SUPPLEMENTAL DATA

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Arsenic Removal from Drinking Water: Experiences with Technologies and Constraints in Practice

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Location	Site name	study period	system size				removal system				source water quality																	comment	performance			Generation and handling of residuals
			pop. served	av. flow [gpm]	vol. treated [gal.]	comment	type	vendor	design flow rate [gpm]	comment	As total soluble [µg/L]	As(V) [µg/L]	As(III) [µg/L]	pH (S.U.)	dissolved oxygen	TOC [mg/L]	SiO2 [mg/L]	P [mg/L]	Nitrate (as N) [mg/L]	Sulfate [mg/L]	Fe soluble [µg/L]	Mn soluble [µg/L]	U soluble [µg/L]	Sb soluble [µg/L]	V soluble [µg/L]	Ammonia		run length [gal] / [BV]	backwash (regeneration) frequency [d]	comment	
											OEPA Raw Water Data (not available from Battelle)							as P										run length for initial treatment. The As-MCL was not exceeded anymore after treatment modification (without media change)			
																		as PO4													
Felton, DE	Town of Felton	2006/09/14 - 2007/11/03	428	263	43,446,110		coagulation/filtration: FM-348-AS, Macrolite media; FeCl3 addition & pre-existing NaOCl injection system (pre- & post-chlorination)	Kinetico	375	14 sampling events with As levels > MCL due to insufficient iron addition or particulate breakthrough from the filters	30.4	5.2	25.2	8.2	2.8	0.8	9.6	<0.06	<0.04	9	<25	1.5	<0.1	NA	0.16	0.32		NA	1.4		Backwash wastewater supernatant was recycled back to the head of the treatment system after settling, sludge was pumped to the sewer.
Okanogan, WA	City of Okanogan	2008/08/14 - 2009/08/14	2500	527	139,435,000	only one out of 4 wells (650gpm / 2055gpm) used in study	coagulation/filtration: FH13 Electromedia-I; prior NaOCl and FeCl3 addition	Filtronics	750		18.6	15.6	3	8	1.8	<0.7	24.1	<0.06	<0.04	110	45	70.3	0.5	NA	0.3	0.05	Contrary to the Battelle data, As(III) was the predominant species during most of the study period (13.4µg/l on average; As(V) 4.7µg/l). Other water quality data consistent with Battelle data.	NA	0.4		Backwash wastewater was reclaimed in a tank. Sludge of backwash solids was discharged to the sewer.
Three Forks, MT	City of Three Forks	2006/11/27 - 2008/02/08	2000	206	30,499,000	only Well 2, which was used for the study, had elevated As levels, Wells 5, 6, 8 and 9 did not.	coagulation/filtration: FM-248-AS, Macrolite media; NaOCl and FeCl3 addition	Kinetico	250	As levels > MCL (soluble & particulate) can break through the filters within 2 hr of service time; iron > secondary MCL. Filter performance can not be improved by increasing Fe dosages, the use of an organic polymer nor by smaller media size fraction. Only blending with water from other wells reduces As concentrations < MCL levels	63.7	62.4	1.3	7.5	5.2	0.8	48.7	<0.06	0.4	18	<25	<0.1	3.8	NA	8.4	<0.05		NA	1.1	Backwash should have been much more frequent to avoid As & Fe breakthrough.	Residuals: backwash wastewater and filter-to-waste rinse water. 10% discharged via sewer to a lagoon used for irrigation, 90% reclaimed after being passed through a bag filter
Arnaudville, LA	Town of Arnaudville	2006/07/17 - 2010/09/16	1200	335	363,096,450		iron removal: FM-284-AS with Macrolite media; KMnO4 addition	Kinetico	770	The system did not work well overall: several system stops, filter fouling due to unintentional aeration, erratic iron addition 2007/12 - 2009/07. Effluent with elevated As & Fe concentrations.	34.5	0.8	33.7	7	0.6	1.8	41.7	<0.06	<0.04	<1.0	2072	129	<0.1	NA	0.7	1.9		NA	0.5	unintentional aeration in contact tank: extensive biofouling leading to backwashing >8x/d; backwashing up to 16x/d after iron addition	wastewater: 5.5% of water production, discharged to building sump, emptied by gravity to a pond
Delavan, WI	Vintage on the Ponds	2005/07/12 - 2006/06/03	52	20*	2,500,200	nursing home facility. *maximal flowrate. An average flow is not given because accurate flowrate data were not attainable	iron removal: PM2162D6 Pressure Filtration System with Macrolite media; prior NaOCl addition; water softening system downstream	Kinetico	45	On-demand system operation made it difficult to adjust chlorine dosing rates -> erratic chlorine residuals. As(III) and Fe(II) were only partially or not oxidized when the chlorine injection system did not work properly and/or due to the presence of chloramines formed by chlorination due to elevated ammonia levels. Additional contact time in the pressure filters enhanced As & Fe oxidation.	20.5	1.4	19.1	7.5	1.2	1.8	14.3	<0.06	<0.04	<1	1400	18.3	<0.1	NA	0.1	2.8		NA	4	102 backwash cycles during study period	Backwash wastewater discharged to sanitary sewer line.
Fountain City, IN	Northeastern Elementary School	2008/09/22 - 2009/10/29	600	48	941,500	school	iron removal: G2 media; prior NaOCl injection	US Water Systems	60		18.1	5.5	12.6	7.5	2.9	1.6	13.9	<0.03	<0.05	2	855	53.1	NA	NA	<0.1	0.7		NA	50	8 backwash events during study period	Backwash wastewater discharged to the sewer. No G2 media replacement required during study period.
Sabin, MN	Sabin	2006/01/30 - 2007/04/29	500	231	14,884,800	175 service connections	iron removal: FM-248-AS, Macrolite media; pre-existing NaOCl injection system (pre- & post-chlorination)	Kinetico	250	Low rated of manganese removal and accumulation in the distrubution system. Increased chlorine dosages for prechlorination enhanced soluble Mn oxidation and removal, but reduced filter run length	28.3	15.9	12.4	7.3	5.9	1.8	29.7	<0.1	<0.04	410	990	305	5.3	<0.1	0.11	0.19		NA	2.3	1 - 4 backwashes / week	Backwash wastewater discharged to building sump, which emptied by gravity to sanitary sewer.
Sandusky, MI	City of Sandusky	2006/06/14 - 2007/06/22	2916	163	61,883,000	one well out of four was used in the study (main supply well)	iron removal: AERALATER Type II, prechlorination/oxidation (NaOCl)	Siemens Water Technologies	340	2.5mg/L chlorine dosage (as Cl2) was not able to achieve breakpoint chlorination due to ammonia presence. As(III) oxidation partially inhibited (by chloramines). Occasional particulate iron breakthrough.	22	9.7	12.3	7.1	0.5	1.5	13.9	<0.1	<0.01	89	1244	34.5	0.6	NA	1.1	0.3		NA	3	backwash frequency 3 times/week until February 2007, then 2 times/week	Backwash wastewater discharged to building sump, which emptied to sanitary sewer.
Sauk Centre, MN	Big Sauk Lake Mobile Home Park	2005/07/13 - 2006/10/01	37	4	2,017,000	mobile homes	iron removal: CP-213f, Macrolite media; KMnO4 addition	Kinetico	20	Particulate As & Fe breakthrough -> more frequent backwashing. Mn passed through the filter (high TOC inhibited formation of filterable Mn solids) -> increase KMnO4 dosage -> elevated Mn concentrations in treated water	20.7	7.1	13.6	7.1	1.48	3.9	25	<0.1	<0.04	<5.0	3149	154	<0.1	NA	<0.1	1.2		NA	0.4	backwash cycles were increased to as many as 11 per day throughout the study	Backwash wastewater and associated solids were discharged to a septic system, then to a sanitary sewer
Waynesville, IL	Village of Waynesville	2009/07/15 - 2010/09/19	450	84.4	12,603,800		iron removal: GreensandPlus media; NaMnO4 addition	Peerless	96	incomplete iron oxidation in 3 of 13 sampling events (147µg/l) and presence of "soluble" manganese (756µg/l on av.) in NaMnO4-treated water.	31.5	3.3	22.6	7.1	1.3	9	20.1	0.17	<0.05	<1	1456	19	NA	<0.1	0.2	3.6		NA	3		backwash and rinse wastewater, discharged to a sump emptying into two septic tanks in series, then to the sanitary sewer system. Sludge was disposed.

Location	Site name	study period	system size				removal system				source water quality																comment	performance			Generation and handling of residuals
			pop. served	av. flow [gpm]	vol. treated [gal.]	comment	type	vendor	design flow rate [gpm]	comment	As total soluble [µg/L]	As(V) [µg/L]	As(III) [µg/L]	pH (S.U.)	dissolved oxygen	TOC [mg/L]	SiO2 [mg/L]	P [mg/L]	Nitrate (as N) [mg/L]	Sulfate [mg/L]	Fe soluble [µg/L]	Mn soluble [µg/L]	U soluble [µg/L]	Sb soluble [µg/L]	V soluble [µg/L]	Ammonia		run length [gal] / [BV]	backwash (regeneration) frequency [d]	comment	
Climax, MN	Climax	2004/08/11 - 2005/08/12	264	122 / 142	13,829,000	average flow rate varied depending on which of the two wells was operational	iron removal with iron addition: FM-236-AS, Macrolite media; NaOCl addition. FeCl3 addition starting in January 2005	Kinetico	140	As levels in treated water 14.1µg/L -> supplemental iron addition from January 2005 on -> As levels below MCL	34.6	<0.1	34.8	7.4	NA	<1.0	27.3	<0.10	NA	120	540	130	NA	<0.1	0.4	0.7		NA	1.9	backwash settings were slightly modified after 5 months leading to water savings. Media was not replaced.	Backwash wastewater was discharged to an underground sump and pumped to a sanitary sewer line for disposal
Conneaut Lake, PA	Conneaut Lake Park	2009/12/03 - 2010/12/17	250	153	20,114,000	Seasonal resort	iron removal with iron addition: AD-GS+ (Greensand Plus) media; NaOCl injection and FeCl3 addition before filtration	AdEdge Technologies	250	Due to high pressure by the pump, the anticipated flowrate was reduced to 190gpm. Good As removal, but Fe leaking (64µg/L in average effluent)	28	2.2	25.8	8	3.1	<1.0	12.7	<0.03	<0.05	21	151	66.3	NA	<0.1	0.2	0.14		83,000 / NA	1.08	Run length per vessel. Backwash frequency of the filter 26hrs; less frequent washing due to daily system run time <12hrs (backwash every 2-3d)	Backwash wastewater discharged into holding tanks. Supernatant was recycled to the header of the filtration skid after >4hrs settling, the sludge was discharged to a sewer.
Pentwater, MI	Village of Pentwater	2005/11/22 - 2006/12/08	1000	350	39,185,000	population increasing during the summer months; one out of 3 wells used in the study (primary well)	iron removal with iron addition: FM-260-AS, Macrolite media; pre-existing NaOCl addition; FeCl3 addition after June 2006.	Kinetico	400	incomplete As(III) oxidation (due to chloramines). Consistent As removal to <10g µg/l only achieved with supplemental iron addition.	13.2	2.1	11.1	6.9	1.3	2.5	11.1	<0.1	<0.04	1	465	32.6	<0.1	NA	1	0.3		NA	2.3	backwash 3 times a week.	Backwash wastewater discharged to building sump, which emptied by gravity to sanitary sewer.
Goshen, IN	Clinton Christian School	2008/06/06 - 2009/06/19	142	16.2	517,174	school	iron removal & adsorptive media: AD26 (oxidation / filtration) & E33 (adsorption); prior NaOCl injection	AdEdge Technologies	25	The majority of (particulate) As was filtered out by AD26 media. Operational issue: maintaining target level of free chlorine residuals difficult	26.3	11.6	14.7	7.4	NA	<1.0	18.1	<0.03	<0.05	2	758	97.4	NA	NA	<0.1	0.2		NA / 123,763 (AD26); NA / 81,055 (E33)	3 (AD26) / 39 - 44 (AD33)	run lengths projected based on throughput	Backwash wastewater discharged to Rock Run Creek, spent bag filters went into municipal trash. E33 media would be disposed at a sanitagy landfill (no replacement required during study perdiod)
Springfield, OH	Chateau Estates Mobile Home Park	2005/09/21 - 2006/09/24	600	37	16,873,000	226 connections for a population of 600. average flows: AD-33: 37gpm; AD-26: 90 - 130gpm (two alternating wells)	iron removal & adsorptive media: AD26 (oxidation / filtration; Fe & Mn removal) & AD33 (adsorption); preexisting NaOCl & polyphosphate addition (prior to AD26)	AdEdge Technologies	250	Operational issue: chlorine injection system failed to control chlorine residuals (4mg/L instead of 1mg/L). An inline filter placed before the chlorine monitor seemed to resolve the problem.	16.6	1.4	15.4	7.3	2.1	<1.0	18.5	<0.10	<0.04	21	1010	37.4	1.2	0.3	0.24	0.21		NA	NA / 2.5	AD-33 system: 4 backwash cycles during study period (not required, as the pressure loss was insignificant). AD-26 system: backwashed every 2 to 3 days. Media was not replaced.	Backwash wastewater was discharged to the sewer.
Stewart, MN	Stewart	2006/02/02 - 2007/02/28	600	188; 166	20,441,000	av. flow AERALATER: 188pm, APU-300: 176gpm	iron removal & adsorptive media: Type II AERALATER for iron removal pretreatment; APU-300 system with AD33 adsorptive media; post-chlorination (NaMnO4), fluoridation and polyphosphate addition	Siemens & AdEdge Technologies	250	First week of operation: NaMnO4 addition to oxidize As(III) to As(V). NaMnO4 addition (inadvertently) discontinued due to elevated manganese leves and microbial-mediated As(III) oxidation (As removal efficiency of gravity filter reduced from 60% to 34%). Short AD-33 media run lengths due to competition from elevated P and biofouling in adsorption vessels	32.9	1	31.9	7.7	2.2	7.2	26.6	<0.1	<0.04	<5	1359	28	<0.1	NA	<0.1	1.7	Source Water data from Well No. 3 (one of the two wells)	NA / 25,300	90	AERALATER backwash: once a week; APU-300 backwash 4 times a year	Wastewater discharged to building sump, which emptied by gravity to two holding tanks before being pumped to the sanitary sewer
Willard, UT	Hot Springs Mobile Home Park (HSMHP)	2008/12/11 - 2010/10/18	117	7.3	5,629,000	110 to 125 residents	iron removal & adsorptive media: Adsorbia GTO; Birm/Filox oxidizing media.	Filter Tech	30		13.6	7.6	6	7.5	2.3	<1	13.3	NA	0.2	6	129	165	NA	<0.1	4.3	0.05		NA	NA / 1	pre-oxidation vessel backwashed daily. Adsorbia GTO adsorptive media did not require backwash	Backwash wastewater discharged to a septic tank
Alvin, TX	Oak Manor Municipal Utility District	2006/04/25 - 2008/04/08	189	129	35,358,250		adsorptive media: APU-30S system, Sorb 33 media; pre-existing chlorination system	Severn Trent Services (STS)	150		19	1.4	17.6	7.8	1.7	0.7	16	<0.05	<0.05	1	37	61.7	1.5	NA	1.9	0.2		26,638,090 / 28,736	30	Run length of the lag vessel (lead vessel: 9,527,220 gal / 10,227 BV). Progressively less effective backwash observed after 1 year.	Backwash wastewater was discharged into a small ditch and subsequently drained into a roadside ditch.
Anthony, NM	Desert Sands Mutual Domestic Water Consumers Association	2004/01/16 - 2005/07/14	1886	271	52,645,000		adsorptive media: SORB 33-S (granular form); APU-300 system. pre-chlorination	Severn Trent Services (STS)	320	45% media loss (disintegration of the granular media during the run). Throughput between backwash events decreased from 3680 BV to 630 BV for each of the two vessels	22.3	0.7	21.6	7.7	NA	1.6	35.1	0.1	NA	190	<30	9	NA	<0.1	0.5	NA		NA / 40,600	7		
Anthony, NM	Desert Sands Mutual Domestic Water Consumers Association	2005/07/29 - 2006/08/16	1886	251	46,553,000		adsorptive media: SORB 33-p (pelletized form); APU-300 system. pre-chlorination (NaOCl)	Severn Trent Services (STS)	320	12% media loss	22.3	0.7	21.6	7.7	NA	1.6	35.1	0.1	NA	190	<30	9	NA	<0.1	0.5	NA		NA / 49,500	7		Backwash wastewater discharged to an evaporation pond, spent media could be disposed of in a sanitary landfill.
Bow, NH	White Rock Water Company (WRWC)	2004/10/13 - 2006/09/26	96	40	13,115,925	96 homes served. Study period divided into 3 runs with similar outcomes	adsorptive media: G2; pre-existing NaOCl and NaOH addition; pH lowered by H2SO4 before treatment, raised with NaOH afterwards	ADI International Inc.	40	G2 media not effective in removing As < 10µg/L. As, Mn, and silica can be leached from the media. Changing pH conditions can cause changes in lead & copper concentrations in the distribution system.	44.1	43.6	0.5	6.8	NA	<0.7	19.7	<0.10	NA	12	<25	1.5	NA	0.7	0.6	NA		NA / 3000	NA	No backwash required (system backwashed only 3 times during the demonstration study)	Spent media was disposed of in a non-hazardous waste landfill. Backwash wastewater was discharged to a rip-rap lined surface drainage and allowed to infiltrate into the ground.

Location	Site name	study period	system size				removal system				source water quality																comment	performance			Generation and handling of residuals
			pop. served	av. flow [gpm]	vol. treated [gal.]	comment	type	vendor	design flow rate [gpm]	comment	As total soluble [µg/L]	As(V) [µg/L]	As(III) [µg/L]	pH (S.U.)	dissolved oxygen	TOC [mg/L]	SiO2 [mg/L]	P [mg/L]	Nitrate (as N) [mg/L]	Sulfate [mg/L]	Fe soluble [µg/L]	Mn soluble [µg/L]	U soluble [µg/L]	Sb soluble [µg/L]	V soluble [µg/L]	Ammonia		run length [gal] / [BV]	backwash (regeneration) frequency [d]	comment	
Brown City, MI	Brown City	2004/05/11 - 2007/05/02	1334	564	154,000,000	1334 community members (664 service connections)	adsorptive media: SORB 33 (granular form); APU-300 system. pre-existing post-chlorination, pre-chlorination (NaOCl) implemented in May 2005	Severn Trent Services (STS)	640	Throughput between consecutive backwash events decreased with prechlorination (3000BV to 150BV). Prechlorination: As removal improved significantly	12	2.5	9.6	7.3	NA	<0.50	8.1	<0.10	NA	74	133	15.7	NA	<0.1	<0.1	NA		NA / 20,800	10	run length without pre-chlorination (total As-breakthrough). As-conc. remained <10µg/l after the implementation of pre-chlorination. Backwash frequency was lower without pre-chlorination (every 41 days). Media was not replaced.	Backwash wastewater discharged to a drainage ditch.
Bruni, TX	Webb Consolidated Independent School District	2005/12/08 - 2008/05/15	230	40.2	8,841,000	school	adsorptive media: AD-33; pre-existing NaOCl addition system & pH adjustment / control system (CO2) upstream	AdEdge Technologies	40	Operational issues with pH adjustment system and adsorption vessel flow meters/totalizers	55.2	19.6	35.6	8	1.5	0.9	42.3	<0.06	<0.04	98	<25	4.3	10.2	NA	4.4	<0.05		NA	NA	no As breakthrough during the study	No backwash required during the study period
Buckeye Lake, OH	LEADS Head Start Building	2006/06/28 - 2010/02/24	60	<2	303,200	school	adsorptive media: ARM 200; prior NaOCl injection	Kinetico	10	Elevated total trihalomethanes and aloacetic acids in effluent after system startup. Probable causes: chlorine and elevated TOC in AM influent.	14.5	2.4	12.1	7.6	NA	2	NA	NA	<0.1	24	1241	80.3	NA	NA	NA	0.9		NA	180	only one backwash in study period (after 6 months)	Backwash wastewater discharged to the sewer. No media replacement required during study period.
Dummerston, VT	Charette Mobile Home Park	2005/06/24 - 2006/10/10	14	6.1	745,000	mobile homes	adsorptive media: A/I Complex 2000; preexisting NaOCl addition	Aquatic Treatment Systems (ATS)	22	aluminium leached from the adsorptive media (decreasing trend). As breakthrough occured sooner than expected presumably due to high pH, competing anions (silica), and higher-than-expected As concentrations	30.1	28.6	1.5	7.9	6.1	<0.7	12.3	<0.06	0.24	20	<25	4.2	2	NA	0.6	<0.05		NA / 16750	NA	run length per train following the final columns (5600 BV if considering the three columns in each train as one large column). No backwash required for system operation.	Only spent media as residual (not specified how it was discharged)
Geneseo HIlls, IL	Geneseo Hills Subdivision	2008/05/08 - 2010/07/30	480	32	33,158,263		adsorptive media: AD-33; pre-existing chlorine addition system upstream	AdEdge Technologies	200	av. flow = on-demand flowrates; peak-flowrate: 156gpm. Average residence time: 11hr -> 8.2lb solids (incl. arsenic laden iron particles) settled in the hydropneumatic tanks in 3915gal ww	19.6	2.1	17.5	7.1	1.5	1.8	20.3	0.1	<0.05	<1.0	227	8.3	NA	<0.1	<0.1	1.2		NA	45	operational issue: bag filter assembly upstream of the backwash holding tank -> clogging during backwashing	Wastewater discharged to a backwash holding tank (much solids, mainly iron). Supernatant recycled upstream of the chlorine addition point; sludge accumulated & transferred to sludge holding tank
Goffstown, NH	Orchard Highlands Subdivision	2005/04/15 - 2006/08/06	42	13	2,085,000	homes	adsorptive media: AD-33; pre-existing aeration for radon removal	AdEdge Technologies	10	Unexpectedly short run length for As probably due to shorter EBCT and competing anions (phosphorus).	33.1	32.3	0.8	6.9	5.1	<0.7	25.7	0.2	<0.04	5.8	5.8	2.8	2.4	NA	0.4	0.05		NA / 25,710	NA	Run length of the lag vessel (lead vessel: 19,500 BV). No backwash required (system backwasehd twice in total)	Spent media disposed of at a sanitary landfill, backwash wastewater was discharged to an on-site surface drainage field
Goffstown, NH	Orchard Highlands Subdivision	2006/09/06 - 2007/08/06	42	13	1,374,000	homes	adsorptive media: AD-33; pre-existing aeration for radon removal	AdEdge Technologies	10	Lead vessel rebedded and switched to lag position. short run length: see reasons for Run1 + the lead vessel containing partially used media.	33.1	32.3	0.8	6.9	5.1	<0.7	25.7	0.2	<0.04	5.8	5.8	2.8	2.4	NA	0.4	0.05		1,374,000 / 18,370	NA	No backwash required (system backwashed twice in total)	Spent media disposed of at a sanitary landfill, backwash wastewater was discharged to an on-site surface drainage field
Stevensville, Queen Anne's County, MD	Grasonville, Queen Anne's County, Prospect Bay	2004/06/30 - 2007/04/02	300	207	71,533,000	300 connections; only one of two wells (operation alternating daily) chosen for the study	adsorptive media: SORB 33; APU-300 system. pre-chlorination (implemented in November 2004)	Severn Trent Services (STS)	300	First months: post-chlorination. Prechlorination: As removal improved significantly	18.7	0.3	18.4	7.3	NA	NA	14.1	<0.1	NA	4.3	254	1.4	NA	<0.1	<0.1	NA		NA / 7400	20	run length with post-chlorination (As(III)-breakthrough). As-conc. remained <10µg/l after the implementation of pre-chlorination. Media was not replaced.	Backwash wastewater discharged to a tanker truck and transported to a WWTP for disposal.
Lead, SD	Terry Trojan Water District	2008/04/04 - 2009/11/29	187	71.5	27,978,780	community water system incl. 10 commercial service connections	adsorptive media: ArsenXnp; post-chlorination with pre-existing system	SolmeteX	75		23	22.5	0.5	7.3	NA	<1	15	<0.01	0.5	2	<25	0.8	NA	0.3	0.7	<0.05		14,725,250 / 70,310	NA	no backwash needed for the media	spent media given back to the vendor
Lead, SD	Terry Trojan Water District	2009/11/30 - 2010/05/23	187	69.2	7,231,940		adsorptive media: ArsenXnp & LayneRT; post-chlorination with pre-existing system	SolmeteX	75	System rebedded with LayneRT medium in lag position; lead vessel containing partially exhausted ArsenXnp	23	22.5	0.5	7.3	NA	<1	15	<0.01	0.5	2	<25	0.8	NA	0.3	0.7	<0.05		NA	NA	no backwash needed for the media	
Nambe Pueblo, NM	Nambe Pueblo	2007/05/15 - 2009/09/28	500	114	64,580,000	150 service connections	adsorptive media: AD-33; pre-existing chlorine addition system & pH adjustment / control system (CO2) upstream	AdEdge Technologies	160	3 - 4 incidences of elevated As & U levels (higher than source concentrations) due to losses of pH control (adsorbed As & U "flushed" out of the media beds)	31.4	31.2	0.2	8.5	NA	2.1	14.1	<0.10	0.6	28	<30	1.3	32.9	<0.1	8.6	NA		NA	NA		Neither backwash nor media replacement was required during the study period
Pomfret, CT	Seely-Brown Village	2009/02/04 - 2009/12/02	48	9.8	581,200	nursing home facility	adsorptive media: ArsenXnp	SolmeteX (acquired by Layne Christensen Company)	15	instead of replacing spent ArsenXnp media, the vendor recommended replacing it by a new medium, LayneRT	25.2	23.2	2	7.3	2.3	<1.0	13.4	0.49	0.06	18.5	<25	7.2	NA	<0.1	0.4	<0.05		NA / 15,000	NA	No backwash required during the performance evaluation study	Spent filters disposed of with landfill trash, spent media regenerated with other spent media and used in non-drinking water applications.
Pomfret, CT	Seely-Brown Village	2009/12/03 - 2010/09/24	48	10	606,600	nursing home facility	adsorptive media: LayneRT	SolmeteX (acquired by Layne Christensen Company)	15		25.2	23.2	2	7.3	2.3	<1.0	13.4	0.49	0.06	18.5	<25	7.2	NA	<0.1	0.4	<0.05		NA / 18,000	NA	No backwash required during the performance evaluation study	Spent filters disposed of with landfill trash, spent media regenerated with other spent media and used in non-drinking water applications.

Location	Site name	study period	system size				removal system				source water quality																comment	performance			Generation and handling of residuals
			pop. served	av. flow [gpm]	vol. treated [gal.]	comment	type	vendor	design flow rate [gpm]	comment	As total soluble [µg/L]	As(V) [µg/L]	As(III) [µg/L]	pH (S.U.)	dissolved oxygen	TOC [mg/L]	SiO2 [mg/L]	P [mg/L]	Nitrate (as N) [mg/L]	Sulfate [mg/L]	Fe soluble [µg/L]	Mn soluble [µg/L]	U soluble [µg/L]	Sb soluble [µg/L]	V soluble [µg/L]	Ammonia		run length [gal] / [BV]	backwash (regeneration) frequency [d]	comment	
Rimrock, AZ	Arizona Water Company	2004/06/24 - 2006/08/30; 2006/11/27 - 2007/03/28	2556	30	22,143,000	only one well out of six was used for the study (main supply well: 315gpm)	adsorptive media: AD-33; APU-100 system; prior NaOCl addition	AdEdge Technologies	45	Media changeout in November 2006 after reaching 10µg/l As breakthrough in August 2006. Water in the distribution system had higher As levels (19.3µg/l) due to blending with untreated water from other wells.	64.8	64.8	<0.10	7.1	NA	3.4	24.8	<0.10	NA	9.5	<25	8.1	NA	NA	NA	NA		17,164,000 / 52,150	60	run length: As breakthrough before media rebedding. Backwash frequency: 30 days in first year, prolonged to quarterly later	Backwash wastewater recycled by blending the recycle tank supernatant with influent water and removing solids by a bag filter. Spent media could be disposed of at a sanitary landfill (non-hazardous)
Rollinsford, NH	Rollinsford	2004/02/09 - 2004/10/27	450	95	11,926,000	average flow with both wells operating. One well operating: 60gpm	adsorptive media: AD-33; APU-100 system; pre-existing chlorine addition system & pH adjustment system (CO2) upstream	AdEdge Technologies	100	higher than normal system Δp and inlet pressure -> frequent backwashes -> high media loss. pH control system: mechanical problems -> consistent reduction of pH to target value 7.0 failed	33.9	13.9	20.1	7.4	NA	<1.0	13.6	<0.10	NA	36	<30	68.6	NA	<0.1	<0.1	NA		NA / 12,500 - 17,000	8	Backwash frequency = average number of operating days between backwashes. Media replaced by end of this phase (39 - 53% media loss)	backwash wastewater discharged to on-site subsurface infiltration area; spent media disposed of at a sanitary landfill
Rollinsford, NH	Rollinsford	2004/11/03 - 2005/01/15	450	112	3,921,000	average flow with both wells operating.	adsorptive media: AD-33; APU-100 system; pre-existing chlorine addition system & pH adjustment system (CO2) upstream	AdEdge Technologies	100	higher than normal system Δp and inlet pressure -> frequent backwashes -> high media loss. pH control system: mechanical problems -> consistent reduction of pH to target value 7.0 failed	33.9	13.9	20.1	7.4	NA	<1.0	13.6	<0.10	NA	36	<30	68.6	NA	<0.1	<0.1	NA		NA / 12,500 - 17,000	4	Backwash frequency = average number of operating days between backwashes.	backwash wastewater discharged to on-site subsurface infiltration area; spent media disposed of at a sanitary landfill
Rollinsford, NH	Rollinsford	2005/06/13 - 2006/05/08	450	97	12,881,000	average flow with both wells operating. One well operating: 58gpm	adsorptive media: AD-33; APU-RWS system; pre-existing chlorine addition system	AdEdge Technologies	120	valve tree instead of controller valves solved the elevated Δp and inlet pressure problem. pH control system: mechanical problems -> consistent reduction of pH to target value 7.0 failed	33.9	13.9	20.1	7.4	NA	<1.0	13.6	<0.10	NA	36	<30	68.6	NA	<0.1	<0.1	NA		NA / 12,500 - 17,000	36	Backwash frequency = average number of operating days between backwashes.	backwash wastewater discharged to on-site subsurface infiltration area; spent media disposed of at a sanitary landfill
Susanville, CA	Richmond Elementary School	2005/09/07 - 2007/06/13	250	9.3	303,000	school	adsorptive media: A/I Complex 2000; A/P Complex 2002 oxidative media	Aquatic Treatment Systems (ATS)	12	Iodine (IO4-) and aluminium leached from the oxidizing and adsorptive media (iodine: decreasing trend; Al leaching continously, but below secondary drinking water standard)	36.6	4.7	31.9	7.5	1	1	14.5	<0.06	0.1	17	<25	5.5	0.8	NA	0.2	<0.05		NA / 5200	NA	Run length considering the three adsorptive columns as one large column. No backwash required during the study period. Adsorptive media was replaced after 18 months of system operations	Spent media could have been disposed of in a sanitary landfil (non-hazardous), but was recycled by the vendor
Taos, NM	Town of Taos	2006/02/14 - 2007/10/23	5000	503	22,977,000	5000 residences plus summer tourists. the treated supply well contributed only 10% to the 1,000,000 gal water tower capacity	adsorptive media: SORB 33; CO2 pH control system, post-chlorination	Severn Trent Services (STS)	450	Frequent and prolonged system downtime caused by non-system related issues (power outages).	13.9	11.8	2.1	9.5	0.7	<0.7	30.4	<0.06	<0.04	41	<25	0.3	0.4	NA	34.2	<0.05		NA	NA	Neither media replacement no backwash required during the study (system backwashed five times for the study purpose)	Backwash wastewater discharged to an evaporative pond.
Tohono O'odham Nation, AZ	Covered Wells	2008/02/13 - 2010/03/19	310	60	11,686,000		adsorptive media: AD-33; pre-existing chlorine addition system & pH adjustment / control system upstream	AdEdge Technologies	63	Operational issues with CO2 pH adjustment / control system	32.5	31.4	1.1	8.2	4.3	0.8	26.4	<0.06	1.2	23	<25	0.4	7.9	NA	32.7	<0.05		NA	NA	No backwash nor media replacement required during study period	
Valley Vista, AZ	Arizona Water Company, Sedona	2004/06/24 - 2004/10/25	1520	36	2,058,000	Run 1. One out of four wells was used in the study	adsorptive media: FA-236-AS, AAFS50 media; pre-existing NaOCl addition	Kinetico	37	Effluent As concentrations varied with influent pH values. Relatively short run length. pH adjustment increased AAFS50's adsorptive capacity, tripling the media run length (Run 2). Intermittent system operation influenced media run length positively (Run 3). Distribution system: As concentrations partially higher than those of the treatment effluent (8 - 27 µg/L) due to blending with untreated water.	38.1	37.8	0.3	7.7	NA	NA	18.5	<0.1	NA	8.7	<30	<0.1	NA	<0.1	15.7	NA		NA / 8240	20	6 backwash cycles during study period	Spent media was disposed of in a non-hazardous waste landfill. Backwash wastewater was recycled.
Valley Vista, AZ	Arizona Water Company, Sedona	2004/10/25 - 2005/10/12	1520	36	7,580,000	Run 2 & 2a. One out of four wells was used in the study	adsorptive media: FA-236-AS, AAFS50 media; pre-existing NaOCl addition; pH adjustment (H2SO4)	Kinetico	37		38.1	37.8	0.3	7.7	NA	NA	18.5	<0.1	NA	8.7	<30	<0.1	NA	<0.1	15.7	NA		NA / 23,030	35	10 backwash cycles during study period	Spent media was disposed of in a non-hazardous waste landfill. Backwash wastewater was recycled.
Valley Vista, AZ	Arizona Water Company, Sedona	2005/10/12 - 2006/03/07	1520	36	3,411,000	Run 3. One out of four wells was used in the study	adsorptive media: FA-236-AS, AAFS50 media; pre-existing NaOCl addition. intermittent run-time (16hr/d instead of 24hr/d), longer EBCT than Run 1	Kinetico	37		38.1	37.8	0.3	7.7	NA	NA	18.5	<0.1	NA	8.7	<30	<0.1	NA	<0.1	15.7	NA		NA / 10,360	37	4 backwash cycles during study period	Spent media was disposed of in a non-hazardous waste landfill. Backwash wastewater was recycled.
Valley Vista, AZ	Arizona Water Company, Sedona	2006/03/07 - 2006/09/18	1520	37	8,464,000	Run 4. One out of four wells was used in the study	adsorptive media: FA-236-AS, ARM200 media; pre-existing NaOCl addition	Kinetico	37	ARM200 media without pH adjustment: run length comparable to AAFS50 media with pH adjustment	38.1	37.8	0.3	7.7	NA	NA	18.5	<0.1	NA	8.7	<30	<0.1	NA	<0.1	15.7	NA		NA / 25,720	23	8 backwash cycles during study period	Spent media was disposed of in a non-hazardous waste landfill. Backwash wastewater was recycled.
Wales, ME	Spring Brook Mobile Home Park	2005/03/07 - 2006/02/17	14	11.2	927,916	14 mobile homes served	adsorptive media: A/I Complex 2000; A/P Complex 2002 oxidative media	Aquatic Treatment Systems (ATS)	14	As levels > MCL after 3 months until media change after another 3 months. A/P Complex 2002 oxidative media showed a significant adsorptive capacity for As	38	4.6	33.4	8.6	NA	<0.7	10.7	<0.06	<0.04	18	<25	9.6	0.9	0.4	0.1	<0.05		171,000 / 5100	NA	run length per train (system = 2 trains); considering the three adsorption columns as one large column. The media were replaced after 5 to 6 months.	Spent media could have been disposed of in a sanitary landfil (non-hazardous), but was recycled by the vendor

Location	Site name	study period	system size				removal system				source water quality																	comment	performance			Generation and handling of residuals
			pop. served	av. flow [gpm]	vol. treated [gal.]	comment	type	vendor	design flow rate [gpm]	comment	As total soluble [µg/L]	As(V) [µg/L]	As(III) [µg/L]	pH (S.U.)	dissolved oxygen	TOC [mg/L]	SiO2 [mg/L]	P [mg/L]	Nitrate (as N) [mg/L]	Sulfate [mg/L]	Fe soluble [µg/L]	Mn soluble [µg/L]	U soluble [µg/L]	Sb soluble [µg/L]	V soluble [µg/L]	Ammonia		run length [gal] / [BV]	backwash (regeneration) frequency [d]	comment	
Wales, ME	Spring Brook Mobile Home Park	2006/09/08 - 2007/08/29	14	5.6	390,980	14 mobile homes served	adsorptive media: Siemens GFH; Filox-R oxidative media	Aquatic Treatment Systems (ATS)	7	Only 1 of 2 trains filled with GFH media. Filox-R media had no adsorptive capacity for As, but GFH shows 5 times the adsorptive capacity of A/I Complex 2000.	38	4.6	33.4	8.6	NA	<0.7	10.7	<0.06	<0.04	18	<25	9.6	0.9	0.4	0.1	<0.05		391,000 / 11,600	NA	Considering the three adsorption columns as one large column.	
Wales, ME	Spring Brook Mobile Home Park	2006/09/08 - 2007/08/29	14	7.6	516,074	14 mobile homes served	adsorptive media: Kimera CFH-12; Filox-R oxidative media	Aquatic Treatment Systems (ATS)	7	Only 1 of 2 trains filled with CFH-12 media. Filox-R media had no adsorptive capacity for As, but CFH-12 shows 4 times the adsorptive capacity of A/I Complex 2000.	38	4.6	33.4	8.6	NA	<0.7	10.7	<0.06	<0.04	18	<25	9.6	0.9	0.4	0.1	<0.05		516,000 / 15,300	NA	Considering the three adsorption columns as one large column.	
Reno, NV	South Truckee Meadows General Improvement District (STMGID) at Washoe County	2005/09/27 - 2006/05/03	8300	275	15,567,000	one out of five supply wells used for the study; treated water blended with water from other wells	adsorptive media: GFH; pre-existing prechlorination system	Siemens	350	Antimony breakthrough at 6µg/L at 3000 BV. Unexpectedly short run length for As probably due to competing anions (silica, phosphorus). Operational difficulties concerning backwash (involving SCADA & PLC).	89.4	89.1	0.3	7.4	NA	<1	68.6	<0.10	NA	8	<30	<0.1	NA	15.8	3	NA		NA / 7200	NA	Backwash was not required by the system, but has been done a few times for test purpose.	Spent media disposed of at a sanitary landfill, backwash wastewater directly discharged to the sewer.
Reno, NV	South Truckee Meadows General Improvement District (STMGID) at Washoe County	2007/04/05 - 2007/07/03	8300	276	18,848,000	one out of five supply wells used for the study; treated water blended with water from other wells	adsorptive media: GFH (one vessel), CFH-0818 (two vessels); pre-existing prechlorination system	Siemens & Kemira Water Solutions	350	Antimony breakthrough at 6µg/L at 1225 BV. Unexpectedly short run length for As probably due to competing anions (silica, phosphorus). Operational difficulties concerning backwash (involving SCADA & PLC).	89.4	89.1	0.3	7.4	NA	<1	68.6	<0.10	NA	8	<30	<0.1	NA	15.8	3	NA		NA / 3700	NA	Backwash was not required by the system, but has been done a few times for test purpose.	Spent media disposed of at a sanitary landfill, backwash wastewater directly discharged to the sewer.
Wellman, TX	City of Wellman	2006/08/10 - 2008/04/17	225	91	14,744,962	95 service connections	adsorptive media: AD-33; pre-existing NaOCl addition system	AdEdge Technologies	100	Av. flow: flow metes/totalizers recorded different results (118gpm on average with electromagnetic flow meter) -> master totalizer values used	50.2	38.4	2.8	8.2	6.6	5.2	45.5	<0.06	0.6	240	<25	0.4	10.1	<0.1	151	<0.05	Source water quality only from Well 1 (of 5). Only the nitrate level is higher (5.4) for the five wells combined & chlorinated	NA	NA	no As breakthrough during the study	Neither backwash nor media replacement was required during the study period
Woodstock, CT	Woodstock Middle School	2009/03/10 - 2010/09/30	510	16.4	544,600	school	adsorptive media: Adsorbia GTO	Dow Chemical Company	20		20.9	18	3	7.7	0.6	<1.0	14.3	<0.02	<0.05	19.5	<25	17.1	NA	<0.1	0.2	<0.05		395,000 / 7600	7 - 77	Random backwash frequency (backwash timer not functioning correctly).	Backwash wastewater discharged to the sewer. No AM nor bag filter replacement required during study period.

Table S2. Examples of websites (listed alphabetically) hosted by non-governmental organizations that provide aggregated information on technologies for drinking water treatment

name	type	Comments	URL
aquaeXpert	Information platform hosted by the Swiss Gas and Water Industry Association	Competence center for questions on drinking water quality (French, German and Italian)	http://aquaexpert.svgw.ch/
Blue Tech Research	Subsidiary of the consultancy O_2 Environmental	Global provider of water technology market intelligence	http://www.bluetechresearch.com/
Environmental XPRT	Subsidiary of the consultancy XPRT Media	Global marketplace, industry marketplace and information resource	http://www.environmental-expert.com/
Leaders Innovation Forum for Technology	Platform hosted by the Water Environment Research Foundation (WERF) and Water Environment Federation (WEF)	Intended to help bring new water technology to the field quickly and efficiently	http://www.werf.org/lift
The Water Network	Moderated peer-to-peer platform	Online knowledge sharing platform and business exchange for global water professionals	https://thewaternetwork.com/
Water Online	Online newsletter	Source of technical information and thought leadership for the drinking water and wastewater treatment communities	http://www.wateronline.com/
Water Research Foundation	Membership organization	Hosts knowledge Portals (extensive, topic-specific resource areas that provide access to synthesized information and other key resources on top industry issues) available to subscribers	http://www.waterrf.org/
Watershare®	Membership organization	Selected partner knowledge institutes from all over the world share in the use of expert water-related tools	https://www.watershare.eu/
WaterWorld	Online newsletter	Provides daily international business and industry-related news, current issue articles, and access to years of searchable editorial archives	http://www.waterworld.com/