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Restoring the Salton Sea with drought and lithium

The solution (to lithium extraction and the Salton Sea) is beneath and beyond the Salton Sea: beneath as in shallow and deep groundwater and geothermal water containing lithium; beyond as in teaming with Arizona to desalt groundwater and use the reject water to fill the Salton Sea; and beyond as in reducing the need for WaterFix and restoring the ecosystem of San Francisco Bay. Only now, with the West in a long drought that may be the new normal and the certainty of reduced snow storage, can we see real and sustainable solutions for the Salton Sea as important for all Californians. Drought (or new normal) combines with new desalting technologies, new drilling technology, new carbon dioxide removal (CDR), and new energy (geothermal and lithium) to suggest re-evaluating opportunities.

Additional submitted attachment is included below.

From: markcapron oceanforesters.org
Sent: Monday, 28 February, 2022 12:52 PM
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Cc: icarp@opr.ca.gov; Kaitlin Morton <kmorton@kearnswest.com>; CaliforniaNature@resources.ca.gov; 'michael.mckibben@ucr.edu' <michael.mckibben@ucr.edu>; m hasan <m.hasan@oceanforesters.com>; jimstewart oceanforesters.org <jimstewart@oceanforesters.org>
Subject: Restoring the Salton Sea with drought and lithium

Dear Jennifer and Lisa,

The solution is beneath and beyond the Salton Sea: beneath as in shallow and deep groundwater and geothermal water containing lithium; beyond as in teaming with Arizona to desalt groundwater and use the reject water to fill the Salton Sea; and beyond as in reducing the need for WaterFix and restoring the ecosystem of San Francisco Bay. Only now, with the West in a long drought that may be the new normal and the certainty of reduced snow storage, can we see real and sustainable solutions for the Salton Sea as important for all Californians. Drought (or new normal) combines with new desalting technologies, new drilling technology, new carbon dioxide removal (CDR), and new energy (geothermal and lithium) to suggest re-evaluating opportunities.

Attached "SaltonSea, CDR, & Water…" sketches possible projects. You can mix and match or plan for concurrent or sequential trials. The numbers in the pictures are 20-year averages.

Attached "SaltonSea Salinity35Area400" is a "what if" spreadsheet for each project. The primary message – When these facilities are installed, California can adjust two to five parameters to hold the Salton Sea area near 400 square miles and simultaneously hold salinity below 35 ppt for a couple centuries.

The key will be coordinating the stakeholders of each opportunity to maximize the overall benefit. The overall project can be the Salton Sea's circular economy, except for the groundwater depletion, which you can ration to last past the area's flooding by sea level rise.

Feel free to distribute these documents or excerpts from them widely, especially to your experts. We really appreciate "won't work … because" comments as they often improve the opportunities. We are available for phone or virtual discussion most days between 10am and 6pm, California time.

Adding to Dr. McKibben's thoughts – The children of Imperial County and elsewhere can have clean air, healthy food, healthy climate, and lucrative careers in green energy near the Salton Sea.

Thank you,

Mark, Mohammed, and Jim

Mark E. Capron, PE
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Ventura, California
Cell: 805-760-1967, Skype: Mark.Capron2
Feed the world. Fuel the world. Restore natural CO_2 levels. Cure climate change.

California–Arizona Water, CO_2 Removal, Air Quality, and Food Opportunities
Salton Sea and San Francico Bay ecosystem restorations while mining lithium

The solution is beneath and beyond the Salton Sea: beneath as in shallow and deep groundwater and geothermal water containing lithium; beyond as in teaming with Arizona to desalt groundwater using the reject water to fill the Salton Sea; and beyond as in reducing the need for WaterFix and restoring the ecosystem of San Francisco Bay. Only now, with the West in a long drought that may be the new normal and the certainty of reduced snow storage, can we see real and sustainable solutions for the Salton Sea as important for all Californians. Drought (or new normal) combines with new desalting technologies, new drilling technology, new carbon dioxide removal (CDR), and new energy (geothermal and lithium) to suggest re-evaluating opportunities.

Four possible government and private investment opportunities provide multiple synergies to achieve these outcomes:

- Refilling the Salton Sea (400 square miles) to reduce toxic dust storms over five years.
- Restoring the Salton Sea salinity to less than 35 ppt and the associated ecosystem for healthy aquatic foods production over ten years. (Food worth over $1B/year.)
- Carbon dioxide removal (CDR) and sequestration that compliments the ecosystem restoration and renewable mining of lithium from deep groundwater.
- Analogous restoration of San Francisco Bay's historic ecosystem.

The **CDR Facility** is an electrochemical alkalinity addition process. (There are at least a dozen start-up companies.) These ocean alkalinity processes have two water outputs: (1) high alkalinity water (high pH, basic); and (2) low alkalinity water (low pH, acidic). Both also have pure hydrogen and oxygen outputs. The green hydrogen is sold as carbon-negative fuel or green chemical (ammonia fertilizer) production. The renewable acid water can be used to increase the yield of lithium from far beneath the Salton Sea.

Adding alkalinity to seawater allows the water to absorb and retain more CO_2 indefinitely. That is, adding alkalinity temporarily raises the water pH (countering ocean acidification). Then more CO_2 dissolves in the water (from the air or from growing shellfish), which lowers its pH. More alkalinity may be added, and so on.

Sustainable Ecosystem of (carbon-negative) Aquatic Foods Ecosystem Restoration (**SEAFoods EcoRestor)** becomes possible when Salton Sea salinity in similar to the ocean. SEAFoods EcoRestor could produce healthy food if herbicides and pesticides are flushed out.

SEAFoods EcoRestor is a combination of Ecosystem Recovery, Nutrient Recycling, to match the nutrient extraction, and CDR to offset shellfish forming shell. It is about 20% (by area) intensely managed nutrient recycling-plant growing-harvesting and 80% no-take reserve – marine protected areas proactively managed for biodiversity conservation with livelihoods.

Both the Salton Sea (Projects A-C) and San Francisco Bay (Project D) require about 10 billion oysters to filter their water in a week or two. 10 billion oysters will grow about 700,000 tons of shell per year. The growing oysters would be worsening ocean acidification by 300,000 tons of CO_2 per year if not for the CDR. With CDR, abundant shellfish lock the alkalinity provided by the CDR facility in seashells while the shell buffering effect helps maintain pH near the historic 8.2 independent of atmospheric CO_2 concentrations. With the CDR facility enabling sustained shellfish growth, the SEAFoods EcoRestore can produce carbon-negative food. There are currently no other plans for carbon-negative food.

In Figures 1-6, (Projects A-C) the **Ag Treat Facility** removes agriculture herbicides, pesticides, and salt from the agriculture (Ag) drainage.

The **GW Desal Facility** (Projects B, C) could start with reverse osmosis on slightly brackish groundwater (near 3,000 ppm). Producing roughly equal amounts of product water and reject brine provides the additional (above the evaporation rate) water needed to refill the Sea.

The **SW Desal Facility's** (Project C) purpose is to remove salt from the Salton Sea. (The SW Desal Facility is unnecessary, if employing deep injection.) It does so by extracting the saltiest water from low points in the Salton Sea and concentrating the reject brine to about 30% salt. In Figure 1 all the water input to the SW Desal Facility is the saltiest water from the Salton Sea. In Figure 3, the input would be a blend of the saltiest Salton Sea water and seawater from the Gulf of California.

In Figure 7 (Project D), **San Francisco Bay** restoration involves restoring an ecosystem of shellfish and underwater plants (seagrass and seaweed) aided by CDR to neutralize ocean acidification. The Salton Sea (current condition) could host trials of CDR processes (the ones not requiring sea life) so that only safe and effective processes are considered for other locations.

The associated worksheet "SaltonSea Salinity35Area400…" contains a tab for each project. There are many adjustable parameters in each tab allowing "what if" calculations. The primary message of the worksheet tabs – When these facilities are installed, California can adjust two to five parameters to hold the Salton Sea area between 400 square miles simultaneously holding salinity below 35 ppt for a couple centuries.

A. Restore the Salton Sea with groundwater, CDR, and deep injection[1]

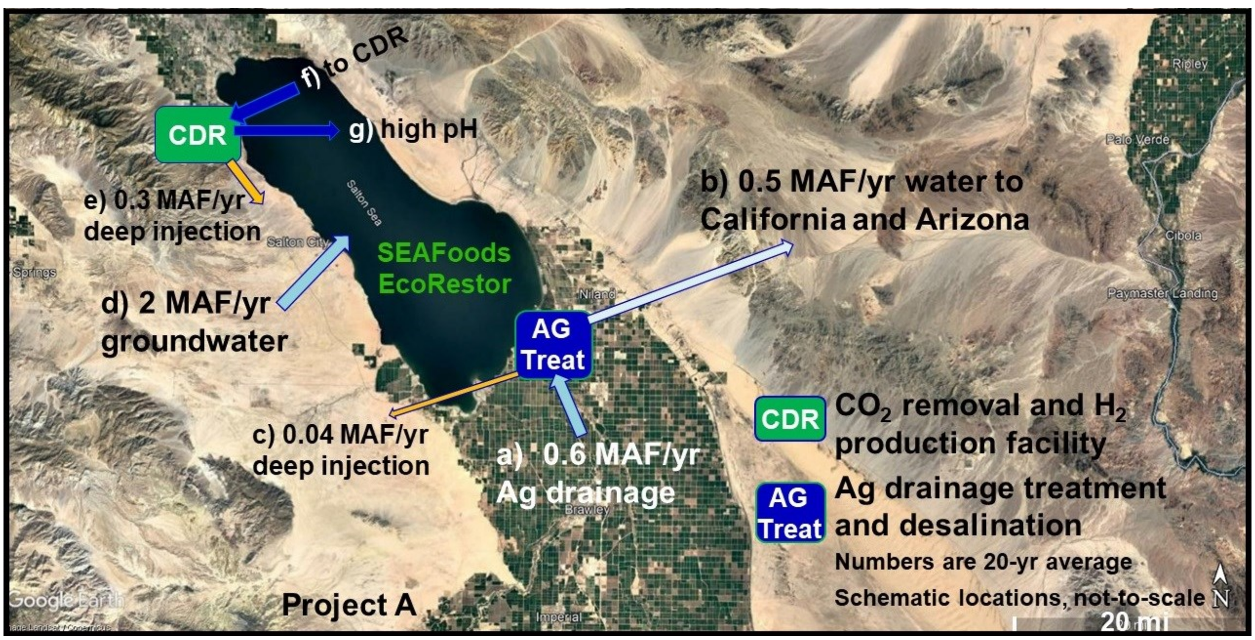

Fig. 1 – Filling and restoring the Salton Sea with local groundwater – Aerial schematic

After 10 years, the sea could be maintained at 35 ppt salinity and 400 sq. mi. The Figures 1 and 2 (Project A, worksheet tab "A Sal35Area400Gw-DpInjt") would:

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[1] See Excel worksheet "SaltonSea Salinity35 Area400…" with 20-year projections of Salton Sea salinity, area, and the fraction of area that would be filled with brine ponds. The numbers are adjustable over a wide range.

1. Clean the agriculture drainage water for reuse in Arizona and California, injecting the toxic brine reject water deep underground. This brine may be suitable for lithium mining.
2. Pump otherwise useless groundwater directly into the Salton Sea. Pumping 2 MAF/yr of groundwater could deplete area brackish groundwater in two thousand years[2].
3. Increase the alkalinity of the saltiest Salton Sea water for carbon dioxide removal (CDR).
4. Inject the saltiest low alkalinity (acidic) water deep underground. This brine may be suitable for lithium mining.

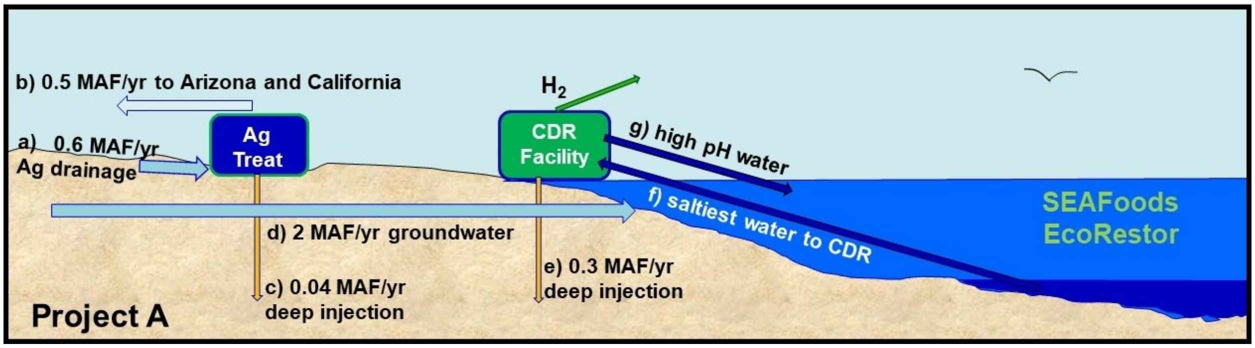

Fig. 2 – Filling and restoring the Salton Sea with local groundwater – Elevation schematic

Lettered features of Project A (Figures 1 and 2):

a) Agriculture drainage is treated for reuse.
b) The treated ag drainage produces about 0.5 MAF/yr of clean water
c) Treated ag drainage produces about 0.04 MA/yr of toxic brine, injected deep underground.
d) The sea starts filling with 2 MAF/yr of 3 ppt groundwater pumped directly into the sea.
e) About 0.3 MAF/yr of the saltiest sea water is treated to lower pH and injected deep ($10{,}000^+$ feet) underground. Acidic water can prevent plugging during groundwater injection and can extract more lithium long-term.
f) The sea's saltiest water supplies the CDR Facility.
g) The high pH water makes the Salton Sea a CO_2 sink.

B. Restore the Salton Sea while exporting desalted groundwater

After 10 years, the sea could be maintained at 35 ppt salinity and 400 sq. mi. The Figures 3 and 4 (Project B, worksheet tab "B Sal35Area400DeslGwDpInjt") would:

1. Same as Project A, except pump twice as much groundwater. Pumping 4 MAF/yr of groundwater could deplete area brackish groundwater in a thousand years[2].
2. Desalt the groundwater.
3. Send the product water to Arizona and California.
4. Pump the reject brine from groundwater desal into the Salton Sea.

[2] Per the 2008 Lawrence Livermore National Laboratory study, "As a whole, groundwater storage in the basin is very large, potentially as high as 4.5 to 6.5 billion acre-feet in current estimates, yet much of this confined to greater depths where quality is poor (high salinity), producibility is low (poor permeability and accessibility) and natural recharge, required for sustained use as a supply, is not well demonstrated from available data." There is "shallow" groundwater, no more than 2,000 ft considered to be isolated from "deeper" (20,000 ft) groundwater. The new drilling tech discusses 60,000-ft deep wells providing geothermal energy anywhere under existing coal power plants.

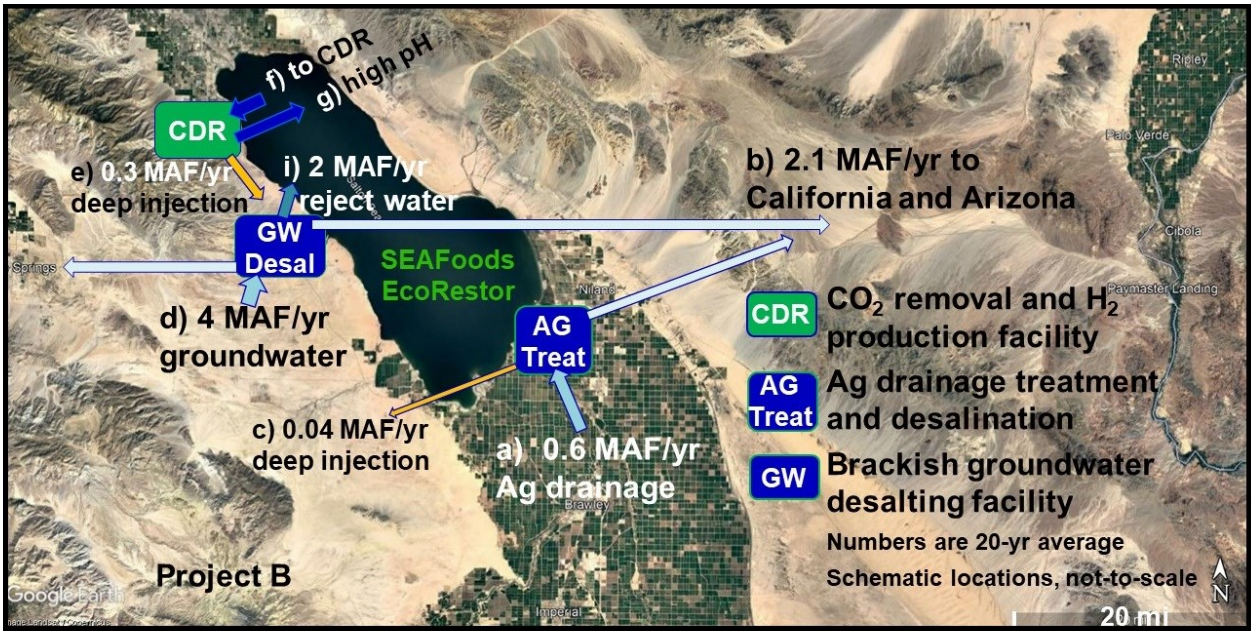

Fig. 3 – Filling and restoring the Salton Sea with improved water supply – Aerial schematic

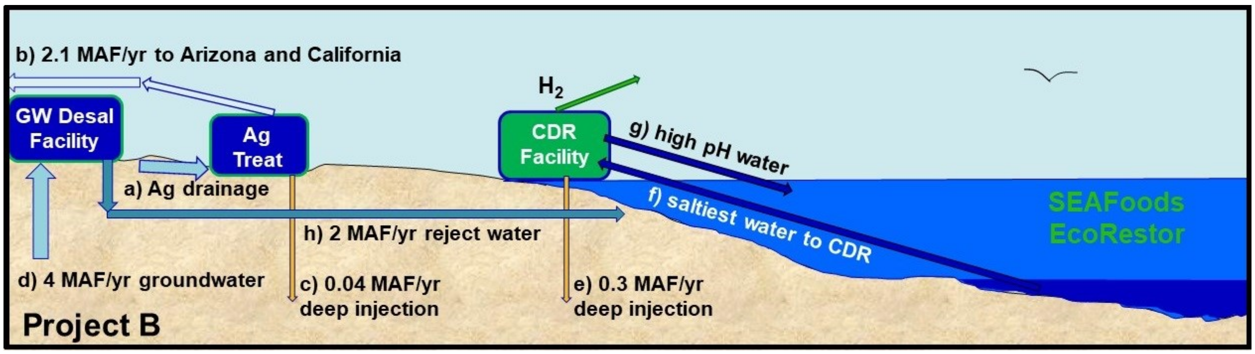

Fig. 4 – Filling and restoring the Salton Sea with improved water supply – Elevation schematic

Lettered features of Project B, which adds groundwater desalting (Figures 3 and 4):

a) Agriculture drainage is treated for reuse. Same as A.
b) Groundwater desalting combines with treated ag drainage to about 2.1 MAF/yr of clean water for export.
c) Treated ag drainage produces about 0.04 MA/yr of toxic brine, injected deep underground. Same as A.
d) Project B pumps about 4 MAF/yr of 3 ppt groundwater for desalination.
e) The saltiest sea water is treated to lower pH and injected deep ($10{,}000^{+}$ feet) underground. Same as A.
f) The sea's saltiest water supplies the CDR Facility. Same as A.
g) The high pH water makes the Salton Sea a CO_2 sink. Same as A.
h) The reject brine from groundwater desalting fills and restores the Salton Sea.

C. Restoring the Salton Sea with in-sea salt storage (no deep injection)

After 10 years, the sea could be maintained at 35 ppt salinity and 400 sq. mi. After 20 years the 300 ppt brine would occupy about 10% of the sea's volume. The Figures 5 and 6 (Project C, worksheet tab "C Sal35Area400BrineSto") would:

1. Same as for Project B, except concentrated (300 ppt) brine storage in ponds within the Salton Sea replaces the deep underground injection of 30 to 90 ppt low pH brine. After 20 years, the brine would occupy about 11% of the area of the Salton Sea when stored 40 feet thick without additional evaporation.

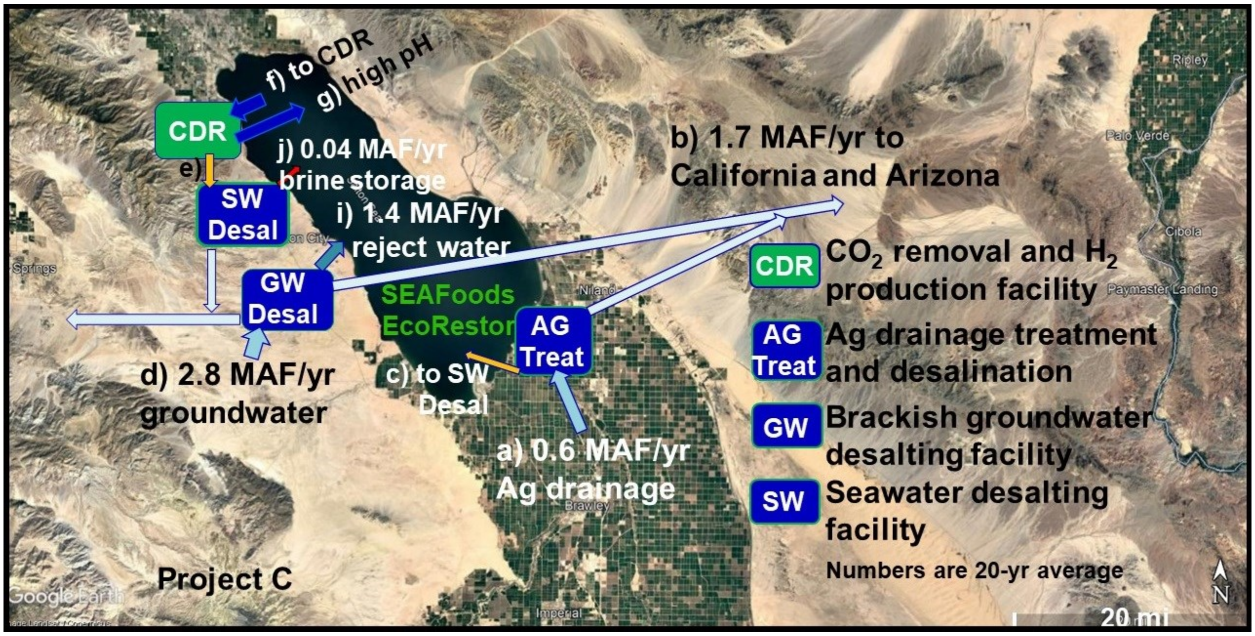

Fig.5 – Filling and restoring the Salton Sea with in-sea salt storage – Aerial schematic

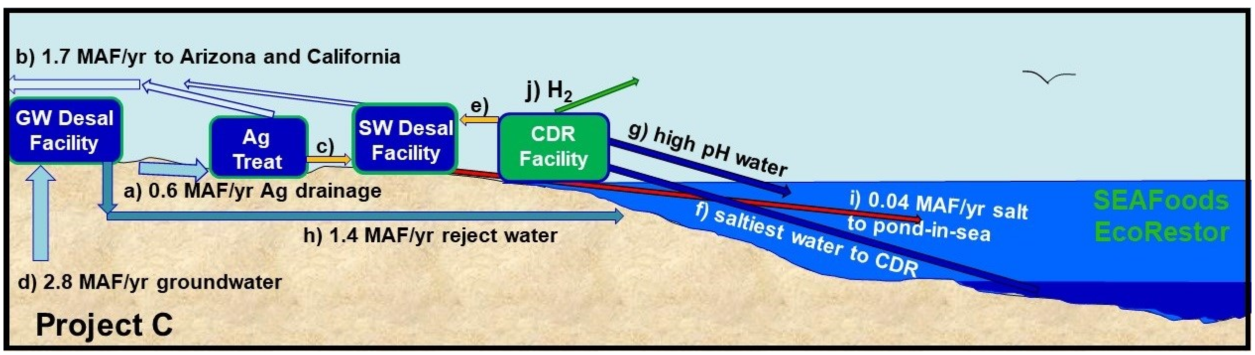

Fig. 6 – Filling and restoring the Salton Sea with in-sea salt storage – Elevation schematic

Lettered features of Project C, which avoids deep groundwater injection while storing 300 ppt brine in the Salton Sea (Figures 5 and 6):

a) Agriculture drainage is treated for reuse. Same as A and B.
b) Desalting the saltiest Salton Sea water combines with groundwater desalting and treated ag drainage cleaning producing about 1.7 MAF/yr of clean water.
c) Treated ag drainage is further treated to recycle more water and store concentrated salts in ponds within the Salton Sea.
d) Project C pumps about 2.8 MAF/yr of 3 ppt groundwater for desalination.
e) The saltiest sea water is treated to lower pH and further desalted.
f) The sea's saltiest water supplies the CDR Facility. Same as A and B.
g) The high pH water makes the Salton Sea a CO_2 sink. Same as A and B.
h) The reject brine from groundwater desalting fills and restores the Salton Sea. Same as B.

i) The salt removed in the SW Desal Facility might be about 30% salt. It could be mined for minerals before being placed in ponds in the sea. The ponds might be subsurface. The pond levees could consist of AquaDams filled with brine with density about 0.2 kg/L greater than the surrounding sea water.

j) Alkalinity addition CDR has byproduct hydrogen for green fuel and chemicals. Same as A and B.

D. Restore the San Francisco Bay ecosystem with knowledge from the Salton Sea

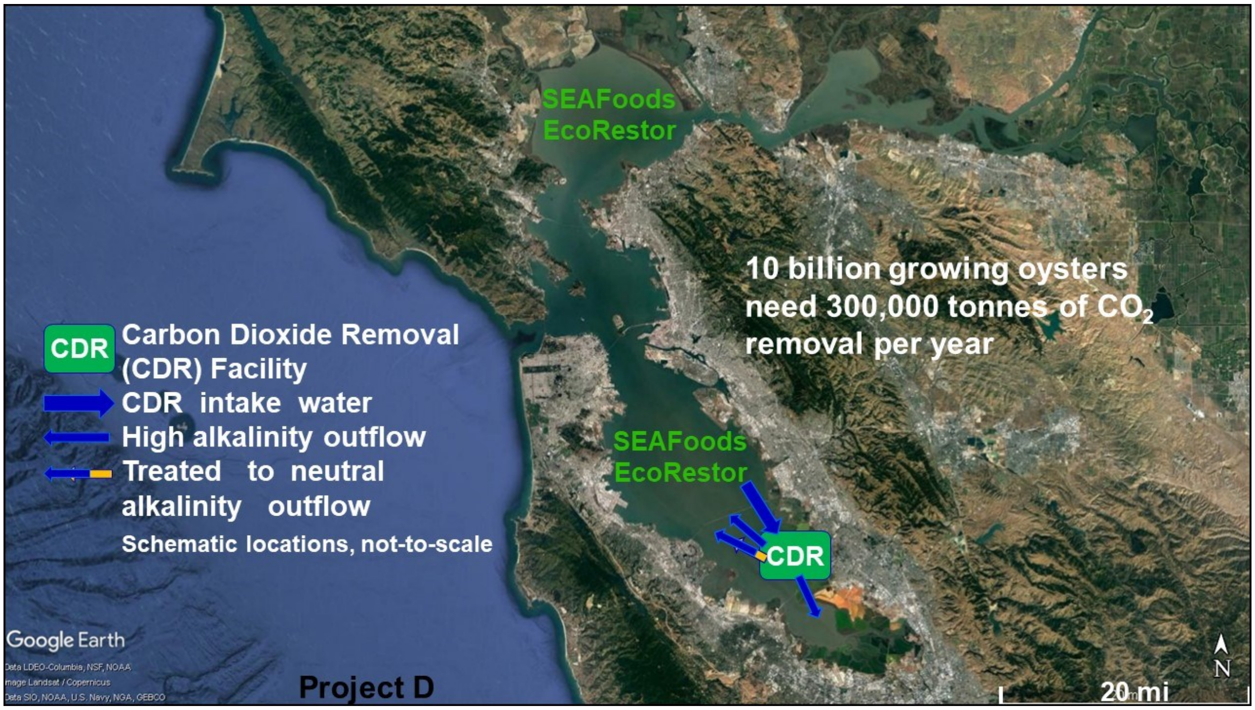

Fig. 7 – Restoring San Francisco Bay ecosystem

When San Francisco Bay had abundant oysters (as recently as 1950) underwater plants thrived. The Bay had a thriving herring fishery and was a mecca for recreational fishing. The Figure 7 (Project D, worksheet tab "D SFBaySEAFoods") would:

1. Employ CDR information from Salton Sea Projects A-C.
2. Coordinate the revival of filter feeders and underwater plants in San Francisco Bay as SEAFoods EcoRestore living reefs with biodiversity conservation and livelihoods for communities around the Bay. Filter feeders (mostly bivalve shellfish, but also some finfish like herring and anchovies) are essential to water clarity. Clear water is essential for underwater photosynthesis. Photosynthesis temporarily provides oxygen and higher pH for the filter feeders. Sequestering organic matter makes the provided oxygen and raised pH more long-term.
3. Employ CDR so that historic shellfish populations are self-sustaining. About ten billion oysters could provide historic filtration volumes, perhaps filtering all San Francisco Bay's water in a week. Ten billion oysters would grow about 750,000 tons of shell per year, which would worsen ocean acidification by the equivalent of 300,000 tons of CO_2/year. Because atmospheric concentrations of CO_2, and ocean acidification, are increasing, it may be necessary to more than offset the emissions of the shellfish forming shell if they, and the restored ecosystem, are to thrive.

Other possible projects, not pictured

Project E would refill the Salton Sea to 400 square miles in a few years with a combination of agriculture drainage and pumped groundwater (or the reject brine of pumped groundwater). Because Project E does not remove the saltiest water, the sea's average salinity keeps increasing about 1 ppt per year, after a temporary decrease. See worksheet "SaltonSea Salinity35Area400…" tab "E Sal>60Area400".

Project F would import water from the Gulf of California. After a few years, the sea could be maintained at 35 ppt salinity and 400 sq. mi. and maintained indefinitely. The Gulf water quickly fills and cleans the sea. This option would provide more brine for mining lithium. See worksheet "SaltonSea Salinity35Area400…" tab "F Sal35Area400Gulf".

Because the Salton Sea is below sea level, the seawater can flow by gravity with a syphon pulling it over a high point that is less than 30 feet above the Gulf. There is an opportunity to generate electricity as the water drops into the Salton Sea. Exporting water from the northern end of the Gulf either prevents the southward dispersal of Colorado River water or pulls in water from the Pacific Ocean.

The project can include SEAFoods EcoRestor and CDR for the northern Gulf. In the Gulf of California, the SEAFoods EcoRestor could emphasize restoring some of its unique species, such as the vaquita, the world's smallest and most endangered porpoise, and the hawksbill turtle.