EXHIBIT 12

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

June 2009

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.

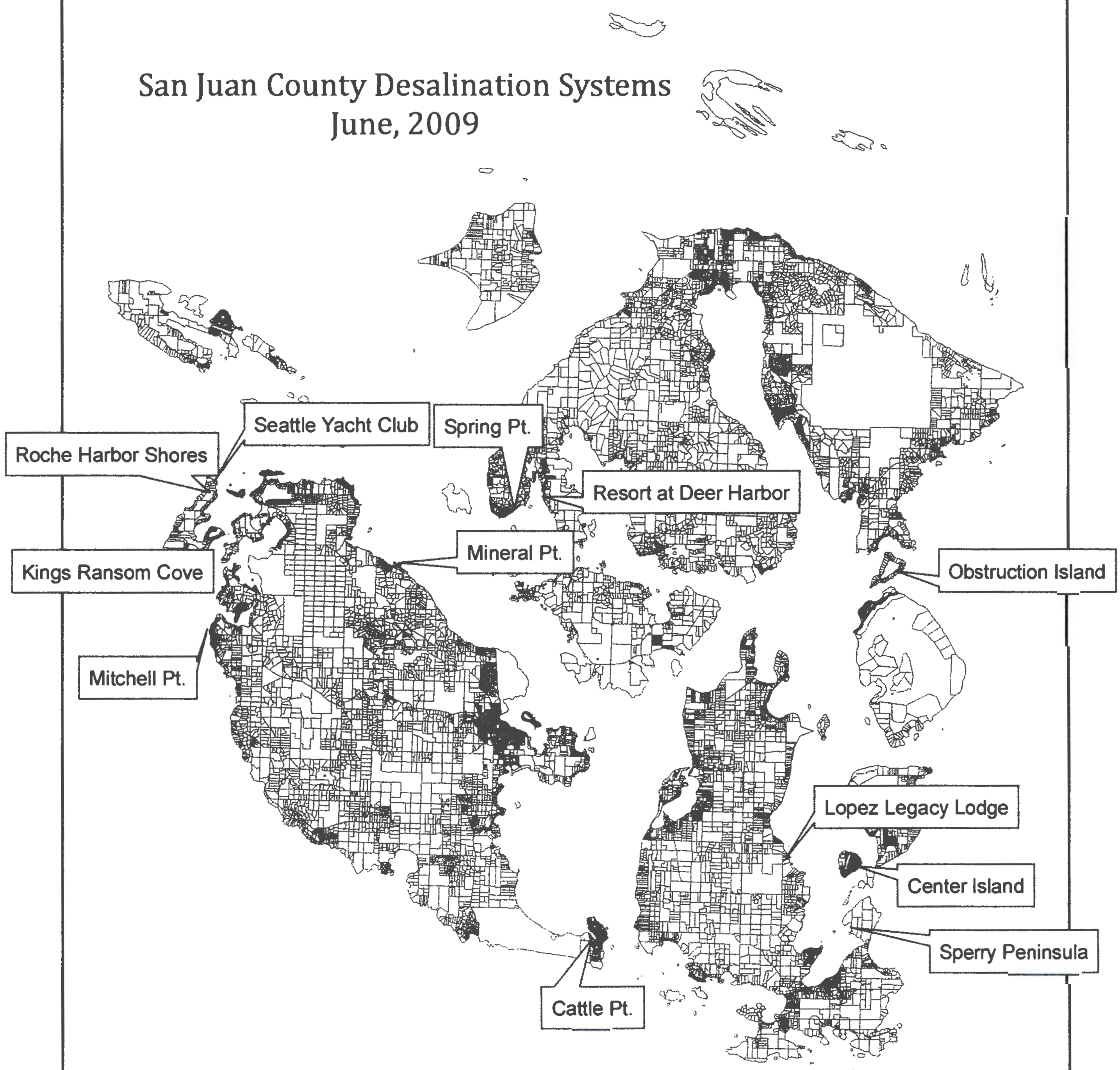
This document includes an Executive Summary and 5 Appendices:

For Technical Questions, Please Call:

Ronald D. Mayo, PE -- 135 Four Wheel Drive; Lopez Island, WA 98261

360 468 2693 -- fishguy@rockisland.com

San Juan County Desalination Systems
June, 2009



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).

Table B - RO Plant Capital Costs

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.

Table C - Charges in Several Water Systems (Surface and RO)

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. *Water users must be advised to take extreme care to protect against the induction of saltwater into freshwater aquifers.*
3. *State 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 <u>small</u> 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 $3/4^{th}$ 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 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.)

Appendix 1 – Tables, Figures and A Listing of Related Agencies

This is a collection of data and text supporting the Report "The Current Status of Desalination Systems in San Juan County, Washington

Figure 1 - One variation of the Reverse Osmosis process is illustrated in simple terms on Figure 1. Figure 1 assumes that the plant's production rate is 10 gpm (14,400 gpd) and that the "reject" water is produced at 30 gpm. Other variations exist in the ratio of production/reject flows.

Statistical Summary - Reverse Osmosis Plants in the Greater San Juans and Washington State.

In the Appendix 5 are 15 detailed descriptions of RO systems in the Greater San Juans. The following Tables expose the same information in a manner that allows easier comparison. Three of these systems are outside of San Juan County. They were included to provide a better basis for comparing and illustrating the nature of RO plants.

Table 1 is a listing of 12 RO plants in San Juan County of which 7 were in place before 2003. There are a 541 connections approved (of 410 actually connected).

Table 2 is a listing of RO plants now in service on nearby islands. These are included to allow added comparison between RO Plants on Islands.

Table 3 is a listing of all other RO plants (permitted for domestic water) in the state that the WSDOH has in their files.

Planning for several new RO treatment plants is underway within San Juan County at this time. To the best of our knowledge the are: Spencer Landing (construction approval pending); Hunter Bay on Lopez (initial permitting); Snug Harbor on San Juan (planning); Richardson on Lopez (early planning). An RO plant has been planned on Sucia Island for the state park (construction pending).

Added Data Relative to Existing RO Systems

Table 4 (Attached) is Existing RO plants with a listing of:

- "Function" or a description of pattern of use. For instance, "Primary" indicates a plant that supplies all or most of the water on a year around basis. "Summer" operates in the summer only, with wells used in the winter. "Back-Up" backs up the other (primary) source.
- "Group" indicates the size of system with "A" being larger than 14 connections and "B" smaller.
- The last three columns are contact information for the existing RO Plants.

Table 5 (Attached) is a listing of the primary design and operating characteristics of the Existing RO Plants.

- Membrane Maintenance-Of the 15 plants in the greater San Juans 3 have their membranes cleaned at the RO plant; 2 replace the membranes rather than clean them; and the other 10 send the membrane off island for cleaning (generally to the manufacturer).
- Intake types-Of the 15 RO plants, 4 use trenches or wells for their intake and the other 11 use screened inlets.
- Effluent-Of the 15 RO plants, 6 use slotted pipes hanging from a dock; 4 use "Duck bill" nozzles; and 4 use underwater nozzles; and one is a screened outlet.
- RO Equipment - Of the 15 RO plants, 7 use Watermaker Equipment. The rest vary. The total production capacity is 210,900 gpd.

Table 6 is an estimate of actual production from the RO Plants in SJ County. Specifically while the rated treatment capacity is on the order of 124,900 gpd, the actual annual average production is 23,200 gpd or 19% of the rated capacity. This is 57 gpd per actual connection.

Table 7 illustrates the increase of connections and capacity from 2002 to 2008. In 2002 there were 8 RO plants in SJC and in 2008 12 RO Plants. The number of actual connections increased from 299 to 410. The treatment capacity increased from 64,100 gpd to 124,900.

Table 8 Illustrates Maintenance and Electrical Cost for four RO plants for which data is available. The average annual cost per active connection was $787. The electrical portion of that was $93/year or 12%. The cost of electricity average $0.0027/gallon or about $3/day. This includes the relatively high cost of electricity for the Potlatch facility on Guemes Island. (Single-phase power source). Of the three plants in SJ County the average power consumption is one Kilowatt hour per 31 gallons of potable water produced (with a range of 26 to 38 gallons). Larger systems are typically more much more efficient with power consumption up to 88 gallons per kwh.

Table 9 compares six systems in SJC. It compares the single-family residential (SFR's) units of several systems in terms of size and consumption. It also illustrates the impact of water costs on consumption and the impact of meters. In fairly simple terms, cheaper water leads to higher water use.

Table 10 provides a basis for estimating costs for small RO Plants (up to 40,000 gpd) based on capital cost data from six existing plants esculated to 2008. As is typical with similar systems the unit costs decrease with increased size.

Agencies Regulating Public Water Systems

Developing a public water system in the State of Washington is not a simple process. This is the contact list provided recently by the department of Ecology.

- Washington Department of Ecology - Rod Thompson, LG,LHG,LEG □Regional Hydrogeologist □Water Quality Program □NWRO

- Washington Department of Ecology - Mr. Buck Smith of the Water Resources Program at (425) 649-7147. (Water Resources Program Policy #1015)

- Washington Department of Ecology - Mr. Jeff Bash of our Shorelands and Environmental Assistance Program at (425) 649-7035 to inquire if any shoreline permits may be necessary to obtain.

- San Juan County to inquire if other permits or requirements are needed relative to drinking water and the Shorelines Management Act, such as a County Shoreline Substantial Development Permit.

- Washington State Dept. of Health – For detailed design standards and operational procedures.

- Washington Dept. of Fish & Wildlife - to inquire if an HPA permit is required.

- Washington Dept. of Natural Resources - for a Right of Way permit or approval for facility construction within a tidal zone if applicable.

- Army Corp of Engineers

- US Fish & Wildlife

- National Marine Fisheries Service (NMFS)

Review of Friday Harbor RO Study in1994.

This review is included for reference:

In 1994 a committee of the Friday Harbor City Council wrote a brief report that considered the advisability of constructing a reverse osmosis plant (100,000 gpd) to provide a supplementary source of domestic water for the Town of Friday Harbor.

The report found that a plant of that size would have a capital cost of $1,200,000 including regulatory costs. The annual operating cost would be on the order of $157,000.

While this project was not undertaken we believe that it would serve as a valid starting point for consideration of an RO plant for the Town. It may or may not be the best option.

For reference, a 100,000 gpd RO plant would be larger that the largest RO plant (Sperry) now in SJ County by a factory of 4.

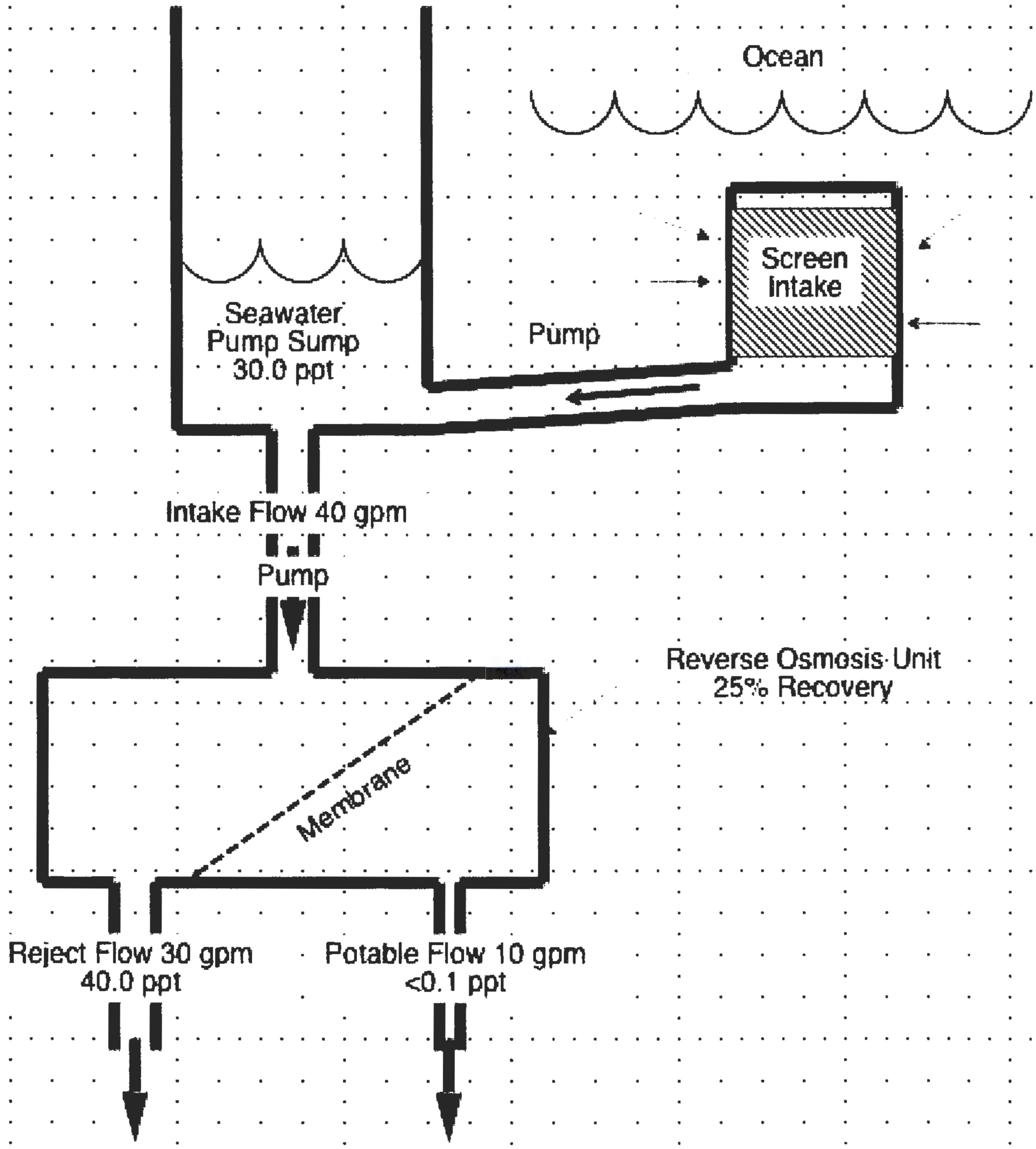


Figure 1 - Nominal Flow Relationships In Reverse Osmosis System
14,400 G/D capacity
100% Utilization

Table - 1 Desalinization (RO) Plants in San Juan County				
(All Seawater)	Year Into Service	Approved Conn	Actual Conn	Treatment Cap. gpd
Cattle Point (SJ Is)	1999	71	39	21,600
Center Island (SJ County)	1991	185	139	8,400
Kings Ransom Cove (Henry Is	2000	3	3	3,000
Lopez Legacy Lodge (Lopez I:	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 (SJ County)	2008	48	28	2,000
Resort at Deer Harbor (Orcas I	2005	51	51	14,000
Roche Harbor Shores (Henry I	2008	8	8	3,000
Seattle YC (Henry Island)	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	124900

Table - 2 Desalinization (RO) Plants on Other Islands				
(All Seawater)	Year Into Service	Approved Conn	Actual Conn	Treatment Cap. gpd
Eliza Island (Whatcom Cty)	1993	93	62	16,000
Hat Island (Snohomish Cty)	2002	300	285	40,000
Potlatch (Skagit Cty-Guemes Is)	1998	33	28	30,000
Totals		426	375	86,000

Table 3 - Desalinization (RO) Plants Elsewhere in State			
BRAKER THOMAS ORCHA	Grp B	DOUGLAS	Well
CLARKS RESTAURANT	Grp A	GRAYS HBR.	Well
COVENANT CHRISTIAN SC	Grp A	WHATCOM	Well
DMS WATER ASSOCIATIO	Grp B	WHATCOM	Well
DOUBLE L MOBILE HOME	Grp A	WHATCOM	Well
LAMB-WESTON PASCO	Grp A	FRANKLIN	Well
LIGO WATER SYSTEM	Grp A	BENTON	Well
MISSION RANCH ESTATES	Grp B	WHATCOM	Well
PARISEAU ORCHARD	Grp B	OKANOGAN	Well
SNAKE RIVER VINEYARD:	Grp A	WALLA WALLA	Well
WISER LAKE KINGDOM H.	Grp A	WHATCOM	Well
YAK CO - FAIRWAY ESTA	Grp B	YAKIMA	Well
YORK-WILEY WATER SYS	Grp B	SPOKANE	Well

Table 4 - Functions and Contacts for Existing RO Systems

	Function	Class	Primary Contact	Primary Contact e-mail	Alt Contact
Cattle Point (SJ Is)	Primary	A	Dan Drahn	dan@boundary-water.com	Eleanor McMill
Center Island (SJ County)	Primary	A	Dan Drahn	dan@boundary-water.com	Rob Morrice
Eliza Island (Whatcom Cty)	Primary	A	Jerry Masadin	mcstrut@hotmail.com	
Hat Island (Snohomish Cty)	Primary	A	Charles Motson	hioffice@hatisland.com	Charles Motson
Kings Ransom Cove (Henry Is.)	Primary	B	John Hart	john@hartpac.com	Guy Nibler
Lopez Legacy Lodge (Lopez Is.)	Primary	B	Andrew Evers	water@rockisland.com	
Mineral Point (SJ Is)	Summer	A	Bruce Hansen	fbhansen@rockisland.com	
Mitchell Point (SJ Is)	Summer	A	Don Hendrix	dlhendrix@centurytel.net	
Obstruction Island (SJ County)	Summer	A	Dan Drahn	dan@boundary-water.com	Deborah Hellese
Potlatch (Guemes Island)	Primary	A	Mike Fox	fox@skagitpud.org	Greg Peterka
Resort at Deer Harbor (Orcas Is)	Primary	A	John Hart	john@hartpac.com	Steve Cade
Roche Harbor Shores (Henry Is.)*	Primary	B	John Hart	john@hartpac.com	Guy Nibler
Seattle YC (Henry Island)	Primary	A	John Hart	john@hartpac.com	Dick Plows
Sperry Peninsula (Lopez Is)	Primary	B	Andrew Evers	water@rockisland.com	Phil Hedley
Spring Point (Orcas Is)	Back-up	A	John Ryberg	jonwan@rockisland.com	John Hart

*INACTIVE per SJ County

A=Class A is larger than 14 connections

B=Class B is smaller than 15 connections

Table 5 - Operating Characteristics of existing RO Systems	Membrane Maintenance	Intake Type	RO Equipment Supplier	Capacity-gpd	Effluent Pipe
Cattle Point (SJ Is)	S	Horizontal Beach Well Casing	WES Inc.	21,600	"Duck bill" nozzle
Center Island (SJ County)	S	Screen hung from dock	US Watermaker	8,400	Underwater nozzle
Eliza Island (Whatcom Cty)	C	Screen hung from dock	US Watermaker	16,000	Underwater nozzle
Hat Island (Snohomish Cty)	C	2 Beach Wells	Aquamembrane/Sien	40,000	Underwater nozzle
Kings Ransom Cove (Henry Is.)	S	Screen hung from dock	US Watermaker	3,000	Slotted Pipe on dock
Lopez Legacy Lodge (Lopez Is.)	S	Well screens on sea bottom	WATEK	14,400	Well screens on sea bottom
Mineral Point (SJ Is)	S	Well screens on sea bottom	ITT-Water Eq. Tech.	10,000	Underwater nozzle
Mitchell Point (SJ Is)	R	Well screens on sea bottom	Sea Recovery	12,000	"Duck bill" nozzle
Obstruction Island (SJ County)	C	Screened	US Watermaker	2,000	Slotted Pipe on dock
Potlatch (Guemes Island)	R	Beach Well	Osmonics	30,000	"Duck bill" nozzle
Resort at Deer Harbor (Orcas Is)	S	Screen hung from dock	US Watermaker	14,000	Slotted Pipe on dock
Roche Harbor Shores (Henry Is.)	S	Screen hung from dock	US Watermaker	3,000	Slotted Pipe on dock
Seattle YC (Henry Island)	S	Screen hung from dock	US Watermaker	4,500	Slotted Pipe on dock
Sperry Peninsula (Lopez Is)	S	Beach Trench	Water Link	25,000	"Duck bill" nozzle
Spring Point (Orcas Is)	S	Screen hung from dock	Sea Recovery	7,000	Slotted Pipe on dock
				210,900	
	C=Clean at RO Plant				
	N=No decision yet.				
	R. Replace membranes when worn out				
*INACTIVE per SJ County	S.Send the membranes out for cleaning				

Table 6-RO Production Est.	Approved	Actual	Rated Treatment	Summer Months	Other Months	Basis fc
in San Juan County	Conn	Conn.	Capacity. gpd	Use gpd	Use gpd	Valı
Cattle Point (SJ Is)	71	39	21,600	5,500	3,000	Da
Center Island (SJ County)	185	139	8,400	3,200	1,200	Da
Kings Ransom Cove (Henry Is.)	3	3	3,000	900	600	Estir
Lopez Legacy Lodge (Lopez Is.)	2	2	14,400	2,500	500	Conver:
Mineral Point (SJ Is)	19	16	10,000	4,800	-	Conver
Mitchell Point (SJ Is)	44	38	12,000	3,300	1,800	Data/
Obstruction Island (SJ County)	48	28	2,000	1,400	700	Estir
Resort at Deer Harbor (Orcas Is)	51	51	14,000	6,000	1,200	Estir
Roche Harbor Shores (Henry Is.)	8	8	3,000	2,400	1,600	Estir
Seattle YC (Henry Island)	11	11	4,500	3,300	2,200	Estir
Sperry Peninsula (Lopez Is)	5	5	25,000	9,000	300	Conver
Spring Point (Orcas Is)	94	70	7,000	2,000	-	Da
Totals	541	410	124,900	44,300	13,100	
		Current Total Production in gallons/year>>>>>>>				8,5
		Current Average Production in gallons/day>>>>>			19%	
*INACTIVE per SJ County		Average Annual Production in g/d per actual connection>>>				

Table 7-RO Production Increa	2002	2002	2002	2008	2008
in San Juan County	Approved	Actual	Treatment	Approved	Actual
(By Year)	Conn	Conn.	Capacity. gpd	Conn	Conn.
Cattle Point (SJ Is)	60	33	21,600	71	39
Center Island (SJ County)	135	135	4,000	185	139
Kings Ransom Cove (Henry Is.)	3	3	3,000	3	3
Lopez Legacy Lodge (Lopez Is.)	-	-	-	2	2
Mineral Point (SJ Is)	19	16	10,000	19	16
Mitchell Point (SJ Is)	19	36	12,000	44	38
Obstruction Island (SJ County)	-	-	-	48	28
Resort at Deer Harbor (Orcas Is)	-	-	-	51	51
Roche Harbor Shores (Henry Is.)	-	-	-	8	8
Seattle YC (Henry Island)	11	11	4,500	11	11
Sperry Peninsula (Lopez Is)	5	5	2,000	5	5
Spring Point (Orcas Is)	94	60	7,000	94	70
Totals	346	299	64,100	541	410
*INACTIVE per SJ County		Increase in 6 years>>>>>>		56%	37%

Table 8 - Maintenance and Electrical Costs	Active Connections	Plant Capacity-gpd	Most Recent Maint-All	Most Recent Electrical	Estimate Unit Electrical $ per Gallon
Cattle Point (SJ Is)	39	21,600	$30,000	$2,700	$ 0.0015
Mineral Point (SJ Is)	16	10,000	$17,000	$1,700	$ 0.0029
Mitchell Point (SJ Is)	38	12,000	$21,000	$2,800	$ 0.0027
Potlatch (Skagit Cty-Guemes Is)	28	30,000	$27,200	$4,000	$ 0.0058
Total Connections	121				
Plant Capacity-gpd		73,600			
All Maintenance Cost			$95,200	12%	
Electrical Costs Only				$11,200	
Annual Total Main.Cost/Conn			$787		elect.per g.
Annual Electrical Cost/Conn.				$93	$ 0.0027

Table 9 - A Comparison of Several Water Systems In the San Juan County

Water System	Eastsound	Frid. Har.	Harbor	Fish Bay	Cattle Pt	Potlatch
Island	Orcas	San Juan	Lopez	Lopez	San Juan	Guemes
Type of Units*	SFR	SFR	SFR	SFR eq.	SFR	SFR
Source of Water	Surface	Surface	Well	Wells	RO	RO
Timeframe	Yr 2000	Yr 2000	Yr 2002	Yr 2002	Yr 2002	Yr 2002
Annual Total-MG	35.57	40.17	3.13	9.3	0.96	0.62
Peak Month-MG	4.74	5.36	0.45	1.33	0.13	0.06
Average Month-Gal/Conn	5,156	4,133	5,325	6,858	2,424	1,845
Nominal Connections	575	810	49	113	33	28
Peak Month-GPD/Conn	266	213	296	381	125	69
Ave.Month-GPD/Conn	172	136	175	225	81	62
Metered?	Yes	Yes	Yes	Yes	Yes	Yes
Charges Based on Meters?	Yes	Yes	No	No	Yes	Yes
Monthly Ch-@Ave Use	$31	$44	NA	NA	$81	$75
Monthly Ch-@4,000 GPM	$28	$37	NA	NA	$120	$130

*SFR=Single Family Res.

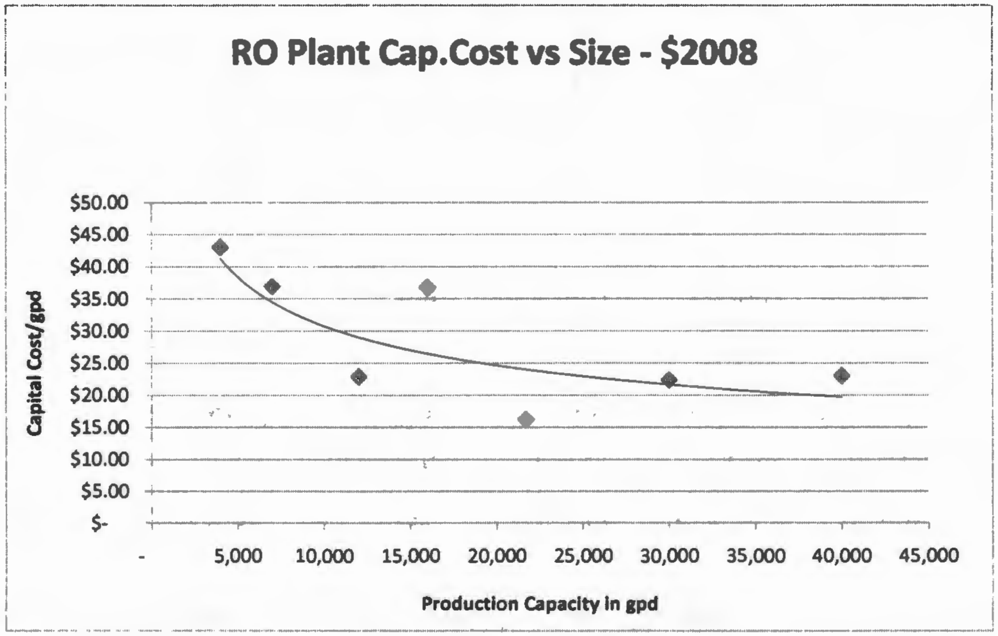
RO Table 10 - RO System Capital Costs

by Ron Mayo
Lopez

Table 10-RO Plant Capital Cost Escalated to 2008 $Dollars

Source: Ron Mayo 9/15/03 (Systems with Cost data available)
updated by Boundary water Inc. 10/08

System	Daily Prod. Cap. gpd	Start Servic Service	Reported Capital Cost	Voluntee Labor	Imputed Cap.Cost	ENR Const ndex@Sta	Est.Index 10/1/2008	Projected Cap.Cost	Projected $/gpd		Capacity-gp	$/g
Center	4,000	1991	$ 30,000	70%	$100,000	4,818	8,293	$ 172,125	$ 43.03		4,000	$
Spring	7,000	2001	$ 200,000	0%	$200,000	6,410	8,293	$ 258,752	$ 36.96		7,000	$
Mitchell	12,000	1996	$ 200,000	0%	$200,000	6,039	8,293	$ 274,648	$ 22.89		12,000	$
Eliza	16,000	1996	$ 300,000	30%	$428,571	6,039	8,293	$ 588,532	$ 36.78		16,000	$
Cattle Point	21,700	1998	$ 250,000	0%	$250,000	5,900	8,293	$ 351,398	$ 16.19		21,700	$
Guemes	30,000	1999	$ 488,500	0%	$488,500	6,039	8,293	$ 670,828	$ 22.36		30,000	$
Hat	40,000	2002	$ 750,000	0%	$750,000	6,750	8,293	$ 921,444	$ 23.04		40,000	$
												$



Appendix 2 - AVOIDING OR MINIMIZING POTENTIAL IMPACTS OF RO DESALINATION IN SAN JUAN COUNTY[1]

by Richard R. Strathmann 24 Apr 2009

RO (Reverse Osmosis) plants pump seawater or other feed water at high pressure through permeable membranes that allow the passage of water molecules while blocking the passage of salt, other dissolved minerals, and contaminants.

Demand for desalinization plants will likely continue to grow in San Juan County. Few coastal areas in the Pacific NW have the limited supply of freshwater and proximity to seawater that occur in San Juan County.

Several potential sources of impacts on sea life from desalination plants have been identified. Minimizing those impacts will protect marine resources.

POTENTIAL SOURCES OF IMPACTS ON SEA LIFE FROM RO DESALINATION PLANTS

Potential sources of impacts from RO desal plants have been noted (Tularum & Ilahee 2007; Einav et al. 2002; Lattemann and Höpner 2008). These include:

- **Discharge of brine to receiving waters.** Water of greater density because of its greater salinity sinks below water of lower salinity. If denser, more saline water sinks to the seafloor, the denser water can, 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 in some circumstances.

- **Chemicals used in pre- and post-treatment of water.** Most or all future desal plants in San Juan County will not be using these chemicals (D. Drahn, A. Evers, personal communications). Here are examples of chemicals that have been used in RO desal plants (not necessarily in the County) to overcome chemical scaling from impurities in the water and biological growth and clogging of the membranes in an RO plant. Chemicals such as sodium hypochlorite or chlorine prevents growth of organisms; ferric or aluminum chloride may be added for flocculation to form larger masses that are easier to remove by filters and removal of suspended matter; sulfuric or

[1] This footnote was provided by Mike Kaill of Friday Harbor: *Richard has addressed the issues that are of concern to me. The only thing I might add is to assure that permit review, including consistent and knowledgeable application of such policy as may develop out of this effort be carefully done. -MK*

hydrochloric acid may be added for pH adjustment; sodium bisulfite to neutralize remaining chlorine; polymaleic acid and phosphonates are typical scale inhibitors. Chemicals are also used in cleaning membranes (which can be enzymes to remove bacterial slimes, detergents, biocides to kill bacteria, chelators such as EDTA to remove scale, acids to dissolve inorganics, and caustics to dissolve organic material and silica). With on site cleaning, most of the cleaning chemicals are washed into the brine that is discharged into the marine environment. **Discharge of brine to receiving waters.** Water of greater density because of its greater salinity sinks below water of lower salinity. If denser, more saline water sinks to the seafloor, the denser water can, 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 in some circumstances.

- **Impingement** (marine animals killed or injured as they collide with screens at the intake)

- **Entrainment** (marine life sucked into the system with seawater)

- **Noise from pumps**

- **Energy** required for generating the pressure differences required for desalination by reverse osmosis

- **Leaking of brine from pipes or other spills on land into groundwater**

- **Installation of the desal plant near the shoreline**, including potential impacts from impervious surfaces and removal of vegetation near the shoreline for a building housing equipment or a road to access the site

- **Other impacts of development or water intensive uses** in areas that otherwise could not support them

EXAMPLES OF OBSERVED IMPACTS AND NON-IMPACTS OF RO DESALINATION PLANTS ON SEA LIFE

Large desal plants elsewhere

The studies of marine impacts found in a literature search were for RO desalination plants that discharge larger volumes of brine at higher salinities than those in San Juan County. A study in Spain tracked substitution of an assemblage of animals characterized by Polychaeta, Crustacea, and Mollusca for another dominated by nematodes (Del Pilar Ruso et al. 2007). The plant was large with initially a high salinity (68 parts per thousand) and discharge of 65,000 m^3 per day. The changes were correlated with greater salinities near the discharge and also with differences in organic matter, depth, and sediment sizes. They also found changes in abundances of polychaetes (a group of animals living in and on the sea floor sediments) (Del Pilar Ruso et al. 2008). At the site of another large plant in the Canary Islands (discharge of 17,000 m^3/day of water of 90 parts per thousand salinity), a seagrass was less abundant near the outfall (Pérez Talavera and Quesada Ruiz 2001).

However, at another site in Spain with discharge of high salinity (60 parts per thousand) water, there was no detectable effect on benthic animals or fishes, and the lack of detectable effect was attributed to rapid dilution of discharged brine and high variability of abundances in the habitat (Raventos et al. 2006).

Limited information from sites and RO plants like those in San Juan County

Studies for a marine biota more similar to that in San Juan County and for smaller desalination plants with discharges at lower salinity, like those presently in San Juan County, would be useful. A literature search has thus far revealed no similarly detailed studies from desalination plants in California or from small desalination plants. Ideally such studies would include before and after sampling at control and impact sites. Megan Dethier (unpublished observation) found no apparent change in sea life on rocks near a desalination plant outfall on Haro Strait, where tidal currents are fast and mixing is rapid.

Two studies in the San Juan Islands, following installation of desalination plants, indicated rapid mixing of water near the discharge pipes. In each case salinities were reduced to concentrations near or not detectably different from that of the surrounding water within a few feet of the discharge pipe. A discharge into Griffin Bay near San Juan Island is described in Mayo (2009, Appendix 4, communicated by Dan Drahn and Chris Betcher). The mixing occurred in slow currents (speeds of 0 to 3 feet per minute). The volume flow of discharged water was unstated. At a discharge into Lopez Sound, measurements indicated rapid mixing to salinities near that of the receiving water but the volume flow of effluent and the current velocities in the receiving water were unstated (Andrew Evers, personal communication).

Ongoing modeling of mixing of discharged water may provide improved predictions of mixing of discharged water under a range of conditions (Dan Drahn and Tom Boydston, personal communication).

The sites expected to be most vulnerable to impacts from small desalination plants are sheltered bays in which currents and mixing are slow, especially those with basins that could accumulate sinking effluent water. In such cases the effect of denser (higher salinity) water on mixing of water near the seafloor would be the possible source of impacts on sea life. Small bays with low flushing would also be the sites where volume pumped could remove a greater proportion of slow swimming planktonic animals.

No studies of effects or lack of effects of desalination plant discharges on juvenile salmon or other fish moving along shore were found in a literature search. In the study by Raventos et al. (2006), some fish, instead of avoiding the discharge site, aggregated near the discharge pipe, as can happen at artificial reefs where there are no natural rock reefs. In a laboratory study with artificial seawater, Iso et al. (1994) observed that juvenile sea bream spent less time in water at high salinities, but the salinities with this effect were very high, with avoidance at 45 ppt salinity.

AVOIDING OR MINIMIZING IMPACTS IN THE SAN JUAN ISLANDS

Mixing at outfalls:

Impacts from effluent water from desalination plants are expected to be reduced where the brine is rapidly dispersed by currents or waves and greater in environments where mixing is slow (Höpner and Windelberg 1996; Höpner 1999; Lattemann and Höpner 2008).

The plants and animals in the San Juan Islands are likely to tolerate the increased salinities observed near outfalls of small desalination plants after some mixing has occurred. Salinities in the waters of the San Juan Islands commonly vary by several parts per thousand.

Pooling of denser water at the seafloor is most likely to occur where discharges are into sheltered bays where currents are often slow and into basins that would retain denser water. If, even with mixing, the water was dense enough to sink to the sea floor and form a stable layer that retards further mixing, then the impacts on sea life would be substantial. Bottom water and sediments would become hypoxic or anoxic. This situation occurs naturally in some basins, such as Saanich Inlet, where less saline water overlies more saline water.

However, for a small desal plant, pumping about 50,000 gallons per day and with brine mixed to within one part per thousand close to the outfall, under most circumstances the currents from tides and winds are expected to be adequate to further mix the water. A total capacity of 50,000 gallons per day is a small fraction of the volume at low tide in many of the bays. The vertical salinity difference would be within the range that commonly occurs with lowered surface salinities from freshwater runoff. Impacts may be more substantial in small bays in which discharged water could enter a basin. For such situations, additional useful studies would include direct observations of the movement of the discharged plume of mixing water under a variety of current conditions, with known rates of discharge and measured salinities of discharged and receiving water. The discharged water could be marked by a dye such as fluorescein mixed with the brine. This dyed discharge plume would indicate whether or not the mixing effluent water was sinking to the seafloor.

There may be information on currents sufficient to overcome density gradients by mixing in the kinds of small bays in the San Juan Islands with the kinds of salinity differences that have been observed near outfalls. Additional information may be available because common sources of density stratification are freshwater in flow and surface warming.

Where accumulation of denser, more saline water near the seafloor is suspected, monitoring of oxygen and pH (acidity) are indications of impacts from reduced mixing. Monitoring sulfide in sediments could reveal a history of low oxygen. Sediment cores could show the level at which black anoxic sediment occurs.

Design of effluent pipes varies. In some plants the intake and discharge pipes are designed with intake screened to exclude organisms and discharge pipe configured solely to enhance mixing. In other systems, intake and discharge are switched at intervals to avoid fouling of pipes, and both then have similar screens. A comparison of mixing with these two arrangements and demonstration of best design for each will help to minimize impacts.

While uncertainty about mixing and sinking of water remains, impacts could be avoided by not sitting outfalls in waters with slow currents and with basins in which denser water could accumulate. Such sites could be identified and listed. Locating an outfall in such an area could require demonstration that mixing effluent water does not sink even when currents are slowest and mixing least.

Impingement and entrainment of marine animals:

Slow moving marine animals are killed when they are sucked against a filtering screen at the intake or sucked into a desalination plant with the seawater. A present standard for an intake is a screen size less than 1/8" to exclude larger organisms (D. Drahn, personal communication). A screen of this size excludes juvenile fish but not small larvae, like those of clams, mussels, oysters, and sea urchins.

The capacity of 12 desalination plants in San Juan County is 124,000 gallons per day (Mayo 2009, Table 5). That amount of freshwater is expected to require a 4 to 1 ratio of seawater to freshwater (Mayo, personal communication) and thus pumping of about 496,000 gallons per day of seawater (2456 cubic yards). Measured face velocities at several intake screens were approximately 0.1 feet per second (Mayo 2009), which is about 3 centimeters per second. Many small larvae (of sea urchins, clams, mussels, oysters, some crustaceans, etc.) do not swim that fast. (F.-S. Chia, et al. 1984). If this face velocity is representative, at full capacity slow swimming animals would be removed from a volume equal to about 1.4 miles by 1 square yard each day. Average production is about 1/5 of this volume flow (R. Mayo, personal communication).

However, as a proportion of a local population, losses from impingement and entrainment are expected to be low if the volume pumped is a small fraction of the volume of a bay. For many bays, the proportion of water pumped is low, even with a low rate of flushing. As an example, 50,000 gallons per day is about 250 cubic yards per day; soundings and area from a chart indicate about 500,000 cubic yards at low tide in Mitchell Bay. In three weeks, the volume of water pumped would be equivalent to about 1% of the volume of the bay. The small expected effect depends on scale. If desalination capacity were greatly increased within a small bay in which larvae were retained, then losses from impingement and entrainment could impact animals within that bay.

Intakes below the sediment surface have been recommended as a means of avoiding impingement and entrainment of animals, but mussels have settled within a system supplied by in this manner (Andrew Evers, personal communication), which indicates that larvae were drawn into the gravel used as a filter.

The first stage filters in an RO desalination plant are back flushed to clear the filter (D. Drahn and Tom Boydston, personal communication). A filter of 20 to 25 microns excludes animal embryos and larvae. Few planktonic eggs are less than 50 microns. Those that survive the impingement between flushings of the filter would be returned to the plankton. A study could demonstrate survival and mortality of small animals caught on the filter and then washed away when the filter is flushed. Survival presumably depends on the type of filter, frequency of back flushing, and swimming speeds and vulnerability of small animals.

Inclusion in permit applications of face velocity at filters and a calculation of volume pumped at capacity relative to volume of an embayment would give one indication of probable losses from impingement and entrainment.

Energy use:

Ron Mayo (personal communication) gives the energy requirements for three desalination plants on San Juan Island as 38, 29, and 26 gallons per kilowatt hour. If production were at the current capacity of 124,000 gallons per day for the 12 desalination plants in San Juan County and at 30 gallons/kWh, then production would require 4133 kilowatt hours daily, which is about 0.7% of the 560,000 kWh per day average energy consumption in San Juan County. The average production is much less than full capacity: 23,500 gallons per day with an energy requirement of about 800 kWh per day. Additional desalination capacity will increase energy demand, as will other development in the County. Ron Mayo (pers. comm.) estimates the present energy use for desalination in the County as equivalent to the energy use of 15 housing units. Another way of estimating energy for desalination is from the 16 connections, 5500 gal/day (summer), 3000 gal/day (other seasons), and 38 gal/kWh for desalination at Cattle Point, and the 50.7 kWh/day per average household in the County (Ron Mayo 2009, Table 6, and personal communication). From these estimates, desalination would be 4.8% of an average household's energy use. These estimates could be improved for accuracy, by including other desalination plants, and by comparison with costs for water from other sources, such as wells, cisterns, or hauling.

Chemicals used in operation:

Lattemann and Höpner (2008) say that various metals from corrosion are in low concentrations and that dechlorination with sodium bisulfite is done to protect membranes. They nevertheless mention discharge of chemicals used in cleaning as potentially harmful to aquatic life.

Information from the operators of desalination plants in San Juan County is that most, possibly all, future desal plants in the County will not be using these chemicals. Most small RO plant operators replace membranes or send them away to be cleaned.
There are several procedures that can minimize impacts of cleaning chemicals.
(1) Off-site cleaning of membranes could be required.
(2) If there is on-site cleaning, a requirement for chemicals used in cleaning to be known to be harmless.

Of chemicals used for cleaning membranes, acid and alkaline treatments (low and high pH) can be rendered not toxic from pH effects if pH is subsequently adjusted before the cleaners are discharged, but some cleaners are proprietary mixes of unknown composition. The second requirement would eliminate on site use of proprietary cleaners of unknown composition. Operators prefer hydrochoric acid to sulfuric acid because it is gentler on equipment and because the chloride present after neutralizing the acid is already present in seawater at a high concentration (D. Drahn, personal communication).

The MSDS (material safety data sheet) for polymaleic acid (a scale inhibitor) says that it is no more than slightly toxic if absorbed or swallowed, that it is moderately irritating to eyes and skin, and that significant health effects are not expected if less than a mouthful is swallowed (indicating low toxicity for this scale inhibitor).

Some cleaners also occur in household products. These are enzymes that remove bacterial slimes, biocides that kill bacteria, and detergents. These cleaners are therefore part of a more extensive environmental and regulatory issue. Quantities used in desal plants could be evaluated in relation to quantities entering the sea from other sources and any effects from those other sources.

The EDTA that removes scale occurs in household products. It is a chelator of divalent positive ions. EDTA is a component of algal culture medium and thus is introduced to cultures of marine larvae at low concentrations with no known ill effects. The MSDS indicates (for health effects) that EDTA is a mild irritant.

Flocculents are generally used in very large plants that remove the material and dispose of it in land fills (D. Drahn, personal communication).

(3) Latteman and Höpner (2008) suggest prefiltration, and UV disinfection as means of reducing the need for chemical treatments.

Subsurface sources of water, such a beach wells, have also been recommended as means of reducing chemical treatments (Campbell and Jones 2005). However, beach wells are not a possibility on all shores and require more extensive disturbance to the sea floor during construction.

There is also a "pickling" process for keeping membranes when they are not in use. The chemical is sodium metabisulfite and may not present problems of toxicity in the concentrations discharged. The MSDS for sodium metabisulfite indicates irritation to eyes or skin and recommends dilution as the treatment, with no known or anticipated mutagenic effect. Toxicity at low concentrations is not expected.

Operators and installers of desalination plants in San Juan County can provide advice on practical means of minimizing impacts from chemicals used with desalination plants. A recommendation for minimizing marine impacts is that sodium metabisulfite solutions be allowed as a membrane preservative and that no other chemical additions be allowed without submittals and evaluation (D. Drahn, personal communication). A potential problem with permitting on-site cleaning is the difficulty of assuring proper disposal of cleaning chemicals.

Salt-water leaks on land:

Leaks of seawater on land can be prevented by
(1) use of pipes unlikely to fail, such as high density polyethylene pipes and
(2) a design for buildings so that overflows or spills within the building goes into a drain that leads to the effluent outflow pipe.
The polyethylene pipe for the FHL seawater system has been in use for many years without a break in the pipe. The spills that have occurred were because of design features that can be avoided in desal plants. Also, RO desalination is often installed where it is intended to halt the intrusion of freshwater into groundwater that can be associated with withdrawal of water from wells.

Impervious surfaces and other impacts of construction near shorelines:

Design, siting, and construction are or can be under the regulations for other shoreline development.

Noise from pumps:

If standards for acceptable sound levels exist in the county, they presumably apply to desalination plants as they do to other facilities.

Cumulative impacts

One difficulty in detecting impacts of desal plants in San Juan County is that the plants are small but will likely be numerous. Thus impacts may be cumulative but not large at any one site. Minimizing reliance on desalination for water supplies until more experience is gained on impacts (or lack of impacts) for sea life is one way to avoid undesired impacts.

Also, this discussion has addressed potential impacts of small desalination plants, not larger desalination plants, as might be anticipated for towns like Friday Harbor or East Sound.

Permit review:

Marine impacts could be reduced by changes in the criteria for permit review.

Permit applications in San Juan County have included data on currents distant from and quite different from the site of the desalination plant outfall. The County review process does not appear to consider the impacts that could occur where currents are slow and where basins could accumulate denser water. Also, developments in the County may still be permitted where water supplies are uncertain and later application for RO desalination likely.

Criteria for sites of outfalls and other best practices that would guide applicants for desal plants and review of applications would be useful. Such information is available for other kinds of shoreline development. Criteria for best practices could minimize impacts by guiding design, construction, and operation.

Threshold volumes could be stated such that above a given capacity and recovery rate of the desal plant additional analysis of marine impacts would be required to inform a decision on the permit application.

Also, sites in bays with slow currents and basins could be identified as sites at which a permit would not be issued before a site-specific study indicated that there would be adequate mixing and no accumulation of denser water at the sea floor.

Characteristics of existing desal plants in the county that are in Table 5 of Mayo (2009) include
on or off-site membrane cleaning,
type of intake, capacity,
type of effluent discharge.

This information on proposed plants may already be required for permits, but in any case this information should be included along with
volume of brine to be discharged per time,
salinity of the brine produced at the outfall,
useful detail on the characteristics of intake screens or filters and their flushing,
the type and position of the diffuser at the outfall,
so far as available, information on bottom topography and currents at the outfall.
Reported currents should be relevant to the outfall site and include currents at times of slack water on calm days.

A general requirement after installation could be measurement of salinities at and near the outfall when currents in the receiving water are minimal to assess mixing of discharged water. That would create a data base that would aid improved design for outfalls from future desal plants.

References:

Campbell, R. L., and A. T. Jones. 2005. Appropriate disposal of effluent from coastal desalination facilities. Desalination 182: 365-372.

Chia, F.-S., J. Buckland-Nicks, and C. M. Young. 1984. Locomotion of marine invertebrate larvae: a review. Canadian Journal of Zoology 62: 1205-1222.

Del Pilar Ruso, Y., J. A. De la Ossa Carretero, F. Giménez Casalduero, J. L. Sánchez Lizaso. 2007. Spatial and temporal changes in infaunal communities inhabiting soft-bottoms affected by brine discharge. Mar. Environ. Research 64: 492-503.

Del Pilar Ruso, Y., J. A. De la Ossa Carretero, F. Giménez Casalduero, J. L. Sánchez Lizaso. 2008. Effects of a brine discharge over soft bottom Polychaeta assemblage. Environmental Pollution 156: 240-250.

Einav, R., K. Harussi, and D. Perry. 2002. The footprint of the desalination processes on the environment. Desalination 152: 141-154.

Höpner, T. 1999. A procedure for environmental impact assessments (EIA) for seawater desalination plants. Desalination 124: 1-12.

Höpner, T., and J. Windelberg. 1996. Elements of environmental impact studies on coastal desalination plants. Desalination 108: 11-18.

Iso, S., S. Suizu, and A. Maejima. 1994. The lethal effect of hypertonic solutions and avoidance of marine organisms in relation to discharged brine from a desalination plant. Desalination 97: 389-399.

Lattemann, S., and T. Höpner. 2008. Environmental impact and impact assessment of seawater desalination. Desalination 220: 1-15.

Mayo, R. 2009. The current status of desalination systems in San Juan County, Washington and issues impacting their use. Unpublished report to the San Juan County Water Resources Committee.

Pérez Talavera, J. L., and J. J. Quesada Ruiz. 2001. Identification of the mixing processes and in brine discharges carried out in Barranco del Torro Beach, south of Gran Canaria (Canary Islands). Desalination 139: 277-286.

Raventos, N., E. Macpherson, and A. García-Rubiés. 2006. Effect of brine discharge from a desalination plant on macrobenthic communities in the NW Mediterranean. Mar. Environ. Research 62: 1-14.

Tularum, G. A., and M. Ilahee. 2007. Environmental concerns of desalinating seawater using reverse osmosis. J. Environ. Monitoring 9:805-813.

WATEK

LOPEZ WATER LLC

This facility went into service in the summer of 2007, initially serving 2 connections. The RO system has a nominal capacity of 14,400 gpd (10 gpm). The current service area is property owned by the Bumstead family. Planning is based on the eventual expansion to surrounding properties.

The system consists of two (2) 2" HDPE pipes constructed in the Lopez Sound tidal zone for seawater intake and salt water reject. Each of the HDPE pipes is 450 feet long extending to the marine water. A 2" perforated HDPE pipe is provided at the ends of the 2" HDPE pipes for seawater intake and salt water reject dispersion in the sea. The perforated pipe (a 4 foot length of a 3"+ well screen) is elevated 30 inches above the sea bottom.

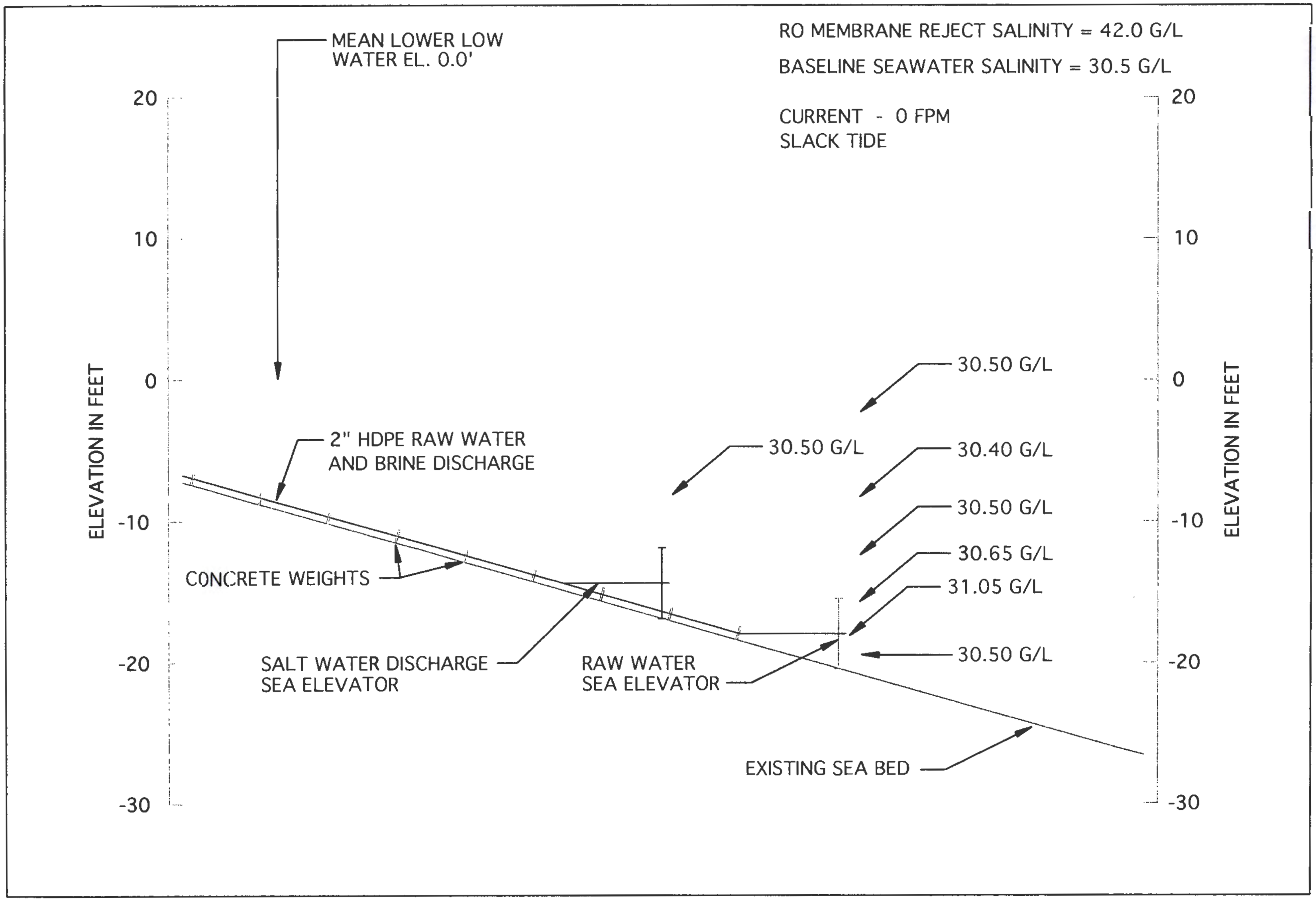
Seawater is pumped to an upland building in which the RO desalination water system is installed. The seawater pump is in a dry pit on shore. 40 gpm of seawater is pumped to the RO desalination water system, 10 gpm of potable water is produced from the seawater, and 30 gpm of salty reject water is returned to Lopez Sound via the 2" HDPE discharge pipe.

A recent series of test produced these measurements: (see following attached drawing)

Salinity of water column (ave. 4 samples)	30.5 g/L
Salinity of reject flow at RO Plant (1 sample)	42.0 g/L
Salinity at outfall screen of reject (ave. 4 samples)	31.05 g/L
Salinity of reject 18" down current (ave. 4 samples)	30.65 g/L

The RO plant operates year around. It is the only source of water for the family compound.

The Approximate Capital Cost of RO Plant is $300,000 includes construction, design and permitting costs - built 2006.



civil\design\drawing
By: evers

APRIL , 2009

ORIGINAL SHEET - ANSI A

WATEK

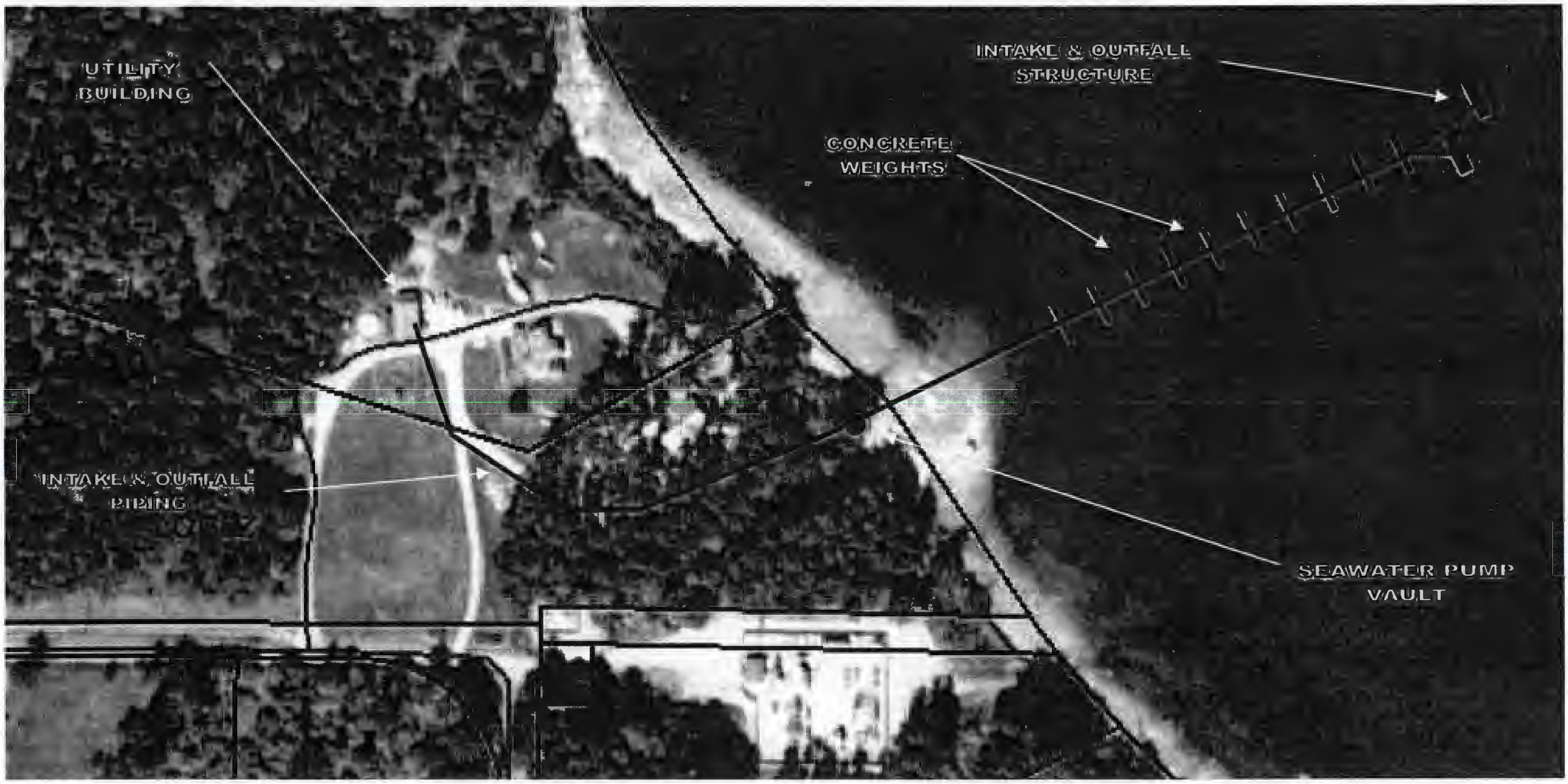
Watek
4489 Mud Bay Rd
Lopez, WA U.S.A.
98261
Tel. 360.468.4272
Fax. 360.468.4272
www.watekwater.com

Client / Project
LOPEZ WATER
LOPEZ ISLAND
RO DESALINATION PROJECT

Figure No.
FIGURE 1 OF 1

Title
LOPEZ WATER
OUTFALL

LOPEZ WATER DESALINATION SCHEMATIC



4489 Mud Bay Rd – Lopez, WA 98261, USA – (360) 468-4272 – water@rockisland.com – Watek LLC

Appendix 3-Response by Andrew Evers to Appendix 2 by Dr Strathmann
December 2008

(Mr Evers is a consulting engineer who is involved in the planning and operation of a number of RO plants described in this document)

Dear Richard,

I appreciate your curiosity. Unfortunately, I am not the best source for this information. A research agency, such as the EPA or the US Army Corps of Engineers, would be a more appropriate source. Asking me as an individual to defend an entire industry places an undue burden on my time and resources. I like researching my industry and educating others about my field of expertise and I regret I do not have the time to do more.

While I respect your diligence and curiosity, I would respectfully submit that the scientific information available and the extensive regulatory oversight of this industry are already more than adequate to protect the public and environmental health of the San Juans. Please note that large desalination plants, most often in waters with weaker currents and less tidal action, have been intensively studied for years (e.g. Guantanamo for 50 years) with no known long-term effects. Furthermore, it is a highly regulated industry whereby each project is thoroughly vetted by 11 different government agencies, a standard much more rigorous than any other regulated industry in the San Juans.

No one wants to see the San Juans degraded, least of all me. I am an environmental engineer that cares very much for the environment and is always looking for the best solution to environmental problems. I specialize in water and wastewater treatment, design, and installation. Any time I work on a desalination plant I go though multiple environmentally conscious agencies and answer all their questions and meet their standards in order to proceed with any particular project. This process usually takes two years.

I believe that San Juan County has an obligation to make policy based on rational, scientific information. The desalination industry has met this standard. Furthermore, I am not sure how having one more government agency overseeing my work will improve environmental and public safety, especially when the agency has a biased no-growth agenda. Before I begin any desalination plant the following agencies have already vetted it: the US Army Corps of Engineers; US dept of Fisheries; National Marine Fisheries Service; WA state Depart. of Natural Resources; WA State dept of Ecology; WA State depart Health; WA State dept of Fish and Wildlife; San Juan County Public Works; San Juan County dept of Health; and two permits from the San Juan County dept of Community Planning - 1) from the Building dept and 2) a Substantial Development permit.

Once again, I respectfully submit that this level of oversight, combined with the numerous scientific studies is more than adequate to protect the public and environmental health of all those in the San Juan Islands.

BOUNDARY WATER INC.
CIVIL ENGINEERING PLANNING LAND SURVEYING

CIVIL ENGINEERING | PLANNING | LAND SURVEYING

Memo

To: Dr. Richard Strathmann

From: Tom Boydston

CC: Dan Drahn

Date: 04/28/09

Re: Cattle Point Desalination Plant Discharge Salinity Measurements

---

Cattle Point Desalination Plant Discharge Salinity Measurements

Measurements of the salinity in the near vicinity of the outfall were taken by divers on 2/4/1999 and 2/17/2000.
The salinity meter was calibrated and operated by Jen-Jay Diving, who also converted the conductivity data to salinity.
Discharge rate was 30 gpm from the 2" pipe on both dates.
The ambient current was 0-3 feet per minute on 2/17/2000 and 2 feet per minute on 2/4/1999.
23 readings were taken on 2/17/2000
14 readings were taken on 2/4/1999
I entered the data into Excel but could find no patterns and it is not designed to plot the data in a useful way.

I created a computer model using Visual Plume (VP), from the federal EPA, at each set of conditions. Only 1 measured data location was near the model's predicted plume path centerline which is the only set of locations for which it will produce predicted salinities.
That point was the closest measurement point to the discharge pipe.
At that point the field measurements read 10% lower than the VP prediction in 1999 and 17% lower in 2000.
These are large errors but on the safe side.
In other words the model is good because it predicts higher salinities than the actual field measurements record.

VP using the 1999 conditions and data set calculates 29.749 ppt where the plume hits the bottom which is 0.89 ppt or 3% above the measured ambient of 28.860. (only 1 data point)
The ambient varies by 6.5% from the one upstream point to one other point that is arguably ambient.
I claim that the point 12 ft above the discharge is ambient because it is lower salinity than the other ambient. That is, it is not raised by the discharge, even though it is potentially impacted by the discharge.
Even if it were impacted by the discharge that would make its un-impacted value even lower and mean that the variations in the background salinity are even more than we use in this analysis.
The predicted salinity rise where the plume hits the bottom is less than the local variations in the ambient salinity.

VP using the 2000 conditions and data set calculates 28.354 ppt where the plume hits the bottom which is 0.57 ppt or 2% above the mean of the 6 measured upstream ambient data points.
The mean of those 6 measured upstream ambient data points which is 27.78 ppt.
The ambient varies by 9.8% across the 6 upstream measurement points.
The predicted salinity rise where the plume hits the bottom is less than the local variations in the ambient salinity.
These are environmentally defensible numbers but higher than I would like to see.

365D Spring Street PO Box 897 Friday Harbor, WA 98250 360.378.4171 fax 360.378.6827 info@boundary-water.com
Lopez Island Office 360.468.3539 fax 360.468.3031

Next I entered the data into AutoCAD as 3 dimensional points with x = horizontal distance from the discharge in the direction of the current, y = vertical distance above the bottom, and with z = salinity in PPT.
I used this data to draw salinity contour lines on the depth vs. horizontal distance plane and plotted them.
The graphs of the AutoCAD drawings are attached.

The graphs of the Visual Plume are also attached.
The vertical depth full scale on each chart is set to show the full water depth on the day measured.
The horizontal scales on the charts are set to that same scale as the vertical.
These full scale graphs show an area that is smaller than the acute mixing zone.
The plume was calculated until it reached a dilution of 54 which is equivalent to a centerline salinity 1% above ambient.

Again you can see that the significant data is limited to 1 data point each year. That point being very close to the discharge opening.

My conclusion is that the Cattle Point Desalination Plant's impact on the water salinity at a point 12" from the discharge is on the close order of the natural salinity variations over the range of the measurements.
Furthermore at distances greater than 3 feet the impact is not distinguishable from background variations.

Notes:
Conditions during the salinity measurements used as input to VP.

Cattle Point Field Measurement 02/04/1999
Conditions: 35% recovery=52.3ppt, 30gpm discharge rate
350 ft offshore, bottom = -15 MLLW, 3 ft above bottom,
2 inch pipe open directed up. Ambient=28.86 ppt, current=2 ft/min=1 cm/sec, vena contracta 0.61,
calculations stopped at dilution=54=1% over ambient
File name "D:\Program Files\Plume\Data\CattlePointAsBuilt1999.vpp"

Cattle Point Field Measurement 02/17/2000
Conditions: 35% recovery=52.3ppt, 30gpm discharge rate
350 ft offshore, bottom = -17 MLLW, 3 ft above bottom,
2 inch pipe open directed up. Ambient=27.40 ppt, current=3 ft/min=1.5 cm/sec, vena contracta 0.61,
calculations stopped at dilution=54=1% over ambient
File name "D:\Program Files\Plume\Data\CattlePointAsBuilt2000.vpp"

Explanation of the graphs:

"Plume Elevation" is the view looking horizontally at the plume with the current flowing from left to right.
It shows the plume as it rises and falls as it drifts with the current to the right.
The vertical axis it the depth with the bottom of the chart at 5.2 meters or 4.5 meters is at the bottom at the site.
The difference is the different tide heights during the measurements.
The horizontal axis is scaled to be the same as the vertical axis.

"Plan View" is the view looking down on the plume as from an airplane with the current flowing from left to right.
The terms north south east and west are arbitrary. Current flow is east to west.
It shows the plume as it gets wider by diffusion as it drifts with the current to the right.
The vertical axis is scaled to match the Plume Elevation graph.
The horizontal axis is scaled to be the same as the vertical axis.

"Ambient Properties" shows the Depth vs the Density of the plume. The density is in units of sigma-T which is the same as the salinity measured in parts per thousand (PPT.) The vertical line on the left is the ambient salinity which is the same at all depths. The plume itself starts on the right side of the graph at the salinity in the pipe at the height of the discharge. As you follow the line to the left you are seeing the depth of the plume at lower and lower salinities.
You can see how the plume rises and then falls as it gets more and more dilute until it hits the bottom.
The horizontal axis is scaled to fit the full range of the output.
The vertical axis is scaled to match the Plume Elevation graph.

"Plumes Dilution Prediction" shows the dilution ratio rising as the plume moves to the right.
It starts at zero dilution at the discharge at the lower left and the dilution increases as the plume moves to the right.
It stops at 54 because I set the model to stop calculating at a dilution of 54 which is the same as 1% over ambient.
If you compare this to the horizontal position on the Plume Elevation View at this point you can see that this point is below the bottom. i.e. that was plenty far to carry the calculations.
The horizontal axis is scaled to match the Plume Elevation graph.
The vertical axis is scaled to fit the full range of the output.

"Predicted Relationships" shows the lower end of the curve of pollutant concentration (PPM) as it moves horizontally (x position) with the current. It comes onto the chart from up at 52 or so and goes down as it moves to the right. It ends again at a dilution of 54 or 1% over ambient.
The horizontal axis is scaled to match the Plume Elevation graph.
The vertical axis is scaled to show the last bit of the curve, other wise it just shows a straight vertical line. If we followed the curve out to the right to unjustifiably large dilutions it would asymptotically approach the horizontal line of the ambient salinity, which is different for the 2 different years.

BOUNDARY WATER INC.
CIVIL ENGINEERING PLANNING LAND SURVEYING
P.O. BOX 897, FRIDAY HARBOR, WA. 98250 (360) 378-4171

Cattle Point Salinity Field Data 02/04/1999
Raw Data

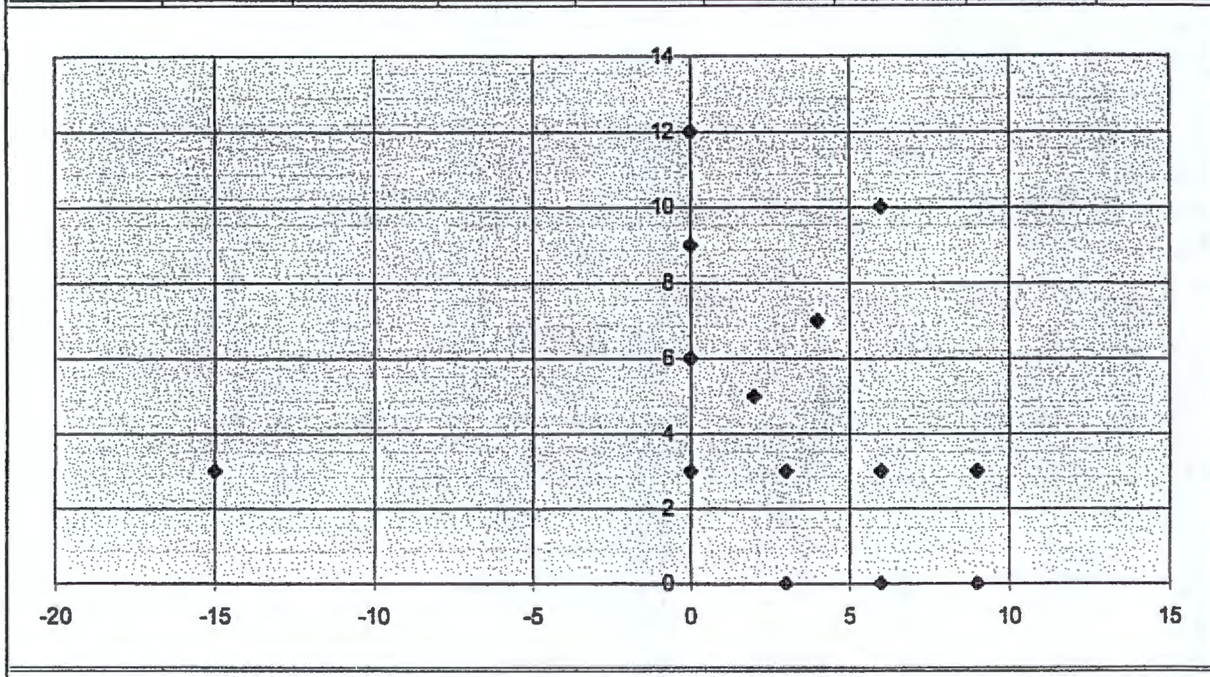
2" dia port
30 gpm at 52.3 ppt
ambient current +2 Ft/min 1.016 cm/sec
surface 15 ft 4.572 m

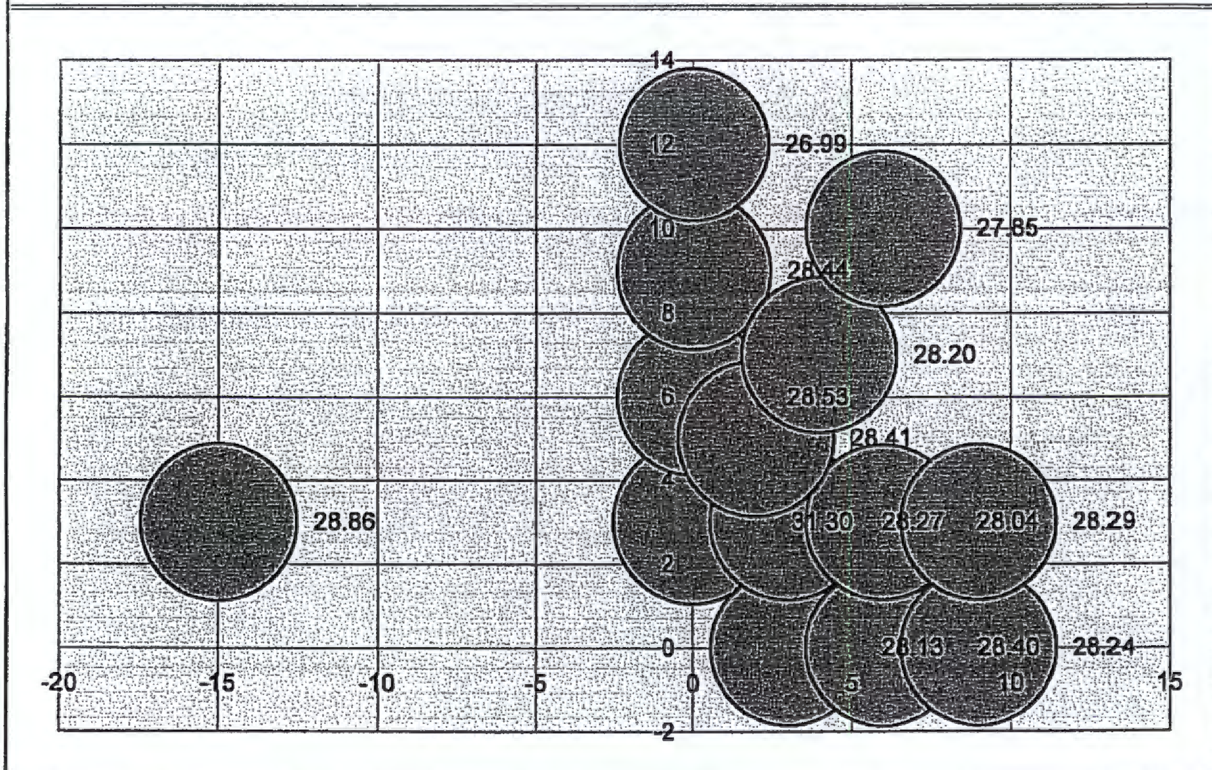
point #	x pos	z pos	Salintiy	Temp C	
1	0	3	31.30	7.8	Near Port
2	0	6	28.53	7.7	
3	0	9	28.44	7.7	
4	0	12	26.99	7.6	
5	3	0	28.13	7.6	
6	6	0	28.40	7.6	
7	9	0	28.24	7.6	
8	3	3	28.27	7.6	
9	6	3	28.04	7.6	
10	9	3	28.29	7.6	
11	2	5	28.41	7.6	
12	4	7	28.20	7.6	
13	6	10	27.85	7.6	
14	-15	3	28.86	7.6	Upstream assumed ambient

Cattle Point Salinity Field Data 02/04/1999

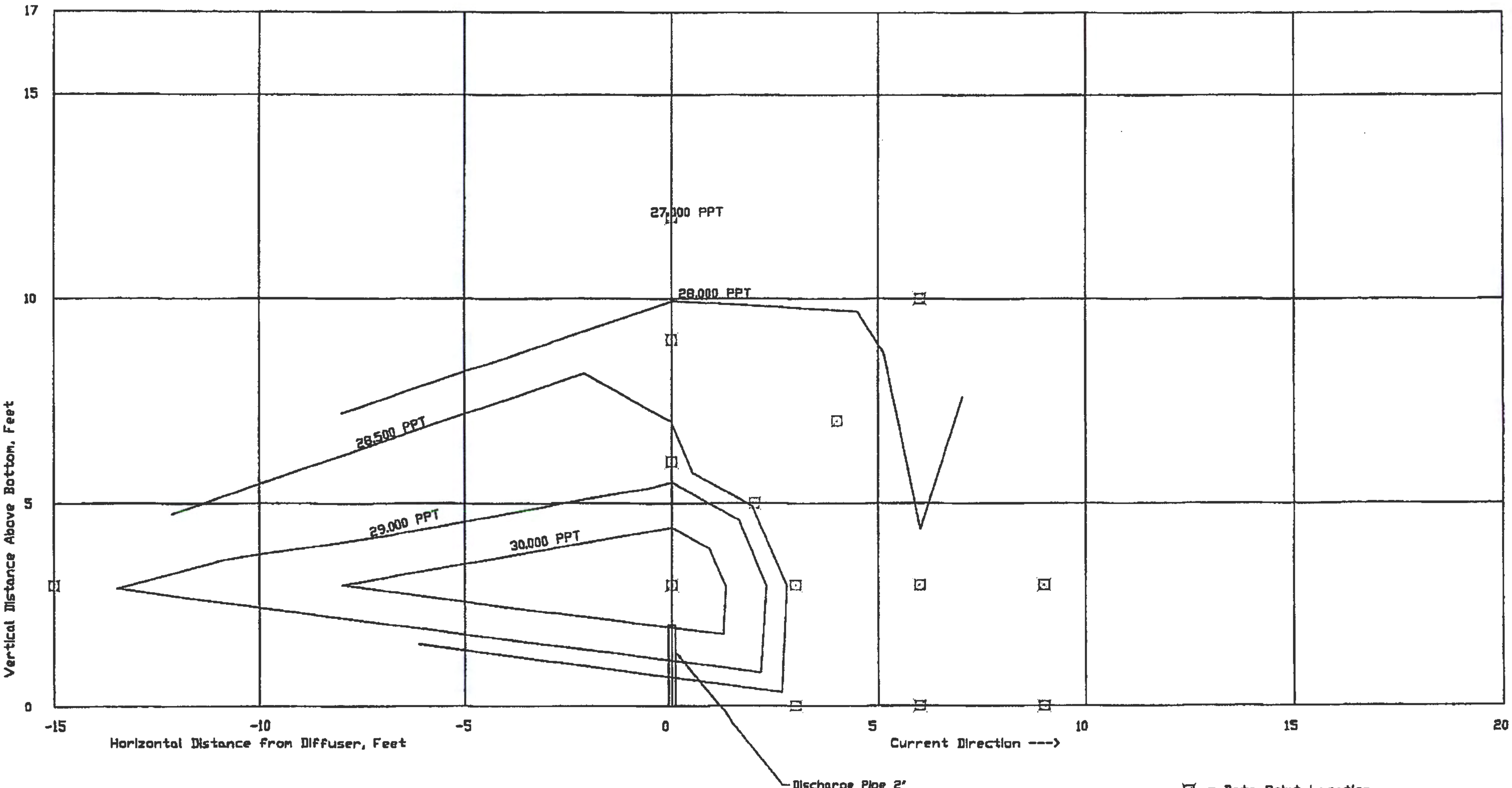
X axis = horizontal location (current is to the right)
Y axis = height above the bottom

BOUNDARY WATER INC.
CIVIL ENGINEERING PLANNING LAND SURVEYING
P.O. BOX 897, FRIDAY HARBOR, WA. 98250 (360) 378-4171





Cattle Point Visual Plume Prediction Detailed output for 2/4/1999											
and Data Analysis										BOUNDARY WATER INC.	
2/4/1999	Depth	Amb-cur	P-dia	Polutnt	Dilutn	x-posn					
Step	(m)	(cm/s)	(in)	(ppm)	()	(m)					
0	3.962	1	1.562	52300	1.00	0.000					
10	3.940	1	1.891	46089	1.22	0.000				CIVIL ENGINEERING PLANNING LAND SURVEYING	
20	3.914	1	2.313	44634	1.50	0.000				P.O. BOX 837, FRIDAY HARBOR, WA. 98250 (360) 378-4171	
30	3.881	1	2.830	41801	1.83	0.000					
40	3.841	1	3.467	39476	2.24	0.000					
50	3.792	1	4.254	37569	2.73	0.001					
60	3.732	1	5.235	36004	3.33	0.002					salinity ppt
70	3.659	1	6.473	34721	4.07	0.003		<-this is depth at measured point #1 below			
80	3.567	1	8.071	33668	4.96	0.005			Polutant measured at #1 below ppm		31.30
90	3.453	1	10.230	32804	6.06	0.009			Polutant predicted at #70 left ppm		34.72
100	3.306	1	13.440	32096	7.39	0.017				model's error	3.42
110	3.113	1	20.300	31524	8.98	0.033				model's % error	10%
116	3.057	1	26.390	31401	9.41	0.042		begin overlap,			
120	3.042	1	29.550	31378	9.50	0.045					
130	3.026	1	35.840	31363	9.56	0.050					
140	3.020	1	41.050	31359	9.57	0.052					
150	3.017	1	45.330	31357	9.58	0.054					
160	3.016	1	48.980	31355	9.59	0.055					
170	3.015	1	52.110	31355	9.59	0.056					
180	3.014	1	54.790	31354	9.59	0.057					
190	3.014	1	57.070	31354	9.59	0.057					
200	3.013	1	58.960	31354	9.59	0.058					
210	3.013	1	60.500	31353	9.59	0.058					
220	3.013	1	61.700	31353	9.59	0.059					
230	3.013	1	62.560	31353	9.59	0.059					
240	3.013	1	63.100	31353	9.59	0.059					
250	3.013	1	63.320	31353	9.59	0.060					
251	3.013	1	63.320	31353	9.59	0.060		local max rise			
260	3.013	1	63.220	31353	9.59	0.060					
270	3.013	1	62.800	31353	9.59	0.060					
280	3.013	1	62.070	31353	9.59	0.061					
290	3.013	1	61.020	31353	9.59	0.061					
300	3.013	1	59.650	31353	9.59	0.061					
310	3.014	1	57.950	31353	9.59	0.062					
320	3.014	1	55.920	31353	9.59	0.062					
330	3.014	1	53.530	31353	9.59	0.063					
340	3.015	1	50.760	31353	9.59	0.064					
350	3.017	1	47.600	31353	9.59	0.065					
360	3.019	1	43.990	31353	9.59	0.066					
370	3.023	1	39.860	31353	9.60	0.068					
380	3.031	1	35.110	31351	9.60	0.071					
390	3.051	1	29.580	31341	9.64	0.076					
397	3.097	1	25.340	31277	9.90	0.083		end overlap,			
400	3.145	1	23.500	31200	10.22	0.090					
410	3.413	1	20.850	30785	12.43	0.115					
420	3.679	1	21.430	30439	15.16	0.136					
430	3.961	1	23.170	30155	18.49	0.157					
440	4.268	1	25.500	29923	22.54	0.179					salinity ppt
449	4.572	1	28.010	29749	26.94	0.202		Bottom		Salinity predicted at bottom	29.75
450	4.608	1	28.310	29732	27.48	0.205				ambient Salinity	28.86
460	4.986	1	31.600	29575	33.50	0.234			predicted Salinity rise ppm at bottom		0.89
470	5.408	1	35.380	29447	40.84	0.267			predicted Salinity rise % at bottom		3%
480	5.882	1	39.690	29341	49.79	0.306					
485	6.140	1	42.080	29296	54.98	0.328		stop dilution reached,			
point #	x pos	z pos						Salintiy	Temp C		
1	0	3		31300				31.30	7.8	Near Port	
2	0	6		28530				28.53	7.7		
3	0	9		28440				28.44	7.7	I argue from the autocad plot that	
4	0	12		26990				26.99	7.6	<—this is also an ambient salinity.	
5	3	0		28130				28.13	7.6	This means that the	
6	6	0		28400				28.40	7.6	ambient variation is =	6.5%
7	9	0		28240				28.24	7.6		
8	3	3		28270				28.27	7.6		
9	6	3		28040				28.04	7.6		
10	9	3		28290				28.29	7.6		
11	2	5		28410				28.41	7.6		
12	4	7		28200				28.20	7.6		
13	6	10		27850				27.85	7.6		
14	-15	3		28860	ambient			28.86	7.6	Upstream assumed ambient	
									This is best ambient to use because it is at		
									the same depth as the point in question.		
									The other ambient is used only to get		
									a handle on the local variaions in ambience.		
							max	28860			
							min	26990			
							ambient variation	6.5%			



Cattle Point Desal Diffuser Field Data 02/04/1999

Diffuser: CattlePointAsBuilt1999.vpp.db | Ambient: D:\Program Files\Plume\Data\CattlePointAsBuilt1999.001.db | Special Settings | Text Output | Graphical Output |

Project D:\Program Files\Plume\Data\CattlePointAsBuilt1

"D:\Program Files\Plume\Data\CattlePointAsBuilt1999"
Cattle Point Field Measurement 02/04/1999
Conditions: 35% recovery=52.3ppt, 30gpm discharge rate
350 ft offshore, bottom = -15 MLLW, 3 ft above bottom,
2 inch pipe open directed up. Ambient=28.86 ppt, current=2 ft/min=1 cm/sec, vena contracta 0.61,
calculations stopped at dilution=54=1% over ambient

Ambient file list
Filename Cases
D:\Program Files\Plume\Data\CattlePointAsBuilt1999

D:\Program Files\Plume\Data\CattlePointAsBuilt1999

After run go to tab
- ○ Diffuser
- ○ Ambient
- ○ Special
- ○ Text
- ● Graphics

Units Conversion
- ● Convert data
- ○ Label only

UM3

Model Configuration
- ☐ Brooks far-field solution
- ☐ Graph effective dilution
- ☐ Average plume boundary
- ☐ Amb. current vector averaging
- ☐ Tidal pollution buildup
- ☐ Same-levels time-series input

Case selection
- ● Base or selected case
- ○ Sequential, all ambient list
- ○ Sequential, parse ambient
- ○ All combinations

Diffuser, Flow, Mixing Zone Inputs

Port diameter	n/r	Port elevation	Vertical angle	Hor angle	Num of ports	n/r	n/r	n/r	n/r	Acute mix zone	Chronic mix zone	Port depth	Effluent flow	Effluent density(*)	Effluent temp	Effluent conc
in	m	m	deg	deg		m	s	s	s	m	m	m	MGD	sigmaT	C	ppm
2		0.60961	90	0	1					6.5533	65.533	3.9624	0.0432	52.3	7.8	52300

Parameters for selected row

Froude number	
Eff density (kg/m3)	
Port vel (m/s)	
P-dia (m)	0.0508
P-dia (in)	2.0
Case No.	1

Time Series-Files (optional)

Borrow time-series from project: D:\Program Files\Plume\Data\CattlePointAs

	Port depth	Effluent flow	Effluent density(*)	Effluent temp	Effluent conc
Time-series filename	click for file	click for file	click for file	click for file	click for file
Time increment (hrs)					
Time cycling period					
Measurement unit					

Diffuser: CattlePointAsBuilt1999.vpp.db   Ambient: D:\Program Files\Plume\Data\CattlePointAsBuilt1999.001.db | Special Settings | Text Output | Graphical Output |

Ambient Inputs

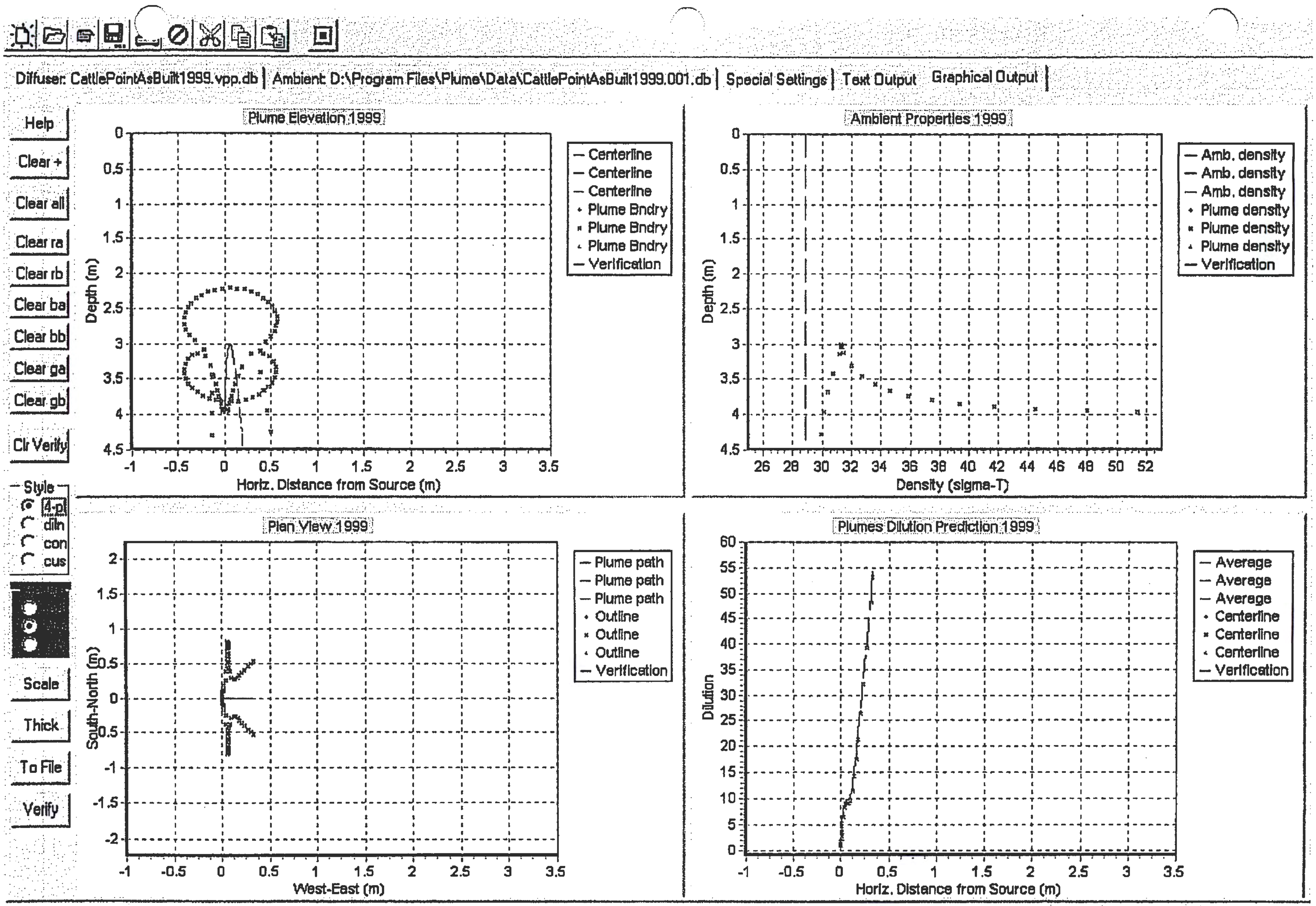
	Measurement depth or height	Current speed	Current direction	Ambient density(t)	Ambient temperature	Background concentration	Pollutant decay rate(t)	n/r	n/r	Far-field diffusion coeff
Depth or Height		depth	depth	depth	depth	depth	depth	depth	depth	depth
Extrapolation (sfc)		constant	constant	constant	constant	constant	constant	constant	constant	constant
Extrapolation (btm)		constant	constant	constant	constant	constant	constant	constant	constant	constant
Measurement unit	m	cm/s	deg	sigmaT	C	ppm	s-1	cm/s	deg	m0.67/s2
	0	1	0	28.86	7.6	28860	0	1	0	0.0003
	4.572									

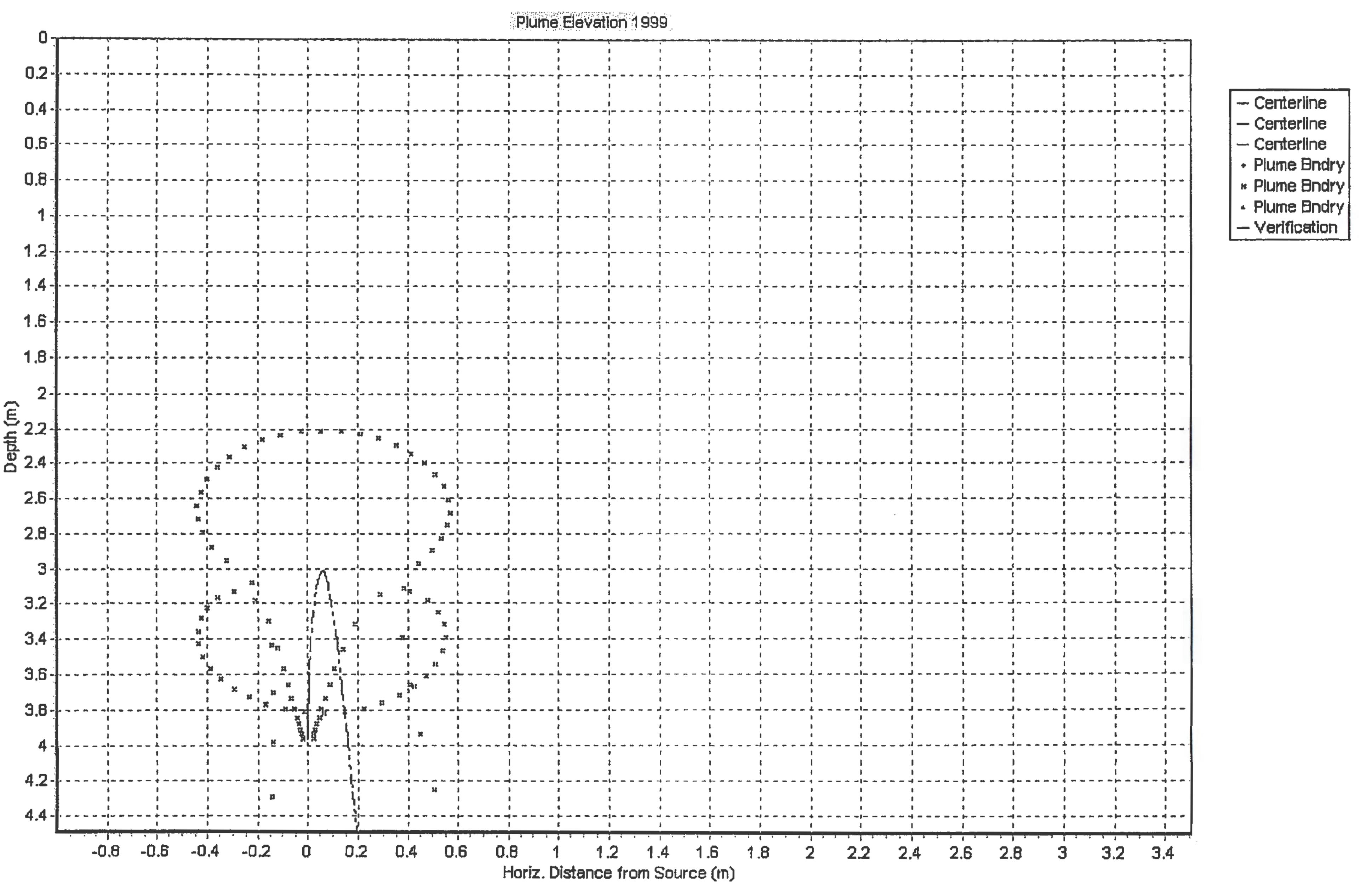
Ambient file list
Filename
CattlePointAsBuilt1999.00

Time-Series Files (optional)

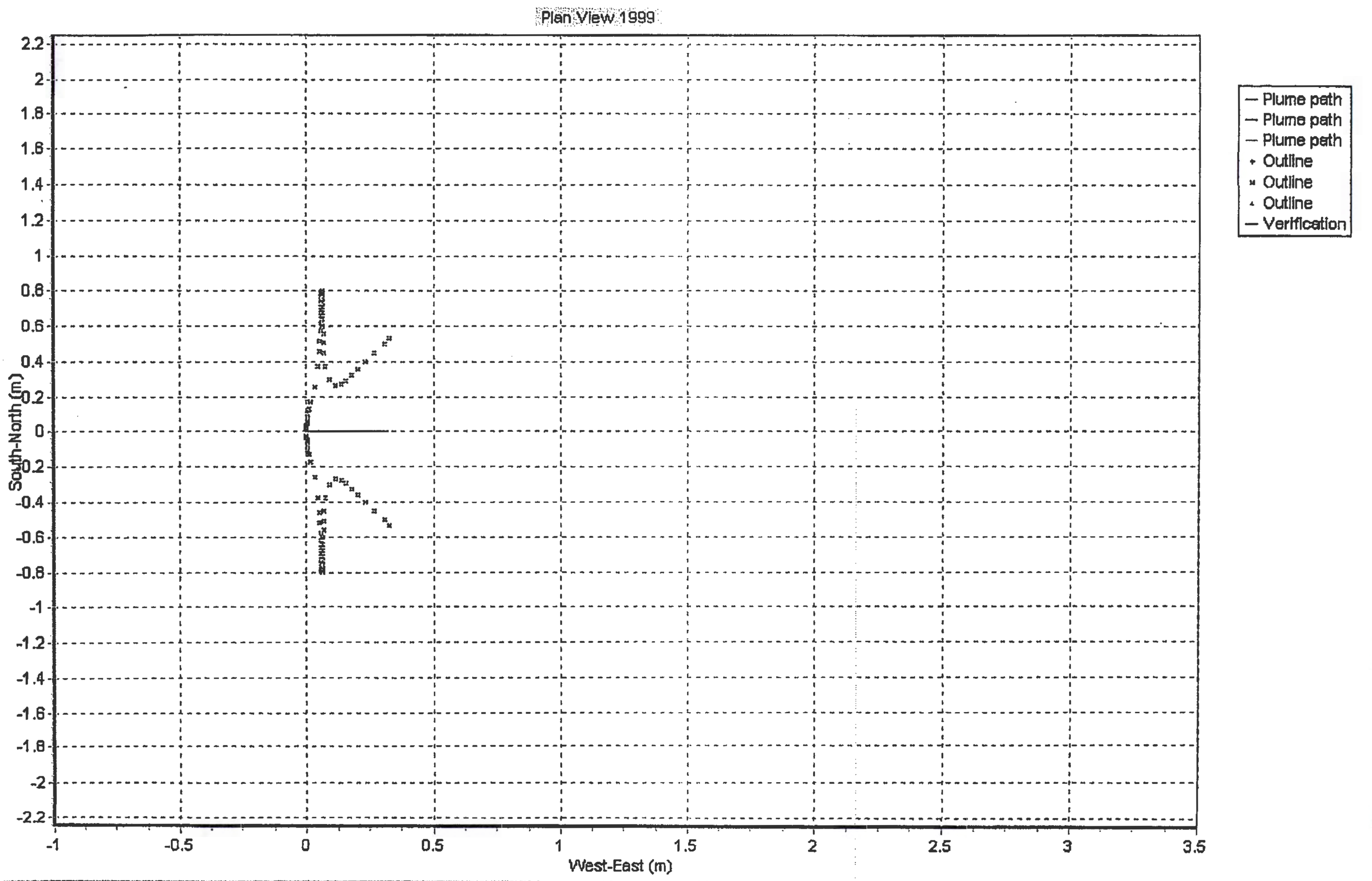
Borrow time-series files from project: D:\Program Files\Plume\Data\CattlePointAsBuilt1999

Time-series filename		click for file	click for file	click for file	click for file	click for file	click for file	click for file	click for file	click for file
Time increment (hrs)										
Cycling period										
File measurement unit										

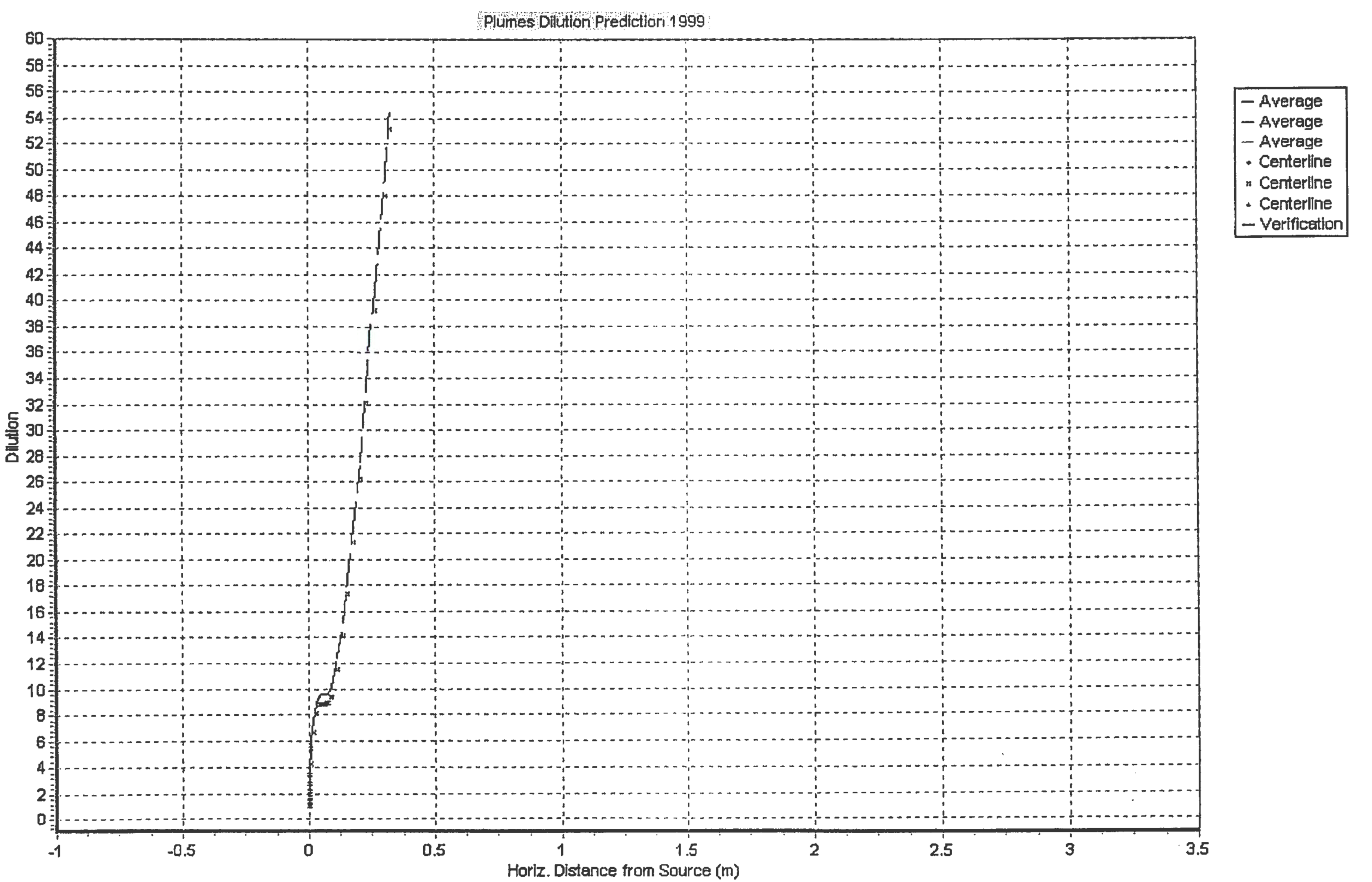

Diffuser: CattlePointAsBuilt1999.vpp.db
Ambient: D:\Program Files\Plume\Data\CattlePointAsBuilt1999.001.db
Special Settings
Text Output
Graphical Output
Help
Clear +
Clear all
Clear ra
Clear rb
Clear ba
Clear bb
Clear ga
Clear gb
Clr Verify
Style
4-pl
diln
con
cus
Scale
Thick
To File
Verify
Plume Elevation 1999
Depth (m)
Horiz. Distance from Source (m)
Centerline
Centerline
Centerline
Plume Bndry
Plume Bndry
Plume Bndry
Verification
Ambient Properties 1999
Depth (m)
Density (sigma-T)
Amb. density
Amb. density
Amb. density
Plume density
Plume density
Plume density
Verification
Plan View 1999
South-North (m)
West-East (m)
Plume path
Plume path
Plume path
Outline
Outline
Outline
Verification
Plumes Dilution Prediction 1999
Dilution
Horiz. Distance from Source (m)
Average
Average
Average
Centerline
Centerline
Centerline
Verification

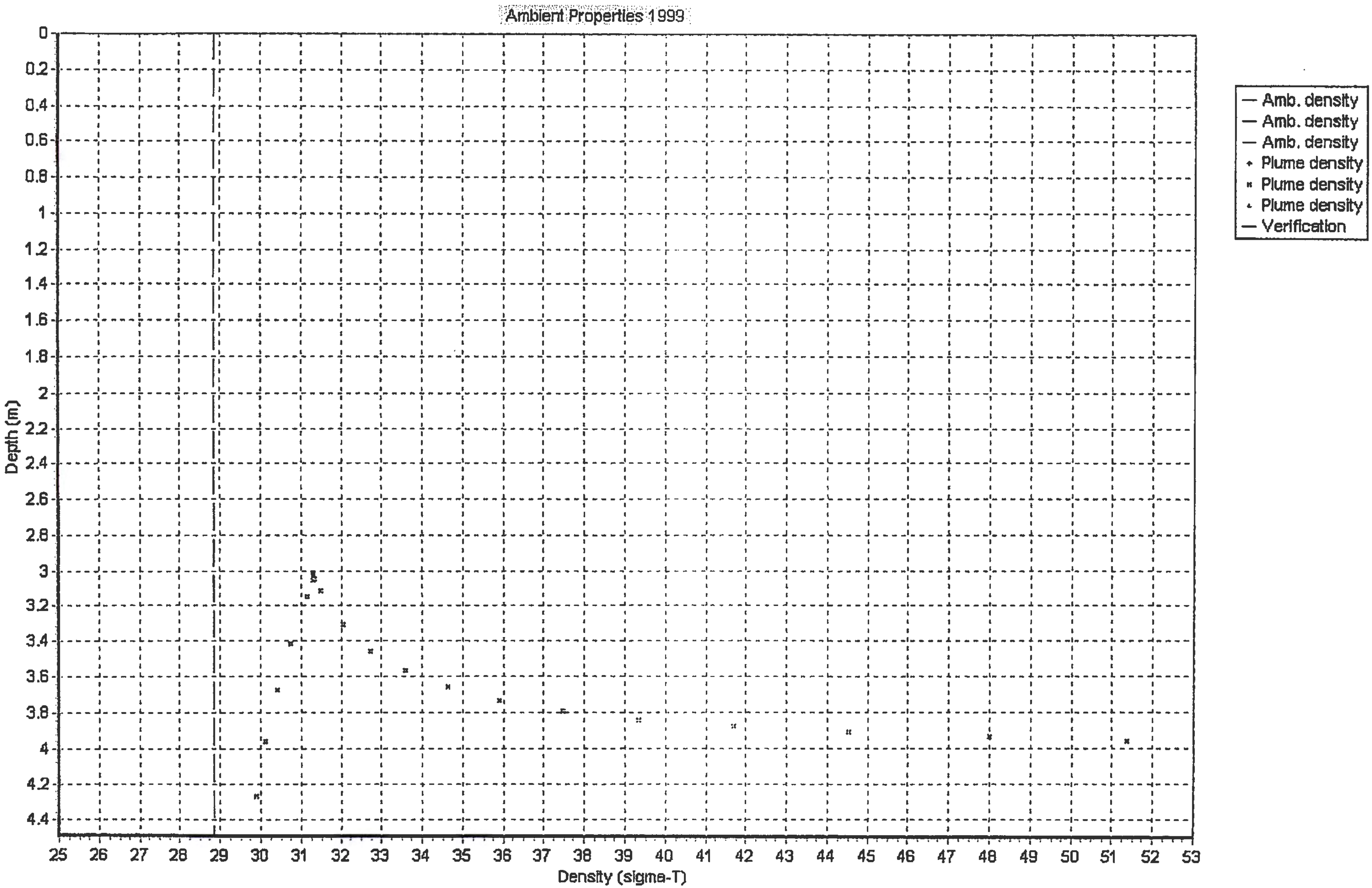


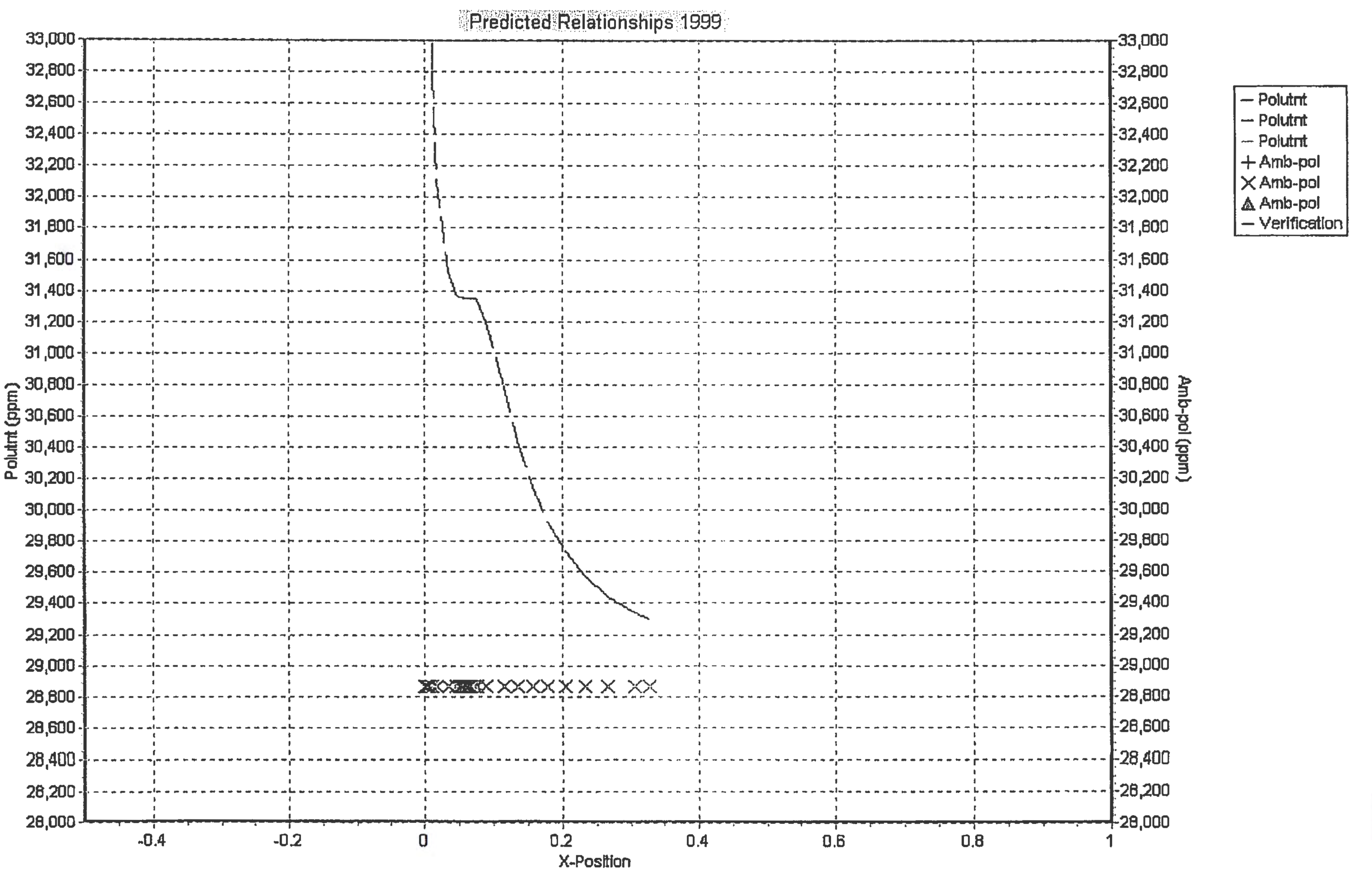
Plume Elevation 1999
Depth (m)
Horiz. Distance from Source (m)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
3.8
4
4.2
4.4
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
Centerline
Centerline
Centerline
Plume Bndry
Plume Bndry
Plume Bndry
Verification



Plan View 1999
South-North (m)
West-East (m)
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
-2
-2.2
-1
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
Plume path
Plume path
Plume path
Outline
Outline
Outline
Verification


Plumes Dilution Prediction 1999
Dilution
Horiz. Distance from Source (m)
60
58
56
54
52
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-1
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
Average
Average
Average
Centerline
Centerline
Centerline
Verification


Ambient Properties 1999
Depth (m)
Density (sigma-T)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
3.8
4
4.2
4.4
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
Amb. density
Amb. density
Amb. density
Plume density
Plume density
Plume density
Verification


Predicted Relationships 1999
Polutnt (ppm)
Amb-pol (ppm)
X-Position
33,000
32,800
32,600
32,400
32,200
32,000
31,800
31,600
31,400
31,200
31,000
30,800
30,600
30,400
30,200
30,000
29,800
29,600
29,400
29,200
29,000
28,800
28,600
28,400
28,200
28,000
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
Polutnt
Polutnt
Polutnt
Amb-pol
Amb-pol
Amb-pol
Verification

BOUNDARY WATER INC.
CIVIL ENGINEERING PLANNING LAND SURVEYING
P.O. BOX 897, FRIDAY HARBOR, WA. 98250 (360) 378-4171

Cattle Point Salinity Field Data 02/17/2000

Raw Data

2" dia port

discharge rate 30 gpm

ambient current +0 to +3 Ft/min 1.524 cm/sec

surface 17 ft = 5.1816 meters

point #	x pos	z pos	Salintiy	Temp
1	0	3	29.1	8
2	0	6	28.4	7.7
3	0	8	27.9	7.5
4	0	13	28.4	7.5
5	0	17	28	7.4
6	5	0	26.6	7.5
7	10	0	27.4	7.5
8	15	0	28.6	7.4
9	20	0	28.8	7.5
10	5	3	26.7	7.5
11	10	3	28.7	7.5
12	15	3	28.7	7.4
13	20	3	28.8	7.5
14	4	7	28.3	7.4
15	7.5	10.5	28.5	7.4
16	11	14	28.5	7.4
17	12	17	28.6	7.4
18	-5	0	28.5	7.5
19	-10	0	28.4	7.5
20	-15	0	28.3	7.5
21	-5	3	25.7	7.5
22	-10	3	28.4	7.5
23	-15	3	27.4	7.5

Cattle Point Salinity Field Data 02/17/2000

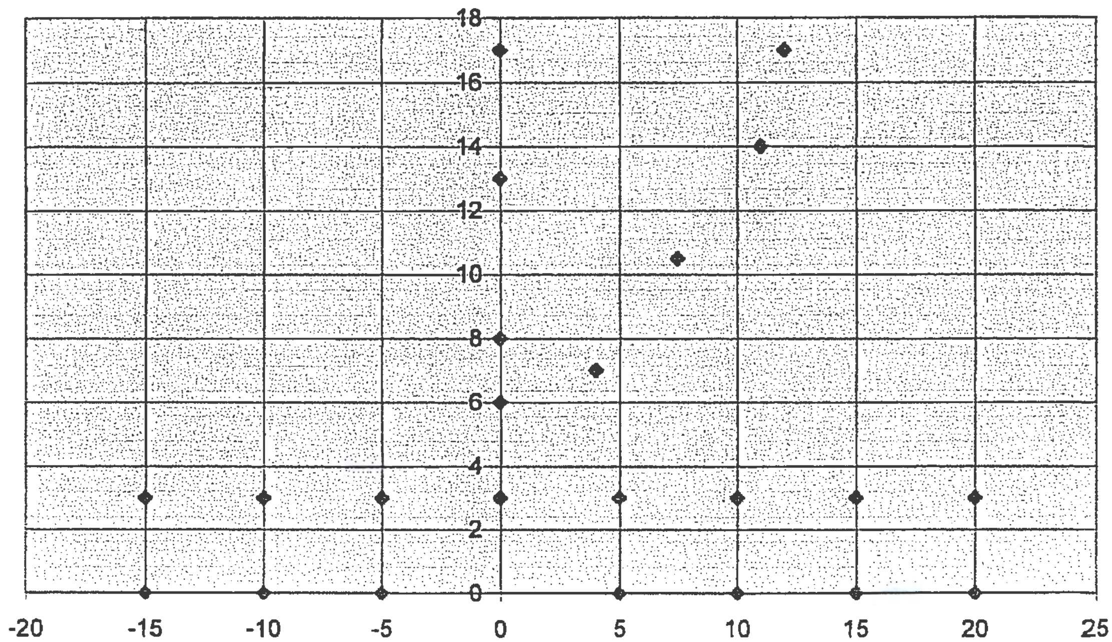
X axis = horizontal location (current is to the right)

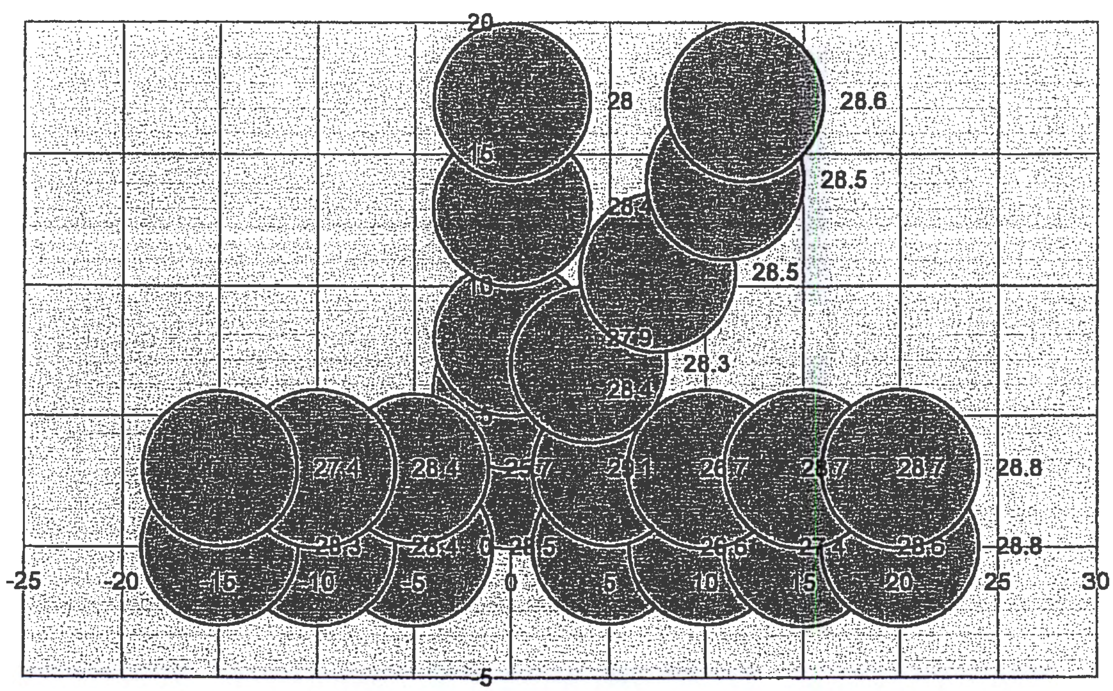
Y axis = height above the bottom

BOUNDARY WATER INC.

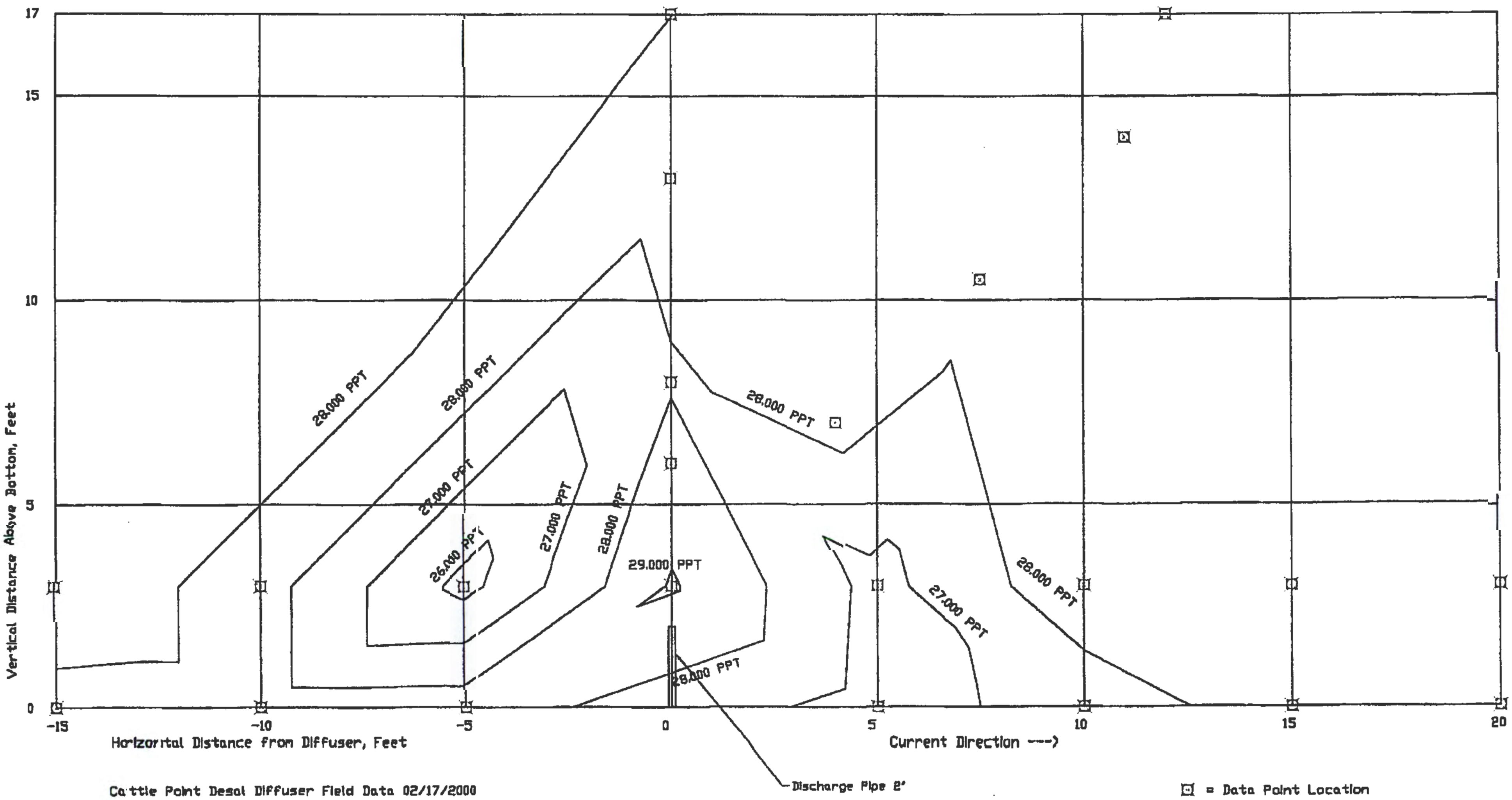
CIVIL ENGINEERING PLANNING LAND SURVEYING

P.O. BOX 897, FRIDAY HARBOR, WA. 98250 (360) 378-4171





Cattle Point Visual Plume Prediction Detailed output for 2/17/2000											
and Data Analysis											
2/17/2000	Depth	Amb-cur	P-dia	Polutnt	Dilutn	x-posn					
Step	(m)	(cm/s)	(in)	(ppm)	()	(m)					
0	4.572	1.5	1.56	52300	1.00	0.000					
10	4.550	1.5	1.89	47827	1.22	0.000					
20	4.523	1.5	2.31	44157	1.50	0.000					
30	4.490	1.5	2.83	41147	1.83	0.000					
40	4.451	1.5	3.47	38677	2.24	0.001					
50	4.402	1.5	4.26	36651	2.73	0.001					salinity ppt
60	4.342	1.5	5.25	34989	3.34	0.003	<--this is depth at measured point #1 below				
70	4.268	1.5	6.49	33626	4.07	0.005				Polutant measured at #1 below ppm	29.10
80	4.176	1.5	8.11	32507	4.97	0.008				Polutant predicted at #60 left ppm	34.99
90	4.061	1.5	10.31	31590	6.06	0.014				model's error	5.89
100	3.913	1.5	13.67	30837	7.40	0.026				model's % error	17%
110	3.748	1.5	20.34	30281	8.83	0.047					
115	3.713	1.5	23.77	30174	9.17	0.055		begin overlap,			
120	3.693	1.5	26.61	30128	9.32	0.060					
130	3.674	1.5	31.28	30100	9.42	0.067					
140	3.666	1.5	35.09	30091	9.45	0.071					
150	3.661	1.5	38.32	30086	9.47	0.073					
160	3.659	1.5	41.08	30083	9.48	0.075					
170	3.657	1.5	43.45	30082	9.49	0.077					
180	3.656	1.5	45.47	30081	9.49	0.078					
190	3.655	1.5	47.17	30080	9.49	0.079					
200	3.655	1.5	48.57	30079	9.50	0.080					
210	3.654	1.5	49.69	30079	9.50	0.081					
220	3.654	1.5	50.53	30078	9.50	0.082					
230	3.654	1.5	51.11	30078	9.50	0.083					
240	3.654	1.5	51.42	30078	9.50	0.083					
246	3.654	1.5	51.48	30078	9.50	0.084		local maximum rise or fall,			
250	3.654	1.5	51.47	30078	9.50	0.084					
260	3.654	1.5	51.27	30078	9.50	0.085					
270	3.654	1.5	50.80	30078	9.50	0.085					
280	3.654	1.5	50.08	30078	9.50	0.086					
290	3.655	1.5	49.10	30078	9.50	0.087					
300	3.655	1.5	47.86	30078	9.50	0.088					
310	3.656	1.5	46.35	30078	9.50	0.089					
320	3.657	1.5	44.55	30078	9.50	0.090					
330	3.658	1.5	42.47	30078	9.50	0.092					
340	3.660	1.5	40.07	30078	9.50	0.093					
350	3.664	1.5	37.33	30077	9.50	0.096					
360	3.670	1.5	34.20	30076	9.51	0.099					
370	3.681	1.5	30.63	30072	9.52	0.103					
380	3.707	1.5	26.58	30049	9.60	0.111					
385	3.737	1.5	24.50	29992	9.82	0.118		end overlap,			
390	3.802	1.5	22.45	29861	10.34	0.130					
400	4.047	1.5	20.58	29424	12.56	0.164					
410	4.305	1.5	21.39	29060	15.34	0.194					
420	4.582	1.5	23.11	28762	18.70	0.224					
430	4.884	1.5	25.42	28517	22.80	0.257					salinity ppt
438	5.148	1.5	27.62	28354	26.72	0.286		Bottom	predicted at bottom		28.35
440	5.218	1.5	28.21	28317	27.80	0.294				ambient Salinity (mean)	27.78
450	5.588	1.5	31.49	28152	33.90	0.336				predicted Salinity rise ppm at bottom	0.57
460	5.999	1.5	35.26	28017	41.32	0.384				predicted Salinity rise % at bottom	2%
470	6.458	1.5	39.58	27906	50.38	0.440					
474	6.656	1.5	41.46	27868	54.53	0.464		stop dilution reached,			
Point #	depth			sal ppm		sal ppt					
1	4.267			29100		29.10					
2	3.353			28400		28.40					
3	2.743			27900		27.90					
4	1.219			28400		28.40					
5	0.000			28000		28.00					
6	5.182			26600		26.60					
7	5.182			27400		27.40					
8	5.182			28600		28.60					
9	5.182			28800		28.80					
10	4.267			26700		26.70					
11	4.267			28700		28.70					
12	4.267			28700		28.70					
13	4.267			28800		28.80					
14	3.048			28300		28.30					
15	1.981			28500		28.50					
16	0.914			28500		28.50					
17	0.000			28600		28.60					
18	5.182			28500		28.50					
19	5.182			28400		28.40					
20	5.182			28300		28.30					
21	4.267			25700		25.70					
22	4.267			28400		28.40					
23	4.267			27400	ambient	27.40					
					max	28.5					
					min	25.7					
					ambient variation	9.8%					
					mean ambient	27.78					



Cattle Point Desal Diffuser Field Data 02/17/2000

Diffuser: CattlePointAsBuilt2000.vpp.db | Ambient: D:\Program Files\Plume\Data\CattlePointAsBuilt2000.001.db | Special Settings | Text Output | Graphical Output |

Project D:\Program Files\Plume\Data\CattlePointAsBuilt2

"D:\Program Files\Plume\Data\CattlePointAsBuilt2000"
Cattle Point Field Measurement 02/17/2000
Conditions: 35% recovery=52.3ppt, 30gpm discharge rate
350 ft offshore, bottom = -17 MLLW, 3 ft above bottom,
2 inch pipe open directed up. Ambient=27.40 ppt, current=3 ft/min=1.5 cm/sec, vena contracta 0.61,
calculations stopped at dilution=54=1% over ambient

Ambient file list
Filename Cases
D:\Program Files\Plume\Data\CattlePointAsBuilt2000

D:\Program Files\Plume\Data\CattlePointAsBuilt2000

After run go to tab
- Diffuser
- Ambient
- Special
- Text
- (selected) Graphics

Units Conversion
- (selected) Convert data
- Label only

UM3

Model Configuration
- [ ] Brooks far-field solution
- [ ] Graph effective dilution
- [ ] Average plume boundary
- [ ] Amb. current vector averaging
- [ ] Tidal pollution buildup
- [ ] Same-levels time-series input

Case selection
- (selected) Base or selected case
- Sequential, all ambient list
- Sequential, parse ambient
- All combinations

Diffuser, Flow, Mixing Zone Inputs

Port diameter	n/r	Port elevation	Vertical angle	Hor angle	Num of ports	n/r	n/r	n/r	n/r	Acute mix zone	Chronic mix zone	Port depth	Effluent flow	Effluent density(*)	Effluent temp	Effluent conc
in	m	m	deg	deg		m	s	s	s	m	m	m	MGD	sigmaT	C	ppm
2		0.60961	90	0	1					6.5533	65.533	4.572	0.0432	52.3	7.8	52300

Parameters for selected row

Froude number	
Eff density (kg/m3)	
Port vel (m/s)	
P-dia (m)	0.0508
P-dia (in)	2.0
Case No.	1.0

Time Series-Files (optional)

Borrow time-series from project: D:\Program Files\Plume\Data\CattlePointAs

	Port depth	Effluent flow	Effluent density(*)	Effluent temp	Effluent conc
Time-series filename	click for file	click for file	click for file	click for file	click for file
Time increment (hrs)					
Time cycling period					
Measurement unit					

Diffuser: CattlePointAsBuilt2000.vpp.db   Ambient: D:\Program Files\Plume\Data\CattlePointAsBuilt2000.001.db | Special Settings | Text Output | Graphical Output |

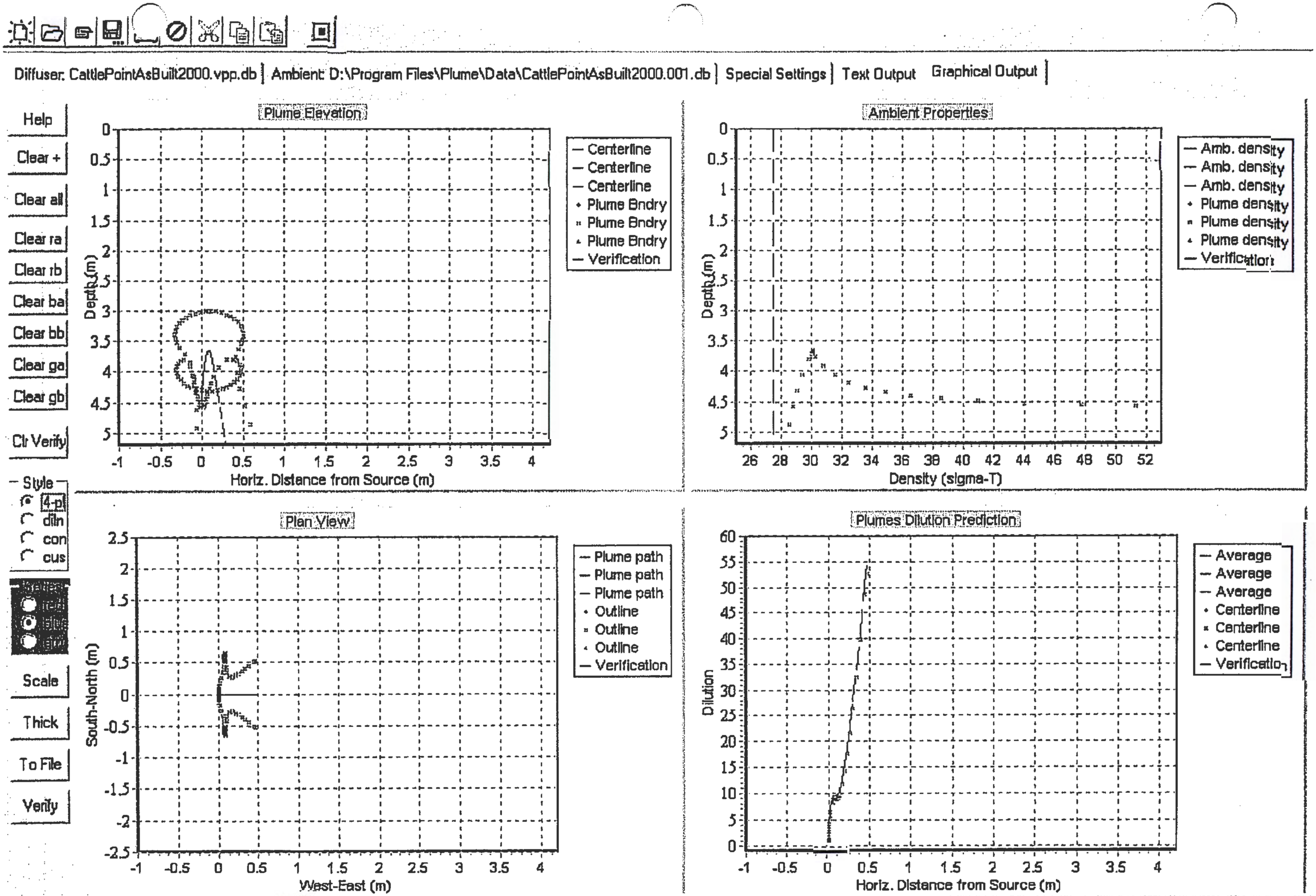
Ambient Inputs

	Measurement depth or height	Current speed	Current direction	Ambient salinity	Ambient temperature	Background concentration	Pollutant decay rate(t)	n/r	n/r	Far-field diffusion coeff
Depth or Height		depth	depth	depth	depth	depth	depth	depth	depth	depth
Extrapolation (sfc)		constant	constant	constant	constant	constant	constant	constant	constant	constant
Extrapolation (btm)		constant	constant	constant	constant	constant	constant	constant	constant	constant
Measurement unit	m	cm/s	deg	sigmaT	C	ppm	s-1	cm/s	deg	m0.67/s2
	0	1.5	0	27.4	7.6	27400	0	1.5	0	0.0003
	5.1817									

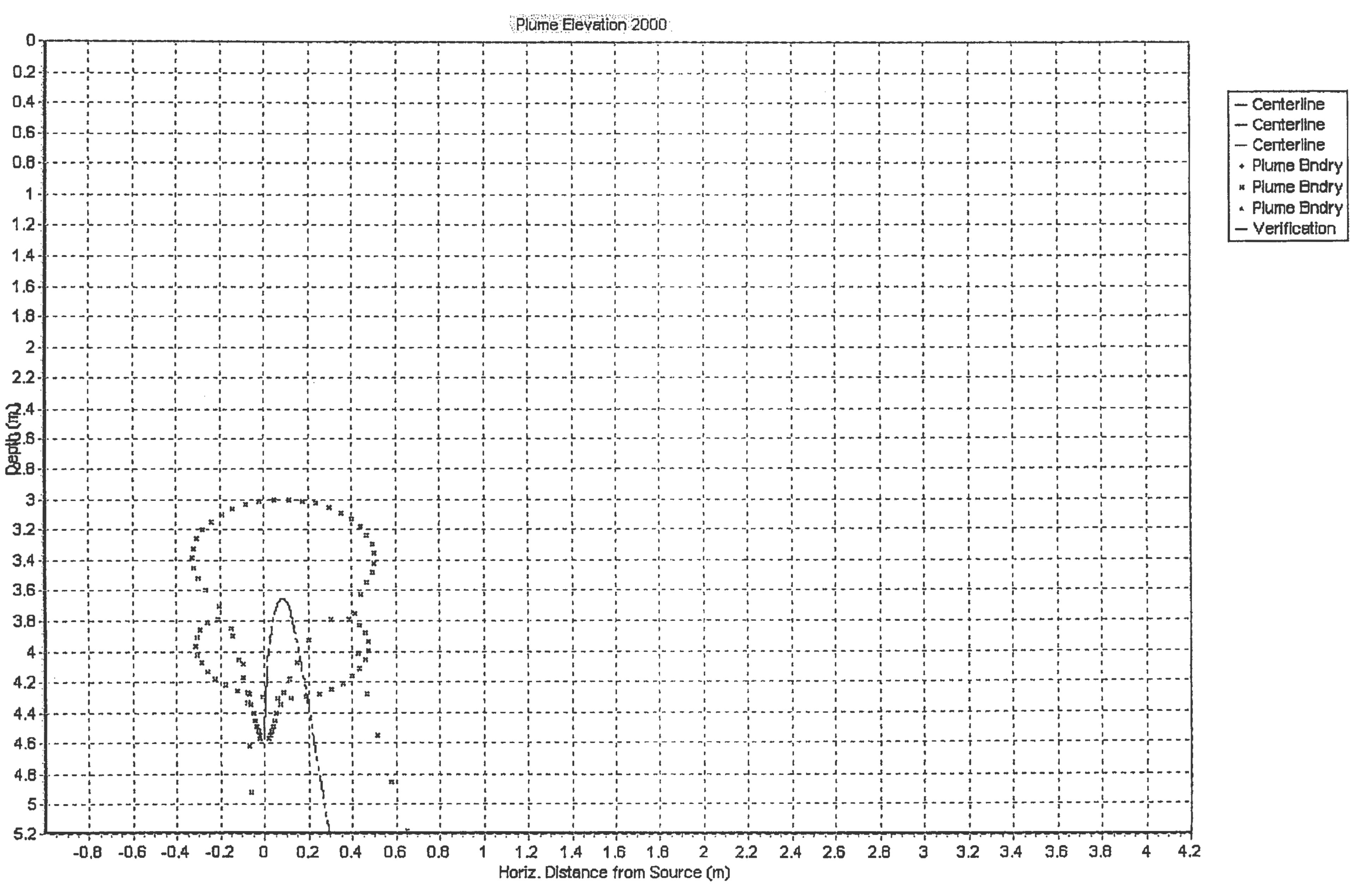
Ambient file list: Filename
CattlePointAsBuilt2000.00'

Time-Series Files (optional)   **Borrow time-series files from project:** D:\Program Files\Plume\Data\CattlePointAsBuilt2000

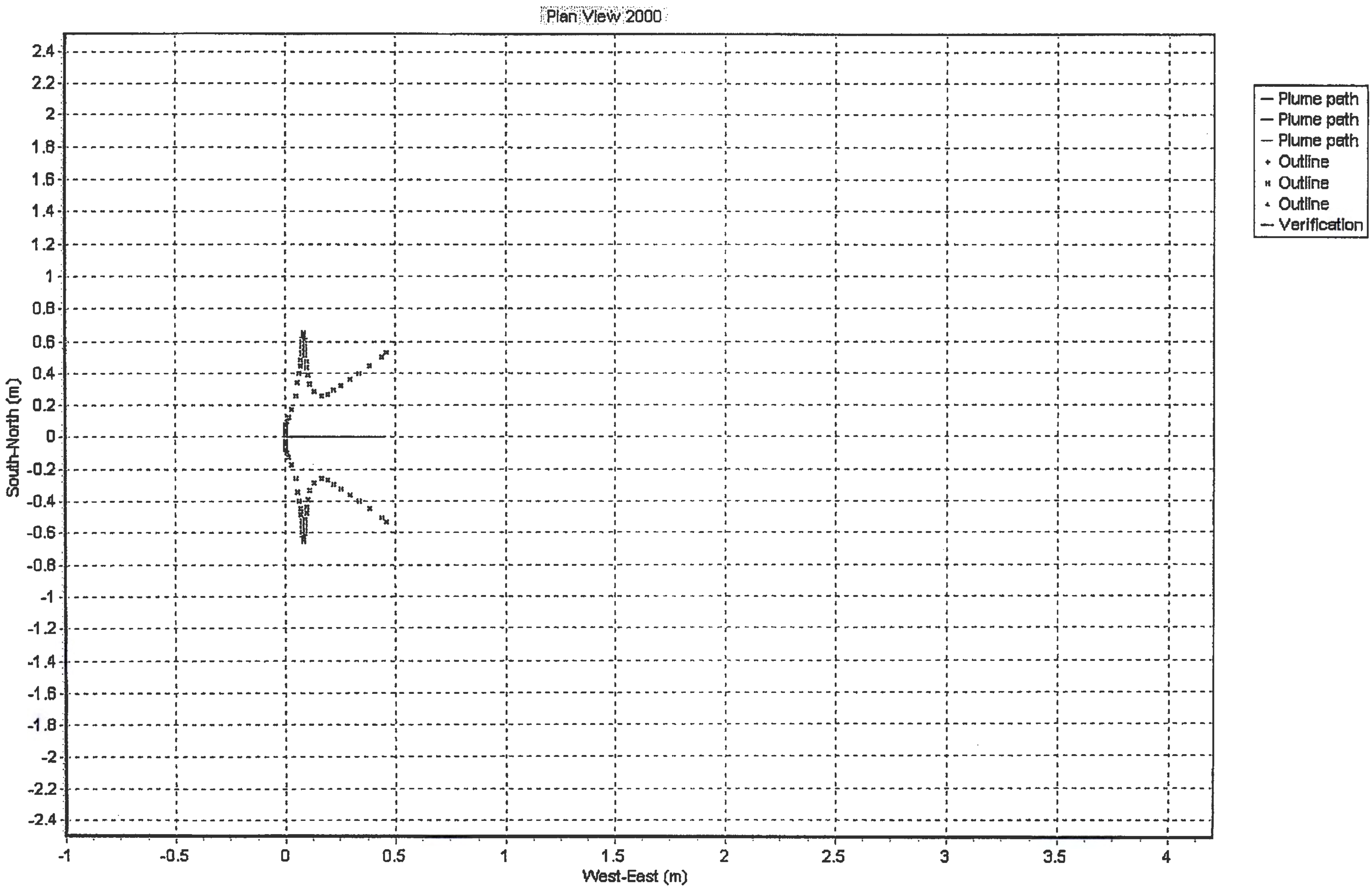
Time-series filename		click for file	click for file	click for file	click for file	click for file	click for file	click for file	click for file	click for file
Time increment (hrs)										
Cycling period										
File measurement unit										

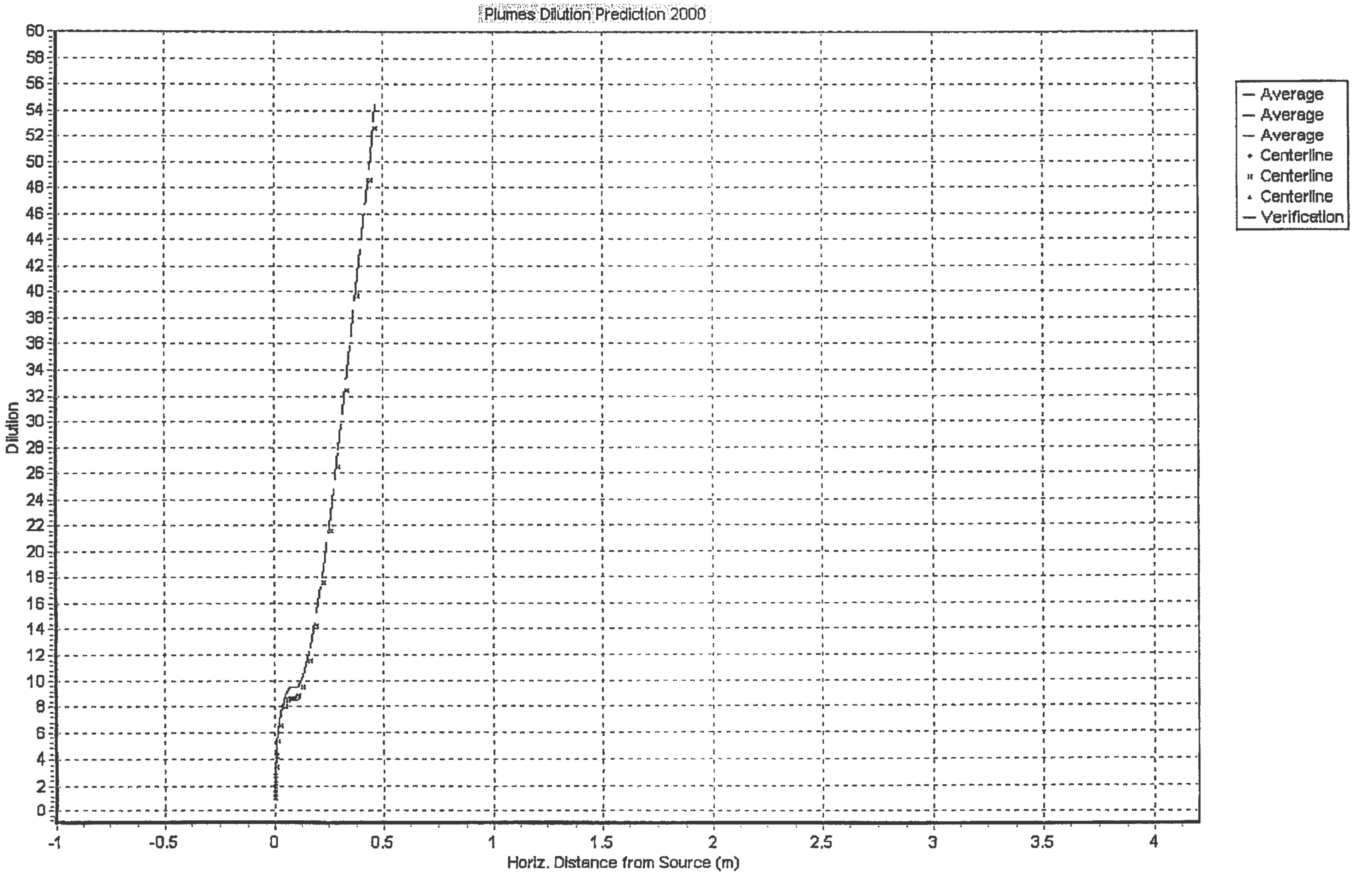


Diffuser: CattlePointAsBuilt2000.vpp.db
Ambient: D:\Program Files\Plume\Data\CattlePointAsBuilt2000.001.db
Special Settings
Text Output
Graphical Output
Help
Clear +
Clear all
Clear ra
Clear rb
Clear ba
Clear bb
Clear ga
Clear gb
Clr Verify
Style
4-pl
diln
con
cus
Scale
Thick
To File
Verify
Plume Elevation
Depth (m)
Horiz. Distance from Source (m)
Centerline
Centerline
Centerline
Plume Bndry
Plume Bndry
Plume Bndry
Verification
Ambient Properties
Depth (m)
Density (sigma-T)
Amb. density
Amb. density
Amb. density
Plume density
Plume density
Plume density
Verification
Plan View
South-North (m)
West-East (m)
Plume path
Plume path
Plume path
Outline
Outline
Outline
Verification
Plumes Dilution Prediction
Dilution
Horiz. Distance from Source (m)
Average
Average
Average
Centerline
Centerline
Centerline
Verification

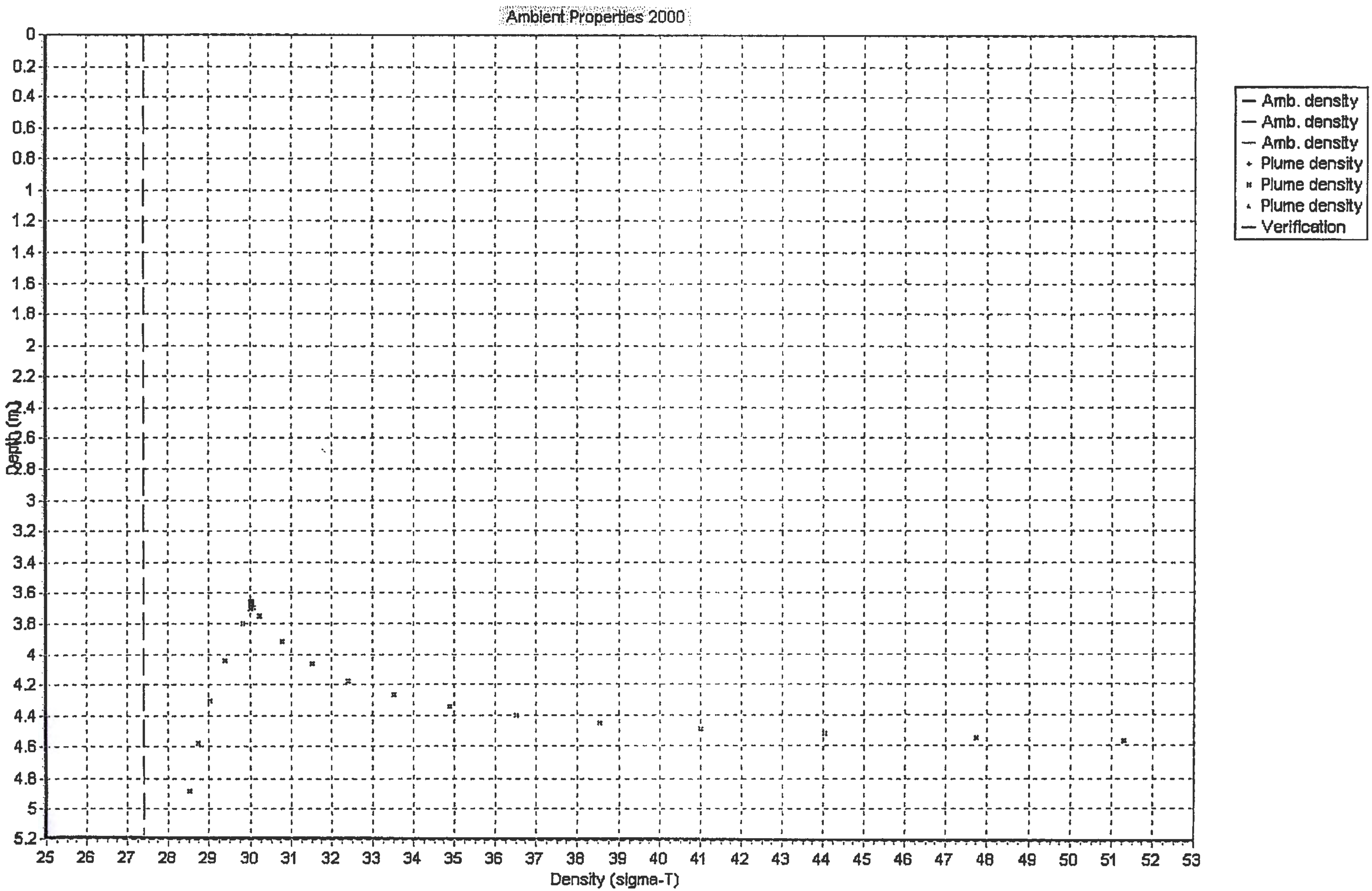


Plume Elevation 2000
Depth (m)
Horiz. Distance from Source (m)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
3.8
4
4.2
4.4
4.6
4.8
5
5.2
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
3.8
4
4.2
Centerline
Centerline
Centerline
Plume Bndry
Plume Bndry
Plume Bndry
Verification

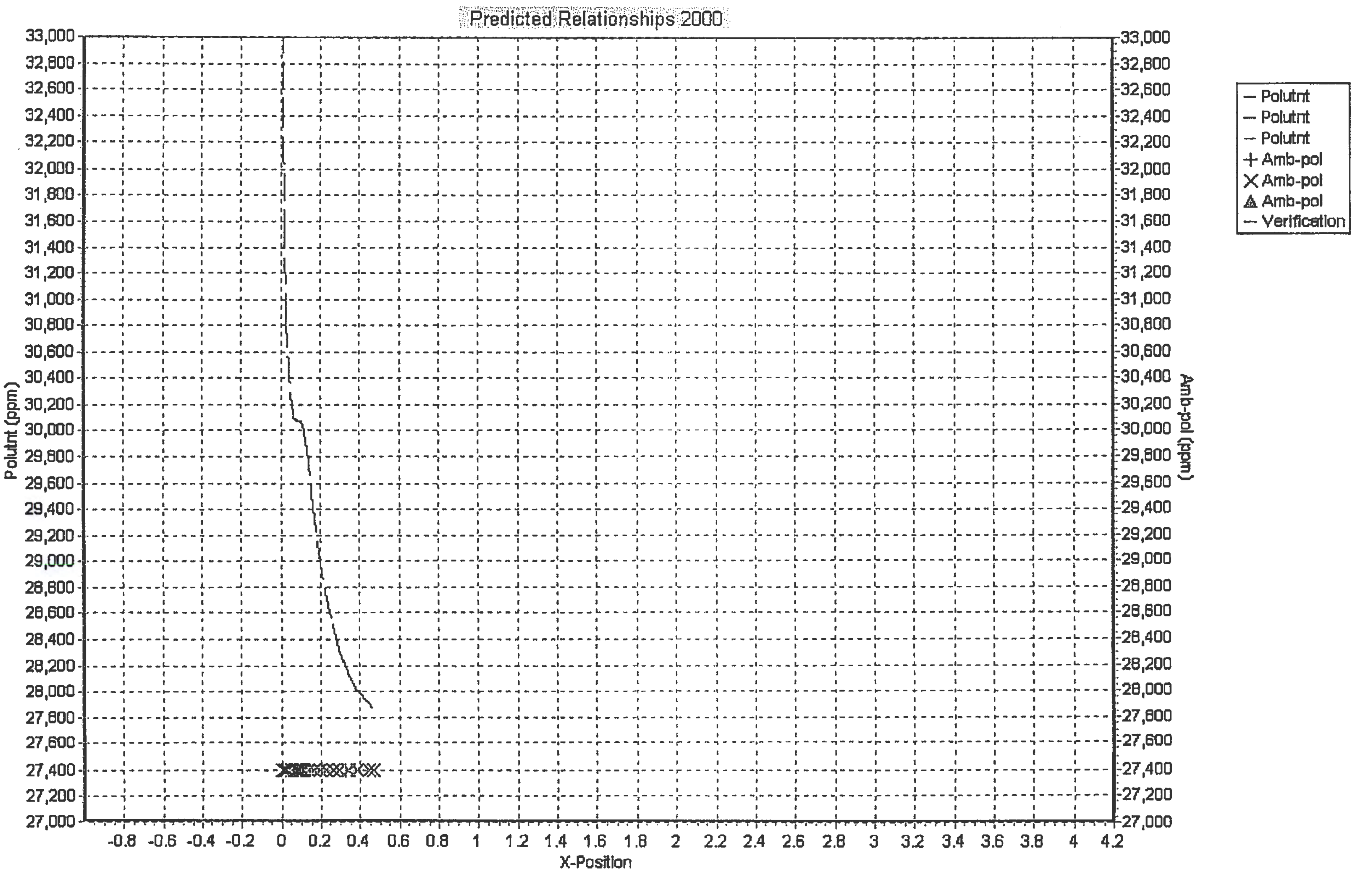

Plan View 2000
South-North (m)
West-East (m)
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
-2
-2.2
-2.4
-1
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
Plume path
Plume path
Plume path
Outline
Outline
Outline
Verification



Plumes Dilution Prediction 2000
Dilution
60
58
56
54
52
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
-1
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
Horiz. Distance from Source (m)
Average
Average
Average
Centerline
Centerline
Centerline
Verification



Ambient Properties 2000
Depth (m)
Density (sigma-T)
Amb. density
Amb. density
Amb. density
Plume density
Plume density
Plume density
Verification



Predicted Relationships 2000
Polutnt (ppm)
Amb-pol (ppm)
X-Position
33,000
32,800
32,600
32,400
32,200
32,000
31,800
31,600
31,400
31,200
31,000
30,800
30,600
30,400
30,200
30,000
29,800
29,600
29,400
29,200
29,000
28,800
28,600
28,400
28,200
28,000
27,800
27,600
27,400
27,200
27,000
-0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2 2.2 2.4 2.6 2.8 3 3.2 3.4 3.6 3.8 4 4.2
Polutnt
Polutnt
Polutnt
Amb-pol
Amb-pol
Amb-pol
Verification

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

In 2002 we (Ronald Mayo, PE, Lopez Island) did an inventory of 11 Reveres Osmosis (RO) systems in the greater San Juans and then in late 2008 we looked at those systems again plus four other system. The 15 systems are:

1. Cattle Point Water System, San Juan Island
2. Center Island Community RO System near Lopez
3. Eliza Island RO System near Bellingham, Whatcom County
4. Hat Island Community Association RO System, Snohomish County
5. Kings Ransom RO System
6. Lopez Legacy Lodge RO System
7. Mineral Point Community Club RO System
8. Mitchell Point Water System, San Juan Island
9. Obstruction Island Water System, San Juan County
10. Potlatch Beach RO System Guemes Island, WA
11. Resort at Deer Harbor RO System
12. Roche Harbor Shores RO System
13. Seattle Yacht Club RO System
14. Sperry Peninsula RO System, Lopez Island
15. Spring Point HOA Water System, Orcas Island

These 15 system inventories, plus information gained from other sources was used as a basis for much of the information contained in this report.

Cattle Point Water System, San Juan Island

Contact and Operator: Carol Herbert and Eleanor McMillen - Commissioner, Cattle Point Water District

I spoke to Carol Herbert on July 31, 2002 for about an hour and a half. Ms Herbert is a certified operator in most or all aspects of water treatment plants. She has been involved in the operation of this plant since it started up and is currently the contract operator for the Mineral Point RO system. She appears to be very knowledgeable in the operation of RO plants of this size. Mrs. McMillen participated in document review including the final draft of this survey. Dan Drahn, P.E., Boundary Water Inc. (BWI), the original designer and project engineer, reviewed and updated information (to October 2008) based on recent analysis prepared for the Department of Health (DOH).

History Some years ago the three wells serving the community began to lose capacity and show signs of seawater intrusion. After legal action went on for some time the developer undertook the construction of an RO desalinization system and a new reservoir.

The primary issues impacting construction were the time required to obtain permits (and DNR leases) and the design criteria. The developer was required to pay the capital costs.

The chronology of the water system is as follows:

Development started providing water from original System	1970
Planning started for RO System	1994
RO System Placed in Service	1999
Developers transferred control of the water system to the Cattle Point Water District	2000

Present System - The desalinization plant is a reverse osmosis (RO) type with a capacity of 21,600 gpd or 15 gallons per minute. The system has two separate RO units of 4 membranes each. As an operating procedure it only uses one unit at any one time. 49 gpm is supplied to the RO unit at up to 1000 psi. (Currently it operates in the 700 to 800 psi range.) Water Equipment Systems Inc. supplied the RO unit, which was assembled and tested in Florida by a sub-contractor, Environmental Products Inc.

When membranes require cleaning they are sent out of the county.

The intake system consists of a horizontal well casing and well screen extended about 300 ft from a beach access vault out into the ocean with a screen. A Grundfos submersible pump is inserted in the casing and delivers water to a seawater day tank at the treatment plant. An intermediate pump forces the water through the filters and into a third high-pressure pump that feeds the membrane filters. Water passing through the membranes is pumped by a fourth set of pumps to the 90,000-gallon water tank.

The process (brine) water is discharged in a 4" pipe extended into Griffin Bay about 400 ft. The discharge assembly at the end of the pipe directs the concentrated seawater vertically into the water column above. Depth at the discharge is about 15' at a mean lower-low tide level. The effectiveness of the Cattle Point discharge was measured twice by divers during full-plant operation. Measurements were made in 1999 and 2000 by Jen-Jay Diving at slack tide. With a concentrate discharge of 27 gpm, differences in salinity from background levels were generally undetectable at a radius of about 10 feet. The brine was fully dispersed and there was no indication of the heavier concentrate moving toward the bottom.

A 27-page memo (April 200) from Boundary Water Inc describing the Jen-Jay discharge tests is attached as Appendix 3 to this report.

The intake/discharge system has been relatively trouble free. It is serviced once a year.

The water system is approved for 72 Equivalent Residential Units (ERU) consisting of homes and Accessory Dwelling Units (ADUs). In 2007 there were 39 connections in service. Occupancy and use are seasonal with winter occupancy estimated at about 50% and summer occupancy about 67%. Full build-out would account for 65-72 ERU depending on accessory unit construction. The system continues to average 2000-3000 gpd during the winter and 4000 to 5500 gpd in the summer. Average summer occupied use was estimated at 165 gpd per connection in 2007. The RO system is operated as the sole water source for the water district. The wells that were the original water sources are kept on a stand-by basis for emergency use only. The community is very conscious of water quality because of the earlier problems with the wells.

Costs - The 1999 capital costs for this system were in the range of $300,000 for the RO treatment plant only and $500,000 including a 90,000-gallon reservoir and other improvements.

The operating costs in 2007 have not changed substantially since 2002 and are in the range of $30,000 per year of which approximately $15,000 per year is for the operator; $2,700 is for electricity and the remaining amount is for filter cartridges, chemicals, phone lines, and other water district expenses. Operating costs are kept low by many hours of volunteer work from the water district commissioners and other community members.

The operating costs are met by monthly charges of $20 per connection plus $0.025/gallon for water used during the month. On this basis the occupied summer monthly charge for an average house is ($0.025 x 165 gpdpc x 30 + $20) = $81 per month.

Consultants: Boundary Water Inc. (BWI), Friday Harbor, (formerly MPD Inc.) was the primary design consultant. The prepared design was reviewed by an engineer at CH2M-Hill Inc. before DOH submittal.

BWI oversaw the first year of plant operation, training owners and initial operators, before the plant was retested and handed over to the homeowners association for continued operation.

Future – The RO plant is sized to serve projected summer demand at full-build out, full-occupancy. On an annual basis, the plant was estimated to be running at less than 25% maximum capacity in 2007. The water district expects this RO system will meet the future water needs of this community as planned.

Center Island Community RO System near Lopez

2008 update provided by Rob Morrice in October 2008

History - Center Island was developed in the early 1960's with water being provided by a developer-constructed system based primarily on a single well. While this was generally sufficient it was over- pumped through a misunderstanding and salinity increased and quality declined. Another well was drilled and though quality was good the quantity was inadequate. The community looked at a number of options. These included piping water from a system on Decatur Island, catchments, barging of water, more wells and a high tech gadget by

Boeing. After some study it was determined by the community to develop a desalinization system and ultimately they were able to construct a 3,000gpd SWRO.

At the time plans were being developed for the SWRO system it was determine that the system had never been approved by the DOH so the approval process was complicated. A major issue was to set the appropriate criteria for water use in periods of high use. Historical records reflecting recreational use and types of dwellings showed that summertime use was only 25gpd per connected household in June through September. On this basis the DOH approved (in 1993) the system for 99 connections with only a 3,000-gallon SWRO unit and a 1,300gpd well. (I.e. 43 gpd/connection).

Over a period of time the SWRO production was increased to 4,000gpd and the well's nominal

production started to fall off to 800gpd well below the 1,300gpd. The developments water supply approval had been increased to no more than 135 ERU's (Equivalent Housing Units) which is 128 connections, the community facility is counted as 8 ERU's. A connection may or may not have a residence on it but all have meters. (The houseless connection typically is used only for camping.)

In 2005 it was evident that available connections were running out and the need for more water was the only way to obtain more connections (50) from the DOH. A water committee was formed to examine the issue and it was decided to refurbish the current SWRO and build another in duplicate. Using new technology, the original SWRO was increased to 4300 gpd and with a second unit production was increased to 8600 gpd. Two units in parallel with redundant pumps and piping would allow a seamless transition between the low and high usage seasons.

Full time residents are currently at 9

The chronology of this Group B water system is as follows:

Development started providing water from original system in 1962

Planning started for first SWRO about 1989

SWRO placed into service in 1991

System approval in 1992

Planning started for second SWRO 2005

System approved (185 ERU's) and placed into service 5/2008

2008 Present System – The desalinization plant's maximum capacity is 8,600 gpd. The typical SWRO will be approx. 4000 gpd considering membrane age/ water temperature and pressure stressed on membranes.

The SWRO production last year was 287,000 gallons (for the summer season of 4 months, running at 60% duty), and 266,000 gallons for the balance of the year, 30% duty. Summer months average 3,200 gpd and winter month average 1,200 gpd.

Of the old wells one (high Sulfur) is used strictly for (non-potable) washing equipment, fire truck filling and boat washing. The other useable well is supplying 20 gpd to the domestic system to maintain it's "back-up" capability. Otherwise all needs are met by the SWRO.

The intake is a PVC well screen and a pump on a dock. It has a capacity of 32gpm.

The SWRO is operated as the water system source all year. Currently serving 91 ERU's. In the summer months the plant is operating on the average of 60% duty time.

The island has two reservoirs, 20,000 and 35,000 gallons. The 35k will be doubled in the spring of 2009 to 72,600 gallons.

Costs – The capital costs for this system were in the $100,000 range. It was paid for through an expansion fund. This money was added to the original connection fee for those lots prior to the latest expansion and all lots current without a connection paid the same amount prior to expansion to insure a connection in the future.

All lots with a connection are metered and read twice a year, early summer and in the fall. Water usage is $0.01/ gallon for the first 3,000 gallons and $0.02 for the balance during the OFF season (Oct-May). Peak season (June-Sept) is $0.01 for the first 3,000 gallons, $0.04 up to 9,000 and $1.00 over 9,001. The current water connections also pay a $50.00 annual maintenance fee, and all back maintenance fees are paid up to date for new connections.

The annual fee and the unit water charge only fund the SWRO plant. The balance of the island infrastructure is paid from either annual dues or special assessments.

Consultants: Rob Morrice- CIA /Dan Drahn-MPD Inc. and the manufactures.

Future – It's expected that the current system will meet all needs for this development far into the future.

Eliza Island RO System near Bellingham, Whatcom County

This is based on a conversation with Ken Thomas on August 14, 2002 for about an hour. Mr. Thomas is municipal/civil engineer who was with the City of Bellingham and did occasional outside work as a consulting engineer. He was the engineer for the Eliza Water System and continues to be involved in their activities. In November 2008, Gary McFadden, the current operator of this system, reviewed this document.

History - Eliza Island was platted in the 1970's as a recreational development. (A recreational development is one that does not permit year-around living.). Its original water supply was a shallow well subject to surface drainage. The storage reservoirs were fiberglass containers once used as boat molds. Water was pumped to these tanks in the winter and consumed in the summer. As the development grew, the supply was clearly not adequate in terms of quantity or purity. (Seawater intrusion was not a problem.) In late 1992 the situation became critical and by mid-1994 an RO unit was put into place. Because the situation had achieved emergency status permits were obtained very quickly. Construction was done by the residents with, mainly, volunteered equipment. (One cannot anticipate such quick permit action now.) Since water had become so critical there was little resistance to the undertaking.

The development now has 137 lots of record. 93 are now receiving water, with about 62 of these having permanent housing structures. The rest are "temporary".

The chronology of the water system is as follows:

Development started with water from original System	1970?
Planning started for RO System	November 1992
First RO System Placed in Service	June 1994
Second RO System Placed in Service	June 1997

The primary issues impacting development was the absolute necessity of obtaining water.

Present System - The initial RO system was sized for production of 8,000 gpd. The original intake was 12 inch perforated pipe dug into the beach.

A second RO system was installed in 1997, again an 8,000-gpd unit. At the time of construction at 12,000 gallon elevated tank was installed to meet storage and pressure requirements. The installation of this second unit was primarily to fulfill permit conditions that require a back-up unit where no second source, such as a well, is available.

Because of changing currents the original intake was becoming silted in and less productive. For this reason they are currently designing and permitting a pumped-screened intake on the dock.

Power is supplied to the water system by a diesel generator (60kW). Fuel consumption is on the order of a 1,000 gpy.

The system (16,000 gpd rated capacity) is operated an average of about one-hour per day for the full year. In the winter that may be about one hour per month. In the summer, full operation may occur for 8 to 10 hours every fourth day. In the period Jan. 1 to July 31, 2002 about 162,000 gallons of water were produced, with total machine operating time of 583 hours. Water production in 2001 was 267,970 gallons. (62 connections with an average annual use of 12 gpd.)

The Sea Resources Corporation of California supplied the RO equipment for both units.

The membranes are cleaned on site when necessary. It is fairly simple and to be preferred to losing time shipping to a factory for cleaning.

Our biggest equipment problem is the salt-water environment that is very tough on electric motors and anything in carbon steel.

In the future, if needed, a third 8,000 gpd RO unit can be easily installed.

Costs - The initial cost for Phase 1 of this system was on the order of $200,000 excluding most labor and construction tools. Phase 2, the Reservoir and Unit 2, was an additional $250,000. It was paid for by an assessment against all 93-property owners equally.

The operating costs for the entire system are met through payments by the 93 lots. They pay $100 per year as a base charge. In addition each user pays $0.04 per gallon.

The moneys collected for operation also as also used for a reserve fund. It was used when, after 8 years use, a RO membrane blew out. Thus water users may avoid additional periodic assessments to pay for major maintenance and equipment replacement efforts.

Consultants: Ken Thomas of Bellingham (now with RH2 Engineering).

Future - They expect that they will continue using this system for their development for some time in the future. While expansion is not immediately contemplated, an additional 8,000-gpd unit can be installed.

Hat Island Community Association RO System, Snohomish County

I spoke to Mr. Stienstra, on August 9, 2002 for just less than an hour. He is currently managing construction of the new RO system and appears to be knowledgeable in the design and operation of RO plants. He has worked on RO units on ships for some time. This text was reviewed and modified by Charles Motson, the RO Plant manager in October 2008.

History - Hat Island, is a recreational property development, near Everett. It was originally platted for about 950 lots. To date 285 homes have been constructed and are on the water system. They consider that full build-out will be a total of a 600 homes. The remaining 350 lots are not considered buildable. The water supply has been wells but as early as 1984 discussions were being held about constructing an RO system as the wells were being depleted. At one point a pipeline to the mainland was consider but this was rejected based on a cost estimate of $7 million. Finally in 1999 a vote of landowners approved the construction of an RO system.

The chronology of the water system is as follows:

Development started with water from original System	1964
Planning started for RO System	1999
RO System Placed in Service	2002

The primary issues impacting development were the time required to obtain permits (and DNR leases) and approval by the property owners.

Present System - The desalinization plant was sized to supplement the existing wells although it may be operated as a single source eventually. The initial installation will be for 40,000 gpd with space and piping provided for an additional 40,000 gpd. (We have assumed that a Phase 2 installation of 40,000 gpd will occur when the 300-connection level is reached.

The International Aquamembrane Company of San Marcos, California supplied the original RO equipment. IA is no longer our service provider. We now use Siemens Engineers. (They now clean their membranes "in-house".)

The intake is two beach wells equipped with submersible pumps. These are now (2008) giving us significant issues with volume and pressure

Originally effluent is discharged to an exfiltration pond. This has been changed to direct outflow.

The RO system is using the existing reservoirs (316,000 gallons).

Costs - The capital costs for the first stage of this system was $750,000. It is estimated that addition of the second stage (40,000 gpd) RO units will add about $200,000

The initial capital cost will be met by the assessment approved in 1999 of $960 per lot (950 lots) or approximately $912,000. The phase 2 costs will probably be met in the same way.

The original estimate of operating costs for the system (including RO) is expected in the range of $16,600 per year. This has turned out to be higher.

The operating costs are met by a flat rate charge (per lot, developed) of $150/year and a charge for water use of $0.02/gallon.

The water user may expect periodic assessments to pay for major maintenance and equipment replacement efforts.

Consultants: Gray and Osborne of Seattle was the primary engineering consultant.

Future - They expect that they will continue using this system for their development for some time in the future.

Kings Ransom RO System

This information is from public records and other technical sources. The operators chose not to provide additional information. The system is located on Henry Island.

This system was placed in service in 2000. The RO plant has a capacity of 3,000 gpd. The estimated summertime level of production is 900 gpmdand the wintertime level of production is 600 gpd . It operates year-around.

This is a Class B system serving 3 connections. The manager is Guy Nibler . The consulting engineer is John Hart.

The membranes are sent off Island for cleaning.

The inlet is a screen hung from the dock and the outlet is a slotted pipe hung from the dock.

Lopez Legacy Lodge RO System

This material is based on a questionnaire response by Andy Evers, engineer, prepared in October 2008.

This facility went into service in the summer of 2008, initially serving 2 connections. The RO system has a nominal capacity of 14,400 gpd (10 gpm). The current service area is property owned by the Bumstead family. Planning is based on the eventual expansion to surrounding properties.

The estimated summertime level of production is 2,500 gpd and the wintertime level of production is 500 gpd. It operates year-around.

Brief History - After drilling four very expensive low-producing wells over the past twenty years, they decided to pursue technologies to desalinate sea water as an alternative.

The system consists of two (2) 2" HDPE pipes constructed in the Lopez Sound tidal zone for seawater intake and salt water reject. Each of the HDPE pipes is 450 feet long extending to the marine water. A 2" perforated HDPE pipe is provided at the ends of the 2" HDPE pipes for seawater intake and salt water reject dispersion in the sea. The perforated pipe (a 4 foot length of a 3"+ well screen) is elevated 30 inches above the sea bottom.

Seawater is pumped to an upland building in which the RO desalination water system is installed. The seawater pump is in a dry pit on shore. 40 gpm of seawater is pumped to the RO desalination water system, 10 gpm of potable water is produced from the seawater, and 30 gpm of salty reject water is returned to Lopez Sound via the 2" HDPE discharge pipe.

A recent series of test produced these measurements:

Salinity of water column (ave. 4 samples)	30.5 g/L
Salinity of reject flow at RO Plant (1 sample)	42.0 g/L
Salinity at outfall screen of reject (ave. 4 samples)	31.05 g/L
Salinity of reject 18" down current (ave. 4 samples)	30.65 g/L

The RO plant operates year around. It is the only source of water for the family compound.

The Approximate Capital Cost of RO Plant is $300,000 includes construction, design and permitting costs - built 2007.

Approximate annual Operating cost for RO Plant. Does this include volunteer labor?

Electrical .3 cents / gallon or $1 = 330 gallons

Group B water system operator per county and state DOH requirements - $450 / month

Misc. system maintenance $1,500 annually

Both the intake and outflow is screened thru horizontal well screens 30" off the bottom.

Do you chemically treat your RO membrane or do you send it back to the factory. No - Send them to a cleaning specialist.

Who manufactured your RO plant? WATEK

Who was the consulting engineer? Andrew Evers

What advice would you have for a group starting a new RO system in San Juan County? Call Watek and see if you can possibly get on their schedule for desalination plant design and construction. On the more serious side, currently each desalination plant is evaluated by the permitting authorities individually, and policy for desalination is currently being formed. Although desalination is based on sound science and good engineering, it is the "new kid on the block" for most people as a water resource, and it takes *patience and a willingness to educate* in order to both get an individual plant approved and to help foster logical standardized policies for the future.

What you see in the future for the system? Will you enlarge? Yes, we will enlarge to meet demand.

Have you closing comments, especially relative to environmental impacts. Desalination of seawater, which makes up 97% of the water on earth, is the least harmful and most sustainable water resource available. Taking freshwater from the natural environment (from lakes, rivers, aquifers or wetlands) is the most damaging to the aquatic life that depends on freshwater for survival. If the exploitation of the fresh water resource continues, the damage to our natural environment will be catastrophic. Here in the San Juan Islands, many freshwater wells are suffering from seawater intrusion due to the overexploitation of the water resource. Desalination offers an environmental solution that allows us to have sufficient drinking water with the least impact possible. Aquatic marine life has not been damaged by any of the desalination plants in the San Juan's and there are no aquatic dead zones caused by the desalination process.

Mineral Point Community Club RO System San Juan Island

I spoke to Donald Sept, system manager, on July 31, 2002 for more than an hour. Mr. Sept is an engineer and has been deeply involved in the technical and managerial aspects of the water system since 1995. He is a resident of the Mineral Point Community. He appears to be very knowledgeable with all aspects of the RO system. In October 2008, Bruce Hansen, the current system manager, modified the 2002 document into this form.

History - The development is for no more than 19 connections with 16 now in service. Currently only 6 of the 16 connections are "full time", with the remainder seasonal or weekend residents. Some years ago two of the three wells serving the community began to lose capacity and show signs of surface and ground water contamination. The third well, which is still in service, was being overproduced in the summer. Since this well (in fractured shale and limestone formations) sometimes operated at a water level 30 feet below MLLW, seawater intrusion was a concern. The well is only about 330 feet onshore from San Juan Channel shoreline.

After some study and some expenditures on the two contaminated wells, it was decided by the property owners that development of a desalinization system was the best way to provide a reliable supply of water for the community. The chronology of the water system is as follows:

Development started with water from original system	1974
Planning started for RO System	1996
RO System Placed in Service	1999

The primary issues impacting development were the time required to obtain permits and the DNR easement for the use of State tidelands.

Adjacent developments use wells for their water supply.

Present System - The desalinization plant was sized to provide 400 gpdpc for 19 connections or 7,600 gallons per day (gpd). The actual installation is a reverse osmosis (RO) type with a capacity of 7.0 gpm product water, nominally 10,000 gpd. It uses four membranes. The salt water feed to the RO unit is 25 gpm. Currently the plant is operating at about 800-psi inlet pressure to the membranes. As the membranes foul the pressure will be increased to maintain the design capacity, up to approximately 1200 psi maximum. The Water Link Corporation of Florida supplied the RO equipment, including auxiliary pumps, filter, controls, treatment facilities and electrical equipment.

The intake/discharge system consists of three 3-inch HDPE pipelines. Two are intake lines and one is a reject discharge line. The intake lines are use alternately in one-month intervals. The lines are buried in the beach down to a minus four feet (MLLW=0.0 feet). The intake lines terminate at strainer where the elevation is about minus 10 feet (MLLW). The intake strainers are about 300 feet from the "high water" line on shore. The reject discharge line is about 30 feet longer than the intake lines.

The saltwater intake pump is located in the plant onshore (versus submersible pumps used at some plants). A 20,000-gallon reservoir (from the initial system) provides storage and head to the development.

The RO system is operated as the water source generally from early July to late September in order to maintain the static water level in the well during the dry season when there is little replenishment of the groundwater. For the rest of the year it is typically operated twice a week for about an hour. (Rather than cleaning and pickling for long term storage) The average production in the summer is 4,800 gpd.

Costs - The capital costs for this system are unavailable.

Currently (2008) the operating cost is in the range of $16,000 to 17,000 per year of which $12,000 per year is the costs for the operator. Electricity costs have been about $1,700 per year for the RO unit and the well. The remaining operating costs include water quality tests, filter cartridges, chemicals, phone service, annual marine inspections and routine maintenance, etc.

The initial capital costs were met by a one-time assessment against all 19 lots.

The operating costs are met by distributing the cost against the improved lots with meters.

There is a separate annual assessment against all lots to pay for major equipment replacement or repairs.

Consultants: MPD of Friday Harbor was the primary engineering consultant. Don Sept served as Project Director for the Mineral Point Community.

Future - They expect that they will continue operating the RO system as the source of water in the summer and the well in the rest of the year. Should the well have to be abandoned for any reason, the RO system has the capacity to meet potential demands of the community at full development and with full time residents, without any expansion.

Mitchell Point Water System, San Juan Island

The current president of the three member Mitchell Point Water Association Board is Dr. Donald L. Hendrix. He is a retired US Government scientist with 31 years experience in Biology and Analytical Chemistry. Dr. Hendrix prepared this 2008 revision of the original 2002 system report.

Our current state-certified operator is Carol Herbert. She is also the operator of the Mineral Point RO system and was previously the operator of the Cattle Point RO system.

History - The development is approved for 44 connections with 38 now in service. Approximately 24 of the 368 connections are "full-time", with the remainder either summer residents or vacant lots. Note that MPWA was created as an entity separate from the Mitchell Point Owner's Association (MPOA) by a court ruling. It currently serves houses in four separate developments. The original water source was a well into cracked basalt. The well penetrates the MLLW elevation but the pump is set above this level. During the higher demand during summer months, the well capacity decreases from 7.5 gpm to 1.5 gpm, which is not adequate for the demand. After investigation of various possible remedies, the decision was made to construct a RO facility to supplement the well's output during the summer months.

The chronology of the water system is as follows:

Development started providing water from original System	1972
Planning started for RO System	1993
RO System Placed in Service	1996

The primary issues impacting development were the time required to obtain permits (and DNR leases) and the design criteria.

Present System - The desalinization (RO) plant was sized to supplement the existing well. It has a capacity of 500 gph or about 12,000 gallons per day (gpd). The actual installation is a reverse osmosis (RO) type not unlike units installed on ships. The Sea Recovery Corporation of California supplied the RO equipment. The average production in the summer is 3,300 gpd. In the winter 1,800.

The intake is an 8-inch diameter perforated screen set at 30 feet below MLLW about 100 feet from shore (into Haro Strait) on 64.35 ft^2 (0.015 ac) of tideland plus bottom land leased from the State. A submersible stainless steel well pump is set inside the screen and discharges into a 2-inch heavy walled rubber pipe. Servicing requires divers for pump replacement and cleaning. Water from the intake is pumped to the RO unit located ca. 235 feet above sea level via a three inch PVC pipe where it is stored in a 1,500 gal buffer tank until processed. Water processed by the RO unit is stored in a 44,000-gallon reservoir. Water is pumped out of Haro Strait at the rate of 40-45 gpm. The RO system utilizes filtered seawater at the rate of 31 gpm to produce ca. 8 gpm of filtered water. The brine created in this process is returned to Haro Strait at the rate of 23 gpm via a second three inch PVC pipe. The outflow is located 75 feet directly beyond the seawater inlet and 60 feet below MLLW. The end of the outflow pipe is fitted with a flexible rubber assembly resembling lips, which prevent sea life from entering this discharge pipe.

The Mitchell Point Water System uses both a well and RO to supply the development's water needs. In normal operation the well is pumped "on demand" from signals within the water storage reservoir. When the well is not able to satisfy demand, the RO system is operated manually. In the winter the RO operation is primarily for maintenance. The RO membranes are maintained year around by flushing them with 50 gal of deionizer water each day. However, in summer the RO unit may supply more than 150,000 gallons per month. (a 42% service factor) Summer operation is from June to November. If it were expanded to a third bank of membranes, we feel that the RO system alone could provide for all of the 44 units in the event of well failure.

Costs - The original capital costs for this system were in the range of $150,000 for the RO treatment plant only (with building). The added capital costs since the original RO installation have been about $50,000. The initial costs were met by charging $3,500 for each of 44 lots ($154,000).

The operating costs for the system (including RO) are approximately $21,000 per year of which $5,000 per year is the costs for the operator; $2,800 is for electricity and the remaining amount is for filter cartridges, chemicals, phone lines, etc. There is currently a reserve fund set aside for replacement of membranes or major equipment repair or replacement. The state-certified operator serves MPWA on a contractual basis at an hourly rate.

Operating costs are met with an annual fee plus a water use fee. The annual flat fee is $120 for connected lots and $60 for unconnected lots. The water rates (over a six month period) are:

0-15,000 gallons	$0.0225/gallon
15,000-25,000 gallons	$0.0270/gallon
25,000+ gallons	$0.0320/gallon

Typical water use per household is on the order of 50,000 gallons per year. The annual fee plus the water fee would total $1,250/year for this household. (136 gallons per day per household.)

The water user may expect periodic additional assessments to pay for major maintenance and equipment replacement.

Consultants: CH2M Seattle was the primary engineering consultant.

Future - They expect that they will continue using this system for their development in the future. . MPWA is currently considering adding a third bank of membranes to the RO system (there are two membrane assemblies in each bank) which should raise their processed water output rate to ca. 900 gph (21,000 gpd). Their current bylaws prohibit selling water to adjacent systems but at least four lots in the development could have houses constructed upon them in the future and several houses currently being served have undergone significant expansion recently increasing demand on the existing water supply.

Obstruction Island Water System, San Juan County

Contact and Operator - This information was provided in November 2008 by Mgr-D Helleson and Engineer Dan Drahn. The water master is Norton Smallwood.

History - Obstruction Island has 2 low producing wells. Attempts to drill addition wells were unsuccessful so after years of discussion and debate the Club decided desalination was our best option. This would provide the additional water needed and protect our wells from being over pumped.

Service area - While there are 48 lots on Obstruction Island the total approved connections for the island is 42. Prior to the desal plant we had 29 approved connections. The 2,000 GPD plant added 13 connections. The plant was designed to be increased to 7,000 gpd when and if we need the additional connections. The plant was put into service in 2008 as a Group A water system.

System Description - Sea water is pumped from the end of a dock to the desal plant. Raw water goes thru an 800-micron filter, a spin disk filter (25 microns), a 10-micron filter and a 5-micron filter prior to the RO membranes. Our RO system consists of 3 4" x 40" membranes (composite polyamide from Hydranautics). The product water passes thru a calcite filter for pH adjustment and chlorine is added as the water is pumped to the water reservoir. There is a non-treated fresh water tank used for back flush of the RO filters and the spin disk filters. Product water is collected in a 150-gallon tank and is batched to the 58,000-gallon reservoir. The reservoir is an important part of managing water production and use. Well water and desal product water mix in the reservoir before going out to the distribution system.

Specific Items –

The RO plant is operated only in summer months

In addition to the RO plant there are 2 wells

RO water production in 2008 was 5,000 gallons. 2008 was the start-up. Our best estimate of initial summer production is 1400 GPD. Winter is 700 GPD.

The approximate Capital Cost of RO Plant is $220,000 including all permitting, design, equipment and construction costs.

The approximate annual operating cost for RO Plant is not yet available.

The seawater intake is screened

The outlet from the RO Plant is gravity fed back to the bay. The outlet is on the dock.

How are operating cost met and what are the charges? We have a yearly water use fee and a per gallon fee if a households daily use exceeds 150 gallons.

Do you chemically treat your RO membrane or do you send it back to the factory. We just performed our first seasonal shutdown. We used two cleaning solutions and a preserving solution. This was done in-situ.

Who manufactured your RO plant? US Watermakers

Who was the consulting engineer? Dan Drahn, of Boundary Water of Friday Harbor.

What advice would you have for a group starting a new RO system in San Juan County? Keep it simple and use local contractors for the manufacture.

What you see in the future for the system? Will you enlarge? We have no plans to enlarge. We hope to use our conservation plan and the size of our storage reservoir to support getting more water certificates if they are ever desired. The built out of the island is capped at the 48 lots so growth is not an open issue for the Club.

Potlatch Beach RO System Guemes Island, WA

This is a record of my phone interview with Larry Saunders Contract Administrator on August 1, 2002 and Greg Peterka Engineering Manager on August 9, 2002 for about a half an hour each. They are members of the PUD's technical staff and familiar with all aspects of the Potlatch Beach RO system. Mike Fox reviewed this in November 2008.

History - The development is for about 33 connections with 28 now in service. (Approximately 90% of the existing connections are "full-time"), with the remainder summer residents)

Some years ago the wells serving the community began show signs of seawater intrusion and attempts at finding better wells was unsuccessful. The property owners approach the PUD for assistance. After some study it was determined by the PUD and the property owners to develop a desalinization system and ultimately the present system was constructed and put into service (in 1998). The chronology of the water system is as follows:

Development started providing water from original System	1950's
Planning started for RO System	1995
RO System Placed in Service	Summer 1999

The primary issues impacting development were the time required to obtain permits (and DNR leases), the lack of 3-phase power, the capital costs and the NSF certification of the equipment by Washington State Department of Health.

The Skagit County PUD operates primarily as water utility. This is fairly unusual as most PUD's are primarily in the electricity business. The PUD has seven water systems including this one on Guemes. The Potlatch Beach system is the only PUD system on Guemes, where there are a number of other community water systems. The PUD has a crew that operates and maintains the water systems. Several individuals are particularly well acquainted with the RO treatment system.

Present System - The desalinization plant is a reverse osmosis (RO) type with a capacity of 21 to 24 gpm (30,000 gpd if operated 24 hours per day). It uses 2 RO membranes that have a projected life of 7 to 10 years. The system consists of dual-media filtration, 5-micron cartridge pre-filtration, and the desalination RO units, followed by a calcite contactor to raise the permeate pH. Within the desalination RO units, the water is pumped through a series of polyamide membrane elements that provide salt rejection in excess of 99.5%. The end result is water satisfactory for domestic purposes. The Osmonics Corporation of Minnesota supplied the RO equipment.

The PUD construction staff did much of the construction.

The intake system - To reach the water, the Skagit PUD drilled a 40-foot well on the beach but after encountering complications with the sand density, it was abandoned as a well. The engineers then tacked on an 80-foot pipe at a T-angle attached to the original well casing. The extended pipe was placed in a stone filled channel and is perforated to allow salt water from the Guemes Channel to infiltrate into the pipe before being pumped by the well pump into the desalination system. 70 gpm is supplied to the RO unit at up to 900 psi. The treated water is then pumped into the 30,000-gallon reservoir.

No water right was required for the system.

Effluent process water is discharged into Guemes Channel, through a 4" PVC line piped back out to the channel with an underwater discharge.

The RO system is the only water supply for the community. One of the original wells is maintained for collecting water from the aquifer for testing.

The RO system is operated only about 3 times per week. Annual production from the RO system is on the order of 620,000 gallons. Assuming 12 months of operation, and 28 current connections, the average water use is 61 gpdpc (gallons per day per connection). The peak month's production is on the order of 60,000 gallons. Assuming 30 days of operation, and 28 connections, the current peak month's water use is 71 gpdpc (gallons per day per connection).

Costs - District records show that the work order for the Guemes RO system was created in June of 1996, but as to how long prior to that the idea was on the table for discussion is unknown. The total project cost was $488,500 and there were 34 assessments for $11,926 each. The work order was officially closed 4 years later in June of 2000 and the first payments on the assessments were due November 1 of 2000.

The operating costs were at least $22,000 per year (2001) of which $9,500 is the costs for the operator, $3,200 is for electricity and the remaining amount includes future filter cartridge replacement, chemicals, phone lines, etc. (The electrical costs of $0.0052/gallon, is higher than some system. This may have to do with the conversion of single-phase power to three-phase.)

There is an allowance for replacement of membranes or major equipment repair or replacement. Once we sent them out for cleaning but have found that there wasn't a significant gain in performance, and they wear out with time anyway. We get about a 4-5 year lifespan out of them. This is a typical life span (we are told) and we just replace once they wear to the point of intolerable chloride passage.

The operating costs are met by monthly charges of $50 per lot and $10/100 cf up to 400 cf per month. Beyond 400 cf per month the charge is $30/100 cf. ($0.0134/gallon and $0.040/gallon)

The water user may expect periodic assessments to pay for major maintenance and equipment replacement efforts.

Consultants: Kennedy-Jenks of Seattle and the Construction Department of the PUD

Future - They expect that they will continue using this system for their development for some time in the future. They do not consider that expansion is likely. It may be that the PUD would develop other RO systems but none are planned at this time.

Our advice for a group starting a new RO system in San Juan County would be: Be sure to size it correctly for maximum performance and maintenance issues. Down time is really hard on the system. Adequate drainage in wet areas, and ventilation of building.

Resort at Deer Harbor RO System

This material is from state and county records and from information provided by its operator Steve Quade.

Originally this community was served by two rock wells and some water was hauled from other locations. When the wells could not produce enough flow this RO facility was put in service.

This facility went into service in 2005 and currently has 51 connections, a RO plant with a nominal production capacity of 14,000 gpd (about 10 gpm), two wells, and a 100,000-gallon reservoir. The system serves the Resort at Deer Harbor.

The inlet is a 6" pipe hung from a dock. In that pipe is a 4"± well screen that is 6 ft long. A well pump is mounted in the well screen. The discharge pipe starts well above sea level where air is drawn into the reject flow. This improves mixing and "marks" the outflow.

The RO plant operates year around. The most recent annual flow was about 1,900,000 gallons. Of that amount 950,000 gallons was from the RO system. There are no immediate plans for RO expansion.

The capital cost was on the order of $200,000 in 2004. Operating costs weren't available. Electric costs are relatively small. The Resort at Deer Harbor pays costs.

The estimated summertime level of production is 6,000 gpd and the wintertime level of production is 1,200 gpd. It operates year-around.

The membrane are cleaned and reconditioned at the factory in California. The only chemical used is chlorine to maintain disinfection.

The treated water is not (like some RO only systems) especially corrosive. This is probably because the RO water is mixed with near equal quantities of fairly hard well water.

The consultant was John Hart. The equipment was from US Watermark.

What advice would you have for a group starting a new RO system in San Juan County? In general wells are to be preferred. Hauling and catchments are not to be preferred.

Roche Harbor Shores RO System

This information is from public records and other technical sources. The operators chose not to provide additional information. The system is located on Henry Island.

This is a Group B system serving 8 connections. The manager is Guy Nibler . The consulting engineer is John Hart.

The RO plant has a capacity of 3,000 gpd. The estimated summertime level of production is 2,400 gpm and the wintertime level of production is 1,600 gpm . It operates year-around.

The inlet is a screen hung from the dock and the outlet is a slotted pipe hung from the dock.

The membranes are sent off Island for cleaning.

According to the Washington State Department of State the County Health Department say that this system is INACTIVE as of May 2008.

Seattle Yacht Club RO System

This information is from public records and other technical sources. The operators chose not to provide additional information. The system is located on Henry Island.

This is a Class A system serving 8 connections. This system was put into service in 1997. The manager is Dick Plows. The consulting engineer is John Hart.

The RO plant has a capacity of 4,500 gpd. The estimated summertime level of production is 3,300 gpd and the wintertime level of production is 2,200 gpd. It operates year-around.

The inlet is a screen hung from the dock and the outlet is a slotted pipe hung from the dock.

The membranes are sent off Island for cleaning.

Sperry Peninsula RO System, Lopez Island

This is based with an interview with Bill Rode Estate Manager, Sperry Peninsula on August 7, 2002 for more nearly an hour. It was reviewed by Phil Hedley on October 30, 2008. Phil is the operator of the existing RO system. Their cooperation on behalf of the owner was greatly appreciated.

History - This property was formerly a summer camp for young people. It comprises the 384-acre Sperry Peninsula, which was acquired by the current owner in 1996. The site was developed by the owner with several residential buildings and support structures. Most of the area remains in its natural condition. The wells on the site when the property changed hands were not large and soon and were clearly inadequate. A water supply was developed using water from a (7-mg) lake on the property but the water treatment methods used were not satisfactory and the lake was unable to meet the quantity demands.

A deep test well was drilled several hundred feet below sea level. It obtained little water but logged a great deal of clay.

Finally, it was determined that a RO system would be constructed for the water supply but the permitting process was a lengthy one so water was trucked to the property from the mainland for about two years. It was common to haul water to the Estate regularly. Permits were eventually obtained and the RO system was constructed. It went into service in February of 2002. The original plant was expanded by about 50% in 2006.

The primary issues impacting development were the time required to obtain permits (and DNR leases) and the intake design.

Present System - The existing RO treatment system has a capacity of about 25,000 gpd (17 gpm). Water is used for domestic and landscaping purposes. The Water Link Corporation of Florida (now ITT) supplied the RO equipment.

The manager estimates that the average use in the summer time is on the order of 9,000 gpd and in the winter is 300 gpd. They have 5 active and approved connections.

The intake is an infiltration trench on the beach on the west side of the property. The terminus of the infiltration pipe is a well drilled on the beach above high tide. The pipe slopes into the well. The pipe extends 300 feet offshore with the last 160' being perforated. The perforated pipe is in a two-foot wide trench and bedded and covered by imported sand. Over the sand is 3/4" washed gravel. To allow withdrawal at low tide, portions of the trench are on the order of 20 feet deep. Construction of the trench and infiltration elements was a significant engineering challenge.

Discharge point is in cove well beyond the infiltration gallery.

This is a description of the system elements in order:

Infiltration trench and perforated intake line.
Beach Well with a submersible pump.
Pipeline to treatment plant.Dual media filter.
5-micron cartridge filters. (4)
1-micron cartridge filter. (4)
High pressure pump (normal operation @ 650 psi up to 900 psi)
RO membrane filters.[1]

[1] The Membrane filters require periotic chemical treatment to reduce scale. This was done "on Site" once early in the system history. Since that time the membrane are removed and transported elsewhere for examination and treatment.

Calcite treatment for treated water.[2]
Chlorine injection.
Pump and pipe to reservoir.
Treated water is stored in a 55,000-gallon reservoir.
Process water that does not pass through the RO media is returned to the bay through a "duck" check valve which produces a jet discharge.

Site Visit - On August 22, 2002 Ron Mayo and Dr. Eugene Richey visited this site as a follow-up to the earlier telephone survey. The purpose of this visit was to verify survey information and gain some firsthand familiarity with their system. Bill Rode guided the visit.

The treatment system is housed in a building about 25' x 60'. The equipment room contained the RO unit, pumps and various tanks. The building also includes an office/lab and storage area. The space provided for the equipment seemed appropriate and it was well maintained. The equipment was logically laid out and clean.

We also viewed the intake site though it was generally buried or underwater. At lower tides the intake restricts system operation. Storage has allowed the system to be shutdown at lower tides.[3]

Costs - The capital costs for the treatment system (excluding intake) were in the same range as other systems surveyed. The capital cost of the intake system was well in excess of the treatment system.

As this is a new system, the operating costs are not yet well developed. The energy consumed for operation has been estimated by the operator based on monthly OP&L charges to be about one kilowatt-hour for each 1000 gallons produced.

Consultants: HC&W-L of Seattle was the primary engineering consultant. Andy Evans currently consults on RO Operation.

Future - Added development is not anticipated on this site and there are no adjacent properties likely to seek out water for this system.

Spring Point HOA Water System, Orcas Island

---

[2] The process water coming out of the RO treatment can be quite corrosive. The calcite treatment was intended to reduce this problem but over the years other treatment was added such as magnesium oxide. They believe this corrosion problem should be given special attention during the design phase.

[3] In 2008 this tidal restriction is still of concern to the staff.

I spoke to John Ryberg, Association President on August 12, 2002 for about an hour. He managed the approval and installation of RO system and appears to be knowledgeable in the operation of RO plants of this size. He has a background in mechanical engineering. He is a member of the County Water Resource Mgmt. Committee, a study and advisory group (Mr. Ryberg reviewed this document once again in October 2008 and made such revisions as to bring it up to date.)

History - The development is for a maximum of 94 connections with about 70 now in service. (Approximately 50 of the 70 connections are "full-time"), with the remainder part-time residents). The original water source was two ponds. The water from these ponds is treated in a package Keystone-type system (with flocculation, filtration and chlorination). As the development grows the pond supply may become inadequate, especially in drought times. After investigation of alternatives, the decision was made to construct a RO facility as a back-up system to the surface water ponds.

The chronology of the water system is as follows:

Development started providing water from original System	Late 1960's
Upgrade of surface water system	1985
Planning started for RO System	1996
RO System Placed in Service	Late 2001

A primary issue impacting development was the time and difficulty in obtaining permits. A technical issue of concern was that they lacked three-phase power and had to install an inverter for the high-pressure R-O pump. (Like Guemes) Finding consultants qualified in small RO plants was difficult and forced the owners to educate themselves.

Present System - The primary water supply continues to be the pond treatment system. The RO system is currently operated primarily to maintain its operational status. Typically it is operated once or twice a week producing 3,000 gallons in each cycle. The RO plant is shut down in the winter when there is ample surface water. Of course, the RO plant will be operated when needed during a drought or during maintenance of the pond water TP. The RO plant was sized to supplement the existing surface water supply. It has a nominal capacity of 11,000 gallons per day (gpd) but de-rated to about 7,000 gpd for our lower seawater temperatures. The actual installation is a package reverse osmosis (RO) type not unlike units installed on ships. The Sea Recovery Corporation of California supplied the RO equipment. The estimated summertime level of production is 1,000 gpd. It does not operate year-around.

(As this is a supplemental system capacity calculations will be based on 7,000 gpd and 70 connections. Should the RO system become the primary source system enlargement will be needed.)

The membranes are sent off-island for cleaning.

The intake is suspended from a dock float and water withdrawn by a 5 HP pump mounted on the fixed dock. The inflow screens have 1/8-inch diam. openings. Sea water is pumped to a 500 gallon staging tank and then pumped into a multi media filter, two cartridge filters (20 and 5 microns) a high pressure pump, the RO membranes, into a finish water staging tank, chlorinated and then pumped 300 feet higher to the storage tanks. (A new 20,000-gallon and the older 80,000 gallon tank). Water from both of the water treatment plants is chlorinated and combined in the reservoirs. RO discharge (brine) water is returned to the sea at the dock float.

When the ponds are not able to satisfy demand, the RO system is operated manually to meet the needs. To date this has not occurred.

Total Dissolved Solids (TDS) is a common measure of treatment effectiveness. This system's RO treatment produces water in the range of 100-150 mg/l.

Costs - The original capital costs for this RO system were in the range of $200,000 to $250,000 for the RO treatment plant, building, intake & discharge system, approx. 3000 feet of ditching/piping/plumbing and the 20,000-gallon reservoir. These costs were met by the homeowners in a series of assessments spread over a number of years. They investigated a DOH state/federal low-interest loan program but decided to fund the system by direct member assessment.

The current operating costs for the system are met by annual fees in the $500 range and use charges that start at about $0.01/gallon up to $0.05/gallon for higher consumption. Of their costs, the cost of the part-time operator is highest single element.

The users are very conscious of their water supply and use is down in drought periods. As a consciousness-raising device, users are given a chart with their water bills that show individual water consumption of all users. Only the person receiving the bill has their consumption identified.

The annual fee includes a factor for maintenance and an equipment replacement fund however this may have to be increased to cover experience with the R-O unit.

Consultants: Thomas Design of Bellingham and Hart Pacific Engineering of Friday Harbor were the engineering consultants.

Future - They expect that they will continue using this system for their development as it approaches build-out.