I-15 ENVIRONMENTAL IMPACT STATEMENT
Farmington to Salt Lake City

# APPENDIX 3J

## Water Quality Technical Report

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I-15 ENVIRONMENTAL IMPACT STATEMENT
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# Water Quality Technical Report

## I-15 Environmental Impact Statement Farmington to Salt Lake City

Lead agency:
Utah Department of Transportation

**March 25, 2024**

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# Abbreviations

| | |
|---|---|
| µg/L | micrograms per liter |
| AADT | average annual daily traffic |
| 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 |
| EIS | environmental impact statement |
| FHWA | Federal Highway Administration |
| GIS | geographic information systems |
| I-15 project | I-15 Farmington to Salt Lake City Project |
| LiDAR | light detection and ranging |
| mg/L | milligrams per liter |
| MS4 | municipal separate storm sewer system |
| SELDM | Stochastic Empirical Loading and Dilution Model |
| TDS | total dissolved solids |
| TSS | total suspended solids |
| UDOT | Utah Department of Transportation |
| UDWQ | Utah Division of Water Quality |
| USGS | U.S. Geological Survey |

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# 1.0 Introduction

This report documents the water quality modeling methods that were used to understand the impacts to both surface water and groundwater quality that are expected as a result of implementing the Action Alternative for the I-15: Farmington to Salt Lake City Project (I-15 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, the modeling performed for the I-15 project compares the expected surface water impacts from discharges and additional impervious areas to surface water quality standards. The modeling methods used were selected by UDOT, as these methods have been used for other Environmental Impact Statements (EIS) in Utah involving both proposed changes to existing roads and evaluation of new roads. The Action Alternative is located within several watersheds. UDOT focused a quantitative water quality analysis on the creeks that have established UDWQ assessment units (AU) partially located within the water quality and water resources evaluation area. These water bodies are Farmington Creek, Ricks Creek, and Mill Creek. UDOT anticipates that the other water bodies whose AUs terminate upstream of the evaluation area would be similarly impacted by the project since their watersheds are very similar to Farmington Creek, Ricks Creek, and Mill Creek.

# 2.0 Highway Stormwater Runoff

The main recurring impact to water quality from many roadway projects is the highway stormwater runoff that flows off impervious areas of the highway surface during a precipitation event. Highway stormwater runoff affects water quality in two ways: the increased volume of runoff compared to existing conditions and the discharge of certain pollutants that are common in highway stormwater runoff. 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 highway and typically include measures for controlling volume and reducing pollutant concentrations.

The impacts to water quality for the I-15 project have been analyzed using the Stochastic Empirical Loading and Dilution Model 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, which was developed as a joint effort between FHWA and USGS to estimate the effects of upstream highway projects on an existing water body.

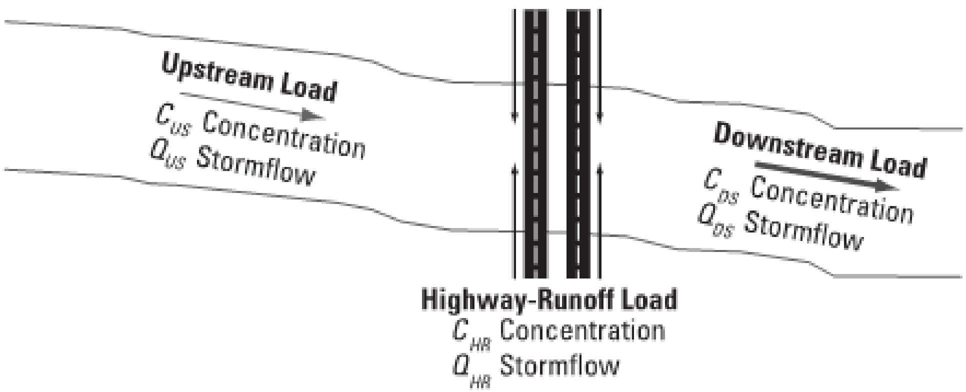
## 2.1 Modeling Overview

### 2.1.1 Stochastic Empirical Loading and Dilution Model

The Stochastic Empirical Loading and Dilution Model (SELDM) 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 upstream highway projects on an existing water body. SELDM uses a range of measured pollutant concentrations in the water body, stream flow rates, and expected range of pollutant concentrations and flow rates from highway stormwater runoff to determine a statistical distribution of a mixed, in-stream pollutant concentration at a specific location. BMPs can also be implemented in the model to reduce the expected pollutant concentrations and flow rates from the highway stormwater runoff using observed removal rates for various BMP options.

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

Figure 2-1. SELDM Schematic




Source: USGS 2013

SELDM has recently been used to evaluate water quality impacts for two other EISs in nearby Little Cottonwood Canyon and the Heber Valley, both of which are sensitive areas that provide drinking water to hundreds of thousands of people. Some of the project alternatives that were analyzed included widening and realigning existing roadways and building new segments of roadway and were located in areas that are important sources of drinking water, provide non-contact water recreation activities, contain sensitive habitats for aquatic species, and have agricultural uses. Much like SELDM did for these past projects, UDOT anticipates that it will help assess and estimate water quality impacts to Farmington Creek, Ricks Creek, and Mill Creek as a result of the I-15 project.

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

### 2.1.2 Pollutants of Concern

UDOT's *Stormwater Quality Design Manual* (UDOT 2021) lists several categories of pollutants of concern, including solids, nutrients, and metals. Each of these categories lists specific pollutants that are common in highway stormwater runoff. For the water quality analysis for the I-15 project, 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
- Other pollutants of concern
  - Dissolved aluminum (Farmington Creek only)
  - pH

Dissolved aluminum and pH are not listed in UDOT's *Stormwater Quality Design Manual* as typical pollutants of concern; however, they have been included in the analysis since Farmington Creek is impaired for aluminum and pH. There is sufficient upstream water quality data to analyze potential effects to Farmington Creek for dissolved aluminum; however, existing data is insufficient to include this analysis for Ricks Creek and Mill Creek. pH was analyzed for all three creeks since existing upstream water quality data was sufficient to support modeling. Including these pollutants where possible determined whether the Action Alternative could potentially worsen the impairment.

## 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 a precipitation event occurs. For this analysis, the outlet points for the Farmington Creek, Ricks Creek, and Mill Creek watersheds were chosen as Farmington Creek at I-15, Ricks Creek at the Rio Grande Trail Crossing, and Mill Creek at 1100 West, respectively. These points coincide with locations where UDWQ has collected historical water quality data for these creeks.

Several different light detection and ranging (LiDAR) datasets that cover these watersheds were acquired from the Utah Geospatial Resource Center (gis.utah.gov) and were used to delineate various parts of the upstream watershed using geographic information systems (GIS) software. A 10-meter dataset was used for the upper areas of the watersheds where little development has occurred, a half-meter dataset was used for developed areas, and a project-specific LiDAR dataset was used to determine the areas of I-15 that drain to each of the creeks. The basin centroid (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), 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 from I-15) 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, curb and gutter streets, and channel improvements in the watersheds. Attachment A, *Upstream Watershed Maps*, includes a map for each watershed that shows the outlet point, watershed extents, and longest flow path.

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

Table 2-1. Upstream Watershed Characteristics

| Watershed | Area | | Basin Centroid | | Longest Flow Path | | Mean Basin Slope | | % Impervious Area | Basin Development Factor |
|---|---|---|---|---|---|---|---|---|---|---|
| | $mi^2$ | acres | Latitude | Longitude | feet | miles | % | ft/mi | | |
| Farmington Creek | 13.09 | 8,380 | 40.9904 N | 111.836 W | 55,571 | 10.5 | 7.55 | 398.4 | 1.74 | 2 |
| Ricks Creek | 3.56 | 2,275 | 40.9485 N | 111.851 W | 30,929 | 5.86 | 15.3 | 806.7 | 4.21 | 3 |
| Mill Creek | 12.67 | 8,106 | 40.8628 N | 111.816 W | 60,301 | 11.4 | 7.64 | 403.5 | 5.83 | 4 |

ft = feet; mi = mile; $mi^2$ = 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 Farmington Creek, Ricks Creek, and Mill Creek from January 1, 2002, to December 31, 2022. Data was obtained for Farmington Creek at the I-15 crossing (Site ID 4990350), for Ricks Creek at the Rio Grande Trail Crossing (Site ID 4990410), and for Mill Creek at 1100 West (Site ID 4990680). These sites were chosen due to their locations at or a short distance downstream of I-15 and the availability of historical data over the past 21 years. In these datasets, several data points had concentration levels that were below the laboratory's analytical method detection limit; therefore, existing values were set at one-half the detection limit, which is standard practice in water quality analyses.

For the existing upstream pollutant concentrations in Farmington Creek, Ricks Creek, and Mill Creek, UDOT used all of 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, which 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) for each watershed with a $\log_{10}$ (a logarithm to the base 10) transformation applied to each individual pollutant concentration. These $\log_{10}$ transformed values were used in SELDM to avoid the possibility of negative concentrations in the stochastic distribution.

Table 2-2 shows the number of samples for each pollutant and the mean, standard deviation, and skew statistics based on both the untransformed values and the $\log_{10}$ transformed values.

Table 2-2. Existing In-stream Pollutant Concentrations

| Pollutant | Units | Number of Samples | Untransformed Values | | | $\log_{10}$ Transformed Values | | |
|---|---|---|---|---|---|---|---|---|
| | | | Mean | Standard Deviation | Skew | Mean | Standard Deviation | Skew |
| ***Farmington Creek*** | | | | | | | | |
| Dissolved aluminum | µg/L | 72 | 31.860 | 46.370 | 1.852 | 1.098 | 0.581 | 0.642 |
| Dissolved cadmium | µg/L | 72 | 0.151 | 0.191 | 1.295 | –1.106 | 0.462 | 0.947 |
| Dissolved chromium | µg/L | 67 | 1.457 | 1.137 | 3.345 | 0.080 | 0.271 | –0.597 |
| Dissolved copper | µg/L | 72 | 23.290 | 27.170 | 3.371 | 1.094 | 0.547 | –0.427 |
| Dissolved lead | µg/L | 70 | 0.445 | 0.595 | 1.175 | –0.763 | 0.595 | 0.642 |
| Dissolved zinc | µg/L | 70 | 15.490 | 15.510 | 1.357 | 0.995 | 0.403 | 0.571 |
| Dissolved nitrogen | mg/L | 31 | 0.493 | 0.291 | 2.101 | –0.367 | 0.230 | 0.065 |
| pH | — | 159 | 7.775 | 0.627 | –0.345 | 0.889 | 0.037 | –1.661 |
| Total phosphorus | mg/L | 169 | 0.102 | 0.176 | 4.639 | –1.300 | 0.481 | 0.539 |
| TDS | mg/L | 167 | 204.300 | 154.300 | 4.753 | 2.227 | 0.268 | –0.036 |
| TSS | mg/L | 167 | 11.010 | 24.700 | 6.937 | 0.715 | 0.457 | 1.016 |
| ***Ricks Creek*** | | | | | | | | |
| Dissolved cadmium | µg/L | 17 | 0.025 | 0.000 | 4.123 | –1.602 | 0.000 | 4.123 |
| Dissolved chromium | µg/L | 12 | 0.560 | 0.145 | 3.029 | –0.262 | 0.088 | 2.808 |
| Dissolved copper | µg/L | 17 | 47.590 | 56.120 | 3.674 | 1.551 | 0.292 | 1.505 |
| Dissolved lead | µg/L | 17 | 0.138 | 0.058 | 0.880 | –0.895 | 0.178 | 0.140 |
| Dissolved zinc | µg/L | 17 | 3.851 | 2.621 | 2.408 | 0.524 | 0.215 | 1.534 |
| Dissolved nitrogen | mg/L | 20 | 0.736 | 0.156 | 0.903 | –0.142 | 0.088 | 0.461 |
| pH | — | 23 | 6.412 | 1.453 | –2.187 | 0.788 | 0.157 | –3.457 |
| Total phosphorus | mg/L | 23 | 0.053 | 0.088 | 3.719 | –1.481 | 0.343 | 2.061 |
| TDS | mg/L | 23 | 181.000 | 77.420 | 0.819 | 2.219 | 0.191 | –0.318 |
| TSS | mg/L | 23 | 15.740 | 18.170 | 3.373 | 1.044 | 0.339 | 0.876 |
| ***Mill Creek*** | | | | | | | | |
| Dissolved cadmium | µg/L | 64 | 0.186 | 0.222 | 1.383 | –1.030 | 0.507 | 0.499 |
| Dissolved chromium | µg/L | 61 | 1.935 | 1.675 | 3.078 | 0.174 | 0.325 | –0.640 |
| Dissolved copper | µg/L | 64 | 20.840 | 22.540 | 1.720 | 1.038 | 0.550 | –0.313 |
| Dissolved lead | µg/L | 61 | 0.491 | 0.639 | 0.954 | –0.746 | 0.620 | 0.668 |
| Dissolved zinc | µg/L | 61 | 12.460 | 11.010 | 2.012 | 0.965 | 0.327 | 0.504 |
| Dissolved nitrogen | mg/L | 78 | 0.697 | 0.527 | 2.178 | –0.251 | 0.284 | 0.143 |
| pH | — | 150 | 8.271 | 0.715 | –3.302 | 0.915 | 0.049 | –6.012 |
| Total phosphorus | mg/L | 153 | 0.045 | 0.068 | 3.526 | –1.584 | 0.412 | 0.837 |
| TDS | mg/L | 155 | 895.900 | 1,840.000 | 6.001 | 2.650 | 0.436 | 1.076 |
| TSS | mg/L | 155 | 20.020 | 38.910 | 3.928 | 0.856 | 0.584 | 0.668 |

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 SELDM, 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 a wide variety of climates. For this analysis, UDOT chose sites from the database to best represent the conditions of the I-15 corridor from Farmington to Bountiful (area of studied creeks) based on the following criteria:

- Western United States to represent northern Utah's typical climate and precipitation patterns.
- AADT between about 93,000 and 277,000 vehicles per day, which is between about 0.5x and 2x the average 2050 AADT of I-15 between Farmington and Bountiful.

Highway stormwater runoff data was used from locations in California, Oregon, Washington, and Colorado. Locations in North Carolina and Massachusetts were added to supplement data only for dissolved nitrogen to obtain a more robust dataset. For the purpose of creating the stochastic distribution in SELDM, UDOT used data from the National Highway Runoff Database and calculated the statistics (using both untransformed and $\log_{10}$ 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 $\log_{10}$ 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 values and the $\log_{10}$ transformed values.

Table 2-3. Pollutant Concentrations in Highway Stormwater Runoff

| Pollutant | Units | Number of Samples | Untransformed Values | | | $\log_{10}$ Transformed Values | | |
|---|---|---|---|---|---|---|---|---|
| | | | Mean | Standard Deviation | Skew | Mean | Standard Deviation | Skew |
| Dissolved aluminum | µg/L | 18 | 80.280 | 112.000 | 2.238 | 1.609 | 0.499 | 0.607 |
| Dissolved cadmium | µg/L | 402 | 0.330 | 0.584 | 8.870 | –0.692 | 0.402 | 0.042 |
| Dissolved chromium | µg/L | 365 | 3.940 | 3.315 | 3.429 | 0.487 | 0.309 | –0.138 |
| Dissolved copper | µg/L | 455 | 21.830 | 23.820 | 4.597 | 1.197 | 0.336 | 0.214 |
| Dissolved lead | µg/L | 419 | 7.350 | 31.490 | 10.730 | 0.118 | 0.743 | 0.329 |
| Dissolved zinc | µg/L | 475 | 102.000 | 146.000 | 4.655 | 1.766 | 0.477 | –0.480 |
| Dissolved nitrogen | mg/L | 29 | 0.520 | 0.305 | 1.477 | –0.356 | 0.270 | –0.896 |
| pH | — | 123 | 6.254 | 0.652 | –0.330 | 0.794 | 0.047 | –0.630 |
| Total phosphorus | mg/L | 528 | 0.322 | 0.440 | 5.803 | –0.705 | 0.451 | –0.590 |
| TDS | mg/L | 330 | 105.000 | 69.600 | 1.301 | 1.904 | 0.382 | –2.110 |
| TSS | mg/L | 665 | 156.000 | 251.000 | 5.904 | 1.946 | 0.476 | –0.730 |

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 10142000 (Farmington Creek above Diversion Near Farmington, Utah) for Farmington Creek, gage 10142500 (Ricks Creek above Diversions near Centerville, Utah) for Ricks Creek, and gage 10145000 (Mill Creek at Mueller Park near Bountiful, Utah) for Mill Creek to calculate various stream flow statistics for SELDM to use in creating the stochastic distributions on which the calculations are based. These flow gages are all upstream of the points where the existing in-stream pollutant concentrations were measured; however, these flow gages provide the best available data and the longest continuous flow record for these creeks. Any differences in actual downstream flow and the gage data relative to upstream watershed size can be attributed to diversions located downstream of the flow gage and the increased percentage of impervious area at lower elevations. SELDM adjusts the flow statistics for actual basin size (statistics are input in units of cubic feet per second per square mile [cfs/mi$^2$]); therefore, UDOT anticipates that these differences will somewhat cancel each other out and cause no significant effect on model results.

UDOT calculated the streamflow statistics of mean, standard deviation, skew, and median using the mean daily flow values 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, including the 7Q10, 1B3, and 4B3 flow rates, corresponding 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 based on date ranges from April through March since this is typically how low-flow statistics are calculated.

To input the flow statistics in cfs/mi$^2$ into SELDM, UDOT divided the low-flow rates by the area upstream of the flow gage. Normal stream flow statistics used the mean daily flows. To avoid negative flow rates, SELDM requires both the untransformed flow statistics and the $\log_{10}$ retransformed statistics, with the latter calculated using the following process:

1. Divide each daily mean flow value in the data set by the area upstream of the flow gage (in square miles).
2. Calculate the $\log_{10}$ 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 $\log_{10}$ statistics.

Table 2-4 shows the values that were input into SELDM to create the stochastic distribution for Farmington Creek, Ricks Creek, and Mill Creek streamflow.

Table 2-4. Upstream Flow Rate Statistics

| Date Range | Number of Daily Mean Flow Values | Minimum Flow Value (cfs) | Maximum Flow Value (cfs) | $Log_{10}$ Retransformed Values [Untransformed Values] (cfs/mi²) | | | | Low Flow Statistics (cfs/mi²) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Mean | Standard Deviation | Skew | Median | 7Q10 | 1B3 | 4B3 |
| ***Farmington Creek – USGS Flow Gage 10142000*** | | | | | | | | | | |
| 06/01/2008 – 05/31/2023 | 5,478 | 0.64 | 396 | 0.581 [1.297] | 2.949 [2.651] | 1.133 [5.373] | 0.392 [0.392] | — | — | — |
| 04/01/2009 – 3/31/2023 | 5,113 | 0.64 | 396 | — | — | — | — | 0.116 | 0.109 | 0.144 |
| ***Ricks Creek – USGS Flow Gage 10142500*** | | | | | | | | | | |
| 05/01/1950 – 04/30/1966 | 5,844 | 0.30 | 37 | 0.565 [0.974] | 2.442 [1.521] | 1.236 [3.842] | 0.426 [0.426] | — | — | — |
| 04/01/1951 – 03/31/1966 | 5,479 | 0.30 | 37 | — | — | — | — | 0.155 | 0.095 | 0.155 |
| ***Mill Creek – USGS Flow Gage 10145000*** | | | | | | | | | | |
| 05/01/1950 – 04/30/1968 | 6,575 | 0.20 | 140 | 0.321 [0.704] | 3.029 [1.284] | 0.926 [4.341] | 0.228 [0.288] | — | — | — |
| 04/01/1951 – 03/31/1968 | 6,210 | 0.20 | 140 | — | — | — | — | 0.196 | 0.211 | 0.221 |

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

### 2.2.5 Highway Site Characteristics

For the existing conditions (No-action Alternative), UDOT defined the highway site as those portions of I-15 that contribute highway stormwater runoff to each of the creeks that were modeled. These areas were determined using a project-specific LiDAR dataset and GIS software. In the delineation of these areas, it was assumed, consistent with typical UDOT design practices, that all runoff originating from the impervious area between the high points adjacent to the creek crossing is conveyed to the creek through one or multiple means. Generally, this was assumed to include sheet flow across the roadway to the roadway barrier where the runoff enters an underground pipe through a catch basin inlet and is generally released into the creek either upstream or downstream of I-15. For the Ricks Creek highway site, I-15 currently slopes to the south at the Ricks Creek crossing; therefore, it was assumed that all runoff south of Ricks Creek is conveyed to a different location. To be conservative, the modeling did not consider any water quality treatment from existing BMPs; therefore, any effects these would have on the flow paths were not used in the model to define the existing basin characteristics.

For the proposed conditions (Action Alternative), UDOT assumed that the roadway profile near these creeks would not be adjusted as part of the project. Using this assumption, the highway site contributing runoff to each creek was assumed to include the impervious area of I-15 that is within the same north-to-south limits as the existing conditions highway site, including the widened area. The flow paths were assumed to be the same as those for the existing conditions.

The highway sites associated with Farmington Creek, Ricks Creek, and Mill Creek are all in the north segment of the Action Alternative, but they are outside the areas that would be impacted by the Farmington

400 West Option or Farmington State Street Option, and the highway pavement area is the same for both options; therefore, the water quality impacts would be the same for either option. The south segment does not include any highway sites associated with the surface water bodies that were analyzed; however, the area of new pavement for either the Salt Lake City 1000 North – Northern Option or the Salt Lake City 1000 North – Southern Option is similar, and the water quality impacts would be the same for either south segment option of the Action Alternative.

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, % impervious area, and basin development factor.

Table 2-5. Highway Site Characteristics

| Watershed | Existing Area, ac | Proposed Area, ac | Longest Flow Path | | Mean Basin Slope | | % Impervious Area | Basin Development Factor |
|---|---|---|---|---|---|---|---|---|
| | | | feet | miles | % | ft/mi | | |
| Farmington Creek | 11.21 | 13.53 | 2,662 | 0.504 | 0.54% | 28.6 | 100% | 9 |
| Ricks Creek | 11.00 | 15.24 | 5,223 | 0.989 | 0.36% | 19.2 | 100% | 9 |
| Mill Creek | 21.93 | 28.80 | 10,042 | 1.902 | 1.23% | 64.7 | 100% | 9 |

ac = acres; ft = feet; mi = mile

### 2.2.6 Precipitation Characteristics

UDOT determined the stormwater runoff rate for each model simulation from the highway site and the upstream watershed 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, as well as the average number of storms per year and the average annual precipitation.

Table 2-6. Nearby Precipitation Gages

| Precipitation Gage | Site Description | Average # of Storms per Year | Average Annual Precipitation (inches) | Average Event Volume (inches) | Average Event Duration (hours) |
|---|---|---|---|---|---|
| Bountiful–Val Verda | Bountiful – South of the Mill Creek Basin | 35 | 16.00 | 0.46 | 8.67 |
| Ogden Pioneer Power House | Entrance to Ogden Canyon | 38 | 18.73 | 0.50 | 7.25 |
| **Average of all gages listed above (from SELDM)** | | 36 | 17.37 | 0.48 | 7.96 |

The watershed locations are between the two gages shown above in Table 2-6. Based on an analysis of these gage locations compared to the locations of the upstream watersheds and highway sites, statistics from both the Bountiful–Val Verda and the Ogden Pioneer Power House gages were used for the Farmington Creek and Ricks Creek watersheds. Only the statistics from the Bountiful–Val Verda gage were used for the Mill Creek site (due to the gage being located near the Mill Creek basin).

### 2.2.7 BMP Performance

To be conservative, UDOT modeled the existing condition (No-action Alternative) assuming no BMP treatment of the highway stormwater runoff. This means that no volume reduction of or pollutant removal from the highway stormwater runoff is reflected in the SELDM model for the No-action Alternative.

For the proposed conditions (Action Alternative), BMP treatment of highway stormwater runoff was applied to the difference in highway stormwater runoff volume between the existing conditions and the proposed conditions. About 17.2%, 27.8%, and 23.8% of the total proposed highway site area is treated by BMPs for Farmington Creek, Ricks Creek, and Mill Creek, respectively. These percentages reflect the increase in impervious area over the existing conditions. This BMP treatment includes both volume reduction and pollutant removal based on general performance statistics for detention basins, as it is anticipated that detention basins will be used to manage the additional highway stormwater runoff. Statistics for BMP performance were taken from a 2021 report published by USGS that provides average water quality treatment statistics for a variety of BMPs which considered the December 2019 version of the International Stormwater Best Management Practices Database (USGS 2021). The statistics include inflow-outflow ratios of volume and of pollutant concentrations, as well as minimum irreducible concentrations below which a pollutant concentration cannot be reduced (“clean water in equals clean water out”).

Table 2-7 gives ranges of volume reduction and pollutant removals for detention basins as presented in the 2021 USGS report (USGS 2021). Note that the actual data used for SELDM varies from the table data to reflect the percentages of highway area treated by a detention basin. Also note that there is not enough data for removal of dissolved aluminum, so only the volume reduction component of the highway stormwater runoff BMPs is considered for dissolved aluminum.

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*** [a] | | | |
| Dissolved cadmium [b] | 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 |
| pH | 0.881–1.082 | 0.932–0.932 | 6.390 |
| 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

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

[a] Only volume reduction applies to dissolved aluminum. There is not enough available data to provide BMP pollutant removal statistics.

[b] Statistics reflect pollutant removal for total cadmium.

## 2.3 Model Results

Results from SELDM are given as a probability distribution of downstream concentrations that result from hundreds of upstream load and highway runoff load combinations. Results are also individually available for the upstream watershed runoff and the highway stormwater runoff. 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. This allows a comparison of the resulting concentrations to applicable water quality standards and the existing conditions (No-action Alternative) in order to understand the impacts that would occur from the Action Alternative.

For the I-15 project, SELDM simulated approximately 1,350 storm events per basin. The statistics presented in Section 2.2 were used to create the stochastic distributions that determine the model inputs for each simulation.

The SELDM results for the existing conditions (No-action Alternative) and the proposed conditions (Action Alternative) are summarized below in Section 2.3.1 for Farmington Creek, Section 2.3.2 for Ricks Creek, and Section 2.3.3 for Mill Creek. The summaries provide a comparison to the surface water quality standards for the beneficial uses represented in the upstream watershed 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.

**What are beneficial uses?**

Lakes, rivers, and other water bodies have uses to humans and other life. These uses are called *beneficial uses*. The State of Utah defines 13 different beneficial uses for water bodies in Utah.

The summaries also include an expected range of concentrations that could be reasonably expected in Farmington Creek, Ricks Creek, and Mill Creek downstream of I-15 after combining upstream flows with highway stormwater runoff at the point where the water quality data was collected for each creek. 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 (very low and very high values) to focus the interpretation of the results on the in-steam concentrations that are expected most often.

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

### 2.3.1 Farmington Creek

This section discusses the results of the SELDM modeling for Farmington Creek by comparing the existing conditions (No-action Alternative) and the proposed conditions (Action Alternative) model results. Table 2-8 gives the surface water quality standards for the beneficial uses represented in the upstream watershed and the percentage of simulated storms during which the downstream concentration of each pollutant of concern would be expected to equal or exceed the surface water quality standards. Table 2-9 gives the central range of concentrations that could be reasonably expected in Farmington Creek downstream of the project for the No-action Alternative and the Action Alternative and the percent change in each end of the central range (80% and 20% of storms) between the No-action Alternative and the Action Alternative. An example of how to interpret the results shown in Table 2-8 and Table 2-9 is given below the tables.

Table 2-8. Farmington Creek SELDM Results Compared to Surface Water Quality Standards

| Pollutant | Units | Surface Water Quality Standards by Beneficial Use | | | % of Simulated Storms Equaling or Exceeding the Farmington Creek Surface Water Quality Standards Downstream of I-15 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Existing Conditions (No-action Alternative) | | | Proposed Conditions (Action Alternative) | | |
| | | 2B | 3B[a] | 4 | 2B | 3B[a] | 4 | 2B | 3B[a] | 4 |
| Dissolved aluminum | µg/L | — | 750 | — | — | 0.64 | — | — | 0.48 | — |
| Dissolved cadmium | µg/L | — | 1.8 | 10 | — | 0.56 | 0.00 | — | 0.92 | 0.00 |
| Dissolved chromium | µg/L | — | 16[b] | 100 | — | 0.00 | 0.00 | — | 0.00 | 0.00 |
| Dissolved copper | µg/L | — | 65 | 200 | — | 8.27 | 4.05 | — | 9.36 | 0.41 |
| Dissolved lead | µg/L | — | 65 | 100 | — | 0.12 | 0.12 | — | 0.12 | 0.00 |
| Dissolved zinc | µg/L | — | 120 | — | — | 0.93 | — | — | 1.43 | — |
| Dissolved nitrogen | mg/L | — | 4[c] | — | — | 0.00 | — | — | 0.00 | — |
| pH | — | 6.5–9.0 | 6.5–9.0 | 6.5–9.0 | 5.53[d] | 5.53[d] | 5.53[d] | 7.18[d] | 7.18[d] | 7.18[d] |
| Total phosphorus | mg/L | — | 0.05[c] | — | — | 50.9 | — | — | 48.5 | — |
| TDS | mg/L | — | — | 1,200 | — | — | 0.19 | — | — | 0.12 |
| TSS | mg/L | — | — | — | — | — | — | — | — | — |

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

Beneficial-use definitions: 2B – Infrequent primary-contact recreation

3B – Warm-water fishery/aquatic life

4 – Agricultural uses including irrigation of crops and stock watering

[a] One-hour criterion – chosen since 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.

[d] Percent of pH values outside (more acidic or more basic than) the standard range of pH values.

Table 2-9. Farmington Creek Expected Concentration Ranges and Percent Change

| Pollutant | Units | Downstream Farmington Creek Concentration Equaled or Exceeded during ____ of Simulated Storms | | | | % Change in Downstream Farmington Creek Concentration during ___ of Simulated Storms | |
|---|---|---|---|---|---|---|---|
| | | Existing Conditions (No-action Alternative) | | Proposed Conditions (Action Alternative) | | | |
| | | 80% | 20% | 80% | 20% | 80% | 20% |
| Dissolved aluminum | µg/L | 4.83 | 36.2 | 4.97 | 39.7 | 2.84 | 8.65 |
| Dissolved cadmium | µg/L | 0.0345 | 0.168 | 0.0353 | 0.168 | 2.27 | 0.18 |
| Dissolved chromium | µg/L | 0.763 | 2.12 | 0.787 | 2.10 | 3.07 | –0.67 |
| Dissolved copper | µg/L | 4.95 | 37.4 | 4.56 | 38.1 | –8.55 | 1.81 |
| Dissolved lead | µg/L | 0.0833 | 0.700 | 0.0896 | 0.648 | 7.09 | –8.01 |
| Dissolved zinc | µg/L | 5.33 | 22.6 | 5.77 | 24.0 | 7.62 | 5.47 |
| Dissolved nitrogen | mg/L | 0.278 | 0.651 | 0.280 | 0.644 | 0.89 | –1.07 |
| pH | — | 7.03 | 7.96 | 7.00 | 7.94 | –0.39 | –0.25 |
| Total phosphorus | mg/L | 0.0235 | 0.122 | 0.0238 | 0.130 | 1.30 | 6.44 |
| TDS | mg/L | 97.9 | 283 | 98.8 | 275 | 0.88 | –2.69 |
| TSS | mg/L | 3.38 | 15.7 | 3.35 | 14.4 | –0.98 | –9.53 |

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. Similar examples are not provided for the Ricks Creek and Mill Creek results in Sections 2.3.2 and 2.3.3 of this report, but the interpretation would be similar to the example provided for Farmington Creek.

As shown in Table 2-8 above, the water quality standard for copper (65 µg/L) for beneficial use classification 3B would be exceeded by 9.36% of storms for the Action Alternative. Table 2-9 above shows that (after mixing stream flows and highway stormwater runoff), the central range for the in-stream concentration of dissolved copper was between 4.56 and 38.1 µg/L for the Action Alternative. While dissolved copper concentration exceedances could occur, they would occur infrequently (for about 9% of storms) and the more commonly occurring central range (4.56 to 38.1 µg/L) is well below the numeric water quality standard. Compared to the No-action alternative, the Action Alternative represents a slight increase in the number of storms that could exceed the numeric water quality standard and a small change in the central range of expected concentrations.

In general, the impacts from the Action Alternative to surface water in Farmington Creek downstream of the project would be minor compared to the No-action Alternative. Of the pollutants of concern that were modeled, Farmington Creek is impaired for aluminum, copper, and pH. Farmington Creek is also impaired for dissolved oxygen and *E. coli.* Total phosphorus, which is a nutrient that can deplete oxygen levels, was modeled. *E. coli* was not modeled since *E. coli* is not typical of highway stormwater runoff. Descriptions of the impacts to Farmington Creek from aluminum, copper, pH, and phosphorus are provided below since these constituents represent the most risk to Farmington Creek.

**Dissolved Aluminum.** The central range of expected aluminum concentrations was modeled between 4.97 and 39.7 µg/L for the Action Alternative. This range is well below the beneficial use classification 3B water quality standard for aluminum (750 µg/L). The modeling shows that the aluminum standard was exceeded by 0.48% of the simulated storms. While the in-stream concentrations of dissolved aluminum could exceed the numeric water quality standard, it would occur infrequently (less than 1% of storms). Compared to the No-action Alternative, the Action Alternative represents a decrease in the percentage of storms that could exceed the numeric water quality standard. Water quality impacts to Farmington Creek for dissolved aluminum as a result of the Action Alternative are considered negligible.

**Dissolved Copper.** The central range of expected copper concentrations was between 4.56 and 38.1 µg/L for the Action Alternative, which is below the numeric water quality standard for beneficial use 3B of 65 µg/L and for beneficial use 4 of 200 µg/L. The numeric standard was exceeded by 9.36% and 0.41% of the simulated storms for beneficial uses 3B and 4, respectively, which means that the in-stream copper concentration would be exceeded infrequently (about 9% of storms). Compared to the No-action Alternative, the Action Alternative represents an increase in the percentage of storms that would exceed the numeric water quality standard (8.27 to 9.36%) for beneficial use 3B and a decrease in the percentage of storms that would exceed the numeric water quality standard by about 3.6% for beneficial use 4. This results in a very low chance that the Action Alternative would impact dissolved copper concentrations in Farmington Creek.

**pH.** The range of acceptable pH values for beneficial uses 2B, 3B, and 4 is between 6.5 and 9.0. This can be compared to the central range of expected values of between 7.00 and 7.94 to show that the expected central range is inside the acceptable range of values. The model also showed that 7.18% of the simulated storms resulted in pH values that were below (more acidic than) the acceptable range for the Action Alternative compared to the No-action Alternative which showed that 5.53% of simulated storms were below the acceptable range of values. While Farmington Creek's pH level could be below the acceptable range, this would happen infrequently and the more common occurring central range of expected values is inside of the acceptable range of values. The results show a very minor decrease in pH levels between the No-action and Action Alternatives and a very minor chance that the Action Alternative would have a negative in-stream impact on pH in Farmington Creek.

**Total Phosphorus.** For the Action Alternative, the central range of expected concentrations for total phosphorus was between about 0.024 and 0.130 mg/L compared to the total phosphorus water quality numeric pollution indicator for beneficial use 3B of 0.05 milligrams per liter (mg/L). The model results also show that about 50.9% and 48.5% of simulated storms exceeded this pollution indicator for the No-action Alternative and the Action Alternative, respectively. The Action Alternative represents a minor increase in the expected central range of total phosphorus concentrations. Compared to the No-action Alternative, the Action Alternative could result in fewer storms that might exceed the total phosphorus concentration limits for this pollution indicator constituent.

### 2.3.2 Ricks Creek

This section discusses the results of the SELDM modeling for Ricks Creek by comparing the existing conditions (No-action Alternative) and the proposed conditions (Action Alternative) model results. Table 2-10 gives the surface water quality standards for the beneficial uses represented in the upstream watershed and the percentage of simulated storms during which the downstream concentration of each pollutant of concern would be expected to equal or exceed the surface water quality standards. Table 2-11 gives the central range of concentrations that could be reasonably expected in Ricks Creek downstream of the project for the No-action Alternative and the Action Alternative and the percent change in each end of the central range (80% and 20% of storms) between the No-action Alternative and the Action Alternative.

### Table 2-10. Ricks Creek SELDM Results Compared to Surface Water Quality Standards

| Pollutant | Units | Surface Water Quality Standards by Beneficial Use | | | | % of Simulated Storms Equaling or Exceeding the Ricks Creek Surface Water Quality Standards Downstream of I-15 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Existing Conditions (No-action Alternative) | | | | Proposed Conditions (Action Alternative) | | | |
| | | 1C | 2B | 3A[a] | 4 | 1C | 2B | 3A[a] | 4 | 1C | 2B | 3A[a] | 4 |
| Dissolved cadmium | µg/L | 10 | — | 1.8 | 10 | 0.00 | — | 0.00 | 0.00 | 0.00 | — | 0.00 | 0.00 |
| Dissolved chromium | µg/L | 50 | — | 16[b] | 100 | 0.00 | — | 0.00 | 0.00 | 0.00 | — | 0.00 | 0.00 |
| Dissolved copper | µg/L | — | — | 65 | 200 | — | — | 14.60 | 2.35 | — | — | 15.00 | 2.27 |
| Dissolved lead | µg/L | 15 | — | 65 | 100 | 0.42 | — | 0.00 | 0.00 | 0.27 | — | 0.00 | 0.00 |
| Dissolved zinc | µg/L | — | — | 120 | — | — | — | 0.00 | — | — | — | 0.00 | — |
| Dissolved nitrogen | mg/L | 10 (4[c]) | — | 4[c] | — | 0.00 | — | 0.00 | — | 0.00 | — | 0.00 | — |
| pH | — | 6.5–9.0 | 6.5–9.0 | 6.5–9.0 | 6.5–9.0 | 38.80[d] | 38.80[d] | 38.80[d] | 38.80[d] | 41.40[d] | 41.40[d] | 41.40[d] | 41.40[d] |
| Total phosphorus | mg/L | 0.05[c] | — | 0.05[c] | — | 33.30 | — | 33.30 | — | 32.30 | — | 32.30 | — |
| TDS | mg/L | — | — | — | 1,200 | — | — | — | 0.00 | — | — | — | 0.00 |
| TSS | mg/L | — | — | — | — | — | — | — | — | — | — | — | — |

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-contact recreation

3A – Cold-water fishery/aquatic life

4 – Agricultural uses including irrigation of crops and stock watering

[a] One-hour criterion – chosen since 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.

[d] Percent of pH values outside (more acidic or more basic than) the standard range of pH values.

Table 2-11. Ricks Creek Expected Concentration Ranges and Percent Change

| Pollutant | Units | Downstream Ricks Creek Concentration Equaled or Exceeded during ____ of Simulated Storms | | | | % Change in Downstream Ricks Creek Concentration during ___ of Simulated Storms | |
|---|---|---|---|---|---|---|---|
| | | Existing Conditions (No-action Alternative) | | Proposed Conditions (Action Alternative) | | | |
| | | 80% | 20% | 80% | 20% | 80% | 20% |
| Dissolved cadmium | µg/L | 0.0266 | 0.0377 | 0.0270 | 0.0383 | 1.74 | 1.54 |
| Dissolved chromium | µg/L | 0.530 | 0.773 | 0.536 | 0.778 | 1.16 | 0.66 |
| Dissolved copper | µg/L | 20.4 | 56.1 | 20.4 | 53.2 | 0.15 | –5.49 |
| Dissolved lead | µg/L | 0.117 | 0.319 | 0.123 | 0.335 | 5.27 | 4.89 |
| Dissolved zinc | µg/L | 3.39 | 9.06 | 3.55 | 9.54 | 4.37 | 5.06 |
| Dissolved nitrogen | mg/L | 0.610 | 0.842 | 0.605 | 0.841 | –0.89 | –0.11 |
| pH | — | 5.34 | 7.38 | 5.36 | 7.36 | 0.47 | –0.29 |
| Total phosphorus | mg/L | 0.0240 | 0.0711 | 0.0235 | 0.0687 | –2.13 | –3.57 |
| TDS | mg/L | 114.1 | 239 | 120 | 232 | 5.15 | –3.11 |
| TSS | mg/L | 8.34 | 26.9 | 8.87 | 26.11 | 5.91 | –2.87 |

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

In general, the impacts from the Action Alternative to surface water in Ricks Creek downstream of the project would be minor compared to the No-action Alternative. Of the 10 pollutants of concern that were modeled, Ricks Creek is impaired only for copper. A description of the impacts to Ricks Creek from copper concentrations is provided below since copper represents the greatest risk to Ricks Creek.

**Dissolved Copper.** The water quality standards for copper (65 µg/L for beneficial use 3B and 200 µg/L for beneficial use classification 4) would be exceeded by 15.0% and 2.27% of simulated storms, respectively, for the Action Alternative after mixing stream flows and highway stormwater runoff compared to 14.6% and 2.35% of storms for the No-action Alternative. Table 2-11 above shows that (after mixing stream flows and highway stormwater runoff), the central range for the in-stream concentration of dissolved copper was between 20.4 and 53.2 µg/L for the Action Alternative compared to 20.4 to 56.1 µg/L for the No-action alternative. While dissolved copper concentration exceedances could occur, they would occur infrequently (for about 15% and 2% of storms) and the more commonly occurring central range (20.4 to 53.2 µg/L for the Action Alternative) is well below the numeric water quality standard. There is a very low chance that the Action Alternative would have a negative in-stream impact on dissolved copper concentrations in Ricks Creek.

## 2.3.3 Mill Creek

This section discusses the results of the SELDM modeling for Mill Creek by comparing the existing conditions (No-action Alternative) and the proposed conditions (Action Alternative) model results. Table 2-12 gives the surface water quality standards for the beneficial uses represented in the upstream watershed and the percentage of simulated storms during which the downstream concentration of each pollutant of concern would be expected to equal or exceed the surface water quality standards. Table 2-13 gives the expected central range of concentrations that could be reasonably expected in Mill Creek downstream of the project for the No-action Alternative and the Action Alternative and the percent change in each end of the central range (80% and 20% of storms) between the No-action Alternative and the Action Alternative.

### Table 2-12. Mill Creek SELDM Results Compared to Surface Water Quality Standards

| Pollutant | Units | Surface Water Quality Standards by Beneficial Use | | | % of Simulated Storms Equaling or Exceeding the Mill Creek Surface Water Quality Standards Downstream of I-15 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Existing Conditions (No-action Alternative) | | | Proposed Conditions (Action Alternative) | | |
| | | 2B | 3B[a] | 4 | 2B | 3B[a] | 4 | 2B | 3B[a] | 4 |
| Dissolved cadmium | µg/L | — | 1.8 | 10 | — | 0.00 | 0.00 | — | 1.25 | 0.00 |
| Dissolved chromium | µg/L | — | 16[b] | 100 | — | 0.00 | 0.00 | — | 0.00 | 0.00 |
| Dissolved copper | µg/L | — | 65 | 200 | — | 7.07 | 0.86 | — | 7.49 | 0.50 |
| Dissolved lead | µg/L | — | 65 | 100 | — | 0.19 | 0.00 | — | 0.12 | 0.05 |
| Dissolved zinc | µg/L | — | 120 | — | — | 0.64 | — | — | 0.57 | — |
| Dissolved nitrogen | mg/L | — | 4[c] | — | — | 0.12 | — | — | 0.00 | — |
| pH | — | 6.5–9.0 | 6.5–9.0 | 6.5–9.0 | 5.52[d] | 5.52[d] | 5.52[d] | 8.02[d] | 8.02[d] | 8.02[d] |
| Total phosphorus | mg/L | — | 0.05[c] | — | — | 31.10 | — | — | 31.10 | — |
| TDS | mg/L | — | — | 1,200 | — | — | 14.10 | — | — | 14.30 |
| TSS | mg/L | — | — | — | — | — | — | — | — | — |

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

Beneficial-use definitions: 2B – Infrequent primary-contact recreation

3B – Warm-water fishery/aquatic life

4 – Agricultural uses including irrigation of crops and stock watering

[a] 1-hour criterion – chosen since 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.

[d] Percent of pH values outside (more acidic or more basic than) the standard range of pH values.

Table 2-13. Mill Creek Expected Concentration Ranges and Percent Change

| Pollutant | Units | Downstream Mill Creek Concentration Equaled or Exceeded during ____ of Simulated Storms: Existing Conditions (No-action Alternative) 80% | Existing Conditions (No-action Alternative) 20% | Proposed Conditions (Action Alternative) 80% | Proposed Conditions (Action Alternative) 20% | % Change in Downstream Mill Creek Concentration during ___ of Simulated Storms 80% | % Change 20% |
|---|---|---|---|---|---|---|---|
| Dissolved cadmium | µg/L | 0.0400 | 0.255 | 0.0406 | 0.254 | 1.62 | –0.59 |
| Dissolved chromium | µg/L | 0.886 | 2.87 | 0.919 | 2.91 | 3.67 | 1.20 |
| Dissolved copper | µg/L | 4.16 | 31.5 | 4.34 | 33.6 | 4.17 | 6.22 |
| Dissolved lead | µg/L | 0.0876 | 0.799 | 0.0888 | 0.823 | 1.40 | 2.90 |
| Dissolved zinc | µg/L | 6.35 | 19.5 | 6.44 | 21.0 | 1.46 | 6.91 |
| Dissolved nitrogen | mg/L | 0.324 | 0.959 | 0.331 | 0.945 | 2.38 | –1.44 |
| pH | — | 7.17 | 8.21 | 7.05 | 8.15 | –1.66 | –0.81 |
| Total phosphorus | mg/L | 0.0169 | 0.0649 | 0.0175 | 0.0681 | 3.55 | 4.80 |
| TDS | mg/L | 184 | 857 | 183 | 921 | –0.77 | 6.96 |
| TSS | mg/L | 4.17 | 25.2 | 4.37 | 23.4 | 4.69 | –7.60 |

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

In general, the impacts from the Action Alternative to surface water quality in Mill Creek downstream of the project would be minor compared to the modeling results for the No-action Alternative. Of the 10 pollutants of concern that were modeled, Mill Creek is impaired for copper and total dissolved solids (TDS). Mill Creek is also impaired for *E. coli*; however, since *E. coli* is not typical of highway stormwater runoff, it has not been modeled using SELDM. Descriptions of the impacts to Mill Creek from copper and TDS are provided below since these constituents represent the most risk to Mill Creek.

**Dissolved Copper.** The water quality standards for copper (65 µg/L for beneficial use 3B and 200 µg/L for beneficial use classification 4) would be exceeded by 7.49% and 0.50% of storms, respectively, for the Action Alternative after mixing stream flows and highway stormwater runoff compared to 7.07% and 0.86% of storms for the No-action Alternative. Table 2-13 above shows that (after mixing stream flows and highway stormwater runoff), the central range for the in-stream concentration of dissolved copper was between 4.34 and 33.6 µg/L for the Action Alternative and 4.16 and 31.5 µg/L for the No-action Alternative. While dissolved copper concentration exceedances could occur, they would occur infrequently (for about 7.5% of storms) and the more commonly occurring central range (4.34 to 33.6 µg/L) is well below the numeric water quality standard. The model results show a very low chance that the Action Alternative would have a negative in-stream impact on dissolved copper concentrations in Mill Creek.

**Total Dissolved Solids.** The modeled central range of expected TDS concentrations is between 183 and 921 mg/L for the Action Alternative compared to 184 to 857 mg/L for the No-action Alternative. The central range for the Action Alternative is below the beneficial use classification 4 water quality standard for TDS (1,200 mg/L). The TDS standard was modeled to be exceeded by 14.3% of the simulated storms for the Action Alternative compared to 14.1% for the No-action Alternative. While the in-stream concentrations of TDS could exceed the numeric water quality standard, it would occur infrequently (about 14.3% of storms). Compared to the No-action Alternative, the Action Alternative represents a slight increase in the percentage of storms that could exceed the numeric water quality standard. There is a very minor increase in the frequency that the Action Alternative could result in TDS concentrations in Mill Creek that exceed the standard. The more frequent modeled central range would not exceed the standard.

# 3.0 Summary

The results of the SELDM modeling show that for most 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 80% and 20% of simulated storms) for Farmington Creek, Ricks Creek, and Mill Creek for the Action Alternative compared to the No-action Alternative. The main pollutant of concern is dissolved copper as all three creeks are impaired for copper and it is a common pollutant in highway stormwater runoff. The central range of expected concentrations is below the most stringent surface water quality numeric standards of 65 µg/L for beneficial use 3A and 3B waters. Modeling for all three creeks showed a slight increase in the percentage of simulated storms that exceeded the copper standard between the No-action Alternative and the Action Alternative with the largest increase being an additional about 1% of simulated storms in Farmington Creek that might exceed the copper standard. These exceedances would occur infrequently, and UDOT anticipates that for most storms, the surface water quality would be essentially the same between the No-Action and Action alternatives.

# 4.0 References

[UDOT] Utah Department of Transportation

2021 Stormwater Quality Design Manual. May.

[USGS] U.S. Geological Survey

2013 Stochastic Empirical Loading and Dilution Model (SELDM) Version 1.0.0. Chapter 3, Section C, *Water Quality,* Book 4, *Hydrologic Analysis and Interpretation,* page 4.

2021 Statistical Methods for Simulating Structural Stormwater Runoff Best Management Practices (BMPs) With the Stochastic Empirical Loading and Dilution Model (SELDM). Scientific Investigations Report 2020-5136. https://doi.org/10.3133/sir20205136.

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# ATTACHMENT A
## Upstream Watershed Maps

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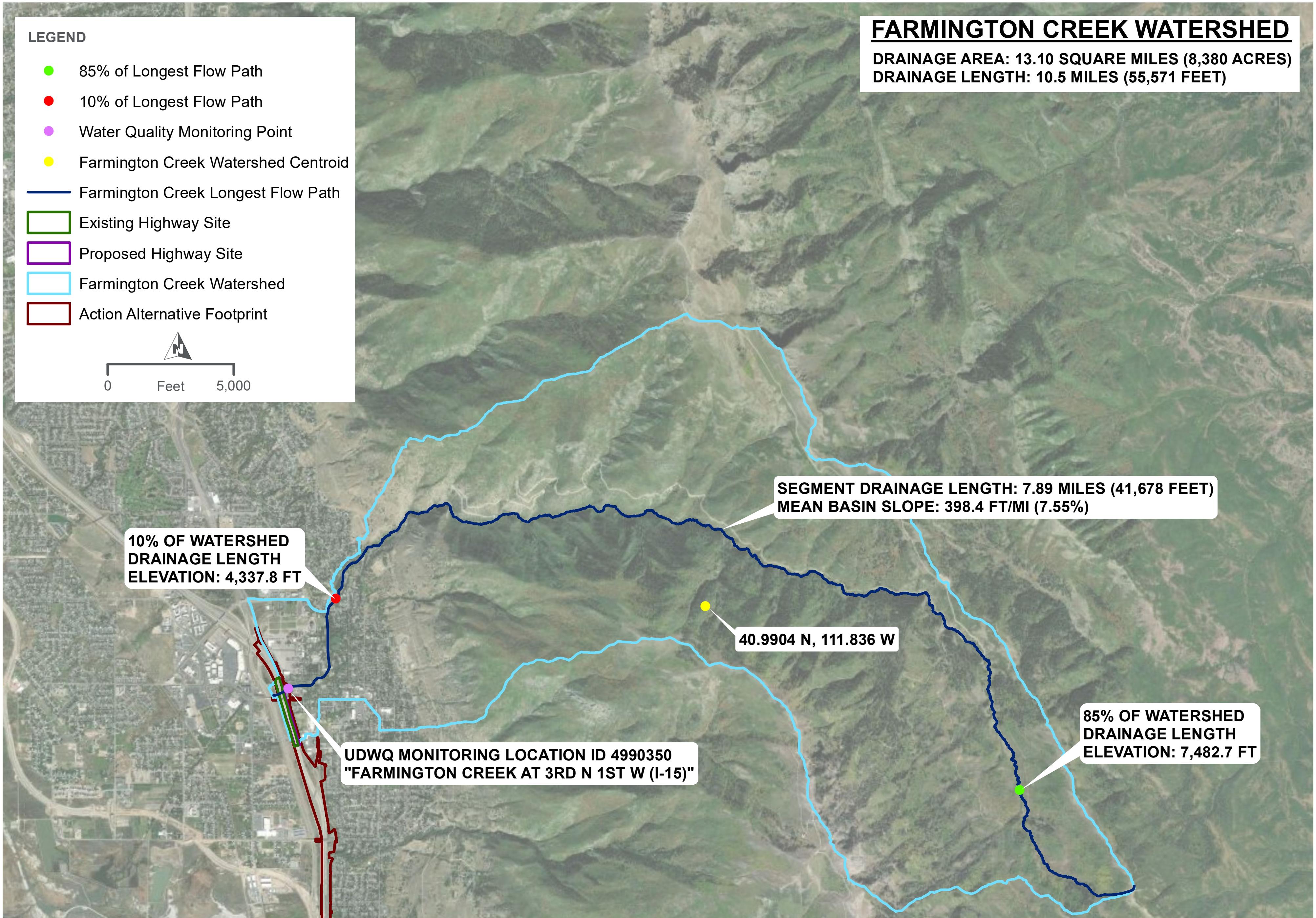
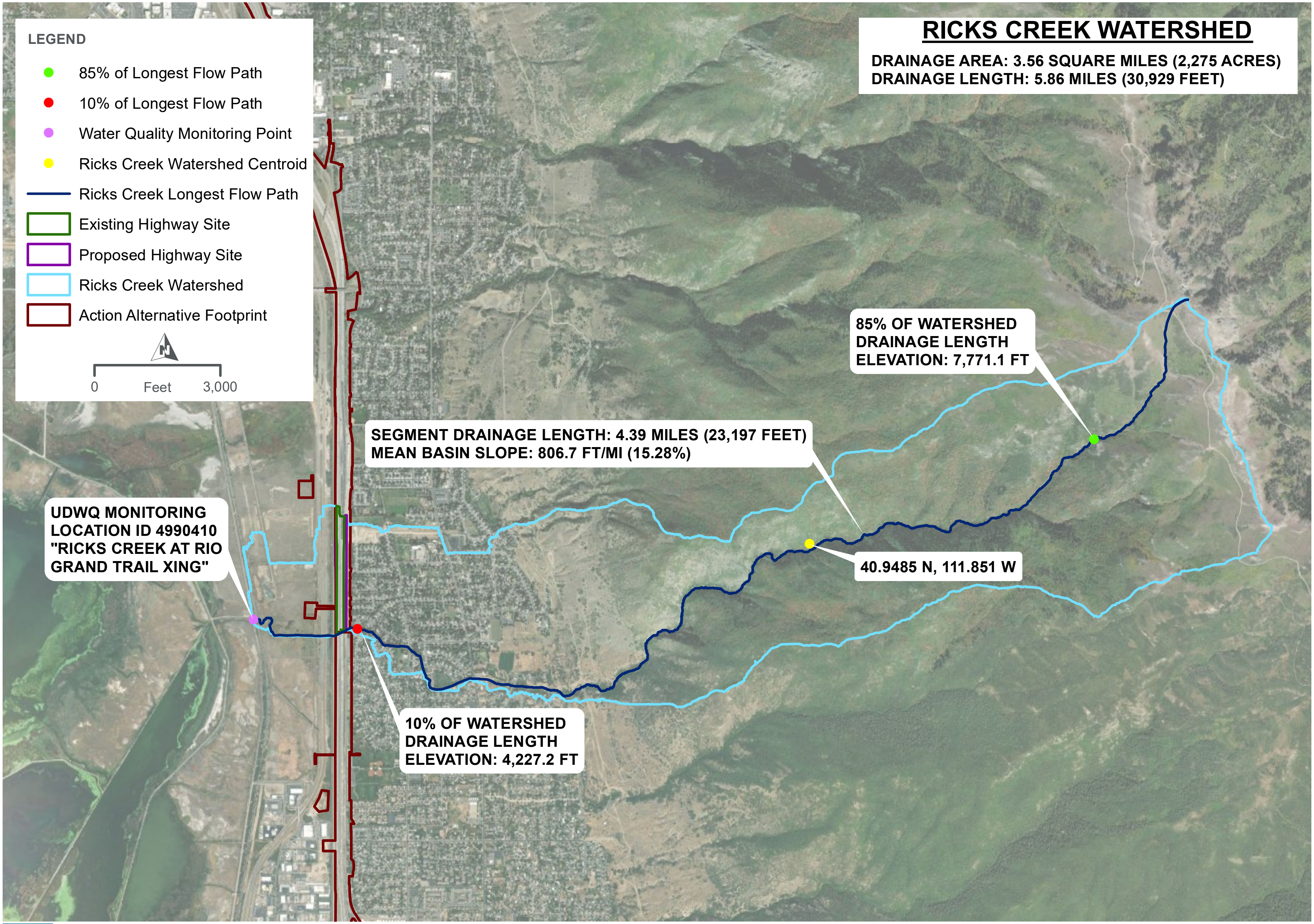
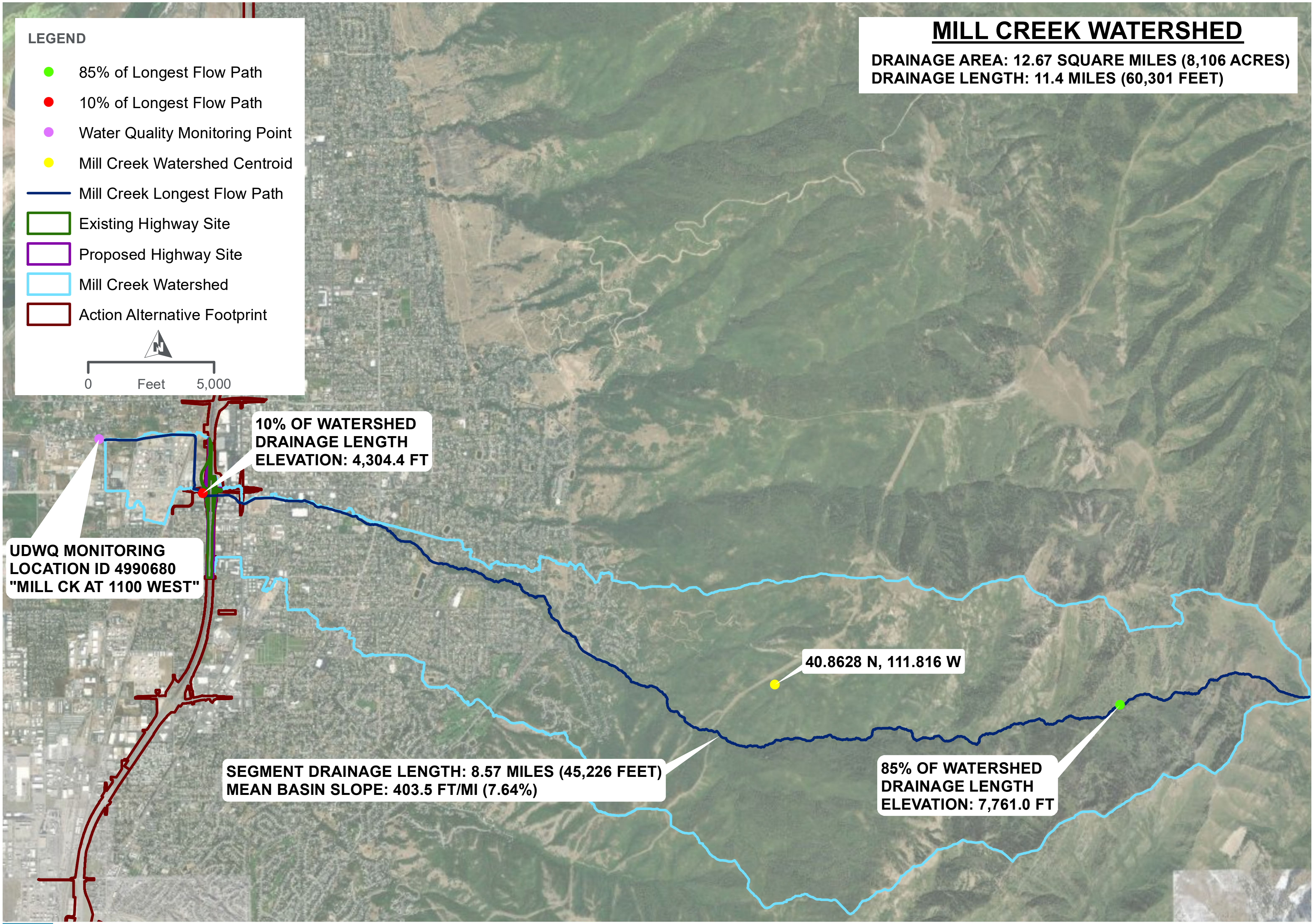



SELDM WATERSHED MAP
FARMINGTON CREEK



RICKS CREEK WATERSHED
DRAINAGE AREA: 3.56 SQUARE MILES (2,275 ACRES)
DRAINAGE LENGTH: 5.86 MILES (30,929 FEET)
LEGEND
85% of Longest Flow Path
10% of Longest Flow Path
Water Quality Monitoring Point
Ricks Creek Watershed Centroid
Ricks Creek Longest Flow Path
Existing Highway Site
Proposed Highway Site
Ricks Creek Watershed
Action Alternative Footprint
N
0
Feet
3,000
85% OF WATERSHED DRAINAGE LENGTH ELEVATION: 7,771.1 FT
SEGMENT DRAINAGE LENGTH: 4.39 MILES (23,197 FEET)
MEAN BASIN SLOPE: 806.7 FT/MI (15.28%)
UDWQ MONITORING LOCATION ID 4990410 "RICKS CREEK AT RIO GRAND TRAIL XING"
40.9485 N, 111.851 W
10% OF WATERSHED DRAINAGE LENGTH ELEVATION: 4,227.2 FT




## SELDM WATERSHED MAP
MILL CREEK

# ATTACHMENT B
## Farmington Creek, Ricks Creek, and Mill Creek SELDM Graphs

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# ATTACHMENT B
## Farmington Creek, Ricks Creek, and Mill Creek SELDM Graphs

### Farmington Creek

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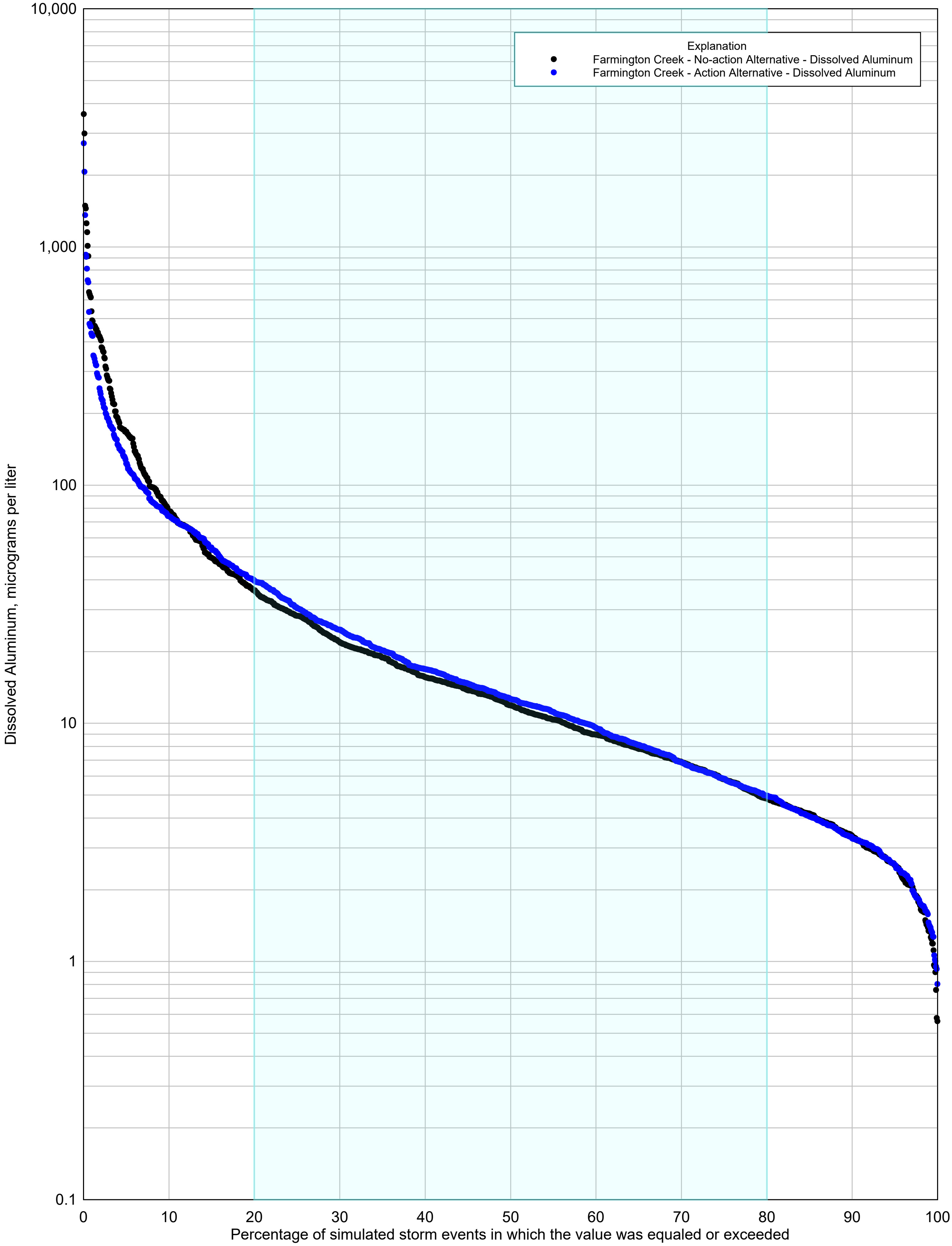
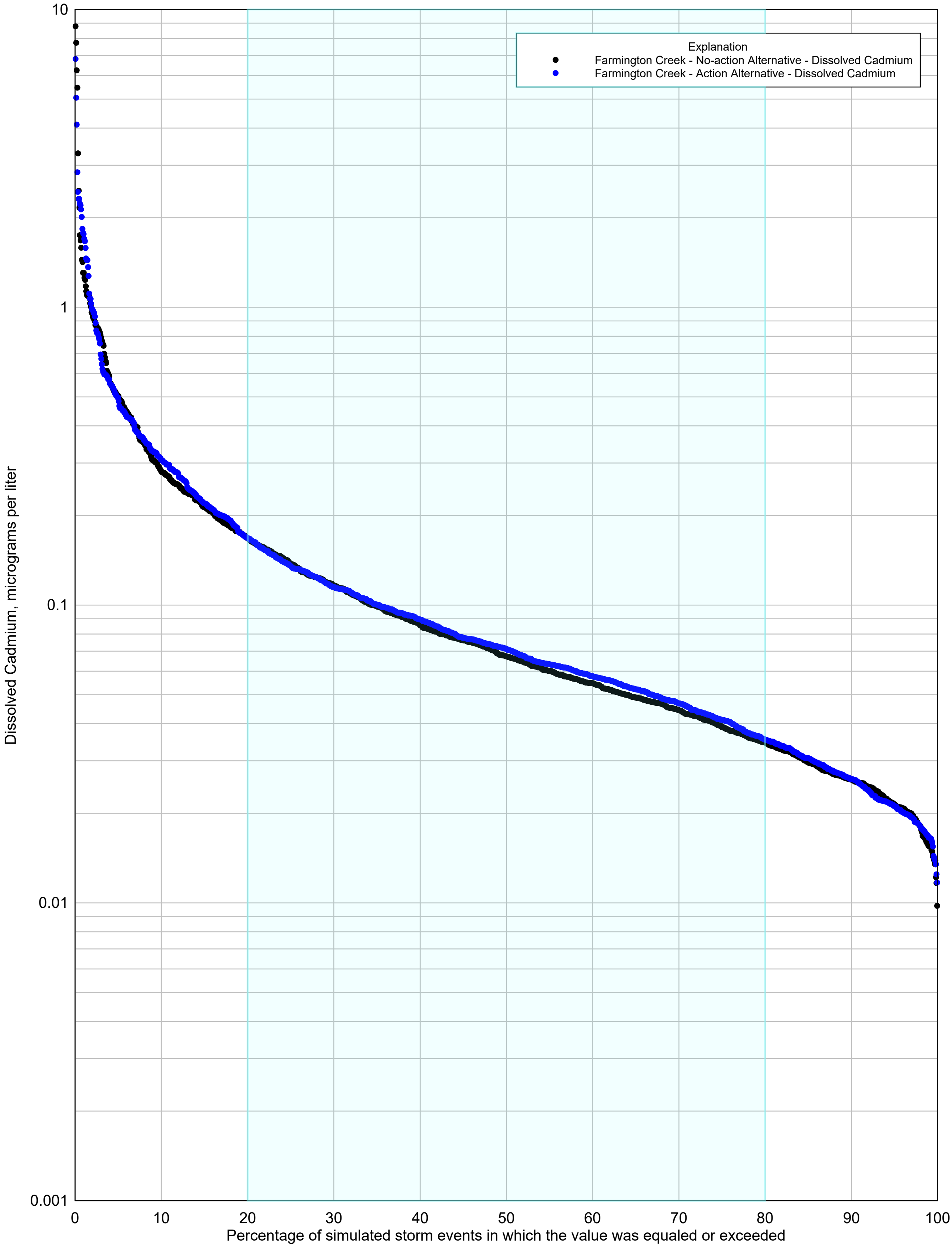
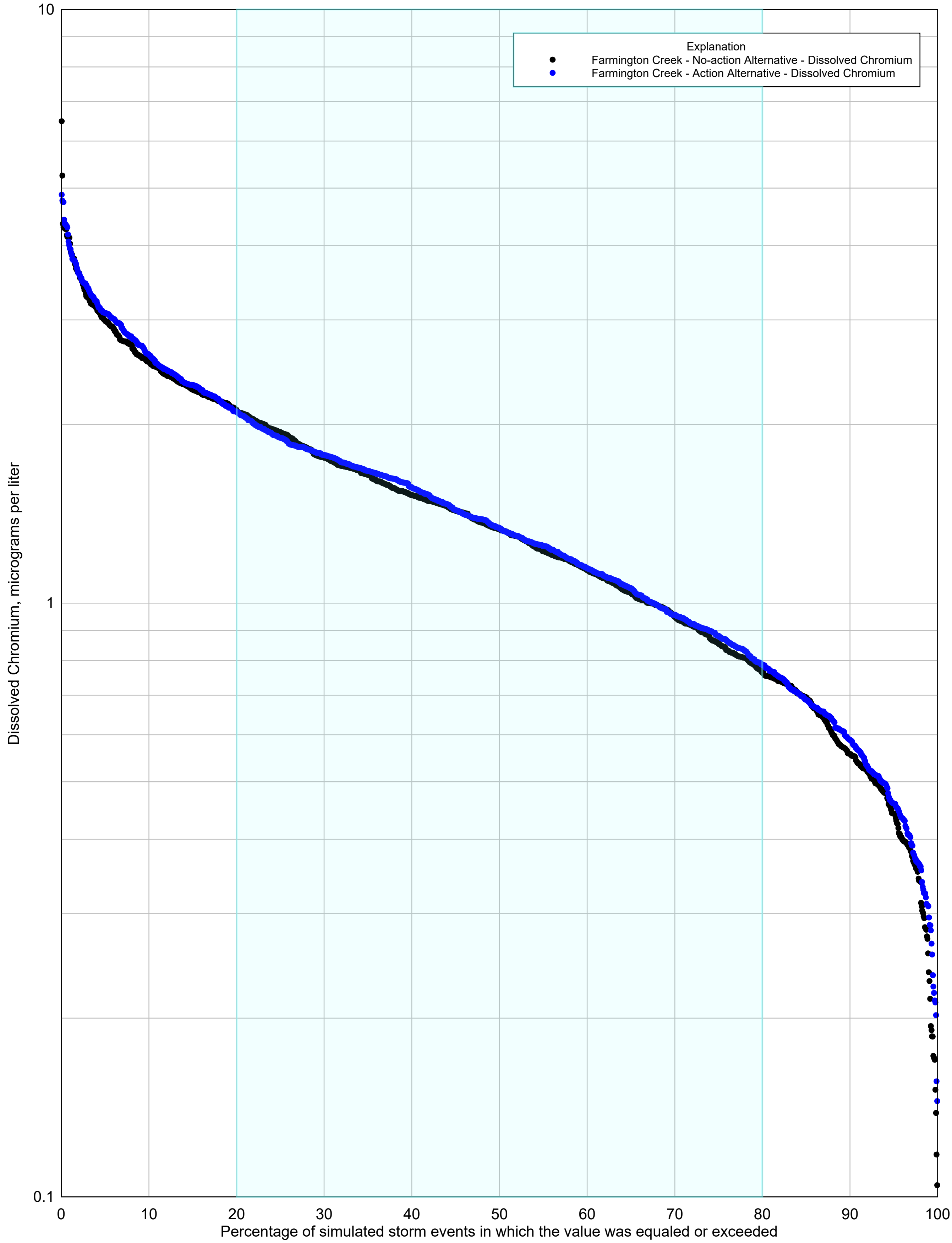
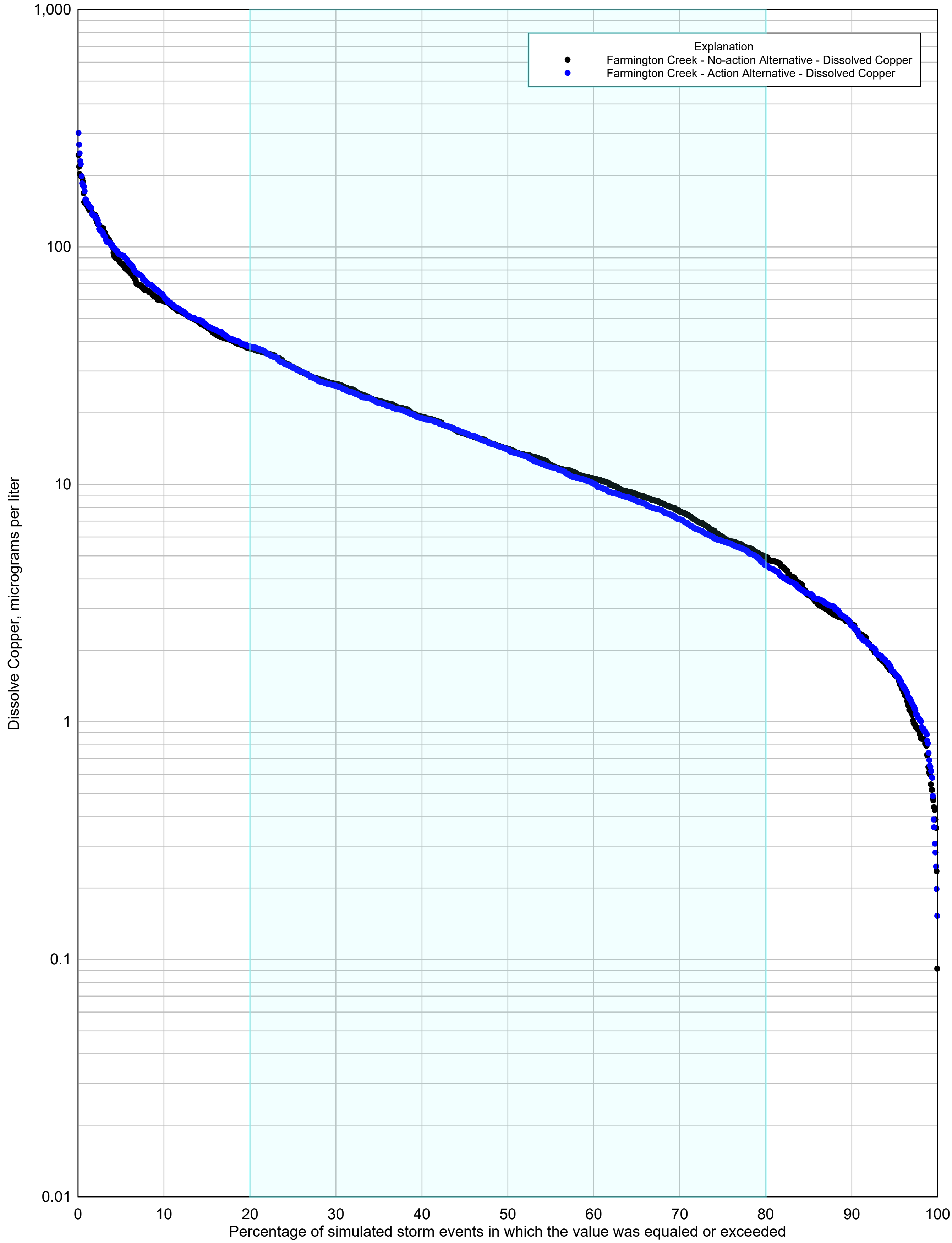


Explanation
Farmington Creek - No-action Alternative - Dissolved Aluminum
Farmington Creek - Action Alternative - Dissolved Aluminum
Dissolved Aluminum, micrograms per liter
10,000
1,000
100
10
1
0.1
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded

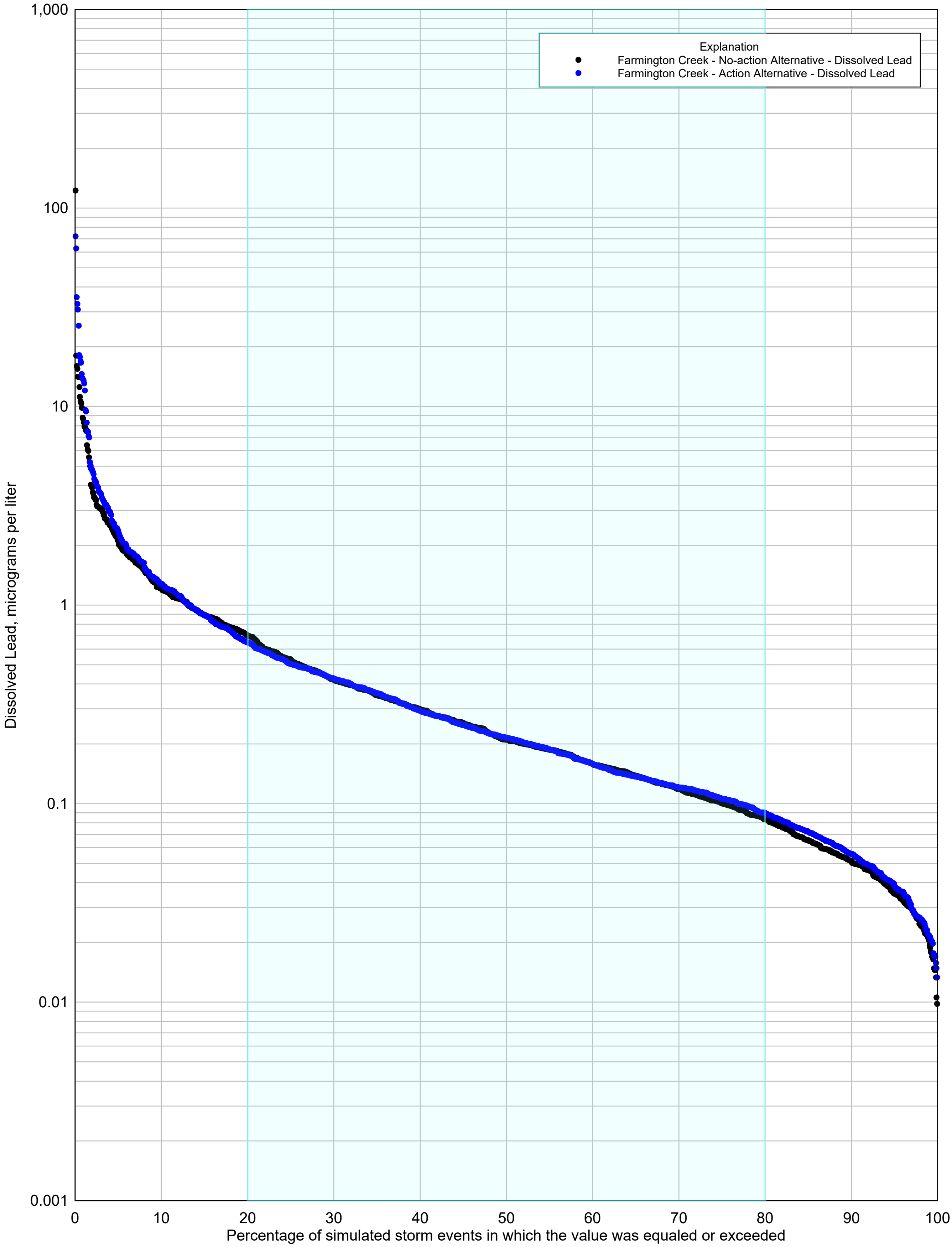

Explanation
Farmington Creek - No-action Alternative - Dissolved Cadmium
Farmington Creek - Action Alternative - Dissolved Cadmium
Dissolved Cadmium, micrograms per liter
10
1
0.1
0.01
0.001
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded



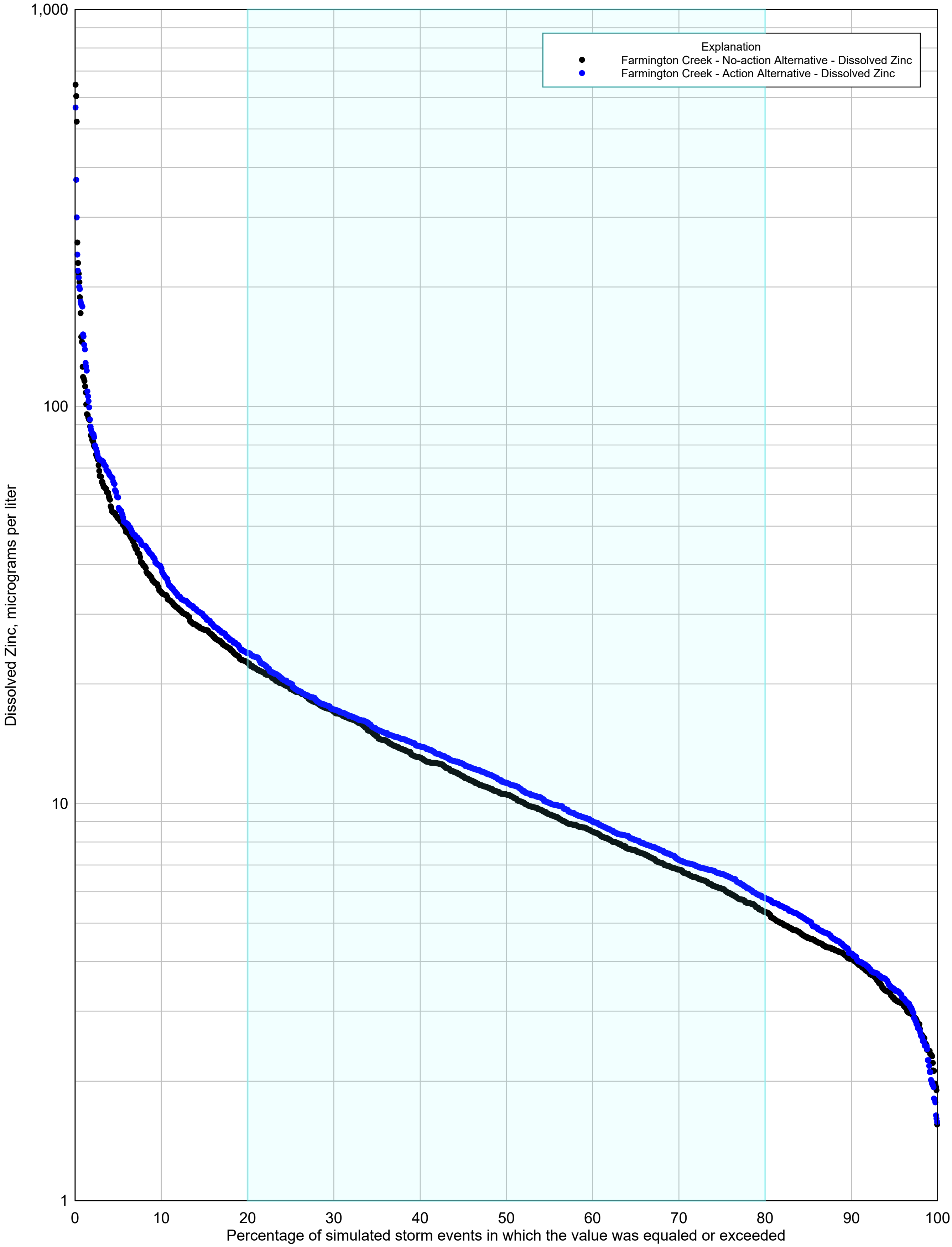
Explanation
Farmington Creek - No-action Alternative - Dissolved Chromium
Farmington Creek - Action Alternative - Dissolved Chromium
10
1
0.1
Dissolved Chromium, micrograms per liter
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded



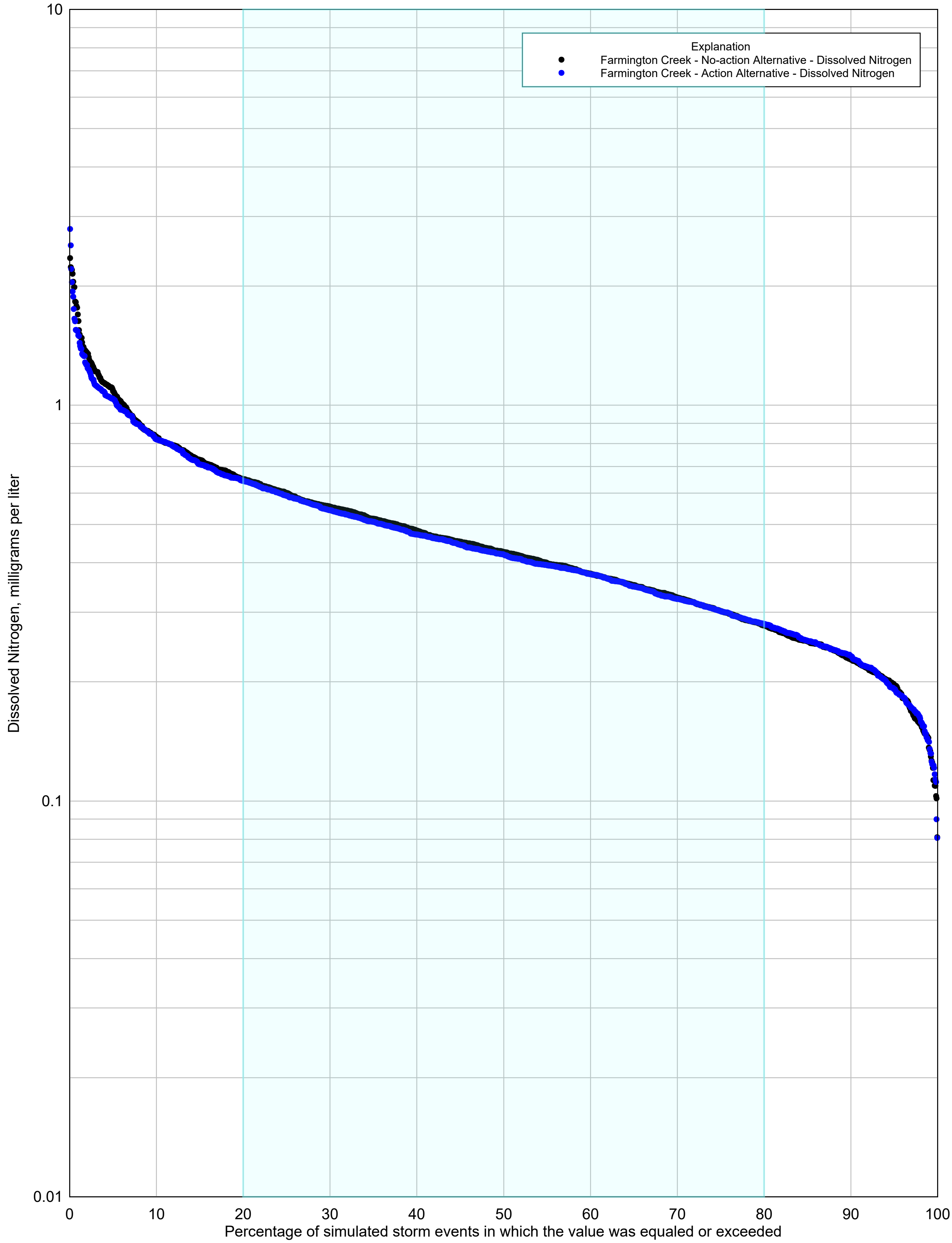
Explanation
Farmington Creek - No-action Alternative - Dissolved Copper
Farmington Creek - Action Alternative - Dissolved Copper
Dissolve Copper, micrograms per liter
1,000
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded



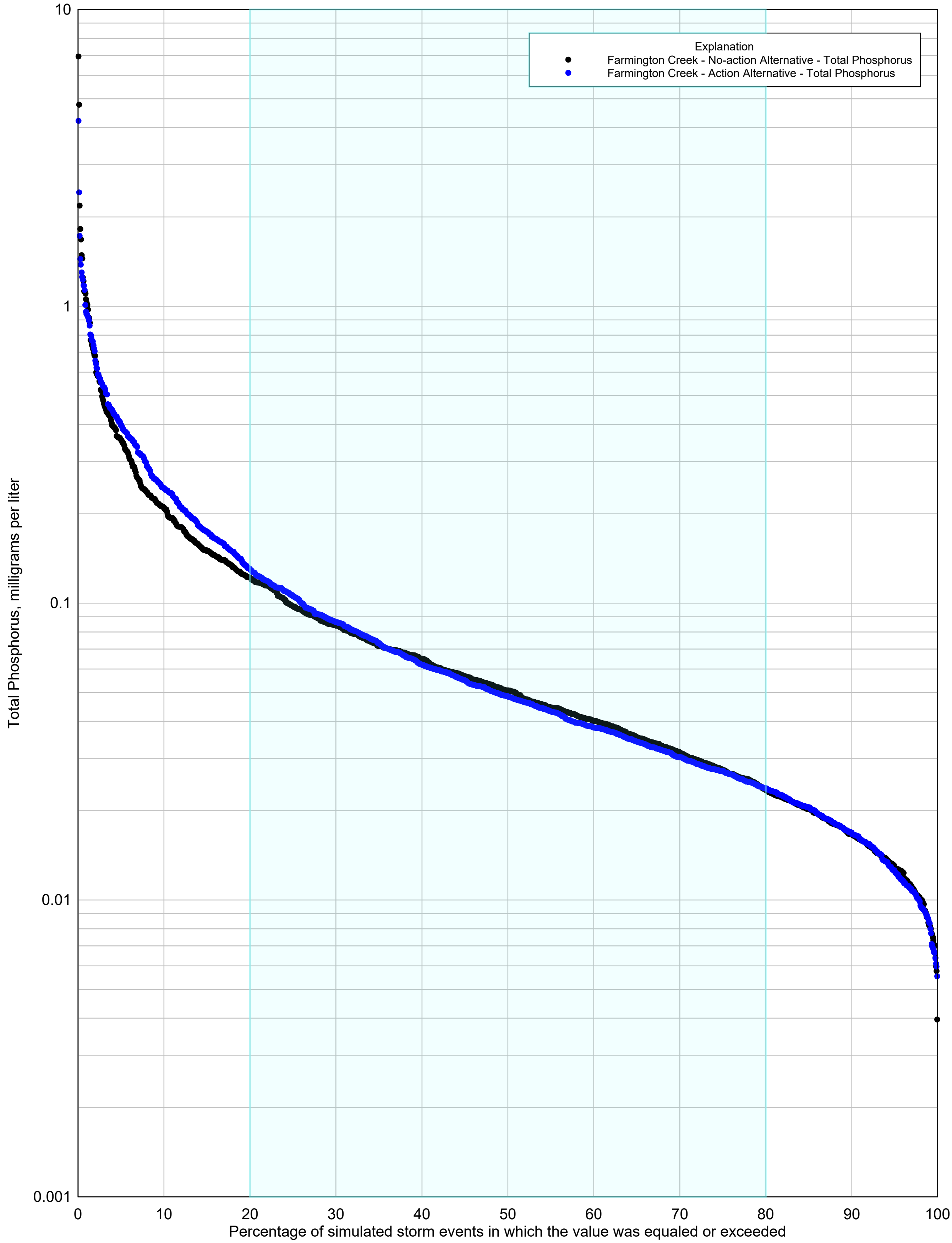
Explanation
Farmington Creek - No-action Alternative - Dissolved Lead
Farmington Creek - Action Alternative - Dissolved Lead
1,000
100
10
1
0.1
0.01
0.001
Dissolved Lead, micrograms per liter
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded

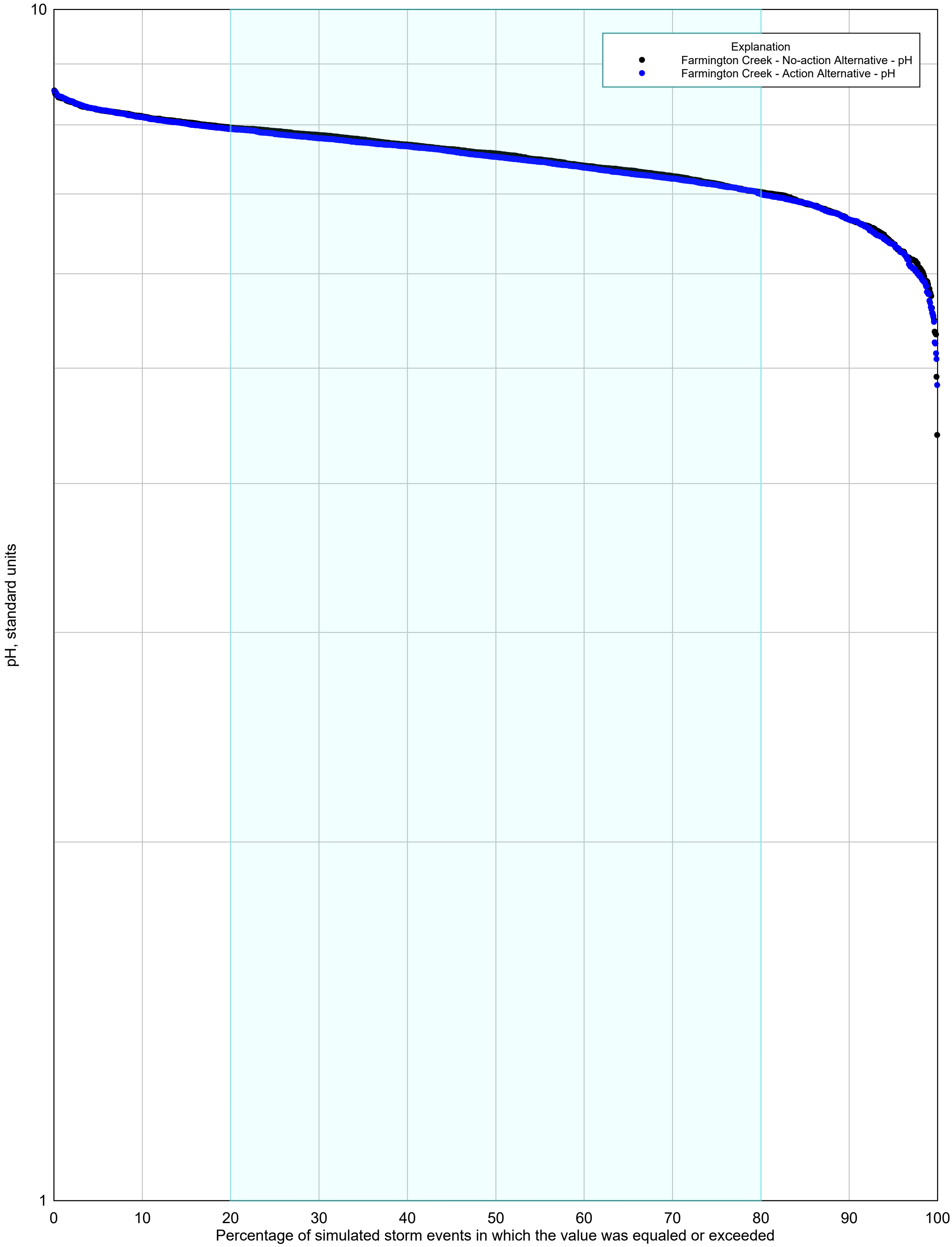


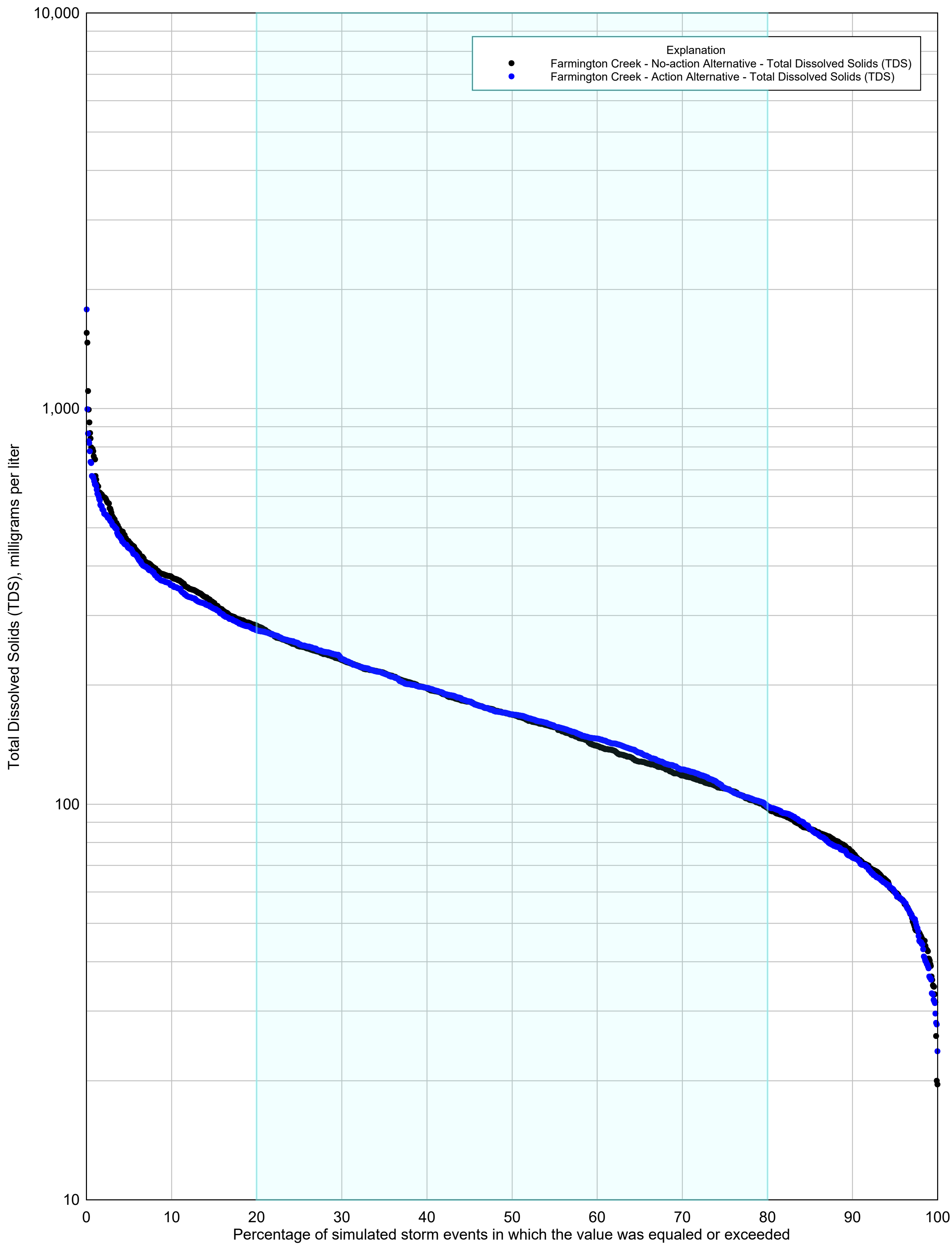
Explanation
Farmington Creek - No-action Alternative - Dissolved Zinc
Farmington Creek - Action Alternative - Dissolved Zinc
1,000
100
10
1
0
10
20
30
40
50
60
70
80
90
100
Dissolved Zinc, micrograms per liter
Percentage of simulated storm events in which the value was equaled or exceeded



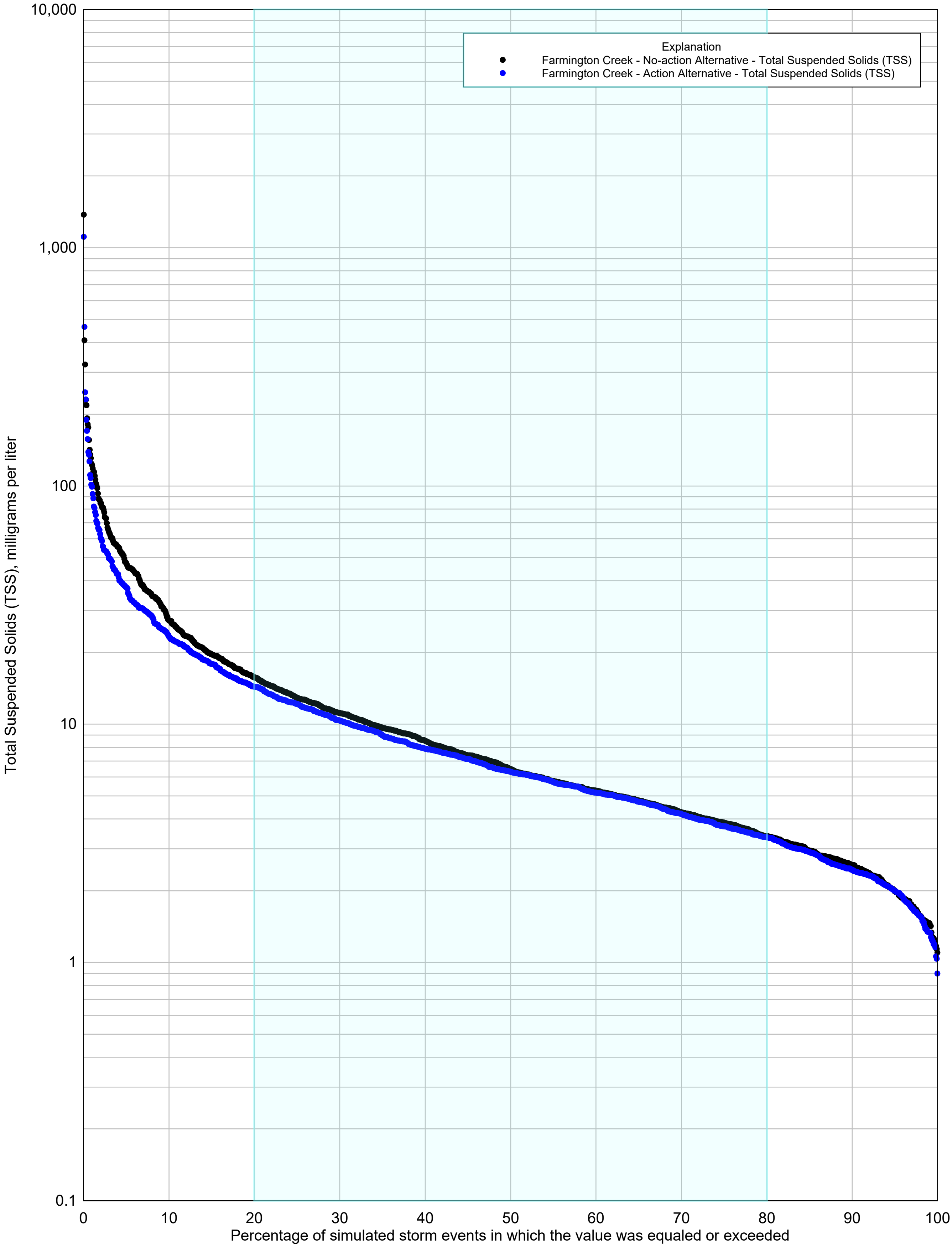
Explanation
Farmington Creek - No-action Alternative - Dissolved Nitrogen
Farmington Creek - Action Alternative - Dissolved Nitrogen
Dissolved Nitrogen, milligrams per liter
Percentage of simulated storm events in which the value was equaled or exceeded
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
90
100


Explanation
Farmington Creek - No-action Alternative - Total Phosphorus
Farmington Creek - Action Alternative - Total Phosphorus
Total Phosphorus, milligrams per liter
10
1
0.1
0.01
0.001
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded


Explanation
Farmington Creek - No-action Alternative - pH
Farmington Creek - Action Alternative - pH
pH, standard units
10
1
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded



Explanation
Farmington Creek - No-action Alternative - Total Dissolved Solids (TDS)
Farmington Creek - Action Alternative - Total Dissolved Solids (TDS)
Total Dissolved Solids (TDS), milligrams per liter
10,000
1,000
100
10
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded


Explanation
Farmington Creek - No-action Alternative - Total Suspended Solids (TSS)
Farmington Creek - Action Alternative - Total Suspended Solids (TSS)
Total Suspended Solids (TSS), milligrams per liter
10,000
1,000
100
10
1
0.1
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded

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# ATTACHMENT B

## Farmington Creek, Ricks Creek, and Mill Creek SELDM Graphs

### Ricks Creek

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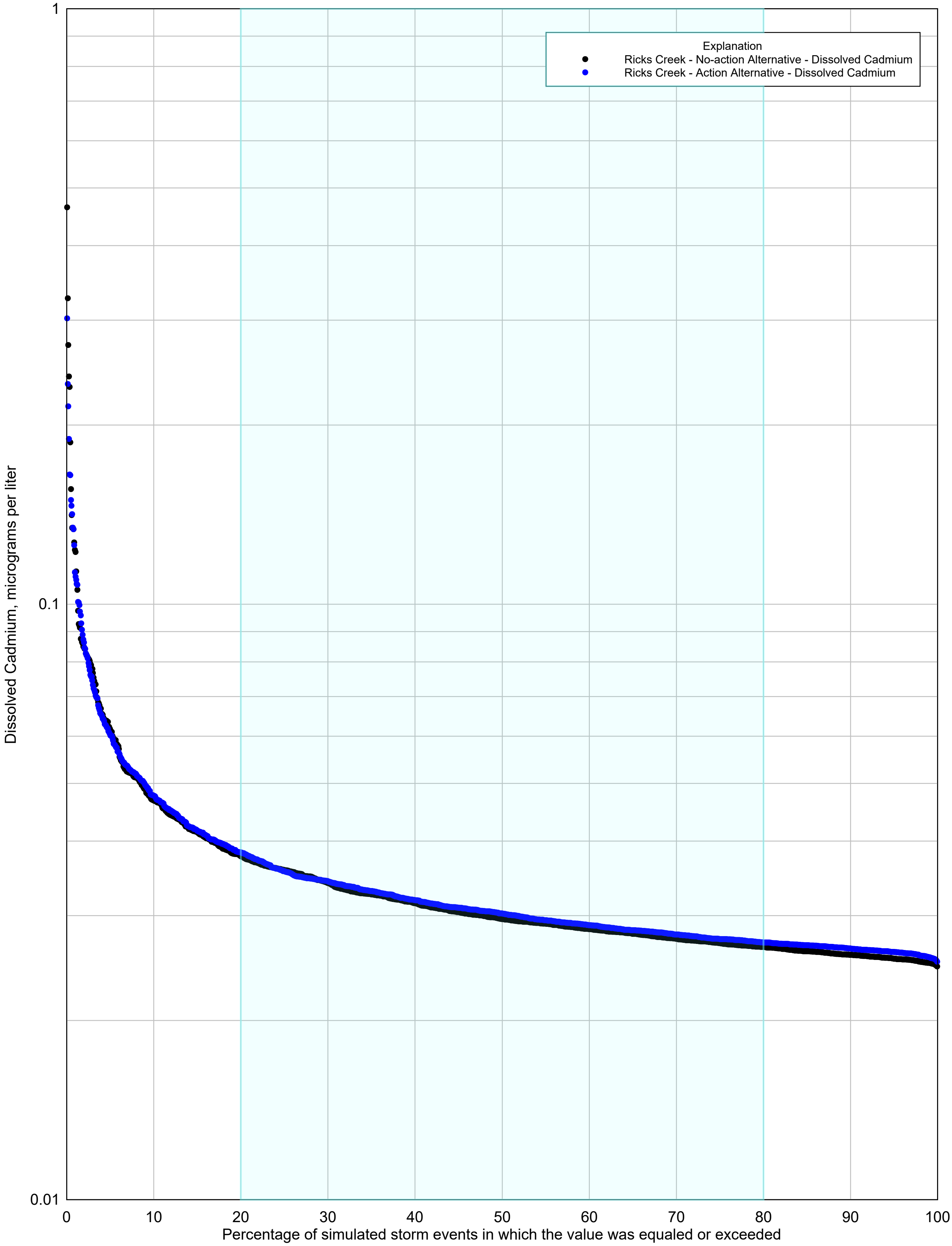
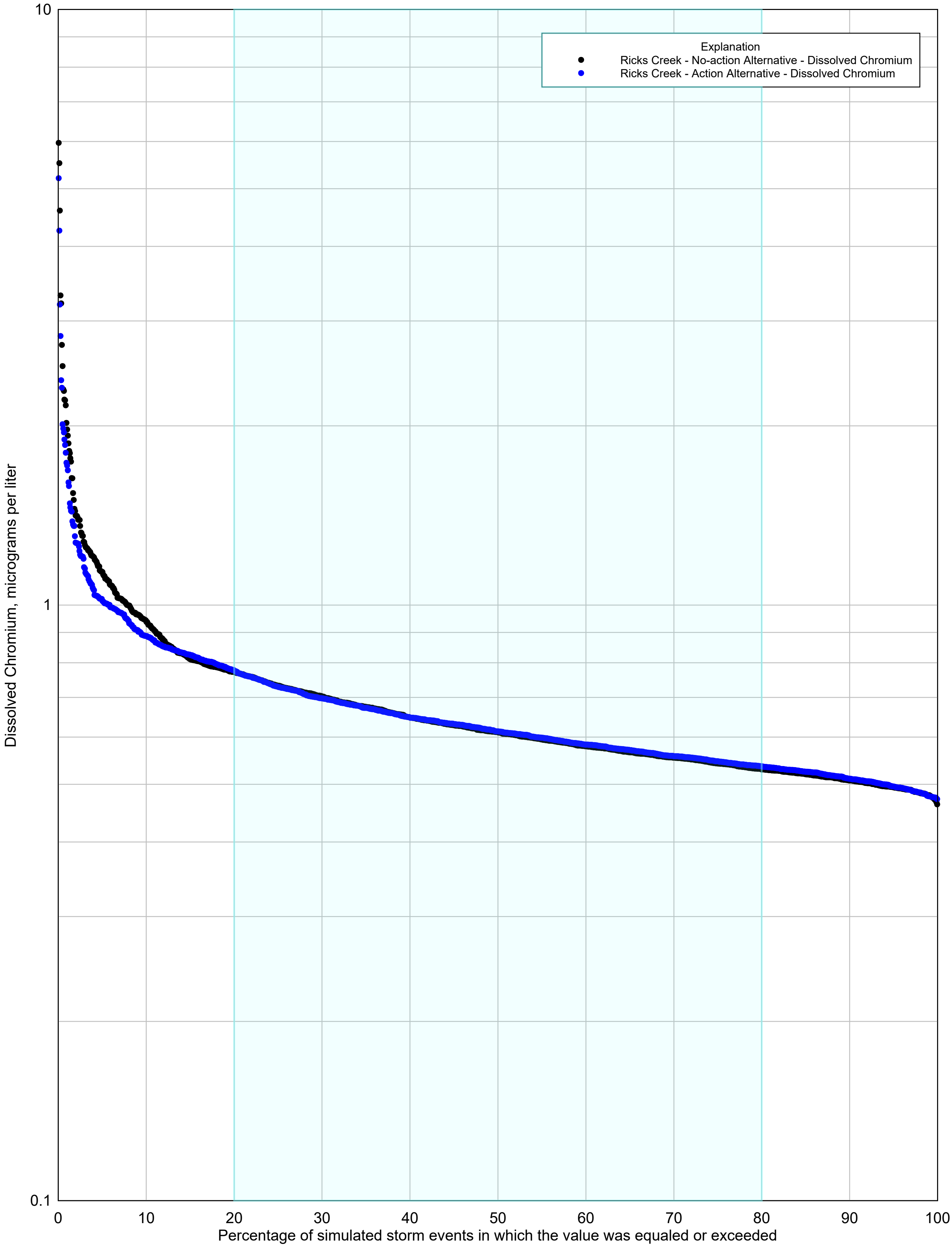
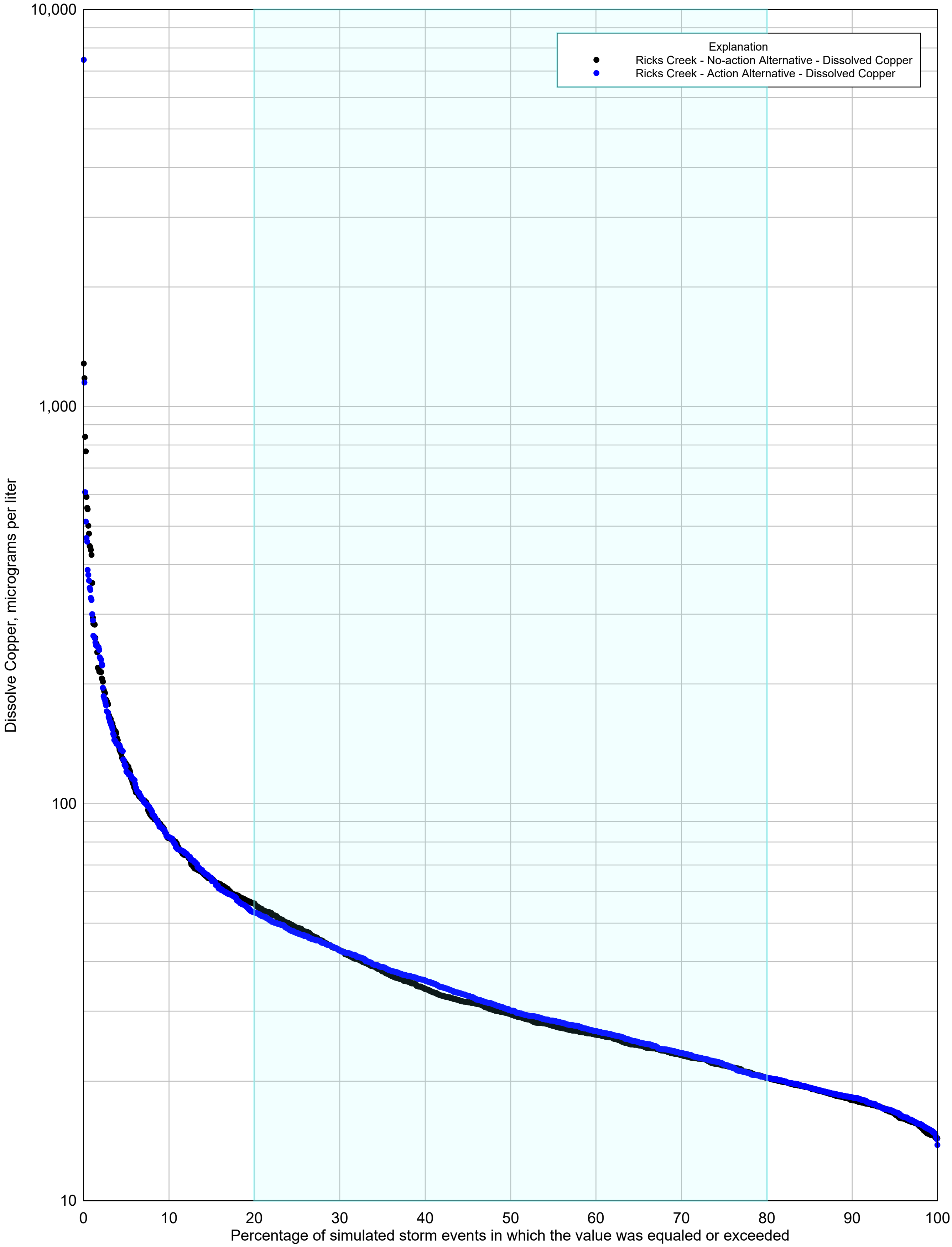
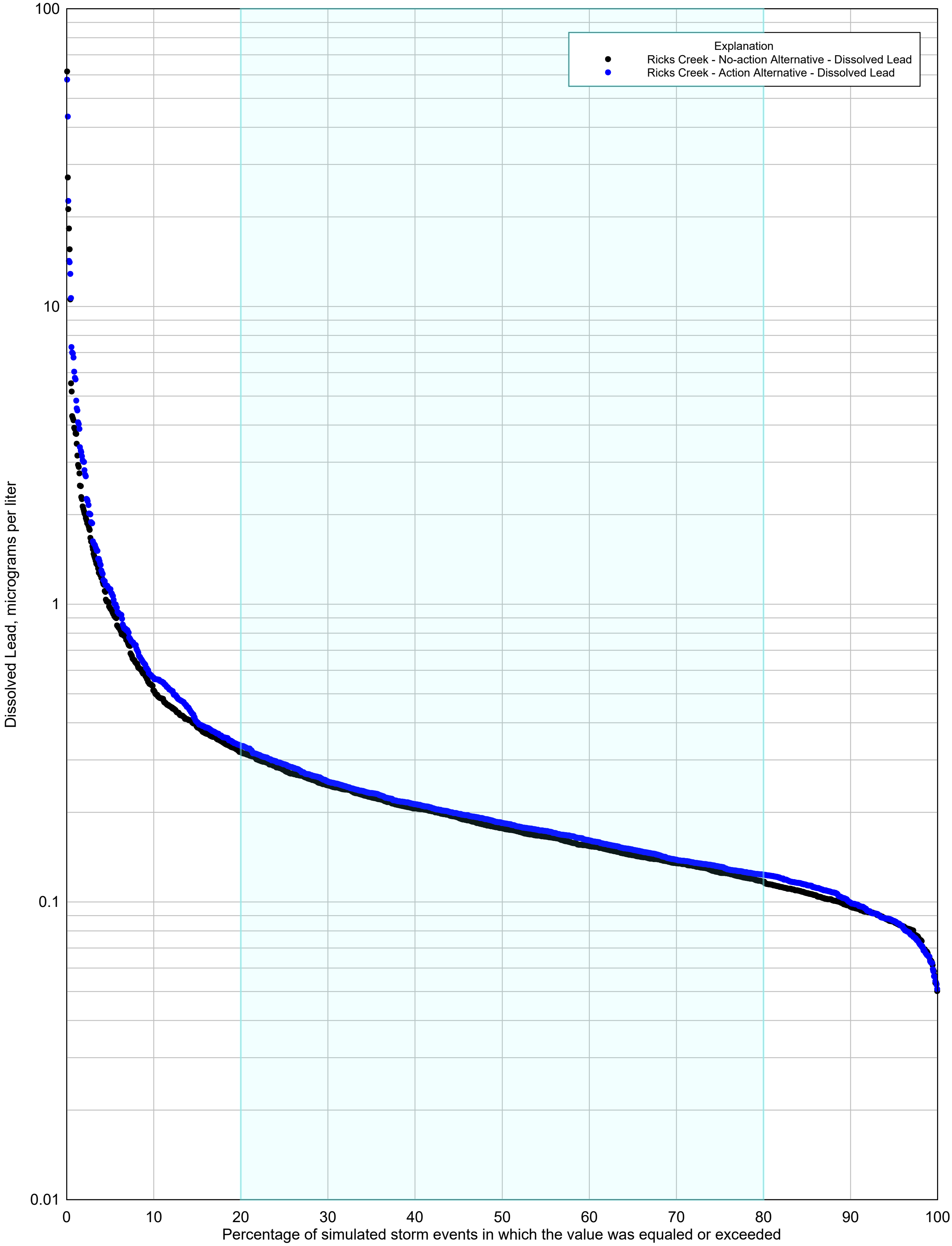


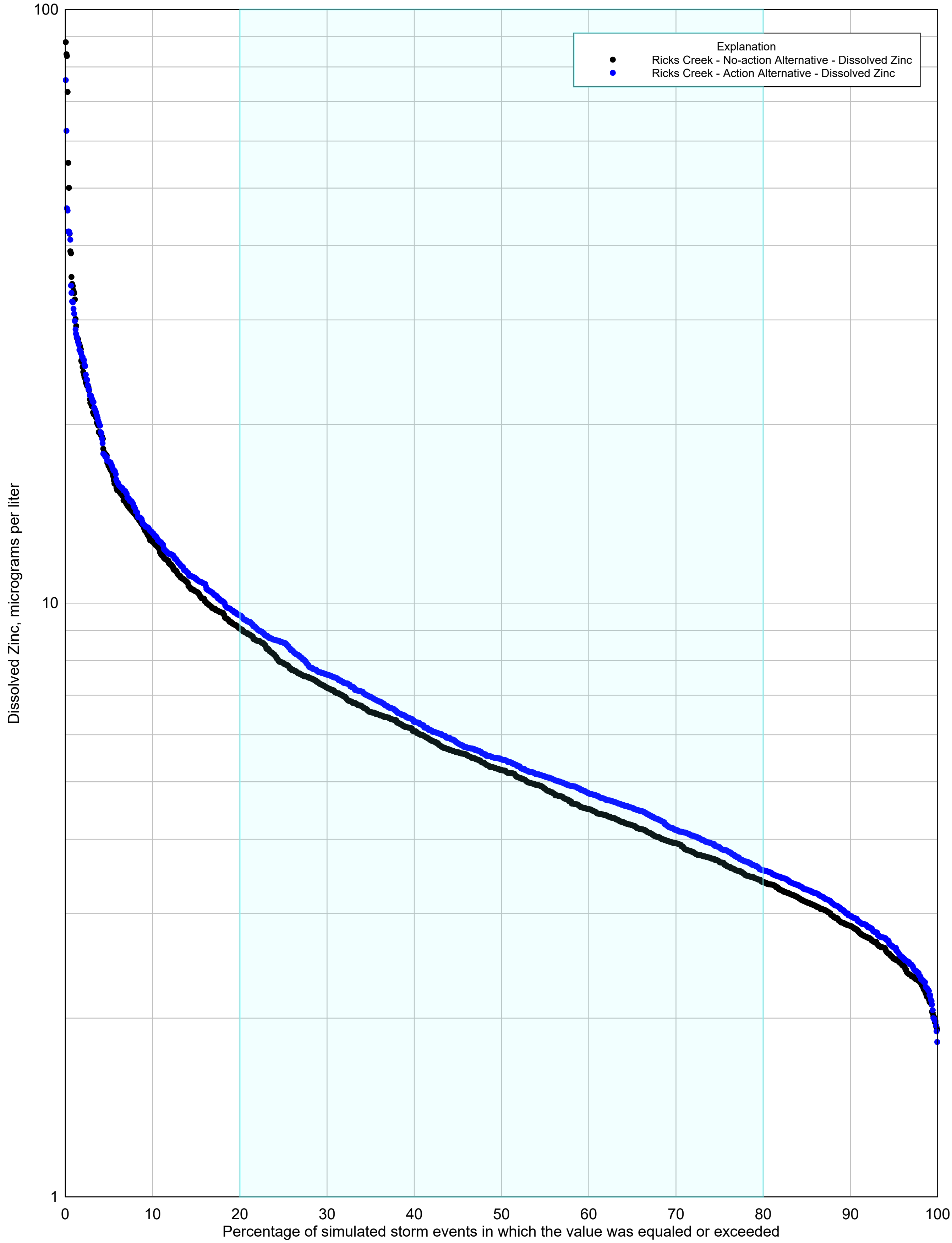
Explanation
Ricks Creek - No-action Alternative - Dissolved Cadmium
Ricks Creek - Action Alternative - Dissolved Cadmium
Dissolved Cadmium, micrograms per liter
1
0.1
0.01
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded

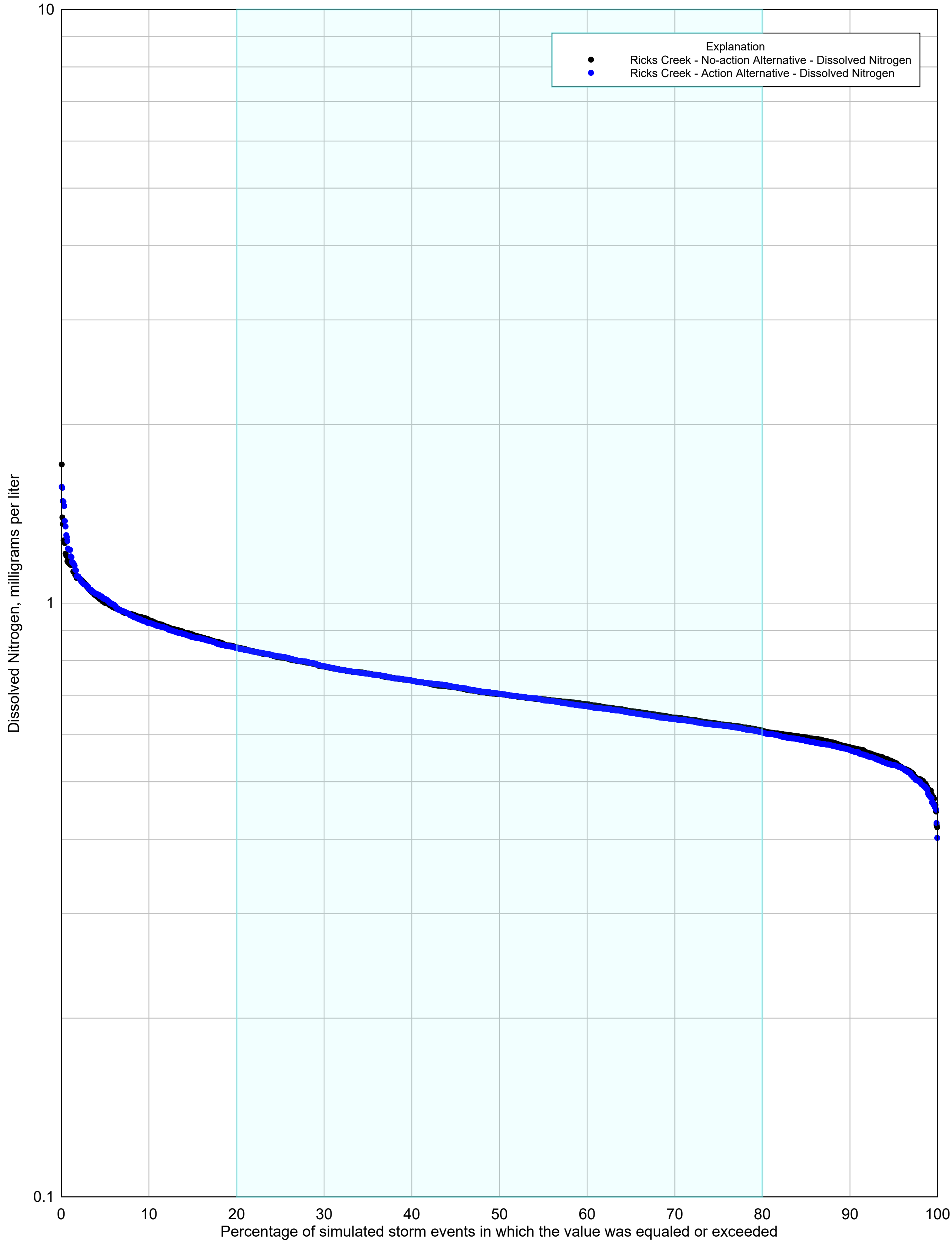


Explanation
Ricks Creek - No-action Alternative - Dissolved Chromium
Ricks Creek - Action Alternative - Dissolved Chromium
10
1
0.1
0
10
20
30
40
50
60
70
80
90
100
Dissolved Chromium, micrograms per liter
Percentage of simulated storm events in which the value was equaled or exceeded

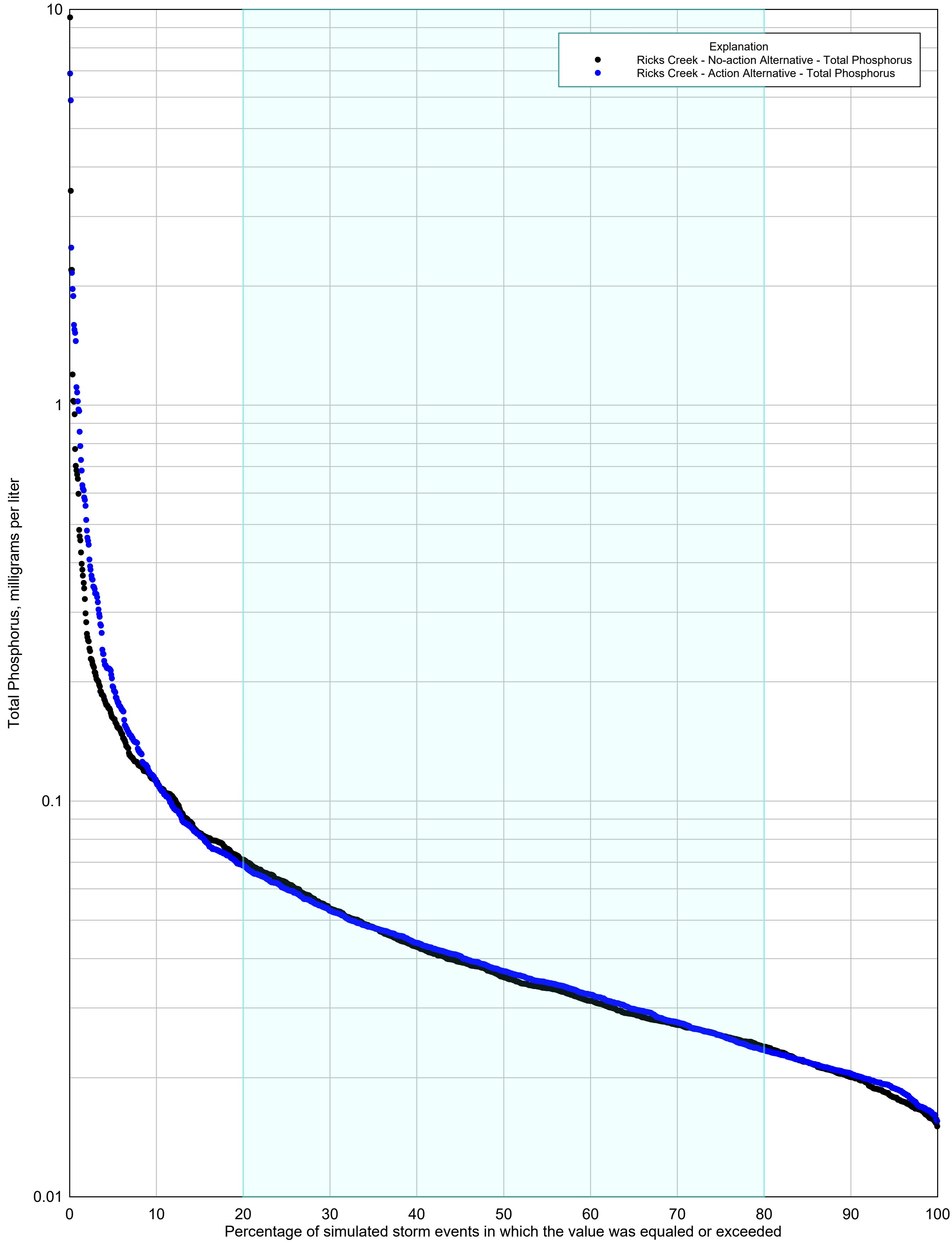

Explanation
Ricks Creek - No-action Alternative - Dissolved Copper
Ricks Creek - Action Alternative - Dissolved Copper
10,000
1,000
100
10
0
10
20
30
40
50
60
70
80
90
100
Dissolve Copper, micrograms per liter
Percentage of simulated storm events in which the value was equaled or exceeded


Explanation
Ricks Creek - No-action Alternative - Dissolved Lead
Ricks Creek - Action Alternative - Dissolved Lead
100
10
1
0.1
0.01
Dissolved Lead, micrograms per liter
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded

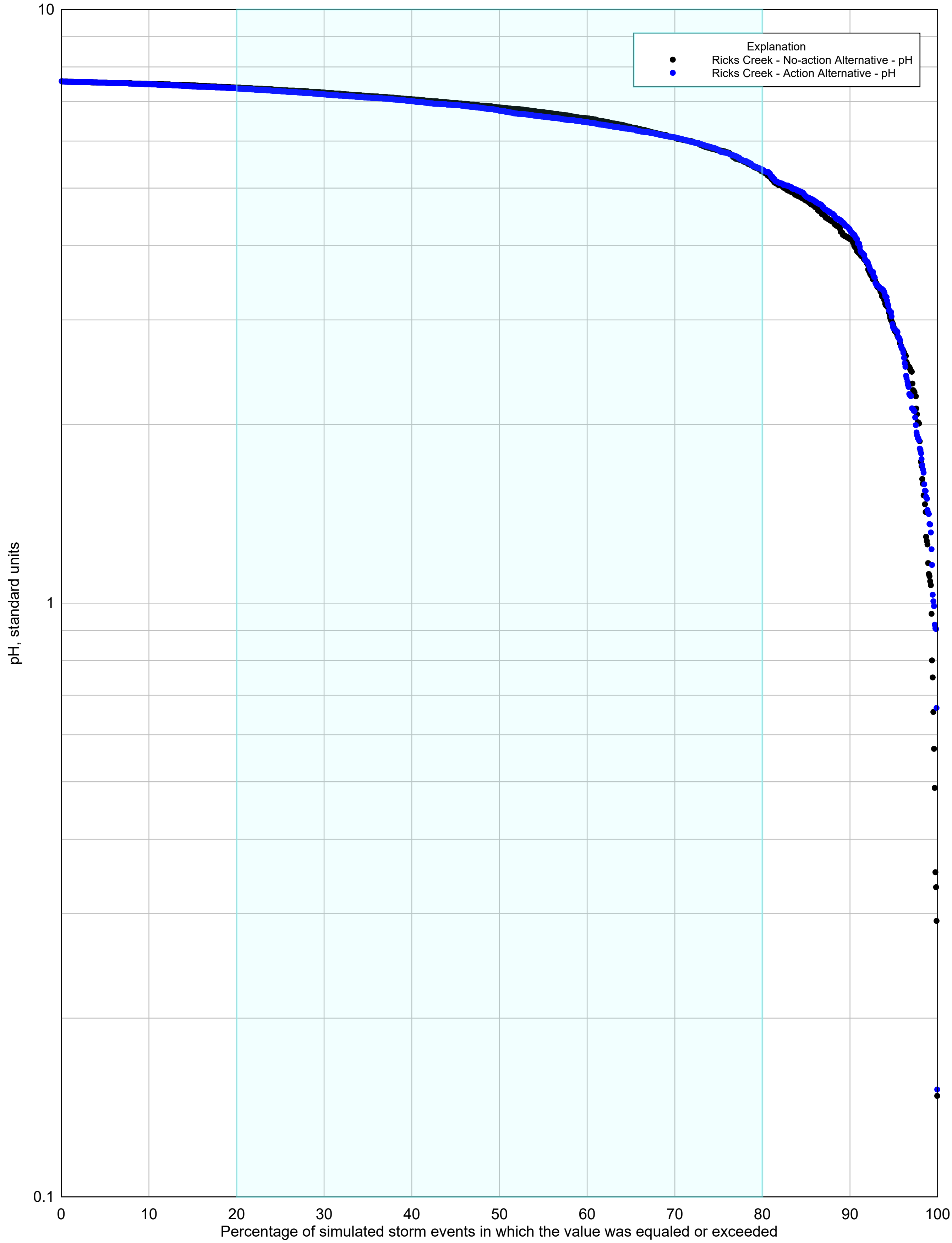

Explanation
Ricks Creek - No-action Alternative - Dissolved Zinc
Ricks Creek - Action Alternative - Dissolved Zinc
Dissolved Zinc, micrograms per liter
100
10
1
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded

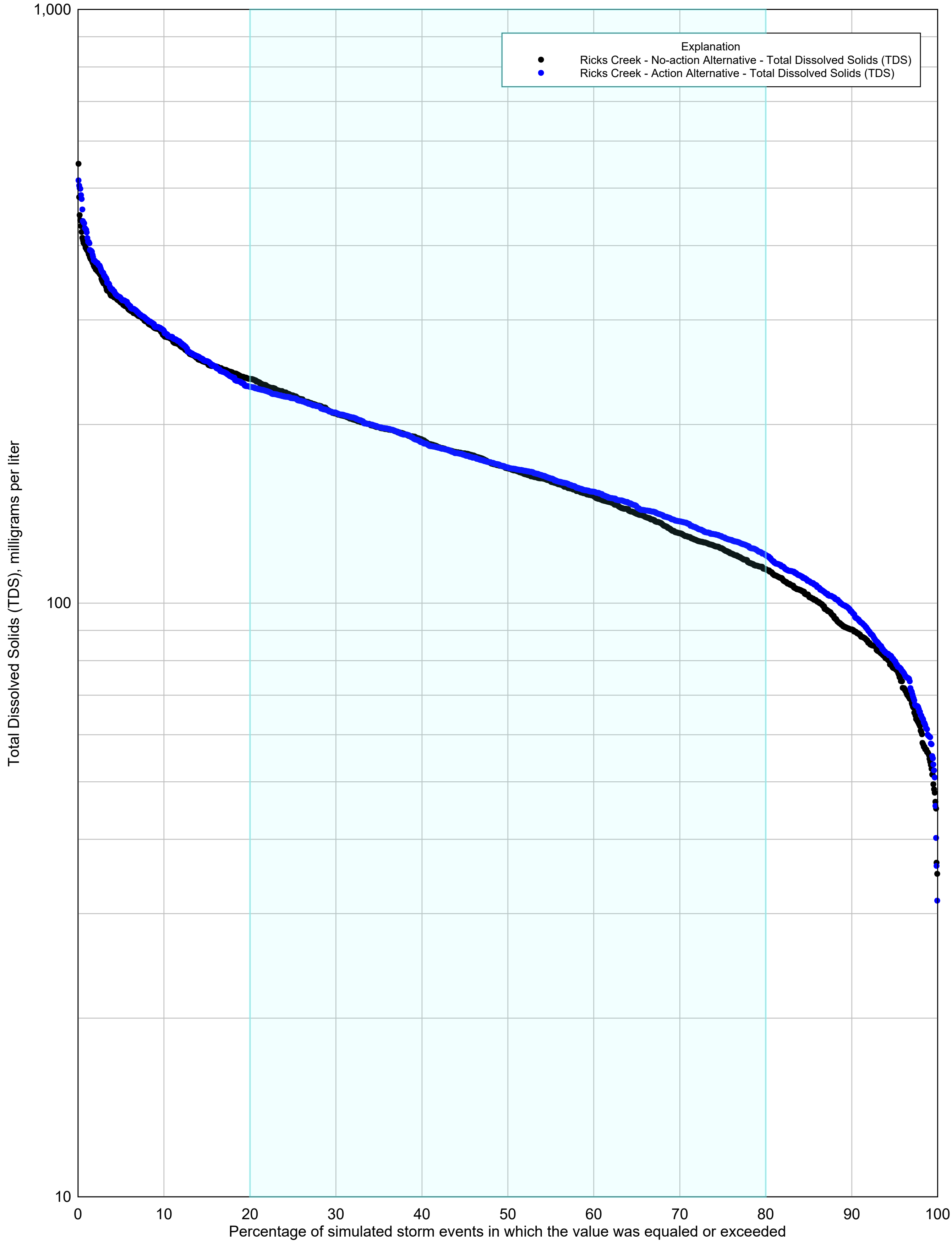


Explanation
Ricks Creek - No-action Alternative - Dissolved Nitrogen
Ricks Creek - Action Alternative - Dissolved Nitrogen
Dissolved Nitrogen, milligrams per liter
10
1
0.1
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded

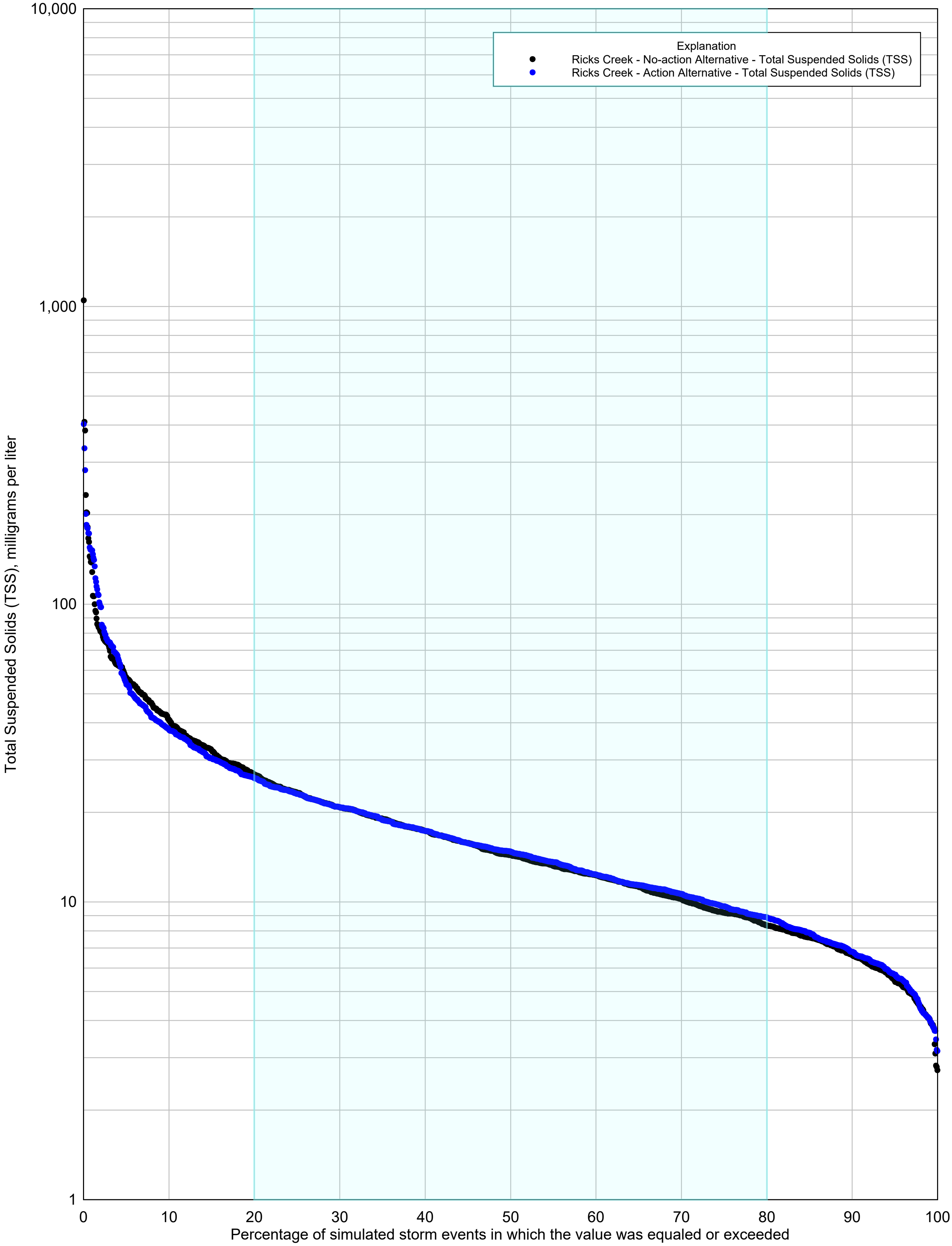


Explanation
Ricks Creek - No-action Alternative - Total Phosphorus
Ricks Creek - Action Alternative - Total Phosphorus
Total Phosphorus, milligrams per liter
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded


Explanation
Ricks Creek - No-action Alternative - pH
Ricks Creek - Action Alternative - pH
pH, standard units
10
1
0.1
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded



Explanation
Ricks Creek - No-action Alternative - Total Dissolved Solids (TDS)
Ricks Creek - Action Alternative - Total Dissolved Solids (TDS)
1,000
100
10
0
10
20
30
40
50
60
70
80
90
100
Total Dissolved Solids (TDS), milligrams per liter
Percentage of simulated storm events in which the value was equaled or exceeded


Explanation
Ricks Creek - No-action Alternative - Total Suspended Solids (TSS)
Ricks Creek - Action Alternative - Total Suspended Solids (TSS)
Total Suspended Solids (TSS), milligrams per liter
10,000
1,000
100
10
1
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded

# ATTACHMENT B

## Farmington Creek, Ricks Creek, and Mill Creek SELDM Graphs

### Mill Creek

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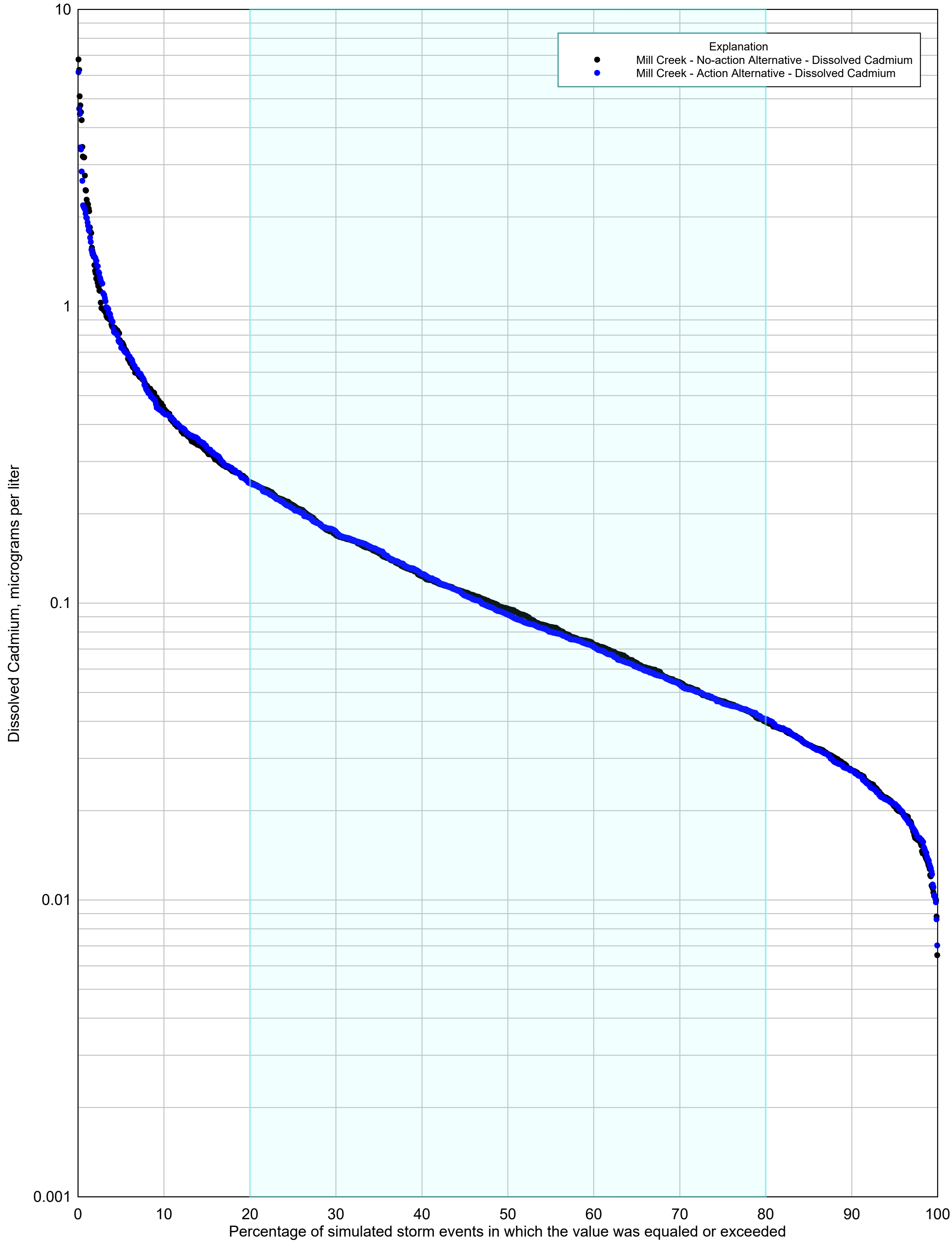
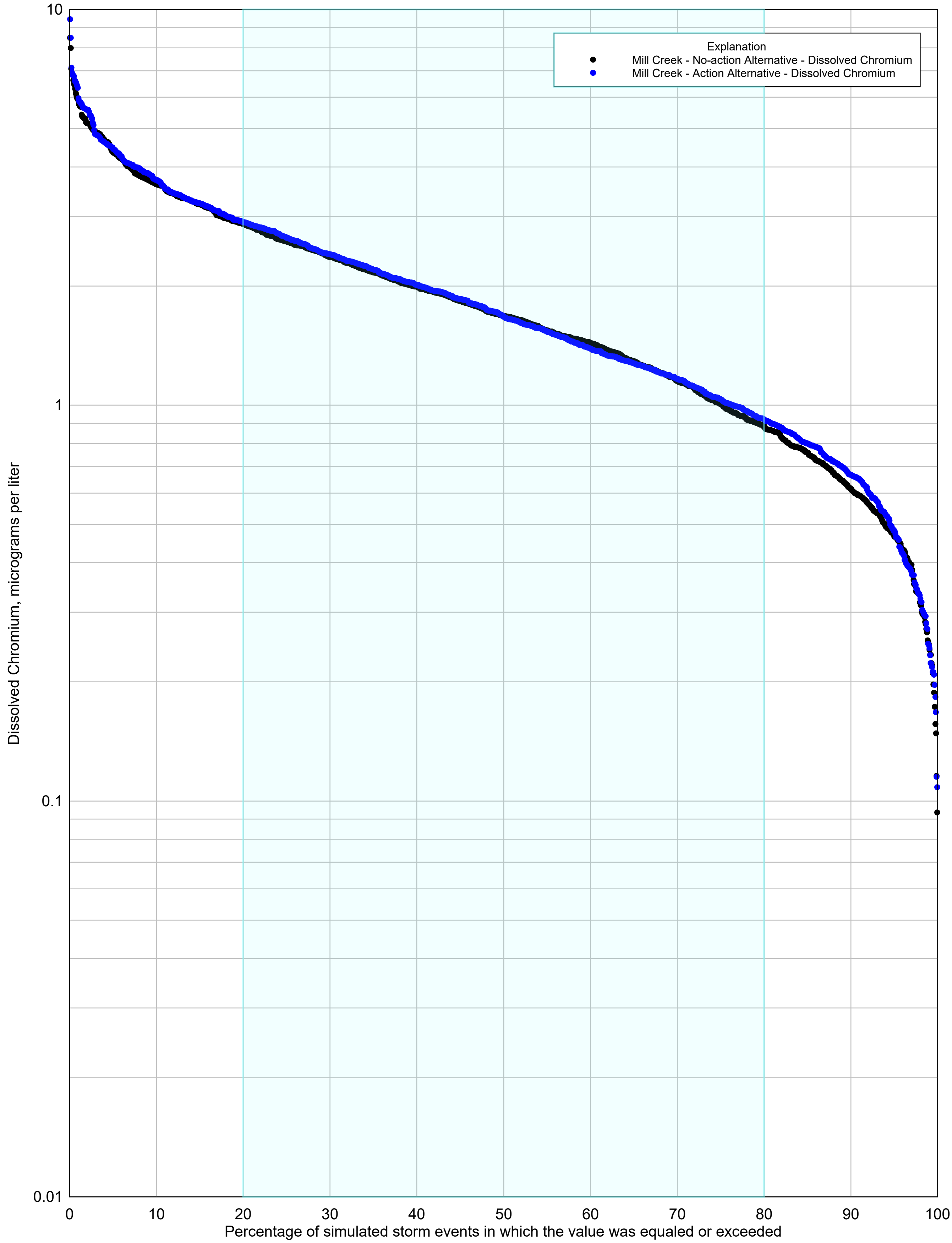
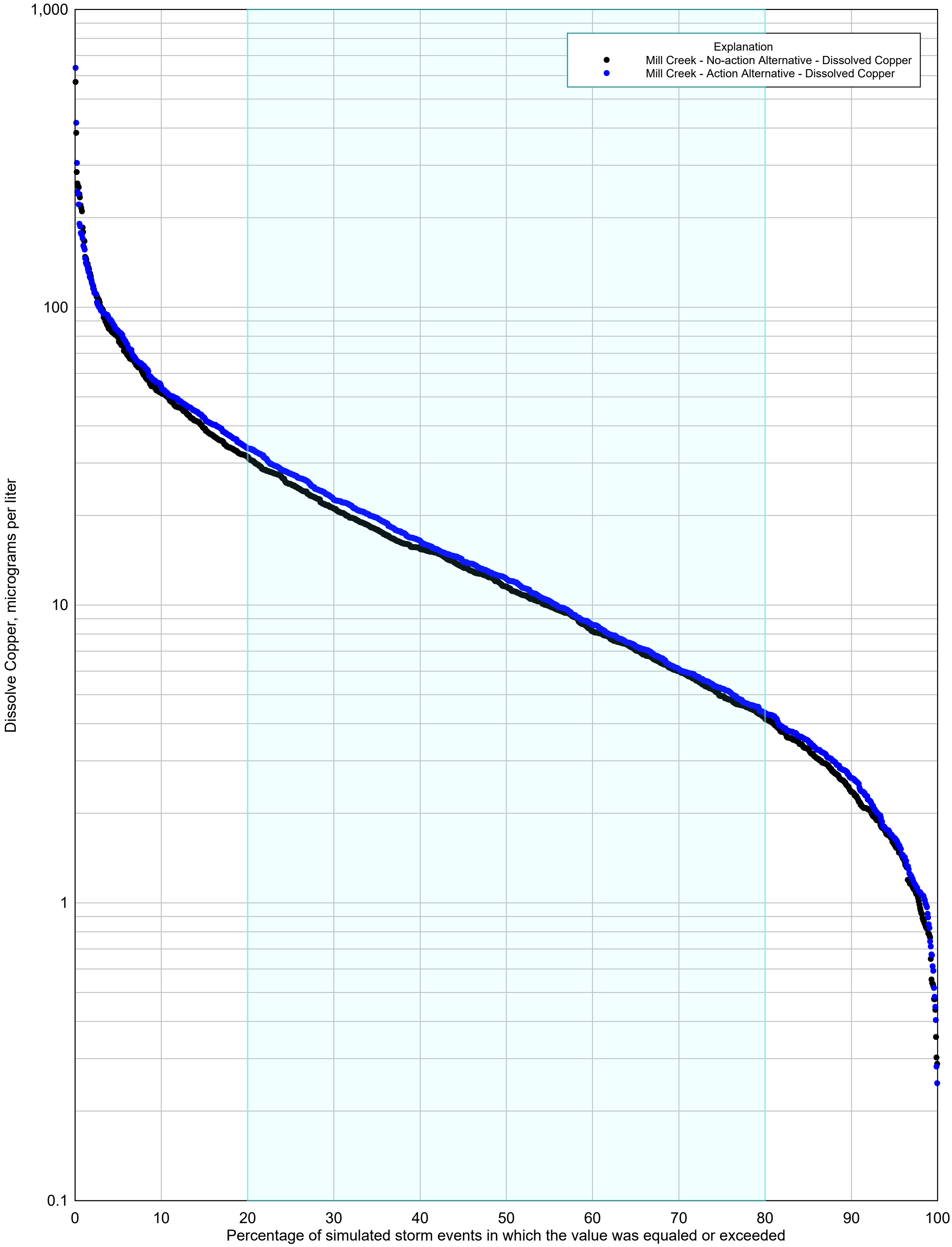


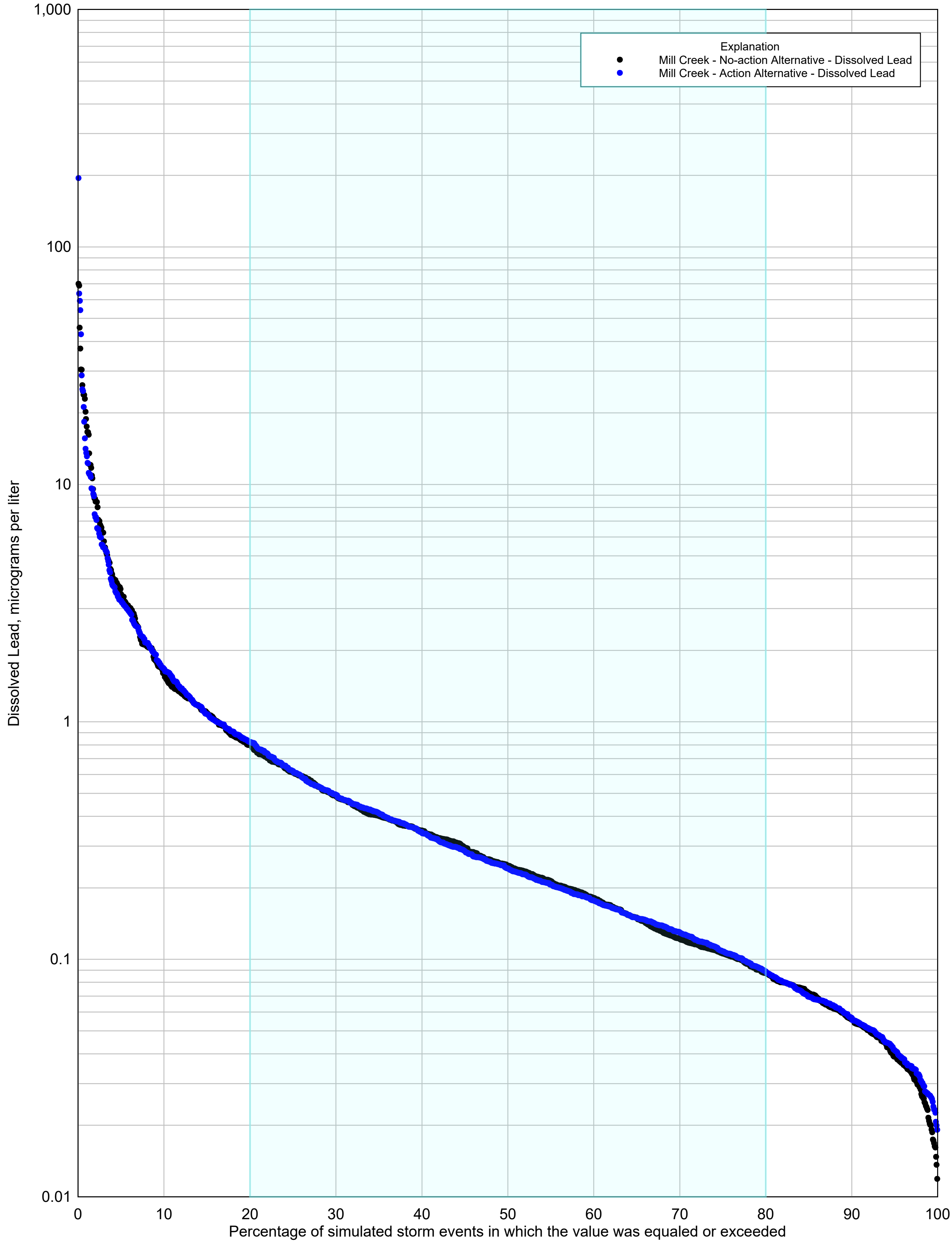
Explanation
Mill Creek - No-action Alternative - Dissolved Cadmium
Mill Creek - Action Alternative - Dissolved Cadmium
10
1
0.1
0.01
0.001
Dissolved Cadmium, micrograms per liter
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded



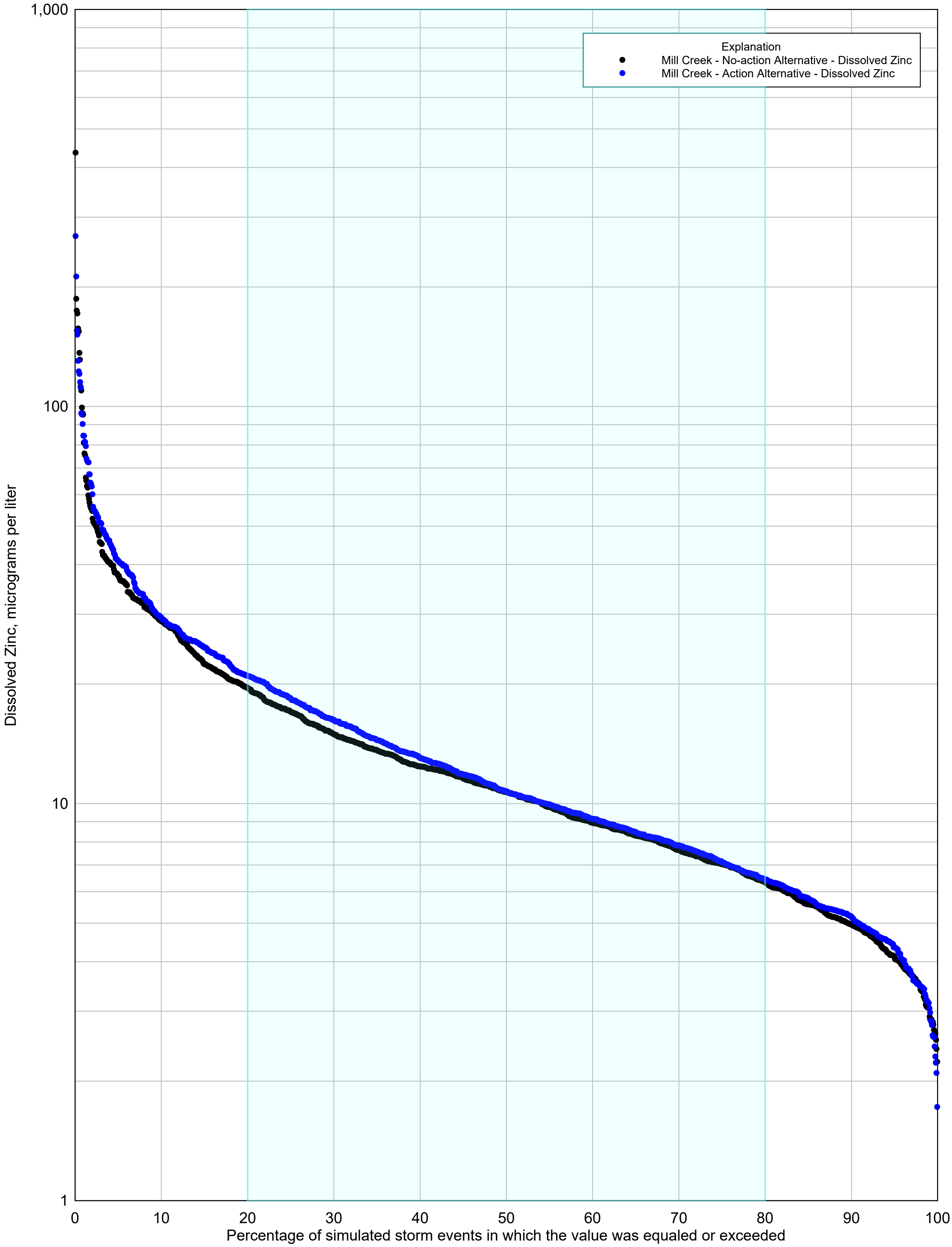
Explanation
Mill Creek - No-action Alternative - Dissolved Chromium
Mill Creek - Action Alternative - Dissolved Chromium
Dissolved Chromium, micrograms per liter
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded

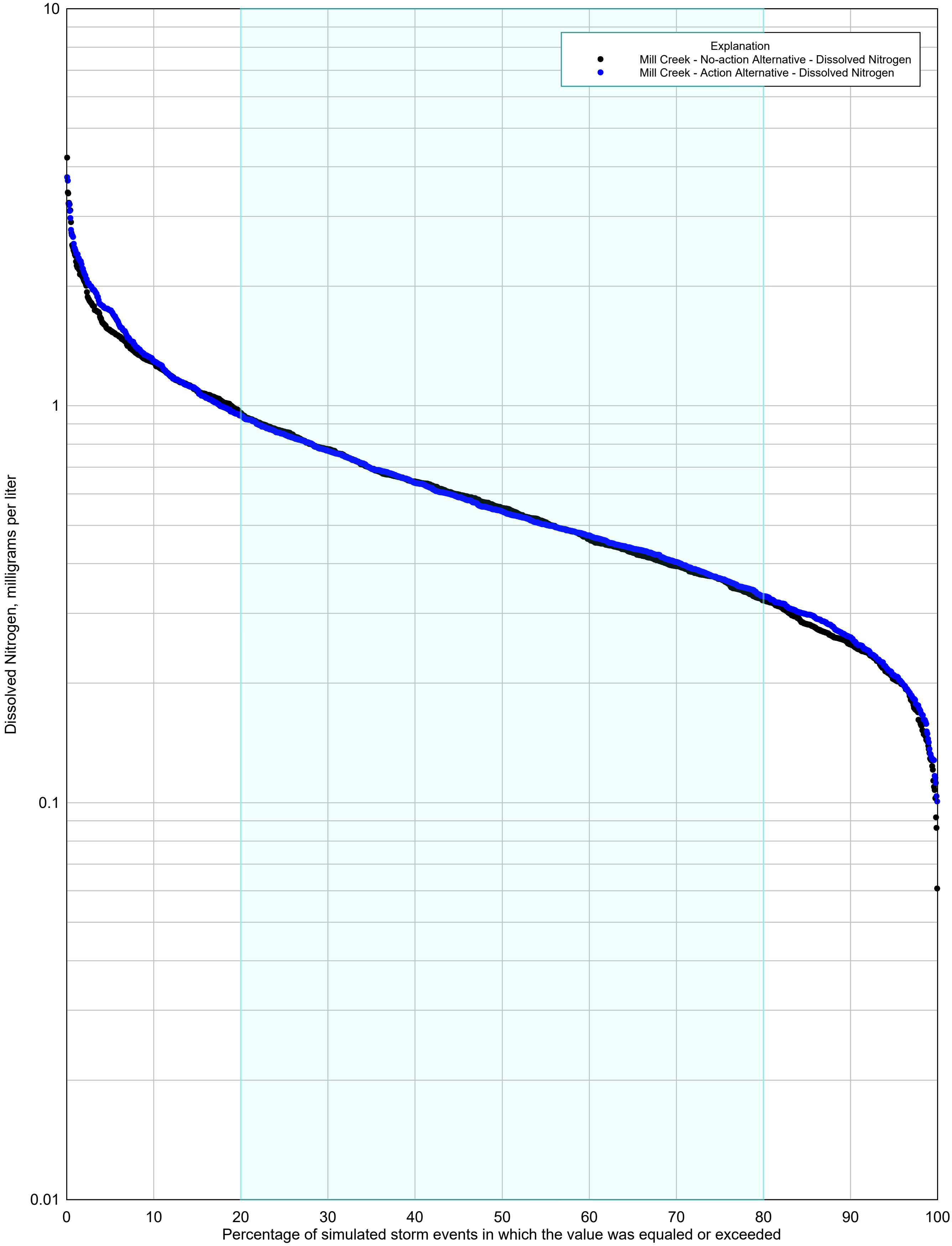


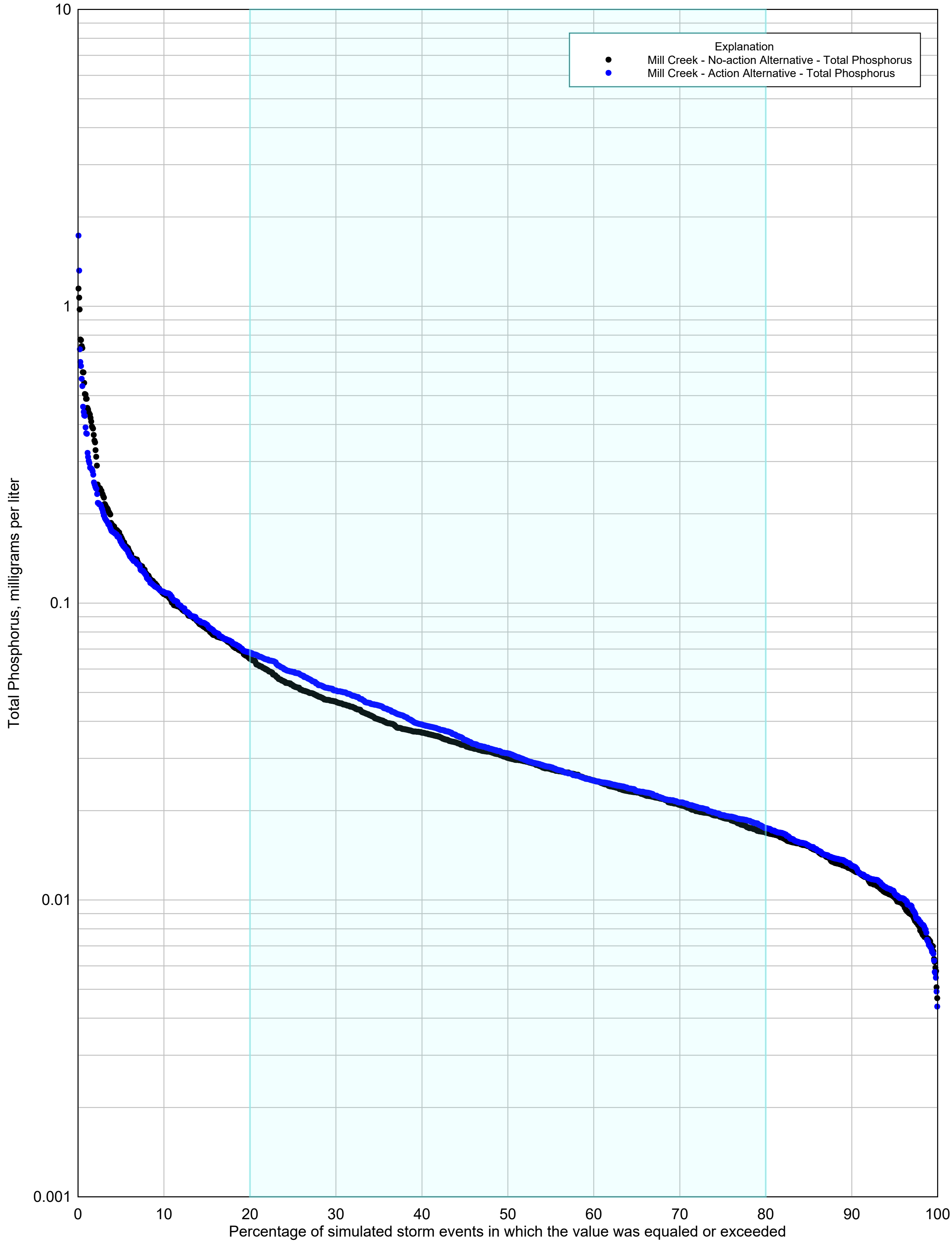
Explanation
Mill Creek - No-action Alternative - Dissolved Copper
Mill Creek - Action Alternative - Dissolved Copper
1,000
100
10
1
0.1
Dissolve Copper, micrograms per liter
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded



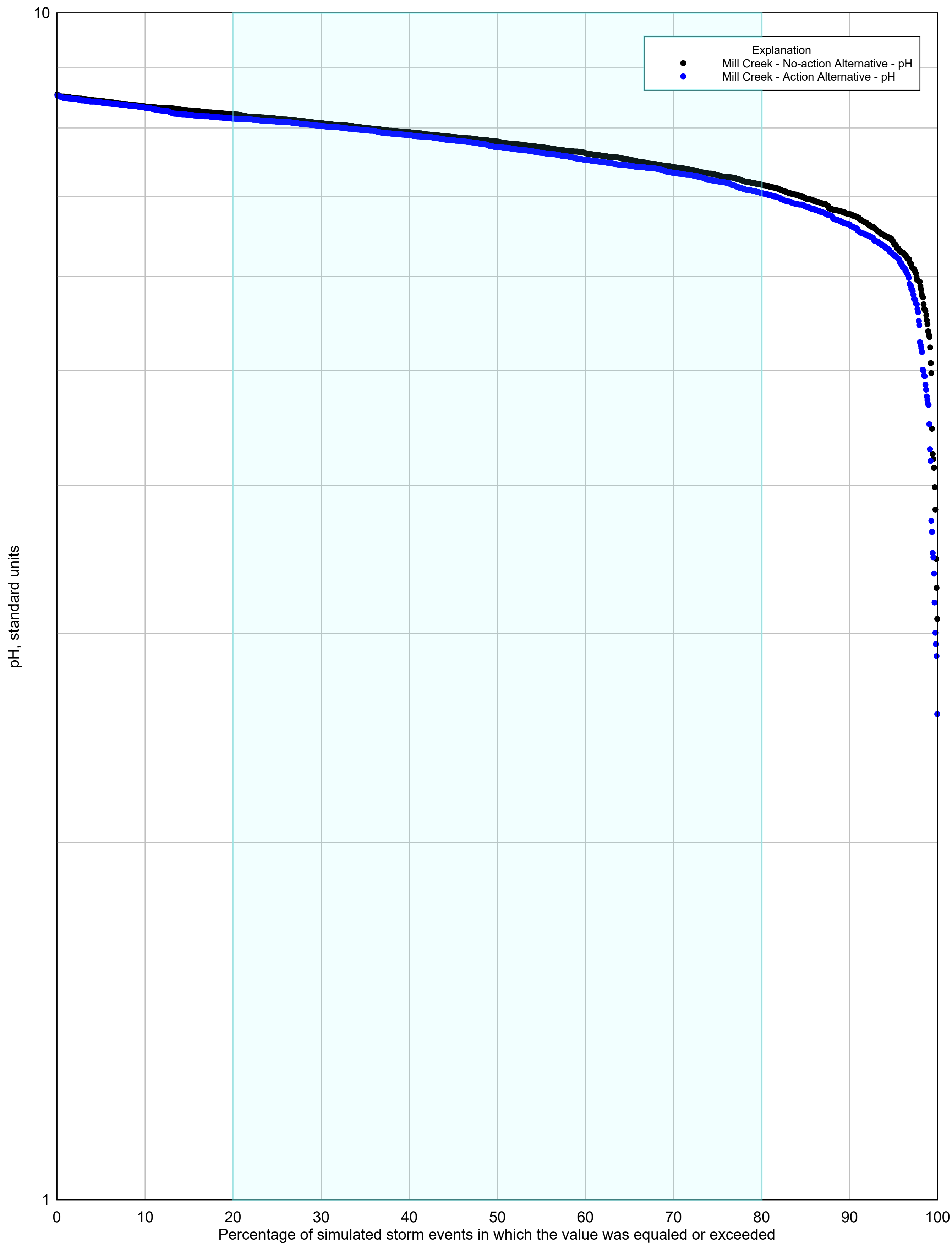
Explanation
Mill Creek - No-action Alternative - Dissolved Lead
Mill Creek - Action Alternative - Dissolved Lead
1,000
100
10
1
0.1
0.01
Dissolved Lead, micrograms per liter
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded


Explanation
Mill Creek - No-action Alternative - Dissolved Zinc
Mill Creek - Action Alternative - Dissolved Zinc
1,000
100
10
1
Dissolved Zinc, micrograms per liter
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded

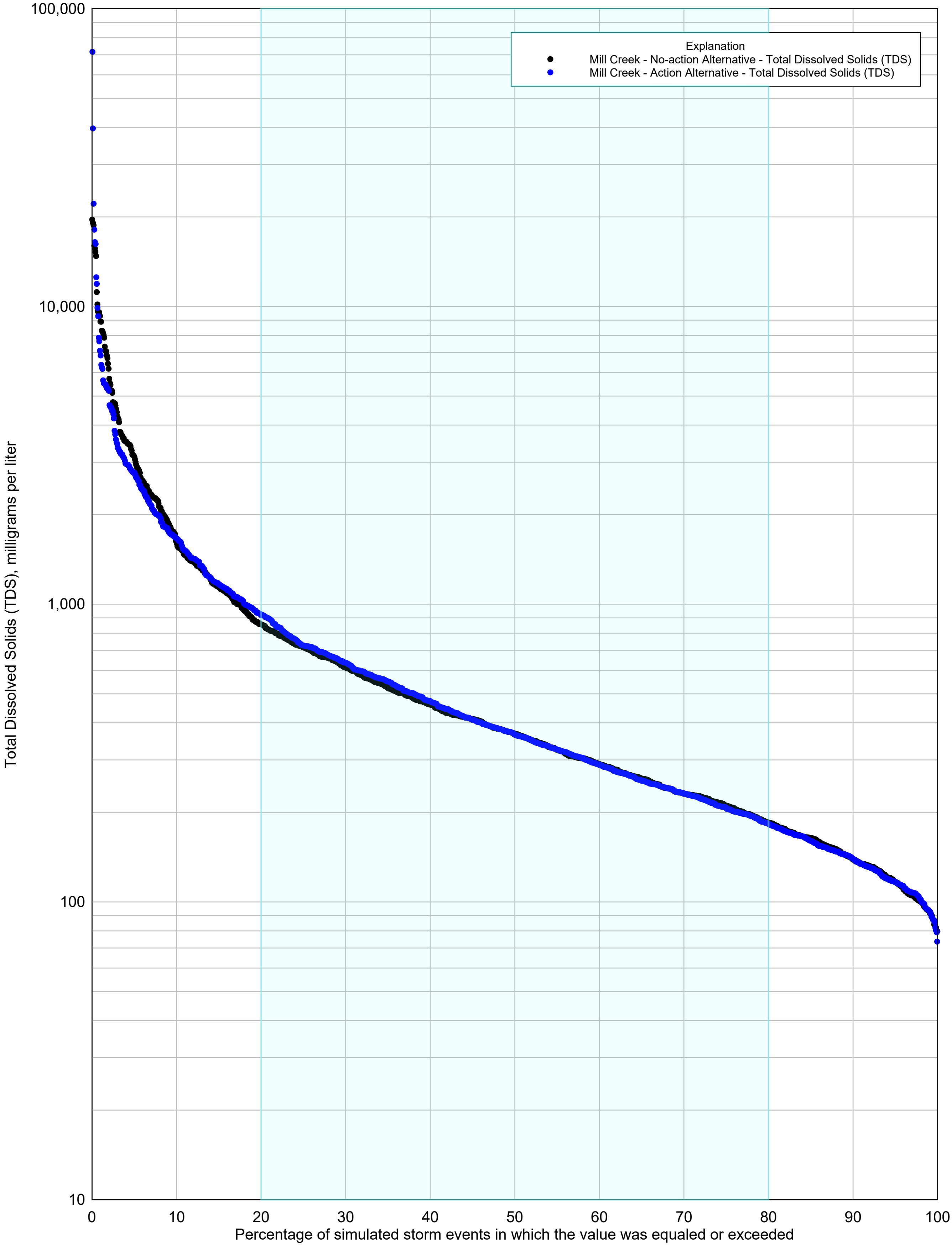

Explanation
Mill Creek - No-action Alternative - Dissolved Nitrogen
Mill Creek - Action Alternative - Dissolved Nitrogen
Dissolved Nitrogen, milligrams per liter
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded

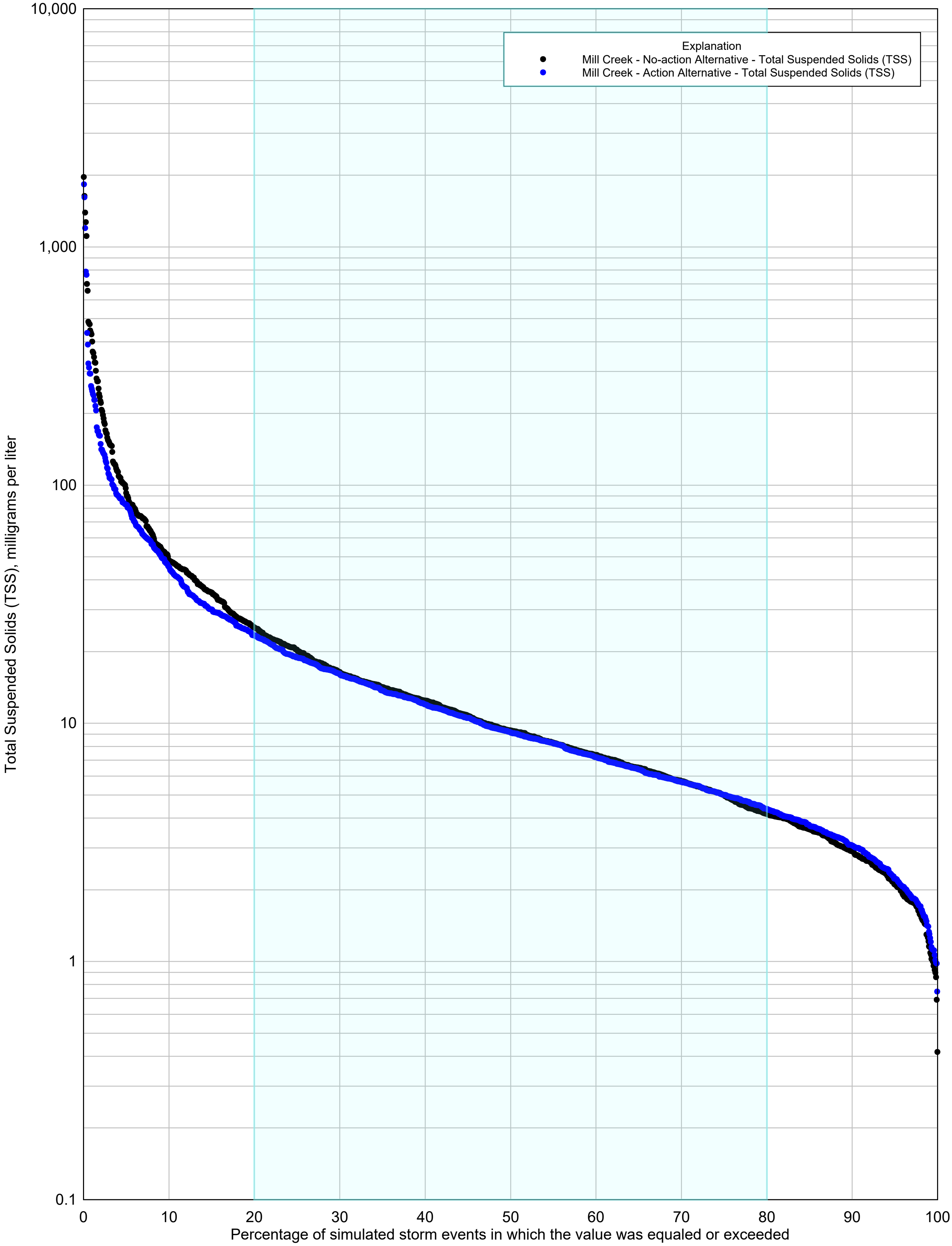


Explanation
Mill Creek - No-action Alternative - Total Phosphorus
Mill Creek - Action Alternative - Total Phosphorus
Total Phosphorus, milligrams per liter
10
1
0.1
0.01
0.001
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded



Explanation
Mill Creek - No-action Alternative - pH
Mill Creek - Action Alternative - pH
pH, standard units
Percentage of simulated storm events in which the value was equaled or exceeded
10
1
0
10
20
30
40
50
60
70
80
90
100


Explanation
Mill Creek - No-action Alternative - Total Dissolved Solids (TDS)
Mill Creek - Action Alternative - Total Dissolved Solids (TDS)
100,000
10,000
1,000
100
10
Total Dissolved Solids (TDS), milligrams per liter
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded


Explanation
Mill Creek - No-action Alternative - Total Suspended Solids (TSS)
Mill Creek - Action Alternative - Total Suspended Solids (TSS)
Total Suspended Solids (TSS), milligrams per liter
10,000
1,000
100
10
1
0.1
0
10
20
30
40
50
60
70
80
90
100
Percentage of simulated storm events in which the value was equaled or exceeded