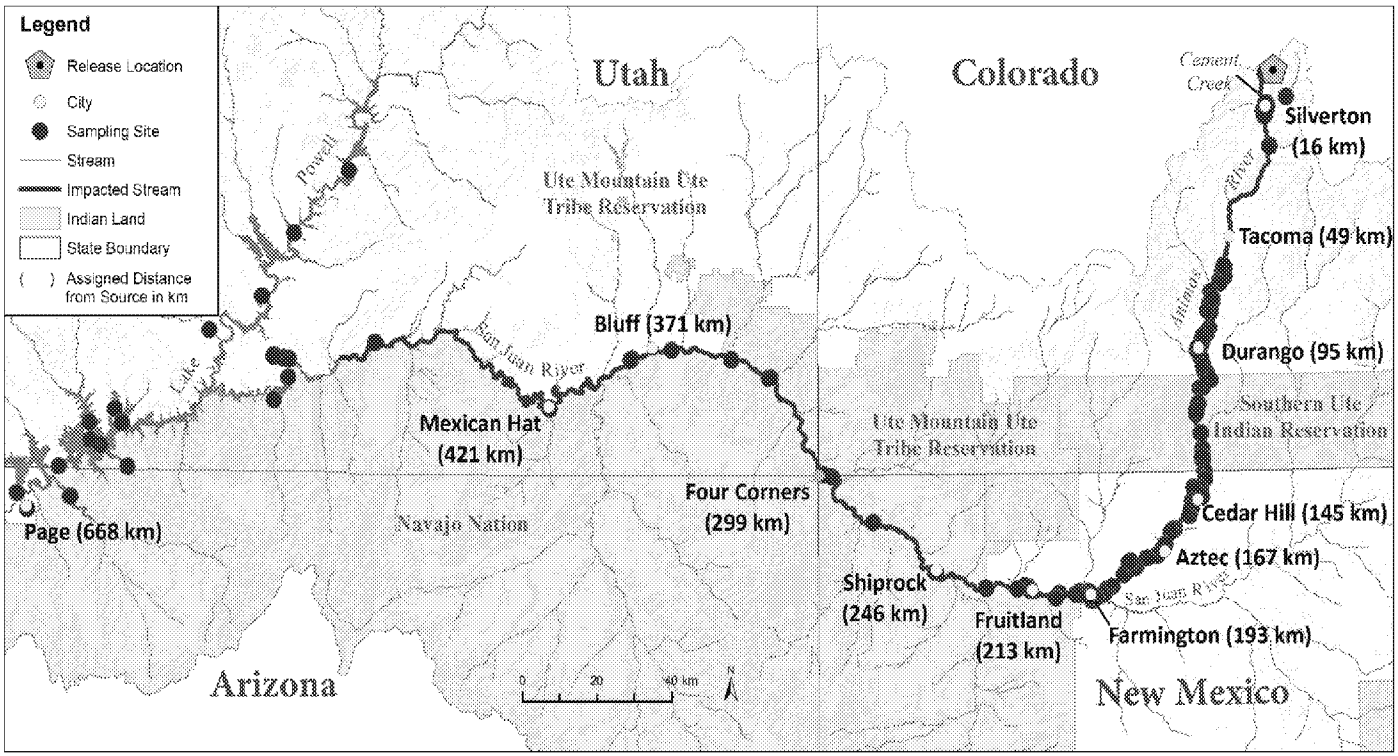
Gold King Monitoring Briefing

October 21 2016

OW/Region Review Monitoring

Overview

- **About the data**
- **Patterns at sites**
- **What's been happening post event**
- **Getting to "background" or "pre-event"**
- **Correlation analysis was sensitive indicator of Gold King**
- **Comparison to water quality criteria**
- **Snowmelt season June 2016**



OW/Region Review Monitoring

Detailed site list

294 individual sites

Agency	SiteID	Description	Distance from source (km)	Site Type	Location	Latitude	Longitude	Media
CO(CDPHE)	CO_GKM_0	Effluent - Mine Adit (Gold King Mine Adit)	0.00	Mine Effluent	Source	37.89455	-107.63827	SW, SED
EPA	CC06		0.00	Source	Source	37.894583	-107.638358	SW
NNEPA	NNEPA-32GOLDKING0	Gold King Mine adit	0.00	Source	Source	37.8946387	-107.6384095	SW
CO(CDPHE)	CO_GKM_1	Gold King Mine Effluent	0.79	Main	North Fork Cement Creek	37.895200	-107.6468	SW
CO(CDPHE)	CO_GKM_2	Influent Prior to Treatment	0.80	Main	North Fork Cement Creek	37.895200	-107.647000	SW
CO(CDPHE)	9458	Cement Cr abv Gold King Mine	0.82	Reference	Cement Creek	37.89605	-107.64696	SW
CO(CDPHE)	CO_GKM_3	(Gold King Mine) Treatment Effluent	0.82	Reference	Cement Creek	37.89572	-107.64714	SW
CO(CDPHE)	CO_RI_R2	Cement Creek above Gold King	0.82	Reference	Cement Creek	37.8961917	-107.64682	SW
CO(CDPHE)	CO_RI_R3	Cement Creek Upstream of GKM Treatment	0.82	Reference	Cement Creek	37.89545	-107.6475	SW
USGS	375344107384801	CEMENT CR ABV N FORK CEMENT CR NR SILVERTON, CO	0.82	Reference	Cement Creek	37.8956556	-107.6469389	SW
CO(CDPHE)	CO_RI_M1	Cement Cr blw Gold King Mine	0.87	Main	Cement Creek	37.89468	-107.64737	SW
EPA	GKM13		0.87	Main	Cement Creek	37.8946916	-107.647253	SW
NNEPA	NNEPA-32EPAPOND40	USEPA Gold King Mine Pond 4 outlet	0.89	Pond (treatment	Cement Creek	37.8946506	-107.6474652	SW
CO(CDPHE)	CO_RI_M2	Cement Creek (below mine)	0.90	Main	Cement Creek	37.89456	-107.64774	SW
CO(CDPHE)	9456	Cement Creek below Gold King	0.97	Main	Cement Creek	37.8939683	-107.647855	SW
CO(CDPHE)	CO_RI_M4	Cement Creek Downstream of GKM Treatment	0.98	Main	Cement Creek	37.8938	-107.64762	SW
USGS	375333107385401	CEMENT CR ABV AMER TUNNEL BLW N FORK CEMENT CR	1.13	Main	Cement Creek	37.892575	-107.6483611	SW
USGS	375322107391101	CEMENT CR ABV S FORK CEMENT CR NR SILVERTON, CO	1.75	Main	Cement Creek	37.8897	-107.6532694	SW
CO(CDPHE)	9454	Cement Creek Ski Resort Before Entering Las Animas River	3.06	Main	Cement Creek	37.8848	-107.66526	SW
USGS	09358550	CEMENT CREEK AT SILVERTON, CO	12.41	Main	Cement Creek	37.819664	-107.663719	SW
EPA	CC48		12.54	Main	Cement Creek	37.819984	-107.663275	SW, SED
NNEPA	NNEPA-32CEMENTCR0	Cement Creek at Silverton Park	12.83	Main	Cement Creek	37.8181866	-107.6616043	SW
RCWWN	CORIVWCH_WQX-323	Cement Cr	13.08	Main	Cement Creek	37.8159	-107.6618	SW
EPA	CC 14th St Bridge		13.45	Main	Cement Creek	37.812475	-107.661401	SW
CO(CDPHE)	CEM49	Cement Creek above Animas River	13.78	Main	Cement Creek	37.8099933	-107.6606917	SW
CO(CDPHE)	9488	Animas River above Cement Creek	13.90	Reference	Upper Animas	37.810892	-107.659445	SW, SED
CO(CDPHE)	CO_RI_R9	Animas River above Cement Creek	13.90	Reference	Upper Animas	37.811065	-107.659232	SW
EPA	A68		13.90	Reference	Upper Animas	37.811202	-107.659167	SW, SED
RCWWN	CORIVWCH_WQX-103	13th St Br	13.90	Reference	Upper Animas	37.811	-107.6589	SW
RCWWN	CORIVWCH_WQX-467	Howardsville	13.90	Reference	Upper Animas	37.8326	-107.6002	SW
USGS	09358000	ANIMAS RIVER At SILVERTON, CO.	13.90	Reference	Upper Animas	37.810917	-107.658897	SW
CO(CDPHE)	9487	Animas River (below Cement Creek) above Mineral Creek	14.63	Main	Upper Animas	37.8040225	-107.664772	SW, SED
CO(CDPHE)	CO_RI_R8	Mineral Creek above Animas River	15.14	Reference	Upper Animas	37.80282	-107.6728217	SW
EPA	M34		15.14	Reference	Upper Animas	37.8028	-107.67222	SW, SED
CO(CDPHE)	82	Animas River near Silverton	15.56	Main	Upper Animas	37.7970013	-107.6693973	SW, SED
CO(CDPHE)	9486	Animas River (below Cement Creek) (blw Mineral Cr Conf)	15.66	Main	Upper Animas	37.79625	-107.66942	SW
RCWWN	CORIVWCH_WQX-3579	Above A72	15.88	Main	Upper Animas	37.7942	-107.66894	SW
EPA	A72		16.35	Main	Upper Animas	37.79027	-107.667578	SW, SED
USGS	09359020	ANIMAS RIVER BELOW SILVERTON, CO	16.35	Main	Upper Animas	37.790272	-107.667587	SW
RCWWN	CORIVWCH_WQX-3611	A72	16.40	Main	Upper Animas	37.78993	-107.66756	SW
CO(CDPHE)	AN72	imas River at gage above (just upstream) Railroad Bridge (below Mineral Cree	16.42	Main	Upper Animas	37.7897672	-107.6675452	SW, SED
EPA	GKMSE27		24.24	Main	Upper Animas	37.72437	-107.65405	SEDIMENT
EPA	A73		24.48	Main	Upper Animas	37.7221583	-107.6548278	SW
CO(CDPHE)	9485	Animas River in canyon 3 above Elk Creek	24.53	Main	Upper Animas	37.721807	-107.654554	SW
EPA	A75D		45.13	Main	Middle Animas	37.597779	-107.775621	SW, SED
CO(CDPHE)	81	Animas River at Bakers Bridge	63.50	Main	Middle Animas	37.45844	-107.7997567	SW, SED
RCWWN	CORIVWCH_WQX-88	Baker's Br	63.54	Main	Middle Animas	37.4581	-107.8001	SW

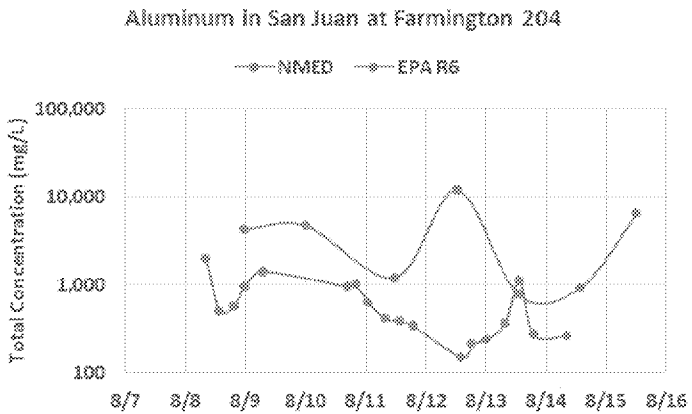
About the data

- **1396 total and dissolved water samples through 8/27/2016**
- **818 river sediment samples through 9/1/2016**
- **The draft chapter displays data through 6/27/2016—will be updated**

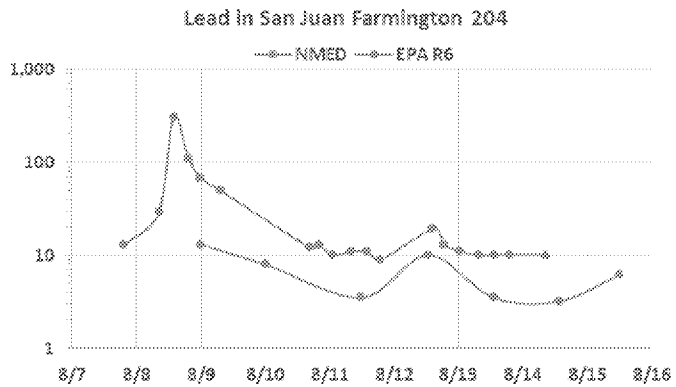
Sediment (mg/kg)

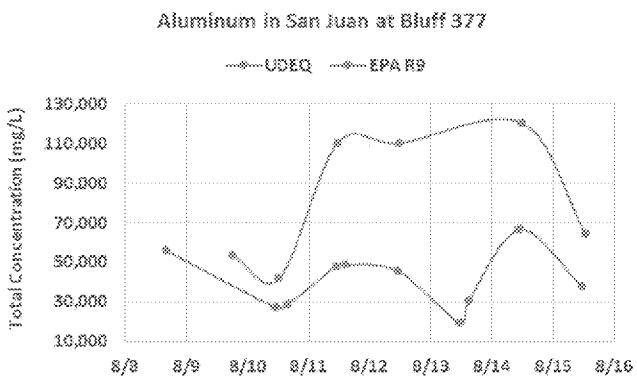
Samp_No	River km	Date	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
CC48SE_082715	12.54	8/27/15 12:10	6,100.00	0.70	44.00	110.00	0.29	3.10	1,100.00	5.50	3.40	250.00	46,000.00	720.00	2,800.00	550.00	0.10	7.10	2.50	1,300.00	2.20	3.20	82.00	0.29	28.00	830.00
CC48SE_083115D	12.54	8/31/15 11:40	7,400.00	0.58	58.00	130.00	0.52	2.20	1,100.00	7.90	4.60	220.00	58,000.00	990.00	3,300.00	800.00	0.08	11.00	3.20	1,800.00	2.80	5.40	140.00	0.49	41.00	560.00
CC48SE_083115	12.54	8/31/15 11:40	9,200.00	0.69	62.00	130.00	0.49	2.40	1,400.00	7.80	4.80	240.00	70,000.00	1,000.00	4,100.00	750.00	0.10	11.00	3.40	2,300.00	3.10	5.80	240.00	0.49	42.00	620.00
CC48SE_091615	12.54	9/16/15 14:00	6,600.00	0.55	45.00	92.00	0.34	1.90	1,100.00	6.00	3.10	180.00	51,000.00	790.00	2,900.00	560.00	0.05	9.60	2.40	1,500.00	2.50	4.00	100.00	0.38	31.00	510.00
CC48SE_091715	12.54	9/17/15 14:20	7,400.00	0.86	42.00	110.00	0.31	1.70	1,000.00	6.30	3.00	180.00	52,000.00	740.00	3,200.00	560.00	0.07	10.00	2.30	1,700.00	2.40	4.50	120.00	0.40	31.00	430.00
CC48SE_091915	12.54	9/19/15 14:15	7,400.00	0.95	43.00	100.00	0.33	2.10	1,100.00	5.50	3.20	200.00	57,000.00	820.00	2,900.00	560.00	0.07	9.60	2.50	1,800.00	2.40	4.60	140.00	0.39	31.00	570.00
CC48SE_092015	12.54	9/20/15 14:40	6,400.00	0.47	37.00	84.00	0.28	1.60	960.00	5.10	2.90	160.00	48,000.00	800.00	2,700.00	610.00	0.07	7.50	2.10	1,500.00	2.00	3.10	83.00	0.33	27.00	460.00
CC48SE_092115D	12.54	9/21/15 14:25	6,500.00	0.53	43.00	96.00	0.32	1.90	1,100.00	5.50	3.10	180.00	50,000.00	780.00	2,800.00	510.00	0.06	9.30	2.20	1,500.00	2.40	3.60	120.00	0.35	30.00	540.00
CC48SE_092115	12.54	9/21/15 14:25	6,800.00	0.56	46.00	100.00	0.32	2.40	1,100.00	6.00	3.60	200.00	54,000.00	860.00	2,900.00	610.00	0.11	9.80	2.40	1,500.00	2.40	4.00	130.00	0.35	31.00	630.00
CC48SE_092415	12.54	9/24/15 15:05	6,100.00	0.70	38.00	94.00	0.29	2.30	1,000.00	5.20	3.00	190.00	47,000.00	750.00	2,700.00	520.00	0.04	8.90	2.30	1,400.00	2.10	3.30	99.00	0.32	27.00	600.00
CC48SE_092815	12.54	9/28/15 15:00	4,400.00	0.41	37.00	84.00	0.26	2.40	720.00	4.70	3.20	200.00	35,000.00	710.00	2,000.00	520.00	0.04	7.50	2.30	940.00	1.90	2.70	77.00	0.30	27.00	620.00
CC48SE_100115	12.54	10/1/15 15:15	7,300.00	0.56	55.00	110.00	0.33	2.00	1,100.00	6.80	3.50	200.00	55,000.00	970.00	3,200.00	640.00	0.12	12.00	2.60	1,800.00	3.00	4.70	130.00	0.45	36.00	530.00
CC48SE_102615	12.54	10/26/15 9:50	7,000.00	0.48	48.00	97.00	0.33	2.20	1,000.00	5.10	3.70	180.00	62,000.00	630.00	3,400.00	600.00	0.08	7.20	2.70	1,400.00	2.10	2.70	95.00	0.34	31.00	600.00
CC48_SED_060616L	12.54	6/6/16 10:10	9,000.00	3.90	51.00	91.00	0.34	1.40	1,300.00	6.50	7.40	89.00	71,000.00	360.00	5,000.00	920.00	0.02	4.60	4.30	1,200.00	5.00	1.40	61.00	0.27	40.00	410.00
CEM49_05/03/2016	13.78	5/3/16 17:00	8,300.00		46.00			0.87			4.70	86.00	87,100.00	410.00		640.00			1.70		1.50					360.00
CEM49_05/11/2016	13.78	5/11/16 13:50	7,000.00		54.00			0.77			4.00	120.00	100,000.00	470.00		540.00			1.70		1.80					350.00
CEM49_05/19/2016	13.78	5/19/16 11:00	7,700.00		51.00			1.60			4.70	120.00	95,000.00	450.00		560.00			1.30		1.50					500.00
CEM49_05/26/2016	13.78	5/26/16 9:45	7,900.00		43.00			2.10			5.00	130.00	79,000.00	460.00		560.00			1.70		1.50					640.00
CEM49_06/01/2016	13.78	6/1/16 9:50	6,700.00		30.00			2.90			5.00	110.00	63,000.00	290.00		470.00			2.40		1.00					870.00
CEM49_06/07/2016	13.78	6/7/16 12:00	6,800.00		38.00			1.80			7.40	93.00	63,000.00	340.00		690.00			3.40		1.50					510.00

About Sharing Data from Multiple Providers



R6 and NMED





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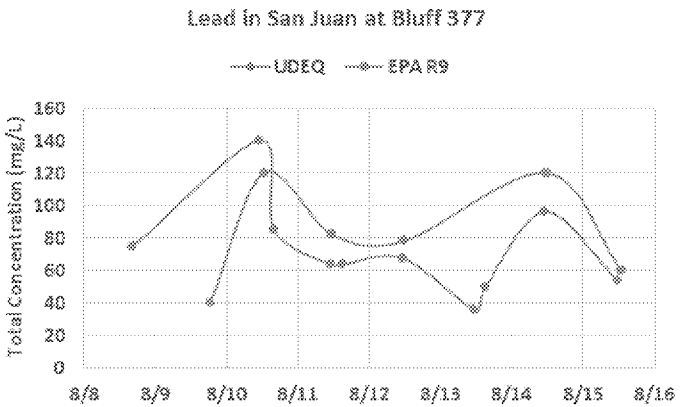
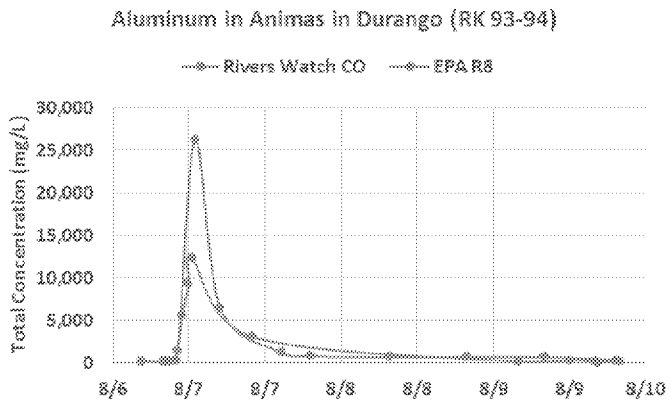
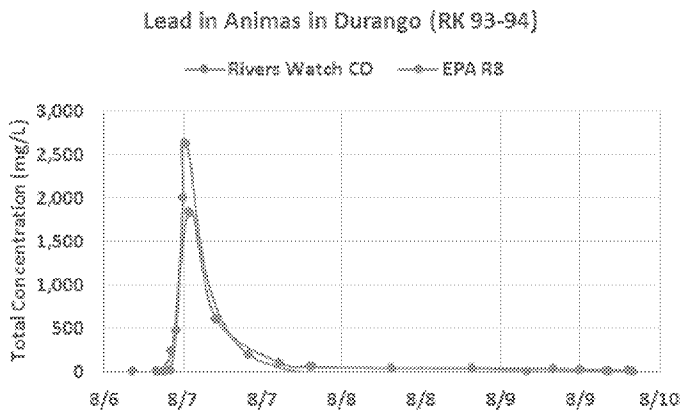
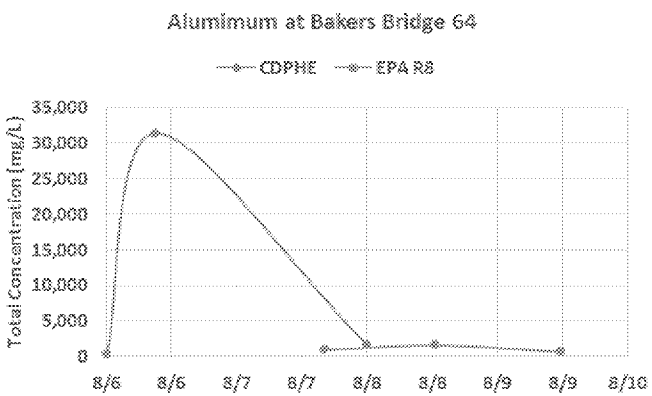


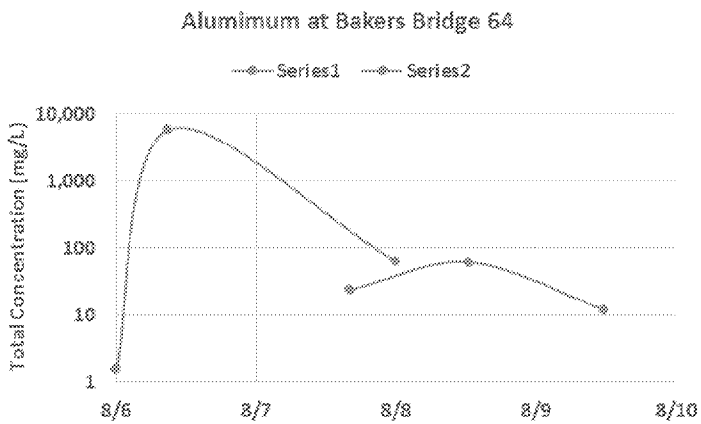
Differences among Data Providers-- Colorado





NGO's play bigger role in Colorado





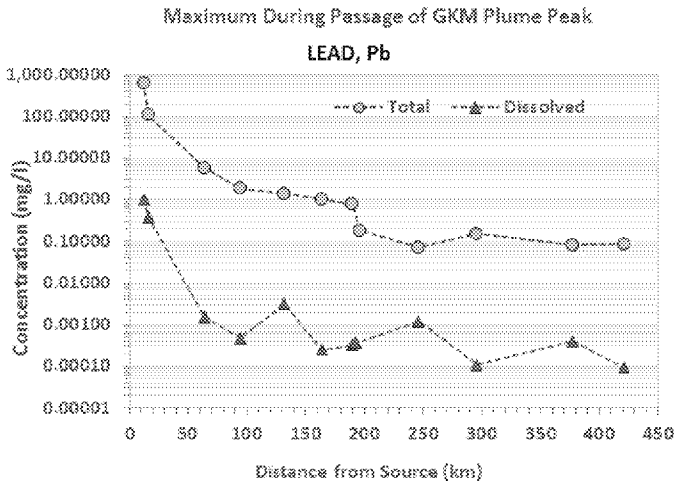
EPA R8 and CDPHE

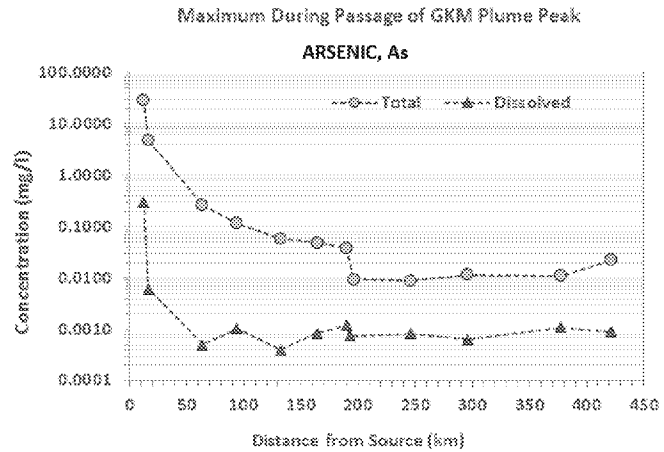
Overall

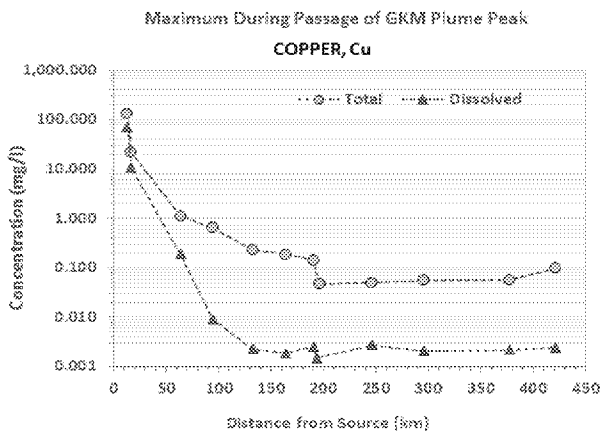
- **Gold King Plume was observed through whole system**
- **Most deposited in the Animas but could be detected in the San Juan**
- **Post Event through Fall 2016:**
  - Water quality in upper/middle Animas returned to “normal”
  - Water quality in lower Animas elevated with respect to aluminum and iron
  - Carried into and through San Juan
- **2016 Snowmelt had elevated metals throughout the system—partly Gold King**
- **ORD team hypothesizes all Gold King metals out of system**
- **2016 August samples at pre-event levels**
- **Metals correlation technique can help establish that going forward**
- **Some water quality exceedances during plume and post event varying by location and state/tribe**

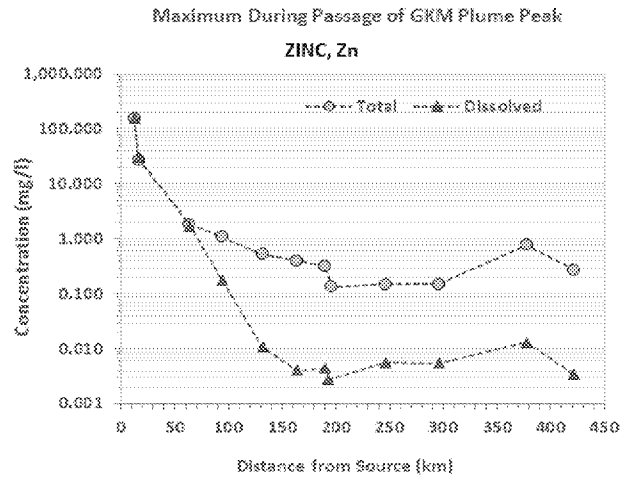
Highlights of the Gold King Release and Plume

- **Concentrations were high at source**
- **Declined steeply in first 100 km**
- **Relatively constant through San Juan**









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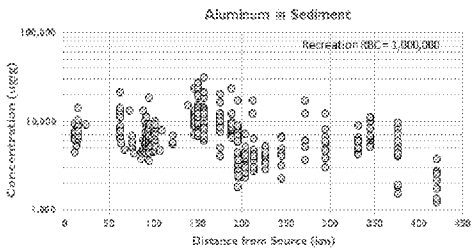
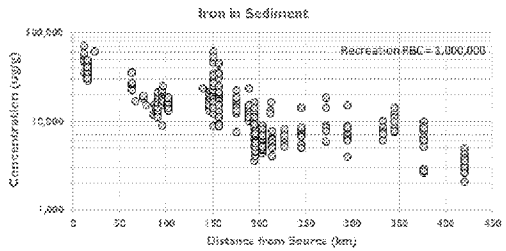
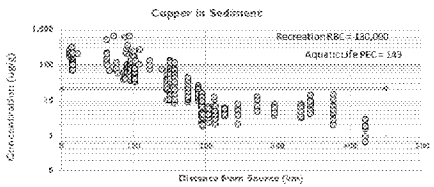
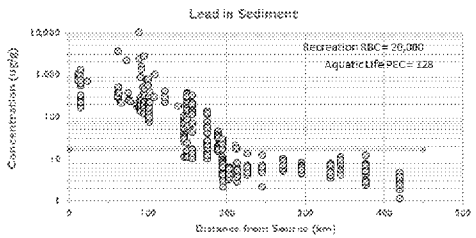
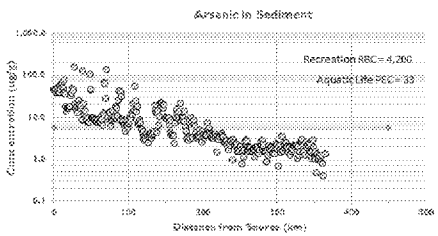
Strong Longitudinal Patterns -- Sediment

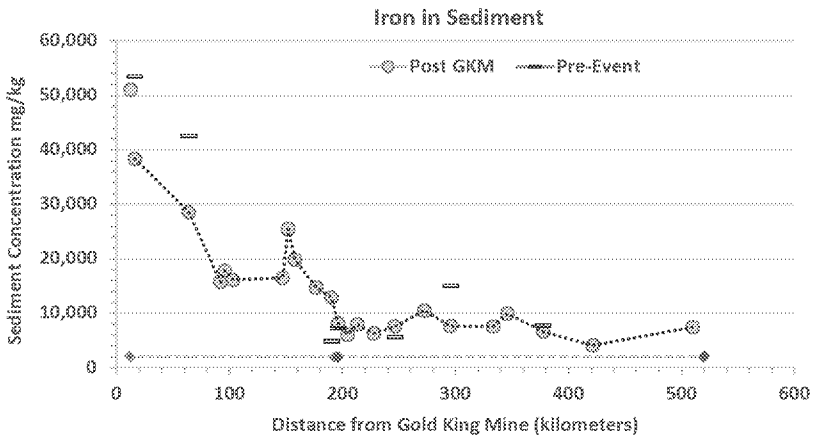


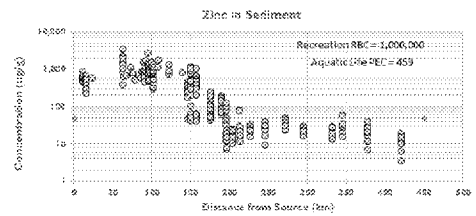


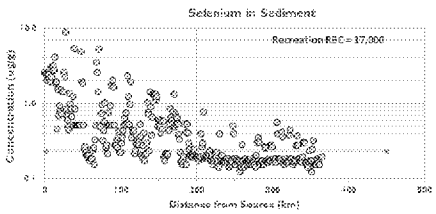












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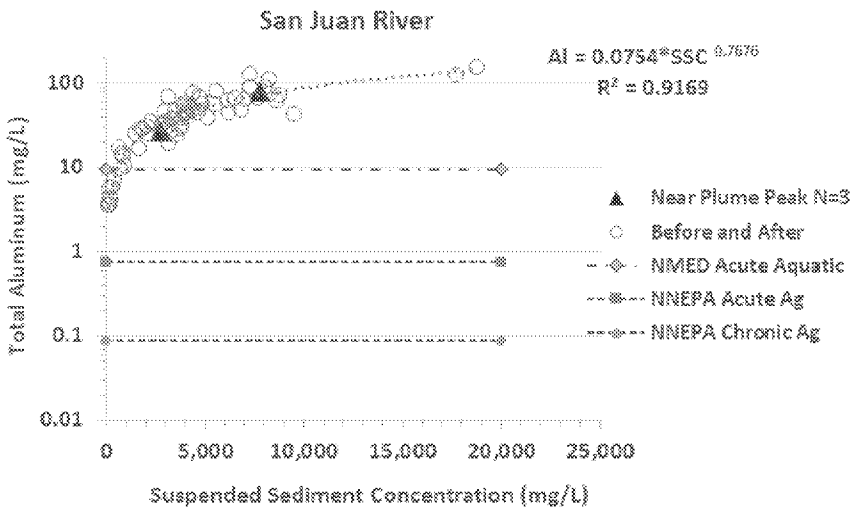
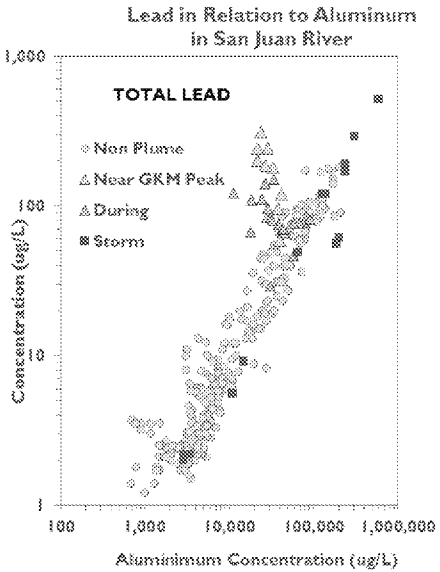
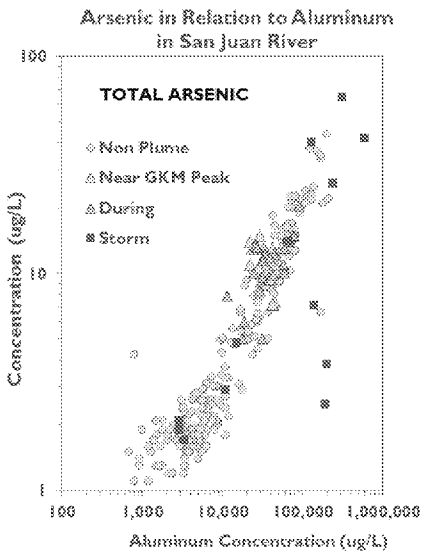
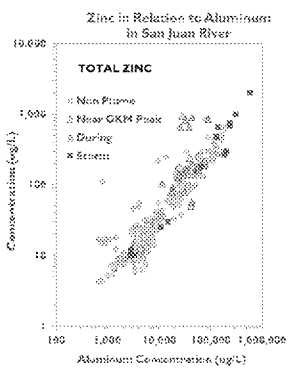
Correlation Analysis for "Finger-printing" and Establishing Background

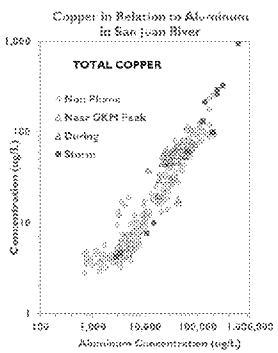






Total Aluminum and Trace Metals





Surface Water Quality Screening Criteria

mg/L

Screening Criteria			Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
Domestic Water Supply	Domestic Supply	New Mexico		0.0060	0.010	2.0	0.0040	0.0050		0.10		1.30		0.0150			0.0020		0.7		0.050			0.002		10.50
	Domestic Source	Utah			0.010	1.0	0.0040	0.010		0.050				0.0150			0.0020				0.050	0.050				
	Domestic Water Supply	Navajo Nation		0.00560	0.010	1.0	0.0040	0.0050		0.10		1.30		0.0150			0.0020		0.6		0.050	0.0350		0.0020		2.10
	Drinking Water	Ute Mountain Ute	8.2000	0.00560	0.000	1.0		0.0050		0.16		1.00		0.0500			0.0001		0.1		0.050	0.1000				5.00
	Domestic Supply 1-Day	Colorado				1.0		0.0050		0.050				0.050			0.0020					0.10				
Recreation and Human Contact	Primary Human Contact	Navajo Nation		0.370	0.030	98.0	1.870	0.470				9.330		0.0150			0.280		18.7		4.670	4.670		0.0750		280.0
	Secondary Human Contact	Navajo Nation		0.370	0.280	98.0	1.870	0.470				9.330		0.0150			0.280		18.7		4.670	4.670		0.0750		280.0
	Ceremonial, other uses	Ute Mountain Ute	0.2000	0.0056	0.0000	1.0000		0.0050		0.1600		1.0000		0.0500			0.0001		0.1000		0.0500	0.1000				5.0000
	Fish consumption	Ute Mountain Ute		0.056	0.00001			0.084		670.0							0.000		4.6		4.200	110.000				26.0
	Recreational	Utah	621	0.248	0.186	124.2	1.242	0.062		0.4100	7.9310	6.208	851.6	0.9100		31.0	1.242	3.104	17.5		3.104	3.630		0.0250	6.21	217.8
	Recreational	Region 6	170.0	0.0670	0.050	33.0	0.330	0.0830		220.0	0.050	6.70	120.0	0.20		7.80	0.050	0.830	3.30		0.830			0.0020	0.83	50.0
Agriculture	Irrigation	Region 6		5.0				0.010		0.10	1.0	0.20		5.0		0.20			0.20		0.130				0.10	2.0
	Irrigation	New Mexico	5.0		0.10			0.010		0.10	0.050	0.20		5.0				1.0			0.130				0.10	2.0
	Irrigation (short-term)	Utah	20.0		2.0			0.050		1.0	5.0	5.0	20.0	10.0		10.0		0.050	2.0		0.020				1.0	10.0
	Irrigation (long-term)	Utah	5.0		0.10			0.010		0.10	0.050	0.20	5.0	5.0		0.20		0.010	0.20		0.020				0.10	2.0
	Agricultural Uses	Utah			0.10			0.010		0.10		0.20		0.10							0.050					
	Agricultural Supply	Navajo Nation	5.0		2.0			0.050		1.0	0.050	0.20		10.0				1.0			0.020				0.10	10.0
	Agriculture	Ute Mountain Ute			0.1			0.010		0.1		0.20		0.1			0.0100		0.200		0.020					2.0
	Revised Ag Water Supply	Region 9	5.0		2.0			0.050		1.0	0.050	0.20		10.0				1.0			0.020				0.10	10.0
	Agriculture	Colorado			0.10		0.10	0.010		0.10		0.20		0.10		0.20		0.30	0.20		0.020					2.0
Livestock	Livestock	Region 6					0.10	0.050		1.0		0.50		0.10			0.010		1.0		0.250				0.10	25.0
	Livestock updated	Region 9			0.20			0.050		1.0	1.0	0.50		0.10							0.050				0.10	25.0
	Livestock	New Mexico			0.20			0.050		1.0	1.0	0.50		0.10			0.010				0.050				0.10	25.0
	Livestock	Utah	5.0		0.20			0.050	500.0	1.0	1.0	0.50		0.10	250.0		0.010				0.050		1000.0		0.10	25.0
	Livestock Watering	Navajo Nation			0.20			0.050		1.0	1.0	0.50		0.10							0.050				0.10	25.0
	Wildlife Habitat	New Mexico															0.000770				0.005					
Aquatic Life	Acute Ag and Wildlife	Navajo Nation	0.750	0.088	0.340			0.0039				0.0258		0.1361			0.0024		0.8417		0.0330	0.0106		0.70		0.2108
	Acute Warm Water	Ute Mountain Ute	0.050		0.150			0.0039		1.005		0.0258		0.1361			0.0001		0.8417		0.0200	0.0114				0.2108
	Aquatic Acute	Region 6		8.358	0.340			0.00288		0.9720		0.0250		0.130		3.710	0.00140		0.8130		0.020	0.00990				0.290
	Aquatic Acute	Region 9		8.3580			0.340	0.00288		0.9720		0.0250		0.130		3.710	0.1040		0.8130		0.020	0.00990				0.290
	Aquatic Acute	New Mexico	9.5725		0.340			0.003134		0.0160		0.0273		0.145		3.8348	0.0014	7.920	0.884		0.020	0.0117				0.3169
	Warm Water Fish 1-hr	Utah	0.750		0.340			0.004		1.005		0.0258	1.0	0.1361					0.0935		0.01840	10.59717				0.213
	Warm Water Fish 4-day	Utah	0.0870		0.150			0.000		0.1308		0.0162	1.0	0.00531			0.000012		0.093		0.00460					0.213
	Chronic Warm Water	Ute Mountain Ute			0.150			0.000398		0.1308		0.0162		0.00531			0.000012		0.093		0.00500	0.001				0.213
	Aquatic Acute	Colorado	7.9432		0.3400			0.0047		0.0160		0.0240		0.1253		3.6647			0.7879		0.01840	0.00585				0.2800
	Aquatic Chronic	Region 6		3.3480	0.150			0.00072		0.1260	0.050	0.0160		0.0050		2.050	0.00077		0.090		0.0050					0.2190
	Aquatic Chronic	Region 9		3.3480			0.150	0.00072		0.1260		0.0160		0.0050		2.050	0.00077		0.090		0.0050					0.2190
	Chronic Ag and Wildlife	Navajo Nation	0.0870	0.030	0.150			0.0004				0.0162		0.0053			0.000001		0.0935		0.0020			0.150		0.2125
	Aquatic Chronic	New Mexico	3.8351		0.150			0.000777		0.0110		0.0170		0.0056		2.1187	0.00077	1.8950	0.098		0.0050					0.2400
	Aquatic Chronic	Colorado	1.1340		0.150			0.000674		0.0110		0.0151	1.0	0.00488		2.0247	0.00001		0.0875		0.00460	0.0002		0.0150		0.2120

Agriculture

Hours at or above criteria during passage of the GKM plume

	Animas River							San Juan River				
	Cement Creek (RK 12.5)	Silverton (RK 16.4)	Bakers Bridge (RK 64)	Durango (RK 94.2	SUIT NAR06 RK 132	Aztec (RK 162.9	Farmington (RK 190.2)	Farmington (RK196)	Ship Rock (RK 246.3)	4 Corners (RK 295.8)	Bluff (RK 377.6)	Mexican Hat (RK 421.5)
Aluminum	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Antimony	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Arsenic	0	7.00	8.50	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Beryllium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cadmium	0	5.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Calcium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chromium	0	1.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cobalt	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Copper	0	9.75	11.25	5.25	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iron	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lead	0	13.25	29.50	24.00	30.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Magnesium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Manganese	0	13.75	32.25	15.75	16.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Molybedenum	0	2.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nickel	0	2.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potassium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Selenium	0	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Silver	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sodium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Thallium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vanadium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zinc	0	5.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Source	***CO***	***CO***	***CO***	***CO***	***CO***	***NM***	***NM***	***NM***	***NM***	***Utah***	***Utah***	***Utah***

Aquatic Acute

Hours at or above criteria during passage of the GKM plume

	Animas River							San Juan River				
	Cement Creek (RK 12.5)	Silverton (RK 16.4)	Bakers Bridge (RK 64)	Durango (RK 94.2	SUIT NAR06 RK 132	Aztec (RK 162.9	Farmington (RK 190.2)	Farmington (RK196)	Ship Rock (RK 246.3)	4 Corners (RK 295.8)	Bluff (RK 377.6)	Mexican Hat (RK 421.5)
Aluminum	0	8.50	10.25	5.25	6.00	3.00	0.00	14.00	18.00	0.00	0.00	8.00
Antimony	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Arsenic	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Beryllium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cadmium	0	6.25	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Calcium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chromium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cobalt	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Copper	0	9.75	12.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iron	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lead	0	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Magnesium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Manganese	0	4.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Molybedenum	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nickel	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potassium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Selenium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Silver	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sodium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Thallium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vanadium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zinc	0	13.75	12.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Source	***CO***	***CO***	***CO***	***CO***	***CO***	***NM***	***NM***	***NM***	***NM***	***Utah***	***Utah***	***Utah***
	Not Designated											

OW/Region Review Monitoring

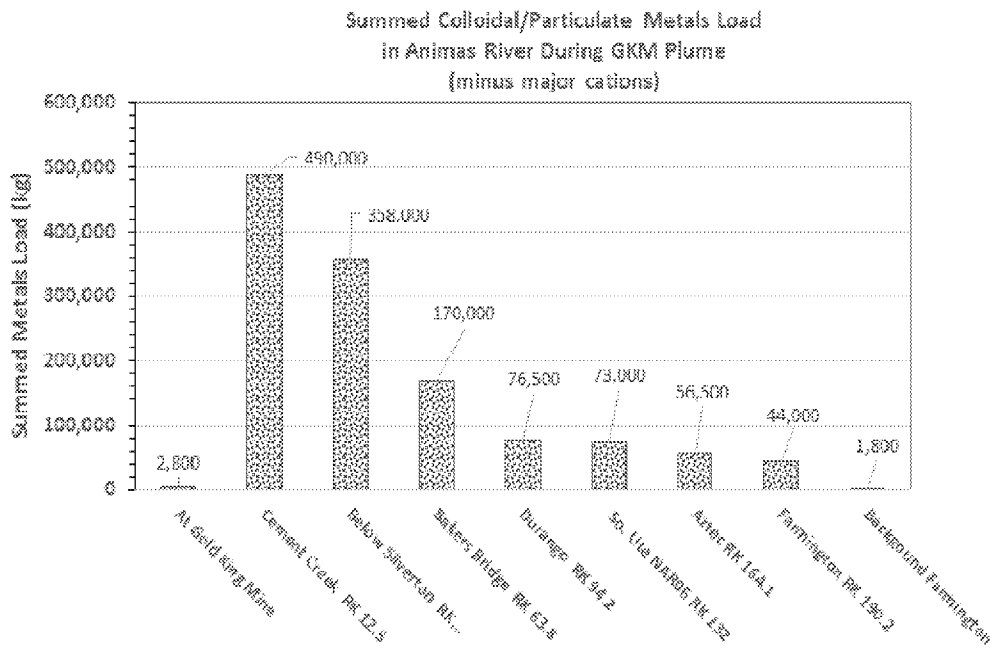
Aquatic Chronic

Hours at or above criteria during passage of the GKM plume

	Animas River							San Juan River				
	Cement Creek (RK 12.5)	Silverton (RK 16.4)	Bakers Bridge (RK 64)	Durango (RK 94.2	SUIT NAR06 RK 132	Aztec (RK 162.9	Farmington (RK 190.2)	Farmington (RK196)	Ship Rock (RK 246.3)	4 Corners (RK 295.8)	Bluff (RK 377.6)	Mexican Hat (RK 421.5)
Aluminum	0	13.75	18.75	33.00	45.25	11.00	16.75	18.00	18.00	37.50	30.25	17.50
Antimony	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Arsenic	0.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Barium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Beryllium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cadmium	17.75	13.75	12.75	7.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Calcium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chromium	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cobalt	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Copper	17.75	9.75	15.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iron	17.75	13.75	30.00	37.25	44.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lead	17.75	6.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Magnesium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Manganese	17.75	6.25	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Molybedenum	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nickel	3.75	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potassium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Selenium	4	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Silver	17.5	13.75	11.75	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sodium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Thallium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vanadium	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zinc	17.75	13.75	13.00	2.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Source	*CO*	*CO*	*CO*	*CO*	*CO*	*NM*	*NM*	*NM*	*NM*	*Utah*	*Utah*	*Utah*
	Not Designated											

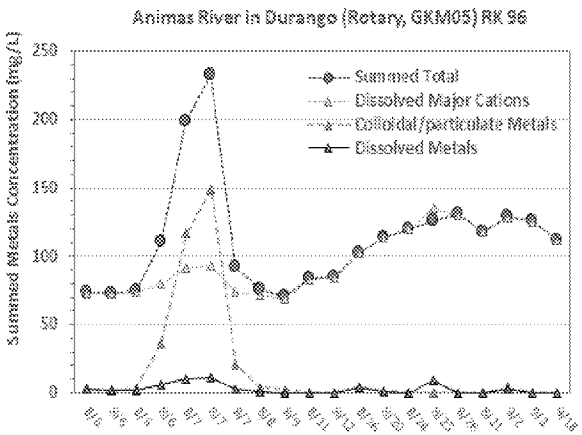
OW/Region Review Monitoring

Most of Gold King Release settled in the Animas River

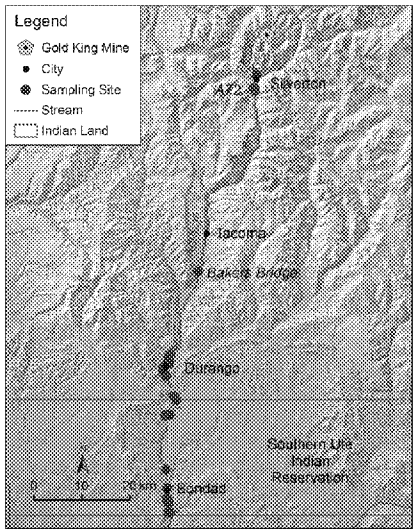


OW/Region Review Monitoring

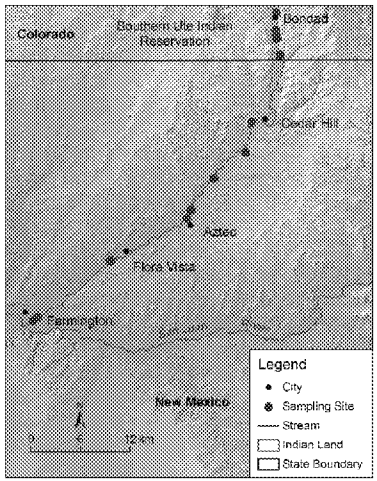
Has water and sediment quality returned to pre-event conditions? Perspectives



- Statistical comparisons with pre-release data or related approaches such as correlation analysis
  - Answers the question objectively
  - Limited by available pre-release data
  - Must account for effects of flow (storms, snowmelt, low flows)
- Were changes "important"?
  - Were water quality criteria exceeded?
  - Many sets of applicable criteria – states, tribes, EPA guidance
- ORD report
  - Tries to stick more to 1st approach
  - Discusses but does not emphasize criteria exceedance
  - Focuses on state, tribal criteria
  - Advice appreciated

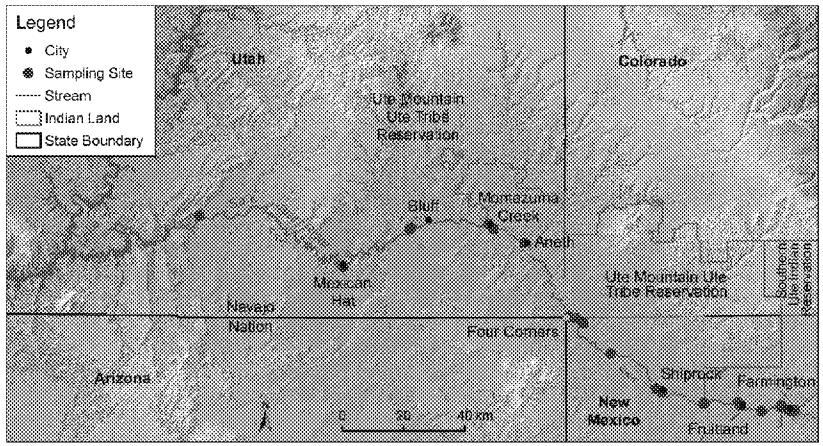


Release plume clearly visible or detectable through most of system



Trace metals low, iron and aluminum concentrations changing

Sites reach low point in most metals going into winter



Metals elevated during snowmelt throughout the system. Evidence GK part of mix.

August sampling indicates concentrations at most locations are the same or lower levels than Fall 2015

Release

- August 2015

FALL 2015

- Sept-Oct 2015

Winter 2015

- Sampling Hiatus

Spring Snowmelt

- March –June 2016

Summer 2016

- July-Aug 2016

Mass analysis and water quality suggests Gold King release gone

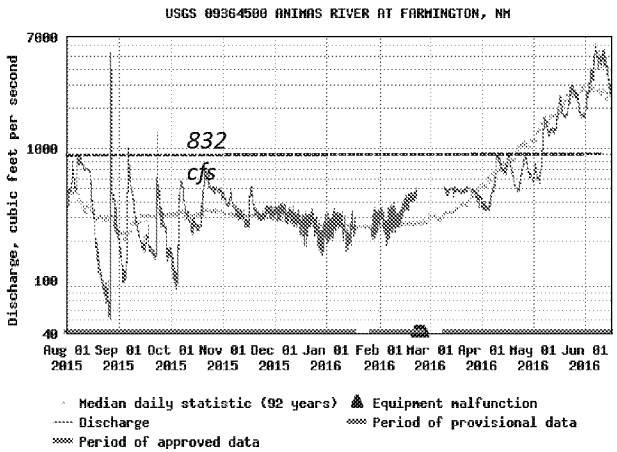
- WQ returns to close to background within days
- Adjustments to water chemistry into August (1-3 weeks)
- Post event trajectories varied by location

- Iron and aluminum adjustments--probably a geochemical story but no minerology sampling to confirm
- Statistical analysis confirms Al, Fe not at pre-event
- Storms in lower Animas and San Juan clean out system

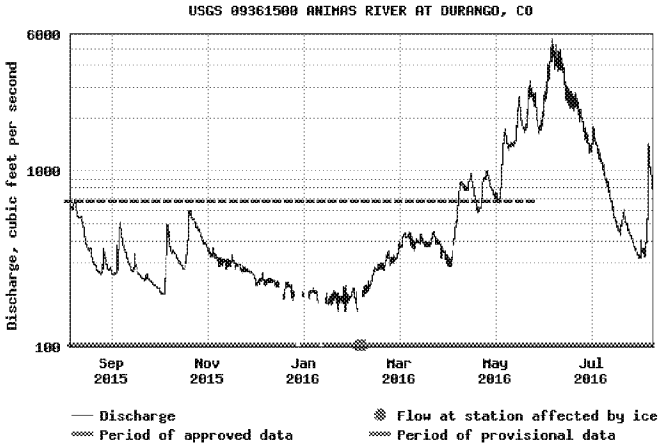
- Metals mobile in entire system
- Big snowmelt event in headwaters of Animas—average below
- Some metals due to Gold King
- Sites with sufficient sampling show metals end snowmelt at low concentrations suggesting release deposits probably moved out

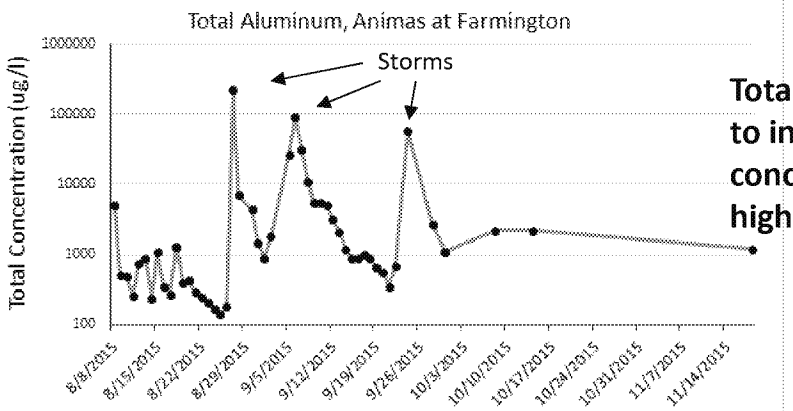
Have to Pay Attention to Streamflow—Effects varied spatially

Lower Animas and San Juan Rivers



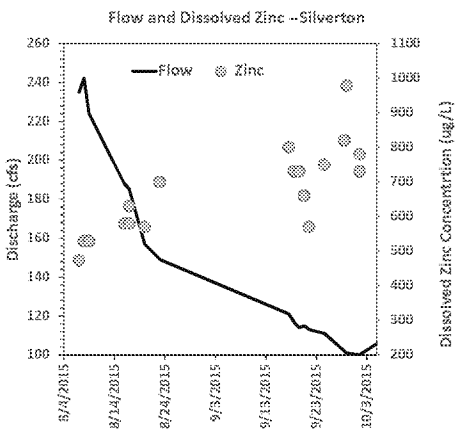
Upper and Middle Animas





Total metals tend to increase concentration in high flow

Many dissolved metals increase concentration in lower flow



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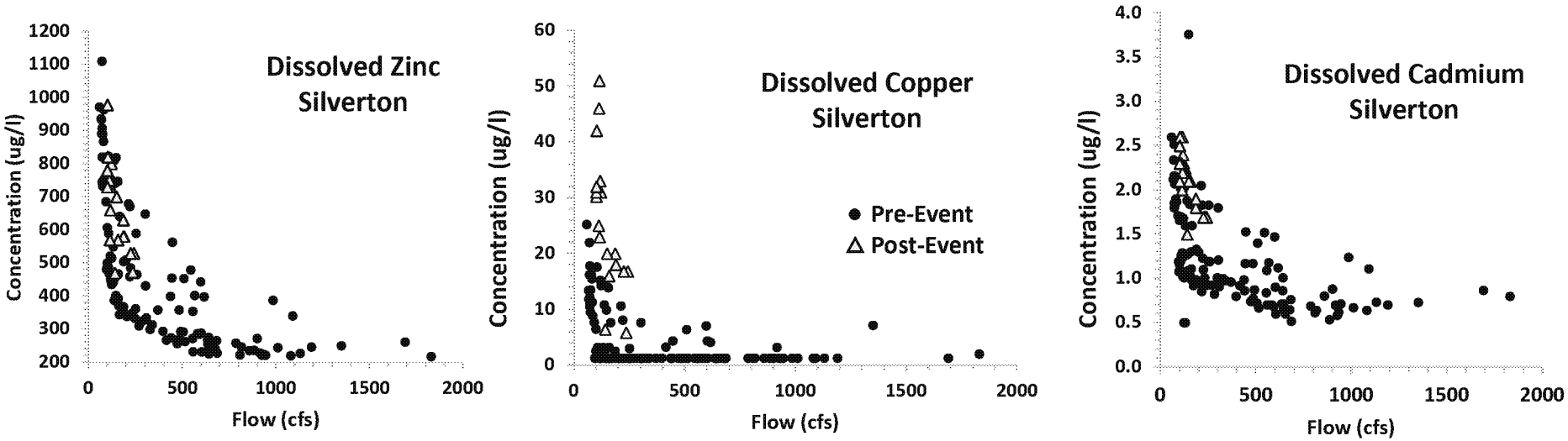
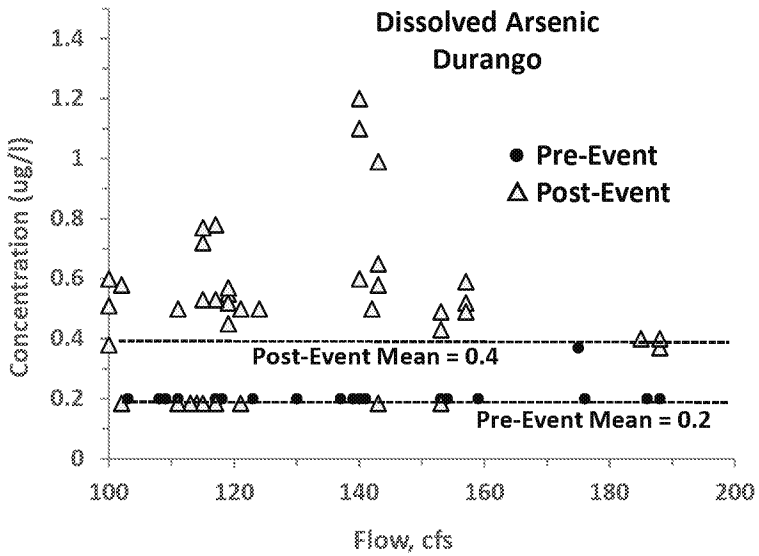
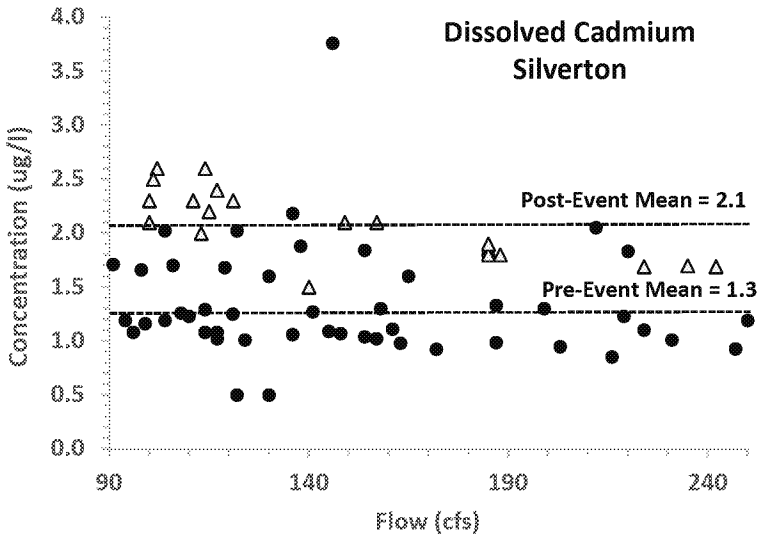


Figure 8-3. Some post-event dissolved metal concentrations (yellow triangles) at Silverton look to be elevated relative to pre-event samples (black circles). However, as stated, post-event data should only be compared to pre-event data at similar flow.

Dissolved metals concentrations at Silverton show a strong inverse relationship to streamflow. The rising temporal trend in post-event dissolved metals (Figure 3) is thus likely related to steadily declining flow during the post-event sampling period (Figure 5). The conclusion is that comparative analyses (pre-event versus post-event samples) must be done using samples taken at similar flows. For a complete synopsis of water concentration relationships to flow on various sites of the Animas River, see Appendix X.





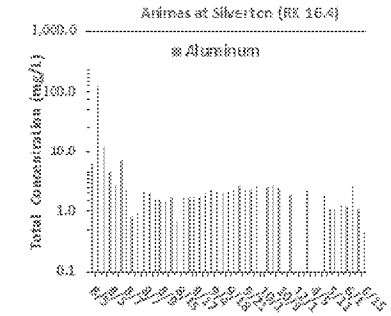
EXAMPLE:

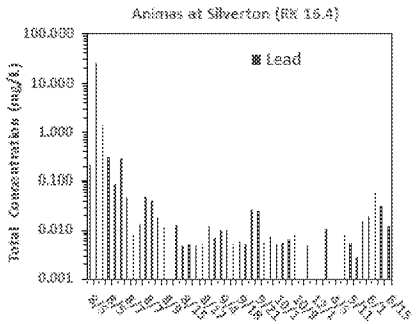
Statistically significant differences

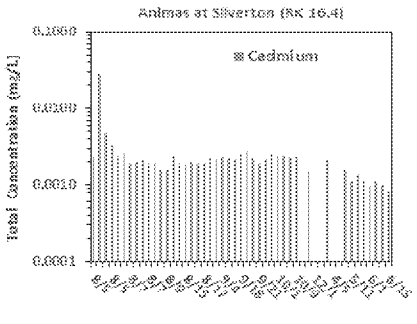
Below Criteria:

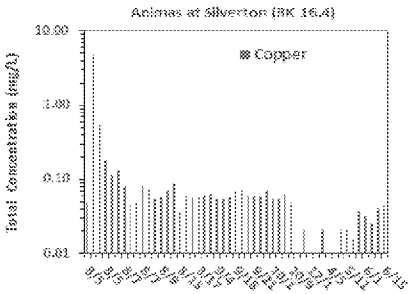
Aquatic acute: Arsenic 340 ug/l Cadmium 4.7 ug/l

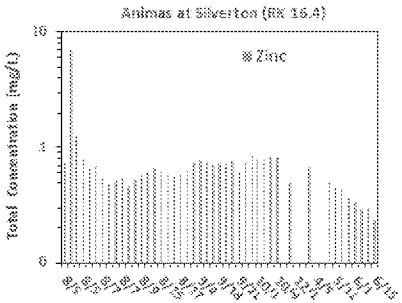
Animas Below Silverton -- Total Water Concentration

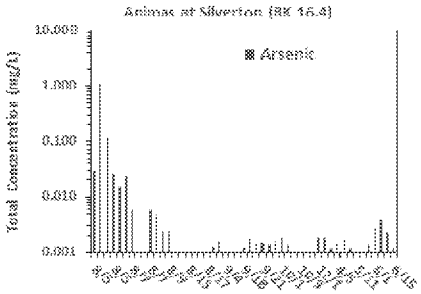








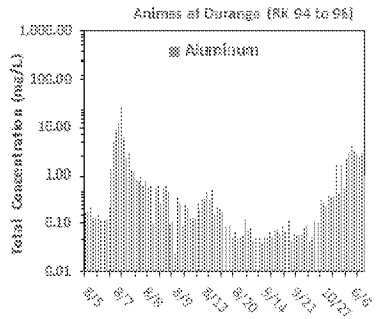


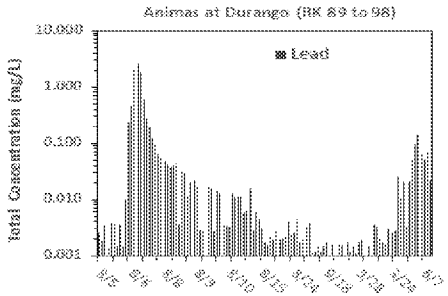


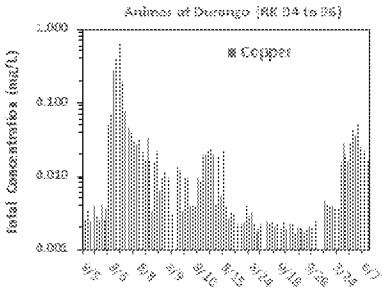
Total Concentrations

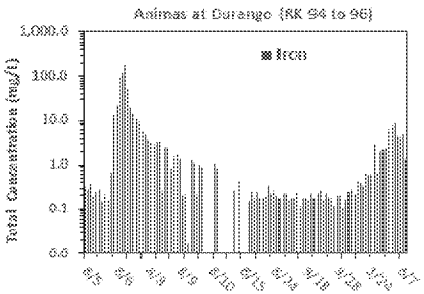
Metal	Pre (ug/l)	Post (ug/l)	t-test p-value	Wilcoxon p-value
Aluminum	2207	2053	0.68	0.11
Cadmium	1.94	2.09	0.27	0.24
Copper	26	57	0.0001	0.00005
Iron	3038	3746	0.05	0.04
Lead	10.3	8.6	0.70	0.80
Manganese	1440	1449	0.53	0.63
Zinc	654	645	0.43	0.60

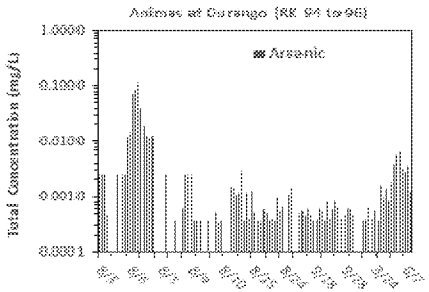
Middle Animas at Durango

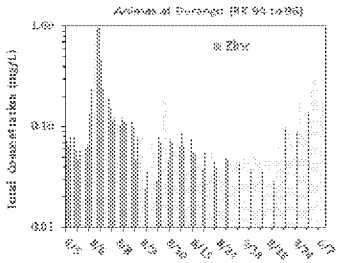




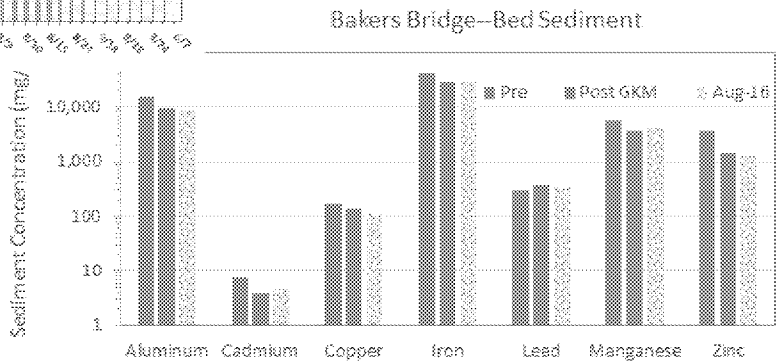








No trends in bed sediments



OW/Region Review Monitoring

Results for the Middle Animas River—Comparison to Historic Data

Dissolved Concentrations at Durango

Total Concentration — Animas River at Durango

Metal	Pre (ug/l)	SE	Post (ug/l)	SE	t-test p-value	Wilcoxon p-value	Criteria
Aluminum	152	55	94	13	0.005	0.03	1,134 (aqu. chronic)
Cadmium	0.25	0.02	0.22	0.03	0.27	0.90	10 (agri.)
Copper	2.7	0.40	3.0	0.73	0.67	0.90	200 (agri.)
Iron	301	85	211	9.3	0.017	0.12	1,000 (aqu. chronic)
Lead	3.7	0.54	2.0	0.33	Non-Detection Bias		50 (1-day drinking)
Manganese	102	10	83	4.1	0.02	0.05	200 (agri.)
Zinc	54	6.1	44	1.6	0.02	0.15	2,000 (agri.)
n=	37		57				

Dissolved Concentrations at SUIT

Metal	Pre (ug/l)	Post (ug/l)	t-test p-value	Wilcoxon p-value
Aluminum	36	46	0.41	0.37
Cadmium	0.61	0.06	Non-Detection Bias	
Copper	4.3	1.8	Non-Detection Bias	
Iron	40.8	50.8	0.37	0.43
Lead	7.8	0.39	Non-Detection Bias	
Manganese	27.0	20.0	0.32	0.19
Zinc	8.3	10.0	Non-Detection Bias	

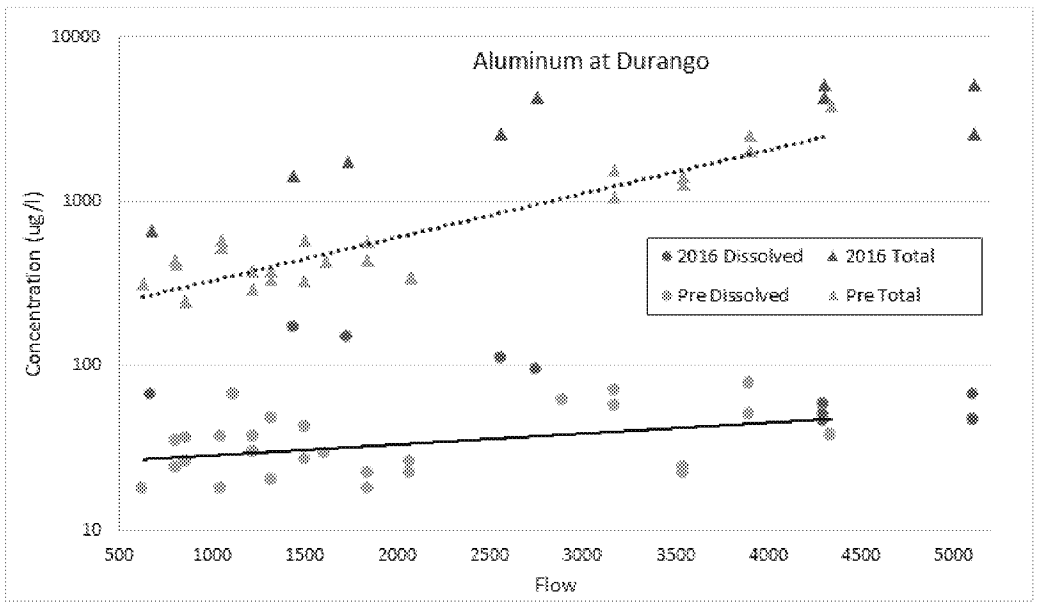
Total Concentrations at SUIT

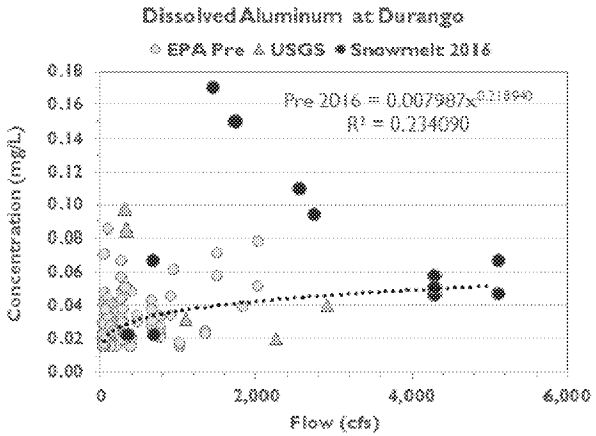
Metal	Pre (ug/l)	Post (ug/l)	t-test p-value	Wilcoxon p-value
Aluminum	387	280	0.30	0.64
Cadmium	1.5	0.15	Non-Detection Bias	
Copper	5.0	3.9	0.18	0.05
Iron	435.6	543.1	0.42	0.18
Lead	13	5.6	Non-Detection Bias	
Manganese	75.6	79.7	0.72	0.27
Zinc	25.2	27.8	0.62	0.69

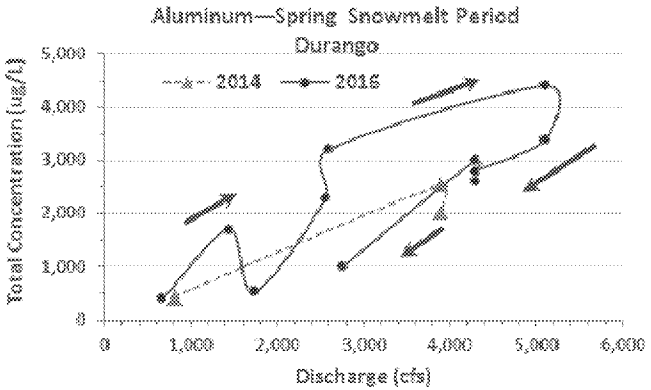
Middle Animas water and sediment appears to be at or lower than historic on average Sept-Oct 2015

OW/Region Review Monitoring

Spring Snowmelt Period 2016 – Water Quality Comparisons
Metal Concentrations in the Animas at Durango

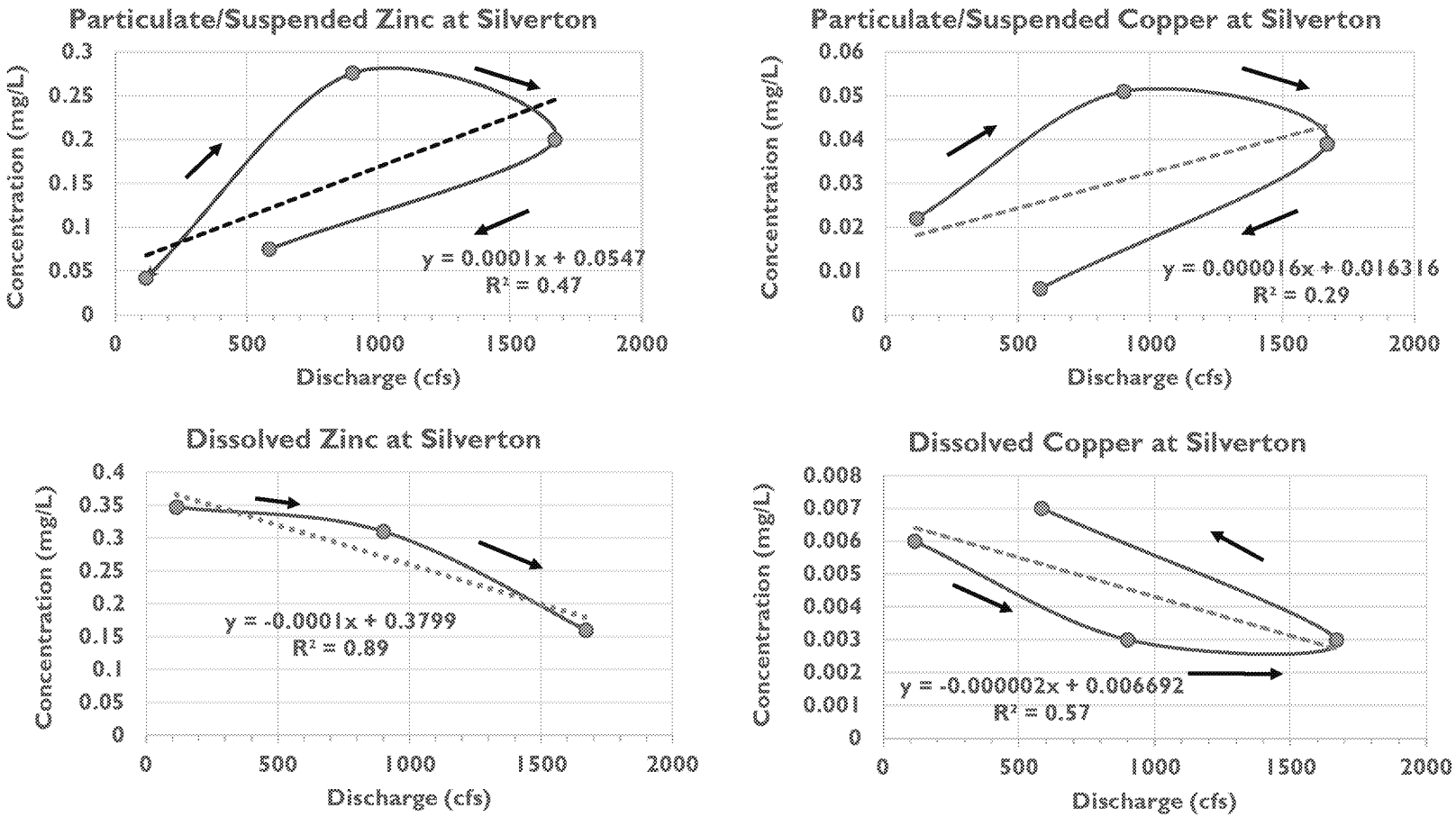






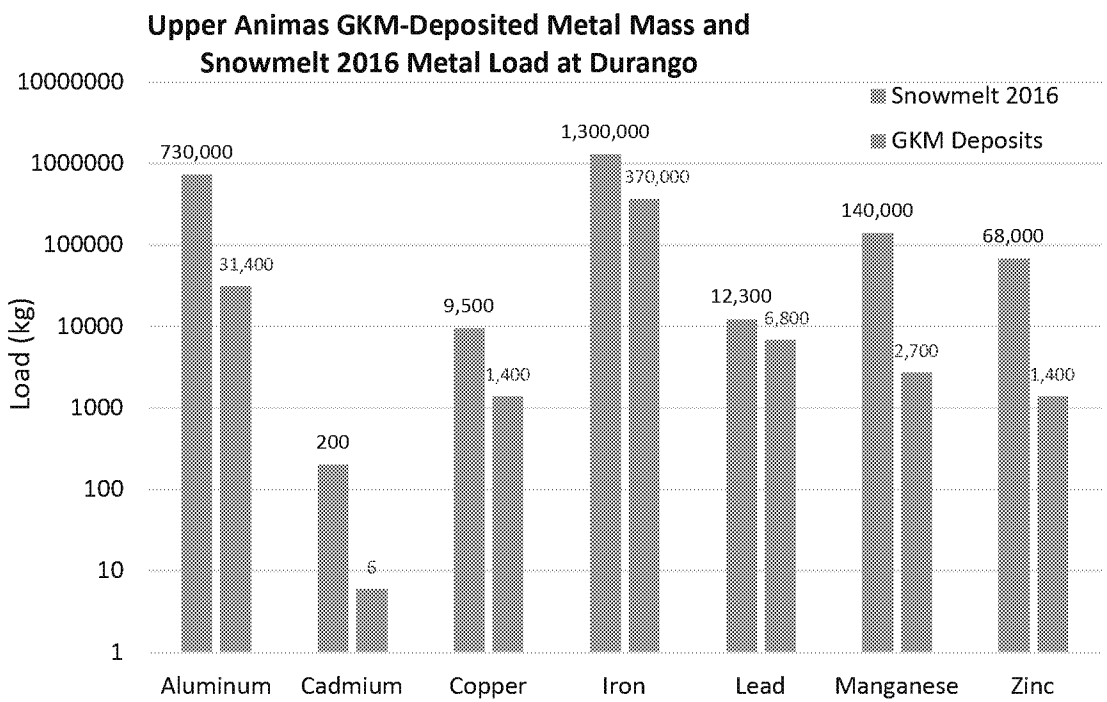
OW/Region Review Monitoring

Metals Behavior in Relation To Flow During Spring Snowmelt Period



Earlier USGS studies showed hysteresis during snowmelt events

Metals mass carried during 2016 Snowmelt Relative to deposits

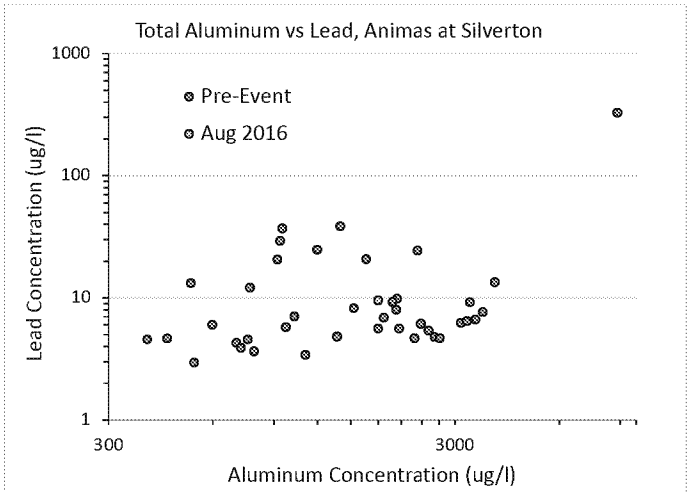


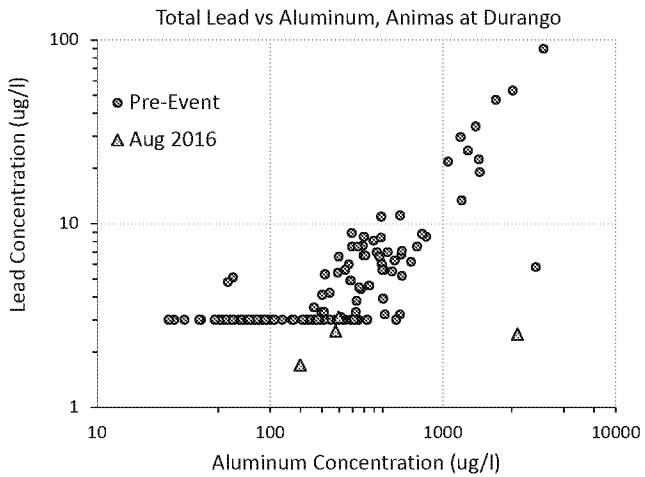
More than enough metals were carried during 2016 snowmelt to account for deposited Gold King mass

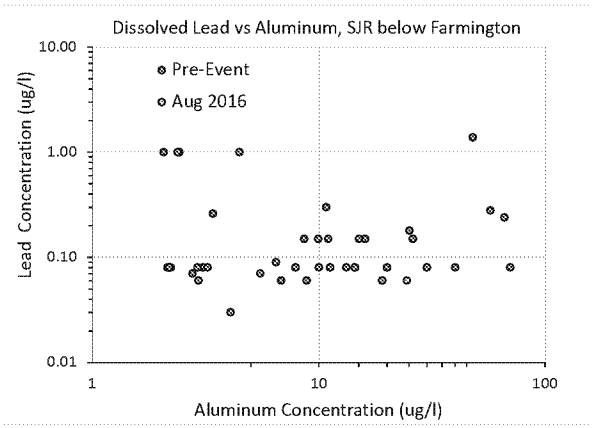
Detailed analysis not emphasized today suggests enough can be attributed to Gold King

Remainder is ongoing contamination

2016 Monitoring Middle Animas







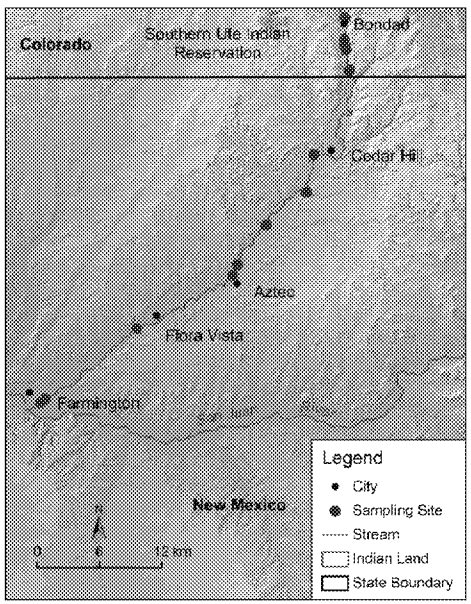
August 2016 data falls into expected background at all sites

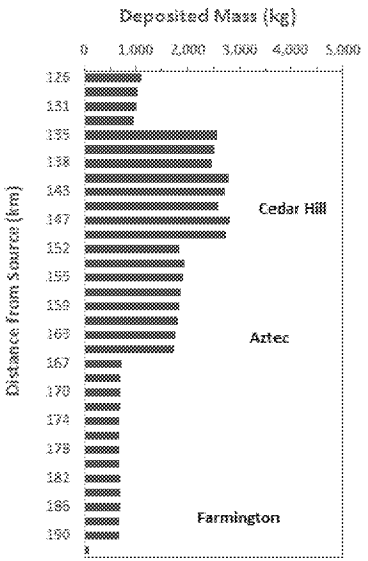
OW/Region Review Monitoring

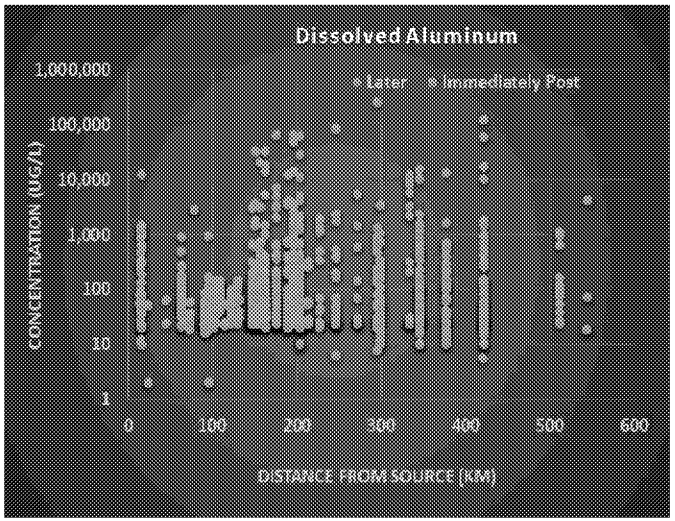
Results for the Animas River at Farmington

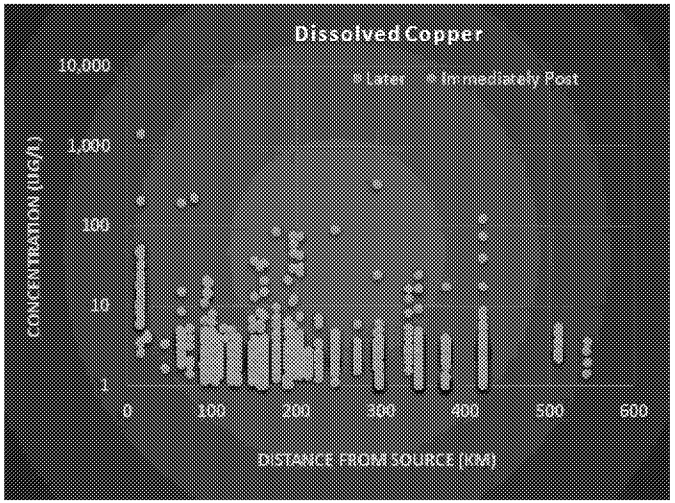
Dissolved Concentrations

Metal	Pre (ug/l)	Post (ug/l)	t-test p-value	Wilcoxon p-value
Aluminum	10	126	0.0002	0.0004
Cadmium	0.05	0.11	0.15	0.27
Copper	2.52	2.49	0.97	0.97
Iron	7	78	0.0003	0.001
Lead	0.22	0.34	0.53	0.52
Manganese	31	28	0.85	0.59
Zinc	12	5	0.14	0.11



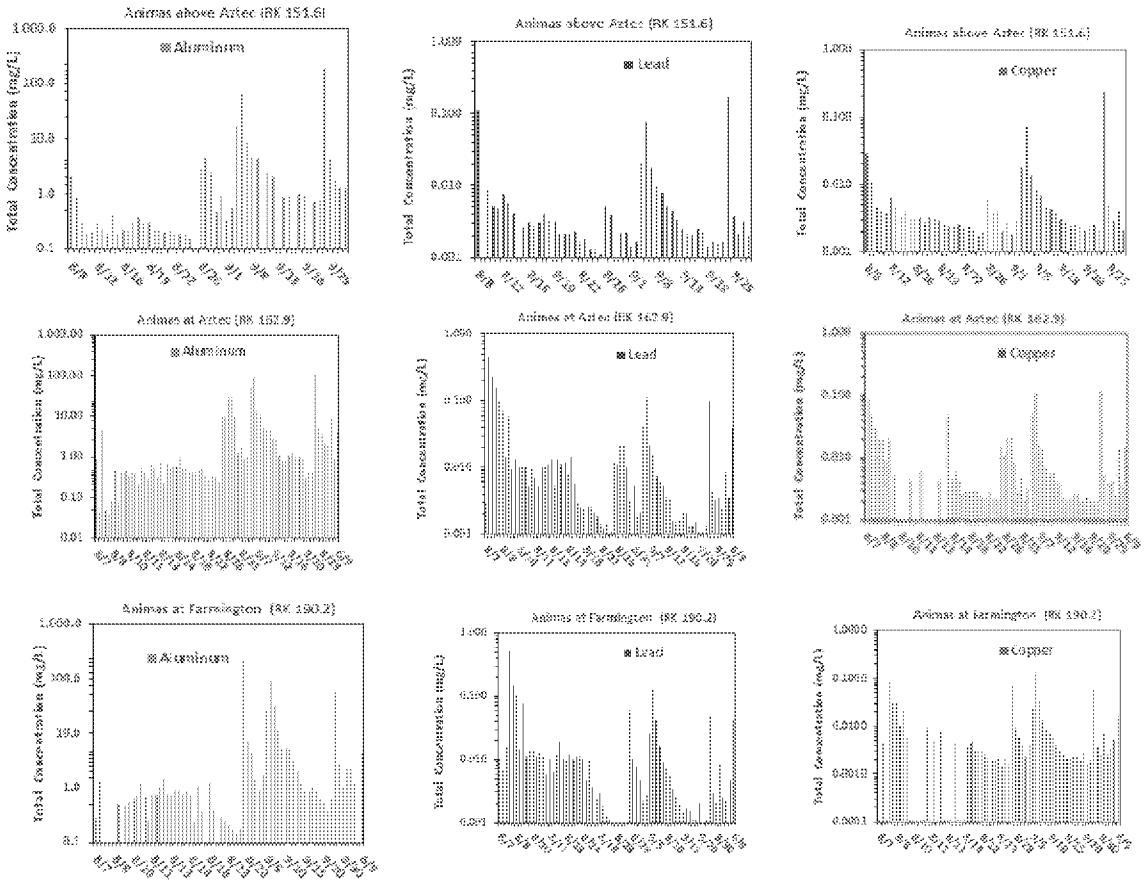






Lower Animas River Post Event

TOTAL WATER CONCENTRATION



OW/Region Review Monitoring

Large storm occurs on August 27

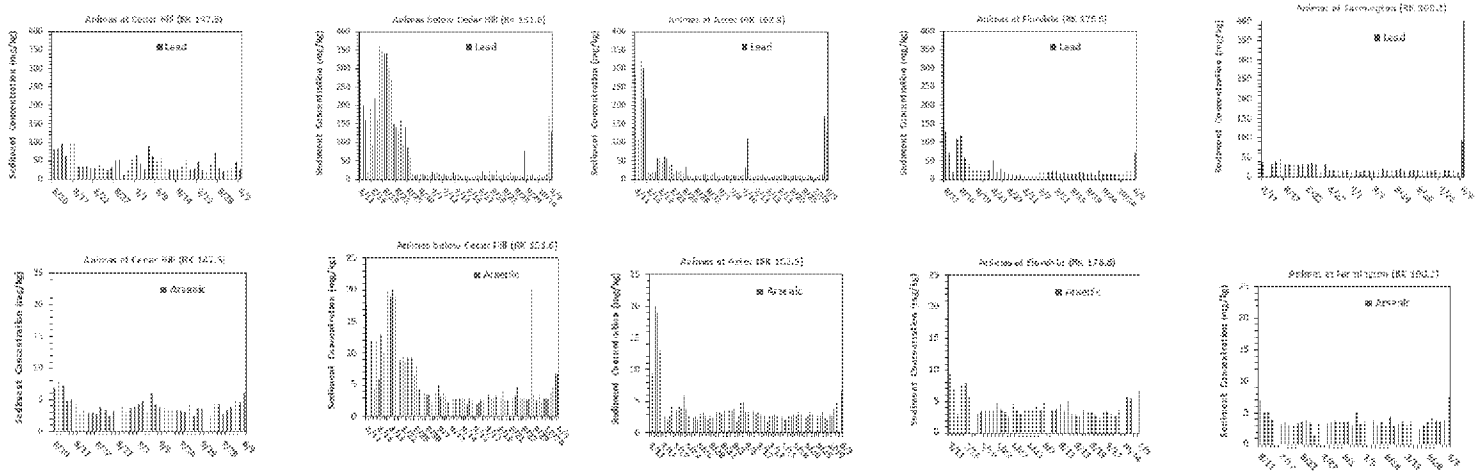
Strong effect on bed sediments and water quality for rest of season

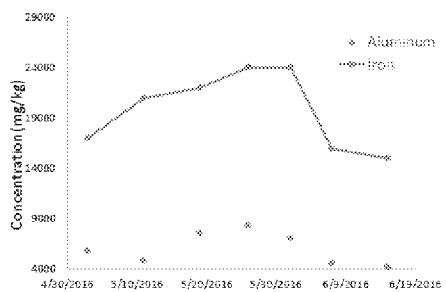
We hypothesize that deposited material (iron and aluminum oxides initially "scavenged" metals from the water. Once deposits were removed in storm, metals in the water increased because no longer sorbed.

Affects from RK 151 to 190.

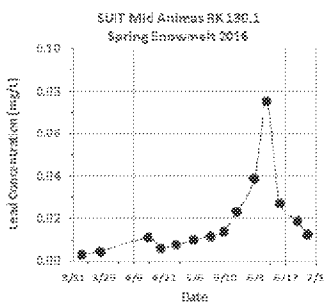
Lower Animas Bed Sediments

RK 147.5 Cedar Hill **RK 151.6** **RK 162.9 Aztec** **RK 176.6 Flora Vista** **RK 190.2 Farmington**





Mid Animas bed during snowmelt period



Clearly deposition zone between 151 and 175

Large storm cleans lower river of deposits

Clear until 2016 snowmelt—shown is one sample collected at peak

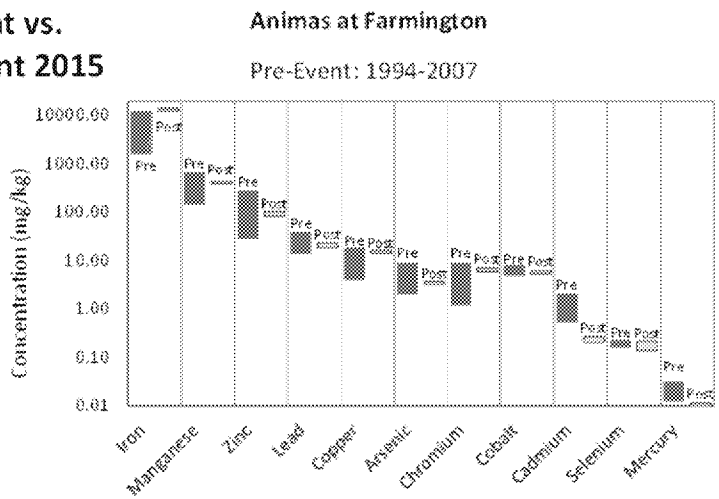
Bed sediment did appear to return to low background in August sample (not on figures yet)

Animas River at Farmington

Pre-event vs. Post Event 2015

Dissolved Concentration — **Animas River at Farmington**

Metal	Pre (ug/l)	SE	Post (ug/l)	SE	t-test p-value	Wilcoxon p-value
Aluminum	10	2.9	126	306	0.0002	0.0004
Cadmium	0.05	0.01	0.11	0.06	0.15	0.27
Copper	2.52	1.1	2.49	0.34	0.97	0.97
Iron	7	1.4	78	220	0.0003	0.001
Lead	0.22	0.30	0.34	0.40	0.53	0.52
Manganese	31	17	28	10	0.85	0.59
Zinc	12	14	5	1.4	0.14	0.11
n=	**9**		**16**			



Pre-event vs. Snowmelt 2016

Bed Sediment Concentration — **Animas River at Farmington**

Metal	Pre-Event (mg/kg)	SE	Fall 2015 (mg/kg)	SE	t-test p-value	Wilcoxon p-value
Aluminum	Not Measured	-	9800	479	-	-
Cadmium	1.1	0.70	0.2	0.02	0.022	0.001
Copper	8.6	3.2	15	0.58	0.47	0.57
Iron	4476	2807	13300	381	0.18	0.12
Lead	23	7.5	21	1.3	0.31	0.34
Manganese	318	145	420	12	0.72	0.51
Zinc	89	68	93	6.0	0.41	0.19
n=	**6**		**46**			

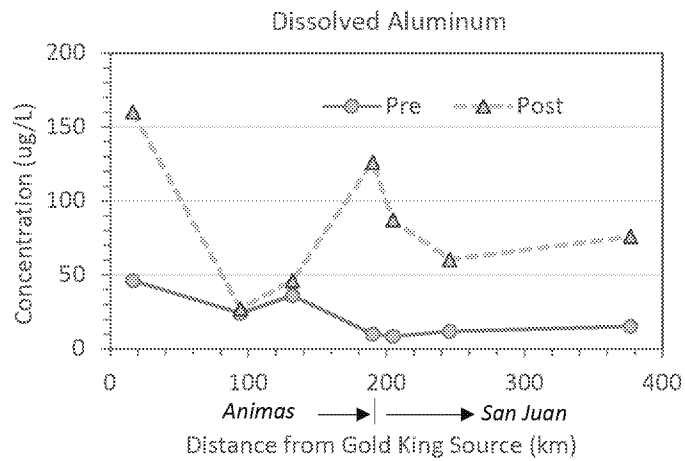
Bed Sediment Concentration — **Animas River at Farmington**

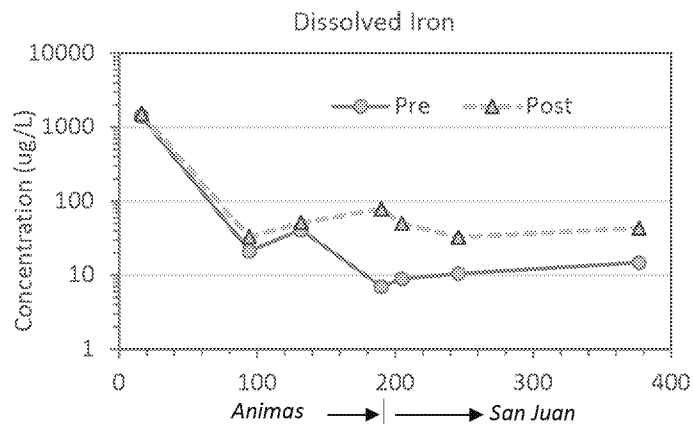
Metal	Pre-Event (mg/kg)	SE	2016 Snowmelt (mg/kg)	z-score	Aug-
Aluminum	Not Measured	-	9500	-	1100
Cadmium	1.1	0.7	0.88	-0.11	0.3
Copper	8.6	3.2	35	3.4	17.5
Iron	4476	2807	17000	1.8	1450
Lead	23	7.5	94	3.9	25
Manganese	318	145	840	1.5	475
Zinc	89	68	350	1.6	120
n=	**6**		**1**		

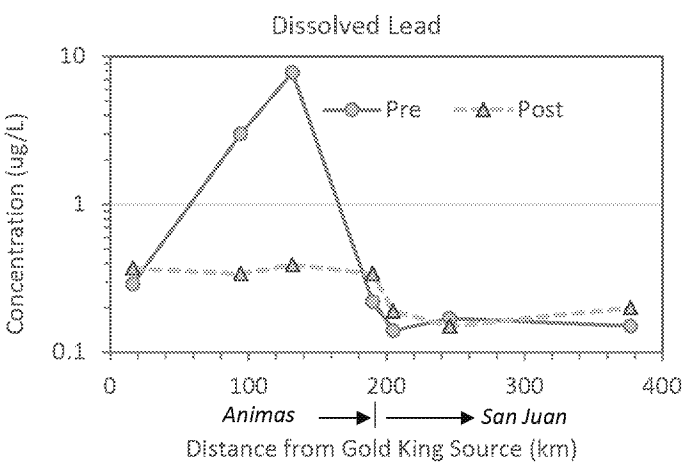
At Snowmelt Peak Aug 16

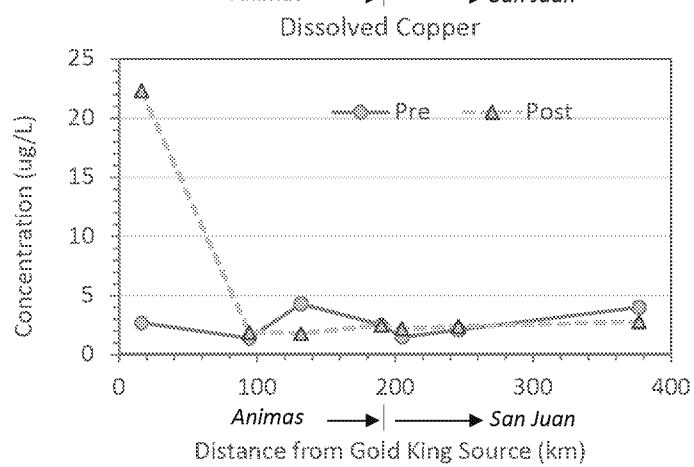
OW/Region Review Monitoring

Fall 2015 water concentrations of Fe and Al relative to pre-event.







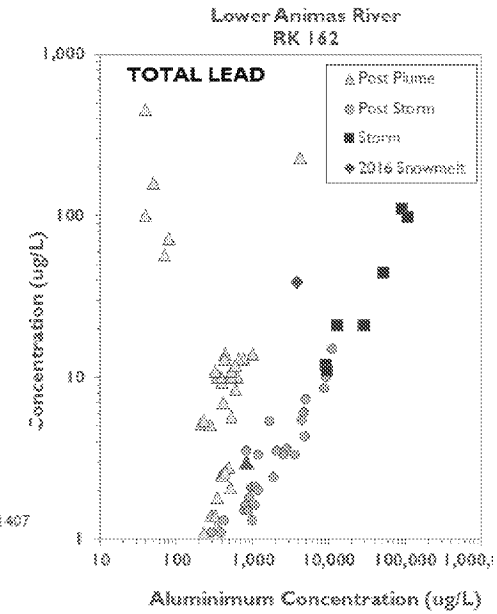


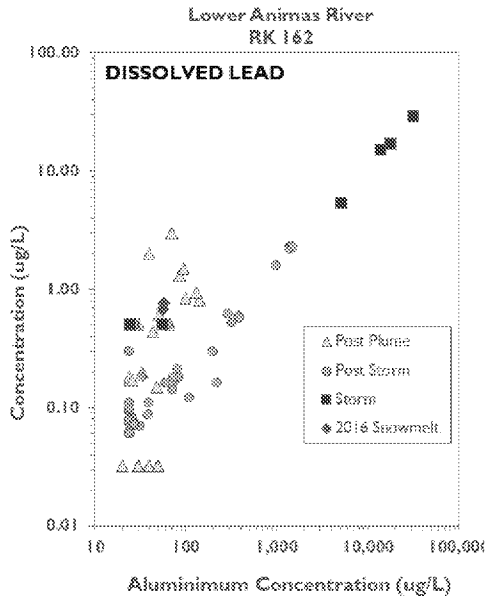
Dissolved iron and aluminum increased in weeks after the release in the lower Animas

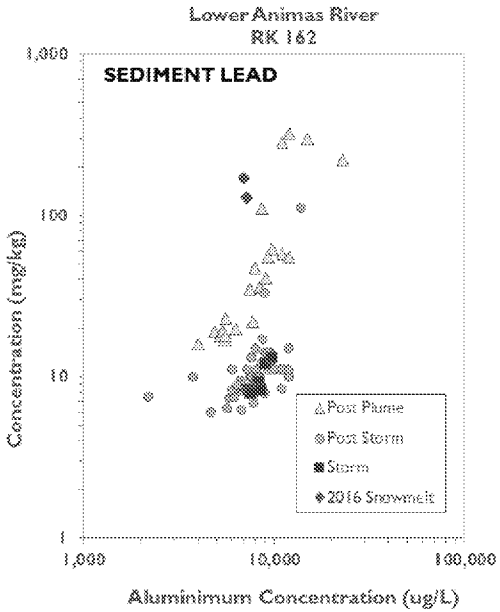
Increased concentrations carried through into San Juan where they passed through but elevated concentrations (no deposition)

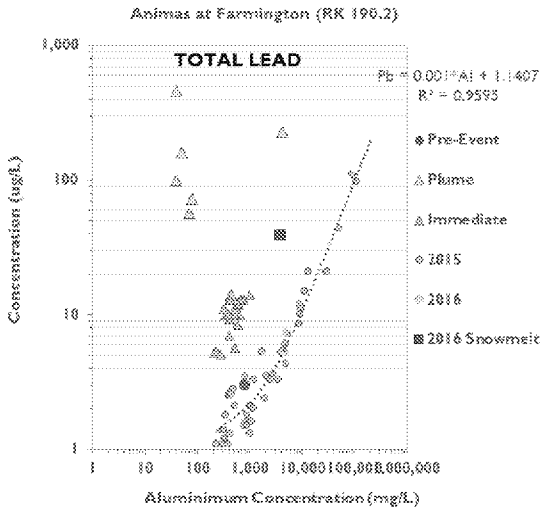
Trace metals not affected in San JUan

Metal Fingerprinting as a diagnostic Lower Animas at 162









Lead NM Dissolved:

aquatic chronic	4.7 ug/L
domestic water	15
livestock	100

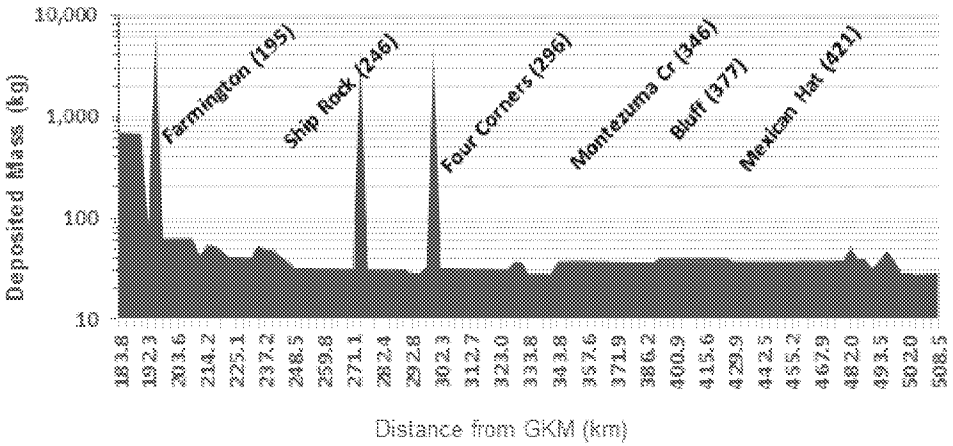
Sediment Region 6 PEC:

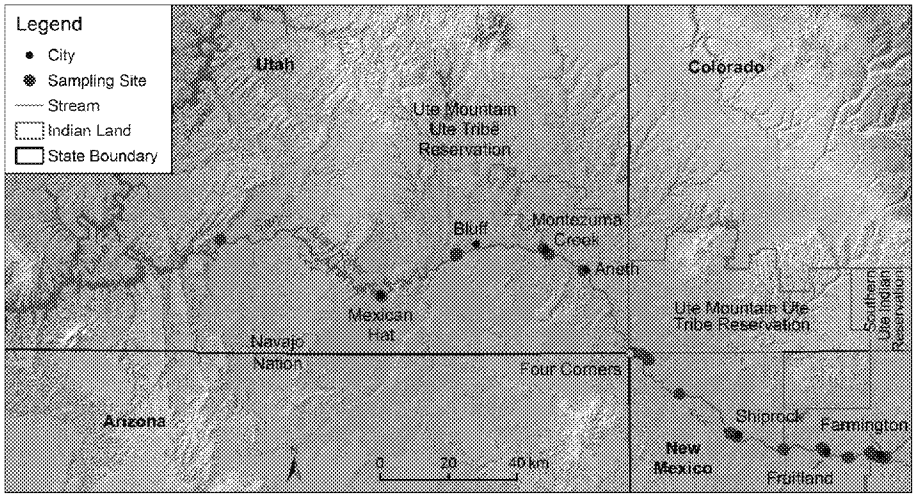
Lead 128

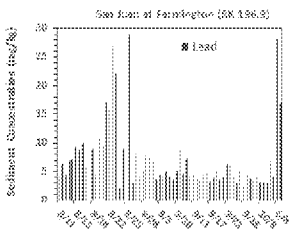
OW/Region Review Monitoring

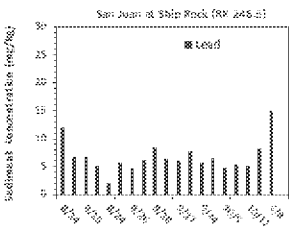
San Juan River

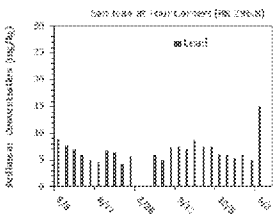
WASP predicted deposition

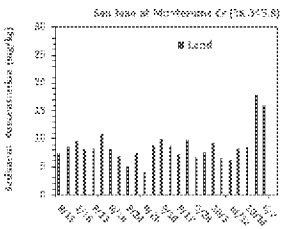


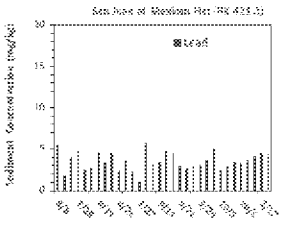


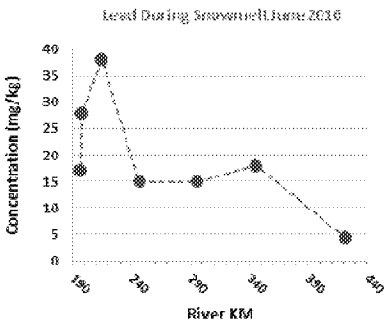












OW/Region Review Monitoring

Bed Sediments: Upper San Juan River – from Farmington to 4-Corners

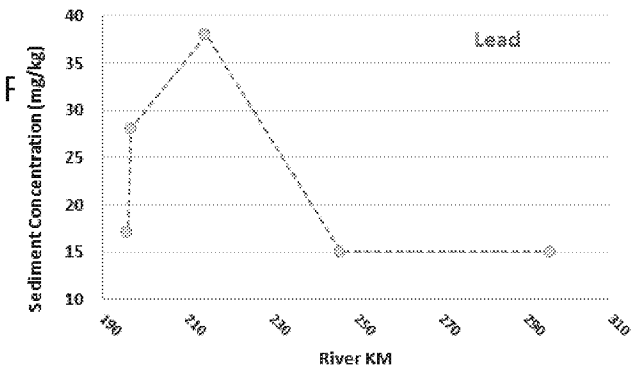
Bed Sediment Concentration — **Upper San Juan River**

Metal	Pre-Event (mg/kg)	SE	Fall 2015 (mg/kg)	SE	t-test p-value	Wilcoxon p-value
Aluminum	Not Measured	-	3950	207	-	-
Cadmium	Predominantly Non-Detects	-	0.055	0.01	-	-
Copper	4.3	1.4	4.5	0.20	0.85	0.66
Iron	3500	1374	6300	214.2	0.004	0.005
Lead	7.1	2.7	5.6	0.28	0.03	0.004
Manganese	165	14	185	4.6	0.3	0.57
Zinc	21	2.6	20	1.2	0.94	0.18
n=	36		175			

Bed Sediment Concentration — **Upper San Juan River**

Metal	Pre-Event Mean (mg/kg)	SE	Spring 2016 Mean (mg/kg)	SE	t-test p-value	Wilcoxon p-value
Aluminum	Not Measured	-	6000	848	-	-
Cadmium	Predominantly Non-Detects	-	0.26	0.06	-	-
Copper	**4**	1	**12**	2.2	0.0023	0.01
Iron	**3,500**	1,374	**11,200**	800	0.0004	0.04
Lead	**7**	3	**21**	4.5	0.005	0.0017
Manganese	**165**	14	**340**	35	0.0003	0.0014
Zinc	**21**	3	**85**	16	0.0003	0.0014
n=	36		5			

During/Post Plume



Immediately after 2016 snowmelt peak

Pre-Event Statistical Comparisons for the San Juan River

Dissolved Concentrations

Upper SJ

Metal	Pre (ug/l)	Post (ug/l)	t-test p-value	Wilcoxon p-value
Aluminum	8.3	87.1	<0.0001	<0.0001
Cadmium	0.31	0.47	Non-Detection Bias	
Copper	1.5	2.2	Non-Detection Bias	
Iron	8.9	50.1	<0.0001	<0.0001
Lead	0.14	0.19	Non-Detection Bias	
Manganese	14.1	10.5	0.11	0.007
Zinc	4.3	3.2	Non-Detection Bias	

Middle SJ

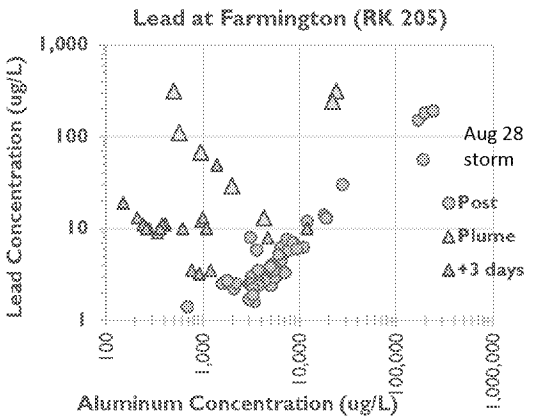
Metal	Pre (ug/l)	Post (ug/l)	t-test p-value	Wilcoxon p-value
Aluminum	11.7	60.3	<0.0001	<0.0001
Cadmium	0.38	0.50	Non-Detection Bias	
Copper	2.1	2.4	Non-Detection Bias	
Iron	10.5	32.4	0.00036	0.0018
Lead	0.17	0.15	Non-Detection Bias	
Manganese	8.3	4.7	0.023	0.04
Zinc	4.1	3.8	Non-Detection Bias	

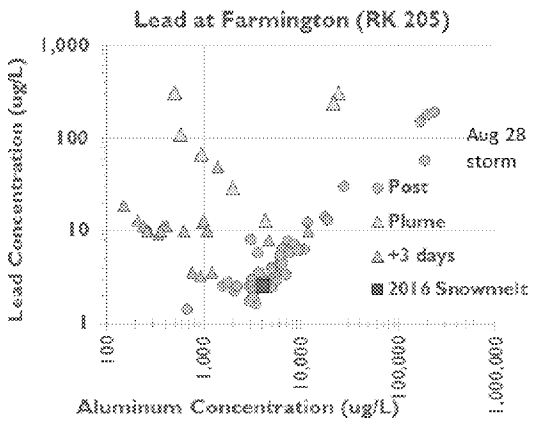
Lower SJ

Metal	Pre (ug/l)	Post (ug/l)	t-test p-value	Wilcoxon p-value
Aluminum	15.1	75.9	<0.0001	<0.0001
Cadmium	0.52	0.50	Non-Detection Bias	
Copper	4.0	2.8	Non-Detection Bias	
Iron	14.8	43.1	0.00027	<0.0001
Lead	0.15	0.20	Non-Detection Bias	
Manganese	4.6	3.0	0.04	0.02
Zinc	5.1	5.2	Non-Detection Bias	

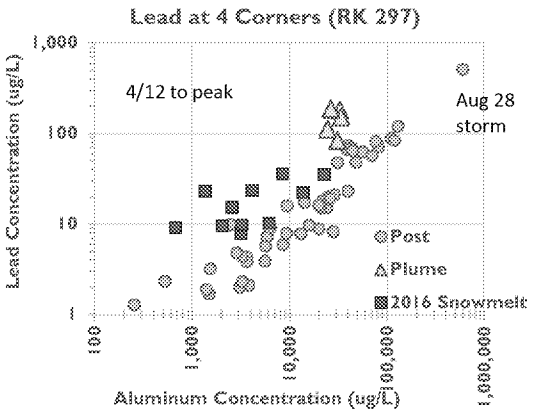
Total Water at Individual Sites in San Juan

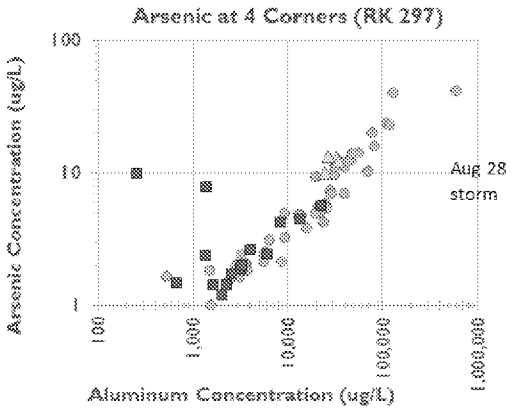
Upper SJ



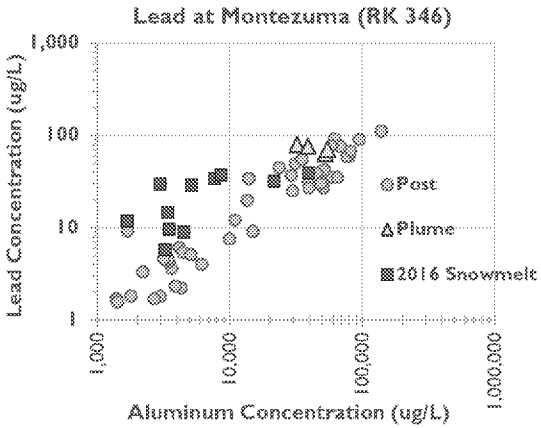


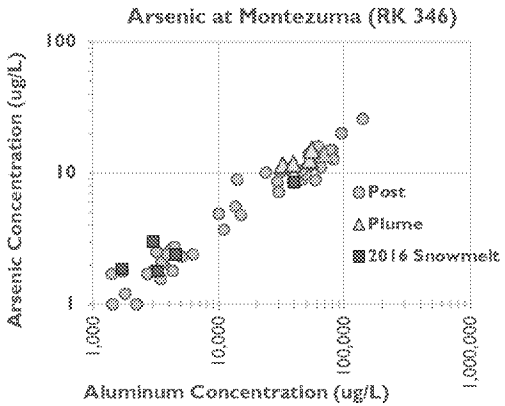
Mid SJ





Lower SJ





OW/Region Review Monitoring

Animas River

Post Event Water Quality Exceedance Count**

** Note that criteria based on hardness assigned same relatively low value by state; likely to overestimate count)

Colorado Animas River

			Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
TOTAL	Domestic Supply 1-Day	Colorado	0	0	0	0	0	4	0	0	0	0	37	0	0	0	0	0	0	0	0	0
	Agriculture	Colorado	0	0	5	0	0	2	0	0	7	0	19	0	100	0	0	1	0	0	0	2
n= 290	Aquatic Acute	Colorado	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Aquatic Chronic	Colorado	65	0	0	0	0	0	0	0	0	108	0	0	0	0	0	0	0	0	0	0

			Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
Dissolved	Domestic Supply 1-Day	Colorado	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Agriculture	Colorado	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n= 309	Aquatic Acute	Colorado	0	0	0	0	0	1	0	0	3	0	0	0	0	0	0	0	0	0	0	8
	Aquatic Chronic	Colorado	0	0	0	0	0	18	0	0	8	0	4	0	1	0	0	5	24	0	0	14

New Mexico Animas River

			Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
TOTAL	Domestic Supply	New Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Irrigation	New Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n= 397	Livestock	New Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Wildlife Habitat	New Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	0	0	0	0
	Aquatic Acute	New Mexico	10	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0
	Aquatic Chronic	New Mexico	4	0	0	0	0	0	0	0	0	0	0	0	0	2	0	21	0	0	0	0

			Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
Dissolved	Domestic Supply	New Mexico	0	0	1	0	2	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0
	Irrigation	New Mexico	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n= 411	Livestock	New Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Wildlife Habitat	New Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Aquatic Acute	New Mexico	0	0	0	0	0	0	1	0	4	0	0	0	0	0	0	0	0	0	0	0
	Aquatic Chronic	New Mexico	0	0	0	0	0	1	3	0	6	0	8	0	0	0	0	0	0	0	0	0

OW/Region Review Monitoring

San Juan River Post Event Water Quality Exceedance Count**

** Note that criteria based on hardness assigned same, relatively low value by state; likely to overestimate count)

New Mexico San Juan River

TOTAL n= 219

		Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
Domestic Supply	New Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Irrigation	New Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Livestock	New Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wildlife Habitat	New Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0
Aquatic Acute	New Mexico	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Aquatic Chronic	New Mexico	136	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0

Dissolved n= 223

		Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
Domestic Supply	New Mexico	0	0	2	0	4	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0
Irrigation	New Mexico	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Livestock	New Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Wildlife Habitat	New Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aquatic Acute	New Mexico	0	0	0	0	0	0	7	0	8	0	0	0	0	0	0	0	0	0	0	0
Aquatic Chronic	New Mexico	0	0	0	0	0	7	7	0	9	0	9	0	1	0	0	0	0	0	0	0

UTAH San Juan River

TOTAL n= 300

		Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
Domestic Source	Utah	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Recreational	Utah	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Irrigation (short-term)	Utah	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Irrigation (long-term)	Utah	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agricultural Uses	Utah	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Livestock	Utah	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Warm Water Fish 1-hr	Utah	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Warm Water Fish 4-day	Utah	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Dissolved n= 302

hardness at 300

		Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
Domestic Source	Utah	0	0	2	2	3	0	2	0	0	0	5	0	0	0	0	0	0	0	0	0
Recreational	Utah	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Irrigation (short-term)	Utah	4	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Irrigation (long-term)	Utah	13	0	0	0	0	0	1	2	1	9	0	0	11	0	0	0	0	0	2	0
Agricultural Uses	Utah	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0
Livestock	Utah	13	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0
Warm Water Fish 1-hr	Utah	36	0	0	0	0	0	0	0	4	18	0	0	0	0	1	0	0	0	0	2
Warm Water Fish 4-day	Utah	0	0	0	0	0	6	0	0	7	18	11	0	0	0	1	3	0	0	0	2

OW/Region Review Monitoring

San Juan River Post Event Water Quality Exceedance Count**

** Note that criteria based on hardness assigned same, relatively low value by state; likely to overestimate count)

Navajo Nation San Juan River

			Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Molybdenum	Nickel	Potassium	Selenium	Silver	Thallium	Vanadium	Zinc
TOTAL	Domestic Water Supply	Navajo Nation	0	0	154	100	116	14	18	0	0	0	260	0	0	0	0	0	0	19	0	0
	Primary Human Contact	Navajo Nation	0	0	25	0	0	0	0	0	0	0	260	0	0	0	0	0	0	0	0	0
n= 589	Secondary Human Contac	Navajo Nation	0	0	0	0	0	0	0	0	0	0	260	0	0	0	0	0	0	0	0	0
	Agricultural Supply	Navajo Nation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0
	Livestock Watering	Navajo Nation	0	0	0	0	0	0	0	0	0	0	53	0	0	0	0	0	0	0	0	0
	Acute Ag and Wildlife	Navajo Nation	549	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Chronic Ag and Wildlife	Navajo Nation	583	0	0	0	0	0	0	0	0	0	0	0	0	0	0	148	0	0	0	0
Dissolved	Domestic Water Supply	Navajo Nation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n= 556	Primary Human Contact	Navajo Nation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Secondary Human Contac	Navajo Nation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Agricultural Supply	Navajo Nation	22	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	3	0
	Livestock Watering	Navajo Nation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
	Acute Ag and Wildlife	Navajo Nation	0	0	0	0	0	1	0	0	16	0	1	0	0	0	0	0	0	0	0	6
	Chronic Ag and Wildlife	Navajo Nation	0	0	0	0	0	169	0	0	21	0	23	0	0	2	0	0	0	0	0	6

Ute Mountain Ute Tribe San Juan River

			Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Molybdenum	Nickel	Potassium	Selenium	Silver	Thallium	Vanadium	Zinc
TOTAL	Drinking Water	Ute Mountain Ute	205	0	209	0	0	0	1	0	0	0	50	0	0	2	0	0	0	0	0	0
	Ceremonial, other uses	Ute Mountain Ute	0	0	209	0	0	0	6	0	0	0	50	0	0	2	0	0	0	0	0	0
n= 209	Fish consumption	Ute Mountain Ute	0	0	209	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Agriculture	Ute Mountain Ute	0	0	0	24	0	0	2	0	1	0	10	0	0	1	0	3	0	0	0	0
	Acute Warm Water	Ute Mountain Ute	194	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
	Chronic Warm Water	Ute Mountain Ute	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0
Dissolved	Drinking Water	Ute Mountain Ute	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n= 209	Ceremonial, other uses	Ute Mountain Ute	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Fish consumption	Ute Mountain Ute	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Agriculture	Ute Mountain Ute	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Acute Warm Water	Ute Mountain Ute	0	0	0	0	0	1	0	0	3	0	1	0	0	0	0	0	0	0	0	1
	Chronic Warm Water	Ute Mountain Ute	0	0	0	0	0	61	1	0	7	0	7	0	0	205	0	0	29	0	0	1