
APPENDIX 3C

Water Quality Technical Report

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Water Quality Technical Report

**Kimball Junction Environmental
Impact Statement**

May 28, 2025

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Attachment B. Highway Site Map

Attachment C. SELDM Results Graphs

Abbreviations

µg/L	micrograms per liter
AADT	average annual daily traffic
ac	acre
AU	Utah Division of Water Quality assessment unit
AWQMS	Ambient Water Quality Monitoring System
BMP	best management practice
cfs	cubic feet per second
cfs/mi ²	cubic feet per second per square mile
FHWA	Federal Highway Administration
ft	feet
GIS	geographic information system
I-80	Interstate 80
LiDAR	light detection and ranging
mg/L	milligrams per liter
mi	miles
MS4	municipal separate storm sewer system
SELDM	Stochastic Empirical Loading and Dilution Model
SR-224	State Route 224
TDS	total dissolved solids
TSS	total suspended solids
UDOT	Utah Department of Transportation
UDWQ	Utah Division of Water Quality
USGS	U.S. Geological Survey
WFRC	Wasatch Front Regional Council
WRCC	Western Regional Climate Center
WWTP	wastewater treatment plant

1.0 Introduction

This report documents the water quality modeling methods that were used to understand the expected impacts to surface water quality from each of the action alternatives for the Kimball Junction Project. A municipal separate storm sewer system (MS4) permit has been issued to the Utah Department of Transportation (UDOT) by the Utah Division of Water Quality (UDWQ), which authorizes UDOT to discharge stormwater from its right-of-way to surface waters in accordance with the requirements of the permit. The permit does not authorize discharges that would cause or contribute to in-stream exceedances of water quality standards. To meet the requirements of the MS4 permit, UDOT used the modeling to compare the expected surface water quality from discharges and additional impervious areas to existing conditions and the applicable surface water quality standards. Both of the action alternatives are located in the East Canyon Creek watershed, which has an established UDWQ assessment unit (AU) for which historical water quality data are available.

2.0 Highway Stormwater Runoff

The main recurring discharge from many road projects is the highway stormwater runoff that flows off impervious areas of the highway surface during precipitation into a surface water body. Highway stormwater runoff can affect water quality in two ways. First, the volume of runoff can increase compared to existing conditions, and second, certain pollutants that are common in stormwater runoff can be discharged into receiving waters. These impacts can usually be partially mitigated using best management practices (BMPs) for stormwater as required by UDOT's MS4 permit. BMPs are usually located alongside the roadway and typically include measures for controlling volume and reducing pollutant concentrations.

The impacts to water quality from the action alternatives have been analyzed using the Stochastic Empirical Loading and Dilution Model (SELDM) considering both the increased runoff volume and the average pollutant concentrations in highway stormwater runoff.

What is SELDM?

SELDM is the Stochastic Empirical Loading and Dilution Model. It was developed as a joint effort between FHWA and USGS to estimate the effects of upstream highway projects on an existing body of water.

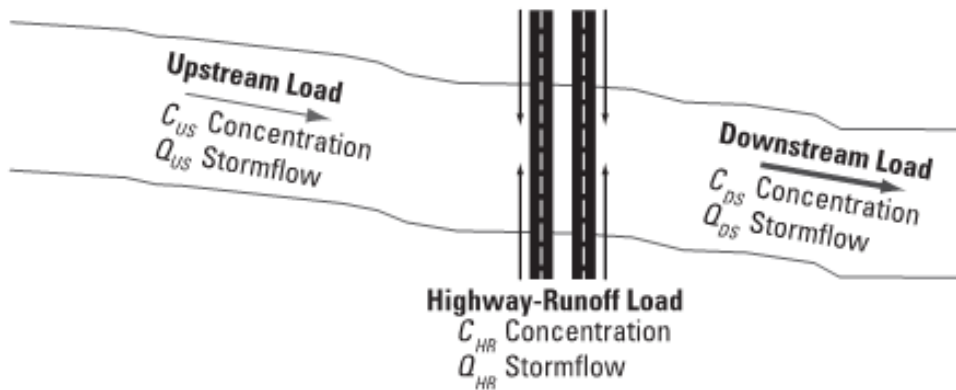
2.1 Modeling Overview

2.1.1 Stochastic Empirical Loading and Dilution Model

SELDM (USGS 2022) was created through a joint effort by the Federal Highway Administration (FHWA) and the U.S. Geological Survey (USGS) to estimate, using Monte Carlo methods, the effects of mixing runoff from highway projects to an existing water body. SELDM uses a range of measured background pollutant concentrations in the water body, stream flow rates, and an expected range of pollutant concentrations and flow rates from highway stormwater runoff to determine a statistical distribution of a mixed, in-stream pollutant concentration downstream of the highway's surface water discharge point. BMPs can also be implemented and accounted for in the model to reduce the expected pollutant concentrations and flow rates from the highway stormwater runoff using observed treatment efficiencies for various BMP options.

Figure 2-1 shows a basic schematic of how SELDM calculates the results. The model treats the input variables (pollutant concentration and flow rates for both the upstream water body and highway runoff) as random numbers that follow a stochastic distribution and combines them using a mass balance approach and Monte Carlo methods. By using this method, a variety of conditions for the four input values can be combined, resulting in hundreds or thousands of simulations and downstream concentrations and streamflow values.

Figure 2-1. SELDM Schematic



Source: USGS 2013

Section 2.1.2 below describes the pollutants of concern that were chosen for assessment based on their typical presence in highway stormwater runoff and the creek's impairment status for a particular constituent or water quality characteristic. Section 2.2, *Model Parameter Development*, discusses the development of model parameters, including both those that are constant (site parameters) and those that are observed (empirical), to develop a stochastic distribution (mean and standard deviation) of pollutant concentrations, flow rates, precipitation, and change with each model simulation. Section 2.3, *Model Results*, discusses the modeling results for East Canyon Creek.

2.1.2 Pollutants of Concern

UDOT's *Stormwater Quality Design Manual* (UDOT 2021) lists several categories of pollutants of concern that are typically found in highway stormwater runoff, including solids, nutrients, and metals. Each of these categories lists specific pollutants that are common in highway stormwater runoff. For the project's water quality analysis, the following pollutants were analyzed using SELDM:

- Solids
 - Total dissolved solids (TDS)
 - Total suspended solids (TSS)
- Nutrients
 - Dissolved nitrogen
 - Total phosphorus
- Metals
 - Dissolved cadmium
 - Dissolved chromium
 - Dissolved copper
 - Dissolved lead
 - Dissolved zinc

East Canyon Creek is impaired for total phosphorus concentrations, water temperature, and dissolved oxygen. Total phosphorus is a typical pollutant of concern in highway stormwater runoff and has been included in the list of pollutants of concern for this analysis. UDOT did not quantitatively analyze impacts to water temperature or dissolved oxygen. Water temperature has seasonality effects, which are difficult to correct in a stochastic analysis, and dissolved oxygen is tied to water temperature as described in the TMDL study (UDWQ 2010). Sediment, organic matter, and nutrients might also reduce dissolved oxygen concentrations, and impacts from these constituents will be reduced by the BMPs that are planned as a part of the Kimball Junction Project.

2.2 Model Parameter Development

2.2.1 Upstream Watershed Characteristics

An upstream watershed includes all the area that drains to a specified outlet point when precipitation occurs. For this analysis, the outlet point for the East Canyon Creek watershed was chosen as East Canyon Creek above the East Canyon wastewater treatment plant (WWTP). UDWQ has collected historical water quality data at this location since at least 2003 (the first year of data used for this analysis). The following methods were used to characterize the watershed and develop input parameters for SELDM.

A half-meter light detection and ranging (LiDAR) dataset that covers the East Canyon Creek watershed was acquired from the Utah Geospatial Resource Center (gis.utah.gov) and was used to delineate the upstream watershed using geographic information systems (GIS) software.

The basin centroid (the geographic center of the basin), longest flow path (the path that a drop of water would take to travel from the point of the basin farthest from the outlet to the outlet), and mean basin slope (defined as the average slope between points representing 10% and 85% of the longest flow path) for each watershed were also determined using GIS software. Approximate percentages

of impervious area (not including the roadways) for each upstream watershed were determined using the USGS StreamStats application.

Finally, the basin development factor (an integer value between 0 and 12) for the existing upstream basin was qualitatively determined by analyzing the presence of storm drains, streets with curb and gutter, and channel improvements in the watershed. Attachment A, *Upstream Watershed Map*, includes a map for the East Canyon Creek watershed that shows the outlet point, watershed extents, and longest flow path.

Table 2-1 shows the drainage area, basin centroid, length of the longest flow path, mean basin slope, percent impervious area, and basin development factor that were used in the model for the upstream East Canyon Creek watershed.

Table 2-1. Upstream Watershed Characteristics

Watershed	Area		Basin Centroid	Longest Flow Path		Mean Basin Slope		% Impervious Area	Basin Development Factor
	mi ²	acres		feet	mi	%	ft/mi		
East Canyon Creek	51.57	33,007	40.700 N, -111.541 W	99,133	18.8	1.96	103.3	3.68	3

Definitions: ft = feet; mi = mile; mi² = square miles

2.2.2 Existing In-stream Pollutant Concentrations

UDOT used the Ambient Water Quality Monitoring System (AWQMS) database maintained by UDWQ to obtain existing water quality data for East Canyon Creek. Data were obtained for Site ID 4925260, East Canyon Creek, above the East Canyon WWTP from January 1, 2003, to August 24, 2023. This site was chosen because of its location downstream of the project area and the availability of historical data. In the water quality dataset, several data points had concentration levels that were below the laboratory’s analytical method detection limit. These values were set at one-half the detection limit, which is standard practice in surface water quality analyses.

For the existing upstream pollutant concentrations, UDOT used all the data points in the dataset acquired from the AWQMS database and calculated the mean, standard deviation, and skew values for each pollutant of concern. These are the values that SELDM requires to create the stochastic distribution for the model simulations. In addition, UDOT calculated the same statistics (mean, standard deviation, and skew) using a log₁₀ (a logarithm to the base 10) transformation applied to each pollutant concentration in the data set. The statistics that were calculated using the log₁₀ transformed values were used in SELDM, as shown in the manual (USGS 2013), to avoid the possibility of negative concentrations in the stochastic distribution.

Table 2-2 shows the number of samples for each pollutant of concern and the mean, standard deviation, and skew statistics based on both the untransformed and the log₁₀ transformed values.

Table 2-2. Existing East Canyon Creek In-stream Pollutant Concentrations

Pollutant	Units	Number of Samples	Untransformed Values			Log ₁₀ Transformed Values		
			Mean	Standard Deviation	Skew	Mean	Standard Deviation	Skew
Dissolved cadmium	µg/L	42	0.1357	0.1788	1.635	-1.111	0.3974	1.635
Dissolved chromium	µg/L	43	1.507	0.8226	1.438	0.1283	0.1975	1.063
Dissolved copper	µg/L	43	2.222	2.219	1.415	0.1693	0.3816	0.5869
Dissolved lead	µg/L	40	0.4081	0.5665	1.415	-0.7623	0.5500	0.7798
Dissolved nitrogen	mg/L	18	0.7722	0.5524	1.818	-0.1951	0.2660	0.5181
Total phosphorus	mg/L	71	0.02409	0.01882	1.773	-1.720	0.2875	0.5786
TDS	mg/L	78	592.9	162.7	1.257	2.758	0.1156	-0.07388
TSS	mg/L	76	12.66	19.57	4.332	0.8416	0.4506	0.5114
Dissolved zinc	µg/L	40	10.43	6.691	1.355	0.9419	0.2544	0.4759

Definitions: µg/L = micrograms per liter; mg/L = milligrams per liter; TDS = total dissolved solids; TSS = total suspended solids

2.2.3 Highway Stormwater Runoff Pollutant Concentrations

As part of developing the SELDM model, USGS and FHWA created the National Highway Runoff Database, which includes measured concentrations of pollutants in highway stormwater runoff from locations across the United States. These locations include various highway types, both rural and urban, with a wide variety of average annual daily traffic (AADT) conditions and climates. For this analysis, UDOT chose sites from the database to best represent the conditions of the Interstate 80 (I-80) and State Route 224 (SR-224) corridors near Kimball Junction based on the following criteria:

- Western United States to represent northern Utah’s typical climate and precipitation patterns.
- AADT between about 35,500 and 106,500 vehicles per day. The traffic volumes forecasted by the Wasatch Front Regional Council (WFRC; WFRC 2023) on I-80 and SR-224 near Kimball Junction are an AADT of about 71,000 vehicles per day in 2050. The AADT that UDOT used as in input to SELDM is between about 0.5 times and 1.5 times WFRC’s forecasted AADT (length weighted value – individual segments range between 39,500 and 85,500 vehicles per day).

Highway stormwater runoff data were used from locations in California and Washington. Locations in North Carolina and Hawaii were added to supplement data only for dissolved nitrogen to obtain a more robust dataset. To create the stochastic distribution in SELDM, UDOT used data from the National Highway Runoff Database and calculated the statistics (using both untransformed and log₁₀ transformed values) for the mean, standard deviation, and skew based on the data points at the selected sites. Similar to the existing in-stream pollutant concentrations, the statistics based on the log₁₀ transformed values are used in SELDM to avoid the possibility of negative concentrations in the stochastic distribution. The sample values that had concentrations at levels below the analytical method detection limit were set at one-half the detection limit, similar to the existing in-stream pollutant concentrations, as described above.

Table 2-3 shows the number of samples for each pollutant and the mean, standard deviation, and skew statistics based on the untransformed and the log₁₀ transformed values.

Table 2-3. Pollutant Concentrations in Highway Stormwater Runoff

Pollutant	Units	Number of Samples		Untransformed Values			Log ₁₀ Transformed Values		
		Total	Above Detection Limit	Mean	Standard Deviation	Skew	Mean	Standard Deviation	Skew
Dissolved cadmium	µg/L	171	71	0.2249	0.2431	2.754	-0.8246	0.4010	-0.4731
Dissolved chromium	µg/L	174	143	4.279	6.527	4.370	0.3625	0.4647	0.3607
Dissolved copper	µg/L	195	195	12.77	11.01	2.134	0.9761	0.3383	0.02573
Dissolved lead	µg/L	186	87	3.850	15.26	6.596	-0.1364	0.6325	0.8206
Dissolved nitrogen	mg/L	69	66	0.2528	0.2721	2.560	-0.8055	0.4478	-0.1549
Total phosphorus	mg/L	207	188	0.6092	1.900	6.813	-0.6799	0.5694	0.1796
TDS	mg/L	156	153	207.0	675.0	7.685	1.802	0.5891	0.000222
TSS	mg/L	249	247	194.0	482.0	6.491	1.869	0.5664	-0.06182
Dissolved zinc	µg/L	196	189	50.59	59.08	2.933	1.479	0.4771	-0.5765

Definitions: µg/L = micrograms per liter; mg/L = milligrams per liter; TDS = total dissolved solids; TSS = total suspended solids

2.2.4 Upstream Flow Rates

UDOT used the USGS streamflow gage data from gage 10133800 (East Canyon Creek Near Jeremy Ranch, Utah) to calculate various stream flow statistics for SELDM to use in creating the stochastic distribution on which the calculations are based. This flow gage is about 1,500 feet downstream of the point where the existing in-stream pollutant concentrations were measured. It provides the best available data and the longest continuous record for flow rates in East Canyon Creek. UDOT anticipates that any differences between the actual flow at the upstream point where the existing in-stream pollutant concentrations were measured and the downstream gage location would be minor because the points are close together. Furthermore, SELDM adjusts the flow statistics for actual basin size (statistics are input in units of cubic feet per second per square mile [cfs/mi²]).

UDOT calculated the streamflow statistics of mean, standard deviation, skew, and median using the mean daily flow values from this gage between October 1, 2001, and September 30, 2023, so that SELDM could create the stochastic distribution of flow rates that was used in the model simulations. In addition, UDOT used the USGS Hydrologic Toolbox software to calculate the low-flow statistics for these creeks, specifically the 7Q10, 1B3, and 4B3 flow rates, that correspond to the minimum 7-day average flow that occurs, on average, once every 10 years; the minimum 1-day average biological flow rate that occurs, on average, once every 3 years; and the 4-day average biological flow rate that occurs, on average, once every 3 years, respectively. The low-flow rates were calculated using the mean daily flow rates from gage 10133800 between April 1, 2002, and March 31, 2023, because low-flow statistics are typically calculated using date ranges from April through March instead of the typical water year from October through September.

To input the flow statistics in cfs/mi² into SELDM, UDOT divided the untransformed mean daily flow statistics and the low-flow rates (7Q10, 1B3, and 4B3) by the area upstream of the flow gage (57.2 mi²). SELDM also requires the log₁₀ retransformed statistics for the mean daily flow rates to avoid negative flow values. The log₁₀ retransformed statistics were calculated using the following process:

1. Divide each daily mean flow value in the data set by the area upstream of the flow gage.
2. Calculate the log₁₀ value for each value calculated in step 1.
3. Calculate the mean, standard deviation, skew, and median statistics using the values from step 2.
4. Calculate the inverse logarithm (base 10) for each of the statistics calculated in step 3, except for skew (the statistic for skew in SELDM should be the same as for step 3). The results of this step are the retransformed log₁₀ statistics.

Table 2-4 shows the values that were input into SELDM to create the stochastic distribution for East Canyon Creek streamflow.

Table 2-4. Upstream Flow Rate Statistics

Date Range	Number of Daily Mean Flow Values	Flow Value (cfs)		Log ₁₀ Retransformed Values [Untransformed Values] (cfs/mi ²)				Low Flow Statistics		
		Minimum	Maximum	Mean	Standard Deviation	Skew	Median	7Q10	1B3	4B3
10/1/2002 – 9/30/2023	8,035	2.21	371	0.38837 [0.5900]	2.2980 [0.7238]	0.8032 [3.220]	0.3252 [0.3252]	–	–	–
4/1/2002 – 3/31/2023	7,670	2.21	371	–	–	–	–	0.0767	0.0545	0.0981

Definitions: cfs = cubic feet per second; cfs/mi² = cubic feet per second per square mile

2.2.5 Highway Site Characteristics

The highway site characteristics are unique for each of the alternatives that were analyzed for the project’s environmental impact statement. For the action alternatives (Alternatives A and C), UDOT defined the highway site as the impervious area from the preliminary design models and all existing impervious areas where changes are proposed under at least one of the action alternatives. For the No-Action Alternative, UDOT defined the highway site as the existing impervious area where changes are proposed under at least one of the action alternatives.

Table 2-5 shows the highway site characteristics that were calculated for input into SELDM, including the highway site area, length of the longest flow path, mean basin slope, percent impervious area, and basin development factor. Attachment B, *Highway Site Map*, shows the highway sites that were defined for use in the SELDM model.

Table 2-5. Highway Site Characteristics

Alternative	Impervious Area (ac)	Longest Flow Path		Mean Basin Slope		% Impervious Area	Basin Development Factor
		feet	miles	%	ft/mi		
No-Action Alternative	45.73	26,481	5.015	0.48%	25.42	100%	6
Alternative A	52.36	26,492	5.017	0.48%	25.43	100%	6
Alternative C	51.65	26,493	5.017	0.48%	25.44	100%	6

Definitions: ac = acres; ft = feet; mi = mile

2.2.6 Precipitation Characteristics

UDOT determined the stormwater runoff rate from the highway site and the upstream watershed for each model simulation using precipitation statistics from nearby rainfall gages that SELDM uses to determine the stochastic distribution. SELDM contains predetermined precipitation statistics for several precipitation gages that were used for this project. Table 2-6 lists the gages that were used for this analysis, the average number of storms per year, and the average annual precipitation at these gages.

Table 2-6. Precipitation Gages and Comparison to Upstream Watershed Data

Precipitation Gage	Site Description	Average # of Storms per Year	Average Annual Precipitation (inches)	Average Event Volume (inches)	Average Event Duration (hours)
Silver Lake Brighton	Brighton Ski Resort – Big Cottonwood Canyon	53	31.94	0.60	9.73
Mountain Dell Dam	Mountain Dell Dam in Parley’s Canyon	39	17.93	0.46	7.06
Oakley 3 NE	About 3.75 miles northeast of Oakley, Utah	37	14.76	0.40	6.60
Average of all gages listed above (from SELDM)		43	21.54	0.49	7.80

The East Canyon Creek watershed upstream of the East Canyon WWTP encompasses two main areas: Park City, Utah, and Snyderville, Utah. According to the Western Regional Climate Center (WRCC), the average annual precipitation for Park City from September 1, 1992, through June 10, 2016, is 20.62 inches (WRCC 2024a). The average annual precipitation for Snyderville from October 1, 1991, through May 29, 2016, is 22.55 inches (WRCC 2024b). The average annual precipitation for these two locations is 21.59 inches, which is 0.05 inch higher than the average for the three gages used in the analysis (see Table 2-6 above). Because the average annual precipitation for the three gages is similar to the average annual precipitation in the watershed and the gages used are in locations surrounding the watershed, UDOT determined that these gages sufficiently represent the precipitation conditions in the area.

2.2.7 BMP Performance

To be conservative in the analysis, UDOT modeled the No-Action Alternative, assuming no BMP treatment of the highway stormwater runoff. For this reason, no volume reduction or pollutant removal from the highway stormwater runoff is reflected in the SELDM model results for the No-Action Alternative.

For both of the action alternatives, in accordance with UDOT’s *Stormwater Quality Design Manual*, BMP treatment of highway stormwater runoff was applied to the difference in highway stormwater runoff volume between the existing conditions and the proposed conditions. The model considers that about 12.7% and 11.5% of the total highway site area is treated by routing stormwater through BMPs for Alternative A and Alternative C, respectively. These percentages reflect the approximate increase in impervious area with the project over the existing conditions. In SELDM, BMP treatment includes both volume reduction and pollutant removal based on general performance statistics for detention basins.

For this analysis, the statistics for BMP performance were taken from a 2021 report published by USGS, which considered the December 2019 version of the International Stormwater Best Management Practices Database (USGS 2021). This report provides average water quality treatment statistics, including inflow-outflow ratios of volume and pollutant concentrations and minimum irreducible concentrations below which a pollutant concentration cannot be reduced (clean in = clean out) for a variety of BMP types.

Table 2-7 gives ranges of volume reduction and pollutant removals for detention basins as presented in the 2021 USGS report (USGS 2021), because UDOT anticipates that detention basins would be used to manage the additional highway stormwater runoff. For example, the outflow concentration for dissolved chromium can be between about 30.5% and 133.9% of the inflow concentration; however, it is most likely that the outflow concentration would be between about 54.6% and 70.5% of the inflow concentration. Note that the actual data used for SELDM vary from the table data to reflect the percentages of highway areas treated by detention basins.

Table 2-7. BMP Performance Statistics

Pollutant	Range of Inflow to Outflow Ratios	Range of Most Probable Inflow to Outflow Ratios	Minimum Irreducible Concentration
Volume Reduction			
All pollutants	0.0658–1.8986	0.1411–0.6570	–
Pollutant Removal			
Dissolved cadmium ^a	0.025–1.803	0.025–0.120	0.078 µg/L
Dissolved chromium	0.305–1.339	0.546–0.705	0.430 µg/L
Dissolved copper	0.496–1.698	0.672–0.672	0.860 µg/L
Dissolved lead	0.000–2.244	0.107–0.107	0.310 µg/L
Dissolved zinc	0.164–2.186	0.394–0.553	4.060 µg/L
Dissolved nitrogen	0.000–1.832	0.522–0.760	0.032 mg/L
Total phosphorus	0.089–2.356	0.258–0.323	0.028 mg/L
TDS	0.301–1.944	0.831–0.936	9.940 mg/L
TSS	0.000–1.682	0.000–0.000	2.110 mg/L

Source: USGS 2021

Definitions: µg/L = micrograms per liter; mg/L = milligrams per liter; TDS = total dissolved solids; TSS = total suspended solids

^a Statistics reflect pollutant removal for total cadmium.

2.3 Model Results

For Alternatives A and C, the results from SELDM are presented as a probability distribution of downstream concentrations that result from hundreds of combinations of mixing in-stream pollutant concentrations, highway stormwater runoff concentrations, East Canyon Creek flow rates, precipitation events, and BMP removal rates that were determined from the stochastic distributions of the inputs that are presented in Section 2.2, *Model Parameter Development*. This probability distribution is calculated to give the percentage of simulated storms that would result in a downstream concentration greater than or equal to a given concentration, and it allows a comparison of the resulting concentrations to applicable water quality standards and the No-Action Alternative to understand the potential risks of impacts that could be expected from both of the action alternatives.

For the Kimball Junction Project, SELDM simulated about 1,470 storms for each project alternative. The SELDM results for the No-Action Alternative and the action alternatives are summarized below in Section 2.3.1, *Alternative A*, and Section 2.3.2, *Alternative C*. Although the results for the No-Action Alternative are the same for both action alternatives, they are repeated in each section to provide an easier comparison.

What are beneficial uses?

Lakes, rivers, and other water bodies have uses to humans and other life. These uses are called beneficial uses.

Additionally, the summaries provide a comparison to applicable surface water quality standards for the stream’s beneficial uses. These expected impacts are represented by providing the percentage of simulated storms during which the downstream concentration of each pollutant of concern equals or exceeds the surface water quality standards.

The summaries also include an expected range of concentrations in East Canyon Creek that could be reasonably expected after combining upstream flows with highway stormwater runoff just upstream of the East Canyon WWTP. These ranges represent the concentration that would be equaled or exceeded for 80% of simulated storms (low end or more frequent) and 20% of simulated storms (high end or less frequent). This central range is used because stochastic analysis typically excludes the results that were calculated at the extremes in the stochastic distributions (relatively very low and very high values) to focus the interpretation of the results on the in-stream concentrations that are expected most often.

To help UDOT visualize the impacts to water quality, the distribution of modeled in-stream concentrations for the action alternatives and each pollutant of concern after combining upstream flows with highway stormwater runoff have been plotted against the No-Action Alternative distribution of modeled concentrations. These plots are included in Attachment C, *SELDM Results Graphs*.

2.3.1 Alternative A

This section discusses the results of the SELDM modeling for East Canyon Creek by comparing the model results for the No-Action Alternative to the model results for Alternative A.

Table 2-8 shows the surface water quality standards for East Canyon Creek’s beneficial uses and the percentage of simulated storms during which the resulting downstream concentration (at the point upstream of the East Canyon WWTP) of each pollutant of concern is expected to equal or exceed the surface water quality standards.

Table 2-9 shows the central range of concentrations that could be reasonably expected in East Canyon Creek downstream of the project area for the No-Action Alternative and Alternative A and the percent change in each end of the central range (80% and 20% of storms) between the No-Action Alternative and Alternative A. An example of how to interpret the results shown in Table 2-8 and Table 2-9 is provided following the tables.

Table 2-8. SELDM Results Compared to Surface Water Quality Standards for Alternative A

Pollutant	Units	Surface Water Quality Standards by Beneficial Use				% of Simulated Storms Equaling or Exceeding the East Canyon Creek Surface Water Quality Standards Upstream of the East Canyon WWTP							
						No-Action Alternative				Alternative A			
		1C	2B	3B	4	1C	2B	3B	4	1C	2B	3B	4
Dissolved cadmium	µg/L	10	–	1.8 ^a	10	0.00	–	1.29	0.00	0.07	–	0.75	0.07
Dissolved chromium	µg/L	50	–	16 ^{a,b}	100	0.00	–	0.07	0.00	0.00	–	0.00	0.00
Dissolved copper	µg/L	–	–	65 ^a	200	–	–	0.07	0.00	–	–	0.07	0.07
Dissolved lead	µg/L	15	–	65 ^a	100	0.34	–	0.00	0.00	0.41	–	0.00	0.00
Dissolved zinc	µg/L	–	–	120 ^a	–	–	–	0.00	–	–	–	0.00	–
Dissolved nitrogen	mg/L	10 (4 ^c)	–	4 ^c	–	0.07 (0.75)	–	0.75	–	0.00 (0.61)	–	0.61	–
Total phosphorus	mg/L	0.05 ^c	–	0.05 ^c	–	11.88	–	11.88	–	14.15	–	14.15	–
TDS	mg/L	–	–	–	1,200	–	–	–	0.20	–	–	–	0.07
TSS	mg/L	–	–	–	–	–	–	–	–	–	–	–	–

Definitions: µg/L = micrograms per liter; mg/L = milligrams per liter; TDS = total dissolved solids; TSS = total suspended solids

Beneficial-use definitions: 1C = domestic/drinking water with prior treatment; 2B = infrequent primary-contract recreation; 3B = warm-water fishery/aquatic life; 4 = agricultural uses including irrigation of crops and stock watering

^a The 1-hour criterion was chosen because impacts from stormwater runoff typically move downstream and dissipate quickly.

^b Hexavalent chromium (has a more stringent water quality standard than trivalent chromium [570 µg/L]).

^c Pollution Indicator.

Table 2-9. Expected Concentration Ranges in East Canyon Creek and Percent Change with Alternative A

Pollutant	Units	No-Action Alternative		Alternative A		% Change in Downstream East Canyon Creek Concentration during _____ of Simulated Storms	
		80%	20%	80%	20%	80%	20%
Dissolved cadmium	µg/L	0.0393	0.154	0.0403	0.145	2.29	-6.28
Dissolved chromium	µg/L	0.950	1.91	0.967	1.97	1.71	3.15
Dissolved copper	µg/L	0.842	3.04	0.818	3.22	2.90	5.86
Dissolved lead	µg/L	0.0736	0.517	0.0720	0.548	-2.24	5.55
Dissolved zinc	µg/L	5.88	14.4	5.78	14.5	-1.83	0.090
Dissolved nitrogen	mg/L	0.377	1.09	0.385	0.990	1.95	-10.12
Total phosphorus	mg/L	0.0135	0.0382	0.0140	0.0398	3.44	4.14
TDS	mg/L	450	712	451	707	0.27	-0.72
TSS	mg/L	3.79	18.2	4.11	18.9	7.95	3.55

Definitions: µg/L = micrograms per liter; mg/L = milligrams per liter; TDS = total dissolved solids; TSS = total suspended solids

The following is an example of how to interpret the results shown above in Table 2-8 and Table 2-9. A similar example is not provided for the Alternative C results in Section 2.3.2, *Alternative C*, but the interpretation would be similar to the example provided for Alternative A.

As shown in Table 2-8 above, the dissolved cadmium water quality standard (1.8 µg/L) for beneficial use classification 3B would be exceeded by 0.75% of storms for Alternative A. Table 2-9 above shows that the central range for the in-stream concentration of dissolved cadmium (after mixing stream flows and highway stormwater runoff) was between 0.0403 and 0.145 mg/L for Alternative A. Although dissolved cadmium concentration exceedances could occur, they would occur infrequently (for less than 1% of storms), and the more commonly occurring central range (0.0403 to 0.145 µg/L) is below the numeric water quality standard (1.8 µg/L). Compared to the No-Action Alternative, Alternative A represents a decrease in the number of storms that could exceed the numeric water quality standard, a small increase in concentration for more frequent storms, and a small decrease in concentration for less frequent storms.

In general, the impacts from Alternative A to surface water quality in East Canyon Creek downstream of the project area would be minor compared to the No-Action Alternative. Of the pollutants of concern that were modeled, East Canyon Creek is impaired for total phosphorus. East Canyon Creek is also impaired for water temperature and dissolved oxygen; however, as described in Section 2.1.2, *Pollutants of Concern*, these water quality parameters were not modeled. The impacts to East Canyon Creek from total phosphorus are described below.

Total Phosphorus. As shown in Table 2-8 above, the total phosphorus water quality standard (pollution indicator of 0.05 mg/L) for beneficial use classifications 1C and 3B would be exceeded by 14.15% of storms for Alternative A after mixing stream flows and highway stormwater runoff, compared to 11.88% of storms for the No-Action Alternative. Table 2-9 above shows that the central range for the in-stream concentration of total phosphorus (after mixing stream flows and highway stormwater runoff) was between 0.014 and 0.0398 mg/L for Alternative A and 0.0135 and 0.0382 mg/L for the No-Action Alternative. Although total phosphorus concentration exceedances could occur, they would occur infrequently (for about 14% of storms), and the more commonly occurring central range (0.014 to 0.0398 mg/L) is below the numeric water quality standard (0.05 mg/L). The model results show a low chance that Alternative A would have an adverse in-stream impact on total phosphorus concentrations in East Canyon Creek.

2.3.2 Alternative C

This section discusses the results of the SELDM modeling for East Canyon Creek by comparing the model results for the No-Action Alternative to the model results for Alternative C. Table 2-10 shows the surface water quality standards for East Canyon Creek's beneficial uses and the percentage of simulated storms during which the resulting downstream concentration (at the point upstream of the East Canyon WWTP) of each pollutant of concern is expected to equal or exceed the surface water quality standards. Table 2-11 shows the central range of concentrations that could be reasonably expected in East Canyon Creek downstream of the project for the No-Action Alternative and Alternative C and the percent change at each end of the central range (80% and 20% of storms) between the No-Action Alternative and Alternative C.

Table 2-10. SELDM Results Compared to Surface Water Quality Standards for Alternative C

Pollutant	Units	Surface Water Quality Standards by Beneficial Use				% of Simulated Storms Equaling or Exceeding the East Canyon Creek Surface Water Quality Standards Upstream of the East Canyon WWTP							
						No-Action Alternative				Alternative C			
		1C	2B	3B	4	1C	2B	3B	4	1C	2B	3B	4
Dissolved cadmium	µg/L	10	–	1.8 ^a	10	0.00	–	1.29	0.00	0.20	–	1.23	0.20
Dissolved chromium	µg/L	50	–	16 ^{a,b}	100	0.00	–	0.07	0.00	0.00	–	0.00	0.00
Dissolved copper	µg/L	–	–	65 ^a	200	–	–	0.07	0.00	–	–	0.14	0.00
Dissolved lead	µg/L	15	–	65 ^a	100	0.34	–	0.00	0.00	0.20	–	0.14	0.07
Dissolved zinc	µg/L	–	–	120 ^a	–	–	–	0.00	–	–	–	0.00	–
Dissolved nitrogen	mg/L	10 (4 ^c)	–	4 ^c	–	0.07 (0.75)	–	0.75	–	0.00 (0.34)	–	0.34	–
Total phosphorus	mg/L	0.05 ^c	–	0.05 ^c	–	11.88	–	11.88	–	13.70	–	13.70	–
TDS	mg/L	–	–	–	1,200	–	–	–	0.20	–	–	–	0.07
TSS	mg/L	–	–	–	–	–	–	–	–	–	–	–	–

Definitions: µg/L = micrograms per liter; mg/L = milligrams per liter; TDS = total dissolved solids; TSS = total suspended solids

Beneficial-use definitions: 1C = domestic/drinking water with prior treatment; 2B = infrequent primary-contract recreation; 3B = warm-water fishery/aquatic life; 4 = agricultural uses including irrigation of crops and stock watering

^a The 1-hour criterion was chosen because impacts from stormwater runoff typically move downstream and dissipate quickly.

^b Hexavalent chromium (has a more stringent water quality standard than trivalent chromium [570 µg/L]).

^c Pollution Indicator.

Table 2-11. Expected Concentration Ranges in East Canyon Creek and Percent Change with Alternative C

Pollutant	Units	Downstream East Canyon Creek Concentration Equaled or Exceeded during ____ of Simulated Storms				% Change in Downstream East Canyon Creek Concentration during ____ of Simulated Storms	
		No-Action Alternative		Alternative C		80%	20%
		80%	20%	80%	20%		
Dissolved cadmium	µg/L	0.0393	0.154	0.0394	0.153	0.18	-0.46
Dissolved chromium	µg/L	0.950	1.91	0.949	1.98	-0.09	3.83
Dissolved copper	µg/L	0.842	3.04	0.813	3.10	-3.52	2.03
Dissolved lead	µg/L	0.0736	0.517	0.0751	0.507	2.06	-2.03
Dissolved zinc	µg/L	5.88	14.4	5.90	14.8	0.29	2.78
Dissolved nitrogen	mg/L	0.377	1.09	0.382	0.997	1.07	-9.30
Total phosphorus	mg/L	0.0135	0.0382	0.0133	0.0421	-1.43	9.27
TDS	mg/L	450	712	454	704	0.90	-1.11
TSS	mg/L	3.79	18.2	3.95	18.7	4.18	2.57

Definitions: µg/L = micrograms per liter; mg/L = milligrams per liter; TDS = total dissolved solids; TSS = total suspended solids

In general, the impacts from Alternative C to surface water quality in East Canyon Creek downstream of the project area would be minor compared to the No-Action Alternative. Of the pollutants of concern that were modeled, East Canyon Creek is impaired for total phosphorus. East Canyon Creek is also impaired for water temperature and dissolved oxygen; however, as described in Section 2.1.2, *Pollutants of Concern*, these water quality parameters were not modeled. The impacts to East Canyon Creek from total phosphorus are described below.

Total Phosphorus. As shown in Table 2-10 above, the total phosphorus water quality standard (pollution indicator of 0.05 mg/L) for beneficial use classifications 1C and 3B would be exceeded by 13.7% of storms for Alternative C after mixing stream flows and highway stormwater runoff compared to 11.88% of storms for the No-Action Alternative.

Table 2-11 above shows that the central range for the in-stream concentration of total phosphorus (after mixing stream flows and highway stormwater runoff) was between 0.0133 and 0.0421 mg/L for Alternative C and 0.0135 and 0.0382 mg/L for the No-Action Alternative. Although total phosphorus concentration exceedances could occur, they would occur infrequently (for about 13.7% of storms), and the more commonly occurring central range (0.0133 to 0.0421 mg/L) is below the numeric water quality standard (0.05 mg/L). The model results show a low chance that Alternative C would have an adverse in-stream impact on total phosphorus concentrations in East Canyon Creek.

3.0 Summary

The results of the SELDM modeling show that, for the pollutants of concern, there is a very minor difference in the central range of expected concentrations (the concentrations that would be equaled or exceeded for between 80% and 20% of simulated storms) for both Alternative A and Alternative C compared to the No-Action Alternative.

The main pollutant of concern is total phosphorus because East Canyon Creek is impaired for total phosphorus. The modeled central range of expected concentrations for total phosphorus (0.0133 to 0.0421 mg/L) is below the surface water quality numeric standard of 0.05 mg/L (beneficial uses 1C and 3B).

Exceedances of water quality standards for all modeled constituents would occur infrequently. UDOT anticipates that, for most storms, the surface water quality would be essentially the same among the No-Action Alternative, Alternative A, and Alternative C.

4.0 References

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- 2021 Stormwater Quality Design Manual. May.

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- 2010 East Canyon Reservoir and East Canyon Creek Total Maximum Daily Load (TMDL). May.

[USGS] U.S. Geological Survey

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[WFRC] Wasatch Front Regional Council

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[WRCC] Western Regional Climate Center

- 2024a Park City, Utah (426644) Period of Record Monthly Climate Summary. <https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ut6644>. Accessed May 15.
- 2024b Snyderville, Utah (427942) Period of Record Monthly Climate Summary. <https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ut7942>. Accessed May 15.

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ATTACHMENT A
Upstream Watershed Map

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LEGEND

- 85% of Longest Flow Path
- 10% of Longest Flow Path
- Water Quality Monitoring Point
- East Canyon Creek Watershed Centroid
- East Canyon Creek Longest Flow Path
- Study Area
- East Canyon Creek Watershed



EAST CANYON CREEK WATERSHED

DRAINAGE AREA: 51.57 SQUARE MILES (33,007 ACRES)
DRAINAGE LENGTH: 18.8 MILES (99,133 FEET)

**UDWQ MONITORING
LOCATION ID 4925260
"E CAN CK AB EAST
CANYON WWTP"**

**10% OF WATERSHED
DRAINAGE LENGTH
ELEVATION: 6299.64**

40.700 N, 111.541 W

**SEGMENT DRAINAGE LENGTH: 14.1 MILES (74,350 FEET)
MEAN BASIN SLOPE: 103.261 FT/MI (1.96%)**

**85% OF WATERSHED
DRAINAGE LENGTH
ELEVATION: 7,753.71 FT**

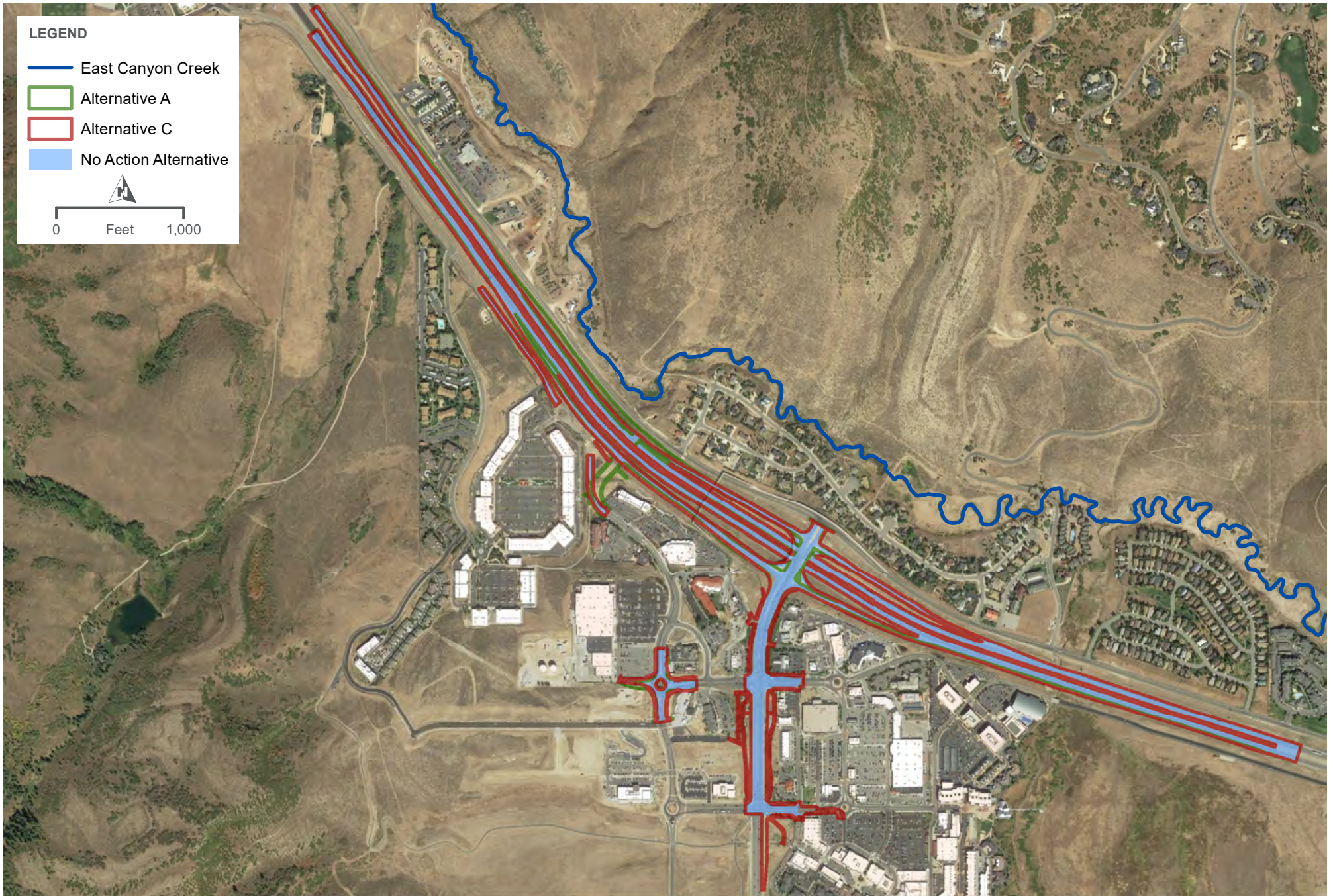
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ATTACHMENT B
Highway Site Map

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LEGEND

- East Canyon Creek
- Alternative A
- Alternative C
- No Action Alternative

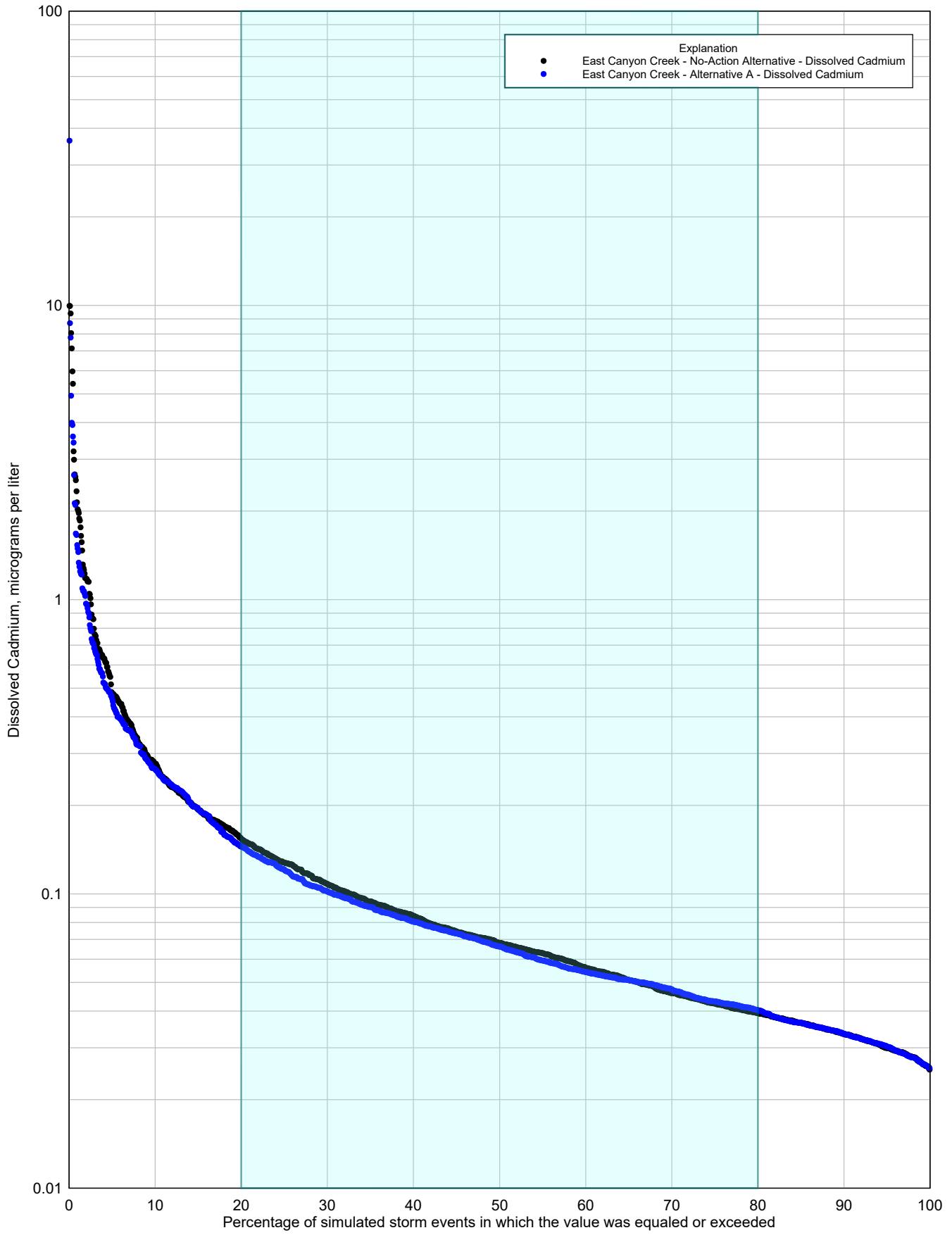


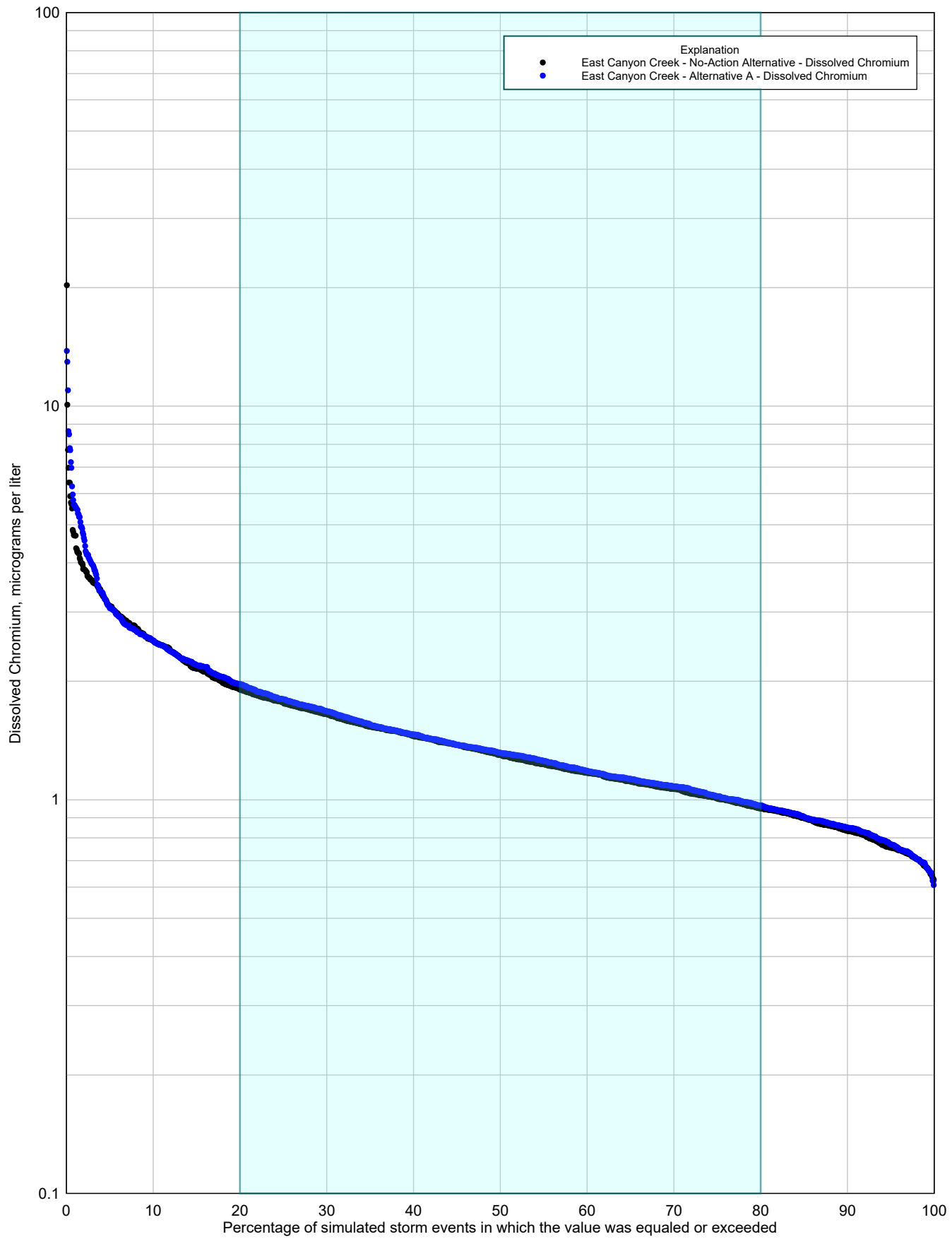
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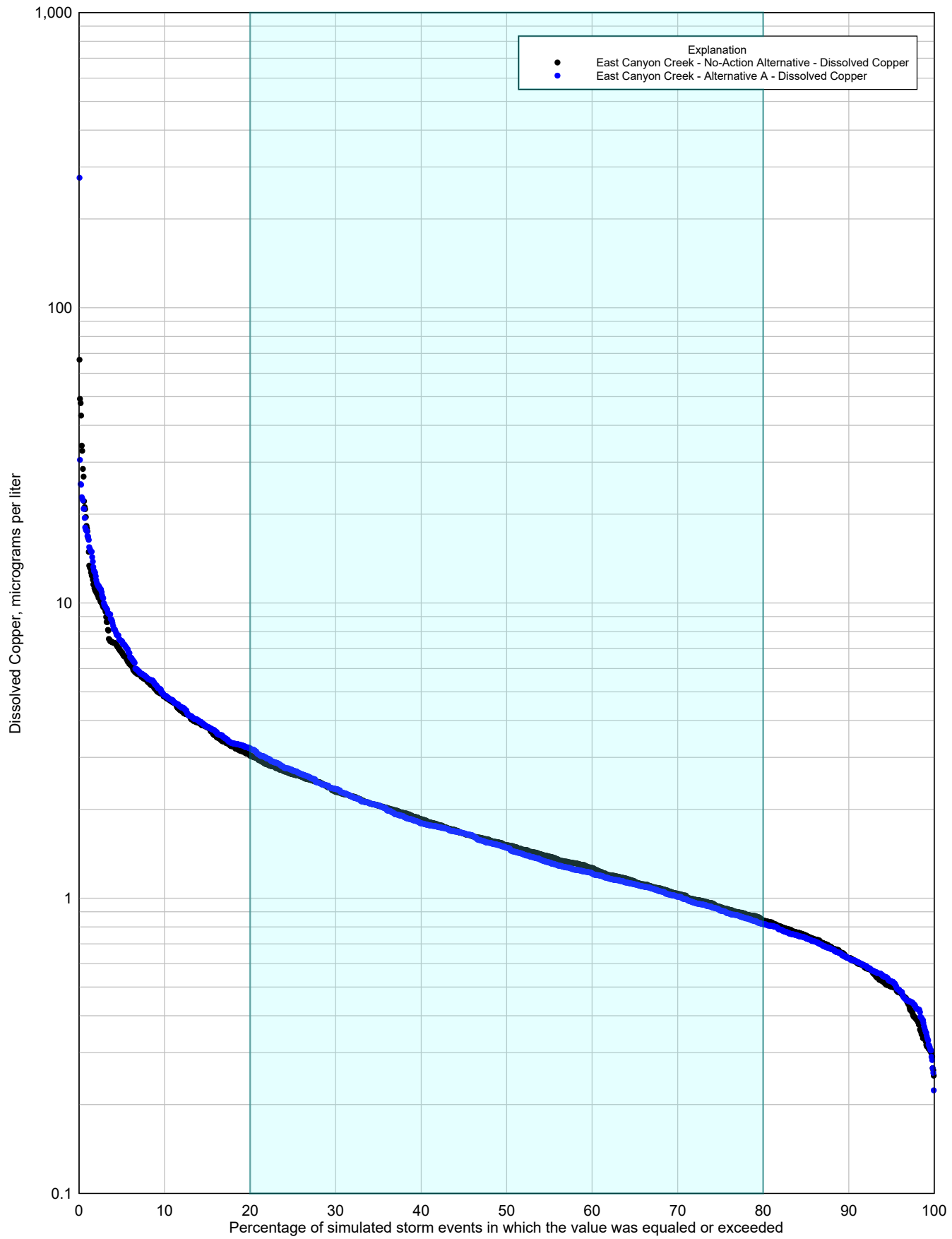
ATTACHMENT C
SELDM Results Graphs

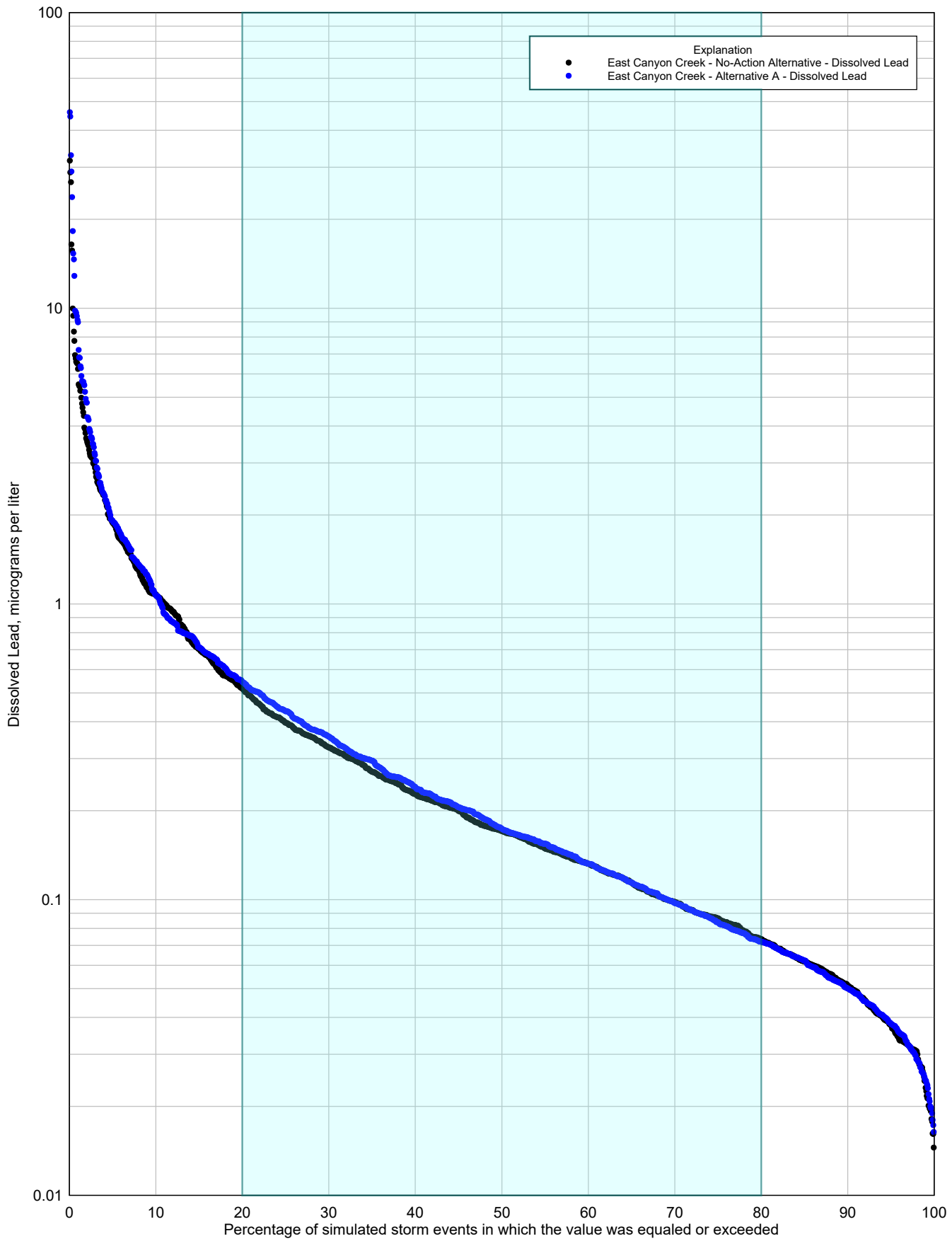
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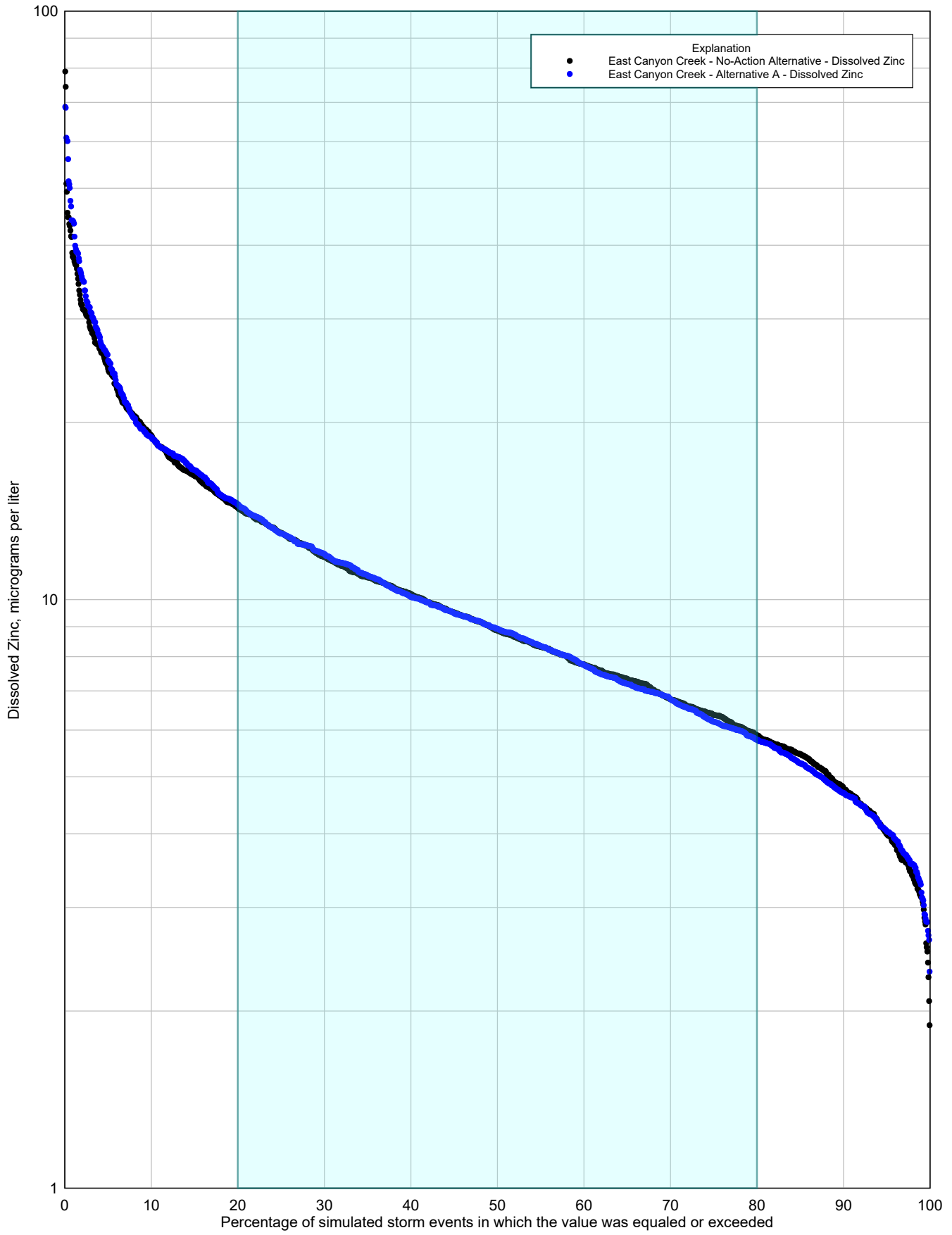
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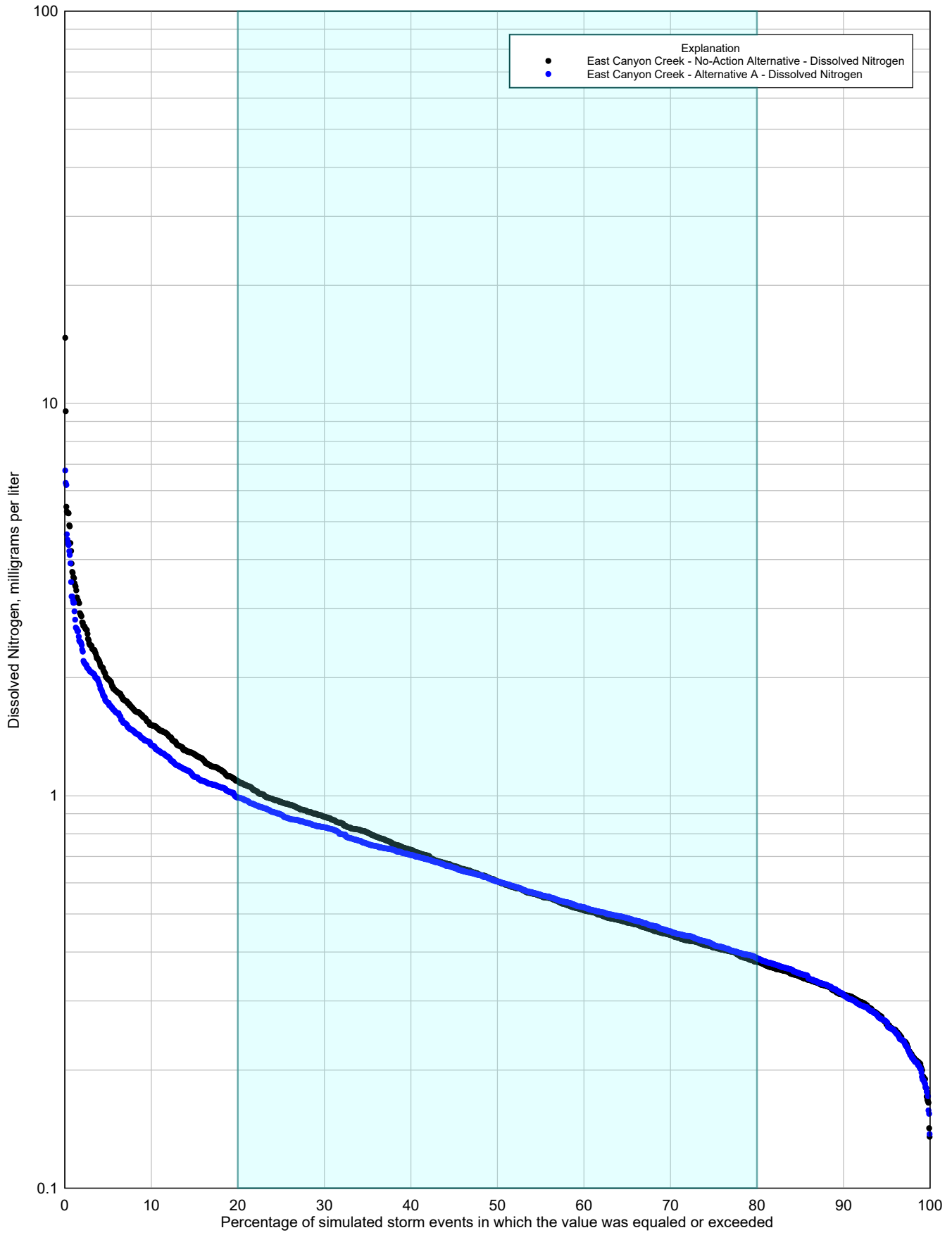


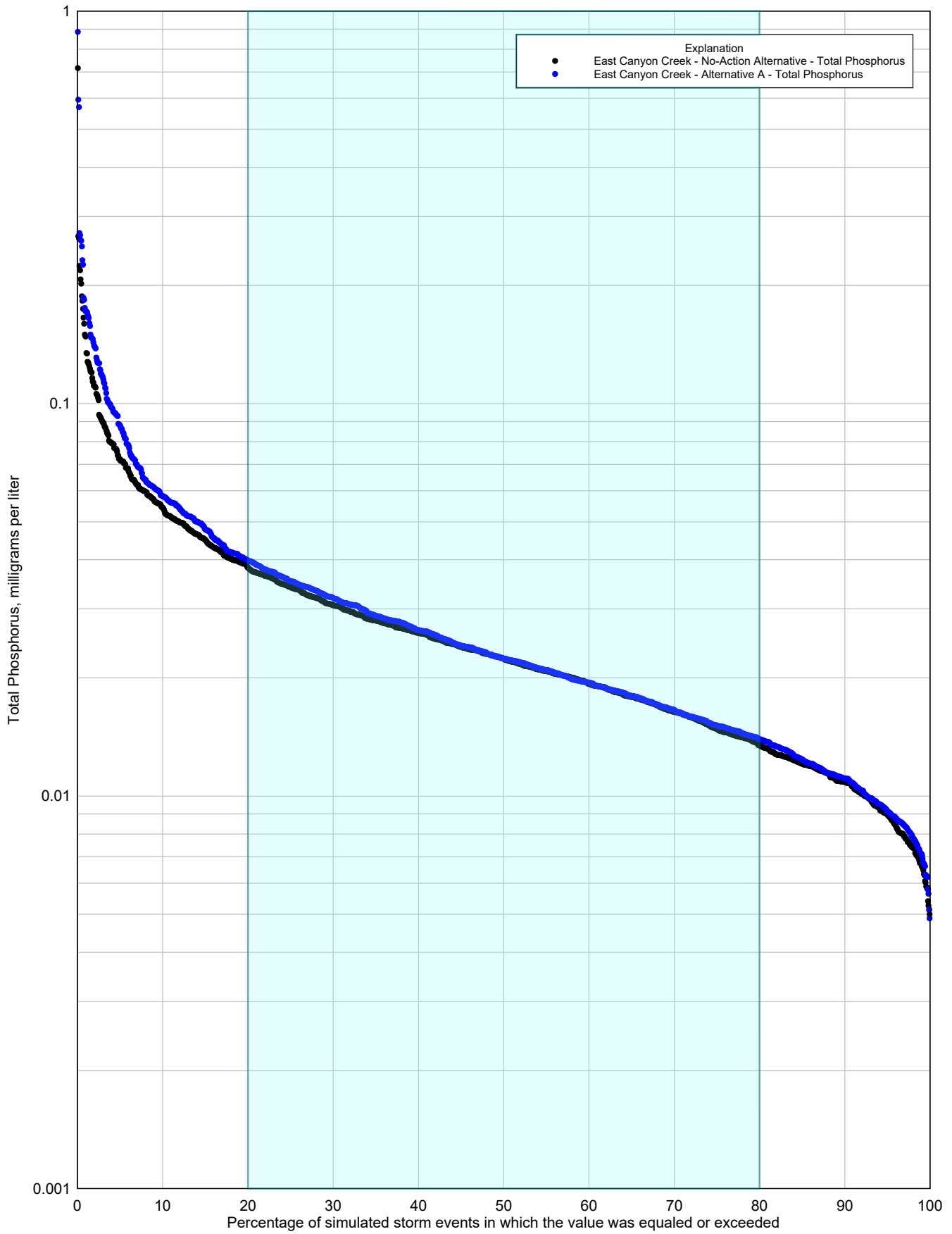


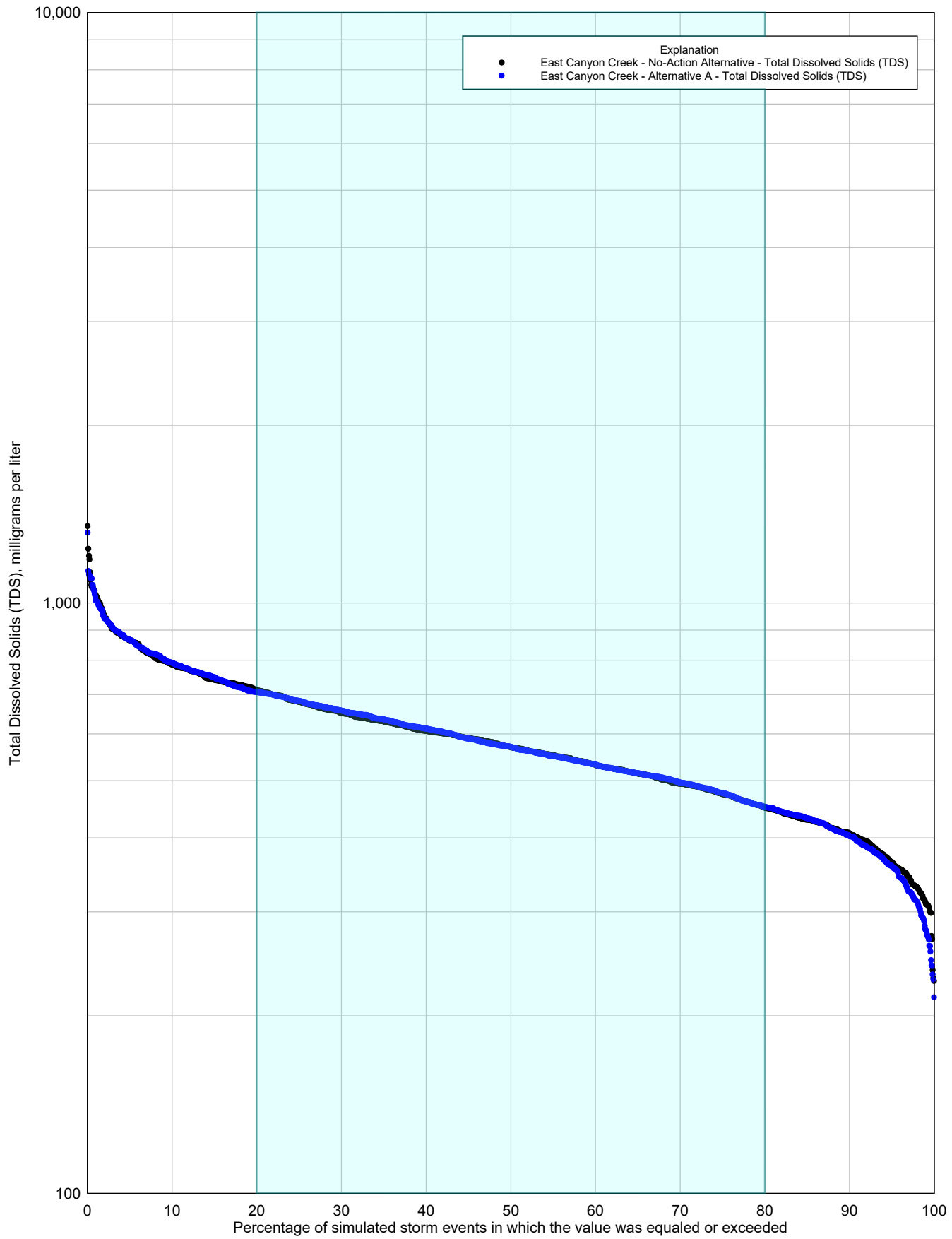


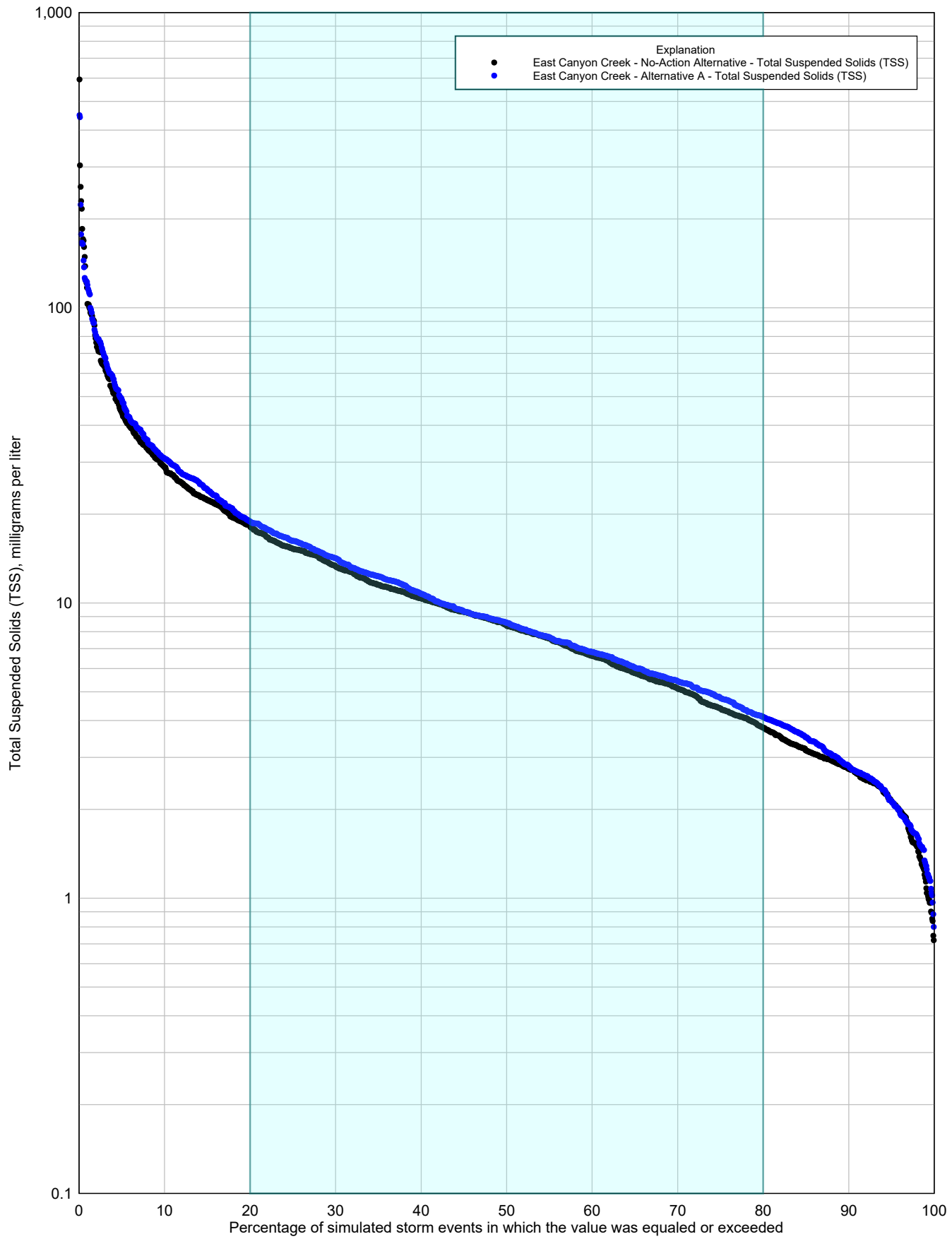










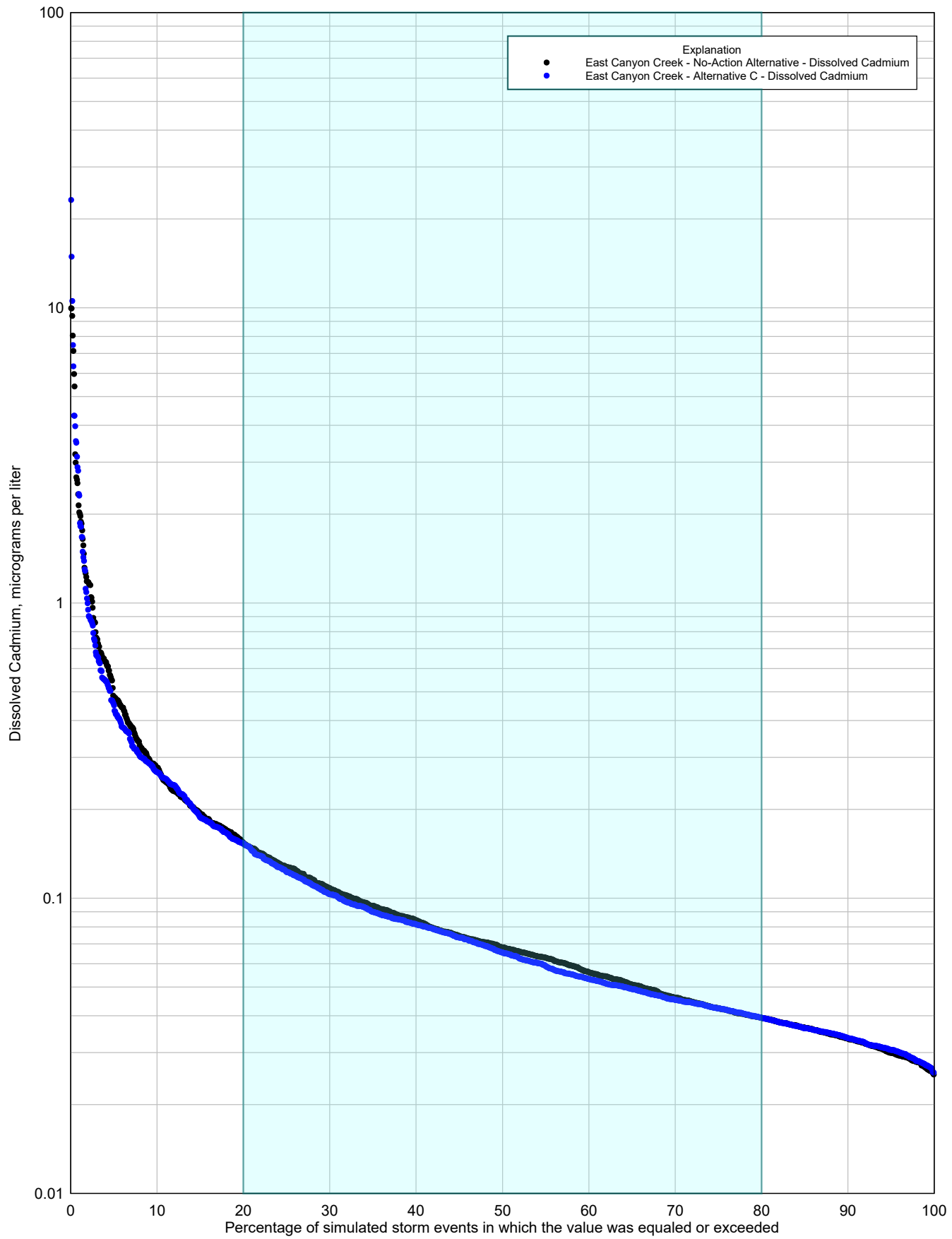


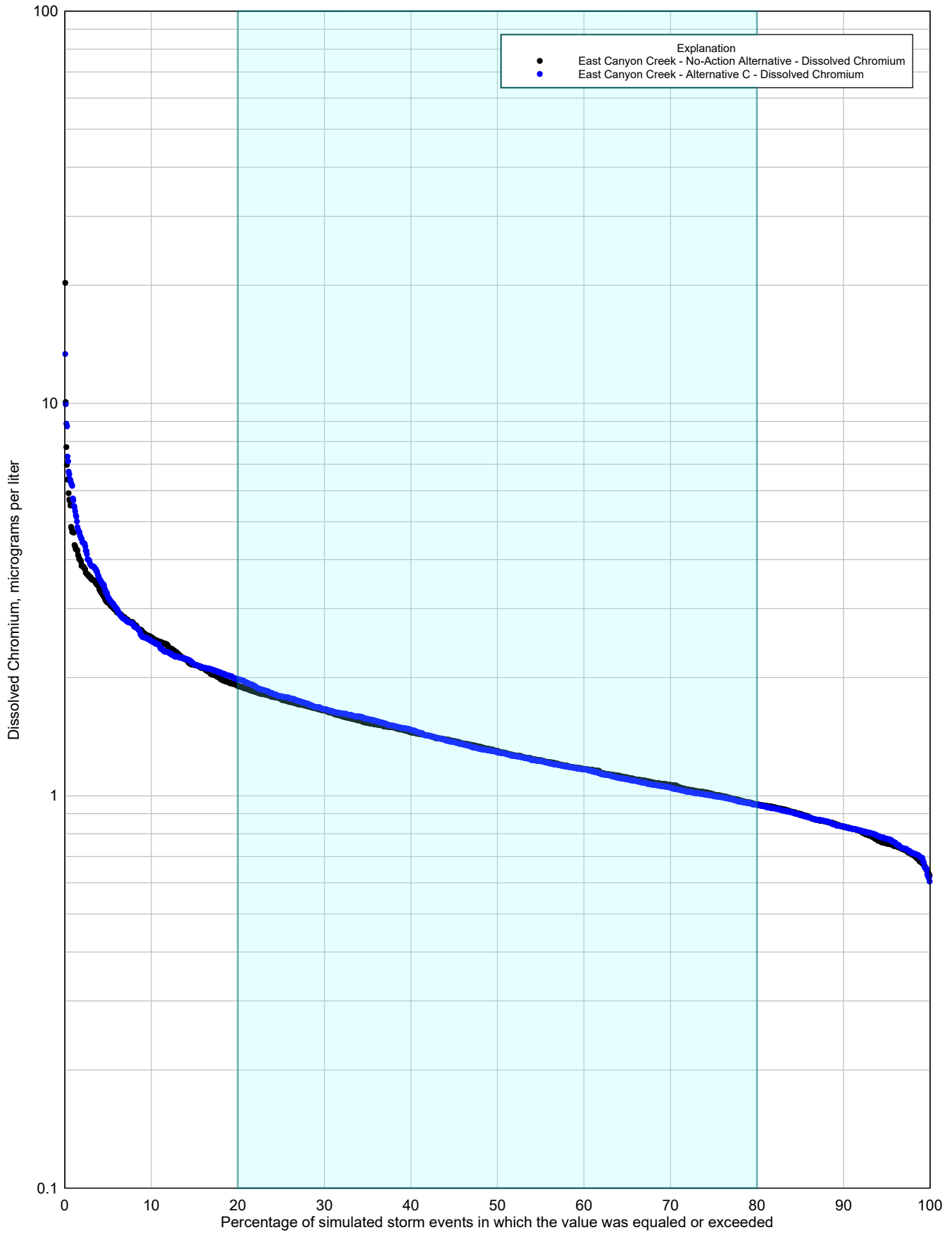
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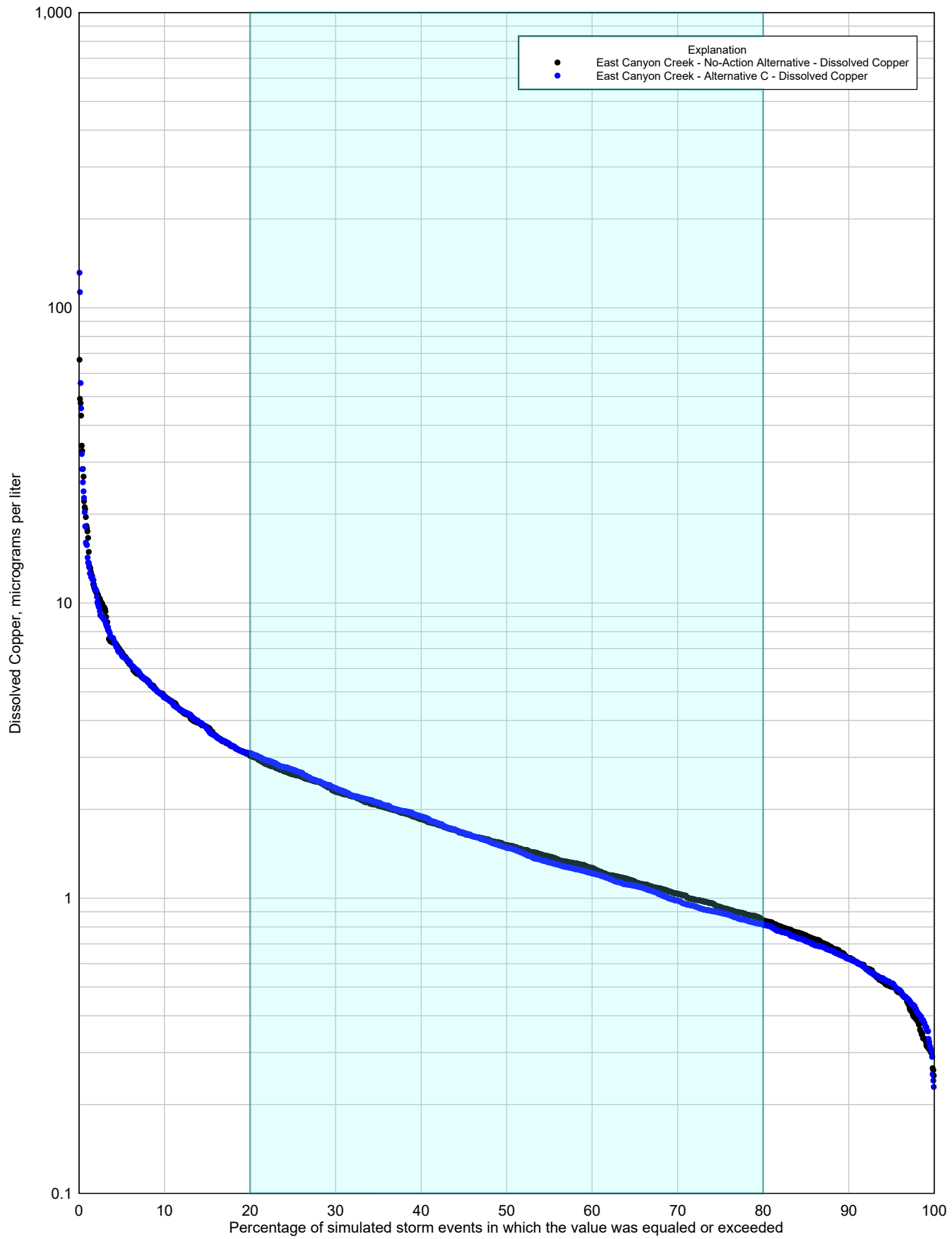
ATTACHMENT C
SELDM Results Graphs

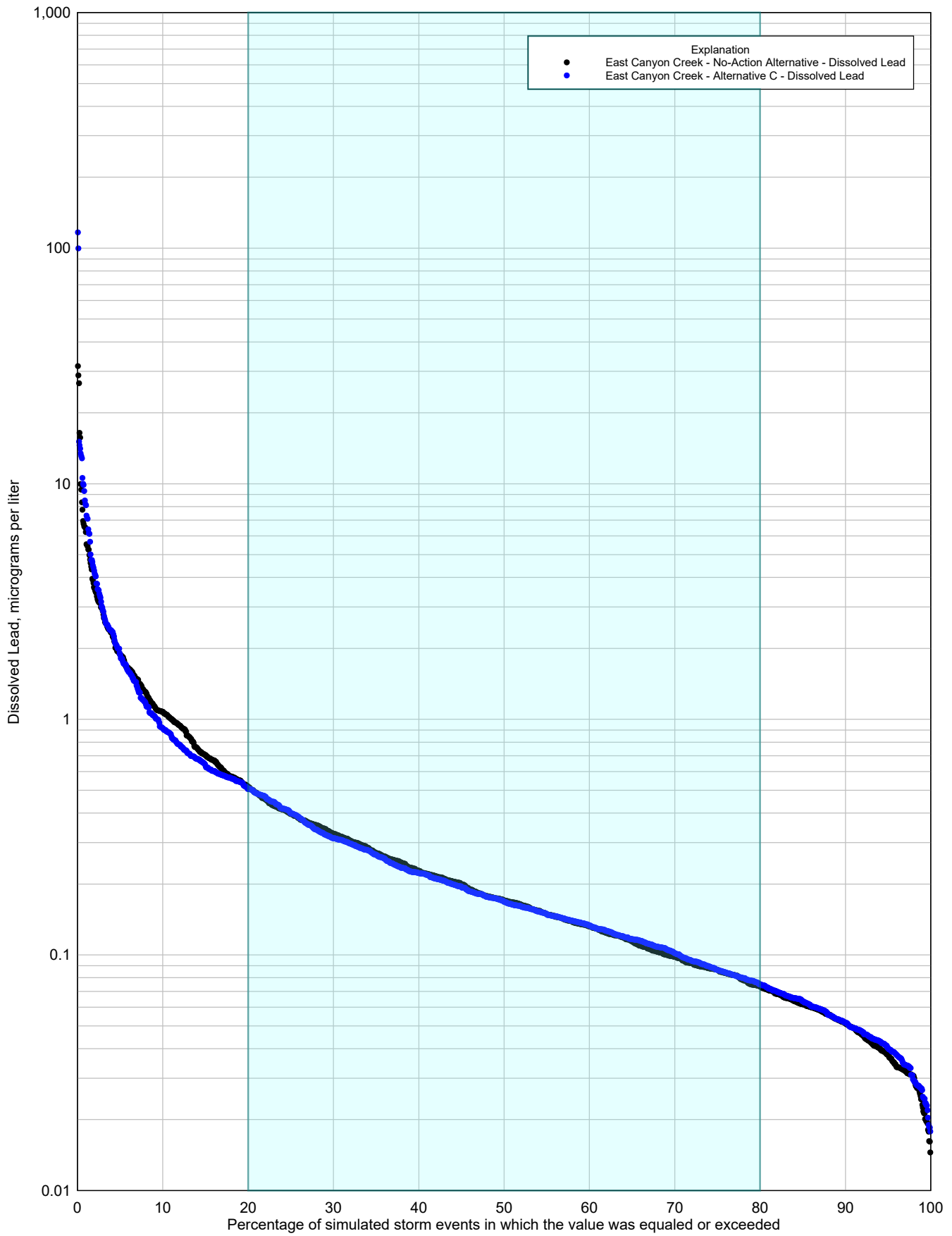
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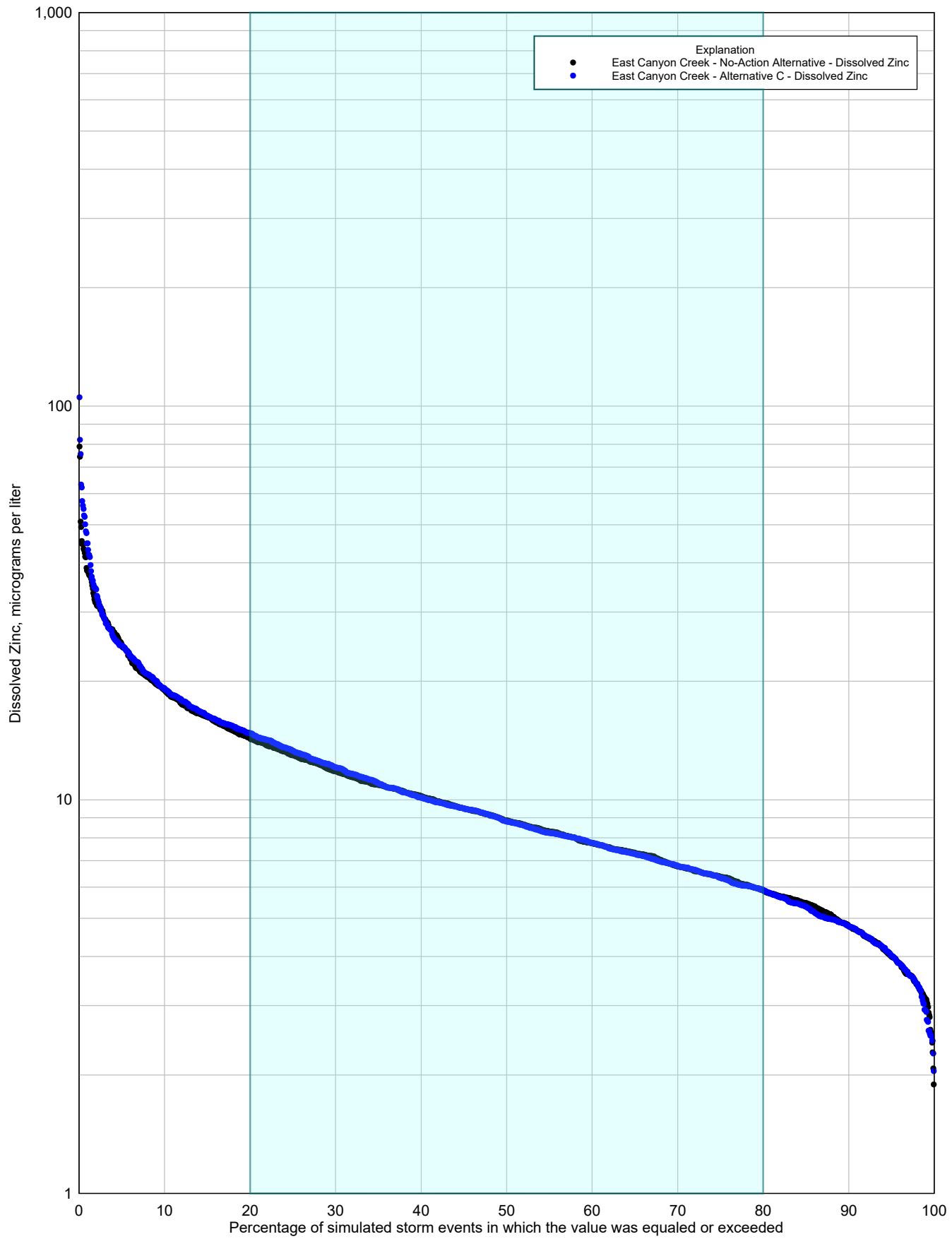
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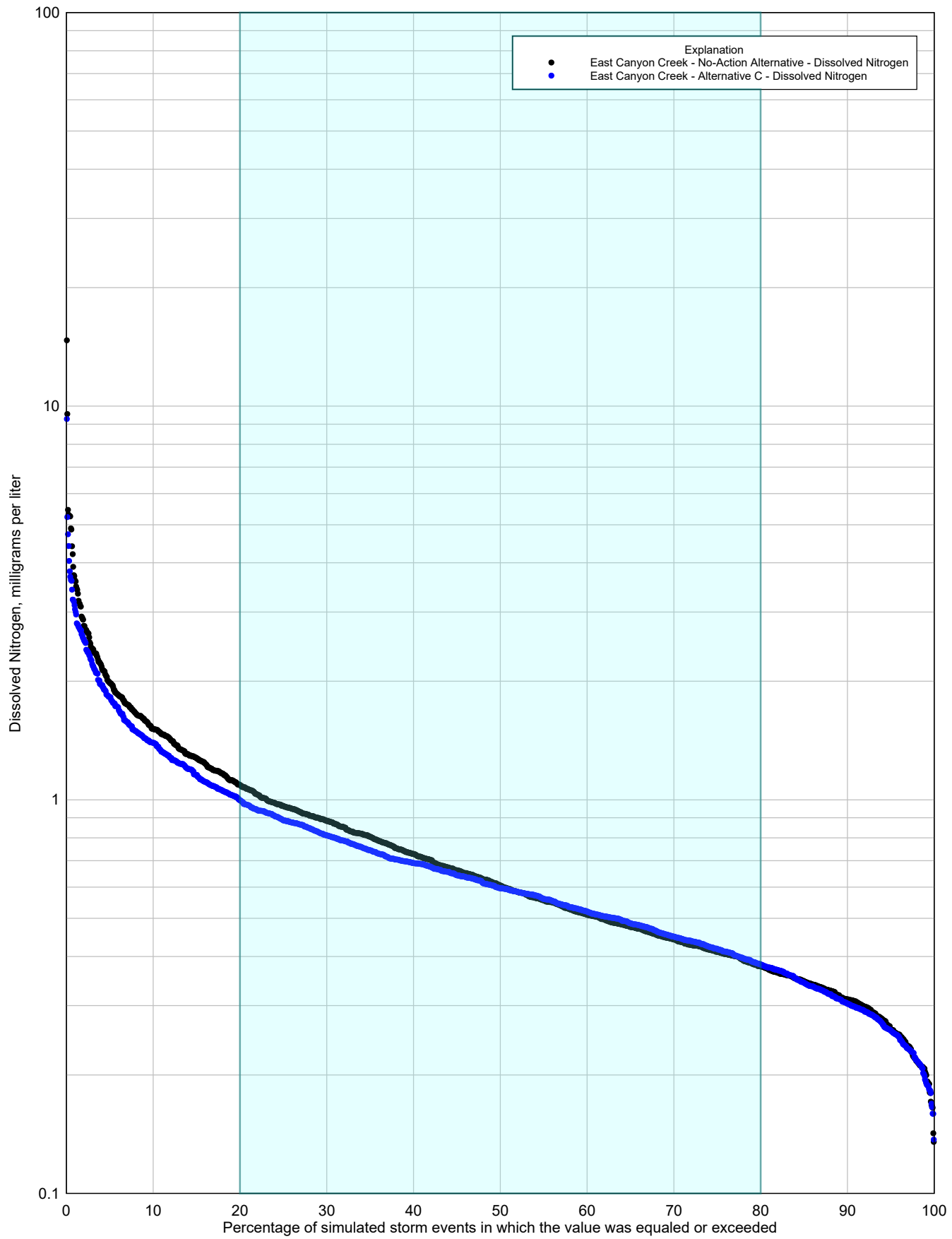


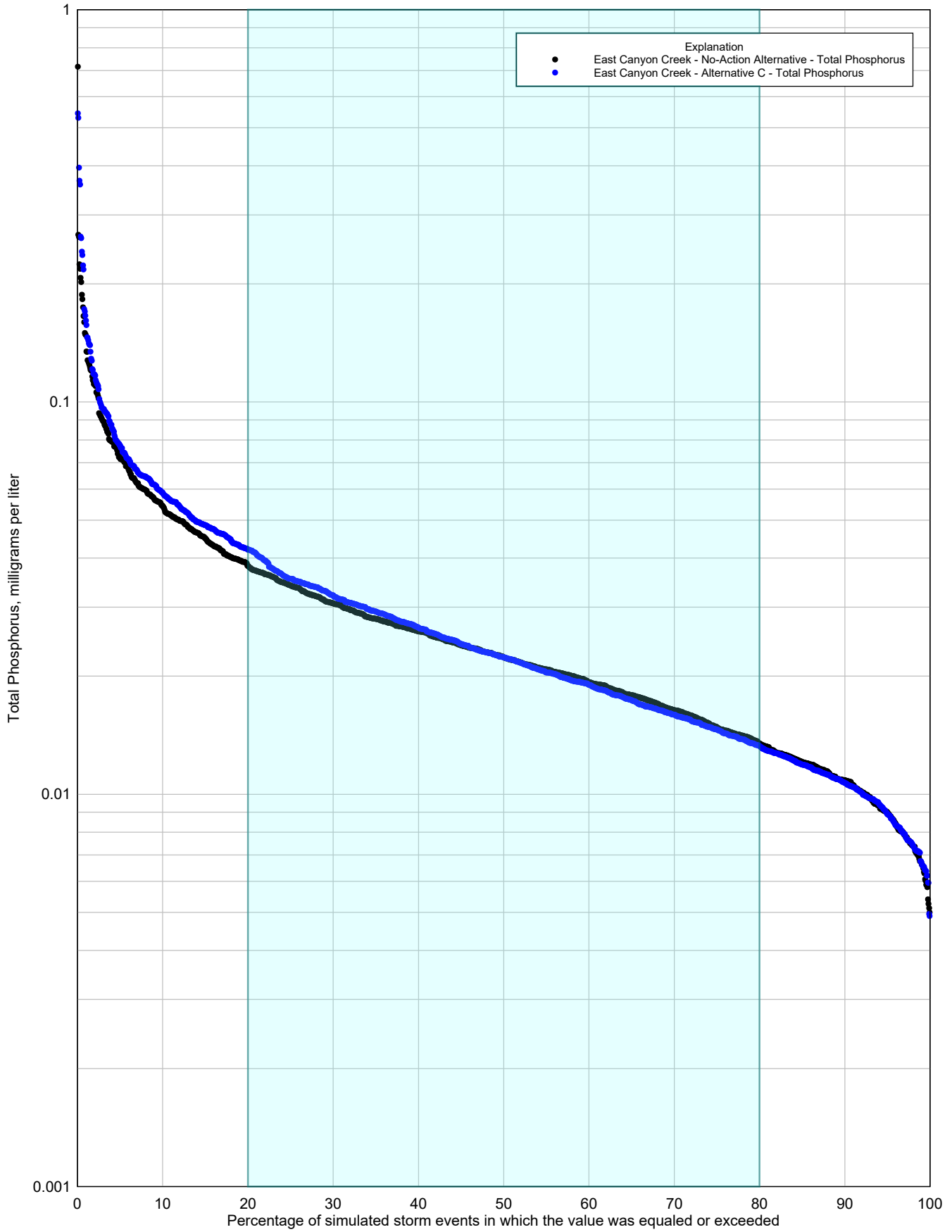


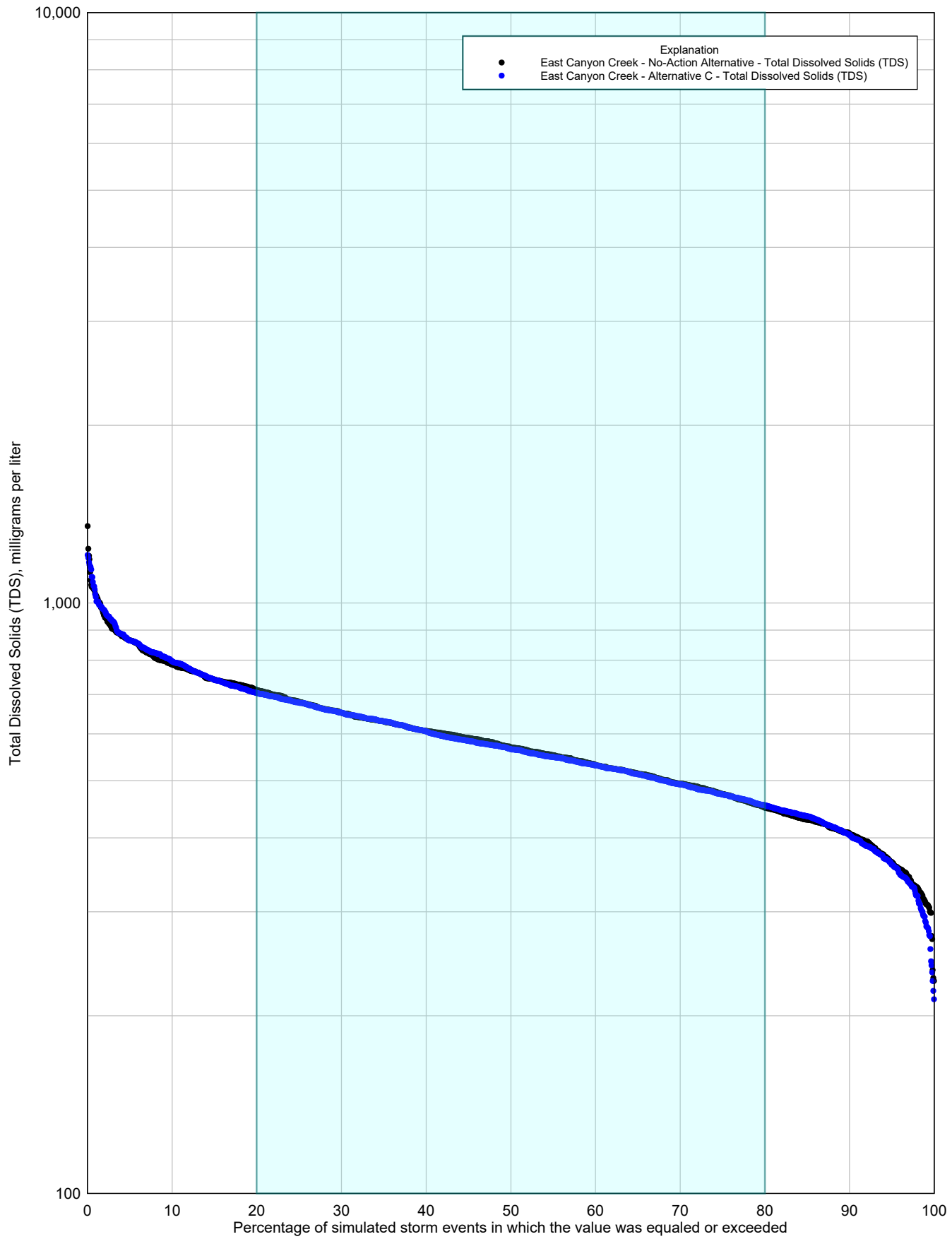


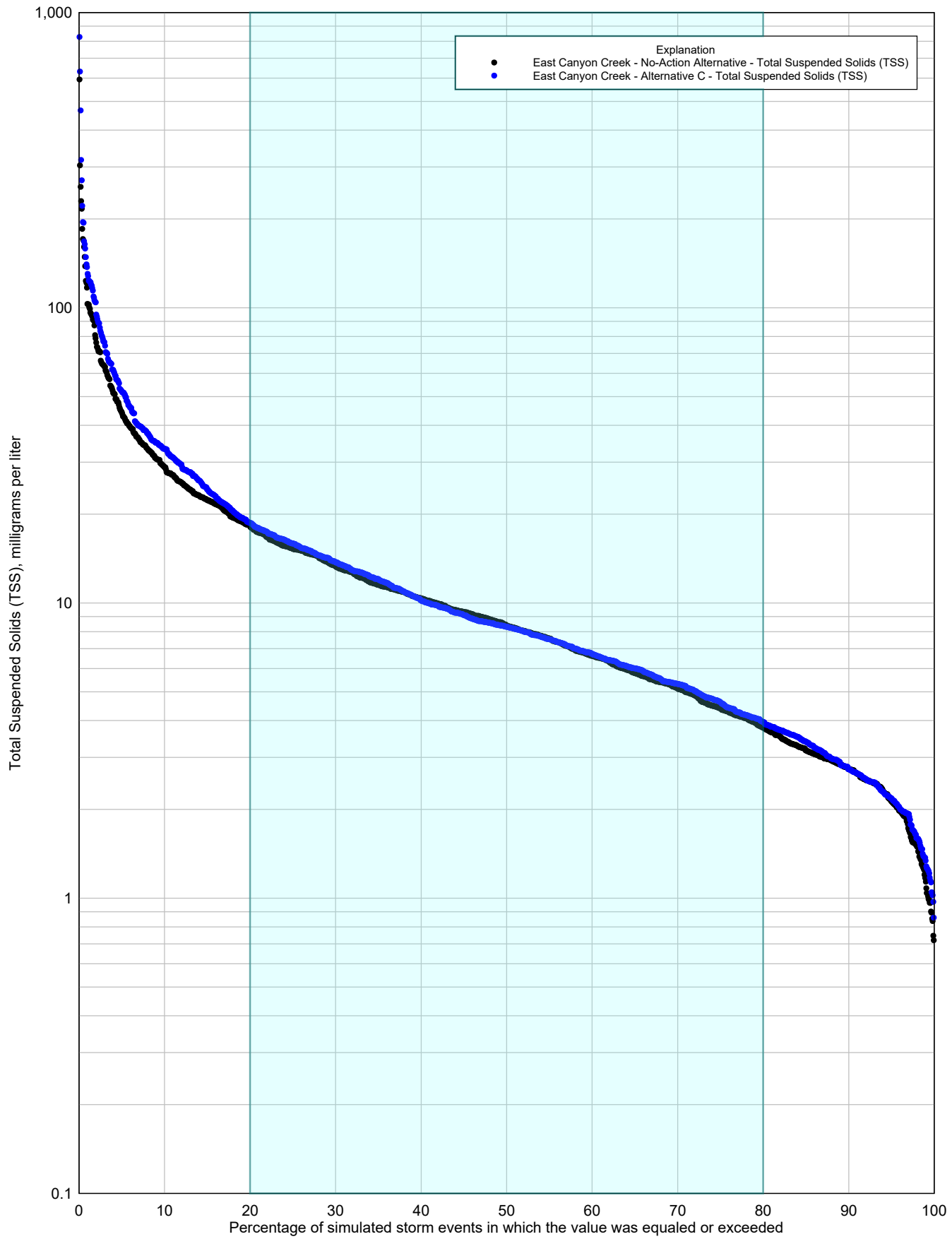












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