California Water
A Long Term and Systematic Solution

An Alternative to the Peripheral Canal
The Joseph Jensen Desalination Facility

Prepared for:

State of California – Department of Water Resources
Metropolitan Water District of Southern California

3/1/12

EXECUTIVE SUMMARY

The present, long term water strategy for the State of California lies in a $15 billion general bond issuance, intended to fund and construct a Peripheral Canal ("Canal") around the San Joaquin River Delta ("Delta") in northern California. Construction of this canal would not guarantee water deliveries during drought years and, given the unique fresh water to salt water balance within the Delta, potential future litigation under both the Federal and State Endangered Species Acts may occur following completion of the Canal. This report proposes an alternate, long term water strategy.

California does not have a water problem, California has an energy problem. With over 800 miles of coastline, ocean water is readily available to the state, but desalination is a significant energy consuming alternative. However, an opportunity exists for the Metropolitan Water District of Southern California ("MWD") to fund and develop a competition for the creation of new desalination technologies. In addition, capital costs for alternate energy sources (i.e. wind and solar) continue to decline - beneficial to a state with an ample supply of both renewable energies. Combining such alternative energy sources with new and improved desalination technologies, the State of California is uniquely positioned to be at the forefront of a revolutionary, multi-faceted salt water purification solution. MWD has for over a century, searched far and wide in meeting its water demands. This report asserts that the technology exists and the time is now for MWD to capitalize on the resource that resides on its very doorstep.

More than 100 years ago, Fred Eaton presented William Mulholland with a "crazy" idea to build more that 200 miles of pressurized pipeline from the Owens River Valley to the City of Los Angeles. Today, a similarly "crazy" idea of building an 18.5 mile tunnel, more than a thousand feet below the surface of the earth, from the Santa Monica Bay to the Joseph Jensen Water Treatment Facility in the Sepulveda Basin, is now being proposed.

The decision to either construct a potentially litigious $15 billion canal in northern California or applying an equitable $15 billion in the heart of southern California, building the most technologically ambitious desalination project in the world, lies with MWD. This report inquires:

> "What would $15 billion do for the southern California economy?"
>
> "What technological advancements can be realized by funding a competitive desalination 'X-Prize'?"
>
> "What would the world's most sophisticated water treatment facility do for the water future of the State of California and for the world?"

Energy balance within the State of California will be more critical as the state moves forward, especially when consideration is given to the energy requirements of a new, high speed rail network. Peak and off-peak pumping along with solar and wind generation mean that large power demands must be made variable as power supply is made available. To this end, this report also proposes a new, 20,000 acre-foot reservoir be constructed between the Wind Gap and Edmonston Pumping Plants to allow for peak and off-peak pumping operation of the Edmonston Pumping Plant. Such a proposal would also allow the state to sell the Edmonston energy “supply” during peak electric demands.

Lastly, science should make greater attempts in ascertaining the root causes behind reductions in aquatic species within the San Joaquin River Delta, particularly the Delta Smelt. Whether the reductions are the result of fluctuations in salt water to fresh water ratios, the timing and frequency of pumping, increases in nitrates from sewage dischargers or a combination of factors, a consensus should first be reached as to these root causes with a reasonable action plan established and implemented, providing clear direction to all stakeholders. The time is upon California to broach the subject of a ‘locks’ system within the Delta and to acquire ‘buy-in’ from environmental groups to further study and explore the concept as beneficial to species enhancement.

California - Blessed with the international headquarters of nearly every major civil and construction engineering firm in the world - Blessed with the brain trust of the Silicon Valley – Blessed with the un-matched intellectual capital provided by the Golden State’s CSU, UC and prestigious private universities. If California cannot feed its water hunger by now doing the ‘impossible’ in the most eco-friendly way imaginable – then it cannot be done.

SUMMARY OF PROPOSED PROJECT

The proposed Joseph Jensen Desalination Facility (“JJDF”) is located within a 125’ wide shaft, drilled at a 30° decline into the earth to a depth of approximately 1,400 feet below the surface of the earth within the Sepulveda Basin, west of the I-5/I-210 interchange in Sylmar, California. The project consists of one 25-foot diameter (equal in size to the English Chanel “Chunnel”), reinforced concrete lined tunnel, drilled at a downhill gradient from the Santa Monica Bay to the base of the Sepulveda Basin. The length of the tunnel between the Santa Monica Bay and the Sepulveda Basin is approximately 18.5 miles. Constructed with a “fall” of approximately 40 feet, this pipeline would have an operational flow capacity of roughly 2,300 cubic feet per second or 1.4 billion gallons per day.

Located between the primary intake structure in the Santa Monica Bay and the JJDF is the Pacific Palisades Filtration Facility (“PPFF”). This facility filters incoming ocean water while also diluting and discharging brine water returning from the JJDF. A new discharge pipeline, approximately 6 feet in diameter, would be constructed along the ocean floor a distance of approximately 9 miles to the south, intercepting the outfall pipeline of the Hyperion Sewer Treatment Facility, 5 miles west of the of city of El Segundo. By diluting the effluent brine of the water treatment facility with the effluent of the sewage treatment facility, a normalization of suspended salts can be realized prior to discharge into the ocean environment, preventing “hot zones” and protecting the ocean environment. Adjustments to brine concentrations are made at the PPFF while underwater sensors sample and report suspended salts data, thus maintaining consistent and normalized salt effluent concentrations.

The most significant feature of the project is the underground desalination and pumping facility of the JJDF. Requiring a lift of nearly 1,400 feet to reach the storage facility of the Sepulveda Basin, the world’s first sub-terrain desalination plant and pumping facility would be an engineering and construction marvel. Pushing salt water through a series of innovative, 30° inclined reverse osmosis (or other) stage filters, the newly desalinated (and/or potentially de-ionized water) would be directly discharged into the Sepulveda Basin, ready for further surface water treatment at the existing Joseph Jensen Water Treatment Plant or for delivery to other downstream water treatment facilities connected to the MWD raw or treated water system. If discharged into the raw water storage system, plant efficiency could be reduced to allow for water blending to an allowable level of Total Dissolved Solids (TDS).

As desalination is a significant energy consumer, power will be supplied by the existing, on-site Sylmar Substation. Additional benefits, such as brine recovery and sea salt production, can be realized by utilizing the on-site railroad spur to ship salts to the Antelope Valley for drying and processing. Lastly, to compensate for large energy demands, thermal and photovoltaic solar generating facilities can also be constructed in the Antelope Valley near existing transmission facilities.

ENNIS CONSULTING

California Water

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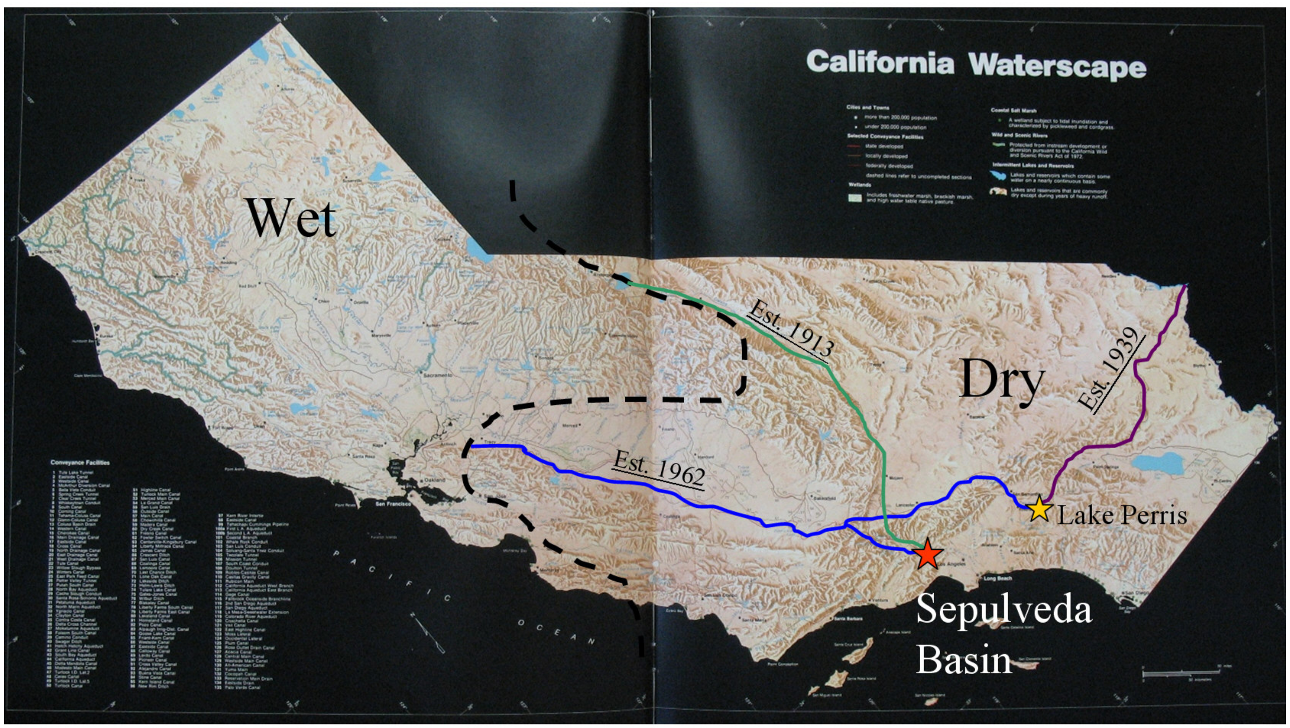
March 2012

CALIFORNIA WATER HISTORY AND BACKGROUND

DIVISION AND DELIVERY

The state of California can be divided into two water halves. The north half receives enough precipitation to meet its own needs while the southern half does not. To combat this fact of nature, the state has, over the course of the past century, constructed canals which bring water to the drier south. The convergence of the Los Angeles aqueduct and the California Aqueduct occurs at the Sepulveda Basin. The Sepulveda Basin is one of two head works for the MWD water distribution network and is the focus of the second half of this report.

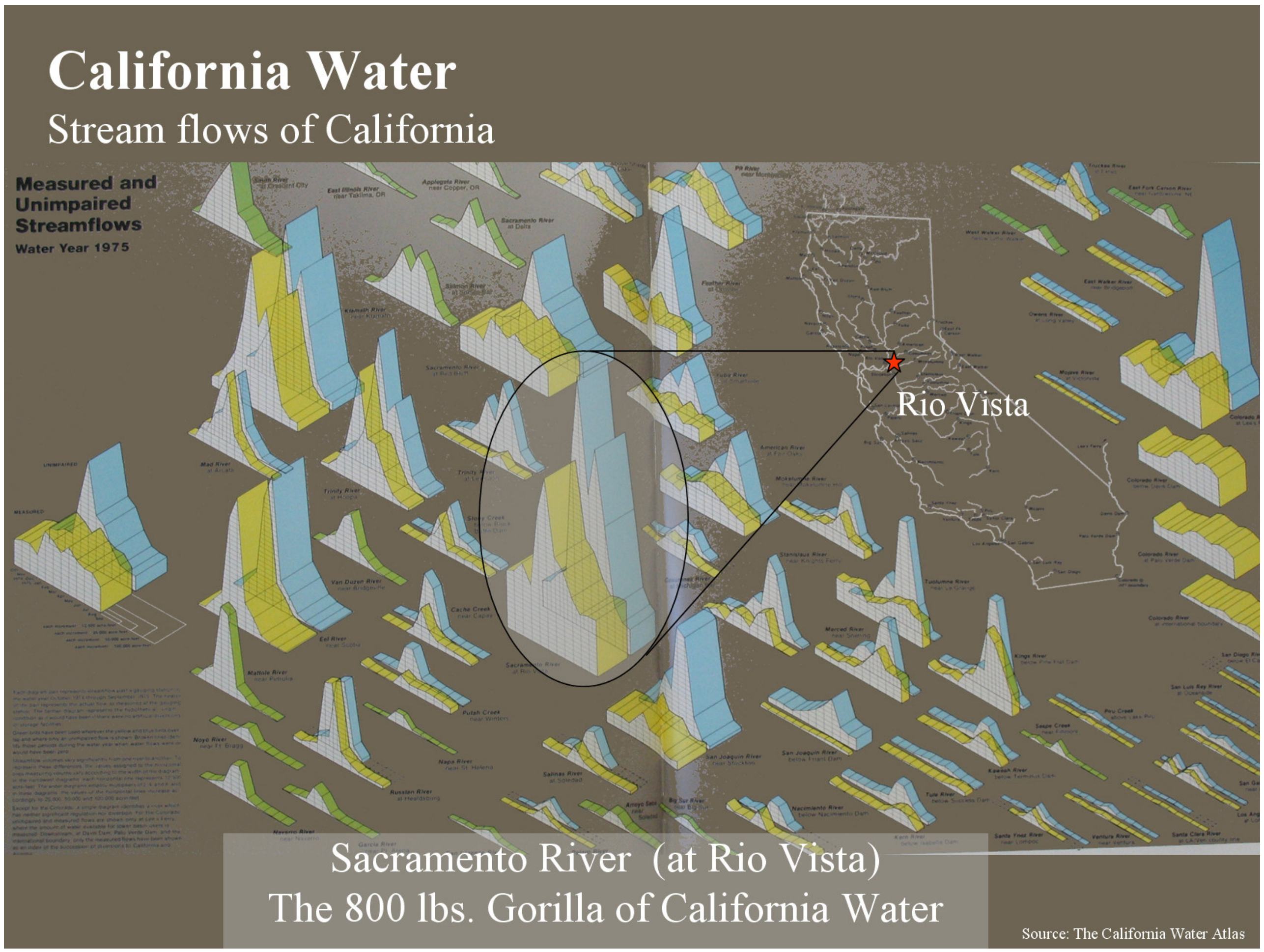
California Water
Division and Delivery



Source: The California Water Atlas

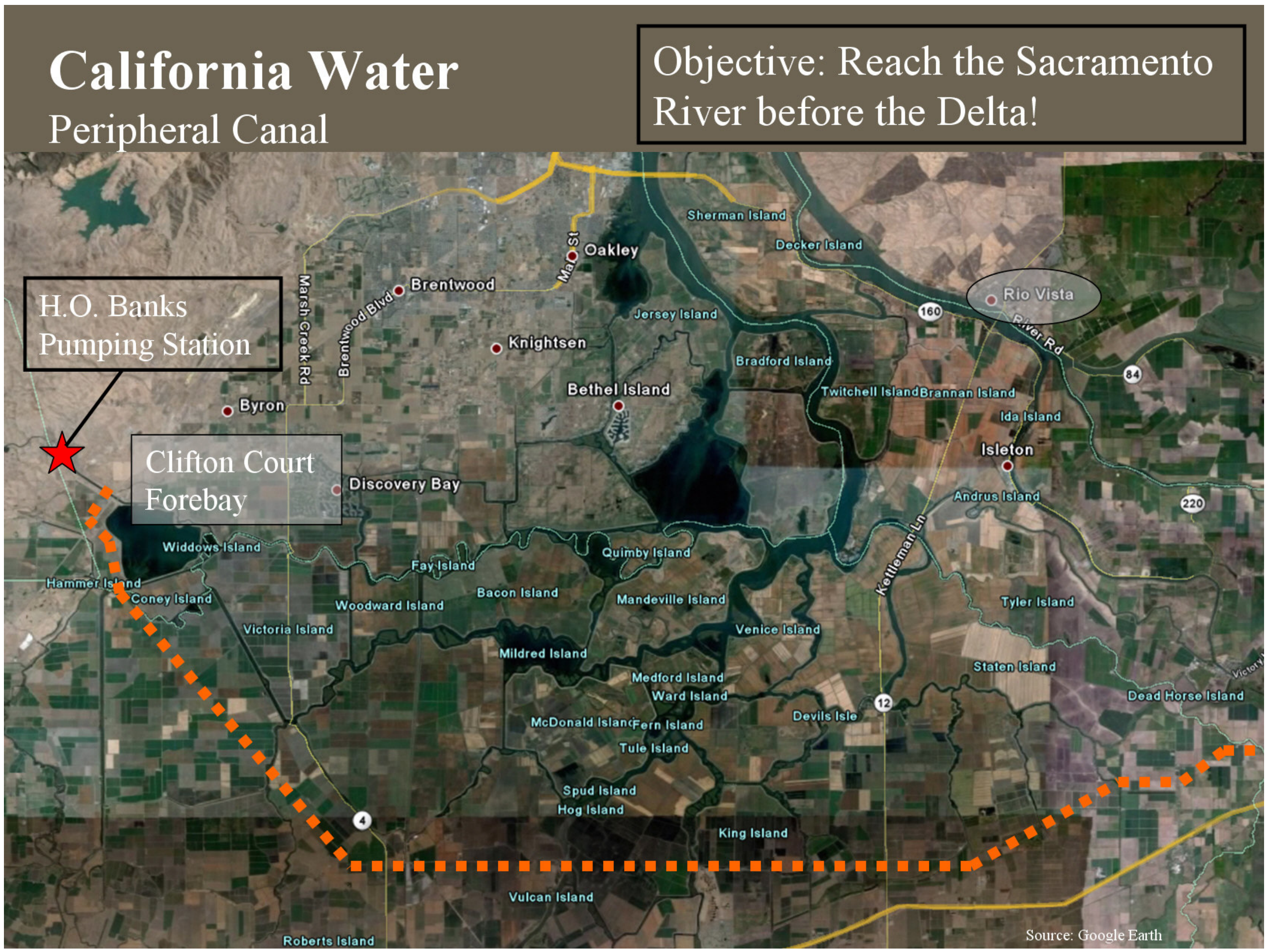
STREAM FLOWS OF CALIFORNIA

Not every river in California is created equal. The largest flow of fresh water in the state (~33 MAF/yr) occurs along the Sacramento River at the small town of Rio Vista, just upstream of the San Joaquin Delta ("Delta"). In the 2006 water year, approximately 3.5 MAF was pumped out of the Delta by the Harvey Banks Pump Station which lies at the southwestern edge of the Delta. This facility and its pumping have been blamed for the reduction of Delta Smelt. Are smelt reductions tied to unbalanced fresh water to salt water ratios? Are too many sewage nutrients to blame? Does pumping out of the Delta occur at the wrong times of year, diminishing spawn? Or lastly, are the fish simply following the flow of fresh water to the pumps, in the hopes of encountering salt water? It is the responsibility of science to fully answer these questions before a Peripheral Canal is funded and constructed.



PERIPHERAL CANAL

In an attempt to combat reductions in the Delta smelt and other fish species, the present “solution” is to construct a peripheral canal which would effectively capture and divert the Sacramento River before it enters the Delta. A study and an environmental impact report are currently in process with documents ready for review in the 4th quarter of 2012 and 2nd quarter of 2013. It is uncertain what remedy would occur should the Delta Smelt migrate to the new intake structure of the peripheral canal. In addition, it is not readily apparent that a peripheral canal would fix salt water to fresh water ratios within the Delta or remove excess sewage effluent nutrients, should such factors be found to be the causes behind species reductions.



PERIPHERAL CANAL – A $10 TO $15 BILLION PROJECT

The construction of a peripheral canal is not only expensive, but the costs continue to rise as the complexity of the project reveals itself. The proposed tunnels are very large, the soil within the Delta is of poor quality for tunneling, and the surrounding water table is very high. The combination of these factors will require additional buttressing during construction and an increase in steel lining the tunnel, greatly increasing costs. As a result, the peripheral canal plan is now being referred to as "audacious".

California Water

Peripheral Canal – A $10 to $15 Billion Project

Calif. eyes $10 billion cost to tunnel delta water

Published online on Thursday, Dec. 03, 2009
The Associated Press

Comments (0) Recommend (0)

SACRAMENTO, Calif. -- State water officials say it could cost $10.6 billion to send water to Southern California through a proposed project of tunnels under the Sacramento-San Joaquin Delta.

The Department of Water Resources presented the cost estimate Thursday to a group of state and federal agencies studying ideas to safeguard water deliveries out of the delta.

Two tunnels, about 150 feet underground, are being considered as an alternative to building a proposed canal around the fragile estuary. A third tunnel would serve as an intake tunnel.

Jerry Johns, DWR deputy director, described the cost as preliminary and says more design work needs to be done over the next year.

Cost estimates for a proposed canal have ranged between $8.3 billion to $9.4 billion.

Audacious Delta tunnel plan weighed

By Matt Weiser / The Sacramento Bee
Monday, Feb. 20, 2012 | 12:00 AM

It reveals that the project is "pushing the state of the art for tunneling projects in North America," and poses numerous "constructability challenges" due to its enormous size and cost.

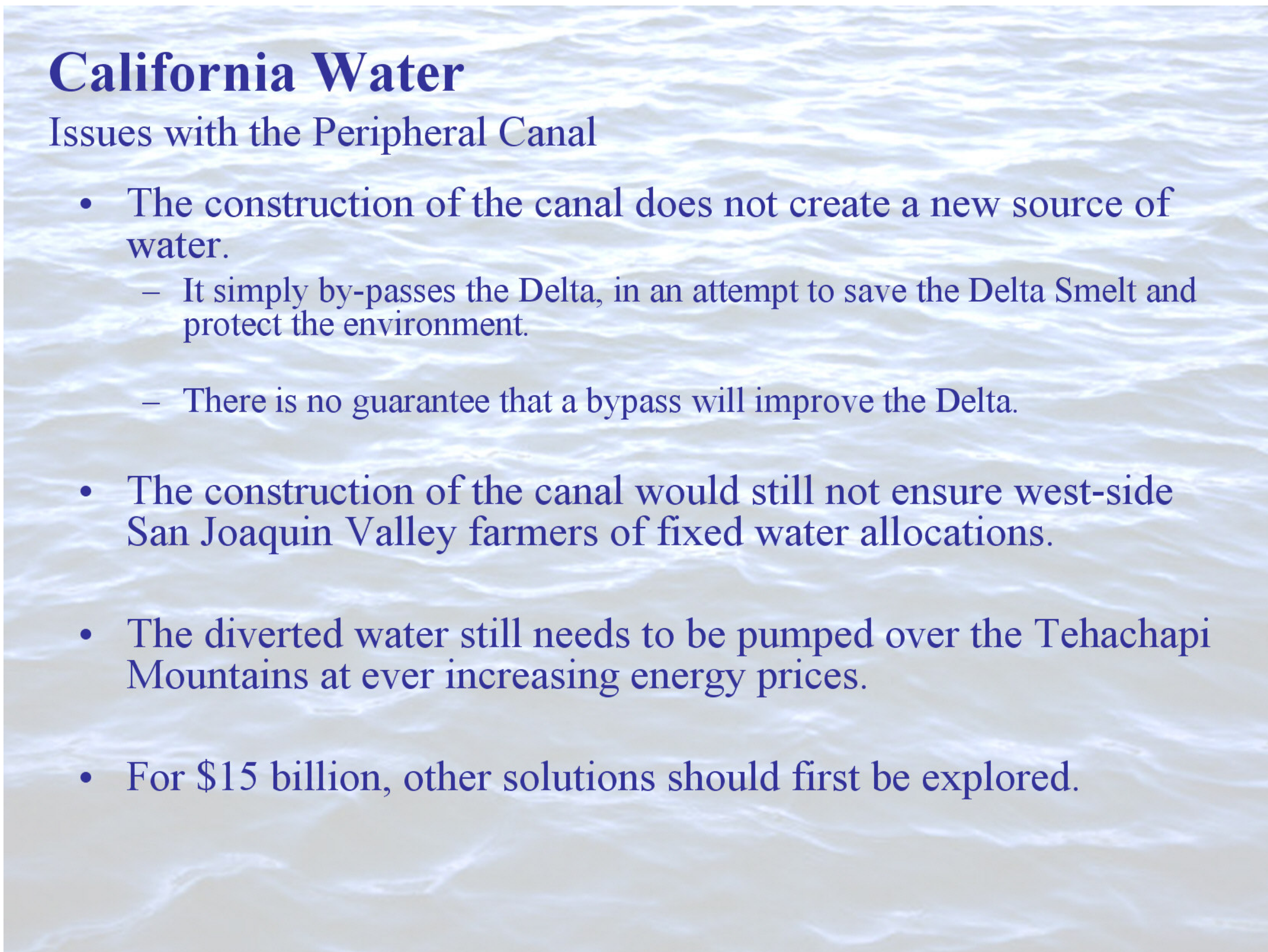
Sanchez told The Bee that the cost is now estimated at around $14 billion, an increase of more than $1 billion since the last formal estimate in 2010.

The increase is due partly to the need to tunnel deeper -- 150 feet down -- to avoid the bulk of the Delta's loose peat and sedimentary soils, and to find a depth that will equalize groundwater and soil pressures, which will forever work against the concrete tunnels.

The cost could go higher still. Sanchez said portions of the tunnel -- at least the northern stretch -- may require an additional steel liner as an extra bolster against the strains imposed by the water itself.

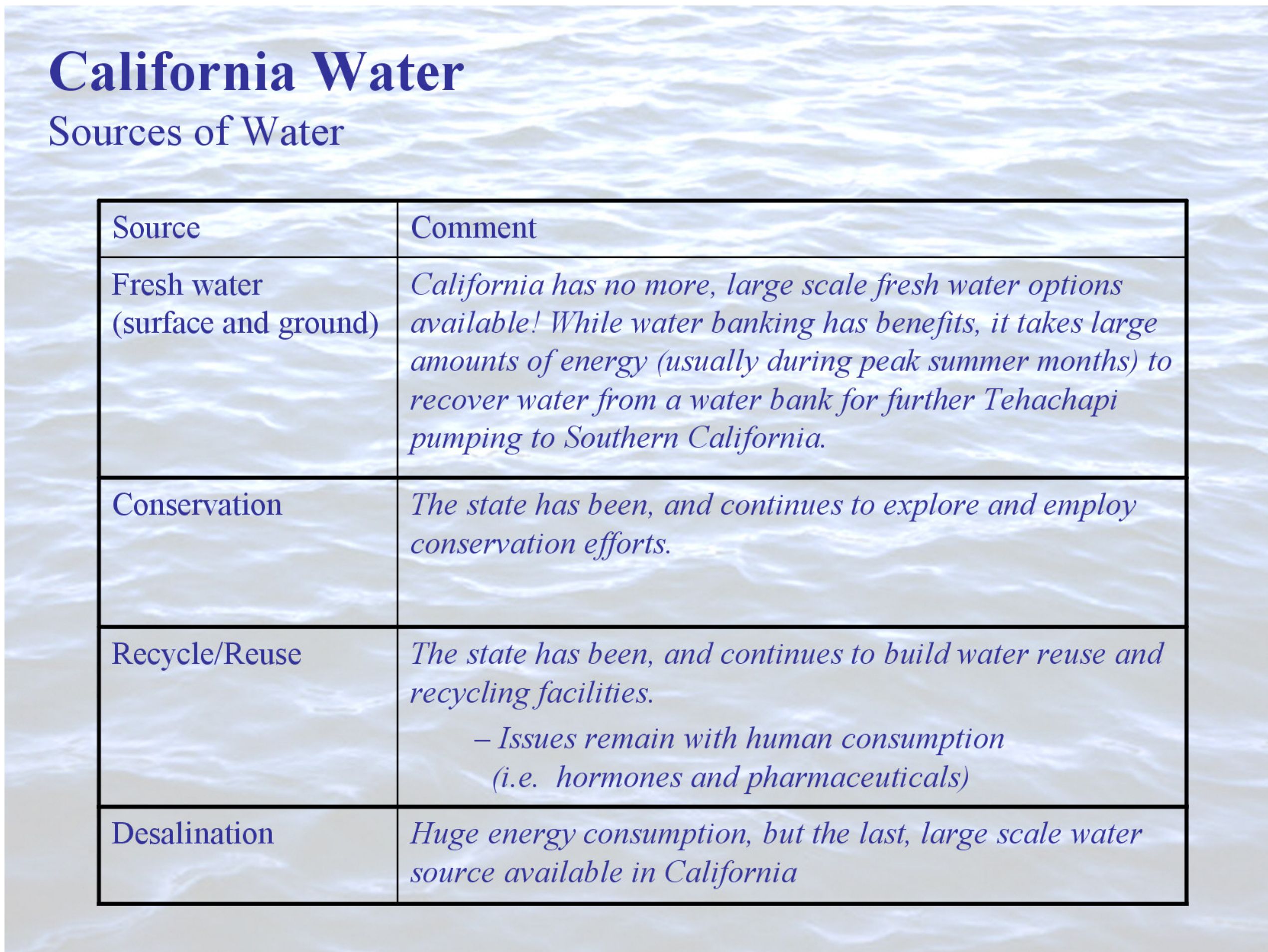
ISSUES WITH THE PERIPHERAL CANAL

The construction of a peripheral canal does not create or provide a new source of water. It simply grabs water before it enters the Delta in the hopes that such a by-pass will prevent future issues with the eco-system of the Delta (such as the Delta Smelt). Science has not determined the root causes for reductions in the Delta Smelt. While the Sacramento River does not appear to be over-allocated (~10% of average annual Sacramento River flow), the peripheral canal must first become a proven solution. The construction of the canal does not guarantee water deliveries and all diverted water still needs to be pumped over the Tehachapi's at ever increasing energy prices. This report inquires, "Is there a better $15 billion solution?"



SOURCES OF WATER

Before allocating $15 billion, California must first explore other alternatives. The state has virtually exhausted all fresh water options and even if found, pumping into Southern California will always require lifting water over a mountain range. Conservation efforts can always be improved with conversion of planted areas to hardscaped surfaces, low water plantings and synthetic lawns. Recycling efforts can be significantly increased where every golf course, park and cemetery in Southern California is irrigated via satellite tertiary treatment plants providing recycled water. The last frontier for California is desalination, but it is a huge energy consumer.



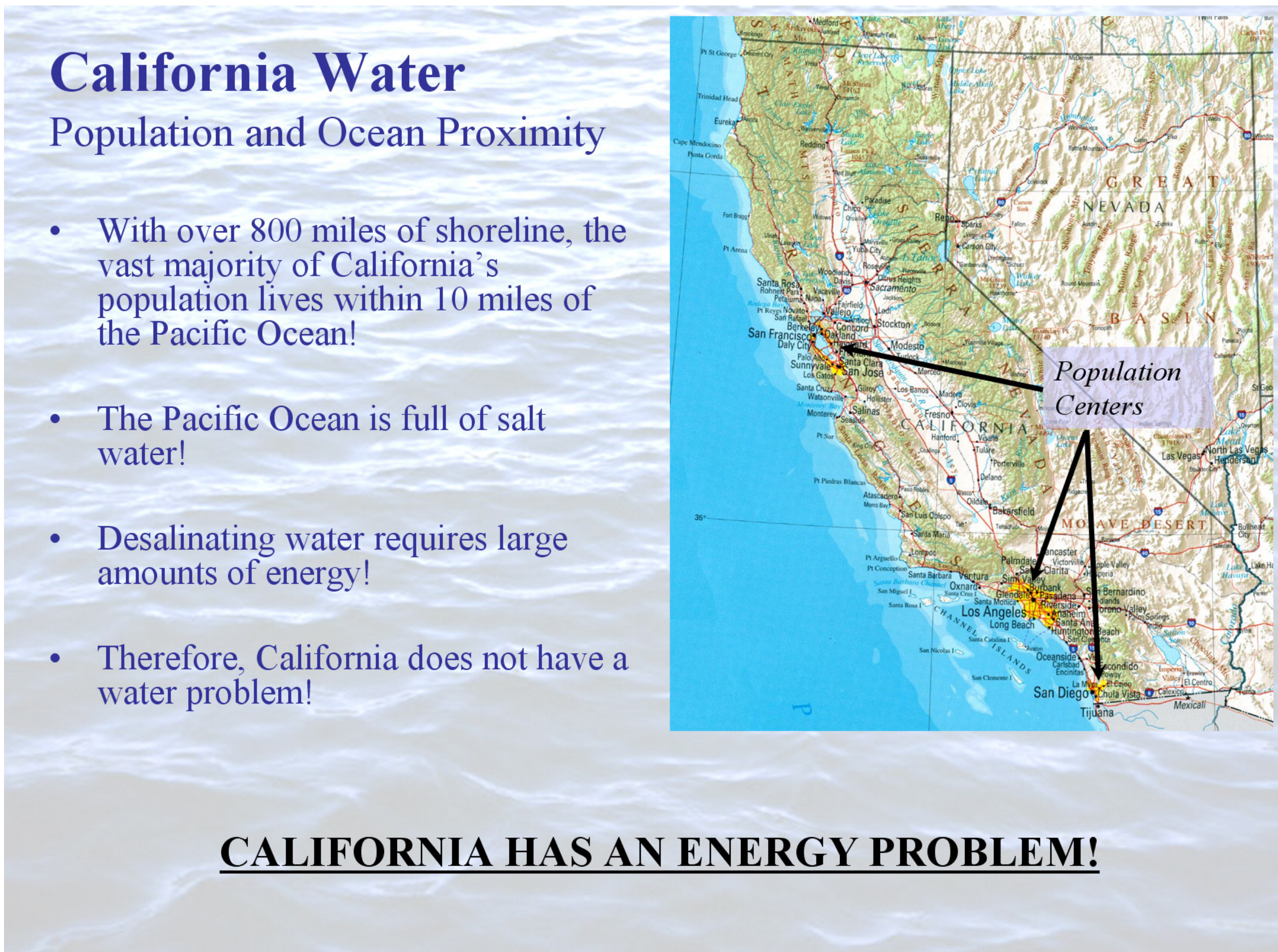
California Water

Sources of Water

Source	Comment
Fresh water (surface and ground)	*California has no more, large scale fresh water options available! While water banking has benefits, it takes large amounts of energy (usually during peak summer months) to recover water from a water bank for further Tehachapi pumping to Southern California.*
Conservation	*The state has been, and continues to explore and employ conservation efforts.*
Recycle/Reuse	*The state has been, and continues to build water reuse and recycling facilities.* *– Issues remain with human consumption (i.e. hormones and pharmaceuticals)*
Desalination	*Huge energy consumption, but the last, large scale water source available in California*

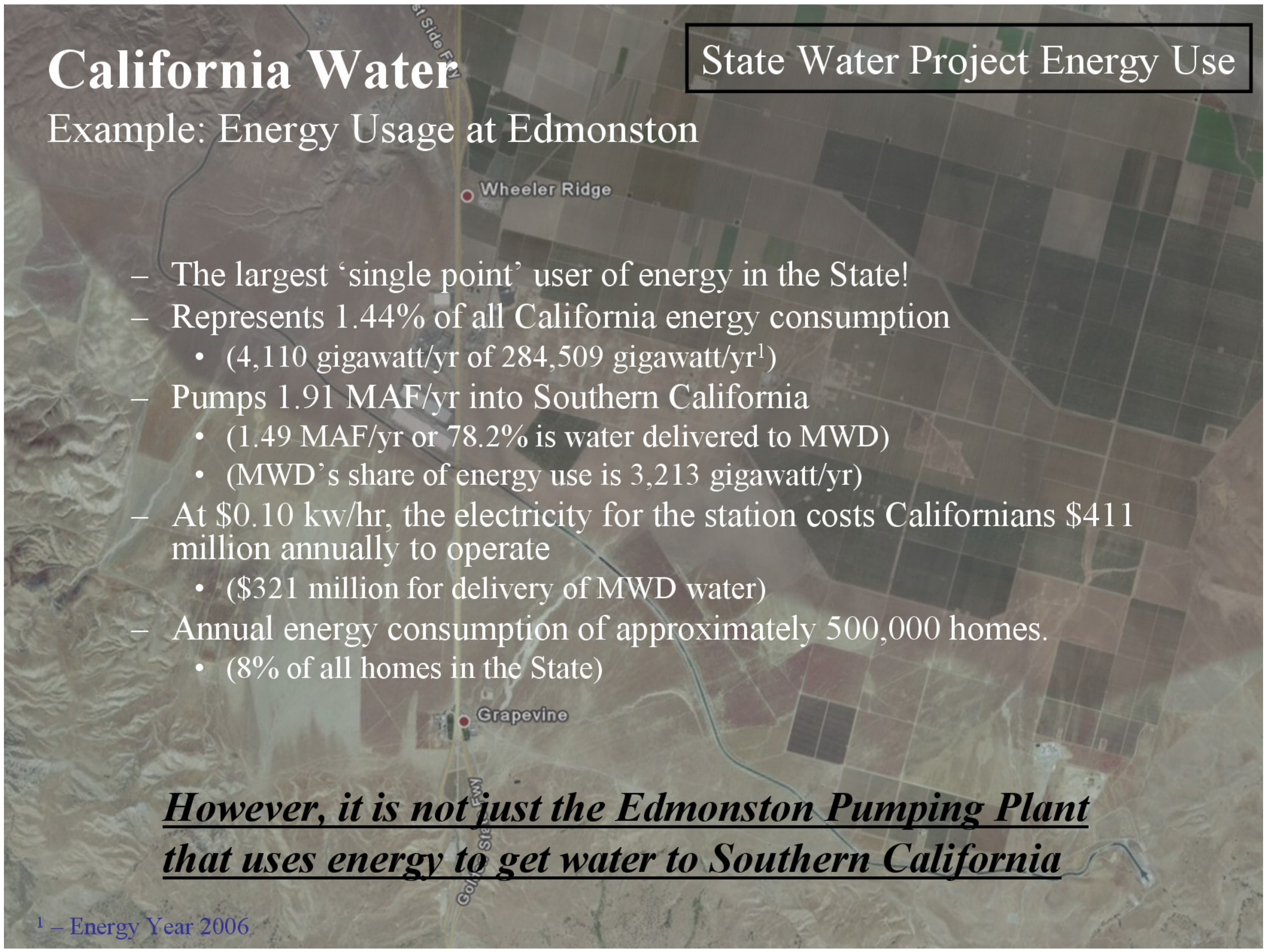
POPULATION AND OCEAN PROXIMITY

California has more than 800 miles of shoreline with the Pacific Ocean, but as stated earlier, the northern half of the state receives enough precipitation to meet its own needs. The obvious downside is that the Pacific Ocean is full of salt water and that removing the salts from this water requires large amounts of electricity. The end result is that California does not have a water problem - California has an energy problem. Within reason, if the state had a copious supply of energy, it could desalinate any amount of ocean water.



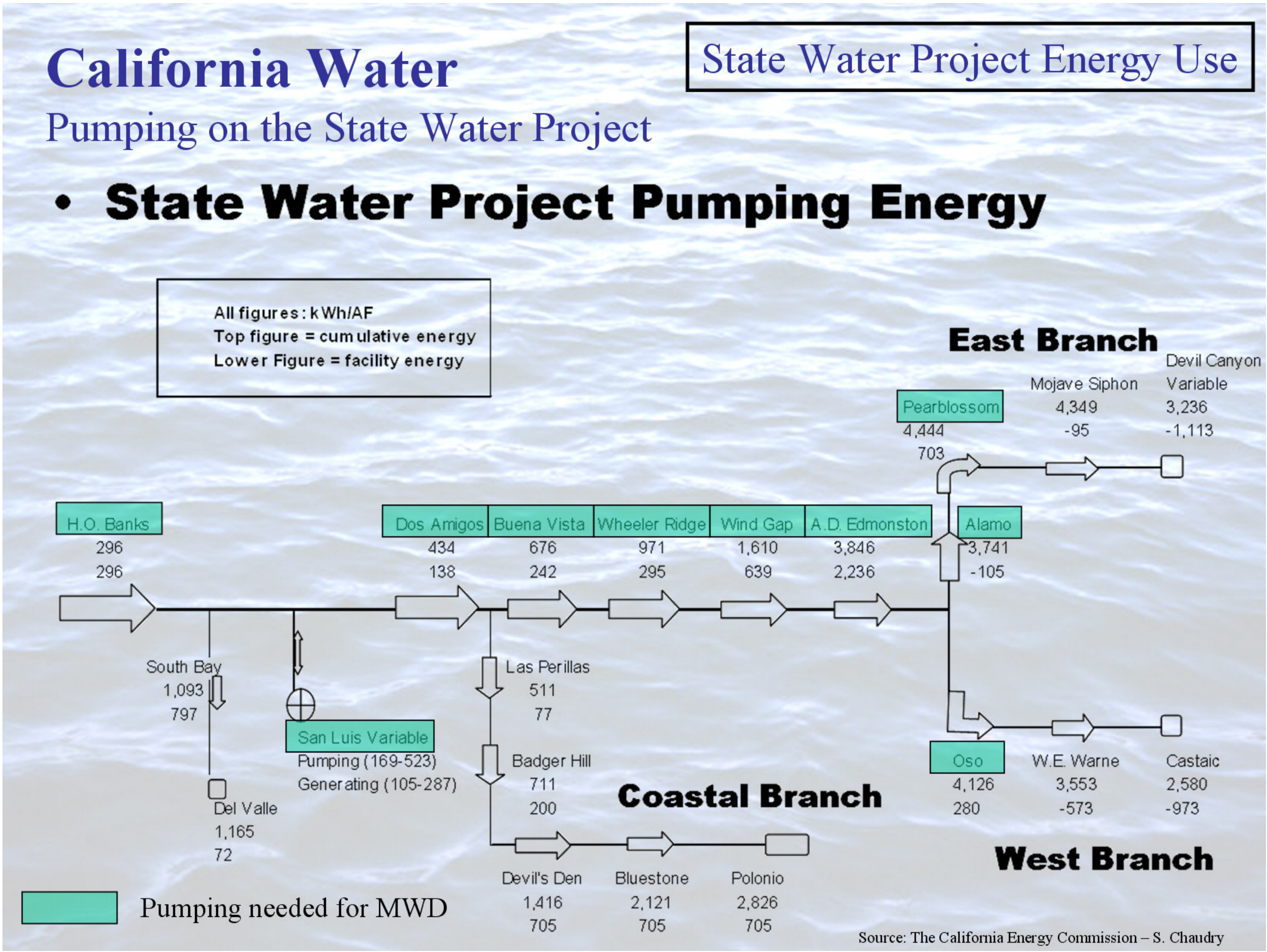
EXAMPLE: ENERGY USAGE AND EDMONSTON

Approximately 10% of the energy used in the State of California is consumed in the transport, treatment and pressurization of potable water. As example, the Edmonston Pumping plant south of Bakersfield consumed 1.44% of the entire state energy use in the 2006 water year. In the consumption of 4,110 gigawatts of electricity, approximately 1.91 MAF were pumped over the Tehachapi mountain range. Assuming $0.10/kW-hr, this station costs California ratepayers approximately $411 million to operate. This one facility is equal to the energy demand of 500,000 homes.



PUMPING ON THE STATE WATER PROJECT

In getting water from the San Joaquin Delta to the Los Angeles Basin, five additional pumping stations lie upstream of the Edmonston Pumping Plant. The first is the H.O. (Harvey) Banks facility, followed by the Dos Amigos, Buena Vista, Wheeler Rider, and the Wind Gap pumping facilities. As the graphic illustrates, a large of amount of energy is required in the movement of water from Northern California to Southern California.



SWP DELIVERY AND USAGE

State Water Project water delivery by agency shows that, when compared to the pumping facility required to convey such delivery for the 2006 water year, approximately 42% of all water being pumped out of the Delta is delivered to the Metropolitan Water District. After turnout of 1.24 million acre-feet to the Kern Water Agency for agricultural uses, nearly 80% of all water entering the Buena Vista, Wheeler Ridge, Wind Gap and Edmonston plants is for water delivery to MWD.

California Water

SWP Delivery and Usage

State Water Project Energy Use

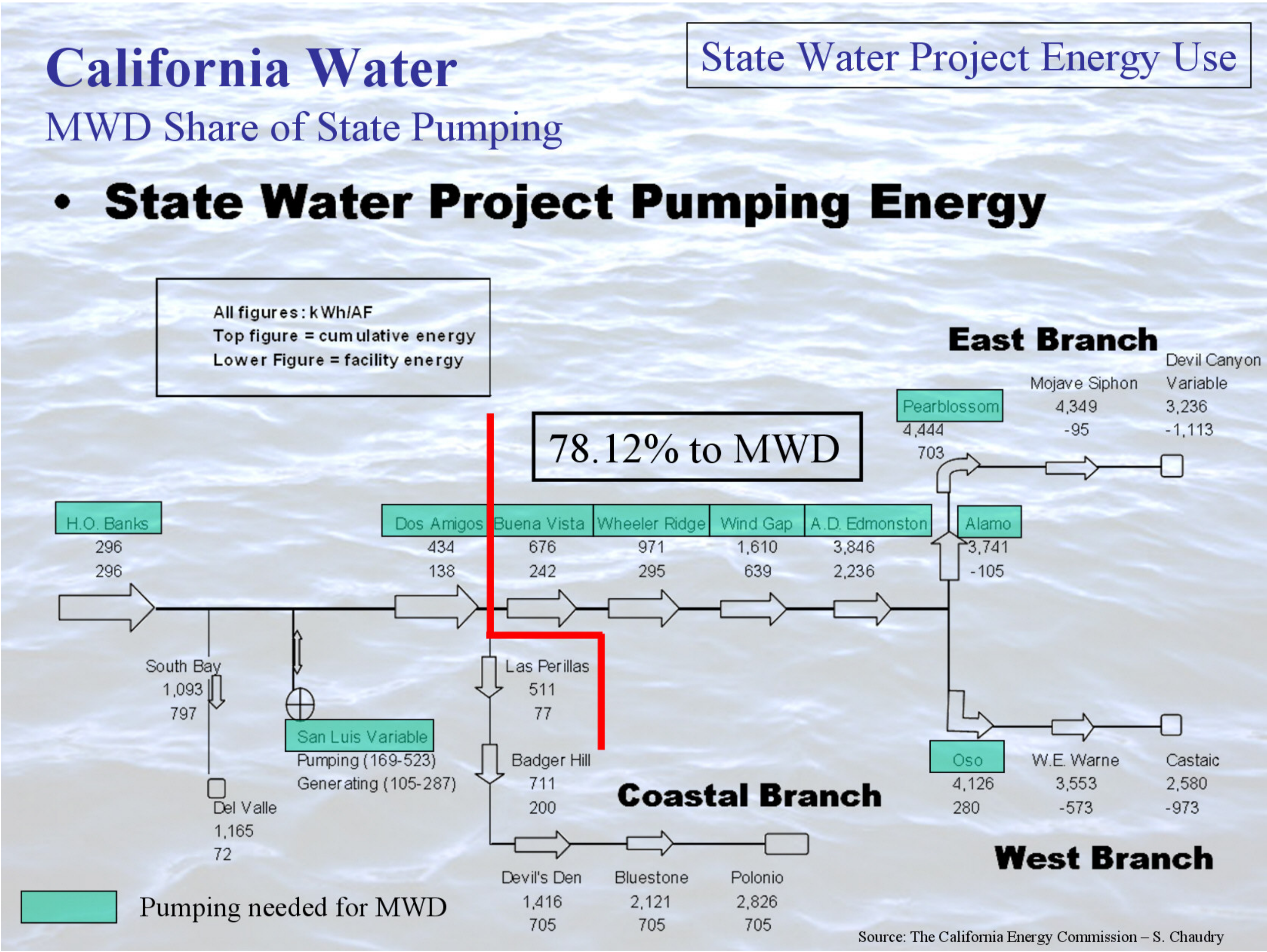
Historical State Water Project Deliveries: 2006
(All units in acre-feet)

Agency	Total	% Total	Cumulative Total	Reverse Cumulative Total		
County of Butte	468	0.0%	468	3,592,647		
City of Yuba City	5,342	0.1%	5,810	3,587,305		
Napa County FC& WCD	7,784	0.2%	13,594	3,579,521		
Solano County WA	30,655	0.9%	44,249	3,548,866		
Alameda County FC&WCD, Zone 7	53,528	1.5%	97,777	3,495,338		
Alameda County WD	43,079	1.2%	140,856	3,452,259		
Santa Clara Valley WD	74,637	2.1%	215,493	3,377,622		
Oak Flat WD	4,242	0.1%	219,735	3,373,380		
County of Kings	9,530	0.3%	229,265	3,363,850		
Dudley Ridge WD	74,926	2.1%	304,191	3,288,924		
Empire West Side ID	3,282	0.1%	307,473	3,285,642		
Kern County WA	1,242,544	34.6%	1,550,017	2,043,098		
Tulare Lake Basin WSD	109,572	3.0%	1,659,589	1,933,526		
San Luis Obispo County FC&WCD	4,209	0.1%	1,663,798	1,929,317		
Santa Barbara County FC&WCD	23,275	0.6%	1,687,073	1,906,042		
Antelope Valley-East Kern WA	80,384	2.2%	1,767,457	1,825,658		
Castaic Lake WA (+Rch 31A, 5&7)	62,752	1.7%	1,830,209	1,762,906		
Coachella Valley WD	121,100	3.4%	1,951,309	1,641,806		
Crestline-Lake Arrowhead WA	257	0.0%	1,951,566	1,641,549		
Desert WA	50,000	1.4%	2,001,566	1,591,549		
Mojave WA	34,014	0.9%	2,035,580	1,557,535		
Metropolitan Water District	1,490,078	41.5%	3,525,658	67,457		
Palmdale WD	12,492	0.3%	3,538,150	54,965		
San Bernardino Valley MWD	35,329	1.0%	3,573,479	19,636		
San Grabriel Valley MWD	13,524	0.4%	3,587,003	6,112		
San Gorgonio Pass WA	4,262	0.1%	3,591,265	1,850		
Ventura County FCD	1,850	0.1%	3,593,115	0		
Total	3,593,115	100.0%	3,593,115	0		
	% Water Passing (AF/yr)					% MWD
(green)	Harvey Banks Pumping Plant					41.99%
(orange)	Dos Amigos Pumping Plant					44.17%
(grey)	Buena Vista, Wheeler Ridge, Wind Gap, Edmonston					78.18%

78.2% of all SWP delivery south of the Buena Vista pump station goes to MWD

MWD SHARE OF STATE PUMPING

Shown schematically, the red line illustrates the nearly 80% allocation of water entering the Buena Vista Pumping Station is for MWD delivery. The station names highlighted in green show energy consumption while energy recovery occurs at the Mojave Siphon, Devil Canyon Variable, W.E. Warne and Castaic generation facilities. Accounting for energy recovery and using a base energy price of $0.10/kw-hr, the cost to transport 1 acre-foot of water from the Delta to MWD is approximately $258 (38% energy recovery) to the end of the west branch and $326 (29% energy recovery) to the end of the east branch.



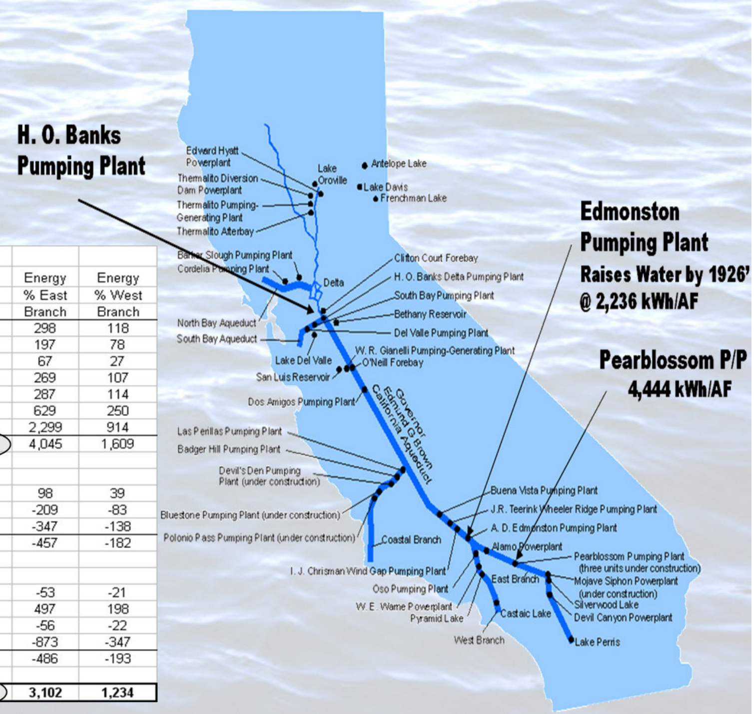
MWD ELECTRIC USAGE

However, the energy required in moving water through the State Water Project far outweighs energy recovery. In the 2006 water year, 8,055 gigawatts of electricity were required in the transport of water through the San Joaquin Valley (5,655 gigawatts for delivery of MWD allocation). Accounting for energy recovery, approximately 4,337 gigawatts of electricity were required in delivering water through the State Water Project to MWD. An analysis of the 2006 water year shows a combined east/west branch energy recovery on the SWP to be just 23%, likely the result of reduced pump efficiencies and increased water deliveries to AVEK and other, higher elevation end users. Such efficiency reductions further increase the delivered cost of MWD water.

California Water

MWD Electric Usage

- **State Water Pumping Facilities**



State Water Project Energy Usage - Year 2006 (For delivery to MWD)

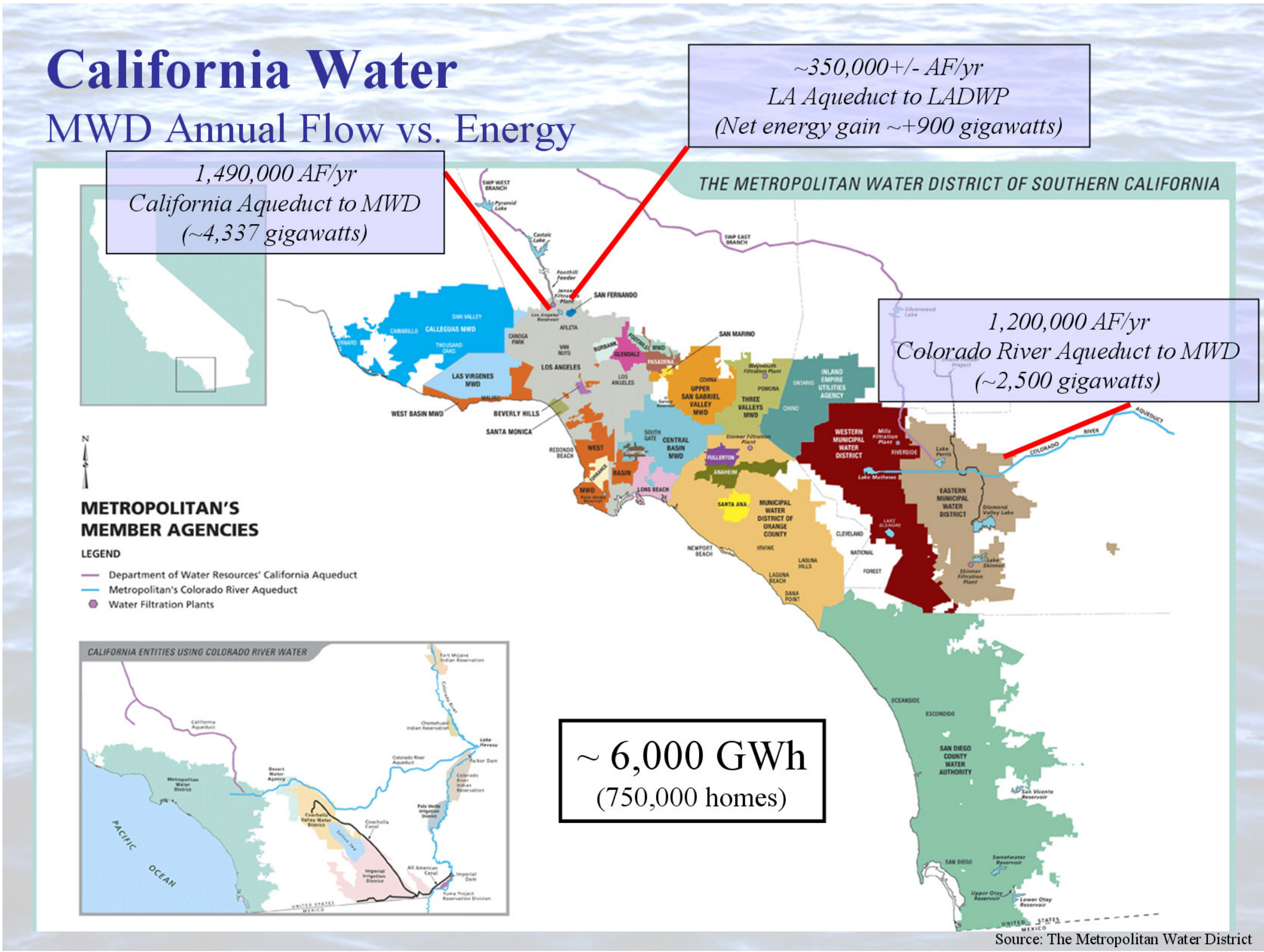
Pumping Plants	Year	Energy Use (gigawatts)	%MWD	Total % MWD Energy	Energy % East Branch	Energy % West Branch
Harvey Banks	2006	991	41.99%	416	298	118
Dos Amigos	2006	623	44.17%	275	197	78
San Luis Variable	2006	211	44.17%	93	67	27
Buena Vista	2006	481	78.18%	376	269	107
Wheeler Ridge	2006	514	78.18%	402	287	114
Wind Gap	2006	1,125	78.18%	880	629	250
Edmonston Pumping Plant	2006	4,110	78.18%	3,213	2,299	914
Subtotal		8,055		5,655	4,045	1,609
West Branch						
Oso	2006	138	99.56%	138	98	39
Warne (Production)	2006	-294	99.56%	-292	-209	-83
Castaic (Production)	2006	-487	99.56%	-485	-347	-138
				-639	-457	-182
East Branch						
Alamo (Production)	2006	-87	84.53%	-74	-53	-21
Pearblossom	2006	794	87.47%	694	497	198
Mojave Siphon (Production)	2006	-90	87.47%	-79	-56	-22
Devil Canyon (Production)	2006	-1,396	87.47%	-1,221	-873	-347
				-679	-486	-193
Total Energy Demand				4,337	**3,102**	**1,234**

<u>In 2006, delivering water to MWD end users required 4,337 gigawatts of electricity</u>

Source: http://www.water.ca.gov/swp/operationscontrol/monthly.cfm

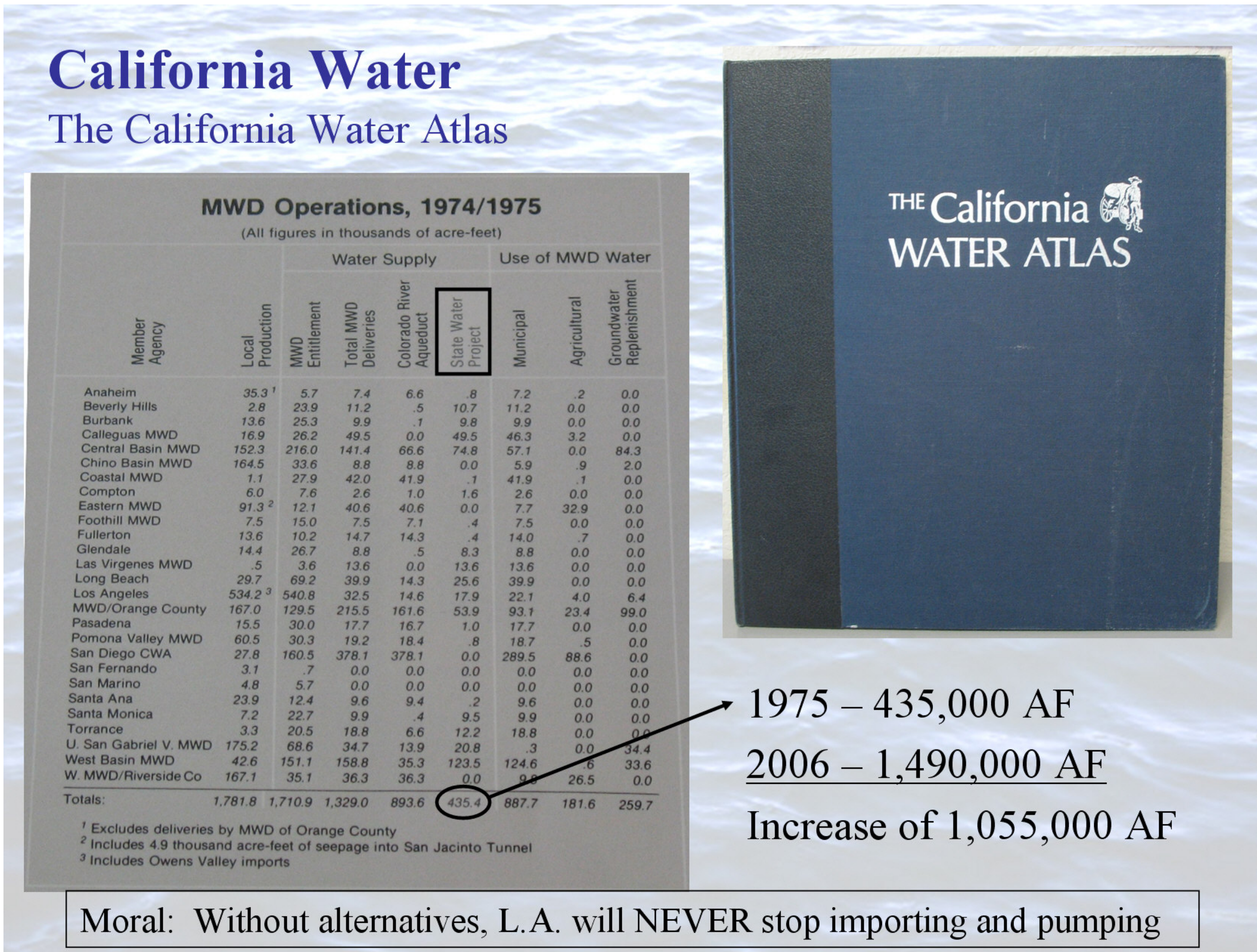
MWD ANNUAL FLOW VS. ENERGY

In the review of all MWD delivered water, approximately 4,337 gigawatts of electricity were required in the delivery of 1.49 million acre-feet of water to MWD through the SWP, a net production of 900 gigawatts were realized in the delivery of an estimated 350,000 acre-feet of water (estimated) via the Los Angeles Aqueduct (Owens River Project), while another 2,500 gigawatts were required in the delivery of 1.2 million acre-feet of Colorado River water. In all, approximately 6,000 gigawatts of electricity are needed to deliver water to MWD, equaling the energy consumption of approximately 750,000 homes.



THE CALIFORNIA WATER ATLAS

Prepared in the early 1970's, the California Water Atlas is considered a "bible" of California water. Within this book is a table showing that in the 1974/75 water year, approximately 435,000 acre-feet of SWP water were delivered to MWD. By the 2006 water year, approximately 1,490,000 acre-feet of water were delivered. As Nevada and Arizona continue to acquire their legal entitlements to Colorado River water, the eyes of southern California grow larger upon the Sacramento River and a peripheral canal. What role has the increase in pumping played on the eco-system within the Delta and could variable pumping (or other) be used to control the salt water to fresh water ratios within the Delta?



MWD Operations, 1974/1975

(All figures in thousands of acre-feet)

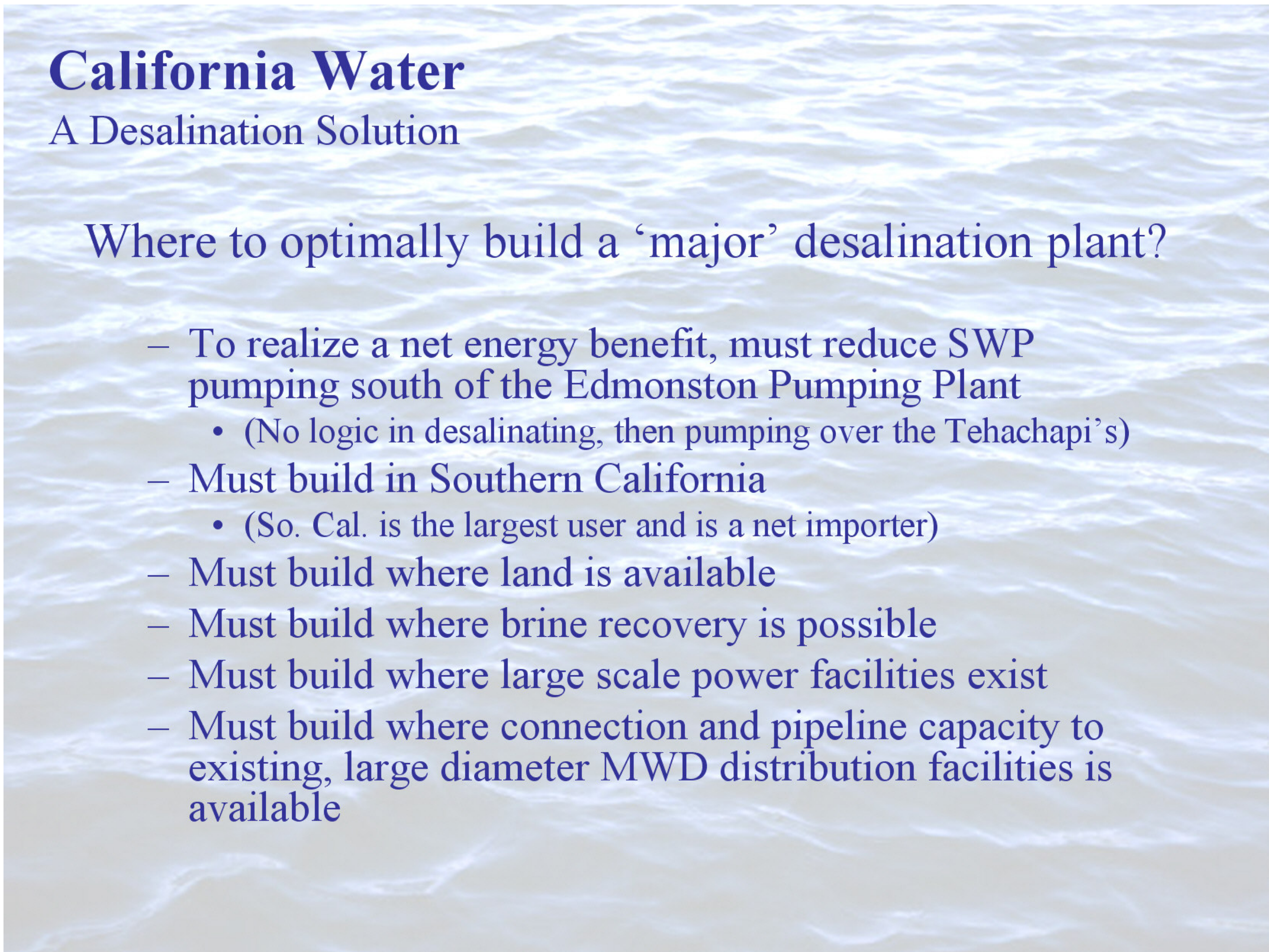
Member Agency	Local Production	Water Supply: MWD Entitlement	Total MWD Deliveries	Colorado River Aqueduct	State Water Project	Use of MWD Water: Municipal	Agricultural	Groundwater Replenishment
Anaheim	35.3 [1]	5.7	7.4	6.6	.8	7.2	.2	0.0
Beverly Hills	2.8	23.9	11.2	.5	10.7	11.2	0.0	0.0
Burbank	13.6	25.3	9.9	.1	9.8	9.9	0.0	0.0
Calleguas MWD	16.9	26.2	49.5	0.0	49.5	46.3	3.2	0.0
Central Basin MWD	152.3	216.0	141.4	66.6	74.8	57.1	0.0	84.3
Chino Basin MWD	164.5	33.6	8.8	8.8	0.0	5.9	.9	2.0
Coastal MWD	1.1	27.9	42.0	41.9	.1	41.9	.1	0.0
Compton	6.0	7.6	2.6	1.0	1.6	2.6	0.0	0.0
Eastern MWD	91.3 [2]	12.1	40.6	40.6	0.0	7.7	32.9	0.0
Foothill MWD	7.5	15.0	7.5	7.1	.4	7.5	0.0	0.0
Fullerton	13.6	10.2	14.7	14.3	.4	14.0	.7	0.0
Glendale	14.4	26.7	8.8	.5	8.3	8.8	0.0	0.0
Las Virgenes MWD	.5	3.6	13.6	0.0	13.6	13.6	0.0	0.0
Long Beach	29.7	69.2	39.9	14.3	25.6	39.9	0.0	0.0
Los Angeles	534.2 [3]	540.8	32.5	14.6	17.9	22.1	4.0	6.4
MWD/Orange County	167.0	129.5	215.5	161.6	53.9	93.1	23.4	99.0
Pasadena	15.5	30.0	17.7	16.7	1.0	17.7	0.0	0.0
Pomona Valley MWD	60.5	30.3	19.2	18.4	.8	18.7	.5	0.0
San Diego CWA	27.8	160.5	378.1	378.1	0.0	289.5	88.6	0.0
San Fernando	3.1	.7	0.0	0.0	0.0	0.0	0.0	0.0
San Marino	4.8	5.7	0.0	0.0	0.0	0.0	0.0	0.0
Santa Ana	23.9	12.4	9.6	9.4	.2	9.6	0.0	0.0
Santa Monica	7.2	22.7	9.9	.4	9.5	9.9	0.0	0.0
Torrance	3.3	20.5	18.8	6.6	12.2	18.8	0.0	0.0
U. San Gabriel V. MWD	175.2	68.6	34.7	13.9	20.8	.3	0.0	34.4
West Basin MWD	42.6	151.1	158.8	35.3	123.5	124.6	.6	33.6
W. MWD/Riverside Co	167.1	35.1	36.3	36.3	0.0	9.8	26.5	0.0
Totals:	1,781.8	1,710.9	1,329.0	893.6	435.4	887.7	181.6	259.7

[1] Excludes deliveries by MWD of Orange County
[2] Includes 4.9 thousand acre-feet of seepage into San Jacinto Tunnel
[3] Includes Owens Valley imports

DESALINATION SELECTION CRITERIA

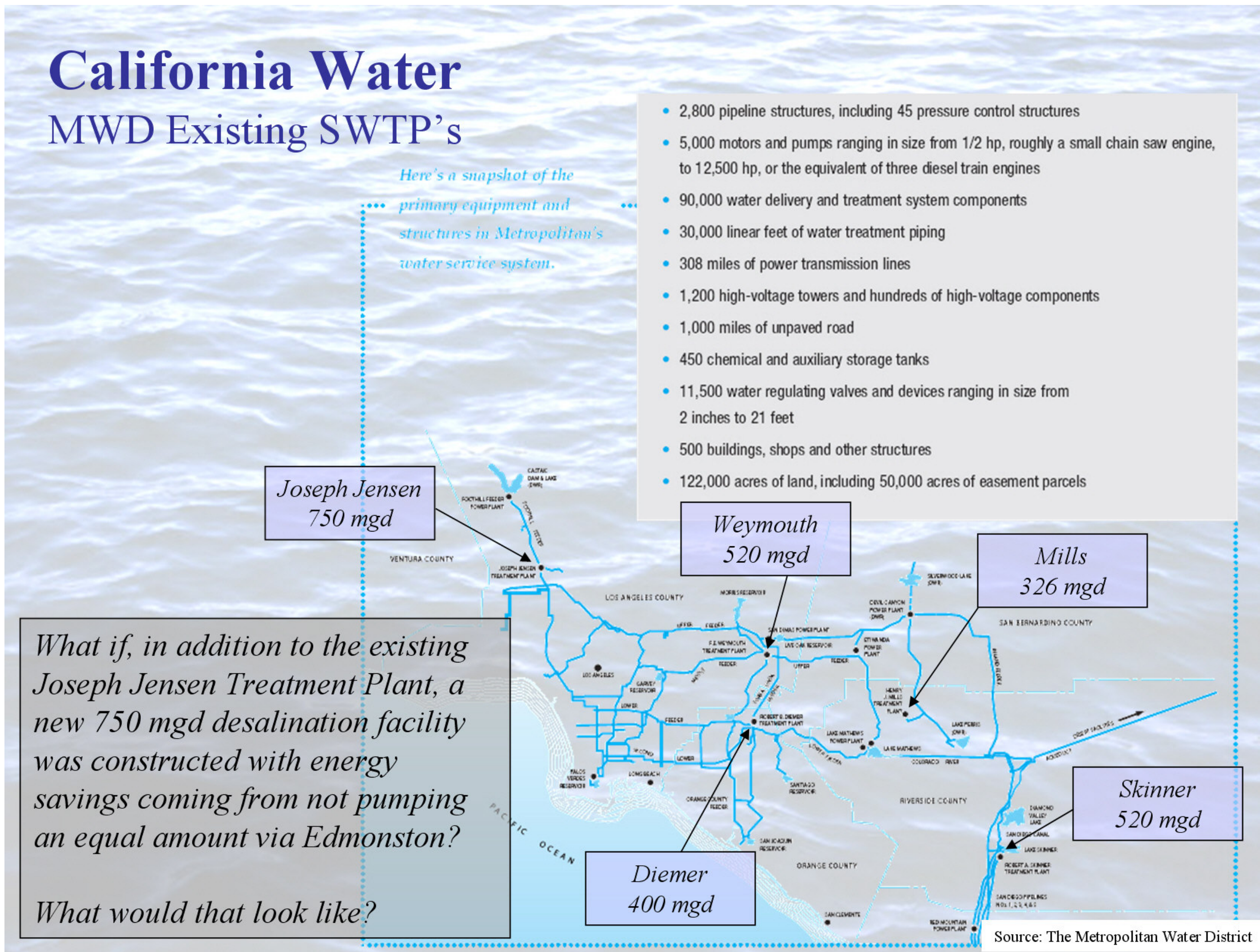
A DESALINATION SOLUTION

Upon review of the energy required in the transport of water to Southern California, there is no economic justification in constructing a large scale desalination facility anywhere but in southern California. However, an aerial photo review of Los Angeles demonstrates that locating such a facility is not readily apparent. Such a facility should be built where not only land is available, but where sufficient infrastructure, such as power supply and water distribution, already exist. Brine recovery and disposal are also necessary elements to any desalination proposal.



EXISTING MWD SURFACE WATER TREATMENT PLANTS

Water supply infrastructure are already present at existing surface water treatment plants within the MWD distribution system. Because of distance limitations, Skinner, Mills and Weymouth are excluded while Diemer is also excluded for a lack of sufficient water storage or power supply. In conclusion, the Joseph Jensen Facility should be further explored as a potential desalination facility. The following slides demonstrate how this facility could be utilized for desalinating and distributing ocean water.



THE JOSEPH JENSEN DESALINATION PROJECT

ENNIS CONSULTING

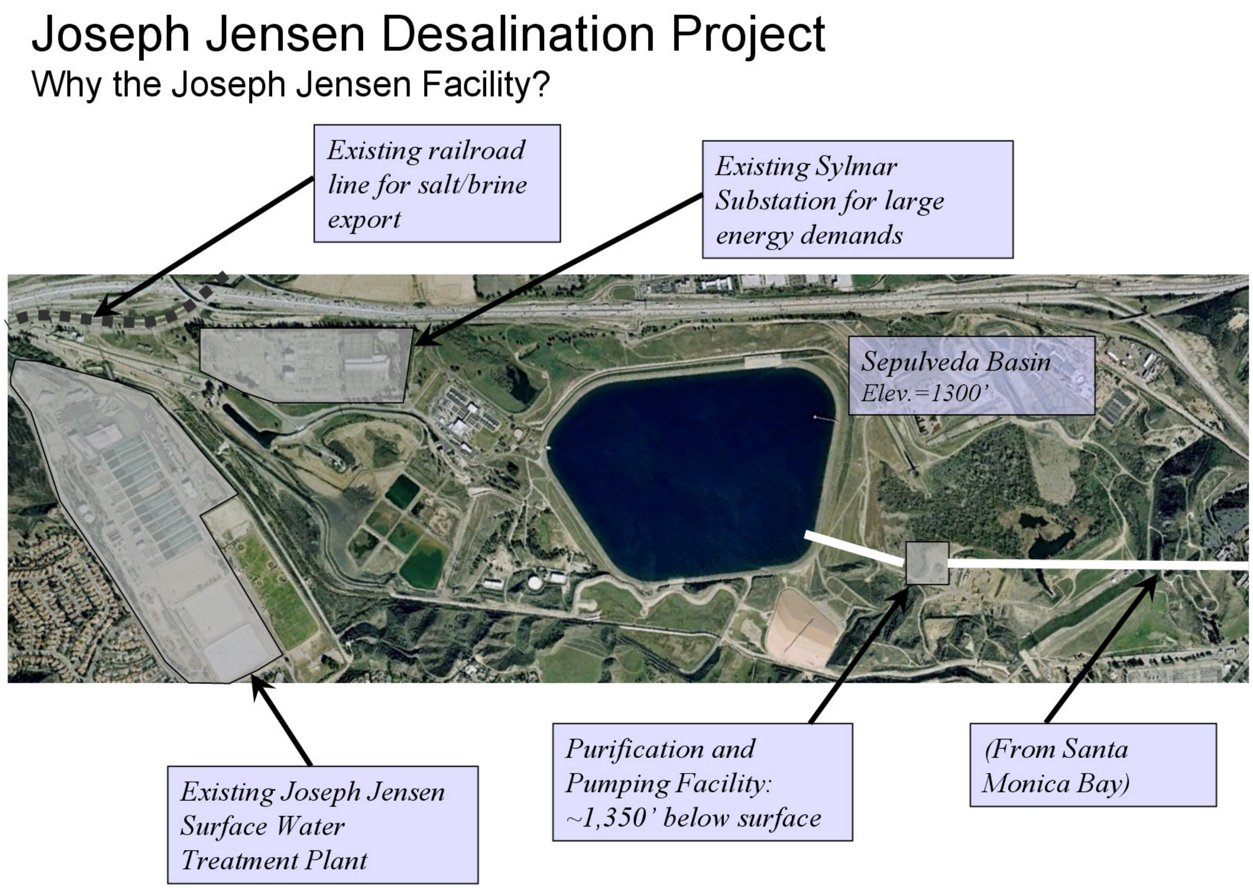
Metropolitan Water District
Joseph Jensen Desalination Project

March 2012

THE METROPOLITAN WATER DISTRICT
of SOUTHERN CALIFORNIA

WHY THE JOSEPH JENSEN FACILITY

Advantages to the Joseph Jensen facility are: 1) At 18.5 miles, it is the closest MWD water treatment plant to the Pacific Ocean. 2) The existing Sylmar Substation. 3) The existing Sepulveda Basin (the confluence of the Los Angeles and California Aqueducts).
4) The existing headworks of both the raw water and treated water distribution networks for MWD. 4) An existing rail road spur for the export of brine.
5) An adequate supply of buildable land. 6) Expansion capacity of the existing Joseph Jensen Water Treatment Plant.

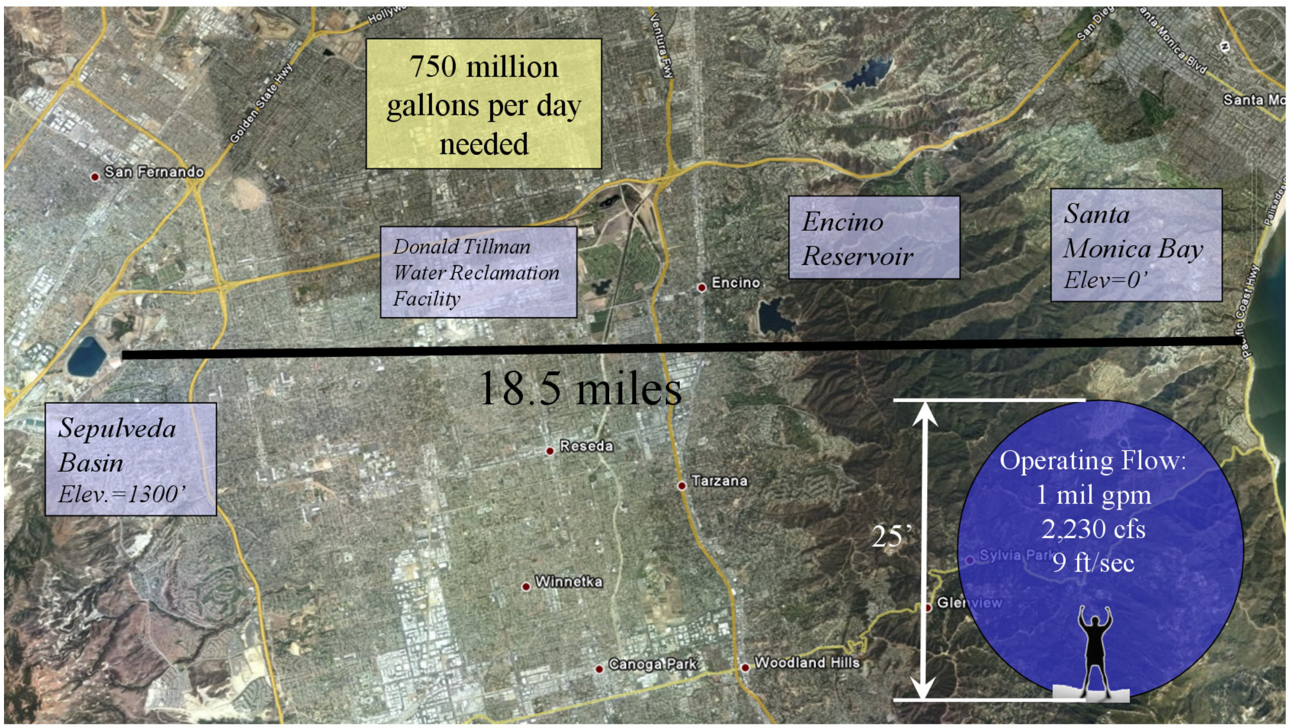


PIPELINE CONSTRUCTION – PLAN VIEW

The proposal is to construct a 25-foot diameter tunnel under the San Fernando Valley, from the Santa Monica Bay to the Sepulveda Basin. An estimate of 750 million gallons/day (7 times larger than the world's largest desalination facility) of sea water supply has been used in the evaluation of this proposal. In this evaluation, it is apparent that existing technologies would need to be significantly improved to treat this volume of water as provided in Alternate 4 of this report. As a comparison of costs, the Eurotunnel connecting England and France was three tunnels, 32 miles long under the English Channel, constructed at a total cost of $21 billion.

Joseph Jensen Desalination Project

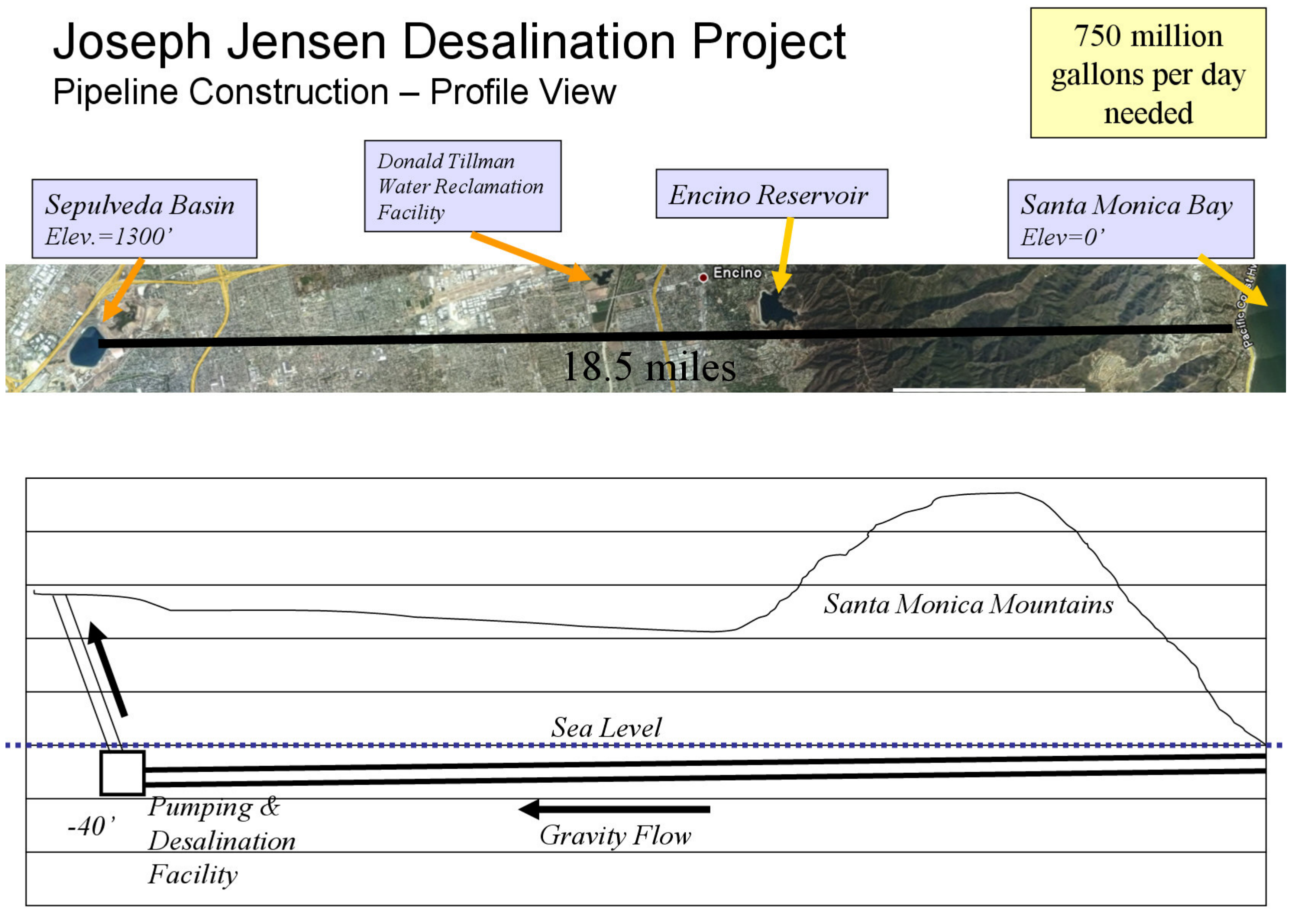
Pipeline Construction – Plan View



The Eurotunnel was 3 tunnels, 32 miles, 25' diameter – Total Cost = $21 billion

PIPELINE CONSTRUCTION – PROFILE VIEW

In cross section, the pipeline would be constructed at a downhill gradient from the Santa Monica Bay to the base of the Sepulveda Basin. Electric supply from the nearby Sylmar Substation would provide power to pumps, lifting sea water from the tunnel to the Sepulveda Basin. Approximately one significant earthquake fault line, residing just south of the Sepulveda basin, would need to be crossed in the construction of this pipeline. Note in this aerial photo the location of the Donald Tillman Water Reclamation Plant in relation to the proposed pipeline.



PIPELINE CONSTRUCTION – PIPELINE HYDRAULICS

A preliminary engineering evaluation of the pipeline shows that at a design flow of 2,230 cfs, a velocity of approximately 6 feet/second could be attained with a cross sectional flow of a little more than ½ full. Allowing a 10-foot operational clearance within the tunnel would allow for a catwalk, power supply and brine return pipeline to be supported within the ceiling and sides of the tunnel structure, ensuring operational maintenance and periodic inspection, particularly following earthquake events. An additional benefit of the tunnel is its proximity to the Donald Tillman Water Reclamation Plant, which could utilize the new tunnel in discharging sewage effluent to the Hyperion Sewage Treatment Plant via a realigned brine discharge pipeline.

Joseph Jensen Desalination Project

Pipeline Construction – Pipeline Hydraulics

PIPE CALCULATION SPREADSHEET

Pipe Inside Dia.	300.00 in
Calculated Slope	0.0004 ft/ft
Manning's n	0.012
Minimum Vel.	1.00 fps
Maximum d/D	0.99 in/in
Target Flow Rate	2230.00 cfs

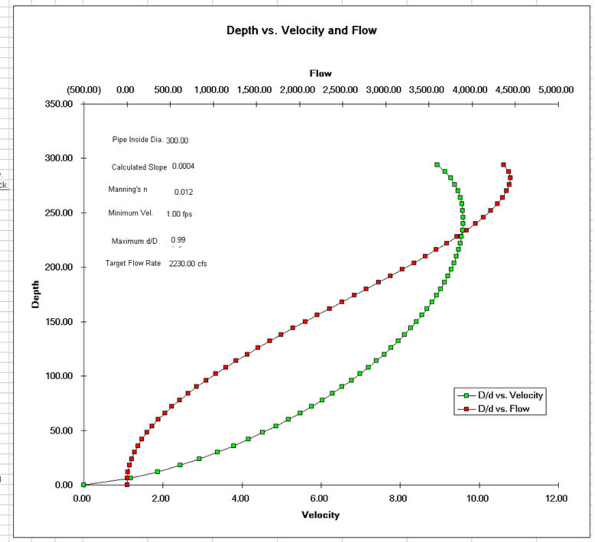
Start slope =	0.0000	Increment = 0.0001
0.0004	1	<<Change to 1 to start iteration
(SS=0.013, SD=0.015)		Enter Zero to Zero Out Values

ZERO

ITERATE

Results >>>>>>	FLOW GOVERNS
Calc. Flow Rate	2347.89 cfs
Vel. at Calc. Flow	8.68 fps
d at Calc. Flow	162.00 in
d/D at Calc. Flow	0.54 in/in

Depth of Flow (in.)	Velocity (fps)	Flow Rate (cfs)	Flow Rate (gpm)	Flow Rate (mgd)	Flow Check	Vel. Check	d/D Check	Set to o:k if vel req'mnts satisfied	Set to o:k flow req'mnts satisfied	Flow	Vel	d/D	Gov. Check
0.00	0.00	(0.00)	(0.00)	(0.00)									
6.000	1.18	2.78	22.26	0.032	0.0000	1.18	0.02	o:k					
12.000	1.87	12.31	98.72	0.142	0.0000	1.87	0.04	o:k					
18.000	2.43	29.25	234.67	0.338	0.0000	2.43	0.06	o:k					
24.000	2.93	53.87	432.10	0.622	0.0000	2.93	0.08	o:k					
30.000	3.38	86.23	691.67	0.996	0.0000	3.38	0.10	o:k					
36.000	3.79	126.32	1,013.27	1.459	0.0000	3.79	0.12	o:k					
42.000	4.17	174.06	1,396.23	2.011	0.0000	4.17	0.14	o:k					
48.000	4.52	229.32	1,839.50	2.649	0.0000	4.52	0.16	o:k					
54.000	4.86	291.93	2,341.69	3.372	0.0000	4.86	0.18	o:k					
60.000	5.18	361.68	2,901.20	4.178	0.0000	5.18	0.20	o:k					
66.000	5.47	438.35	3,516.17	5.063	0.0000	5.47	0.22	o:k					
72.000	5.76	521.68	4,184.58	6.026	0.0000	5.76	0.24	o:k					
78.000	6.03	611.39	4,904.24	7.062	0.0000	6.03	0.26	o:k					
84.000	6.29	707.21	5,672.80	8.169	0.0000	6.29	0.28	o:k					
90.000	6.53	808.81	6,487.80	9.342	0.0000	6.53	0.30	o:k					
96.000	6.76	915.88	7,346.63	10.579	0.0000	6.76	0.32	o:k					
102.000	6.99	1,028.07	8,246.57	11.875	0.0000	6.99	0.34	o:k					
108.000	7.20	1,145.04	9,184.80	13.226	0.0000	7.20	0.36	o:k					
114.000	7.40	1,266.41	10,158.37	14.628	0.0000	7.40	0.38	o:k					
120.000	7.59	1,391.81	11,164.26	16.077	0.0000	7.59	0.40	o:k					
126.000	7.77	1,520.85	12,199.31	17.567	0.0000	7.77	0.42	o:k					
132.000	7.95	1,653.11	13,260.28	19.095	0.0000	7.95	0.44	o:k					
138.000	8.11	1,788.20	14,343.83	20.655	0.0000	8.11	0.46	o:k					
144.000	8.27	1,925.67	15,446.51	22.243	0.0000	8.27	0.48	o:k					
150.000	8.41	2,065.08	16,564.78	23.853	0.0000	8.41	0.50	o:k					
156.000	8.55	2,205.97	17,694.98	25.481	0.0000	8.55	0.52	o:k					
162.000	8.68	2,347.89	18,833.33	27.120	2,347.8882	8.68	0.54	o:k	o:k	######	8.68	0.54	1.00
168.000	8.80	2,490.33	19,975.94	28.765	2,490.3344	8.80	0.56						
174.000	8.92	2,632.81	21,118.81	30.411	2,632.8119	8.92	0.58						
180.000	9.02	2,774.80	22,257.78	32.051	2,774.8030	9.02	0.60						
186.000	9.12	2,915.77	23,388.54	33.679	2,915.7715	9.12	0.62						
192.000	9.21	3,055.16	24,506.64	35.290	3,055.1608	9.21	0.64						
198.000	9.29	3,192.39	25,607.41	36.875	3,192.3908	9.29	0.66						
204.000	9.36	3,326.86	26,686.01	38.428	3,326.8560	9.36	0.68						
210.000	9.42	3,457.92	27,737.33	39.942	3,457.9202	9.42	0.70						
216.000	9.47	3,584.91	28,755.98	41.409	3,584.9128	9.47	0.72						
222.000	9.52	3,707.12	29,736.26	42.820	3,707.1212	9.52	0.74						
228.000	9.55	3,823.78	30,672.05	44.168	3,823.7827	9.55	0.76						
234.000	9.58	3,934.07	31,556.73	45.442	3,934.0728	9.58	0.78						
240.000	9.59	4,037.09	32,383.06	46.632	4,037.0889	9.59	0.80						
246.000	9.59	4,131.83	33,143.00	47.726	4,131.8277	9.59	0.82						
252.000	9.58	4,217.15	33,827.42	48.711	4,217.1513	9.58	0.84						
258.000	9.56	4,291.74	34,425.69	49.573	4,291.7362	9.56	0.86						
264.000	9.52	4,353.99	34,925.05	50.292	4,353.9899	9.52	0.88						
270.000	9.46	4,401.91	35,309.42	50.846	4,401.9078	9.46	0.90						
276.000	9.38	4,432.80	35,557.24	51.202	4,432.8025	9.38	0.92						
282.000	9.28	4,442.72	35,636.81	51.317	4,442.7226	9.28	0.94						
288.000	9.14	4,424.94	35,494.16	51.112	4,424.9386	9.14	0.96						

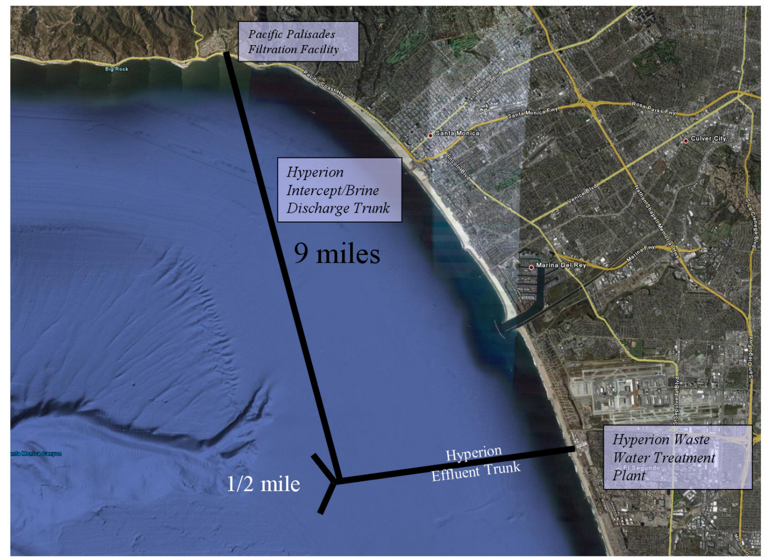


PACIFIC PALISADES FILTRATION FACILITY

Prior to flowing downstream to the Sepulveda Basin, the PPFF would remove suspended materials from incoming source water and blend removed particulates back with brine effluent returning from the Sepulveda Basin. The effluent brine trunk leaving this facility (dependent upon the need to combine with Tillman effluent) is estimated to be a 9-mile long, 6-foot diameter pipeline constructed on the ocean floor and connected to the effluent trunk exiting the Hyperion Sewage Treatment Facility, 5 miles west of the City of El Segundo. By combining brine with sewage effluent, salt ratios can be diluted and reduced in order to prevent "hot zones".

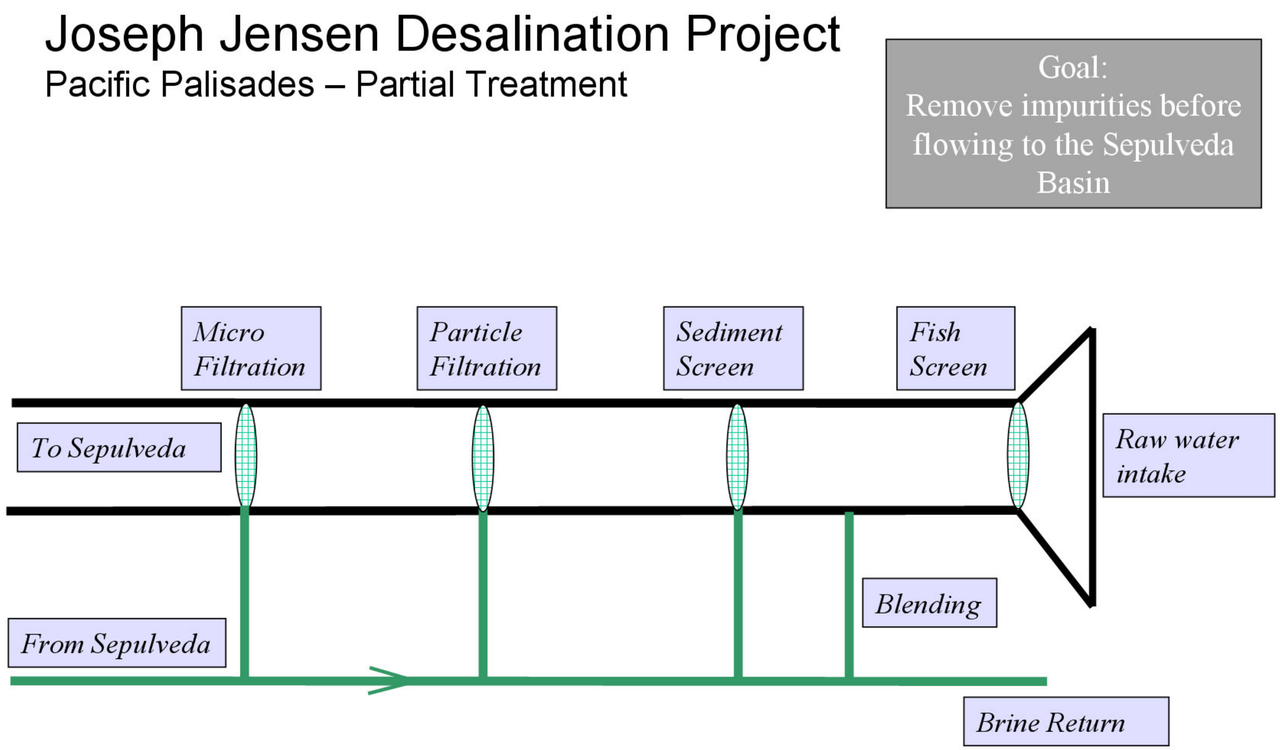
Joseph Jensen Desalination Project
Pacific Palisades Filtration Facility

Joseph Jensen Desalination Project
El Segundo Pipeline



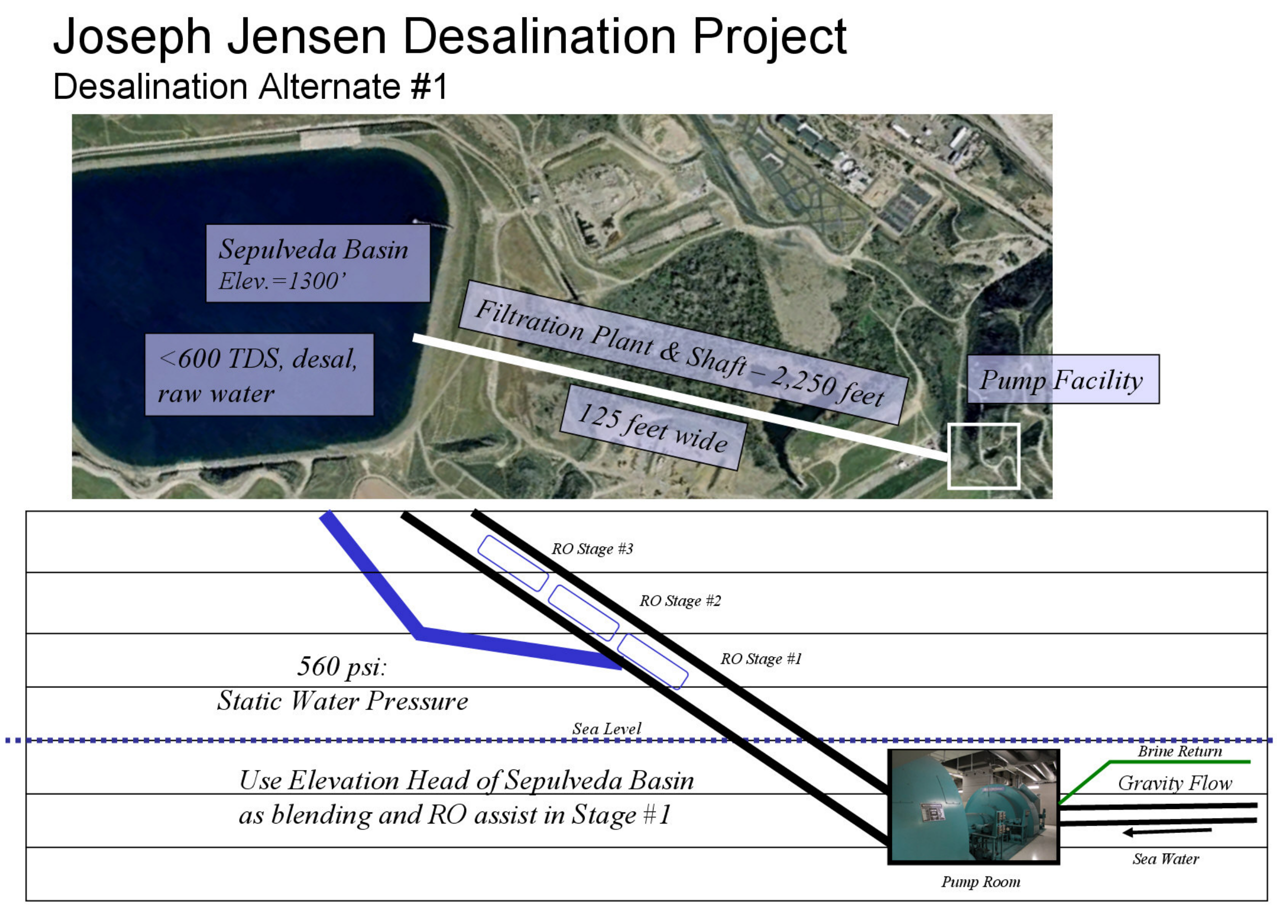
PACIFIC PALISADES – PARTIAL TREATMENT

Ocean influent contains particulates and suspended materials which will need to be removed before the process of desalination can begin at the JJDF. Screening of influent for fish, trash, and seaweeds would be followed by sediment screening, then particle and potentially micro filtration. The goal of the PPFF is impurity removal before transporting ocean water to the JJDF.



DESALINATION ALTERNATE #1

The first alternate is to construct a vertically inclined treatment plant inside the lifting shaft, accessing the underground pump facility. By utilizing the existing elevation head of raw water within the Sepulveda Basin, mixing could occur to lower the salt concentration of influent sea water and reduce the amount of pressure and filtration necessary within the reverse osmosis process. Since pumps will need to be of sufficient size to lift water to the Sepulveda Basin, such pressure head could be immediately provided in an underground RO treatment plant.

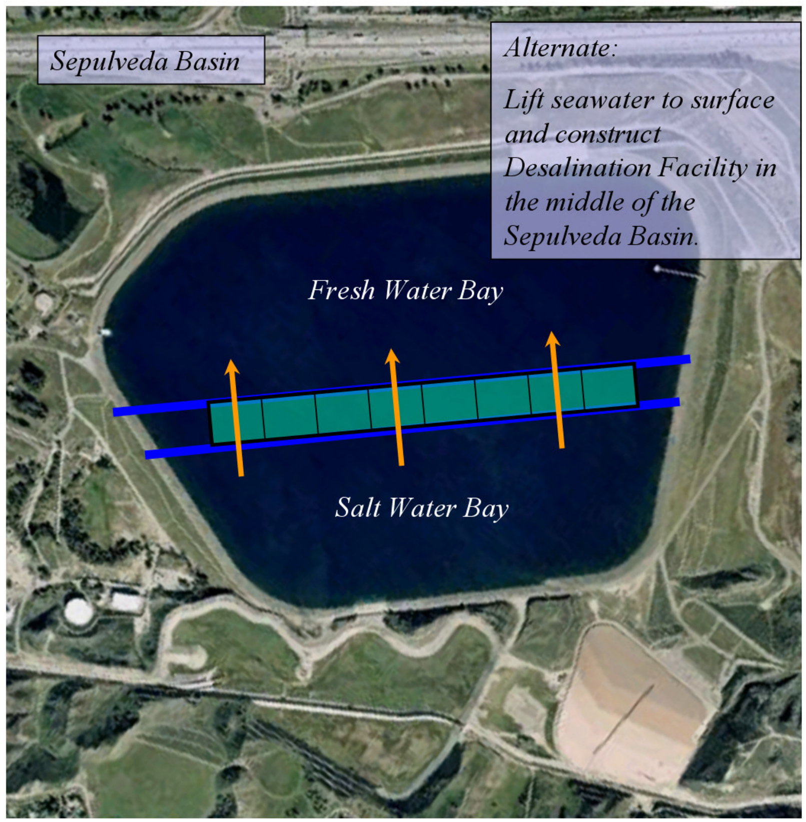


DESALINATION ALTERNATE #2

The second alternate is to lift sea water directly into the Sepulveda Basin and construct a reverse osmosis treatment plant between a salt water and fresh water bay. Sea water could be partially treated for cost savings and further treatment by downstream surface water treatment plants or fully treated and discharged directly into the MWD potable distribution network.

Joseph Jensen Desalination Project

Desalination Alternate #2

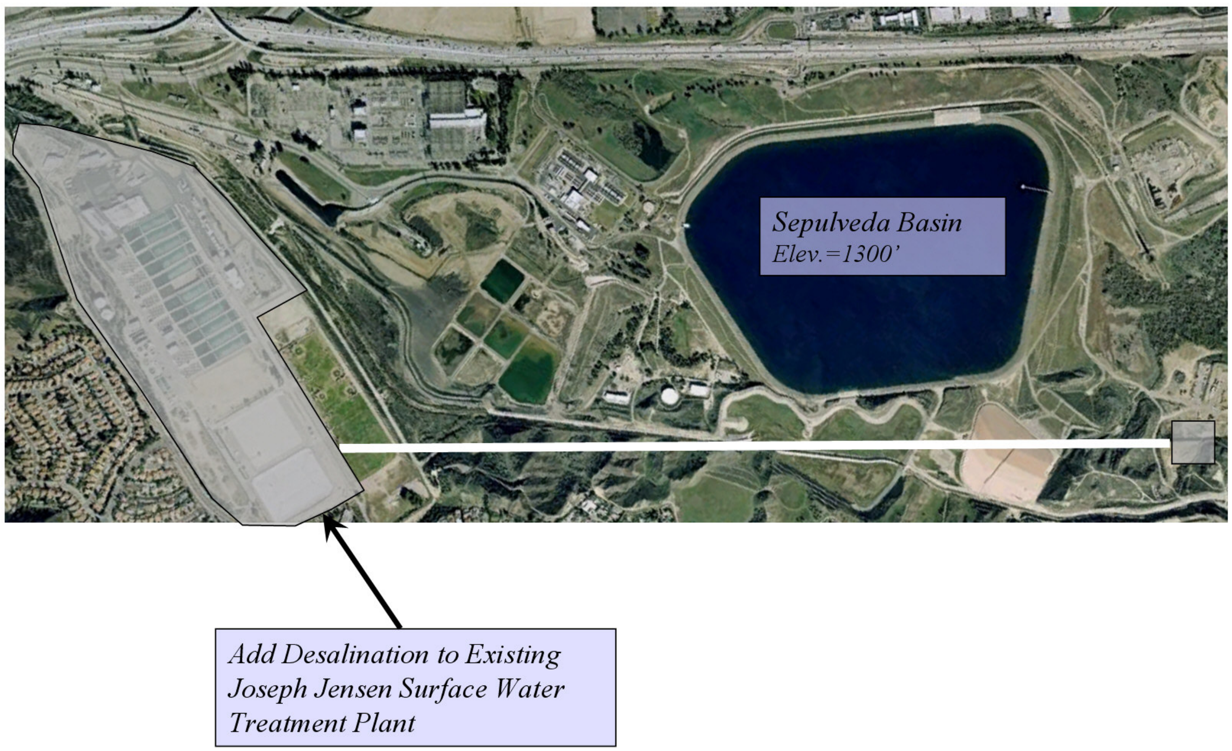


DESALINATION ALTERNATE #3

The third alternate is to directly pump sea water into an expanded Joseph Jensen Reverse Osmosis treatment facility for treatment and distribution into the MWD potable distribution network.

Joseph Jensen Desalination Project

Desalination Alternate 3

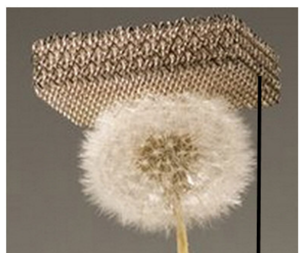


DESALINATION ALTERNATE #4

The Metropolitan Water District has historically maintained an ample cash reserve and could, similar to the X-Prize which provides monetary reward for technological innovation, fund and promote a world-wide desalination competition. For a $50 million prize, the competition would seek out the most technologically advanced desalination solution, providing for the greatest flow of treated water with the smallest amount of energy input. As example, a recent news article discussed how HRL Laboratory of Malibu, CA created the world's lightest material. What if this material could be modified and given an electrical charge to improve the electro-deionization process? With a $50 million reward on the line, the results of such an X-Prize would change the quality of life for the entire world – and MWD would have some profitable right to the technology.

Joseph Jensen Desalination Project

Desalination Alternate 4 – New Technology

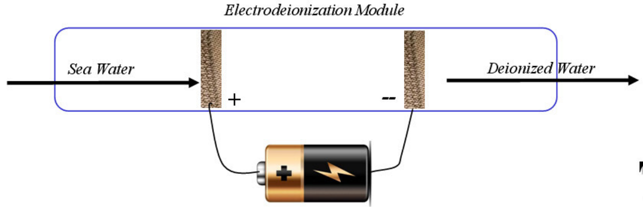


World's lightest material!

In addition to its ultra-low density, the material's cellular architecture gives rise to unprecedented mechanical behavior for a metal, including complete recovery from compression exceeding 50% strain and extraordinarily high energy absorption. Developed for the Defense Advanced Research Projects Agency (DARPA), the novel material could be used for battery electrodes, catalyst supports, and acoustic, vibration or shock energy damping.

This new material redefines the limits of lightweight materials because of its unique "micro-lattice" cellular architecture. Using an innovative fabrication process developed by HRL senior scientist Dr. Alan Jacobsen, the team was able to make a material that consists of 99.99% open volume by designing the 0.01% solid at the nanometer, micron and millimeter scales. "The trick is to fabricate a lattice of interconnected hollow tubes with a wall thickness of 100 nanometers, 1,000 times thinner than a human hair," said lead author Dr. Tobias Schaedler.

If this latticed metal can be manufactured at an incredibly small scale where openings between the lattice are 100 microns or less, and dependent upon the metal material selected, a high electrical charge could be applied to a coating resin along the lattice to quickly capture Na+ and Cl- atoms from passing sea water.



Using electrical charge, suspended Na+ and Cl- atoms cling to metal lattice, purifying ocean water

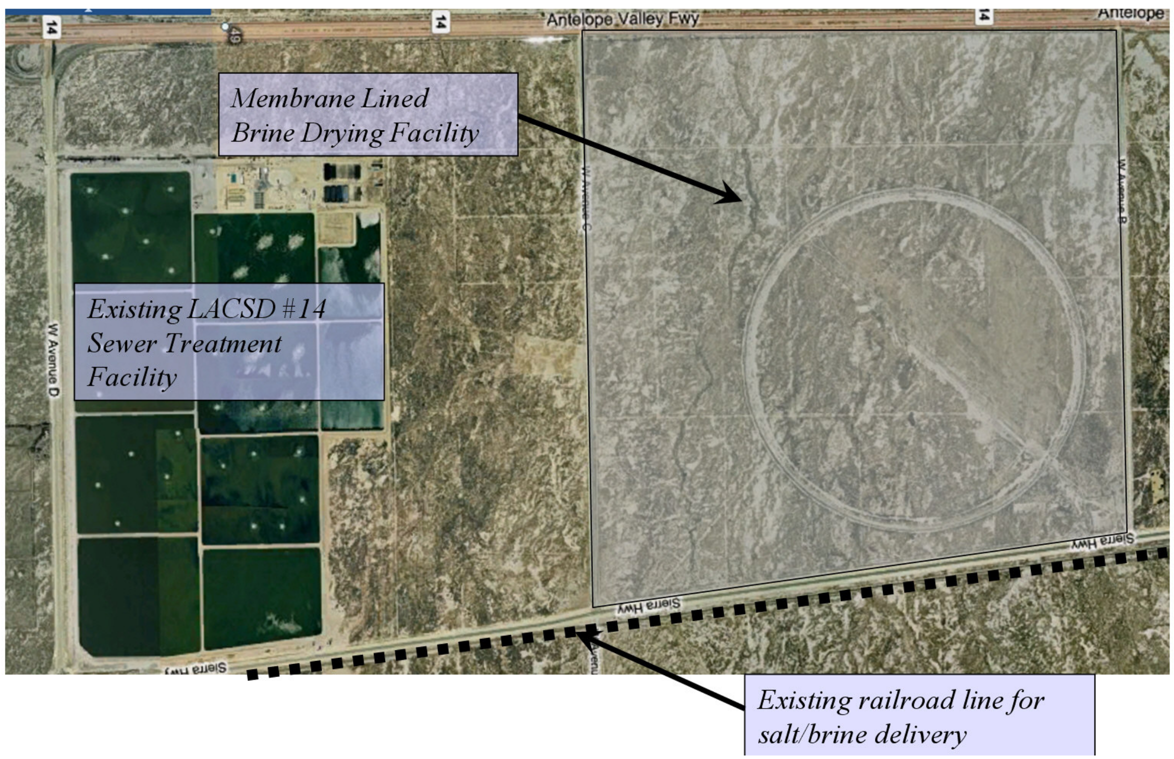
The $50 million MWD Desalination X-Prize!

SEA SALT PRODUCTION

The existing rail facility at the Sepulveda Basin could be utilized to transport a percentage of the brine for processing in the Antelope Valley, located 30 miles to the northeast of the Sepulveda Basin. The County of Los Angeles presently owns acres of land around the existing LACSD #14 sewer treatment facility which serves the cities of Lancaster and Palmdale. By building a brine recovery and drying facility, MWD could create cost recovery in the marketing, distribution and sale of "Santa Monica Sea Salt".

Antelope Valley Brine Recovery Facility

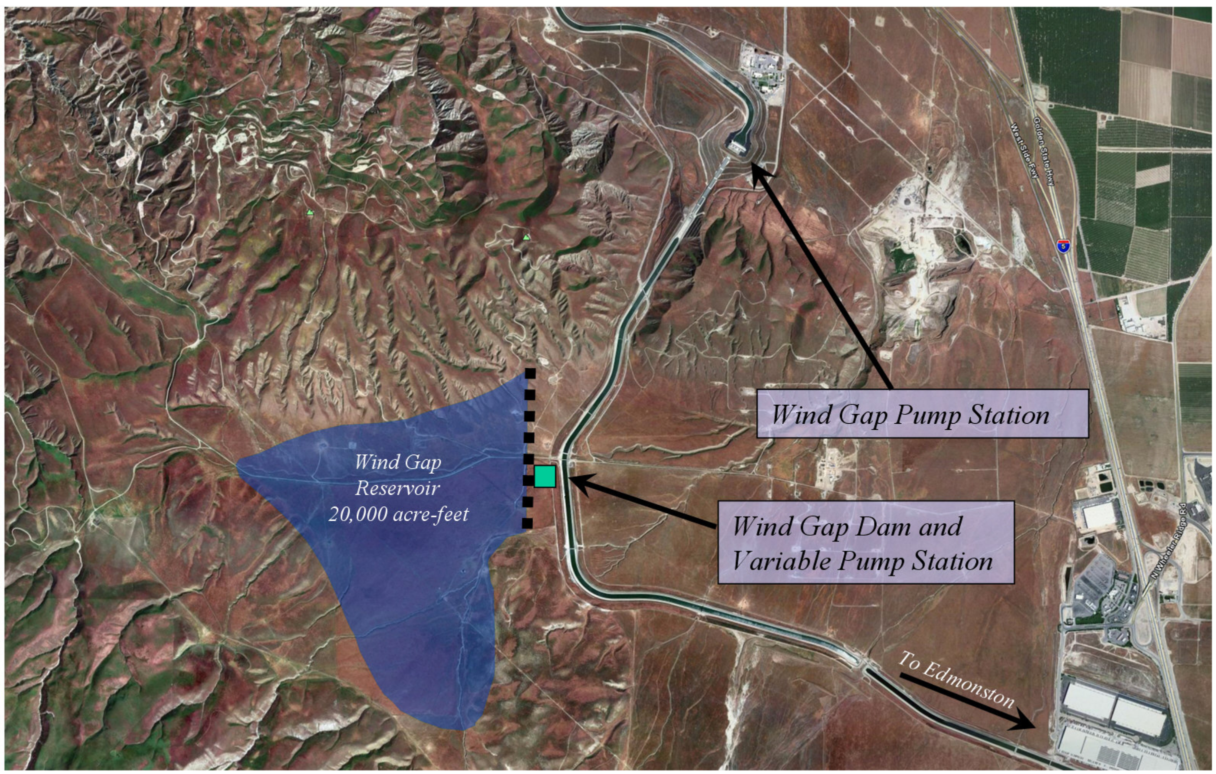
Sea Salt Production



THE WIND GAP RESERVOIR

The ability to operate SWP pump facilities as energy supply is made available will only become more crucial in the coming years. While the Diablo Canyon nuclear plant runs continuously, solar generating facilities only provide power during daylight hours. Since the Edmonston Pumping Plant is such a large energy consumer, the ability to slow down or stop pumping is not an option. The Wind Gap Reservoir would allow the California Aqueduct to continue flowing while operations at Edmonston could be throttled in concert with energy supply.

State Water Project – Energy Optimization
The Wind Gap Reservoir

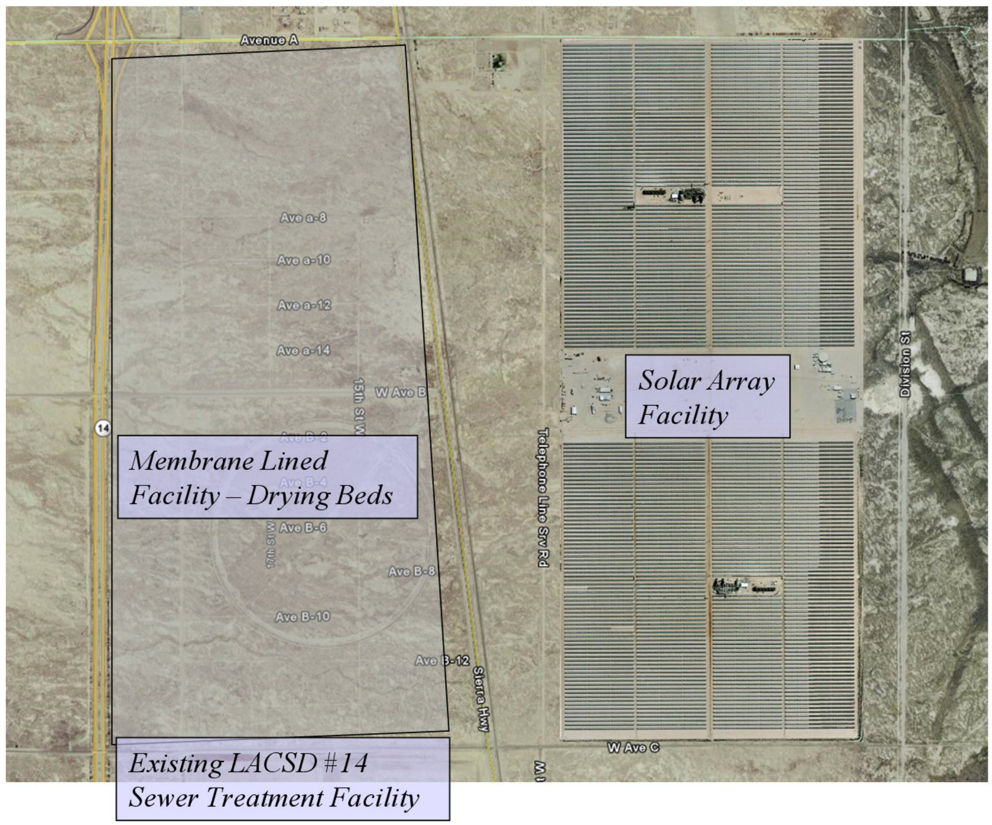


ANTELOPE VALLEY - SOLAR ARRAY FACILITY

The decision to install either photovoltaics or thermal solar is a cost to benefit dynamic. As photovoltaic prices continue to drop, an expected price point of $1/watt equates to constructing a 1,000 MW facility for approximately $1 billion in panels and another $1 billion in other hard costs (~$2 billion total). Applying $10 billion to the Joseph Jensen project, $250 million for the Brine Recovery Facility, $750 million for the Wind Gap Reservoir and $2 billion for the Solar Array facility (and keeping the last $2 billion in reserve), the opportunity to build a sustainable Los Angeles for $15 billion is achievable and perhaps a better solution than a peripheral canal.

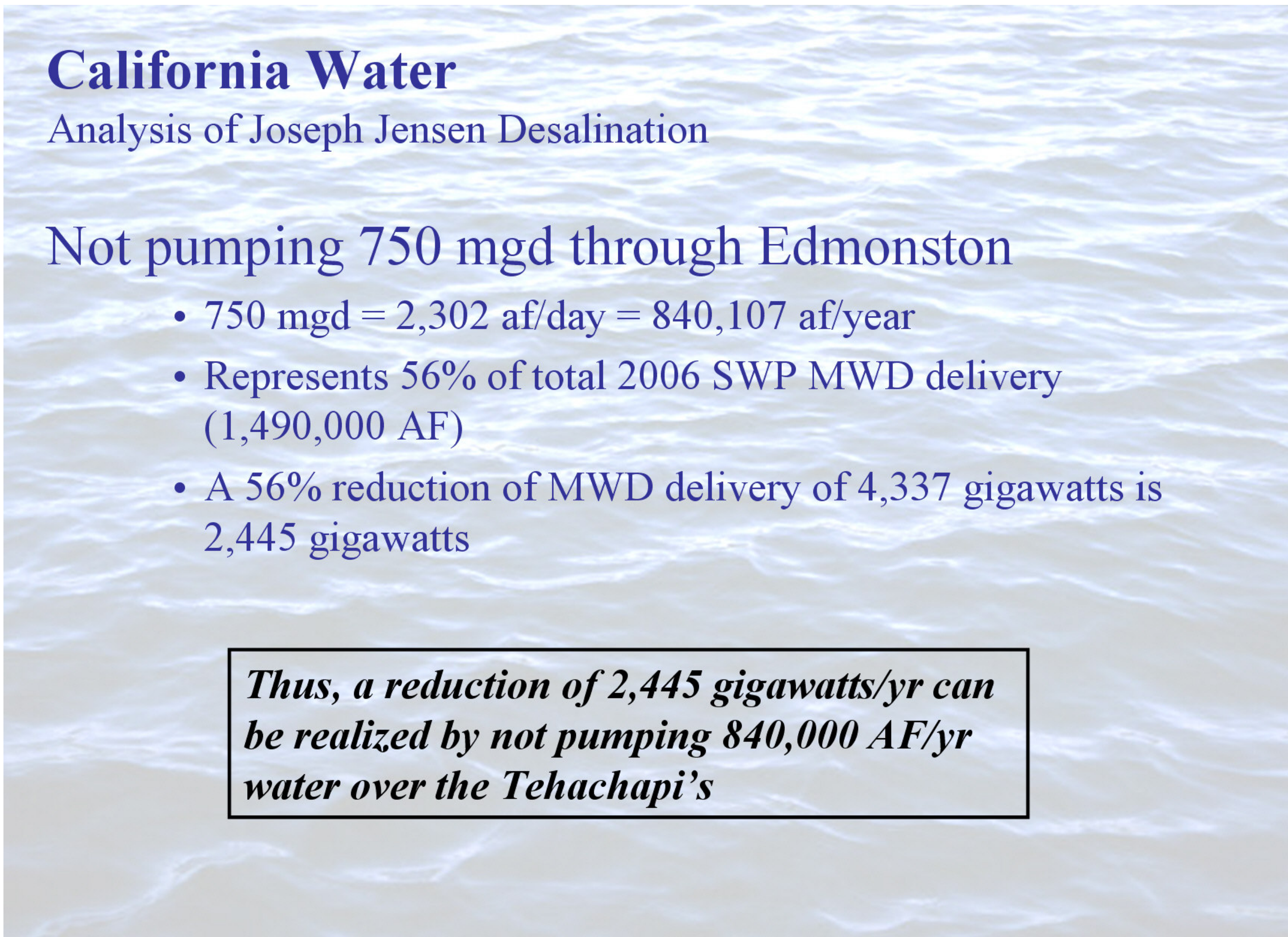
Antelope Valley Brine Recovery Facility

Solar Array Facility



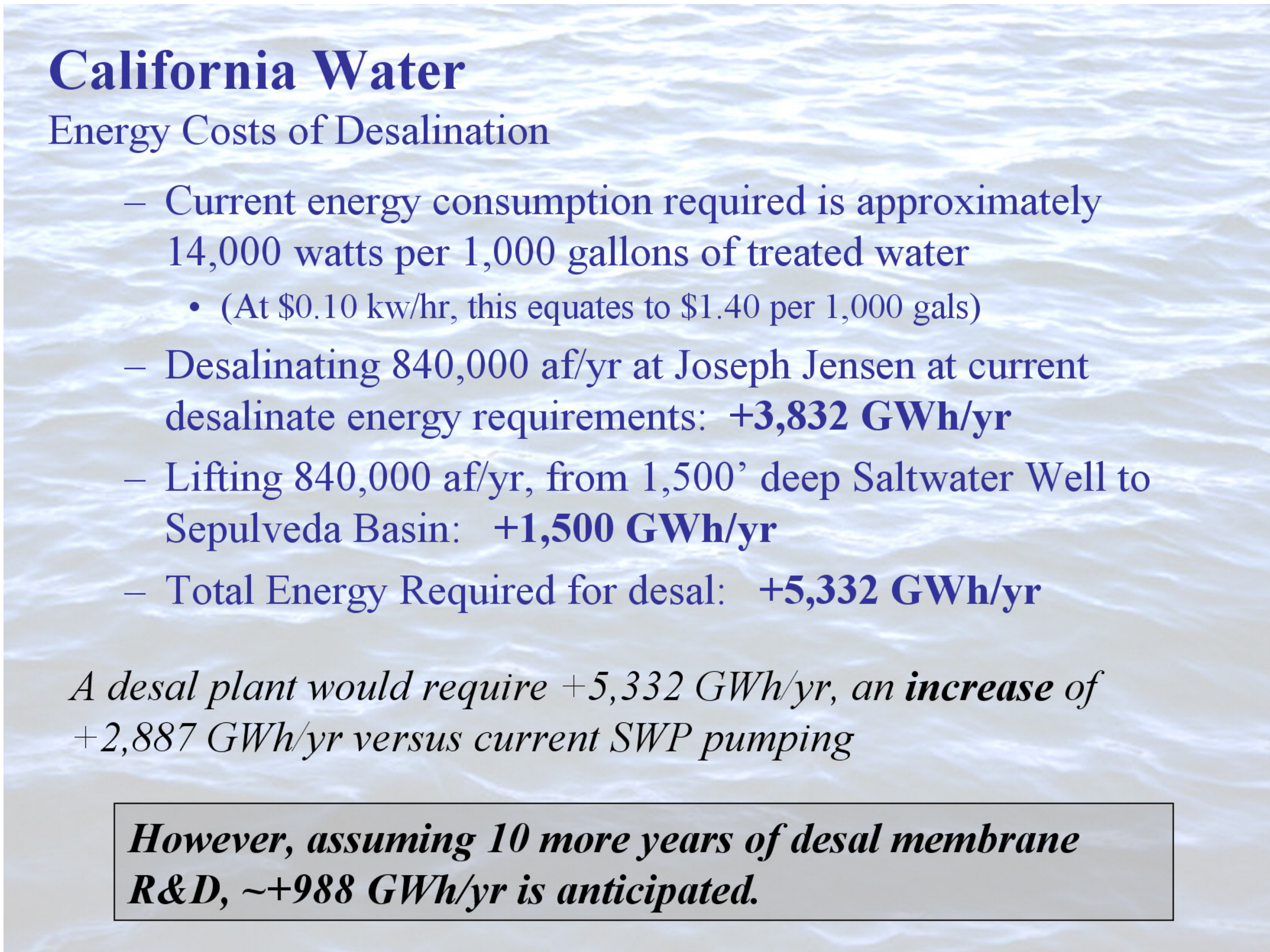
ANALYSIS OF JOSEPH JENSEN DESALINATION

If 750 mgd (~840,000 acre-feet/year) could be desalinated at Joseph Jensen, how much electricity could be saved by not pumping water from the Delta to Los Angeles? According to data from the 2006 water year, approximately 2,445 gigawatts of electricity were required in delivering an average of 750 mgd to Southern California. Thus, a savings of 2,445 gigawatts could be realized by not pumping 750 mgd from the Delta to Los Angeles.



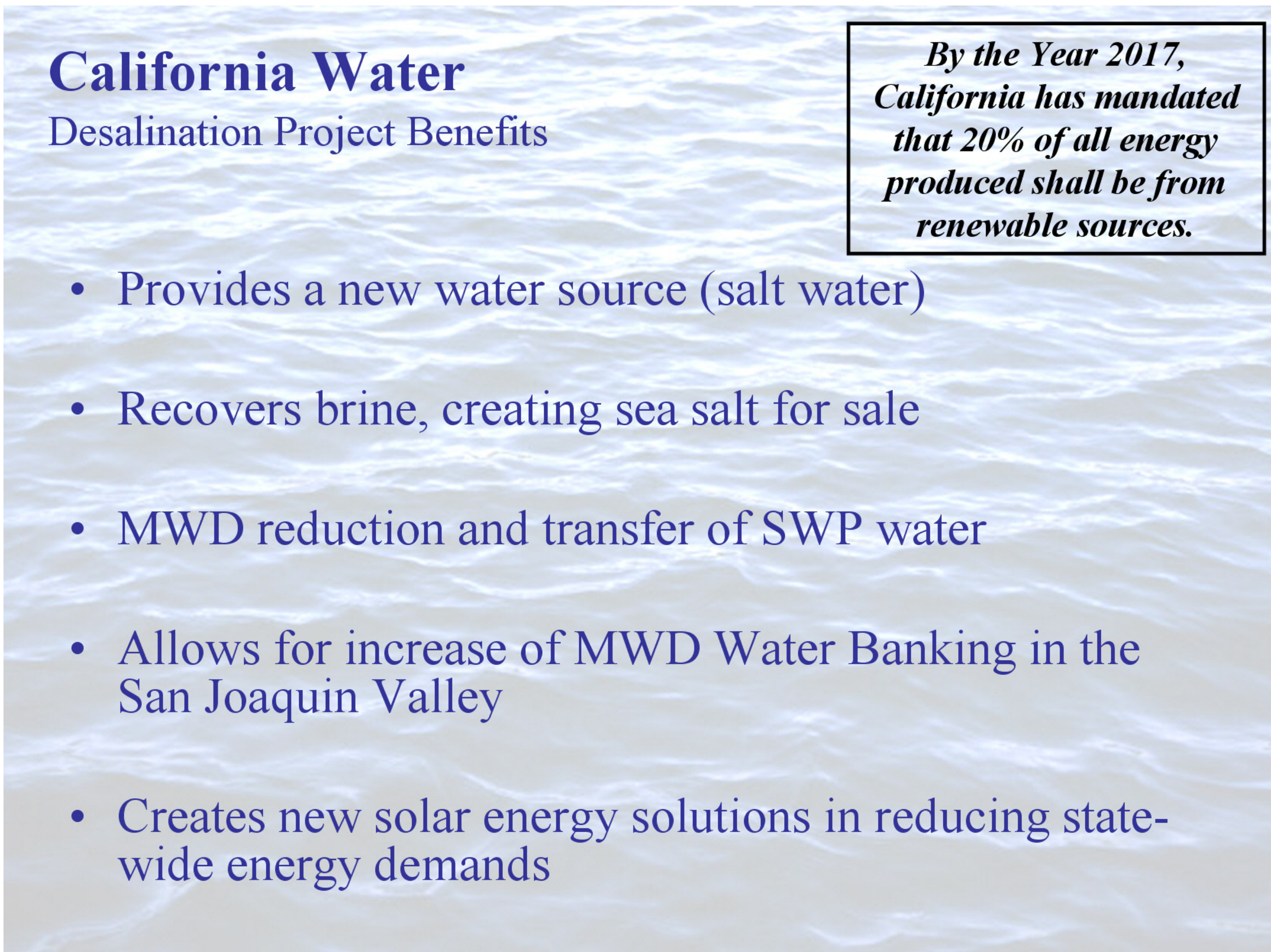
ENERGY COSTS OF DESALINATION

However, even though 2,445 gigawatts of electricity could be saved by not pumping from the Delta to L.A., approximately 5,332 gigawatts of electricity would be required in lifting and treating 750 mgd at the Joseph Jensen facility. This represents a net increase of 2,887 gigawatts of electricity required for desalination versus Delta delivery and treatment. As stated throughout this report, California does not have a water problem, California has an energy problem. However, with new R&D into desalination processes (specifically an X-Prize solution) and a 10-year build out of the project, it is estimated that a net increase of less than 1,000 gigawatts of electricity would be required to desalinate 750 mgd at Joseph Jensen versus transporting water from the Delta to southern California.



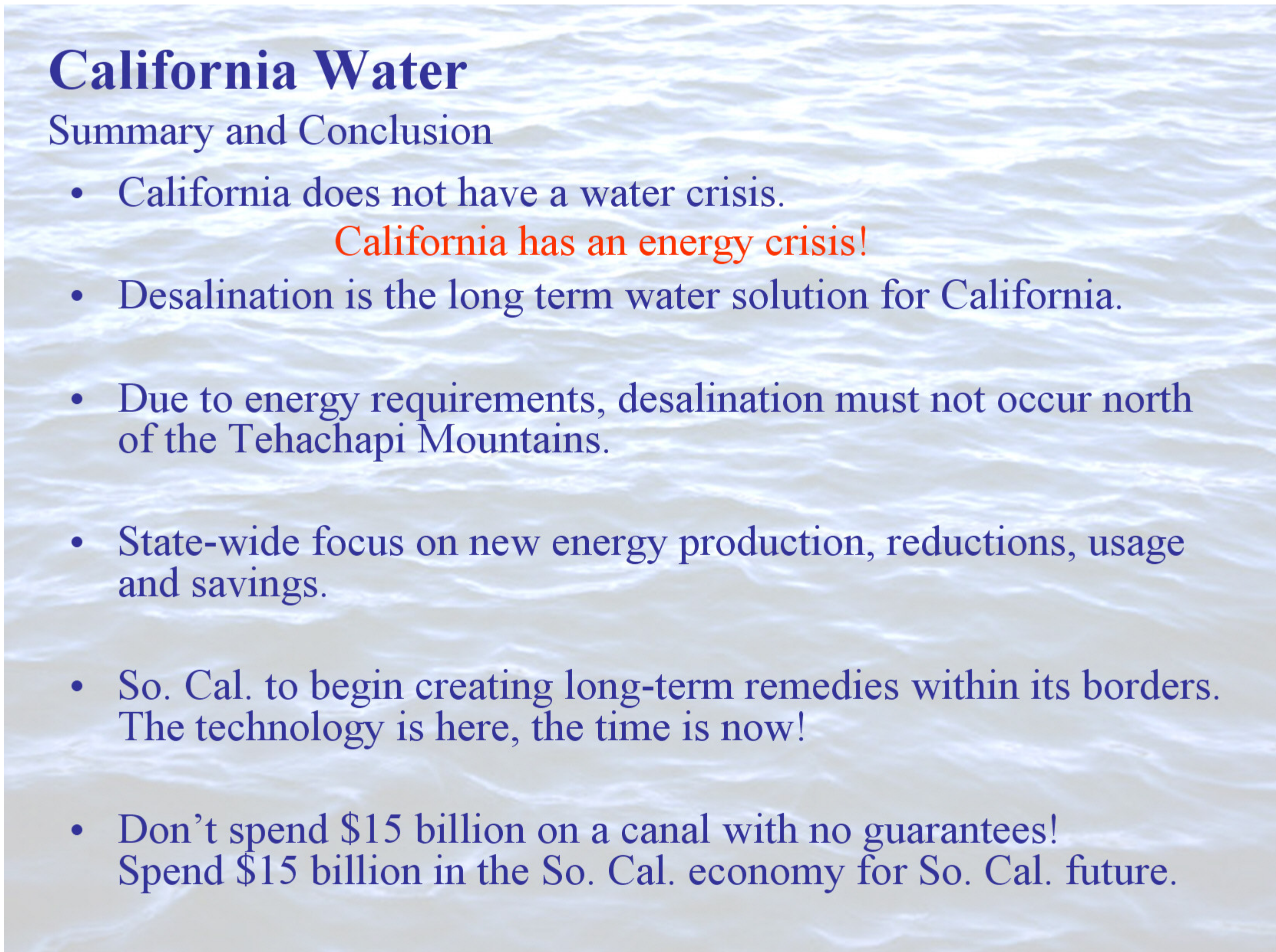
DESALINATION PROJECT BENEFITS

Desalination is the last and best source of water available to southern California. The project has an opportunity to capture and recover salt for sale. MWD can reduce pumping over the Tehachapi's, transfer and/or sell available Delta water to agricultural uses, water bank available water or even allow for an increase in fresh water into the Delta. The sizable bond offering can also construct renewable energy solutions as mandated by the State of California.



SUMMARY AND CONCLUSION

California has an ample water supply, the missing ingredient is energy. Unlike many dry places of the world, California has 800 miles of coast line. Technological innovation and desalination are the keys to California's future. Because of the costs of transporting water to southern California, desalination efforts must not be constructed north of the Tehachapi's. The solution lies in greater efficiencies within the water cycle which include more satellite treatment plant recycling, construction of Wind Gap Reservoir and peak and off-peak operation of Edmonston. MWD should consider being at the leading edge of innovation as it has the resources and capability in achieving this goal. Lastly, there is no certainty in the construction of the peripheral canal. If $15 billion is to be spent, it should be spent in southern California.



RECOMMENDATIONS

1. Use the San Luis Reservoir more efficiently for water storage and delivery as the operation of the H.O. Banks Pumping Plant continues to become more varied.

2. Construct the 20,000 acre-foot Wind Gap Variable Reservoir to work in conjunction with the San Luis Reservoir operations and to operate the Edmonston Pumping Plant during low energy demands. By creating these efficiencies, California can sell Edmonston power demands during peak energy consumption by routing SWP water into the Wind Gap facility.

3. The efficiency of agriculture watering is rarely discussed as a source of water, but when it comes to saving large amounts, the ability to water crops more efficiently can equate to many acre-feet of water savings. Consider setting aside $1 billion in bond money for water efficiency grants for users of SWP water.

4. Establish grants and rebates for the creation of small, satellite reclaimed water treatment plants for MWD member agencies which could be installed for just one golf course or park. Also, as approximately 70% of all residential water demands are for landscaping purposes, consider rebates for the installation of synthetic lawns and desert-scaping of residential landscapes.

"While humanity has made amazing advancements in technology, medicine, and chemistry, it still has not discovered an easy and affordable way of removing salts from ocean water. Our collective ability in providing affordable desalination would save more lives and provide more benefit for civilization than any other advancement, cure or discovery could ever hope to achieve. Water is life - and there exists no greater goal for mankind than in the provision of clean, affordable, desalinated drinking water. To this end, the time has come for California to demonstrate its innovative leadership - for if California cannot do it, then it cannot be done."

(All aerial photography courtesy of Google Earth)

A “BALANCED” DELTA

In addition to variable pumping by the H.O. Banks Pumping plant in attaining fresh water to salt water ratios within the Delta, a system of locks could be installed to control tidal flows entering the upper Delta. During periods of high saline concentration or during especially high tides, the locks would be shut. During periods of low concentration, the locks would open. The locks would be open the majority of time with closures occurring only to “get the balance right”. However, if a $15 billion bond is being proposed solely for the protection of one species, perhaps Californians should first be educated upon the “cost vs. benefit” of species protection. If done correctly, building these locks and mitigating for species impacts is likely the best and most economical alternative of all.

The Delta Locks

A “Balanced” Delta