



## Department of Energy

Washington, DC 20585

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U.S. Nuclear Regulatory Commission  
Attn: Document Control Desk  
Deputy Director  
Mail Stop T8F5  
Washington, DC 20555-0001

Subject: *Draft Development of Risk-Based Alternative Concentration Limits for the New Rifle, Colorado, Processing Site*

To Whom It May Concern:

The U. S. Department of Energy, Office of Legacy Management (DOE-LM) is currently planning to update the New Rifle Groundwater Compliance Action Plan (GCAP) in 2013. One potential compliance strategy is no remediation with the application of alternate concentration limits (ACLs).

Enclosed for your consideration is a document that DOE-LM developed to evaluate potential human health risks associated with contaminants at the New Rifle processing site. Risk numbers are based on current or anticipated values from established sources and worst case exposure assumptions.

Your input on this risk document will be helpful in revising the GCAP, particularly if ACLs are selected to support the compliance strategy. DOE-LM is available at your convenience to discuss this information.

Please call me at (970) 248-6073 if you have any questions. Please send any correspondence to:

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Sincerely,

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# Development of Risk-Based Alternate Concentration Limits for the New Rifle, Colorado, Processing Site

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U.S. DEPARTMENT OF  
**ENERGY**

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Management



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**March 2012**

**Draft**



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## Abbreviations

ACL	alternate concentration limit
EPA	U.S. Environmental Protection Agency
IRIS	Integrated Risk Information System
POC	point-of-compliance
RBC	risk-based concentration
UPL	upper prediction limit

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## 1.0 Purpose

The purpose of this analysis is to develop risk-based alternate concentration limits (ACLs) for groundwater at the New Rifle, Colorado, Uranium Mill Tailings Radiation Control Act Title I processing site that will be protective of potential exposures at the gravel mining ponds downgradient of the site. The approach needs to account for current and probable future land use in the vicinity of the New Rifle site. In recent years, extreme fluctuations in groundwater concentrations of some constituents have been observed in areas of the site where excavation, dewatering, and construction activities were conducted by the City of Rifle, the current site owner. Based on investigations conducted in support of a pilot-scale groundwater remediation system at the site, vanadium-contaminated soils were identified in the subsurface where former evaporation ponds were located during processing activities. Disturbance of these areas has led to anomalously high concentrations of vanadium in groundwater samples. This area of soil contamination has tentatively been designated a “no disturbance” zone (Figure 1), though no formal controls have yet been put in place. A restriction on earthmoving activities could complicate or adversely affect the City of Rifle’s future plans for the site.

## 2.0 Approach and Assumptions

For the purposes of this analysis, it was assumed that children (the most sensitive receptor) could have access to the gravel ponds and would swim in those ponds on a regular basis. Equations and exposure parameters for risk assessment were obtained from the U.S. Environmental Protection Agency’s (EPA’s) Risk Assessment Guidance for Superfund (Part A) (EPA 1989) and EPA’s updated *Exposure Factors Handbook: 2011 Edition* (EPA 2011). Values for exposure parameters were chosen to provide conservative estimates of risk.

It is assumed that ACLs would be needed for point-of-compliance (POC) wells located outside and downgradient of the existing source area of soil contamination. These wells will serve as early detection wells for movement of contamination from the source area at levels that could adversely affect water quality of the gravel ponds. A north-south line of wells was selected as potential POC locations—wells RFN-0217, -0659, -0664, and -0669. Data from pond surface locations RFN-0320, -0323, -0452, -0453, and -0575 were used in this evaluation (see Figure 1 for locations).

Maximum risk-based concentrations (RBCs) protective of surface water in a swimming scenario were calculated using information provided in Table 1. The number of swimming events per month is an upper threshold (EPA 2011) for all age groups (181 minutes or roughly 3 hours per month). Because of the climate in the Rifle area, it was assumed that swimming would only be likely for a maximum of 4 months of the year. Average and upper threshold rates for ingestion of water while swimming were used to bound the calculations. The most recent toxicity data from EPA’s Integrated Risk Information System (IRIS) were used for each constituent in the analysis. Carcinogenic and noncarcinogenic effects were considered in the calculations for arsenic. Noncarcinogenic effects were considered for all other constituents.





Figure 1. Location Map, New Rifle, Colorado, Processing Site



Table 1. Risk-Based Concentration Comparison Table

Contaminant	Ingestion Rate (L/event)	Events/year (at 60 min/event)	RfD <sup>a</sup> (mg/kg-d)	Maximum RBC (mg/L) <sup>b</sup>	Maximum observed in all ponded water (mg/L)	Maximum observed in persistent ponds (mg/L) <sup>c</sup>	Maximum observed in groundwater <sup>d</sup> (mg/L)
Arsenic (n)	0.05 <sup>e</sup>	12 <sup>f</sup>	0.0003	5.8	0.094	0.043	0.195
Arsenic (c)	0.05	12	1.5 <sup>g</sup>	0.16	0.094	0.043	0.195
Molybdenum	0.05	12	0.005	96	12.5	3.01	7.7
Selenium	0.05	12	0.005	96	0.0827	0.033	1.4
Uranium	0.05	12	0.003	59.4	0.435	0.435	0.188
Vanadium <sup>h</sup>	0.05	12	0.0009	17.4	4.63	1.68	14.3
Arsenic (n)	0.12 <sup>i</sup>	12	0.0003	2.7	0.094	0.043	0.195
Arsenic (c)	0.12	12	1.5 <sup>g</sup>	0.066	0.094	0.043	0.195
Molybdenum	0.12	12	0.005	45	12.5	3.01	7.7
Selenium	0.12	12	0.005	45	0.0827	0.033	1.4
Uranium	0.12	12	0.003	27	0.435	0.435	0.188
Vanadium	0.12	12	0.0009	8.1	4.63	1.68	14.3

c = carcinogenic

L/event = liters per event

mg/kg-d = milligrams per kilogram-day

mg/L = milligrams per liter

min/event = minutes per event

n = noncarcinogenic

RfD = Reference dose

Values highlighted in yellow exceed RBC.

<sup>a</sup> From IRIS

<sup>b</sup> Maximum permitted in ponds; equivalent to hazard quotient of 1 or 10<sup>-6</sup> risk level

<sup>c</sup> Locations RFN-320, -323, and -575 (2000–present)

<sup>d</sup> POC wells (2000–present)

<sup>e</sup> Average rate from EPA 2011 (portion of table shaded gray)

<sup>f</sup> Upper threshold from EPA 2011 (181 minutes per month; swimming in fresh water); assumed 4 months per year

<sup>g</sup> Slope factor from IRIS (mg/kg-d)<sup>-1</sup>

<sup>h</sup> Vanadium RBC based on proposed RfD that is currently under review (EPA 2011)

<sup>i</sup> Upper threshold from EPA 2011 (unshaded portion of table)

Equations and Assumptions:

$$\text{Intake (ingestion)} = (\text{CW} \times \text{IR} \times \text{EF} \times \text{ED}) / (\text{BW} \times \text{AT})$$

$$\text{Intake (absorption)} = (\text{CW} \times \text{SA} \times \text{PC} \times \text{ET} \times \text{ED} \times \text{CF}) / (\text{BW} \times \text{AT})$$

CW = water concentration

IR = ingestion rate = 0.05 liter per event and 0.12 liter per event

EF = exposure frequency = 36 events per year

ED = exposure duration = 7 years

BW = body weight = 38.3 kilograms (child)

AT = averaging time = ED × 365 days per year = 2,555 days for noncarcinogens

AT = 365 days per year × 70 years = 25,550 days for carcinogens

SA = skin surface area available for contact = 1.08 × 10<sup>4</sup> square centimeters (child 6–12; EPA 2011)

PC = dermal permeability constant = 0.001 centimeter per hour

ET = exposure time = 1 hour per event

CF = conversion factor = 1 liter per 1,000 cubic centimeters

Table 1 shows the maximum RBCs for each constituent under the exposure scenario described above. These concentrations equate to a hazard quotient of 1 (noncarcinogens) or a risk of  $10^{-6}$  (carcinogens) for ingestion of each constituent in surface water. Maximum historical concentrations of each constituent observed in POC wells and in pond locations are provided for comparison. Note that EPA's acceptable risk range is  $10^{-4}$  to  $10^{-6}$ , indicating that RBCs up to two orders of magnitude higher than the carcinogenic RBCs listed for arsenic could be considered acceptable. RBCs based on noncarcinogenic arsenic exposures are more limiting than those for the high end of the carcinogenic risk range.

### 3.0 Observations and Discussion

#### 3.1 Risk Evaluation

An examination of Table 1 indicates that all concentrations of molybdenum, selenium, and uranium observed in POC wells and surface water have been below their respective maximum RBCs. In most cases, groundwater and surface water concentrations were below RBCs by an order of magnitude or more. These results suggest that ACLs based on maximum observed concentrations at POC wells should be adequately protective for these constituents in surface water and that even higher ACLs could be justified.

Maximum vanadium concentrations in groundwater exceeded the RBC for the upper threshold level of water ingestion only. For arsenic, the RBC based on carcinogenic risks ( $10^{-6}$ ) has been exceeded in groundwater for the upper and mean ingestion rates; the maximum pond concentration exceeded the upper threshold ingestion carcinogenic RBC. No noncarcinogenic RBCs for arsenic were exceeded in either surface water or groundwater.

A look at location-specific chemical data indicates that the potential for unacceptable risks associated with site surface water is somewhat lower than the summary-level analysis suggests. The highest surface water concentrations are generally associated with locations RFN-0452 and -0453. These areas often contain very little water; water quality there may be influenced more by evaporation than by direct discharge of groundwater. The limited amount of water in these areas makes a swimming scenario unlikely. Rather, any ingestion of water is likely to be through incidental contact as opposed to immersion. No default assumptions are available for such contact, but reasonable estimates might be at least one order of magnitude lower than a swimming scenario. The areas in which water persists throughout the year (e.g., RFN-0323, -575) are the locations where contaminant concentrations are lowest—typically one to two orders of magnitude below maximum observed concentrations. When only surface water data for persistently wet pond locations were considered (locations RFN-0320, -0323, and -0575), all concentrations were below their respective RBCs for both upper and mean ingestion rates for all constituents (Table 1).

Figure 2 through Figure 5 show time-concentration plots for pond and POC locations for arsenic and vanadium. All of these figures show that maximum concentrations were observed prior to or in the early 2000s. Concentrations have declined from those levels and have remained fairly low and stable. Using historical maximum concentrations in the risk analysis provides a worst-case scenario. It does not represent current site conditions but provides a potential upper bound on conditions that could be expected in the future.



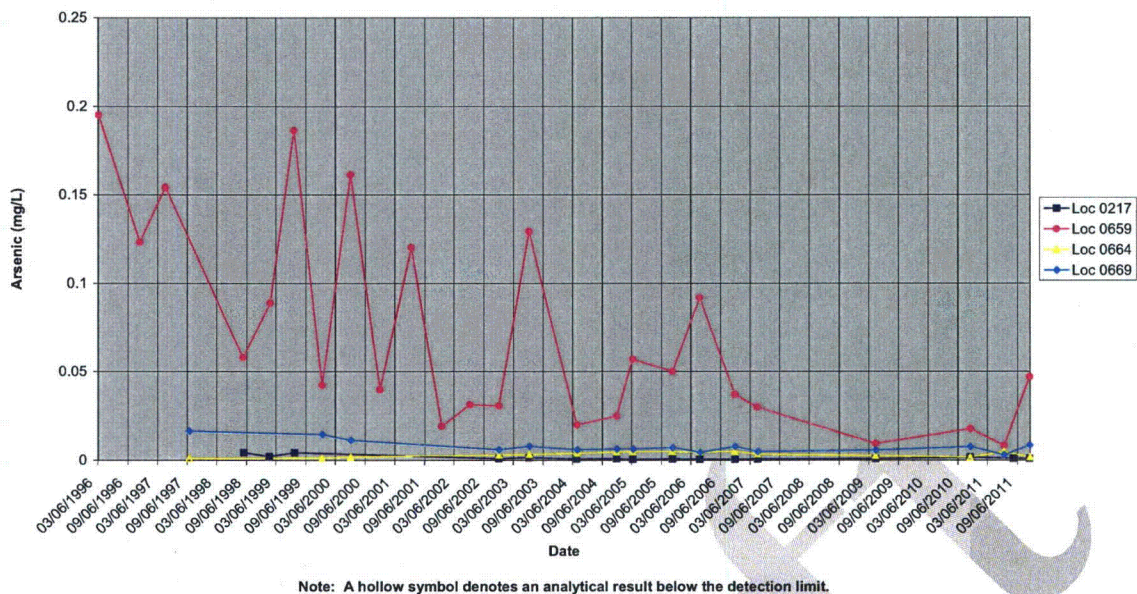


Figure 2. Arsenic in POC Wells

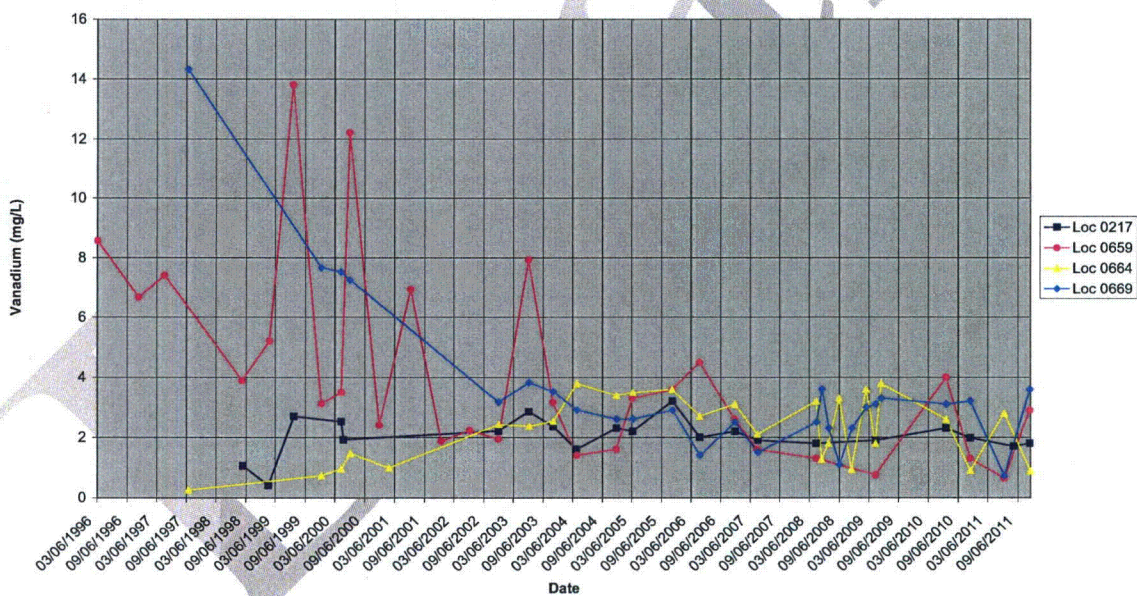
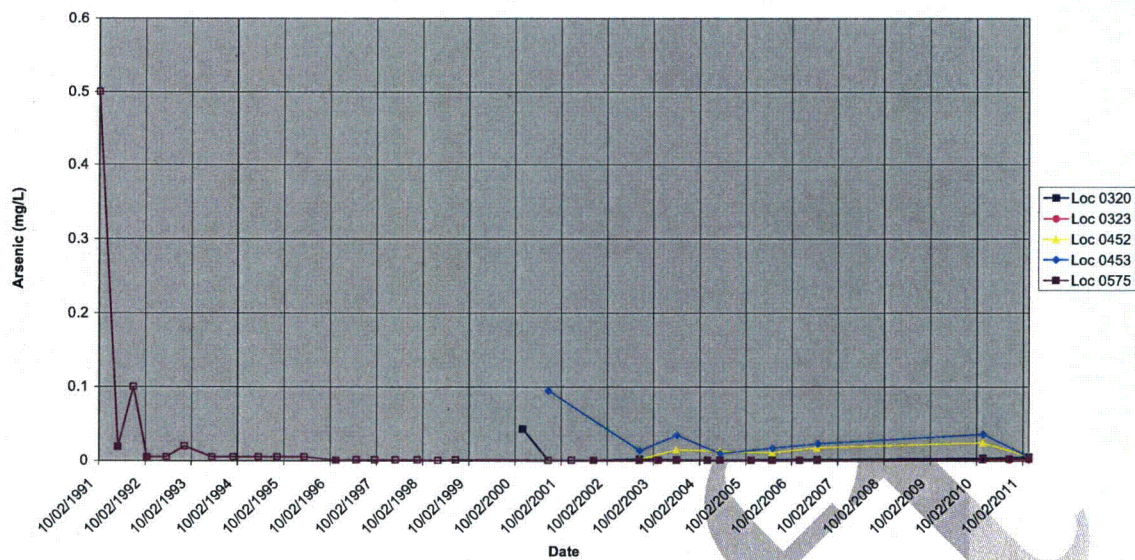


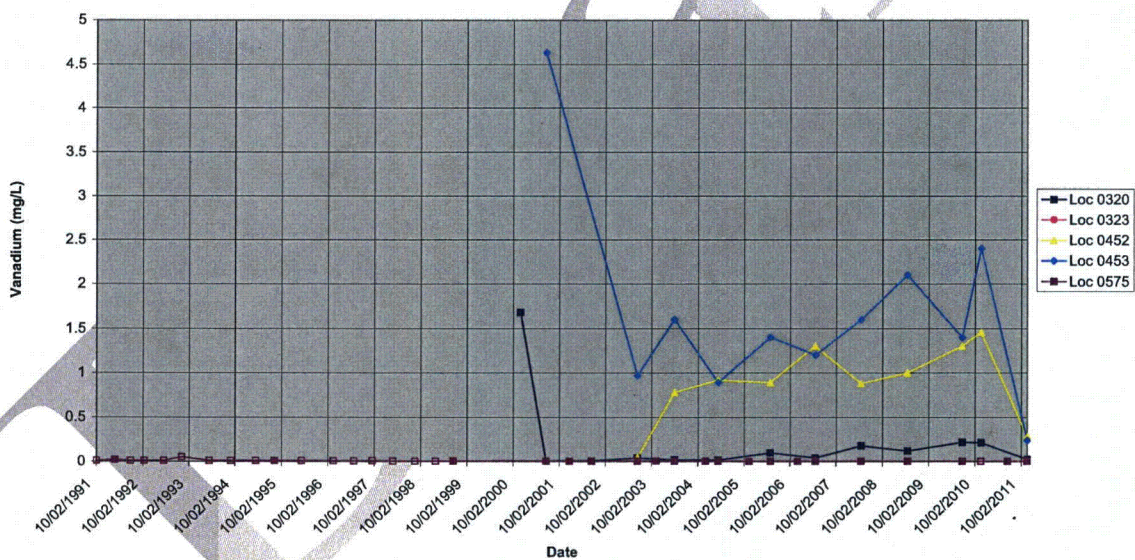
Figure 3. Vanadium in POC Wells





Note: A hollow symbol denotes an analytical result below the detection limit.

Figure 4. Arsenic in Pond Water



Note: A hollow symbol denotes an analytical result below the detection limit.

Figure 5. Vanadium in Pond Water

Concentrations at surface locations RFN-320, -0323, and -0575 are generally an order of magnitude less than concentrations in POC wells. Statistics comparing POC wells and representative “wet” surface locations are presented in Table 2. Mean values were calculated using all data collected since the beginning of calendar year 2000; the detection limit was used as the estimated value for samples below the detection limit. Therefore, mean values are somewhat conservative (likely overestimate the actual mean). Mean surface water concentrations for arsenic are about an order of magnitude lower than POC concentrations; vanadium surface water concentrations are almost two orders of magnitude lower than concentrations in POC wells.

*Table 2. Summary Statistics for New Rifle Groundwater and Surface Water (2000–2010)*

Constituent/measurement	Groundwater <sup>a</sup>	Surface Water <sup>b</sup>
Arsenic: mean (mg/L)	0.0261	0.0021
Arsenic: range (mg/L)	0.00041–0.195	0.0003–0.043
Vanadium: mean (mg/L)	2.99	0.05824
Vanadium: range (mg/L)	0.258–12.2	<0.002–1.68

mg/L = milligrams per liter

<sup>a</sup> POC wells RFN-0217, -0659, -0664, and -0669

<sup>b</sup> Surface locations RFN-320, -323, and -575

### 3.2 Review of the “No-Disturbance” Area

Significant spikes in concentrations of some contaminants, most notably vanadium, have been observed in wells near the no-disturbance area as a result of earthmoving and dewatering activities in recent years. Vanadium concentrations in well RFN-0855 (located at the eastern edge of the no-disturbance area) ranged from 720 to 1,600 mg/L during the 2008/2009 sampling events. No subsequent spike was observed in any of the POC wells, though concentrations fluctuated within a few milligrams per liter. These results suggest that while the disturbance of some areas through excavation and dewatering may result in temporary increases in groundwater contaminant concentrations, these effects are localized and do not affect the overall aquifer water quality. It is possible that restrictions on subsurface disturbance are not necessary to maintain current surface water quality (main point of exposure). Surface water concentrations have not historically exceeded RBCs calculated for even a conservative swimming scenario. Observed attenuation of vanadium and arsenic indicates that significant migration of those constituents at levels that could adversely affect pond surface water is highly unlikely.

These results indicate that the main risk drivers for the New Rifle site are vanadium and arsenic. Based on current land use and conservative future land use assumptions (access to ponds for swimming), no unacceptable risks are expected to be associated with surface water use if surface water concentrations do not increase appreciably over those observed in the last several years.

## 4.0 Approaches for ACL Selection

A number of different approaches can be used for establishing numerical values for ACLs. The establishment of ACLs must balance the need for being protective with the requirement that ACLs must be set at levels that are “as low as reasonably achievable.” Based on the results of this evaluation, the options that could be used to set numerical values for ACLs at the New Rifle site include the following:



- The risk-based concentrations calculated above could be used as ACLs for the POC wells. These concentrations would be protective in the ponds. Attenuation between the POC wells and ponds would ensure that these levels are not exceeded in the ponds. The RBCs are conservative; it is possible to justify numbers up to an order of magnitude higher based on the observed attenuation between the POC wells and the ponds (Table 2). Table 3 provides the maximum RBCs for the POC wells calculated above.
- Assuming the groundwater system is stable and protective barring any significant upward trend in concentrations, a statistical approach could be employed. The last 9 years of “stable” data (essentially the flat portion of time-concentration plots) could be used to determine an upper prediction limit (UPL) or upper threshold value. One upper threshold estimator is simply the maximum observed value over the period of interest. Parametric and nonparametric statistical methods are also available for calculating statistically based UPLs (EPA 2010). Table 3 provides the maximum values observed in POC wells over the last 9 years as well as statistically based UPLs using EPA’s ProUCL 4.1 software (<http://www.epa.gov/osp/hstl/tsc/software.htm>).

Regardless of the method used for establishing ACLs, the long-term monitoring approach for the site should provide a discussion of action levels that would need to be met to trigger further evaluation of site groundwater. A single exceedance of an ACL would likely not be such a trigger. A statistically significant trend or persistently elevated concentrations would more likely signal that groundwater conditions are being adversely affected and that some evaluation of the system is needed to identify the cause of this instability. The approach will need to be incorporated into the Groundwater Compliance Action Plan for the site.

Table 3. Possible Options for ACL Values

Constituent	Max. Noncarcinogenic RBC (mg/L)	Max. Concentration since 2002 (mg/L)	Statistical UPL since 2002 (mg/L) <sup>b</sup>
Arsenic	5.8 <sup>a</sup>	0.129	0.116 (nonparametric)
Molybdenum	96	3.1	5.261 (nonparametric)
Selenium	96	1.4	1.247 (nonparametric)
Uranium	59.4	0.188	0.146 (parametric)
Vanadium	17.4	7.92	7.227 (nonparametric)

<sup>a</sup> Carcinogenic RBCs would range from 0.16 to 16 mg/L ( $10^{-6}$  to  $10^{-4}$ )

<sup>b</sup> Method used based on distribution of data

## 5.0 References

EPA (U.S. Environmental Protection Agency), 1989. *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A), Interim Final*, EPA/540/1-89/002, December.

EPA (U.S. Environmental Protection Agency), 2009. *ProUCL Version 4.1.00 Technical Guide (Draft), Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations*, EPA/600/R-07/041, May.

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