CITY OF Salem
AT YOUR SERVICE

PUBLIC WORKS FIELD OFFICE
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June 7, 2007

Donn Miller
Oregon Water Resources Department
725 Summer St NE, Suite A
Salem OR 97301-1271

SUBJECT: **2006 ANNUAL REPORT FOR ASR LIMITED LICENSE #001**

Dear Mr. Miller:

This letter will serve as the City of Salem's 2006 annual report for our ASR system, operating under Limited License #001. This report includes information on progress made during 2006, water quality data, aquifer and stream flow level data, and water recharge and recovery accounting.

ASR Limited License #001 was issued in 1997 with a March 6, 2002 expiration date. In June 1998, the Oregon Department of W ater Resources (OWRD) granted a minor adjustment of the water quality monitoring program required by Limited License #001. In January 2002, the City applied for a five-year renewal of the adjusted limited license in order to further test the capabilities of the ASR system. The renewal was approved by OWRD on March 5, 2002, which allowed the adjusted limited license to remain in effect until its expiration on March 6, 2007. In June 2006, OWRD granted a minor adjustment to Limited License #001, modifying Condition 8 to allow the City to take a well field approach to the analytical testing of the current ASR wells in Woodmansee Park under an updated analyte list. As a result of the amended limited license, the City now collects all water quality data from ASR #5. In March 2007, the City applied for an additional five-year renewal of Limited License #001 in order to continue to explore the feasibility of expanding the ASR program in the Woodmansee Park area. The City has assumed that OWRD will grant the five-year extension of Limited License #001 and thus they have been operating the ASR system in accordance with the June 2006 amended version of the permit.

ASR HISTORY AND UPDATE

The City of Salem began developing the current ASR system in 1996 as a secondary water source for emergency needs and for supplemental needs during the high water use summer seasons. Four wells were constructed in Woodmansee Park in south Salem with an estimated storage capacity of 350 million gallons and a maximum recovery rate of 8.6 million gallons per day. Since the time the wells were brought online, the City has been working through various operational issues in order to optimize the performance of the ASR system with regard to storage and recovery capacity.

The City is currently working with GSI Water Solutions, Inc. to further refine the storage volume capacity of the basalt aquifer that is host to the City's ASR system. Prior to 2005, it was estimated that the basalt system could not store and successfully recover more than 350 million gallons based on hydrogeologic constraints. However, in 2005 the City stored approximately 450 million gallons in the basalt aquifer beneath Woodmansee Park and recovered 330 million gallons. Based on the response of the aquifer system, if demand was there, the City could have most likely recovered the full amount banked in 2005 (i.e., 450 million gallons).

During the summer of 2006, the City utilized the ASR system extensively to supplement the primary water supply from the North Santiam River. Growing demand in the S-2 water service area, in which the ASR system is located, has allowed the City to increase the storage and recovery capacity of the ASR system. In all, the ASR system was used for 109 days during 2006, providing about 555 million gallons of drinking water to Salem's water customers (about 502 million gallons of banked water and 53 million gallons of native groundwater).

WATER QUALITY

The 2006 water quality results for source water, ASR recovered water, ASR receiving water, and ASR 48-hours after recovery are enclosed. Analytical results showed that the water quality remained excellent during all stages of the ASR cycle testing in 2006. Volatile organic compounds (with the exception of disinfection by-products), synthetic organic compounds, and total coliform bacteria were not detected during the water quality program. Chloroform was detected at elevated levels (i.e., up to 84 parts per billion) in recovered water. It is important to note that detected concentration of total trihalomethanes (THMs), even though higher than the Federal Maximum Contaminant Level (MCL) of 80 parts per billion, is not considered a regulatory exceedence since THMs are based on a running annual average and not a one-time value. Furthermore, chloroform, although included with THMs, does not have a maximum contaminant goal established by the EPA. Regardless, the City recovered the stored water but did not deliver water to the system until DBP levels were below the MCL levels; recovered water was pumped to waste. We believe that chloroform most likely is forming in the aquifer during the storage period as a by-product of chlorine and that the longer the storage period the greater tendency there is for it to form. The City may look at reducing the residual chlorine of source water in the future, if chloroform continues to be detected at elevated concentrations. Other regulated parameters, such as metals and radionuclides, were detected at concentrations below their respective regulatory screening criteria. All aesthetic parameters (e.g., odor, color) were very good.

WATER STORAGE ACCOUNTING

The following table summarizes water storage and recovery volumes for the ASR wellfield from 1998 through 2006, as required by Limited License #001. The limited license allows the City to withdraw 95 percent of the water stored and further allows the City to carryover 95 percent of the

water stored into the next year. During 2006, the City recovered 95% of the ASR volume injected during 2006 (359.22 MG) plus the entire ASR carryover remaining in the ASR account from previous years (143.7 MG). After depleting the ASR account, the City continued to operate the ASR wells and pumped 52.53 MG of native groundwater under their existing water rights.

Calendar Year	ASR Account Carryover from Previous Year	ASR Volume Stored during Current Year	5% Reduction to ASR Volume Stored during Current Year	Total ASR Volume Available for Recovery	ASR Volume Recovered	Native Groundwater Production	Remaining ASR Balance	5% Reduction of ASR Balance for Carryover into next Year
	Volume in millions of gallons (MG)							
1998	97.11	340.78	323.74	420.85	210.34	0	210.51	199.99
1999	199.99	279.88	265.89	465.88	100.30	0	365.58	347.30
2000	347.30	0.0	0.0	347.30	1.59	0	345.71	328.42
2001	328.42	10.97	10.42	338.84	224.86	0	113.98	108.28
2002	108.28	169.26	160.80	269.08	16.24	0	252.84	240.20
2003	240.20	273.73	260.04	500.24	242.35	0	257.89	245.0
2004	245.0	137.5	130.6	375.6	321.2	0	54.4	51.7
2005	51.7	456.7	433.9	485.6	334.3	0	151.3	143.7
2006	143.7	378.13	359.22	502.9	502.9	52.53	0	0

The balance of the ASR account at the start of 2007 was 0 MG. The City is currently injecting source water at their Woodmansee Park ASR system with the goal of banking up to 450 million gallons for the 2007 ASR season.

AQUIFER AND STREAMFLOW LEVELS

Aquifer water levels recorded in operational ASR wells 2 and 4, as well as the City's five monitoring wells (ASR 3, Arlene, Friendship, Park 1, and Park 2) are enclosed. Within the operational wells, drawdown is very pronounced at the start of recovery operations, which is typical of basalt wells that commonly have a low (e.g., 50 percent) well efficiency. Similarly, the rapid recovery after pumping is also indicative of the low well efficiency of the basalt wells. The hydraulic response observed in monitoring wells Arlene, Park 1, and Park 2, indicate that these wells are in direct hydraulic connection with the aquifer host to the City's ASR system. Both ASR 3 and Friendship wells show less of a response to ASR activities compared to the other monitoring wells. This would be expected for the Friendship well since it is located further from the ASR system, but the reason for the muted response at ASR 3 is uncertain since it is completed in the primary target storage zone at a depth of 315 feet below ground surface. Additional work on the conceptual hydr geologic model of the Woodmansee area and surrounding areas is being completed by the City as part of their plan to

assess the potential of more fully utilizing their existing ASR system and potentially expanding it to different pressure zones within the City.

Stream flow monitoring for Pringle Creek, Clark Creek, and Croisan Creek was discontinued in 2006 under a verbal agreement with OWRD. However, since stream flow data are not available for when greater volumes are stored in the basalt aquifer, the City agreed to continue to collect surface water data in 2007 to see if there is a measurable response due to injecting and storing 450 million gallons in the basalt aquifer. If no response is again observed, then the City will discontinue future stream flow monitoring unless the City elects to increase the storage volume beyond 450 million gallons.

THE FUTURE PLAN

The City is currently conducting a comprehensive evaluation of its ASR program. Specifically, the City is trying to determine the maximum storage capacity of the aquifer in the Woodmansee Park area and exploring the feasibility of expanding the ASR operations at Woodmansee and elsewhere in the City. Additionally, the City added their ASR wells as additional points of appropriation to their existing groundwater rights. Since this transfer process has been approved by OWRD, the City can now pump up to 5.3 million gallons per day of native groundwater from the aquifer after it has depleted its ASR storage account. By utilizing native groundwater in conjunction with ASR activities the City will fully realize the full potential of its ASR system as a true secondary water source for the community.

We trust this report fulfills the requirements of the annual report required by the limited license. Please call me with any questions.

Sincerely,

Jason Pulley
Water Quality Supervisor

Enclosures:
1. Water Quality Data
2. Water Level Graphs

cc: Sophia Hobet, Water Services Manager
Larry Eaton, GSI Water Solutions

City of Salem ASR System
Cycle 11: 2005/2006

		Injection Water	Injection Period			Recovery Period					Native Groundwater
		Turner Control	Baseline GW	35%	70%	Prior to Recovery	25%	50%	75%	95%	
		10/24/2005	10/18/2005	1/4/2006	4/25/2006	6/26/2006	8/8/2006	8/22/2006	9/12/2006	10/2/2006	12/7/2006
Field Parameters	Temperature	6.7	10	11.2	10.8	13.2	13.6	11.6	13.5	11.6	8.5
	Conductivity	56.2	105	45	51	65	58.5	67.9	76.7	86.2	75
	Dissolved Oxygen	9.3	1.65	3.79	6.09	9.4	4.12	5.73	3.27	4.22	3.79
	pH	6.85	7	6.61	6.84	7.14	7.2	7.27	7.25	7.22	7.21
	Turbidity	0.1	0.63	0.37	0.82	0.75	0.09	0.07	0.15	0.07	0.37
	ORP	733	103.9	65.3		111	159	162	150	104	69
Geochemical	Bicarbonate	16.4	28.2	24	18.3	14.5	23.1	25.3	28	29.6	30.6
	Calcium	ND	7.53	6.37	4.43	4.58	6.08	4.59	6.84	6.54	20.3
	Carbonate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Chloride	4	7.9	4.3	4	3.9	5.8	5.9	9.4	11.7	11.1
	Hardness (as CaCO3)	19	27	24	14	15	21	24	26	29	30
	Magnesium	1.33	2.32	1.78	1.41	1.13	1.71	2.05	2.36	2.42	2.7
	Nitrate as N	ND		0.1	ND	ND	ND	ND	ND	ND	ND
	Nitrite as N	ND		ND	ND	ND	ND	ND	ND	ND	ND
	Total Nitrate-Nitrite	ND		0.1	ND	ND	ND	ND	ND	ND	ND
	Potassium	0.655	1.17	0.101	1	0.488	0.96	1.19	1.46	1.68	11
	Silica	12.9	30.3	21.5	18.7	24.2	22.5	17.9	9.98	10.9	32.1
	Sodium	4.66	8.58	7.75	6.37	4.52	7.58	8.64	10.3	8.99	11
	Sulfate	1.5	8.2	12.8	9.3	3.1	12.5	12.2	9.93	11.1	11.5
	Total Alkalinity	16.4	28.2	22	18.3	14.5	23.1	25.3	28	29.6	30.6
	Total Dissolved Solid	31	72	79	58	40	69	70	68	72	92
	Total Organic Carbon	0.58	ND	ND	ND	0.77	0.6	0.59	ND	ND	0.243
	Total Suspended Solids	ND		ND	ND	ND	ND	ND	ND	ND	ND
Disinfection	Chloroform (Trichloromethane)	0.0236	0.0062	0.0094	0.022	0.0823		0.0032		0.0012	0.0024
By-Products	Bromodichloromethane	0.0023	ND	ND	ND	0.0016		ND		ND	ND
	Dibromochloromethane	ND	ND	ND	ND	ND		ND		ND	ND
	Bromoform (Tribromomethane)	ND	ND	ND	ND	ND		ND		ND	ND
	Total Trihalomethanes	0.0267	0.0062	0.0094	0.022	0.0839		0.0032		0.0012	0.0024
	Monochloroacetic Acid	ND	ND	ND	ND	ND		ND		ND	ND
	Dichloroacetic Acid	ND	ND	ND	ND	0.0091		ND		ND	ND
	Trichloroacetic Acid	0.0133	ND	ND	ND	0.0313		ND		ND	ND
	Monobromoacetic Acid	0.0154	ND	ND	ND	ND		ND		ND	ND
	Dibromoacetic Acid	ND	ND	ND	ND	ND		ND		ND	ND
	Total Haloacetic Acids	0.0267	ND	ND	ND	0.0404		ND		ND	ND
Metals	Aluminum	ND	ND			ND					
	Antimony	ND	ND	ND	ND	ND					
	Arsenic	ND	ND	ND	ND	ND					
	Barium	ND	ND	ND	ND	ND					
	Beryllium	ND	ND	ND	ND	ND					
	Cadmium	ND	ND	ND	ND	ND					
	Chromium	ND	ND	ND	ND	ND					
	Copper	ND	ND			ND					
	Iron (Total)	ND	0.026			0.061					
	Iron (Dissolved)	ND	ND			ND					
	Lead	ND	ND	ND	ND	ND					
	Manganese (Total)	ND	ND			ND					
	Manganese (Dissolved)	ND	ND			ND					
	Mercury	ND	ND	ND	ND	ND					
	Nickel	ND	ND	ND	ND	ND					
	Selenium	ND	ND	ND	ND	ND					
	Silver	ND	ND			ND					
	Thallium	ND	ND	ND	ND	ND					
	Zinc	ND	ND			ND					

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Synthetic Organic Compounds (SOCs) (Regulated)	2,4,5-TP (Silvex)	ND				ND					
	2,4-D	ND				ND					
	Alachlor (Lasso)	ND				ND					
	Atrazine	ND				ND					
	Benzo(a)Pyrene	ND				ND					
	BHC-gamma (Lindane)	ND				ND					
	Carbofuran	ND				ND					
	Chlordane	ND				ND					
	Dalapon	ND				ND					
	Di(2-ethylhexyl)adipate *(adipates)*	ND				ND					
	Di(2-ethylhexyl)phthalate *(phthalates)*	ND				ND					
	Dibromochloropropane (DBCP)	ND				ND					
	Dinoseb	ND				ND					
	Dioxin	ND				ND					
	Diquat	ND				ND					
	Ethylene Dibromide (EDB)	ND				ND					
	Endothall	ND				ND					
	Endrin	ND				ND					
	Glyphosate	ND				ND					
	Heptachlor	ND				ND					
	Heptachlor Epoxide	ND				ND					
	Hexachlorobenzene (HCB)	ND				ND					
	Hexachlorocyclopentadiene	ND				ND					
	Methoxychlor	ND				ND					
	Polychlorinated Biphenyls (PCBs)	ND				ND					
	Pentachlorophenol	ND				ND					
	Picloram	ND				ND					
	Simazine	ND				ND					
	Toxaphene	ND				ND					
	Vydate (Oxamyl)	ND				ND					
Volatile Organic Compounds (VOCs) Regulated	1,1,1-Trichloroethane	ND				ND					
	1,1,2-Trichloroethane	ND				ND					
	1,1-Dichloroethylene	ND				ND					
	1,2,4-Trichlorobenzene	ND				ND					
	1,2-Dichlorobenzene (o)	ND				ND					
	1,2-Dichloroethane (EDC)	ND				ND					
	1,2-Dichloropropane	ND				ND					
	1,4-Dichlorobenzene (p)	ND				ND					
	Benzene	ND				ND					
	Carbon Tetrachloride	ND				ND					
	Chlorobenzene (monochlorobenzene)	ND				ND					
	cis-1,2-Dichloroethylene	ND				ND					
	Ethylbenzene	ND				ND					
	Dichloromethane (methylene chloride)	ND				ND					
	Styrene	ND				ND					
	Tetrachloroethylene	ND				ND					
	Toluene	ND				ND					
	trans-1,2-Dichloroethylene	ND				ND					
	Trichloroethylene	ND				ND					
	Vinyl chloride	ND				ND					
	Total Xylenes	ND				ND					

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Cycle 11: 2005/2006

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Radionuclides	Combined Radium 226/228					ND					
	Uranium [1]					ND					
	Gross Alpha	9.4 +/- 0.9				ND					
	Beta/Photon emitters [2]										
	Gross Beta	15.8 +/- 1.9				ND					
	I - 131 [3]					ND					
	Sr-90 [3]					-0.217 +/- 0.593					
	Tritium 3					3.24 +/- 150					
	Radon	12 +/- 22	377 +/- 34	380 +/- 29	384 +/ 28	356 +/- 37					
Bacteriological	Fecal Coliforms/E.Coli				Absent	Absent					
	Total Coliform				Absent	Absent					
Miscellaneous	Odor					1.4					
	Color					ND					
	Methylene Blue Active Substance					ND					
	Corrosivity (Langelier Saturation Index)		-2.54			-3.52					
	Asbestos					ND					
	Cyanide (as free cyanide)					ND					
	Fluoride		0.58		0.7	1					

2006 Water Elevation