



2016 Annual Water Quality Report



YOUR WATER. YOUR FUTURE.

2016 Annual Water Quality Report

Prepared by the Water Control Department

Contributing efforts by
Arizona State University

May 2017



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Introduction

The Central Arizona Project (CAP) delivers Colorado River water from Lake Havasu, located on Arizona's western border, to central and southern Arizona. The total CAP system is 336 miles long and consists of open canals, inverted siphon pipelines, tunnels, pumping plants, check structures, turnouts, and the Lake Pleasant storage reservoir. CAP is Arizona's largest supplier of renewable water.

CAP is a multi-purpose project with an annual Colorado River diversion of approximately 1.5 million acre-feet delivered to cities, industries, Indian communities, and agricultural customers as it crosses the arid desert. Colorado River water offsets groundwater mining, which benefits the state by conserving water, providing long-term storage for future use, supplementing surface water supplies, bolstering drought management, and complying with the Arizona Groundwater Management Act. CAP also provides flood control, power management, recreation, and wildlife benefits.

CAP does not provide potable water directly to the public, but supplies raw Colorado River water to municipal water treatment plants. These plants perform the necessary filtering, disinfection, and other treatment of the water to remove suspended particles and bacteria. The treated water is then delivered through the municipal distribution system for domestic use.

Water Quality Program

In a concerted effort to provide vital information and minimize water quality impacts to customers, CAP has developed a water quality monitoring program, which consists of three areas:

- 1) Ongoing monitoring of primary pollutants and general water chemistry
- 2) Ongoing corrosion and materials studies
- 3) Customers' parameters of interest

Water quality monitoring provides data and information to CAP staff and customers about patterns and trends in the canal and Lake Pleasant water quality. The data can also be used to identify potential water contaminant sources.

Water comes from two basic sources: (1) Colorado River, and (2) Lake Pleasant. As previously mentioned, the Colorado River is the main source of CAP water, but Agua Fria River inflow from rainfall/runoff on the Lake Pleasant watershed mixes with Colorado River water that is stored in the reservoir.

The CAP canal system has cross-drainage structures, which are designed to convey natural drainages over or under the CAP canal. However, there is some limited onsite drainage that is collected in the CAP system.

Historical Water Quality Information

Prior to 1996, the United States Bureau of Reclamation (USBR) and the Central Arizona Water Conservation District (CAWCD) cooperated with the United States Geological Survey (USGS) for a water quality sampling program. The USGS collected monthly and quarterly grab samples at three sites on the CAP canal system:

	Location	USGS Site Name	USGS Site Number
(1)	Planet Ranch Road bridge (Mile Post 8)	CAP CANAL AT MP 7.9 NR PARKER DAM, AZ	09426700
(2)	7th Street bridge (Mile Post 162)	CAP CANAL AT MP 162.3 AT 7TH ST AT PHOENIX, AZ	09427100
(3)	County Road bridge just upstream of the Santa Rosa Turnout (Mile Post 252)	CAP CANAL ABV BRADY PUMPPLANT NR COOLIDGE AZ	09427300

The water quality program tested and analyzed over 50 parameters. Historical CAP water quality data was published in the annual USGS Water Resources Data for Arizona reports. The data is also available online at <http://nwis.waterdata.usgs.gov/nwis/qwdata>. The period of record for the historical data is July 1985 through September 1995. The cooperative agreement with the USGS sampling program expired on September 30, 1995.

CAP began publishing an annual water quality report in 1996. Copies of the annual reports since 1996 can be obtained by contacting the CAP Water Control Department at (623) 869-2573.



Canal Water Quality Data



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CAP Canal Water Quality Data

CAP's water quality program consists of real-time water quality data from sensors installed at various locations along the canal system, and regularly scheduled grab samples, which are analyzed by a commercial laboratory. CAP also coordinates with its customers to provide additional sampling if needed.

Real-Time Water Quality Program

The transition to a single real-time water quality sensor, located in the canal adjacent to CAP Headquarters, was completed in January 2014. This multi-probe device is intended to replace the sensors at the Mark Wilmer Pump Plant, Hassayampa Pump Plant, and the Waddell Pump/Generator Plant, except for the Hach turbidity meter still in use at the Mark Wilmer Pump Plant. Parameters measured include: turbidity, temperature, conductivity, pH, and dissolved oxygen. Currently, a real-time sensor is also located in the canal near McDowell Rd in Mesa. Real-time data can be found on CAP's website at:

<http://www.cap-az.com/departments/water-operations/water-quality>

Grab Sample Program and Results

CAP contracts with a State of Arizona licensed and certified laboratory to perform the water quality analysis on grab samples. This program includes the following constituents and sampling sites:

-Water Quality Constituents-

General Parameters:	Temperature	(field measured)
	pH	(field measured)
	Dissolved Oxygen (DO)	(field measured)
	Conductivity	(field & lab measured)
	Alkalinity	
	Ammonia Nitrogen	
	Barium	
	Bromide	
	Calcium	
	Chloride	
	Copper	
	Dissolved Organic Carbon	
	Dissolved Iron	
	Iron (Total)	
	Magnesium	
	Manganese	
	Nitrate	
	Orthophosphate-P	
	Potassium (Total)	
	Silica	

	Sodium (Total)	
	Specific Conductance	
	Strontium	
	Sulfate	
	Total Dissolved Solids (TDS)	
	Total Phosphorus-P	
	Total Suspended Solids (TSS)	
	Turbidity	
Taste and Odor:	MIB / Geosmin	(as needed basis only)
Pathogens:	Giardia / Cryptosporidium	
Priority Pollutants:	Heavy Metals (As, Cd, Cr, Pb, Hg, Se, Ag, U)	
	Volatile Organic Compounds (VOC's)	
	Volatile Organic Aromatics (VOA's)	
	Organophosphorus Pesticides	
	Carbamate Pesticides	
	Chlorinated Herbicides	
	Perchlorate	

-Water Quality Sampling Sites-

	CAP Canal at Milepost
Mark Wilmer Pump Plant	0
Little Harquahala Pump Plant	59.5
99th Avenue (Lake Pleasant Parkway)	148.9
McKellips Road	193.3
Brady Pump Plant	253.8
San Xavier Pump Plant	318.3

Figure 1 is a map that identifies the above mentioned grab sample locations. Table 1 shows the grab sample schedule for 2016. The water quality data collected during 2016 is presented in Table 2 – Table 7. The data shows the measured values for each month per site. Figure 2 – Figure 6 provide graphical representations of site versus time comparisons for dissolved oxygen (DO), water temperature, pH, turbidity, and total dissolved solids (TDS). The results for the grab sample program are also updated monthly on CAP's website:

<http://www.cap-az.com/departments/water-operations/water-quality>

Central Arizona Project Canal Sampling Program

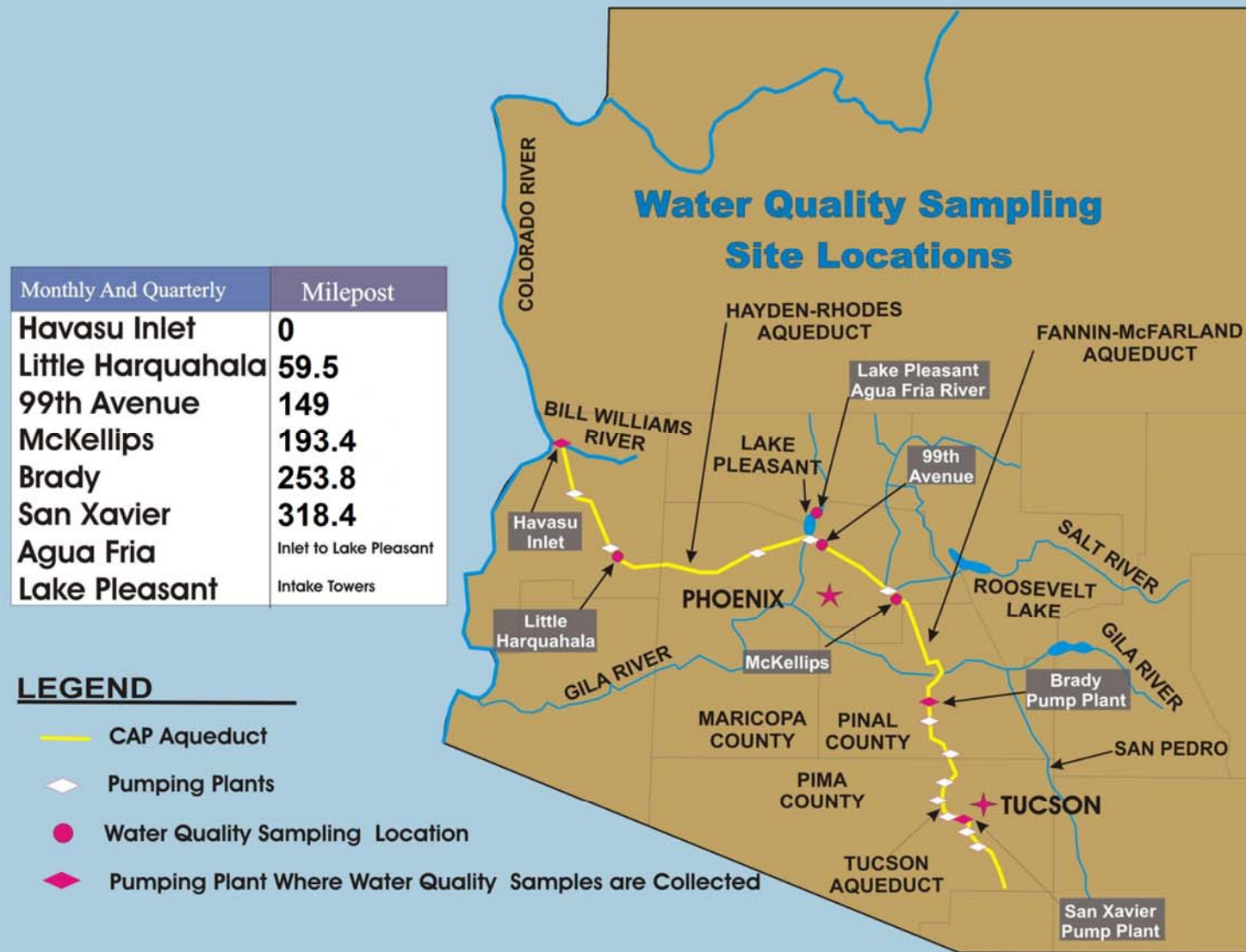


Figure 1 CAP Sampling Location Map

Table 1 Grab Sample Schedule – 2016

Month	Havasu	Little Harquahala	Lake Pleasant	99th Ave. (Lake Pleasant Parkway)	McKellips	Brady	San Xavier
JAN	G, H (1/12)	G, H (1/12)		G, H (1/11)	G, H (1/6)	G, H (1/5)	G, H (1/5)
FEB	G, H, GC, PP (2/10)	G, (2/10)	G, H, GC, PP (2/9)	G, H, GC, PP (2/3)	G, H (2/3)	G, H (2/24)	G, H, GC, PP (2/24)
MAR	G, H (3/8)	G, H (3/8)		G, H (3/10)	G, H (3/7)	G, H (3/15)	G, H (3/15)
APR	G, H (4/7)	G, H (4/7)		G, H (4/6)	G, H (4/6)	G, H (4/13)	G, H (4/13)
MAY	G, H, GC, PP (5/11)	G, H (5/11)	G, H, PP (5/5)	G, H, GC, PP (5/2)	G, H (5/4)	G, H (5/3)	G, H, GC, PP (5/3)
JUN	G, H (6/9)	G, H (6/9)		G, H (6/8)	G, H (6/8)	G, H (6/14)	G, H (6/14)
JUL	G, H (7/12)	G, H (7/12)		G, H (7/13)	G, H (7/13)	G, H (7/7)	G, H (7/7)
AUG	H (8/1), G, GC, PP (8/4)	G, H (8/4)	G, H, GC, PP (8/1)	G, H, GC, PP (8/2)	G, H (8/2)	G, H (8/16)	G, H, PP (8/16)
SEP	G, H (9/13)	G, H (9/13)		G, H (9/6)	G, H (9/6)	G, H (9/14)	G, H (9/14)
OCT	G, H (10/6)	G, H (10/6)		G, H (10/4)	G, H (10/4)	G, H (10/11)	G, H (10/11)
NOV	G, H, GC, PP (11/16)	G, H (11/16)	G, H, GC, PP (11/16)	G, GC, PP (11/14), H (11/16)	G, H (11/16)	G, H (11/15)	G, H, GC, PP (11/15)
DEC	G, H (12/21)	G, H (12/21)		G, H (12/7)	G, H (12/7)	G, H (12/20)	G, H (12/20)

G= General Chemistry: alkalinity, ammonia nitrogen, barium, bromide, calcium, chloride, copper, dissolved organic carbon*, dissolved iron, total iron, magnesium, manganese, nitrate, orthophosphate, potassium, silica, sodium, specific conductance, strontium, sulfate, total dissolved solids (TDS), total phosphorus, total suspended solids (TSS), and turbidity.

H= Hydrolab readings of temperature, dissolved oxygen, conductivity, and pH will be taken each month at Lake Pleasant.

GC= Giardia/Cryptosporidium

PP= Priority pollutants: metals (silver, arsenic, cadmium, chromium, mercury, lead, selenium), volatile organic compounds (VOCs) semi-volatile organic compounds (semi-VOCs), aldicarbs, herbicides, perchlorate (beginning August 2004), and uranium (beginning August 2013).

Table 2 Lake Havasu Grab Sample Results

Lake Havasu 2016 at Mark Wilmer Pumping Plant, Parker Arizona													
General Chemistry Analytes	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature	°F	50.3	EQ	60.2	67.9	70.9	80.0	83.2	84.5	78.3	74.4	68.9	53.6
Dissolved Oxygen	mg/L	10.73	EQ	9.06	9.56	9.61	9.35	9.68	8.86	6.76	7.68	8.08	10.41
Specific Conductance	µS/cm	986	EQ	1011	996	971	982	959	969	969	963	957	947
pH		8.5	EQ	7.7	8.2	8.5	8.2	7.8	8.3	8.2	8.2	8.2	8.5
Alkalinity in CaCO3 units	mg/L	120	130	130	130	130	130	110	120	120	120	120	130
Ammonia Nitrogen	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.05	ND
Barium, Total, ICAP/MS	µg/L	140	140	130	130	130	130	110	130	140	140	130	120
Bromide	µg/L	87	83	83	84	84	81	80	83	82	85	88	88
Calcium, Total, ICAP	mg/L	79	80	74	76	78	75	74	70	71	72	75	78
Chloride	mg/L	99	96	95	94	92	89	93	95	96	93	92	93
Copper, Total, ICAP/MS	µg/L	ND	410.0	ND	ND	120.0	ND	ND	ND	ND	ND	21.0	ND
Dissolved Organic Carbon	mg/L	2.8	2.7	0.6	2.6	2.8	2.9	3.7	3.4	3.3	3.1	3.4	2.9
Iron, Dissolved, ICAP	mg/L	ND	ND	ND	ND	0.02	ND	ND	ND	ND	ND	ND	ND
Iron, Total, ICAP	mg/L	0.08	0.10	ND	0.04	0.08	ND	ND	ND	0.04	0.21	0.16	0.03
Magnesium, Total, ICAP	mg/L	29	29	27	26	27	26	28	27	26	26	27	29
Manganese, Total, ICAP/MS	µg/L	4.4	4.4	3.2	3.1	6.3	2.6	ND	4.5	12.0	12.0	7.7	4.2
Nitrate as Nitrogen by IC	mg/L	0.28	0.31	0.40	0.40	0.34	ND	ND	ND	ND	ND	0.26	0.27
Orthophosphate as P	mg/L	ND	ND	ND	ND	ND	ND	0.03	ND	ND	ND	ND	ND
Potassium, Total, ICAP	mg/L	5.1	5.0	4.7	5.0	4.8	4.9	4.9	4.7	4.8	4.9	5.1	5.1
Silica	mg/L	8.9	9.0	8.5	8.4	7.9	8.2	8.3	8.2	8.9	10.0	10.0	10.0
Sodium, Total, ICAP	mg/L	100	99	91	97	92	97	100	93	93	95	100	100
Specific Conductance	µS/cm	1000	1000	1000	1000	1000	1000	990	1000	1000	1000	1000	1000
Strontium, ICAP	mg/L	1.2	1.2	1.1	1.2	1.1	1.1	1.2	1.1	1.1	1.1	1.1	1.2
Sulfate	mg/L	260	250	250	250	240	240	240	240	240	240	240	240
Total Dissolved Solids (TDS)	mg/L	670	660	700	640	680	660	660	640	670	640	640	670
Total phosphorus as P	mg/L	ND	ND	ND	0.02	ND	ND	ND	ND	ND	ND	ND	ND
Total Suspended Solids (TSS)	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Turbidity	NTU	0.91	1.60	0.80	0.88	0.75	0.44	0.42	0.83	1.10	1.80	1.30	1.50
Quarterly Analytes Detected	These Results are the Priority Pollutants that are Reported by Exception as Detected by the Quarterly Samples												
Arsenic, Total, ICAP/MS	µg/L	2.6	2.2			2.7			2.6			2.5	
Silver Total ICAP/MS	µg/L		ND			1.40			ND			ND	
Hexavalent Chromium	µg/L		ND			ND			ND			0.02	
Perchlorate - Low Level	µg/L		2.4			ND			ND			ND	
Uranium, Total, ICAP/MS	µg/L	4.7	4.4			4.3			4.0			4.1	
Data Recovered with Hydrolab in Field				General Chemistry Data Sampled Monthly					Priority Pollutants Sampled Quarterly				
NA = Analyte not Sampled				ND = Analyte not Detected					EQ = Equipment Problem				

Table 3 Little Harquahala Grab Sample Results

Little Harquahala Pumping Plant 2016													
General Chemistry Analytes	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature	°F	49.9	EQ	58.8	66.3	71.9	78.6	81.4	85.2	79.6	73.2	68.0	53.4
Dissolved Oxygen	mg/L	10.66	EQ	12.20	9.80	9.61	9.23	9.05	8.32	7.70	7.34	8.46	10.78
Specific Conductance	µS/cm	984	EQ	1009	1013	977	981	963	968	967	965	1000	947
pH		8.6	EQ	7.6	8.3	8.5	8.2	8.3	8.2	8.2	8.1	8.3	8.5
Alkalinity in CaCO3 units	mg/L	120	130	130	130	130	120	120	120	120	120	120	130
Ammonia Nitrogen	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.06	ND	0.08
Barium, Total, ICAP/MS	µg/L	140	140	130	130	130	130	110	120	120	130	130	130
Bromide	µg/L	86	83	82	83	81	80	81	82	82	86	85	85
Calcium, Total, ICAP	mg/L	78	80	79	77	76	74	74	69	73	72	74	79
Chloride	mg/L	98	96	94	94	92	89	93	94	97	93	93	93
Copper, Total, ICAP/MS	µg/L	ND	740.00	ND	ND	330.00	ND	ND	ND	ND	ND	73.00	ND
Iron, Dissolved, ICAP	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron, Total, ICAP	mg/L	0.11	0.11	ND	0.03	0.15	ND	ND	0.04	ND	0.18	0.09	ND
Magnesium, Total, ICAP	mg/L	28	29	29	28	26	26	28	26	27	26	26	29
Manganese, Total, ICAP/MS	µg/L	5.3	3.4	2.8	4.9	3.6	2.8	3.2	5.5	2.2	10.0	4.0	2.2
Nitrate as Nitrogen by IC	mg/L	0.28	0.32	0.41	0.39	0.33	ND	ND	ND	ND	ND	ND	0.27
Orthophosphate as P	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	0.01	ND	ND	ND
Potassium, Total, ICAP	mg/L	5.0	5.0	5.0	4.8	4.8	4.9	5.0	4.6	5.2	5.0	5.0	5.1
Silica	mg/L	9.2	9.2	8.4	8.2	7.1	7.4	8.0	7.9	8.6	9.5	9.6	9.5
Sodium, Total, ICAP	mg/L	100	100	97	93	94	96	100	93	99	96	99	100
Specific Conductance	µS/cm	1000	1000	1000	1000	1000	1000	990	1000	1000	1000	1000	1000
Strontium, ICAP	mg/L	1.2	1.2	1.2	1.2	1.1	1.1	1.2	1.1	1.1	1.1	1.1	1.2
Sulfate	mg/L	260	250	250	250	240	240	240	240	250	240	240	240
Total Dissolved Solids (TDS)	mg/L	690	670	690	630	670	660	640	640	630	640	650	670
Total phosphorus as P	mg/L	ND	ND	ND	0.04	ND	ND	ND	ND	ND	ND	ND	ND
Total Suspended Solids (TSS)	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Turbidity	NTU	0.77	3.20	0.71	1.60	2.10	0.37	0.52	0.53	0.45	2.50	0.74	0.76
Quarterly Analytes Detected	These Results are the Priority Pollutants that are Reported by Exception as Detected by the Quarterly Samples												
NO QUARTERLY SAMPLES ARE TAKEN AT THIS LOCATION													

Data Recovered with Hydrolab in Field

General Chemistry Data Sampled Monthly

Priority Pollutants Sampled Quarterly

NA = Analyte not Sampled

ND = Analyte not Detected

EQ = Equipment Problem

Table 4 99th Avenue (Lake Pleasant Parkway) Grab Sample Results

99th Avenue (Lake Pleasant Parkway) 2016													
General Chemistry Analytes	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature	°F	51.1	50.0	60.5	67.4	69.1	64.8	66.3	85.2	74.2	73.7	68.2	55.7
Dissolved Oxygen	mg/L	10.84	11.39	12.30	10.21	9.37	7.86	7.25	6.46	6.27	8.85	9.62	10.67
Specific Conductance	µS/cm	984	998	1009	1013	979	994	978	984	951	961	947	951
pH		8.7	8.8	7.8	8.2	8.5	8.1	7.8	7.8	8.1	8.3	8.4	8.5
Alkalinity in CaCO3 units	mg/L	120	120	130	130	130	120	120	120	120	120	120	120
Ammonia Nitrogen	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium, Total, ICAP/MS	µg/L	140	140	130	140	140	130	120	120	120	32	130	120
Bromide	µg/L	90	83	81	82	83	85	90	88	84	85	82	90
Calcium, Total, ICAP	mg/L	82	76	76	81	79	74	71	70	78	69	74	67
Chloride	mg/L	98	96	94	94	92	96	94	95	94	94	100	96
Copper, Total, ICAP/MS	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	12.00	ND	ND
Iron, Dissolved, ICAP	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron, Total, ICAP	mg/L	0.07	0.05	0.07	0.18	0.14	0.05	0.03	ND	0.05	0.08	0.09	0.06
Magnesium, Total, ICAP	mg/L	30	26	27	28	28	28	30	28	28	25	27	25
Manganese, Total, ICAP/MS	µg/L	3.0	2.8	3.8	8.6	6.2	5.0	5.8	6.4	13.0	9.2	5.0	3.1
Nitrate as Nitrogen by IC	mg/L	0.27	0.29	0.40	0.38	0.34	ND	ND	ND	ND	ND	ND	0.26
Orthophosphate as P	mg/L	ND	0.01	ND	ND	0.06	ND	ND	ND	ND	ND	ND	ND
Potassium, Total, ICAP	mg/L	5.5	4.7	4.6	5.5	5.1	5.3	5.1	5.0	5.3	4.6	5.0	4.4
Silica	mg/L	8.7	8.2	7.7	8.8	8.2	7.9	8.0	7.8	8.7	7.6	9.6	8.2
Sodium, Total, ICAP	mg/L	100	97	92	100	98	100	100	96	100	90	99	90
Specific Conductance	µS/cm	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Strontium, ICAP	mg/L	1.3	1.1	1.1	1.2	1.2	1.2	1.2	1.1	1.2	1.1	1.1	1.0
Sulfate	mg/L	260	250	250	250	250	250	250	240	240	240	260	240
Total Dissolved Solids (TDS)	mg/L	670	650	660	630	640	680	650	650	650	620	640	670
Total phosphorus as P	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.09	ND
Total Suspended Solids (TSS)	mg/L	ND	ND	ND	12.00	ND	ND	ND	ND	34.00	ND	ND	ND
Turbidity	NTU	1.80	0.61	0.57	1.50	0.64	0.44	0.51	0.84	3.40	1.20	0.74	0.63
Quarterly Analytes Detected	These Results are the Priority Pollutants that are Reported by Exception as Detected by the Quarterly Samples												
Arsenic, Total, ICAP/MS	µg/L		2.9			2.7			2.8			2.3	
Orthophosphate as PO4	µg/L		0.03			0.17			ND			ND	
Uranium, Total, ICAP/MS	µg/L		4.7			4.6			4.0			4.2	
Data Recovered with Hydrolab in Field			General Chemistry Data Sampled Monthly						Priority Pollutants Sampled Quarterly				
NA = Analyte not Sampled			ND = Analyte not Detected						EQ = Equipment Problem				

Table 5 McKellips Rd. Grab Sample Results

McKellips Rd. 2016													
General Chemistry Analytes	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature	°F	51.1	51.4	62.5	67.9	70.9	67.9	67.1	73.3	75.6	74.9	67.4	56.4
Dissolved Oxygen	mg/L	10.99	11.08	12.39	10.26	9.70	9.11	8.55	8.29	7.94	9.05	9.91	10.99
Specific Conductance	µS/cm	984	999	1011	1017	977	993	982	985	980	962	946	950
pH		8.6	8.6	7.5	8.3	8.4	8.1	8.1	8.0	8.2	8.4	8.4	8.6
Alkalinity in CaCO3 units	mg/L	120	130	130	130	120	120	120	120	120	120	120	120
Ammonia Nitrogen	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium, Total, ICAP/MS	µg/L	120	140	130	140	140	120	120	120	120	120	140	120
Bromide	µg/L	86	81	78	82	80	90	91	88	85	85	87	88
Calcium, Total, ICAP	mg/L	76	77	78	75	72	72	73	70	76	70	70	67
Chloride	mg/L	100	96	95	94	92	97	95	96	95	94	94	96
Copper, Total, ICAP/MS	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron, Dissolved, ICAP	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron, Total, ICAP	mg/L	0.02	0.07	ND	0.03	0.10	ND	ND	ND	0.02	ND	ND	0.03
Magnesium, Total, ICAP	mg/L	29	27	28	27	26	28	29	29	29	26	26	25
Manganese, Total, ICAP/MS	µg/L	2.8	4.6	3.4	4.7	4.8	4.1	4.8	5.1	7.9	4.7	ND	2.4
Nitrate as Nitrogen by IC	mg/L	0.26	0.28	0.38	0.36	0.32	ND	ND	ND	ND	ND	ND	ND
Orthophosphate as P	mg/L	0.01	0.01	0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium, Total, ICAP	mg/L	4.8	4.8	4.9	4.7	4.8	5.2	5.4	5.0	5.4	4.7	4.9	4.4
Silica	mg/L	8.6	8.3	7.4	7.6	6.9	7.2	7.6	7.5	8.5	7.4	7.9	7.6
Sodium, Total, ICAP	mg/L	100	98	97	91	93	98	100	98	100	91	96	91
Specific Conductance	µS/cm	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Strontium, ICAP	mg/L	1.2	1.2	1.2	1.1	1.1	1.1	1.2	1.1	1.2	1.1	1.1	1.0
Sulfate	mg/L	260	250	250	250	250	250	250	250	250	240	240	250
Total Dissolved Solids (TDS)	mg/L	660	640	650	630	670	670	660	650	650	630	630	670
Total phosphorus as P	mg/L	ND	ND	0.20	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Suspended Solids (TSS)	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	14.00	ND	ND	ND
Turbidity	NTU	0.62	0.59	0.93	1.20	0.68	0.54	0.55	0.86	3.70	1.10	0.37	0.64
Quarterly Analytes Detected													
These Results are the Priority Pollutants that are Reported by Exception as Detected by the Quarterly Samples													
NO QUARTERLY SAMPLES ARE TAKEN AT THIS LOCATION													

Data Recovered with Hydrolab in Field

General Chemistry Data Sampled Monthly

Priority Pollutants Sampled Quarterly

NA = Analyte not Sampled

ND = Analyte not Detected

EQ = Equipment Problem

Table 6 Brady Pumping Plant Grab Sample Results

Brady Pumping Plant 2016													
General Chemistry Analytes	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature	°F	53.1	59.6	63.3	70.1	71.0	71.6	75.2	83.3	78.4	75.4	66.4	56.2
Dissolved Oxygen	mg/L	10.01	9.55	11.77	8.55	9.48	9.81	9.00	9.01	8.49	9.58	8.92	10.78
Specific Conductance	µS/cm	955	1012	1010	1004	976	993	981	981	977	962	EQ	939
pH		8.4	7.5	7.8	8.5	8.5	8.2	8.1	8.1	8.3	8.4	8.4	8.6
Alkalinity in CaCO3 units	mg/L	120	120	120	120	120	120	120	110	120	120	110	100
Ammonia Nitrogen	mg/L	0.06	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium, Total, ICAP/MS	µg/L	130	140	130	130	130	140	120	120	120	160	130	120
Bromide	µg/L	90	86	84	82	82	87	90	84	83	84	84	82
Calcium, Total, ICAP	mg/L	74	79	76	74	79	75	71	70	73	76	69	76
Chloride	mg/L	98	95	97	90	93	96	95	96	100	94	95	93
Copper, Total, ICAP/MS	µg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron, Dissolved, ICAP	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron, Total, ICAP	mg/L	0.07	0.03	0.08	ND	0.10	0.14	ND	0.09	ND	0.07	0.04	0.03
Magnesium, Total, ICAP	mg/L	28	28	27	26	28	28	28	28	28	28	27	29
Manganese, Total, ICAP/MS	µg/L	6.9	6.2	7.3	ND	4.8	8.9	4.0	12.0	6.6	6.9	5.2	3.0
Nitrate as Nitrogen by IC	mg/L	ND	0.31	0.35	0.31	0.30	ND	ND	ND	ND	ND	ND	ND
Orthophosphate as P	mg/L	0.01	0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium, Total, ICAP	mg/L	4.8	5.2	4.9	5.1	5.2	5.2	5.0	5.0	5.3	5.2	5.1	5.2
Silica	mg/L	7.9	7.5	6.9	6.5	7.1	7.5	7.0	7.2	8.1	7.4	6.2	8.2
Sodium, Total, ICAP	mg/L	100	100	97	97	100	98	97	97	100	100	100	100
Specific Conductance	µS/cm	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Strontium, ICAP	mg/L	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.2	1.2	1.1	1.2
Sulfate	mg/L	260	250	260	240	250	250	250	250	250	240	240	240
Total Dissolved Solids (TDS)	mg/L	700	660	620	650	660	660	630	640	620	630	610	630
Total phosphorus as P	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.04	ND
Total Suspended Solids (TSS)	mg/L	ND	ND	ND	ND	16	17	ND	19	ND	ND	ND	ND
Turbidity	NTU	1.80	1.80	0.90	0.39	0.61	0.56	0.51	1.30	0.95	1.60	0.87	0.44
Quarterly Analytes Detected													
These Results are the Priority Pollutants that are Reported by Exception as Detected by the Quarterly Samples													
NO QUARTERLY SAMPLES ARE TAKEN AT THIS LOCATION													

Data Recovered with Hydrolab in Field

NA = Analyte not Sampled

General Chemistry Data Sampled Monthly

ND = Analyte not Detected

Priority Pollutants Sampled Quarterly

EQ = Equipment Problem

Table 7 San Xavier Grab Sample Result

San Xavier Pumping Plant 2016													
General Chemistry Analytes	Units	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature	°F	52.7	59.6	61.7	69.2	69.0	75.9	81.9	83.1	78.3	73.6	63.1	54.0
Dissolved Oxygen	mg/L	9.13	8.72	10.27	8.85	6.94	8.81	7.91	8.15	7.42	8.69	8.53	9.95
Specific Conductance	µS/cm	970	1012	1014	1025	980	1002	991	973	978	963	960	931
pH		8.3	7.0	10.3	8.3	8.3	8.2	8.1	8.0	8.2	8.3	8.3	8.5
Alkalinity in CaCO3 units	mg/L	120	120	120	120	120	120	120	120	120	120	98	100
Ammonia Nitrogen	mg/L	ND	0.06	ND	ND	0.06	ND	ND	0.06	ND	0.05	0.08	ND
Barium, Total, ICAP/MS	µg/L	130	140	140	140	140	130	120	120	130	150	120	130
Bromide	µg/L	86	88	84	82	81	89	92	86	84	85	95	82
Calcium, Total, ICAP	mg/L	67	79	75	72	75	76	73	70	66	72	66	74
Chloride	mg/L	98	97	99	90	94	97	97	95	100	96	100	93
Copper, Total, ICAP/MS	µg/L	ND	ND	2.40	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dissolved Organic Carbon	mg/L	2.9	3.1	2.1	2.9	3.0	3.1	3.5	3.6	3.7	3.4	5.0	3.2
Iron, Dissolved, ICAP	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron, Total, ICAP	mg/L	0.14	0.14	0.12	0.10	0.13	0.20	0.13	0.21	0.09	0.06	0.03	0.04
Magnesium, Total, ICAP	mg/L	26	29	27	26	28	30	30	28	26	28	29	28
Manganese, Total, ICAP/MS	µg/L	4.8	5.2	6.1	7.8	5.7	7.7	5.9	17.0	8.9	5.3	5.1	2.7
Nitrate as Nitrogen by IC	mg/L	ND	ND	0.34	0.28	ND	ND	ND	ND	ND	ND	ND	ND
Orthophosphate as P	mg/L	0.02	0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium, Total, ICAP	mg/L	4.4	5.1	5.0	5.1	5.1	5.5	5.4	5.3	4.8	5.2	5.5	5.1
Silica	mg/L	7.1	7.3	6.4	6.5	6.6	8.3	7.6	8.1	7.6	7.2	6.7	6.6
Sodium, Total, ICAP	mg/L	92	100	98	97	100	100	100	99	91	99	110	100
Specific Conductance	µS/cm	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Strontium, ICAP	mg/L	1.1	1.2	1.2	1.1	1.2	1.2	1.2	1.1	1.0	1.2	1.2	1.2
Sulfate	mg/L	260	260	260	240	250	250	250	250	260	250	260	240
Total Dissolved Solids (TDS)	mg/L	690	650	660	640	690	660	630	640	640	660	620	650
Total phosphorus as P	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.05	ND
Total Suspended Solids (TSS)	mg/L	ND	11.00	11.00	15.00	ND	10.00	11.00	ND	ND	ND	ND	ND
Turbidity	NTU	4.30	4.20	1.40	1.00	0.81	1.00	1.70	6.00	2.90	2.00	0.50	0.45
Quarterly Analytes Detected	These Results are the Priority Pollutants that are Reported by Exception as Detected by the Quarterly Samples												
Arsenic, Total, ICAP/MS	µg/L		1.9			2.7			3.5			2.2	
Orthophosphate as PO4	mg/L		0.04			ND			ND			ND	
Di(2-Ethylhexyl)phthalate	ug/L		0.60			ND			ND			ND	
Data Recovered with Hydrolab in Field		General Chemistry Data Sampled Monthly							Priority Pollutants Sampled Quarterly				
NA = Analyte not Sampled		ND = Analyte not Detected							EQ = Equipment Problem				

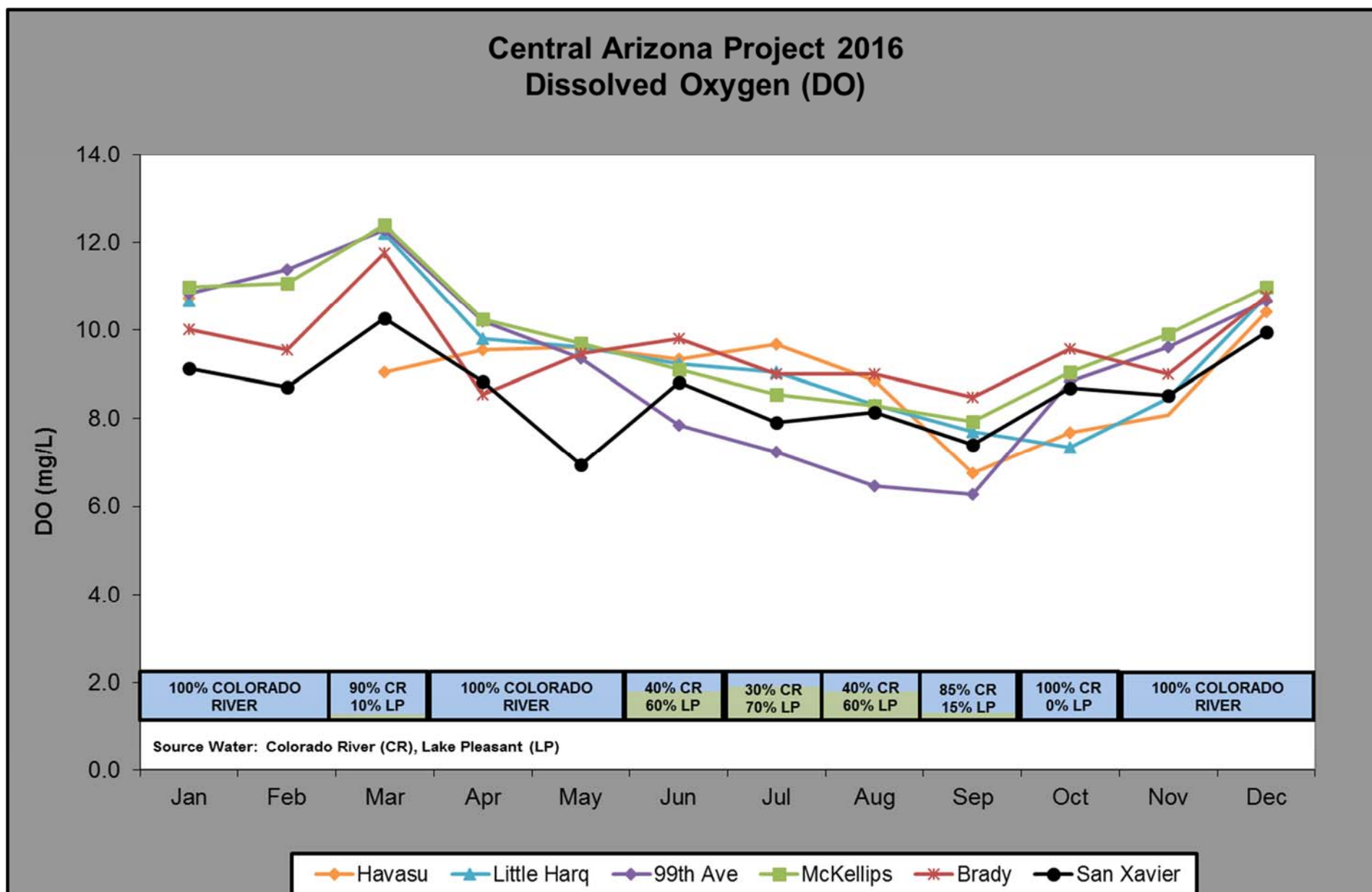


Figure 2 Canal Hydrolab Dissolved Oxygen Results

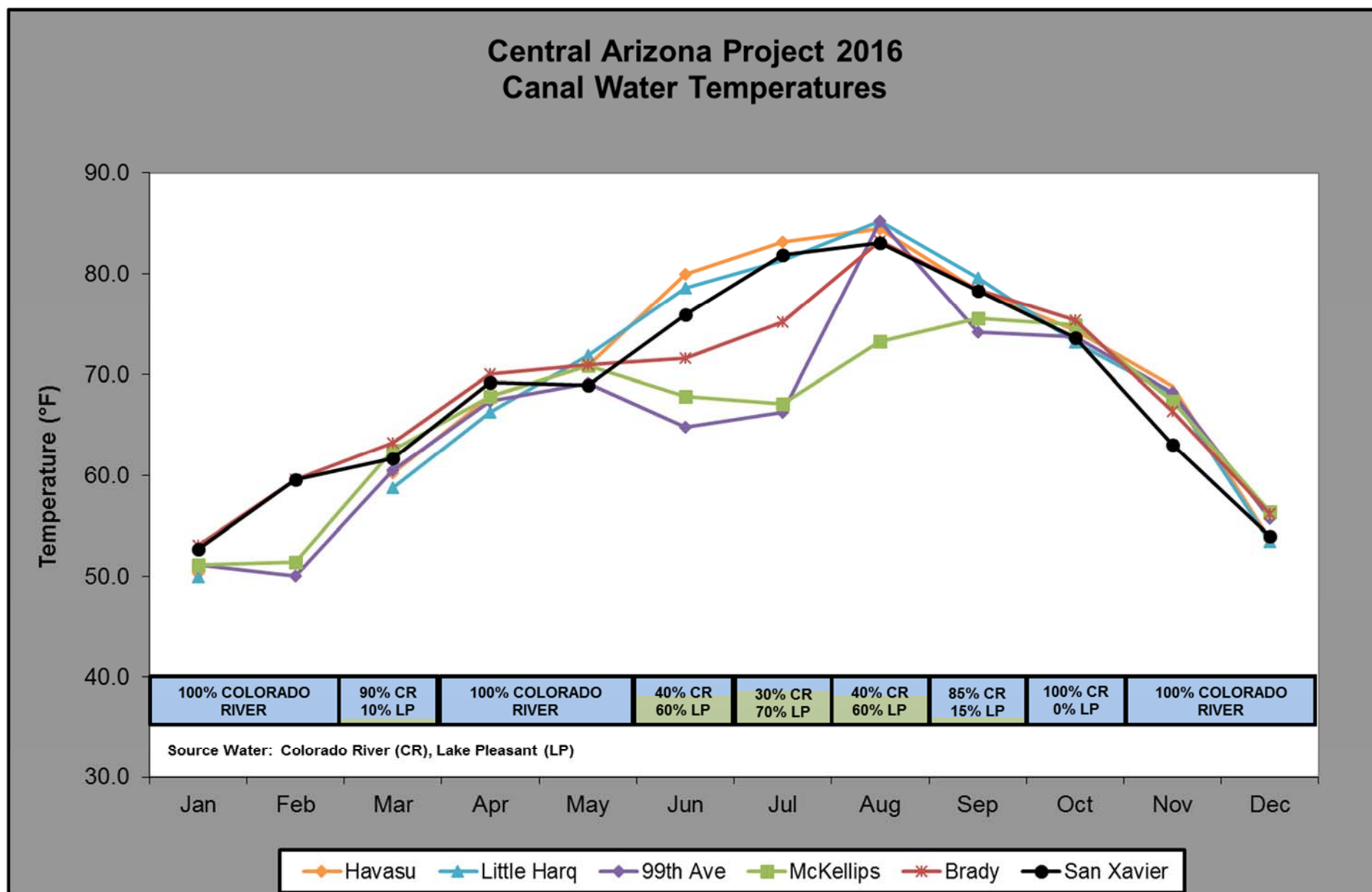


Figure 3 Canal Hydrolab Temperature Results

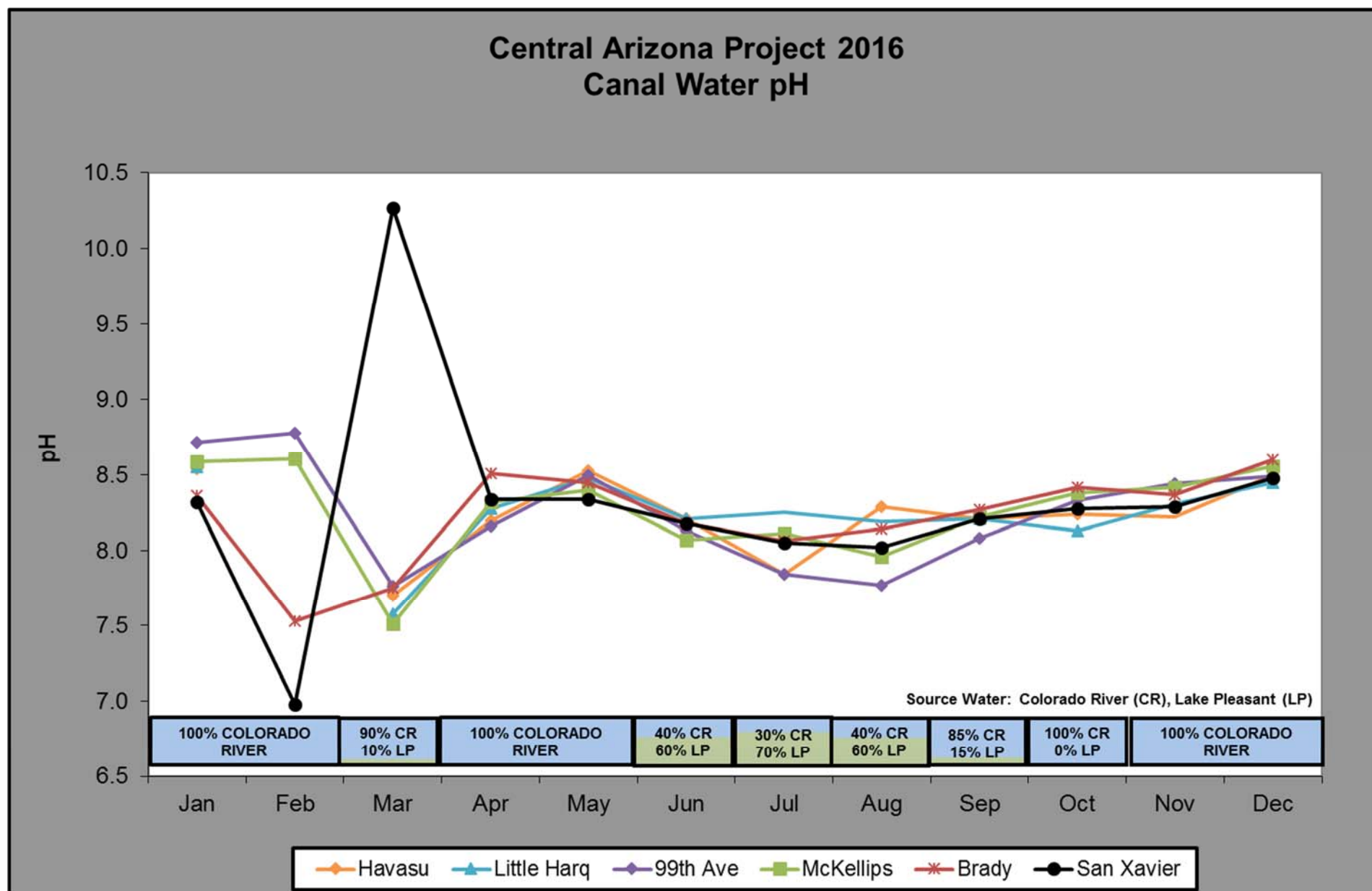


Figure 4 Canal Hydrolab pH Results

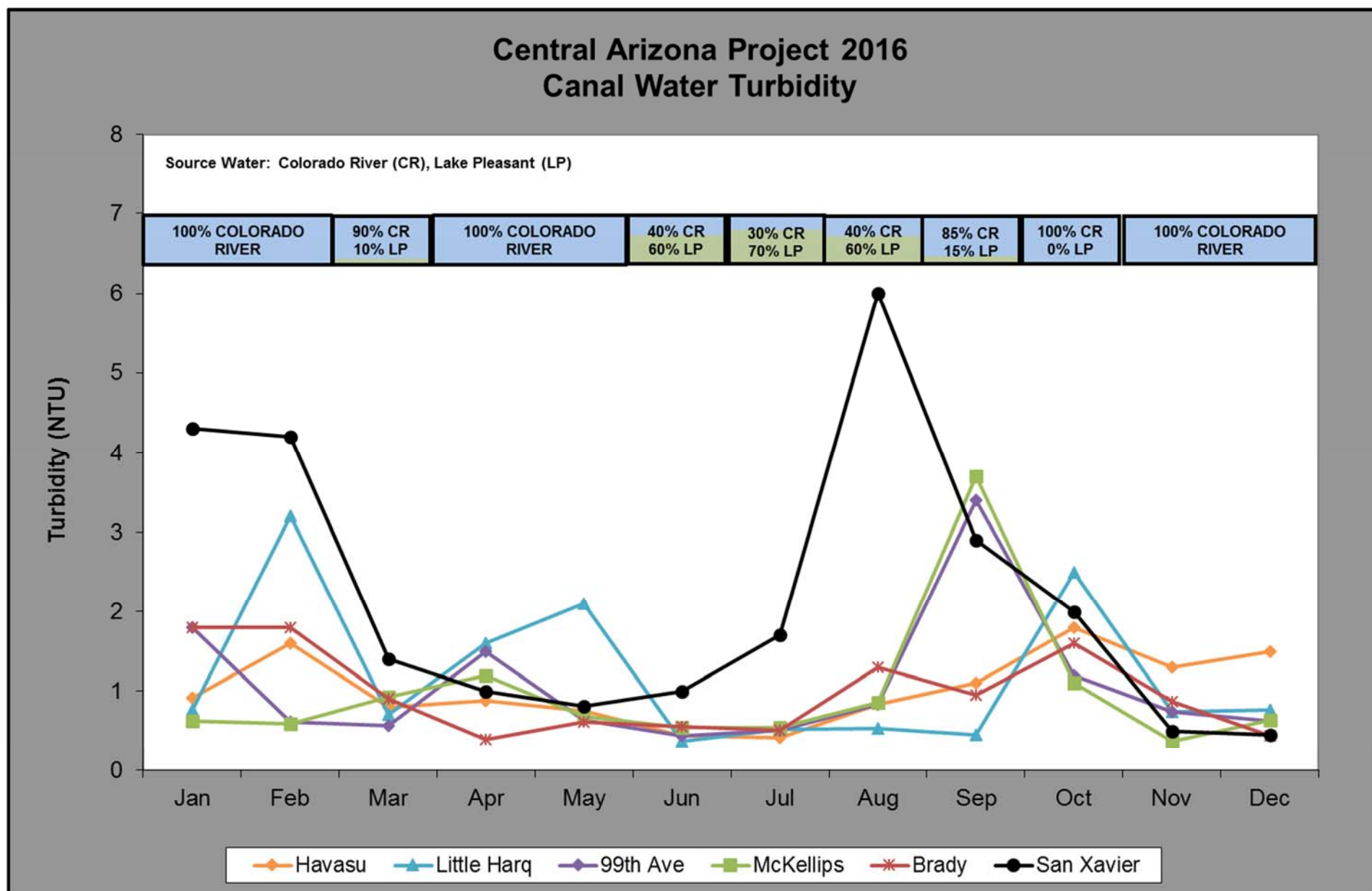


Figure 5 Canal Grab Sample Turbidity Results

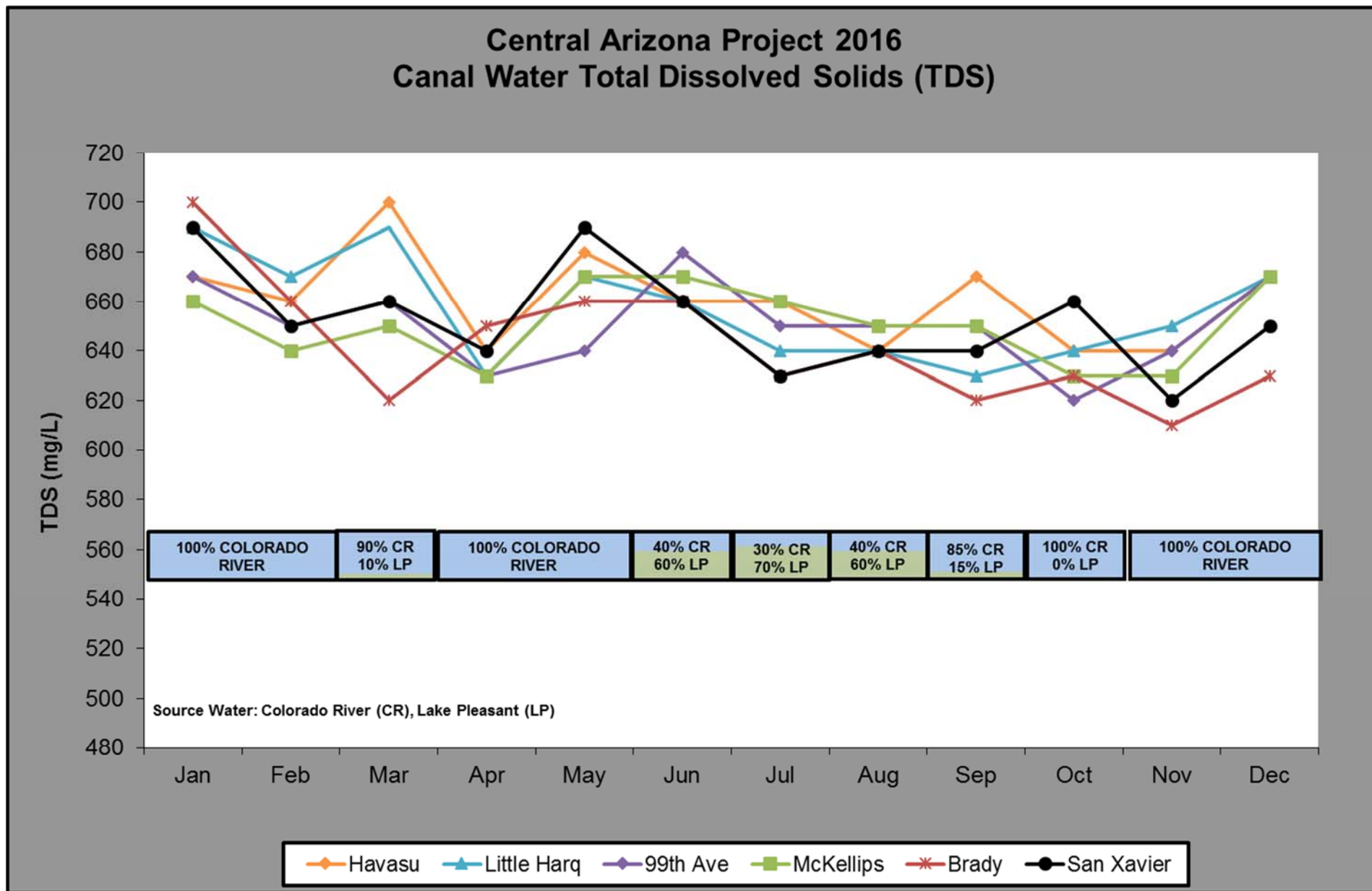


Figure 6 Canal Grab Sample Total Dissolved Solids (TDS) Results



Lake Pleasant Water Quality Data



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Lake Pleasant Reservoir Water Quality Data

The CAP aqueduct system utilizes Lake Pleasant as a seasonal pumped-storage reservoir. During a typical year, Colorado River water is pumped into the lake from October to May when water demands and electricity costs are lower. During the summer, when water demands and electricity costs are higher, water is released from the lake for customer deliveries. CAP's summer 2016 operating strategy was similar to the last five years. In an effort to maximize CAP's energy resources, releases from Lake Pleasant began in June and continued until the beginning of September.

The Agua Fria River flows into Lake Pleasant and inflows vary each year (see Figure 7). During dry years on the watershed the reservoir storage is mostly Colorado River water, and during wet years with substantial runoff, the reservoir has a blend of Colorado River and Agua Fria River water.

Water enters the lake from the Agua Fria River channel on the north end of the lake. Releases to the CAP canal are made from the Waddell Pump/Generating station located below the New Waddell Dam on the south end of the lake. Consequently, inflows from the Agua Fria are not immediately released to CAP customers from Lake Pleasant.

Lake Pleasant Sampling

The sampling dates for this location were: February 9, May 5, August 1, and November 16, 2016. The water quality of the lake represents a blend of Colorado River water and Agua Fria River water. The lake was relatively clear with turbidity levels averaging 0.52 NTU, and Total Dissolved Solids (TDS) levels averaging 670 mg/L. In years with significant runoff from the Agua Fria, the TDS levels are much lower than those in Colorado River water. Table 8 contains the Lake Pleasant grab sample results.

Lake Pleasant Depth Profiles

The largest changes in lake water chemistry are related to seasonal changes and depth. Depth profile measurements were collected at the towers at New Waddell Dam using a portable Hydrolab multi-probe water quality sensor on January 11, February 16, March 10, April 12, June 8, July 13, August 1, September 6, October 3, November 22, and December 15, 2016. No data was taken during the month of May due to equipment failure. The water quality parameters measured included temperature, pH, and dissolved oxygen. Figure 8 – Figure 10 contain the Lake Pleasant depth profile results.

Lake Pleasant depth profiles indicate that thermal stratification occurred in the summer months. The upper layer (epilimnion) was oxygen-rich, with a higher temperature, as well as having a slightly higher pH. The lower layer (hypolimnion), was lower in dissolved oxygen with lower temperatures and slightly lower pH.

The oxygen deficit conditions at the lower depths may cause sediment nutrient release through the process of reduction. If the sediment/water interface is exposed to prolonged periods of anoxia, reducing conditions allow the formation of nutrients previously unavailable

for organisms. Reduction of these nutrients cause taste and odor changes in the water. This reduction may lead to sapropel formation, a compound that is high in hydrogen sulfide and methane, and has a shiny, black color due to the presence of ferrous sulfide. This compound is responsible for the occasional "rotten-egg" odor associated with releases from the hypolimnion layer through the lower portal on the intake towers.

Nutrients, such as nitrogen and phosphorous, become unbound from their ionic association with metals, such as iron, and manganese. This process may free up nutrients, which contribute to algae blooms in the canal system. Precipitates of iron and manganese cause discolored water and treatment problems.

Typically, the degree of stratification gradually forms during spring/summer and lasts until the latter part of fall. Usually by November or December, the lake has de-stratified. This phenomenon is caused by the decrease in surface water temperatures, which increase the surface water density and result in displacement or mixing of surface water with deeper water. This mixing restores the lake to a more uniform water chemistry profile.

The intake towers at the New Waddell Dam have sets of intake portals at two different levels, which are 100 feet apart in elevation (Lower and Upper Gate). Adjustable operation of the upper and lower portals offers CAP opportunities to manage the quality of water released from the lake for customer deliveries.

From 1994 through 1997, water releases were made through the upper gates as long as possible. It was believed that this zone had the best water quality. By the end of the summer, the lake elevation was lower than the upper gates so all releases were switched over to the lower gates. At that time, the lower quality water from the bottom zone of the lake was introduced into the canal system, resulting in treatment concerns for the cities.

In 1998, a new operational scheme was used to manage the water quality from the releases at Lake Pleasant. This new scheme consisted of using only the lower portals for releases during the entire summer. The use of the lower gates during the initial releases in June allowed medium-oxygenated bottom water to be released early in the release period, while prolonging the retention of the high-oxygenated epilimnion water. This minimized the volume of anoxic water, which would have been delivered from the lake during the latter part of the summer release period.

In 2005, the lake release strategy was further modified to improve water quality for valley cities. Lake Pleasant releases were terminated in mid-September as opposed to mid-October. Termination of releases reduced the amount of anoxic water that was being delivered to the downstream treatment plants. Table 9 summarizes operations at the dam; included in the table are the approximate minimum and maximum annual elevations, and the approximate blend of Colorado River water and Lake Pleasant water that was delivered to valley cities.

Lake Pleasant Inflow

Prepared 5/23/2017

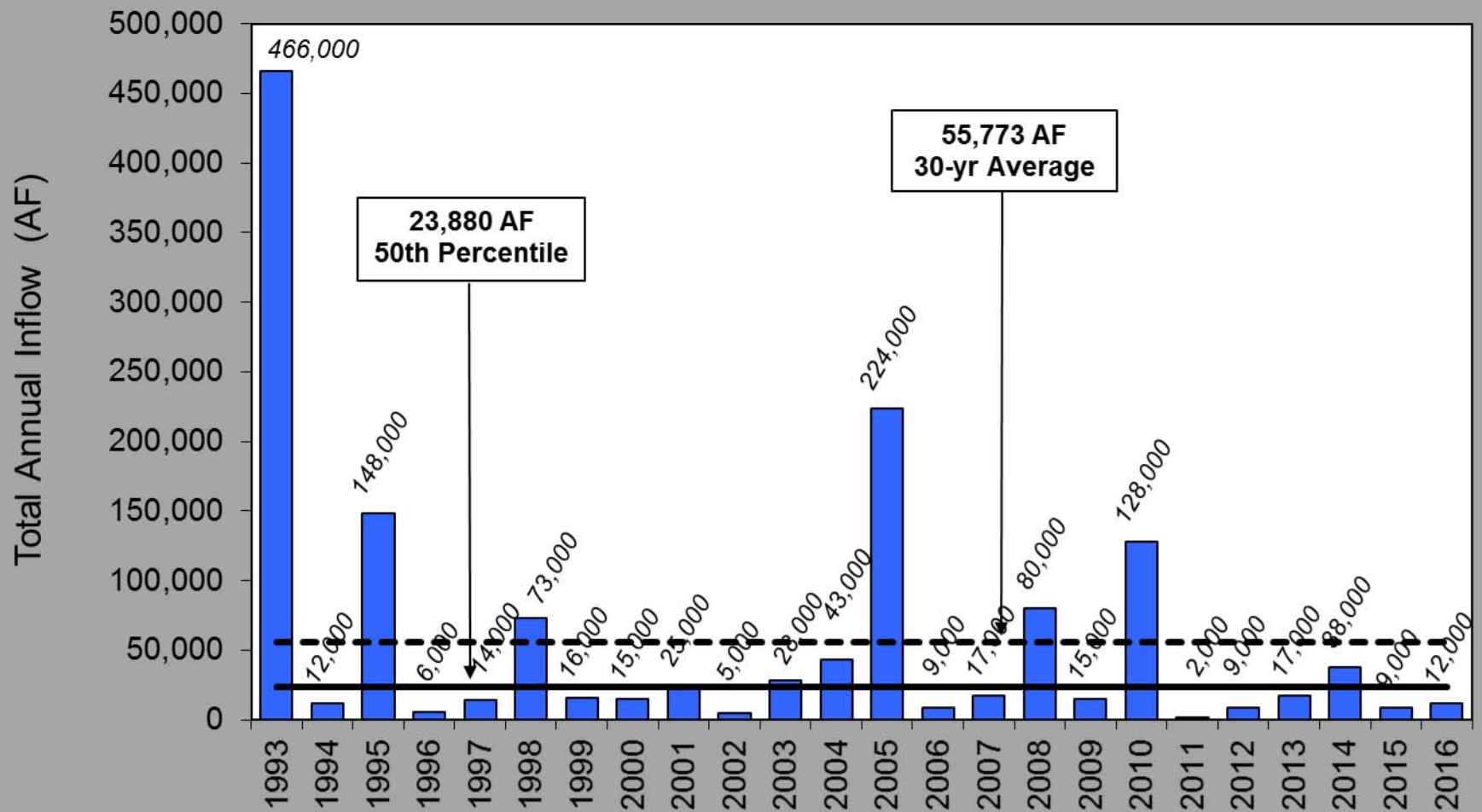


Figure 7 Lake Pleasant Agua Fria Inflows from 1993 – 2016

Table 8 Lake Pleasant Grab Sample Results

Lake Pleasant 2016 Water Quality Sampling Results					
General Chemistry Analytes	Units	2/9/2016	5/5/2016	8/1/2016	11/16/2016
Temperature	°F	SEE LAKE PROFILE PLOTS			
pH					
Dissolved Oxygen	mg/L				
Field Conductivity	µS/cm				
Alkalinity in CaCO3 units	mg/L	120	120	120	120
Ammonia Nitrogen	mg/L	ND	ND	ND	ND
Barium, Total, ICAP/MS	µg/L	130	120	130	120
Bromide	µg/L	90	95	92	110
Calcium, Total, ICAP	mg/L	76	70	75	69
Chloride	mg/L	96	94	98	100
Copper, Total, ICAP/MS	µg/L	ND	ND	ND	ND
Iron, Dissolved, ICAP	mg/L	ND	ND	ND	ND
Iron, Total, ICAP	mg/L	ND	ND	ND	ND
Magnesium, Total, ICAP	mg/L	31	26	30	30
Manganese, Total, ICAP/MS	µg/L	2.6	2.1	5.1	8.0
Nitrate as Nitrogen by IC	mg/L	ND	ND	ND	ND
Orthophosphate as P	mg/L	ND	ND	ND	ND
Potassium, Total, ICAP	mg/L	5.3	5.3	5.6	5.6
Silica	mg/L	9.0	7.8	8.4	8.4
Sodium, Total, ICAP	mg/L	100	98	100	100
Specific Conductance	µS/cm	1000	1000	1000	1100
Strontium, ICAP	mg/L	1.2	1.1	1.2	1.1
Sulfate	mg/L	260	260	250	260
Total Dissolved Solids (TDS)	mg/L	660	650	680	690
Total phosphorus as P	mg/L	ND	ND	ND	ND
Total Suspended Solids (TSS)	mg/L	ND	ND	ND	ND
Turbidity	NTU	1.20	0.32	0.27	0.28
Quarterly Analytes Detected	These Results are the Priority Pollutants that are Reported by Exception as Detected by the Quarterly Samples				
Arsenic, Total, ICAP/MS	µg/L	2.8	3.2	2.8	4.5
Mercury	µg/L	0.36	ND	ND	ND
Benzene	µg/L	0.69	ND	ND	ND
Uranium ICAP/MS	µg/L	ND	ND	ND	4.40

Data Recovered with Hydrolab in Field

General Chemistry Data Sampled Monthly

Priority Pollutants Sampled Quarterly

NA = Analyte not Sampled

ND = Analyte not Detected

EQ = Equipment Problem

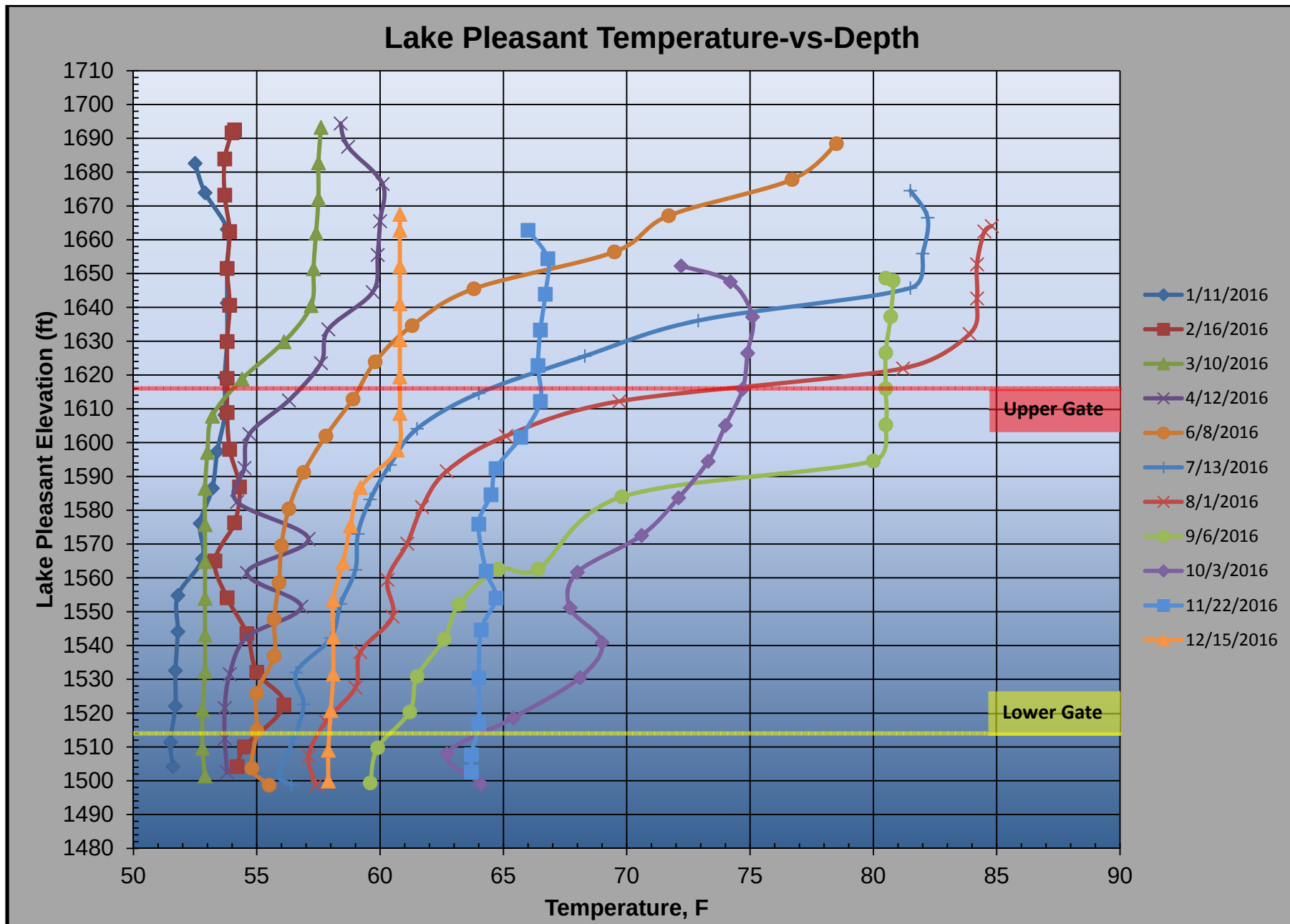


Figure 8 Lake Pleasant Depth Profile, Temperature

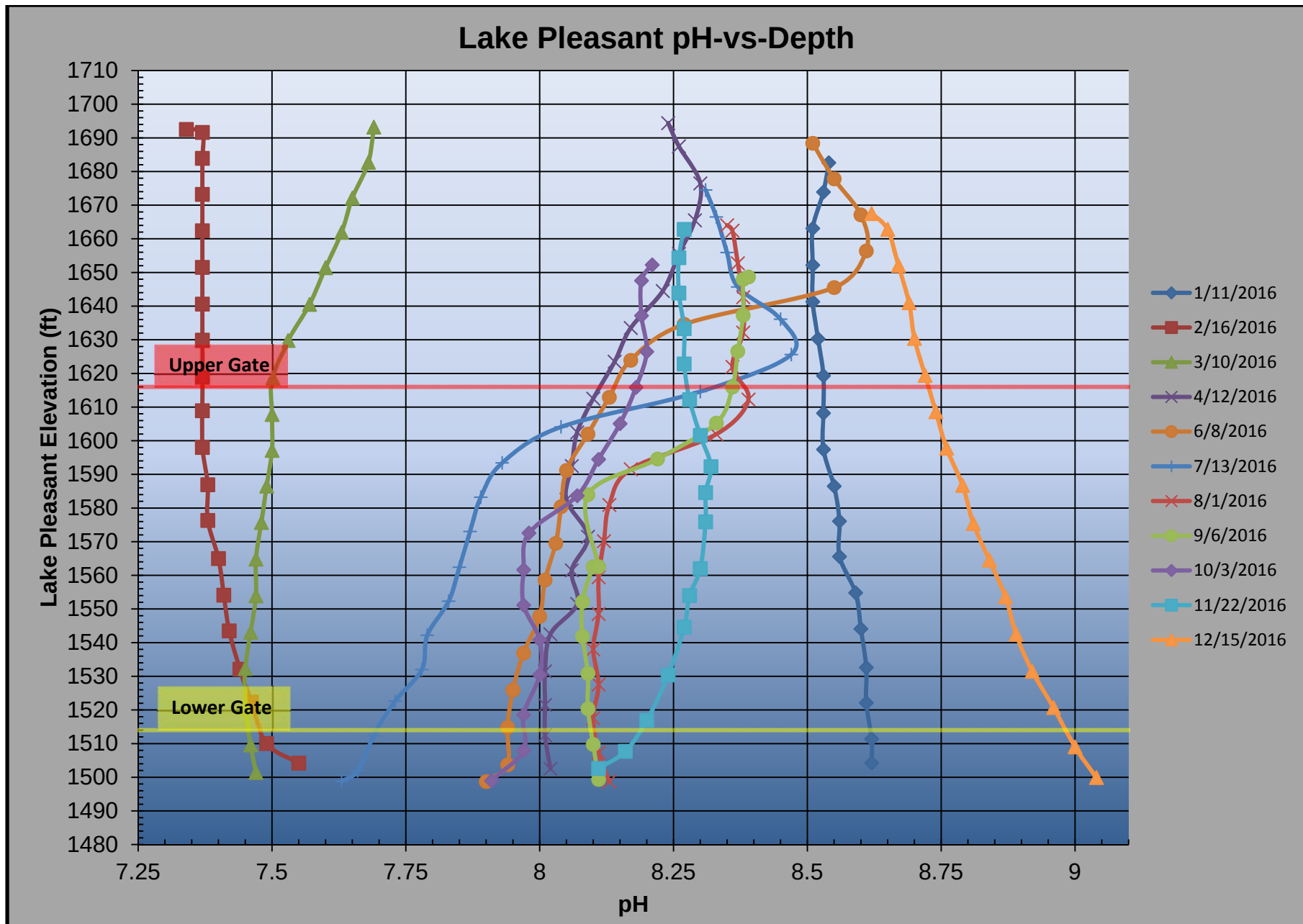


Figure 9 Lake Pleasant Depth Profile, pH

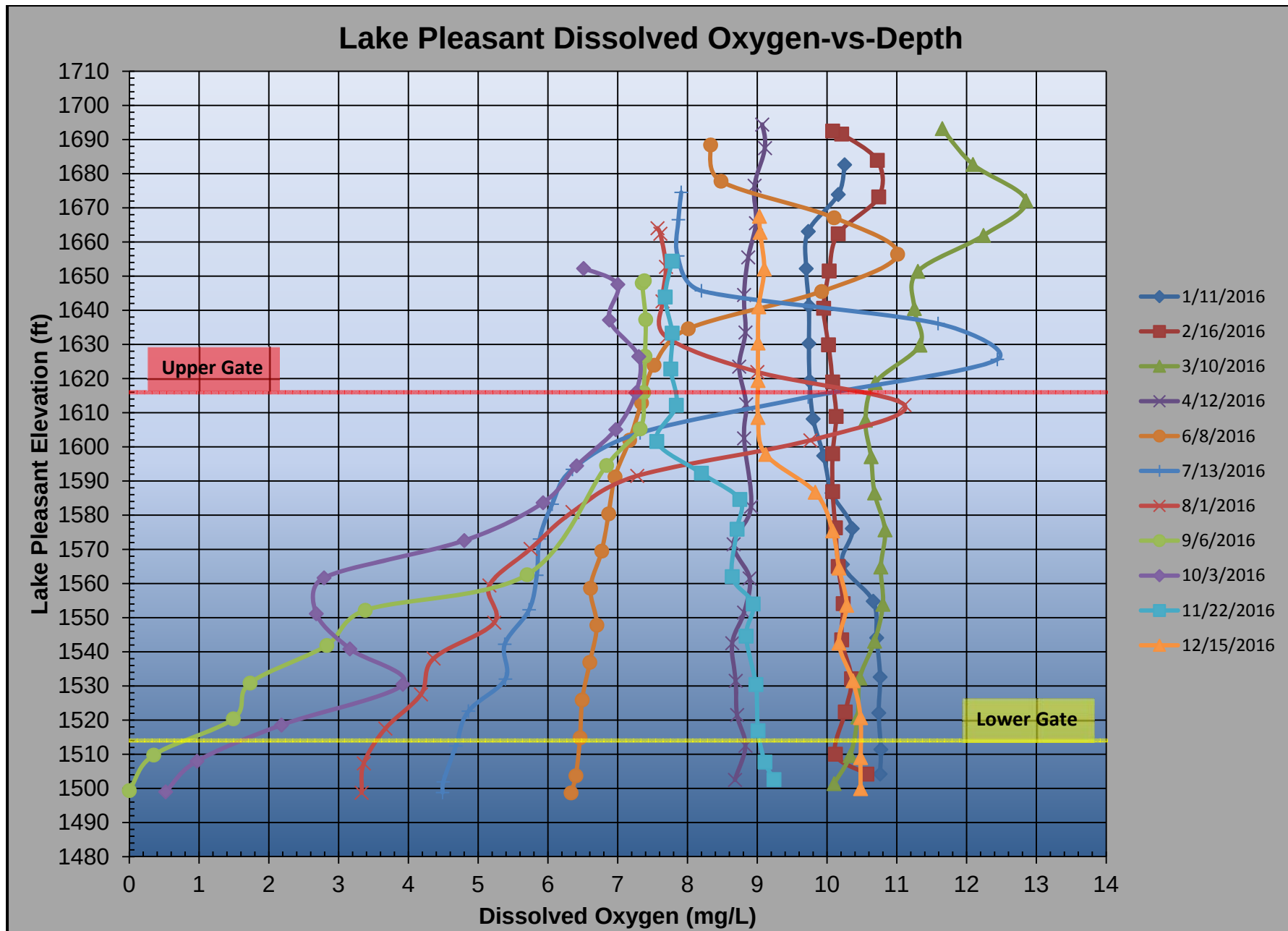


Figure 10 Lake Pleasant Depth Profile, DO

Table 9 Lake Pleasant Operations Summary

2016 Lake Pleasant Operations	
•	11,817 AF of gaged inflow (50% percentile inflow = 23,880 AF)
•	May 31, 2016 Elevation = 1697.04 (ft)
•	September 17, 2016 Elevation = 1652.46 (ft)
•	Change in Elevation = 44.58 (ft)

2016 Lake Pleasant Release Summary			
Month	Waddell Released (AF)	Pass-Thru (AF)	% Ratio
March	10501	102447	10/90
June	112,673	66815	60/40
July	119,947	52257	70/30
August	87736	53497	60/40
September	22496	118831	15/85
October	1165	126197	0/100



General Discussion and Summary



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General Discussion

Water Quality Sampling Results

Turbidity – The suspended solids were relatively low with canal turbidity levels averaging 1.24 NTU. Average turbidity in Lake Pleasant was 0.52 NTU. The water in the canal and Lake Pleasant is very clear, and the lake bottom can be seen at depths of 25 – 30 feet. In general, when canal flows are lower or remain steady, the turbidity is low. When flow increases occur, the higher velocities cause an increase in turbidity levels. These increases in turbidity are usually very short in duration. Furthermore, it has been observed that seasonal pumping increases at the Salt Gila Pump Plant result in increased turbidity in the canal downstream of the plant. The increase in flow stirs up the sediment deposits and creates a noticeable effect on turbidity. Algae blooms in the canal also have an impact on turbidity. Blooms are generally localized and do not contribute significantly to the overall turbidity levels of CAP water.

TDS – Total dissolved solids represent the concentration of dissolved minerals in the water. The TDS levels in CAP water are high when compared to most groundwater sources. For the year, the average TDS was 653 mg/L in the canal and 670 mg/L at Lake Pleasant.

pH – The canal pH ranged from 7.0 to 10.3 and had an average pH of 8.3. One data point in March at San Xavier was clearly an outlier with a reading of 10.3.

Temperature – Average canal water temperature for the year was 68.0°F with minimal differences between the Havasu, Phoenix, and Tucson areas of the canal system. However, monthly and seasonal temperatures varied considerably along the canal system. Maximum temperatures reached 85.2°F and minimum temperatures were 49.9°F.

Note: From May to September Lake Pleasant water is released for customer deliveries downstream of the Waddell Turnout. Lake Pleasant water is generally cooler than normal canal water, therefore lower canal water temperatures are observed at downstream sampling locations.

DO – The average dissolved oxygen levels were fairly uniform throughout the canal system. The canal sampling locations had an average DO of approximately 9.29 mg/L for 2016 with measurements ranging from 6.27 mg/L to 12.39 mg/L. Fluctuations in DO followed the canal water temperature trends with an inverse relationship. Lower levels of DO exist in Lake Pleasant at lower elevations in the late summer. Water released from the lake quickly aerates and mixes, establishing saturated conditions by the time it reaches the main canal.

Metals – Dissolved heavy metals were detected in both the canal and in Lake Pleasant. Arsenic was consistently detected in the canal with an average concentration of 2.6 µg/L and at Lake Pleasant, where the average concentration was 3.3 µg/L.

Other heavy metals detected in Lake Pleasant included mercury and uranium. Mercury was detected once at Lake Pleasant during the first quarter of 2016 at a level of 0.36 µg/L. Hexavalent Chromium was detected one time at Lake Havasu at a level of 0.02 µg/L in the last quarter. Silver was detected once at Havasu pumping plant at a level of 1.4 µg/L in the second quarter.

Uranium – In 2013, the City of Phoenix and ASU reported measuring elevated levels of uranium in CAP water. After further sampling and analysis, CAP and ASU concluded that the uranium detected was well below the EPA's Maximum Contaminant Level. However, because of these events, CAP has added uranium to its list of priority pollutants. The current sampling program consists of quarterly uranium testing on samples collected at some locations. The 2016 average concentration of uranium detected in the canal was 4.3 µg/L. More information regarding uranium in Arizona waterways can be found in the 2013 August and November issues of the Regional Water Quality Newsletter, published by ASU:

<http://faculty.engineering.asu.edu/pwesterhoff/research/regional-water-quality-issues/regional-water-quality-newsletter/>

VOC's – Benzene was detected in the February samples at Lake Pleasant.

Herbicides – Herbicides were detected at Lake Pleasant Parkway (99th Avenue) and San Xavier.

Pathogens – A significant amount of public drinking water in the urban areas of central and southern Arizona is treated CAP water. One of the biggest concerns is the presence of pathogens in treated water, including Giardia and Cryptosporidium. In 2016, all tests for Giardia and Cryptosporidium had non-detect results.

Table 10 Water Quality Measurements and Regulatory Levels

SUMMARY OF WATER QUALITY ANALYTES AND REGULATORY LEVELS (Regulatory Levels are Drinking Water Standards)					
Analyte	Units	Range of Measured Values	Average Value	US EPA Maximum Contaminant Level (MCL) (Health-based)	US EPA Secondary Maximum Contaminant Level (Aesthetics-based)
Temperature	°F	49.9 – 85.2	68.0	-	-
Dissolved Oxygen	mg/L	6.27 – 12.39	9.29	-	-
Field Conductivity	µS/cm	931 – 1025	980	-	-
pH		7.0 – 10.3	8.3	-	6.5 – 8.5
Alkalinity in CaCO ₃ units	mg/L	98 – 130	121	-	-
Ammonia Nitrogen	mg/L	ND – 0.08	0.06	-	-
Barium, Total, ICAP/MS	µg/L	32 – 160	129	2000	-
Bromide	µg/L	78 – 95	85	-	-
Calcium, Total, ICAP	mg/L	66 – 82	74	-	-
Chloride	mg/L	89– 100	95	-	250
Copper, Total, ICAP/MS	µg/L	ND – 740	198	1300	1000
Di(2-Ethylhexyl)phthalate	µg/L	ND – 0.60	Note 1	-	-
Dissolved Organic Carbon	mg/L	0.6 – 5.0	3.1	-	-
Iron, Dissolved ICAP	mg/L	ND – 0.02	Note 1	-	-
Iron, Total, ICAP	mg/L	0.02 – 0.21	0.09	-	0.3
Magnesium, Total, ICAP	mg/L	25 – 30	28	-	-
Manganese, Total, ICAP	µg/L	2.2 – 17.0	5.6	-	50
Nitrate as Nitrogen by IC	mg/L	ND – 0.41	Note 1	10	-
Orthophosphate-P	mg/L	ND – 0.06	Note 1	-	-
Orthophosphate as PO ₄	µg/L	ND – 0.17	Note 1	-	-
Potassium, Total, ICAP	mg/L	4.4 – 5.5	5.0	-	-
Silica	mg/L	6.2 – 10.0	8.0	-	-
Sodium, Total, ICAP	mg/L	90 – 110	97	-	-
Specific Conductance	µS/cm	990 – 1000	1000	-	-
Strontium, ICAP	mg/L	1.0 – 1.3	1.2	-	-
Sulfate	mg/L	240 – 260	248	-	250
Total Dissolved Solids (TDS)	mg/L	610 – 700	653	-	500
Total phosphorus-P	mg/L	ND – 0.2	Note 1	-	-
Total Suspended Solids (TSS)	mg/L	ND – 34.0	Note 1	-	-
Turbidity	NTU	0.37 – 6.00	1.24	-	-
Metals / Priority Pollutants					
Arsenic	µg/L	1.9 – 3.5	2.6	10	-
Hexavalent Chromium	µg/L	ND – 0.02	Note 1	-	-
Mercury	µg/L	ND – 0.36	Note 1	2	-
Perchlorate – Low Level	µg/L	ND – 2.4	Note 1	-	-
Silver Total ICAP/MS	µg/L	1.4	Note 1	-	-
Uranium	µg/L	4.0 – 4.7	4.3	30	-

ND = Not Detected

Note 1: Average values was not calculated due to test species not being detected consistently throughout the year.

Water Quality Impact from Bill Williams River

As previously mentioned, the CAP aqueduct system begins at Lake Havasu. Figure 11 identifies the intake for the Mark Wilmer Pumping Plant, which is located in a bay-like feature just south of the mouth of the Bill Williams River where it empties into Lake Havasu.

The Bill Williams River, together with its headwaters at Alamo Lake, handles runoff for the majority of the drainage area of west central Arizona. Elevated discharges in the Bill Williams River mobilize more sediment and can generate a turbidity plume in Lake Havasu. During periods of heavy rainfall and runoff, the water quality tends to be low in TDS but very turbid with high concentrations of organic matter and suspended sediments. Over the past years, experimental releases from Alamo Dam have been intended to support ecological studies, improve environmentally sensitive management of the river corridor, and support the development of a predictive relationship between the operation of Alamo Dam and downstream flows and their impact on Lake Havasu and the Colorado River.

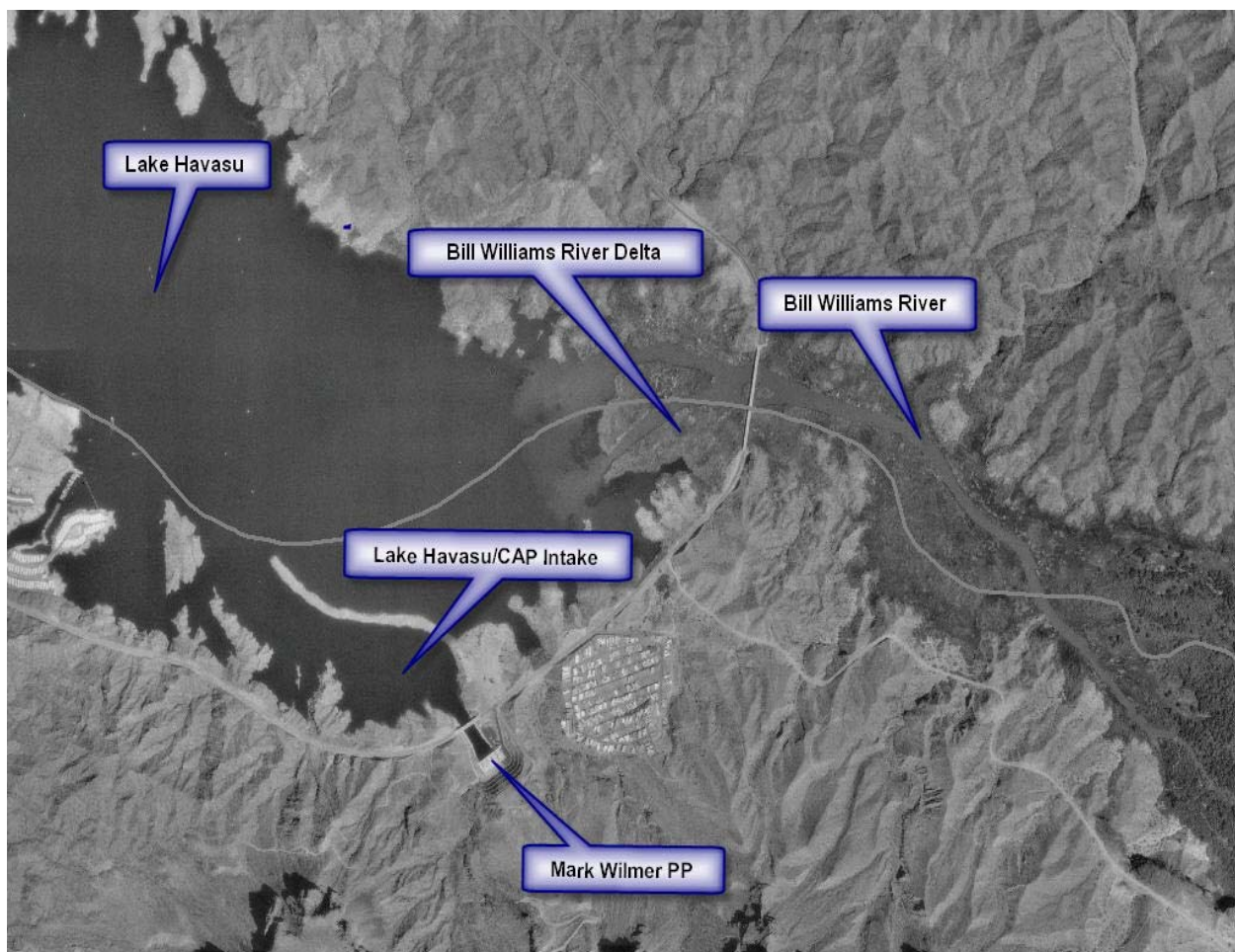


Figure 11 Aerial Photo of CAP Intake and Bill Williams River

In March of 2010 a 3,000 cfs pulse release from Alamo Dam lasted approximately 36 hours. Releases were reduced to 2,000 cfs for a sustained period. These releases from Alamo Dam had a negative impact on CAP and its customers. The release caused turbidity levels

at the CAP intake to spike to about 50 NTU. Two of CAP's recharge facilities were shut down to avoid adversely impacting infiltration rates. In addition, agricultural customers had problems with drip irrigation systems plugging up. Increased turbidity in CAP water also causes issues for the municipal water treatment plants. Under these conditions, if possible, CAP curtails pumping from Lake Havasu until the water quality improves.

There were no experimental releases from Alamo Dam or any discharges from the Bill Williams River that significantly impacted CAP operations during 2016.

Taste and Odor Research Program

Municipal water treatment plants, which treat water supplies from the CAP and SRP systems, have experienced seasonal taste and odor episodes. The water has been described as having a “musty-moldy-earthly” taste or odor, which is suspected of being associated with biological activity in reservoirs and canal systems. Water treatment plants can treat this water with activated carbon to reduce or eliminate the offensive tastes and odors, however, this has significant cost.

Compounds produced by cyanobacteria (blue-green algae) are the suspected causes of the taste and odor problems. Two compounds of concern are Geosmin and 2-methylisoborneol (MIB) which can produce odors at levels as low as 1 part per trillion (ppt). The taste and odor constituents are an aesthetic problem and do not present a health concern at these extremely low levels. MIB detected in samples from several treatment plants appear to be due to planktonic *Oscillatoria* and both planktonic and periphytic *Lyngbya*. Geosmin detected in samples appear to come from periphytic *Anabaena* and *Lyngbya*.

An ongoing cooperative research and implementation program led by ASU has been monitoring the levels of MIB, Geosmin, Cyclocitral, Dissolved Organic Carbon (DOC), UV254, and Total Dissolved Nitrogen (TDN) in the CAP and SRP canal systems. The title of the project is *“Reducing Taste and Odor and Other Algae-Related Problems for Surface Water Supplies in Arid Environments.”*

This project publishes a monthly newsletter, which contains sampling results and recommendations for treatment of MIB and Geosmin. A summary of the project, newsletters distributed from January 2006 – April 2014, and a report are available at:

<http://faculty.engineering.asu.edu/pwesterhoff/research/regional-water-quality-issues/>

Data gathered by the ASU project show CAP water typically to be a very low source of MIB and Geosmin to valley cities. CAP water has the potential of being used as a taste and odor management tool. In the project report, the following recommendation was made regarding CAP water:

“CAP water generally has lower concentrations of MIB than SRP water. This provides an opportunity for blending the two source waters to reduce MIB concentrations in water delivered to the treatment plants. For most years, using more SRP water early in the season, and more

CAP water later in the season, would improve the quality of water delivered to Phoenix's municipal customers."

MIB, Geosmin, and Cyclocitral data gathered by the ASU project from Lake Pleasant and the CAP canal is presented in Table 11. Due to outstanding circumstances Cyclocitral data was no longer sampled after the initial samples in January and February.

Colorado River Basin Salinity Control Program

The Colorado River is used by approximately 40 million people for domestic and industrial uses in the United States and is used to irrigate approximately 5.5 million acres of land. Modeling by Reclamation shows that the quantifiable damages from high salinity water are approximately \$300 million dollars per year to U.S. users, with projections that damages could increase to more than \$500 million by 2030 if the Program were not to continue to be aggressively implemented.

In 1975, the seven Colorado River Basin states adopted, and subsequently EPA approved, a salinity standard for the Colorado River. That standard is composed of numeric criteria for total dissolved solids and a plan of implementation to meet the criteria. The numeric criteria were selected as the 1972 salinity levels at the three Lower Basin monitoring locations: below Hoover Dam (723 mg/L), below Parker Dam (747 mg/L) and at Imperial Dam (879 mg/L). Since the program's implementation, salinity in the river has been reduced by approximately 100 mg/L. For CAP customers this translates to approximately 220,000 tons of salt that did not enter the CAP service area.

CAP participates with Arizona and the other Basin States and Federal Agencies in the implementation of the Program. CAP also worked with the Colorado River Basin Salinity Control Forum and the Forum's technical workgroup to address funding and other issues associated with program implementation.

Table 11 CAP Canal Sampling Results for MIB, Geosmin and Cyclocitral (ASU)

CAP Canal Sampling Results for MIB, Geosmin and Cyclocitral Data Collected by ASU as Part of Project: <i>"Reducing Taste and Odor and Other Algae-Related Problems for Surface Water Supplies in Arid Environments"</i> (All units in ng/L)																		
Newsletter Month	Lake Pleasant (epilimnion)			Lake Pleasant (hypolimnion)			Waddell Canal			CAP/SRP Inter-Connect			Union Hills Inlet*			Union Hills Outlet*		
	MIB	GSMN	Cyclocitral	MIB	GSMN	Cyclocitral	MIB	GSMN	Cyclocitral	MIB	GSMN	Cyclocitral	MIB	GSMN	Cyclocitral	MIB	GSMN	Cyclocitral
Jan-16							3.3	3.8	<2.0	3.9	3.2	<2.0	2.7	<2.0	<2.0	<2.0	<2.0	<2.0
Feb-16	13.3	2.1		18.3	2.6		<2.0	6.0	<2.0				<2.0	4.7	<2.0	3.7	4.5	<2.0
Mar-16							2.6	5.0		<2.0	5.9							
Apr-16	4.1	<2.0		5.7	<2.0		EQ	EQ		EQ	EQ		EQ	EQ		EQ	EQ	
May-16	2.7	<2.0		13.4	2.1		<2.0	2.3		<2.0	<2.0		<2.0	<2.0		<2.0	<2.0	
Jun-16	3.5	<2.0		8.4	3.1		4.5	<2.0		3.2	<2.0		<2.0	<2.0		<2.0	<2.0	
Jul-16	3.5	<2.0		10.9	3.0		2.7	<2.0		3.4	<2.0		2.2	<2.0		2.9	<2.0	
Aug-16	<2.0	<2.0		7.8	<2.0		5.0	<2.0		6.0	<2.0		5.1	<2.0		5.5	<2.0	
Sep-16	5.5	<2.0		16.6	<2.0		3.8	<2.0		8.2	2.0		9.7	<2.0		9.1	<2.0	
Oct-16							5.0	2.3		4.3	2.1		3.6	<2.0		4.8	2.3	
Nov-16	6.5	<2.0		6.8	<2.0		3.2	2.2		4.0	<2.0		2.3	<2.0		3.3	<2.0	
Dec-16	3.9	<2.0		5.1	<2.0		<2.0	<2.0		2.3	<2.0		<2.0	<2.0		<2.0	<2.0	
* City of Phoenix, Union Hills Water Treatment Plant EQ=Equipment Failure																		

Groundwater Recharge Projects – Water Quality

CAWCD has developed and currently operates six recharge projects:

1. Pima Mine Road Recharge Project
2. Lower Santa Cruz Recharge Project
3. Agua Fria Recharge Project
4. Hieroglyphic Mountain Recharge Project
5. Tonopah Desert Recharge Project
6. Superstition Mountains Recharge Project

The Tucson Active Management Area (AMA) recharge facilities have a cumulative operational capacity of 80,000 acre-feet per year and include the Pima Mine Road and Lower Santa Cruz Recharge Projects. In the Phoenix AMA, there are four facilities: the Tonopah Desert, Hieroglyphic Mountain, Agua Fria, and Superstition Mountains Recharge Projects, with a combined annual operational capacity of 235,000 acre-feet.

A portion of the permitting process and regulatory compliance for these projects requires periodic water quality monitoring. The sampling results are compiled into an annual report, which is a matter of public record and is submitted to the Arizona Department of Water Resources. Copies of the reports or portions of the reports are available by contacting:

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Summary

This report has presented and discussed a variety of parameters in the CAP water quality monitoring program. CAP is sensitive to customer needs, and as changes in water quality issues occur, the water quality monitoring and sampling program will be revised accordingly. The data will then be published in future annual water quality reports.

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