Imperial Irrigation District

In collaboration with:
Sephton Water Technology, Inc.
and CalEnergy Generation

Salton Seawater Marine Habitat Pilot Project

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Project Description

Overview

The Salton Seawater Marine Habitat Pilot Project will evaluate an innovative use of an existing but underutilized technology, a Salinity Gradient Solar Pond, to distill hyper-saline post agricultural water from the Salton Sea. This pure water will supply and maintain a Marine Habitat Pond to demonstrate replacement of soon to be lost marine habitat at the Salton Sea in areas where water supply for habitat is not available. The scope of the Pilot Project includes a single ¼ acre Salinity Gradient Solar Pond and a single ¼ acre marine habitat pond both constructed on recently exposed Salton Sea lakebed owned by the Imperial Irrigation District (IID), see Figure 1.

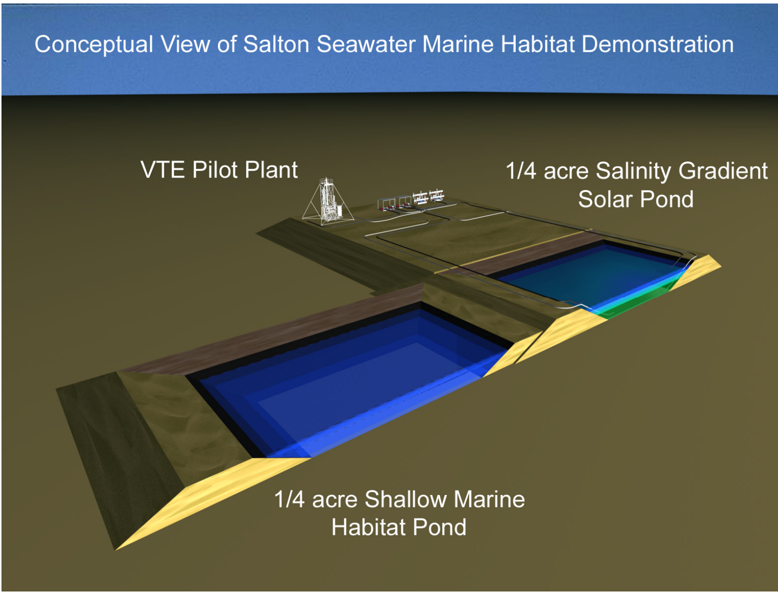


Figure 1. Project Conceptual View

The location of the ponds will be about ½ mile from an existing geothermal power plant owned by CalEnergy Generation and a Vertical Tube Evaporator (VTE) Salton Sea desalination test plant operated by Sephton Water Technology, Inc. that uses low pressure steam from the geothermal plant as a heat source to distill Salton Sea water. The desalination test plant is essential to cost effectively supply the Salinity Gradient Solar Pond with saturated brine and the Marine Habitat Pond with distilled water, both sourced from the Salton Sea. See region and site maps at end, Figures 7, 8, 9, and 10.

Background and Need

The Salton Sea is the terminus of the U.S. side of the Colorado River system. Sitting more than two hundred feet below sea level it receives salts and waste products discharged by farms, cities, and industries along the Colorado River and in the Imperial, Coachella, and northern Mexicali Valleys. The only outflow is by evaporation in the desert sun, causing salts and waste products to concentrate. The Salton Sea is hyper-saline at about 5.5% total dissolved solids (TDS) and rising compared to an average of about 3.5% TDS in the Pacific Ocean. Approximately 4 million metric tons of salt enter the Salton Sea annually, mostly from farms that must drain salts from soils irrigated with slightly saline (0.07% TDS) Colorado River water. The Salton Sea is also eutrophic due to fertilizer in runoff from surrounding farms. The aquatic ecosystem is productive, supporting an abundance of invertebrates and millions of fish, including native desert pupfish and introduced tilapia. The Salton Sea has become a critical source of forage for birds on the Pacific Flyway, supporting thousands of birds and over 400 bird species that use the area.

The inflow to the Salton Sea is currently about one million acre feet per year supplied over 90% by drainage from farms irrigated by the Colorado River system. Annual evaporation loss is currently slightly higher causing an annual decline in level of several inches per year in the last decade. The gradual decline of inflow and level seen in recent years will accelerate dramatically in 2018 due to increased diversion of water from farms to the urban California coast agreed under the Quantification Settlement Agreement in 2003 and the cessation of mitigation water delivered under that agreement from the Colorado River to the Salton Sea. From 2018 forward, this will cause a rapid loss of level on the order of 1 foot per year, a rapid increase in salinity on the order of 0.4% TDS per year, and an exposure of lakebed sediments on the order of two thousand acres per year. Barring intervention, the Salton Sea will reach a new inflow/evaporation equilibrium a few decades later at roughly half the current surface area exposing more than sixty thousand acres of lakebed sediment. Within a few years, the Salton Sea salinity is expected to rise above the 6% TDS thought to be an approximate cutoff for reproduction of the dominant fish species in the Sea. Salinity will continue to rise rapidly until the Sea is too saline to support any fish or fish eating birds. The need for replacement marine habitat or large scale salinity management at the Salton Sea is therefore critical.

The impact of exposing thousands of acres of lakebed sediment containing salts and waste products from 100 years of agriculture and industry is a concern for the public health. The Salton Sea lakebed has large areas of fine sediment that can become airborne in winds as low as 15 mph. In the Spring, 30 mph and higher winds frequently occur. The lakebed sediment also contains depositions of selenium and high levels of salts that will mix with the fine particles of dust. The Imperial County Health Officer, Dr. Stephen Munday, estimated the increase in windblown PM10 dust from exposed Salton Sea lakebed could cause a 30% rise in an already high Imperial County asthma rate.

Problems Addressed

The Salton Seawater Marine Habitat Pilot Project (Project) will develop an integrated set of technical solutions that can simultaneously address three problems resulting from the decline of the Salton Sea: loss of critical marine habitat, public health impacts from dust, and salinity management.

First, is the critical need for replacement marine habitat at the Salton Sea to support fish eating birds. The central Project objective is to develop a cost effective method to provide long term contaminant free distilled water supply to marine habitat ponds at any location on soon to be exposed Salton Sea lakebed. There are currently three saline aquatic habitat projects planned on the Salton Sea shore. Each relies primarily on brackish water from existing river inflows mixed with some Salton Sea water to raise salinity to about 2% TDS. The two larger projects, the State Species Conservation Habitat project and the Federal Red Hill Bay project, rely on water supply from the New and Alamo Rivers respectively which both have high levels of pollution including selenium sometimes exceeding recommended levels for wildlife. These projects will provide less than one tenth of the 30,000 to 60,000 acres of habitat estimated by State wildlife officials to be sufficient to replace lost Salton Sea marine and shoreline habitat.

Salton Sea water has lower levels of selenium and other pollutants than the New and Alamo Rivers but high salinity. Distilled water from the Salton Sea has been shown to have no detectable selenium and very low salt content. The water reclamation method demonstrated will use a Salinity Gradient Solar Pond to capture and store thermal energy for distillation of Salton Seawater and recycling of marine habitat pond water. The solar energy source, Salton Sea water source, and the marine habitat pond will all be in close proximity avoiding any need to pump water long distances to habitat areas remote from existing river or agricultural drain locations clustered at the north and south ends of the Salton Sea. In addition to providing a contaminant free water supply, distilled water drawn from the Salton Sea can sustain habitat along the many miles of west side and east side shoreline that have no continuous fresh or brackish water supply at all. If proven effective and affordable, the methods tested by this Project will greatly expand the areas of Salton Sea shoreline that can be converted to marine habitat.

The second critical problem addressed by this Project is the risk to public health posed by PM10 dust that will blow from thousands of acres of exposed lakebed onto surrounding farms and communities. Aquatic habitat projects of any type on the Salton Sea lakebed will prevent dust by keeping the ground covered with water. One advantage of the integrated marine habitat and solar pond distillation method tested by this Project is that it can be considered for any area of exposed lakebed around the remaining Salton Sea regardless of proximity to rivers or other sources of fresh or brackish water inflow. A second advantage is that both Marine Habitat Ponds and Salinity Gradient Solar Ponds will fully and permanently cover potential dust emitting ground. A third advantage is that Salinity Gradient Solar Ponds of a sufficient scale can supply heat to generate electricity as well as distill water. This solar energy technology is capable of generating power from stored heat any time, day or night, on demand. Project costs can be offset by selling excess electricity to the grid, supplying renewable power for pumping water needed by other aquatic habitat projects, or supplying both power and heat for other desalination projects. The integrated Marine Habitat and Salinity Gradient Solar Ponds are modular and scalable and are capable of being built out in phases as the Salton Sea recedes with increasing benefit to the environment from each acre of pond installed.

The third challenge addressed by the technologies developed by this Project is what to do with the millions of tons of salts concentrating in the Salton Sea and posing a threat to the ecosystem as the salinity rises. Salinity Gradient Solar Ponds can indefinitely store three thousand to five thousand metric tons of salt per acre of pond depending on the depth and configuration. Roughly one thousand acres of Salinity gradient solar ponds could take all of the salt coming into the Salton Sea in a year. The salts are stored as highly concentrated brine and provide a benefit by serving as a medium for the capture and storage of solar energy. The mix of magnesium, sulfate, and potassium, as well as the dominant sodium and chloride salts present in the Salton Sea are suitable for use in Salinity Gradient Solar Ponds following basic filtration and removal of colored organic material. Chemical contaminants are not problematic and would be safely isolated from the environment by the plastic liner normally used under Salinity Gradient Solar Ponds and by a layer of clean low salinity water continuously applied to the upper pond surface in the implementation proposed.

This Project will execute a pilot test of the use of thermal energy from both low pressure geothermal steam and the sun to recover high quality distilled water from the Salton Sea while concentrating the remaining mix of salts for use in Salinity Gradient Solar Ponds. A Salton Seawater desalination test plant now being expanded to demonstration scale will use low pressure geothermal steam as the energy source to establish initial target salinity in both ponds by delivering distillate to dilute Salton Sea water in the ¼ acre Marine Habitat Pond and by delivering brine concentrate from that distillation to the ¼ acre Salinity Gradient Solar Pond. Once the Salinity Gradient Solar Pond is operational, an existing VTE desalination pilot plant will be moved to the Salinity Gradient Solar Pond to use solar heat to drive the distillation of Salton Sea water to sustain both ponds against evaporative losses. Concentrated Salton Sea brine will go the bottom of the Salinity Gradient Solar Pond to increase the thermal storage capacity without brine discharge to the environment. This will demonstrate salinity management of Salton Sea habitat with beneficial use of both the distilled water and the salt.

Project Scope of Work

Year 1, Designs, Permits, Small Scale Tests

1. Consult with Salinity Gradient Solar Pond and desalination consultants on the design of ponds for the Salton Sea environment and methods for creating and maintaining a salinity gradient using locally available Salton Sea water and distillate.

2. Consult with biologists who know the local ecosystem regarding the design, target salinity, target water quality, and ideal biota for the shallow saline habitat pond. The U.S. Fish and Wildlife Service and California Department of Fish and Game each have biologists familiar with the Salton Sea ecosystem.

3. Design a ¼ acre salinity gradient solar pond, a ¼ acre Marine Habitat Pond and pipelines connecting to the VTE Pilot Plant and along the shoreline to the VTE Demonstration Plant. A mechanical engineer and civil engineer will be consulted on a seismically sound design for the pond dikes and pipelines.

4. Apply for permits and start a NEPA Categorical Exclusion and a CEQA (MND) process for the ponds, pipelines, and operation as soon as engineering and process designs are sufficiently advanced. Permits expected include a U.S. Army Corps of Engineers 404 permit for construction in a former waterway, a discharge permit exemption and 401 permit from the Regional Water Quality Control Board, us U.S. Department of Fish & Game 1602 permit, an Imperial County Conditional Use Permit, an Imperial County Public Works encroachment permit for crossing dike roads with pipes, an IID encroachment permit for crossing any canals with pipes and for the ponds, and an Imperial County Building and Grading Permit for the ponds. The ¼ acre Salinity Gradient Solar Pond and adjacent ¼ acre Marine Habitat Pond will be constructed after all permits and permissions are obtained.

5. Measure insolation at the project location over four seasons by installing and monitoring a pyranometer at the site. Estimate available solar energy for thermal desalination and possible future electrical generation.

6. Investigate the efficacy of available molecular monolayer or film products to reduce evaporative losses by dosing selected products into seawater in an evaporation pan. Measure evaporation rate and temperatures while holding salinity steady with distilled water make-up over time versus a non-dosed control pan. Test molecular monolayer chemicals and transparent membrane materials against an open pan control for their ability to reduce surface evaporation and pass sunlight. Test additives or materials of interest over time for durability and dosing requirements in various weather conditions.

7. Drill core samples at the pond location for a geotechnical study of soils under the playa. Install temperature probes and heated fluid loops into the drill holes. Record temperature at various depths under the playa over four seasons. Obtain sub-surface thermal conduction data by injecting hot fluid into a borehole pipe loop and measuring temperature rise in an array of adjacent boreholes. Estimate heat loss from the bottom of a Salinity Gradient Solar Pond and evaluate thermal conductivity of soil for geo-cooling.

8. Develop a protocol for concentrating, clarifying, and decolorizing saturated Salton Sea brine. Based on consultation and prior experience, perform a salt separation pre-treatment if compatible, then concentrate either raw Salton Sea water or salt separation reject in the VTE Pilot Plant to target TDS values for the lower convective zone of the Salinity Gradient Solar Pond. Analyze the brine for TDS, TSS, optical clarity, chromatic absorption, and major ions after settling out solids. If any brine is problematic with respect to clarity, precipitation of solids, or other issues, devise and test methods to resolve those problems.

9. Test a literature recommended activated charcoal filtration method for decolorizing Salton Sea brine concentrates using brine samples concentrated in the VTE Plant. A yellow color from organic matter needs to be removed for optimal efficiency.

10. Work with contractors experienced in local dike construction to develop construction methods for heavy equipment on soft playa. Try moveable work platforms, progressive berm fill and compaction, and extra low ground pressure per square inch tires and tread extensions.

Year 2, Pond, Plant, and Pipeline Construction, Pond Commissioning

1. Construct 600ft of seawater intake and return pipelines between the VTE Demonstration Plant and the Salton Sea shoreline crossing a seawater dike with a dirt road on top, an irrigation drain canal, and two service roads. Use designs created and permitted in 2009-2010 after renewing all permits. In consultation with the California Department of Fish and Wildlife, design and build a seawater intake system capable of preventing take of small fish and being relocated as the shoreline recedes.

2. Fabricate a modification to effect 1 in the existing VTE Pilot Plant to use it as a flash chamber when operating the VTE Plant with solar thermal energy. Test the flash chamber modification with hot water feed under vacuum and calculate an efficiency of vapor production by measuring the condensed vapor and inflow/outflow temperatures. Alternatively, construct a pilot scale Barometric Evaporator as a steam generator if prototype testing is successful and funds are available.

3. Construct a ¼ acre Salinity Gradient Solar Pond on recently exposed Salton Sea lakebed with ¼ acre of Marine Habitat Pond on the seaward side as a buffer between the solar pond and the Salton Sea. The Salinity Gradient Solar Pond will have compacted earth fill dike walls approximately 13 feet above the lakebed with a horizontal to vertical slope of 2:1. The Marine Habitat Pond will have a lower dike of about 8ft. IID crews and equipment or IID selected contractors will construct the ponds and dikes on IID owned land about ½ mile southeast of the VTE Demonstration Plant and the CalEnergy geothermal plant.

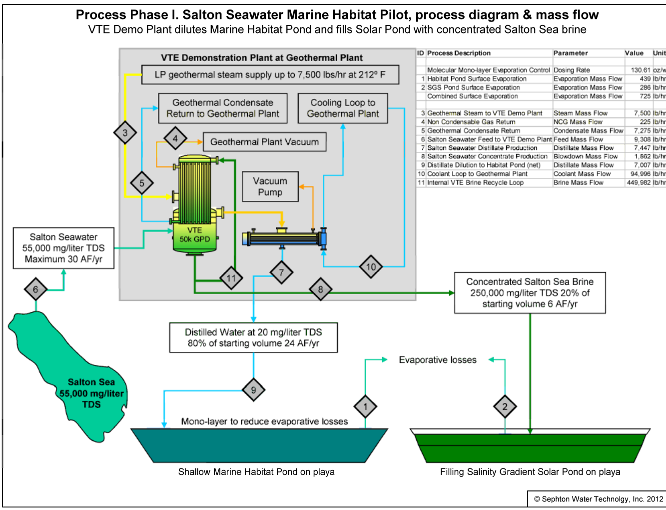
4. Bury a network of small sample collection pipes and temperature probes at key locations under the bottom of the Salinity Gradient Solar Pond and Marine Habitat Pond and in the dike walls to monitor any leakage of brine and conduction of heat.

5. Install a conductivity, temperature, and sampling apparatus with diffusers and suction pipes in the Salinity Gradient Solar Pond capable of smoothly changing the sampling elevation from the pond bottom to the surface.

6. Line the bottom and sides of the ¼ acre Salinity Gradient Solar Pond with polypropylene or other selected high temperature liner.

7. Construct about ½ mile of pipelines between the seawater intake location on the shore directly west of the VTE Demonstration Plant and the two ponds for brine, distillate, and a cooling water loop.

8. Construct a small seawater intake and return for the Marine Habitat Pond for nutrient management.

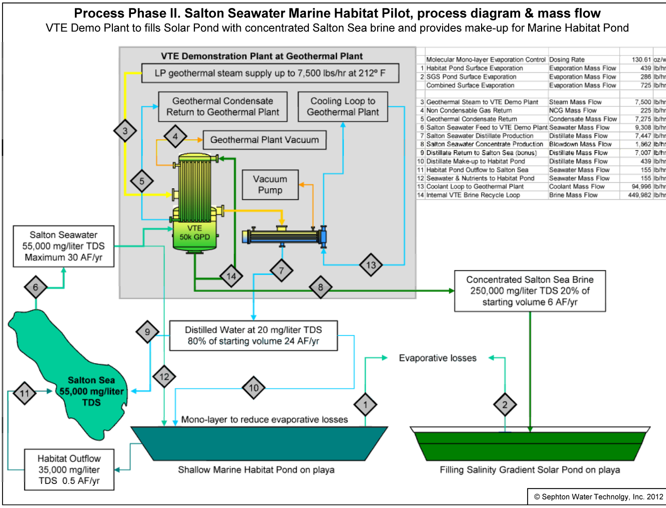


ID	Process Description	Parameter	Value	Units
	Molecular Mono-layer Evaporation Control	Dosing Rate	130.61	oz/wk
1	Habitat Pond Surface Evaporation	Evaporation Mass Flow	439	lb/hr
2	SGS Pond Surface Evaporation	Evaporation Mass Flow	286	lb/hr
	Combined Surface Evaporation	Evaporation Mass Flow	725	lb/hr
3	Geothermal Steam to VTE Demo Plant	Steam Mass Flow	7,500	lb/hr
4	Non Condensable Gas Return	NCG Mass Flow	225	lb/hr
5	Geothermal Condensate Return	Condensate Mass Flow	7,275	lb/hr
6	Salton Seawater Feed to VTE Demo Plant	Feed Mass Flow	9,308	lb/hr
7	Salton Seawater Distillate Production	Distillate Mass Flow	7,447	lb/hr
8	Salton Seawater Concentrate Production	Blowdown Mass Flow	1,862	lb/hr
9	Distillate Dilution to Habitat Pond (net)	Distillate Mass Flow	7,007	lb/hr
10	Coolant Loop to Geothermal Plant	Coolant Mass Flow	94,996	lb/hr
11	Internal VTE Brine Recycle Loop	Brine Mass Flow	449,982	lb/hr

Figure 2. Process Phase 1

9. The Marine Habitat Pond will go into operation shortly after construction is finished. It will be filled with Salton Sea water and diluted with distilled water to a target salinity recommended by consulting biologists, see Figure 2 for a process diagram. The Marine Habitat Pond water will be periodically tested for major ions, contaminants of concern such as selenium and boron, and the growth of microscopic and macroscopic flora and fauna. Surface evaporation from the Saline Habitat pond will be made up with selenium free distilled water from the VTE Demonstration Plant during this early operation phase, see process diagram in Figure 3. A small measured inflow and outflow of Salton Sea water will be tested to supply essential nutrients. The Saline Habitat Pond water quality can be improved by drawing some out as feedstock for the pond located VTE Plant

and replacing it with blended distillate and Salton Sea water as needed. Once established, the pond will be stocked with desert pupfish and/or other recommended species transported from other Salton Sea populations by methods recommended by Fish and Wildlife Agencies.



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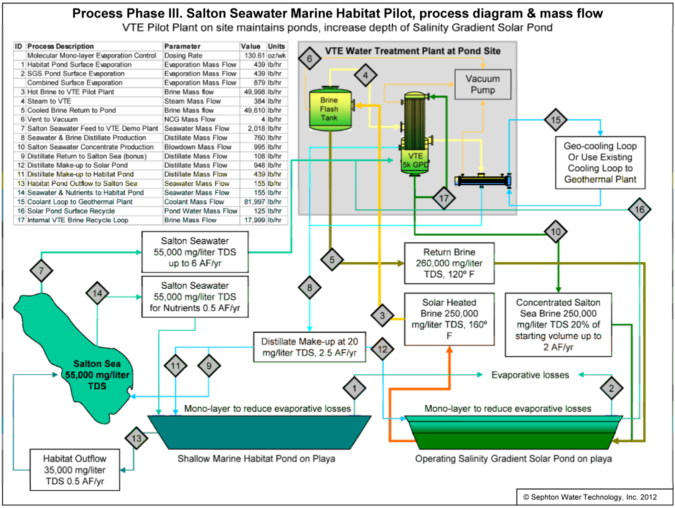
4	Non Condensable Gas Return	NCG Mass Flow	225	lb/hr
5	Geothermal Condensate Return	Condensate Mass Flow	7,275	lb/hr
6	Salton Seawater Feed to VTE Demo Plant	Seawater Mass Flow	9,308	lb/hr
7	Salton Seawater Distillate Production	Distillate Mass Flow	7,447	lb/hr
8	Salton Seawater Concentrate Production	Blowdown Mass Flow	1,862	lb/hr
9	Distillate Return to Salton Sea (bonus)	Distillate Mass Flow	7,007	lb/hr
10	Distillate Make-up to Habitat Pond	Distillate Mass Flow	439	lb/hr
11	Habitat Pond Outflow to Salton Sea	Seawater Mass Flow	155	lb/hr
12	Seawater & Nutrients to Habitat Pond	Seawater Mass Flow	155	lb/hr
13	Coolant Loop to Geothermal Plant	Coolant Mass Flow	94,996	lb/hr
14	Internal VTE Brine Recycle Loop	Brine Mass Flow	449,982	lb/hr

Figure 3. Process Phase 2

10. The Salinity Gradient Solar Pond will be filled with a minimum 36 inch bottom storage layer of 26% TDS brine, a 32 inch gradient layer ranging from 26% to 3% TDS brine, and an 18 inch surface convective layer. With the agreed supply of 7,500 lbs/hr of low pressure geothermal steam, it will take about three months to concentrate enough Salton Sea water into 26% TDS brine to fill the Salinity Gradient Solar Pond to the 6ft depth needed for 3 to 4 feet of bottom layer and to set up a salt concentration gradient. Once operational, further surface evaporation from both the Salinity Gradient Solar Pond and the Marine Habitat Pond will be made up with distillate from the relocated VTE Pilot Plant, see the process diagram in Figure 4.

11. Create a continuous salinity gradient in the Salinity Gradient Solar Pond by layering of distillate above the near saturated storage layer. Layer about 18 inches of low salinity clarified Salton Sea water and/or distillate on the surface of the salinity gradient solar pond. Monitor the evolution of the gradient and the gradual build up of heat in the storage layer at the bottom of the pond. Draw off heat from the bottom layer if it rises above operating temperature. Monitor the clarity of the pond water and apply corrective measures if algae growth or other problems occur.



ID	Process Description	Parameter	Value	Units
	Molecular Mono-layer Evaporation Control	Dosing Rate	130.61	oz/wk
1	Habitat Pond Surface Evaporation	Evaporation Mass Flow	439	lb/hr
2	SGS Pond Surface Evaporation	Evaporation Mass Flow	439	lb/hr
	Combined Surface Evaporation	Evaporation Mass Flow	879	lb/hr
3	Hot Brine to VTE Pilot Plant	Brine Mass flow	49,998	lb/hr
4	Steam to VTE	Steam Mass Flow	384	lb/hr
5	Cooled Brine Return to Pond	Brine Mass flow	49,610	lb/hr
6	Vent to Vacuum	NCG Mass Flow	4	lb/hr
7	Salton Seawater Feed to VTE Demo Plant	Seawater Mass Flow	2,018	lb/hr
8	Seawater & Brine Distillate Production	Distillate Mass Flow	760	lb/hr
10	Salton Seawater Concentrate Production	Blowdown Mass Flow	995	lb/hr
9	Distillate Return to Salton Sea (bonus)	Distillate Mass Flow	108	lb/hr
12	Distillate Make-up to Solar Pond	Distillate Mass Flow	948	lb/hr
11	Distillate Make-up to Habitat Pond	Distillate Mass Flow	439	lb/hr
13	Habitat Pond Outflow to Salton Sea	Seawater Mass Flow	155	lb/hr
14	Seawater & Nutrients to Habitat Pond	Seawater Mass Flow	155	lb/hr
15	Coolant Loop to Geothermal Plant	Coolant Mass Flow	81,997	lb/hr
16	Solar Pond Surface Recycle	Pond Water Mass Flow	125	lb/hr
17	Internal VTE Brine Recycle Loop	Brine Mass Flow	17,999	lb/hr

Figure 4. Process Phase 3

Year 3, Solar and Habitat Pond Integrated Operation Testing

1. The Marine Habitat Pond will be monitored over at least one year to demonstrate a stable and acceptable water quality for habitat. The desert pupfish and any other fish population will be monitored and bird forage activity will be noted. If the water quality or biological activity goes out of the target ranges recommended by consulting biologists, corrective measures will be tested and implemented where successful.

2. Once the Salinity Gradient Solar Pond reaches operating temperature, the relocated VTE Pilot Plant will use steam generated in the converted vacuum flash chamber from hot brine pumped out of the Salinity Gradient Solar Pond storage layer. The vapor flashed from the hot brine will be condensed to distillate and pumped back to the surface layer of the Salinity Gradient Solar Pond to make up evaporative losses and compensate for diffusion of salt from the storage layer to the surface layer. The slightly cooled brine will be at higher salinity after flashing steam. It will be returned to the storage layer of the pond to maintain the high salinity there and be reheated by the sun. This Salinity Gradient Solar Pond maintenance operation will be demonstrated over the course of a year.

3. During this solar powered phase of the Project, Salton Sea water and/or Marine Habitat Pond water will be fed to the VTE Pilot Plant to produce distillate to offset surface evaporation and maintain the solar pond salinity gradient. Any excess brine will be added to the Salinity Gradient Solar Pond storage layer to increase the heat capacity and depth. In a commercial solar energy operation, this

brine would be used to charge a new Salinity Gradient Solar Pond with brine to ready it for operation. The Marine Habitat Pond will be demonstrated concurrently with the Salinity Gradient Solar Pond operation over the course of a year.

4. The water in both ponds will be continuously monitored for salinity and temperature at different depths and periodically sampled to analyze the water chemistry and biological activity. The bottom sediments of the Marine Habitat Pond and the dike between the ponds and soils around the ponds will be sampled for leakage of salts. The clarity of the Salinity Gradient Solar Pond water is critical and will be frequently monitored and corrected if needed by filtration, flocculation, additives or other means. If unusual fish or bird mortality is observed, corrective measures will be taken.

5. The data from all tests will be analyzed and reported with recommendations on the suitability of the concept for implementation or further study. If the tests are largely successful, a commercial scale demonstration will be designed at an appropriate location.

Project Funding

A grant from the California DWR was awarded for this Project in 2013 under the Salton Sea Financial Assistance Program in the amount of $692,819 and has been secured by contract between the IID and the State. Under the contract with the California DWR, IID pledged local funds in the amount of $511,186. These local funds are drawn from a Salton Sea Restoration Fund provided by three area water agencies, the IID, the Coachella Valley Water District, and the San Diego County Water Authority under the QSA Joint Powers Authority (JPA). The IID manages expenditure of these local funds with oversight from the QSA JPA Commission.

The IID was awarded a grant from the U.S. Bureau of Reclamation Yuma Area Office for this Project in early 2014 in the amount of $100,000. The contracting process is underway for this grant.

Figure 5. VTE Demonstration Plant under construction in 2014 with pipe connections to VTE Pilot Plant behind

The developer of the VTE geothermal desalination technology, Project partner Sephton Water Technology, Inc. subcontracting under the IID has pledged to donate the use of the VTE Pilot Plant and VTE Demonstration Plant equipment it owns for the three year life of the project. The VTE Pilot Plant will be relocated to the Salinity Gradient Solar Pond under this Project to operate on solar heat from the pond. The assembly of the VTE Pilot Plant for its current installation at the CalEnergy geothermal power plant was previously funded by $672,233 in grants from the U.S. Bureau of Reclamation plus donations from Sephton Water Technology, Inc. Improvements to the VTE Pilot Plant and construction now underway to install the VTE Demonstration Plant at the CalEnergy geothermal plant has been funded by a $1.3 million grant from the California DWR plus $150,000 from the U.S. Bureau of Reclamation. The VTE Demonstration Plant will have the capacity to dilute the Marine Habitat Pond and fill the Salinity Gradient Solar Pond with brine concentrate within a few months, photo in Figure 5.

Project Site

Figure 6. Pond Site in 2014 showing newly exposed playa

A site has been approved by the landowner (IID) and the geothermal leaseholder (CalEnergy). Several proposed site options for ponds on newly exposed Salton Sea shoreline in the vicinity of the VTE Pilot Plant were proposed to CalEnergy in 2010. The site shown in Figure 6 was the only one approved because geothermal injection wells have already been drilled a few thousand feet below the site so no more drilling on that land is expected. The site is southwest of the VTE Demonstration Plant about ½ mile with space on exposed playa for two ¼ acre ponds and ample exposed playa for future expansion.

Salinity Gradient Solar Pond construction will involve building about 520 linear feet of rock and earth fill dike 13ft high by 60ft wide at the base with a 1:2 slope and a 10ft wide walkway on top. Moderate grading will be needed plus excavation of the base of the dike through the barnacle shell and fish bone beach material to clay soil below. The Salinity Gradient Solar Pond will need to be lined as the soil is very permeable.

Marine Habitat Pond construction will involve building about 480 linear feet of rock and earth fill dike 8ft high by 40ft wide at the base with a 1:2 slope and a 10ft wide walkway on top. Grading will be not be required unless consulting biologists specify an irregular base, however excavation of the base of the dike will be needed for a seismically safe dike.

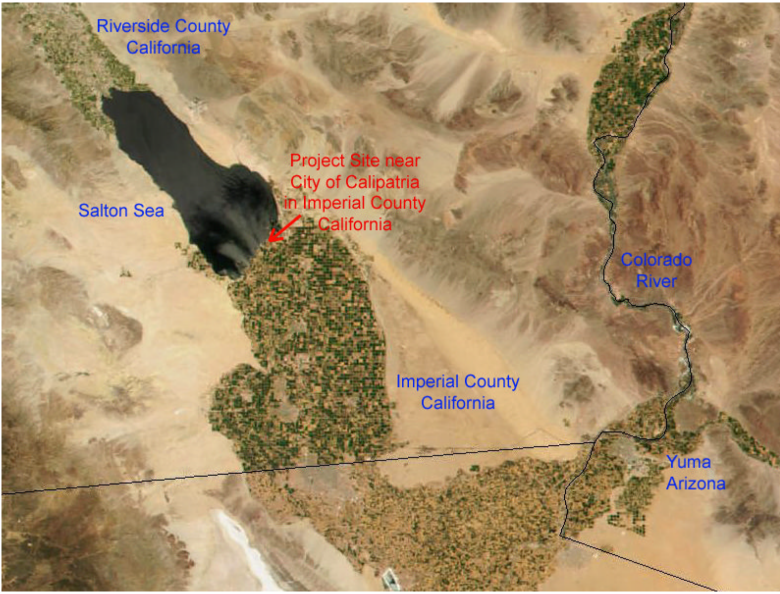


Figure 7. Project Site in Region

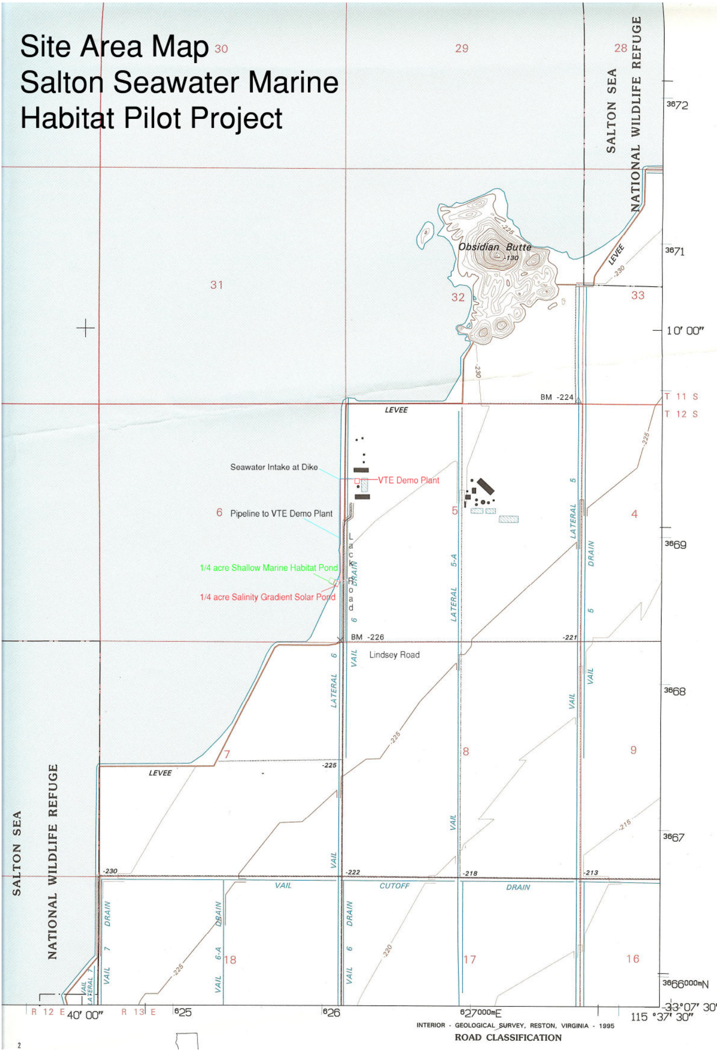


Figure 8. Project Site within USGS Obsidian Butte quadrangle map.

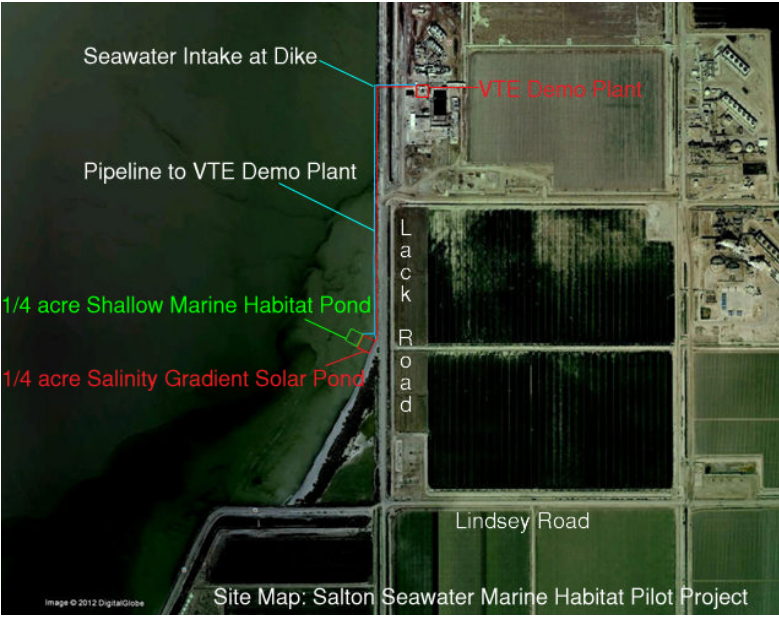


Figure 9. Full Site Map, satellite view, showing VTE Demonstration Plant, Pipeline, and Ponds

Figure 10. Site Map, satellite view, showing proposed Pond locations on new playa