Aluminum Toxicity testing of Pajarito Plateau Stormwater

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- Aluminum (Al) is prevalent in soils, sediments, and rocks and is mobilized during stormwater events on the Pajarito Plateau.

- Unlike other metals, Al has been shown to be bioavailable, or potentially toxic in both dissolved and solid-phase forms, and toxicity can be enhanced at both low and high pH.

- Al is the 6th most prevalent reason for stream impairments in NM (NMED, 2016).

- However, much of the mineral phase Al in stormwater may be unavailable (*i.e.*, non-toxic).

- Toxicity should be demonstrated by exposure to known Al-sensitive organisms

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- Four sites identified as reference or background stormflow channels with minimal human influences

- Automated stormflow samplers deployed at reference locations

- Bandelier National Monument sites:
  - Burnt Mesa-1
  - Ponderosa-1

- Western Mountain sites:
  - E-240 gage-site (Pajarito canyon)
  - E-252 gage site (Water canyon)

- Burnt Mesa 1
    - Ephemeral channel
    - Tributary to Frijoles canyon
    - Lithology is primarily Bandelier Tuff
    - Stormwater slightly acidic (pH 5.8-6.3)
    - Very low hardness (~12 mg/L as $CaCO_3$)
    - High turbidity (527 NTU)

- Water Canyon (E-252)
  - Intermittent channel
  - Tributary to the Rio Grande
  - Lithology is primarily Bandelier Tuff
  - Stormwater slightly acidic (pH 5.8-6.4)
  - Very low hardness (~12 mg/L as $CaCO_3$)
  - Moderate turbidity (52 NTU)

- Two test organisms chosen

  - *Ceriodaphnia dubia*
    - A water flea that lives in the water column and is sensitive to Al

  - *Hyalella azteca*
    - An amphipod, less sensitive to Al, however, lives in sediments

Photo: Scott Bauer

- Exposures to control waters of low (24 mg $CaCO_3$) and moderate hardness (100 mg $CaCO_3$)

- Acute exposures for 48 h (*C. dubia*) and 96 h (*H. azteca*).

- Of the four sites, the two Bandelier sites registered/collected storm water samples in 2019.

Site:	Sample Hardness (mg/L as $CaCO_3$)	Sample Hardness-dependent Al Acute criteria (µg/L)	Sample Al concentration µg/L
Burnt Mesa	12	188	12,800
Ponderosa	12	188	1,720

Table-1a: Survivorship of *C. dubia* in Burnt Mesa storm water

Site	Exposure	24 hour survival	48 hour survival	Result
Burnt Mesa1	Control (moderately-hard)	100%	95%	No statistically significant difference in survival in any exposure relative to controls.
	Control (soft)	95%	95%	
	0.2 μm filtered Burnt Mesa	100%	100%	
	0.45 μm filtered Burnt Mesa	100%	100%	
	1 μm filtered Burnt Mesa	100%	100%	
	10 μm filtered Burnt Mesa	100%	100%	
	Unfiltered Burnt Mesa	100%	100%	

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Table-1b: Survivorship of *C. dubia* in Ponderosa storm water

Site	Exposure	24 hour survival	48 hour survival	Result
Ponderosa1	Control (moderately-hard)	100%	100%	No statistically significant difference in survival in any exposure relative to controls.
	Control (soft)	95%	95%	
	0.2 μm filtered Ponderosa	100%	100%	
	0.45 μm filtered Ponderosa	100%	100%	
	1 μm filtered Ponderosa	100%	100%	
	10 μm filtered Ponderosa	100%	100%	
	Unfiltered Ponderosa	100%	90%	

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Table-2a: Survivorship of *H. azteca* in Burnt Mesa storm water

Site	Exposure	48 hour survival *	96 hour survival *	Result **
Burnt Mesa1	Control (moderately-hard well water)	95%	95%	No statistically significant difference in survival between controls.
	Control (soft/diluted well water)	82.5%	77.5%	
	10 µm filtered Burnt Mesa	92.5%	90%	No statistically significant difference in survival in 10 µm filtered relative to controls.
	Unfiltered Burnt Mesa	75%	75%	Statistically significant difference in survival in unfiltered sample relative to moderately-hard well water control. No statistically significant difference in survival in unfiltered sample relative to soft-water control.

* Definitive counts conducted during 48-hr water renewal and 96-hr test termination
** Data analysis should be considered preliminary until final QA/QC has occurred.

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Table-2b: Survivorship of *H. azteca* in Ponderosa storm water

Site	Exposure	48 hour survival *	96 hour survival *	Result **
Ponderosa1	Control (moderately-hard well water)	95%	95%	No statistically significant difference in survival between controls.
	Control (soft/diluted well water)	82.5%	77.5%	
	10 μm filtered Ponderosa	77.5%	75%	No statistically significant difference in survival in 10 μm filtered relative to controls.
	Unfiltered Ponderosa	77.5%	65%	Statistically significant difference in survival in unfiltered sample relative to <u>moderately-hard water control</u>. No statistically significant difference in survival in unfiltered sample relative to <u>soft-water control</u>.

* Definitive counts conducted during 48-hr water renewal and 96-hr test termination
** Data analysis should be considered preliminary until final QA/QC has occurred.

- Storm water Al typically exceeds hardness-dependent Al criteria.

- Mortality of *C. dubia* in stormwater was negligible and not statistically different than control waters.

- Mortality of *H. azteca* was negligible and where observed, was related to both low hardness storm water and control lab water

- Contributions of the Bandelier tuff to stormwater are high in Al, yet the mineral forms present in stormwater are not toxic to Al-sensitive test organisms.

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