

# **Contaminant Loads from Stormwater to Coastal Waters in the San Francisco Bay region:**

**Comparison to other pathways and  
recommended approach for future evaluation**

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# The Model

## A simple rainfall / runoff model

$$W = \sum_{j=1}^n (C_j * r_j * i * A_j)$$

### Where

W = Contaminant load from a hydrologic unit

C = Stormwater contaminant concentration for land use  $j$

r = Runoff coefficient for land use  $j$

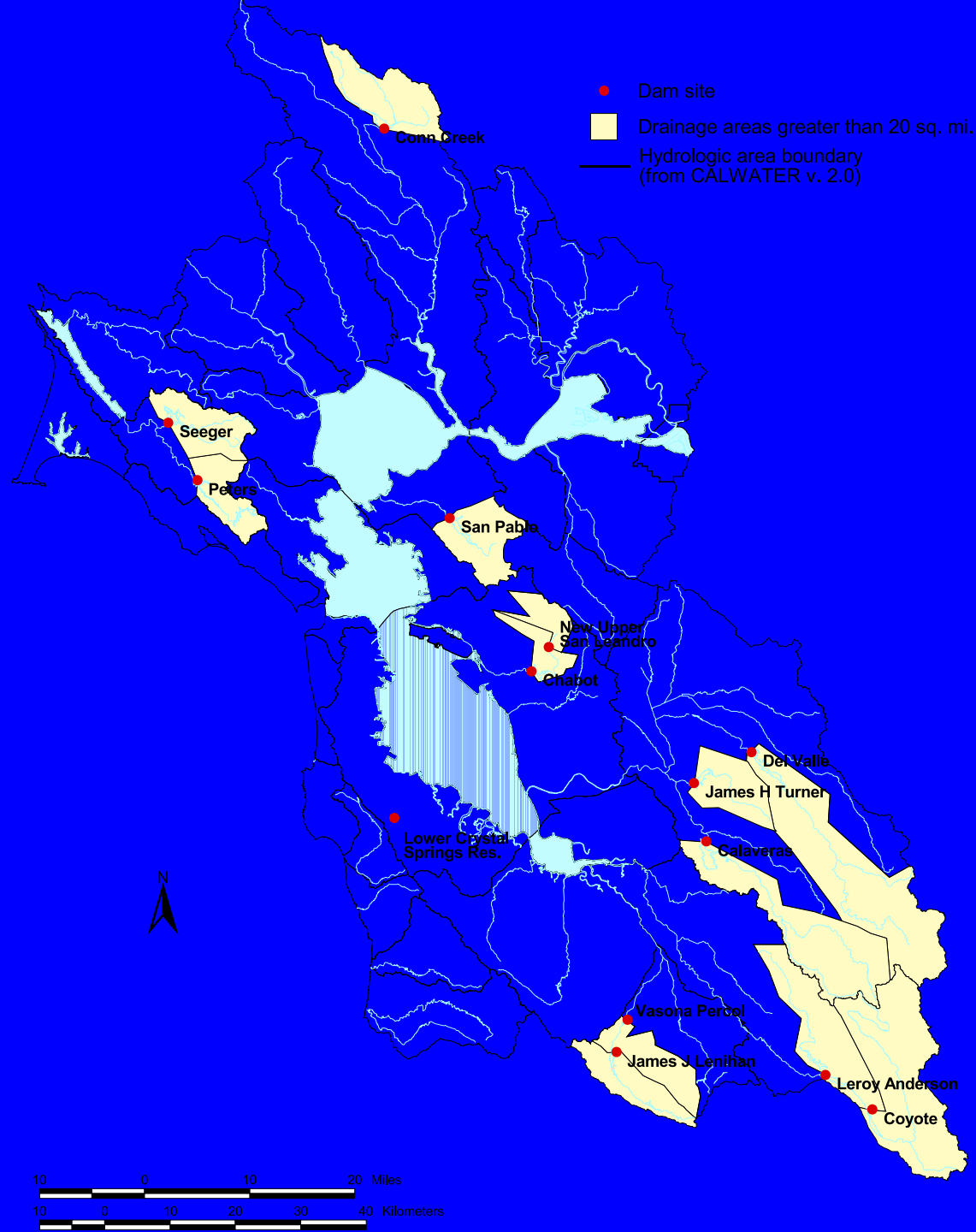
i = Average rainfall for the hydrologic unit

A = Area of land use  $j$  in the hydrologic unit

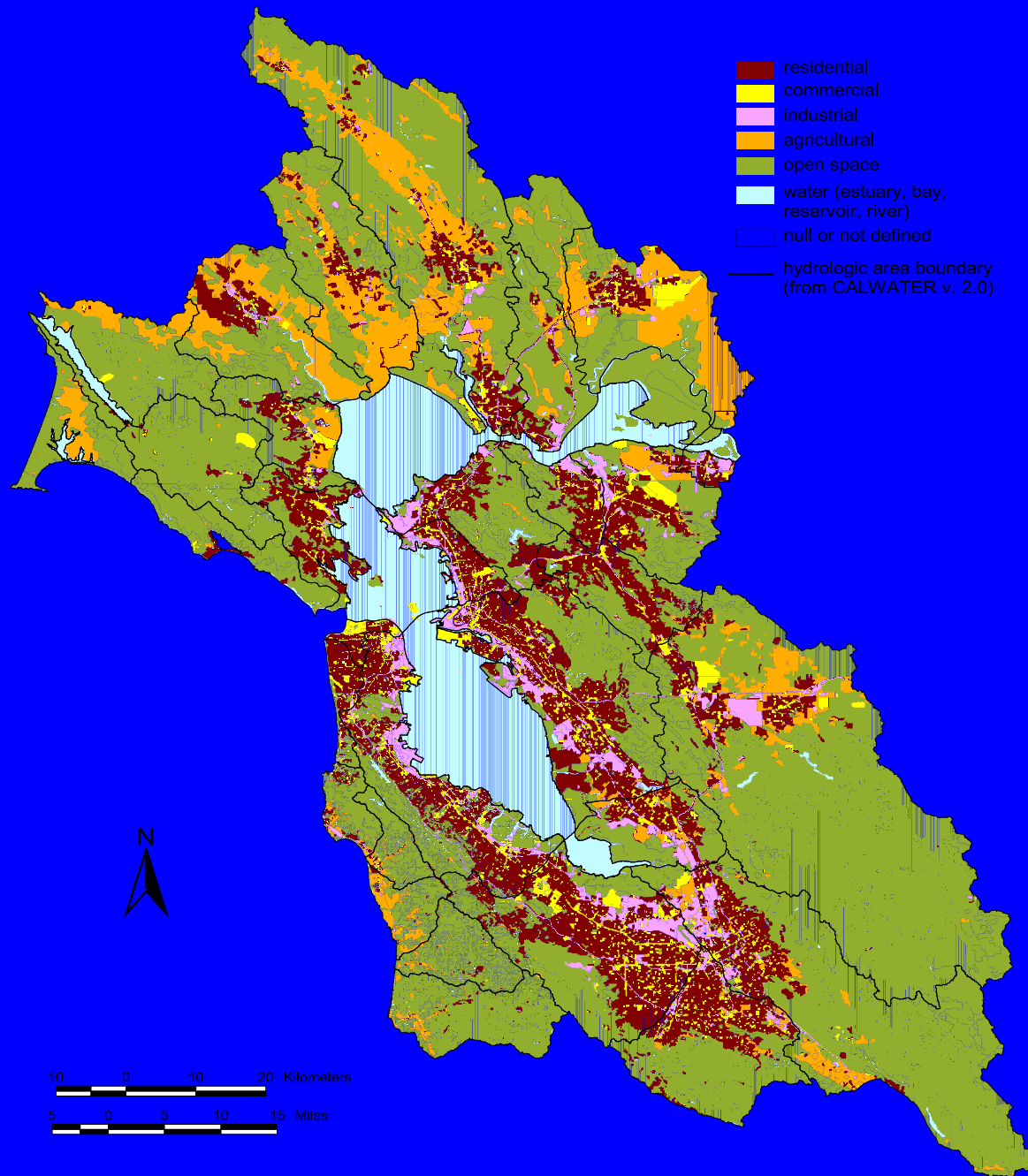
# Hydrologic Areas CALWater Map



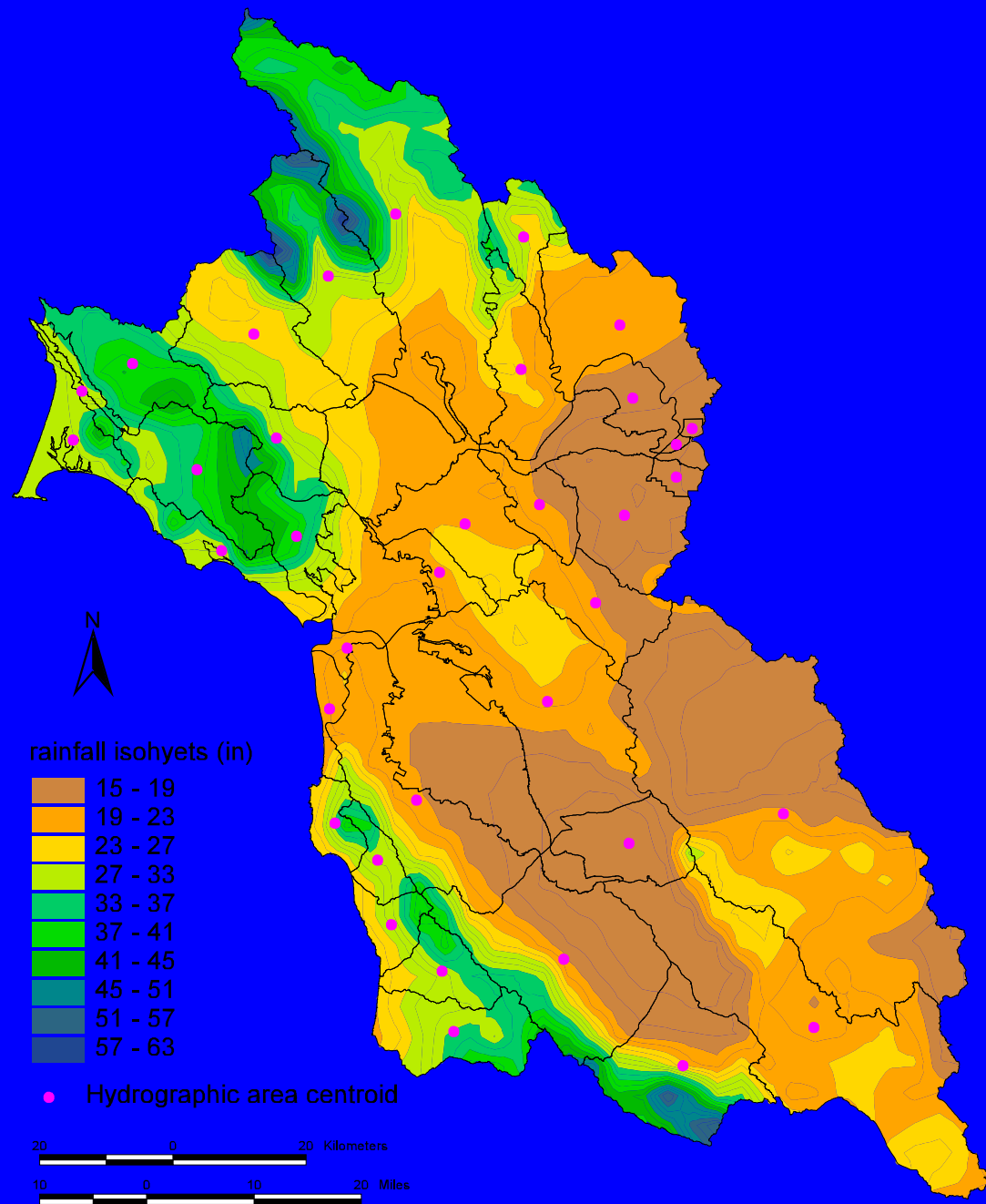
# Drainage Areas That Were Disregarded In The Modeling Process



# Land Use Input Into The Model (ABAG)



# Rainfall Input Into The Model (PRISM)



# Bay Area Characteristics

## Drainage area – 8,552 sq km

- Residential – 21%
- Commercial – 5%
- Industrial – 4%
- Agricultural – 13%
- Open Space – 56%



# Runoff Coefficients

|                     | Low  | Best | High |
|---------------------|------|------|------|
| <b>Residential</b>  | 0.20 | 0.35 | 0.50 |
| <b>Commercial</b>   | 0.60 | 0.90 | 0.95 |
| <b>Industrial</b>   | 0.60 | 0.90 | 0.95 |
| <b>Agricultural</b> | 0.05 | 0.10 | 0.20 |
| <b>Open Space</b>   | 0.10 | 0.25 | 0.50 |

# Limitations And Problems With the Model

- Calibrated well for impervious areas
- The model is inherently linear
- Data are not available for many of the substances of concern
- Rainfall does not characterize the variability in contaminant loads accurately
- The modeling areas are not defined as discrete watersheds

# Estimated Mass Loads From Storm Water Runoff (t/y)

|                  | Lower bound | Upper bound | Best estimate |
|------------------|-------------|-------------|---------------|
| Suspended solids | 170,000     | 670,000     | 310,000       |
| BOD              | 8,600       | 25,000      | 16,000        |
| Nitrate          | 810         | 3,200       | 1,500         |
| Phosphate        | 280         | 850         | 510           |

# Estimated mass loads from storm water runoff (t/y) (continued)

|          | Lower bound | Upper bound | Best estimate |
|----------|-------------|-------------|---------------|
| Cadmium  | 1.3         | 3.7         | 2.3           |
| Chromium | 22          | 64          | 40            |
| Copper   | 36          | 110         | 66            |
| Lead     | 44          | 150         | 81            |
| Nickel   | 27          | 78          | 49            |
| Zinc     | 150         | 470         | 280           |

# Contaminants Not Quantified

- COD
- Nitrite
- Ammonia
- Mercury
- Selenium
- Total PCBs
- Total PAH
- Total DDT
- Total Chlordane
- Dieldrin
- Chlorpyrifos
- Diazinon
- Dioxins
- Total coliform
- Fecal coliform
- Enterococcus
- MTBE

# Methodologies For Other Pathways

- **Effluent discharges** were quantified by combining 1998 concentrations and flow on a monthly time step and summing to annual loads
- **Atmospheric deposition** was quantified using data from the SFEI Air Deposition Pilot Study
- **Dredged material disposal** was qualified by combining data from the ocean disposal data set for concentrations and volumes and using a density of  $1.087 \text{ g/cm}^3$
- **Central valley loads** were quantified by combining Delta Outflow with RMP concentration data

# Comparisons Of The Pathways

|         | Total<br>load (t) | Runoff<br>% | Effluent<br>% | Atmosphere<br>% | Dredge<br>% |
|---------|-------------------|-------------|---------------|-----------------|-------------|
| SS      | 320,000           | 98          | 2.4           | -               | -           |
| Nitrate | 4,500             | 33          | 67            | -               | -           |
| PO4     | 1,500             | 34          | 66            | -               | -           |
| Cd      | 2.4               | 95          | 3.4           | 1.5             | 0.0         |
| Cr      | 57                | 70          | 2.3           | 1.6             | 26          |
| Cu      | 74                | 89          | 8.0           | 1.5             | 1.6         |
| Ni      | 64                | 76          | 7.5           | 0.9             | 15          |
| Zn      | 320               | 87          | 11            | -               | 2.5         |

# Comparisons of Local Pathways With Central Valley Loads

|         | Local Bay (t) | Central Valley (t) | Relative<br>Magnitude |
|---------|---------------|--------------------|-----------------------|
| SS      | 320,000       | 3,500,000          | 11x                   |
| Nitrate | 4,500         | 43,000             | 10x                   |
| PO4     | 1,500         | 6,400              | 4x                    |
| Cd      | 2.4           | 1.6                | 0.7x                  |
| Cr      | 57            | 550                | 10x                   |
| Cu      | 74            | 270                | 4x                    |
| Ni      | 64            | 410                | 6x                    |
| Zn      | 320           | 428                | 1.3x                  |



# Recommendations

- a. **Watershed characterization** using factors that relate to storm water transport of priority contaminants
- b. **Conceptual model development** (sources, transport, transformations, pathways, loadings, and losses)
- c. **Development of evaluations strategies** for classes of contaminants with similar properties
- d. **Establish a regional network of observation watersheds**
- e. **Extrapolate to other watersheds**

# Achievements Since This Report

- A new estimate of sediment loads from the Delta is in draft form
- The PCB Budget Report is in review
- The Hg Air Deposition Report is in review
- The Storm Drainage Areas study is ongoing
- NHD is Ongoing
- Conceptual design has started for better determination of loads from local watersheds following the RMAS / SWAMP program

# Potential Further Development And Uses For This Model And Data Set

## SFEI could run the model again

- For pollutants where concentrations are more poorly quantified
- For discrete watersheds and / or for areas defined by the needs of local managers / governments / scientists and engineers
- For future management scenarios