Seawater Desalination Issue Summary

FORWARD

Coastal power plant in Carlsbad, CaliforniaThere are numerous proposals to build desalination facilities on California's coast and estuaries. Desalination facilities have also been proposed in several other states including Texas and Hawaii and a facility was recently built in Tampa, Florida. This discussion and issue summary is for Surfrider Foundation activists who wish to become informed regarding desalination and participate in review of a planned desalination plant. We hope this background paper highlights some of the issues of concern when evaluating the prudence of building a desalination facility in your area. Also, we hope this provides a little "food for thought" when considering alternatives to desalination, or alternative technology and practices for implementing desalination.

OVERVIEW

Producing drinking water from seawater has been technologically achievable for several decades. Until recently, however, application of seawater desalination ("desal") on a large scale has been primarily limited to arid regions of the world that have a cheap supply of energy, such as in the Middle East. Saudi Arabia produces 30% of the world's output of desalinated seawater. The cost of energy is important due to the fact that the two primary technologies used for desalination, distillation and reverse osmosis, require a lot of energy, either to boil and then re-condense water (distillation) or to force water molecules through semi-permeable membranes at high pressure (reverse osmosis).

Advances in reverse osmosis membrane technology have recently reduced the cost of producing water from approximately $2,000 per acre-foot in 1990 (1 acre-foot equals approximately 326,000 gallons, or the average use a household in a year) to about $800 per acre-foot.1 In southern California, the Metropolitan Water District is offering local water agencies subsidies of up to $250 per acre-foot to implement desalination projects. This subsidy reduces the cost of producing desalinated drinking water and makes desalination facilities more economically viable for local water agencies. However, the subsidies only defray costs and do not reduce the cumulative costs in the region. Furthermore, many of these subsidies are not intended for research and development, and consequently will not directly lower the overall cost of producing freshwater through desalination over time.

A desal facility using reverse osmosis technology forces seawater through membranes with tiny pores large enough to pass water molecules but too small for salt molecules. For every 2 gallons of seawater introduced, about 1 gallon of drinking water is produced and 1 gallon of concentrated brine (about twice the normal salt concentration of seawater) is returned to the ocean.

Several seawater desal facilities have recently been proposed in California, Hawaii and Texas and a large facility has been constructed to produce 25 million gallons per day (mgd) of drinking water in Tampa, Florida. The Florida project is experiencing technical difficulties that are impairing full production and clouding the economic and environmental post-operation analysis. In California, a State Desalination Task Force has reviewed desalination and has created draft issue papers and a final report.
http://www.owue.water.ca.gov/recycle/desal/desal.cfm

The California Coastal Commission has also prepared a report on desalination and associated California Coastal Act applicability.
http://www.coastal.ca.gov/energy/14a-3-2004-desalination.pdf

Simultaneously, several California state and local government agencies are currently grappling with the numerous regulatory issues confronting permit applications for coastal desalination facilities. Some of these same agencies also have regulatory authority and/or budgetary discretion over implementing alternative technologies and rules to provide additional water -- primarily through wastewater reclamation and/or conservation.

The stated benefit of desal is primarily a reliable flow of freshwater to supplement other sources that will not supply growing populations. Desalination may also include the environmental benefit of reducing our unsustainable reliance and over-drafting of rivers, streams and aquifers, thereby reducing the adverse environmental impacts on those resources. Also, a constant flow of freshwater from desalination could avoid the environmental disruption of building more dams for storage. However, to ensure these potential environmental benefits come to fruition could require complex legal mechanisms and each project proposal might involve different complications.

Desal facilities can have several potential negative environmental impacts, depending upon where they are located, how they are designed and operated, and the end use of the produced water. In some cases, there are also concerns about "privatizing" what has always been a public resource, as well as additional complications if a private owner is a foreign entity. Listed below are some of the potential negative impacts of desal projects:

ISSUE SUMMARY

1. Seawater Intake. There are several alternatives for gathering the "source" water for desalination: intake pipes in the ocean, beach wells (seawater aquifers) and intake galleries (collection systems buried beneath nearshore sediment). Unless the seawater intake is gathered from beach wells or galleries there is an inevitable destruction of marine life (fish and smaller marine life like eggs and larvae) as the water is drawn into the desal plant. "Impingement" is the term for the mortality of larger animals that are trapped and killed on the intake screens, and "entrainment" refers to smaller organisms (e.g., larvae and eggs) that slip through the screens and are killed once they enter either the reverse osmosis membranes of the desal plant or the cooling condensers of an adjacent electric generating plant.

One of the reasons that desal plants are often proposed for co-location with coastal electric generating plants is that they take advantage of the existing cooling water intake and outfall pipes. Desal "source" or "feed" water is typically taken off of the discharge (hot) side of the power plant cooling water system and the concentrated brine is discharged by mixing it with the remaining cooling water return to the ocean. In this way, no additional seawater is drawn from the ocean, and proponents argue that no "additional" marine life mortality is attributed to the desal process. However, although there is some debate about the degree to which sea life survives the trip through a power plant cooling system, any sea life that did survive would then be destroyed by the filtration and reverse osmosis steps of the desal process. Furthermore, because of the energy-intensive nature of desalination plants, co-location of these plants could mean that the generator is in use when it otherwise wouldn't be. The more the generator runs, the more water it takes for cooling, the more fish that die. The cumulative energy demands of desalination facilities will translate into additional electric generator output to supply the desal facilities.

The US Environmental Protection Agency, under a court order, is currently reviewing the rules on cooling water intakes for power plants. Cooling water intakes are regulated under the authority of the Clean Water Act Section 316 (b), and the EPA is reviewing whether "once-through" cooling meets the "best technology available" standards mandated by that Act. Generators could be compelled, at least in many circumstances, to retrofit the plant with cooling towers that recycle water. These towers cool the water with forced air from large fans. This technology would either eliminate or dramatically reduce the marine life mortality and cumulative impacts on marine ecosystems from once-through cooling.

Furthermore, under the "consistency" authority granted the states through their participation and compliance with the federal Coastal Zone Management Act, coastal states may review permits granted by federal agencies. The state agency in charge of the coastal zone management plan can then deny the federal permit if it is found to be inconsistent with the state's management plan. In the present case, this means that the coastal management authority could either deny the cooling water intake and/or discharge permits for the co-located generator or desalination facility.

2. Estuaries vs. Ocean Source Water. There has been a dramatic loss of estuarine habitat in California — especially in the southern region of the state. Most of our coastal wetlands and estuaries have been filled and developed or are highly degraded from pollution and unnatural sediment loading. Consequently, estuarine habitat is a precious commodity and this creates heightened threats to aquatic and terrestrial life that depend on estuaries for some stage of their life history (e.g., birds, fish, invertebrates, etc).

Therefore, desalination facilities that rely on estuarine "source" water should be viewed with heightened scrutiny. Many of the entrainment and impingement issues that impact marine life and healthy marine ecosystems are arguably made worse when they impact estuarine species and the intricate ecological balance of estuarine ecosystems.

3. Brine Discharge. Seawater contains about 35,000 parts per million (ppm) salt. During the reverse osmosis process, water molecules are forced through membranes while the salt particles are retained by the membrane and end up in a "reject stream" that is about twice as salty (70,000 ppm) as seawater. If this were discharged directly back into the ocean or into a coastal estuary there would likely be some negative impacts to sea life in that immediate area of the discharge. If a desal plant is located next to a power plant, they can mix this brine water with the higher volumes of "hot" cooling water that are being returned to the ocean. This dilutes the brine and marginally lowers the discharge temperature so there is arguably less of an impact on sea life. In the same vein, desalination plants might be co-located with wastewater treatment facilities, or connected by pipes, so the brine could be mixed with the freshwater discharge and possibly reach a salt concentration and temperature closer to ambient ocean conditions.

The impacts on marine life are, for the most part, dislocation of indigenous populations. For instance, the marine life normally found in the area of the discharge (the Zone of Initial Dilution — or ZID) might be displaced and the area re-inhabited by organisms more tolerant to dynamic salt concentrations and temperatures (e.g., estuarine species). Furthermore, the concentration of dead marine life in the discharge may attract an uncommon congregation of filter feeders and other scavengers. In short, the natural ecosystem is disrupted, but this does not necessarily lead to lower biomass in the area. However, this would be a site-specific determination and would depend on variables like ocean current, depth, and maybe most importantly, how close the discharge is to sensitive and essential fish habitat.

4. Building on the Coast. Although desal plants are not nearly as huge or ugly as power plants, they are an industrial facility that some people may object to. Being located along the coast, the structures may impair views, block coastal access, result in the filling of wetlands, or otherwise negatively impact the experience of going to the beach.

5. Growth Inducement? If the water produced from desal is used to reduce our reliance on imported water and more water then ends up being retained in water source areas to help sustain the environment there, then desal may produce a net environmental benefit. If, on the other hand, the water not taken from these rivers is diverted to other users and the river doesn't benefit, desal may not result in a net environmental benefit. And if the desal plant fuels new growth along the coast rather than just replacing imported water, it may contribute to environmental degradation. This question of whether water is for "replacement" or "new source" is at the heart of the question of "growth inducement."

It is also important to note that many of the current proposals are located in areas with dramatic surface run-off problems and limited sewage treatment capacity. Adding a "new" source of freshwater to this system will arguably exacerbate an already difficult problem to as the produced water is used and becomes wastewater and urban runoff.

These direct and indirect concerns about growth inducement are difficult, if not impossible, to quantify and analyze without the project proponent identifying the "end user" of the water supply. It is therefore important the any Environmental Impact Report (EIR) or other environmental analysis of the project identify the end user(s). The EIR should also evaluate project alternatives that may have less environmental impact, including water conservation and recycling.

6. Cost and Power Use. Desal is an expensive way to make water and uses a lot of electricity. Water most be pumped through special membranes at about 900 pounds per square inch (psi) pressure to remove the salt, then the water often must often be pumped several miles to a water distribution network. Depending on the specific project proposed, water costs to consumers may go up at least 30% and could more than double. The required electrical energy is often produced by fossil fuel burning power plants that cause air pollution.

7. Dependance on Power Plants. As mentioned above, there are logical reasons to locate desal facilities next to power plants. But power plants are under pressure to eliminate their use of "once through" cooling water that kills fish. See http://www.epa.gov/waterscience/316b/ for more information on this topic. Power plants may be required by the U.S. EPA to install a "closed loop" cooling system that reduces the amount of seawater intake and fish kill by 90% or more. Some may convert to an air cooling system that uses no water or a recirculating cooling water system that uses a cooling tower and reduces seawater intake by 90% or more. If these changes take place, it may no longer make sense to locate the desal plant next to the power plant. In fact, it may no longer make sense to locate power plants along the coast. Looking at this another way, if a desal plant is installed at an existing coastal power plant facility, that may not be a good investment if the power plant cooling system that is the basis for the desal plant is removed or modified. From the power company's perspective, if a desal plant is built next to a power plant, that may represent a disincentive to upgrade the power plant's cooling system.

8. Alternative Sources of Potable Water: As with any social choice, the determination to implement desalination facilities should be compared with other alternatives. Some of the possible alternatives include improved water conservation and greater implementation of wastewater reclamation.

Although water agencies are constantly struggling to provide citizens with affordable and reliable drinking water, it is evident that we still do not use water very efficiently. This is directly apparent in the amount of urban runoff that we see every day. There is some concern that desal will reduce the drive to use existing sources of water efficiently, and consequently negatively impact programs to advocate for water conservation. The southern California region has experienced dramatic population growth over the past several years. Yet, the demand for water has remained relatively constant in large part because of efforts at water conservation. These current conservation efforts are arguably only scratching the surface of what could be a much broader effort in the southern California region, and other areas of the country may not be employing these strategies at all.

Water reclamation is the practice of treating wastewater to allow re-use the water. Although there has been considerable controversy surrounding the use of reclaimed water as a source of drinking water, there are more and more examples of successful programs that either use this water for irrigation (offsetting the need to use drinking water for this purpose), or for injection into groundwater aquifers (reducing the negative impacts from overdrafting our aquifers and/or reserving this water for potable uses in the future). Besides providing a reasonable alternative to desalination, widespread implementation of reclamation could dramatically reduce the amount of partially treated or untreated wastewater being discharged into the ocean.

In addition, in many places we have either over-used or polluted our groundwater. If desal should reduce our dependency on groundwater, we may be less inclined to properly manage or clean up our ground water resources. On a similar note, reverse osmosis technology has been proposed as a means for cleaning up polluted groundwater. While this may seem attractive at first glance, it should not be used as a tool to justify continued pollution.

In conclusion, reviewing alternatives to desal should not only consider the dramatically lower cost of conservation and reclamation, but should also account for the benefits of reducing the pollution reaching our waterways through urban runoff and sewage discharge.

9. Private Ownership: The California Coastal Commission report on desalination raises a number of concerns regarding private ownership of desalination facilities. Historically, the ocean has been regarded as a public resource to be utilized and enjoyed by all people and animals in a sustainable, non-extractive manner. Using the ocean as a source of drinking water (clearly an extractive use) changes all that. While one desal facility may not have a significant effect on the ocean, many such facilities (see cumulative impacts discussion below) may have detrimental effects.

Typically, most of the water supply infrastructure in the United States is owned and operated by public or semi-public agencies. Quality of the water, reliability of the water supply system, and the price of the delivered water are all subject to the scrutiny of various regulatory agencies, local governmental bodies, and the general public. A water supply system operated by a private company (perhaps a multinational company) may not be subject to the same restrictions. Their profit goals may encourage rate increases, reductions in quality, and promotion of more water use, as opposed to calls for more water conservation and recycling.

The subject of ownership by a multinational private company raises additional concerns regarding potential challenges to US laws that a multinational corporation might regard as restrictions on "free trade" or an undue limitation on their ability to make a profit.

10. Cumulative Impacts: An environmental analysis conducted under CEQA (California Environmental Quality Act) or NEPA (National Environmental Quality Act) should include an assessment of the cumulative impacts of not only the proposed project, but also other proposed projects (and existing facilities) in the area. These impacts would include the cumulative entrainment/impingement bioregion impacts, cumulative energy consumption impacts, cumulative growth-related impacts, and cumulative wastewater & urban runoff impacts, among others. This is especially import in areas where existing air quality, water quality or ecosystem health in already compromised. In California, 18 new desalination facilities have been proposed, with a cumulative production capacity of 187 million gallons per day. Some facilities are with a few miles of each other, potentially impacting the same bioregion of the ocean and/or other common environmental resources. These projects should not be reviewed in a vacuum.

CONCLUSION

With the rise of interest in desalination, partly caused by improvements in reverse osmosis technology, there is a wealth of information coming to the forefront. This fast growing interest in desalination has also caused government agencies and non-governmental organizations to quickly begin discussions about policy that will guide the implementation of this technology. We suggest that any review of local proposals include a thorough research of all of the issues outlined above. We have provided a list of reference sites to start your research. Please feel free to contact Joe Geever or Rick Wilson at the Surfrider Foundation National Headquarters if you have questions or recommendations about the discussion surrounding desalination.

REFERENCES

Information of desalination from California Department of Water Resources Water Desalination Task Force
http://www.owue.water.ca.gov/recycle/desal/desal.cfm

California Coastal Commission report (March 2004) "Seawater Desalination and the California Coastal Act"
http://www.coastal.ca.gov/energy/14a-3-2004-desalination.pdf

USEPA Guidance on cooling water intake structures
http://www.epa.gov/waterscience/316b/

The United States Desalination Coalition http://www.usdesal.org/