

**The Current Status of Desalination Systems in
San Juan County, Washington
Executive Summary
And a
Technical Supplement**

The purpose of this paper is to summarize the current status of public water systems using desalination in San Juan County and to discuss issues impacting its use. This paper draws from material developed for San Juan County (SJC), by the SJC Water Resources Advisory Committee (WRMC) and provides comments by various specialists.

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Appendix 2 – Avoiding or Minimizing Potential Impacts of RO Desalination in San Juan County by Richard R. Strathmann 24 Apr 2009

Appendix 3 – A Description of Design Elements of the Lopez Water LLC RO Plant on Lopez Island, WA by Andrew Evers of Watek

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Appendix 5 – Detailed Inventory Greater San Juan Reverse Osmosis Systems.

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The Current Status of Desalination Systems in San Juan County, Washington Executive Summary

Background – The purpose of this paper is to summarize the current status of public water systems using desalination in San Juan County and to discuss issues impacting its use. This paper draws from material developed for San Juan County (SJC), by the SJC Water Resources Advisory Committee (WRMC). A Technical Supplement is available from the SJCWRMC that expands on the subject and provides comments by various specialists.

Definition - Desalination is accomplished in several ways. Since all of the systems described here are based on reverse osmosis (RO) we will generally use that term in our discussions. The technical definition of RO is:

Reverse osmosis is a physical process in which a suitably pretreated water is delivered at high pressure against a semi-permeable membrane. The membrane rejects most solute ions and molecules, while allowing water of very low mineral content to pass through. The process produces a reject concentrate waste stream [effluent] in addition to the clear permeate product. Reverse osmosis systems have been successfully applied to saline ground-waters, brackish waters, and seawater. (1997 AWWA Edition of the 10 State Standards)

General History - The first commercial RO plant went into service for the city of Colinga, CA, in 1965 producing 5,000 gallons per day (gpd) of potable water. By 2001 about 6,700 RO plants were in planning or production around the world. Many of these plants can produce well in excess of 5.0 million gallons per day (mgd) or 200 times greater than any RO plant in San Juan County.

Data Collection - In gathering data for this paper we considered the 12 community RO systems in San Juan County and three other RO systems in other parts of the State (Eliza Island, Whatcom County; Potlatch on Guemes Island, Skagit County; and Hat Island, Snohomish County). These 15 are the only approved RO systems that treat marine waters in the State. (Statewide there are 13 RO systems that treat brackish well water, none in SJC.)

San Juan County - San Juan County is one of 39 counties in the State of Washington. It is composed of 172 named islands in Upper Puget Sound with a land area of 175 square miles and a marine water area of roughly 446 square miles.

The estimated population of the entire county (April 1, 2008) was 16,100. The only incorporated town is Friday Harbor with a population of approximately 2,250. The census bureau estimates there to be 11,153 Housing Units (HU) in the county in April 2008, or 1.44 people per HU. Summertime populations in the San Juan County are estimated to peak over these values by 30% to 50%.

Water Supply in San Juan County - Within the county are 89 Group A water systems (generally more than 12 HUs), serving 5,370 connections and 304 Group B water systems,

serving 1,085 connections. In addition, there are about 4,700 individual water systems served mainly by individual wells.

The five largest water systems in the county are: The Town of Friday Harbor, San Juan Island (1483 connections); Eastsound Water Users, Orcas Is. (918); Roche Harbor, San Juan Is. (408); Doe Bay Water Users, Orcas Is. (269); and Rosario, Orcas Is. (177). These larger systems are served primarily from lakes or surface streams.

Of the 393 Group A and B water systems in the county, 12 receive some or all of their water supplies from RO plants. Of the 6,455 Group A and B connections, 410 (6.3%) are served by RO plants. (See Table A) At this time the average daily production of potable water from RO plants in SJC is 23,528 gpd, or 19% of the total treatment capacity of 124,900 gpd.

Table A - Desalination (RO) Plants in San Juan County (All Seawater)	Year Into Service	Approved Conn	Current Actual Conn	Treatment Cap. gpd
*Cattle Point (SJ Is.)	1999	71	39	21,600
Center Island (SJC)	1991	185	139	8,400
Kings Ransom Cove (Henry Is.)	2000	3	3	3,000
Lopez Legacy Lodge (Lopez Is.)	2008	2	2	14,400
*Mineral Point (SJ Is.)	1998	19	16	10,000
*Mitchell Point (SJ Is.)	1996	44	38	12,000
Obstruction Island (SJC)	2008	48	28	2,000
Resort at Deer Harbor (Orcas Is)	2005	51	51	14,000
Roche Harbor Shores (Henry Is.)	2008	8	8	3,000
Seattle YC (Henry Is.)	1997	11	11	4,500
Sperry Peninsula (Lopez Is.)	2002	5	5	25,000
Spring Point (Orcas Is.)	2001	94	70	7,000
Totals		541	410	124,900

Energy Consumption - The average energy consumption for the three plants with asterisk(*) in SJC is one kilowatt-hour per 31 gallons of potable water produced in RO systems. (Very large systems may approach one kilowatt-hour per 80 gallons.) If we assume that 1 kWh/31 gal is appropriate for all of the SJC systems, then, at an average production rate of 23,528 gpd, the annual RO energy consumption would be 277,000 kWh per year. The annual electrical energy sold by OPALCO in SJC is approximately 206,000,000 kWh. Thus energy use for RO systems is currently approximately 0.13% of the total electrical energy sales in SJC.

The average energy consumption of a single housing unit in SJC is approximately 18,500 kWh per year. Thus the RO energy consumption to serve 410 HUs is equal to about 15 HUs.

RO Plant Capital Costs - Table B gives an idea of the capital costs involved in new RO plants (in 2008 US Dollars).

System	Production Cap. gpd	Capital Cost	Projected \$/gpd
Center	4,000	\$172,125	\$43.03
Spring	7,000	\$258,752	\$36.96
Mitchell	12,000	\$274,648	\$22.89
Eliza	16,000	\$588,532	\$36.78
Cattle Point	21,700	\$351,398	\$16.19
Guemes	30,000	\$670,828	\$22.36
Hat	40,000	\$921,444	\$23.04

If we assume, for example, a community (30 lots) well has failed and it is proposed that it be replaced by an RO plant with a capacity of 18,000 gpd, the capital cost would be about \$25 /gpd (trended value) or \$450,000, or \$15,000 per lot. Though \$15,000 is a significant amount, it is a relatively small amount as compared to loss incurred if the homeowners had to abandon their lots and existing homes.

Water System	Eastsound	Frid. Har.	Cattle Pt	Potlatch
Island	Orcas	San Juan	San Juan	Guemes
Type of Units*	SFR	SFR	SFR	SFR
Source of Water	Surface	Surface	RO	RO
Timeframe	Yr 2000	Yr 2000	Yr 2002	Yr 2002
Annual Total-Million Gal.	35.57	40.17	0.96	0.62
Peak Month-MG	4.74	5.36	0.13	0.06
Average Month-Gal/Conn	5,156	4,133	2,424	1,845
Nominal Connections	575	810	33	28
Peak Month-gpd/Conn	266	213	125	69
Ave.Month-gpd/Conn	172	136	81	62
Metered?	Yes	Yes	Yes	Yes
Charges Based on Meters?	Yes	Yes	Yes	Yes
Monthly Ch-@Ave Use	\$31	\$44	\$81	\$75
Monthly Ch-@4,000 gal	\$28	\$37	\$120	\$130

*SFR=Single Family Res.

Comparative Water Charges – The cost of water is typically higher from RO systems than other sources (wells, surface water) in the County. Table C compares several different systems, two with surface water sources (and treatment) and two based on RO systems. Water costs roughly 4 times more per unit of supply in the RO systems. In apparent response to that higher unit cost, the consumption of water in the RO systems is significantly less.

The reason for that higher cost is not necessarily because RO plants are more expensive per unit of production than other water sources. It is a matter of scale. Smaller plants are expensive on a per unit basis.

Current RO Planning Activities - Planning for several new RO treatment plants is underway within San Juan County at this time. An RO plant has been approved on Sucia Island for the state park (construction pending).

AGENCIES REGULATING RO SYSTEMS - All public water systems in the state are be regulated by a number of separate county, state and federal agencies. This is true no matter what the source of water is or what the treatment process is. These include the Washington State departments: of Ecology. Health. Fish & Wildlife. Natural Resources; the US Army Corp of Engineers, Fish & Wildlife, National Marine Fisheries Service; and finally several of San Juan County’s several Departments including Community Development and Planning; Public Works; and Health and Community Services.

It is important to note that all public water systems are subject to similar regulation by a number of agencies and that twelve RO systems in SJC have been approved in the last 13 years.

Some specific agency responses specific to RO systems:

Washington State Department of Health (WSDOH) RO Technology - The WSDOH Water System Design Manual (2001) identifies RO (membrane filtration) as an "alternative technology." This is from that manual to describe the implication of such a determination:

Alternate technologies are characterized as being new or innovative types of facilities or treatment techniques. Alternate technologies for surface water treatment must undergo a stand-alone approval process prior to installation in any specific site. Laboratory and/or field studies may be required depending on the technology pursuant to WAC 246-290-250 before development of specific designs.

We can find no place that suggests that WSDOH prohibits the use of RO systems and we have been told by the this area's WSDOH regional water engineer that no such state prohibition exists.

Washington State Department of Ecology (WSDoE) Policy for Seawater Withdrawal - The current WSDoE rules as relate to RO plants are summarized:

1. A
t this time, a water right permit under Chapter 90.03 or Chapter 90.44 RCW will not be required for the diversion withdrawal of saltwater from a marine water body.

2. W
ater users must be advised to take extreme care to protect against the induction of saltwater into freshwater aquifers.
3. S
tate jurisdiction exists for enforcement against contamination of an aquifer due to saltwater intrusion. When the use of saltwater is determined to be detrimental to the public interest, Ecology may enforce to protect public health, interest, and the safety of the environment

Washington State Department of Ecology (WSDoE) Policy for Discharge Permits - This was received from Rod Thompson, DoE, July 30, 2008:

Thank you for your recent inquiry asking whether or not a NPDES permit would be required for a proposed desalination plant, and what are Ecology's recommendations on the topic of RO plant wastewater disposal from desalination plants. (From:)

Technically any discharge of pollutants to surface waters of the state requires an NPDES permit, and it can be argued that concentrated brine is a pollutant. However, Ecology is not currently issuing NPDES discharge permits for small desalination plants due to workload issues and because we believe that the water quality benefit of such permits would be marginal. Desalination plants return salts to the saltwater (albeit at concentrations above ambient levels) and as such do not constitute a serious concern unless discharge volumes are relatively high (for example more than a range of 10-15 homes), and the receiving waters have poor dilution or circulation.

The proposed facility should not discharge any corrosion control chemicals or disinfecting agents (or any other toxic chemicals) in their system to receiving waters because such discharges would violate state law. These chemicals should be contained and not discharged. Also the discharge pipe should be placed beyond the mean low-low tide line and far enough from the shoreline to take advantage of diluting currents. A depth of at least 10 feet at low low tide is recommended. Also please be aware that desalination brine is denser than saltwater and will tend to pool on the bottom if the circulation is poor. Some marine organisms are very sensitive to salinity changes and could be adversely affected near the outfall if this happens.

If any saltwater, concentrated brine, or other effluent is planned to be discharged to ground, rather than back to saltwater, please contact DoE.

Large desalination plant discharges demand a careful review, and Ecology will most likely require an NPDES permit for large desalination plant discharges. In addition to those discussed above, other issues with larger desalination plant discharges include:

1. Fisheries biologists at WDFW may have concerns about increasing salinity levels in the immediate vicinity of an outfall, as there could be deleterious effects on some marine biota. Apparently some marine organisms, while adapted to saltwater, are intolerant to changes in salinity. Fisheries biologists should be consulted regarding the optimum location for desalination plant discharges from the shoreline.

2. Please be aware that desalination plant discharges will behave very differently from domestic wastewater plant discharges, due to differences in buoyancy. While domestic wastewater discharge plumes rise in saltwater, concentrated brine discharges will likely sink. This could cause bottom pockets of effluent concentrations around outfalls. In one proposal Ecology received, the desalination discharge was to be injected into an existing WWTP discharge pipe. This could radically change the character of the treatment plant outfall plume, potentially affecting the dilution ratios and consequently the plant NPDES limits.

3. The control, management, and discharge prevention of corrosion inhibitor or scale control chemicals and also disinfecting agents, all of which can be toxic, is even more critical with large desalination plants than smaller ones.

San Juan County Desalination Rules - SJC has established rules specifically applicable to desalination in the County (Uniform Development Code - Page 38, SJCC Chapter 18.50 - Shoreline Master Program). These are policy statements that control current actions. They can be modified by the County Council if not in conflict with State and Federal laws. These are the sections most applicable to the intent of this paper:

B. Regulations – Desalination/RO

5. Desalination and reverse osmosis systems will not be allowed for the purposes of providing the primary water supply within new subdivisions and short subdivisions. Such facilities may be allowed for the purpose of supplying water for an established community water system.

7. Desalination and reverse osmosis brine discharge is not considered to be potentially harmful to aquatic life or water quality provided all required state and federal requirements are met.

8. All desalination and reverse osmosis installations shall comply with the following regulations:

a. The intake and discharge lines must be trenched, run, or located together except where necessary to provide adequate separation between intake and discharged water.

b. The intake and discharge lines must be engineered so as to not materially interfere with normal public use of public tidelands or navigation. The intake point shall not float on the surface.

d. The use of existing wells with salt-water contamination or intrusion as the intake source for desalination or reverse osmosis systems is prohibited unless specifically authorized by the County department of health and community services.

e. The use of pre-filtration beach wells located landward of the line of mean lower low water is allowed provided all state and federal requirements are met.

Both recent history and the inclusion of this section in the UDC would suggest that San Juan County does allow construction and use of RO systems to provide water to established community water systems. However, there are situations (defined above) where they are not allowed.

ISSUES OF CONCERN - Various groups and individuals have noted issues that they believe to be of concern relative to proposals for new RO water supply systems. The resolution of these issues should be part of the approval process. We'll discuss several that are of special interest in SJC.

Membrane Cleaning - Chemicals are used to overcome chemical scaling from impurities in the water and biological growth and clogging of the membranes in an RO plant. While this procedure can be done on site, it is a specialized procedure that is difficult to master. Most of RO operators replace membranes or send them to specialized membrane cleaning shops. All of the RO plants in SJC do this at this time.

Membrane Pickling - Chemicals are also used to “pickle” membranes when a plant is shut down for more than a few days. This is especially true of plants operated only part of the year. The generic pickling solution is sodium meta-bisulfate, which has been shown not to be toxic, having no adverse effects, even at full strength with normal outfall dilution at the discharge. The Department of Fish and Wildlife has reviewed MSDS data and has specifically allowed discharge of this common household chemical in quantities and frequencies needed to operate a plant. We recommend that this preservative be allowed.

Intake Damage to Marine Organisms – 10 of 12 RO plant in SJC have screened intakes.¹ Typically these screens have an approach velocity on the order of 0.1 foot per second (fps). Filters of various types follow the intake screen

¹ Three of the intakes have 1/8” openings while others are somewhat smaller. The WS Fish and Wildlife Department and various federal agencies set the standards for screen size and configuration. Often these standards are a function of aquatic species and size. (Example: <http://wdfw.wa.gov/hab/engineer/fishscrn.htm>)

In any case, some small swimming organisms and various planktonic forms will not be excluded by screened intakes but will be captured by influent filters at the RO plant. Assuming proper design, most of these organisms should be filtered out and returned to the sea before getting to the high-pressure system. However, it is likely that there will be losses though their significance is unknown.

Two of the 12 SJC RO plant intakes are beach trenches or wells. While this is an appealing concept, success depends on the character of the beach materials.

Effluent Effects – All of the SJC RO plants discharge back into marine waters, generally through single “nozzles” It has been suggested that the effluent from RO plants (typically about 3/4th of the inflow rate) may cause damage to marine organisms. This effluent is generally about 33% saltier than the water originally drawn into the plant. This effluent, because of its greater density, will sink to the bottom and, in some circumstances, form a stable pool on the seafloor that resists mixing. Decrease in oxygen and associated changes then kill marine animals and plants. Also, increased salinity affects some marine animals and plants.

This does not appear to be an issue in the SJC RO plants. This may be due to the small size of these plants and/or the currents at the outfall. We have access to three separate field measurements that would suggest that the increase of seawater salinity where the effluent water leaves the discharge pipe is less than 2 parts per thousand (ppt) and is undetectable at 10 feet.

Impact of RO on Land Use - Permitting unrestricted RO enables development or water-intensive uses in areas that otherwise could not support them. However, this is a matter of land use planning. We believe that zoning and other land planning tools should be used to control growth, rather than restricting infrastructure.

In addition, it should be noted that the San Juan County Desalination Rules specifically state: “5. Desalination and reverse osmosis systems will not be allowed for the purposes of providing the primary water supply within new subdivisions and short subdivisions. Such facilities may be allowed for the purpose of supplying water for an established community water system.” (Underlined for emphasis.)