

Technical Setup in Progress

Training starts at 9:05 am

Please put your name/affiliation in:

- **Chat box (Teams Participants)**
- **Nametags & Chat Box (On-site Participants)**



CALIFORNIA DEPARTMENT OF
WATER RESOURCES



DSM2 Learning Series

Agenda

Welcome/Introduction

Nicky Sandhu, Jamie Anderson, Nicole Osorio, and Parviz Nader-Tehrani

Session 1: DSM2 Planning Study Input: Presentation and Hands-on

Brad Tom

Session 2: DSM2 Planning Study Output: Presentation and Hands-On

Brad Tom

Hands-on Exercise Helpers

Kijin Nam, Ines Ferreira, Peyman Namadi, Wenli Yin, Kevin He

Housekeeping Items

- The training will be recorded in Teams
 - Keep muted / camera off
 - Questions: Teams chat box
 - Hands-on task done: Teams “Raise Your Hand”
- Teams participants:
 - Teams Breakout Room for help with exercises
- On-site participants:
 - Wi-Fi: CNRAGuest
 - Restroom needs CNRA Badge to return
- Training Feedback Survey
 - To be sent out after the training; QR code & link in chat

DSM2 Learning Series: Planning

Oct 27, 2023



Modeling Support Office, Delta Modeling Section

DSM2 Learning Series: Planning Studies

October 27, 2023



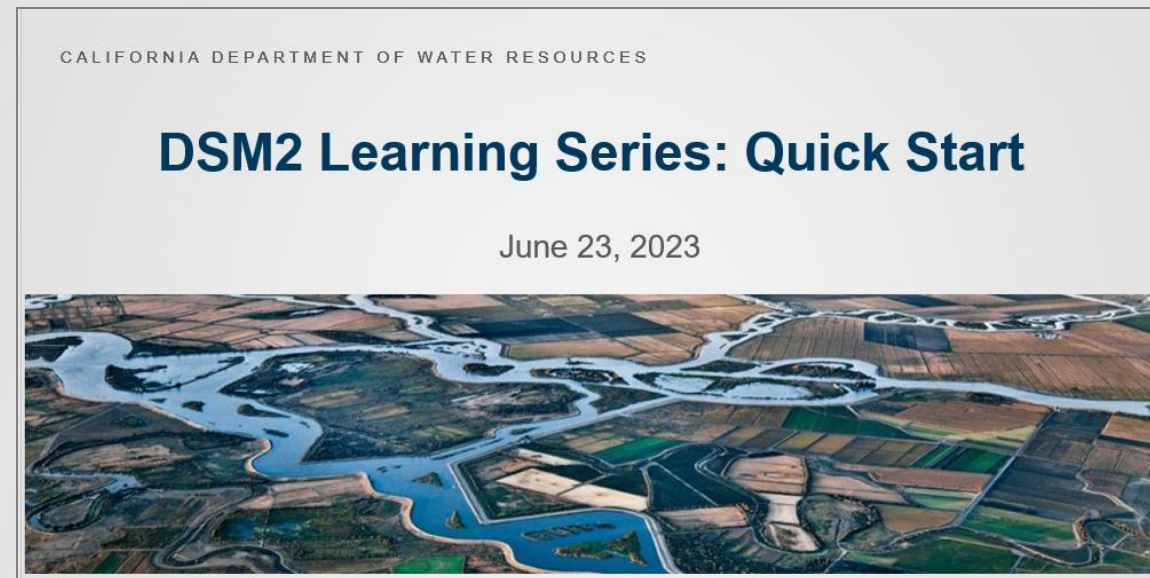
Nicky Sandhu, Jamie Anderson,
Nicole Osorio, and Parviz Nader-Tehrani

Modeling Support Office

DSM2 Learning Series



DSM2 Learning Series



Follow-Up Survey



Please suggest topics for
future learning sessions
on the **Follow-Up Survey**

Course Prerequisite

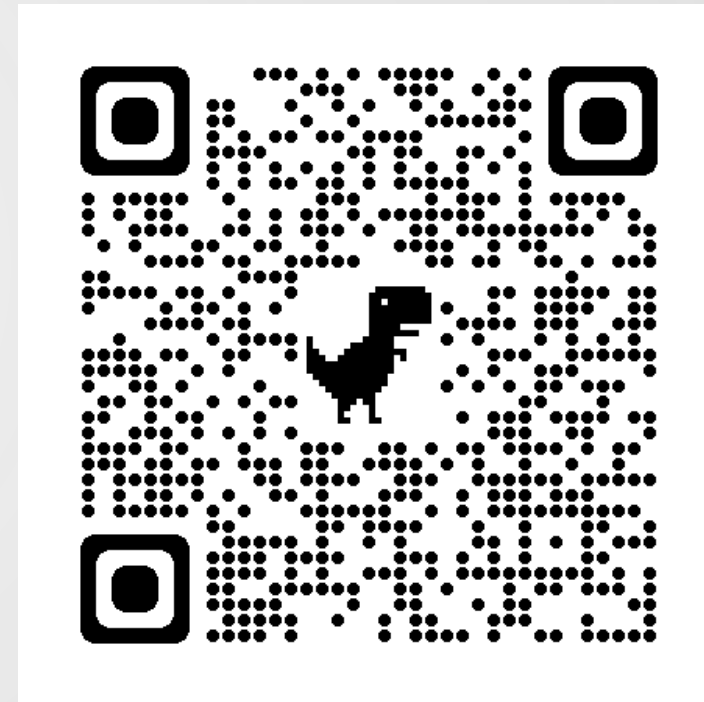
DSM2 Quick Start

Course Videos



<https://www.youtube.com/playlist?list=PL33EJkVWqE1UkKFFz6A4A0LLyXqLVeHD5>

Course Slides



https://github.com/CADWR/DeltaModeling/DSM2LearningSeries/tree/main/quick_start



Delta Simulation Model II (DSM2)

How is DSM2 used?

Today's class exercises use
2021 Delivery Capability Report
studies **AS EXAMPLES ONLY**

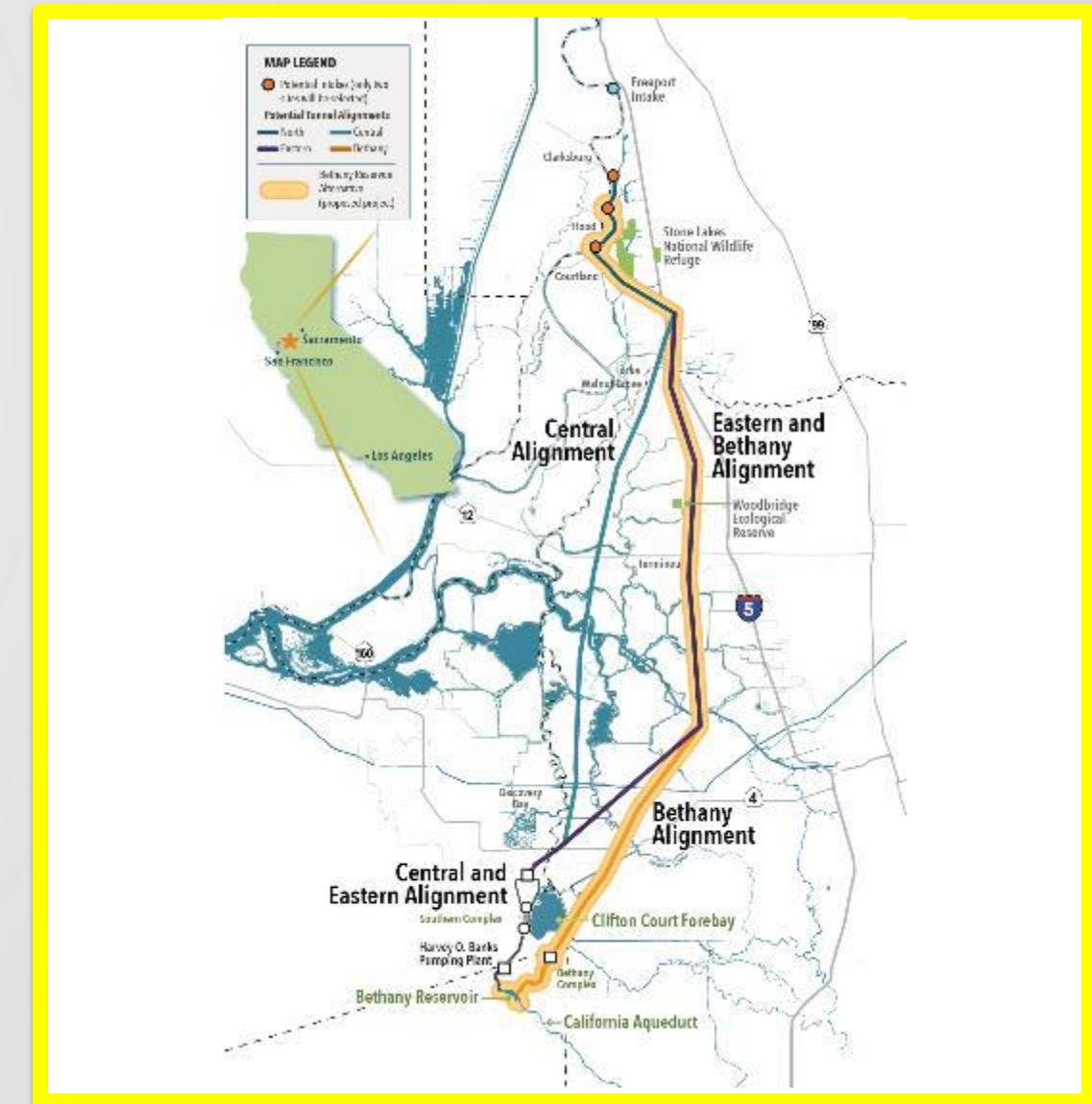
Historical



Real-Time



Planning



e.g. Delta Conveyance,
Climate Change

Model Integration-Handshake

What is each one modeling?
How is each one representing it?
How to connect?



- Boundary conditions: Sacramento & San Joaquin River flows, S. Delta pumping, etc
in hands-on exercises
- Sea level rise – covered briefly today



Interactive Survey

Switch to Menti
Paste link in chat

Where to get DSM2 for planning studies




To recreate an **existing planning study**,
get DSM2 executable from **that study's release** package



To create a **new planning study**,
get DSM2 from **the latest release on CNRA open data**

DSM2 official releases: CNRA Open Data


Organization



California Department of Water Resources


DWR manages California's water resources, systems, and infrastructure, including the State Water Project (SWP), in a responsible, sustainable way. [read more](#)

Social


 Twitter

Dataset Topics Activity Stream Showcases

Data and Resources


 **DSM2 FC.2023.01**

[More Info](#) [Go to resource](#)

 **DSM2 2023.01 Historical Update** 🔥


Historical update 2023.01 validated with DSM2 v8.2.2

[More Info](#) [Download](#)

 **DSM2 2023.01 Historical Update Output**


DSS output files for 2023.01 Historical Update

[More Info](#) [Download](#)

 **DSM2-Hg / Open Water Mercury Program inputs**


A zip file containing the DSM2-Hg model, and inputs for the Open Water Mercury Program.

[More Info](#) [Download](#)

 **DSM2 2022.01 Historical Update** 🔥


Historical update 2022.01 validated with DSM2 v8.2.2.

[Preview](#) [Go to resource](#)

 **DSM2 2022.01 Historical Update Output**


DSS output files for 2022.01 Historical Update

[More Info](#) [Download](#)


 **DSM2 v8.3.1**

DSM2 v8.3.1 includes a debugging message level implementation to control the amount of debug...

[Preview](#) [Go to resource](#)

 **DSM2 v8.2.2**

[Preview](#) [Go to resource](#)




<https://data.cnra.ca.gov/dataset/dsm2>

DSM2 v 8.2.2 is used in this learning session



https://cadwrdeltamodeling.github.io/dsm2/dsm2_learning_series/
<https://github.com/CADWRDeltaModeling/dsm2>
<https://cadwrdeltamodeling.github.io/dsm2/>

 **DSM2 version 8.2**

Search

GitHub
v8.3.1 ☆ 6

DSM2 version 8.2

[Home](#)

[Getting Started](#)

[Manual \(archive\)](#)

[Reference](#)

[Installation](#)

[DSM2 Learning Series \(new for 2023\)](#)

[Tutorials \(archive\)](#)

[FAQs](#)

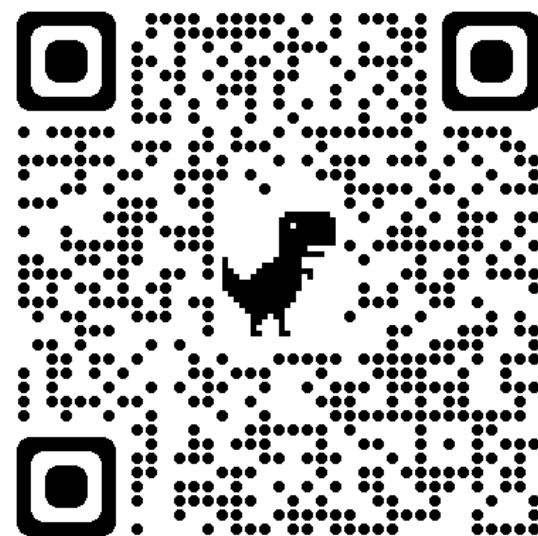
[Release Notes](#)

DSM2 Documentation

Overview:

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.

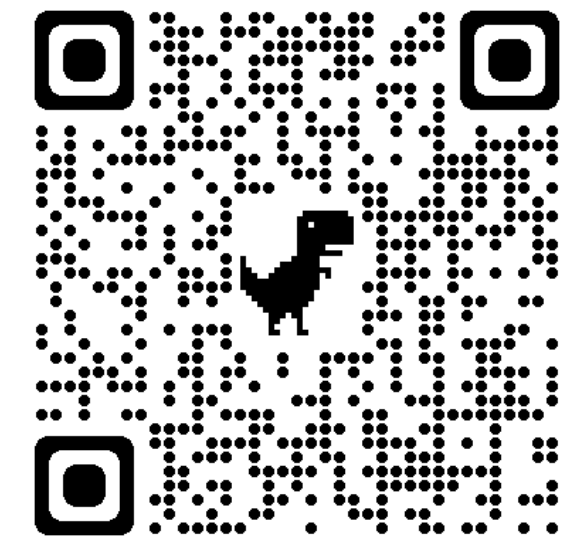
[Table of contents](#)
Overview:



DSM2 Learning Series



DSM2 code



DSM2 documentation

Today's Topics

- Brief overview of DSM2 [Jamie Anderson](#)
- Historical vs planning studies [Jamie Anderson](#)
- CalSim Overview [Nicole Osorio](#)
- Training Delta Salinity ANN [Nicole Osorio](#)
- Level of Development & Climate Change [Jamie Anderson](#)
- CalSim output as DSM2 input [Jamie Anderson](#)
- DSM2 planning process [Parviz Nader-Tehrani](#)

Delta Simulation Model II (DSM2)

Hydro

Flow, velocity, water levels

Qual

Water Quality Model

- **Salinity** including chloride, bromide, ...
- Water Temperature
- Dissolved oxygen

GTM

General Transport Model

- Salinity
- Suspended sediment
- Sediment bed
- Mercury
- Modular for easy expansion

ECO-PTM

Ecological Particle Tracking Model

- Neutrally buoyant particles
- Position oriented particles
- Salmon particles

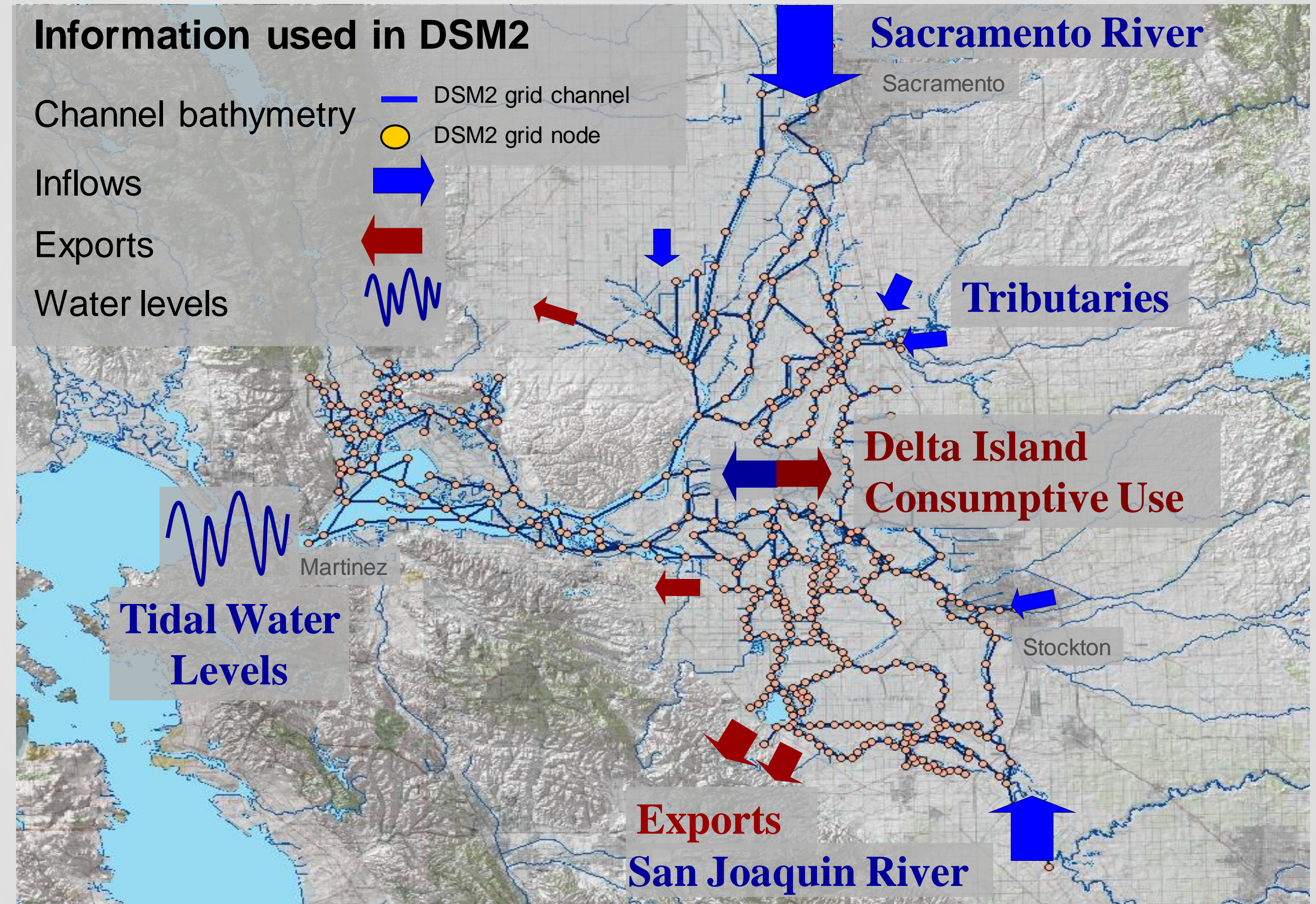
DSM2

Boundary Conditions

In planning studies, CalSim provides inflows & exports to DSM2

Consumptive Use

- From Delta Channel Depletion (DCD) model
- Same total amount used in both CalSim & DSM2
- Total amount divided
 - 5 locations CalSim
 - 200+ locations DSM2



What is a SWP/CVP/Delta planning study?

- A planning study is a **long-term operational scenario** for the SWP & CVP for specified
 - Hydrology and climate
 - Operating rules and regulatory requirements
 - Water demands
 - Infrastructure & channel configuration
- For **scenario comparison** purposes
NOT for recreating historical conditions

Historical vs Planning Studies

Study Type	Models Used	Hydrology and water demands	Physical System & Infrastructure	Operating Rules & Regulations
Historical	NOT CalSim	N/A	N/A	N/A
	DSM2	Based on historical data	Based on historical data	Based on historical data

Baseline may include historically-based hydrology, infrastructure, operating rules and regulations.
CalSim simulations ARE NOT meant to represent actual historical conditions.

Historical vs Planning Studies

Study Type	Models Used	Hydrology and water demands	Physical System & Infrastructure	Operating Rules & Regulations
Historical	NOT CalSim	N/A	N/A	N/A
	DSM2	Based on historical data	Based on historical data	Based on historical data
Planning Baseline + Alternatives	CalSim	Chosen Scenario	Chosen Scenario	Chosen Scenario
	DSM2	Chosen Scenario	Chosen Scenario	Chosen Scenario

Baseline may include historically-based hydrology, infrastructure, operating rules and regulations for

CalSim simulations ARE NOT meant to represent actual historical conditions.

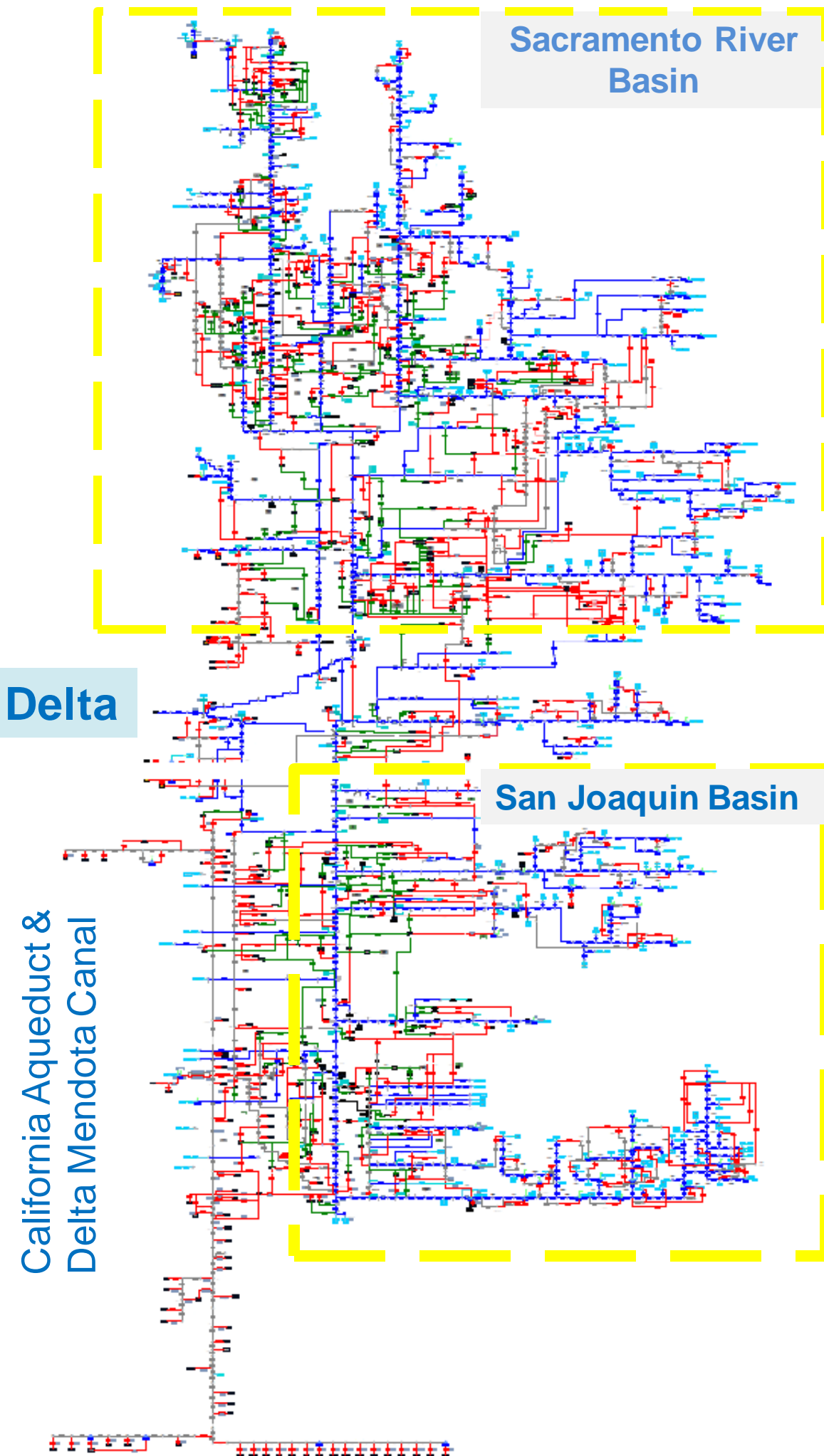
Models Used for Planning Studies

Nicole Osorio will
introduce CalSim

CalSim3
Water Operations



DSM2
Delta Flows &
Water Quality

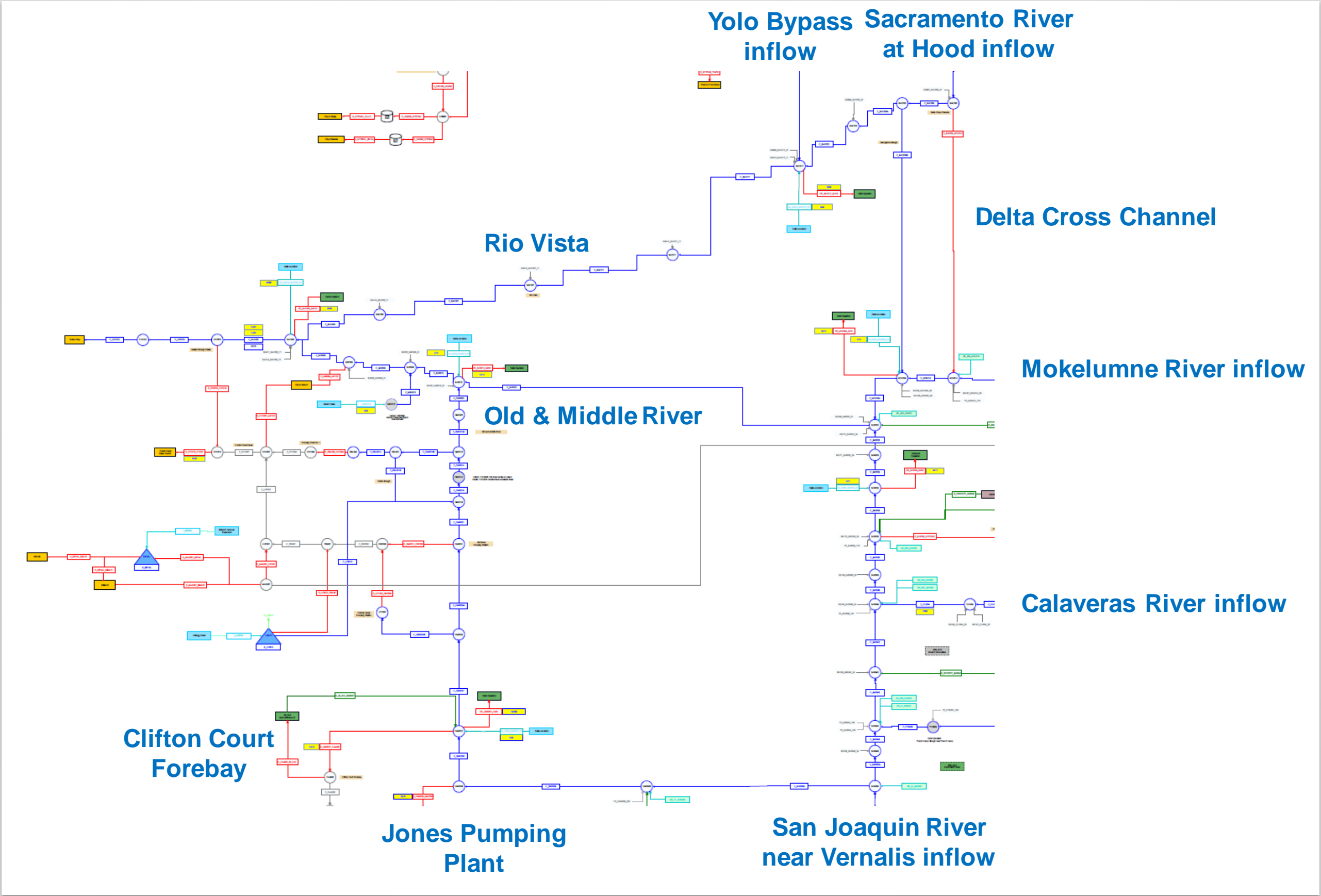


Statewide SWP-CVP System

CALSIM 3

- Monthly-timestep statewide long-term planning model
- Simulates operations of the CVP/SWP and the rest of water resources infrastructure in Central Valley and Sacramento-San Joaquin Delta
- Accounts for operational objectives, physical constraints, and legal and institutional agreements and statutes
- Latest versions use 100 years of historical hydrology (WY 1922-2021) which are modified to reflect a fixed level of development

CALSIM 3 Delta Schematic



CALSIM 3 Delta Regulations

- SWRCB Decision-1641 (D-1641)
- 2019 FWS and NMFS Biological Opinions under the Long-Term Operations of the CVP and SWP
- 2020 SWP Incidental Take Permit (ITP)

SWRCB State Water Resources Control Board

FWS Fish & Wildlife Service

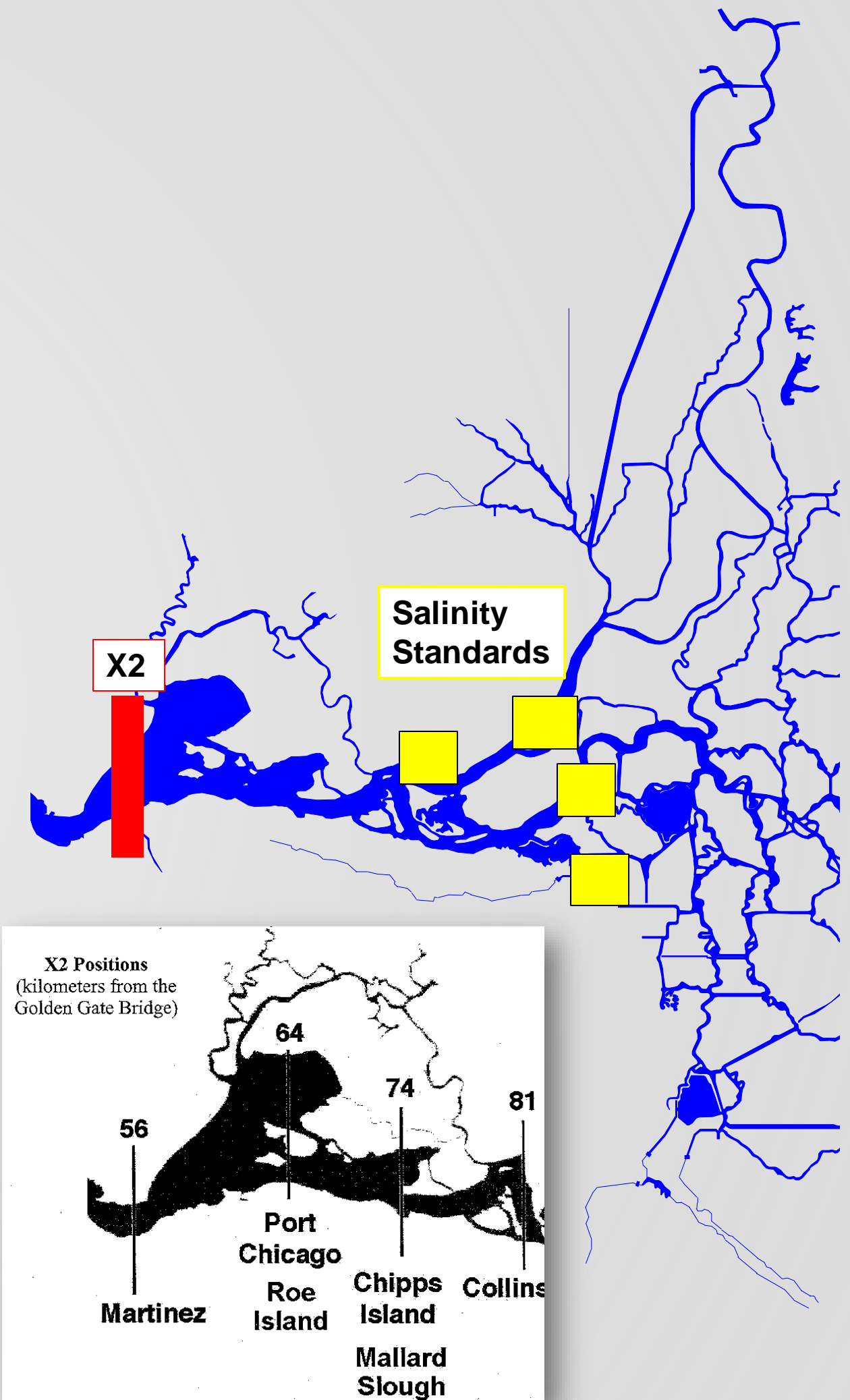
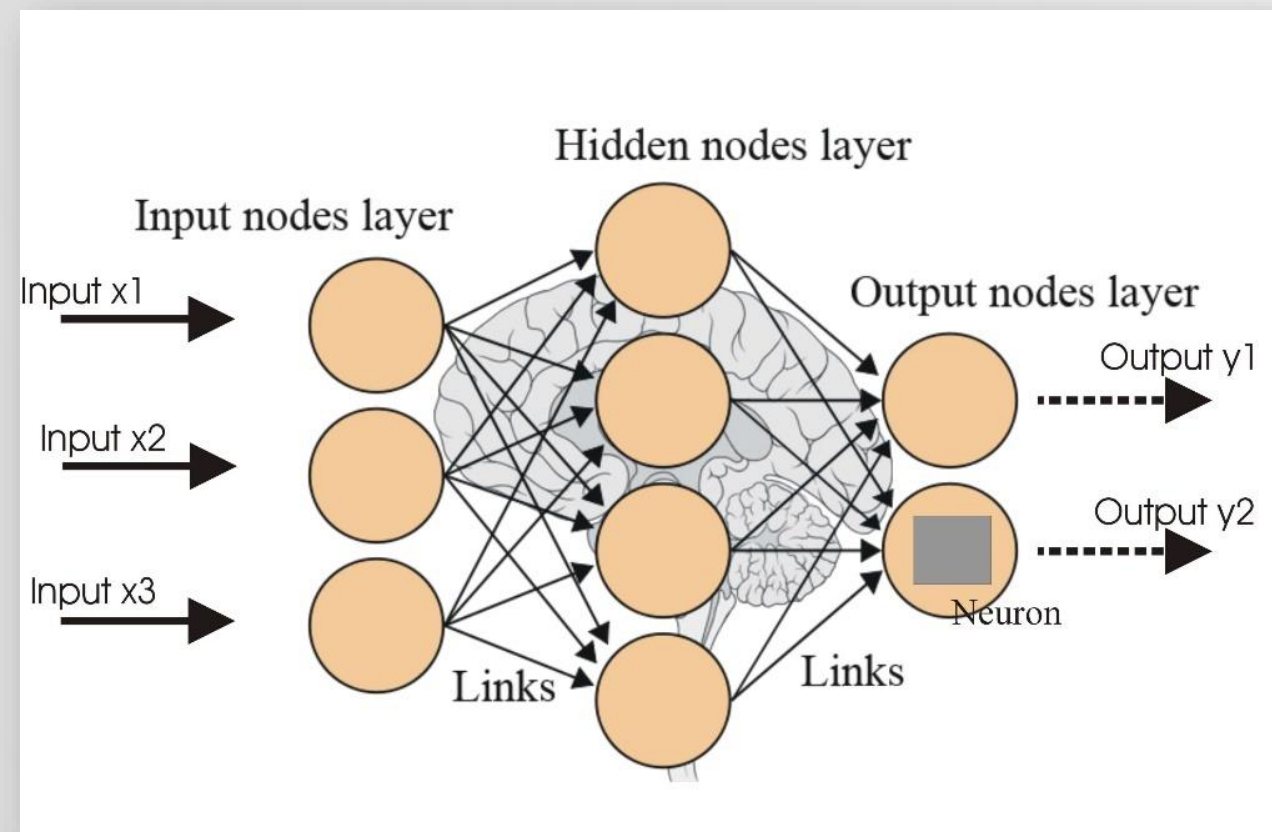
NMFS National Marine Fisheries Service

CVP Central Valley Project

SWP State Water Project

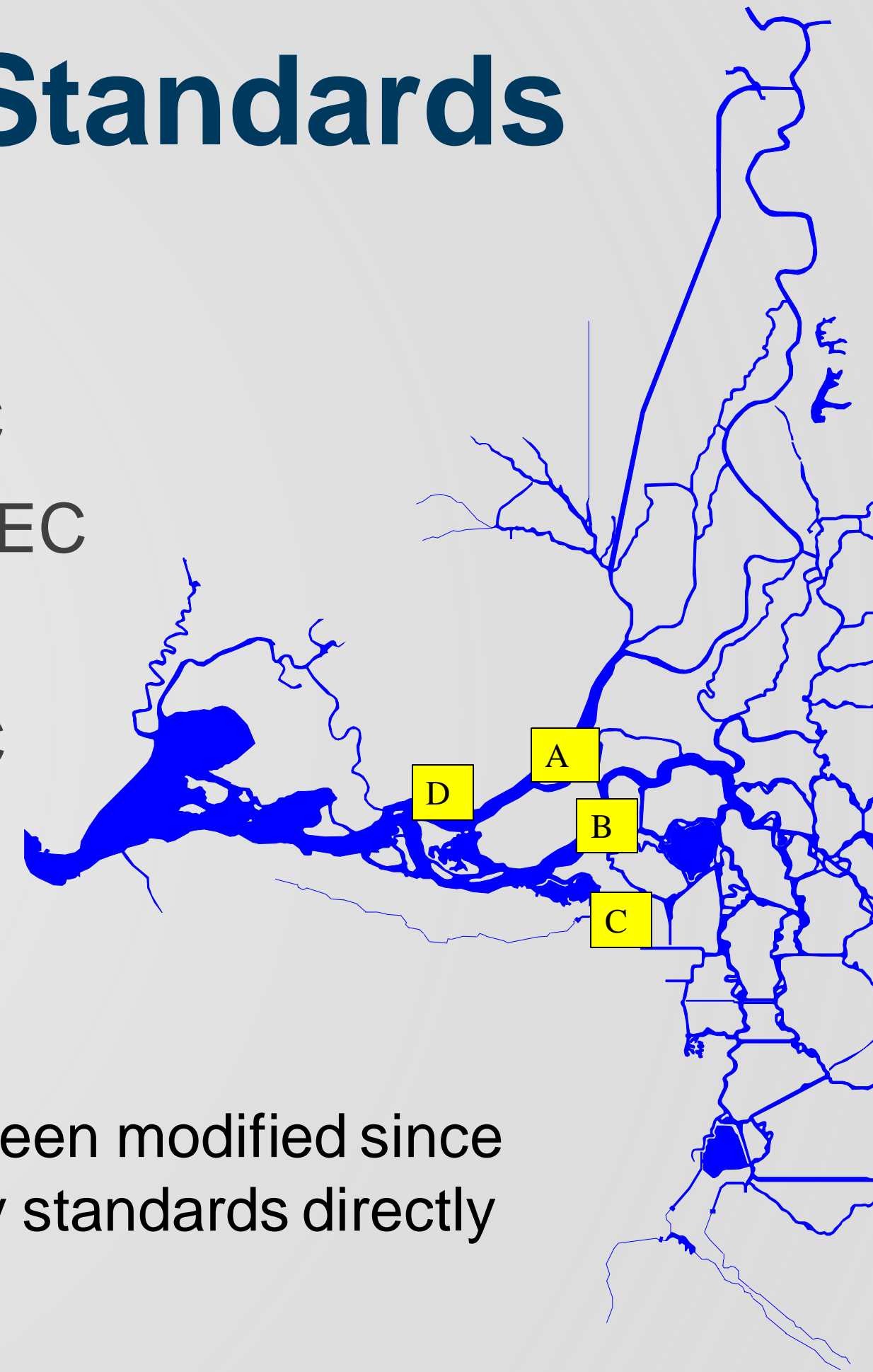
CALSIM 3 - ANN

- Artificial Neural Network (ANN) is used to determine the flow-salinity relationship to meet **Delta Salinity** and **X2 position** standards
- Trained and validated with DSM2
- Embedded in **CALSIM** as a dynamic link library (DLL)



CALSIM 3 – D-1641 Salinity Standards

- All studies have these standards:
 - **A. Emmaton**: Apr-Aug, 0.45-2.78 mmhos/cm EC
 - **B. Jersey Point**: Apr-Aug, 0.45-2.20 mmhos/cm EC
 - **C. Rock Slough**: year-round, 130-225 mg/l Cl
 - **D. Collinsville**: Oct-May, 8.0-19.0 mmhos/cm EC



Modeled standards are based on actual standards, but they have been modified since CalSim has a monthly time step and can't represent daily or 14-day standards directly

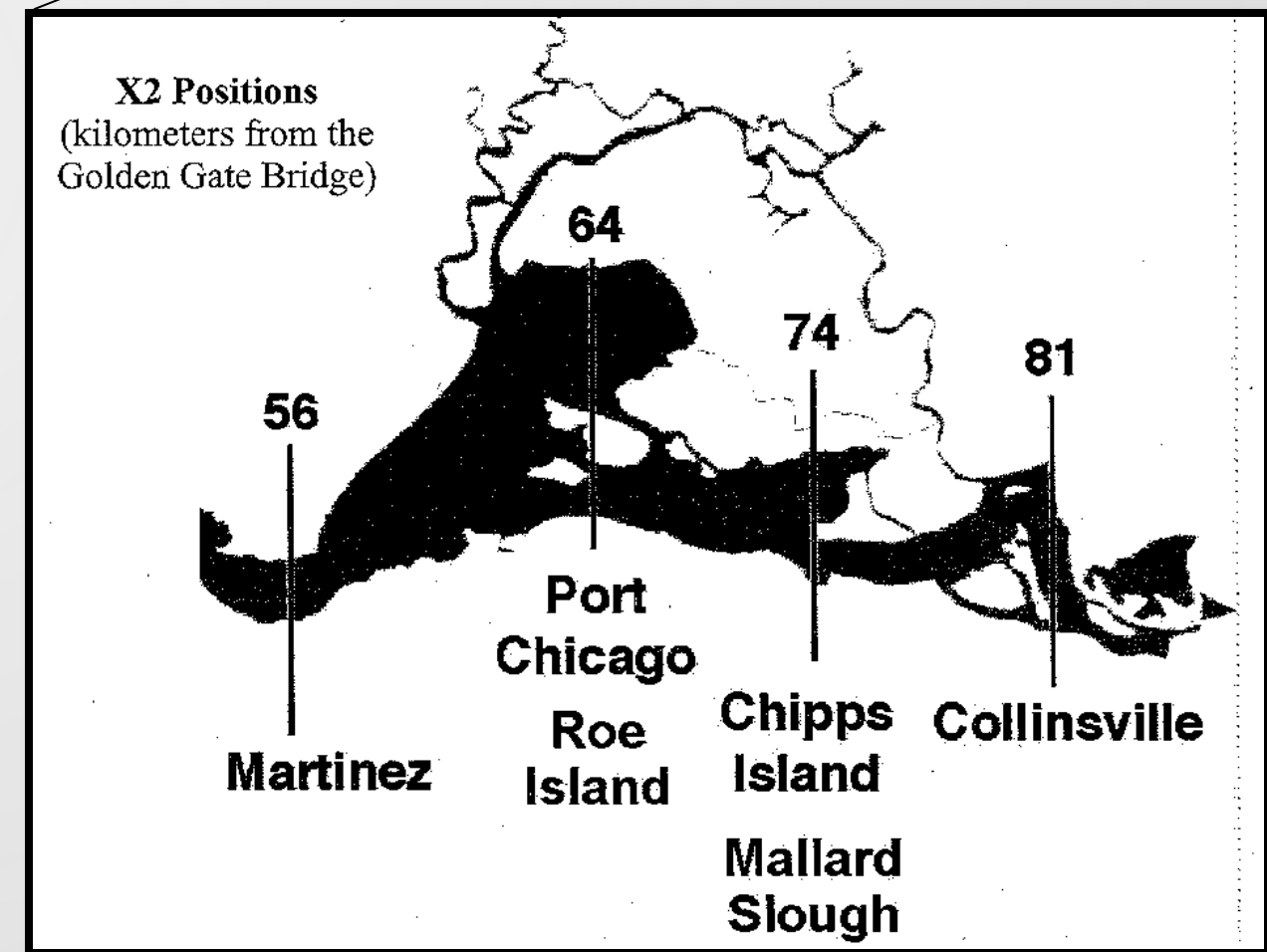
EC Electrical Conductivity

Cl Chloride

CALSIM 3 – D-1641 Minimum Required Delta Outflow: X2 Position

- X2
 - Location of the 2 ppt isohaline (kilometers from Golden Gate Bridge)
 - Represented by EC of 2.64 mmhos/cm
 - Estimated by ANN DLL
 - Three compliance locations
 - Roe, Chipps, Confluence

ANN Artificial Neural Network
DLL Dynamic Link Library
ppt Parts-per-thousand



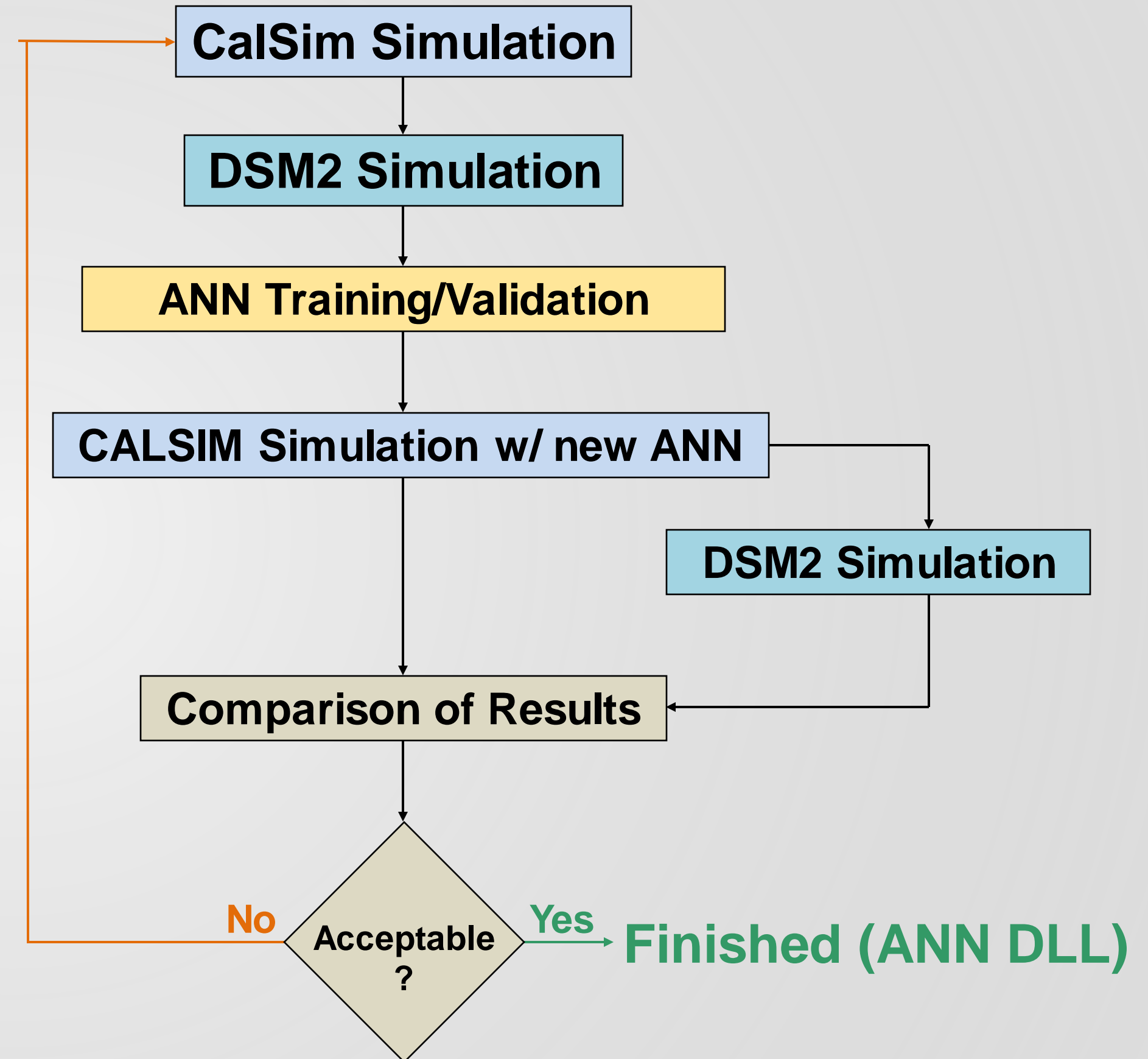
Training Delta Salinity ANN

Full Circle Analysis

Full-circle ANN retaining needed if a study has

- New infrastructure
- Climate change / sea level rise
- Significant changes in Delta channel configuration

TIP: using an existing ANN saves time and resources if it is appropriate for your study



ANN Artificial Neural Network
DLL Dynamic Linked Library

What does level of development mean?

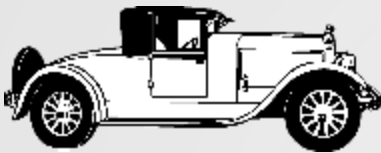


- CalSim 3 uses a “level of development” (LOD) approach to simulate operation of water management facilities and flows in rivers, streams, and channels
- **LOD can be thought of as a pattern of water use**
- The following are held constant over the simulation period for a specific LOD:
 - Facilities
 - Land use
 - Water supply contracts
 - Regulations

Level of Development explained with cars

Year Represented in CalSim Hydrology 1922-2021*	1922	1950's	2021

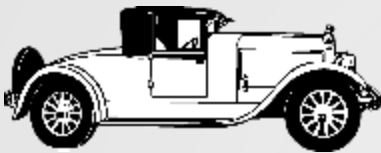





***The 2021 DCR CalSim 3 studies used for this training have a simulation period from 1922-2015. But the latest versions use an extended hydrology from 1922-2021.**

Level of Development explained with cars

Year Represented in CalSim Hydrology 1922-2021*	1922	1950's	2021
Historical-actual evolution through time NOT used in CalSim			

*The 2021 DCR CalSim 3 studies used for this training have a simulation period from 1922-2015.
But the latest versions use an extended hydrology from 1922-2021.

Level of Development explained with cars

Year Represented in CalSim Hydrology 1922-2021	1922	1950's	2021
Historical-actual evolution through time NOT used in CalSim			
Baseline 2020 Level of Development			

CalSim planning studies use a **fixed level of development** (2020 or 2040) for facilities, land use, water supply contracts, and regulatory requirements for the entire simulation period, not an evolving level of development.

Level of Development explained with cars

Year Represented in CalSim Hydrology 1922-2021	1922	1950's	2021
Historical-actual evolution through time NOT used in CalSim			
Baseline 2020 Level of Development			
Future Scenarios 2040 Level of Development			

CalSim planning studies use a **fixed level of development** (2020 or 2040) for facilities, land use, water supply contracts, and regulatory requirements for the entire simulation period, not an evolving level of development.

Climate Change in DSM2 Planning Studies

- Changes in Delta **inflows and exports come from CalSim**
 - **Climate change methodologies evolve**, so different studies may not use the same climate change representation
 - **DSM2 “inherits” the climate change representation used in the CalSim** study as it is reflected in Delta inflows and exports
- **Martinez water levels are detrended** to bring the entire baseline time series to the same base sea level
- For **sea level rise**,
 - Retrain CalSim ANN (0, 15, 30, and 55 cm currently available)
 - Adjust Martinez water levels and salinity

Provided for
today's hands-on
exercises

Water Year Types can change for Climate Change Scenarios



Wet $9.2 \geq$

Above Normal $7.8 < 9.2$

Below Normal $6.8 \leq 7.8$

Dry $5.4 \leq 6.5$

Critical < 5.4

Sacramento Valley Water Year Index =

$0.4 * \text{Current Apr-Jul Runoff Forecast (in maf)} + 0.3 * \text{Current Oct-Mar Runoff in (maf)} + 0.3 * \text{Previous Water Year's Index}$

**Similar index for San Joaquin Valley

Studies that have **changes in hydrology**, such as climate change, **can change the water year types** in CalSim
WYT_SAC_ and WYT_SJR_

Some operations and standards are based on water year type



DSM2 Planning Study Inputs

From CalSim

- Delta Inflows: Sacramento, San Joaquin, and others
- Export pumping: SWP, CVP, and other Delta exports
- Delta Cross Channel and Suisun Marsh Salinity Control Gate operations
- Level of sea level rise (if used)

Assumption/User Input

- Martinez water levels and salinity
- Temporary barrier installation/removal dates (if used)
- Head of Old River operations (if used)
- Study specific assumptions

Sample DSM2 input from CalSim3 Output

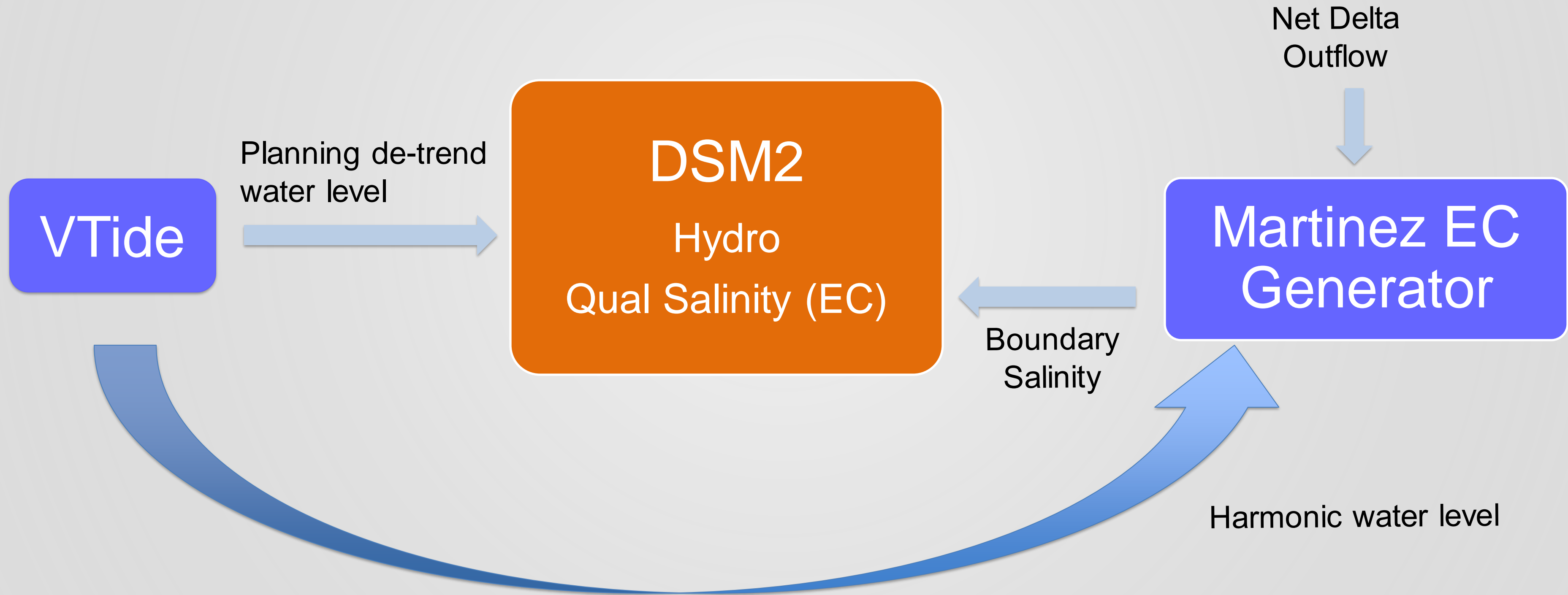
A single DSM2 input may be several CalSim outputs combined

DSM2 and CalSim have different time steps

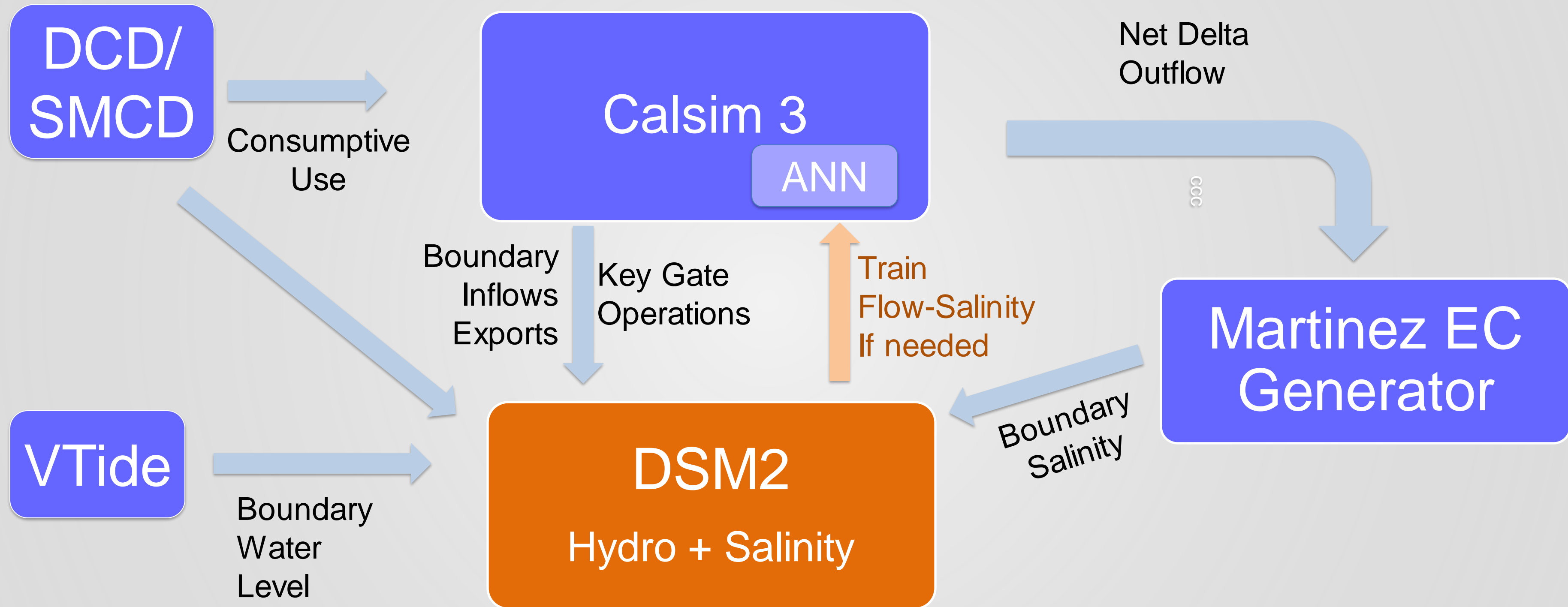
- 1-month CalSim
- 15-min DSM2

DSM2 Name		DSM2 Node	CalSim3
BOUNDARY_FLOW			
sac	FLOW	330	C_SAC041
vernalis		17	C_SJR070
calaveras	FLOW-CHANNEL	21	C_CLV004
cosumnes		446	C_CSM005
yolo		316	C_CSL005
moke	FLOW-INFLOW	447	C_MOK022 SR_60N_MOK019 SR_26S_MOK014
SOURCE_FLOW			
COSMA1	FLOW-DELIVERY	33	D_SJR028_WTPDWS
<u>northbay</u>		273	C_CSL004B
ccc		206	D408
<u>cvp</u>		181	C_DMC000
SOURCE_FLOW_RESERVOIR			
swp	FLOW-DELIVERY	clifton_court	C_CAA003
NODE_CONCENTRATION			
vernalis	SALINITY-EC	17	VERNWQFINAL

DSM2 Downstream Boundary Martinez



DSM2 Planning Process **NO Sea Level Rise**



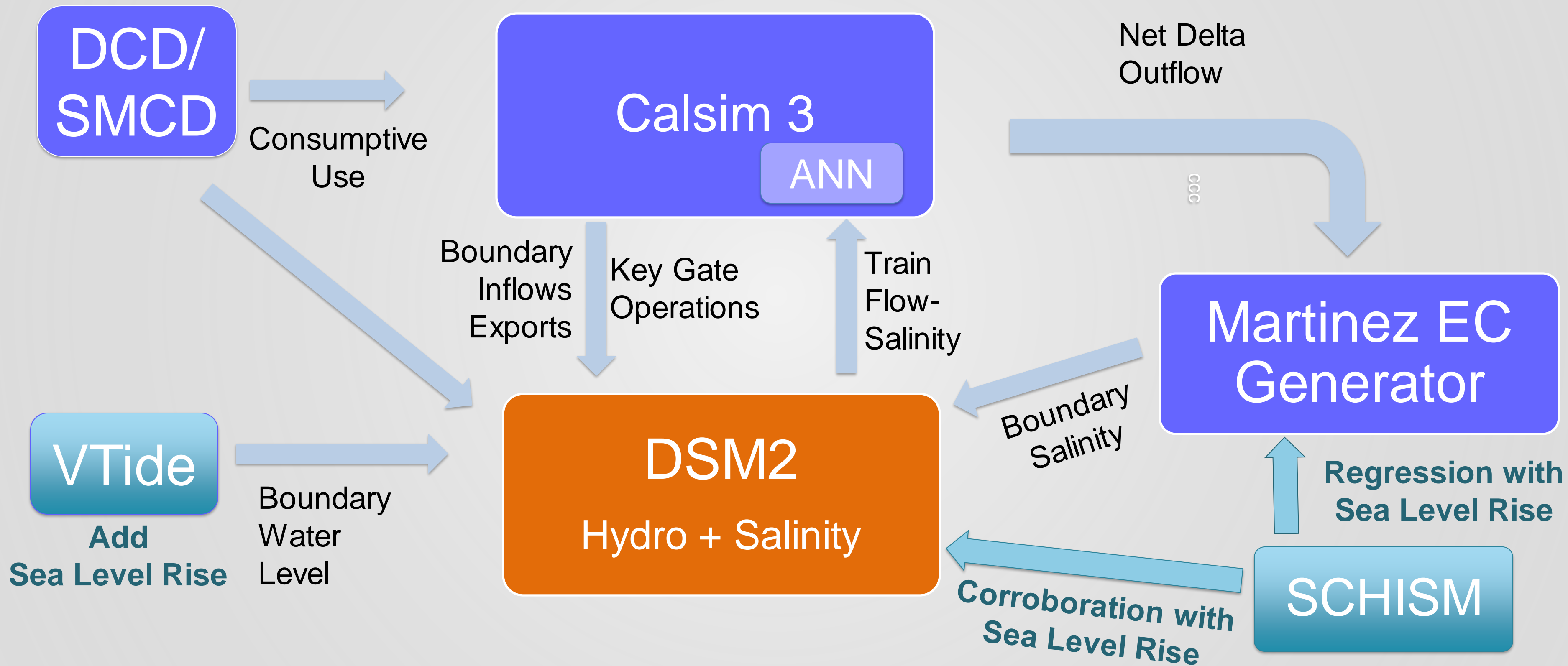
ANN=Artificial Neural Network
EC=Electrical Conductivity

DCD=Delta Channel Depletion
SMCD= Suisun Marsh Channel Depletion

SCHISM corroboration

- SCHISM corroboration for sea level rise
 - changes DSM2 dispersion coefficients and
 - helps create EC boundary conditions
- Only used in scenarios with sea level rise

DSM2 Planning Process **with Sea Level Rise**



ANN=Artificial Neural Network
EC=Electrical Conductivity

DCD=Delta Channel Depletion
SMCD= Suisun Marsh Channel Depletion

Questions?

Please enter questions into the chat

DSM2 QR Codes
& break timer
next slide



Prabhjot.Sandhu@water.ca.gov

Jamie.Anderson@water.ca.gov

Nicole.Osorio@water.ca.gov

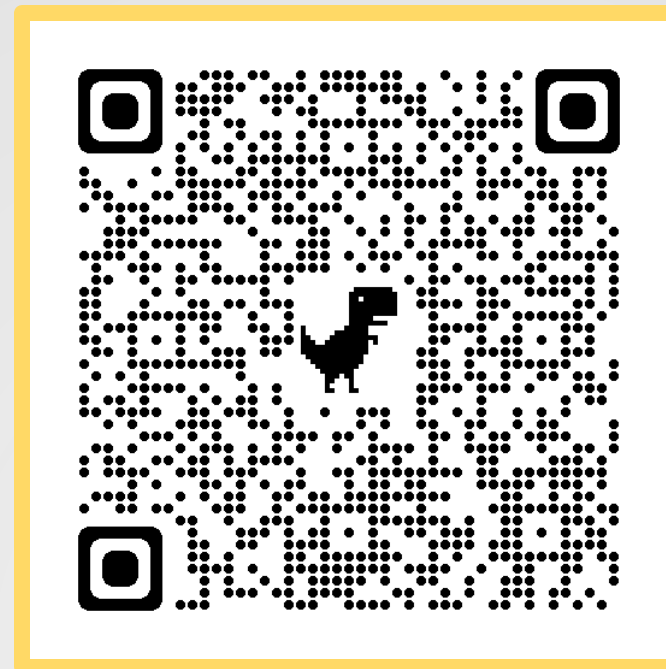
Parviz.Nader-Tehrani@water.ca.gov

10-minute break

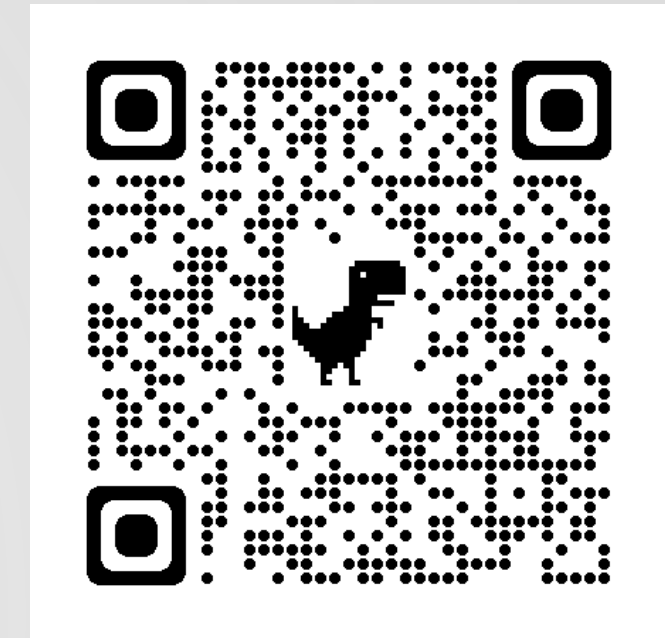
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DSM2 Learning Series



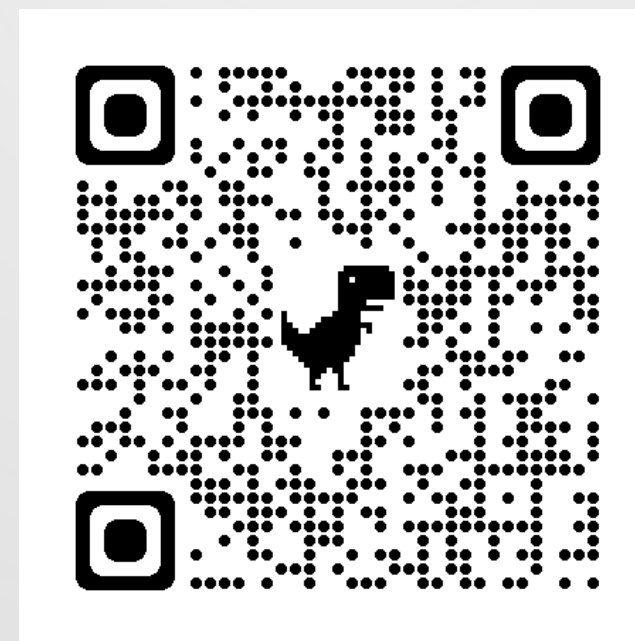
Follow-Up Survey



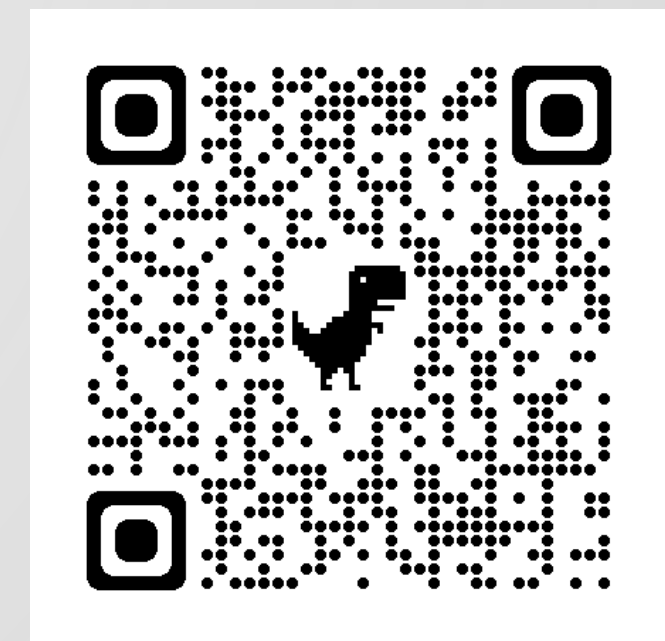
DSM2 Quick Start



DSM2 Releases



DSM2 code



DSM2 documentation