2018 Oral Abstracts

Bonita Peak Mining District 2016 Benthic Macroinvertebrate Assessment

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Abstract 1

The Bonita Peak Mining District (BPMD) was designated by the Environmental Protection Agency (EPA) as a Superfund site on the National Priorities List in 2016. The EPA identified 48 distinct contaminant sources related to mining activities that warrant further investigation. The 48 sources are scattered throughout the Upper Animas River and tributaries in San Juan County, Colorado. BPMD is located in a highly-mineralized zone of the San Juan Mountains where high metal concentrations from natural and mine-related sources have contributed to a long history of degraded water quality in the Upper Animas River and tributaries. Numerous studies have documented the impacts to benthic macroinvertebrates (BMI) from metal contamination in this region, particularly for the Animas River and its tributaries, but the last spatially comprehensive evaluation of BMI distribution in the Upper Animas watershed was conducted in the mid-1990s by Anderson (2007a). While this historical information is valuable, an updated evaluation was warranted, given that remediation projects that have been completed in the watershed during the past 20 years. Furthermore, several of the contaminant sources identified by the EPA for inclusion in the Superfund site are located in subwatersheds where benthic communities were not surveyed by Anderson in the mid-1990s.

For this research, we conducted surveys throughout the Upper Animas River and Mineral Creek watersheds across a gradient of metal exposure to BMI through water and sediment to accomplish the following objectives: 1) Provide a spatially comprehensive evaluation of the current condition of BMI communities throughout BPMD; 2) Document metal concentrations of BMI tissue, which are reflective of overall metal bioavailability; 3) Characterize the physical habitat for aquatic life at surveyed sites; and 4) Examine what environmental factors are most responsible for differences in benthic communities across BPMD.

Data from our 2016 surveys suggest the following conclusions:

- BMI communities within BPMD vary from reach to reach, ranging from sparsely populated sites with substantial metal contamination to sites with abundant, diverse communities that reflect minimal exposure to metal contamination.
- The most robust, diverse benthic communities were observed at sites located on tributaries (Cunningham Creek, Maggie Gulch, Picayne Gulch, Bear Creek, and Mill Creek), on the South Fork of Mineral Creek, and on the uppermost reaches of the South and North Forks of the Animas River. We observed the lowest benthic diversity and abundance in two general areas: 1) at sites on Mineral Creek from the Middle Fork of Mineral Creek to the Animas River; 2) on the South Fork of the Animas River immediately upstream of the confluence with Eureka Gulch; and 3) at sites near Animas Forks and throughout the West Fork of the Animas River.
- In some locations, healthy BMI communities sharply decline in diversity and abundance over a relatively short distance.
- Several sites that currently do not have an aquatic life use designation had benthic communities that, based on Multi-metric index (MMI) (CDPHE 2010b) scores, would be in attainment of a class two aquatic life use designation. Many sites in BPMD have benthic communities that would not meet an aquatic life use designation.

- We found a gradient of sensitivity among the three metal-sensitive BMI families that directly corresponds with increases in several metals and minerals in BMI tissue, pore water, and surface water. The loss or addition of each of the three metal-sensitive families over time could be a valuable indicator for assessing the successfulness of remediation efforts.
- We used statistical correlation and non-metric multi-dimensional scaling ordination (NMS) to examine the correlations between environmental factors and benthic communities in BPMD. There was broad agreement between the two methods that surface water and pore water metal and mineral concentrations more strongly influenced BMI communities than other environmental parameters. There was a weaker relationship between BMI communities and concentrations of metals and minerals in sediment.
- Multiple lines of evidence, including statistical correlation, NMS, and hazard quotients, suggest that surface water concentrations of Al, Cd, Cu, and Zn likely shape the distribution and community composition of BMI populations across BPMD. Further research, such as experimental bioassays, could confirm if these and other metals that correlated with BMI metrics have a direct causative effect on BMI communities.

Long-term monitoring of benthic communities has been demonstrated as an effective tool for detecting improvements in water quality and the health of aquatic life following mining-related remediation efforts (Clements et al. 2010). To assess the success of remediation efforts in BPMD, we recommend an annual, long-term monitoring program that targets a subset of the 2016 sites across a gradient of metal exposure. BMI monitoring programs that are long-term, and ideally occur on an annual frequency, are more effective at isolating the direct effects of anthropogenic activities from natural variability of communities. Sites selected for continued monitoring should be located in close downstream proximity to remedial actions. In addition, we recommend that Animas River sites downstream of Silverton be included in a long-term monitoring plan to determine if remediation efforts translate to down-canyon improvement in the health of aquatic life. Monitoring assessment should focus on BMI metrics that most strongly correlated with metal exposure, which include total richness, density, EPT, MMI, and the richness of metal sensitive families.

Morphology and chemistry of reservoir sediments in the City of Aztec, Drinking-Water Reservoir #1

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Abstract 2

Trace elements, including metals and metalloids, adsorbed to or precipitated on suspended sediments deposited in water supply reservoirs are a potential source of contamination to communities that depend on stored water for agricultural and public supply. Metals such as lead and aluminum are present in both the water and suspended sediments of the Animas River upstream of the diversion for the Aztec Ditch, which supplies the City of Aztec Drinking-Water Reservoir #1. The reservoir has accumulated sediments since the 1940s. There is a need to understand historical metals deposition associated with reservoir sediments and to evaluate the potential mobility of metals from the sediments. Concern about the presence and concentration of legacy metals followed the Gold King Mine release in 2015. Knowledge acquired regarding legacy metals and metal mobility in reservoir sediments will help in understanding: 1) metals contamination to the Animas River and San Juan River watersheds over time; 2) potential impacts to treatment processes; and 3) treatment and source-water protection options. The main objectives of this study are to identify constituents of concern in the reservoir sediment, evaluate the concentrations of those constituents over time (with depth in the reservoir), and determine the potential effects on drinking water treatment.

Examining the Rights-of-Way Process for Indian Allotment Lands Navajo-Gallup Water Supply Project

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Abstract 4

This research examines the Rights-of-Way process for Navajo allotment lands. Today, there are 566 Indian nations. Each nation has its own history relating to Indian allotment lands. In the 1880s, allotment lands were created through federal Indian policy as tribal trust lands were allotted to individual Indian tribal members of various nations. This research examines a real example of the Rights-of-Way process for Navajo allotment lands as it relates to the Navajo- Gallup Water Supply Project. Land access for allotment lands is questionable. Water access for the Water Supply Project secured and supplied through the recent Navajo Nation San Juan River Water Rights Settlement. The water pipeline alignment will cross six types of land. Each type has its own Rights-of-Way process. This research will examine the current Rights-of-Way process for Navajo allotment lands. This research applied three methods to identify the current Rights-of-Way process for allotment lands. A document review for existing federal and tribal policy for allotment lands finds that the Navajo Nation does not have authority over allotment lands. The U.S. Bureau of Indian Affairs has authority over allotment lands. For Navajo allotment lands, the Rights-of-Way process is initiated by the U.S. Bureau of Reclamation for the Water Supply Project. The Bureau of Indian Affairs will approve or disapprove Rights-of-Way easement. The results show the current Rights-of-Way process for Navajo allotment land is quite general. After examination, the research identifies areas of improvement for the current the Rights-of-Way process. This research provides recommendations to improve and update the current Rights-of-Way process starting with a better framework to understand the Rights- of-Way process for Navajo allotment lands.

Post Gold King Mine Release Water Quality in the Animas and San Juan River During Spring Snowmelt Updated with 2017 Water Sampling

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Abstract 5 – Both Oral and Poster

An accidental breach of the Gold King Mine on August 5, 2015 released approximately 500,000 kg (455 tons) of particulate and dissolved metals into the Animas River at Silverton, Colorado. The released mass flowed through the Animas and San Juan Rivers as a slurry of acidic water with high concentrations of particulate and dissolved metals that declined rapidly as the plume travelled due to dilution, geochemical reactions, and deposition. Ninety-five percent of the GKM release mass was deposited in the rivers in the form of iron and aluminum oxides. The mineral deposits were later re-entrained and moved to the receiving waters in Lake Powell, UT in timesteps that varied by location. The metals left behind in the lower Animas and San Juan Rivers amounted to 10% of the initial release and were remobilized within 3 weeks of the initial event. The mass deposited in the upper Animas River between Silverton and Durango, CO comprised 85% of the initial release and remained in place for 8 months until it was washed through the rivers during snowmelt runoff the following spring. Based on extensive post-event monitoring, EPA concluded that all the GKM released metals were delivered to Lake Powell by the time the 2016 snowmelt season ended (USEPA 2016; Sullivan *et al.* 2017). EPA monitored water quality during snowmelt in 2017 to further evaluate that hypothesis.

Our assessment used several approaches to characterize and pinpoint GKM-related metals within the typical seasonal patterns of metals transport and the historic effects of mining-related contamination in the rivers. Metal concentrations before and after the GKM event were compared, depending on the availability of data. Reclamation efforts in the mining impacted segment of the Animas from Silverton to Durango have generated an extensive database for comparison, while pre-GKM data is relatively sparse in the lower Animas and San Juan Rivers. Accounting for the GKM mass was accomplished with sampled metal concentrations and flow data available at well distributed USGS gages. A simple "finger printing" technique using the relationships among metals available in most water and sediment samples was very effective for identifying the Gold King release within the background concentrations normally transported by the rivers.

Snowmelt sampling in 2016 found that most of the GKM metals were mobilized and transported episodically from April through June (U.S. EPA 2016). Increased metals concentrations were pronounced in the upper Animas River where most of the release had been deposited.

Elsewhere, the fingerprinting technique could detect GKM release metals as they passed through the rivers even though concentrations were quite low and within state water quality criteria. The excess metals mass attributed to the GKM release that was delivered to Lake Powell during 2016 snowmelt was in reasonable agreement with the estimated deposition within the river.

However, careful comparison to historic data indicated that an additional ~ 110,000 kg of particulate material that had apparently deposited in Cement Creek during the initial release was remobilized during peak runoff, bringing the total GKM release to the Animas River to ~ 600,000 kg (550 tons). This release value was consistent with the previously reported estimated delivery to Lake Powell in 2016 (U.S. EPA 2016).

Metals concentrations during 2017 snowmelt were well within their typical ranges observed prior to the GKM release at all locations within the Animas and San Juan Rivers. There were no lingering GKM release effects

detectable in concentrations or with the fingerprinting technique. Within the 20-year record available in the upper Animas, the total and dissolved concentrations of many metals during snowmelt reached historic lows in 2017, especially copper and zinc that have been shown to impact aquatic communities within this segment (Figure 1). Lower concentrations were only partially accounted for by the removal of metals at the treatment plant installed by EPA in Cement Creek after the GKM release.

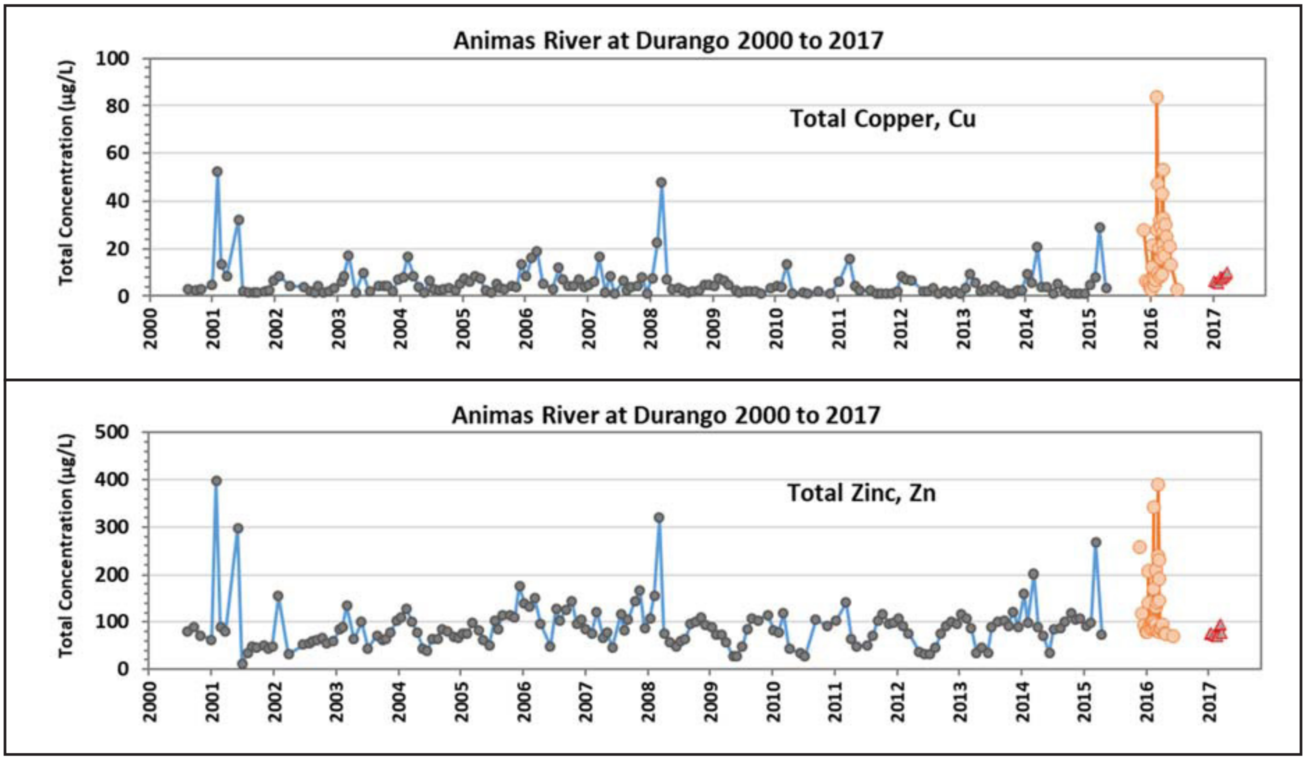

Figure 1. Record of total copper and zinc concentrations in the Animas River at Durango from 2000 to 2017. Data was composited from samples collected by Colorado River Watch, Colorado Department of Public Health and Environment, and U.S. EPA Region 8. The GKM release and Fall 2015 data are not included in these figures to emphasize the movement of metals during 2016 snowmelt from March 1 to June 30. (See U.S. EPA 2016 for release event concentrations)

References

U.S. EPA. 2016 Analysis of the Transport and fate of metals released from the Gold King Mine in the Animas and San Juan Rivers (Final Report). U.S. Environmental Protections Agency, Washington. D.C. EPA/600/R-16/296. Available at: https://www.epa.gov/goldkingmine/fate-transport-analysis.

Sullivan, K., M. Cyterski, C. Knightes, J. Washington, S. Kraemer, L. Prieto, B. Avant. 2017. An overview of the Gold King Mine Release and its transport and fate in the Animas and San Juan Rivers. Abstract. Presented at the New Mexico Water Institute 2nd Annual Gold King Mine Release Workshop. Held June 18-22, Farmington, NM.

Communication of Environmental Risks to the Public

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Abstract 6

Complex sites involving multiple contaminants, exposure pathways and receptors pose challenges in communicating risks to the public. For each contaminant, there can be numerical standards and guidelines for different media including groundwater, surface water, drinking water, sediment, air, and the tissue of crops, livestock, fish, game animals, and wildlife. Within each media, there may be different standards and guidelines for different exposure pathways, exposure durations, receptors, and jurisdictions. With regard to lead, alone, at least 18 standards and guidelines exist for various media.

Standards for Lead in Water (mg/L)

Drinking Water	Ground Water	Surface Water Aquatic Life Acute	Surface Water Aquatic Life Chronic	Surface Water Irrigation	Surface Water Livestock Watering
0.015	0.05	0.14	0.005	5	0.1

Risk Screening Levels for Lead in Sediment/Soil (mg/kg)

Human Health Residential	Human Health Industrial	GKM Human Health Recreational	Flora	Invertebrates	Birds	Mammals
400	800	20,000	120	1,700	11	56

Standards and Guidelines for Lead in Air, Food and Children's Blood

Residential Air (ug/m^3)	Corn & Fruiting Vegetables (mg/kg)	Cattle, Pigs and Sheep (mg/kg)	Fish (mg/kg)	Children's Blood (ug/dL)
0.15	0.05	0.1	0.3	5

Maintaining scientific accuracy while creating public trust in the authoritativeness of dynamic information and competing safety thresholds was the challenge for both emergency response and long-term protection of the affected citizenry following the August 5, 2015 Gold King Mine (GKM) Spill. In New Mexico, downstream from the release of millions of gallons of GKM wastewater, residential riverfront and near-river populations were substantially greater than in other jurisdictions. The demographic varied widely ranging from homeless riverfront campers, Diné and other farmers, working-class homeowners, to wealthy vacation-home owners. Risk-based soil screening levels based on potential recreational exposures were administered in jurisdictions upstream from New Mexico. These recreational safety thresholds, however, were deemed to be insufficiently protective for residential areas in New Mexico and created controversy among competing jurisdictions.

An "Exposure and Risk Dashboard" is used to inform New Mexico residents of the Animas and San Juan Watersheds of various contaminant exposure pathways and relative risks. The Dashboard addresses potential exposure pathways involving public drinking water supplies, private domestic wells, water hauling, use of river water for domestic supply, irrigation and livestock watering, livestock, crop and fish tissue, sediment, and recreational activities. For each pathway, a green, yellow and red color system denotes "safe', "use caution" and "unsafe" risk levels, respectively. The holistic Dashboard also addresses contaminants and risks from pre-existing conditions and sources other than mining and milling sites, including pathogens, nitrate, and polychlorinated biphenyls (PCBs) in surface water, sediment, and/or fish tissue.

The use of untreated river water for domestic supply, known to occur in the region for example, is identified as an unsafe practice.

Safe	Use Caution	Unsafe

Potential Exposure Pathway	Risk Level	Explanation
Public Drinking Water Supplies		Public drinking water supplies are subject to multiple protective requirements of the federal Safe Drinking Water Act (SDWA) and, with one exception, are presently safe for all uses. These requirements include: infrastructure construction standards; solids settling and treatment; disinfection; treated water testing; and New Mexico Environment Department (NMED) inspections. The Harvest Gold water system remains on a boil water advisory for reasons unrelated to the GKM spill. For more information on public drinking water systems, please visit the Drinking Water Watch website.
Private Domestic Wells		Private domestic wells are not subject to the protective requirements of the federal SDWA. Many private wells were not constructed in a sanitary manner or have deteriorated as the well has aged. These wells are at risk of contamination by bacteria, parasites, or viruses. See Fact Sheet on disinfecting a domestic well with shock chlorination. High levels of manganese, iron, sulfate, and total dissolved solids existed in some wells prior to the Gold King Mine (GKM) spill. Elevated lead has been detected in private water systems that have galvanized steel plumbing components or lead solder. Following the GKM spill NMED tested more than 600 private domestic water wells in San Juan County, NM. There is no evidence that the GKM spill contaminated any water wells in New Mexico. NMED and the N.M. Bureau of Geology continue to monitor private domestic wells for evidence of mining and milling contamination.
River Water for Domestic Supply		Untreated river water should never be used for domestic supply, even if there are not visible signs of contamination. When untreated water is consumed from surface sources there is a risk of ingesting harmful bacteria, parasites, or viruses. Untreated river water also may contain high levels of lead and arsenic when spring runoff or storm events stir up contaminated river sediments.
Water Hauling		If you haul water for drinking and cooking, it is recommended that you use commercial bottled water, or obtain water from a public water supply system. Hauling untreated water from a ditch, river, lake, spring or private well is not recommended. See Fact Sheet on safe water hauling practices.

Animas and San Juan Rivers, Exposure and Risk Dashboard for Water-Supply Pathways

Revisiting eutrophication data from the Animas River – What happens to stream algae during "Critical Low Flows"?

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Abstract 7

Eutrophication is the over-fertilization of a water body, leading to disruptions in algae populations which can cause depletions of dissolved oxygen, changes to aquatic substrate and habitat, and aesthetic nuisances. Numerous sampling efforts have attempted to characterize and assess nutrient loads in the Animas River and infer their effects on the growth of benthic stream algae and macrophyte communities, known as periphyton.

This presentation will review data collection efforts from 2002 to present, which include ambient nutrients (phosphorus and nitrogen), periphyton analysis (chlorophyll-a and nitrogen isotopes), dissolved oxygen, and pH.

Stream algae is generally considered to be at "nuisance" levels when areal biomass exceeds 10 ug/cm^2 chlorophyll-a (chl-A). A 2006 synoptic study on the Animas River found nuisance levels on several reaches of the Lower Animas: mean chl-A between Cedar Hill and Aztec was 12.46 ug/cm^2, 130.96 ug/cm^2 between Aztec and Flora Vista (an order of magnitude higher than the nuisance benchmark), and 39.03 ug/cm^2 between Flora Vista and Farmington. The flows in the river during that study were between 200 and 400 cfs. As flows decline, less algae is scoured from the rocks and biomass has the potential to build up – a high probability for 2018.

While there have been few follow-up studies that measured algal biomass, photographs can provide a proxy to estimate whether nuisance levels have been reached (examples from 2002, 2012, 2018). Daily fluctuations in dissolved oxygen (DO) and pH can also give insight into the photosynthetic metabolism of periphyton communities and whether they are affecting the water column. Continuous pH data is now available at several USGS gages on the Animas River.

The Animas River from Farmington to Aztec (Estes Arroyo) is subject to a total maximum daily load (TMDL) for nutrients, and the Animas from Estes Arroyo north to the SUIT boundary/CO state line has a TMDL for total phosphorus. TMDLs are designed to limit pollutant inputs to a water body to protect the system in the event it reaches a "critical low flow" condition. At higher flows, pollutants may be diluted to an extent where they do not actually cause observable negative effects, but if the same pollutant loads enter the river when its dilution capacity is diminished, the conditions will be ripe for negative consequences.

This presentation will discuss the TMDL development process, as well as the subsequent high intensity nutrient sampling in 2014 which revealed that TMDLs

Filamentous algae in the Animas River at Riverside Park in Aztec, at 16cfs flow. April 18, 2018

are often exceeded by one or two orders of magnitude. With so much variation in water column nutrient concentrations and loads, what outcome is most likely during actual periods of critical low flow?

Nutrient dynamics in freshwater systems are complicated, and many tradeoffs must be considered when attempting to conduct sampling that will give an accurate representation of a given water body. Limitation by one primary nutrient or another, flow, light, gradient, and temperature can all affect the response that periphyton communities will have to nutrient enrichment. In turn, the periphyton communities themselves can also influence the concentrations of nutrients measureable in the ambient water. Presenter will discuss evidence of these complexities in the record of nutrient data on the Animas in both CO and NM, and discuss implications for future sampling efforts.

Driving Factors in Benthic Macroinvertebrate Community Composition within the Animas River

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Abstract 8

Nearly three years ago, the Gold King Mine (GKM) spill occurred near Silverton, Colorado. Approximately three million gallons of mine drainage was released ultimately ending up in the Animas River. While temporary impacts to water quality were observed as the plume passed through the Southern Ute Indian Reservation, no evidence suggests elevated metal concentrations have created chronic impacts to aquatic life. To better understand how to protect the environmental conditions of the Animas Watershed in the future, a working knowledge of the past and present conditions is needed. Benthic macroinvertebrate (BMI) data, a commonly used indicator of water quality, and surface water samples, collected pre (2014) and post (2015-2017) GKM spill were used for analysis to investigate potential issues to water quality. Surface water samples included a suite of 33 total and dissolved analytes, and 5 nutrient criteria. Analysis indicated total iron and dissolved selenium are statistically significant (p-value <0.05) driving factors of community composition. These data also revealed that following the spill and clean-up responses, nutrient concentrations, specifically total phosphorus, is a statistically significant driving factor of compositional change in BMI communities. This study found a significant difference in community composition in pre and post sampling locations. More investigation is needed to understand what is causing these differences. However, shifting focus from a metals concentrations approach to include significant impacts nutrients could have to BMI composition in the Animas watershed, will yield a more comprehensive understanding of the environmental conditions driving these changes.

Demonstrating BMP Effectiveness With Microbial Source Tracking & Host Fecal Score

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Abstract 9

Traditionally, fecal indicator bacteria (FIB) are used to monitor the presence of fecal matter in environmental waters. FIB, generally not pathogens themselves, are intended as a surrogate for pathogens that originate from human fecal matter. However, FIB can come from a lot of sources - humans, animals, plants, soil and biofilm. This makes FIB an unreliable surrogate and an ineffective tool to assess fecal contamination in areas where multiple sources exist.

Stakeholders in the Animas and San Juan watersheds routinely measure, among others, E.coli concentrations in the rivers. Because it is difficult to implement mitigation measures without knowing exactly where the bacteria came from, microbial source tracking (MST) has been used to identify sources of contamination. While best management practices (BMPs) are used to target the identified sources of contamination for mitigation, their effectiveness are often improperly assessed via FIB because FIB are not specific to any source.

MST markers, being specific to their targeted fecal sources, can specifically demonstrate if a particular source (e.g. human fecal source or cow fecal source) has been mitigated by the BMP even if FIB levels show little change. Additionally, a site human fecal score (HFS) has been developed by a team of researchers, from the U.S. Environmental Protection Agency, Southern California Coastal Water Research Project (SCCWRP), and Stanford University, to objectively assess the extent of human fecal contamination at a site using a standardized mathematically defined approach.

The HFS is a single number that statistically integrates all human fecal marker data (quantifiable, detected but not quantifiable, and non-detect - as all data, even non-detects, contain valuable information) from all samples at a given site. This gives a simple and intuitive way to assess and communicate BMP effectiveness by providing a score before and after BMP implementation. This approach can also be applied to other fecal host sources, e.g. a cow fecal score if a cow fecal MST marker is used in place of the human fecal MST marker.

The use of these advanced technologies therefore can provide effective evaluation of BMP performance, and inform selection and implementation of BMP to obtain highest benefit of protecting public health with lowest cost of BMP implementation.

Mineralogy and Chemistry of Mine Waste Rock Piles in Mining Districts in Southern Colorado and New Mexico

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Abstract 10 – Both Oral and Poster

Legacy issues of past mining activities forms negative public perceptions of mining, and inhibits future minerals production in the state. There are tens of thousands of inactive or abandoned mine features in mining districts in New Mexico and southern Colorado (including coal, uranium, metals, and industrial minerals districts), however many of them have not been inventoried or prioritized for reclamation. Abandoned mine lands (AML) are areas that were mined and left unreclaimed where no individual or company has reclamation responsibility (also called inactive, legacy, and orphaned mines). These may consist of excavations that have been deserted and where further mining is not intended. Most of these mine features do not pose any physical or environmental hazard and many more, pose only a physical hazard, which is easy, but costly to remediate. A complete inventory and characterization of these features is needed.

Some of these sites have the potential to contaminate surface water, groundwater and air quality. Heavy metals in mine waste piles, tailings and acid mine drainage can potentially impact water quality and human health. State and federal agencies and mining companies have mitigated many of the physical safety hazards by closing some of these mine features, but very few of these reclamation efforts have examined the long-term environmental effects. There is still potential for environmental effects long after remediation of the physical hazards, as found in several areas in New Mexico (for example Terrero, Jackpile, and Questa mines).

The NMBGMR in cooperation with the Mineral Engineering Department at New Mexico Tech, EPSCoR, and the NMAML program is conducting research on legacy mine features in New Mexico and southern Colorado. The project involves field examination and data collection of the mine features. Samples are collected to determine total whole rock geochemistry, mineralogical, physical, and engineering properties, acid-base accounting (Fig. 1), hydrologic conditions, particle size analyses, soil classification, shear strength testing for stability analysis, and prioritization for remediation, including hazard ranking. Not only are samples collected for geochemical and geotechnical characterization, but the mine features are being mapped, evaluated for future mineral-resource potential, and evaluated for slope stability.

Some waste rock piles and tailings could be potential resources for critical minerals and other commodities needed for U.S. technologies. Potential mineral recovery from mine wastes has the potential not only to support cleanup efforts financially, but to remove metals that could be part of the environmental and public safety hazard. Some of the critical minerals identified recently by the U.S. Department of the Interior are found in some of the existing mining districts and legacy mines. Most of the waste rock piles surrounding the mine features are suitable for backfill material in areas of remediation.

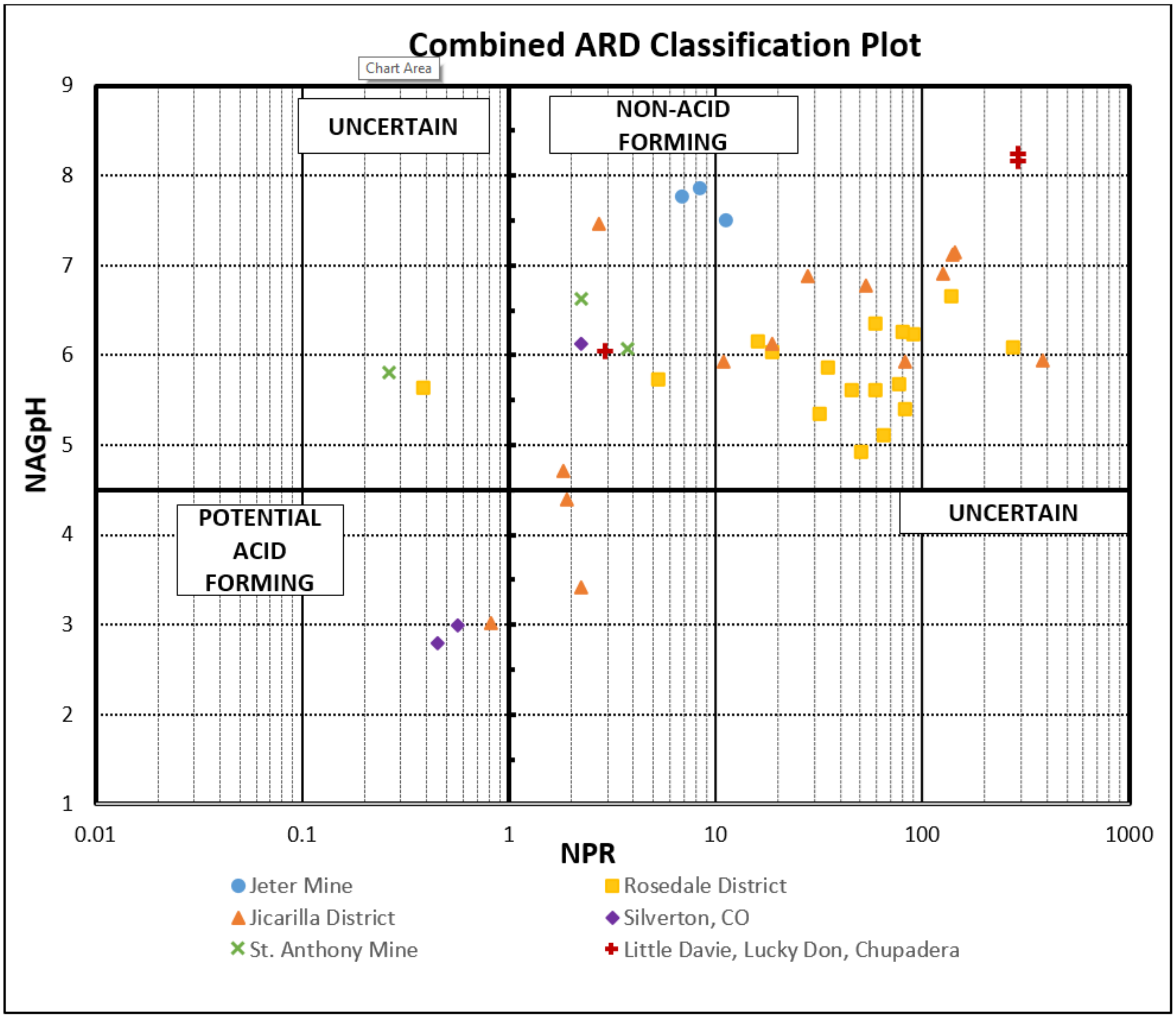

Figure 1. Acid Rock Drainage (ARD) plot of waste rock pile at mines examined during the NMBGMR AML project. The results for the waste rock piles from the Little Davie, Lucky Don, Chupadera, and Jeter uranium mines (Socorro County), St. Anthony uranium mine (Cibola County), Jicarilla gold mines (Lincoln County) and Silverton gold-silver mines (Colorado) are shown for comparison (unpublished work in progress). Results of these mines will be published in future reports. Samples that plot in the uncertain and potential acid forming fields are not suitable for backfill material and need to be handled with care during reclamation.

Geochemistry of the Animas River Alluvial Aquifer after the Gold King Mine Spill, San Juan County, New Mexico

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Abstract 11

On August 5, 2015 the accidental breech of the Gold King Mine (GKM), located in Colorado, resulted in the movement of millions of gallons of bright orange water through the Animas River in northwestern New Mexico. This water, which was loaded with dissolved metals and contaminated sediments, posed a potential risk to groundwater quality in the Animas Valley. The Animas River from the Colorado-New Mexico border flows through Quaternary alluvial deposits, which are largely made up of sediment eroded from Paleogene rocks into which the Animas River has incised. While most water for domestic use and irrigation in the area is largely sourced from the Animas River, there are many private domestic and irrigation wells in the valley completed in the alluvial aquifer with depths of about 30 to 60 feet.

We collected water samples from up to 26 wells within and near the Animas Valley between the NM-CO border and Farmington, NM several times between January 2016 and June 2017. The objectives of this study were to characterize the hydrogeologic system, investigate groundwater/surface water interactions, and assess the possible impacts of the GKM spill to shallow groundwater.

General water chemistry, stable isotope and environmental tracer data, and modeling of two- endmember mixing indicate that shallow groundwater is primarily comprised of young river water and older regional groundwater from the underlying Nacimiento Formation. The river water end-member is characterized by total dissolved solids (TDS) concentrations less than 500 mg/L, a calcium bicarbonate water type, and tritium values above 5 tritium units. The regional groundwater end-member is characterized by much higher TDS concentrations close to 10,000 mg/L, a sodium sulfate water type, undetectable tritium content, and an apparent carbon-14 age of approximately 20,000 years before present. The upwelling of regional groundwater due to the gradual thinning of the Nacimiento Formation to the south, significantly affects water quality by increasing the TDS content to above 1,000 mg/L in some areas south of Aztec.

The main process that may potentially introduce contaminants from upstream mines into the shallow groundwater is the seepage of irrigation water (diverted river water) through the bottoms of ditches and agricultural fields to recharge the aquifer. Potential groundwater contaminants associated with the GKM spill, which include iron, aluminum, manganese, lead, copper, arsenic, zinc, cadmium, and mercury, were found to be below U.S. Environmental Protection Agency (USEPA) maximum contaminant levels (MCLs). Several wells in the shallow aquifer produced water that exceeds USEPA secondary MCLs for dissolved iron and manganese.

It is difficult to determine the source of these trace metals, which were observed to be present in the shallow groundwater before the GKM spill. While the GKM spill exhibited high iron and manganese concentrations, these metals are also known to be ubiquitous in fluvial sediments, such as those that make up the alluvial aquifer. Therefore, results from this study do not suggest that the groundwater quality has necessarily been impacted by the GKM spill. However, continued monitoring of groundwater quality is recommended.

Rapid and in-situ analysis of metal concentrations in agricultural fields in San Juan County using Portable X-ray fluorescence (PXRF)

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Abstract 13

Portable X-ray fluorescence (PXRF) spectrometry provides fast, non-destructive analysis of total concentration of many elements in soils. This technique is a powerful tool to study the spatial distribution of contaminants in the environment and allows immediate response to situations like the Gold King Mine (GKM) spill in 2015 that contaminated the Animas and San Juan Rivers in the four corners region of the U.S. Southwest. Immediately after the spill, irrigation ditches within the state of New Mexico and Navajo Nation were closed for weeks, prohibiting contaminated river water from entering the agricultural fields. Questions remain as to whether the GKM metals were flushed out of the river or not and if surface water contamination may have spread through the watershed. Using the PXRF we evaluated the total concentration of 9 elements (Al, As, Pb, Ca, Cr, Cu Mn, Fe, Zn) of potential concern metals in fields used to grow alfalfa, vegetables and pasture grass. Representative soil samples were collected from each field for verification of PXRF analysed metal concentration using inductively coupled plasma (ICP) spectroscopy after acid digest in the lab. The analysed results were compared to the US Environmental Protection Agency (EPA) residential screening level (RSL) in soil. The spatial variability of the metal concentrations was also analysed by mapping in ArcGIS by interpolation using ordinary Kriging method to compare with future changes in metal concentrations. The average concentration of total As and Mn exceeded the guideline value (As-7.07 ppm, Mn-180 ppm) specified by NMED at certain hotspots that were identified for pasture (As-7.19 ppm, Mn-874.92 ppm), alfalfa (As-6.92 ppm, Mn-545.04 ppm) and vegetable (As-7.13 ppm, Mn-312.84 ppm) fields. Other elements of concern were below the EPA-RSL. The metal concentrations for post-growing season have been scanned using PXRF and will be further analysed by geostatistical tools in R for comparison.

Metal Contaminants in the Animas and San Juan Watershed

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Abstract 14

On August 5, 2015, three-million gallons of acid rock drainage was accidentally released into the Animas Watershed from the Gold King Mine (GKM) in Silverton, Colorado. While contamination from this one event may not have reached closed irrigation ditches and fields, legacy mining waste has been seeping into the river for over 150 years which has sparked concern over the safety of the watershed. The total concentration of nine elements were analyzed in soil, leaf, and produce samples. Portable X-Ray fluorescence was used in three different agricultural fields to assess soil and leaf samples. The average concentration of As in soils exceeded the guideline value (7.07 ppm) specified by NMED at certain hotspots that were identified for pasture (7.19 ppm), alfalfa (6.92 ppm) and vegetable (7.13 ppm) fields. On observing the exceedances in areas close to the irrigation sources, plant tissue samples were collected in four quadrants in a gradient of irrigation water flow of the field. The concentration range of As in leaf tissues for pasture (0.89-1.25 ppm, n = 12), alfalfa (0.94-1.11 ppm, n = 12) and vegetable (0.5-0.9 ppm, n = 24) fields were all below the guideline value of 1.7 ppm. Thus, higher concentrations of arsenic and manganese that in some hotspots did not correlate to increased metal uptake in leaf tissues. Furthermore, inductively-coupled plasma optical emission spectrometry testing did not reveal an excessive uptake of metals in above-ground produce, as evidenced by the toxic metal, Arsenic values of all produce samples (n=19) presenting at non-detectable amounts. For now, the people of San Juan county should not be fearful of consuming locally grown produce from the area because the produce tested is below safety guidelines released by the World Health Organization and the Institutes of Medicine.

The Corn Pollen Path and the Gold King Mine Spill

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Abstract 15

We as Navajo people view as things as having life and draw no distinction between abiotic and biotic. In our holy songs we sing about being children of the earth. We were made from ears of corn and the big wind gave us life. Water is revered and held sacred. The rivers carry our prayers and are an integral part of our ceremonial life. When the Gold King Mine Spill happened it affected a holy part of our world, the San Juan River. We watched our children, the corn and plants wither and die. We need the water and plants in our ceremonies to help restore balance and harmony to our world. Without being sure of the sanctity of our water and plants, our holy corn pollen path was disrupted.

Soil-microbial Feedbacks to Decomposition Differences between Native and Invasive Shrub Species in an Animas River Riparian Zone

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Abstract 17

Alterations to river water flow has undoubtedly changed western US riparian vegetation. However, invasive plants persist in the face of river restoration efforts, and questions remain about invasive vs. native shrub interactions. Soil microbiological processes such as decomposition and nutrient mineralization provide a likely set of mechanisms structuring native and invasive co-existence or replacement. To address this issue, we measured decomposition rates from four common northern New Mexico riparian woody species' litter in soil where each plant species was growing in a full-factorial laboratory transplant experiment. Litters collected from near the Animas River in Bloomfield, NM consisted of the native species cottonwood (*Populus fremontii*) and coyote willow (*Salix exigua*), compared to invasive salt cedar (*Tamarix ramosissima*) and Russian olive (*Elaeagnus angustifolia*). Litter bags of each plant type were buried in soil collected from under the canopy of each species. Decomposition was measured via litter mass loss, trace gas evolution from soil during the experiment, and microbial exo- enzyme activity from soil at the conclusion of the experiment. The most mass from each species occurred when they were incubated in *Populus* soils. Invasive species litter lost the least mass when incubated in native *Salix* soil. Soil respiration (CO_2 efflux) was higher under invasive litter decomposing in their own soil. However, invasive species induced higher soil respiration when decomposed in native soil; a situation that simulates plant invasion. Invasive litter decomposing in any soil resulted in a 2-orders of magnitude spike in N_2O emissions after 30 days incubation, which is thought to be indicative of higher rates of N mineralization followed by denitrification. The highest potential rates of B-glucosaminidase and acid phosphatase activity were measured from invasive species soils incubated with native species litter, a situation that simulates restoration efforts and points toward phosphate limitation as a consideration in future invasive vs. native shrub interaction research. These data suggest that there are important differences between native and invasive shrub litter effects on microbial carbon and nitrogen cycling, including periods of high N_2O emissions during decomposition processes. These results help argue that microbiological and biogeochemical processes are considerations in riparian restoration campaigns.

The Biological Response to the Gold King Mine Release in the Animas and San Juan Rivers

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Abstract 18

In response to the Gold King Mine (GKM) release on August 5, 2015, EPA mobilized field crews to sample water, sediment, and biological data from river segments impacted by the plume, which include the Animas River near Silverton, CO to its confluence with the San Juan River in Farmington NM, and the San Juan River from the Animas confluence to Lake Powell in UT. The EPA's response sampling included biological data collection at 22 sites in the fall of 2015 (near- term) and follow-up data collection at 30 sites in fall 2016 (long-term). These data with data collected by state and tribal partners[1] and historic datasets were used to answer the following questions: Did the GKM event add to biological degradation in the already contaminated upper Animas River? Did the GKM release degrade biological communities in other segments of the Animas and San Juan rivers that had not been known to have metal contamination? EPA evaluated potential changes in species composition, population abundance, and metals in tissue by comparing the post-GKM release data to the pre-release conditions.

The Animas River is one of many rivers in the western US that is impacted by historic mining and ongoing acid mine drainage that results in a longitudinal gradient in metal concentrations and biological condition from the headwaters downriver. The upper Animas River (Silverton to Baker's Bridge) experienced the highest metal concentrations during the GKM plume, the greatest number of water quality criteria excursions, and the greatest deposition of sediment immediately following the plume. Metal concentrations in benthic macroinvertebrate tissue were high in the pre-release dataset and continue to be high following the GKM release.

Historic biological monitoring conducted in this portion of the watershed over the last several decades has established that the upper Animas and several tributaries support only a limited benthic macroinvertebrate community and generally do not support fish (only transient fish, no reproduction) because of the poor water quality. Metal sensitive species were extirpated from the upper Animas prior to the release, leaving only some of the most metal tolerant aquatic life. Therefore, no clear differences in the aquatic community structure were observed in the pre- and post-GKM release biological data in the upper Animas River.

The benthic macroinvertebrate and fish populations in the Animas River generally improve in the middle and lower Animas River. These reaches support more sensitive taxa that are not found in the upper Animas. As the Gold King release moved through the river and approached the middle Animas river, both dissolved and colloidal/particulate metal concentrations declined rapidly as chemical reactions and hydraulic processes diluted, transformed, and deposited material. This resulted in few excursions of water quality standards and concentrations that were not likely to adversely affect aquatic biota. Our analysis of the 2015 post-GKM

1 Biological data providers included Colorado Parks and Wildlife (CPW), Colorado Department of Public Health and Environment (CDPHE), New Mexico Environment Department (NMED), New Mexico Department of Game and Fish (NMDGF), Southern Ute Indian Tribe (SUIT), Navajo Nation Environmental Protection Agency (NNEPA), and U.S. Fish and Wildlife Service (US FWS).

release fish data collected by CPW from the Animas River near Durango agrees with existing state analyses, reports, and press announcements that conclude fish were not exposed to acutely toxic concentrations. Fish populations including stocked trout and native species in the vicinity of Durango were at historic highs one month following the GKM release. Overall, we did not observe a long-term loss of or change in the more sensitive invertebrate and fish taxa, and for some metrics, a slight improvement was observed a year following the event.

Pre-release data were limited for the lower Animas River; however, the NMDFG fish tissue sampling design for the lower Animas and upper San Juan rivers provided meaningful statistical comparisons of near-term and long-term metal bioaccumulation following the release by including multiple species, replicates, tissue types (muscle and liver) and sampling dates. Metals were significantly elevated in fish liver and to a lesser extent in muscle tissue during August 2015 in the lower Animas at locations with elevated GKM metals in water and sediment. For the most part, however, high liver concentrations did not translate to high muscle concentrations. In March 2016, the concentration of metals in tissue were low throughout both rivers. Additionally, the body burdens of 8 metals in the pre-release (SUIT) and post-release EPA fish data taken at the same locations were very similar despite differences in methods, supporting the conclusion that biological conditions were at background conditions in fall 2016.

By the time the GKM plume reached the confluence with the San Juan River, total metal concentrations had declined by three orders of magnitude from what they were when the plume entered the Animas because of the combined effects of the dilution, chemical reactions, and deposition. The excursions of aquatic life water quality criteria in the San Juan were limited to metals that are naturally high in the sediment and water, making direct toxic effects related to the GKM release unlikely. Metals in fish tissue samples collected from the San Juan by all data sources were generally very low and often less than detection limits.

The FWS fish population data for the San Juan showed that fish abundance in 2015 and 2016 was generally within pre-release norms. The exception to this was suppressed abundance of bluehead sucker, flannelmouth sucker and speckled dace in the middle reaches of the San Juan in both 2015 and 2016, which coincided with historically high populations of predator/competitor species (i.e., razorback sucker, Colorado pikeminnow and channel catfish).

The EPA 2016 biological sampling was the first effort to cover the entire Animas and San Juan rivers in a single sampling event with consistent sampling methods. Our ability to conduct a watershed-scale analysis of data collected by all partners was limited by the different sampling and analytical methods and revealed the need for a consistent sampling approach. This was especially true for studies focusing on biological uptake of metals. Future watershed-scale monitoring efforts should include the development of consistent sampling methods when an objective is to compare results to data collected from other areas of the watershed.

Groundwater Level Monitoring Along the Animas River, New Mexico, After the Gold King Mine 2015 Mine-water Release

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Abstract 19

The Gold King Mine spill that occurred in August 2015 rapidly drained water that was backed up behind the blocked mine adit, quickly eroding the waste rock pile that was outside of the mine. As result, roughly 490,000 kg of sediment was released with the water, turning the water an orange color. The water that flowed into the Animas River was loaded with dissolved metals and contaminated sediments, which posed a possible risk to groundwater quality in the Animas Valley. While the river has since returned to its normal color, there is still concern that the metals left on the streambed may affect the shallow alluvial aquifers and impact the communities in the surrounding area.

To determine if water from the river was infiltrating in to the alluvial aquifers of New Mexico during or after the spill, a water-level monitoring network was developed. The monitoring network consisted of roughly 60 existing wells and was used to construct groundwater elevation contour maps to determine the direction of groundwater flow in the Animas Valley between Farmington and the NM/CO boarder. The monitoring network of wells was measured four times per year, over two years, during hydraulically significant periods to understand the seasonal fluctuations of the water table and how it affects the groundwater/ surface water interactions; during baseflow conditions (late-January), the initial snowmelt/onset of irrigation season (mid-March), peak snowmelt/extended irrigation season (early-June), and at the end of irrigation season (mid-October).

A subset of wells were instrumented with pressure transducers to continuously collect water- level data. The groundwater hydrographs recorded at these wells showed distinct patterns that were used to categorize most of the measured wells based on their different hydrograph characteristics. Wells close to the river typically had a direct correlation to river stage with a distinct increase that correlates to peak snowmelt in the river followed by a rapid drop in groundwater levels through August. Most of the hydrographs begin increasing in late March at the beginning of irrigation season and continue to increase through July and do not begin to decrease until the end of irrigation in late October.

Groundwater level measurements were used to construct water table maps to assess groundwater flow direction and the hydraulic gradient between groundwater and the river stage. In general, groundwater flows to the southwest (downstream) and towards the river. In most areas, the Animas River is gaining water from the groundwater, as groundwater from the surrounding valley flows down gradient, discharging to the river. However, in some areas, water-levels in close proximity to the river have a nearly flat hydraulic gradient between groundwater and the river, where small seasonal fluctuations in groundwater levels and river stage can turn a slightly gaining reach to a slightly losing reach. Groundwater levels in the valley are generally lowest in March, before the irrigation season begins, and highest in October, near the end of the irrigation season. High seasonal water-level fluctuations were observed near the Cedar Hill and Inca communities, where we observed an apparent reversal in gradient that changes the river in those areas from a gaining stream in the summer during irrigation season to a losing reach in the winter.

River water primarily recharges the shallow aquifer as a result of irrigation practices in the area. During the growing season (March through October), water is diverted from the river into irrigation ditches and canals that transport water to agricultural fields. Water seeping through the bottoms of canals and ditches and past

the root zone in agricultural fields recharges the shallow aquifer, resulting in groundwater levels increasing significantly during irrigation season throughout most of the study area, as was observed from groundwater level measurements in the majority of wells. While the seepage of irrigation water through canal and ditch bottoms and agricultural fields is the primary mechanism by which river water enters the aquifer, there is evidence that water can infiltrate directly from the river into the aquifer in some areas.

Therefore, we recommend that in the event of another mine water release, that residents with a well within 300 feet of the river (especially near the communities of Inca and Cedar Hill) discontinue pumping of the well temporarily until the contaminant plume in the river has passed.

Differentiating Mining and Natural-Sourced Contaminants in the Tributaries of the San Juan River, USA

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Abstract 23

The Gold King Mine event elucidated the historical and ongoing metal releases from the Bonita Peak Mining District, Colorado, USA to the Animas and San Juan Rivers. However, the Animas River represents only one of seven main tributaries to the San Juan River, and each tributary watershed has a unique mining history, underlying geology, and flow regime (i.e. snowmelt, rainfall, and/or baseflow). In order to differentiate geochemical signatures in mobile particles among mined versus unmined tributaries, total and filtered trace element concentrations from the downstream most location in each tributary watershed were downloaded from the Storage and Retrieval Database (STORET) along with United States Geological Survey (USGS) measured discharge. Particulate metal loads were determined for each discharge event within a watershed by averaging discrete sampling events by a representative discharge. Additionally, principal component analysis (PCA) and lead isotopes were utilized. Geochemical signatures in mobile particles varied with discharge event, where the largest shift in particulate metal signatures occurred within snowmelt-dominated watersheds between snowmelt runoff and rainfall/baseflow. Additionally, particulate metal loads mobilized during rainfall most closely reflected the underlying geologic units. From the PM loads, PCA, and Pb-isotopic analysis, we posit that PM loads mobilized in the Animas River during snowmelt which are sourced from the headwater regions represented a mining signature, whereas PM loads mobilized throughout the watershed during rainfall reflected the underlying geologic units.

The San Juan Watershed Group: Using ESRI's Story Maps as a Tool for Communicating Water Quality Data

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Abstract 25

Watershed groups often struggle to get their message out, or present data in a way that is understandable and accessible to the public. Story Maps, created by ESRI, the makers of ArcGIS software, offer an innovative medium for organizations to communicate their data to the public. Combined with maps and a variety of other media formats, Story Maps can transform data into a narrative that is interactive, engaging, and approachable. This presentation will exhibit a Story Map of the San Juan Watershed Group's water quality monitoring history, with an emphasis on communicating data to a public audience.

In 2001 severe algae blooms inundated the lower Animas River, and triggered concerns about water quality and nutrient enrichment. A group of concerned citizens came forward to address nutrient and bacteria pollution and formed the present-day San Juan Watershed Group. In the seventeen years since its inception, the San Juan Watershed Group has monitored water quality in the Animas, La Plata, and San Juan Rivers, and has accumulated a substantial water quality dataset. Some of the Group's data have been made available to the public via reports and presentations, and more recently, the Colorado Data Sharing Network. However, the Group has lacked a living, consolidated database, and a comprehensive, accessible narrative of their work and history.

This Story Map tackles both of those deficiencies by bringing the San Juan Watershed Group's data into a single database, and transforming that data into a visually engaging spatiotemporal presentation. In addition to introducing the Story Map as a useful tool for communicating science, this presentation will also briefly describe the initial database and map configuration requirements for Story Map creation.

Educating the public and decision-makers about watershed issues and serving as a repository of information to the public are two of the San Juan Watershed Group's primary objectives. However, finding an effective medium for communicating water quality day has made achieving those objectives difficult. Story Maps are one way that watershed groups can bridge the gap and achieve their objectives for communicating science to the public.

Surface Water Geochemistry during Monsoon Generated Flow Events in the Animas and San Juan Rivers, 2016-2017

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Abstract 27

A relatively large percentage of the Animas and San Juan Rivers' metals and suspended- sediment load can occur during a short period of the annual hydrograph. Peak-flow events often occur in northwestern New Mexico following monsoon storms from July to October. Quantifying constituents of concern such as aluminum, iron, manganese, lead, and arsenic in fluvial systems during these short-duration, high-load periods is challenging for a number of reasons: site access, timing and duration of flow events, restrictions due to proximity, labor and laboratory costs, as well as temporal and spatial heterogeneity of concentrations. Lack of sample data during these periods may severely bias modelling and understanding of metals and suspended sediment flux. Understanding variations in water quality during monsoon events is also important for water-resources management, when dynamic surface waters are used as an agricultural or drinking water source.

Technological solutions exist to improve acquiring water-quality data over a range of flows. The U.S. Geological Survey deployed online sensors and automated pumping samplers, triggered remotely via Raven cellular modems, to sample a suite of metals and suspended sediment during periods of short duration, high turbidity flow events in 2016-2017. The results of this sampling campaign are presented and show the relation between metals and suspended-sediment concentrations in the Animas and San Juan Rivers.

Figures 1 and 2 show provisional data from two sampling events in 2017 from a sampling location near Fruitland, New Mexico. The August 2017 event was relatively short spanning about 12 hours. An event beginning on September 27th was a multi-day event with turbidity values greater than the instrument operating range (3030 FNU) for more than three days. Despite similar turbidity readings, iron concentrations (dissolved and total) ranged by more than an order of magnitude. Maximum dissolved iron concentrations measured during the August event were about 0.4 mg/L, whereas the maximum measured concentration on 9/28/17 was 2 mg/L. The results from this study demonstrate the need for on-demand, remote sampling to inform watershed transport models and the beneficial use of dynamic water resources.

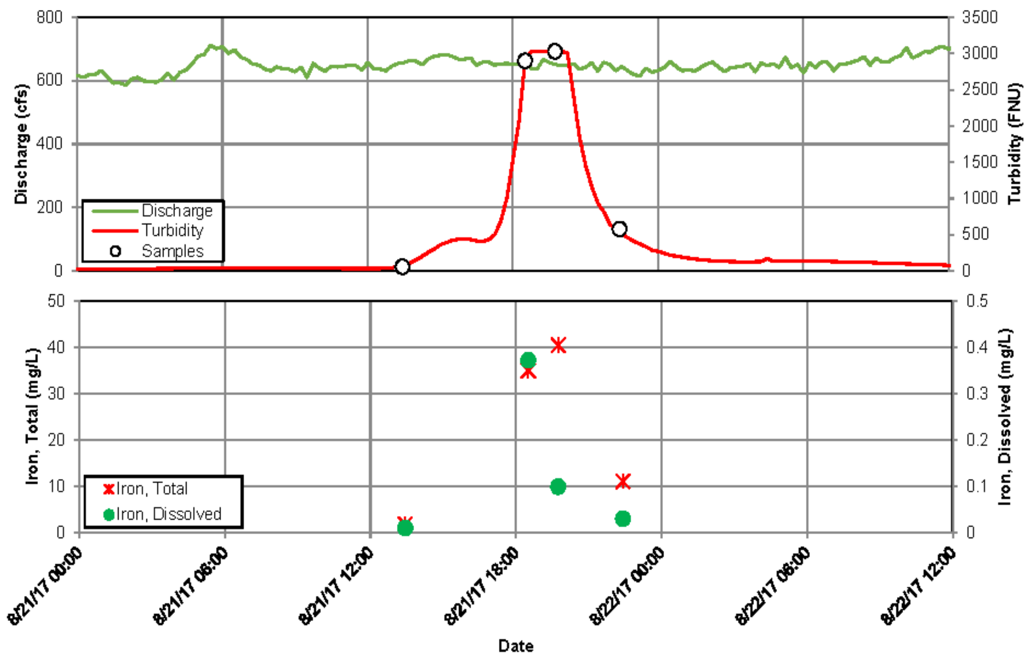

Figure 1. Sampling event at Fruitland monitoring site in August, 2017

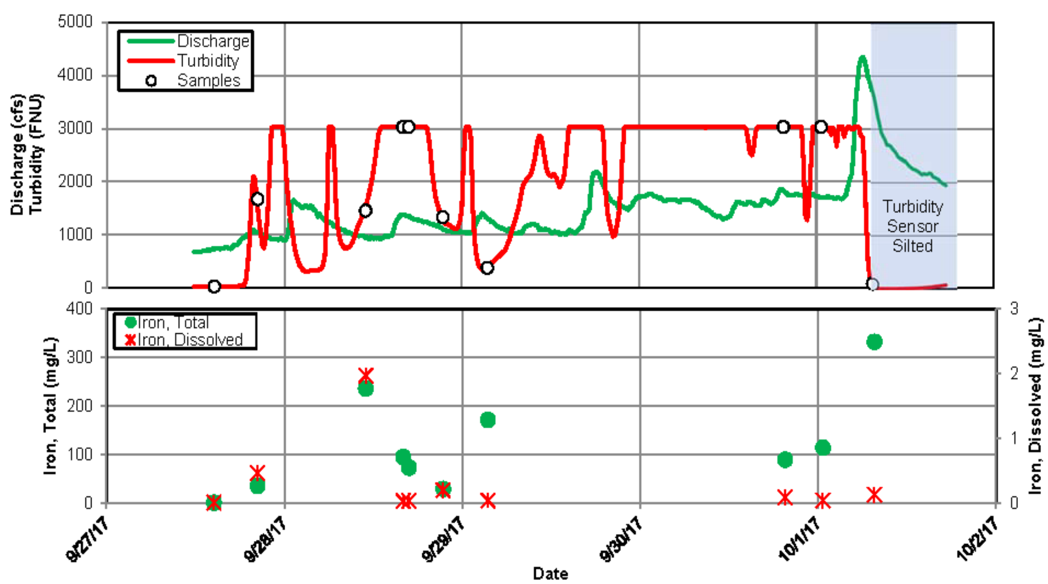

Figure 2. Multi-day monsoon event at Fruitland monitoring site in September and October, 2017