
OUTPUTPATHS
NAME    TYPE   INTERVAL     PERIOD  FILENAME
#Antioch
rsan007  ec     15min        inst     $DSSOUT
rsan007  ec     15min        inst     $HRTXTOUT
rsan007  ec     1day         ave      $DSSOUT
rsan007  ec     1day         ave      $DAYTXTOUT
#San Joaquin River at Brandt Bridge
rsan072  ec     15min        inst     $DSSOUT
rsan072  ec     15min        inst     $HRTXTOUT
rsan072  ec     1day         ave      $DSSOUT
rsan072  ec     1day         ave      $DAYTXTOUT
#Old River at Clifton Court Ferry
rold040  ec     15min        inst     $DSSOUT
rold040  ec     15min        inst     $HRTXTOUT
rold040  ec     1day         ave      $DSSOUT
rold040  ec     1day         ave      $DAYTXTOUT
END
```

Section Keyword →
Field Keywords →
DSS & text output for Rio Vista specified by channel and distance
Section END →
Section Keyword →
Field Keywords →
DSS and text output specified by RKI for Antioch, SJR Brandt Bridge, and Old River at Clifton Court Ferry
Section END →

**Figure 5-7: Sample QUAL Output Specification Input File-output.inp**

The output.inp file includes the section OUTPUTPATHS. For the purpose of the tutorial, output is only requested at four locations. A new output.inp file is created for each simulation in which different output types and/or locations are desired.

**output.inp Sections**

- **OUTPUTPATHS**

### 5.7.1 OUTPUTPATHS

| | | |
|---|---|---|
| Section keyword: | OUTPUTPATHS | Section where desired output is specified |
| Field keywords: | CHAN | Channel number. If CHAN is used, also use DIST and don't use NAME. |
| | DIST | Distance from the upstream node downstream along channel in feet; Alternatively if it is desired to use the downstream location along the entire length of the channel, use the word LENGTH instead of a numerical distance. Use DIST with CHAN. |
| | NAME | Location name. The node number to which the location name corresponds must be specified, typically in a translations input file. Used for DSS B part. If NAME is used, don't use CHAN and DIST. |
| | TYPE | Type of data (FLOW, STAGE, FLOW-EXPORT, FLOW-DIVERSION, GATE, EC, TDS, etc.) Used for DSS C part. |
| | INTERVAL | Time interval of time series output data: 15MIN, 1HOUR, 1DAY, 1MON, IR-DECADE. Used for DSS E part. |
| | PERIOD | Period for which data are to be written:<br>INST — write instantaneous values to the output file<br>AVE — write values averaged over the interval specified under the keyword INTERVAL, e.g. daily or monthly averages, etc. |

| | |
|---|---|
| FILENAME | Name of output file to be written to, if the file name ends with the extension *.dss the output will be written to that file in DSS format, otherwise the output will be a text file. |

Required: no

Overwrites: no

Description: Time-varying text and DSS output is specified in this section.

Example:

Output specified by channel number and distance:

```
OUTPUTPATHS
CHAN       DIST   TYPE   INTERVAL      PERIOD FILENAME
# Sac River@Rio Vista
430        9684   ec     1HOUR         INST   $DSSOUT
430        9684   ec     1HOUR         INST   $HRTXTOUT
430        9684   ec     1DAY          AVE    $DSSOUT
430        9684   ec     1DAY          AVE    $DAYTXTOUT
END
```

Output specified by name [in this case RKI -River Kilometer Index]:

```
OUTPUTPATHS
NAME      TYPE   INTERVAL      PERIOD  FILENAME
#Antioch
rsan007   ec     15min         inst     $DSSOUT
rsan007   ec     15min         inst     $HRTXTOUT
rsan007   ec     1day          ave      $DSSOUT
rsan007   ec     1day          ave      $DAYTXTOUT
END
```

Use in tutorial:

The sample output.inp file (Figure 5-7) specifies EC output at four locations (Figure 4-11). Instantaneous (15 minute or hourly) and daily average data are requested in both text and DSS formats. The environment variable definitions for the output file names are located in the dsm2.inp file (Figure 5-2). One DSS file will be created and separate text output files will be created for instantaneous and daily average data. The first section specifies hourly and daily average output for the Sacramento River at Rio Vista using channel number and distance references. The second section specifies 15-minute and daily average output for Antioch, the San Joaquin River at Brandt Bridge, and Old River at Clifton Court Ferry using the NAME field keyword. The names for each of the locations are defined in the ***dsm2demo/data/grid/translations.inp*** file. A sample file listing output for locations throughout the Delta can be found in the file ***dsm2demo/study/input/qual/additional_sample_ files/ output_full_delta.inp***. To use this file instead of the output.inp file,

**Output Files**

- **qual-oct96.dss**
- **qual-daily-oct96.txt**
- **qual-hourly-oct96.txt**

replace the output.inp pathname in the dsm2.inp file with the pathname for the output_full_delta.inp file.

## 5.8 **runtime.inp:** Simulation Time Period Input File

**runtime.inp**
**Sections**
- **SCALAR**

The simulation time period is specified in the input file runtime.inp. For this tutorial, the runtime.inp file is located in the directory ***dsm2demo/study/input/qual***. The sample runtime.inp file used in this tutorial is shown in Figure 5-8. The runtime.inp file includes the section SCALAR. A new runtime.inp file is created for each simulation with a different simulation period.

### 5.8.1 **SCALAR:** Runtime scalar variables

| | | |
|---|---|---|
| Section keyword: | SCALAR | |
| Field keywords: | none | |
| Required: | yes | |
| Overwrites: | yes | by scalar name |
| Description: | This section is used to input the values of single variables (scalars) to DSM2. Each line in the scalars section consists of two fields: the variable name and the value (in that order). | |
| | run_start_date | Date of simulation start (ddmonyyyy, e.g. 01jun1994 or restart or tidefile). If use an actual date, also define the variable run_start_time. If value is set equal to “restart” then simulation will start from the time in the restart file, and the variable run_start_time does not need to be defined. If value is set equal to “tidefile”, the simulation will start from the time in the tide file, and the variable run_start_time does not need to be defined. |
| | run_start_time | Hour of simulation start (HHHH, e.g. 0000 or 2400). Used with run_start_date when run_start_date is specified as a date. |
| | run_end_date | Date of end of simulation (ddmonyyy, e.g. 31aug1994). Used with run_end_time. If run_end_date is used, comment out run_length. |

Section Keyword →

Simulation period Oct 4, 1996 0:00 to Oct 31, 1999 24:00

Section END →

```
# DSM2 input file
# Simulation run time Oct 4, 1996-Oct 31, 1996

# Run start and end times
SCALAR
run_start_date   04OCT1996
run_start_time   0000
run_end_date     31OCT1996 # if used, comment out run_length
run_end_time     2400
#run_length      # not used
#comment out run_end date and time if you use run_length
END
```

**Figure 5-8: Sample QUAL Simulation Time Period Input File-runtime.inp**

| | |
|---|---|
| run_end_time | Hour of the end of the simulation (HHHH, e.g.1500). Used with run_end_date. |
| run_length | Length of simulation in days and hours (##DAY_##HOUR, e.g. 91DAY_15HOUR). If run_length is used, comment out or omit run_end_date and run_end_time. |

Example:

```
SCALAR
run_start_date 04OCT1996
run_start_time 0000
run_end_date   31OCT1996
run_end_time   2400
END
```

Use in tutorial:
The sample runtime.inp file (Figure 5-8) specifies the simulation time period. In this case, the simulation starts on October 4, 1996 at midnight (hour 0:00) and runs through October 31, 1996 at midnight (hour 24:00).

**Simulation Period**

**October 4, 1996 0:00 to October 31, 1996 24:00**

The simulation begins on October 4th to allow for a three day warm-up period in the HYDRO simulation. See the comparison between the warm-start and cold-start results for November 1996 in the HYDRO tutorial section 4.21.1.

## 5.9 **scalar.inp:** Scalar Variable Input File

Scalar variables are defined in the input file scalar.inp. For this tutorial, the scalar.inp file is located in the directory ***dsm2demo/study/input/hydro***. The sample scalar.inp file used in this tutorial is shown in Figure 4-12. The scalar.inp file includes the section SCALAR. Typically the tidal representation (historical/realistic or repeating) and the time step are the only variables that are changed in the scalar.inp file from simulation to simulation.

**scalar.inp Sections**

- **SCALAR**

### 5.9.1 **SCALAR:** DSM2 scalar variables

| | | |
|---|---|---|
| Section keyword: | SCALAR | |
| Field keywords: | none | |
| Required: | yes | |
| Overwrites: | yes | by scalar name |

Section Keyword
Miscellaneous scalar variables
Data checking and warning scalar variables
Print level scalar variable
QUAL scalar variables
Section END

```
# DSM2 input file

# Various single-argument options (constants, coefficients, ...)
SCALAR
flush_output     10day    # interval to flush output
display_intvl    1day     # how often to display model time progress
checkdata        false    # check input data w/o simulation

# Note: all cont_* scalars are "true" or "false".
cont_unchecked   true     # continue on unchecked data (use data value)
cont_question    false    # continue on questionable data (use data value)
cont_missing     false    # continue on missing data (use previous value)
cont_bad         false    # continue on bad data (use previous value)

warn_unchecked   false    # warn about unchecked data
warn_question    true     # warn about questionable data
warn_missing     false    # warn about missing data

printlevel       1        # amount of printing, 0 to 9, increasing with number.

# following all Qual variables
Qual_time_step   15min    # Qual time step, in minutes
Dispersion       t        # true Activate dispersion
Init_Conc        100.0    # initial concentration value
#tide_length     25hour   # tide length
END
```

**Figure 5-9: Sample QUAL Scalar Variable Input File-scalar.inp**

Description: This section is used to input the values of single variables (scalars) to DSM2. Each line in the scalars section consists of two fields: the variable name and the value (in that order). (Note: The flush_output interval should be kept at one day or greater; less than one day will result in long times to write to DSS files at the end of a run.)

| | |
|---|---|
| flush_output | Interval to flush output, (e.g. 5day). The flush_output interval should be kept at one day or greater; less than one day will result in long times to write to DSS files at the end of a run. |
| display_intvl | How often to display model time progress (e.g. 1hour) |
| checkdata | Check input data without simulation, true or false |
| cont_unchecked | Continue simulation when data flagged as unchecked are encountered, true or false. If true, use data, if false end simulation if data flagged as unchecked are encountered. |
| cont_question | Continue simulation when data flagged as questionable are encountered, true or false. If true, use data, if false end simulation if data flagged as questionable are encountered. |
| cont_missing | Continue simulation when missing data are encountered, true or false. If true, DSM2 uses the previous value when missing data are encountered and continues with the simulation. If false, DSM2 ends the simulation. |
| cont_bad | Continue simulation when data flagged as bad are encountered, true or false. If true, use data, if false end simulation if data flagged as bad are encountered. |

| | |
|---|---|
| warn_unchecked | Print a warning to the screen when data flagged as unchecked are encountered. |
| warn_question | Print a warning to the screen when data flagged as questionable are encountered. |
| warn_missing | Print a warning to the screen when data flagged as questionable are encountered. |
| printlevel | Amount of printing of screen output, 0 to 9. Amount of information printed increases with increasing number. |
| qual_time_step | Computational time step length (e.g. 5min, 15min). Although typically the same time step is used in both HYDRO and QUAL, the time steps are not required to be the same. |
| Dispersion | Activate dispersion<br>f = false-don't include dispersion<br>t = true, include dispersion. |
| Init_Conc | Initial concentration value. If more than one constituent is simulated, the same value will be used for all constituents. This value is used if initial concentrations are not specified in a restart file. |
| tide_length | Repeating tide length (e.g. 25 hours). This value is only required if a repeating tide is used. |

Use in tutorial:

The sample scalar.inp file (Figure 5-9) defines variables that don't change with time (scalars). The first several sets of variables define display, printing, and data checking options. The computational time step is set equal to 15 minutes. The dispersion variable is set to "true" so dispersion will be included in the fate and transport calculations. An initial concentration for all water quality constituents of 100 is to be used if the initial concentrations are not provided in a restart file. In this tutorial, the initial conditions are provided in a restart file.

**Scalar Values**
- **15-minute time step**
- **Include dispersion**

The variable tide_length is commented out since this is a historical tide simulation, and that variables is related to a repeating tide simulation. If the repeating tide variable is not commented out for a historical/realistic tide simulation, it is ignored by DSM2. The value of the repeating_tide variable (t = repeating tide, f = historical/realistic tide) from the HYDRO scalar.inp file (Figure 4-12) is recorded in the binary HYDRO transfer file (also known as a HYDRO tide file). Thus the QUAL scalar.inp file does not explicitly include a variable to indicate the tidal representation used in the simulation.

## 5.10 **tide.inp:** Specification of HYDRO Binary Results Input File

**tide.inp Sections**

- **TIDEFILE**

The binary results file from HYDRO that provides QUAL with hydrodynamic information is specified in the input file tide.inp. For this tutorial, the tide.inp file is located in the directory ***dsm2demo/study/input/qual***. The sample tide.inp file used in this tutorial is shown in Figure 5-10. The tide.inp file includes the section TIDEFILE. This file is changed when a different set of hydrodynamic conditions from a different HYDRO simulation are desired.

### 5.10.1 **TIDEFILE**

Section keyword: TIDEFILE

| | | | |
|---|---|---|---|
| Field keywords: | START_DATE | starting date of tidefile. Use a specific date if desired (e.g. 05JAN1987), or use: | |
| | | generic | to ignore the tidefile time stamp and simply start with the model run. |
| | | runtime | to try to find the model start runtime in the tidefile (HYDRO binary transfer file) . |
| | | leave empty | to try to find the model start runtime in the tidefile (HYDRO binary transfer file) Same as specifying runtime |
| | | last | to start right after the previous tidefile ends (not allowed on first tidefile). |

| | |
|---|---|
| Section Keyword➔ | TIDEFILE |
| Field Keywords➔ | START_DATE    END_DATE    FILENAME |
| HYDRO binary results file | runtime    length    ./output/hydro-oct96.htf |
| Section END➔ | END |

**Figure 5-10: Sample QUAL Specification of HYDRO Binary Results File Input File-tide.inp**

| | | | |
|---|---|---|---|
| | | previous | to start right after the previous tidefile ends (not allowed on first tidefile). Same as specifying last |
| | END_DATE | ending date of tidefile. Use either a date spec, or a time length (e.g. 3day_5hour), or use: | |
| | | length | to mean use the entire length of the tidefile. If the tidefile is repeating (if it was generated by a repeating tide run in Hydro), and 'length' is given, then the tidefile will be recycled an integer number of times. |
| | FILENAME | Name of the binary HYDRO results transfer file (tidefile) | |
| Required: | yes (for Qual and PTM) | | |
| Overwrites: | no | | |
| Description: | This section lets Qual and PTM know what order to use the binary output files from Hydro which contain channel flows and stages, reservoir flows, and external flows. Each time-averaged set of flows, along with its timestamp, is called a 'tide block'; a single tidefile will typically contain several of these tideblocks, along with some preliminary header information. If the tidefile was generated by a repeating tide, then the tideblocks will usually be 15 minutes or 1 hour in length, and the collection of tideblocks in a single tidefile will span exactly one tidal day (the length of a tidal day is specified in the SCALAR section, keyword TIDE_LENGTH. | | |

Example:

```
TIDEFILE
START_DATE   END_DATE     FILENAME
runtime      length       ./output/hydro-oct96.htf
END
```

**Hydrodynamic input provided to QUAL from HYDRO binary output file**

Use in tutorial:
The sample tide.inp file (Figure 5-10) specifies the name of the HYDRO binary results transfer file (tidefile) that provides hydrodynamic input to QUAL. The variable START_DATE=runtime indicates that QUAL will read the start time for the HYDRO results from the binary results transfer

file (tidefile). The variable END_DATE=length indicates that the entire binary results file will be used. The HYDRO binary results file used for the QUAL tutorial is ***dsm2demo/study/output/hydro-oct96.htf***. The HYDRO binary results file was created during the HYDRO tutorial.

## 5.11 Geometry Input Files

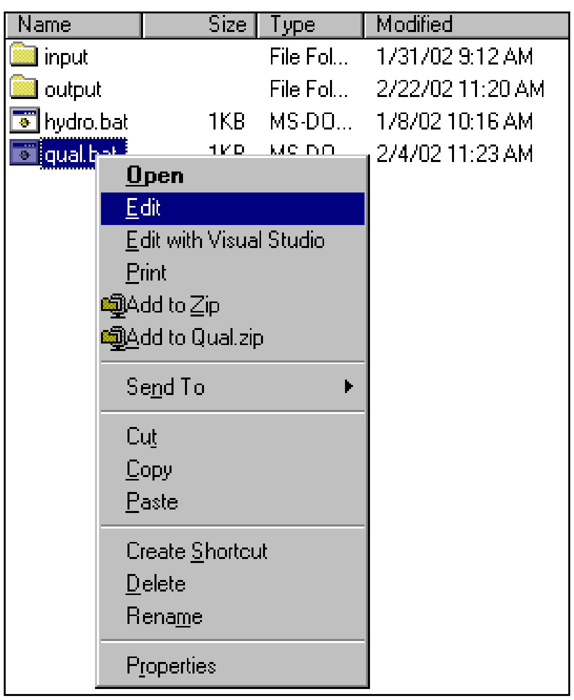
The geometry input files used in QUAL are identical to those used in HYDRO. Complete descriptions of the geometry files can be found in the HYDRO tutorial in sections 4.11 through 4.18.

## 5.12 Running QUAL

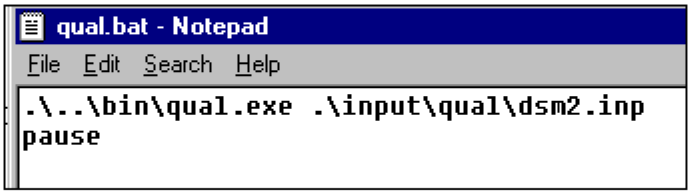
Now the adventures begin, and we will run QUAL using the input files described in the sections 5.3 to 5.11.

### 5.12.1 Steps for Running the QUAL Tutorial

1. Obtain the tutorial files if you have not already done so (see section 2.1 for instructions on how to download the files).
2. If you have not already done so, run the HYDRO tutorial (see section 4.20)
3. On your PC, go to the directory ***dsm2demo/study***.
4. [Optional step] The qual.bat batch file is used to run QUAL. To view the contents of the batch file, right click on the qual.bat icon and select Edit. Note: If you select Open, it will run the batch file instead of opening it so that the contents can be viewed.



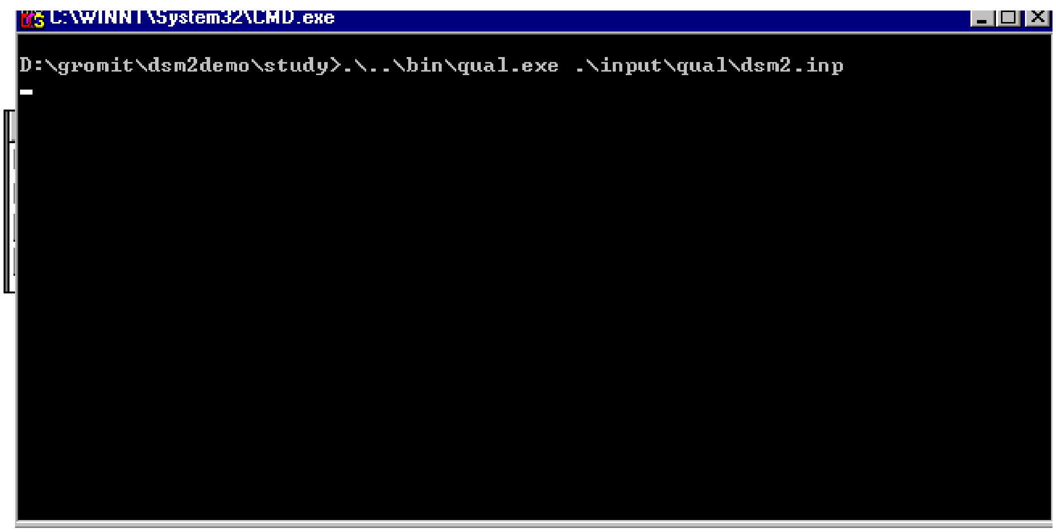
A notepad file will open with the contents of the batch file as shown below. The first line of the batch file runs QUAL in a DOS window. The second line of the batch file causes QUAL to pause at the end so that the user can read the final screen output. The user must then press any key to close the DOS window. Without the pause statement, QUAL would close the DOS window and the user would not be able



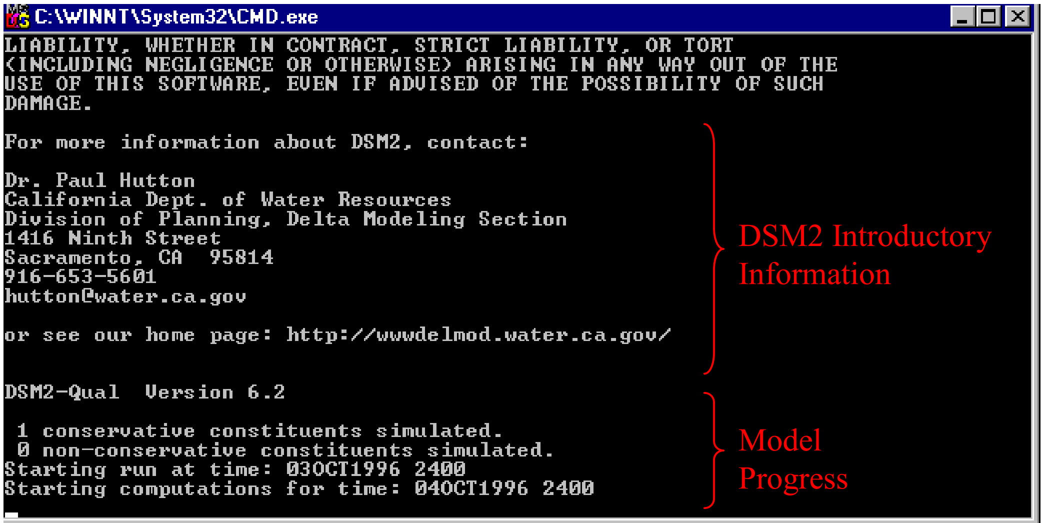

to read the final screen output.

5. To run QUAL, double click on the qual.bat icon.

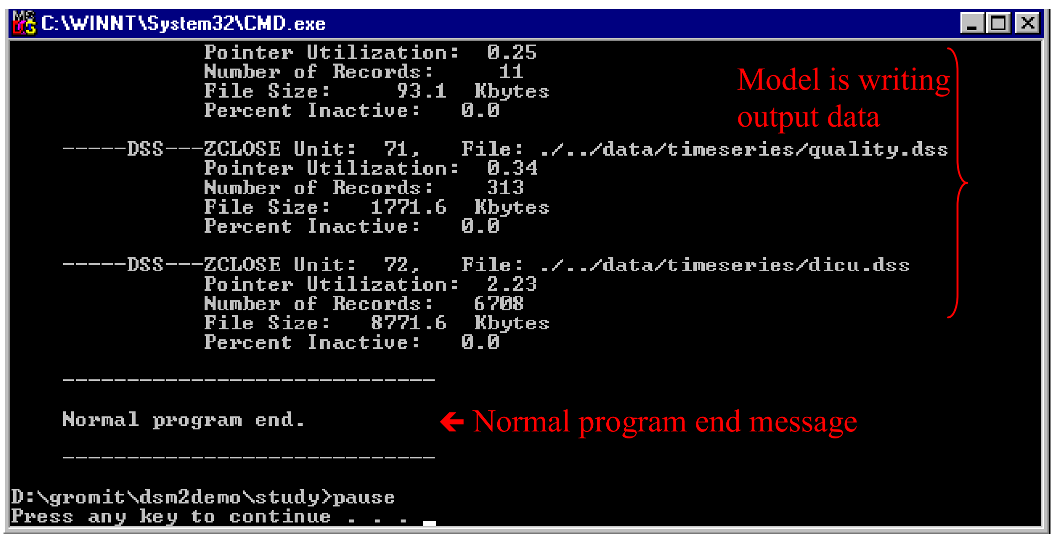
   A DOS shell will open and the first line will echo the command to run QUAL that is listed in the batch file.




Some introductory information on DSM2 will scroll across the screen. Then text indication the progress of the simulation will appear. Don't worry about the network iterations at a maximum warning. On a dual processor PC with 930Mhz chips and 512MB of RAM, a one-month historical simulation for October 1996 takes approximately 4 minutes.




6. When a QUAL simulation finishes, the DOS prompt window remains open due to the pause command in the batch file. If the simulation ran correctly, a Normal program end message will appear near the bottom of the DOS window. Press any key to exit the DOS window.




7. Congratulations, you just completed a successful QUAL run.

### 5.12.2 Examining Output from the QUAL Tutorial Simulation

To examine the output from the QUAL simulation for October 1996:

1. On your PC, go to the directory ***dsm2demo/study/output***.
2. Notice that the output files created were:
   - qual-daily-oct96.txt Daily EC text output
   - qual-hourly-oct96.txt Hourly EC text output
   - qual-oct96.dss DSS EC time series output file
   - qual-oct96.out Screen output file
   - qual-rst-oct96.out Text restart file
3. To view the text output for 15-minute and hourly simulated EC concentrations, double click on the qual-hourly-oct96.txt icon. A sample of the text hourly EC output file is shown in Figure 5-11. Data are listed in a single column. DSS style pathname headings separate the data from the various output locations. For this tutorial, output are provided at four locations (Antioch, Rio Vista, San Joaquin River at Brandt Bridge and Old River at Clifton Court Ferry - Figure 4-11). The simulated 15-minute or hourly EC concentrations have been plotted in Excel and are shown in Figure 5-12. Red lines indicate the daily average output from QUAL. This is not analogous to the 25 hour running averages that were computed as part of the post processing of the HYDRO results to estimate average flow values over the 24hr 50min tidal cycle.
4. To view the text output for daily average simulated EC, double click on the qual-daily-oct96.txt icon. A sample of the text daily average EC output file is shown in Figure 5-13. Data are listed in a single column. DSS style pathname headings separate the data from the various output locations. For this tutorial, output are provided at four locations (Antioch, Rio Vista, San Joaquin River at Brandt Bridge and Old River at Clifton Court Ferry - Figure 4-11). The simulated daily average EC concentrations have been plotted in Excel and are shown in Figure 5-12. Red lines indicate the daily average output from QUAL. This is not analogous to the 25 hour running averages that were computed as part of the post processing of the HYDRO results to estimate average flow values over the 24hr 50min tidal cycle.

```
/DSM2-QUAL-6.2+CHAN/RSAN007/EC//15MIN/FROM-ALL/ ← DSS style pathname that indicates location, type of data, and data interval
UMHOS/CM ← Data units
INST-VAL ← Data are instantaneous values
03OCT1996 2400  3.364E+03
04OCT1996 0015  2.844E+03
04OCT1996 0030  2.844E+03
04OCT1996 0045  2.844E+03
04OCT1996 0100  2.787E+03    Antioch 15-minute EC data
• • •  Several lines omitted for illustration purposes • • •
31OCT1996 2300  4.564E+03
31OCT1996 2315  4.344E+03
31OCT1996 2330  4.214E+03
31OCT1996 2345  4.061E+03
31OCT1996 2400  3.861E+03
01NOV1996 0015   0.00
/DSM2-QUAL-6.2+CHAN/RSAN072/EC//15MIN/FROM-ALL/ ← DSS style pathname that indicates location, type of data, and data interval
UMHOS/CM ← Data units
INST-VAL ← Data are instantaneous values
03OCT1996 2400   516.
04OCT1996 0015   516.
04OCT1996 0030   516.
04OCT1996 0045   516.        SJR at Brandt Bridge 15-minute EC data
04OCT1996 0100   516.
• • •  Several lines omitted for illustration purposes • • •
31OCT1996 2300   458.
31OCT1996 2315   458.
31OCT1996 2330   458.
31OCT1996 2345   458.
31OCT1996 2400   458.
01NOV1996 0015   0.00
/DSM2-QUAL-6.2+CHAN/ROLD040/EC//15MIN/FROM-ALL/ ← DSS style pathname that indicates location, type of data, and data interval
UMHOS/CM ← Data units
INST-VAL ← Data are instantaneous values
03OCT1996 2400   254.
04OCT1996 0015   254.
04OCT1996 0030   254.
04OCT1996 0045   255.
04OCT1996 0100   255.        Old R at CC Ferry 15-minute EC data
• • •  Several lines omitted for illustration purposes • • •
31OCT1996 2300   340.
31OCT1996 2315   341.
31OCT1996 2330   341.
31OCT1996 2345   341.
31OCT1996 2400   340.
01NOV1996 0015   0.00
/DSM2-QUAL-6.2+CHAN/430_9684/EC//1HOUR/FROM-ALL/ ← DSS style pathname that indicates location, type of data, and data interval
UMHOS/CM ← Data units
INST-VAL ← Data are instantaneous values
03OCT1996 2400   156.
04OCT1996 0100   156.
04OCT1996 0200   156.
04OCT1996 0300   157.        Rio Vista 1 hour EC data
• • •  Several lines omitted for illustration purposes • • •
31OCT1996 2100   150.
31OCT1996 2200   143.
31OCT1996 2300   142.
31OCT1996 2400   141.
```

**Figure 5-11: Sample Text from the Output File qual-hourly-oct96.txt**

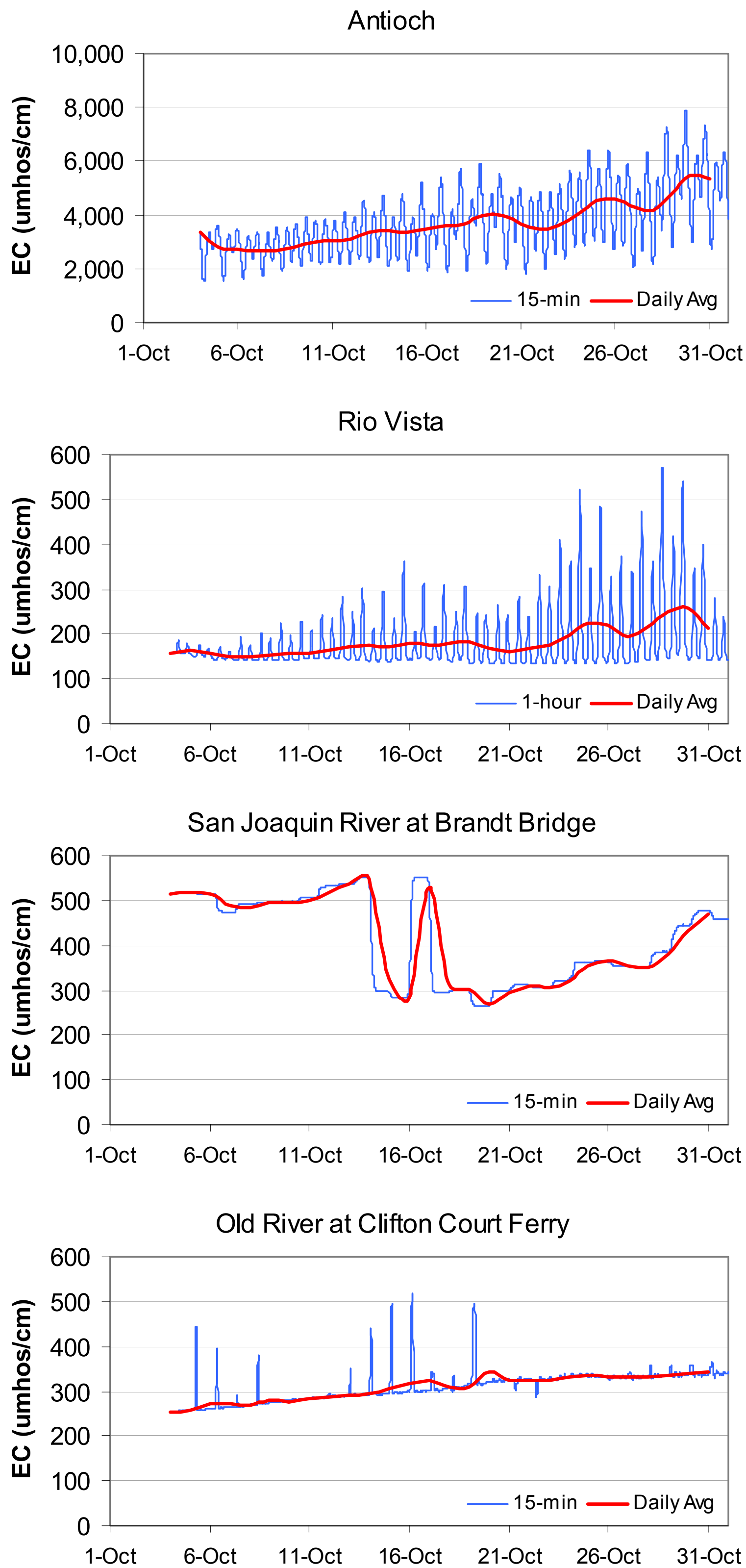


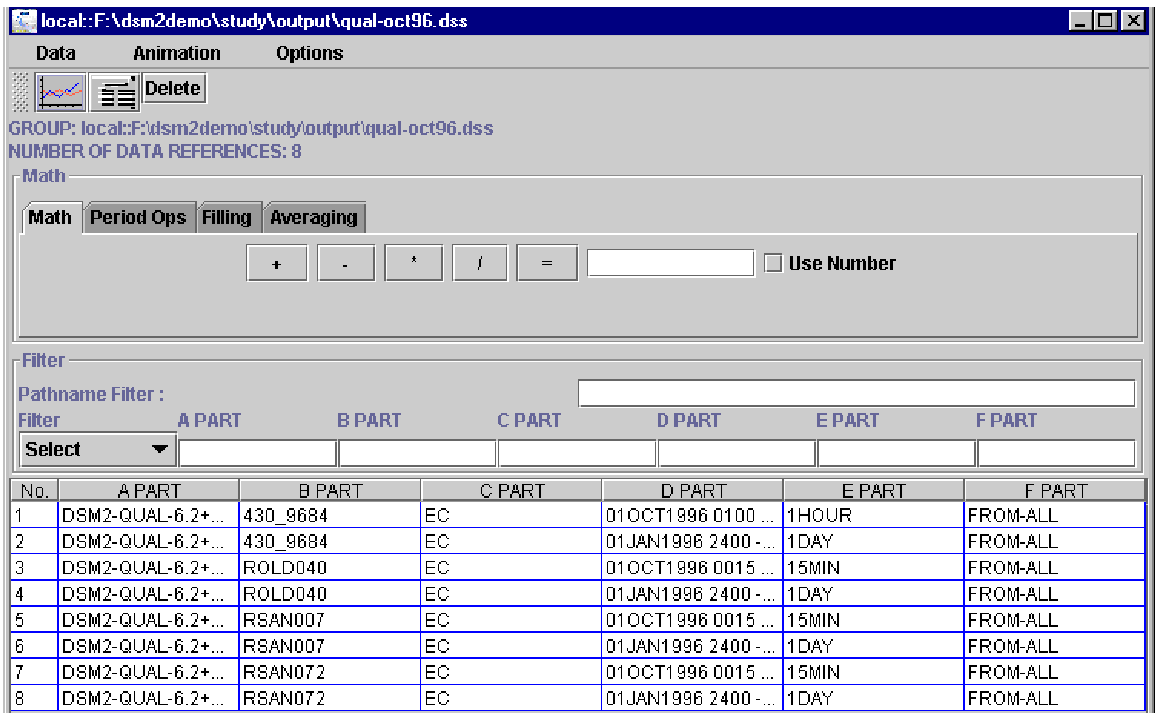

**Figure 5-12: Simulated EC for October 1996**

```
/DSM2-QUAL-6.2+CHAN/430_9684/EC//1DAY/FROM-ALL/ ← DSS style pathname
UMHOS/CM ← Data units                              that indicates location, type
PER-AVER ← Data are period averages                of data, and data interval
03OCT1996 2400   156.
04OCT1996 2400   163.
05OCT1996 2400   157.        Rio Vista daily average EC
• • •  Several lines omitted for illustration purposes • • •
29OCT1996 2400   257.
30OCT1996 2400   212.
31OCT1996 2400   171.
/DSM2-QUAL-6.2+CHAN/RSAN007/EC//1DAY/FROM-ALL/  ← DSS style pathname
UMHOS/CM ← Data units                              that indicates location, type
PER-AVER ← Data are period averages                of data, and data interval
03OCT1996 2400  3.364E+03
04OCT1996 2400  2.790E+03
05OCT1996 2400  2.715E+03    Antioch daily average EC data
• • •  Several lines omitted for illustration purposes • • •
29OCT1996 2400  5.467E+03
30OCT1996 2400  5.342E+03
31OCT1996 2400  4.942E+03
/DSM2-QUAL-6.2+CHAN/RSAN072/EC//1DAY/FROM-ALL/  ← DSS style pathname
UMHOS/CM ← Data units                              that indicates location, type
PER-AVER ← Data are period averages                of data, and data interval
03OCT1996 2400   516.
04OCT1996 2400   517.
05OCT1996 2400   516.        SJR Brandt Bridge daily average EC data
• • •  Several lines omitted for illustration purposes • • •
29OCT1996 2400   431.
30OCT1996 2400   469.
31OCT1996 2400   461.
/DSM2-QUAL-6.2+CHAN/ROLD040/EC//1DAY/FROM-ALL/  ← DSS style pathname
UMHOS/CM ← Data units                              that indicates location, type
PER-AVER ← Data are period averages                of data, and data interval
03OCT1996 2400   254.
04OCT1996 2400   256.
05OCT1996 2400   273.        Old R at CC Ferry daily average EC data
• • •  Several lines omitted for illustration purposes • • •
29OCT1996 2400   338.
30OCT1996 2400   341.
31OCT1996 2400   342.
```

**Figure 5-13: Sample Text from the Output File qual-daily-oct96.txt**

6.

7. Although use of VISTA for analysis of DSS files is beyond the scope of this tutorial, an image of the VISTA window displaying the pathnames from the hydro-oct96.dss file for the flow and stage data for the four output locations used in this tutorial are shown below. Recall that data were saved on a one-hour interval for Rio Vista and on a 15-minute interval for the other four locations. The B Part of the DSS pathname reflects the locations name given in the output.inp file. Since Rio Vista was referred to by a channel number and distance, its name is represented as channel#_distance (430_9684 in this case). The other locations are referred to by their names, which correspond to RKI (River Kilometer Index) values in this case.




## 5.13 Exercises for Modifying the HYDRO Simulation

This section contains exercises that cover some of the common changes made to DSM2 input files. These exercises involve modifying the input files from the October 1996 simulation. For reference, a complete set of input files is provided for each tutorial.

### 5.13.1 Changing the Simulation Period in HYDRO

**Exercises to change the simulation period from Oct96 to Nov96**

- **Cold start**
- **Warm start**

**Files to be changed**

- **dsm2.inp**
- **io.inp**
- **runtime.inp**
- **tide.inp**

For this exercise, we will change the simulation period used in the tutorial from October 1996 to November 1996. Two different methods for running November 1996 will be illustrated in this exercise. In the first method, the simulation period will be changed to November 1996 and the model will be run from a "cold start" (i.e. a constant value is used for the initial conditions ). For the second method, the restart file from the October 1996 simulation will be used to provide the initial conditions, termed a "warm start". For this exercise, the following files will be modified:

- dsm2demo/study/input/qual/dsm2.inp (cold and warm start)
- dsm2demo/study/input/qual/runtime.inp (cold and warm start)
- dsm2demo/study/input/qual/io.inp (cold and warm start)

**Method 1: Cold Start**

1. Run a November 1996 HYDRO simulation (see section 4.21.1). You can use either the warm start or the cold start simulation. For this demonstration, the warm start simulation was utilized.
2. On your PC, go to the directory ***dsm2demo/study/input/qual***
3. [Optional step]. If desired, make backup copies of the files that will be modified during this exercise: dsm2.inp, io.inp, runtime.inp, and tide.inp.
4. Open the dsm2.inp file.
5. Change the value of the environment variable run from oct96 to nov96cs (November 1996 cold start).

```
# DSM2-QUAL input file.
# Grid: 2.0
# UPDATED: 2-14-2002, jamiea
# >>DEMO ONLY<<

# This is the main input file; other input files
# are specified here.

ENVVARS
NAME          VALUE
RUN           nov96cs
GRID          ./../data/grid
TIMESERIES    ./../data/timeseries
IRREG         $GRID/irreg
DSSOUT        ./output/qual-$RUN.dss
HRTXTOUT      ./output/qual-hourly-$RUN.txt
DAYTXTOUT     ./output/qual-daily-$RUN.txt
END
• • •  Rest of the file omitted for illustration purposes • • •
```

6. Save and close the dsm2.inp file.

7. Open the file io.inp
8. Delete the input restart file line from the io.inp file.

```
# I/O filenames
IO_FILES
MODEL    TYPE        IO     INTERVAL      FILENAME
output   none        none   none          ./output/qual-$RUN.out
qual     restart     out    1day          ./output/qual-rst-$RUN.out
qual     restart     in     none          ./output/qual-oct4.rst
END
```

9. Save and close the io.inp file.
10. Open the file runtime.inp.
11. Change run_start_date to 01NOV1996 and change run_end_date to 30NOV1996.

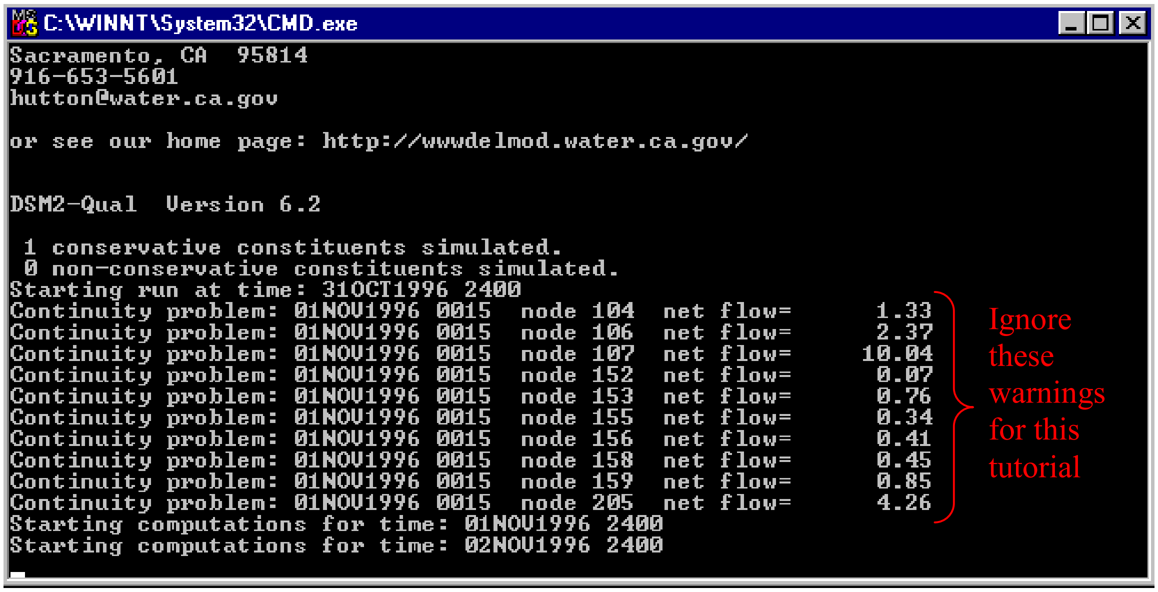
```
# DSM2 input file
# Simulation run time Nov 1, 1996-Nov 30, 1996

# Run start and end times
SCALAR
run_start_date  01NOV1996
run_start_time  0000
run_end_date    30NOV1996  # if used, comment out run_length
run_end_time    2400
END
```

12. Save and close the runtime.inp file.
13. Open the file tide.inp
14. Change the input HYDRO binary results file to the file from the November 1996 simulation (hydro-nov96ws.htf).

```
TIDEFILE
START_DATE    END_DATE      FILENAME
runtime       length        ./output/nov96ws/hydro-nov96ws.htf
END
```

15. Save and close the tide.inp file.
16. On your PC, go to the directory ***dsm2demo/study***.
17. To run QUAL, double click on the qual.bat icon.
18. Notice on the screen that the simulation starts on 31OCT1996 2400 (which is the same as 01NOV1996 000). There will be several warnings about continuity problems at certain nodes in the DSM2 grid. For this tutorial, ignore those warnings.




19. When a QUAL simulation finishes, press any key to exit the DOS window.
20. On your PC, go to the directory ***dsm2demo/study/output***. The newly created output files are:
    - qual-daily-nov96cs.txt  Daily EC text output
    - qual-hourly-nov96cs.txt  Hourly EC text output
    - qual-nov96cs.dss  DSS EC time series output file
    - qual-nov96cs.out  Screen output file
    - qual-rst-nov96cs.out  Text restart file
21. The simulation results in the text output files can be put in Excel and plotted. The simulated EC concentrations are shown in Figure 5-14. Note that at all four locations the EC concentrations for the cold start begin at 100 umhos/cm as specified in the scalar.inp input file. These simulation results can be compared to the results from October 1996 (Figure 5-12).

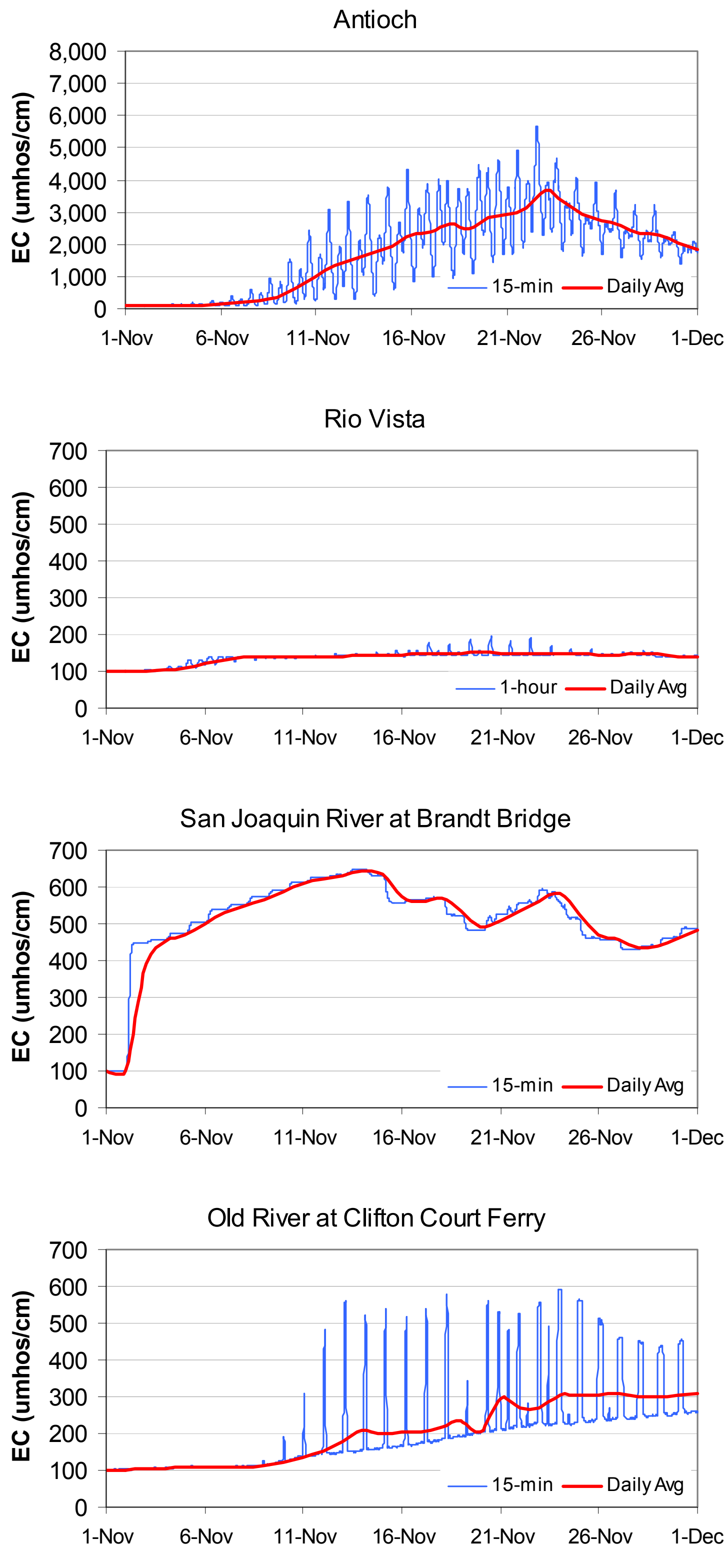



**Figure 5-14: Simulated Flows for November 1996-Cold Start**

**Method 2: Warm Start**

1. Run a November 1996 HYDRO simulation (see section 4.21.1). You can use either the warm start or the cold start simulation. For this demonstration, the warm start simulation was utilized.
2. On your PC, go to the directory ***dsm2demo/study/input/qual***
3. [Optional step]. If desired, make backup copies of the files that will be modified during this exercise: dsm2.inp, io.inp, runtime.inp, and tide.inp.
4. Open the dsm2.inp file.
5. Change the value of the environment variable run from oct96 to nov96ws (November 1996 warm start).

```
# DSM2-QUAL input file.
# Grid: 2.0
# UPDATED: 2-14-2002, jamiea
# >>DEMO ONLY<<

# This is the main input file; other input files
# are specified here.

ENVVARS
NAME          VALUE
RUN           nov96ws
GRID          ./../data/grid
TIMESERIES    ./../data/timeseries
IRREG         $GRID/irreg
DSSOUT        ./output/qual-$RUN.dss
HRTXTOUT      ./output/qual-hourly-$RUN.txt
DAYTXTOUT     ./output/qual-daily-$RUN.txt
END
• • •  Rest of the file omitted for illustration purposes • • •
```

6. Save and close the dsm2.inp file.
7. Open the file io.inp
8. Set the input restart file to the restart file from the October 1996 simulation (qual-rst-oct96.out).

```
# I/O filenames
IO_FILES
MODEL    TYPE       IO     INTERVAL      FILENAME
output   none       none   none          ./output/qual-$RUN.out
qual     restart    out    1day          ./output/qual-rst-$RUN.out
qual     restart    in     none          ./output/qual-rst-oct96.out
END
```

9. Save and close the io.inp file.
10. Open the file runtime.inp.

11. Change run_start_date to 01NOV1996 and change run_end_date to 30NOV1996. Note: this is identical to the change made for the cold start simulation.

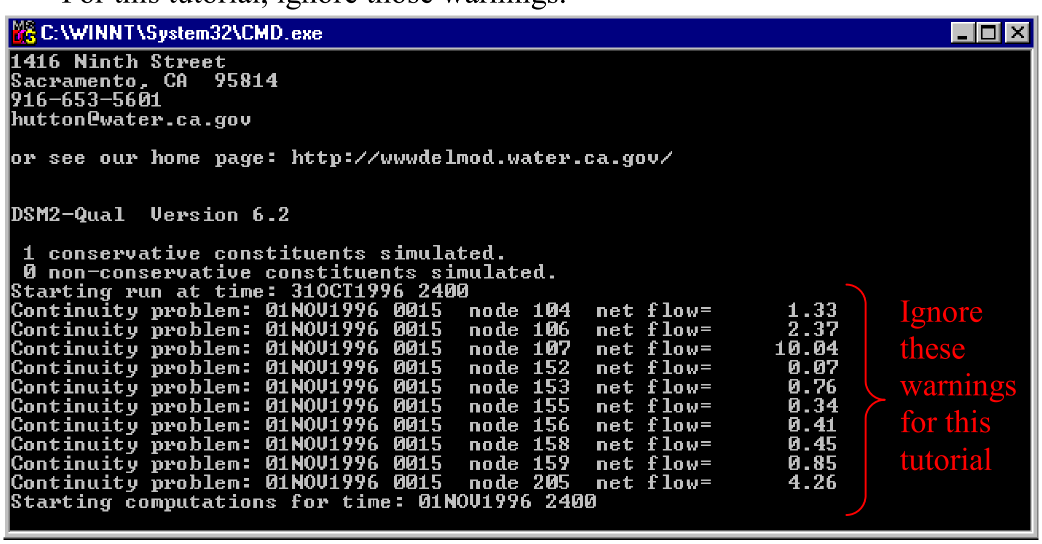
```
# DSM2 input file
# Simulation run time Nov 1, 1996-Nov 30, 1996

# Run start and end times
SCALAR
run_start_date  01NOV1996
run_start_time  0000
run_end_date    30NOV1996  # if used, comment out run_length
run_end_time    2400
END
```

12. Save and close the runtime.inp file.
13. Open the file tide.inp
14. Change the input HYDRO binary results file to the file from the November 1996 simulation (hydro-nov96ws.htf). Note: this is identical to the change made for the cold start simulation.

```
TIDEFILE
START_DATE    END_DATE      FILENAME
runtime       length        ./output/nov96ws/hydro-nov96ws.htf
END
```

15. Save and close the tide.inp file.
16. On your PC, go to the directory ***dsm2demo/study***.
17. To run QUAL, double click on the qual.bat icon.
18. Notice on the screen that the simulation starts on 31OCT1996 2400 (which is the same as 01NOV1996 000). There will be several warnings about continuity problems at certain nodes in the DSM2 grid. For this tutorial, ignore those warnings.



19. When a QUAL simulation finishes, press any key to exit the DOS window.
20. On your PC, go to the directory ***dsm2demo/study/output***. The newly created output files are:
    - qual-daily-nov96ws.txt Daily EC text output
    - qual-hourly-nov96ws.txt Hourly EC text output
    - qual-nov96ws.dss DSS EC time series output file
    - qual-nov96ws.out Screen output file
    - qual-rst-nov96ws.out Text restart file
21. The simulation results in the text output files can be put in Excel and plotted. The simulated EC concentrations are shown in Figure 5-15. These simulation results can be compared to the results from October 1996 (Figure 5-12) and the cold start results for November 1996 (Figure 5-14).

**Comparison of simulation results**

The simulation results from text output files for the cold and warm start exercises can be plotted in Excel and compared. For comparison purposes, the cold start results were subtracted from the warm start results. EC differences for the four output locations are shown in Figure 5-16. Note that significant differences in the simulation results occur depending on if a warm start or a cold start is used. This is different from the results of the HYDRO simulation (Figure 4-29 and Figure 4-30) which gave the same results after a short warm up period of a few days. Water quality results require a longer time to reach appropriate values than hydrodynamic results.

In the Delta depending on conditions this warm-up period can vary from two to six months. To create the restart file used in the October 1996 simulation (qual-oct4.rst), HYDRO and QUAL simulations were run for June 1, 1996 0:00-October 3, 1996 24:00. The file qual-oct4.rst was the output restart file generated from the QUAL simulation from June1, 1996-October 3, 1996. As an advanced exercise, create the HYDRO and QUAL simulations necessary to create a restart file for October 4$^{th}$, 1996. Recall that October 4$^{th}$ was selected as the start date of the QUAL simulation to allow for the 3-day warm-up period in HYDRO October 1996 simulation that used a cold start. If a HYDRO restart file had been available for October 1, 1996, the 3-day delay in the QUAL simulation would not have been necessary.

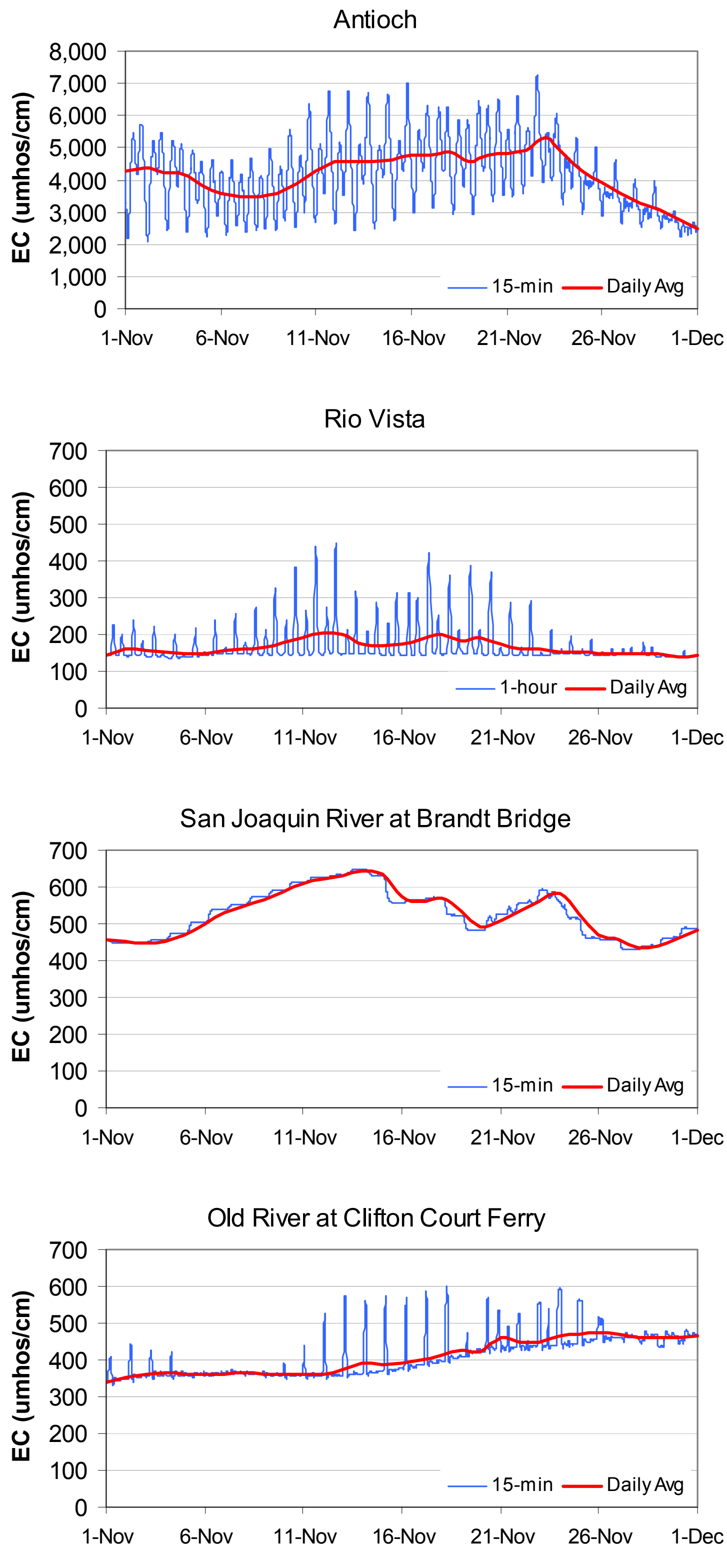



**Figure 5-15: Simulated Flows for November 1996-Warm Start**

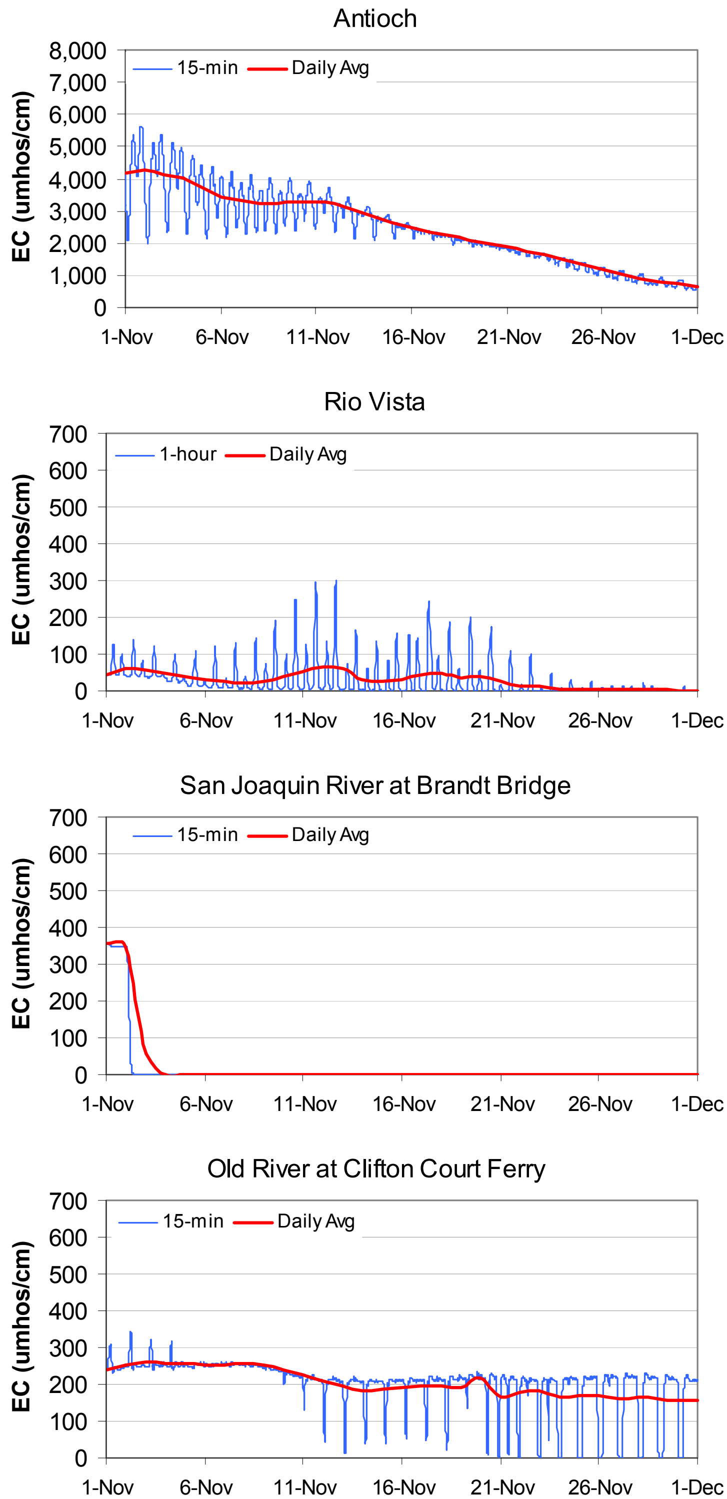



**Figure 5-16: Differences in Simulated EC for November 1996- Warm Start Minus Cold Start**

# 6 **Appendix A:** Background Topics

This appendix provides brief reviews of concepts that aid in the understanding of DSM2 input files.

## 6.1 Environment Variables

DSM2 allows for the use of environment variables. Environment variables allow the user to define a variable, known as an environment variable, once in the main input file. The environment variable can then be referred to in the other input files. Environment variables can be upper or lower case. Common uses of environment variables include specification of file path names and file suffixes or prefixes that refer to the study name. Names utilized for environment variables can be selected by the user. An example of environment variable declarations in a DSM2 input file is given in Figure 6-1.

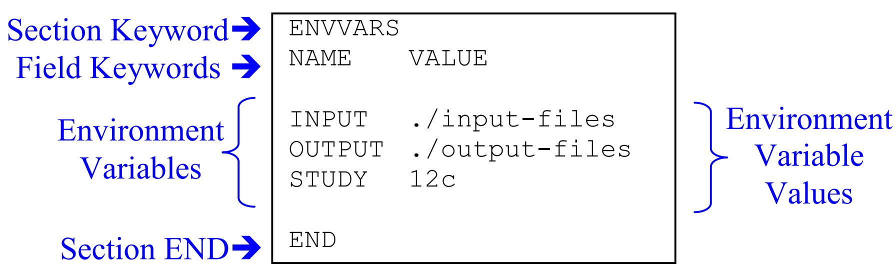



**Figure 6-1: Example of Environment Variable Declarations**

In Figure 6-1, three environment variables are declared: INPUT, OUTPUT, and STUDY. INPUT refers to the directory "`./input-files`" which would be a directory named `input-files` located in the current directory (indicated by the "./"). Similarly OUTPUT refers to the directory "`./output-files`" which would be a directory named `output-files` located in the current directory (indicated by the "./"). The environment variable STUDY is a text identifier for a particular simulation, "`12c`" in this case.

The user may select the text to be used as an environment variable. If more than one environment variable is desired that contains the same starting characters, the variables must be specified in order with the variable with the fewest common characters first, the variable with the second fewest common characters next, etc. For example, if it were desired to use the environment variables OUTPUT, OUTPUT1, OUTPUT2, and OUTPUT12, the environment variable OUTPUT would have to be listed first, the variable OUTPUT1 listed second, followed by OUTPUT2 and OUTPUT 12 in any order. Declarations of the environment variables OUTPUT, OUTPUT1, OUTPUT2, and OUTPUT12 are given in Figure 6-2. In this example, the environment variables represent output files named output.txt, output1.txt, output2.txt and output12.txt. The environment variables are declared in the correct order in Figure 6-2A. For the declarations given in Figure 6-2A, the environment variables would be interpreted by DSM2 as OUTPUT represents a file named output.txt, OUTPUT1 represents a file named output1.txt, OUTPUT2 represents a file named output2.txt, and OUTPUT12 represents a file named output12.txt. However, if the environment variables are declared in the incorrect order, they can be misinterpreted by DSM2. In Figure 6-2B, DSM2 would interpret the environment variables OUTPUT12, OUTPUT1, and OUTPUT all to represent a file named output12.txt. Since the variables OUTPUT1 and OUTPUT consist of characters that are completely represented by the previously declared variable OUTPUT12 (**OUTPUT1**2 and **OUTPUT**12), DSM2 does not properly recognize those variables. However, since the variable OUTPUT2 is not completely contained in the previously defined OUTPUT12, its value is properly assigned as the file name output2.txt.

A) Correct Order for Variable Declarations

```
ENVVARS
NAME     VALUE
OUTPUT   output.txt
OUTPUT1  output1.txt
OUTPUT2  output2.txt
OUTPUT12 output12.txt
END
```

B) Incorrect Order for Variable Declarations

```
ENVVARS
NAME     VALUE
OUTPUT12 output12.txt
OUTPUT2  output2.txt
OUTPUT1  output1.txt
OUTPUT   output.txt
END
```

**Figure 6-2: Order of Environment Variable Declarations**

The environment variables can be utilized in any of the input files. Environment variables are denoted with a dollar sign ($), and may optionally be surrounded with parentheses or curly braces, for example: $STUDY, $(STUDY), ${STUDY}. Environment variables are replaced with value assigned to them in the main DSM2 input file. Examples of use of environmental variables in input files are given in Figure 6-3 and Figure 6-4.

In Figure 6-3, flow data for 9 locations are provided in DSS format. Information under the field keywords `a_part` through `priority` indicate information related to how the data are stored in DSS and how they will be utilized in DSM2 (this will be covered elsewhere in the manual). Under

Section Keyword → INPUTPATHS
Field Keywords → name … filename
Specified Flows (sac … nb)
File Containing Flow Data ($INPUT/flow.dss)
Section END → END

```
INPUTPATHS
name      a_part       b_part    c_part    e_part   f_part        fillin    priority     filename

sac       MERGED+CHAN RSAC155   FLOW      1DAY     DWR-DMS-DSM2 last      0            $INPUT/flow.dss
sjr       MERGED+CHAN RSAN112   FLOW      1DAY     DWR-DMS-DSM2 last      0            $INPUT/flow.dss
moke      MERGED+CHAN RMKL070   FLOW      1DAY     DWR-DMS-DSM2 last      0            $INPUT/flow.dss
csmr      MERGED+CHAN RCSM075   FLOW      1DAY     DWR-DMS-DSM2 last      0            $INPUT/flow.dss
yolo      MERGED+CHAN BYOLO040  FLOW      1DAY     DWR-DMS-DSM2 last      0            $INPUT/flow.dss
ccc       MERGED+CHAN CHCCC006  FLOW      1DAY     DWR-DMS-DSM2 last      0            $INPUT/flow.dss
cvp       MERGED+CHAN CHDMC004  FLOW      1DAY     DWR-DMS-DSM2 last      0            $INPUT/flow.dss
swp       MERGED+CHAN CHSWP003  FLOW      1DAY     DWR-DMS-DSM2 last      0            $INPUT/flow.dss
nb        MERGED+CHAN SLBAR002  FLOW      1DAY     DWR-DMS-DSM2 last      0            $INPUT/flow.dss

END
```

**Figure 6-3: Example of Use of the Environment Variable INPUT**

Section Keyword → OUTPUTPATHS
Field Keywords → CHAN … FILENAME
Desired Output
Output File Names
Section END → END

```
OUTPUTPATHS
CHAN      DIST         TYPE         INTERVAL     PERIOD       FILENAME
# Sac River@Green's Landing
418       4814         FLOW         15MIN        INST_VAL     ${OUTPUT}/flow-${STUDY}.dss
418       4814         STAGE        15MIN        INST_VAL     ${OUTPUT}/stage-${STUDY}.dss
# Clifton Court Forebay Gates
82        length       FLOW         15MIN        INST_VAL     ${OUTPUT}/flow-${STUDY}.dss
82        length       STAGE        15MIN        INST_VAL     ${OUTPUT}/stage-${STUDY}.dss
#DMC intake (DMC at Tracy Pumping Plant)
216       0            FLOW         15MIN        INST_VAL     ${OUTPUT}/flow-${STUDY}.dss
216       0            STAGE        15MIN        INST_VAL     ${OUTPUT}/stage-${STUDY}.dss
# San Joaquin River at Brandt Bridge
10        9400         FLOW         15MIN        INST_VAL     ${OUTPUT}/flow-${STUDY}.dss
10        9400         STAGE        15MIN        INST_VAL     ${OUTPUT}/stage-${STUDY}.dss
END
```

**Figure 6-4: Example of Use of the Environment Variables OUTPUT and STUDY**

the field keyword `filename`, the environment variable INPUT is utilized to indicate that the input flow data are located in the file $INPUT/flow.dss. Using the definition for the environmental variable given in Figure 6-1, the path to the input flow data file is `./input-files/flow.dss`. This path would be interpreted as the file `flow.dss` is located in a subdirectory `input-files`. The directory `input-files` is located in the current directory (indicated by the "`./`").

Example of use of environment variables OUTPUT and STUDY are shown in Figure 6-4. The input file in Figure 6-4 indicates desired model output at four locations. At each location, fifteen-minute flow and stage outputs are specified. Under the field keyword `FILENAME`, the names of the output files are specified. In this example, two output files are specified, one for flow output and one for stage output.

Environment variables can be specified in any input file. Typically the environment variables are defined in the main input file (dsm2.inp) or in the CALSIM input file (calsim.inp).

## 6.2 DSS Information

The Hydrologic Engineering Center (HEC) developed a database for time series data known as the Hydrologic Engineering Center Data Storage System (HEC-DSS or just DSS). Time varying input data for DSM2 is specified in DSS format.

In DSM2, the DSS pathname parts are typically assigned the following values:

| | |
|---|---|
| A PART | Typically a text string that may indicate information such as the type of data or the scenario associate with the data. |
| B PART | Typically a location name, node number, or channel number. |
| C PART | Typically indicates the type of data. |
| D PART | Typically indicates the starting date for the time series data. |
| E PART | Typically indicates the time interval of time series data. |
| F PART | Typically a text string that indicates the study name or the source of the data. |

### 6.2.1 DSS Viewing Tools

The Department of Water Resources has developed a tool for viewing and manipulating data in DSS called VISTA. Information on VISTA is available at http://modeling.water.ca.gov/delta/models/dsm2/tools/vista/index.html.The Hydrologic Engineering Center has developed several tools for viewing, manipulating, and creating DSS files. See HEC's DSS web site for further details http://www.hec.usace.army.mil/software/software_distrib/hec-dss/hecdssprogram.html.

### 6.2.2 Links to DSS Information on the Internet

An overview of DSS: http://www.hec.usace.army.mil/publications/pubs_distrib/dss/overview.pdf

DSS documentation: http://www.hec.usace.army.mil/publications/pubs_distrib/dss/hecdss.html

DSS download: http://www.hec.usace.army.mil/software/software_distrib/hec-dss/hecdssprogram.html

Time series data for the Sacramento San Joaquin Delta system in DSS format for use with DSM2: http://www.iep.ca.gov/dss/

## 6.3 Text Input File Pathname Priorities

Input data for a specific variable at a specific location may be provided in DSM2 from more than one source. However, only a single value will be used for a given time step. Thus, the priority of these data sets must be specified by assigning a priority to the pathname that refers to each data set. Pathname priorities are specified as an integer between 0 and N. Lower numbers indicate higher priorities, for example a "1" indicates first priority, a "2" indicates second priority, etc. If a higher priority (lower number) is specified for a data path, then that data is used when it is available. If data are missing or bad in that path, then data for the next lower priority (next higher number) path at the same location will be used to replace the missing or bad data. If no data are specified for a specific time during the model simulation, DSM2 will not run. Paths are assumed to be at the same location if they are at the same object (node, channel, or reservoir). This allows for filled-in data to automatically be used from a separate pathname, without having to create a single path for a location. A priority of 0 means ignore the priority system and always use the specified path. See Figure 6-5 for an illustration of the DSM2 regular time series input path priorities.

## 6.4 VISTA: DSS File Viewer and Data Analysis Tool

The Department of Water Resources has developed a tool for viewing and manipulating data in DSS called VISTA. Information on VISTA is available at http://modeling.water.ca.gov/delta/models/dsm2/tools/vista/index.html.

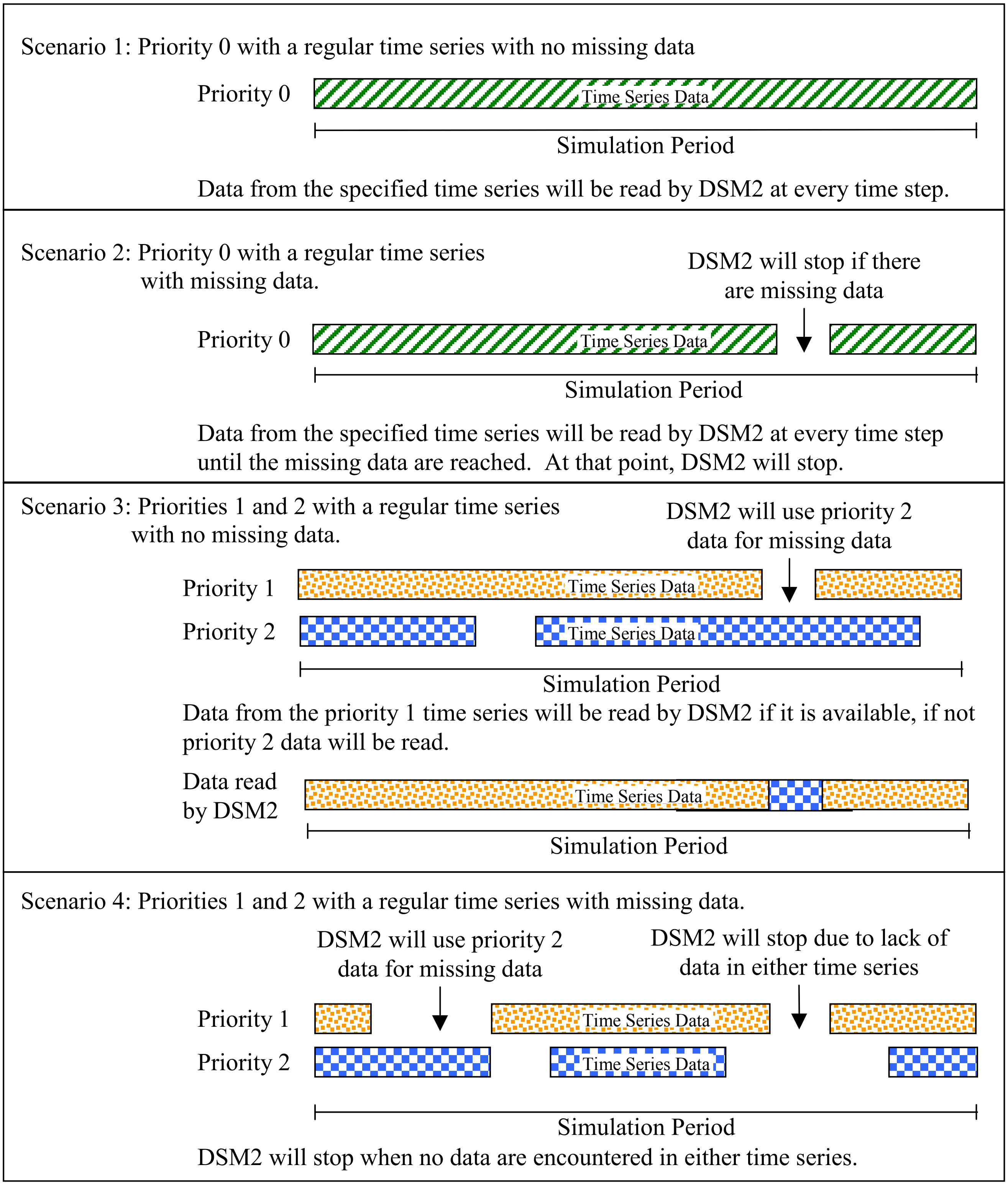



**Figure 6-5: DSM2 Regular Time Series Priorities**

## 6.5 Gates: An introduction to modeling flow barriers in DSM2

**Gate: In DSM2 a gate is defined as a barrier to flow.**

**Gates are assigned to DSM2 nodes.**

In DSM2 a gate is defined as a barrier to flow. Thus the term gate refers to devices such as weirs. A weir (gate) can either span the entire length of the channel, or a weir can have a rectangular notch. For a notched weir, flow can only pass through the notched area. Flow passes over a weir only when the water surface elevations exceed the crest elevation. The width of the weir is specified for both the upstream and downstream sides of the weir. Although the upstream and downstream widths are often identical in DSM2, the values can differ. The upstream and downstream sides of a weir are defined by the upstream and downstream designations for each channel in the ***dsm2demo/data/grid/channels.inp*** file. Flow over the weir is controlled by flow coefficients ranging from zero (closed) to 1 (fully open).

In addition to allowing flow to pass over a weir (gate), flow may pass through a weir if the weir contains pipes (culverts). A weir can contain any number of pipes, but all of the pipes in a weir must be identical in size and vertical placement. Pipes may be either open or closed. Flow through pipes is controlled by flow coefficients ranging from zero (closed) to 1 (fully open).

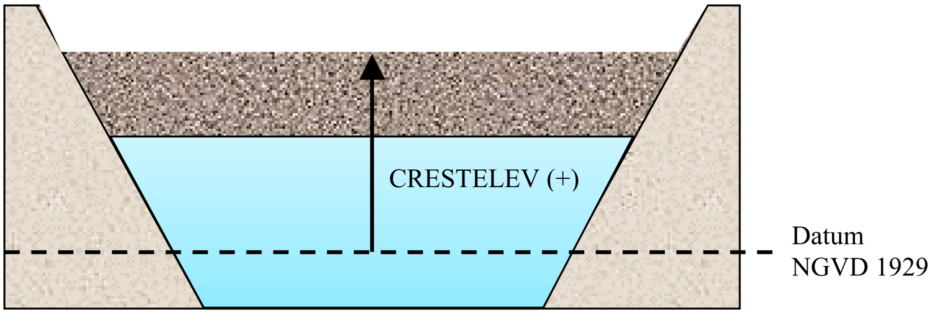
**Pipe: In DSM2 a pipe is defined as a conduit (culvert) that allows flow to pass through a barrier (gate).**

Four gate configurations have been chosen for illustration purposes:

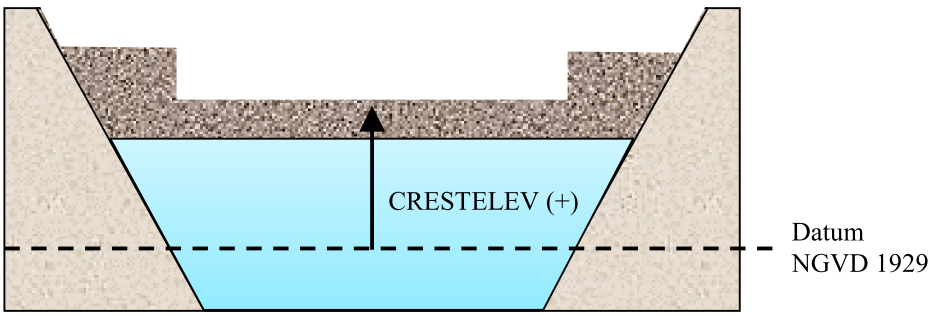
- A weir type gate that extends across the entire width of the channel
- A notched weir type gate
- A weir type gate that extends across the entire width of the channel with three pipes
- A notched weir type gate with two pipes

The number of pipes selected is strictly for illustration purposes. Required input parameters for the gates such as crest elevation are also included in the illustrations. Profile views of the four illustrative gates with the datum located below the crest are given in Figure 6-6 and with the datum above the crest are presented in Figure 6-7. However the most common configuration in the Delta is the case where the datum is located below the crest elevation and above the pipe invert elevation. This case is shown in Figure 6-8. Plan views of the illustrative gates are shown in Figure 6-9.

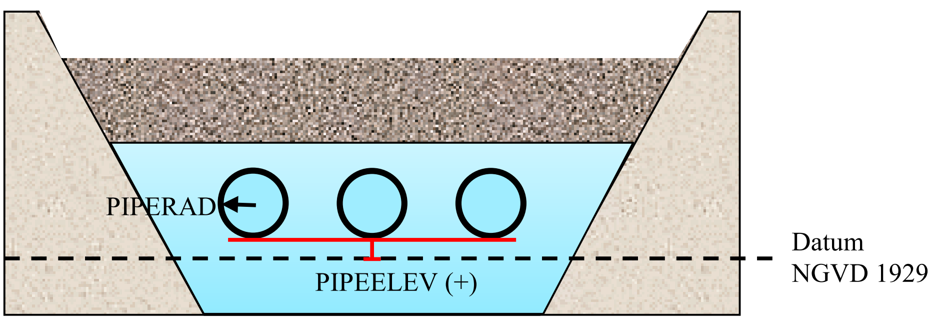
A table of typical gate configurations used in DSM2 studies is presented in the HYDRO tutorial in Table 4-1.



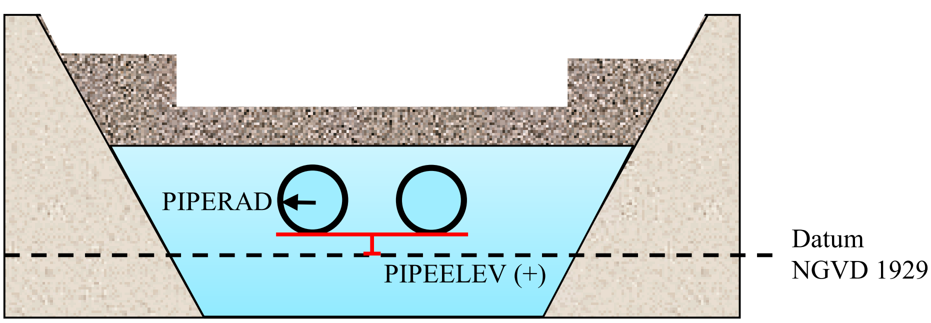

Full Width Weir Gate




Notched Weir Gate

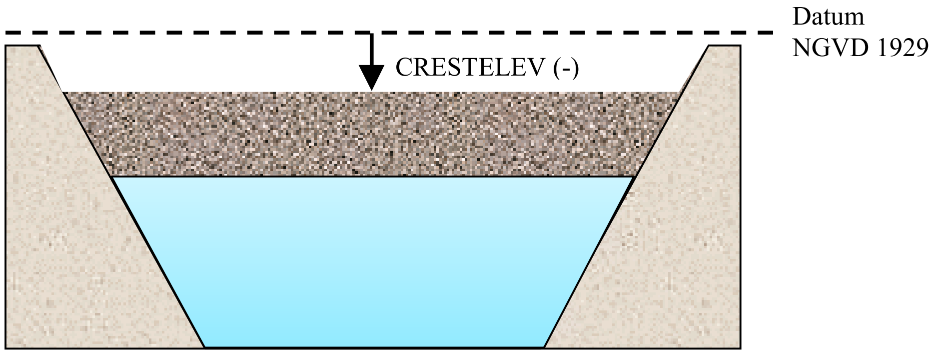



Full Width Weir Gate with 3 Pipes

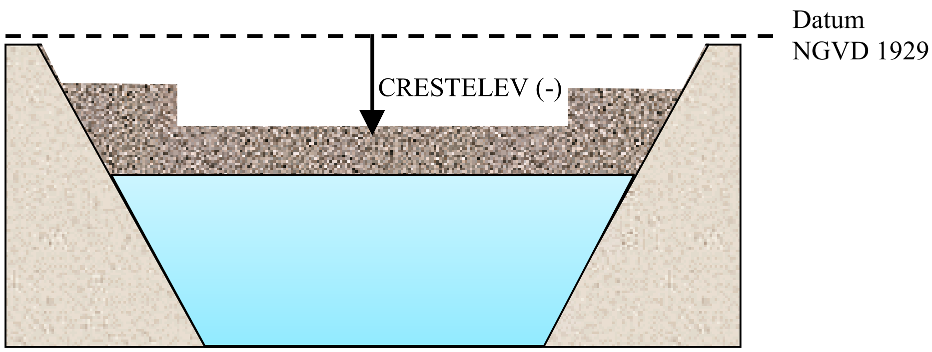



Notched Weir Gate with 2 Pipes

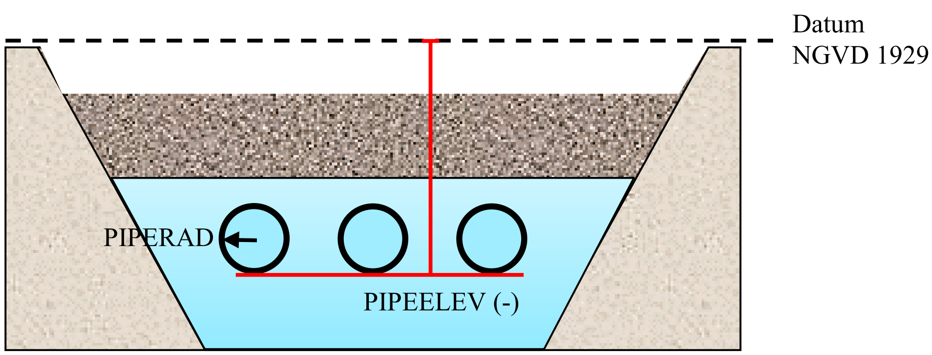
**Figure 6-6: Profile View of Gates with Datum Below the Gate Crest**



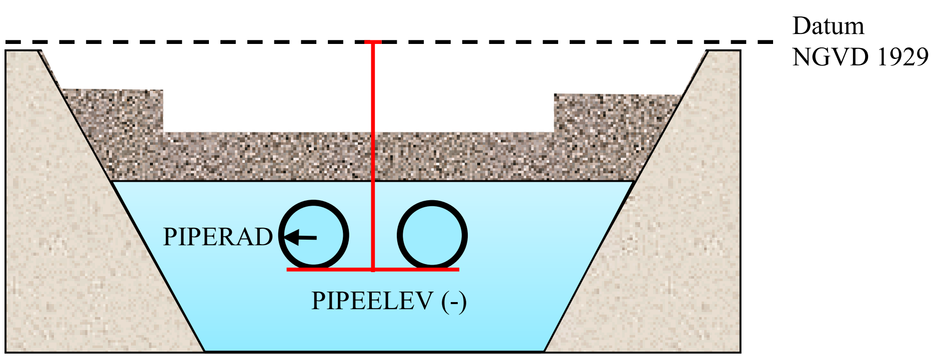

Full Width Weir Gate




Notched Weir Gate

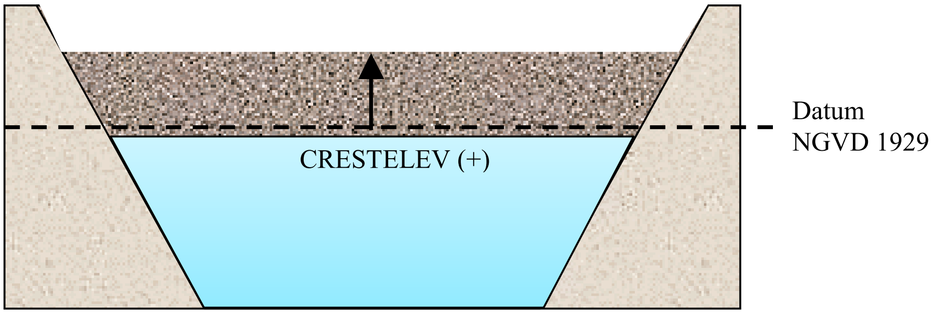



Full Width Weir Gate with 3 Pipes

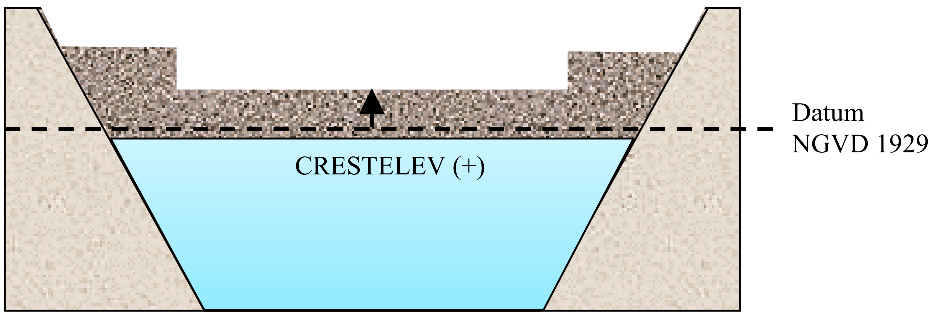



Notched Weir Gate with 2 Pipes

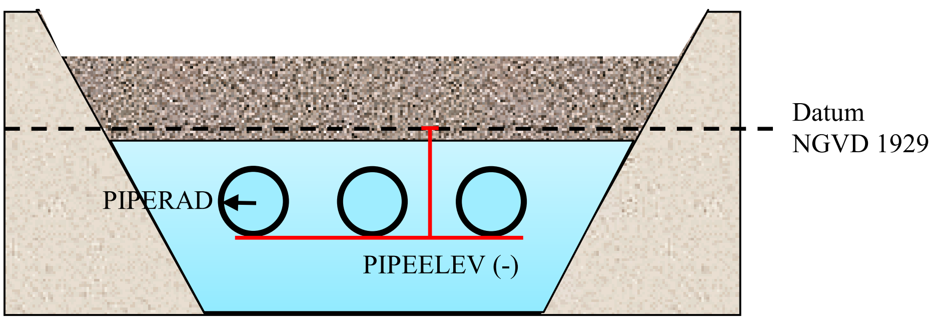
**Figure 6-7: Profile View of Gates with Datum Above the Gate Crest**



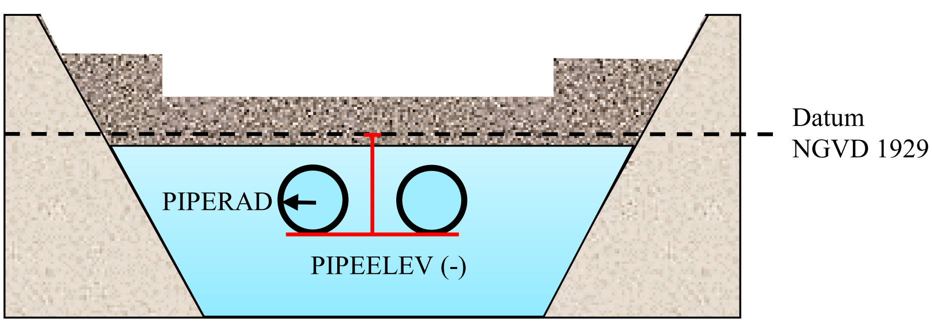

Full Width Weir Gate




Notched Weir Gate




Full Width Weir Gate with 3 Pipes




Notched Weir Gate with 2 Pipes

**Figure 6-8: Profile View of Gates with Datum between the Gate Crest and the Pipes (Common in the Delta)**

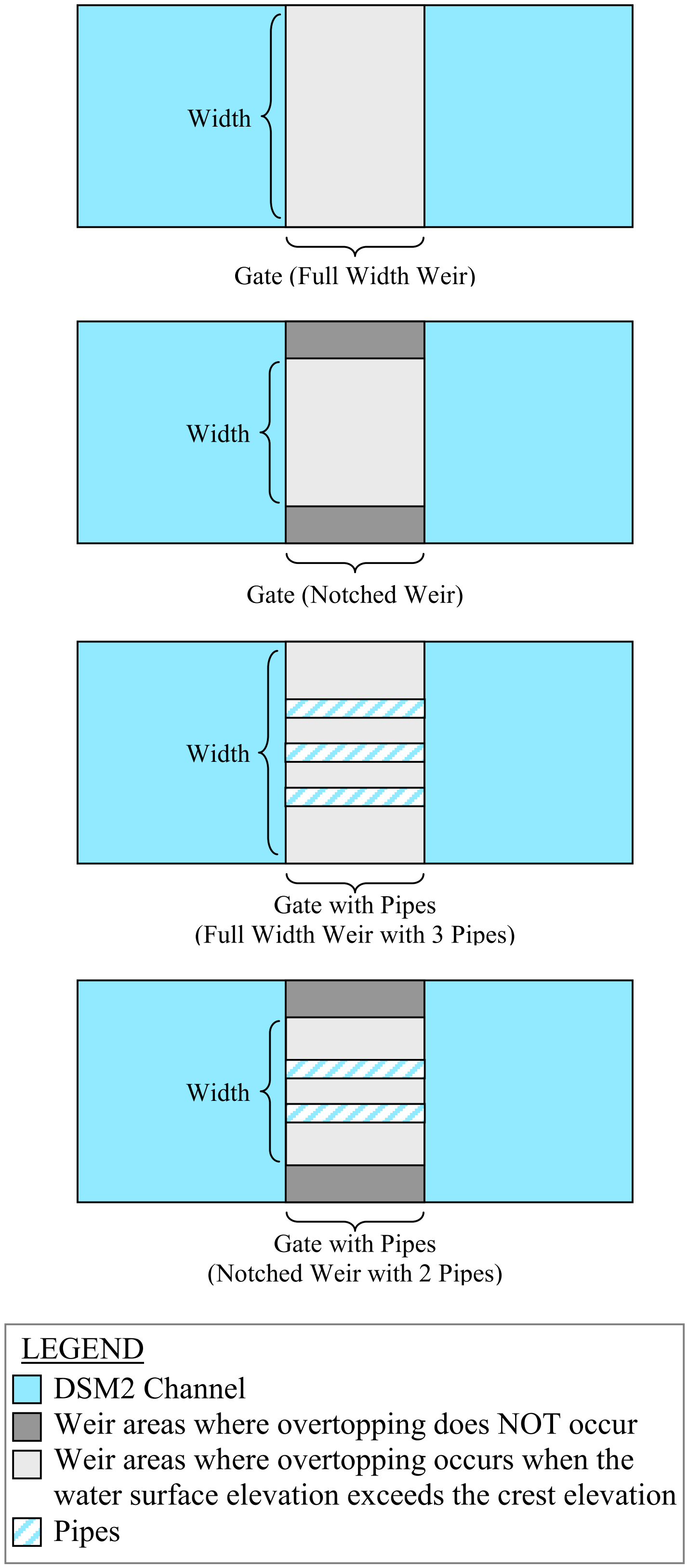



**Figure 6-9: Plan View of DSM2 Gates**

# 7 Appendix B: Acronyms and Abbreviations

Table 7-1 appendix provides a list of acronyms and abbreviations used in this tutorial.

**Table 7-1 : Acronyms and Abbreviations**

| Acronym or Abbreviation | Definition |
|---|---|
| ANN | Artificial Neural Network |
| CCWD | Contra Costa Water District |
| CDEC | California Data Exchange Center |
| COE | United States Army Corps of Engineers |
| CSDP | Cross Section Development Program- used to view bathymetry data |
| DICU | Delta Island Consumptive Use |
| DO | Dissolved Oxygen |
| DSM2 | Delta Simulation Model II-one-dimensional hydrodynamic, water quality, and particle tracking models for channel networks |
| DSS | Data Storage System developed by the Hydrologic Engineering Center. Time varying input for DSM2 is specified in DSS format. |
| DWR | California Department of Water Resources |
| ESO | Environmental Services Office (DWR) |
| GUI | Graphical User Interface |
| HEC | Hydrologic Engineering Center |
| IEP | Interagency Ecological Program |
| NOAA | National Oceanic and Atmospheric Administration |
| USGS | United States Geological Survey |