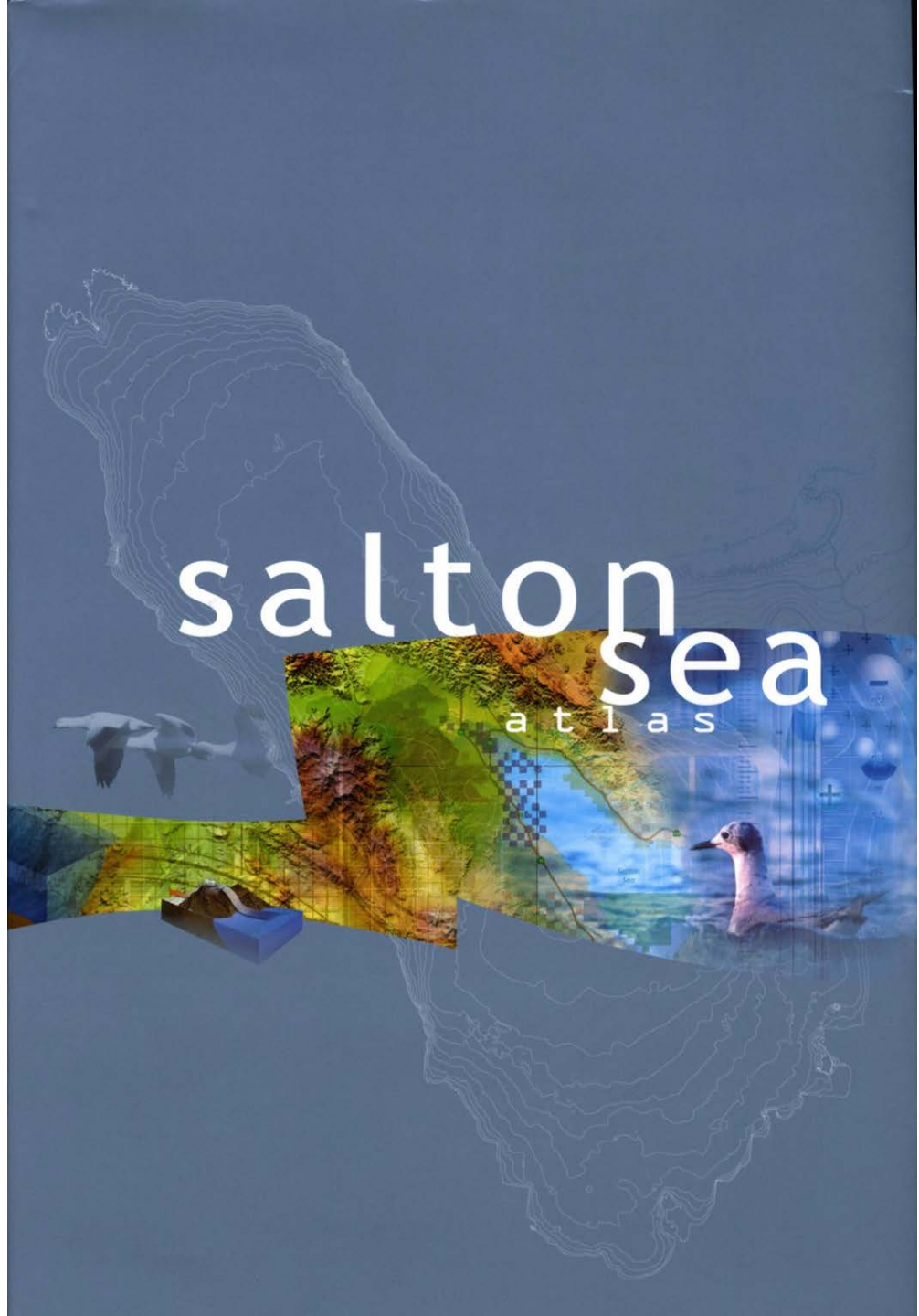


Salton Sea

A Human and Ecological Tragedy

by Prof. Michael K. Stenstrom

**An important
Source!
A publication of the
University of
Redlands and ESRI**



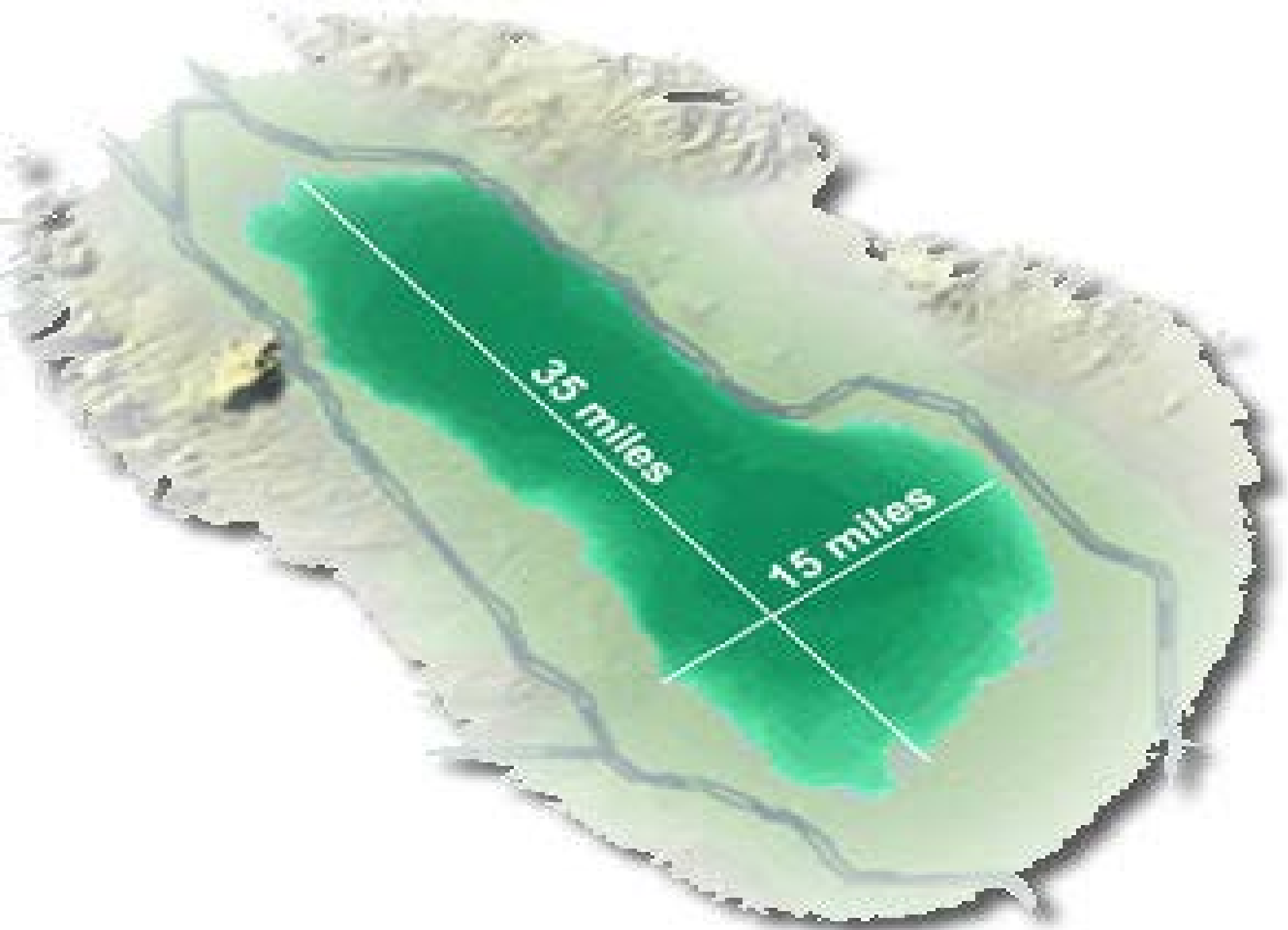
Outline

- Where is it? What is it, a lake, not a Sea! Its climate.
- How it was formed – not just a mistake
- The California Rivera
- Why hasn't it dried up?
- Wildlife
- Depressed Communities
- Solutions

Figure 1

The Salton Sea and Vicinity





Precipitation

California

Inches per month



The rainy season in California lasts from October through April. During this time, stormy, wet weather (2 - 5 days) alternates with clear, dry weather (7 - 14 days).

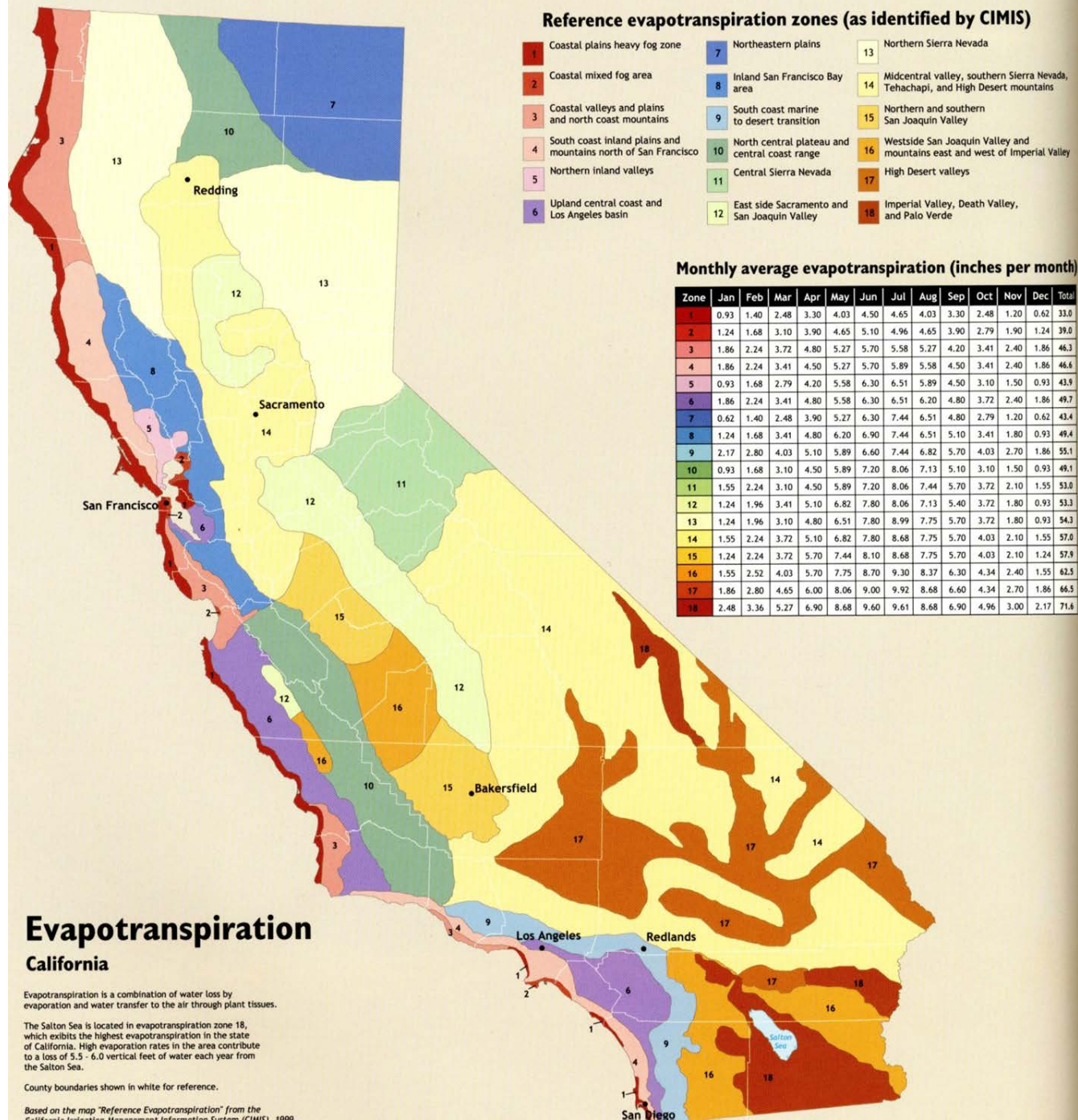
County boundaries shown in gray for reference.

Based on data from the PRISM Climate Mapping Project, a joint project between the Natural Resources Conservation Service National Water and Climate Center, and the Spatial Climate Analysis Service at Oregon State University.

Annual Average of Monthly Precipitation

Based on monthly total precipitation from 1961 - 1990





Evapotranspiration California

Evapotranspiration is a combination of water loss by evaporation and water transfer to the air through plant tissues.

The Salton Sea is located in evapotranspiration zone 18, which exhibits the highest evapotranspiration in the state of California. High evaporation rates in the area contribute to a loss of 5.5 - 6.0 vertical feet of water each year from the Salton Sea.

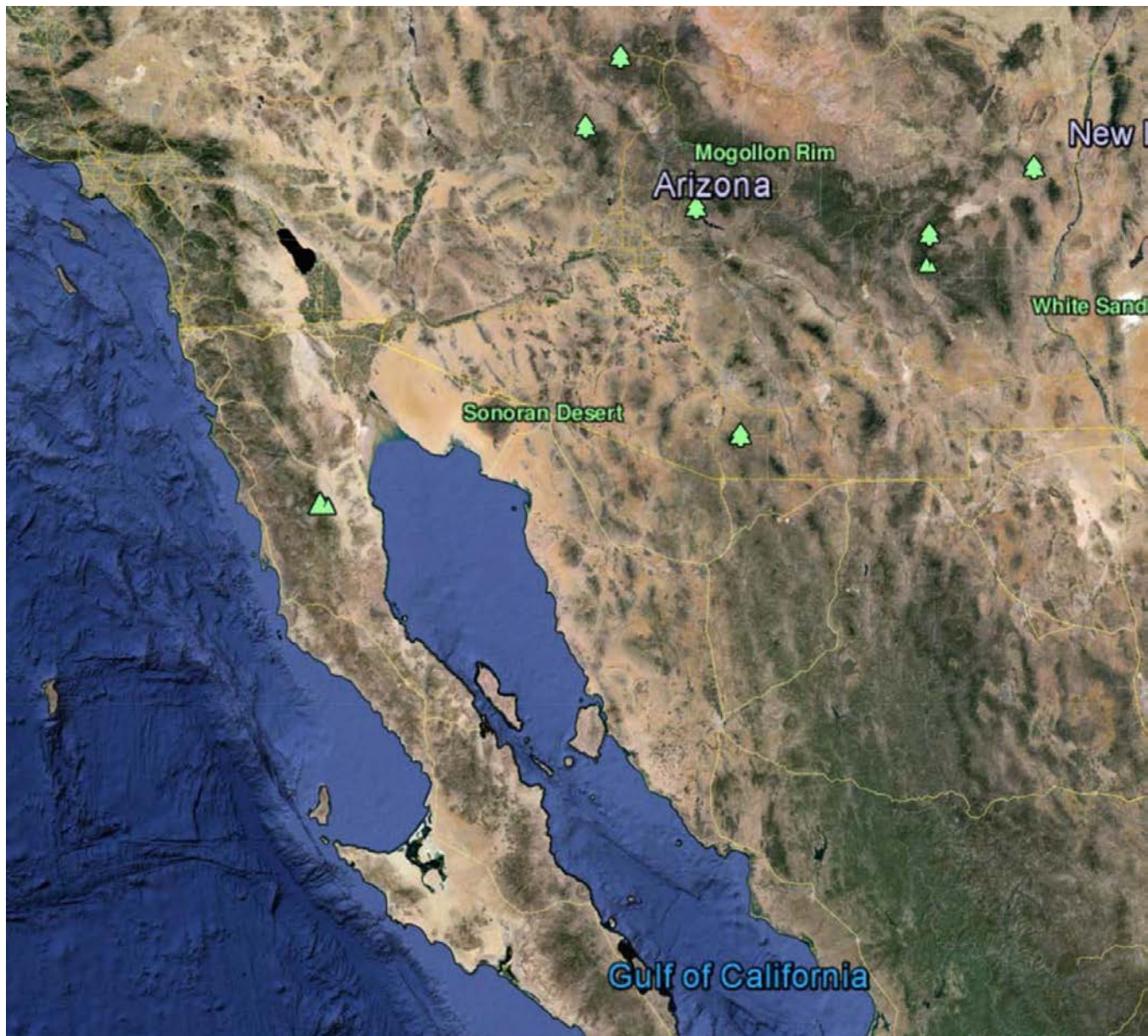
County boundaries shown in white for reference.

Based on the map "Reference Evapotranspiration" from the California Reference Information System (CIMIS), 1999

How was the Sea formed?

Time Line

- Pre-1500:** Called Lake Cahuilla by native residents, the lake experiences periods of flooding and drought.
- 1540:** First exploration of the Colorado River delta by Spanish.
- 1800s:** Cycle of flooding and drought continues.
- 1892:** Salt mine established. Railroad station serving the mine is named Salton.
- 1905:** Floodwaters of the Colorado River change course and flow into Salton Sink.
- 1906:** Salton Sea is measured to be 195 feet below sea level.
- 1942:** All-American Canal provides water to the Imperial Valley, supporting agriculture.
- 1958:** Salton City, a new community on the western shore of the lake, is developed.
- 1960:** On the northern edge of the lake, the North Shore Beach and Yacht Club is developed.
- 1980s to present:** Increased salinity and concentrations of chemicals result in declining wildlife.
- 2000** Diversion of water to San Diego agreement
- 2004:** New approaches to saving the Salton Sea are studied.
- Present** – almost nothing has been done to stabilize the Sea

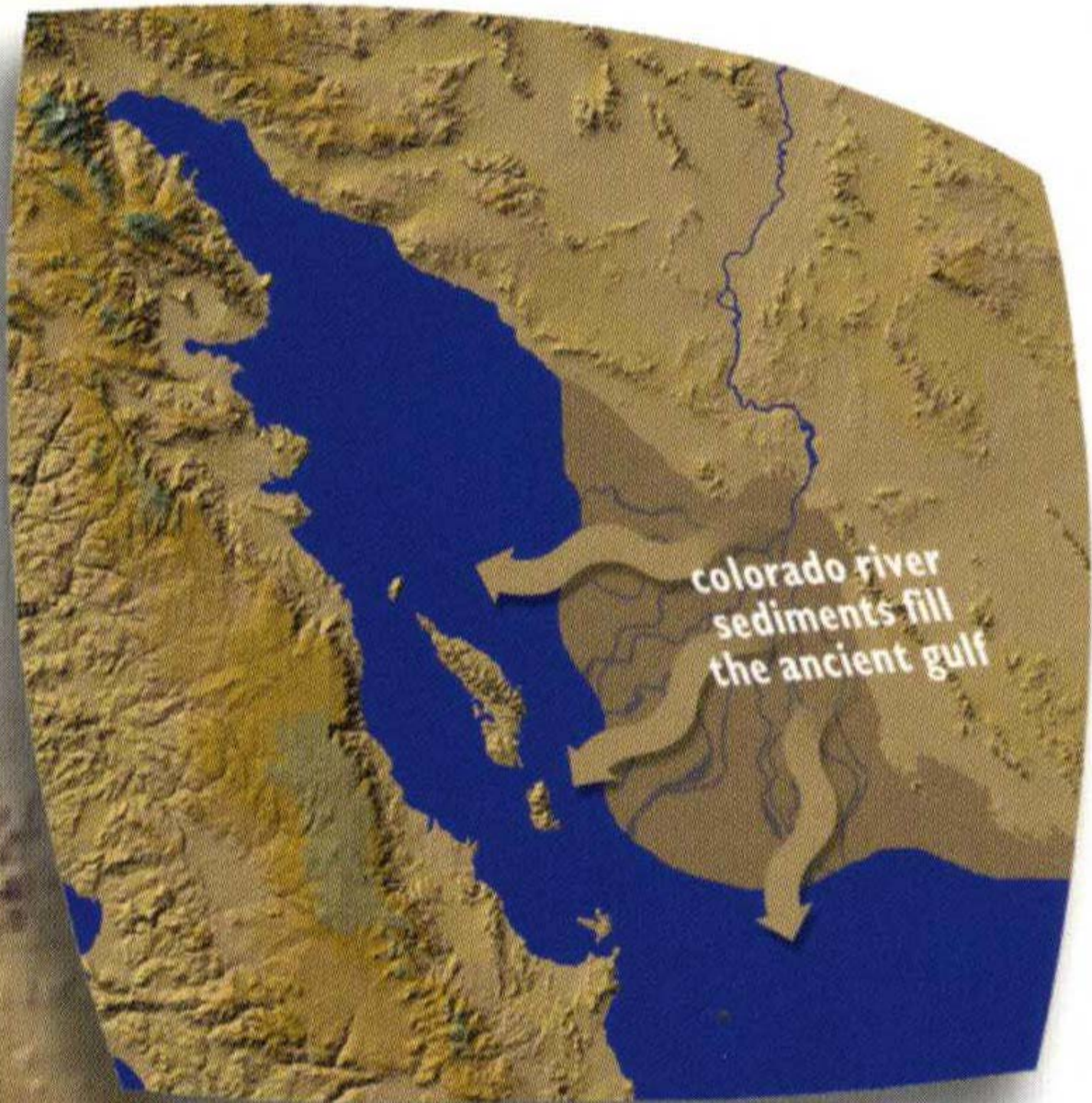


Gulf of California/Sea of Cortez

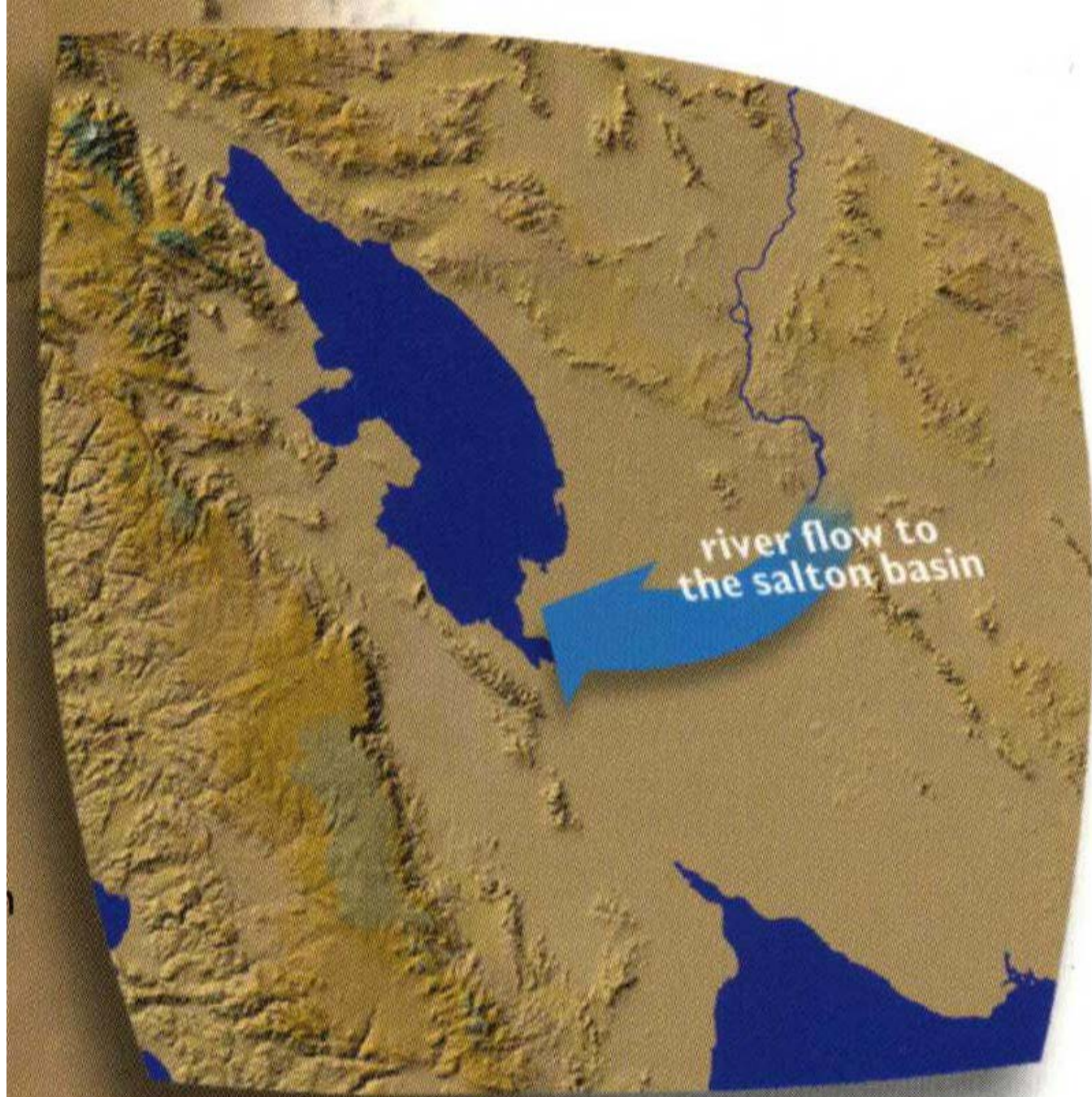


Colorado River

ancient gulf



colorado river
sediments fill
the ancient gulf



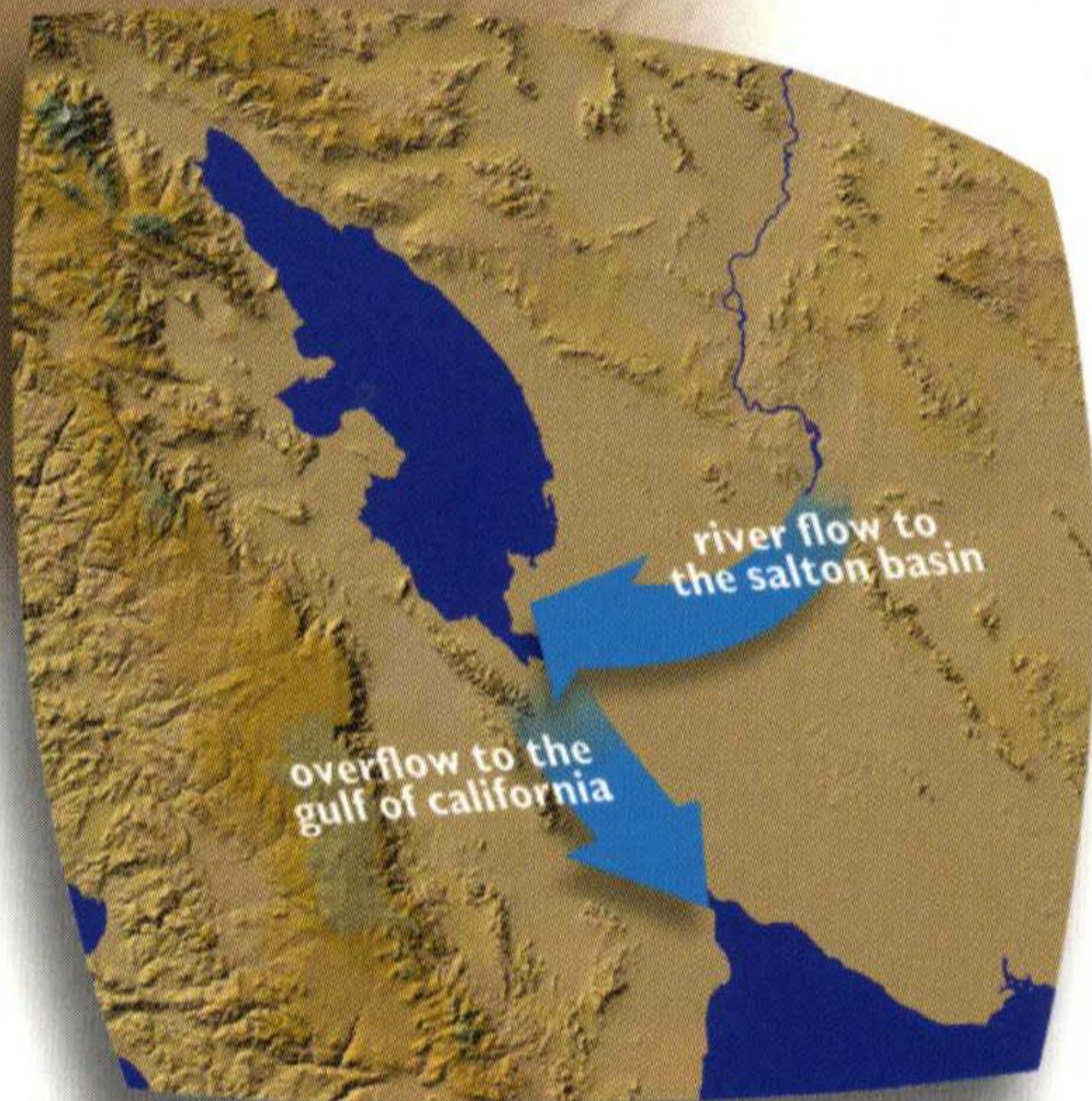
• Indio
(present day)

Current Salton Sea shoreline

Ancient
Lake
Cahuilla

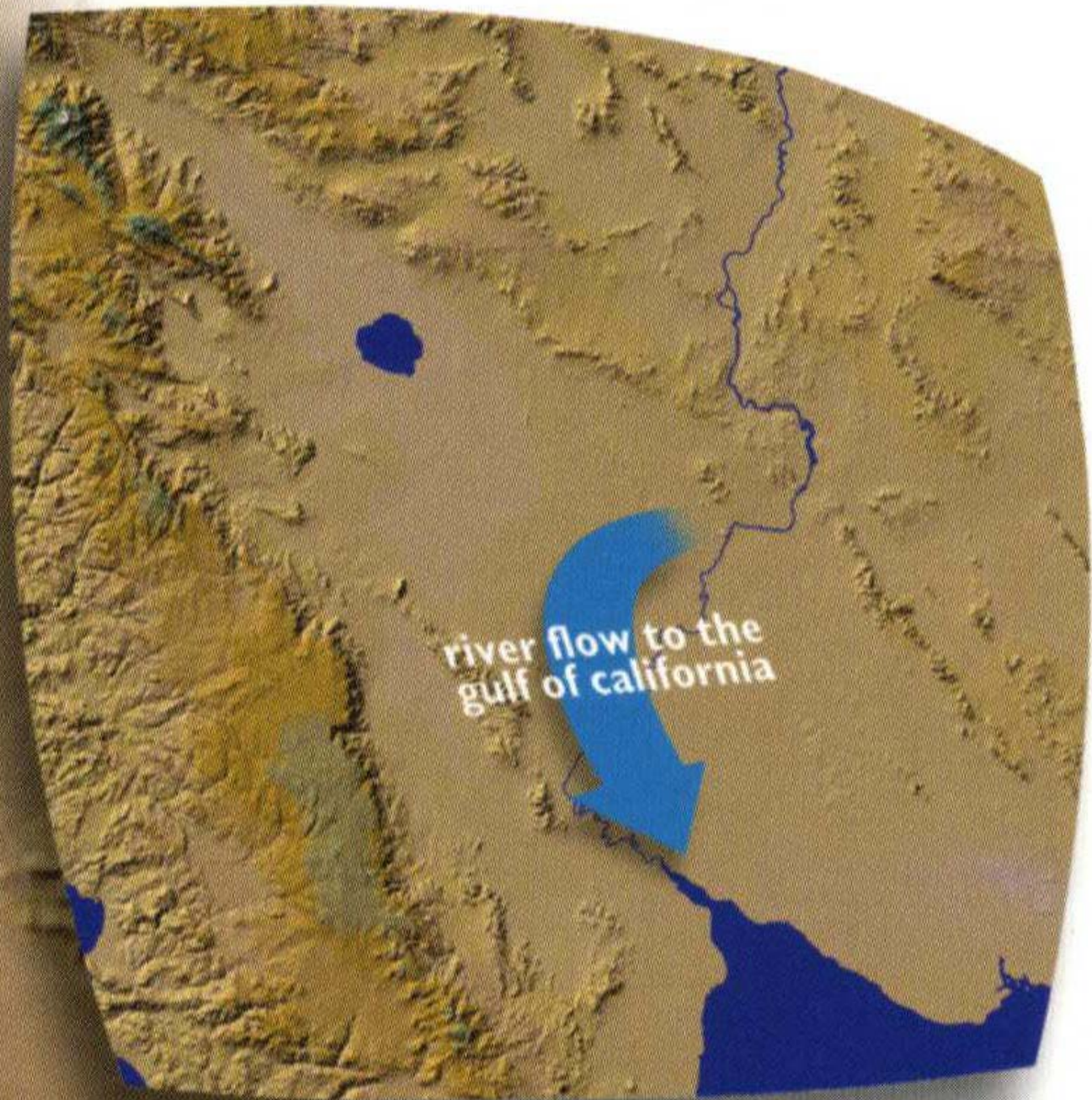
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river flow to
the salton basin

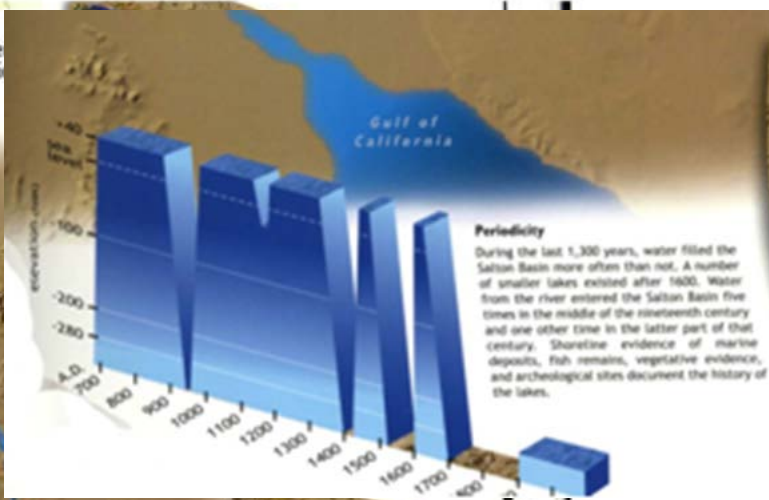
overflow to the
gulf of california



river flow to the
gulf of california

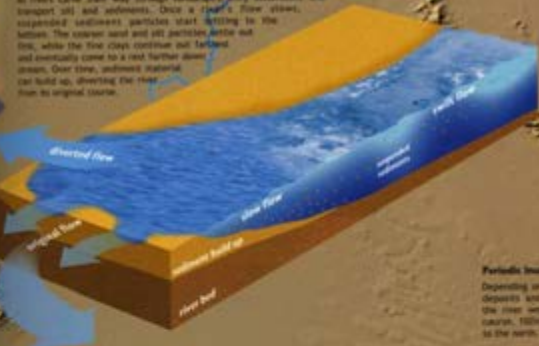


River
Period



Situation

As rivers carve their way through landscapes, they accumulate and transport soil and sediments. Once a river's flow slows, suspended sediment particles start settling to the bottom. The heavier sand and silt particles settle out first, while the fine clays continue to fall and eventually come to a rest farther down stream. Over time, sediment deposits can build up, diverting the river from its original course.



Gulf Flow

Once the deltaic berm was established, it cut off flow from the Colorado River to the northern Salton Basin, effectively drying out the inland lake.



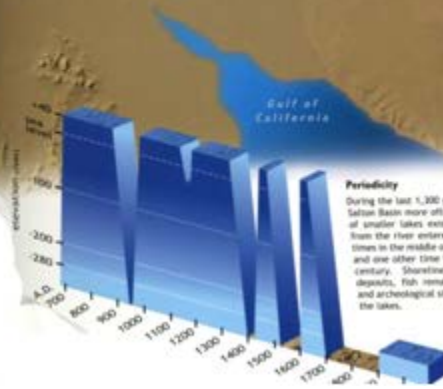
Periodic Inundation

Depending on sediment deposits and flooding, the river would change course, filling the basin to the north.



Over Flow

At times, the river would flow to the Gulf via the Salton Basin. This occurred when the lake filled to the height of the deltaic berm, overflowing into the Gulf.



The redlands institute

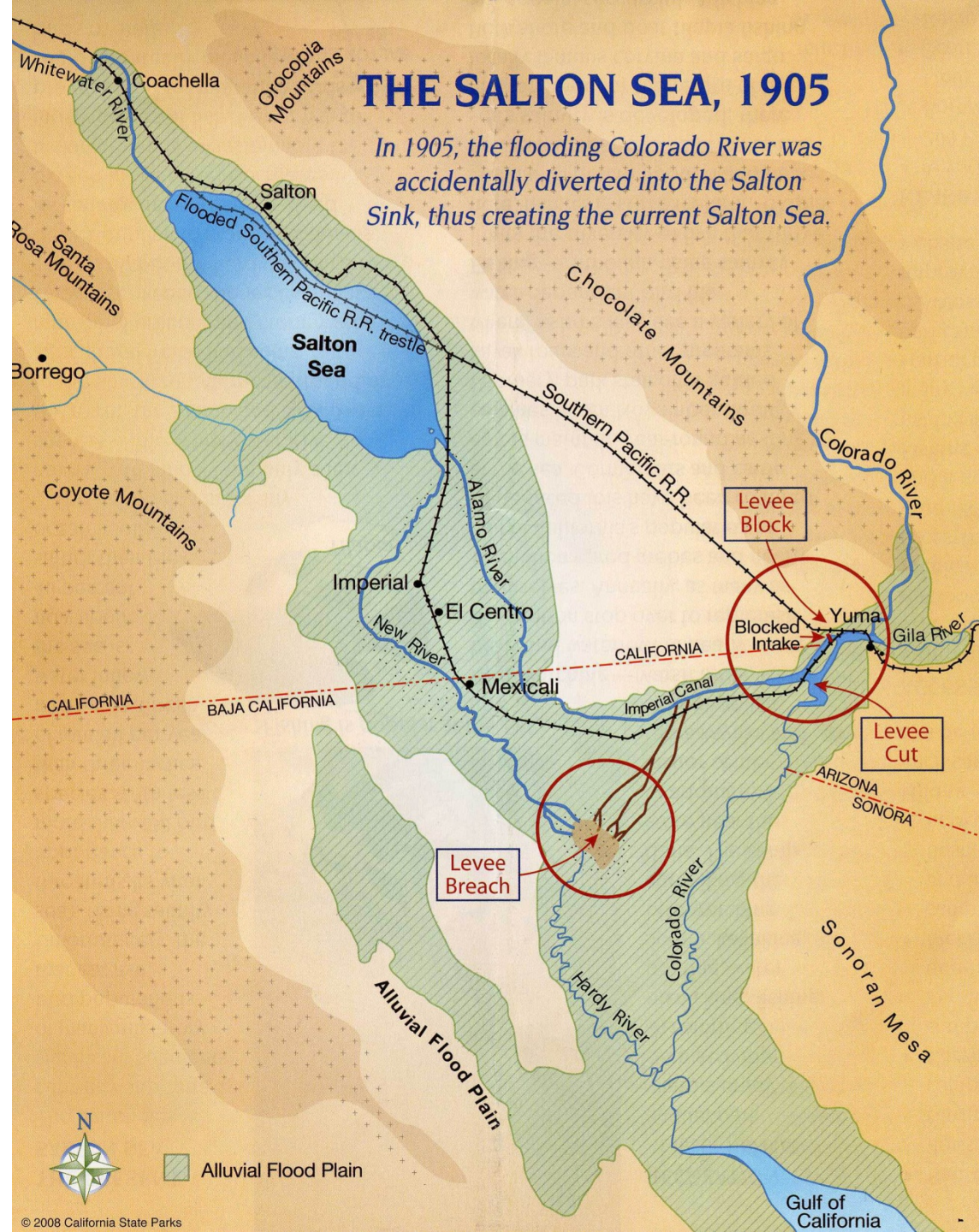
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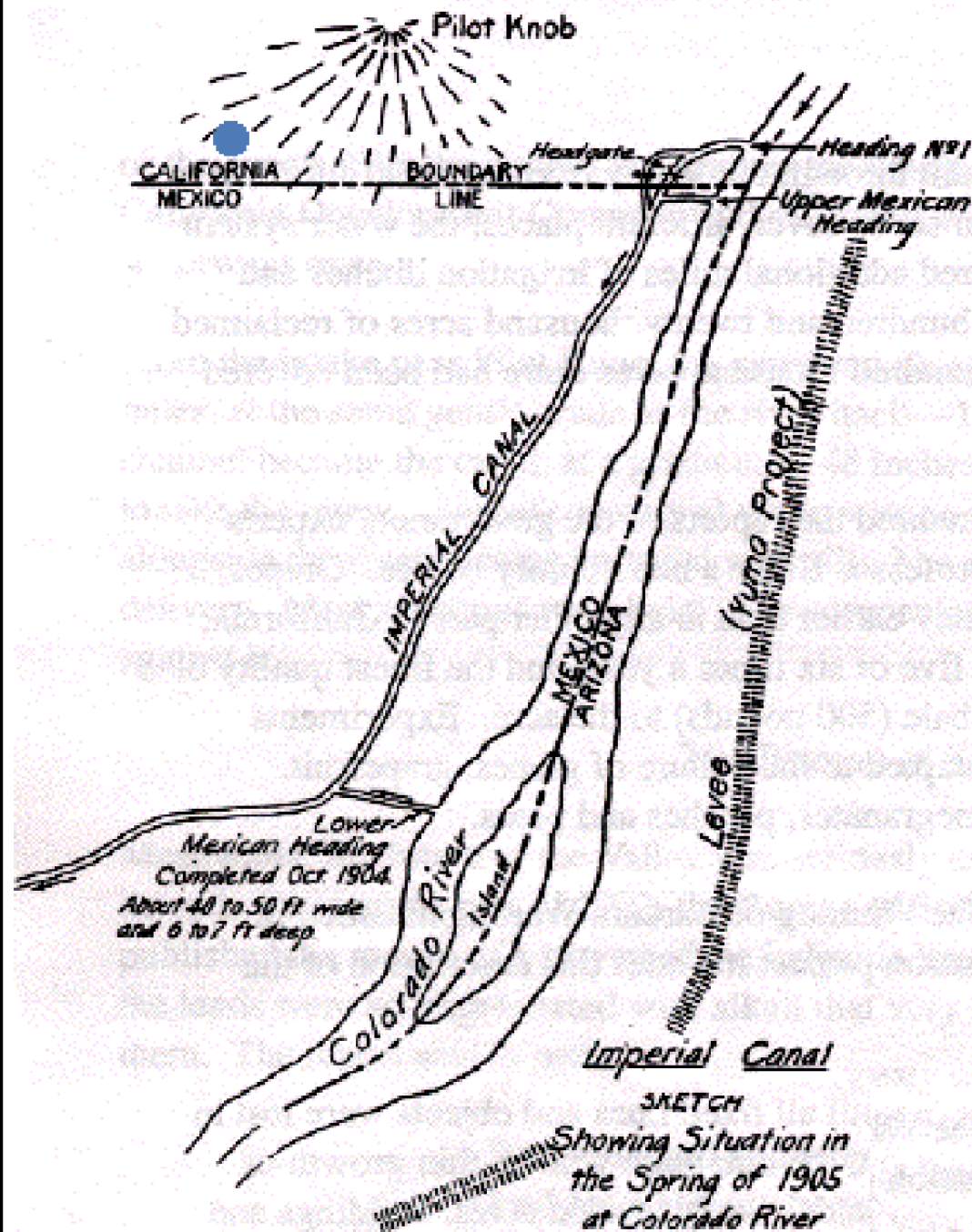
lockages
n. Floods, which
get the riverbed and
river. This carries
delta and creating

of its delta, building
is gradually pushed
it is often rapid. For
over as much as 200
times and lower than
about years ago are today
a delta has formed a berm separating
from basin, cutting off the northern reach

THE SALTON SEA, 1905

In 1905, the flooding Colorado River was accidentally diverted into the Salton Sink, thus creating the current Salton Sea.

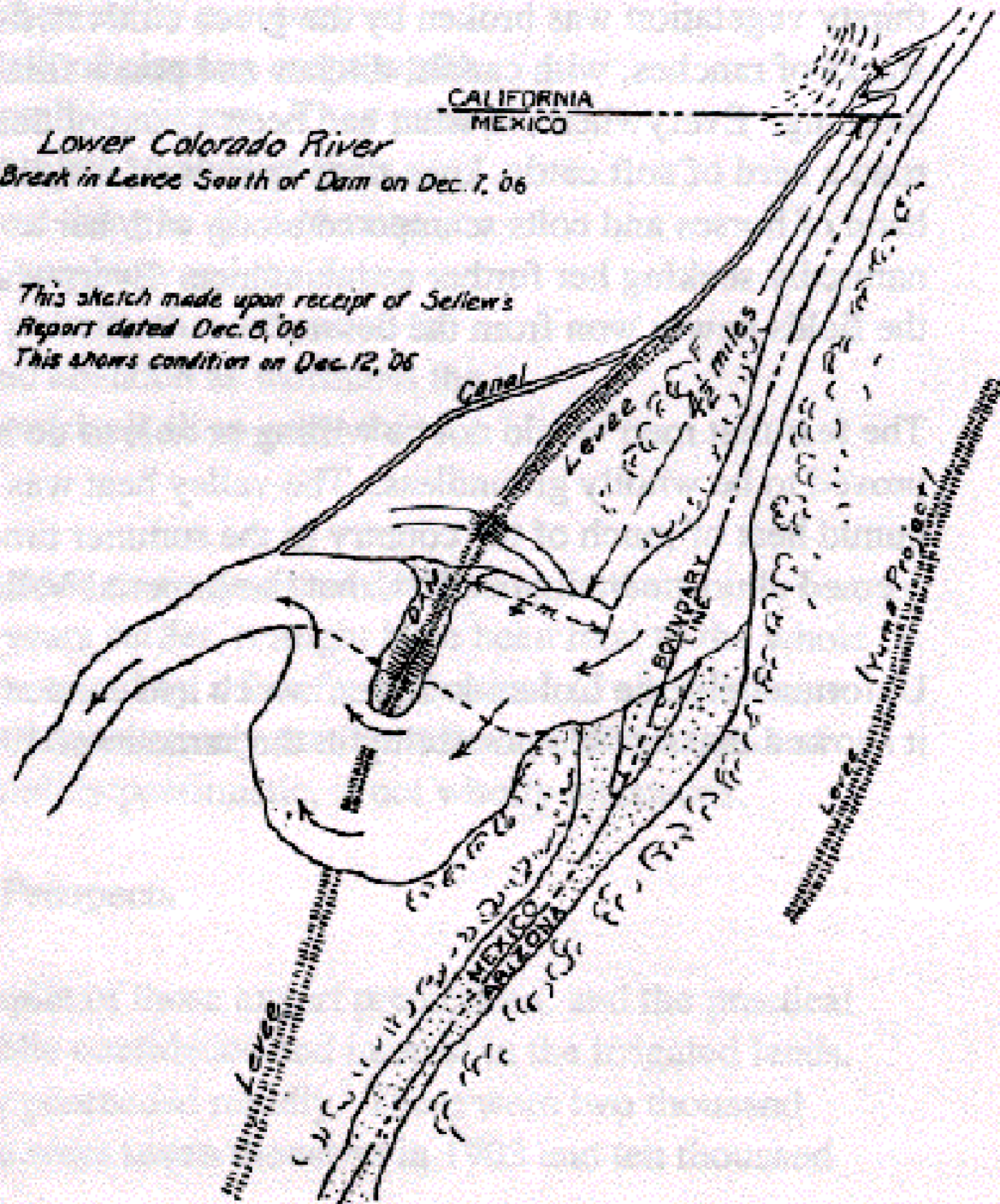




SKETCH
Showing Situation in
the Spring of 1905
at Colorado River

Lower Colorado River
Break in Levee South of Dam on Dec. 7, '06

*This sketch made upon receipt of Seliows
Report dated Dec. 8, '06
This shows condition on Dec. 12, '06*





The California Rivera

- Development in the 1950's
- Salton City and its water front
- The North Shore Yacht Club – Beach Boys, Frank Sinatra, Jerry Lewis
- Bombay Beach
- Other Beach Communities



Salton Sea



Greetings from

Salton Sea



Supplement to
Los Angeles Times

An aerial photograph of North Shore Beach in Los Angeles. The image shows a long, curved beach with a large parking lot filled with cars. Several buildings, including a large hotel or resort, are situated along the beach. A prominent feature is a large, striped, tent-like structure on the beach. The ocean is visible in the foreground, with waves breaking on the shore. The background shows a hilly landscape under a clear sky.

**THE
NORTH SHORE BEACH
STORY**

Tuesday, April 10, 1962



Dressed up for a Motorcycle Movie



boutwell studio



Today (2014)



Tilapia, the only remaining fish in the Sea, survive but are stressed by the high salinity and temperature, and both reduce the dissolved oxygen concentration



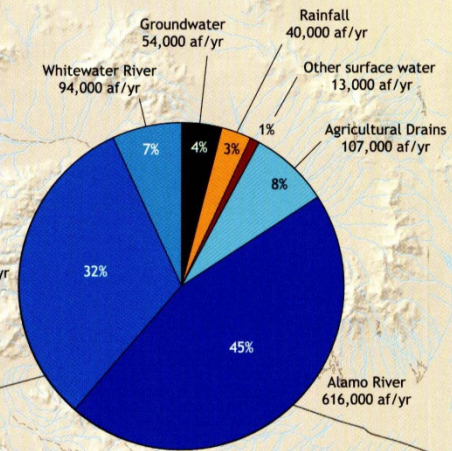
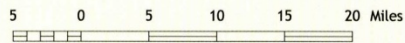
Why hasn't the Sea
dried up?

Sources of Inflow, 2000 Salton Sea Area

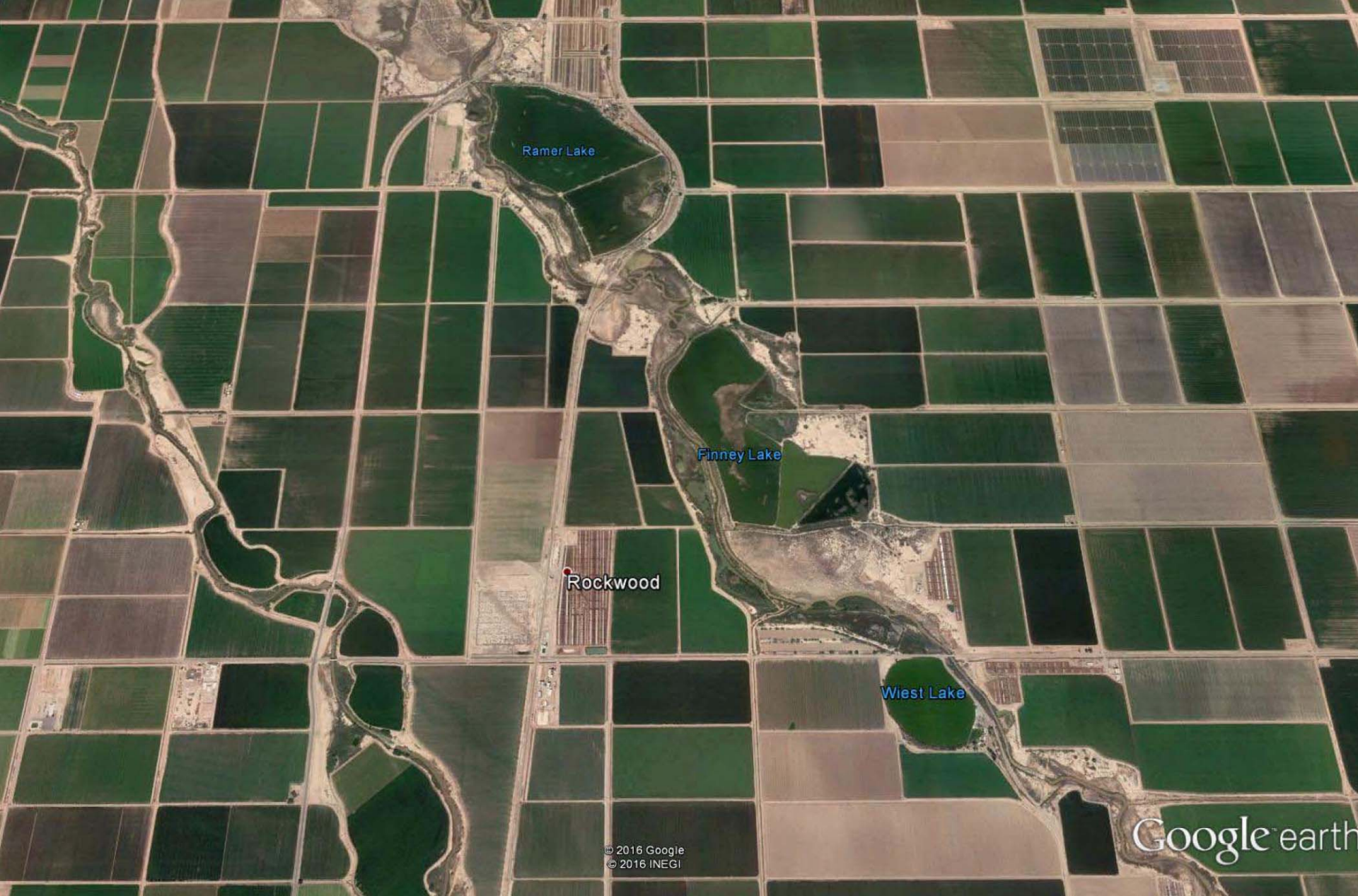
- █ Alamo River (616,000 acre-feet per year)
- █ New River (429,000 acre-feet per year)
- █ Whitewater River (94,000 acre-feet per year)
- █ Agricultural drains (107,000 acre-feet per year)
- █ Agricultural areas

The Salton Sea receives little water from rainfall. The majority of the inflow to the Sea comes from commercial agricultural drains or the major rivers in the watershed.

Based on data from the Salton Sea Authority.



**Comparative inflow
(acre-feet per year)**



New River (right) and Alamo River (left) showing small lakes (lagoons) that provide treatment



Ramer Lake, along the Alamo River

Arundo







Salton Sea Elevation

- Elevation is changing
- Increased until about 1978. There were back-to-back major storms in California that swamped the Salton Sea.
- The level rose and the communities around the Sea were flooded.
- Commercial areas in Bombay Beach and Salton City were flooded with salt water, effectively destroying shore facilities.
- At this point many people and businesses left the area and the decline of the Sea began.

Salton Sea Elevation Con't

- The Sea's level stabilized afterwards but in recent years has declined
- An agreement to transfer water from the Imperial Irrigation District to San Diego has caused the level to decline, with sharp declines expected in the near future
- As the level declines, shore line is exposed, creating dust storms during dry windy conditions
- Elevated respiratory problems are already documented in Brawley and southern communities
- Two examples of Sea Decline follow



4th St

Avenue A

Avenue D

Avenue F

Avenue G

Avenue H

Aisle of Palms

5th St

Avenue B

Avenue C

Avenue E

W115.735°

W115.725°

N33.3468°



4th St

Avenue A

Avenue D

Avenue F

Avenue G

Avenue H

Aisle of Palms

5th St

Avenue B

Avenue C

Avenue E

W115.735°

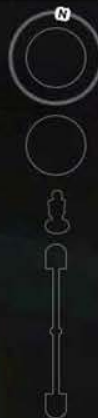
W115.725°

N33.3468°

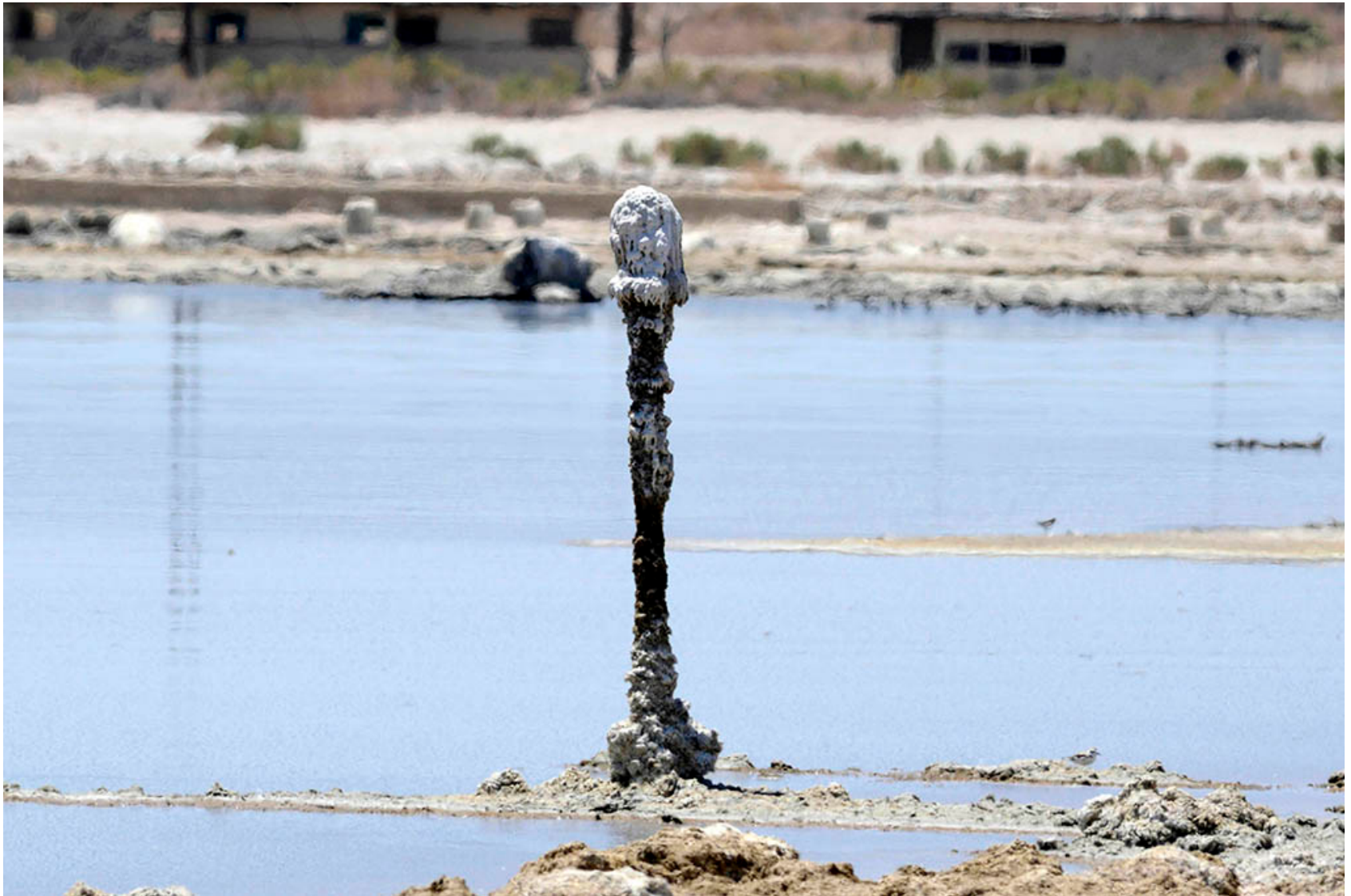


Imagery Date: 8/28/2014 33°24'06.79" N 116°01'59.28" W elev -232 ft eye alt 9923 ft

8/28/2014
1994 2014



Imagery Date: 8/28/2014 33°24'06.79" N 116°01'59.28" W elev -232 ft eye alt 9923 ft



Salt Covered Parking Meter in 2014. Notice the sea level behind the meter

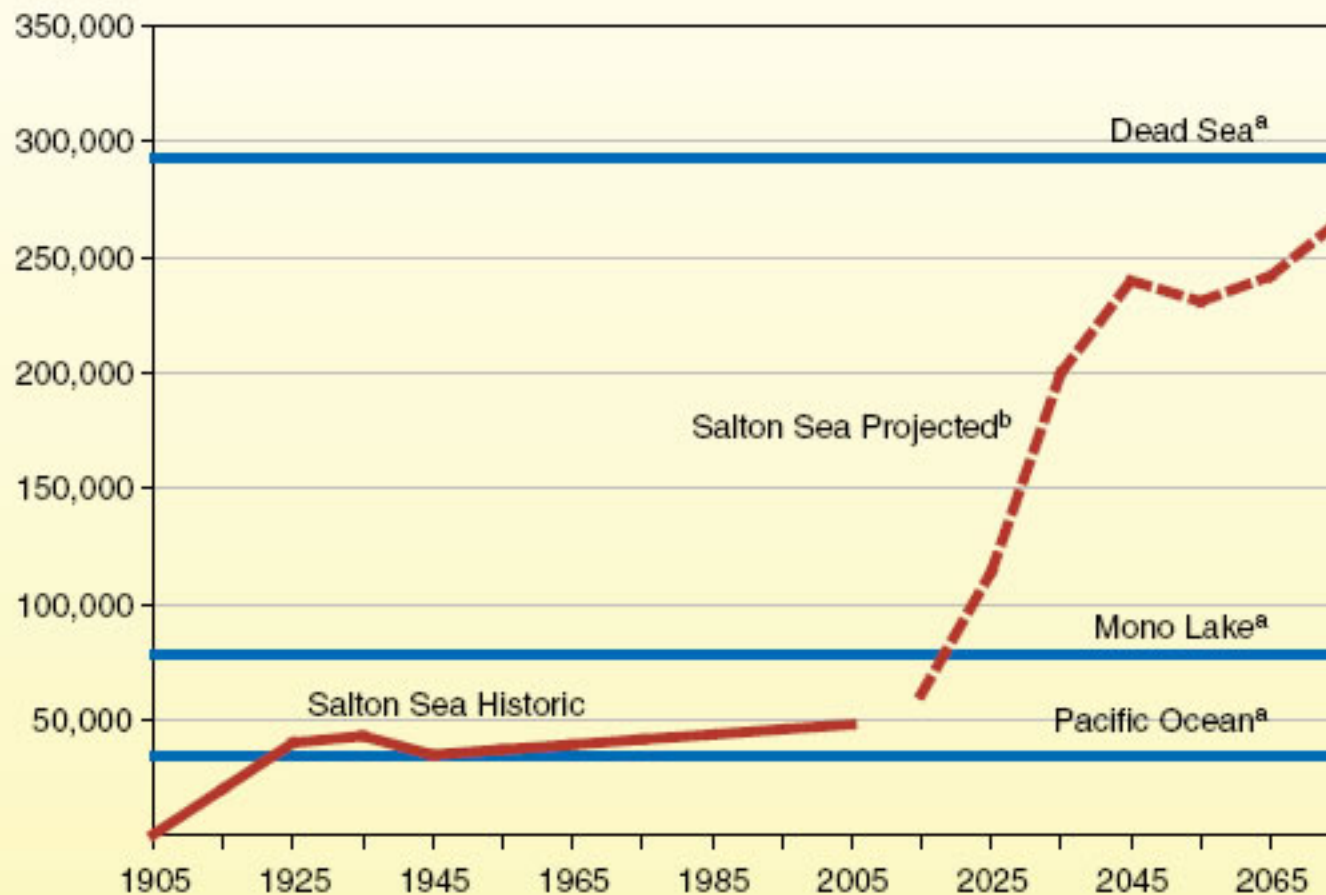


Here is the same meter in 2015, one year later. The water has completely receded

Figure 3

Salton Sea Salinity

Milligrams Per Liter



^aSalinity levels for other water bodies are shown (at current levels) as constant for comparison only.

^bProjected salinity from *Salton Sea Ecosystem Restoration Program Draft Environmental Impact Report*.

Saline Lakes Are Being Created and Impacted Around the World due to Development and Climate Change

Aral Sea (Kazakhstan and Uzbekistan)

Dead Sea (Israel)

Mono Lake (USA)

Owens Lake (USA)

Great Salt Lake (USA)

Bogoria and Magadi (Kenya)

Aral Sea



1977

1977



1987

1987



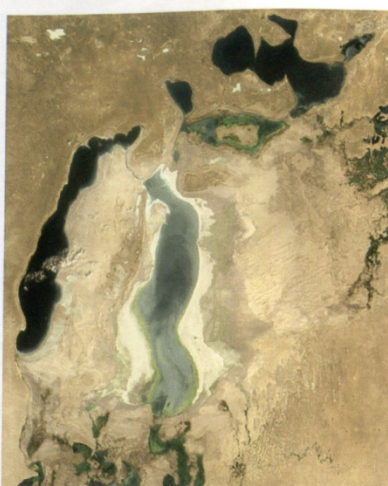
1988

1998



2006

2006



2010

2010



2014

2014





What do you think about being under water?

Wildlife

- Bird life continues but is impacted
- Outbreaks of avian botulism
- As fish decline, so will the bird population























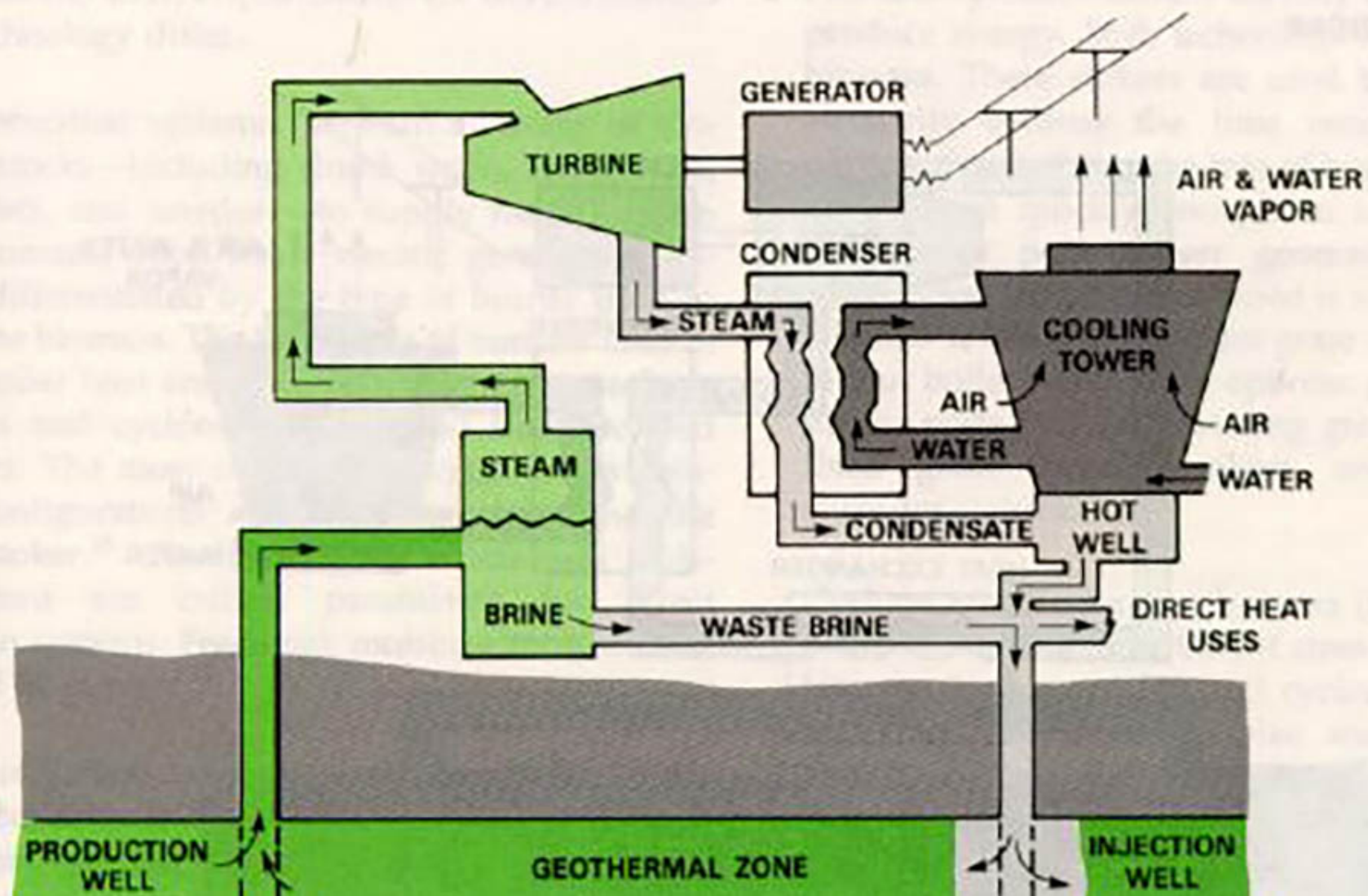
Natural Resources

- Geothermal
- Fish farming
- Very inexpensive land



There are many geothermal plants in the area, which pump hot ground water, extract heat and the return the cool water.

Figure C4. Single-Flash Geothermal Electricity Generating System for Liquid-Dominated Hydrothermal Resources



Communities in Distress

- Bombay Beach
- Salton City
- Salton Sea Beach
- Desert Shores
- North Shore
- Niland



A model California Community







Salvation Mount, in Niland



Salton City – sparsely developed

Previous Warnings

Study to Preserve Salton Sea Hinges on Federal Fund Action

**Continuation of Surveys Held Vital to Agriculture and
Recreation in Area; Tests Await \$103,000 Appropriation**

BY KEN OVERAKER

Times Staff Writer

Preliminary studies on what's wrong with the Salton Sea and how its problems can be corrected have been started by the federal government.

But whether these studies continue depends on congressional approval of a \$103,000 appropriation this year.

The sea, created shortly after the turn of the century when the Colorado River went on rampage, is sustained today by water wastes from desert farms, and appears to be gasping for life.

Unless something is done to prevent

its salinity from rising further, experts predict its demise as a game fishery by 1975.

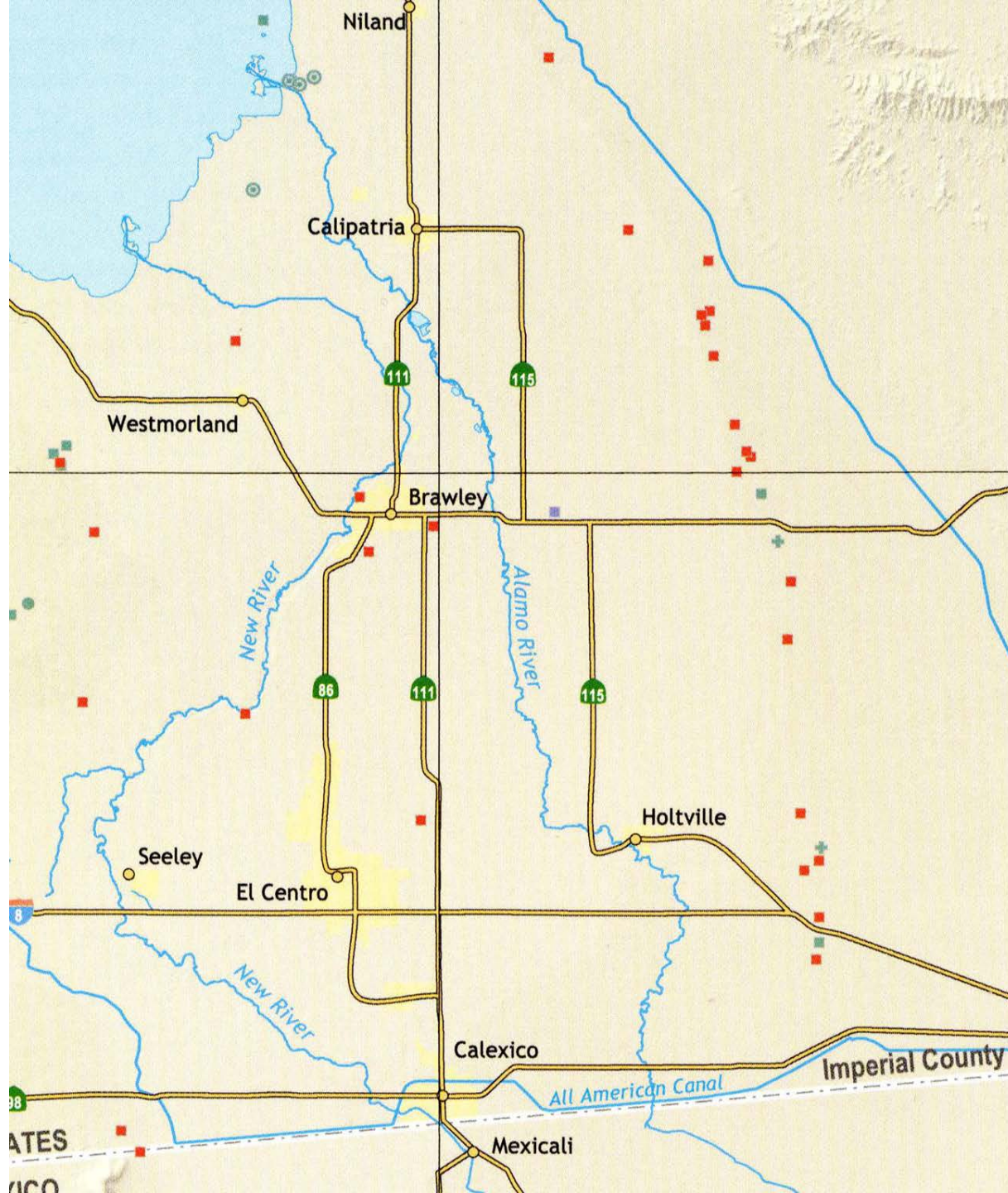
They foresee that soon after that it will be too salty even for swimmers, boaters and water skiers.

Then this jewel in the desert will become another Dead Sea, another Great Salt Lake.

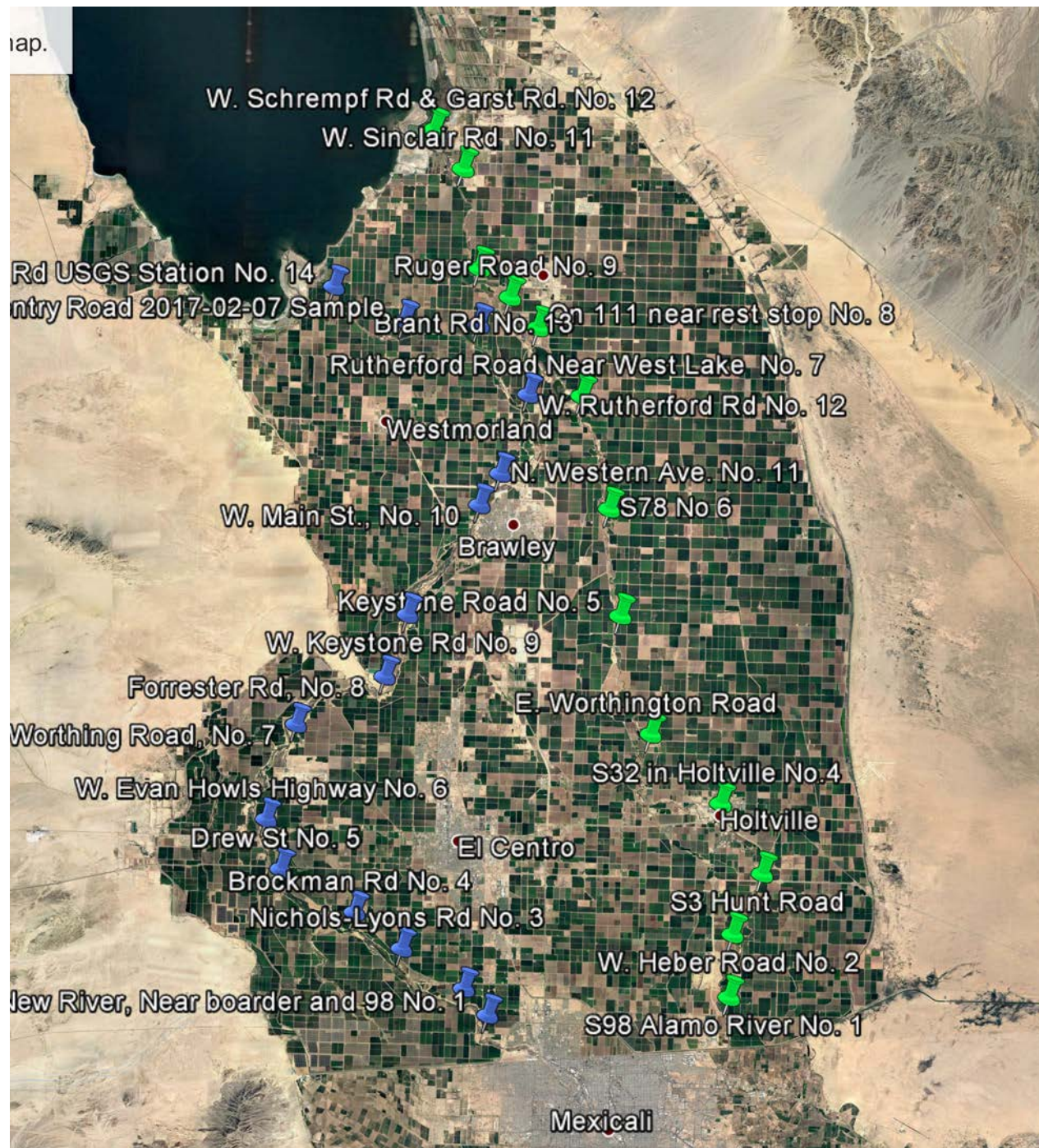
Yet many people hope to keep it alive. The burgeoning populations of Southern California and Arizona looks to it more and more for recreation.

Property Investments

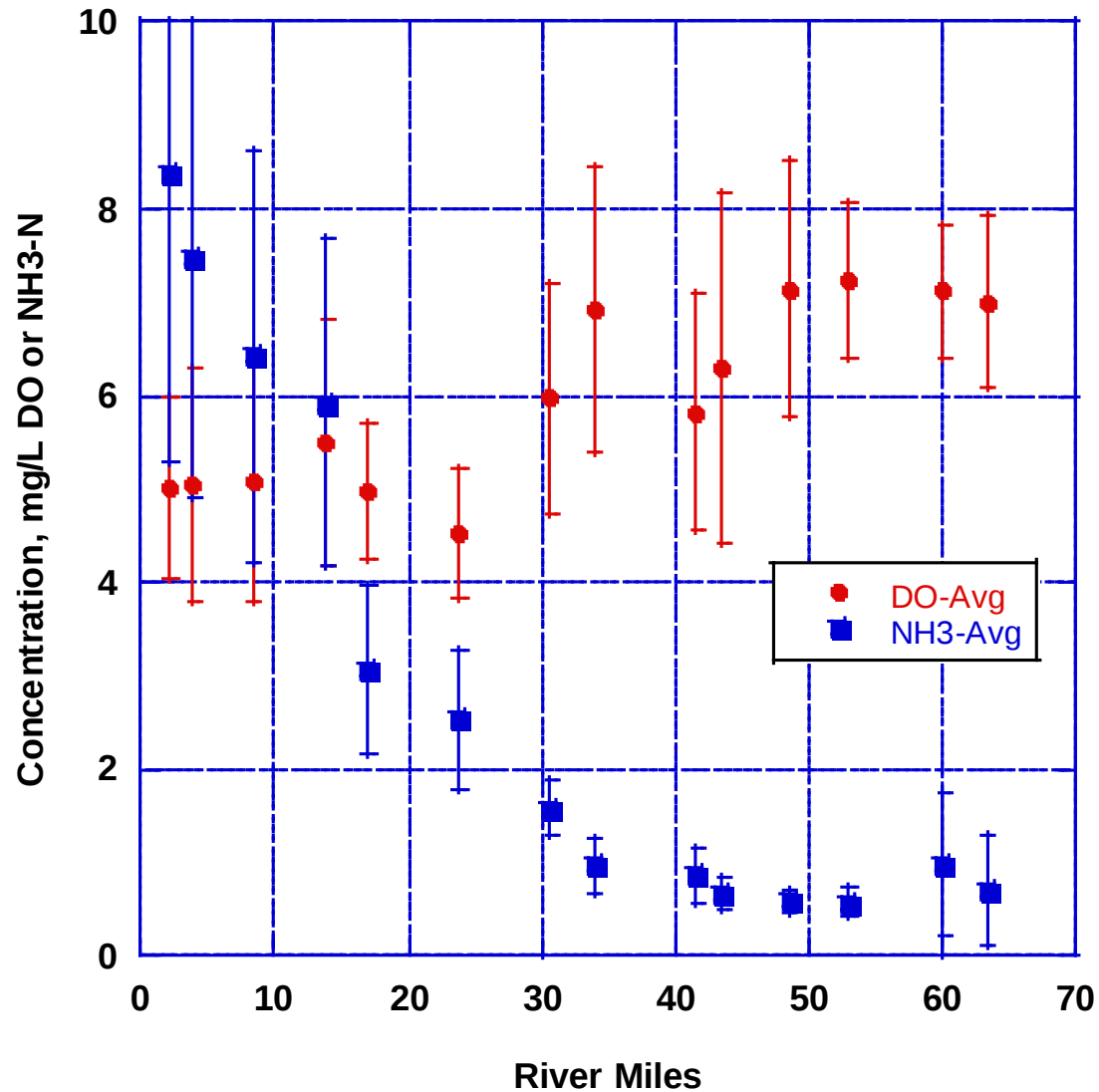
Millions of dollars hinge on its



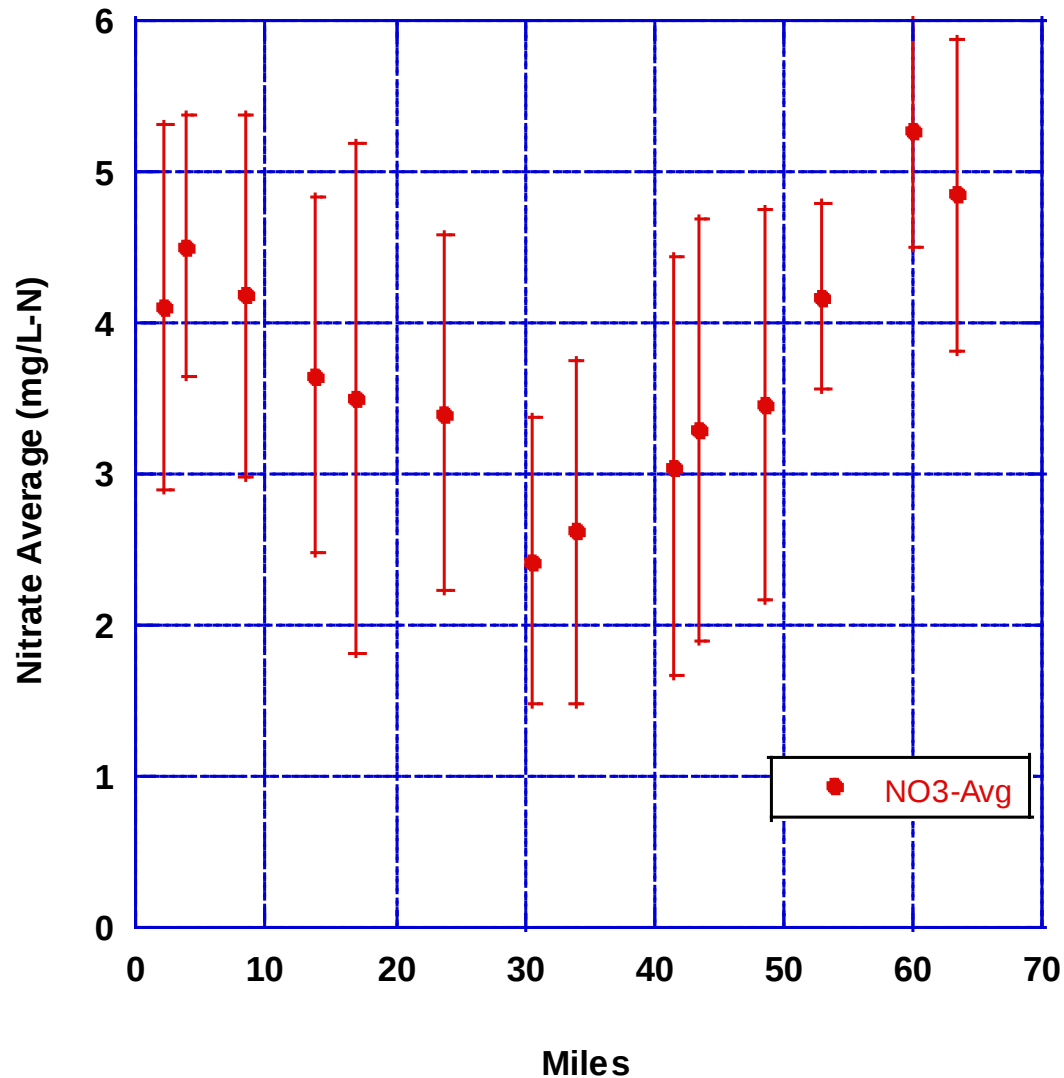
map.



New River NH3 and DO Concentration (four samplings, 6/2016-2/2017)



New River NO₃-N Concentration (four samplings, 6/2016-2/2017)

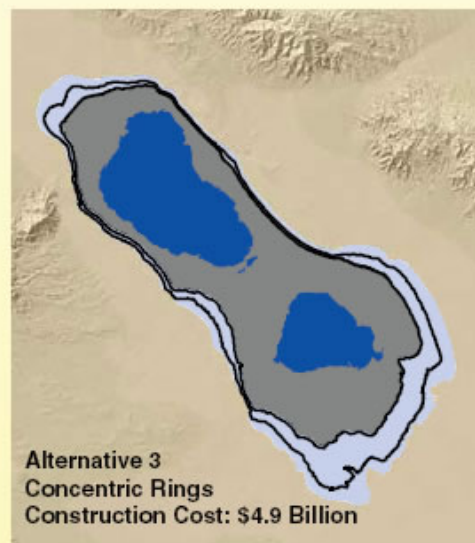
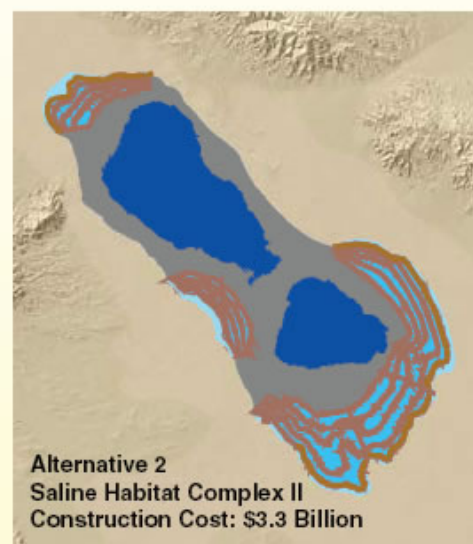
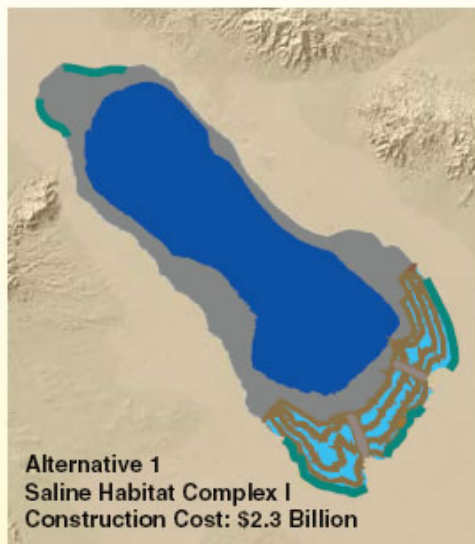


Solutions

- Two big problems
 - Not enough water – current runoff will be redirected to San Diego.
 - No “sink” for the salt – if you use RO to reduce the Sea’s salinity, what do you do with the brine?
- Two categories of solutions
 - Segregate the Sea into parts, low and high salinity
 - Canals to the Pacific or Sea of Cortez

Figure 5

Salton Sea Restoration Alternatives



Shoreline Waterway
Marine Sea

Saline Habitat Complex
Brine Sink

Exposed Playa
Recreational Saltwater Lake

Figure 5 (continued)

Salton Sea Restoration Alternatives

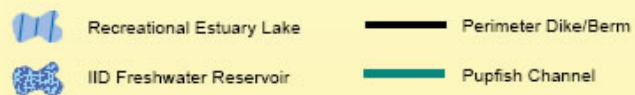
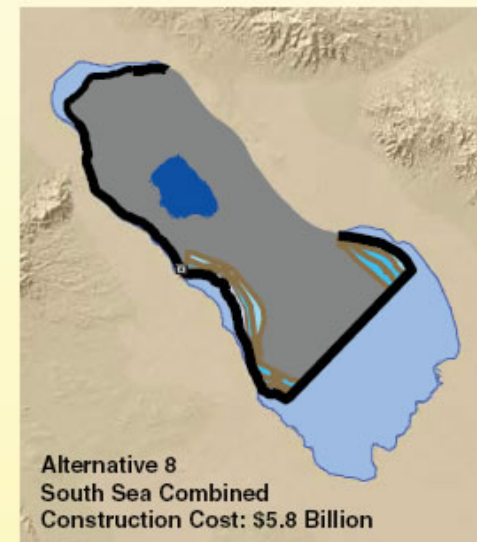
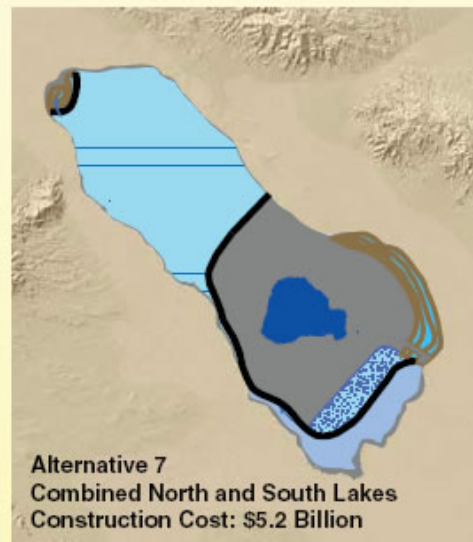
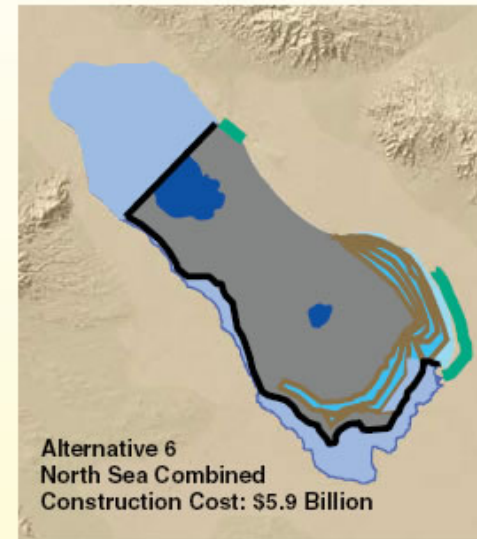
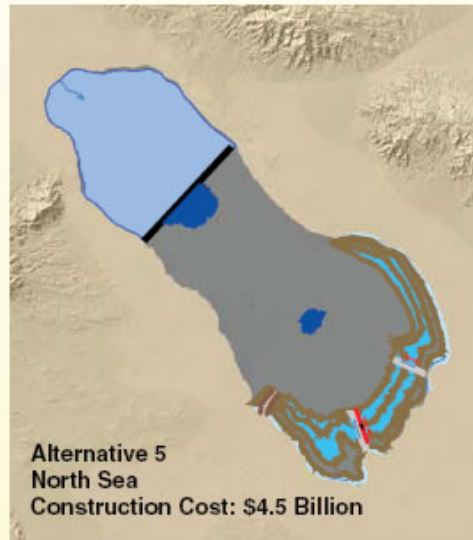
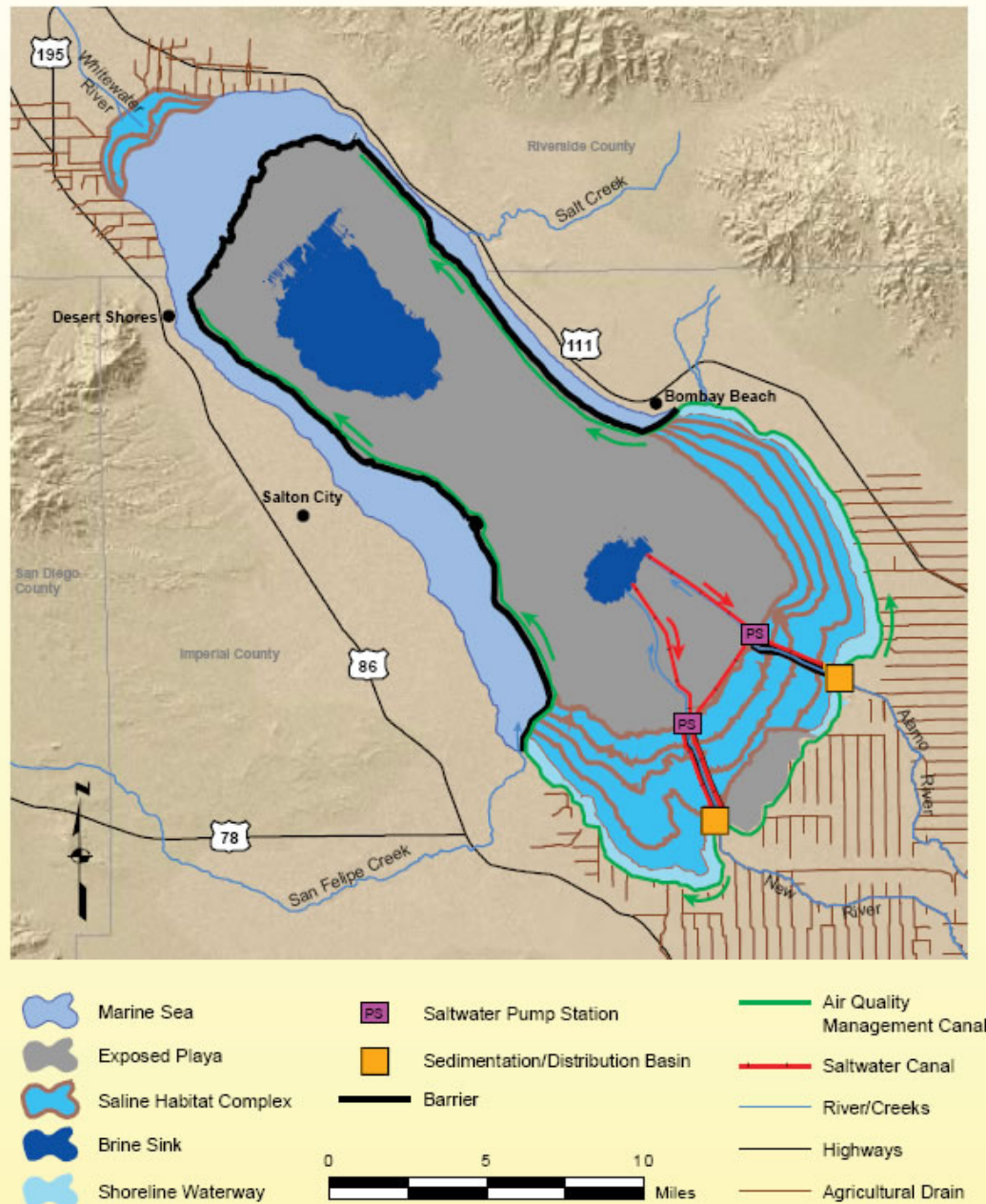
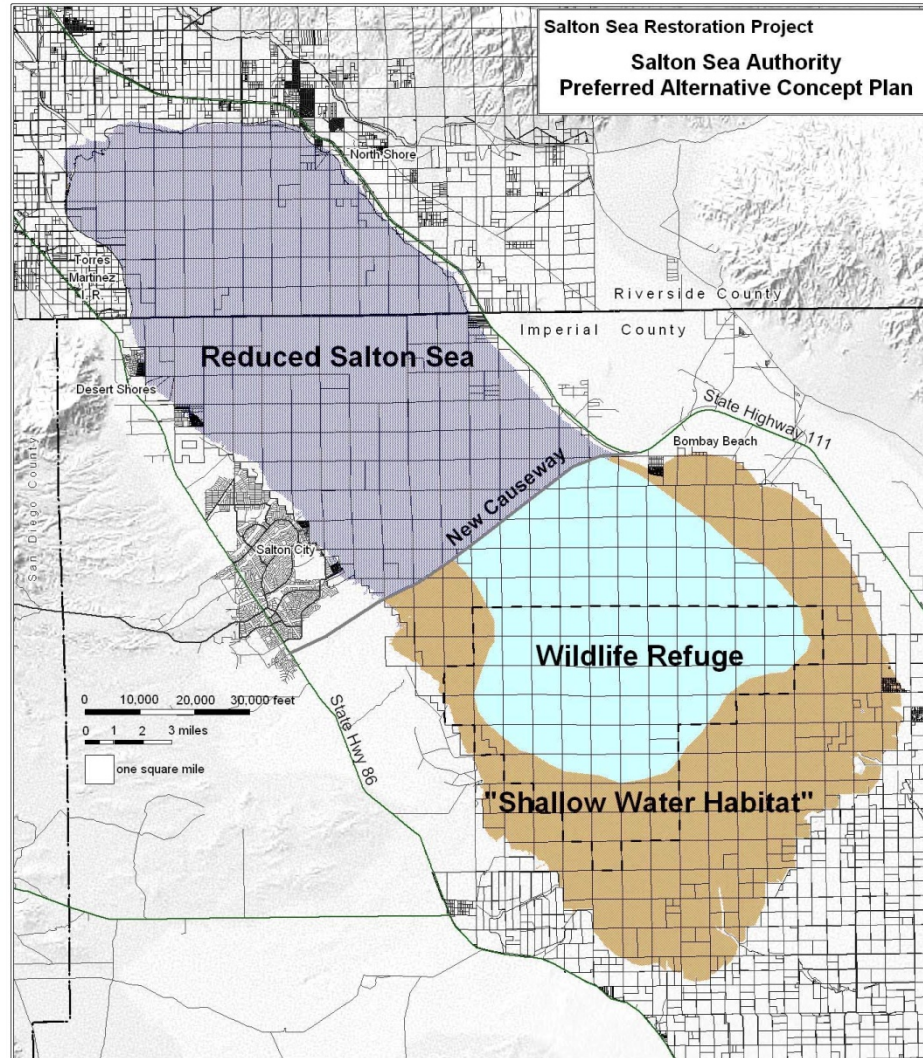


Figure 6

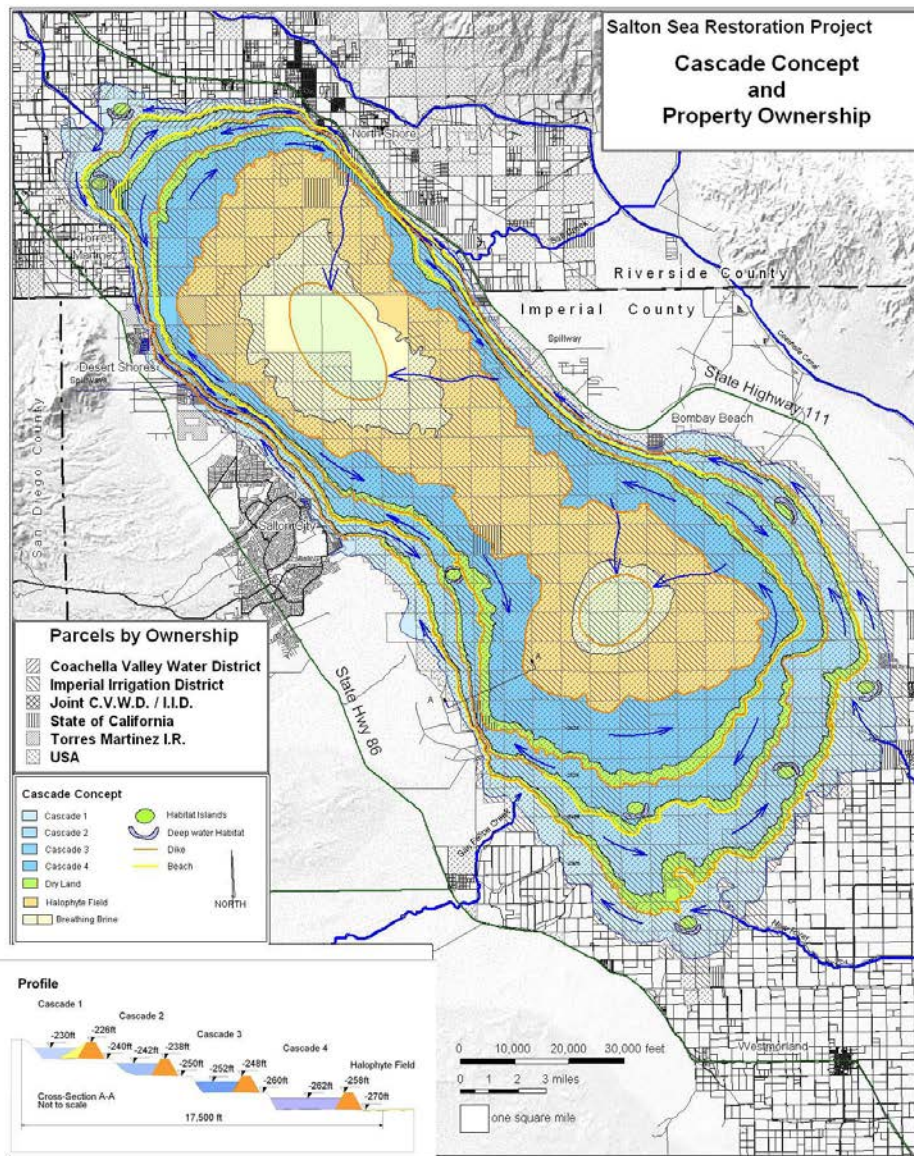
Preferred Alternative



Salton Sea Restoration Project
Salton Sea Authority
Preferred Alternative Concept Plan



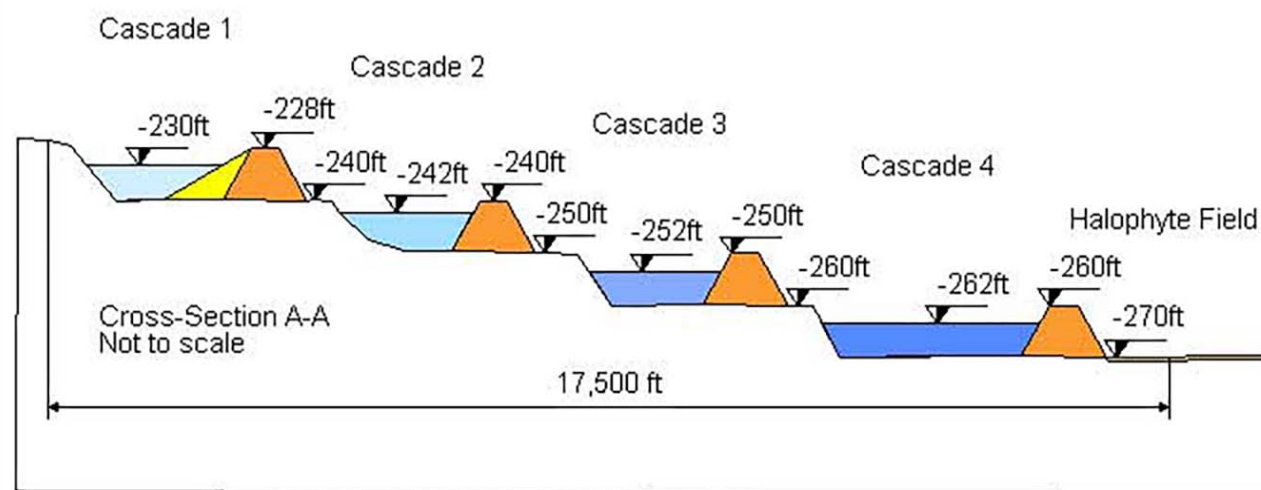
October 18, 2004



Cascade Concept



Profile



Cascade Concept by: The Consortium

Canals

- An alternative solution was proposed by an engineering company in 2003.
- Two canals to the ocean
- One canal will be used to transport salty brine back to the ocean
- The second canal will bring fresh sea water to the sea
- The hope is to stabilize the salinity at about 35 g/L
- Also the Sea's level could be managed.



Where do we go from here?

- The great depression stalled all efforts to improve the Sea
- The Federal government has no interest in helping solve the problems
- A new administration could change this
- Local interest exist but there are few resources and businesses seem unwilling to help
- *Do you have a few billion to spare?*