# Brine Disposal Options and Analytical Tools

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# Brine disposal methods proposed by Cal Desal agencies

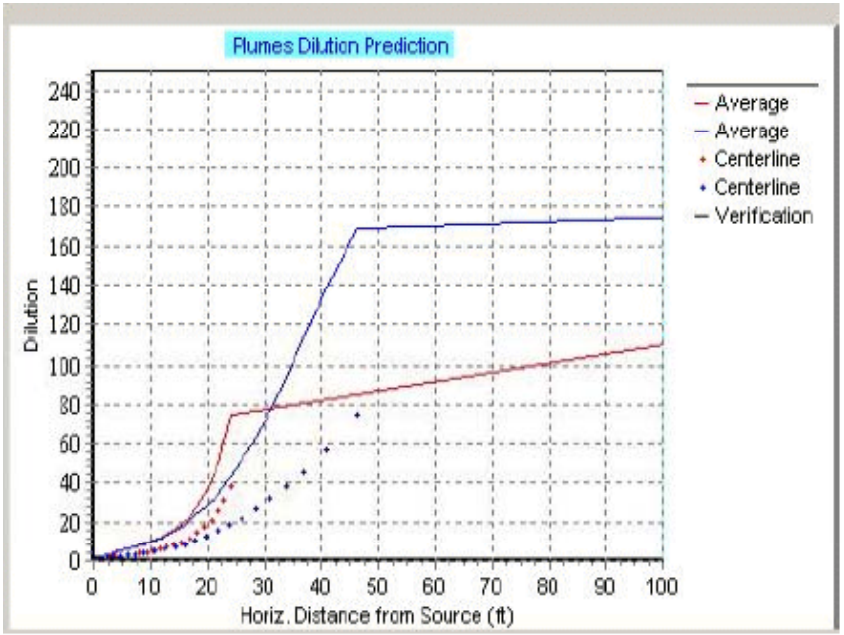
* Dedicated brine-only diffuser systems
* Co-disposal through existing POTW outfalls

# Benefits of co-disposal

* Can improve water quality characteristics of discharge
  * Minimizes salinity difference between discharge and ambient ocean water
  * Reduces potential for plume surfacing
  * Reduces concentrations of some constituents in wastewater discharges (suspended solids, BOD, metals)
* Composition of combined discharge may vary with time

# Near-field methods

* Diffuser models (e.g., Visual Plumes, Cormix)
  * Single and merged submerged plumes
  * Typically used to simulate near-field zone of initial dilution (ZID), with some far-field capability




Source: Model output from Visual Plumes Manual, 2003

# Near-field methods

* Analytical solutions for positively buoyant plumes

(e.g., Fischer et al., 1979)

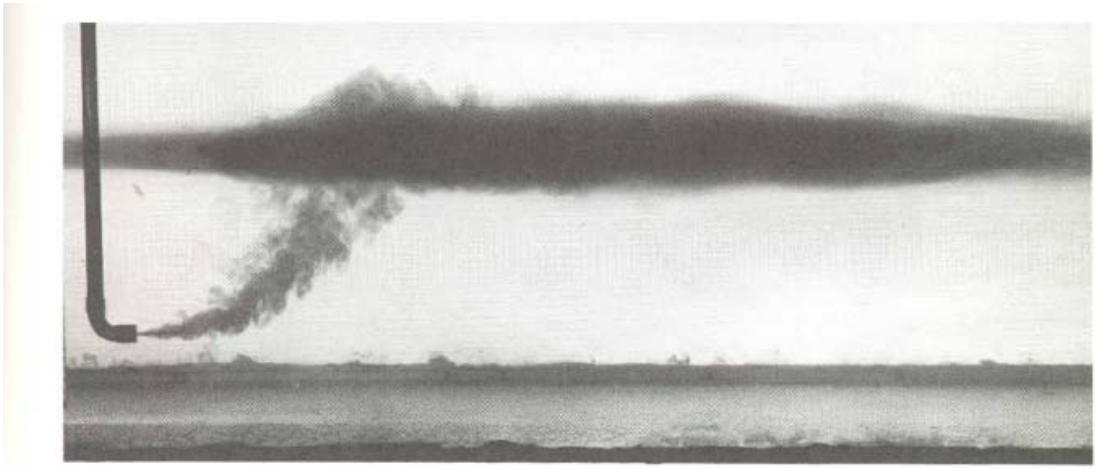


*Figure 9.32* Horizontal turbulent buoyant jet in a density-stratified environment. $R_0 = 0.036$, $N = 0.56$. [From Fan (1967).]

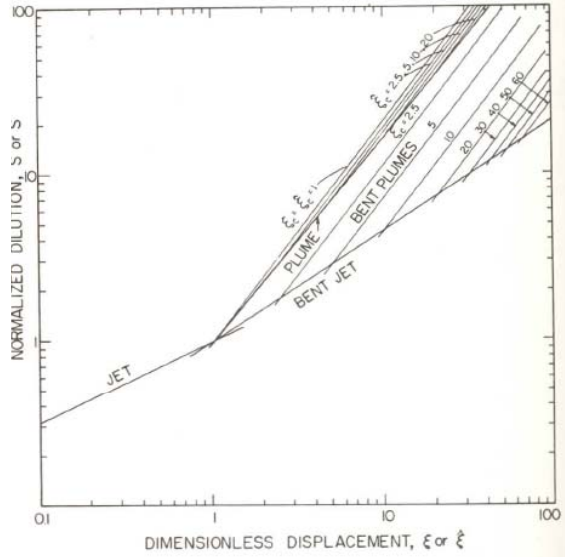



*Figure 9.22* Mean dilution in round turbulent buoyant jets in a uniform crossflow (see Tables 9.4–9.7 for symbols).

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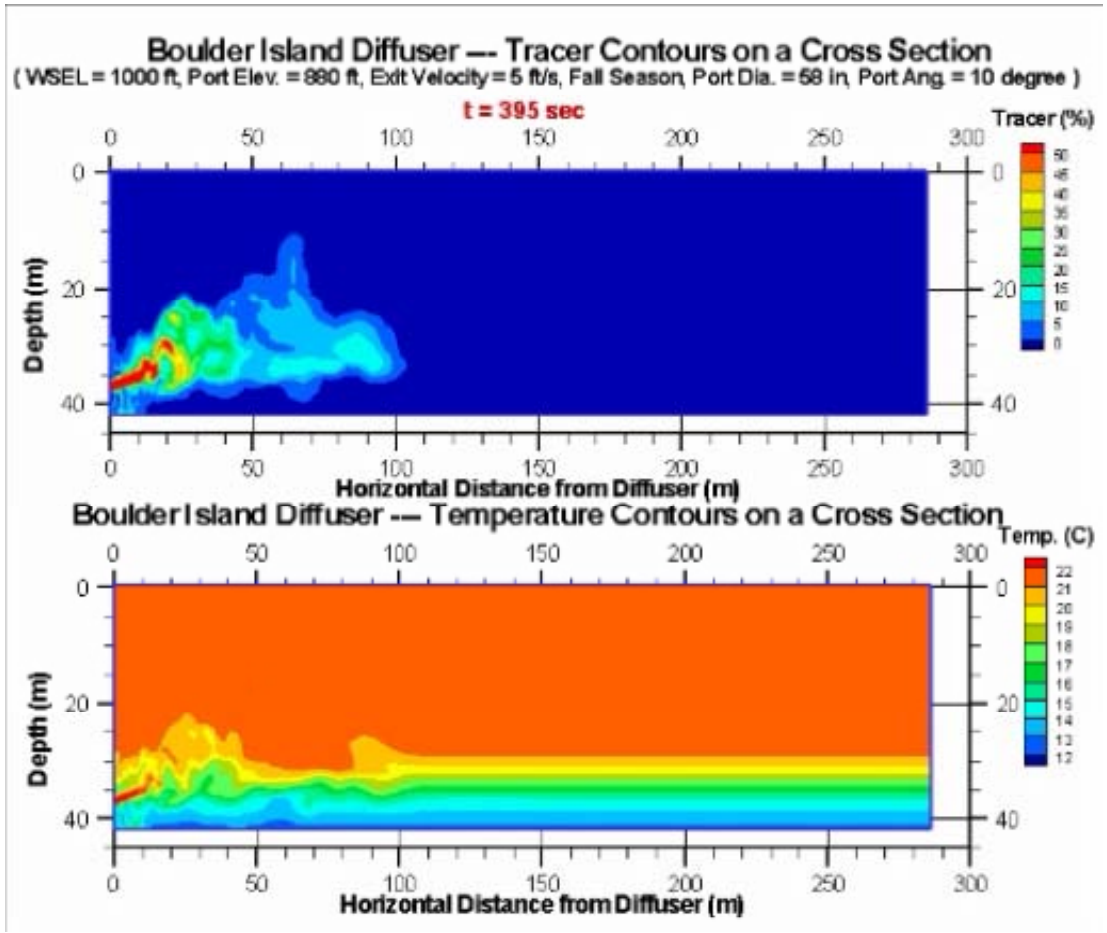
(From Fischer et al., 1979)

# Near-field methods

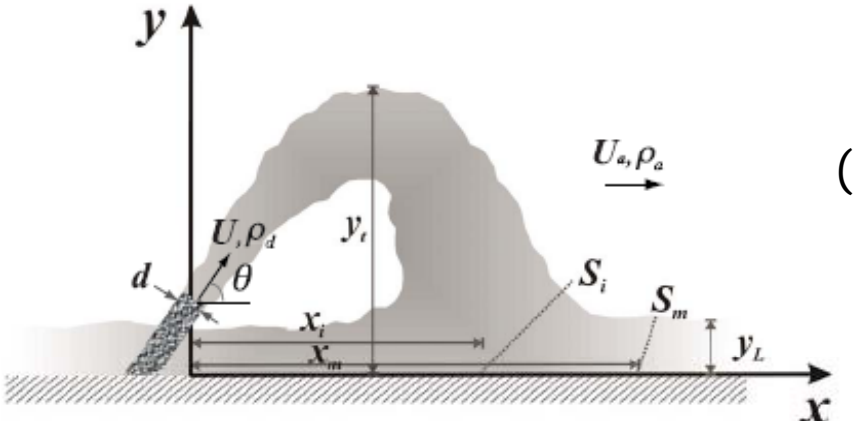



* 3-D modeling approaches (e.g., Large-Eddy Simulations (LES))

# Near-field methods

* Analytical solutions for negatively buoyant plumes

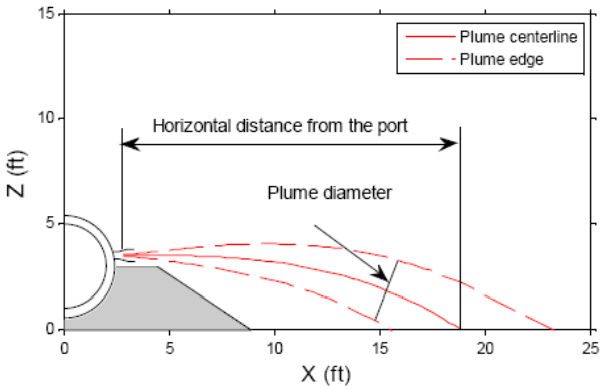
(e.g., Roberts et al. 1997, Kikkert et al. 2007, Marti et al. 2011)



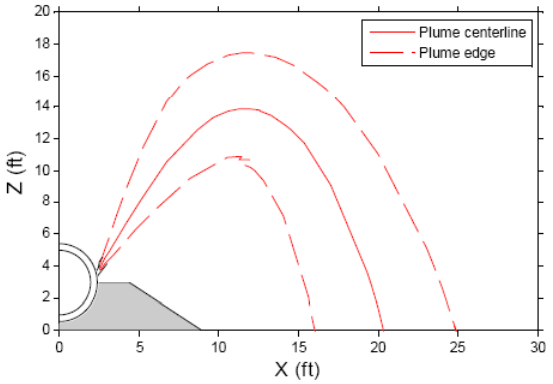

(From Marti et al. 2007)

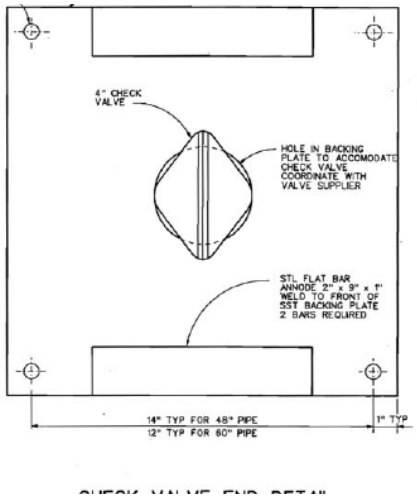
**Fig. 1.** Definition sketch for an inclined dense jet based on Roberts et al. (1997)

# Existing diffusers can be modified to improve near-field dilution

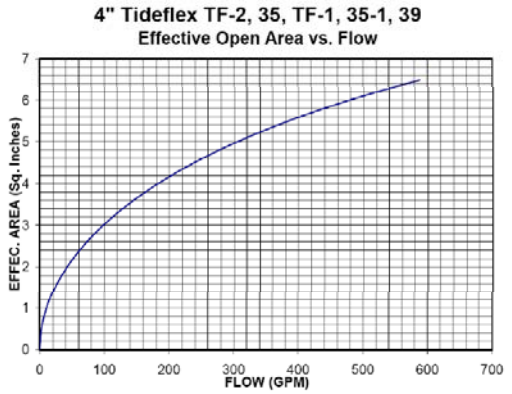



Horizontal ports can be angled upward (typically 60⁰)




Tideflex type valves can be added to increase port exit velocity

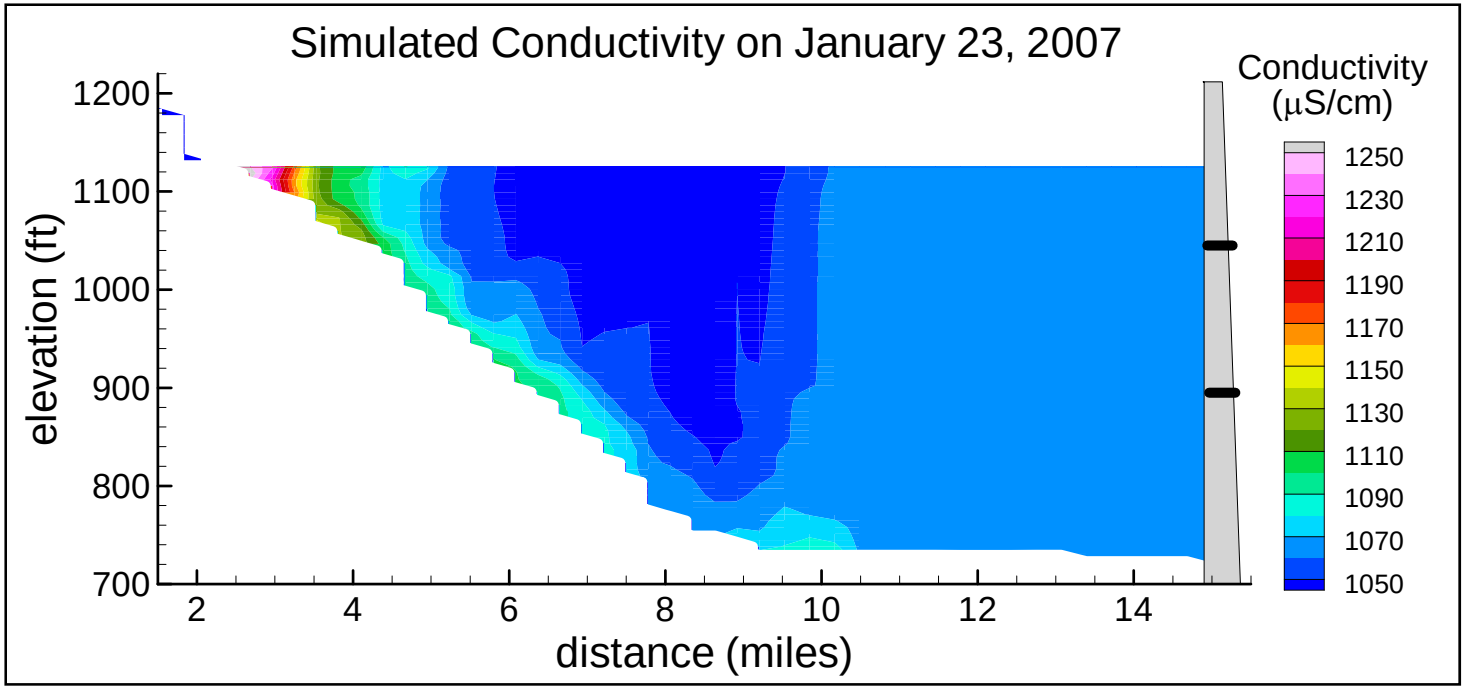


# Far-field analytical methods

* 3-D modeling techniques
  * Need good data (current, tides, winds)
  * Advances in computational power make 3-D modeling feasible in wide range of situations
* May be necessary to evaluate:
  * Far-field impacts of sinking plumes
  * Impacts to sensitive areas (MLPAs, ASBS)
  * Impacts of multiple discharges
  * Effects of currents and tides

# Negatively buoyant discharges and evaluation of sea floor impacts

* Sinking plumes will flow along the bottom
* 3-D models can simulate these effects (need good bathymetry data!), or physical models



# Use of probabilistic analyses

* Water quality criteria involve **frequency, magnitude, duration**
* Probabilistic analyses can be used to establish how long, how often, and how much
  * To develop appropriate effluent limitations
  * To assess likely toxicity
* Permitting, monitoring and compliance approaches need to recognize these variables

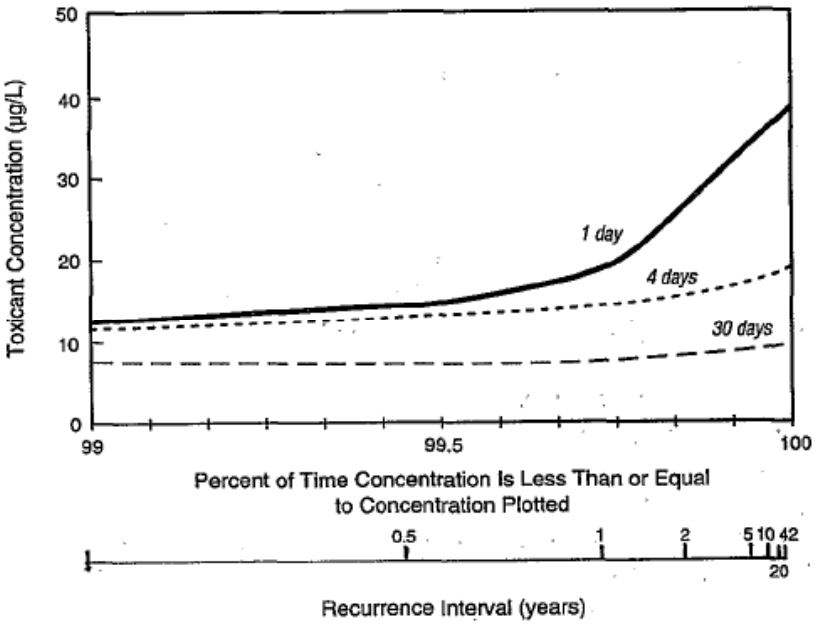



**Figure 4-4. Frequency of Occurrence of Concentrations in Receiving Waters and Recurrence Intervals Generated by a Continuous Simulation Model**

Source: USEPA 1991 (TSD)

# Conclusions

* Significant dilution occurs in near-field with a well-designed discharge system
* Confidence in analytical tools is warranted
* Choice of analytical tools will be site- and situation-specific
* Frequency, magnitude, and duration need to be considered explicitly

# Conclusions, cont'd.

* Co-disposal solutions need to consider full range of potential discharge conditions
  * Diurnal patterns in flows, blending, and concentrations
  * Potential future reuse of wastewater (long-term change in discharge composition)
  * Addition of new flow streams (e.g., brine lines)
* Dilution analyses, permit requirements, monitoring requirements, and compliance determinations need to be consistent

# Supplemental Information

# Animation of dense plume from 3-D model (ELCOM)