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Arsenic Removal from Drinking Water by Adsorptive Media U.S. EPA Demonstration Project at Taos, NM Final Performance Evaluation Report

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Sally Gutierrez, Director
National Risk Management Research Laboratory

ABSTRACT

This report documents the activities performed and the results obtained for the EPA arsenic removal technology demonstration project at the Town of Taos in New Mexico. The main objective of the project was to evaluate the effectiveness of Severn Trent Services' (STS) SORB 33™ adsorptive media in removing arsenic to meet the maximum contaminant level (MCL) of 10 µg/L. Additionally, this project evaluated 1) the reliability of the treatment system for use at small water facilities, 2) the required system operation and maintenance (O&M) and operator skill levels, and 3) the capital and O&M cost of the technology. The project also characterizes water in the distribution system and residuals generated by the treatment process. The types of data collected include system operation, water quality, process residuals, and capital and O&M cost.

The STS system consisted of a carbon dioxide (CO_2) pH control system and three 63-in-diameter, 86-in-tall fiberglass reinforced plastic (FRP) vessels in parallel configuration, each designed for approximately 60 ft^3 of SORB 33™ pelletized media. The media is an iron-based adsorptive media developed by Bayer AG and packaged under the name SORB 33™ by STS. The system was designed for a flowrate of 450 gal/min (gpm) (or 150 gpm to each vessel), corresponding to an empty bed contact time (EBCT) of about 3.0 min and a hydraulic loading rate of 6.9 gpm/ft^2. The actual amount of media loaded based on freeboard measurements was 216 ft^3 (or 72 ft^3/vessel), thus resulting in a longer EBCT of 3.2 min even at a higher flowrate of 503 gpm.

Upon approval of engineering plans by the New Mexico Environment Department/Drinking Water Bureau (NMED/DWB) and completion of a pipeline project by the Town of Taos, the APU-450 treatment system began operating on February 14, 2006. From February 14, 2006 through October 23, 2007, the treatment system operated for only 215 days, with an average daily operating time of only 3.9 hr. Frequent and prolonged system downtime occurred during the performance evaluation study, caused primarily by non-system-related issues, such as power outages and facility pipeline leakage. Because the treatment system and booster pump station were not integrated with the Town's system control and data acquisition (SCADA) system, the operator had to manually operate the system. The labor intensive nature of system operations also contributed to the fewer and shorter daily runs. The system treated approximately 22,977,000 gal of water, or 14,192 bed volumes (BV), which was only 11% of the vendor-estimated working capacity for the SORB 33™ media. Because the system was far from reaching the treatment target of 10 µg/L after about 20 months of operation, a decision was made to discontinue the performance evaluation study.

Source water supplied by Well 8 had an average total arsenic concentration of 16.9 µg/L with soluble As(V) as the predominating species at 16.8 µg/L (on average). pH values of source water were high, ranging from 9.5 to 9.8 and averaging 9.6. After some troubleshooting, the pH control system effectively reduced pH values of the water entering the treatment system to 7.3 to 7.4, close to the target value of 7.2. The automatic pH control system used a JUMO pH/Proportional Integral Derivative (PID) to regulate CO_2 gas flow with signals received from an inline pH probe. CO_2 gas was injected to a side stream of water with a microporous membrane module housed in a sanitary cross.

During the performance evaluation study, total arsenic was reduced to an average of less than 1 µg/L, except for the one spike at 7.4, 7.2, and 8.8 µg/L at the TA, TB, and TC sampling locations, respectively. The exact cause of the spike was unknown. Little or no iron or manganese was measured in raw water and system effluent.

Comparison of the distribution system sampling results before and after the system startup showed no significant differences in concentrations of arsenic and other analytes. This was because the treated Well

8 water contributed only 10% of the capacity in a 1,000,000-gal water tower, from which water was distributed either directly to the distribution sytem or indirectly through a 500,000-gal storage tower.

Backwash wastewater was sampled three times during the performance evaluation study. pH values ranged from 7.4 to 8.1 and averaged 7.7, somewhat higher than that of the treated water used for backwash. The water used for backwash was withdrawn from a 50,000-gal holding tank. Some CO_2 degassing likely took place during storage and transit, thereby elevating the pH values. As expected, total suspended solids (TSS) values were low, ranging from 16 to 82 mg/L and averaging 37 mg/L. Concentrations of total arsenic, iron, and manganese ranged from 1.1 to 11.8 μg/L, from 0.14 to 8.9 mg/L, and from 0.7 to 64.0 μg/L, respectively, with the majority of iron and manganese existing in the particulate form. The unexpectedly high iron concentrations in the backwash wastewater might have been media fines produced during the backwashing process.

The capital investment for the system was $296,644 consisting of $202,685 for equipment, $32,750 for site engineering, and $61,209 for installation, shakedown, and startup. Using the system's rated capacity of 450 gpm (or 648,000 gal/day [gpd]), the capital cost was $659/gpm (or $0.46/gpd) of design capacity. This calculation does not include the cost of the building to house the treatment system.

The O&M included only incremental costs associated with media replacement and disposal, CO_2 supply, electricity, and labor. Although not replaced, the media changeout cost was estimated to be $41,749 for all three adsorption vessels, which would represent the majority of the O&M cost. CO_2 cost was $0.29/1,000 gal of water treated, most of the CO_2 cost was for the lease of four 380-lb dewars and two 50-lb back-up cylinders.

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ABBREVIATIONS AND ACRONYMS

Δp	differential pressure
AAL	American Analytical Laboratories
Al	aluminum
AM	adsorptive media
APU	arsenic package unit
As	arsenic
ATSI	Applied Technology Systems, Inc.
ATS	Aquatic Treatment Systems
AWWA	American Water Works Association
BET	Brunauer, Emmett, and Teller
bgs	below ground surface
BV	bed volume(s)
Ca	calcium
C/F	coagulation/filtration
Cl	chlorine
CO_2	carbon dioxide
CRF	capital recovery factor
Cu	copper
DBPs	disinfection by-products
DO	dissolved oxygen
DWB	Drinking Water Bureau
EBCT	empty bed contact time
EPA	U.S. Environmental Protection Agency
F	fluoride
Fe	iron
FedEx	Federal Express
FRP	fiberglass reinforced plastic
gpd	gallons per day
gpm	gallons per minute
HIX	hybrid ion exchanger
HDPE	high-density polyethylene
hp	horsepower
ICP-MS	inductively coupled plasma-mass spectrometry
ID	identification
ISFET	Ion Sensitive Field Effect Transistor
IX	ion exchange
LCR	(EPA) Lead and Copper Rule

MCL	maximum contaminant level
MDL	method detection limit
MEI	Magnesium Elektron, Inc.
MIOX	mixed oxidants
Mg	magnesium
Mn	manganese
Na	sodium
NA	not analyzed
NMED	New Mexico Environmental Department
NS	not sampled
NSF	NSF International
NTU	nephlemetric turbidity units
O&M	operation and maintenance
OIT	Oregon Institute of Technology
ORD	Office of Research and Development
ORP	oxidation-reduction potential
P	phosphorus
PID	Proportional Integral Derivative
Pb	lead
psi	pounds per square inch
PLC	programmable logic controller
PPE	personal protective equipment
PO_4	phosphate
POU	point-of-use
PVC	polyvinyl chloride
QA	quality assurance
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
RPD	relative percent difference
RO	reverse osmosis
Sb	antimony
SCADA	system control and data acquisition
SDWA	Safe Drinking Water Act
SiO_2	silica
SMCL	secondary maximum contaminant level
SO_4	sulfate
STS	Severn Trent Services
TBD	to be determined
TCLP	Toxicity Characteristic Leaching Procedure
TDS	total dissolved solids
TOC	total organic carbon
TSS	total suspended solids
V	vanadium

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Ms. Tien Shiao, who is currently pursuing a Master's degree at Yale University, was the Battelle Study Lead for this demonstration project.

1.0 INTRODUCTION

1.1 Background

The Safe Drinking Water Act (SDWA) mandates that the U.S. Environmental Protection Agency (EPA) identify and regulate drinking water contaminants that may have adverse human health effects and that are known or anticipated to occur in public water supply systems. In 1975 under the SDWA, EPA established a maximum contaminant level (MCL) for arsenic at 0.05 mg/L. Amended in 1996, the SDWA required that EPA develop an arsenic (As) research strategy and publish a proposal to revise the arsenic MCL by January 2000. On January 18, 2001, EPA finalized the arsenic MCL at 0.01 mg/L (EPA, 2001). In order to clarify the implementation of the original rule, EPA revised the rule text on March 25, 2003 to express the MCL as 0.010 mg/L (10 µg/L) (EPA, 2003). The final rule requires all community and non-transient, non-community water systems to comply with the new standard by January 23, 2006.

In October 2001, EPA announced an initiative for additional research and development of cost-effective technologies to help small community water systems (<10,000 customers) meet the new arsenic standard and to provide technical assistance to operators of small systems in order to reduce compliance costs. As part of this Arsenic Rule Implementation Research Program, EPA's Office of Research and Development (ORD) proposed a project to conduct a series of full-scale, onsite demonstrations of arsenic removal technologies, process modifications, and engineering approaches applicable to small systems. Shortly thereafter, an announcement was published in the *Federal Register* requesting water utilities interested in participating in Round 1 of this EPA-sponsored demonstration program to provide information on their water systems. In June 2002, EPA selected 17 out of 115 sites to host the demonstration studies.

In September 2002, EPA solicited proposals from engineering firms and vendors for cost-effective arsenic removal treatment technologies for the 17 host sites. EPA received 70 technical proposals for the 17 host sites, with each site receiving one to six proposals. In April 2003, an independent technical panel reviewed the proposals and provided its recommendations to EPA on the technologies that it determined were acceptable for the demonstration at each site. Because of funding limitations and other technical reasons, only 12 of the 17 sites were selected for the demonstration project. Using the information provided by the review panel, EPA, in cooperation with the host sites and the drinking water programs of the respective states, selected one technical proposal for each site.

In 2003, EPA initiated Round 2 arsenic technology demonstration projects that were partially funded with Congressional add-on funding to the EPA budget. In June 2003, EPA selected 32 potential demonstration sites and the community water system at the Town of Taos in New Mexico was one of them.

In September 2003, EPA again solicited proposals from engineering firms and vendors for arsenic removal technologies. EPA received 148 technical proposals for the 32 host sites, with each site receiving from two to eight proposals. In April 2004, another technical panel was convened by EPA to review the proposals and provide recommendations to EPA with the number of proposals per site ranging from none (for two sites) to a maximum of four. The final selection of the treatment technology at the sites that received at least one proposal was made, again through a joint effort by EPA, the state regulators, and the host site. Since then, four sites have withdrawn from the demonstration program, reducing the number of sites to 28. Severn Trent Service's (STS) SORB 33™ Arsenic Removal Technology was selected for demonstration at the Town of Taos.

As of December 2008, 39 of the 40 systems were operational and the performance evaluation of 32 systems was completed.

1.2 Treatment Technologies for Arsenic Removal

The technologies selected for the Round 1 and Round 2 demonstration host sites include 25 adsorptive media (AM) systems (the Oregon Institute of Technology [OIT] site has three AM systems), 13 coagulation/filtration (C/F) systems, two ion exchange (IX) systems, and 17 point-of-use (POU) units (including nine under-the-sink reverse osmosis [RO] units at the Sunset Ranch Development site and eight AM units at the OIT site), and one system modification. Table 1-1 summarizes the locations, technologies, vendors, system flowrates, and key source water quality parameters (including As, iron [Fe], and pH) at the 40 demonstration sites. An overview of the technology selection and system design for the 12 Round 1 demonstration sites and the associated capital cost is provided in two EPA reports (Wang et al., 2004; Chen et al., 2004), which are posted on the EPA website at http://www.epa.gov/ORD/NRMRL/wswrd/dw/arsenic/index.html.

1.3 Project Objectives

The objective of the Round 1 and Round 2 arsenic demonstration program is to conduct 40 full-scale arsenic treatment technology demonstration studies on the removal of arsenic from drinking water supplies. The specific objectives are to:

- Evaluate the performance of the arsenic removal technologies for use on small systems.
- Determine the required system operation and maintenance (O&M) and operator skill levels.
- Characterize process residuals produced by the technologies.
- Determine the capital and O&M cost of the technologies.

This report summarizes the performance of STS's arsenic removal system at the Town of Taos in New Mexico from February 14, 2006, to October 23, 2007. The types of data collected included system operation, water quality (both across the treatment train and in the distribution system), residuals, and capital and O&M cost.

Table 1-1. Summary of Round 1 and Round 2 Arsenic Removal Demonstration Sites

Demonstration Location	Site Name	Technology (Media)	Vendor	Design Flowrate (gpm)	Source Water Quality		
					As (µg/L)	Fe (µg/L)	pH (S.U.)
Northeast/Ohio							
Wales, ME	Springbrook Mobile Home Park	AM (A/I Complex)	ATS	14	38[a]	<25	8.6
Bow, NH	White Rock Water Company	AM (G2)	ADI	70[b]	39	<25	7.7
Goffstown, NH	Orchard Highlands Subdivision	AM (E33)	AdEdge	10	33	<25	6.9
Rollinsford, NH	Rollinsford Water and Sewer District	AM (E33)	AdEdge	100	36[a]	46	8.2
Dummerston, VT	Charette Mobile Home Park	AM (A/I Complex)	ATS	22	30	<25	7.9
Felton, DE	Town of Felton	C/F (Macrolite)	Kinetico	375	30[a]	48	8.2
Stevensville, MD	Queen Anne's County	AM (E33)	STS	300	19[a]	270[c]	7.3
Houghton, NY[d]	Town of Caneadea	C/F (Macrolite)	Kinetico	550	27[a]	1,806[c]	7.6
Newark, OH	Buckeye Lake Head Start Building	AM (ARM 200)	Kinetico	10	15[a]	1,312[c]	7.6
Springfield, OH	Chateau Estates Mobile Home Park	AM (E33)	AdEdge	250[e]	25[a]	1,615[c]	7.3
Great Lakes/Interior Plains							
Brown City, MI	City of Brown City	AM (E33)	STS	640	14[a]	127[c]	7.3
Pentwater, MI	Village of Pentwater	C/F (Macrolite)	Kinetico	400	13[a]	466[c]	6.9
Sandusky, MI	City of Sandusky	C/F (Aeralater)	Siemens	340[e]	16[a]	1,387[c]	6.9
Delavan, WI	Vintage on the Ponds	C/F (Macrolite)	Kinetico	40	20[a]	1,499[c]	7.5
Greenville, WI	Town of Greenville	C/F (Macrolite)	Kinetico	375	17	7827[c]	7.3
Climax, MN	City of Climax	C/F (Macrolite)	Kinetico	140	39[a]	546[c]	7.4
Sabin, MN	City of Sabin	C/F (Macrolite)	Kinetico	250	34	1,470[c]	7.3
Sauk Centre, MN	Big Sauk Lake Mobile Home Park	C/F (Macrolite)	Kinetico	20	25[a]	3,078[c]	7.1
Stewart, MN	City of Stewart	C/F&AM (E33)	AdEdge	250	42[a]	1,344[c]	7.7
Lidgerwood, ND	City of Lidgerwood	Process Modification	Kinetico	250	146[a]	1,325[c]	7.2
Midwest/Southwest							
Arnaudville, LA	United Water Systems	C/F (Macrolite)	Kinetico	770[e]	35[a]	2,068[c]	7.0
Alvin, TX	Oak Manor Municipal Utility District	AM (E33)	STS	150	19[a]	95	7.8
Bruni, TX	Webb Consolidated Independent School District	AM (E33)	AdEdge	40	56[a]	<25	8.0
Wellman, TX	City of Wellman	AM (E33)	AdEdge	100	45	<25	7.7
Anthony, NM	Desert Sands Mutual Domestic Water Consumers Association	AM (E33)	STS	320	23[a]	39	7.7
Nambe Pueblo, NM	Nambe Pueblo Tribe	AM (E33)	AdEdge	145	33	<25	8.5
Taos, NM	Town of Taos	AM (E33)	STS	450	14	59	9.5
Rimrock, AZ	Arizona Water Company	AM (E33)	AdEdge	90[b]	50	170	7.2
Tohono O'odham Nation, AZ	Tohono O'odham Utility Authority	AM (E33)	AdEdge	50	32	<25	8.2
Valley Vista, AZ	Arizona Water Company	AM (AAFS50/ARM 200)	Kinetico	37	41	<25	7.8

Table 1-1. Summary of Round 1 and Round 2 Arsenic Removal Demonstration Sites (Continued)

Demonstration Location	Site Name	Technology (Media)	Vendor	Design Flowrate (gpm)	Source Water Quality		
					As (µg/L)	Fe (µg/L)	pH (S.U.)
Far West							
Three Forks, MT	City of Three Forks	C/F (Macrolite)	Kinetico	250	64	<25	7.5
Fruitland, ID	City of Fruitland	IX (A300E)	Kinetico	250	44	<25	7.4
Homedale, ID	Sunset Ranch Development	POU RO[f]	Kinetico	75 gpd	52	134	7.5
Okanogan, WA	City of Okanogan	C/F (Electromedia-I)	Filtronics	750	18	69[c]	8.0
Klamath Falls, OR	Oregon Institute of Technology	POE AM (Adsorbsia/ARM 200/ArsenX^{np}) and POU AM (ARM 200)[g]	Kinetico	60/60/30	33	<25	7.9
Vale, OR	City of Vale	IX (Arsenex II)	Kinetico	525	17	<25	7.5
Reno, NV	South Truckee Meadows General Improvement District	AM (GFH/Kemiron)	Siemens	350	39	<25	7.4
Susanville, CA	Richmond School District	AM (A/I Complex)	ATS	12	37[a]	125	7.5
Lake Isabella, CA	Upper Bodfish Well CH2-A	AM (HIX)	VEETech	50	35	125	7.5
Tehachapi, CA	Golden Hills Community Service District	AM (Isolux)	MEI	150	15	<25	6.9

AM = adsorptive media process; C/F = coagulation/filtration; HIX = hybrid ion exchanger; IX = ion exchange process; RO = reverse osmosis
ATS = Aquatic Treatment Systems; MEI = Magnesium Elektron, Inc.; STS = Severn Trent Services
(a) Arsenic existing mostly as As(III).
(b) Design flowrate reduced by 50% due to system reconfiguration from parallel to series operation.
(c) Iron existing mostly as Fe(II).
(d) Withdrawn from program in 2007.
(e) Facilities upgraded systems in Springfield, OH from 150 to 250 gpm, Sandusky, MI from 210 to 340 gpm, and Arnaudville, LA from 385 to 770 gpm.
(f) Including nine residential units.
(g) Including eight under-the-sink units.

2.0 SUMMARY AND CONCLUSIONS

The performance evaluation of STS's APU-450 treatment system at the Town of Taos in New Mexico was conducted during February 14, 2006, through October 23, 2007. Based on the information collected during the course of the study, the following summary and conclusions were made relating to the overall project objectives:

Performance of the arsenic removal technology for use on small systems:

- The Carbon Dioxide Gas Flow Control System was effective at consistently reducing raw water pH values to levels close to the target value of 7.2. However, some troubleshooting was required during system shakedown.
- SORB 33™ media effectively removed arsenic to below 10 μg/L during the performance evalution study. Because of limited use of the treatment system, it treated only less than 14,200 bed volumes (BV) (or 22,977,000 gal) of water.
- Backwash was not necessary to operate the system. Backwash was performed five times, primarily for the study purpose.

Required system O&M and operator skill levels:

- The daily demand on the operator's time was reasonable, typically about 40 min/day to visually inspect the system and record operational parameters. Extra time was needed from the operator to help troubleshoot the carbon dioxide pH control system and, to a less extent, the arsenic treatment system.
- Frequent and prolonged system downtime was observed; it was caused primarily by non-system related issues, such as power outages and transmission line leakage.

Characteristics of residuals produced by the technology:

- A relatively small quantity of solids (i.e., 4 lb), was produced during each backwash event, which produced over 12,000 gal of wastewater. Arsenic constituted only a fraction of the solids (i.e., 4×10^{-4} lb). Most iron discharged might have come from media fines.

Capital and O&M cost of the technology:

- The capital investment for the system was $296,644, including $202,685 for equipment, $32,750 for site engineering, and $61,209 for installation, shakedown, and startup. Using the system's rated capacity of 450 gal/min (gpm) (or 648,000 gal/day [gpd]), the capital cost was $659/gpm (or $0.46/gpd) of design capacity. This calculation does not include the cost of the building to house the treatment system.
- The estimated media changeout cost for all three adsorption vessels was $41,749, which represents the majority of the O&M cost. Media changeout did not occur during the performance evaluation period.

3.0 MATERIALS AND METHODS

3.1 General Project Approach

Following the predemonstration activities summarized in Table 3-1, the performance evaluation study of the STS treatment system began on February 14, 2006. Table 3-2 summarizes the types of data collected and considered as part of the technology evaluation process. The overall system performance was evaluated based on its ability to consistently remove arsenic to below the target MCL of 10 μg/L through the collection of water samples across the treatment train. The reliability of the system was evaluated by tracking the unscheduled system downtime and frequency and extent of repair and replacement. The unscheduled downtime and repair information were recorded by the plant operator on a Repair and Maintenance Log Sheet.

Table 3-1. Predemonstration Study Activities and Completion Dates

Activity	Date
Introductory Meeting Held	December 1, 2004
Project Planning Meeting Held	March 7, 2005
Final Letter of Understanding Issued	March 24, 2005
Request for Quotation Issued to Vendor	March 28, 2005
Vendor Quotation Received	April 29, 2005
Purchase Order Established	May 12, 2005
Engineering Package Submitted to NMED	June 24, 2005
Letter Report Issued	August 19, 2005
Approval Granted by NMED	September 12, 2005
System Delivered to Site	October 3, 2005
Study Plan Issued	November 2, 2005
System Installation Completed	December 8, 2005
System Shakedown Completed	February 3, 2006
Performance Evaluation Begun	February 14, 2006
Performance Evaluation Completed	October 23, 2007

NMED = New Mexico Environment Department

The O&M and operator skill requirements were evaluated based on a combination of quantitative data and qualitative considerations, including the need for pre- and/or post-treatment, level of system automation, extent of preventative maintenance activities, frequency of chemical and/or media handling and inventory, and general knowledge needed for relevant chemical processes and related health and safety practices. The staffing requirements for the system operation were recorded on an Operator Labor Hour Log Sheet.

The quantity of aqueous and solid residuals generated was estimated by tracking the volume of backwash wastewater produced during each backwash cycle. Backwash wastewater was sampled and analyzed for chemical characteristics.

The cost of the system was evaluated based on the capital cost per gpm or gpd of design capacity and the O&M cost per 1,000 gal of water treated. This task required tracking the capital cost for equipment, site engineering, and installation, as well as the O&M cost for chemical supply, electricity consumption, and labor.

Table 3-2. Evaluation Objectives and Supporting Data Collection Activities

Evaluation Objective	Data Collection
Performance	-Ability to consistently meet 10 µg/L arsenic MCL in treated water
Reliability	-Unscheduled system downtime -Frequency and extent of repairs including a description of problems, materials and supplies needed, and associated labor and cost
System O&M and Operator Skill Requirements	-Pre- and post-treatment requirements -Level of automation for system operation and data collection -Staffing requirements including number of operators and laborers -Task analysis of preventative maintenance including number, frequency, and complexity of tasks -Chemical handling and inventory requirements -General knowledge needed for relevant chemical processes and health and safety practices
Residual Management	-Quantity and characteristics of aqueous and solid residuals generated
System Cost	-Capital cost for equipment, engineering, and installation -O&M cost for chemical usage, electricity consumption, and labor

3.2 System O&M and Cost Data Collection

The plant operator performed daily, weekly, and monthly system O&M and data collection according to instructions provided by the vendor and Battelle. On a daily basis (with the exception of Saturdays and Sundays), the plant operator recorded system operational data, such as pressure, flowrate, totalizer, and hour meter readings, and the pH control system's operational data, such as CO_2 application flowrate, pressure, and inline pH readings on a Daily System Operation Log Sheet. The operator also conducted visual inspections to ensure normal system operations. If any problem occurred, the plant operator contacted the Battelle Study Lead, who determined if the arsenic removal system and/or pH control system vendors should be contacted for troubleshooting. The plant operator recorded all relevant information, including the problems encountered, course of actions taken, materials and supplies used, and associated cost and labor incurred, on a Repair and Maintenance Log Sheet. On a weekly basis, the plant operator measured several water quality parameters onsite, including temperature, pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), and recorded the data on an Onsite Water Quality Parameters Log Sheet. Monthly (or as needed) backwash data were recorded on a Backwash Log Sheet.

The capital cost for the arsenic removal system consisted of the cost for equipment, site engineering, and system installation. The O&M cost consisted of the cost for chemical (including CO_2) usage, electricity consumption and labor. CO_2 consumption by the pH control system was tracked on the Daily System Operation Log Sheet. Electricity usage was estimated from utility bills. Labor for various activities, such as routine system O&M, troubleshooting and repairs, and demonstration-related work, were tracked using an Operator Labor Hour Log Sheet. The routine system O&M included activities, such as completing field logs, replacing CO_2 gas dewars, ordering supplies, performing system inspections, and others as recommended by the vendor. The labor for demonstration-related work, including activities, such as performing field measurements, collecting and shipping samples, and communicating with the Battelle Study Lead and the vendors, was recorded, but not used for the cost analysis.

3.3 Sample Collection Procedures and Schedules

To evaluate system performance, samples were collected at the wellhead, across the treatment system, during system backwash, and from the distribution system. The sample types and locations, number of samples taken, and analytes measured during each sampling event are listed in Table 3-3.

Table 3-3. Sampling Schedule and Analyses

Sample Type	Sample Locations	No. of Samples	Frequency	Analytes	Collection Date(s)
Source Water	IN	1	Once (during initial site visit)	Onsite: pH, temperature, DO, and ORP Off-site: As(III), As(V), As (total and soluble), Fe (total and soluble), Mn (total and soluble), Ra (total and soluble) U (total and soluble), V (total and soluble), Na, Ca, Mg, Cl, F, NO_3, NO_2, NH_3, SO_4, SiO_2, PO_4, turbidity, alkalinity, TDS, and TOC	12/01/04
Treatment Plant Water	IN, AP, TT	3	Monthly (first week of each four-week cycle; referred to as speciation week)	Onsite: pH, temperature, DO, and ORP Off-site: As(III), As(V), As (total and soluble), Fe (total and soluble), Mn (total and soluble), Ca, Mg, F, NO_3, SO_4, SiO_2, P, turbidity, and alkalinity	See Appendix B
	IN, AP, TA, TB, TC	5	Monthly (third week of each four-week cycle or regular week)	Onsite: pH, temperature, DO, and ORP Off-site: As (total), Fe (total), Mn (total), SiO_2, P, turbidity, and alkalinity	See Appendix B
Backwash Water	Backwash Discharge Line from Each Vessel to an Evaporative Pond	3	Monthly or as needed	As (total and soluble), Fe (total and soluble), Mn(total and soluble), pH, TDS, and TSS	See Table 4-15
Distribution System Water	Three LCR Locations	3	Monthly	As (total), Fe (total), Mn (total), Cu (total), Pb (total), pH, and alkalinity	See Table 4-16
Residual Solids	Spent Media	NA	NA	TCLP and total Al, As, Ca, Cd, Cu, Fe, Mg, Mn, Ni, P, Pb, Si, and Zn	Section 3.3.5

IN = wellhead; AP = after pH adjustment; TA = after Vessel A; TB = after Vessel B; TC = after Vessel C; and TT = after effluent combined
NA = not available; TCLP = toxicity characteristic leaching procedure

In addition, Figure 3-1 presents a flow diagram of the treatment system along with the analytes and schedules at each sampling location. Specific sampling requirements for analytical methods, sample volumes, containers, preservation, and holding times are presented in Table 4-1 of the EPA-endorsed Quality Assurance Project Plan (QAPP) (Battelle, 2004). The procedure for arsenic speciation is described in Appendix A of the QAPP.

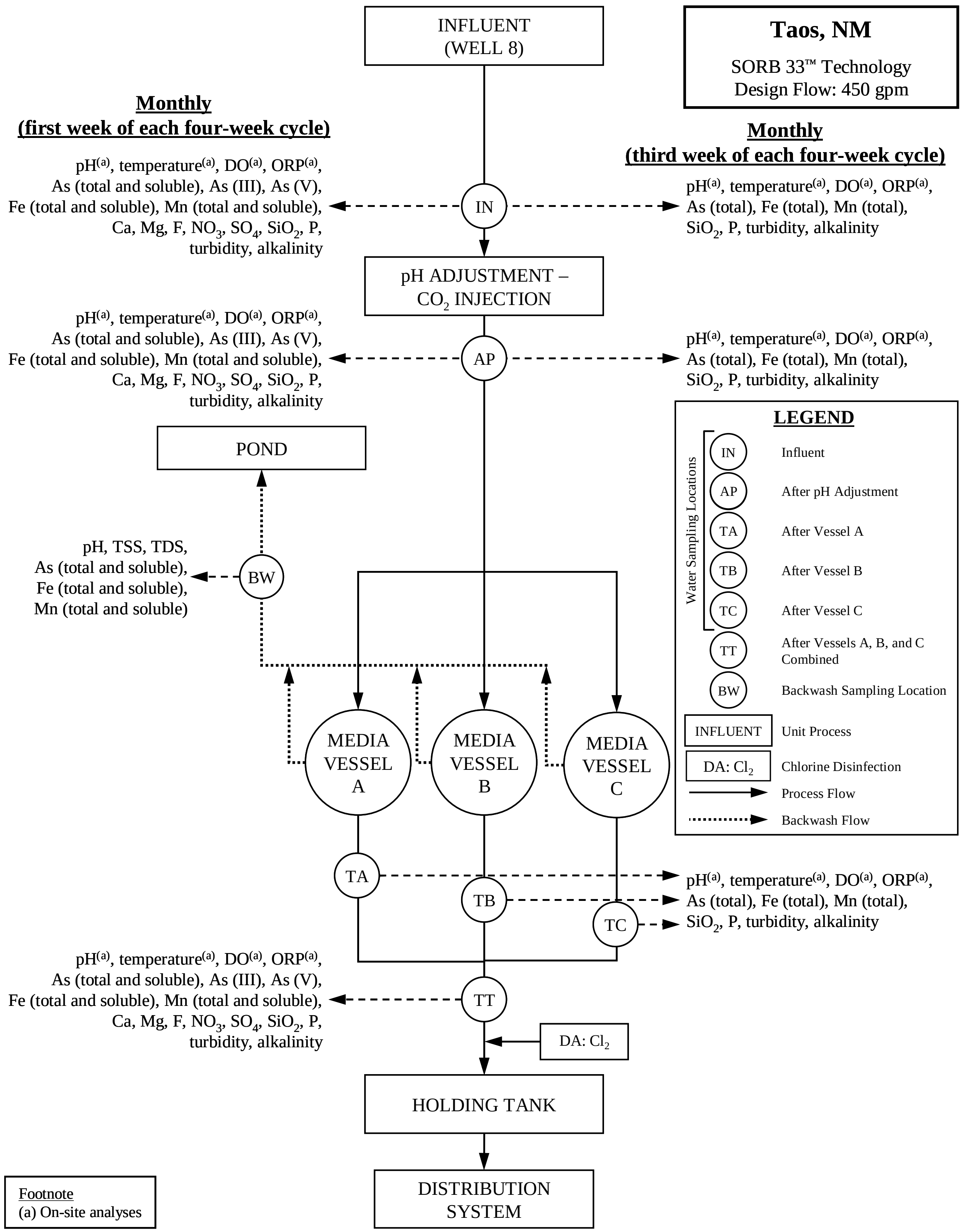


Figure 3-1. Process Flow Diagram and Sampling Schedule and Locations

3.3.1 Source Water. During the initial visit to the site on December 1, 2004, one set of raw water samples was collected from Well 8 and speciated using an arsenic speciation kit (see Section 3.4.1). The sample tap was flushed for several minutes before sampling; special care was taken to avoid agitation, which might cause unwanted oxidation. Analytes for the source water samples are listed in Table 3-3.

3.3.2 Treatment Plant Water. During the system performance evaluation study, water samples were collected across the treatment train by the plant operator for on- and off-site analyses. The original sampling schedule called for the collection of "speciation samples" at the wellhead (IN), after pH adjustment (AP), and after effluent combined (TT) during the first of each four week cycle, and "regular samples" at IN, AP, and after adsorption vessels A, B, and C (TA, TB, and TC) during the third week of each four week cycle (Table 3-3). However, due to frequent system downtime cuased by a variety of reasons discussed in Section 4.4.1, sampling across the treatment plant took place rather randomly from as short as once a week to as long as once in 13 weeks. Further, starting from May 1, 2007, off-site analytes were reduced to only total arsenic. Onsite measurements, however, were performed during most of the sampling events.

3.3.3 Backwash Wastewater. Because pressure differential (Δp) across each adsorption vessel was low and never reached the 10-lb/in^2 (psi) vendor-recommended setpoint, backwash was performed only five times throughout the study period. Backwash was performed when:

- Battelle staff members were onsite to inspect the system and provide operator training on February 14, 2006,
- STS technicians were onsite to repair the system on March 16, 2006, and
- Backwash was initiated manually by the operator to collect backwash wastewater samples on April 10, 2006, July 10, 2007, and October 10, 2007.

Backwash wastewater samples were collected from each of the three adsorption vessels. Tubing, connected to the tap on the discharge line of backwash wastewater, directed a portion of backwash wastewater at about 1 gpm to a clean, 32-gal container over the duration of the backwash for each tank. After the content in the container was thoroughly mixed, composite samples were collected and/or filtered onsite with 0.45-µm filters. Analytes for the backwash samples are listed in Table 3-3.

3.3.4 Distribution System Water. Water samples were collected from the distribution system to determine the impact of the arsenic treatment system on the water chemistry in the distribution system, specifically, the arsenic, lead, and copper levels. Prior to system startup from May to August 2005, four sets of monthly baseline water samples were collected from three Lead and Copper Rule (LCR) sampling locations designated as DS1, DS2, and DS3, within the distribution system. DS1 and DS2 were within a residence while DS3 was within the Town Hall. DS1, DS2, and DS3 were located east, north, and center of the Town with DS3 being the closest to the treatment plant at approximately 5 miles away. Following system startup, distribution system water sampling continued on a monthly basis at the same three locations as discussed.

The homeowners/operator collected samples following an instruction sheet developed according to the *Lead and Copper Monitoring and Reporting Guidance for Public Water Systems* (EPA, 2002). The sample collection and dates and times of last water usage before sampling were recorded for calculations of stagnation times. All first-draw samples were collected from a cold-water faucet that had not been used for at least 6 hr to ensure that stagnant water was sampled. Analytes for the baseline and monthly samples are listed in Table 3-3.

3.3.5 Residual Solids. Because media replacement did not take place during the duration of this demonstration study, no spent media samples were collected. No backwash solids were collected, either, because few solids were present in the backwash wastewater sampling containers.

3.4 Sampling Logistics

3.4.1 Preparation of Arsenic Speciation Kits. The arsenic field speciation method uses an anion exchange resin column to separate the soluble arsenic species, As(V) and As(III) (Edwards et al., 1998). Resin columns were prepared in batches at Battelle laboratories according to the procedures detailed in Appendix A of the EPA-endorsed QAPP (Battelle, 2004).

3.4.2 Preparation of Sample Coolers. For each sampling event, a sample cooler was prepared with the appropriate number and type of sample bottles, disc filters, and/or speciation kits. All sample bottles were new and contained appropriate preservatives. Each sample bottle was affixed with a pre-printed, colored-coded label consisting of the sample identification (ID), date and time of sample collection, collector's name, site location, sample destination. analysis required, and preservative. The sample ID consisted of a two-letter code for a specific water facility, sampling date, a two-letter code for a specific sampling location, and a one-letter code designating the arsenic speciation bottle (if necessary). The sampling locations at the treatment plant were color-coded for easy identification. The labeled bottles for each sampling location were placed in separate Ziplock^{TM} bags and packed in the cooler.

In addition, all sampling and shipping-related materials, such as disposable gloves, sampling instructions, chain-of-custody forms, prepaid/addressed FedEx air bills, and bubble wrap, were included. The chain-of-custody forms and air bills were complete except for the operator's signature and the sample dates and times. After preparation, the sample cooler was sent to the site via FedEx for the following week's sampling event.

3.4.3 Sample Shipping and Handling. After sample collection, samples for off-site analyses were packed carefully in the original coolers with wet ice and shipped to Battelle. Upon receipt, the sample custodian verified that all samples indicated on the chain-of-custody forms were included and intact. Sample IDs were checked against the chain-of-custody forms and the samples were logged into the laboratory sample receipt log. Discrepancies noted by the sample custodian were addressed with the plant operator by the Battelle Study Lead.

Samples for metal analyses were stored at Battelle's inductively coupled plasma-mass spectrometry (ICP-MS) laboratory. Samples for other water quality analyses were packed in separate coolers and picked up by couriers from American Analytical Laboratories (AAL) in Columbus, OH and TCCI Laboratories in Lexington, OH, both of which were under contract with Battelle for this demonstration study. The chain-of-custody forms remained with the samples from the time of preparation through analysis and final disposition. All samples were archived by the appropriate laboratories for the respective duration of the required hold time and disposed of properly thereafter.

3.5 Analytical Procedures

The analytical procedures described in Section 4.0 of the EPA-endorsed QAPP (Battelle, 2004) were followed by Battelle ICP-MS, AAL, and TCCI Laboratories. Laboratory quality assurance/quality control (QA/QC) of all methods followed the prescribed guidelines. Data quality in terms of precision, accuracy, method detection limits (MDL), and completeness met the criteria estrablished in the QAPP (i.e., relative percent difference [RPD] of 20%, percent recovery of 80 to 120%, and completeness of 80%). The quality assurance (QA) data associated with each analyte will be presented and evaluated in a

QA/QC Summary Report to be prepared under separate cover upon completion of the Arsenic Demonstration Project.

Field measurements of pH, temperature, DO, and ORP were conducted by the plant operator using a VWR Symphony SP90M5 Handheld Multimeter, which was calibrated for pH and DO prior to use following the procedures provided in the user's manual. The ORP probe also was checked for accuracy by measuring the ORP of a standard solution and comparing it to the expected value. The plant operator collected a water sample in a clean, plastic beaker and placed the Symphony SP90M5 probe in the beaker until a stable value was obtained. The plant operator also performed free and total chlorine measurements using Hach chlorine test kits following the user's manual.

4.0 RESULTS AND DISCUSSION

4.1 Site Description

4.1.1 Preexisting Facility. The Town of Taos's treatment building, also known as the booster pump station, is located five miles southwest of the Town at 182 Los Cordovas, Taos, NM. It supplies drinking water to approximately 5,000 residences and an influx of tourists in the summer. During the demonstration study, the Town had a total of 10 wells, but only five (i.e., Wells 1 through 5) were used to meet water demand in the distribution system. Wells 1 through 5 operated on a rotating basis, with two or three wells operating at a time. According to the Year 2004 Water Production Consumption Report provided by the facility, the total yearly water production in 2004 was approximately 294,579,000 gal. The daily water demand varied from 439,000 to 978,000 gpd and averaged 695,000 gpd. Chlorination for disinfection was accomplished using a mixed oxidants (MIOX) system at each wellhead for a target total chlorine residual of 0.2 mg/L (as Cl_2).

Designated for the study, Well 8 (Figure 4-1), was not in operation prior to the study due to high pH values and elevated arsenic concentrations in well water. Well 8 was constructed of 10¾-in-diameter casing to a total depth of 2,520 ft with a screened interval spanning from 1,324 ft to 2,520 ft below ground surface (bgs). The static water level was approximately 153 ft bgs. The well was equipped with a 150-horsepower (hp) submersible pump set at 900 ft bgs, capable of producing a flowrate of 450 gpm at a head of approximately 1,000 ft (or 433 lb/in^2 [psi]). After the arsenic treatment system was installed, Well 8 was used as a main supply well.

Located approximately 20 ft from the wellhead, the Well 8 pump house (Figure 4-2) housed all relevant piping and instrumentation, including one control panel, one hour meter, two electric meters, two pressure gauges, one flow totalizer/meter, and one raw water sample tap. When Well 8 was activated at the pump house, water was initially purged into a holding pond (Figure 4-3) for 5 min before being directed to the treatment building (or booster pump station). The treatment building, as originally designed, was used to house an infiltration gallery system comprising of a 10-ft-diameter by 6-ft-tall steel filtration vessel (Figure 4-4), a MIOX injection system, and two booster pumps. The steel filtration vessel, however, was never used and it was removed to make room for the arsenic removal system. Modifications to the treatment building, as discussed in Section 4.3, included a concrete pad, an overhead door, and piping and electrical connections (Figure 4-5).

Water from Well 8 was transported to the treatment building via a 0.8-mile-long, 10-in-diameter high density polyethylene (HDPE) pipeline, chlorinated in the treatment building, and then stored temporarily in a 50,000-gal holding tank on a hill approximately 150 ft from the treatment building (Figure 4-6). The treated water was delivered from the 50,000 gal holding tank to a 1,000,000 gal water tower located southeast of the Town via two 100-hp, 650-gpm booster pumps located in the treatment building and a 3.2-mile-long, 10-in-diameter polyvinyl chloride (PVC) pipeline. (Note that Well 8 supplied only 10% of the capacity of the 1,000,000 gal water tower; the balance was supplied by Wells 1, 2, 3, 3a, 4, and 5). Because Well 8 was not integrated into the Town's system control and data acquisition (SCADA) system, both Well 8 pump and the booster pumps had to be turned on and off manually by the operator. Due to a higher booster pump flowrate, the operator controlled the water level in the 50,000-gal holding tank by turning the booster pumps on and off intermittently. An evaporative pond (Figure 4-7) located outside of the treatment building was used to discharge backwash wastewater generated by the arsenic removal system.

Figure 4-1. Well 8 Wellhead with Pump House in Background

Figure 4-2. Inside of Well 8 Pump House

Figure 4-3. Holding Pond for Raw Water Discharge During Initial Purge

Figure 4-4. Inside of Preexisting Water Treatment Building with Unused Sand Filtration Vessel

Figure 4-5. Modified Treatment Building/Booster Pump Station

Figure 4-6. A 50,000-Gal Holding Tank on Hill

Figure 4-7. Evaporative Pond for Backwash Wastewater Discharge

4.1.2 Source Water Quality. Source water samples were collected and speciated from Well 8 on December 1, 2004, for on- and off-site analyses (Table 3-3). The analytical results are presented in Table 4-1 and compared to those taken by the facility and submitted to EPA for the demonstration site selection. The results after the MIOX treatment obtained from the New Mexico Environment Department/Drinking Water Bureau (NMED/DWB) are presented in Table 4-2.

Arsenic. Total arsenic concentrations in Well 8 ranged from 14.1 to 19 µg/L. Based on the December 1, 2004, speciation results, arsenic existed primarily in the soluble form. Out of 14.1 µg/L of total arsenic, 2.1 µg/L existed as soluble As(III) and 11.8 µg/L (or 84%) as soluble As(V). Therefore, As(V) was the predominant species and prechlorination would not be needed. Based on laboratory and field studies, As(V) is more readily adsorbed onto SORB 33™ media, and oxidation of As(III), if present as the predominant species, should help improve removal efficiency.

Iron and Manganese. Total iron concentrations were low, ranging from less than the method reporting limit of 40 µg/L to 59 µg/L. Based on the December 1, 2004, speciation results, total iron existed primarily in the particulate form. The presence of particulate iron in source water was carefully monitored during the demonstration study to determine if the measurement of particulate iron on December 1, 2004, was simply due to inadvertent aeration of the sample during sampling.

In general, adsorptive media technologies are best suited to sites with relatively low iron levels in source water (i.e., less than 300 µg/L, which is the secondary maximum contaminant level [SMCL] for iron). Above 300 µg/L, taste, odor, and color problems can occur in treated water, along with an increased potential for fouling of the adsorption system components with iron particulates. Because the iron concentration in Well 8 water was low, iron removal was not required.

Table 4-1. Raw Water Quality Data for Town of Taos

Parameter	Unit	Utility Raw Water Data[(a)]	Battelle Raw Water Data
Date		NA	12/01/04
pH	S.U.	9.7	9.5
Temperature	°C	NS	23.9
DO	mg/L	NS	0.7
ORP	mV	NS	NA
Total Alkalinity (as $CaCO_3$)	mg/L	82	96
Hardness (as $CaCO_3$)	mg/L	<5	4.9
Turbidity	NTU	NS	1.9
TDS	mg/L	NS	218
TOC	mg/L	NS	<0.7
Nitrate (as N)	mg/L	NS	<0.04
Nitrite (as N)	mg/L	NS	<0.01
Ammonia (as N)	mg/L	NS	<0.05
Chloride	mg/L	10	11.0
Fluoride	mg/L	NS	1.4
Sulfate	mg/L	38	41.0
Silica (as SiO_2)	mg/L	NS	30.4
Orthophosphate (as P)	mg/L	NS	<0.06
As (total)	µg/L	19	14.1
As (soluble)	µg/L	NS	13.9
As (particulate)	µg/L	NS	0.2
As(III)	µg/L	NS	2.1
As(V)	µg/L	NS	11.8
Fe (total)	µg/L	<40	59
Fe (soluble)	µg/L	NS	<25
Mn (total)	µg/L	<10	5.0
Mn (soluble)	µg/L	NS	0.3
U (total)	µg/L	NS	0.4
U (soluble)	µg/L	NS	0.4
V (total)	µg/L	NS	35.7
V (soluble)	µg/L	NS	34.2
Ra (total)	pCi/L	NS	<1.0
Ra (soluble)	pCi/L	NS	<1.0
Na (total)	mg/L	61	75.1
Ca (total)	mg/L	1.4	1.9
Mg (total)	mg/L	0.1	0.03

NA = not available; NS = not sampled; TDS = total dissolved solids; TOC = total organic carbon
(a) Provided to EPA for demonstration study site selection.

Manganese concentrations in source water were as low as 5.0 µg/L. Based on the December 1, 2004, speciation results, total manganese existed primarily in the particulate form. Out of 5.0 µg/L of total manganese, 0.3 µg/L (or 6%) existed as soluble manganese.

pH. pH values ranged from 9.5 to 9.7, which are higher than the target range of 6.0 to 8.0 for arsenic removal via adsorption with iron media. Therefore, pH adjustment was needed prior to the arsenic removal system. pH adjustment using a CO_2 injection system was proposed by the vendor.

Table 4-2. NMED/DWB Treated Water Quality Data for Taos, NM

Date	Unit	03/26/02	06/04/02	08/20/02	10/29/02	01/30/03	05/05/03	12/09/03	3/22/04	06/30/04	08/25/04	12/30/04
Bromoform	µg/L	0	NS	NS	0	0	0	0.22	0.76	0	0.70	0.39
	µg/L	0	NS	NS	0.30	0	0	NS	NS	NS	NS	NS
	µg/L	0.20	NS	NS	0	0	0.09	NS	NS	NS	NS	NS
	µg/L	0	NS	NS	0	0	0	NS	NS	NS	NS	NS
Bromodichloromethane	µg/L	0	NS	NS	0	0	0	0.26	0.19	0	1.00	0.51
	µg/L	0	NS	NS	0	0	0	NS	NS	NS	NS	NS
	µg/L	0	NS	NS	0	0	0	NS	NS	NS	NS	NS
	µg/L	0	NS	NS	0	0	0	NS	NS	NS	NS	NS
Bromochloroacetic acid	µg/L	0	0	0	0	1.04	0	0	NS	NS	NS	NS
	µg/L	0	0	0	0	0.8	0	NS	NS	NS	NS	NS
	µg/L	0	0	0	0	2.85	0	NS	NS	NS	NS	NS
	µg/L	0	0	0	0	0.55	0	NS	NS	NS	NS	NS
Chlorodibromethane	µg/L	0	NS	NS	0	0	0	0.42	0.46	0.10	1.20	0.71
	µg/L	0	NS	NS	0	0	0	NS	NS	NS	NS	NS
	µg/L	0	NS	NS	0.30	0	0.35	NS	NS	NS	NS	NS
	µg/L	0.40	NS	NS	0	0	0	NS	NS	NS	NS	NS
Total Trihalomethanes (TTHM)	µg/L	0.40	NS	0	0	0	0	0.90	1.51	0.10	3.60	2.02
	µg/L	0	NS	NS	0	0	0	NS	NS	NS	NS	NS
	µg/L	0.20	NS	NS	0.60	0	0.44	NS	NS	NS	NS	NS
	µg/L	0	NS	NS	0.30	0	0	NS	NS	NS	NS	NS
Chloroform	µg/L	0	NS	NS	0	0	0	0	0.10	0	0.70	0.41
	µg/L	0	NS	NS	0.30	0	0	NS	NS	NS	NS	NS
	µg/L	0	NS	NS	0	0	0	NS	NS	NS	NS	NS
	µg/L	0	NS	NS	0	0	0	NS	NS	NS	NS	NS
Monochloroacetic acid	µg/L	0	0	0	0	0	0	0	NS	NS	NS	NS
	µg/L	0	0	0	0	0	0	NS	NS	NS	NS	NS
	µg/L	0	0	0	0	0	0	NS	NS	NS	NS	NS
	µg/L	0	0	0	0	0	0	NS	NS	NS	NS	NS
Dibromoacetic acid	µg/L	0	0.23	0.19	0.17	0	0	0.56	-	-	-	-
	µg/L	0.18	0	0	0.17	0	0	NS	NS	NS	NS	NS
	µg/L	0	0	0.13	0.12	0	0.53	NS	NS	NS	NS	NS
	µg/L	0.18	0.30	0	0	0	0	NS	NS	NS	NS	NS
Monobromoacetic acid	µg/L	0	0	0	0	0	0	0	NS	NS	NS	NS
	µg/L	0	0	0	0	0	0	NS	NS	NS	NS	NS
	µg/L	0	0	0	0	0	0	NS	NS	NS	NS	NS
	µg/L	0	0	0	0	0	0	NS	NS	NS	NS	NS
Dichloroacetic acid	µg/L	0	1.61	0.66	0.54	0	1.87	0	NS	NS	NS	NS
	µg/L	0	0.75	0.72	0.53	0	1.65	NS	NS	NS	NS	NS
	µg/L	0	0.67	0.72	0.48	0	1.61	NS	NS	NS	NS	NS
	µg/L	0	0.78	0.75	0.51	0	1.35	NS	NS	NS	NS	NS
Trichloroacetic acid	µg/L	0	0	0.21	0	0	0.44	0.27	NS	NS	NS	NS
	µg/L	0	0	0.15	0.052	0	0.42	NS	NS	NS	NS	NS
	µg/L	0	0	0.17	0.043	0	0.44	NS	NS	NS	NS	NS
	µg/L	0	0	0.14	0	0	0.40	NS	NS	NS	NS	NS

Note: Only DBPs results available for treated water quality; samples taken at multiple locations within the distribution system.
NS = Not Sampled.

Silica and Orthophosphate. As shown in Table 4-1, silica was at 30.4 mg/L (as SiO_2) and orthophosphate at less than the method reporting limit of 0.06 mg/L (as P). Usually, arsenic adsorption can be influenced by the presence of competing anions such as silica and phosphate, but due to the low levels of these constituents, they were not expected to affect arsenic adsorption onto SORB 33™ media.

Other Water Quality Parameters. Nitrate, nitrite, ammonia, and TOC (total organic carbon) were not detected. Sulfate was at 38 to 41.0 mg/L. Turbidity was at 1.9 NTU. Chloride and fluoride were at 11.0 and 1.4 mg/L, respectively. Alkalinity values ranged from 82 to 96 mg/L. Uranium was at 0.4 µg/L, well below its MCL of 30 µg/L. Vanadium was at 35.7 µg/L, existing almost entirely in the soluble form. Sodium concentrations ranged from 61 to 75.1 mg/L. Calcium, magnesium, and hardness were low, ranging from 1.4 to 1.9 mg/L for calcium and from 0.03 to 0.1 mg/L for magnesium, and at <5 mg/L (as $CaCO_3$) for hardness. Total dissolved solid (TDS) was at 218 mg/L and below its SMCL of 500 mg/L.

4.1.3 Treated Water Quality. Historic treated water data collected by NMED/DWB are provided in Table 4-2. Samples of water after chlorination were collected between March 26, 2002, and December 30, 2004, and analyzed only for disinfection by-products (DBPs). As shown in the table, concentrations of all DBPs were low and did not have any compliance issues.

4.1.4 Distribution System and Regulatory Monitoring. As discussed in Section 4.1.1, the treated water was transported from the 50,000 gal holding tank by two booster pumps to a 1,000,000 gal water tower located southeast of the Town. North of the Town was another water tower with a 200,000-gal capacity that served as a temporary storage for Wells 1 and 2 water before it was transported to the 1,000,000 gal water tower. To supplement the balance of the 1,000,000 gal capacity, water from Wells 3, 3a, 4, and 5 also was pumped to the water tower per schedules established by the SCADA system.

The 1,000,000 gal water tower supplied water to the distribution system either directly or through a 500,000 gal water tower also located southeast of the Town. Based on the information provided by the facility, the distribution system piping was constructed of primarily 6-in PVC pipe. The service lines within the residences were primarily ¾-in copper and ¾-in HDPE pipe.

Under the LCR, water samples were collected from customer taps at 25 residences every three years. The Town also collected samples monthly for bacterial analysis and quarterly for DBPs.

4.2 Treatment Process Description

STS provided an Arsenic Package Unit (APU)-450 arsenic removal system for the Town of Taos. The APU is a fixed-bed, down-flow adsorption system designed for small water systems with flowrates greater than 100 gpm. The APU uses Bayoxide® E33 media (branded as SORB 33™ by STS), an iron-based adsorptive media developed by Bayer AG, for the removal of arsenic from drinking water supplies. Table 4-3 summarizes vendor-provided physical and chemical properties of the media.

SORB 33™ media is delivered in a dry crystalline form and listed by NSF International (NSF) under Standard 61 for use in drinking water applications. The media exists in both granular and pelletized forms, which have similar physical and chemical properties, except that pellets are denser than granules (i.e., 35 vs. 28 lb/ft^3). The pelletized form of the media was used for the Town of Taos.

The treatment train consisted of pH adjustment and adsorption. The APU-450 arsenic removal system consisted of three adsorption vessels arranged in parallel (Figure 4-8), an electrically actuated valve tree, and associated piping and instrumentation. Electrically actuated butterfly valves diverted raw water downward through the three adsorption vessels, which reduced arsenic concentrations to below 10 µg/L. Upon reaching 10-µg/L, the spent media would be removed and disposed of after being subjected to the

Table 4-3. Physical and Chemical Properties of SORB 33™ Media

Physical Properties	
Parameters	**Values**
Matrix	Iron oxide composite
Physical Form	Dry pellets
Color	Amber
Bulk Density (lb/ft^3 or g/cm^3)	35 or 0.56
BET Surface Area (m^2/g)	142
Attrition (%)	0.3
Moisture Content (%,by weight)	<15
Particle Size Distribution (U.S. Standard Mesh)	10 × 35
Crystal size (Å)	70
Crystal phase	α – FeOOH
Chemical Analysis	
Constituents	**Weight (%)**
FeOOH	90.1
CaO	0.27
MgO	1.00
MnO	0.11
SO_3	0.13
Na_2O	0.12
TiO_2	0.11
SiO_2	0.06
Al_2O_3	0.05
P_2O_5	0.02
Cl	0.01

Source: Bayer AG
BET = Brunauer, Emmett, and Teller

EPA Toxicity Characteristic Leaching Procedure (TCLP) test. The media life is dependant upon influent arsenic concentration, pH, and concentrations of interfering ions. Figure 4-9 shows a schematic of the APU-450 arsenic removal system. Table 4-4 summarizes the design features of the arsenic removal system. The major process steps and system components are presented as follows:

- **Intake.** Raw water was pumped from Well 8 and transported to the treatment plant building via a 0.8-mile-long, 10-in-diameter HDPE pipeline. Water entered the building via a 6-in-diameter Schedule 80 PVC pipe to the tie-in point, where the inlet piping was connected to the system through a 6-in-diameter schedule 80 PVC pipe.

- **pH Adjustment.** A Carbon Dioxide Gas Flow Control System manufactured by Applied Technology Systems, Inc. (ATSI) of Souderton, PA, was used to lower the pH of raw water from approximately 9.5 to a target value of 7.2 to increase arsenic removal capacity of the media. CO_2 was used for pH adjustment because 1) CO_2 is less corrosive than mineral acids, such as H_2SO_4, and 2) when the treated water is depressurized after exiting the treatment system, some CO_2 degases, thereby raising pH values of the treated water and reducing its corrosivity to the distribution piping.

Figure 4-8. Photograph of APU-450 Arsenic Removal System

Figure 4-10 shows a schematic of the pH control system, which consisted of a liquid CO_2 supply assembly, an automatic pH control panel (Figure 4-11), a CO_2 loop, a CO_2 membrane module, and a pH probe located downstream of the membrane module. Figure 4-12 presents a composite of photographs of major system components. Details of key process steps and system components are described below.

- Liquid CO_2 in two banks of two 380-lb dewars and two 50-lb backup cylinders vaporized into gaseous CO_2 via a feed vaporizer prior to entering the pH control panel.
- As CO_2 gas flowed to the pH control panel, its flowrate was automatically controlled and regulated by a JUMO pH/Proportional Integral Derivative (PID) controller and an Alicat mass flowmeter to reach the desired pH setpoint. The flowrate also could be regulated manually through the use of a three-way ball valve and a rotameter. A solenoid valve interlocked with the well pump allowed gas to flow only when the well pump was turned on.
- After flowing out of the control panel, CO_2 was injected into water through a Celgard® microporous hollow fiber membrane module housed in a 4-in stainless steel sanitary cross. Table 4-5 provides relevant properties of the membrane module. The sanitary cross was located in a side stream from the main water line to allow only a portion of water to flow through the membrane to minimize the pressure drop. The membrane module introduced CO_2 gas into water at a near molecular level for rapid mixing/reaction in order to achieve a quick pH response/change.

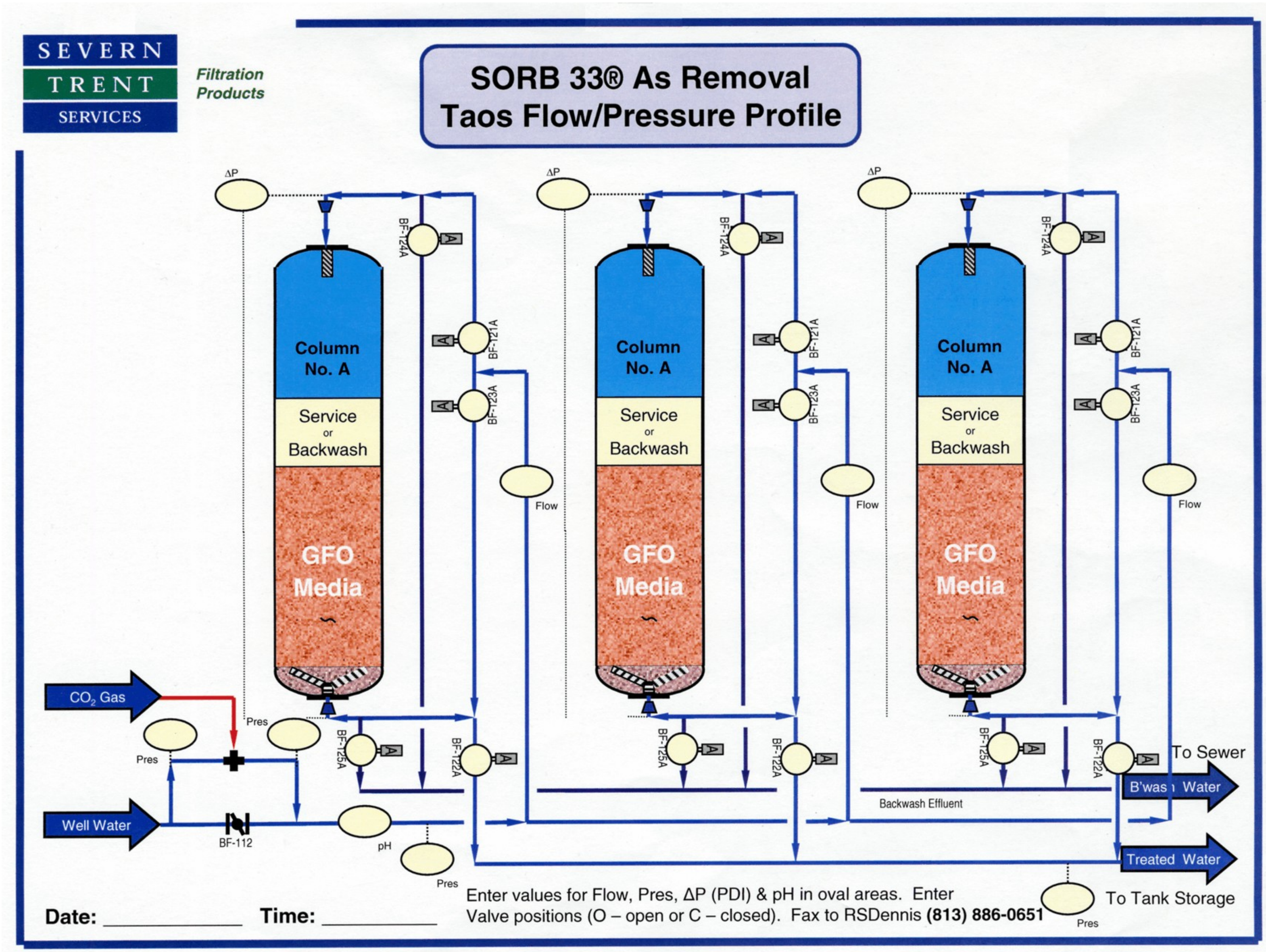


Figure 4-9. Schematic of STS's APU-450 Arsenic Removal System

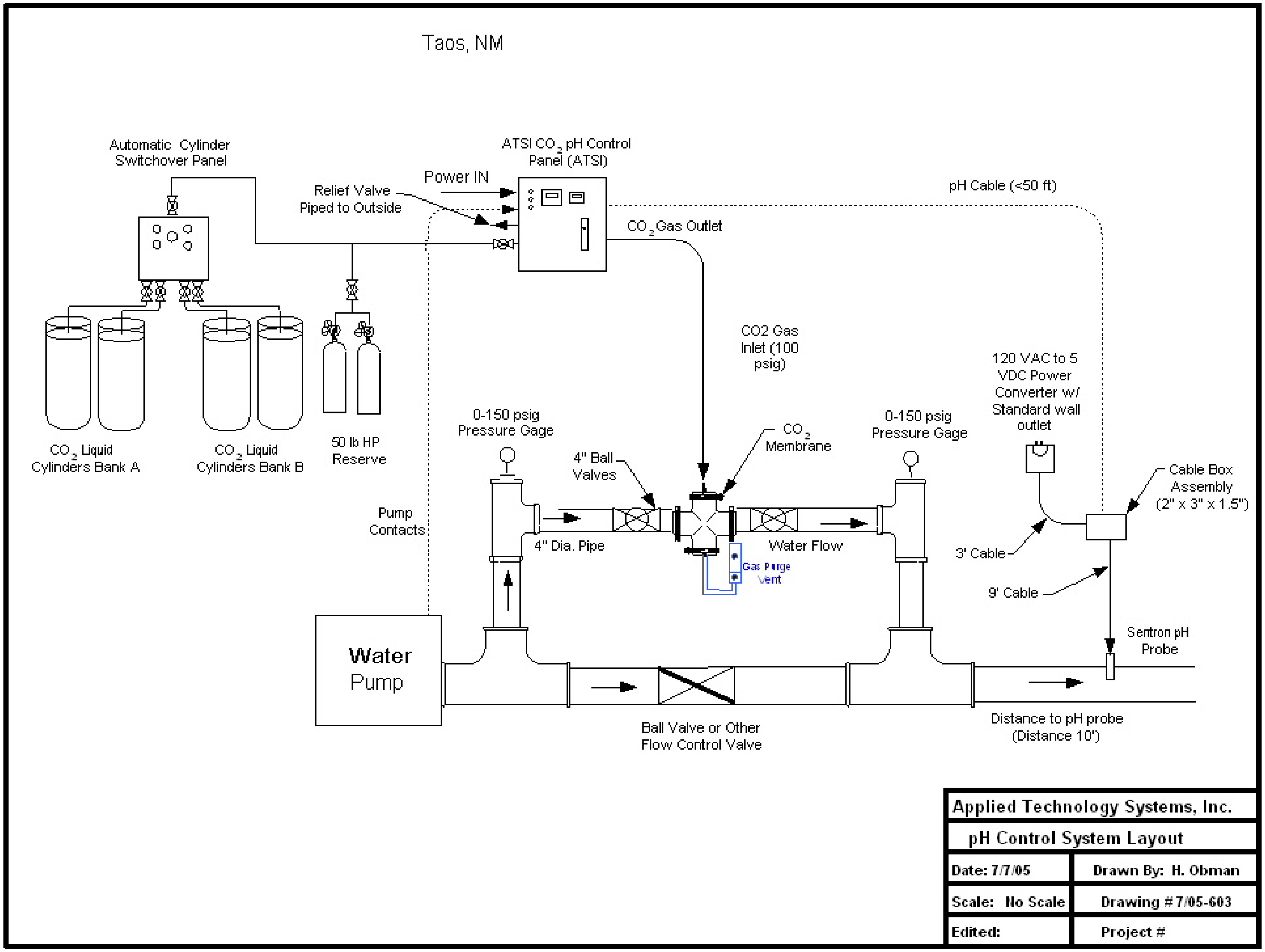
Table 4-4. Design Specifications for STS APU-450 System

Parameter	Value	Remarks
Adsorption Vessels		
Vessel Size (in)	63 D x 86 H	–
Cross-Sectional Area (ft^2/vessel)	21.6	–
No. of Vessels	3	–
Configuration	Parallel	–
Adsorptive Media Beds		
Media Type	SORB 33™	–
Media Weight (lb)	6,264	–
Media Volume (ft^3)	180	60 ft^3/vessel
Media Bed Depth (in)	33	
Pressure Drop across Media Bed(psi)	4 psi	Across a clean bed
Service		
Design Flowrate (gpm)	450	150 gpm/vessel
Hydraulic Loading (gpm/ft^2)	6.9	–
EBCT for System (min)	3.0	Based on design flowrate
Estimated Working Capacity (BV)	130,000	For pelletized media
Throughput to Breakthrough (gal)	175,000,000	1 BV = 1,346 gal
Average Use Rate (gal/day)	224,000	8 to 9 hr of daily operation at 450 gpm
Estimated Media Life (months)	26	Changeout frequency at 33% utilization
Post-chlorination Dosage (mg/L [as Cl_2])	0.5	With MIOX
Backwash		
Pressure Differential Set Point (psi)	10	–
Backwash Flowrate (gpm)	200	–
Backwash Hydraulic Loading (gpm/ft^2)	9.3	–
Backwash Frequency (per month)	1	Based on vendor's recommendation
Backwash Duration (min/vessel)	15	–
Fast Rinse Flowrate (gpm)	200	–
Fast Rinse Duration (min/vessel)	5	–
Wastewater Production (gal/vessel)	4,000	–

  - Located downstream from the sanitary cross was a Sentron Ion Sensitive Field Effect Transistor (ISFET) type silicon chip sanitary pH probe with automatic temperature compensation, that continuously monitored pH levels of the treated water and sent signals back to the pH/PID controller for pH control.

  The CO_2 pH control system was designed to feed 60 ft^3/hr with a maximum flow of 125 ft^3/hr (or 6.9 to 14.3 lb/hr based on a gas density of 0.1146 lbs/ft^3 at 1 atmosphere and 70°F). The actual average use rate was 85.2 ft^3/hr or 9.8 lb/hr.

- **Adsorption.** The APU-450 system consisted of three 63-in × 86-in vessels, designed to hold 60 ft^3 of pelletized SORB 33™ media supported by a gravel underbed. The skid-mounted vessels were made of fiberglass reinforced plastic (FRP), rated for 150 psi working pressure, and piped to a valve rack mounted on a polyurethane-coated, welded frame. According to the original system design with a flowrate of 450 gpm, the empty bed contact time (EBCT) for each vessel and the system was 3.0 min and the hydraulic loading was 6.9 gpm/ft^2.



Source: Applied Technology Systems, Inc. (ATSI)

Figure 4-10. Process Diagram of CO_2 pH Adjustment System

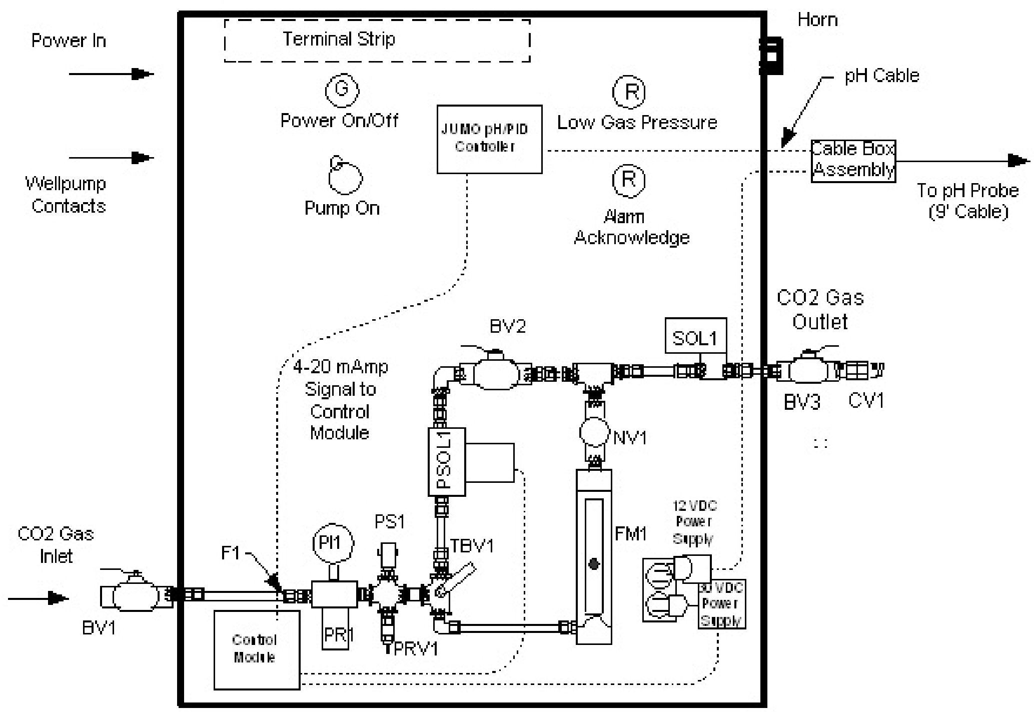


Figure 4-11. pH/PID Control Panel

Figure 4-12. Carbon Dioxide Gas Flow Control System for pH Adjustment
(*Clockwise from Top Left: CO_2 Supply Assembly with Four 380-lb Dewars and Two 50-lb Cylinders; pH Control Panel; Sanitary Cross and CO_2 Loop; and Port for pH Probe*)

Table 4-5. Properties of Celgard®, X50-215 Microporous Hollow Fiber Membrane

Parameter	Value
Porosity (%)	40
Pore Dimensions (µm)	0.04 × 0.10
Effective Pore Size (µm)	0.04
Minimum Burst Strength (psi)	400
Tensile Break Strength (g/filament)	≥300
Average Resistance to Air Flow (Gurley sec)	50
Axial Direction Shrinkage (%)	≤5
Fiber Internal Diameter, nominal (µm)	220
Fiber Wall Thickness, nominal (µm)	40
Fiber Outer Diameter, nominal (µm)	300
Module Dimensions (in)	1.5 × 3.0

Data Source: Celgard®

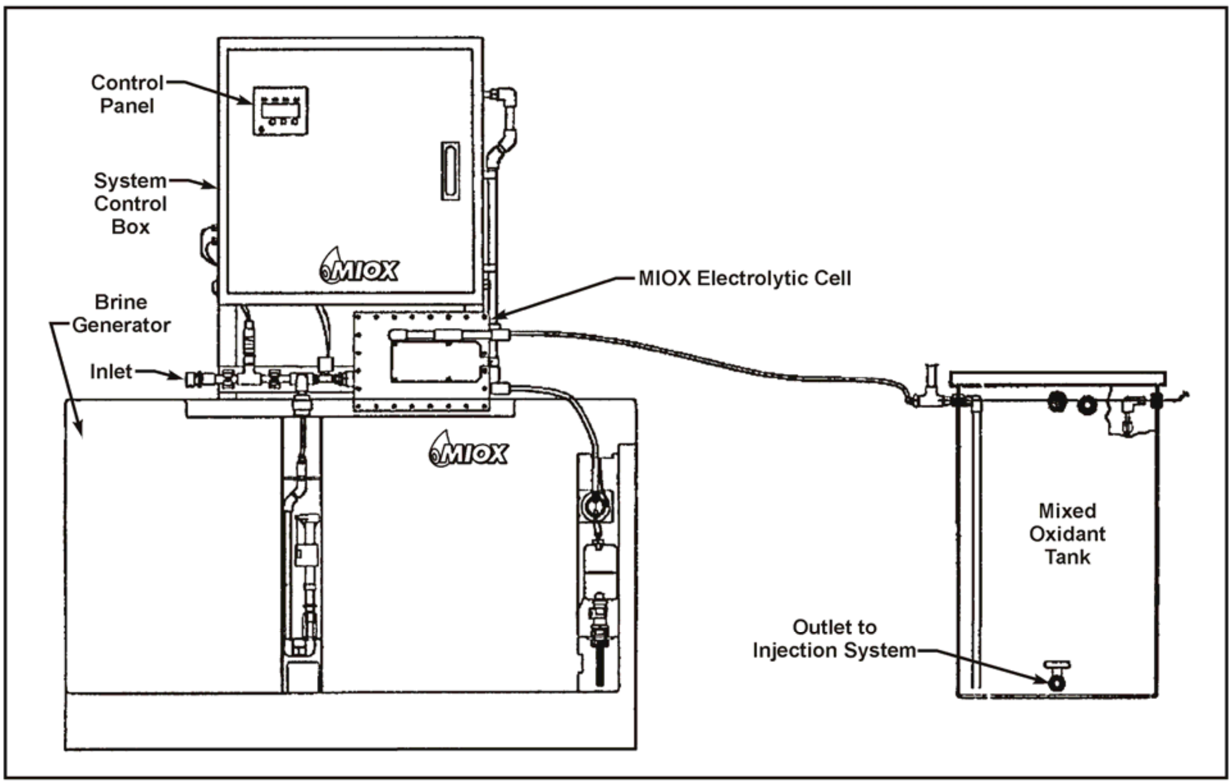
The three adsorption vessels were interconnected with schedule 80 PVC piping and 15 electrically actuated butterfly valves. As the well pump was activated, a signal was sent from the control panel in the pump house to the system to open feed valves (BF 121A, 121B, and 121C) and effluent valves (BF 122A, 122B, and 122C). With the other valves remaining closed, water was diverted downward through the three adsorption vessels. Flow through the three vessels was balanced by throttling the effluent valves, if needed. Flow meters (+GF+SIGNET 8550 ProcessPro™ Flow Transmitter) installed on the supply line of each adsorption vessel monitored instantaneous flowrates through the vessels. The flowmeters also tracked the volume of water treated in each vessel. Differential pressure (Δp) across each vessel was monitored by differential pressure gauges (Mid-West Piston-Type Differential Pressure Gauge). The adsorption vessels were backwashed sequentially whenever the Δp across one vessel reached 10 psi.

- **Backwash.** STS recommended that the APU-450 system be backwashed on a regular basis, approximately once a month to loosen up the media bed. Automatic backwash could be initiated by either a time or a Δp setpoint across each vessel. During a backwash cycle, each vessel was backwashed individually while the other two remained online, reducing the service flowrate to 300 gpm. The backwash flowrate, hydraulic loading, duration, and wastewater production were 200 gpm, 9.3 gpm/ft^2, 20 min (including 5 min for forward flush), and 4,000 gal (including 1,000 gal from forward flush), respectively. The backwash/forward flush flowrates and the amount of wastewater generated were obtained from flowrate and totalizer readings shown on the programmable logic controller (PLC). Backwash and forward flush water was supplied by the 50,000-gal holding tank; the wastewater generated was discharged into a pipe trench/sump and routed via a 12-in drain line to the existing evaporative pond located near the treatment building. The evaporative pond had a capacity of 30,000 gal, enough to hold 12,000 gal of wastewater generated during each backwash event. To meet the state discharge requirements, backwash wastewater had to be kept at an average of 2,000 gpd over a month-long period.

- **Media Replacement.** The media in each vessel is replaced when the arsenic concentration following each vessel approaches 10 µg/L. A TCLP test will be conducted on the spent media before disposal to determine whether the media can be considered non-hazardous. Virgin media is then loaded into each vessel. Based on the vendor's estimate, the media would need to be replaced after treating approximately 175,000,000 gal of water or every 26 months (based on an estimated daily throughput of 224,000 gal). The media was not replaced during the demonstration study.

- **Post-chlorination, Storage, and Distribution.** To provide chlorine residual in the distribution system, post-chlorination was implemented through the use of the existing MIOX SAL-80 system, an onsite mixed oxidant generator. As shown in Figure 4-13, the system consisted of an electrolytic cell, a brine generator, and a mixed oxidant tank. The brine generator served as a salt storage compartment and supplied brine to the electrolytic cell. Brine was electrolyzed and produced mixed oxidants, including Cl_2, HOCl, and/or OCl^- in the cell. The mixed oxidants, referred to as a MIOX solution, were collected in the mixed oxidant tank until they were injected into the treated water for disinfection. The MIOX SAL-80 system was designed for easy salt loading and operated for approximately 500 hr on a single load of salt (i.e., 1,000 lb). The system produced up to 10 lb of chlorine per day, which met the quantity required to reach a target total chlorine residual of 0.2 mg/L (as Cl_2).

  The treated water was stored in the 50,000-gal holding tank located outside of the booster station on a hill. The booster pumps located in the treatment building were manually switched on and off to pump water from the holding tank to the 1,000,000 gal water tower southeast of the town before entering the distribution system.



Source: MIOX®

Figure 4-13. Process Diagram of MIOX SAL-80 System

4.3 Treatment System Installation

4.3.1 System Approval. An application package including a process flow diagram of the treatment system and a schematic of the building footprint and equipment layout was prepared by SMA Engineering, a subcontractor to STS, and submitted by the Town of Taos to NMED/DWB on June 24, 2005. A supplemental submittal followed on July 27, 2005. NMED/DWB reviewed the engineering plans and issued a conditional Approval to Construct on August 15, 2005, with several comments, including 1) lack of a proper disinfection and bacteriological sampling plan equivalent to American Water Works Association (AWWA) standards, 2) incomplete plans and specifications of piping work outside of STS's APU-450 system, and 3) lack of information concerning ways to prevent cross-connection between the backwash wastewater discharge line and sanitary sewer. The Town of Taos submitted its responses to the state's comments on August 18, 2005, including (1) a description of proper disinfection and bacteriological sampling, (2) a one page submittal consisting of plans and specifications of piping work outside of the APU-450 system, and (3) a description of backwash wastewater discharge, which was not connected to the sanitary sewer. NMED/DWB granted its approval of the system application and issued a final Approval to Construct on September 12, 2005. A permit was not required to discharge backwash wastewater to the evaporative pond.

4.3.2 Building Construction. The steel filtration vessel in the existing treatment building was removed to make room for the arsenic removal system. The building was then modified to include a concrete pad and piping and electrical connections (Figure 4-14). The metal side wall panel was temporarily removed to allow for off-loading of the APU-450 arsenic treatment system into the treatment building (Figure 4-15).

Figure 4-14. Modified Booster Pump Station

Figure 4-15. Removal of Treatment Building Side Wall Panel for APU-450 System Off-loading

4.3.3 System Installation, Shakedown, and Startup. Prior to the installation of the treatment system, a pipeline project was undertaken by the Town to rehabilitate water transmission lines. The project was completed on September 13, 2005.

The APU-450 system arrived at the Town of Taos on October 3, 2005. STS's subcontractor, Pumps and Service, off-loaded system components and began plumbing work. The pelletized media arrived in five and a half super sacks (Figure 4-16) on September 30, 2005. Each super sack contained 38 ft^3 of media bringing the total media volume to 209 ft^3.

Figure 4-16. Arrival of SORB 33™ Media in Super Sacks

After Pumps and Service performed most of the installation work, STS made three separate trips to the site from October 17 to 20, 2005, from November 1 to 3, 2005, and from December 1 to 9, 2005, to complete system installation and perform system shakedown and startup. System installation and shakedown were completed on December 8, 2005, and February 3, 2006, respectively, and the performance evaluation officially began on February 14, 2006.

During the site visit from October 17 to 20, 2005, STS loaded underbedding gravel and media and measured freeboard heights before backwash and forward rinse.

The CO_2 pH adjustment system arrived on October 26, 2005, and Pumps and Service installed the system. Four 380-lb CO_2 dewars and two 50-lb backup cylinders arrived on November 1, 2005, delivered by Air Gas.

STS, SMA Engineering, and ATSI returned to the site from November 1 to 3, 2005, and planned to program the PLC, perform media backwash and forward flush, measure freeboard heights after backwash and forward flush, and wire the pH control system to the PLC. However, the plan was set aside after a leak was discovered along the throat of a 4-in nozzle at the top of Vessel C during backwash. Because the vessel was made of FRP, it could not be repaired onsite and had to be replaced with a new vessel. On November 14, 2005, STS removed the media from Vessel C with a vacuum truck, capturing the media in two sacks for future re-loading. A new vessel arrived on November 29, 2005, and Pumps and Service installed the vessel and conducted a hydrostatic test to approximately 60 psi for about 15 min to ensure that the vessel was leak-proof.

STS and ATSI were onsite from December 1 to 9, 2005, to load underbedding gravel and media for Vessel C and complete the agenda items for the last site visit. On December 7, 2005, STS took freeboard measurements for all three vessels after backwash and forward flush and the results are discussed in Section 4.3.5. In addition, a hydraulic test was performed for the system and the results, along with those of vessel backwash, are summarized in Table 4-6. As shown in the table, backwash was completed with flowrates ranging from 200 to 210 gpm, close to the target value of 200 gpm. After a forward flush, the system was allowed to operate in the service mode. Flowrate readings, as recorded from the flowmeter/ totalizers installed on each of the three vessels, ranged from 145 to 150 gpm, close to the design value of 150 gpm. Δp readings across each of the three vessels from individual differential pressure gauges ranged from 1.5 to 3.4 psi, less than the target clean bed Δp of 4 psi. The system flowrate reading from the master flow meter at the wellhead was 510 gpm, higher than the sum of instantaneous readings of the three vessels. The Δp measured across the inlet and out system piping was 6 psi.

Table 4-6. Onsite Backwash and Hydraulic Testing on December 7, 2005

Parameters	System	Vessel A	Vessel B	Vessel C
Backwash Flowrate (gpm)	–	205	200	210
Service Flowrate (gpm)	510	145	150	150
Pressure Differential at Service Flowrate (psi)	6	1.5	3.4	3.5

STS then disinfected the system in accordance with AWWA Standards C-651 and B-300. Personal protective equipment (PPE) was used when working with hypochlorite chemicals. Upon completion, samples were taken for bacteriological tests. System installation was completed on December 8, 2005.

4.3.4 CO_2 pH Control System. Since the CO_2 control system was installed, a number of operational problems occurred. These problems, along with the corrective actions taken, are summarized in Table 4-7. During system shakedown, the CO_2 control system often shut itself off after it and the well pump had been turned on. To resolve to the problem, a 5-min programming delay was added to the pH control system to avoid an alarm and system shutdown due to over-adjustment of pH before water had reached the treatment building from the pump house (recall that there is a 5-min purge at the wellhead immediately after the well pump is turned on).

On January 10, 2006, the operator noticed that the microporous membrane module was contaminated with solvents. The source of contamination was determined to be PVC pipe cement, which was used to repair leaks on the PVC inlet piping. The contaminated membrane module was replaced with a new one by the operator on January 27, 2006.

On February 3, 2006, a significant pressure increase was observed both before (from 30 to 40 psi) and after the sanitary cross (from 25 to 38 psi), and the target pH value of 7.2 could not be reached. After consultation with the vendor, the CO_2 pH control system was temporarily switched from automatic to manual mode. While being onsite performing system inspections and operator training on February 13 and 14, 2006, two Battelle staff members attempted to troubleshoot the problems. After comparing inline pH probe readings with those of a VWR field meter, it was determined that the inline pH probe did not work properly. It also was determined that the pressure gauges before and after the sanitary cross were broken. The operator replaced both the inline pH probe and pressure gauges on March 17, 2006. The system appeared to be working fine in manual mode thereafter.

Although the pH control system worked in manual mode, it failed to operate in automatic mode since the inline pH probe and pressure gauges had been replaced on March 17, 2006. Efforts were made by ATSI to troubleshoot system components, including the mass flow meter, which, however, was found in good order. After a new inline pH probe was sent to the site and installed on May 5, 2006, the system operated in automatic mode thereafter.

On August 16, 2006, the microporous membrane module was found damaged with a visible bent on the module. The cause of the damage was traced back to a water hammer that occurred after a power outage on April 18, 2006; details of the chain of events are discussed in Section 4.4.3. The damaged membrane module was replaced on September 18, 2006.

Table 4-7. Summary of Problems Encountered and Corrective Actions Taken for pH Adjustment System

Duration	Problem Encountered	Corrective Actions Taken	Work Performed by/on
12/16/05	pH control system shut down or failed to turn on when well pump was turned on	Added a 5-min delay to pH control system so it switched on only after water had reached treatment plant	By Operator and ATSI on 12/16/05
01/10/06 – 01/27/06	Presence of solvents in microporous membrane module due to contamination from PVC pipe cement used to repair leaks in system piping	Re-installed new membrane	ATSI provided new membrane and operator re-installed it on 01/27/06
02/03/06 – 03/17/06	Pressure prior to and after sanitary cross experienced sudden increase from 30 to 40 psi and from 25 to 38 psi, respectively	Replaced broken pressure gauges before and after sanitary cross on CO_2 loop	Operator replaced gauges on 03/17/06
02/03/06 – 03/17/06	Inline pH probe failed to reach target pH value of 7.2	Replaced broken inline pH probe	Operator replaced probe on 03/17/06
03/16/06 – 05/08/06	pH control system failed to operate in automatic mode since inline pH probe and pressure gauges had been repaired on 03/17/06	Mass flowmeter troubleshot by ATSI on 03/16/06 but found no problems. New inline pH probe was sent to site on 05/05/06 and system was placed in automatic mode thereafter	Operator and ATSI on 05/08/06
05/16/06 – 05/22/06	CO_2 tanks empty	Replaced CO_2 tanks	Operator/ 05/23/06
08/16/06 – 09/18/06	Damaged CO_2 microporous membrane module discovered	Determined cause of damage to be a water hammer during 04/18/06 power outage; replaced damaged membrane module	Operator/ 09/18/06
09/19/06 – 09/21/06	CO_2 tanks empty	Replaced CO_2 tanks	Operator/ 09/21/06

4.3.5 Media Loading. Media loading was performed by STS on October 17, 2006. The media in super sacks was hoisted to the top of the canopy using a boom truck and loaded through a 12-in × 4-in rigid funnel connected to the top nozzle by a roof hatch and a 6-in PVC pipe into the adsorption vessel partially filled with water (Figure 4-17). A garden hose was used to completely submerge the media, which was allowed to soak for about 4 hr. The top hat distributor with the new sealant was then reconnected to the top piping. STS was onsite on November 1, 2005, to backwash the vessels. However, a leak was discovered for Vessel C and the media in that vessel had to be removed via vacuum and captured into two super sacks. Based on tests conducted by STS's technical center, a 0.85 mm screen recovered 781.6 gm of wetted media compared to 786.4 gm of wetted media that was vacuumed. After the new Vessel C was installed on November 29, 2005, STS re-loaded the gravel and media. The vessels were backwashed on December 7, 2005, with flowrates ranging from 200 to 210 gpm for approximately 30 min. The freeboard heights along with the calculated media volumes in the vessels are summarized in Table 4-8.

Figure 4-17. Media Loading

Before backwash, freeboard measurements taken from the top of the underbedding gravel to the top of the nozzle head were 66, 65, and 66 in for Vessels A, B, and C, respectively. Freeboard measurements taken from the top of each media bed to the top of the nozzle head were 28, 29, and 28 in for Vessels A, B, and C, respectively. Therefore, the bed depths for Vessels A, B, and C were 38, 36, and 38 in, equivalent to 68.4, 64.8, and 68.4 ft^3 of media, respectively, in the vessels. The freeboard measurements after backwash were taken again, with the total media volume increasing slightly from 202 ft^3 to 216 ft^3. In general, free board heights measured after backwash are more accurate because the surface of the media beds is more even after backwash. However, some bed compaction is expected once the media beds are put into service under pressure. For the purpose of this study, the media volumes obtained after backwash were used for all bed volume calculations. (Note that the total amount of media calculated from the freeboard measurements after backwash was 20% more than that used for the system design, but only 3.3% more than that shipped to the site in super sacks).

Table 4-8. Freeboard Measurements and Media Volumes in Adsorption Vessels

Date	Vessel A		Vessel B		Vessel C		Total Volume (ft^3)
	Depth (in)	Volume (ft^3)	Depth (in)	Volume (ft^3)	Depth (in)	Volume (ft^3)	
10/17/05 (Before Backwash)	38	68.4	36	64.8	38	68.4	202
12/07/05 (After Backwash)	40	72.0	39	70.2	41	73.8	216

4.3.6 Punch List Items. Two Battelle staff members performed system inspections and operator training for sample and data collection on February 13 and 14, 2006. The performance evaluation study officially started on February 14, 2006. Table 4-9 summarizes the punch-list items and corrective actions taken from March 15, 2006, to October 12, 2006.

4.4 System Operation

4.4.1 Operational Parameters. The operational parameters for the duration of system operation were tabulated and are attached as Appendix A. Key parameters are summarized in Table 4-10. From February 14, 2006, through October 23, 2007, the system operated for only 838 hr. Because Well 8 (hence the treatment system) and the booster pumps in the treatment building were not tied to the Town's SCADA system, the operator had to manually operate the system by:

(1) Manually switching on a fuse box in the pump house to start the well pump and send an electrical signal via the control panel in the pump house to the treatment building to 1) open the influent and effluent valves on the treatment system, and 2) after a 5-min delay, turn on the pH control system to begin pH adjustment.

(2) Manually turning on and off the booster pumps to control the water level in the 50,000-gal holding tank. As the booster pumps were turned on, water was transferred from the 50,000-gal holding tank to the 1,000,000-gal water tower (see Sections 4.1.1 and 4.1.4).

(3) Manually switching off the fuse box in the pump house to turn off the well pump and send an electrical signal via the control panel in the pump house to turn off the influent and effluent valves of the system and the pH control system.

Table 4-9. System Inspection Punch-List Items

Item No.	Problem Encountered	Corrective Action(s) Taken	Resolution Date
1	Imbalanced flow with lower flowrate through Vessel B than those through other two vessels	• Vessel B's flow meter fixed by removing paddle wheel from meter, spinning for a number of times, and then replacing back into vessel	03/15/06
2	Incorrect Vessel B PLC setting	• Updated PLC program and HMI programs • Backwash programmed for every 90 days and Δp backwash trigger disabled	03/15/06
3	Leaks on Vessel B piping	• Replaced 4-in O ring on feed piping to Vessel B	03/15/06
4	Broken backwash flow meter/totalizer	• Backwash flowmeter/totalizer wired and calibrated by backwashing vessel C and comparing Vessel C's flowmeter with backwash flowmeter/totalizer	03/15/06
5	Broken inline pH probe	• ATSI sent a new inline pH probe to Town • Probe replaced by operator	03/17/06
6	Broken pressure gauges before and after sanitary cross	• Replaced pressure gauges	03/17/06
7	pH control system in manual mode	• Mass flow controller sent back to ATSI for examination and found to be fine • After programming changes with the JUMO controller, pH adjustment system was placed in automatic mode	05/08/06
8	Lack of pressure gauge before CO_2 pH control system	• Town installed pressure gauge before CO_2 pH control system and near raw water sample tap	06/06/06
9	Leaky bypass valve (GV-133) causing discrepancy between Well 8 flowrate of 580 gpm and total flowrate across three vessels of 420 gpm	• Town cleaned and checked leaky bypass valve (GV-133) and determined there were no leaks/problems, and re-installed valve back	07/31/06

Because of the manual operation of the well pump and booster pumps, the operator had to be physically present at the pump house and treatment building for the duration of system operations. As a result, the system operated only when the operator could make time to travel to the pump house and treatment building. Excluding weekends and system downtime caused by a variety of reasons discussed in Section 4.4.3, the system operated for only 215 days during the entire study period. Therefore, the daily system operating time was 3.9 hr/day, equivalent to a use rate of about 16.2%.

As shown in Table 4-11, flowrates and throughputs through the treatment system and individual vessels were tracked by five flow meters/totalizers, including one each positive-displacement flow meter/totalizer (preexisting) at the wellhead and the distribution entry point, and one electromagnetic flow meter/ totalizer (new) on each vessel. Instantaneous flowrate/volume readings were taken at the wellhead and on each vessel. Calculated flowrates also were obtained by dividing volume readings by respective hour meter readings.

Daily usage based on readings from the three totalizers on the vessels ranged from 5,393 to 271,182 gpd and averaged 106,870 gpd, compared to the design value of 224,000 gpd shown in Table 4-4. The total throughput value from these totalizers was 22,977,037 gal, which was 10.6% lower than the 25,704,000 gal throughput value from the master flow meter/totalizer at the wellhead. This wellhead throughput value matched well with calculated wellhead flowrate values, which ranged from 275 to 631 gpm and

Table 4-10. Summary of APU-450 System Operations

Operational Parameter	Value/Condition
Duration	02/14/06–10/23/07
Cumulative Operating Time (hr)	838
Number of Days of System Operation	215
Average Daily Operating Time (hr)	3.9
System Operation – Adsorption	
Average (Range of) Daily Usage (gpd)[a]	106,870 (5,393–271,182)
Total Throughput (gal)	22,977,037
Bed Volumes (BV) [b]	14,192
Average (Range of) System Flowrate (gpm)[c]	503 (410–558)
Average (Range of) Hydraulic Loading (gpm/ft^2)[d]	7.8 (4.2–8.9)
Average (Range of) EBCT for Each Vessel (min)[e]	3.2 (2.9–5.7)
Average (Range of) Inlet Pressure (psi)	26.7 (20.0–30.0)
Average (Range of) Outlet Pressure (psi)	18.5 (10.0–30.0)
Average (Range of) Δp across System (psi)	8.1 (0-16.0)
Average (Range of) Δp across Vessel A (psi)	4.8 (3.0–5.5)
Average (Range of) Δp across Vessel B (psi)	4.5 (3.5–5.0)
Average (Range of) Δp across Vessel C (psi)	4.5 (3.0–7.0)
System Operation – Backwash	
Average (Range of) Backwash Flowrate (gpm)[f]	242 (230–260)
Average (Range of) Hydraulic Loading Rate	11.2 (10.6–12.1)
Average Backwash Duration (min)	15.0
Average (Range of) Wastewater Generated (gal)[f]	3,297 (2,614–4,093)

(a) Average daily demand calculated by dividing total throughput by 215 days.
(b) BV calculated based on 216 ft^3 of media in three vessels.
(c) Sum of instantaneous flowrate readings from three vessels.
(d) Calculated based on flowrates to each vessel.
(e) Calculated based on 72.0, 70.2, and 73.8 ft^3 of media in Vessels A, B, and C, respectively.
(f) Instantaneous flowrate/totalizer readings from flow meter/totalizer installed on backwash discharge line; not including forward flush.

Table 4-11. System Instantaneous and Calculated Flowrates

Flow Meter/Totalizer Type	Location	Instantaneous/ Calculated	Flowrate (gpm)	
			Range	Average
Positive Displacement	At Wellhead	Instantaneous	470–600	575
		Calculated[a]	275–631	515
Electromagnetic	Prior to Vessel A	Instantaneous	128–192	171
	Prior to Vessel B	Instantaneous	92–184	158
	Prior to Vessel C	Instantaneous	151–193	174
Sum of A, B, and C		Instantaneous	410–558	503
Positive Displacement	on Treated Water Line	Calculated[a]	238–643	467

(a) Based on readings on wellhead totalizer and hour meter.

averaged 515 gpm. Instantaneous wellhead flowrate readings were higher and considered less reliable than the calculated values.

Instantaneous flowrate readings for Vessels A, B, and C ranged from 92 to 193 gpm and averaged 171, 158, and 174 gpm, respectively. There was some flow imbalance, with Vessel B receiving approximately 8% less flow. Flowrates through the three vessels combined ranged from 410 to 558 gpm and averaged 503 gpm, which was 2.3% lower than that at the wellhead, but 7.7% higher than that at the distribution entry point. Because fowrate readings from the various flow meters were never reconciled during the performance evaluation, the readings from individual vessels were used for all process-related calculations.

Based on the flowrate readings and media volumes in individual adsorption vessels, hydraulic loading rates averaged 7.8 gpm/ft^2 and EBCTs averaged 3.2 min, both slightly higher than the design values of 6.9 gpm/ft^2 and 3.0 min, respectively.

The system pressures were monitored at the inlet and outlet of the system and individual vessels and plotted in Figure 4-18. Δp readings across each vessel remained rather constant during the study period, with readings ranging from 3.0 to 7.0 psi and averaging 4.8, 4.5, and 4.5 psi across Vessels A, B, and C, respectively. Inlet and outlet system pressure readings also stayed in rather tight ranges, fluctuating between 20 to 30 psi at the inlet and 10 to 30 psi at the outlet. Since backwash would be triggered automatically when Δp had reached 10 psi across a vessel, no automatic backwash took place during the study period. However, five backwashes were performed manually by Battelle, STS, and the operator for the purpose of system inspections and backwash wastewater collections.

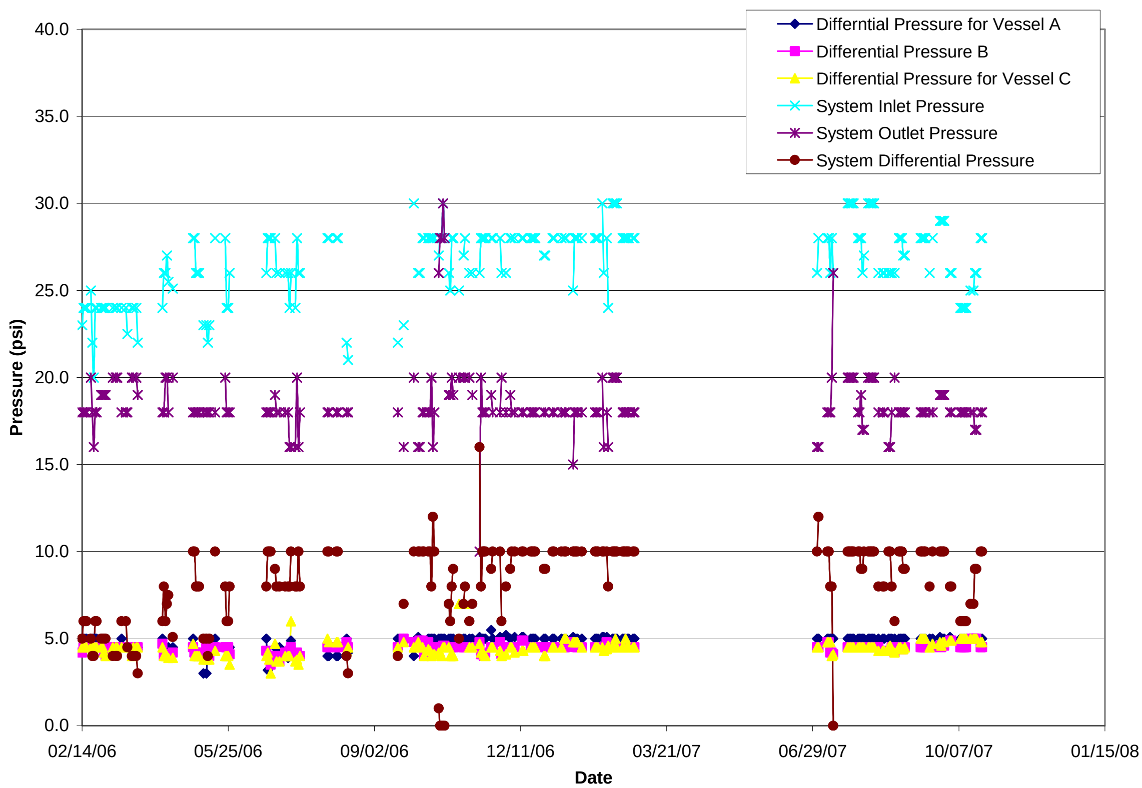


Figure 4.18. System Operation Pressure

4.4.2 Residual Management. Because media replacement was not performed during the performance evaluation, no spent media was produced.

4.4.3 Reliability and Simplicity of Operation. Operational irregularities experienced during the performance evaluation were related primarily to the pH control system. The problems encountered and corrective actions taken were discussed in Section 4.3.4.

Frequent and prolonged system downtime was observed, caused mainly by non-system-related issues, such as power outage and facility pipeline leakage (Table 4-12). On April 18, 2006, a power outage blew the fuse and damaged the control panel in the pump house. Although the fuse was repaired, the control panel, which linked the well pump to the APU-450 system and pH control system, was not repaired because the town wanted to wait until the new control panel could be linked to its existing SCADA network. Due to its high price, the control panel was never replaced during the study period. As a temporary measure, the town opened the inlet and outlet valves of the system and kept them open at all times and installed necessary devices to allow signal to be sent to the pH control system via radio. Meanwhile, the operator continued to operate the system manually by turning on and off the well pump at the pump house and booster pumps in the treatment building during daily system operation as he had been doing. Due to the labor intensive nature of the operation, the system was operated for less than 4 hr/day.

On August 16, 2006, the operator discovered that the membrane module in the sanitary cross was seriously damaged with a visible dent on the module. After an extensive investigation, it was determined that a water hammer probably had caused the damage. Recall that on April 18, 2006, a power outage blew a fuse for the well pump and damaged the control panel in the pump house. After the fuse was fixed and the well pump was turned on, the signal that should have been sent to open the system inlet and outlet valves apparently failed to be delivered. As a result, water was pumped against a dead end, causing a water hammer with an estimated pressure of over 125 psi. The damaged membrane module was replaced on September 18, 2006, after which time no other problems were experienced with the pH adjustment system for the rest of the study duration.

The APU-450 system was shut down five times for durations up to eight weeks due to pipeline leaks. In all cases, the facility utilized its own resources to repair the leaks.

On May 2, 2007, the Town drilled a new well (Well 9) in the proximity of Well 8, and the treatment system was shutdown for just less than 2 months.

Pre- and Post-Treatment Requirements. A pH control system was used for pretreatment. CO_2 was used to lower the pH value of raw water from an average of 9.6 to a target value of 7.2 to maintain effective adsorption by SORB 33™. O&M of the pH control system required routine system pressure checks and regular changeout of CO_2 supply dewars. The operator also recorded pH readings of the in-line probe and performed calibration of the pH probe, as needed. The use of CO_2 for pH adjustment also required relevant safety training and awareness for/by the operator due to added hazards.

System Automation. The system was fitted with automated controls to allow for automatic system operations. For example, each adsorption vessel was equipped with a flow sensor and totalizer, five electrically actuated butterfly valves, and a pressure transmitter, all of which were capable of transmitting and receiving electronic signals to and from the Square D Telemechanique PLC with a Magelis G2220 color touch interface screen. The system also was equipped with an automated Carbon Dioxide Gas Flow Control System, which included a liquid CO_2 supply assembly, an automatic pH control panel, a CO_2 membrane module, and an in-line pH probe located downstream of the membrane module. The APU-450 system was capable of automatic backwash triggered by either a timer or a Δp setting.

Table 4-12. Summary of System Downtimes

Duration	Cause of System Downtime	Corrective Actions Taken	Performed by
03/14/06–03/15/06	System down for maintenance	None	Operator
03/27/06–04/09/06	System down due to leaks in 10-in transmission line between pump house and treatment building	Repaired leaks	Facility
04/18/06–04/30/06	System down due to power outage that damaged fuse and control panel in pump house	Repaired fuse but control panel was never repaired within study period. System had been operated manually ever since	Facility's subcontractor
05/16/06–05/22/06	System down because CO_2 ran out	Replaced CO_2 tanks	Operator
05/29/06–06/19/06	From 05/29/06 to 06/01/06, system ran for only two days; parameters not recorded From 06/02/06 to 06/09/06, system down due to leaks in 10-in transmission line between pump house and treatment building From 06/10/06 to 06/19/06, system ran for only one day; operational parameters not recorded	None Repaired leaks None	NA Facility NA
07/14/06–07/31/06	System ran for only one day; operational parameters not recorded	None	NA
08/17/06–09/17/06	System down due to damaged membrane module within sanitary cross	Replaced membrane module	ATSI and facility
09/19/06–09/21/06	System down because CO_2 ran out	Replaced CO_2 tanks	Operator
09/23/06–09/28/06	System down due to leaks in transmission line between 50,000-gal holding tank and 1,000,000 gal water tower	Repaired leaks	Facility
10/04/06	System down due to leaks in 10-in transmission line between pump house and treatment building	Repaired leaks	Facility
01/23/07–01/30/07	System down because operator could not find time to operate system	None	NA
02/28/07–04/30/07	From 02/28/07 to 03/04/07, system ran for only four days; parameters were not recorded From 03/05/07 to 04/30/07, system down due to leaks in transmission line between 50,000-gal holding tank and 1,000,000 gal water tower	None Repaired leaks	NA Facility
05/02/07–07/01/07	From 05/02/07 to 06/25/07, system down due to drilling of a new well (Well 9), close to Well 8 From 06/26/07 to 07/01/07, system ran for only four days; parameters were not recorded	Completed new well NA	Facility's subcontractor/ 06/25/07 NA

Note: System not operational during weekends.

The automated portion of the system did not require regular O&M; however, operator's awareness and ability to detect system operation problems were necessary when troubleshooting system automation failures. In addition to the hands-on training provided by the equipment vendor, a supplemental operations manual was made available to the operator by the vendor.

Operator Skill Requirements. Under normal operating conditions, the operator skill requirements to operate the system were minimal. However, because of the operational problems encountered with the pH control system and the aftermath of the power outage and transmission line leakage, the operator spent quite a bit of time troubleshooting and repairing the system. Otherwise, the operator was onsite typically two to three times a week and spent about 40 min each time to perform visual inspections and record the system operating parameters on the daily log sheets.

Based on the size of the population served and the treatment technology, the State of New Mexico requires Level 3 Certification for operation of the STS system at the Taos facility. The State of New Mexico has five levels of certifications for operations of public water supply systems, based on the complexity of the treatment and distribution system (such as the size and type of the system, the capacity of the system in terms of size of service area and number of users served, the type and character of the water to be treated, and the physical conditions affecting the treatment plants). The levels range from Level 1, the least complex, to Level 5, the most complex. The APU-450 system installed at the Town of Taos was operated by a Level 3 operator.

Preventive Maintenance Activities. Preventive maintenance included periodic checks of flowmeters and pressure gauges and inspection of system piping and valves. Typically, the operator performed these duties when he was onsite for routine activities. Checking the CO_2 dewars and cylinders and supply lines for leaks and adequate pressure and calibrating the in-line pH probe also were performed.

Chemical Handling and Inventory Requirements. CO_2 used for pH adjustment was ordered on an as needed basis. Typically, two 380-lb dewars lasted for about two weeks. As the CO_2 dewars were delivered to the site by the CO_2 supplier, empty dewars were returned for reuse.

4.5 System Performance

The performance of the system was evaluated based on analyses of water samples collected from the treatment plant and distribution system.

4.5.1 Treatment Plant Sampling. Table 4-13 summarizes the analytical results of arsenic, iron, and manganese concentrations measured at the six sampling locations across the treatment train. Table 4-14 summarizes the results of other water quality parameters. Appendix B contains a complete set of analytical results through the study duration. The results of the water samples collected throughout the treatment plant are discussed below.

Arsenic. Water samples were collected on 23 occasions (including two duplicate sampling events) with field speciation performed during seven of the 23 occasions from IN, AP, and TT sampling locations. Figure 4-19 contains three bar charts showing concentrations of particulate arsenic, soluble As(III), and soluble As(V) for each of the seven speciation events.

Total arsenic concentrations in raw water ranged from 14.5 to 19.5 µg/L and averaged 16.9 µg/L. Soluble As(V) was the predominating species, ranging from 14.3 to 18.0 µg/L and averaging 16.8 µg/L. Soluble As(III) and particulate arsenic also existed, but with much lower concentrations at 0.3 and 0.2 µg/L (on average), respectively. The arsenic concentrations measured were consistent with those collected previously during source water sampling (Table 4-1).

Table 4-13. Summary of Analytical Results for Arsenic, Iron, and Manganese

Parameter	Sample Location	Unit	Sample Count	Concentration			Standard Deviation
				Minimum	Maximum	Average	
As (total)	IN	µg/L	23	14.5	19.5	16.9	1.2
	AP	µg/L	23	14.5	18.8	16.6	1.3
	TA	µg/L	16	0.1	7.4	1.0	1.8
	TB	µg/L	16	0.1	7.2	1.0	1.8
	TC	µg/L	16	0.7	8.8	1.9	2.1
	TT[a]	µg/L	6	<0.1	3.7	0.9	1.4
As (soluble)	IN	µg/L	7	14.6	18.5	17.1	1.2
	AP	µg/L	7	15.3	18.5	16.9	1.1
	TT	µg/L	6	<0.1	4.0	0.9	1.5
As (particulate)	IN	µg/L	7	<0.1	0.5	0.2	0.2
	AP	µg/L	7	<0.1	0.7	0.2	0.2
	TT	µg/L	6	<0.1	<0.1	<0.1	−
As (III)	IN	µg/L	7	0.2	0.5	0.3	0.1
	AP	µg/L	7	0.2	0.6	0.4	0.2
	TT	µg/L	6	0.1	0.5	0.2	0.2
As (V)	IN	µg/L	7	14.3	18.0	16.8	1.2
	AP	µg/L	7	14.6	18.3	16.6	1.3
	TT	µg/L	6	<0.1	3.8	0.7	1.5
Fe (total)	IN	µg/L	19	<25	270	30.7	60.0
	AP	µg/L	19	<25	199	43.3	44.9
	TA	µg/L	12	<25	97.1	32.4	27.5
	TB	µg/L	12	<25	211	40.0	57.3
	TC	µg/L	12	<25	90.3	39.0	26.3
	TT	µg/L	7	<25	65.6	23.2	20.4
Fe (soluble)	IN	µg/L	7	<25	<25	<25	−
	AP	µg/L	7	<25	<25	<25	−
	TT	µg/L	7	<25	<25	<25	−
Mn (total)	IN	µg/L	19	0.4	6.3	1.3	1.4
	AP	µg/L	19	0.6	5.0	1.9	1.2
	TA	µg/L	12	<0.1	2.6	0.9	0.7
	TB	µg/L	12	0.1	2.9	1.0	0.9
	TC	µg/L	12	0.3	1.9	1.0	0.4
	TT	µg/L	7	0.4	1.1	0.7	0.3
Mn (soluble)	IN	µg/L	7	0.2	0.9	0.5	0.2
	AP	µg/L	7	0.4	1.1	0.8	0.3
	TT	µg/L	7	<0.1	0.4	0.2	0.1

(a) Total arsenic taken on March 16, 2006 considered an outlier and not included in calculations.
One-half of detection limit used for samples with concentrations less than detection limit for calculations.

After pH adjustment, total arsenic concentrations remained approximately the same, ranging from 14.5 to 18.8 µg/L and averaging 16.6 µg/L. Soluble As(V) remained the predominating species, averaging 16.6 µg/L. Soluble As(III) and particulate arsenic concentrations averaged 0.4 and 0.2 µg/L, respectively.

The total arsenic breakthrough curves shown in Figure 4-20 indicate that all three vessels removed a majority of the arsenic from pH adjusted water, leaving less than 1.1 µg/L in the treated water after treating approximately 22,977,000 gal of water by the end of the study. This amount of water was

Table 4-14. Summary of Other Water Quality Sampling Results

Parameter	Sample Location	Unit	Sample Count	Concentration			Standard Deviation
				Minimum	Maximum	Average	
Alkalinity (as $CaCO_3$)	IN	mg/L	19	86.0	114	99.7	6.5
	AP	mg/L	19	91.0	106	99.4	4.1
	TA	mg/L	12	75.0	111	97.8	9.6
	TB	mg/L	12	83.0	107	96.5	6.1
	TC	mg/L	12	83.0	105	95.2	5.9
	TT	mg/L	7	87.0	105	98.9	5.9
Fluoride	IN	mg/L	5	1.4	1.6	1.5	0.1
	AP	mg/L	6	1.4	1.6	1.5	0.1
	TT	mg/L	6	1.4	1.6	1.5	0.1
Sulfate	IN	mg/L	6	39.0	42.0	40.7	1.0
	AP	mg/L	7	38.0	45.0	41.0	2.1
	TT	mg/L	7	38.0	46.0	41.6	2.5
Nitrate (as N)	IN	mg/L	7	0.1	0.2	0.2	–
	AP	mg/L	7	0.1	0.2	0.2	–
	TT	mg/L	7	0.1	0.2	0.1	–
Total P (as P)	IN	µg/L	19	<10	18.5	<10	4.6
	AP	µg/L	19	<10	18.5	<10	4.5
	TA	µg/L	12	<10	18.1	<10	5.0
	TB	µg/L	12	<10	18.2	<10	5.1
	TC	µg/L	12	<10	15.4	<10	4.1
	TT	µg/L	7	<10	<10	<10	–
Silica (as SiO_2)	IN	mg/L	19	31.3	34.7	32.8	1.0
	AP	mg/L	19	29.1	34.4	31.9	1.6
	TA	mg/L	12	27.2	36.8	32.3	2.9
	TB	mg/L	12	27.4	36.2	32.8	2.8
	TC	mg/L	12	27.9	35.6	32.8	2.4
	TT	mg/L	7	28.3	37.0	33.0	3.3
Turbidity	IN	NTU	19	0.2	3.0	0.9	0.7
	AP	NTU	19	0.2	2.7	1.2	0.8
	TA	NTU	12	0.4	2.4	1.3	0.7
	TB	NTU	12	0.6	2.0	1.0	0.5
	TC	NTU	12	0.4	1.8	0.9	0.4
	TT	NTU	7	0.6	1.5	1.1	0.3
pH	IN	S.U.	17	9.5	9.8	9.6	0.1
	AP	S.U.	17	6.7	7.9	7.3	0.4
	TA	S.U.	10	6.7	7.7	7.3	0.3
	TB	S.U.	10	7.1	7.5	7.3	0.2
	TC	S.U.	10	7.1	7.7	7.4	0.2
	TT	S.U.	7	7.0	7.9	7.4	0.3
Temperature	IN	°C	17	18.2	28.4	23.6	2.6
	AP	°C	16	18.9	28.1	23.8	2.5
	TA	°C	10	17.7	28.2	24.4	3.1
	TB	°C	10	17.4	28.1	24.5	3.0
	TC	°C	10	17.0	28.0	24.4	3.1
	TT	°C	7	21.3	25.8	22.6	1.5

Table 4-14. Summary of Other Water Quality Sampling Results (Continued)

Parameter	Sample Location	Unit	Sample Count	Concentration			Standard Deviation
				Minimum	Maximum	Average	
DO	IN	mg/L	13	0.9	2.7	1.4	0.5
	AP	mg/L	13	0.8	2.6	1.3	0.5
	TA	mg/L	8	0.8	3.3	1.6	0.7
	TB	mg/L	8	0.7	3.1	1.7	0.7
	TC	mg/L	8	0.5	2.8	1.7	0.7
	TT	mg/L	5	1.2	1.5	1.3	0.1
ORP	IN	mV	17	222	348	269	42.3
	AP	mV	17	224	356	273	43.7
	TA	mV	10	224	412	278	62.3
	TB	mV	10	225	361	283	51.4
	TC	mV	10	222	363	282	53.2
	TT	mV	7	245	343	302	39.5
Total Hardness (as $CaCO_3$)	IN	mg/L	7	2.9	4.2	3.7	0.4
	AP	mg/L	7	2.7	4.5	3.7	0.6
	TT	mg/L	7	0.6	7.9	4.6	3.2
Ca Hardness (as $CaCO_3$)	IN	mg/L	7	2.8	4.1	3.6	0.4
	AP	mg/L	7	2.6	4.4	3.6	0.6
	TT	mg/L	7	0.5	7.9	4.5	3.2
Mg Hardness (as $CaCO_3$)	IN	mg/L	7	<0.1	<0.1	<0.1	−
	AP	mg/L	7	<0.1	0.1	<0.1	0.03
	TT	mg/L	7	<0.1	0.2	<0.1	0.05

One-half of detection limit used for samples with concentrations less than detection limit for calculations.

equivalent to 14,200 BV based on 216 ft^3 of media in the three vessels. The 14,200 BV represents approximately 11% of media capacity estimated to be 130,000 BV by the vendor.

A spike occurred on January 31, 2007, with arsenic concentrations increasing to as high as 8.8 µg/L in the vessel effluent. pH values of these samples were measured at 7.5 to 7.7, just over the average values of 7.3 to 7.4 for all samples collected at the same locations. Therefore, pH was not considered to be the contributing reason. It is worth noting that the same samples also contained somewhat higher iron concentrations (i.e., 67 to 97 µg/L vs. <25 µg/L). The spike might be due to samples taken after prolonged system downtime.

Iron and Manganese. Total iron concentrations in raw water ranged from <25 to 270 µg/L and averaged 30.7 µg/L, existing mostly as particulate iron. Particulate iron might exist in source water as part of natural sediment or formed by inadvertent aeration of samples during sampling. The amounts of DO measured in source water, however, were low, ranging from 0.9 to 2.7 mg/L and averaging 1.4 mg/L. The source water sample taken during the December 1, 2004, site visit, also contained a similar amount of total iron (i.e., 59 µg/L) with over 79% existing as particulate iron. Total iron concentrations were close to or below the method reporting limit of 25 µg/L in raw water except for two occasions on August 2, 2006, and January 31, 2007, when total iron concentrations were 78 and 270 µg/L, respectively. After pH adjustment and adsorption, total iron concentrations remained relatively unchanged, averaging 43.3, 32.4, 40.0, and 39.0 µg/L at AP, TA, TB, and TC locations. It is possible that some iron particles penetrated through the media beds or that some media fines were washed from the media beds. Manganese concentrations were low in raw water and across the treatment train, ranging from 0.7 to 1.3 µg/L. Manganese existed mostly as particulate.

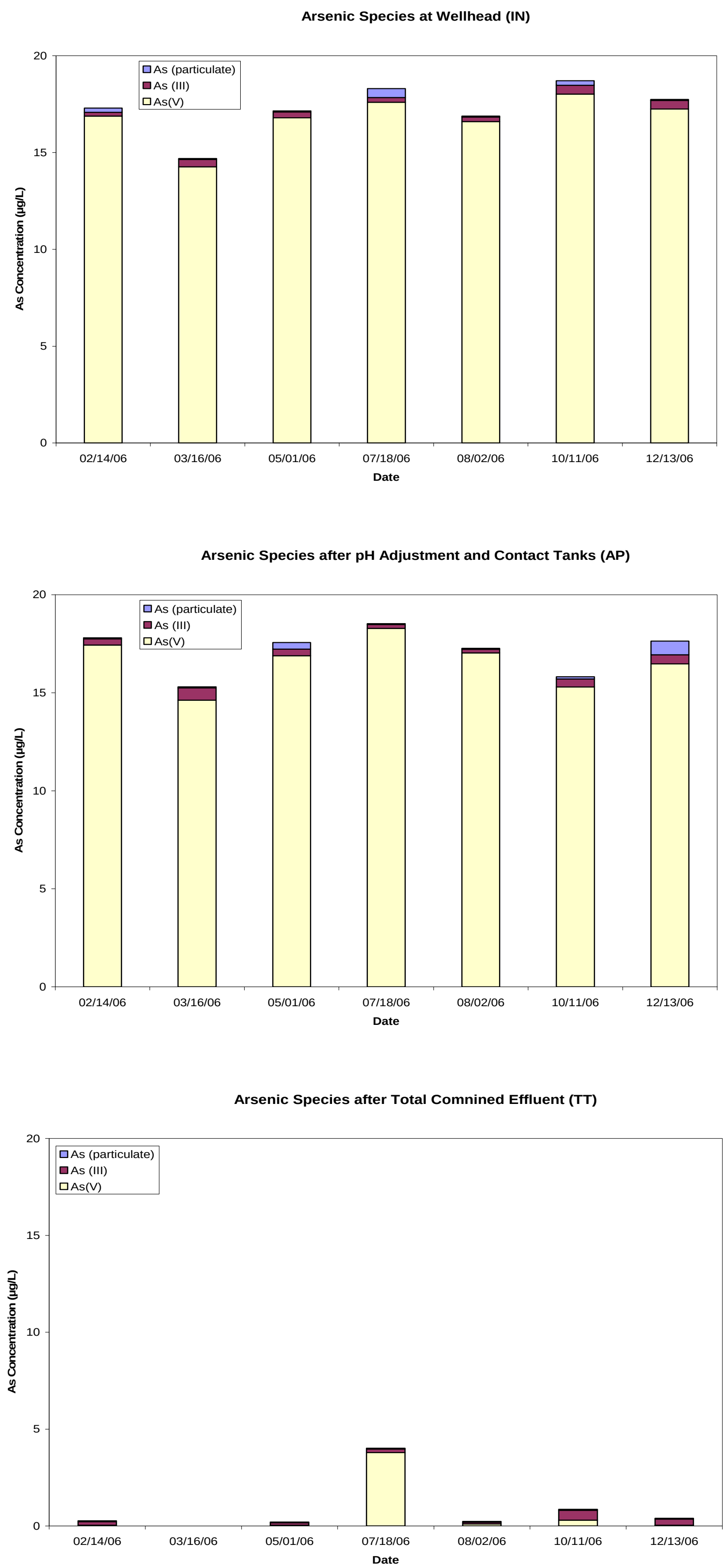


Figure 4-19. Concentrations of Various Arsenic Species at IN, AP, and TT Sampling Locations

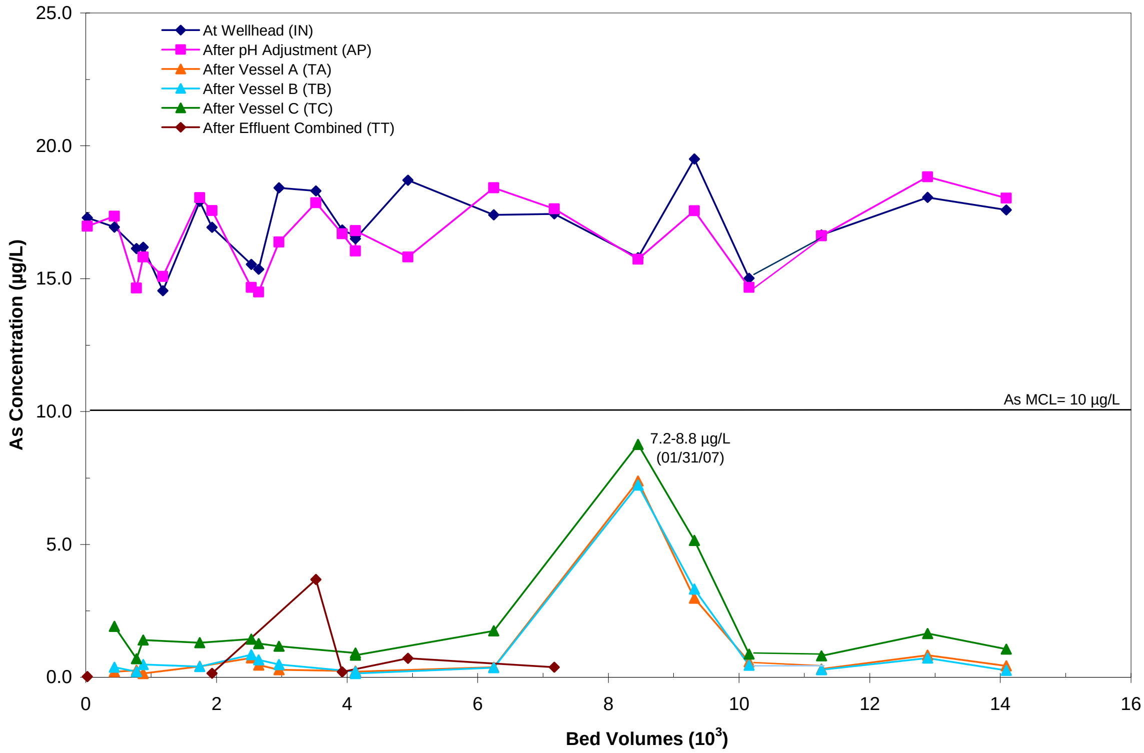


Figure 4-20. Total Arsenic Breakthrough Curves
(Based on 216 ft^3 of Media in All Three Vessels)

Competing Anions. Phosphate and silica, which can influence arsenic adsorption, were measured across the treatment train throughout the demonstration study. Phosphorous concentrations remained below the method reporting limit of 10 µg/L (as P) across the treatment train. Silica concentrations in raw water ranged from 31.3 to 34.7 mg/L and averaged 32.8 mg/L. There were no noticeable reductions of silica concentration across the treatment train. As such, neither phosphorus nor silica would cause harmful effects on arsenic adsorption.

Other Water Quality Parameters. All other water quality parameters measured were comparable to source water results presented in Table 4-1. As shown in Table 4-14, pH values of raw water varied from 9.5 to 9.8 and averaged 9.6. pH values following CO_2 injection varied from 6.7 to 7.9 and averaged 7.3, indicating effective pH adjustment. At near neutral pH values, the media has a greater removal capacity for arsenic, thereby prolonging the media life. After adsorption vessels at TA, TB, and TC, pH values remained rather unchanged, ranging from 7.3 to 7.4. Figure 4-21 presents the pH values measured throughout the treatment train.

As also shown in Figure 4-21, pH values measured with the VWR field meter at the AP location were comparable to those reported by the in-line pH probe, averaging 7.3 and 7.4, respectively, throughout the study duration. Degassing of dissolved CO_2 did not appear to be a concern in terms of elevating pH values measured with the VWR field meter.

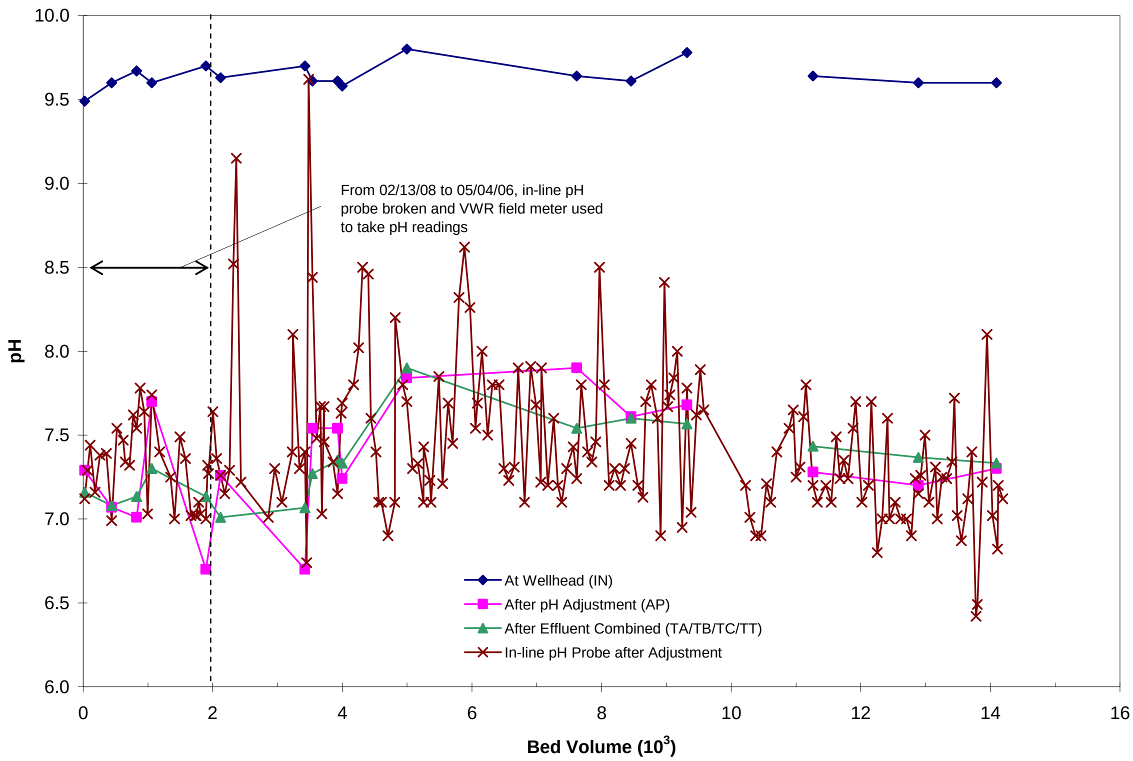


Figure 4-21. pH Values Measured throughout Treatment Train
(Based on 216 ft^3 of Media in all Three Vessels)

Alkalinity, reported as $CaCO_3$, in raw water ranged from 86.0 to 114 mg/L. The results indicated that the adsorptive media did not affect the amount of alkalinity in the treated water. The treatment plant samples were analyzed for hardness only on speciation weeks. Total hardness in raw water ranged from 2.9 to 4.2 mg/L (as$CaCO_3$), and also remained constant throughout the treatment train. Sulfate concentrations in raw water ranged from 39 to 42 mg/L, and remained constant throughout the treatment train. Fluoride results ranged from 1.4 to 1.6 mg/L in all samples, indicating that the media did not remove fluoride. DO levels ranged from 0.9 to 2.7 mg/L and averaged 1.4 mg/L in raw water. ORP readings averaged 269 mV in raw water and remained approximately the same throughout the treatment train.

4.5.2 Backwash Wastewater Sampling. Table 4-15 presents the analytical results for the three adsorption vessels during each of the three monthly backwash wastewater sampling events. pH values ranged from 7.4 to 8.1 and averaged 7.7, somewhat higher than that of the treated water used for backwash. The water used for backwash was withdrawn from the 50,000-gal holding tank. Some CO_2 degassing might have taken place during storage and transit, thereby elevating the pH values. TDS levels ranged from 204 to 228 mg/L. Because very little iron and manganese existed in the source water, TSS values were low, ranging from 16 to 82 mg/L and averaging 37 mg/L (excluding an outlier of 450 mg/L). Concentrations of total arsenic, iron, and manganese ranged from 1.1 to 11.8 μg/L, from 0.14 to 8.9 mg/L, and from 0.7 to 64.0 μg/L, respectively, with the majority of iron and manganese existing in the particulate form. The unexpectedly high iron concentrations in the backwash wastewater suggest some media fines were produced and removed during backwashing. Assuming an average of 3,297 gal backwash (see Table 4-10) and 1,000 gal forward flush wastewater production, each backwash cycle

Table 4-15. Backwash Water Sampling Results

		Vessel A										Vessel B										Vessel C									
		pH	TDS	TSS	As (total)	As (soluble)	As (particulate)	Fe (total)	Fe (soluble)	Mn (total)	Mn (soluble)	pH	TDS	TSS	As (total)	As (soluble)	As (particulate)	Fe (total)	Fe (soluble)	Mn (total)	Mn (soluble)	pH	TDS	TSS	As (total)	As (soluble)	As (particulate)	Fe (total)	Fe (soluble)	Mn (total)	Mn (soluble)
No.	Date	S.U.	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	S.U.	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	S.U.	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
1	04/10/06[(a)]	7.6	210	450	2.4	1.2	1.3	5,388	103	59.4	0.5	7.5	218	20	1.8	1.3	0.6	1,275	51.9	10.9	0.9	7.5	206	22	1.1	1.3	<0.1	997	38.3	5.8	0.3
2	07/10/07	7.7	218	82	2.6	<0.1	2.5	5,560	75.2	53.2	0.7	7.4	206	44	2.7	2.7	<0.1	135	166	0.7	1.0	7.5	204	68	2.5	2.3	0.2	7,465	100	64.0	0.8
3	10/10/07	8.1	222	26	11.8	1.2	10.6	4,742	<25	13.9	<0.1	7.9	228	16	3.8	3.9	<0.1	3,663	<25	14.7	0.4	7.8	210	21	4.7	3.7	1.0	8,906	<25	25.3	0.2

(a) TC samples taken on 04/13/06; TDS = total dissolved solids; TSS = total suspended solids would have discharged 4 lb of solids, comprising of 0.46 lb of iron, 4×10^{-4} lb of arsenic, and 3×10^{-3} lb of manganese.

4.5.3 Distribution System Water Sampling. Prior to the installation/operation of the treatment system, baseline distribution system water samples were collected from three LCR locations from May 25 to August 30, 2005. Following system startup, distribution system water sampling continued on a monthly basis at the same three locations, with samples collected from March 1, 2006, through February 27, 2007. The results of the distribution system sampling are summarized on Table 4-16.

After system startup, arsenic and iron concentrations increased slightly from 0.3 to 1.1 µg/L (on average) and from <25 to 29 µg/L, respectively, while, manganese concentrations decreased from 5.3 to 1.4 µg/L at each of the three sampling locations. The fact that the treated water originated from Well 8 represents only about 10% of the water in the 1,000,000-gal water tower, from which water was sent to the distribution system (Sections 4.1.1 and 4.1.4), explains why the results remained essentially unchanged after system startup.

Measured pH values averaged 7.5 after system startup, compared to an average value of 7.3 before system startup. The higher pH values of Well 8 water did not appear to have affected the pH values in the distribution system with or without system operation. Copper concentrations decreased from 119 to 56 µg/L; lead concententrations decreased slightly from 1.5 to 1.1 µg/L. Alkalinity levels remained unchanged after system startup and averaged 175 mg/L.

4.6 System Cost

The system cost was evaluated based on the capital cost per gpm (or gpd) of the design capacity and the O&M cost per 1,000 gal of water treated. The capital cost included the cost for equipment, site engineering, and installation and the O&M cost included media replacement and disposal, CO_2 consumption, electrical power usage, and labor.

4.6.1 Capital Cost. The capital investment for equipment, site engineering, and installation of the treatment system was $296,644 (Table 4-17). The equipment cost was $202,685 (or 68% of the total capital investment), which included $26,500 for the automatic CO_2 control system, $121,279 for the skid-mounted APU-450 unit, $35,539 for 180 ft^3 of E33 pelletized media ($197/$ft^3$ or $5.64/lb to fill three vessels), $8,660 for shipping, and $10,707 for labor.

The site engineering cost included the cost for preparing a submittal package for permit application and supplemental information to respond to the State's comments (see Section 4.3.1). The engineering cost was $32,750, or 11% of the total capital investment.

The installation cost included the equipment and labor to unload and install the skid-mounted unit, perform piping tie-ins and electrical work, load and backwash the media, perform system shakedown and startup, and conduct operator training. The installation cost was $61,209, or 21% of the total capital investment.

The total capital cost of $296,644 was normalized to the system's rated capacity of 450 gpm (648,000 gpd), which resulted in $659/gpm (or $0.46/gpd) of design capacity. The capital cost also was converted to an annualized cost of $28,000/yr using a capital recovery factor (CRF) of 0.09439 based on a 7% interest rate and a 20-year return period. Assuming that the system operated 24 hours a day, 7 days a week at the system design flowrate of 450 gpm to produce 236,520,000 gal of water per year, the unit capital cost would be $0.12/1,000 gal. Considering that the system actually operated at an average of 503 gpm for 3.9 hr/day in 215 days during the performance evaluation (see Table 4-10), it would produce

Table 4-16. Distribution Water Sampling Results

Sampling Date		As at Entry Point	Fe at Entry Point	Mn at Entry Point	DS1 1st Draw								DS2 1st Draw								DS3 1st Draw							
					Stagnation Time	pH	Alkalinity	As (total)	Fe (total)	Mn (total)	Pb	Cu	Stagnation Time	pH	Alkalinity	As (total)	Fe (total)	Mn (total)	Pb	Cu	Stagnation Time	pH	Alkalinity	As (total)	Fe (total)	Mn (total)	Pb	Cu
No.	Date	µg/L	µg/L	µg/L	hr	S.U.	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	hr	S.U.	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	hr	S.U.	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L
BL1	05/25/05	NA	NA	NA	7.3	7.4	223	0.5	<25	0.2	0.5	32.7	14.6	7.5	178	0.4	<25	3.8	1.3	142	14.6	7.4	236	0.4	<25	0.5	2.4	48.4
BL2	06/22/05	NA	NA	NA	7.3	7.3	163	0.4	<25	0.1	0.4	26.0	14.0	7.4	163	0.4	<25	5.0	1.4	180	13.2	7.5	198	0.4	<25	20.6	2.5	226
BL3	07/20/05	NA	NA	NA	6.8	7.4	176	0.2	<25	0.1	0.6	53.6	14.0	7.4	176	0.2	<25	8.1	2.4	208	8.0	7.3	220	0.2	<25	20.0	2.6	189
BL4	08/30/05	NA	NA	NA	6.7	7.2	132	0.3	<25	0.1	0.6	52.9	14.3	7.2	163	0.2	<25	3.9	2.1	176	12.4	7.2	233	0.2	<25	1.4	1.7	87.0
Average		NA	NA	NA	7.0	7.3	174	0.4	<25	0.1	0.5	41.3	14.2	7.4	170	0.3	<25	5.2	1.8	176	12.1	7.4	222	0.3	<25	10.6	2.3	138
1	03/01/06	0.4	<25	0.2	14.1	7.7	104	0.4	<25	<0.1	0.3	19.7	8.8	7.7	178	0.3	<25	2.8	0.4	77.7	14.5	7.6	174	0.4	<25	8.6	0.2	26.8
2	4/17/2006	NA	NA	NA	7.5	7.8	184	0.1	<25	1.9	2.4	162	13.5	7.6	132	0.1	<25	0.5	0.5	23.1	12.5	7.6	171	0.2	125	1.4	3.1	47.2
3	06/28/06	NA	NA	NA	7.3	7.4	251	2.0	<25	0.3	0.8	22.4	14.0	7.5	147	0.3	<25	<0.1	0.3	34.0	14.1	7.5	172	0.4	<25	10.8	1.1	121
4	08/02/06	0.2	<25	0.4	7.4	7.7	135	0.3	<25	0.2	0.4	18.6	13.1	7.6	143	0.3	<25	2.2	0.9	127	13.6	7.3	257	0.4	<25	0.3	0.7	88.4
5	10/11/06	0.7	<25	0.6	7.3	7.4	194	0.4	<25	<0.1	0.4	43.5	14.2	7.5	161	0.4	<25	1.8	1.4	174	14.6	7.7	111	1.9	169	0.7	1.6	24.8
6	11/29/06	NA	NA	NA	7.6	7.2	160	0.3	80	1.0	0.5	69.2	14.1	7.3	209	0.2	82	0.9	1.6	42.0	14.3	7.3	72	<0.1	<25	0.4	2.5	36.5
7	01/31/07	7.8	79	2.2	8.3	7.7	206	2.4	<25	0.8	2.5	38.2	14.4	7.5	222	1.6	<25	0.3	1.7	47.7	15.2	7.5	187	1.7	<25	0.3	1.0	13.8
8	02/22/07	3.8	<25	0.6	8.3	7.6	215	3.3	<25	<0.1	<0.1	17.2	14.4	7.6	210	3.8	<25	<0.1	<0.1	38.4	15.2	7.7	215	4.4	<25	<0.1	1.3	18.7
Average		2.6	26	0.8	8.5	7.6	181	1.1	<25	0.5	0.9	48.9	13.3	7.5	175	0.8	<25	1.1	0.9	70.4	14.3	7.5	170	1.2	46	2.8	1.5	47.2

BL = Baseline Sampling; NS = not sampled; NA = not analyzed

Table 4-17. Capital Investment Cost for APU-450 System

Description	Quantity	Cost	% of Capital Investment
Equipment Cost			
Automatic CO_2 Control System	1	$26,500	–
APU Adsorption Vessels	3	$55,000	–
Process Valves and Piping	1	$29,500	
Instrumentation and Controls	1	$36,779	
E33 Adsorptive Media (ft^3)	180	$35,539	–
Shipping	–	$8,660	–
Vendor Labor	–	$10,707	–
Equipment Total	–	**$202,685**	**68%**
Engineering Cost			
Vendor Labor/Travel	–	$11,800	–
Subcontractor Labor/ Travel	–	$20,950	–
Engineering Total	**–**	**$32,750**	**11%**
Installation Cost			
Vendor Labor	–	$6,118	–
Vendor Travel	–	$6,197	–
Subcontractor Labor/Travel	–	$48,894	–
Installation Total	–	**$61,209**	**21%**
Total Capital Investment	–	**$296,644**	**100%**

42,961,000 gal of water in one year. Under these conditions, the unit capital cost increases to $0.65/1,000 gal at this reduced rate of use.

4.6.2 Operation and Maintenance Cost. The O&M cost included the cost for such items as media replacement and disposal, CO_2 consumption, electricity usage, and labor (Table 4-18). Although media replacement did not take place during system operation, the media replacement cost would represent the majority of the O&M cost and was estimated to be $41,749 to change out the three vessels. This media changeout cost would include the cost for replacement media and underbedding, spent media analysis and disposal, freight, labor and travel. This cost was used to estimate the media replacement cost per 1,000 gal of water treated as a function of the projected system run length at the 10 µg/L arsenic breakthrough (Figure 4-22).

The chemical cost associated with the operation of the treatment system included the cost for CO_2 gas for pH control. The 380-lb CO_2 dewars were replaced a total of eleven times during the performance evaluation with the system operating for 215 days. Each changeout of two 380-lb CO_2 dewars was $150 (or approximately $0.20/lb) and the delivery charges per changeout were $30.00. Therefore, the total cost incurred for the 11 changeouts was $1,980. The annual rental fees for one 380-lb dewar and one 50-lb high pressure cylinder were $615.40 and $133.40, respectively. Because the cylinder lease was a fixed cost, the total rental fees for four 380-lb dewars and two 50-lb cylinders for the 88-week study period was $4,617. As a result, the CO_2 cost for the 215-day system operation was $6,597 or $0.29/1,000 gal of water treated.

Comparison of electrical bills supplied by the utility before and after system startup did not indicate a noticeable increase in power consumption. Therefore, electrical cost associated with operation of the system was assumed to be negligible.

Under normal operating conditions, routine labor activities to operate and maintain the system consumed an average of 40 min/day. For the 215 days of system operation at a labor rate of $19.5/hr, $2,795 labor cost was incurred when producing 22,977,000 gal of water. Therefore, the estimated labor cost was $0.12/1,000 gal of water treated.

Table 4-18. Operation and Maintenance Cost for APU-450 System

Cost Category	Value	Assumptions
Volume Processed (gal)	22,977,000	Through October 23, 2007 (Table 4-10)
Media Replacement and Disposal Cost		
Media Replacement ($)	$35,539	Vendor quote for 180 ft^3 for all three vessels
Shipping ($)	$1,080	Vendor quote
Vendor Labor/Travel ($)	$3,500	Vendor quote
Media Disposal ($)	$1,630	Vendor quote
Subtotal	$41,749	Vendor quote
Media Replacement and Disposal ($/1,000 gal)	See Figure 4-22	
CO_2 Usage		
CO_2 Gas ($/1,000 gal)	$0.29	Based on consumption of CO_2 for pH adjustment (380-lb dewars)
Electricity Cost		
Electricity ($/1,000 gal)	$0.00	Electrical costs assumed negligible
Labor Cost		
Labor ($/1,000 gal)	$0.12	40 min/day for 215 days (Table 4-10) at a labor rate of $19.5/hr
Total O&M Cost/1,000 gal	See Figure 4-22	

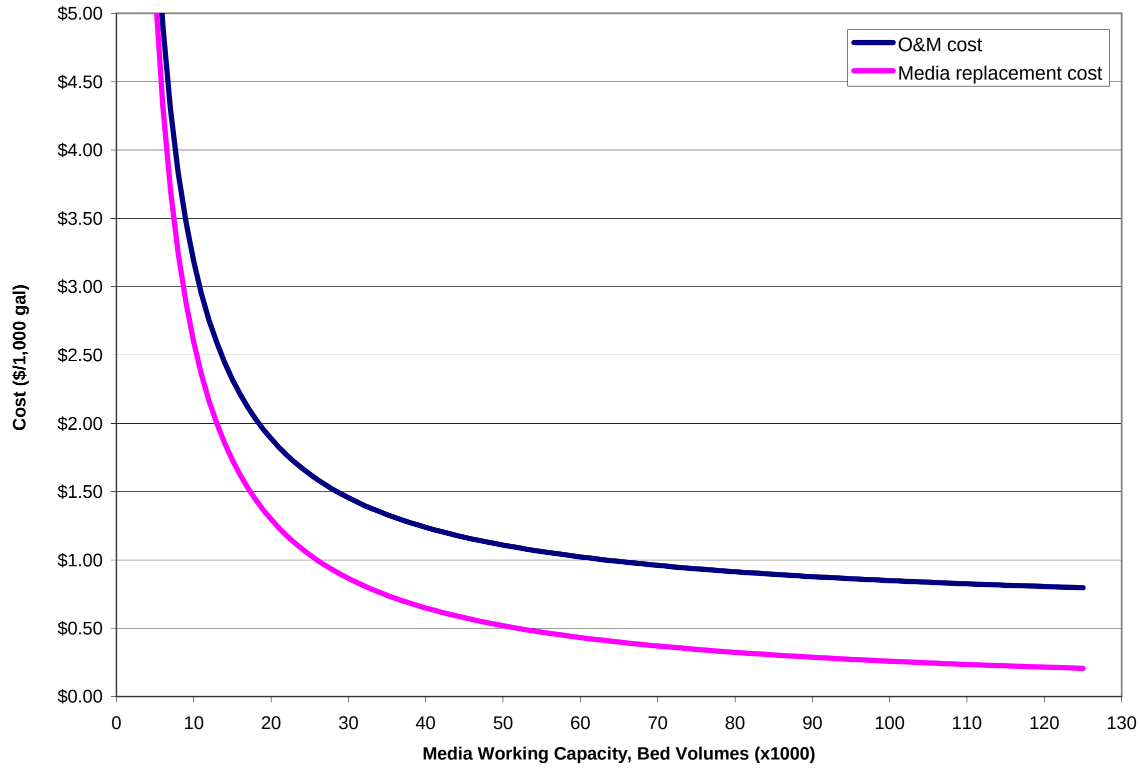


Figure 4-22. Media Replacement and Operation and Maintenance Cost

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APPENDIX A

OPERATIONAL DATA

US EPA Arsenic Demonstration Project at Taos, NM – Daily System Operation Log Sheet

Week No.	Day of Week	Date	Well 8 Well Operational Hours (hr)	Well 8 Flowrate (gpm)	Well 8 Usage (gal)	Well 8 Average Flowrate (gpm)	Vessel A Flowrate (gpm)	Vessel A Usage (gal)	Vessel A Pressure Differential (psi)	Vessel B Flowrate (gpm)	Vessel B Usage (gal)	Vessel B Pressure Differential (psi)	Vessel C Flowrate (gpm)	Vessel C Usage (gal)	Vessel C Pressure Differential (psi)	System Inlet Pressure (psi)	System Oulet Pressure (psi)	System Pressure Differential (psi)	System Average Flowrate (gpm)	System Cumulative Volume Treated (gal)	System Cumulative Bed Volumes Treated[b] (no.)	Distribution Average Flowrate (gpm)	pH (S.U.)
1	Mon	02/13/06	NA	NM	NA	NA	155.0	NA	5.0	100.0	NA	4.5	155.0	NA	4.5	26	20	6	410	NA	NA	NA	7.70[a]
	Tue	02/14/06	1.7	NM	54,000	529	155.0	18,000	5.0	100.5	11,136	4.2	165.5	8,862	4.5	23	18	5	421	37,998	23	NA	7.12[a]
	Wed	02/15/06	2.9	NM	92,000	529	159.6	23,448	5.0	101.4	14,335	4.5	167.7	34,431	4.5	24	18	6	429	110,212	68	NA	7.29[a]
	Thu	02/16/06	2.8	NM	87,000	518	160.5	25,083	5.0	102.3	15,229	4.5	165.7	26,036	4.5	24	18	6	429	176,560	109	NA	7.44[a]
	Fri	02/17/06	5.0	580	155,000	517	158.5	45,119	5.0	100.6	27,697	4.5	160.3	46,993	4.5	24	18	6	419	296,369	183	NA	7.16[a]
	Sat	02/18/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	02/19/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
2	Mon	02/20/06	5.1	580	158,000	516	160.6	46,494	5.0	92.1	28,571	4.5	169.0	48,335	4.5	25	20	5	422	419,769	259	428	7.38[a]
	Tue	02/21/06	6.8	580	211,000	517	165.6	60,057	5.0	115.4	37,009	4.5	166.1	62,474	4.5	22	18	4	447	579,309	358	471	7.39[a]
	Wed	02/22/06	4.5	600	139,000	515	168.8	39,997	5.0	107.9	25,603	4.5	164.1	64,323	4.5	20	16	4	441	709,232	438	456	6.99[a]
	Thu	02/23/06	6.0	600	182,000	506	157.7	49,909	5.0	106.6	32,629	4.5	174.1	53,761	4.5	24	18	6	438	845,531	522	453	7.54[a]
	Fri	02/24/06	6.2	580	188,000	505	165.6	52,311	5.0	101.7	37,707	4.5	163.0	63,904	4.5	24	18	6	430	999,453	617	484	7.47[a]
	Sat	02/25/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	02/26/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
3	Mon	02/27/06	2.6	580	80,000	513	156.7	20,225	4.5	98.5	12,480	4.5	160.3	21,410	4.5	24	19	5	416	1,053,568	651	436	7.34[a]
	Tue	02/28/06	4.7	580	143,000	507	154.3	38,717	4.5	95.7	25,241	4.5	164.6	43,140	4.5	24	19	5	415	1,160,666	717	454	7.32[a]
	Wed	03/01/06	4.0	580	124,000	517	153.7	35,115	4.2	92.8	21,630	4.2	163.2	37,039	4.2	24	19	5	410	1,254,450	775	467	7.62[a]
	Thu	03/02/06	3.7	580	111,000	500	156.2	31,190	4.5	93.2	19,373	4.0	164.6	33,088	4.0	24	19	5	414	1,338,101	826	459	7.54[a]
	Fri	03/03/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	03/04/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	03/05/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
4	Mon	03/06/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	03/07/06	3.8	582	115,000	504	159.6	32,859	4.5	98.1	20,286	4.5	162.4	32,496	4.5	24	20	4	420	1,423,742	879	474	7.78[a]
	Wed	03/08/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Thu	03/09/06	4.0	560	126,000	525	155.8	37,642	4.5	96.5	22,779	4.5	160.5	41,230	4.5	24	20	4	413	1,525,393	942	500	7.64
	Fri	03/10/06	3.7	560	114,000	514	160.2	30,451	4.5	97.2	19,092	4.5	172.6	32,406	4.5	24	20	4	430	1,607,342	993	459	7.03
	Sat	03/11/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	03/12/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
5	Mon	03/13/06	4.4	570	136,000	515	167.1	40,287	5.0	101.0	24,714	4.5	169.7	42,227	4.5	24	18	6	438	1,714,570	1,059	508	7.74[a]
	Tue	03/14/06	NA	NA	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	03/15/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Thu	03/16/06	12.5	560	377,000	503	159.1	64,681	4.5	160.4	71,161	4.5	166.3	62,187	4.5	24	18	6	486	1,912,599	1,181	453	7.40[a]
	Fri	03/17/06	6.9	550	209,000	505	155.1	102,553	4.5	146.0	56,361	4.5	167.4	112,268	4.5	23	18	5	469	2,183,781	1,349	476	7.25[a]
	Sat	03/18/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	03/19/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	nA	NM	NM	NA	NA	NA	NA	NA	NM
6	Mon	03/20/06	3.9	530	NA	NA	153.1	29,873	4.5	151.6	32,521	4.5	152.3	35,851	4.0	24	20	4	457	2,282,026	1,410	NA	7.00[a]
	Tue	03/21/06	5.2	580	NA	NA	155.4	45,059	4.5	147.3	43,291	4.5	160.2	47,612	4.5	24	20	4	463	2,417,988	1,494	NA	7.49[a]
	Wed	03/22/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Thu	03/23/06	5.3	580	163,000	513	151.6	46,506	4.5	147.6	44,867	4.5	150.7	49,296	4.5	24	20	4	450	2,558,657	1,580	NA	7.36[a]
	Fri	03/24/06	5.0	580	153,000	510	155.2	44,138	4.5	150.2	42,132	4.5	160.6	46,236	4.5	22	19	3	466	2,691,163	1,662	NA	7.02[a]
	Sat	03/25/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	03/26/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
7	Mon	03/27/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	03/28/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	03/29/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Thu	03/30/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	03/31/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	04/01/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	04/02/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
8	Mon	04/03/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	04/04/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	04/05/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Thu	04/06/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	04/07/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	04/08/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	04/09/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
9	Mon	04/10/06	4.3	590	130,000	504	164.6	37,479	5.0	157.5	35,923	4.7	167.2	39,500	4.5	24	18	6	489	2,804,065	1,732	NA	7.02[a]
	Tue	04/11/06	1.4	580	42,000	500	165.5	10,499	4.0	155.7	9,558	4.0	165.3	12,542	4.0	26	18	8	487	2,826,774	1,746	405	7.02[a]
	Wed	04/12/06	2.0	580	60,000	500	163.2	22,343	4.0	153.6	19,005	4.0	165.5	20,058	4.0	26	20	6	482	2,888,180	1,784	450	7.10[a]
	Thu	04/13/06	2.3	580	76,000	551	162.3	16,344	4.0	149.5	17,102	4.0	165.7	19,420	4.0	27	20	7	478	2,941,046	1,817	493	7.03[a]
	Fri	04/14/06	4.6	570	144,000	522	163.0	43,321	4.5	150.1	40,707	4.1	169.5	42,618	3.9	26	18	8	483	3,067,692	1,895	500	7.00[a]
	Sat	04/15/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	04/16/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
10	Mon	04/17/06	1.5	470	48,000	533	164.3	14,025	4.5	153.4	13,095	4.2	165.2	14,494	3.9	25	20	5	483	3,109,306	1,921	489	7.32[a]
	Tue	04/18/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	04/19/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Thu	04/20/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	04/21/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	04/22/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	04/23/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM

US EPA Arsenic Demonstration Project at Taos, NM – Daily System Operation Log Sheet (Continued)

			Well 8				Vessel A			Vessel B			Vessel C			System						Distribution	
Week No.	Day of Week	Date	Well Operational Hours hr	Flowrate gpm	Usage gal	Average Flowrate gpm	Flowrate gpm	Usage gal	Pressure Differential psi	Flowrate gpm	Usage gal	Pressure Differential psi	Flowrate gpm	Usage gal	Pressure Differential psi	Inlet Pressure psi	Oulet Pressure psi	Pressure Differential psi	Average Flowrate gpm	Cumulative Volume Treated gal	Cumulative Bed Volumes Treated[(b)] no.	Average Flowrate gpm	pH S.U.
	Mon	04/24/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	04/25/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	04/26/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
11	Thu	04/27/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	04/28/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	04/29/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	04/30/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	05/01/06	1.6	590	27,000	281	176.6	7,660	5.0	155.6	6,849	4.5	174.4	6,902	4.7	28	18	10	507	3,130,717	1,934	NA	7.27[(a)]
	Tue	05/02/06	4.8	580	150,000	521	174.6	35,686	4.0	152.7	33,031	4.2	172.3	40,224	4.0	28	18	10	500	3,239,658	2,001	427	7.64[(a)]
	Wed	05/03/06	2.7	580	87,000	537	175.4	31,175	4.2	153.2	29,109	4.2	173.6	32,001	4.0	26	18	8	502	3,331,943	2,058	593	7.36[(a)]
12	Thu	05/04/06	3.7	580	118,000	532	171.2	34,864	4.0	151.6	32,645	4.0	173.1	35,942	4.0	26	18	8	496	3,435,394	2,122	495	7.26[(a)]
	Fri	05/05/06	3.9	580	120,000	513	170.8	35,402	4.0	149.7	33,152	4.0	171.5	32,298	4.0	26	18	8	492	3,536,246	2,184	479	7.15
	Sat	05/06/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	05/07/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	05/08/06	4.0	580	124,000	517	166.1	41,072	3.0	154.2	38,562	4.2	166.4	42,333	3.8	23	18	5	487	3,658,213	2,260	529	7.29
	Tue	05/09/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	05/10/06	4.2	580	131,000	520	155.0	33,688	3.0	148.2	31,650	4.5	159.2	34,736	3.8	23	18	5	462	3,758,287	2,321	437	8.52
13	Thu	05/11/06	2.4	580	77,000	535	165.8	23,215	4.0	156.3	21,850	4.5	164.7	23,486	3.8	22	18	4	487	3,826,838	2,364	507	9.15
	Fri	05/12/06	4.5	580	139,000	515	157.1	40,436	4.5	146.7	38,005	4.0	163.7	37,235	3.8	23	18	5	468	3,942,514	2,435	481	7.22
	Sat	05/13/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	05/14/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	05/15/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	05/16/06	2.9	580	91,000	523	165.0	26,479	5.0	167.3	24,815	4.5	172	26,848	4.3	28	18	10	505	4,020,656	2,483	NA	NM
	Wed	05/17/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
14	Thu	05/18/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	05/19/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	05/20/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	05/21/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	05/22/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	05/23/06	2.0	580	60,000	500	171.6	18,441	4.5	166.9	17,324	4.5	168.4	19,638	4.0	28	20	8	507	4,076,059	2,518	NA	NM
	Wed	05/24/06	3.8	580	119,000	522	160.7	34,559	4.5	158.9	32,450	4.5	162.6	35,739	4.0	24	18	6	482	4,178,807	2,581	504	NM
15	Thu	05/25/06	4.4	580	137,000	519	164.5	39,735	4.5	157.2	37,315	4.5	163.9	41,014	4.0	24	18	6	486	4,296,871	2,654	485	NM
	Fri	05/26/06	3.4	580	56,000	275	161.7	30,106	4.5	155.8	28,227	4.1	160.9	31,102	3.5	26	18	8	478	4,386,306	2,709	480	NM
	Sat	05/27/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	05/28/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	05/29/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	05/30/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	05/31/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
16	Thu	06/01/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	06/02/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	06/03/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	06/04/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	06/05/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	06/06/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	06/07/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
17	Thu	06/08/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	06/09/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	06/10/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	06/11/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	06/12/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	06/13/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	06/14/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
18	Thu	06/15/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	06/16/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	06/17/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	06/18/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	06/19/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	06/20/06	9.2	570	320,000	580	170.8	80,229	5.0	162.9	75,440	4.3	175.7	82,935	4.0	26	18	8	509	4,624,910	2,857	462	7.0
	Wed	06/21/06	5.6	580	193,000	574	173.5	56,564	3.2	160.8	53,170	4.0	173.6	52,480	4.2	28	18	10	508	4,787,124	2,957	494	7.3
19	Thu	06/22/06	6.5	580	200,000	513	178.2	58,376	4.0	159.9	55,239	4.0	169.5	66,605	3.8	28	18	10	508	4,967,344	3,068	428	7.1
	Fri	06/23/06	9.8	580	297,000	505	158.7	85,420	4.0	151.3	80,557	3.5	173.0	89,383	3.0	28	18	10	483	5,222,704	3,226	408	7.4
	Sat	06/24/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	06/25/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	06/26/06	0.6	580	18,200	506	170.0	5,834	4.5	169.8	5,529	4.0	175.4	5,143	4.7	28	19	9	515	5,239,210	3,236	465	8.1
	Tue	06/27/06	5.8	580	180,960	520	174.5	55,583	4.5	167.1	52,534	4.0	170.6	57,682	3.7	26	18	8	512	5,405,009	3,338	527	7.3
	Wed	06/28/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
20	Thu	06/29/06	5.1	580	157,840	516	172.7	45,190	4.5	160.0	42,552	3.7	178.7	46,812	3.7	26	18	8	511	5,539,563	3,422	448	7.4
	Fri	06/30/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	07/01/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	07/02/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM

US EPA Arsenic Demonstration Project at Taos, NM – Daily System Operation Log Sheet (Continued)

			Well 8					Vessel A				Vessel B				Vessel C				System						Distribution			
Week No.	Day of Week	Date	Well Operational Hours hr	Flowrate gpm	Cumulative Totalizer kgal	Usage gal	Average Flowrate gpm	Flowrate gpm	Cumulative Totalizer gal	Usage gal	Pressure Differential psi	Flowrate gpm	Totalizer gal	Usage gal	Pressure Differential psi	Flowrate gpm	Totalizer gal	Usage gal	Pressure Differential psi	Inlet Pressure psi	Oulet Pressure psi	Pressure Differential psi	Average Flowrate gpm	Cumulative Volume Treated gal	Cumulative Bed Volumes Treated[(b)] no.	Totalizer kgal	Average Flowrate gpm	Usage gal	pH pH
	Mon	07/03/06	1.8	580	7,944	57,000	528	168.7	2,186,547	15,740	4.2	162.2	1,632,525	14,880	4.2	170.2	2,304,360	16,390	4.0	26	18	8	501	5,586,573	3,451	65,589	389	42,000	6.7
	Tue	07/04/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Wed	07/05/06	1.7	580	7,997	53,000	520	166.8	2,202,555	16,008	3.9	157.4	1,647,644	15,119	4.0	166.1	2,320,997	16,637	4.0	26	18	8	490	5,634,337	3,480	65,638	480	49,000	9.6
21	Thu	07/06/06	3.5	580	8,105	108,000	514	159.6	2,234,414	31,859	4.3	151.7	1,677,650	30,006	4.3	164.3	2,353,987	32,990	4.0	24	16	8	476	5,729,192	3,539	65,740	486	102,000	8.4
	Fri	07/07/06	3.7	580	8,221	116,000	523	165.7	2,267,866	33,452	4.9	156.4	1,709,175	31,525	4.5	170.2	2,388,545	34,558	6.0	26	16	10	492	5,828,727	3,600	65,846	477	106,000	7.5
	Sat	07/08/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Sun	07/09/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Mon	07/10/06	3.8	580	8,339	118,000	518	167.5	2,302,536	34,670	4.0	161.6	1,741,831	32,656	4.0	163.8	2,424,444	35,899	3.7	24	16	8	493	5,931,952	3,664	65,957	487	111,000	7.7
	Tue	07/11/06	1.2	580	8,376	37,000	514	160.8	2,313,744	11,208	4.0	163.6	1,752,418	10,587	4.2	178.3	2,436,058	11,614	3.8	28	20	8	503	5,965,361	3,685	65,999	583	42,000	7.0
	Wed	07/12/06	2.1	580	8,440	64,000	508	169.7	2,332,041	18,297	4.0	169.9	1,769,737	17,319	4.0	166.7	2,455,125	19,067	3.5	26	16	10	506	6,020,044	3,718	66,043	349	44,000	7.7
22	Thu	07/13/06	0.2	580	8,446	6,000	500	178.6	2,333,949	1,908	4.0	161.7	1,771,406	1,669	4.0	166.0	2,456,941	1,816	4.0	26	18	8	506	6,025,437	3,722	66,047	333	4,000	7.5
	Fri	07/14/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Sat	07/15/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Sun	07/16/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Mon	07/17/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Tue	07/18/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Wed	07/19/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
23	Thu	07/20/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Fri	07/21/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Sat	07/22/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Sun	07/23/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Mon	07/24/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Tue	07/25/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Wed	07/26/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
24	Thu	07/27/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Fri	07/28/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Sat	07/29/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Sun	07/30/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Mon	07/31/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Tue	08/01/06	6.9	580	8,660	214,000	517	172.0	NA	71,333	4.0	161.3	NA	71,333	4.5	172.3	NA	71,333	5.0	28	18	10	506	6,239,437	3,854	NM	NA	NA	7.3
	Wed	08/02/06	3.5	580	8,780	120,000	571	172.5	2,428,310	40,000	4.0	164.8	1,860,530	40,000	4.5	175.7	2,554,775	40,000	4.8	28	18	10	513	6,359,437	3,928	66,326	NA	279,000	7.2
25	Thu	08/03/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Fri	08/04/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Sat	08/05/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Sun	08/06/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Mon	08/07/06	3.1	580	8,860	80,000	430	187.2	2,457,090	28,780	4.0	170.3	1,887,723	27,193	4.5	178.6	2,584,530	29,755	4.8	28	18	10	536	6,445,165	3,981	66,377	NA	51,000	7.6
	Tue	08/08/06	2.5	580	8,940	80,000	533	182.5	2,466,926	9,836	4.0	168.2	1,897,048	9,325	4.5	176.7	2,594,797	10,267	4.8	28	18	10	527	6,474,593	3,999	66,400	NA	23,000	7.7
	Wed	08/09/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
26	Thu	08/10/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Fri	08/11/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Sat	08/12/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Sun	08/13/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Mon	08/14/06	8.4	580	9,202	262,000	520	181.8	2,562,134	95,208	5.0	160.0	1,987,212	90,164	4.8	171.7	2,693,695	98,898	4.3	22.0	18.0	4.0	514	6,758,863	4,175	66,676	548	276,000	7.8
	Tue	08/15/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Wed	08/16/06	4.2	580	9,334	132,000	524	177.9	2,603,744	41,610	4.2	162.7	2,026,665	39,453	4.5	176.2	2,736,944	43,249	4.5	21.0	18.0	3.0	517	6,883,175	4,251	66,804	508	128,000	8.0
27	Thu	08/17/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Fri	08/18/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Sat	08/19/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Sun	08/20/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Mon	08/21/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Tue	08/22/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Wed	08/23/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
28	Thu	08/24/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Fri	08/25/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Sat	08/26/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Sun	08/27/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Mon	08/28/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Tue	08/29/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Wed	08/30/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
29	Thu	08/31/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Fri	09/01/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Sat	09/02/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Sun	09/03/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Mon	09/04/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Tue	09/05/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Wed	09/06/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
30	Thu	09/07/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Fri	09/08/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Sat	09/09/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM
	Sun	09/10/06	NA	NM	NM	NA	NA	NM	NM	NA	NM	NM	NM	NA	NA	NM	NM	NA	NA	NM	NM	NA	NA	NA	NA	NM	NA	NA	NM

US EPA Arsenic Demonstration Project at Taos, NM – Daily System Operation Log Sheet (Continued)

	Mon	09/11/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	09/12/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	09/13/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
31	Thu	09/14/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	09/15/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	09/16/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	09/17/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	09/18/06	3.5	580	108,000	514	178.3	32,859	5.0	168.5	31,079	4.5	180.7	34,103	4.5	22	18	4	528	6,981,216	4,312	486	8.5
	Tue	09/19/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	09/20/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
32	Thu	09/21/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	09/22/06	5.0	580	158,000	527	128.2	48,222	5.0	176.7	45,961	5.0	185.0	50,334	4.8	23	16	7	490	7,125,733	4,401	490	8.5
	Sat	09/23/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	09/24/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	09/25/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	09/26/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	09/27/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
33	Thu	09/28/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	09/29/06	2.1	580	67,000	532	171.3	20,866	4.0	165.0	19,688	4.8	178.9	21,638	4.5	30	20	10	515	7,187,925	4,440	508	7.6
	Sat	09/30/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	10/01/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	10/02/06	4.3	580	137,000	531	172.7	42,160	5.1	169.0	40,155	4.8	183.3	44,052	4.8	26	16	10	525	7,314,292	4,518	508	7.4
	Tue	10/03/06	2.6	580	82,000	526	179.1	24,648	5.0	172.2	23,154	4.9	182.6	25,416	4.5	26	16	10	534	7,387,510	4,563	436	7.1
	Wed	10/04/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
34	Thu	10/05/06	2.0	580	65,000	542	175.7	20,681	4.9	173.5	19,599	4.9	184.4	21,488	4.5	28	18	10	534	7,449,278	4,601	433	7.1
	Fri	10/06/06	6.0	580	187,000	519	174.1	56,540	4.0	174.6	53,499	4.0	169.5	58,778	4.0	28	18	10	518	7,618,095	4,705	303	6.9
	Sat	10/07/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	10/08/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	10/09/06	6.0	580	182,000	506	171.1	56,786	5.0	169.1	53,733	4.8	164.7	58,940	4.4	28	18	10	505	7,787,554	4,810	350	7.1
	Tue	10/10/06	0.5	580	15,000	500	172.9	3,999	5.0	173.9	3,767	4.5	168.3	4,159	4.3	28	18	10	515	7,799,479	4,817	300	8.2
	Wed	10/11/06	6.4	580	200,000	521	176.6	61,884	5.0	163.5	58,562	4.5	178.5	64,300	4.0	28	20	8	519	7,984,225	4,932	456	7.8
35	Thu	10/12/06	3.7	580	115,000	518	171.6	34,990	5.0	171.8	33,056	4.3	186.8	36,327	4.1	28	16	12	530	8,088,598	4,996	482	7.7
	Fri	10/13/06	4.8	580	150,000	521	184.8	48,129	5.0	170.7	43,623	4.3	185.4	47,913	4.1	28	18	10	541	8,228,263	5,082	486	7.3
	Sat	10/14/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	10/15/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	10/16/06	4.5	580	150,000	556	189.5	43,963	5.0	180.9	42,471	4.5	184.6	47,732	4.2	27	26	1	555	8,362,429	5,165	444	7.3
	Tue	10/17/06	4.9	580	182,000	619	175.7	47,299	5.0	169.2	45,771	4.5	185.8	49,111	4.2	28	28	0	531	8,504,610	5,253	456	7.1
	Wed	10/18/06	0.7	580	25,000	595	191.7	2,028	5.0	172.6	1,932	4.5	193.2	2,115	4.0	28	28	0	558	8,510,685	5,257	NA	7.4
36	Thu	10/19/06	5.6	580	153,000	455	182.0	50,532	5.0	176.6	47,813	4.6	173.2	52,510	4.5	30	30	0	532	8,661,540	5,350	461	7.2
	Fri	10/20/06	0.7	580	20,000	476	175.2	8,732	5.0	168.6	8,268	4.6	187.8	9,079	4.5	28	28	0	532	8,687,619	5,366	643	7.1
	Sat	10/21/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	10/22/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	10/23/06	6.9	580	185,000	447	165.2	67,312	5.0	160.7	63,886	4.5	170.6	70,355	4.5	26	19	7	497	8,889,172	5,491	507	7.9
	Tue	10/24/06	3.1	580	97,000	522	168.4	29,797	5.0	160.0	28,256	4.5	175.9	30,963	4.0	25	19	6	504	8,978,188	5,546	425	7.2
	Wed	10/25/06	5.1	580	155,000	507	165.4	46,679	5.0	158.5	44,114	4.5	173.5	48,385	4.0	28	20	8	497	9,117,366	5,631	359	7.7
37	Thu	10/26/06	4.1	580	126,000	512	166.5	38,256	5.0	163.0	36,246	4.5	175.8	39,808	4.0	28	19	9	505	9,231,676	5,702	447	7.5
	Fri	10/27/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	10/28/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	10/29/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	10/30/06	5.5	580	169,000	512	169.8	52,424	5.0	160.7	49,539	4.5	175.9	54,326	7.0	25	20	5	506	9,387,965	5,799	427	8.3
	Tue	10/31/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	11/01/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
38	Thu	11/02/06	5.3	580	164,000	516	159.2	50,004	5.0	160.7	47,643	4.5	166.2	52,288	7.0	27	20	7	486	9,528,010	5,885	377	8.6
	Fri	11/03/06	4.9	580	151,000	514	166.6	45,826	5.0	162.7	43,271	4.5	172.1	47,443	7.0	28	20	8	501	9,664,550	5,969	446	8.3
	Sat	11/04/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	11/05/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	11/06/06	4.9	580	153,000	520	177.4	46,984	5.0	162.7	38,518	4.5	174.8	48,829	4.5	26	20	6	515	9,798,881	6,052	490	7.5
	Tue	11/07/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	11/08/06	1.7	580	52,000	510	168.9	15,908	5.0	162.2	21,076	4.5	170.6	16,544	4.5	26	19	7	502	9,852,409	6,085	480	7.7
39	Thu	11/09/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	11/10/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	11/11/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	11/12/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	11/13/06	4.5	580	125,000	463	186.1	38,223	5.1	172.1	36,185	4.8	185.1	39,719	4.7	26	10	16	543	9,966,536	6,156	437	8.0
	Tue	11/14/06	4.5	580	156,000	578	171.8	47,782	5.0	164.3	45,322	4.1	177.5	49,771	4.2	28	20	8	514	10,109,411	6,244	470	7.5
	Wed	11/15/06	4.8	580	146,000	507	173.4	45,043	5.0	174.0	22,638	4.1	187.7	46,798	4.2	28	18	10	535	10,223,890	6,315	424	7.8
40	Thu	11/16/06	5.2	580	161,000	516	175.0	49,482	5.0	172.7	66,854	4.0	177.0	51,466	4.1	28	18	10	525	10,391,692	6,419	446	7.8
	Fri	11/17/06	4.3	580	130,000	504	174.4	40,500	5.0	168.3	38,320	4.2	181.9	42,137	4.0	28	18	10	525	10,512,649	6,493	457	7.3
	Sat	11/18/06	NA	NM	NA	NA	NM	NA	NA	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	11/19/06	NA	NM	NA	NA	NM	NA	NA	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM

US EPA Arsenic Demonstration Project at Taos, NM – Daily System Operation Log Sheet (Continued)

	Mon	11/20/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	11/21/06	4.3	570	132,000	512	168.5	41,151	5.5	166.8	39,057	4.5	170.5	42,965	4.5	28	19	9	506	10,635,822	6,569	NA	7.2
	Wed	11/22/06	4.7	575	146,000	518	170.0	45,028	5.0	165.2	42,590	4.5	170.0	46,786	4.5	28	18	10	505	10,770,226	6,652	NA	7.3
41	Thu	11/23/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	11/24/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	11/25/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	11/26/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	11/27/06	3.6	580	110,000	509	172.4	32,450	5.1	170.0	30,601	4.8	175.4	33,593	4.3	28	18	10	518	10,866,870	6,712	347	7.9
	Tue	11/28/06	5.4	580	167,000	515	172.7	52,859	5.0	170.6	50,008	4.1	182.7	54,982	4.0	26	20	6	526	11,024,719	6,810	556	7.1
	Wed	11/29/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
42	Thu	11/30/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	12/01/06	3.8	580	117,000	513	184.5	34,791	5.2	165.6	32,891	4.5	176.5	36,207	4.1	26	18	8	527	11,128,608	6,874	377	NM
	Sat	12/02/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	12/03/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	12/04/06	1.7	580	55,000	539	166.8	17,608	5.0	160.2	16,748	4.5	158.7	18,363	4.5	28	19	9	486	11,181,327	6,906	510	7.9
	Tue	12/05/06	4.7	580	147,000	521	172.4	43,638	4.5	163.8	41,290	4.5	167.9	45,390	4.5	28	18	10	504	11,311,645	6,987	372	7.7
	Wed	12/06/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
43	Thu	12/07/06	4.3	580	133,000	516	162.8	41,077	5.1	169.2	38,851	4.5	171.2	42,723	4.2	28	18	10	503	11,434,296	7,063	NA	7.2
	Fri	12/08/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	12/09/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	12/10/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	12/11/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	12/12/06	0.5	580	13,000	433	178.0	4,158	5.1	181.1	3,913	4.9	187.8	4,296	4.3	28	18	10	547	11,446,663	7,070	NA	7.9
	Wed	12/13/06	5.5	580	147,000	445	175.4	58,459	5.1	170.2	49,565	4.9	170.8	54,516	4.3	28	18	10	516	11,609,203	7,171	NA	7.2
44	Thu	12/14/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	12/15/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	12/16/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	12/17/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	12/18/06	5.3	580	187,000	588	176.5	44,745	5.0	168.2	48,323	4.5	182.6	53,060	4.5	28	18	10	527	11,755,331	7,261	NA	7.6
	Tue	12/19/06	3.6	580	115,000	532	170.0	34,706	5.0	165.5	32,987	4.5	185.2	36,268	4.5	28	18	10	521	11,859,292	7,325	NA	7.2
	Wed	12/20/06	3.5	580	108,000	514	171.5	32,964	5.0	166.1	31,080	4.5	181.6	34,010	4.5	28	18	10	519	11,957,346	7,386	NA	7.1
45	Thu	12/21/06	4.2	580	131,000	520	176.3	40,387	5.0	168.1	38,154	4.5	175.0	41,738	4.5	28	18	10	519	12,077,625	7,460	NA	7.3
	Fri	12/22/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	12/23/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	12/24/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	12/25/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	12/26/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	12/27/06	6.3	580	189,000	500	168.0	56,304	5.0	155.0	52,932	4.5	180.8	58,696	4.0	27	18	9	504	12,245,557	7,564	NA	7.4
46	Thu	12/28/06	2.6	580	86,000	551	170.0	28,113	5.0	164.0	26,910	4.5	168.0	29,290	4.0	27	18	9	502	12,329,870	7,616	NA	7.2
	Fri	12/29/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	12/30/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	12/31/06	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	01/01/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	01/02/07	4.1	580	129,000	524	170.6	40,496	5.0	165.3	39,499	4.5	170.5	37,478	4.5	28	18	10	506	12,447,343	7,688	NA	7.8
	Wed	01/03/07	5.1	580	157,000	513	168.5	54,197	5.0	165.7	53,315	4.5	178.5	51,186	4.5	28	18	10	513	12,606,041	7,786	NA	7.4
47	Thu	01/04/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	01/05/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	01/06/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	01/07/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	01/08/07	3.3	480	104,000	525	170.6	35,651	5.0	169.3	31,290	4.5	173.5	33,356	4.5	28	18	10	513	12,706,338	7,848	NA	7.3
	Tue	01/09/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	01/10/07	4.1	480	127,000	516	180.0	28,797	5.0	170.3	28,000	4.5	172.8	43,303	5.0	28	18	10	523	12,806,438	7,910	419	7.5
48	Thu	01/11/07	3.3	480	NA	NA	164.1	31,708	5.0	164.1	28,670	4.5	189.2	32,897	5.0	28	18	10	517	12,899,713	7,968	414	8.5
	Fri	01/12/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	01/13/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	01/14/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	01/15/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	01/16/07	4.1	480	130,000	528	171.5	39,402	5.1	160.0	37,481	4.8	178.8	41,282	4.8	25	15	10	510	13,017,878	8,041	NA	7.8
	Wed	01/17/07	4.7	480	150,000	532	170.0	41,897	5.0	159.5	39,833	4.6	177.5	43,704	4.8	28	18	10	507	13,143,312	8,118	401	7.2
49	Thu	01/18/07	4.5	480	154,000	570	170.5	45,539	5.0	160.0	43,084	4.5	178.0	47,197	4.8	28	18	10	509	13,279,132	8,202	515	7.3
	Fri	01/19/07	5.3	480	184,000	579	172.8	49,780	5.0	158.9	47,158	4.5	176.8	51,867	4.8	28	18	10	509	13,427,937	8,294	481	7.2
	Sat	01/20/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	01/21/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	01/22/07	3.5	580	120,000	571	175.2	32,833	5.0	168.4	31,063	4.5	175.3	33,948	4.5	28	18	10	519	13,525,781	8,354	443	7.3
	Tue	01/23/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	01/24/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
50	Thu	01/25/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	01/26/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	01/27/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	01/28/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM

US EPA Arsenic Demonstration Project at Taos, NM – Daily System Operation Log Sheet (Continued)

Week No.	Day of Week	Date	Well 8 Well Operational Hours (hr)	Well 8 Flowrate (gpm)	Well 8 Usage (gal)	Well 8 Average Flowrate (gpm)	Vessel A Flowrate (gpm)	Vessel A Usage (gal)	Vessel A Pressure Differential (psi)	Vessel B Flowrate (gpm)	Vessel B Usage (gal)	Vessel B Pressure Differential (psi)	Vessel C Flowrate (gpm)	Vessel C Usage (gal)	Vessel C Pressure Differential (psi)	System Inlet Pressure (psi)	System Oulet Pressure (psi)	System Pressure Differential (psi)	System Average Flowrate (gpm)	System Cumulative Volume Treated (gal)	System Cumulative Bed Volumes Treated[(b)] (no.)	Distribution Average Flowrate (gpm)	pH (S.U.)
	Mon	01/29/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	01/30/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	01/31/07	5.9	580	202,000	571	175.0	55,256	5.0	169.1	52,443	4.5	180.4	57,532	4.5	28	18	10	525	13,691,012	8,456	480	7.5
51	Thu	02/01/07	5.8	580	200,000	575	170.8	55,719	5.0	150.2	52,965	4.5	181.5	58,087	4.5	28	18	10	503	13,857,783	8,559	494	7.2
	Fri	02/02/07	4.6	580	152,000	551	161.0	43,087	5.0	159.5	40,870	4.5	172.8	44,806	4.5	28	18	10	493	13,986,546	8,639	478	7.1
	Sat	02/03/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	02/04/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	02/05/07	2.3	580	70,000	507	174.5	22,052	5.1	170.0	20,967	4.5	176.6	23,468	4.5	30	20	10	521	14,053,033	8,680	493	7.7
	Tue	02/06/07	4.9	580	153,000	520	189.6	46,456	5.1	181.9	43,984	4.5	179.1	47,770	4.3	26	16	10	551	14,191,243	8,765	483	7.8
	Wed	02/07/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
52	Thu	02/08/07	5.5	580	168,000	509	181.1	52,458	5.1	163.1	49,813	4.8	170.0	54,603	4.4	28	18	10	514	14,348,117	8,862	491	7.6
	Fri	02/09/07	2.9	580	102,000	586	178.2	27,362	5.0	171.6	25,889	4.5	173.1	28,393	4.6	24	16	8	523	14,429,761	8,913	540	6.9
	Sat	02/10/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	02/11/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	02/12/07	3.0	580	79,000	439	158.0	30,895	5.0	162.7	29,317	4.5	166.7	32,451	4.5	30	20	10	487	14,522,424	8,970	478	8.4
	Tue	02/13/07	3.1	580	99,000	532	164.3	27,015	5.0	157.6	25,565	4.5	185.7	27,721	4.5	30	20	10	508	14,602,725	9,020	441	7.7
	Wed	02/14/07	2.0	580	60,000	500	175.3	18,084	5.0	167.2	17,013	4.5	187.7	18,977	5.0	30	20	10	530	14,656,799	9,053	467	7.7
53	Thu	02/15/07	3.7	580	114,000	514	174.4	35,186	5.0	162.7	30,272	4.5	184.5	36,341	4.5	30	20	10	522	14,758,598	9,116	486	7.8
	Fri	02/16/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	02/17/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	02/18/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	02/19/07	2.9	580	89,000	511	174.0	27,779	5.0	170.0	29,360	4.5	175.5	29,049	4.5	28	18	10	520	14,844,786	9,169	494	8.0
	Tue	02/20/07	4.2	580	132,000	524	175.5	40,140	5.0	165.0	38,162	4.5	177.0	41,825	4.5	28	18	10	518	14,964,913	9,243	516	7.0
	Wed	02/21/07	4.1	580	128,000	520	174.0	39,481	5.0	164.5	37,388	4.5	175.0	40,974	5.0	28	18	10	514	15,082,756	9,316	463	7.8
54	Thu	02/22/07	4.0	580	121,000	504	175.8	37,148	5.0	163.8	35,143	4.5	176.1	35,623	4.5	28	18	10	516	15,190,670	9,383	479	7.0
	Fri	02/23/07	4.6	580	141,000	511	173.5	43,298	5.0	164.8	41,054	4.5	178.5	43,091	4.5	28	18	10	517	15,318,113	9,461	482	7.6
	Sat	02/24/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	02/25/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	02/26/07	3.1	580	105,000	565	176.9	32,896	5.0	165.0	33,415	4.5	174.9	33,769	4.5	28	18	10	517	15,418,193	9,523	NA	7.9
	Tue	02/27/07	3.2	580	113,000	589	174.9	35,327	5.0	167.9	27,419	4.5	178.8	24,524	4.5	28	18	10	522	15,505,463	9,577	NA	7.7
	Wed	02/28/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
55	Thu	03/01/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	03/02/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	03/03/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	03/04/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	03/05/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	03/06/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	03/07/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
56	Thu	03/08/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	03/09/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	03/10/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	03/11/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	03/12/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	03/13/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	03/14/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
57	Thu	03/15/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	03/16/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	03/17/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	03/18/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	03/19/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	03/20/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	03/21/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
58	Thu	03/22/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	03/23/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	03/24/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	03/25/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	03/26/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	03/27/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	03/28/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
59	Thu	03/29/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	03/30/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	03/31/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	04/01/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	04/02/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	04/03/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	04/04/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
60	Thu	04/05/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	04/06/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	04/07/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	04/08/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM

US EPA Arsenic Demonstration Project at Taos, NM – Daily System Operation Log Sheet (Continued)

			Well 8				Vessel A			Vessel B			Vessel C			System						Distribution	
Week No.	Day of Week	Date	Well Operational Hours	Flowrate	Usage	Average Flowrate	Flowrate	Usage	Pressure Differential	Flowrate	Usage	Pressure Differential	Flowrate	Usage	Pressure Differential	Inlet Pressure	Oulet Pressure	Pressure Differential	Average Flowrate	Cumulative Volume Treated	Cumulative Bed Volumes Treated[(b)]	Average Flowrate	pH
			hr	gpm	gal	gpm	gpm	gal	psi	gpm	gal	psi	gpm	gal	psi	psi	psi	psi	gpm	gal	no.	gpm	S.U.
	Mon	04/09/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	04/10/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	04/11/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
61	Thu	04/12/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	04/13/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	04/14/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	04/15/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	04/16/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	04/17/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	04/18/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
62	Thu	04/19/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	04/20/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	04/21/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	04/22/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	04/23/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	04/24/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	04/25/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
63	Thu	04/26/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	04/27/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	04/28/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	04/29/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	04/30/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	05/01/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	05/02/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
64	Thu	05/03/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	05/04/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	05/05/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	05/06/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	05/07/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	05/08/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	05/09/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
65	Thu	05/10/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	05/11/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	05/12/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	05/13/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	05/14/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	05/15/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	05/16/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
66	Thu	05/17/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	05/18/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	05/19/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	05/20/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	05/21/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	05/22/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	05/23/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
67	Thu	05/24/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	05/25/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	05/26/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	05/27/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	05/28/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	05/29/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	05/30/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
68	Thu	05/31/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	06/01/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	06/02/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	06/03/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	06/04/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	06/05/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	06/06/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
69	Thu	06/07/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	06/08/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	06/09/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	06/10/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	06/11/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	06/12/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	06/13/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
70	Thu	06/14/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	06/15/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	06/16/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	06/17/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM

US EPA Arsenic Demonstration Project at Taos, NM – Daily System Operation Log Sheet (Continued)

			Well 8				Vessel A			Vessel B			Vessel C			System						Distribution	
Week No.	Day of Week	Date	Well Operational Hours hr	Flowrate gpm	Usage gal	Average Flowrate gpm	Flowrate gpm	Usage gal	Pressure Differential psi	Flowrate gpm	Usage gal	Pressure Differential psi	Flowrate gpm	Usage gal	Pressure Differential psi	Inlet Pressure psi	Oulet Pressure psi	Pressure Differential psi	Average Flowrate gpm	Cumulative Volume Treated gal	Cumulative Bed Volumes Treated[(b)] no.	Average Flowrate gpm	pH S.U.
	Mon	06/18/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	06/19/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	06/20/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
71	Thu	06/21/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	06/22/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	06/23/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	06/24/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	06/25/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	06/26/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	06/27/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
72	Thu	06/28/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	06/29/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	06/30/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	07/01/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	07/02/07	41.4	580	1,117,000	450	168.5	339,448	5.0	165.0	328,952	4.5	175.5	374,444	4.5	26	16	10	509	16,548,307	10,221	431	7.2
	Tue	07/03/07	3.7	580	115,000	518	165.0	35,897	5.0	162.5	34,540	4.5	173.5	37,849	4.5	28	16	12	501	16,656,593	10,288	505	7.0
	Wed	07/04/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
73	Thu	07/05/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	07/06/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	07/07/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	07/08/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	07/09/07	4.8	580	150,000	521	164.4	45,907	5.0	168.5	43,439	4.8	174.3	53,604	4.8	28	18	10	507	16,799,543	10,376	490	6.9
	Tue	07/10/07	5.1	580	160,000	523	170.5	47,811	5.0	176.4	46,030	4.8	179.3	44,425	4.8	28	18	10	526	16,937,809	10,462	484	6.9
	Wed	07/11/07	4.8	580	144,000	500	175.8	44,191	5.0	172.0	42,601	4.2	168.9	46,954	4.8	26	18	8	517	17,071,555	10,545	424	7.2
74	Thu	07/12/07	3.5	580	109,000	519	175.0	34,835	5.0	162.5	32,480	4.2	175.4	35,588	4.0	28	20	8	513	17,174,458	10,608	524	7.1
	Fri	07/13/07	5.6	580	173,000	515	176.9	52,239	5.0	170.1	48,574	4.1	171.7	53,602	4.1	26	26	0	519	17,328,873	10,703	473	7.4
	Sat	07/14/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	07/15/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	07/16/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	07/17/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	07/18/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
75	Thu	07/19/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	07/20/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	07/21/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	07/22/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	07/23/07	10.9	580	330,000	505	166.2	103,843	5.0	161.1	96,711	4.5	174.7	106,498	4.5	30	20	10	502	17,635,925	10,893	466	7.5
	Tue	07/24/07	3.6	580	114,000	528	175.2	34,826	5.0	153.1	32,494	4.5	175.5	35,630	4.5	30	20	10	504	17,738,875	10,957	491	7.7
	Wed	07/25/07	2.6	580	81,000	519	174.9	24,980	5.0	155.0	23,290	4.5	177.4	25,553	4.5	30	20	10	507	17,812,698	11,002	506	7.3
76	Thu	07/26/07	3.6	580	109,000	505	179.0	33,905	5.0	152.6	31,645	4.5	175.2	34,266	4.5	30	20	10	507	17,912,514	11,064	463	7.3
	Fri	07/27/07	3.0	580	95,000	528	183.9	29,427	5.0	165.2	27,481	4.5	189.7	30,536	4.5	30	20	10	539	17,999,958	11,118	494	7.6
	Sat	07/28/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	07/29/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	07/30/07	2.1	580	63,000	500	173.0	19,896	5.0	160.5	18,685	4.5	182.0	20,576	4.5	28	18	10	516	18,059,115	11,154	484	7.8
	Tue	07/31/07	6.2	580	191,000	513	172.5	59,405	5.0	158.0	55,484	4.5	180.5	61,055	4.5	28	18	10	511	18,235,059	11,263	489	7.2
	Wed	08/01/07	3.8	580	118,000	518	170.6	37,068	5.0	160.0	34,663	4.5	180.0	37,964	4.5	28	19	9	511	18,344,754	11,331	491	7.1
77	Thu	08/02/07	7.7	580	233,000	504	168.0	71,743	5.0	158.0	67,035	4.5	178.0	73,709	4.5	26	17	9	504	18,557,241	11,462	476	7.2
	Fri	08/03/07	4.7	580	140,000	496	170.0	43,334	5.0	159.5	40,473	4.5	180.5	44,379	4.5	27	17	10	510	18,685,427	11,541	238	7.1
	Sat	08/04/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	08/05/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	08/06/07	4.5	580	140,000	519	172.0	43,845	5.0	160.1	40,924	4.5	188.3	44,770	4.5	30	20	10	520	18,814,966	11,621	322	7.5
	Tue	08/07/07	4.1	580	105,000	427	182.4	31,742	5.0	160.5	29,758	4.5	179.3	32,663	4.5	30	20	10	522	18,909,129	11,680	394	7.2
	Wed	08/08/07	2.8	580	106,000	631	185.3	33,126	5.0	156.1	30,862	4.5	180.2	33,825	4.5	30	20	10	522	19,006,942	11,740	595	7.4
78	Thu	08/09/07	3.7	580	112,000	505	175.2	34,605	5.0	158.1	32,342	4.5	180.5	35,450	4.5	30	20	10	514	19,109,339	11,803	473	7.2
	Fri	08/10/07	4.4	580	134,000	508	181.6	41,740	5.0	170.1	38,973	4.5	179.2	42,742	4.5	30	20	10	531	19,232,794	11,879	485	7.5
	Sat	08/11/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	08/12/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	08/13/07	2.4	580	75,000	521	179.6	23,810	5.0	170.9	22,298	4.5	180.0	24,346	4.3	26	18	8	531	19,303,248	11,923	507	7.7
	Tue	08/14/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	08/15/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
79	Thu	08/16/07	5.4	580	167,000	515	179.7	50,990	5.0	172.8	47,579	4.3	182.8	52,263	4.3	26	18	8	535	19,454,080	12,016	478	7.1
	Fri	08/17/07	5.8	580	177,000	509	162.8	54,921	5.0	167.9	51,321	4.3	183.1	56,358	4.3	26	18	8	514	19,616,680	12,117	480	7.2
	Sat	08/18/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	08/19/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Mon	08/20/07	2.6	580	80,000	513	180.5	23,822	5.0	172.6	23,168	4.3	177.0	25,395	4.5	26	16	10	530	19,689,065	12,161	487	7.7
	Tue	08/21/07	5.2	580	161,000	516	171.2	51,638	5.0	153.6	47,319	4.3	170.0	51,943	4.6	26	16	10	495	19,839,965	12,254	494	6.8
	Wed	08/22/07	4.4	580	135,000	511	175.8	41,227	5.0	184.4	38,522	4.5	175.7	44,576	4.3	26	18	8	536	19,964,290	12,331	500	7.0
80	Thu	08/23/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	08/24/07	4.8	580	146,000	507	182.9	45,644	5.0	165.3	42,479	4.2	180.9	44,266	4.2	26	20	6	529	20,096,679	12,413	458	7.6
	Sat	08/25/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	08/26/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM

US EPA Arsenic Demonstration Project at Taos, NM – Daily System Operation Log Sheet (Continued)

			Well 8				Vessel A			Vessel B			Vessel C			System						Distribution	
Week No.	Day of Week	Date	Well Operational Hours hr	Flowrate gpm	Usage gal	Average Flowrate gpm	Flowrate gpm	Usage gal	Pressure Differential psi	Flowrate gpm	Usage gal	Pressure Differential psi	Flowrate gpm	Usage gal	Pressure Differential psi	Inlet Pressure psi	Oulet Pressure psi	Pressure Differential psi	Average Flowrate gpm	Cumulative Volume Treated gal	Cumulative Bed Volumes Treated(b) no.	Average Flowrate gpm	pH S.U.
81	Mon	08/27/07	1.6	570	49,000	510	165.0	15,891	5.0	160.5	15,123	4.5	171.5	16,663	4.5	28	18	10	497	20,144,356	12,442	521	7.0
	Tue	08/28/07	5.0	570	145,000	483	165.8	47,450	5.0	160.0	44,301	4.5	175.0	48,632	4.5	28	18	10	501	20,284,739	12,529	480	7.1
	Wed	08/29/07	5.0	570	160,000	533	162.5	47,674	5.0	158.5	44,473	4.4	172.5	48,848	4.4	28	18	10	494	20,425,734	12,616	483	7.0
	Thu	08/30/07	5.2	570	159,000	510	160.5	49,212	5.0	156.5	45,943	4.4	172.8	50,497	4.4	27	18	9	490	20,571,386	12,706	481	7.0
	Fri	08/31/07	4.3	570	132,000	512	162.5	40,977	5.0	156.0	38,208	4.5	172.5	42,008	4.5	27	18	9	491	20,692,579	12,781	488	6.9
	Sat	09/01/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	09/02/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
82	Mon	09/03/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	09/04/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	09/05/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Thu	09/06/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	09/07/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	09/08/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	09/09/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
83	Mon	09/10/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Tue	09/11/07	3.7	580	110,000	495	180.0	33,402	5.0	167.4	31,183	4.5	180.4	34,169	5.0	28	18	10	528	20,791,333	12,842	455	7.2
	Wed	09/12/07	2.5	580	80,000	533	179.8	24,502	5.0	168.3	22,898	4.5	185.5	25,198	5.0	28	18	10	534	20,863,931	12,887	493	7.2
	Thu	09/13/07	2.3	580	70,000	507	189.7	21,985	5.0	173.5	20,577	4.5	186.4	22,550	5.0	28	18	10	550	20,929,043	12,927	NA	7.3
	Fri	09/14/07	3.5	580	108,000	514	184.4	33,689	5.0	175.0	31,539	4.5	186.5	34,623	5.0	28	18	10	546	21,028,894	12,989	NA	7.5
	Sat	09/15/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	09/16/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
84	Mon	09/17/07	3.6	580	111,000	514	186.6	34,791	5.0	168.4	32,502	4.5	187.1	35,656	4.5	26	18	8	542	21,131,843	13,052	495	7.1
	Tue	09/18/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	09/19/07	5.4	580	169,000	522	174.9	54,178	5.0	173.2	50,656	4.5	173.7	55,583	4.7	28	18	10	522	21,292,260	13,151	509	7.3
	Thu	09/20/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	09/21/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	09/22/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	09/23/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
85	Mon	09/24/07	1.9	570	57,000	500	168.5	15,356	5.1	165.0	14,430	4.6	172.5	15,847	4.8	29	19	10	506	21,337,893	13,180	412	7.0
	Tue	09/25/07	4.0	570	125,000	521	167.0	38,875	5.0	164.0	36,361	4.5	171.5	39,966	4.6	29	19	10	503	21,453,095	13,251	496	7.3
	Wed	09/26/07	4.3	570	132,000	512	168.0	40,944	5.0	164.5	38,318	4.6	172.0	42,034	4.8	29	19	10	505	21,574,391	13,326	484	7.2
	Thu	09/27/07	4.5	570	139,000	515	167.0	43,395	5.0	163.0	40,560	4.6	171.0	44,640	4.8	29	19	10	501	21,702,986	13,405	489	7.3
	Fri	09/28/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	09/29/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	09/30/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
86	Mon	10/01/07	2.3	580	69,000	500	181.3	20,956	5.1	162.8	19,531	4.9	172.7	21,312	4.9	26	18	8	517	21,764,785	13,443	464	7.7
	Tue	10/02/07	2.6	580	79,000	506	178.5	23,887	5.0	161.1	22,321	4.9	170.8	24,581	4.9	26	18	8	510	21,835,574	13,487	474	7.0
	Wed	10/03/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Thu	10/04/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Fri	10/05/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sat	10/06/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	10/07/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
87	Mon	10/08/07	3.5	580	109,000	519	176.4	34,614	5.0	155.8	32,340	4.5	172.0	35,530	5.0	24	18	6	504	21,938,058	13,550	500	6.9
	Tue	10/09/07	5.6	580	175,000	521	174.0	53,822	5.0	176.3	50,221	4.5	173.3	55,136	5.0	24	18	6	524	22,097,237	13,649	488	7.1
	Wed	10/10/07	3.6	580	110,000	509	175.8	34,775	5.0	157.3	32,548	4.5	189.3	35,751	5.0	24	18	6	522	22,200,311	13,712	491	7.4
	Thu	10/11/07	4.0	580	126,000	525	182.6	38,447	5.0	159.8	36,033	4.5	181.2	39,810	5.0	24	18	6	524	22,304,711	13,777	442	6.4
	Fri	10/12/07	1.3	580	38,000	487	179.9	11,506	5.0	162.3	10,708	4.5	186.3	11,817	5.0	24	18	6	529	22,338,742	13,798	449	6.5
	Sat	10/13/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	10/14/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
88	Mon	10/15/07	4.4	580	135,000	511	185.5	41,821	5.0	170.2	38,970	5.0	172.7	42,979	5.0	25	18	7	528	22,462,512	13,874	485	7.2
	Tue	10/16/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Wed	10/17/07	4.1	580	127,000	516	180.7	39,429	5.0	168.5	36,693	5.0	170.8	40,455	5.0	25	18	7	520	22,579,089	13,946	492	8.1
	Thu	10/18/07	4.8	580	149,000	517	182.6	46,424	5.0	170.8	43,315	5.0	182.1	47,688	5.0	26	17	9	536	22,716,516	14,031	493	7.0
	Fri	10/19/07	4.6	580	142,000	514	179.6	42,869	5.0	166.9	40,029	5.0	171.1	44,027	5.0	26	17	9	518	22,843,441	14,110	478	6.8
	Sat	10/20/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
	Sun	10/21/07	NA	NM	NA	NA	NM	NA	NM	NM	NA	NA	NM	NA	NA	NM	NM	NA	NA	NA	NA	NA	NM
89	Mon	10/22/07	0.6	570	18,000	500	170.0	5,981	5.0	165.0	5,600	4.5	175.5	6,198	4.8	28	18	10	511	22,861,220	14,121	528	7.2
	Tue	10/23/07	4.1	580	127,000	516	181.2	39,197	5.0	178.6	36,497	4.5	181.8	40,123	4.8	28	18	10	542	22,977,037	14,192	484	7.1

(a) From 02/13/08 to 05/04/06, in-line pH probe broken and VWR field meter used to take pH readings.
(a) Bed volume = 71 cu.ft. (531 gal) for Vessel A, 73 cu.ft. (546 gal) for Vessel B, 71 cu.ft. (531 gal) for Vessel C, or 215 cu.ft. (1,608 gal) total for three vessels.
NM = Not Measured; NA = Not Availble.

APPENDIX B

ANALYTICAL DATA TABLES

Analytical Results from Long Term Sampling at Taos, NM

Sampling Date		02/14/06			02/22/06					03/01/06[a]					03/07/06				
Sampling Location		IN	AP	TT	IN	AP	TA	TB	TC	IN	AP	TA	TB	TC	IN	AP	TA	TB	TC
Parameter	Unit																		
Bed Volume	10^3	-	-	0.02	-	-	0.5	0.3	0.5	-	-	0.9	0.5	1.0	-	-	1.0	0.6	1.1
Alkalinity ($CaCO_3$)	mg/L	112	104	100	96	96	96	83	87	95	100	95	95	95	100	100	100	100	95
Fluoride	mg/L	1.4	1.4	1.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfate	mg/L	40	40	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate (as N)	mg/L	0.2	0.2	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total P (as P)	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Silica (as SiO_2)	mg/L	34.6	34.0	30.0	34.1	34.4	34.0	35.5	35.6	31.4	29.6	31.4	29.5	29.8	32.2	30.8	28.7	31.3	32.1
Turbidity	NTU	1.4	1.1	1.4	0.6	0.9	0.8	0.7	0.7	0.6	2.2	0.5	1.9	1.1	1.7	2.1	1.1	0.7	1.8
pH	S.U.	9.5	7.3	7.2	9.6	7.1	7.1	7.1	7.1	9.7	7.0	7.0	7.2	7.2	NA	NA	NA	NA	NA
Temperature	^0C	20.3	20.9	22.3	25.7	24.0	24.6	24.5	24.3	18.2	18.9	17.7	17.4	17.0	NA	NA	NA	NA	NA
DO	mg/L	0.9	0.9	1.2	1.4	1.1	1.2	1.1	1.2	1.1	1.3	1.3	1.4	1.2	NA	NA	NA	NA	NA
ORP	mV	340	350	338	256	259	260	273	282	275	278	278	277	279	NA	NA	NA	NA	NA
Total Hardness ($CaCO_3$)	mg/L	3.6	3.5	3.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ca Hardness ($CaCO_3$)	mg/L	3.5	3.4	2.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mg Hardness ($CaCO_3$)	mg/L	<0.1	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
As (total)	µg/L	17.3	17.0	<0.1	16.9	17.4	0.2	0.4	1.9	16.1	14.6	0.3	0.2	0.7	16.2	15.8	0.1	0.5	1.4
As (soluble)	µg/L	17.1	17.8	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
As (particulate)	µg/L	0.2	<0.1	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
As (III)	µg/L	0.2	0.3	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
As (V)	µg/L	16.9	17.4	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fe (total)	µg/L	<25	<25	<25	<25	<25	<25	<25	31	<25	66	<25	<25	<25	36	76	<25	211	32
Fe (soluble)	µg/L	<25	<25	<25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mn (total)	µg/L	1.0	1.1	0.4	0.7	0.7	0.2	0.1	1.0	0.7	3.1	0.1	<0.1	0.3	2.3	2.9	0.3	2.9	1.4
Mn (soluble)	µg/L	0.6	0.8	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(a) Onsite water quality parameters taken on 03/02/06.

Analytical Results from Long Term Sampling at Taos, NM (Continued)

Sampling Date		03/16/06[a]			04/11/06[b]					05/01/06[c]			05/31/06				
Sampling Location Parameter	Unit	IN	AP	TT	IN	AP	TA	TB	TC	IN	AP	TT	IN	AP	TA	TB	TC
Bed Volume	10^3	-	-	1.2	-	-	1.9	1.3	2.1	-	-	2.0	-	-	2.9	2.2	3.1
Alkalinity ($CaCO_3$)	mg/L	95	91	87	97	97	106	101	97	96	96	96	104 104	104 96	100 96	100 100	96 96
Fluoride	mg/L	1.6	1.6	1.6	-	-	-	-	-	1.5	1.6	1.5	-	-	-	-	-
Sulfate	mg/L	41	41	41	-	-	-	-	-	41	41	42	-	-	-	-	-
Nitrate (as N)	mg/L	0.2	0.2	0.2	-	-	-	-	-	0.1	0.1	0.1	-	-	-	-	-
Total P (as P)	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	18.5 14.8	18.5 16.0	12.1 18.1	11.9 18.2	11.9 14.0
Silica (as SiO_2)	mg/L	31.3	32.6	28.3	32.2	32.3	31.9	32.4	33.1	32.8	32.9	34.8	32.7 31.6	30.2 29.1	30.7 30.9	30.9 31.5	31.2 31.1
Turbidity	NTU	0.6	0.5	1.1	1.3	1.1	2.2	2.0	1.5	0.8	0.9	1.5	0.4 0.6	2.7 1.4	0.8 1.3	0.7 0.6	0.6 0.7
pH	S.U.	9.6	7.7	7.3	9.7	6.7	7.1	7.2	7.1	9.6	7.3	7.0	NA	NA	NA	NA	NA
Temperature	^0C	21.1	12.6	21.4	25.0	25.7	26.1	25.5	25.7	21.4	21.1	21.3	NA	NA	NA	NA	NA
DO	mg/L	1.1	1.1	1.5	1.1	1.0	1.3	1.6	1.4	1.1	1.2	1.2	NA	NA	NA	NA	NA
ORP	mV	243	249	267	348	356	360	361	363	297	305	299	NA	NA	NA	NA	NA
Total Hardness ($CaCO_3$)	mg/L	3.5	3.4	0.8	-	-	-	-	-	4.2	4.3	4.8	-	-	-	-	-
Ca Hardness ($CaCO_3$)	mg/L	3.4	3.3	0.7	-	-	-	-	-	4.1	4.2	4.6	-	-	-	-	-
Mg Hardness ($CaCO_3$)	mg/L	<0.1	<0.1	<0.1	-	-	-	-	-	<0.1	<0.1	0.2	-	-	-	-	-
As (total)	µg/L	14.5	15.1	19.7	17.9	18.1	0.4	0.4	1.3	16.9	17.6	0.2	15.5 15.4	14.7 14.5	0.7 0.5	0.8 0.7	1.4 1.3
As (soluble)	µg/L	14.6	15.3	16.7	-	-	-	-	-	17.1	17.2	0.1	-	-	-	-	-
As (particulate)	µg/L	<0.1	<0.1	3.1	-	-	-	-	-	<0.1	0.3	<0.1	-	-	-	-	-
As (III)	µg/L	0.4	0.6	0.6	-	-	-	-	-	0.3	0.3	0.1	-	-	-	-	-
As (V)	µg/L	14.3	14.6	16.1	-	-	-	-	-	16.8	16.9	<0.1	-	-	-	-	-
Fe (total)	µg/L	<25	<25	<25	<25	<25	66	51	76	<25	64	34	<25 <25	55 49	<25 38	<25 30	<25 52
Fe (soluble)	µg/L	<25	<25	<25	-	-	-	-	-	<25	<25	<25	-	-	-	-	-
Mn (total)	µg/L	0.9	0.8	0.5	1.0	1.2	1.8	1.8	1.5	1.7	2.0	1.1	0.6 0.6	2.5 2.6	0.8 0.8	0.6 0.5	0.7 0.6
Mn (soluble)	µg/L	0.5	0.4	<0.1	-	-	-	-	-	0.6	1.0	0.4	-	-	-	-	-

(a) Onsite water quality parameters taken on 03/13/06. (b) Onsite water quality parameters taken on 04/14/06.
(c) Onsite water quality parameters taken on 05/04/06.

Analytical Results from Long Term Sampling at Taos, NM (Continued)

Sampling Date		06/21/06[a]					07/18/06[b]			08/02/06			08/16/06[c]				
Sampling Location Parameter	Unit	IN	AP	TA	TB	TC	IN	AP	TT	IN	AP	TT	IN	AP	TA	TB	TC
Bed Volume	10^3	-	-	3.2	2.5	3.3	-	-	3.9	-	-	4.2	-	-	4.2	3.5	4.4
Alkalinity ($CaCO_3$)	mg/L	103	95	75	90	83	92	97	100	97	97	101	98 86	98 98	90 94	94 98	98 102
Fluoride	mg/L	-	-	-	-	-	4.1	2.1	2.1	2.0	1.6	1.6	-	-	-	-	-
Sulfate	mg/L	-	-	-	-	-	44	38	43	39	45	38	-	-	-	-	-
Nitrate (as N)	mg/L	-	-	-	-	-	0.2	0.2	0.2	0.1	0.2	0.2	-	-	-	-	-
Total P (as P)	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10 <10	<10 <10	<10 <10	<10 <10	<10 <10
Silica (as SiO_2)	mg/L	32.7	30.8	27.2	27.4	27.9	33.1	32.6	30.9	32.2	30.1	35.3	32.7 33.9	33.5 33.8	32.9 35.2	34.2 35.7	34.5 35.5
Turbidity	NTU	1.1	0.7	2.4	0.8	0.9	0.3	0.8	1.1	0.7	0.4	0.6	1.3 0.2	0.5 0.2	2.1 1.5	0.7 0.7	0.4 0.4
pH	S.U.	9.7	6.7	6.7	7.1	7.4	9.6	7.5	7.3	9.6	7.5	7.4	9.6	7.2	7.0	7.5	7.5
Temperature	^{0}C	24.7	24.9	24.8	24.6	24.4	23.3	24.1	23.1	23.3	24.1	22.5	24.0	22.6	23.5	23.6	23.7
DO	mg/L	NA	NA	NA	NA	NA	1.6	1.3	1.3	1.6	1.3	1.3	2.7	2.6	3.3	3.1	2.8
ORP	mV	258	256	280	327	341	321	324	343	321	324	340	230	236	237	246	250
Total Hardness ($CaCO_3$)	mg/L	-	-	-	-	-	2.9	2.7	0.6	3.8	3.9	7.9	-	-	-	-	-
Ca Hardness ($CaCO_3$)	mg/L	-	-	-	-	-	2.8	2.6	0.5	3.8	3.8	7.9	-	-	-	-	-
Mg Hardness ($CaCO_3$)	mg/L	-	-	-	-	-	<0.1	<0.1	<0.1	0.1	0.1	<0.04	-	-	-	-	-
As (total)	µg/L	18.4	16.4	0.3	0.5	1.2	18.3	17.9	3.7	16.8	16.7	0.2	16.6 16.5	16.0 16.8	0.2 0.2	0.2 0.1	0.9 0.8
As (soluble)	µg/L	-	-	-	-	-	17.8	18.5	4.0	16.8	17.2	0.2	-	-	-	-	-
As (particulate)	µg/L	-	-	-	-	-	0.5	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-
As (III)	µg/L	-	-	-	-	-	0.2	0.2	0.2	0.2	0.2	0.1	-	-	-	-	-
As (V)	µg/L	-	-	-	-	-	17.6	18.3	3.8	16.6	17.0	0.1	-	-	-	-	-
Fe (total)	µg/L	<25	76	55	25	90	<25	<25	66	78	38	<25	<25 <25	<25 <25	28 29	<25 <25	26 27
Fe (soluble)	µg/L	-	-	-	-	-	<25	<25	<25	<25	<25	<25	-	-	-	-	-
Mn (total)	µg/L	0.8	3.2	1.4	0.8	1.1	1.1	0.7	1.1	3.7	2.7	0.4	0.5 0.6	0.6 0.8	1.0 1.4	1.0 0.9	1.0 1.1
Mn (soluble)	µg/L	-	-	-	-	-	0.2	0.4	<0.1	0.9	1.1	0.2	-	-	-	-	-

(a) Onsite water quality parameters taken on 06/29/06. (b) Onsite water quality parameters taken on 07/06/06.
(c) Onsite water quality parameters taken on 08/08/06.

Analytical Results from Long Term Sampling at Taos, NM (Continued)

Sampling Date		10/11/06[(a)]			11/14/06					12/13/06[(b)]			01/31/07[(c)]				
Sampling Location Parameter	Unit	IN	AP	TT	IN	AP	TA	TB	TC	IN	AP	TT	IN	AP	TA	TB	TC
Bed Volume	10^3	-	-	5.2	-	-	6.5	5.6	6.8	-	-	7.6	-	-	8.8	7.6	9.3
Alkalinity ($CaCO_3$)	mg/L	100	103	105	101	103	111	107	105	103	105	103	102	102	102	94	92
Fluoride	mg/L	1.4	1.4	1.4	-	-	-	-	-	1.5	1.5	1.6	-	-	-	-	-
Sulfate	mg/L	42	41	46	-	-	-	-	-	41	41	41	-	-	-	-	-
Nitrate (as N)	mg/L	0.2	0.1	0.1	-	-	-	-	-	0.1	0.2	0.1	-	-	-	-	-
Total P (as P)	µg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	18.4	14.6	16.7	17.5	15.4
Silica (as SiO_2)	mg/L	32.9	30.3	34.9	32.4	32.1	31.5	36.2	34.9	31.9	31.9	37.0	34.7	33.7	35.9	34.6	34.3
Turbidity	NTU	0.3	2.5	0.9	0.8	0.5	0.4	1.5	0.9	0.6	0.6	0.8	3.0	1.2	1.3	1.5	1.4
pH	S.U.	9.8	7.8	7.9	NA	NA	NA	NA	NA	9.6	7.9	7.5	9.6	7.6	7.7	7.5	7.6
Temperature	^{0}C	21.1	21.8	22.1	NA	NA	NA	NA	NA	24.2	25.4	25.8	23.3	22.8	22.7	23.8	24.0
DO	mg/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.0	0.8	0.8	0.7	0.5
ORP	mV	255	258	279	NA	NA	NA	NA	NA	230	236	245	274	285	412	341	293
Total Hardness ($CaCO_3$)	mg/L	4.2	4.5	7.9	-	-	-	-	-	3.4	3.4	6.9	-	-	-	-	-
Ca Hardness ($CaCO_3$)	mg/L	4.1	4.4	7.8	-	-	-	-	-	3.4	3.3	6.8	-	-	-	-	-
Mg Hardness ($CaCO_3$)	mg/L	<0.1	<0.1	<0.1	-	-	-	-	-	<0.1	<0.1	<0.1	-	-	-	-	-
As (total)	µg/L	18.7	15.8	0.7	17.4	18.4	0.4	0.4	1.8	17.4	17.6	0.4	15.8 [15.1] {15.3}	15.7 [15.3] {15.4}	7.4 [6.3] {5.7}	7.2 [6.0] {5.4}	8.8 [7.6] {7.3}
As (soluble)	µg/L	18.5	15.7	0.8	-	-	-	-	-	17.7	16.9	0.4	-	-	-	-	-
As (particulate)	µg/L	0.2	0.1	<0.1	-	-	-	-	-	<0.1	0.7	<0.1	-	-	-	-	-
As (III)	µg/L	0.5	0.4	0.5	-	-	-	-	-	0.4	0.5	0.3	-	-	-	-	-
As (V)	µg/L	18.0	15.3	0.3	-	-	-	-	-	17.2	16.5	<0.1	-	-	-	-	-
Fe (total)	µg/L	<25	52	<25	<25	<25	<25	<25	<25	<25	<25	<25	270 [407] {340}	199 [230] {270}	97 [125] {137}	74 [84] {90}	67 [74] {82}
Fe (soluble)	µg/L	<25	<25	<25	-	-	-	-	-	<25	<25	<25	-	-	-	-	-
Mn (total)	µg/L	0.6	2.7	0.6	0.4	0.7	0.2	1.0	0.6	0.9	1.3	0.7	6.3 [8.7] {7.5}	5.0 [6.1] {6.1}	2.6 [3.8} [2.7]	2.2 [3.4] {2.1}	1.9 [3.2] {1.8}
Mn (soluble)	µg/L	0.4	1.0	0.3	-	-	-	-	-	0.3	0.9	0.2	-	-	-	-	-

(a) Water quality parameters taken on 10/12/06. (b) Onsite water quality parameters were taken on 12/28/06.
(c) [Rerun with ICPMS bottles], {Rerun with AAL bottles}

Analytical Results from Long Term Sampling at Taos, NM (Continued)

Sampling Date		02/21/07					05/01/07					07/31/07					09/12/07				
Sampling Location		IN	AP	TA	TB	TC	IN	AP	TA	TB	TC	IN	AP	TA	TB	TC	IN	AP	TA	TB	TC
Parameter	Unit																				
Bed Volume	10^3	-	-	9.6	8.4	10.2	-	-	NA	NA	NA	-	-	11.6	10.3	12.2	-	-	13.3	11.8	14.0
Alkalinity ($CaCO_3$)	mg/L	114	106	109	96	96	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fluoride	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sulfate	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate (as N)	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total P (as P)	µg/L	<10	12.7	<10	<10	<10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silica (as SiO_2)	mg/L	33.4	31.3	36.8	34.7	34.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Turbidity	NTU	0.4	1.9	1.3	0.6	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	S.U.	9.8	7.7	7.6	7.4	7.7	NA	NA	NA	NA	NA	9.6	7.3	7.6	7.2	7.5	9.6	7.2	7.5	7.3	7.3
Temperature	^{0}C	22.8	22.4	22.1	23.1	22.6	NA	NA	NA	NA	NA	27.5	27.8	27.9	27.8	27.8	28.4	28.1	28.2	28.1	28.0
DO	mg/L	NA[(b)]	NA[(b)]	NA[(b)]	NA[(b)]	NA[(b)]	NA	NA	NA	NA	NA	1.2	1.6	1.8	1.9	2.3	1.6	1.7	1.9	2.0	2.1
ORP	mV	259	255	277	322	343	NA	NA	NA	NA	NA	222	225	226	229	222	222	225	226	225	224
Total Hardness ($CaCO_3$)	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ca Hardness ($CaCO_3$)	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mg Hardness ($CaCO_3$)	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
As (total)	µg/L	19.5	17.6	3.0	3.3	5.2	15.0	14.7	0.6	0.5	0.9	16.6	16.6	0.3	0.3	0.8	18.1	18.8	0.8	0.7	1.6
As (soluble)	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
As (particulate)	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
As (III)	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
As (V)	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fe (total)	µg/L	<25	37	<25	<25	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fe (soluble)	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mn (total)	µg/L	0.9	2.2	0.5	0.5	0.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mn (soluble)	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Analytical Results from Long Term Sampling at Taos, NM (Continued)

Sampling Date		10/23/07				
Sampling Location		IN	AP	TA	TB	TC
Parameter	Unit					
Bed Volume	10^3	-	-	14.7	13.0	15.3
Alkalinity ($CaCO_3$)	mg/L	-	-	-	-	-
Fluoride	mg/L	-	-	-	-	-
Sulfate	mg/L	-	-	-	-	-
Nitrate (as N)	mg/L	-	-	-	-	-
Total P (as P)	µg/L	-	-	-	-	-
Silica (as SiO_2)	mg/L	-	-	-	-	-
Turbidity	NTU	-	-	-	-	-
pH	S.U.	9.6	7.3	7.3	7.4	7.3
Temperature	^0C	26.1	26.2	26.2	26.3	26.1
DO	mg/L	1.4	1.3	1.5	1.6	2.1
ORP	mV	222	224	224	226	222
Total Hardness ($CaCO_3$)	mg/L	-	-	-	-	-
Ca Hardness ($CaCO_3$)	mg/L	-	-	-	-	-
Mg Hardness ($CaCO_3$)	mg/L	-	-	-	-	-
As (total)	µg/L	17.6	18.0	0.4	0.3	1.1
As (soluble)	µg/L	-	-	-	-	-
As (particulate)	µg/L	-	-	-	-	-
As (III)	µg/L	-	-	-	-	-
As (V)	µg/L	-	-	-	-	-
Fe (total)	µg/L	-	-	-	-	-
Fe (soluble)	µg/L	-	-	-	-	-
Mn (total)	µg/L	-	-	-	-	-
Mn (soluble)	µg/L	-	-	-	-	-