Harte Research Institute (HRI)
A Statement on our Desalination Science

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Introduction

Desalination of seawater has been the standard way of obtaining freshwater in the Middle East for over 50 years because it is the only water readily available, and abundant energy resources allow it as an option. However, in recent decades desalination has spread to other parts of the world due to increasing human population, degraded water quality, and now extensive drought conditions in some regions. The United States has joined other countries in looking at desalination as a means to obtain more freshwater resources to sustain its people, industry, and possibly even agriculture, as well as to maintain natural environmental flows of fresh water in streams and rivers.

In general, the high cost to build facilities and the energy to drive the desalination process have been prohibitive to developing desalination except where there were no other viable options. Environmental groups have raised concerns about overall ecological footprint, including brine disposal, and that has also made development contentious. However, with rising surface water costs, reduced sources, new reverse osmosis technology, progress in addressing environmental issues, and the fall in energy prices, the desalination option has become much more economically viable. Small desalination plants operate in many places within the United States and two very large projects are operating in Carlsbad, southern California, and Tampa, Florida. In Texas there are more than 50 small inland desalination plants converting brackish groundwater to potable uses that have been successfully doing so for years. The city of El Paso has demonstrated the viability of large-scale desalination in meeting water needs as an inland city. No such example exists for a Texas coastal city. Several Texas coastal cities and water entities have considered desalination in recent years as a means of supplementing current freshwater resources, but none have developed a functioning large-scale project. Corpus Christi and the Coastal Bend are actively pursuing a viable option.

HRI Position Regarding Desalination

HRI supports desalination as an option to provide freshwater where it is also beneficial to environmental health, such as relieving pressure on freshwater inflows into bays and estuaries which is vital for their health and productivity.

The Texas Coastal Bend has productive but sensitive estuarine habitats and freshwater pass-through requirements on the Nueces River are employed to maintain low salinities in the bays. Desalination can help minimize future diversion of these waters that are vital to the ecological and economic health of the of the Coastal Bend's bays and estuaries. Nonetheless, the development of this water source option should not create environmental problems, offsetting its benefits. Environmental concerns related to desalination must be addressed before any particular site is chosen. After the fact, the only recourse is mitigation of negative impacts, or where that is not possible, living with the results.

Environmental Issues Associated with Desalination

The primary environmental issues for coastal desalination operations include: 1) Intake of water related to impingement and entrainment of marine organisms; 2) discharge of concentrated brine interfering with movement or disrupting migratory patterns of marine organisms; 3) and, water quality issues, including hypoxia/anoxia and concentration of contaminants.

Intake issues are similar to those of power plants, etc. and are documented in many studies, and mitigation measures are well known. Two factors that have the most impact are impingement and entrainment[1]. Impingement of larger fish, marine mammals, and sea turtles can reduce the spawning stock biomass due to an increased mortality rate. In addition, entrainment of smaller invertebrate and fish larvae as well as eggs can reduce recruitment. There is robust scientific literature for ways to address and mitigate these concerns, but location of intakes (and discharge) is a key factor, and there are locations that cannot be mitigated.

Discharge of concentrated brine includes both physical and chemical issues. Every gallon of freshwater produced by desalination can also generate one and a half gallons of concentrated brine. Large volumes of discharge may be an issue because of salinity and the location of the discharge. These discharges will displace "lighter" ambient waters, possibly disrupting local hydrology. Depending on the location, that disruption can interfere with movement of marine organisms, feeding or reproduction, or disrupt migratory patterns of the distribution patterns of eggs and larvae into ecosystems critical for their development, survival, and population persistence.

[1] Impingement occurs when organisms sufficiently large to avoid going through the screens are trapped against them by the force of the flowing source water. Entrainment occurs when very small marine organisms enter the desalination plant intake, are drawn into the intake system, and pass through to the treatment facilities (WateReuse Association (2011) Desalination Plant Intakes: Impingement and Entrainment Impacts and Solutions. 22 pages)

For **water quality**, the constituent chemical makeup of the concentrated brine is also of concern. Heavy metals used to facilitate the desalination process by reducing corrosion and biofouling can be an issue. Contaminants may be present as a constituent of intake water possibly concentrated in the discharge. In a confined area like a canal or channel where dilution or mixing is limited this could create a water quality issue. Additionally, low oxygen content in brine discharges and the stratification caused by dense sinking brines may result in anoxia or hypoxia[2] in such confined areas or where it escapes confines of a deeper channel, expanding to adjacent shallow areas of ecological importance or in bottom waters.

When considering the locations for desalination plant facilities, all of these factors need to be considered for both intake and discharge. The addition of concentrated brine to ecosystem, particularly in estuaries, can have negative environmental impacts on the marine community. As a result, the salinity tolerance of marine organism's needs to be considered when determining the locations of a desalination plant discharge locations. Changes in salinity and temperature can have deleterious effects on many marine species, particularly those in early developmental stages. Minimizing potential discharge impacts requires adequate area, including depth, and water movement, to promote mixing, sufficient to dilute brine to ambient conditions. The Corpus Christi water system has pass-through requirements where water from Lake Corpus Christi must be released downstream to the Nueces Estuary when natural flows would have occurred. It will be more difficult to meet salinity targets in the bays if brine from desalination were significant enough to interfere with salinity patterns in upper Nueces Bay.

Evaluation of Desalination Intakes and Discharges within Corpus Christi Bay

HRI scientists, led by the late Dr. Wes Tunnell, former Endowed Chair for Biodiversity and Conservation, evaluated several potential locations for desalination intake and discharge for the City of Corpus Christi through a contract with the Freese and Nichols consulting firm. HRI had no input as to locations requested to be evaluated. They were determined by criteria outside the evaluation. Location of water intake and concentrated brine discharge is the single most important way to mitigate environmental concerns. Drs. Greg Stunz and Paul Montagna, Endowed Chair of Fisheries and Ocean Health and HRI Chair for HydroEcology, respectively, evaluated several designated sites in Corpus Christi Bay as identified in the overall study. The HRI assessment evaluated potential desalination intakes and discharges options as means to mitigate possible negative environmental impacts in relatively shallow waters of the bay.

[2] Hypoxia is a condition of critically low oxygen in water (2-3 mg/L) and anoxia is when there is no oxygen in the water (0 mg/L).

The HRI report by Stunz and Montagna focused on biophysical impacts of discharge at specified areas designated by the city of Corpus Christi and did not evaluate water quality and contaminant issues. In general, HRI concluded that intake designs and locations should minimize the impact to resident fauna and limit degradation or loss of high-quality habitat. The preferred intake type would be either the subsurface directional drilled or subsurface infiltration gallery intakes depending on site characteristics. While benthic organisms would be impacted during the creation of the subsurface system, once created there would be no freestanding source from which fauna could be impinged or entrained.

Discharge designs and locations must consider the addition of brine concentrate, which can have environmental impacts on the marine community and water quality. Either submerged jet diffusers or submerged pipes (e.g., infiltration galleries) would be best to limit impacts on marine fauna. Submerged jet diffusers would be the quickest method for dilution of effluent and the preferred way to avoid hypoxia. But the location for the discharge is also important and it is likely that a combination of pipes to a specific location with submerged jet diffusers would have the least environmental impact because the discharge would be entering into a more dynamic body of water than most of the bay waters.

HRI's overall and primary conclusion in assessing potential desalination intake and discharge sites in Corpus Christi Bay was that an offshore location of intake and discharge would be the best option to minimize impacts on biota, habitats, and water quality. Locations within the bay present many more potential environmental concerns that may not be easily minimized or mitigated. The best available means of minimizing biophysical impacts were provided for each site as part of the evaluation. Contaminant water quality concerns was beyond the scope of HRI's evaluation, but these issues should also be addressed regardless of location. Intake and discharge into offshore waters areas near inlets like Aransas Pass should be avoided for all the reasons noted. Placement of pipelines to offshore locations from shore locations is a well understood engineering activity, and generally of low environmental risk. Resource and permitting agencies also recognize this and provide guidance to this effect, even expediting permitting outside these sensitive areas. These are summarized in the Marine Seawater Desalination Diversion and Discharge Zones Study as a requirement of House Bill 2031 (84th Legislature).

HRI Expertise Regarding Desalination

The HRI has considerable expertise regarding the impacts of high salinity discharges into coastal waters, including brine discharges associated with oil and gas development; solution mining of salt domes for strategic oil reserve storage; and, desalination plants for production of water for various uses, including human consumption. HRI scientists have almost 200 years of combined expertise relevant to these issues. Institutional Expertise:

Identification and Characterization of Potential Environmental Impacts Mitigation Measures Related to Intake and Discharge Facilities of Seawater Desalination Plants – Dr. Greg Stunz, Endowed Chair for Ocean Health and Fisheries at Harte research Institute and Dr. Paul Montagna, Chair for HydroEcology and Dr. Larry McKinney, Chair for Gulf Strategies.

Regulatory and Permitting Issues Relating to Desalination Seawater Intakes and Concentrate Disposal in Coastal Texas – Dr. Richard McLaughlin, Endowed Chair for Marine Policy and Law at Harte Research Institute