# Final
# Total Maximum Daily Load for *E. coli*, pH, Cadmium, Copper, Iron, Lead, Nickel and Zinc, 54 Pollutant-Waterbody Combinations on 25 Stream Segments, Pond Creek, Muhlenberg County, Kentucky

Pond Creek Downstream, photo by KDOW

**Submitted to:**
**United States Environmental Protection Agency**
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**Atlanta Federal Building**
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# Total Maximum Daily Load for *E. coli*, pH, Cadmium, Copper, Iron, Lead, Nickel and Zinc, 54 Pollutant-Waterbody Combinations on 25 Stream Segments, Pond Creek, Muhlenberg County, Kentucky

**January 2017**

**Kentucky Department for Environmental Protection**
**Division of Water**

**This report is approved for release**

**Peter T. Goodmann, Director**
**Division of Water**

12/29/2016

**Date**

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# GLOSSARY OF ACRONYMS

| | |
|---|---|
| AFO | Animal Feeding Operations |
| AMD | Acid Mine Drainage |
| AML | Abandoned Mine Lands |
| APEL | Alternate Precipitation Effluent Limits |
| APHA | American Public Health Association |
| AWQA | Agricultural Water Quality Act |
| BMP | Best Management Practices |
| CAFOs | Concentrated Animal Feeding Operations |
| CAH | Cold Water Aquatic Habitat |
| CFR | Code of Federal Regulations |
| cfs | cubic feet per second |
| CPP | Continuing Planning Process |
| CWA | Clean Water Act |
| D.C. | District of Columbia |
| DMRE | Division of Mine Reclamation and Enforcement |
| DMR | Discharge Monitoring Report |
| ELG | Effluent Limit Guidelines |
| EPA | Environmental Protection Agency |
| $ft^3/s$ | cubic feet per second |
| GIS | Geographic Information System |
| GNIS | Geographic Names Information System |
| HUC | Hydrologic Unit Code |
| HSG | Hydrologic Soil Groups |
| ICIS | Integrated Compliance Information System |
| KAR | Kentucky Administrative Regulations |
| KDEP | Kentucky Department for Environmental Protection |
| KDMP | Kentucky Division of Mine Permits |
| KDMS | Kentucky Division of Mine Safety |
| KDNR | Kentucky Department for Natural Resources |
| KDOW | Kentucky Division of Water |
| KIBI | Kentucky Index of Biotic Integrity |
| KGS | Kentucky Geological Survey |
| KNDOP | Kentucky No Discharge Operating Permit |
| KRS | Kentucky Revised Statutes |
| KPDES | Kentucky Pollutant Discharge Elimination System |
| KWA | Kentucky Waterways Alliance |
| KPDES | Kentucky Pollutant Discharge Elimination System |
| L | liter |

| | |
|---|---|
| LA | Load Allocations |
| MBI | Macroinvertebrate Bioassessment Index |
| MGD | million gallons per day |
| ml | milliliter |
| mg/L | milligrams per liter |
| MOS | Margin of Safety |
| MS4 | Municipal Separate Stormwater Sewer Systems |
| MSU | Murray State University |
| N/A | Not Applicable |
| NHD | National Hydrography Dataset |
| NLCD | National Landcover Database |
| NRCS | Natural Resources Conservation Service |
| NS | Non-Support |
| ONRW | Outstanding National Resource Water |
| OSRW | Outstanding State Resource Water |
| OSTDS | On-site Sewage Treatment Disposal System |
| PCR | Primary Contact Recreation |
| PS | Partial Support |
| RM | River Mile |
| SCR | Secondary Contact Recreation |
| SMCRA | Surface Mining Control and Reclamation Act |
| SMIS | Surface Mining Information System |
| STP | Sewage Treatment Plant |
| SWPPP | Stormwater Pollution Prevention Plan |
| TMDL | Total Maximum Daily Load |
| µg/L | micrograms per liter |
| µs/cm | microsiemens per centimeter |
| USGS | United States Geological Survey |
| USDA | United Stated Department of Agriculture |
| UT | Unnamed Tributary |
| WAH | Warm Water Aquatic Habitat |
| WET | Whole Effluent Toxicity |
| WKY | Western Kentucky (Coal Bed Designation) |
| WKU | Western Kentucky University |
| WLA | Waste Load Allocation |
| WQC | Water Quality Criteria |
| WWTP | Wastewater Treatment Plant |

## Total Maximum Daily Load (TMDL) Synopsis

**State**: Kentucky
**Major River Basin:** Green
**USGS HUC8 #:** 05110003
**County:** Muhlenberg
**Pollutant(s) of Concern:** *E. coli*, pH, Cadmium, Copper, Iron, Lead, Nickel and Zinc

**Table S.1 Impaired Waterbodies and Pollutants Addressed in this TMDL Document**

| Waterbody | GNIS Number(1) | Pollutant | Suspected Sources | Impaired Use(2) (Support Status)(3) |
|---|---|---|---|---|
| Bat East Creek 0.0 to 3.4 | KY486462_01 | *E. coli* | Source Unknown | PCR (NS) |
| | | Copper | Legacy Coal Extraction | WAH (PS) |
| | | Lead | Legacy Coal Extraction | WAH (PS) |
| Beech Creek 0.0 to 3.9 | KY486697_01 | Cadmium | Surface Mining | WAH (NS) |
| | | Iron | Surface Mining | WAH (NS) |
| | | Nickel | Surface Mining | WAH (NS) |
| | | Zinc | Surface Mining | WAH (NS) |
| Boggess Creek 0.0 to 3.0 | KY487614_01 | *E. coli* | Loss of Riparian Habitat; Non-point Source | PCR (NS) |
| Caney Creek 0.0 to 3.6 | KY488838_01 | *E. coli* | Non-point Source; Urban Runoff/store Sewers | PCR (NS) |
| | | Cadmium(4) | Source Unknown | WAH (PS) |
| Caney Creek 3.6 to 7.6 | KY488838_02 | *E. coli* | Non-point Source | PCR (NS) |
| | | Cadmium(4) | Legacy Coal Extraction | WAH (NS) |
| | | Lead(4) | Legacy Coal Extraction | WAH (NS) |
| Carters Creek 0.0 to 3.1 | KY489022_01 | *E. coli*(4) | Agriculture | PCR (PS) |
| Opossum Run 0.0 to 1.6 | KY499964_01 | *E. coli*(4) | Non-point Source | PCR (NS) |
| Plum Creek 0.0 to 1.65 | KY500964_01 | *E. coli* | Upstream Source; Inappropriate Water Disposal | PCR (NS) |
| | | Cadmium | Non-point Source; Legacy Coal Extraction | WAH (NS) |
| Plum Creek 1.65 to 3.9 | KY500964_02 | *E. coli* | Non-point Source; Upstream Source | PCR (NS) |
| | | pH | Legacy Coal Extraction | PCR (NS), SCR (NS), WAH (NS) |
| | | Cadmium | Non-point Source | WAH (NS) |
| | | Nickel | Non-point Source | WAH (NS) |
| | | Zinc | Non-point Source | WAH (NS) |
| Pond Creek 0.0 to 5.0 | KY501042_01 | Iron(4) | Surface Mining; Legacy Coal Extraction | WAH (NS) |

## Total Maximum Daily Load (TMDL) Synopsis

| Waterbody | GNIS Number[1] | Pollutant | Suspected Sources | Impaired Use[2] (Support Status)[3] |
|---|---|---|---|---|
| Pond Creek 5.0 to 7.5 | KY501042_02 | *E. coli* | Non-point Source; Upstream Source | PCR (PS) |
| | | Cadmium | Legacy Coal Extraction | WAH (NS) |
| | | Iron | Legacy Coal Extraction | WAH (NS) |
| Pond Creek 7.5 to 11.7 | KY501042_03 | *E. coli* | Non-point Source | PCR (PS) |
| | | Cadmium | Petroleum /Natural Gas Production Activities; Non-point Source; Legacy Coal Extraction | WAH (NS) |
| | | Iron | Petroleum /Natural Gas Production Activities; Non-point Source; Legacy Coal Extraction | WAH (NS) |
| Pond Creek 11.7 to 14.4 | KY501042_04 | Cadmium[4] | Surface Mining; Legacy Coal Extraction; Petroleum /Natural Gas Production Activities | WAH (NS) |
| | | Iron[4] | Surface Mining; Legacy Coal Extraction; Petroleum /Natural Gas Production Activities | WAH (NS) |
| Pond Creek 14.4 to 18.1 | KY501042_05 | *E. coli* | Non-point Source | PCR (NS) |
| | | Lead | Upstream Source | WAH (NS) |
| Pond Creek 18.1to 18.7 | KY501042_06 | *E. coli* | Non-point Source | PCR (NS) |
| Saltlick Creek 0.0 to 3.7 | KY502844_01 | *E. coli* | Non-point Source | PCR (NS) |
| Sandlick Creek 0.0 to 4.05 | KY502963_01 | *E. coli* | Non-point Source | PCR (PS) |
| | | Iron[4] | Source Unknown | WAH (PS) |
| | | Lead[4] | Source Unknown | WAH (PS) |
| UT of Bat East Creek 0.0 to 1.9 | KY486462-6.1_01 | *E. coli* | Non-point Source | PCR (NS) |
| UT of Bat East Creek 0.0 to 3.55 | KY486462-1.6_01 | *E. coli* | Non-point Source | PCR (NS) |
| UT of Caney Creek 0.0 to 2.6 | KY488838-2.3_01 | *E. coli* | Municipal (Urbanized High Density Area); Urban Runoff / Store Water; Upstream Source | PCR (PS) |
| | | Lead[4] | Source Unknown | WAH (PS) |
| UT of Caney Creek 0.0 to 2.3 | KY488838-1.8_01 | *E. coli* | Loss of Riparian Habitat; Non-point Source | PCR (NS) |
| | | Lead[4] | Source Unknown | WAH (NS) |

## Total Maximum Daily Load (TMDL) Synopsis

| Waterbody | GNIS Number[1] | Pollutant | Suspected Sources | Impaired Use[2] (Support Status)[3] |
|---|---|---|---|---|
| UT of Plum Creek 0.0 to 2.45 | KY500964-1.65_01 | pH | Legacy Coal Extraction | PCR (NS), SCR (NS), WAH (NS) |
| | | Cadmium | Legacy Coal Extraction | WAH (NS) |
| | | Iron[4] | Legacy Coal Extraction | WAH (NS) |
| | | Nickel | Legacy Coal Extraction | WAH (NS) |
| | | Zinc | Legacy Coal Extraction | WAH (NS) |
| UT of Pond Creek 0.0 to 2.4 | KY501042-6.9_01 | Iron | Surface Mining; Legacy Coal Extraction | WAH (NS) |
| UT of Pond Creek 2.4 to 4.2 | KY501042-6.9_02 | *E. coli* | Non-point Source; Rural Residential Areas | PCR (NS) |
| | | pH | Surface Mining; Legacy Coal Extraction | PCR (NS), SCR (PS), WAH (NS) |
| | | Cadmium[4] | Surface Mining; Legacy Coal Extraction | WAH (NS) |
| UT of Pond Creek 0.0 to 1.4 | KY501042-11.1_01 | Cadmium | Upstream Source; Legacy Coal Extraction | WAH (NS) |

[1] It is a combination of the Geographic Names Information System (GNIS) number and a 2-digit suffix denoting the segment. Any additional numbers following the GNIS number but before the segment number denote the river miles of unnamed tributaries.
[2] PCR: Primary Contact Recreation; SCR: Secondary Contact Recreation; WAH: Warm Water Aquatic Habitat
[3] NS: Non-Support; PS: Partial Support
[4] Included in 2016 303(d) List

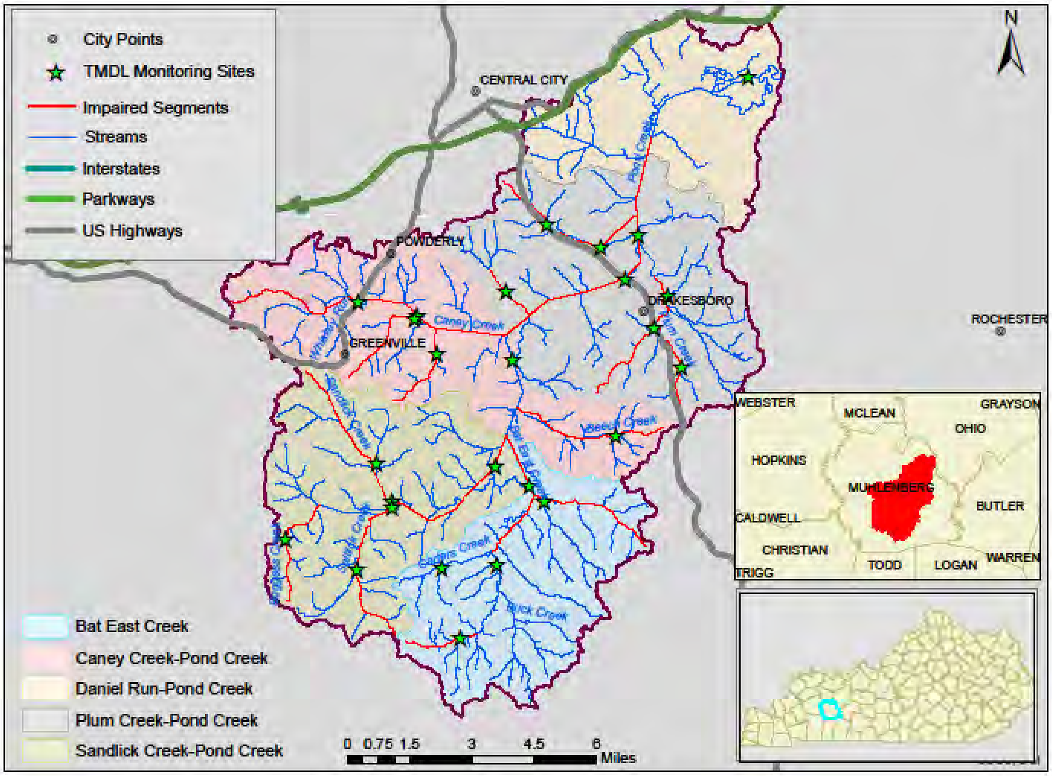


**Figure S.1 Location of the Pond Creek Watershed, TMDL Sampling Stations and Impaired Stream Segments**

**Kentucky Water Quality Criteria (WQC) and the TMDL Endpoint (i.e. Water Quality Standard/ TMDL Target):**

**Table S.2 *E. coli* WQC and TMDL Endpoint**

| Condition | WQC, colonies/100ml[(1)] | TMDL Load, colonies/day[(2)] |
|---|---|---|
| Instantaneous | 240 | $Q_S \times 240 \times 24{,}465{,}758.4$ |
| Geomean | 130 | $Q_S \times 130 \times 24{,}465{,}758.4$ |

[(1)] ml: milliliter
[(2)] $Q_S$ is the flow in the stream in cubic feet per second (cfs or $ft^3/s$).

**Table S.3 pH WQC and TMDL Endpoint**

| Condition | WQC, pH standard units | TMDL Load, Hydrogen Ions, pounds/day[(1)] |
|---|---|---|
| All Conditions | 6.0 (upper limit of hydrogen ion loading) | $Q_S \times 2.060$ |
| All Conditions | 9.0 (lower limit of hydrogen ion loading) | $Q_S \times 2.060E\text{-}3$ |

[(1)] $Q_S$ is the flow in the stream in cfs.

**Table S.4 Iron WQC and TMDL Endpoint**

| Condition | WQC, mg/L[1] | TMDL Load, pounds/day[2] |
|---|---|---|
| Chronic- aquatic life has not been shown to be adversely affected | 3.5 | $Q_S \times 18.8782$ |
| Chronic–aquatic life is adversely affected | 1.0 | $Q_S \times 5.3938$ |
| Acute | 4.0 | $Q_S \times 21.5751$ |

[1] mg/L: milligram per liter
[2] $Q_S$ is the flow in the stream in cfs.

**Table S.5 Cadmium, Copper, Lead, Nickel and Zinc WQCs and TMDL Endpoints**

| Condition | WQC[1], µg/L[2] | TMDL Load, pounds/day[3] |
|---|---|---|
| **Cadmium** | | |
| Chronic | $e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ |
| Acute | $e^{(1.0166*(\ln(hardness))-3.924)}$ | $Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ |
| **Copper** | | |
| Chronic | $e^{(0.8545*(\ln(hardness))-1.702)}$ | $Q_S \times 0.005394 \times e^{(0.8545*(\ln(hardness))-1.702)}$ |
| Acute | $e^{(0.9422*(\ln(hardness))-1.700)}$ | $Q_S \times 0.005394 \times e^{(0.9422*(\ln(hardness))-1.700)}$ |
| **Lead** | | |
| Chronic | $e^{(1.273*(\ln(hardness))-4.705)}$ | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ |
| Acute | $e^{(1.273*(\ln(hardness))-1.460)}$ | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ |
| **Nickel** | | |
| Chronic | $e^{(0.846*(\ln(hardness))+0.0584)}$ | $Q_S \times 0.005394 \times e^{(0.846*(\ln(hardness))+0.0584)}$ |
| Acute | $e^{(0.846*(\ln(hardness))+2.255)}$ | $Q_S \times 0.005394 \times e^{(0.846*(\ln(hardness))+2.255)}$ |
| **Zinc** | | |
| Chronic | $e^{(0.8473*(\ln(hardness))+0.884)}$ | $Q_S \times 0.005394 \times e^{(0.8473*(\ln(hardness))+0.884)}$ |
| Acute | $e^{(0.8473*(\ln(hardness))+0.884)}$ | $Q_S \times 0.005394 \times e^{(0.8473*(\ln(hardness))+0.884)}$ |

[1] Hardness is in units of mg/L as $CaCO_3$.
[2] µg /L: microgram per liter
[3] $Q_S$ is the flow in the stream in cfs.

**Table S.6 Net Alkalinity TMDL Endpoint**

| Condition | Net Alkalinity[1], pounds/day |
|---|---|
| All Conditions | $\geq 0$ |

[1] Net alkalinity is defined as the alkalinity in mg/L as $CaCO_3$ minus the calculated acidity; the calculated acidity is determined using the following equation: Calculated Acidity, mg/l as $CaCO_3$ = 50 × (($10^{(3\text{-pH})}$) + (3 × Fe mg/L/55.8) + (2 × Mn mg/L/54.9) + (3 × Al mg/L/27)).

**TMDL Equation and Calculations:**

A TMDL calculation is performed as follows:

$$TMDL = WLA + LA + MOS$$

Equation S.1

Where:
**TMDL:** the WQC, expressed as a load.
**MOS:** the Margin of Safety, which can be an implicit or explicit additional reduction applied to sources of pollutants that accounts for uncertainties in the relationship between effluent limits and water quality. For this TMDL, the MOS is implicit.
**WLA:** the Wasteload Allocation, which is the allowable loading of pollutants into the stream from Kentucky Pollutant Discharge Elimination System (KPDES) permitted sources.
**KPDES-WLA:** the WLA for the existing KPDES-permitted facilities which have discharge limits for the pollutants of concern.
**MS4-WLA:** the WLA for KPDES-permitted municipal separate stormwater sewer systems (MS4) (including cities, counties, roads and right-of-ways owned by the Kentucky Transportation Cabinet, universities and military bases). There is no MS4 community within this watershed area.
**LA:** the Load Allocation, which is the allowable loading of pollutants into the stream from sources not permitted by KPDES and from natural background.
**Seasonality:** yearly factors that affect the relationship between pollutant inputs and the ability of the stream to meet its designated uses.
**Critical Condition:** the time period when the pollutant conditions are expected to be at their worst.
**Existing Conditions**: the load that exists in the watershed at the time of TMDL development (i.e., sampling) and is causing the impairment.
**Load**: concentration * flow * conversion factor.
**Concentration**: colonies per 100 milliliter (*E. coli*), milligrams per liter (mg/L) (iron, alkalinity, acidity), micrograms per liter (µg/L) (cadmium, copper, lead, nickel, zinc) or standard units (pH).
**Flow (i.e., stream discharge)**: cubic feet per second (cfs).

**Table S.7 TMDLs and Allocations by Impaired Segments**

| Pollutant | Units | TMDL[(1)] | MOS[(2)] | KPDES-WLA[(3)] | LA[(4)] |
|---|---|---|---|---|---|
| **Bat East Creek 0.0 to 3.4** | | | | | |
| *E. coli* | colonies/day | $Q_S\times WQC\times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES}\times WQC\times 24{,}465{,}758.4$ | $Q_{LA}\times WQC\times 24{,}465{,}758.4$ |
| Copper (Chronic) | pounds/day | $Q_S\times 0.005394\times e^{(0.8545*(\ln(hardness))-1.702)}$ | Implicit | $Q_{KPDES}\times 0.005394\times e^{(0.8545*(\ln(hardness))-1.702)}$ | $Q_{LA}\times 0.005394\times e^{(0.8545*(\ln(hardness))-1.702)}$ |
| Copper (Acute) | pounds/day | $Q_S\times 0.005394\times e^{(0.9422*(\ln(hardness))-1.700)}$ | Implicit | $Q_{KPDES}\times 0.005394\times e^{(0.9422*(\ln(hardness))-1.700)}$ | $Q_{LA}\times 0.005394\times e^{(0.9422*(\ln(hardness))-1.700)}$ |
| Lead (Chronic) | pounds/day | $Q_S\times 0.005394\times e^{(1.273*(\ln(hardness))-4.705)}$ | Implicit | $Q_{KPDES}\times 0.005394\times e^{(1.273*(\ln(hardness))-4.705)}$ | $Q_{LA}\times 0.005394\times e^{(1.273*(\ln(hardness))-4.705)}$ |
| Lead (Acute) | pounds/day | $Q_S\times 0.005394\times e^{(1.273*(\ln(hardness))-1.460)}$ | Implicit | $Q_{KPDES}\times 0.005394\times e^{(1.273*(\ln(hardness))-1.460)}$ | $Q_{LA}\times 0.005394\times e^{(1.273*(\ln(hardness))-1.460)}$ |
| **Beech Creek 0.0 to 3.9** | | | | | |
| Cadmium (Chronic) | pounds/day | $Q_S\times 0.005394\times e^{(0.7409*(\ln(hardness))-4.719)}$ | Implicit | $Q_{KPDES}\times 0.005394\times e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_{LA}\times 0.005394\times e^{(0.7409*(\ln(hardness))-4.719)}$ |
| Cadmium (Acute) | pounds/day | $Q_S\times 0.005394\times e^{(1.0166*(\ln(hardness))-3.924)}$ | Implicit | $Q_{KPDES}\times 0.005394\times e^{(1.0166*(\ln(hardness))-3.924)}$ | $Q_{LA}\times 0.005394\times e^{(1.0166*(\ln(hardness))-3.924)}$ |
| Iron (Chronic)[(5)] | pounds/day | $Q_S\times 5.3938$ | Implicit | $Q_{KPDES}\times 5.3938$ | $Q_{LA}\times 5.3938$ |
| Iron (Acute) | pounds/day | $Q_S\times 21.575$ | Implicit | $Q_{KPDES}\times 21.575$ | $Q_{LA}\times 21.575$ |
| Nickel (Chronic) | pounds/day | $Q_S\times 0.005394\times e^{(0.846*(\ln(hardness))+0.0584)}$ | Implicit | $Q_{KPDES}\times 0.005394\times e^{(0.846*(\ln(hardness))+0.0584)}$ | $Q_{LA}\times 0.005394\times e^{(0.846*(\ln(hardness))+0.0584)}$ |
| Nickel (Acute) | pounds/day | $Q_S\times 0.005394\times e^{(0.846*(\ln(hardness))+2.255)}$ | Implicit | $Q_{KPDES}\times 0.005394\times e^{(0.846*(\ln(hardness))+2.255)}$ | $Q_{LA}\times 0.005394\times e^{(0.846*(\ln(hardness))+2.255)}$ |
| Zinc ( Acute and Chronic)[(6)] | pounds/day | $Q_S\times 0.005394\times e^{(0.8473*(\ln(hardness))+0.884)}$ | Implicit | $Q_{KPDES}\times 0.005394\times e^{(0.8473*(\ln(hardness))+0.884)}$ | $Q_{LA}\times 0.005394\times e^{(0.8473*(\ln(hardness))+0.884)}$ |
| **Boggess Creek 0.0 to 3.0** | | | | | |
| *E. coli* | colonies/day | $Q_S\times WQC\times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES}\times WQC\times 24{,}465{,}758.4$ | $Q_{LA}\times WQC\times 24{,}465{,}758.4$ |
| **Caney Creek 0.0 to 3.6** | | | | | |
| *E. coli* | colonies/day | $Q_S\times WQC\times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES}\times WQC\times 24{,}465{,}758.4$ | $Q_{LA}\times WQC\times 24{,}465{,}758.4$ |
| Cadmium (Chronic) | pounds/day | $Q_S\times 0.005394\times e^{(0.7409*(\ln(hardness))-4.719)}$ | Implicit | $Q_{KPDES}\times 0.005394\times e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_{LA}\times 0.005394\times e^{(0.7409*(\ln(hardness))-4.719)}$ |

| Pollutant | Units | TMDL[1] | MOS[2] | KPDES-WLA[3] | LA[4] |
|---|---|---|---|---|---|
| Cadmium (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | $Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ |
| **Caney Creek 3.6 to 7.6** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24{,}465{,}758.4$ | $Q_{LA} \times WQC \times 24{,}465{,}758.4$ |
| Cadmium (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ |
| Cadmium (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | $Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ |
| Lead (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ | $Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ |
| Lead (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ | $Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ |
| **Carters Creek 0.0 to 3.1** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24{,}465{,}758.4$ | $Q_{LA} \times WQC \times 24{,}465{,}758.4$ |
| **Opossum Run 0.0 to 1.6** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24{,}465{,}758.4$ | $Q_{LA} \times WQC \times 24{,}465{,}758.4$ |
| **Plum Creek 0.0 to 1.65** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24{,}465{,}758.4$ | $Q_{LA} \times WQC \times 24{,}465{,}758.4$ |
| Cadmium (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ |
| Cadmium (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | $Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ |
| **Plum Creek 1.65 to 3.9** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24{,}465{,}758.4$ | $Q_{LA} \times WQC \times 24{,}465{,}758.4$ |
| pH[7] | standard units | $6.0 \le pH \le 9.0$ | Implicit | $6.0 \le pH \le 9.0$ | $6.0 \le pH \le 9.0$ |
| Alkalinity, Acidity[8] | mg/L as $CaCO_3$ | Net Alkalinity ≥ 0 | Implicit | Net Alkalinity ≥ 0 | Net Alkalinity ≥ 0 |
| Cadmium (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ |

| Pollutant | Units | TMDL[1] | MOS[2] | KPDES-WLA[3] | LA[4] |
|---|---|---|---|---|---|
| Cadmium (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | $Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ |
| Nickel (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.846*(\ln(hardness))+0.0584)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.846*(\ln(hardness))+0.0584)}$ | $Q_{LA} \times 0.005394 \times e^{(0.846*(\ln(hardness))+0.0584)}$ |
| Nickel (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(0.846*(\ln(hardness))+2.255)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.846*(\ln(hardness))+2.255)}$ | $Q_{LA} \times 0.005394 \times e^{(0.846*(\ln(hardness))+2.255)}$ |
| Zinc ( Acute and Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.8473*(\ln(hardness))+0.884)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.8473*(\ln(hardness))+0.884)}$ | $Q_{LA} \times 0.005394 \times e^{(0.8473*(\ln(hardness))+0.884)}$ |
| **Pond Creek 0.0 to 5.0** | | | | | |
| Iron (Chronic)[9] | pounds/day | $Q_S \times 18.878$ | Implicit | $Q_{KPDES} \times 18.878$ | $Q_{LA} \times 18.878$ |
| Iron (Acute) | pounds/day | $Q_S \times 21.575$ | Implicit | $Q_{KPDES} \times 21.575$ | $Q_{LA} \times 21.575$ |
| **Pond Creek 5.0 to 7.5** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24,465,758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24,465,758.4$ | $Q_{LA} \times WQC \times 24,465,758.4$ |
| Cadmium (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ |
| Cadmium (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | $Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ |
| Iron (Chronic)[5] | pounds/day | $Q_S \times 5.3938$ | Implicit | $Q_{KPDES} \times 5.3938$ | $Q_{LA} \times 5.3938$ |
| Iron (Acute) | pounds/day | $Q_S \times 21.575$ | Implicit | $Q_{KPDES} \times 21.575$ | $Q_{LA} \times 21.575$ |
| **Pond Creek 7.5 to 11.7** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24,465,758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24,465,758.4$ | $Q_{LA} \times WQC \times 24,465,758.4$ |
| Cadmium (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ |
| Cadmium (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | $Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ |
| Iron (Chronic)[5] | pounds/day | $Q_S \times 5.3938$ | Implicit | $Q_{KPDES} \times 5.3938$ | $Q_{LA} \times 5.3938$ |

## Total Maximum Daily Load (TMDL) Synopsis

| Pollutant | Units | TMDL[1] | MOS[2] | KPDES-WLA[3] | LA[4] |
|---|---|---|---|---|---|
| Iron (Acute) | pounds/day | $Q_S \times 21.575$ | Implicit | $Q_{KPDES} \times 21.575$ | $Q_{LA} \times 21.575$ |
| **Pond Creek 11.7 to 14.4** | | | | | |
| Cadmium (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ |
| Cadmium (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | $Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ |
| Iron (Chronic)[5] | pounds/day | $Q_S \times 5.3938$ | Implicit | $Q_{KPDES} \times 5.3938$ | $Q_{LA} \times 5.3938$ |
| Iron (Acute) | pounds/day | $Q_S \times 21.575$ | Implicit | $Q_{KPDES} \times 21.575$ | $Q_{LA} \times 21.575$ |
| **Pond Creek 14.4 to 18.1** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24,465,758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24,465,758.4$ | $Q_{LA} \times WQC \times 24,465,758.4$ |
| Lead (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ | $Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ |
| Lead (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ | $Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ |
| **Pond Creek 18.1 to 18.7** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24,465,758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24,465,758.4$ | $Q_{LA} \times WQC \times 24,465,758.4$ |
| **Saltlick Creek 0.0 to 3.7** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24,465,758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24,465,758.4$ | $Q_{LA} \times WQC \times 24,465,758.4$ |
| **Sandlick Creek 0.0 to 4.05** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24,465,758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24,465,758.4$ | $Q_{LA} \times WQC \times 24,465,758.4$ |
| Iron (Chronic)[5] | pounds/day | $Q_S \times 5.3938$ | Implicit | $Q_{KPDES} \times 5.3938$ | $Q_{LA} \times 5.3938$ |
| Iron (Acute) | pounds/day | $Q_S \times 21.575$ | Implicit | $Q_{KPDES} \times 21.575$ | $Q_{LA} \times 21.575$ |
| Lead (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ | $Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ |
| Lead (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ | $Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ |

| Pollutant | Units | TMDL[1] | MOS[2] | KPDES-WLA[3] | LA[4] |
|---|---|---|---|---|---|
| **UT of Bat East Creek 0.0 to 1.9** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24{,}465{,}758.4$ | $Q_{LA} \times WQC \times 24{,}465{,}758.4$ |
| **UT of Bat East Creek 0.0 to 3.55** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24{,}465{,}758.4$ | $Q_{LA} \times WQC \times 24{,}465{,}758.4$ |
| **UT of Caney Creek 0.0 to 2.6** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24{,}465{,}758.4$ | $Q_{LA} \times WQC \times 24{,}465{,}758.4$ |
| Lead (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ | $Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ |
| Lead (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ | $Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ |
| **UT of Caney Creek 0.0 to 2.35** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24{,}465{,}758.4$ | $Q_{LA} \times WQC \times 24{,}465{,}758.4$ |
| Lead (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ | $Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ |
| Lead (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ | $Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ |
| **UT of Plum Creek 0.0 to 2.45** | | | | | |
| pH[7] | standard units | $6.0 \leq pH \leq 9.0$ | Implicit | $6.0 \leq pH \leq 9.0$ | $6.0 \leq pH \leq 9.0$ |
| Alkalinity, Acidity[8] | mg/L as $CaCO_3$ | Net Alkalinity ≥ 0 | Implicit | Net Alkalinity ≥ 0 | Net Alkalinity ≥ 0 |
| Cadmium (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ |
| Cadmium (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | $Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ |
| Iron (Chronic)[5] | pounds/day | $Q_S \times 5.3938$ | Implicit | $Q_{KPDES} \times 5.3938$ | $Q_{LA} \times 5.3938$ |
| Iron (Acute) | pounds/day | $Q_S \times 21.575$ | Implicit | $Q_{KPDES} \times 21.575$ | $Q_{LA} \times 21.575$ |
| Nickel (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.846*(\ln(hardness))+ 0.0584)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.846*(\ln(hardness))+ 0.0584)}$ | $Q_{LA} \times 0.005394 \times e^{(0.846*(\ln(hardness))+ 0.0584)}$ |

## Total Maximum Daily Load (TMDL) Synopsis

| Pollutant | Units | TMDL(1) | MOS(2) | KPDES-WLA(3) | LA(4) |
|---|---|---|---|---|---|
| Nickel (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(0.846*(\ln(hardness))+2.255)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.846*(\ln(hardness))+2.255)}$ | $Q_{LA} \times 0.005394 \times e^{(0.846*(\ln(hardness))+2.255)}$ |
| Zinc ( Acute and Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.8473*(\ln(hardness))+0.884)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.8473*(\ln(hardness))+0.884)}$ | $Q_{LA} \times 0.005394 \times e^{(0.8473*(\ln(hardness))+0.884)}$ |
| **UT of Pond Creek 0.0 to 2.4** | | | | | |
| Iron (Chronic)(5) | pounds/day | $Q_S \times 5.3938$ | Implicit | $Q_{KPDES} \times 5.3938$ | $Q_{LA} \times 5.3938$ |
| Iron (Acute) | pounds/day | $Q_S \times 21.575$ | Implicit | $Q_{KPDES} \times 21.575$ | $Q_{LA} \times 21.575$ |
| **UT of Pond Creek 2.4 to 4.2** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24{,}465{,}758.4$ | $Q_{LA} \times WQC \times 24{,}465{,}758.4$ |
| Cadmium (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ |
| Cadmium (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | $Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ |
| pH(7) | standard units | $6.0 \leq pH \leq 9.0$ | Implicit | $6.0 \leq pH \leq 9.0$ | $6.0 \leq pH \leq 9.0$ |
| Alkalinity, Acidity(8) | mg/L as $CaCO_3$ | Net Alkalinity ≥ 0 | Implicit | Net Alkalinity ≥ 0 | Net Alkalinity ≥ 0 |
| **UT of Pond Creek 0.0 to 1.4** | | | | | |
| Cadmium (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ |
| Cadmium (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | $Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ |

(1) TMDLs for *E. coli* are expressed as the flow in the stream, $Q_S$ in $ft^3/s$, multiplied by the WQCs: i) 240 *E. coli* colonies/100 ml which must be met in at least 80% of all samples taken within a 30-day period during the Primary Contact Recreational season of May through October; ii) 130 *E. coli* colonies/100 ml as a geometric mean based on not less than 5 samples taken within a 30-day period during the Primary Contact Recreational season of May through October. Then the multiple of Qs and WQC is converted into *E. coli* load (colonies/day) by multiplying the conversion factor of 24,465,758.4. TMDLs for metals are expressed as the flow in the stream, $Q_S$ in $ft^3/s$, multiplied by the WQC in mg/L or µg/L and the appropriate conversion factor to convert the multiple of flow and the WQC into to units of load (pounds/day). The conversion factors are: iron, chronic = 5.3938 (when the WQC of 1.0 mg/L is applied) or 18.8782 (when the WQC of 3.5 mg/L is applied); iron, acute = 21.575; cadmium, copper, lead, nickel and zinc, chronic and acute = 0.005394. Also, pH must remain between 6.0 and 9.0 standard units, inclusive.

(2) The MOS is implicit, see Section 7.3.

(3) The KPDES-WLA for *E. coli* is expressed as the flow in the stream due to KPDES-permitted sources with *E. coli* permit limits, $Q_{KPDES}$ in $ft^3/s$, multiplied by the WQCs and the conversion factor to convert the multiple of flow and the WQC into the unit of load (colonies/day). All KPDES-permitted dischargers must meet both

instantaneous and geomean *E. coli* WQCs. The KPDES-WLA for metals is expressed as the flow in the stream due to KPDES-permitted sources with permit limits for the pollutants addressed by this TMDL, $Q_{KPDES}$, in $ft^3/s$, multiplied by the WQC and the appropriate conversion factor. All KPDES-permitted dischargers must meet both the chronic and acute criteria for pollutants addressed by this TMDL whose WQCs are expressed in both chronic and acute terms. New or expanded KPDES-permitted dischargers with reasonable potential will be allowed contingent upon them meeting WQCs of the pollutants addressed in this document.

(4) The LA is expressed as the flow in the stream from natural background or due to legal but non-KPDES-permitted sources of the pollutants addressed by this TMDL, $Q_{LA}$, in $ft^3/s$, multiplied by the WQC and the appropriate conversion factor, see Section 5.2.

(5) The chronic iron WQC is 1.0 mg/L since the aquatic life is adversely affected. The acute iron WQC is not dependent on impacts to aquatic life; it is 4.0 mg/L in all streams.

(6) The chronic and acute WQCs for zinc are identical.

(7) pH can be converted to a range of allowable loads of hydrogen ions in units of g/day (gram per day); a pH of 6.0 represents a maximum allowable load of hydrogen ions equal to $Q_S \times 2.906$ g/day, and a pH of 9.0 represents a minimum allowable load of $Q_S \times 2.906E\text{-}3$ g/day, where $Q_S$ is the flow in the stream in $ft^3/s$. The TMDL can then be allocated to the KPDES-WLA and the LA based on the fraction of the streamflow each contributes.

(8) Net alkalinity is defined as the alkalinity in mg/L as $CaCO_3$ minus the calculated acidity; the calculated acidity is determined using the following equation: Calculated Acidity, mg/L as $CaCO_3 = 50 \times ((10^{(3-pH)}) + (3 \times \text{Fe mg/L}/55.8) + (2 \times \text{Mn mg/L}/54.9) + (3 \times \text{Al mg/L}/27))$. Monitoring and reporting of net alkalinity will be required both instream and at outfalls at the same frequency as iron and manganese are monitored and reported. Aluminum must be added to KPDES mining permits as report-only in order to determine the calculated acidity. Net alkalinity must be greater than or equal to zero (in both mg/L and pounds/day) in order to buffer metals hydrolysis which can lower pH below acceptable levels.

(9) The chronic iron WQC is 3.5 mg/L since the aquatic life has not been shown to be adversely affected. The acute iron WQC is not dependent on impacts to aquatic life; it is 4.0 mg/L in all streams.

**Translation of WLAs into Permit Limits**

All KPDES- permitted facilities must meet permit limits based on the Water Quality Standards in 401 KAR 10:031. WLAs will be translated into KPDES permit limits as

1. an *E. coli* effluent gross limit of 130 colonies/100 ml as a monthly average and 240 colonies/100 ml as a maximum weekly average;
2. a pH effluent gross limit of between 6.0 and 9.0 standard units and shall not change more than 1.0 standard unit over a period of 24 hours;
3. a chronic iron (Fe) effluent gross limit of 1.0 mg/L if aquatic life is adversely affected and of 3.5 mg/L if aquatic life has not been shown to be adversely affected, and an acute iron effluent gross limit of 4.0 mg/L;
4. a chronic cadmium (Cd) effluent gross limit of $e^{(0.7409*(\ln(\text{hardness}))-4.719)}$ µg/L and $e^{(1.0166*(\ln(\text{hardness}))-3.924)}$ µg/L as an acute limit;
5. a chronic copper (Cu) effluent gross limit of $e^{(0.8545*(\ln(\text{hardness}))-1.702)}$ µg/L and $e^{(0.9422*(\ln(\text{hardness}))-1.700)}$ µg/L as an acute limit;
6. a chronic lead (Pb) effluent gross limit of $e^{(1.273*(\ln(\text{hardness}))-4.705)}$ µg/L and $e^{(1.273*(\ln(\text{hardness}))-1.460)}$ µg/L as an acute limit;
7. a chronic nickel (Ni) effluent gross limit of $e^{(0.846*(\ln(\text{hardness}))+0.0584)}$ µg/L and $e^{(0.846*(\ln(\text{hardness}))+2.255)}$ µg/L as an acute limit;
8. a chronic and acute zinc (Zn) effluent gross limits are identical as of $e^{(0.8473*(\ln(\text{hardness}))+0.884)}$ µg/L.

The WLA for the KPDES permittees which only contain requirements to develop a Stormwater Pollution Prevention Plan (SWPPP) will be addressed through possible revision and implementation of a SWPPP. The KYG050000 (Inactive Mine Lands General Permit) permittees are in compliance if they comply with the permit. KPDES mining permittees must meet the discharge limits set in their KPDES permits.

The following changes to KPDES mining permittees who discharge to a waterbody with a pH TMDL addressed by this document are required:

1. Permittees must report alkalinity in mg/L as $CaCO_3$ and aluminum in units of mg/L whenever and wherever iron and manganese are reported. However, for aluminum this is report-only, no discharge limit is established.
2. There must be sufficient net alkalinity present to buffer metals hydrolysis whenever and wherever iron and manganese are reported. Net alkalinity is defined as the alkalinity of the discharge water minus the calculated acidity; net alkalinity must be greater than or equal to zero. The calculated acidity will be determined using Equation S.2, from Hedin *et al*. (1991), which conservatively assumes iron is in the form of $Fe^{3+}$:

$$\text{Calculated Acidity, mg/L as } CaCO_3 = 50 \times ((10^{(3\text{-pH})}) + (3 \times \text{Fe mg/L}/55.8) + (2 \times \text{Mn mg/L}/54.9) + (3 \times \text{Al mg/L}/27.0))$$

Equation S.2

If the net alkalinity is below zero, then a violation has occurred.

These changes will be made to the existing mining permittees who discharge to a waterbody with a pH TMDL addressed by this document when their permits are renewed. These requirements apply to any new or expanded mining permits which discharge to a waterbody with a pH TMDL addressed by this document.

Table S.8 lists the KPDES permittees within the Pond Creek watershed, with the KPDES number, permittee name, permittee status (as of June 2016), permittee location and the pollutant (addressed in this TMDL only) limits in their permits or the requirements in the permits. The permittees, which are inactive, were active during the data collection period and contributed to the impairment; those permittees will not receive a WLA.

**Table S.8 KPDES Permittees within the Pond Creek Watershed**

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutant Limits/Requirement in the Permit |
|---|---|---|---|---|---|---|
| KY0020010 | Greenville STP | Yes | 1.31 | 37.219167 | -87.169444 | bacteria, pH, Cd, Cu, Pb, Zn |
| KY0066575 | Drakesboro STP | Yes | 0.165 | 37.217222 | -87.040833 | bacteria, pH, Cd, Cu, Pb, Zn |
| KY0108537 | Shaunaco LLC (889-0145) | Yes | 0 | 37.228611 | -87.218889 | pH, Cd, Cu, Fe, Pb, Ni, Zn |
| KY0109606 | Greenville Bulk Plant | Yes | 0 | 37.212500 | -87.184700 | pH |
| KY0111996 | Oxford Mining Co Kentucky LLC (889-0153) | Yes | 0 | 37.265000 | -87.094056 | pH, Fe |
| KYG045755 | Oxford Mining Co Ky LLC (889-0156) | Yes | 0 | 37.179722 | -87.113889 | pH, Fe |
| KYG046498 | Oxford Mining Co Kentucky LLC (889-0153) | Yes | 0 | 37.265000 | -87.094056 | pH, Fe |
| KYG640029 | Central City Water & Sewer | Yes | 0.0005 | 37.173800 | -87.073000 | pH, Fe |
| KYG640108 | Greenville Utilities Commission | Yes | 0.027 | 37.113900 | -87.103200 | pH, Fe |
| KYGW40011 | Thoroughfare Mining LLC (889-5018) | Yes | 0 | 37.294720 | -87.053060 | bacteria, pH, Fe |
| KYGW40062 | Armstrong Coal Co Inc (Consolidated) | Yes | 0 | 37.294990 | -87.052770 | pH, Fe |
| KYP000064 | Powderly, City of | Yes | 0 | 37.235833 | -87.163889 | discharge to Greenville WWTP |
| KYR003239 | Central Pallet Mills | Yes | 0 | 37.237167 | -87.121083 | pH and to develop a SWPPP |
| KYR004015 | Carl Mitchell & Son Implement - Paradise Rd | Yes | 0 | 37.238014 | -87.120822 | pH and to develop a SWPPP |

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutant Limits/Requirement in the Permit |
|---|---|---|---|---|---|---|
| KYR004021 | Harsco Minerals | Yes | 0 | 37.230667 | -87.038861 | pH and to develop a SWPPP |
| KYR10J469 | Muhlenberg County Airport | Yes | 0 | 37.222067 | -87.164333 | to develop a SWPPP |
| KYR10K083 | Owensboro Health Greenville Clinic | Yes | 0 | 37.196391 | -87.187716 | to develop a SWPPP |
| KYR10K315 | Western Kentucky Lateral | Yes | 0 | 37.209464 | -87.209069 | to develop a SWPPP |
| KYR10K433 | Owensboro Health Muhlenberg Healthplex | Yes | 0 | 37.238889 | -87.150189 | to develop a SWPPP |
| KY0023329 | Bremen Consolidated School | No | 0.008 | 37.214000 | -87.132800 | bacteria |
| KY0099538 | Texas Gas Transmission LLC - West Greenville | No | 0 | 37.211111 | -87.206944 | pH |
| KY0106046 | C & R Coal Co Inc (889-0151) | No | 0 | 37.208333 | -87.090000 | pH, Fe |
| KY0107701 | Armstrong Coal Co Inc (889-5014) | No | 0 | 37.298889 | -87.059167 | pH, Cd, Cu, Fe, Pb, Ni, Zn |
| KYG043169 | Black Hills Coal Inc (889-7010) | No | 0 | 37.211111 | -87.228611 | pH, Fe |
| KYG043563 | Beech Creek Energy Inc (889-0062) | No | 0 | 37.196944 | -87.051389 | pH, Fe |
| KYG043825 | Muhlenberg Coals Inc (889-0066) | No | 0 | 37.250278 | -87.068889 | pH, Fe |
| KYG044318 | Armstrong Coal Co Inc (889-0138) | No | 0 | 37.294167 | -87.043333 | pH, Fe |
| KYG044386 | Beech Creek Energy Inc (889-0062) | No | 0 | 37.196944 | -87.051389 | pH, Fe |
| KYG044486 | G & G Energies Inc (889-0074) | No | 0 | 37.170457 | -87.194335 | pH, Fe |
| KYG044573 | Friendship Energy Inc (889-0079) | No | 0 | 37.217528 | -87.175069 | pH, Fe |
| KYG044789 | Beech Creek Energy Inc (889-0084) | No | 0 | 37.170833 | -87.056111 | pH, Fe |

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutant Limits/Requirement in the Permit |
|---|---|---|---|---|---|---|
| KYG044998 | Beech Creek Energy Inc (889-0093) | No | 0 | 37.186944 | -87.070556 | pH, Fe |
| KYG045704 | Schoate Mining Co LLC (889-0155) | No | 0 | 37.245000 | -87.108333 | pH, Fe |
| KYG046025 | C & R Coal Co Inc (889-0126) | No | 0 | 37.178333 | -87.092778 | pH, Fe |
| KYG046026 | C & R Coal Co Inc (889-0122) | No | 0 | 37.175833 | -87.086944 | pH, Fe |
| KYG046617 | Armstrong Coal Co Inc (889-9005) | No | 0 | 37.290278 | -87.060278 | pH, Fe |
| KYG046775 | Armstrong Coal Co Inc (889-5014) | No | 0 | 37.295000 | -87.053600 | pH, Fe |
| KYR000524 | Central Pallet Mill Inc | No | 0 | 37.220000 | -87.118333 | pH and to develop a SWPPP |
| KYR000918 | Harsco Minerals | No | 0 | 37.230667 | -87.038861 | pH and to develop a SWPPP |
| KYR001665 | Carl Mitchell & Son Implement | No | 0 | 37.239428 | -87.121152 | pH and to develop a SWPPP |
| KYR001693 | Meuth Construction Supply | No | 0 | 37.243362 | -87.085699 | pH and to develop a SWPPP |
| KYR00A008 | Reed Minerals | No | 0 | 37.230667 | -87.038861 | pH and to develop a SWPPP |
| KYR00A009 | Reed Minerals | No | 0 | 37.230667 | -87.038861 | pH and to develop a SWPPP |
| KYR10E810 | Muhlenberg Co High School Phas 3 | No | 0 | 37.216500 | -87.189224 | to develop a SWPPP |
| KYR10E960 | Muhlenberg County Emergency SE | No | 0 | 37.235680 | -87.151550 | to develop a SWPPP |
| KYR10F821 | Muhlenberg Co High School | No | 0 | 37.218839 | -87.189686 | to develop a SWPPP |
| KYR10G145 | Greenville WWTP | No | 0 | 37.220472 | -87.169111 | to develop a SWPPP |
| KYR10G154 | Knight Construction & Excavating Inc | No | 0 | 37.212776 | -87.196388 | to develop a SWPPP |
| KYR10G285 | Pogue Chrysler | No | 0 | 37.229353 | -87.157828 | to develop a SWPPP |
| KYR10G428 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G429 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |

## Total Maximum Daily Load (TMDL) Synopsis

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutant Limits/Requirement in the Permit |
|---|---|---|---|---|---|---|
| KYR10G456 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G458 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G631 | US 62 - Muhlenberg Co | No | 0 | 37.198889 | -87.178333 | to develop a SWPPP |
| KYR10G632 | US 62 - Muhlenberg Co | No | 0 | 37.198889 | -87.178333 | to develop a SWPPP |
| KYR10H138 | Muhlenberg Co High School | No | 0 | 37.218839 | -87.189686 | to develop a SWPPP |
| KYR10H705 | Muhlenberg County Park Phase I | No | 0 | 37.226610 | -87.187427 | to develop a SWPPP |
| KYR10I149 | Pogue Electric Service Inc. | No | 0 | 37.224749 | -87.172138 | to develop a SWPPP |
| KYG044105 | Cleaton Coal Co (889-5014) | No | 0 | 37.298889 | -87.059167 | pH, Fe |
| KYG050000* | N/A | N/A | N/A | N/A | N/A | N/A |

* KYG050000 is the Inactive Mine Lands General Permit, see Section 1 of the KPDES Permit KYG050000 for more information regarding the permit coverage eligibility and exclusions. As long as the permittees make good faith effort to comply with the permit, they are considered to be compliant with the TMDL.
N/A: Not Applicable

# 1.0 Introduction

Section 303(d) of the Clean Water Act (CWA) requires States to identify waterbodies within their boundaries that have been assessed and are not currently meeting their designated uses (401 KAR 10:026 and 10:031) and that require the development of Total Maximum Daily Loads (TMDLs). States must establish a priority ranking for such waters, taking into account their intended uses and the severity of pollutants. Section 303(d) also requires that States provide a list of this information called the 303(d) list. This list is submitted to the Environmental Protection Agency (EPA) during even-numbered years and each submittal replaces the previous list.

States are also required to develop TMDLs for pollutants that cause each waterbody to fail to meet its designated uses. The TMDL process establishes the allowable amounts (i.e. "load") of pollutants the waterbody can naturally assimilate while continuing to meet the water quality criteria (WQC) for each designated use. A pollutant load must be established at a level necessary to implement the applicable WQC with seasonal variations and a Margin of Safety (MOS) that takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality. This load is then divided among different sources of the pollutant in a watershed. Information on TMDLs from EPA can be found at: http://www.epa.gov/owow/tmdl.

# 2.0 Problem Definition

Pond Creek watershed is located in the United States Geological Survey (USGS) 8-digit hydrologic unit code (HUC) 05110003 and is designated with a 10-digit HUC 0511000304. Pond Creek is approximately 22 miles long and drains an area of 127 square miles, flowing into the Green River near Rockport, Kentucky. Major tributaries in the Pond Creek watershed include Bat East Creek, Beech Creek, Caney Creek, Plum Creek, Saltlick Creek, and Sandlick Creek.

## 2.1 303(d) Listing History

Monitoring of Pond Creek and its tributaries was conducted at 14 locations by the KDOW, Murray State University (MSU) and Western Kentucky University (WKU) between 1997 and 2001 and in 2006, see Figure 4.1 and Table 4.1. The monitoring efforts determined that thirteen waterbodies within the Pond Creek watershed did not support their designated uses for warm water aquatic life and/or primary and secondary contact recreation. Those waterbodies were listed as impaired on the 2010 303(d) list (KDOW 2010).

Since November 2010, KDOW TMDL monitoring staff revisited the Pond Creek watershed at 26 sites on Pond Creek and its tributaries. The most recent monitoring results revealed additional impaired segments or additional pollutants for existing impaired segments. The new impairments were included in the 2014 303(d) List (KDOW 2014). Some segments listed in 2010 303(d) have different River Miles (RMs) on the 2014 303(d) list due to more accurate National Hydrology Data (NHD). However, the physical stream segments and GNIS numbers are the same.

The TMDL monitoring staff collected more data on 20 of 26 sites since the 2014 303(d) List, and the new impairments will be included in the 2016 303(d) List, see Table S.1.

## 2.2 TMDLs in the Watershed

The CWA requires states to develop TMDLs for pollutants that cause each waterbody to fail to meet its designated uses. Two pH TMDLs were developed for this watershed and approved by EPA:

1. The Beech Creek pH TMDL addressed one segment, Beech Creek 0.0 to 3.9, and was approved by EPA in 2006 (KDOW 2006).
2. The Pond Creek pH TMDL addressed four pH-impaired segments: Pond Creek 9.4-13.6, Pond Creek 13.6-16.3, Pond Creek 16.3-20.0 and Pond Creek 20.0-23.8. The document was approved by EPA in 2007 (KDOW 2007).

This document addresses bacteria, pH and metals (cadmium, copper, iron, lead, nickel and zinc) for 25 impaired waterbodies. Table S.1 shows the segments and pollutants addressed in this TMDL document. KDOW also developed a Health Report for Pond Creek watershed including information on these and other pollutants, which can be accessed at http://water.ky.gov/waterquality/TMDL%20Health%20Reports/Pond%20Creek%20Watershed%20Health%20Report.pdf

# 3.0 Physical Setting

The Pond Creek watershed is located in central Muhlenberg County, Kentucky (Figure S.1). Its catchment area is approximately 127 square miles. Pond Creek is approximately 22 miles long and flows into Green River near Rockport, Kentucky. Pond Creek is a 5$^{th}$ order stream with 257 miles of tributaries based on the 1:24,000-scale NHD.

## 3.1 Geology

Pond Creek watershed lies within the Western Coal Field ecoregion of the Interior River Valleys and Hills Level III ecoregion (Woods *et al*., 2002). It is underlain primarily by the Carbondale Formation of Middle Pennsylvanian age, Quaternary Alluvium, the Tradewater Formation of Middle to Lower Pennsylvanian age, and the Shelburn Formation of Upper Pennsylvanian age (KGS, 2004), see Figure 3.1.

Coal beds in the watershed include the Baker (also known as the Western Kentucky (WKY) Coal Bed Number 13, or WKY#13), Bancroft, Coiltown (WKY#14), Davis (WKY#6), Springfield (WKY#9), DeKoven (WKY#7) Herrin (WKY#11), Paradise (WKY#12), and the Mannington, Mining City, and Lewisport (WKY#4), and an unnamed coal bed, see Figure 3.2.

The sulfur content of coal, mostly from pyrite, is responsible for the production of sulfuric acid once the spoils are exposed to water and oxygen. Sulfuric acid is the predominant acid type in Acid Mine Drainage (AMD) although not all coal mining produces AMD that affects streams, see Section 5.1.2.1. The sulfur content of coal usually varies spatially, but any coal with average sulfur content of greater than or equal to 2.5% is considered to be high in sulfur (Jacobsen, 1993). The sulfur contents of the coal seams mined within the TMDL watershed are shown in Table 3.1.

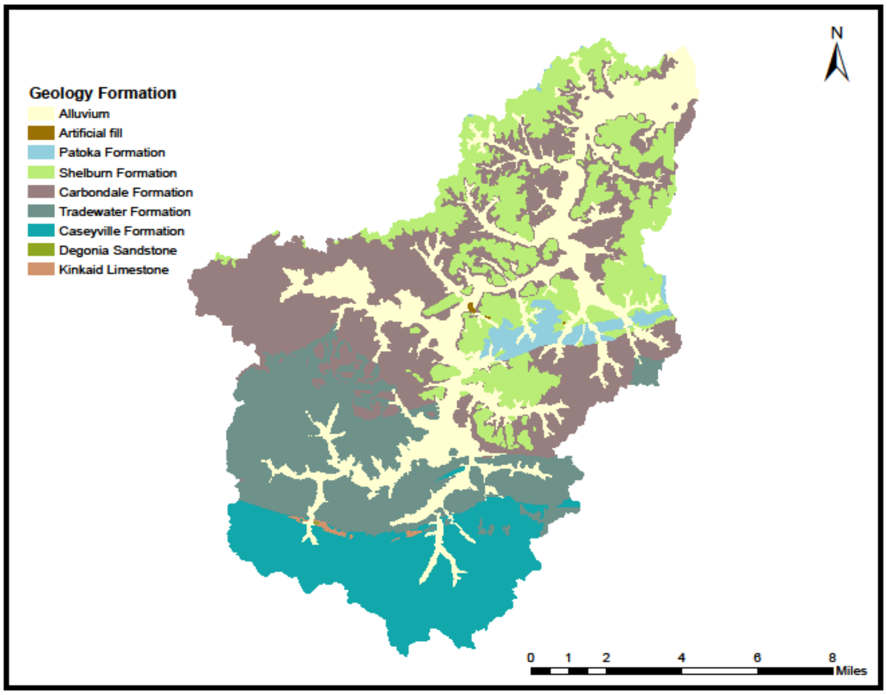


**Figure 3.1 Generalized Geology within the Pond Creek Watershed**

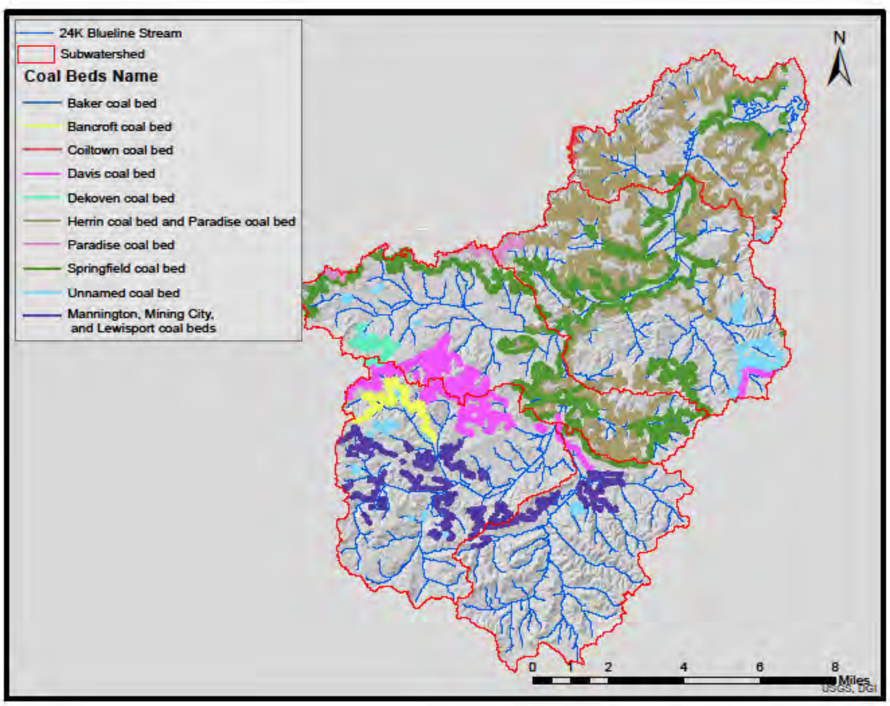


**Figure 3.2 Mapped Coal Beds within the Pond Creek Watershed**

**Table 3.1 Average Total Sulfur Percentages for Coal Beds in the TMDL Watershed**

| Coal Bed | Average Total Sulfur, % | Source |
|---|---|---|
| Mannington, Mining City, and Lewisport (WKY#4) | 3.01 | Greb, Williams, Williamson (1992) |
| Springfield (WKY#9) | 3.3 | Greb, Williams, Williamson (1992) |
| Herrin (WKY#11) | 3.98 | Greb, Williams, Williamson (1992) |
| Davis (WKY#6) | 2.9 | Greb, Williams, Williamson (1992) |
| Coiltown (WKY#14) | 3.2 | Greb, Williams, Williamson (1992) |
| DeKoven (WKY#7) | 3.7 | Jacobsen (1993) |
| Paradise (WKY#12) | 3.3, 2.0 | KGS (Proximate Analysis Downloaded 4/17/2014) Greb, Williams, Williamson (1992) |
| Bancroft | NI(1) | |
| Baker (WKY#8b) | 3.5 | Greb, Williams, Williamson (1992) |
| (1)No information. | | |

No information was found for the Bancroft coal bed, but Greb *et al*. (1992) state "the coal of the Western Kentucky Coal Field is characterized as high-sulfur coal. Although coal with medium to even low sulfur contents occurs in the coal field, the majority of the coal produced is high in sulfur content. The average sulfur contents of the seven coal beds with the largest resources are all more than 3 percent."

The range of soil pH value in the watershed is from 3.8 to 6.7, see Figure 3.3. The soil pH is lower in the upstream area with the values less than 5, while it's around 6 in downstream area. Table 3.2 displays the statistical summary for ambient soil inorganic chemicals in Kentucky (KDEP, 2004).

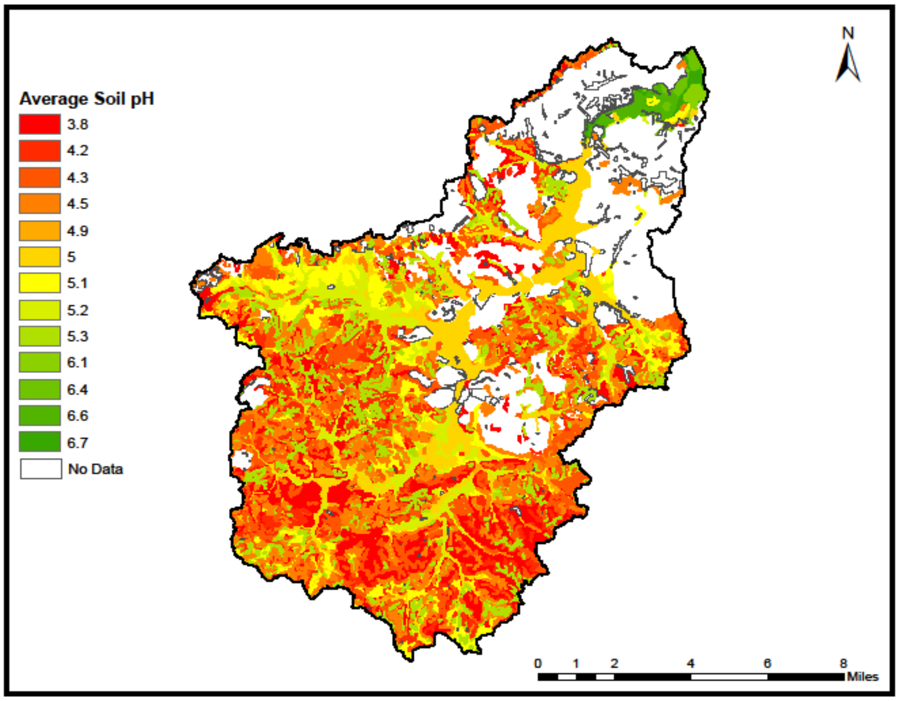


**Figure 3.3 Average Soil pH Value within the Pond Creek Watershed**

**Table 3.2 Kentucky Statewide Summary Statistics for Ambient Soil Inorganic Chemicals**

| Element | Number of Samples | Range (mg/kg) | Mean (mg/kg) | Standard Deviation (mg/kg) |
|---|---|---|---|---|
| Cadmium | 701 | 0.004 - 9.46 | 0.68 | 1.4 |
| Copper | 729 | 0.49 - 636 | 18.9 | 39.7 |
| Iron | 697 | 222 - 86,900 | 22456 | 13269.7 |
| Lead | 808 | 0.03 - 284 | 30 | 31.3 |
| Nickel | 716 | 0.39 - 83.7 | 20.9 | 13.1 |
| Zinc | 721 | 6 - 470 | 55 | 46.3 |

Geologic faults occur in the Pond Creek watershed. Springs are common in the watershed. Pond Creek is not prone to karst development throughout the majority of the watershed, although moderate potential for karst occurs near the headwaters, see Figure 3.4.

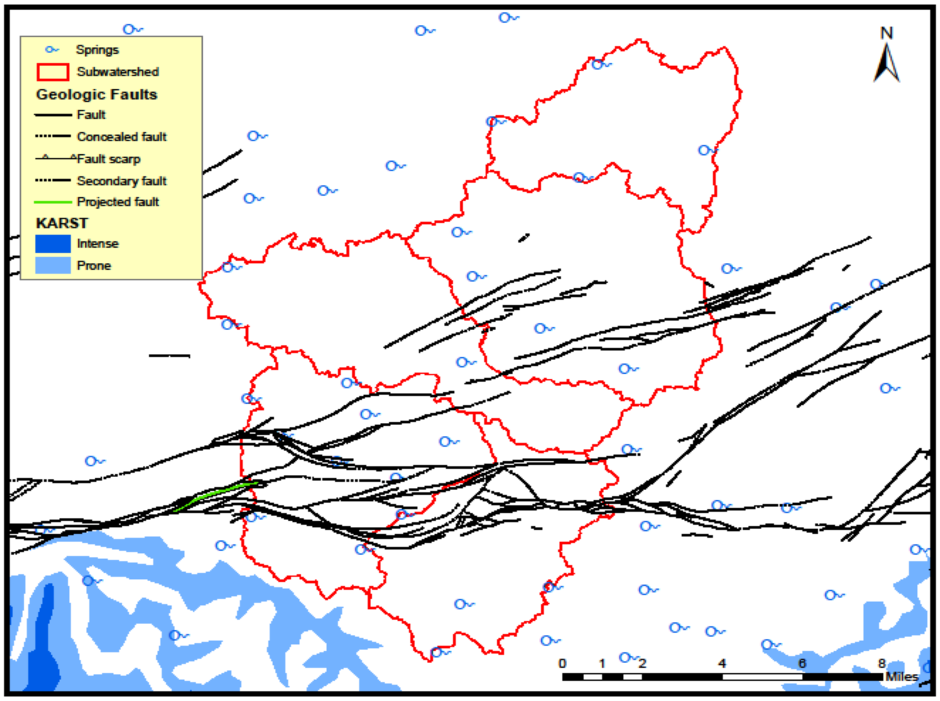


**Figure 3.4 Geologic Faults, Springs, and Karst within the Pond Creek Watershed**

The whole Pond Creek watershed is rated as 3 in groundwater sensitivity see Figure 3.5. Because much of the watershed is underlain by soluble carbonate rocks where dissolution fractures can develop, groundwater in the watershed is susceptible to contamination from surface activities. Dye traces have not been conducted in this watershed. Dye traces would provide data to understand connections between karst features and underground flow routes.

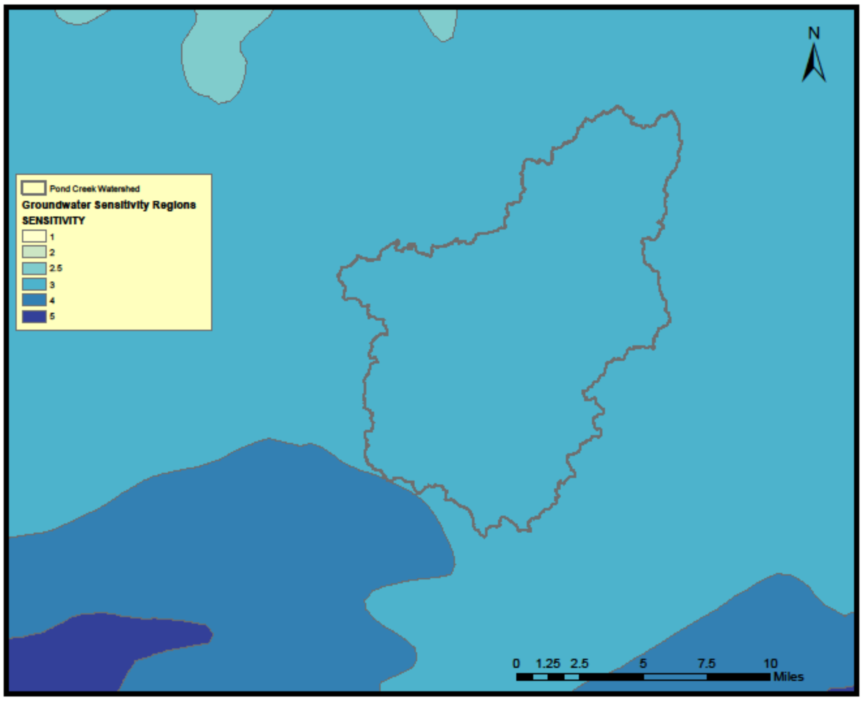


**Figure 3.5 Groundwater Sensitivity Regions Map**

Soil erosion and runoff due to precipitation can both move pollutants to a stream or to groundwater. Figure 3.6 shows the hydrologic soil groups (HSG) in the Pond Creek watershed. The HSG is used to relay information about the runoff potential of a soil when thoroughly wet. For runoff potential, ratings are low, moderately low, moderately high, and high for HSGs A, B, C and D, respectively (United Stated Department of Agriculture – Natural Resources Conservation Service (USDA-NRCS, 2009). Dual HSGs (A/D, B/D, and C/D) are given for certain wet soils that could be adequately drained. The first letter applies to the drained and the second to the undrained condition. Soils are assigned to dual groups if the depth to a Permanent water table is the sole criteria for assigning a soil to hydrologic group D (USDA-NRCS, 2009). One third of the Pond Creek watershed, mostly in the downstream portion, is not rated in terms of hydrologic soil groupings. For the rated area, the dominant HSG is C, which indicates that this watershed has moderately high runoff potential.

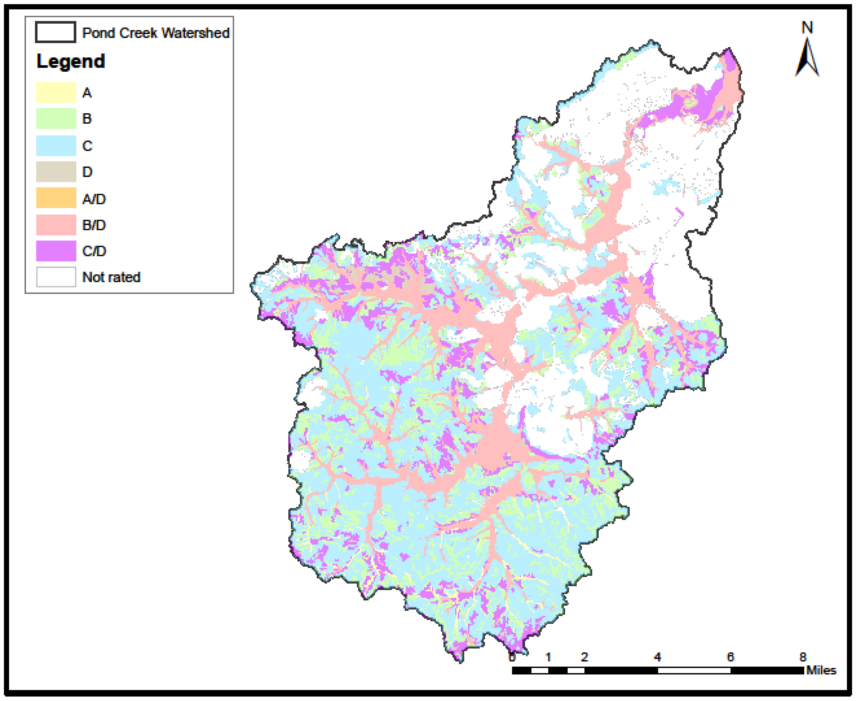


**Figure 3.6 Soil Hydrology Group in the Pond Creek Watershed**

The USDA-NRCS rates the performance of septic tank absorption fields, defined as the area in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Soil ratings are based on soil properties, site features, and the observed performance of the soils. Parameters such as permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of septic tank effluents. One third of the Pond Creek watershed, mostly in the downstream portion, is not rated. The majority of the rest of the watershed is rated as very limited in terms of septic tank absorption suitability, see Figure 3.7.

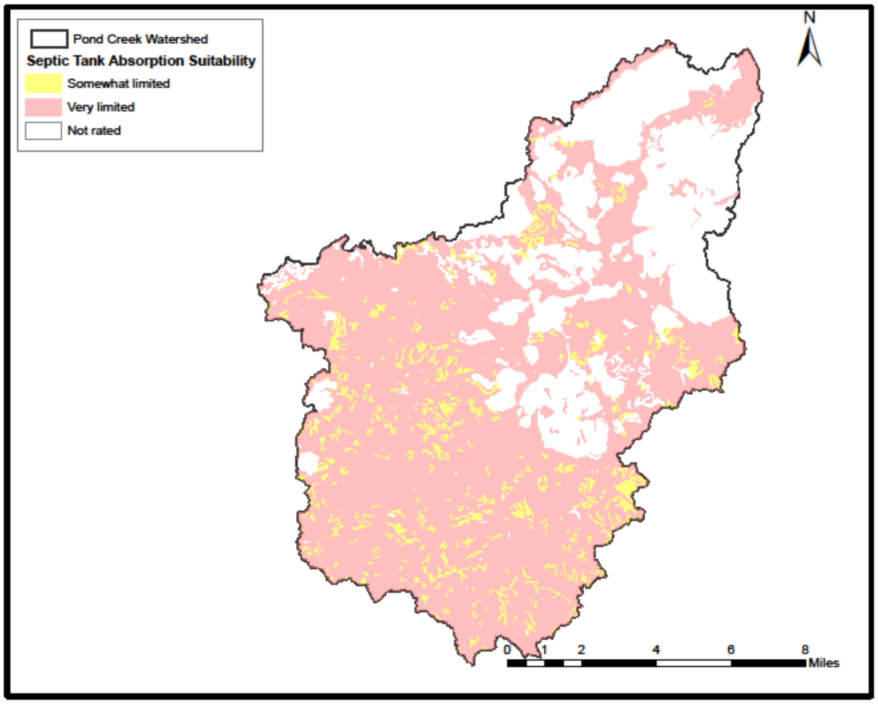


**Figure 3.7 Soil Suitability for Septic Tanks in the Pond Creek Watershed**

## 3.2 Hydrology

Stream orders were mapped using the 1:00,000-scale NHD, see Figure 3.8. Stream order was determined using the Strahler (1952) method. These streams are generally low-gradient with wetlands along portions of their lengths.

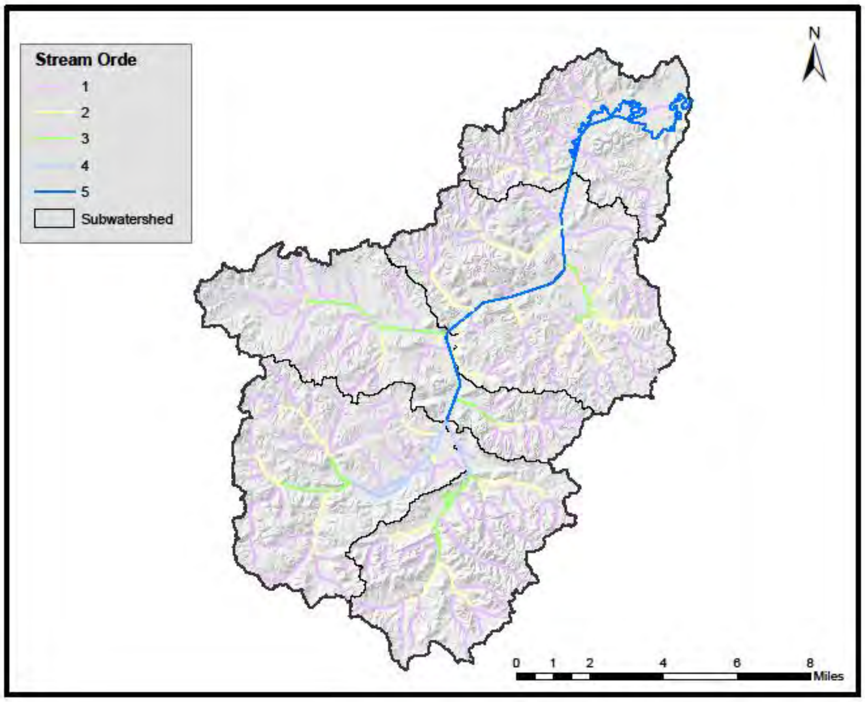


**Figure 3.8 Stream Orders within the Pond Creek Watershed**

Due to the lack of environmental controls during the period prior to the passage of the 1977 SMCRA (see Section 9.4.2), watershed areas must be considered approximate wherever coal operations exist from this era, as often large portions of watersheds had their drainage rerouted, and mapped boundaries may therefore be incorrect. Current mining permits require the return of the area mined to the Approximate Original Contour, reducing or eliminating the impact on watershed boundaries.

## 3.3 Land Cover Distribution

The 2011 National Land Cover Dataset (NLCD, 2011) was used to determine the land cover within the Pond Creek watershed. The NLCD Land Cover Class Definitions are in Appendix A. Table 3.3 lists the percent land cover by class within the watershed. To simplify the pollutant source analysis, some similar land cover categories were combined. All forested land (deciduous, evergreen and mixed) was aggregated and reported as one category - Forest; all residential land cover was aggregated and reported as one category - Developed; all wetland types were aggregated and reported as one category - Wetlands; and all agricultural land uses were aggregated into one category – Agriculture. Individual land covers are also presented in Figure 3.9.

The watershed land cover consists primarily of forest land (50.3%) and agriculture land (28.1%), see Table 3.3 and Figure 3.9.

**Table 3.3 Land Cover within the Pond Creek Watershed (NLCD 2011)**

| Land Cover | % of Total Area | Square Miles |
|---|---|---|
| Developed | 7.0 | 8.95 |
| Water | 2.1 | 2.61 |
| Barren Land | 0.6 | 0.72 |
| Forest | 50.3 | 64.00 |
| Grassland | 8.6 | 10.93 |
| Agriculture | 28.1 | 35.78 |
| Pasture/Hay | 18.5 | 23.54 |
| Cultivated Crops | 9.6 | 12.24 |
| Wetland | 3.0 | 3.88 |
| Shrub/Scrub | 0.2 | 0.31 |

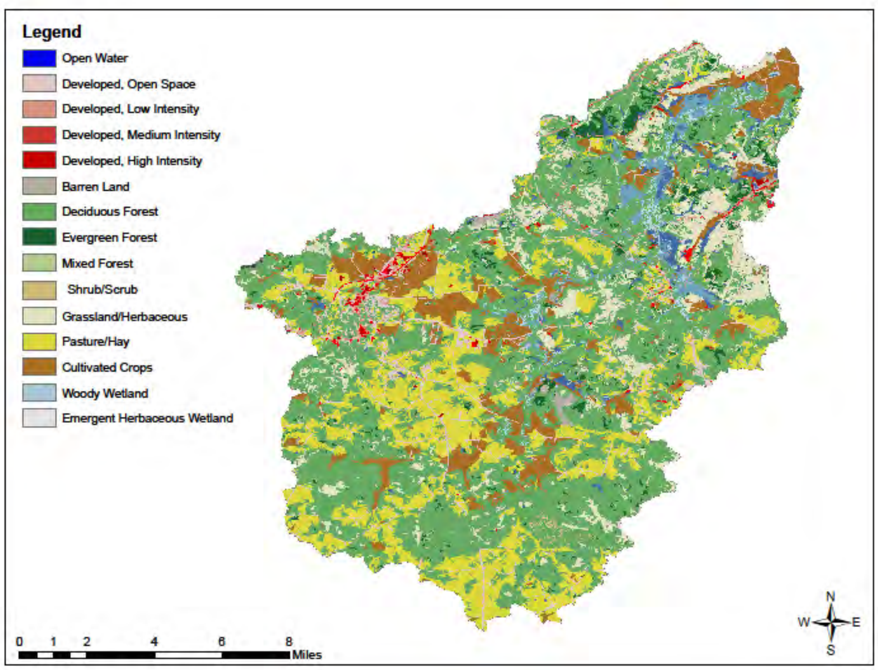


**Figure 3.9 Land Cover within the Pond Creek Watershed (NLCD 2011)**

## 3.4 Mining Activity

Mining is also a significant land use, with both active and inactive mines in the watershed. Coal, oil, and natural gas are among the natural resources of Muhlenberg County. Coal is the county's important revenue-producing natural resource, and at one time Muhlenberg County was the largest coal-producing county in the United States. In 1973, this county produced over 19 million tons of coal from strip mines and over 5 million tons from underground mines. The Pond Creek watershed contains three main land uses: resource extraction (mining and disturbed land area), forest, and agriculture.

The Kentucky Division of Mine Safety (KDMS, formerly the Office of Mine Safety and Licensing) licenses all mines, surface and underground, to operate from a safety as opposed to a revenue or environmental perspective. KDMS began scanning their available maps of mined out areas in 2004 and makes the map available as electronic files and as interactive maps in a GIS (Geographic Information System) framework on the Kentucky Mine Mapping Information System, http://minemaps.ky.gov/MineSearch.aspx. Figure 3.10 displays the mined out area maps in this watershed and Table 3.4 presents the data from KDMS. Of the Pond Creek watershed, 4.1% are surface mined out areas with the acreage of 3,362, 2.5% are underground mined out areas with the acreage of 2,029, and 41% are unknown mined out areas with 33,187 acres.

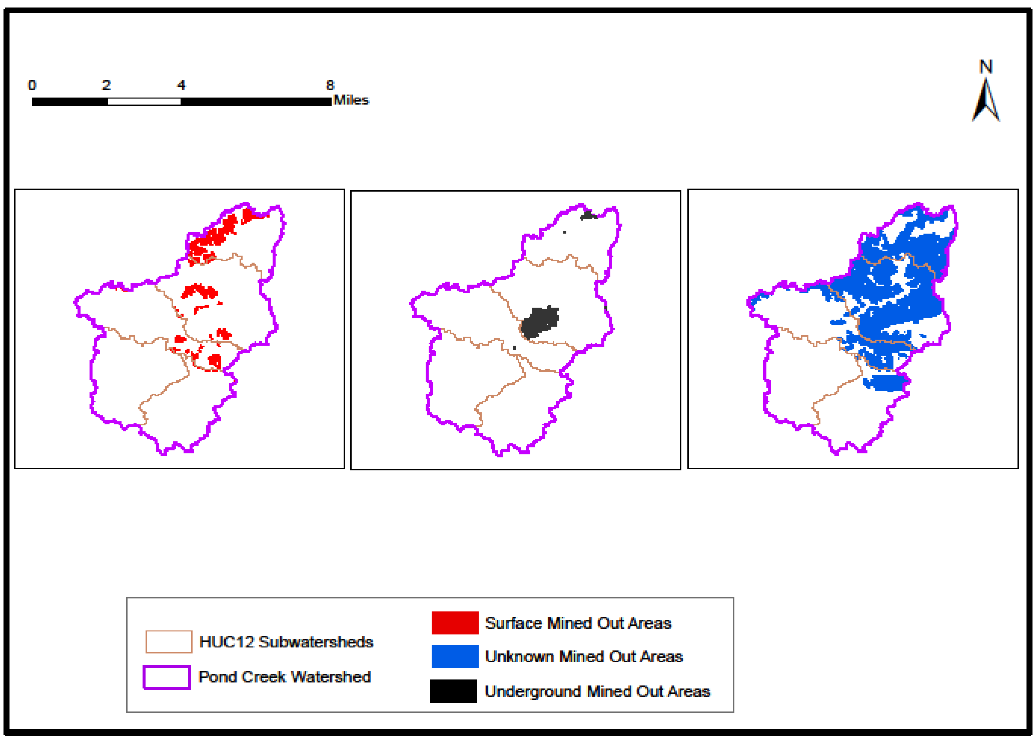


**Figure 3.10 Mined Out Areas within the Pond Creek Watershed**

**Table 3.4 Data from the Office of Mine Safety and Licensing on Mined Out Areas in the Pond Creek Watershed**

| State File Number | SEAM | Mine Type | Surface/Subsurface | Status |
|---|---|---|---|---|
| 04251 | 585 | Auger-Strip Water Coal | Surface | Abandoned |

| State File Number | SEAM | Mine Type | Surface/Subsurface | Status |
|---|---|---|---|---|
| 02106 | 585 | Unknown | Unknown | Abandoned |
| 04251 | 585 | Auger-Strip Water Coal | Surface | Abandoned |
| 04251 | 585 | Auger-Strip Water Coal | Surface | Abandoned |
| 02106 | 585 | Unknown | Unknown | Abandoned |
| 04251 | 585 | Auger-Strip Water Coal | Surface | Abandoned |
| 14136 | 585 | Auger-Strip Truck Coal | Surface | Abandoned |
| 04251 | 585 | Auger-Strip Water Coal | Surface | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| 09953 | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| 04251 | 585 | Auger-Strip Water Coal | Surface | Abandoned |
| 02106 | 580 | Unknown | Unknown | Abandoned |
| - | 580 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| 00980 | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| 00723 | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| 02106 | 580 | Unknown | Unknown | Abandoned |

| State File Number | SEAM | Mine Type | Surface/Subsurface | Status |
|---|---|---|---|---|
| 02106 | 580 | Unknown | Unknown | Abandoned |
| 02106 | 580 | Unknown | Unknown | Abandoned |
| 02106 | 580 | Unknown | Unknown | Abandoned |
| 04251 | 585 | Auger-Strip Water Coal | Surface | Abandoned |
| 04251 | 585 | Auger-Strip Water Coal | Surface | Abandoned |
| 02106 | 585 | Unknown | Unknown | Abandoned |
| 04251 | 585 | Auger-Strip Water Coal | Surface | Abandoned |
| 02106 | 585 | Unknown | Unknown | Abandoned |
| 10760-2 | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| 10167 | 585 | Unknown | Unknown | Abandoned |
| 08995 | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| 00158-2 | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| 06107 | 585 | Auger-Strip Truck Coal | Surface | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |

| State File Number | SEAM | Mine Type | Surface/Subsurface | Status |
|---|---|---|---|---|
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| 04251 | 585 | Auger-Strip Water Coal | Surface | Abandoned |
| 06107 | 585 | Auger-Strip Truck Coal | Surface | Abandoned |
| 00825-2 | 585 | Strip Truck Coal | Surface | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| 10167 | 585 | Unknown | Unknown | Abandoned |
| - | 585 | Unknown | Unknown | Abandoned |
| 18152-2 | 600 | Gob Strip Truck Coal | Surface | Active |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| 09953 | 590 | Unknown | Unknown | Abandoned |
| 09953 | 590 | Unknown | Unknown | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| 04251 | 585 | Auger-Strip Water Coal | Surface | Abandoned |
| 18430-1 | 600 | Strip Truck Coal | Surface | Active |
| 00825-2 | 590 | Strip Truck Coal | Surface | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| 10167 | 590 | Unknown | Unknown | Abandoned |
| 06107 | 590 | Auger-Strip Truck Coal | Surface | Abandoned |
| 04444 | 590 | Unknown | Unknown | Abandoned |
| 09953 | 590 | Unknown | Unknown | Abandoned |
| 09953 | 590 | Unknown | Unknown | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |

| State File Number | SEAM | Mine Type | Surface/Subsurface | Status |
|---|---|---|---|---|
| - | 590 | Unknown | Unknown | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| 00967 | 590 | Unknown | Unknown | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| 92789 | 590 | Unknown | Unknown | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| 90950 | 590 | Unknown | Unknown | Abandoned |
| 06107 | 590 | Auger-Strip Truck Coal | Surface | Abandoned |
| 90950 | 590 | Unknown | Unknown | Abandoned |
| 06107 | 590 | Auger-Strip Truck Coal | Surface | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| - | 590 | Unknown | Unknown | Abandoned |
| 06107 | 590 | Auger-Strip Truck Coal | Surface | Abandoned |
| 06107 | 590 | Auger-Strip Truck Coal | Surface | Abandoned |
| 01570 | 590 | Unknown | Unknown | Abandoned |
| 18152-2 | 590 | Gob Strip Truck Coal | Surface | Active |
| 18152-2 | 590 | Gob Strip Truck Coal | Surface | Active |
| 01570 | 590 | Unknown | Unknown | Abandoned |
| 18152-2 | 590 | Gob Strip Truck Coal | Surface | Active |
| 18152-2 | 590 | Gob Strip Truck Coal | Surface | Active |
| 18152-2 | 590 | Gob Strip Truck Coal | Surface | Active |
| 01570 | 590 | Unknown | Unknown | Abandoned |
| 01570 | 590 | Unknown | Unknown | Abandoned |
| 01570 | 590 | Unknown | Unknown | Abandoned |
| 01570 | 590 | Unknown | Unknown | Abandoned |
| 01570 | 590 | Unknown | Unknown | Abandoned |
| 01570 | 590 | Unknown | Unknown | Abandoned |
| 11949 | 590 | Unknown | Unknown | Abandoned |
| - | 595 | Unknown | Unknown | Abandoned |
| - | 595 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |

| State File Number | SEAM | Mine Type | Surface/Subsurface | Status |
|---|---|---|---|---|
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| 02106 | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| 11324-3 | 600 | Underground Truck Coal | Underground | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| 06620-1 | 600 | Unknown | Unknown | Abandoned |
| 90540 | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| 00980 | 600 | Unknown | Unknown | Abandoned |
| 05032 | 600 | Auger-Strip Truck Coal | Surface | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| 05693 | 600 | Unknown | Unknown | Abandoned |
| 09509-3 | 600 | Unknown | Unknown | Abandoned |
| 92789 | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| 06107 | 600 | Auger-Strip Truck Coal | Surface | Abandoned |
| 05833 | 600 | Unknown | Unknown | Abandoned |
| 05833 | 600 | Unknown | Unknown | Abandoned |
| 01156 | 600 | Underground Rail Coal | Underground | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| 01156 | 600 | Underground Rail Coal | Underground | Abandoned |
| 06107 | 600 | Auger-Strip Truck Coal | Surface | Abandoned |
| 01156 | 600 | Underground Rail Coal | Underground | Abandoned |
| 06107 | 600 | Auger-Strip Truck Coal | Surface | Abandoned |
| 06107 | 600 | Auger-Strip Truck Coal | Surface | Abandoned |
| 06107 | 600 | Auger-Strip Truck Coal | Surface | Abandoned |
| 10888 | 600 | Unknown | Unknown | Abandoned |
| 17740-2 | 600 | Auger-Strip Truck Coal | Surface | Abandoned |
| 17740-2 | 600 | Auger-Strip Truck Coal | Surface | Abandoned |
| 09628-1 | 600 | Unknown | Unknown | Abandoned |
| 05520 | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| 11126 | 600 | Unknown | Unknown | Abandoned |

| State File Number | SEAM | Mine Type | Surface/Subsurface | Status |
|---|---|---|---|---|
| 09628-1 | 600 | Unknown | Unknown | Abandoned |
| 94478 | 600 | Unknown | Unknown | Abandoned |
| 00300 | 600 | Unknown | Unknown | Abandoned |
| 00157 | 600 | Unknown | Unknown | Abandoned |
| 09628-1 | 600 | Unknown | Unknown | Abandoned |
| 00757 | 600 | Unknown | Unknown | Abandoned |
| 91254 | 600 | Unknown | Unknown | Abandoned |
| 94478 | 600 | Unknown | Unknown | Abandoned |
| 01570 | 600 | Unknown | Unknown | Abandoned |
| 18430-1 | 600 | Strip Truck Coal | Surface | Active |
| 18430-1 | 600 | Strip Truck Coal | Surface | Active |
| 18430-1 | 600 | Strip Truck Coal | Surface | Active |
| 18430-1 | 600 | Strip Truck Coal | Surface | Active |
| 18430-1 | 600 | Strip Truck Coal | Surface | Active |
| 18430-1 | 600 | Strip Truck Coal | Surface | Active |
| 18152-2 | 600 | Gob Strip Truck Coal | Surface | Active |
| 01570 | 600 | Unknown | Unknown | Abandoned |
| 18152-2 | 600 | Gob Strip Truck Coal | Surface | Active |
| 01570 | 600 | Unknown | Unknown | Abandoned |
| 15577-3 | 600 | Auger-Strip Truck Coal | Surface | Abandoned |
| 01570 | 600 | Unknown | Unknown | Abandoned |
| 15577-3 | 600 | Auger-Strip Truck Coal | Surface | Abandoned |
| 18152-2 | 600 | Gob Strip Truck Coal | Surface | Active |
| 09628-1 | 600 | Unknown | Unknown | Abandoned |
| 01570 | 600 | Unknown | Unknown | Abandoned |
| 01570 | 600 | Unknown | Unknown | Abandoned |
| 00314 | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| 10888 | 600 | Unknown | Unknown | Abandoned |
| 10888 | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| 06620-2 | 600 | Unknown | Unknown | Abandoned |
| 90343 | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |

| State File Number | SEAM | Mine Type | Surface/Subsurface | Status |
|---|---|---|---|---|
| 17949 | 600 | Auger-Strip Truck Coal | Surface | Abandoned |
| 09953 | 600 | Unknown | Unknown | Abandoned |
| 09509-1 | 600 | Unknown | Unknown | Abandoned |
| 09509-1 | 600 | Unknown | Unknown | Abandoned |
| 01570 | 600 | Unknown | Unknown | Abandoned |
| 09509-1 | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| 10640-1 | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| 09509-3 | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| 92789 | 600 | Unknown | Unknown | Abandoned |
| 06620-4 | 600 | Unknown | Unknown | Abandoned |
| 90344 | 600 | Unknown | Unknown | Abandoned |
| 00980 | 600 | Unknown | Unknown | Abandoned |
| 05877-15 | 600 | Underground Truck Coal | Underground | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| - | 600 | Unknown | Unknown | Abandoned |
| 01570 | 600 | Unknown | Unknown | Abandoned |

| State File Number | SEAM | Mine Type | Surface/Subsurface | Status |
|---|---|---|---|---|
| 18430-1 | 600 | Strip Truck Coal | Surface | Active |
| 18430-1 | 600 | Strip Truck Coal | Surface | Active |
| 18430-1 | 600 | Strip Truck Coal | Surface | Active |
| 18430-1 | 600 | Strip Truck Coal | Surface | Active |
| 03241 | 600 | Underground Truck Coal | Underground | Abandoned |
| 10182 | 620 | Unknown | Unknown | Abandoned |
| 18152-2 | 600 | Gob Strip Truck Coal | Surface | Active |
| - | 600 | Unknown | Unknown | Abandoned |
| 18152-2 | 600 | Gob Strip Truck Coal | Surface | Active |
| 06017 | 600 | Unknown | Unknown | Abandoned |
| 06107 | 600 | Auger-Strip Truck Coal | Surface | Abandoned |
| 01156 | 600 | Underground Rail Coal | Underground | Abandoned |
| 06017 | 600 | Unknown | Unknown | Abandoned |
| 18152-2 | 600 | Gob Strip Truck Coal | Surface | Active |
| 06017 | 600 | Unknown | Unknown | Abandoned |
| 00314 | 600 | Unknown | Unknown | Abandoned |
| 05877-25 | 600 | Underground Truck Coal | Underground | Abandoned |
| - | 655 | Unknown | Unknown | Abandoned |
| 17836 | 655 | Auger-Strip Truck Coal | Surface | Abandoned |
| - | 655 | Unknown | Unknown | Abandoned |
| -: No Information | | | | |

The Pond Creek watershed is still actively being mined. Figure 3.11 and Table 3.5 displays the current permits issued by Kentucky Division of Mine Permits (KDMP) in this watershed (as of June 2016).

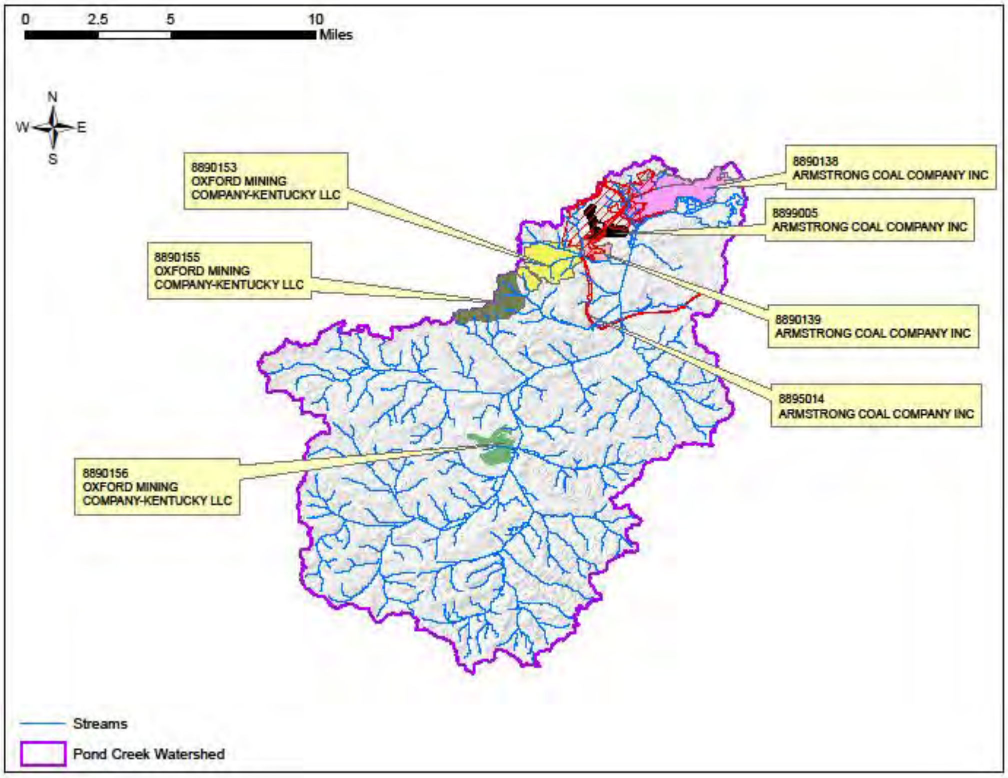


**Figure 3.11 Current Permits Issued by KDMP in the Pond Creek Watershed**

**Table 3.5 Current Permits Issued by KDMP in the Pond Creek Watershed**

| Permit # | Mining Type | Mining Area in Acres | Permittee Name | Date Issued | Original Permit # |
|---|---|---|---|---|---|
| 889-0138 | Surface | 1834.3 | Armstrong Coal Company Inc | 8/24/2007 | 8890032 |
| 889-0138 | Underground | 388.8 | Armstrong Coal Company Inc | 8/24/2007 | 8890032 |
| 889-0153 | Surface | 1207.2 | Oxford Mining Company-Kentucky LLC | 6/25/2010 | 8890153 |
| 889-0155 | Underground | 851.1 | Oxford Mining Company-Kentucky LLC | 1/27/2010 | 8890112 |
| 889-0156 | Surface | 420.4 | Oxford Mining Company-Kentucky LLC | 3/25/2010 | 8890114 |
| 889-9005 | Surface | 312.2 | Armstrong Coal Company Inc | 4/6/2011 | 8899005 |

| Permit # | Mining Type | Mining Area in Acres | Permittee Name | Date Issued | Original Permit # |
|---|---|---|---|---|---|
| 889-5014 | Underground | 1693.1 | Armstrong Coal Company Inc | 4/24/2007 | 895003 |
| 889-0139 | Surface | 260.6 | Armstrong Coal Company Inc | 7/30/2007 | 8890011 |
| 889-5014 | Surface | 731.5 | Armstrong Coal Company Inc | 4/24/2007 | 895003 |

# 4.0 Monitoring

## 4.1 Monitoring History

As stated in Section 2.1, monitoring of Pond Creek and its tributaries was conducted at 14 locations by the Kentucky Division of Water (KDOW), Murray State University, and Western Kentucky University between 1997 and 2001 and in 2006, see Figure 4.1 and Table 4.1.

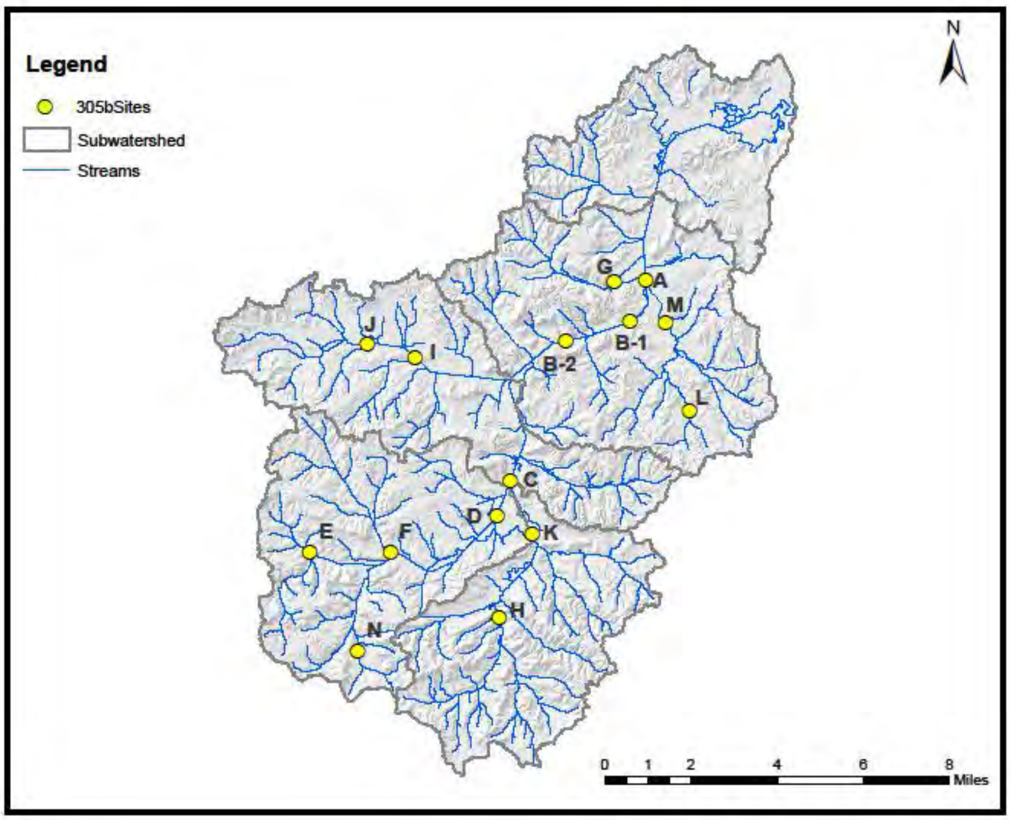


**Figure 4.1 Locations of Historical Sampling Sites within the Pond Creek Watershed**

**Table 4.1 Historical Monitoring Sites in the Pond Creek Watershed**

| Site ID | Waterbody | Waterbody ID | Sample Mile Point | Collection Year | Collector |
|---|---|---|---|---|---|
| A | Pond Creek 4.8 to 7.6 | KY501042_02 | 7.4 | 1997 | KDOW |
| B-1 | Pond Creek 7.6 to 11.7 | KY501042_03 | 8.6 | 1997; 2000 | MSU |
| B-2 | Pond Creek 7.6 to 11.7 | KY501042_03 | 10.2 | 1997; 2000 | MSU |

| Site ID | Waterbody | Waterbody ID | Sample Mile Point | Collection Year | Collector |
|---|---|---|---|---|---|
| C | Pond Creek 11.7 to 14.4 | KY501042_04 | 14.3 | 2000 | MSU |
| D | Pond Creek 14.4 to 18.1 | KY501042_05 | 15.2 | 2000; 2001 | MSU |
| E | Pond Creek 18.1 to 22.1 | KY501042_06 | 20.3 | 2000; 2001 | KDOW |
| F | Sandlick Creek 0.0 to 4.0 | KY502963_01 | 0.2 | 2001 | KDOW |
| G | UT to Pond Creek 0.0 to 2.4 | KY501042-6.9_01 | 1.0 | 2001 | WKU |
| H | Bat East Creek 3.4 to 7.5 | KY486462_02 | 3.9 | 2001 | KDOW |
| I | Caney Creek 0.0 to 3.6 | KY488838_01 | 3.6 | 2001 | KDOW |
| J | Caney Creek 3.6 to 7.6 | KY488838_02 | 3.6 | 1997 | KDOW |
| K | Bat East Creek 0.0 to 3.3 | KY486462_01 | 1.3 | 2001 | WKU |
| L | Plum Creek 1.7 to 3.9 | KY500964_02 | 2.9 | 2001 | WKU |
| M | Plum Creek 0.0 to 1.7 | KY500964_01 | 0.1 | 1997 | KDOW |
| N | Salt lick Creek 0.0 to 3.7 | KY502844_01 | 2.3 | 2002 | KDOW |

## 4.2 KDOW TMDL Monitoring

Since November 2010, KDOW TMDL monitoring staff revisited Pond Creek watershed at 26 sites on Pond Creek and its tributaries, see Figure 4.2 and Table 4.2. Those 26 sampling sites were selected by assessing the watershed's accessibility, the location of exiting impaired segments, drainage areas, karst features, hydrologic changes, potential sources and land use. TMDL staff monitored flow, chloride, sedimentation/siltation, sulfate, total dissolved solids, nutrient/eutrophication biological indicators, specific conductance, *E. coli*, and metals. Table 4.3 shows the sampling sites where TMDL staff also collected biology data.

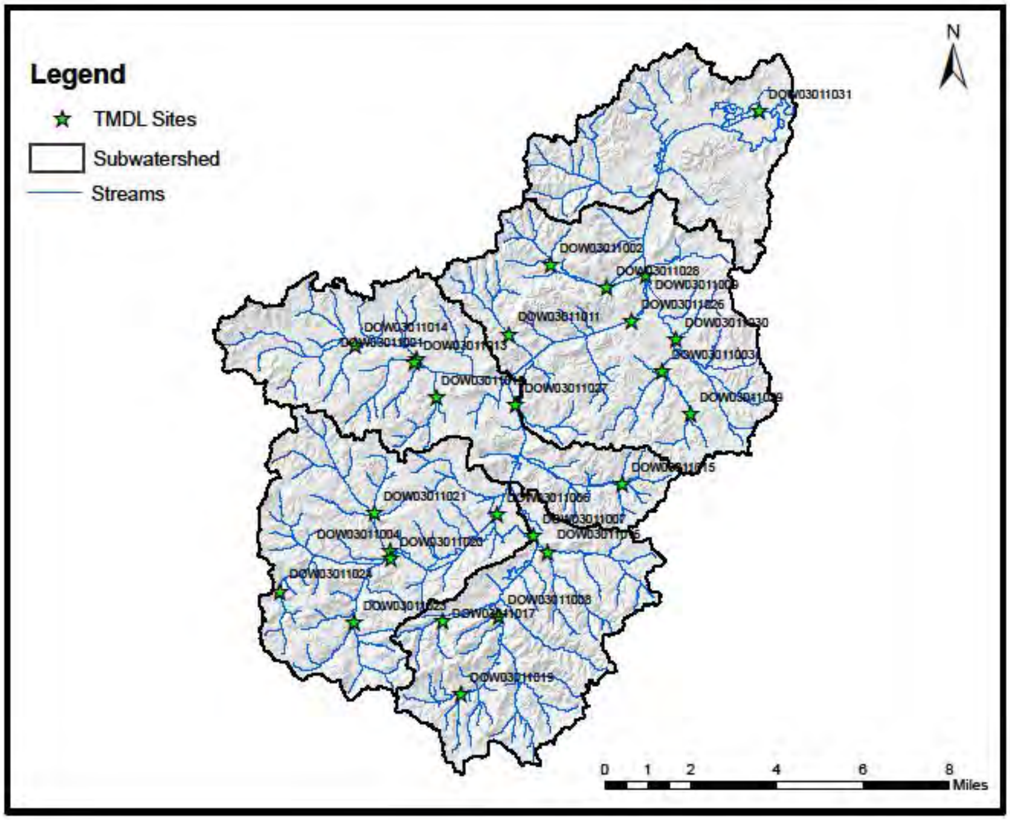


**Figure 4.2 Locations of KDOW TMDL Sampling Sites within the Pond Creek Watershed**

**Table 4.2 Sample Sites by KDOW TMDL in the Pond Creek Watershed**

| Station ID | Stream | RM | UT* RM | Latitude | Longitude |
|---|---|---|---|---|---|
| DOW03011001 | Caney Creek | 2.35 | | 37.21529 | -87.14753 |
| DOW03011002 | UT to UT Pond Creek | 7.4 | 0.2 | 37.24757 | -87.09163 |
| DOW03011003 | UT to Plum Creek | 1.65 | 0.1 | 37.2121 | -87.04406 |
| DOW03011004 | Sandlick Creek | 0.2 | | 37.15018 | -87.15736 |
| DOW03011006 | Pond Creek | 15.2 | | 37.163 | -87.11255 |
| DOW03011007 | Bat East Creek | 1.35 | | 37.15612 | -87.09737 |
| DOW03011008 | Bat East Creek | 3.9 | | 37.12857 | -87.1113 |
| DOW03011009 | Pond Creek | 7.4 | | 37.24472 | -87.05153 |

| Station ID | Stream | RM | UT* RM | Latitude | Longitude |
|---|---|---|---|---|---|
| DOW03011011 | UT to Pond Creek | 11.1 | 0.85 | 37.22409 | -87.10883 |
| DOW03011012 | UT to Caney Creek | 1.8 | 0.64 | 37.20222 | -87.13879 |
| DOW03011013 | UT to Caney Creek | 2.3 | 0.12 | 37.21423 | -87.14854 |
| DOW03011014 | Caney Creek | 3.9 | | 37.2198 | -87.17342 |
| DOW03011015 | Beech Creek | 2.7 | | 37.17416 | -87.0601 |
| DOW03011016 | UT to Bat East Creek | 1.6 | 0.31 | 37.15078 | -87.09112 |
| DOW03011017 | Carters Creek | 1.55 | | 37.12694 | -87.13493 |
| DOW03011019 | UT to Bat East Creek | 6.1 | 0.43 | 37.10246 | -87.12669 |
| DOW03011020 | Pond Creek | 18.35 | | 37.14786 | -87.1571 |
| DOW03011021 | Opossum Run | 0.3 | | 37.16317 | -87.16434 |
| DOW03011023 | Saltlick Creek | 1.55 | | 37.12612 | -87.17216 |
| DOW03011024 | Boggess Creek | 1.4 | | 37.13601 | -87.20348 |
| DOW03011026 | Pond Creek | 8.6 | | 37.22927 | -87.05717 |
| DOW03011027 | Pond Creek | 12.45 | | 37.20022 | -87.10563 |
| DOW03011028 | UT to Pond Creek | 7.35 | 0.97 | 37.24039 | -87.06784 |
| DOW03011029 | Plum Creek | 3 | | 37.19817 | -87.03188 |
| DOW03011030 | Plum Creek | 0.65 | | 37.22318 | -87.03843 |
| DOW03011031 | Pond Creek | 1.85 | | 37.3006 | -87.00456 |
| *UT: unnamed tributary | | | | | |

**Table 4.3 KDOW TMDL Biological Sampling Events in the Pond Creek Watershed**

| Station ID | Stream | Sampling Date | MBI[1] Narrative Result |
|---|---|---|---|
| DOW03011001 | Caney Creek | 8/8/2013 | Fair |
| DOW03011002 | UT to UT Pond Creek | 6/16/2011 | Poor |
| DOW03011008 | Bat East Creek | 6/24/2014 | Good |
| DOW03011012 | Caney Creek UT | 3/26/2014 | Poor |
| DOW03011013 | Caney Creek UT | 4/1/2014 | Fair |
| DOW03011015 | Beech Creek | 6/15/2011 | Poor |
| DOW03011016 | Bat East Creek UT | 6/18/2014 | Fair |
| DOW03011017 | Carters Creek | 5/10/2011 | Poor |
| DOW03011019 | Bat East Creek UT | 4/1/2014 | Fair |
| DOW03011021 | Opossum Run | 3/18/2014 | Fair |
| DOW03011024 | Boggess Creek | 3/26/2014 | Fair |
| DOW03011026 | Pond Creek | 6/25/2014 | Fair |
| (1) MBI = Macroinvertebrate Bioassessment Index. | | | |

# 5.0 Source Identification

For regulatory purposes, the pollutant sources in a watershed can be placed into two categories: KPDES-permitted and non-KPDES-permitted sources. A KPDES-permitted source requires a Kentucky Pollutant Discharge Elimination System discharge permit from the KDOW. KPDES discharge permits include wastewater treatment facilities that discharge directly to a stream, Municipal Separate Storm Sewer System, facilities discharging storm water, some agricultural operations and home units. KPDES discharge permits also include mining facilities which generally discharge to a stream from impoundments or ponds in response to precipitation events. KPDES is not the only permitting program that may affect water quality or quantity within a watershed; other permitting examples include water withdrawal permits, permits to build structures within a floodplain, permits to construct an on-site sewage treatment disposal system (OSTDS), and permits to land apply waste from sewage treatment plants. However, within the framework of the TMDL process, a KPDES-permitted source is defined as one regulated under the KPDES program. Non-KPDES-permitted sources include nonpoint sources of pollution. Nonpoint sources of pollution are often caused by runoff from precipitation over and/or through the ground and are correlated with land use.

## 5.1 KPDES-Permitted Sources

Permitted sources include all sources regulated by the KPDES permitting program. Figure 5.1 and Table 5.1 show all KPDES-permitted facilities within the Pond Creek watershed. In 401 KAR 10:001, KDOW adopted the definition of a point source per 33 U.S.C. 1362(14) as "any discernable, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, or concentrated animal feeding operation or vessel or other floating craft, from which pollutants are or may be discharged." However, 401 KAR 10:001 exempts "agricultural storm water run-off or return flows from irrigated agriculture" from the definition of a point source. A WLA is assigned to a KPDES-permitted source.

Under the KPDES permit, most of the larger facilities are required to submit discharge monitoring report (DMR) data each month, while the smaller facilities are required to submit DMRs each quarter. DMR records for permitted entities are available upon request from the KDOW records custodian. Information on the Kentucky Open Records Act is available at http://water.ky.gov.

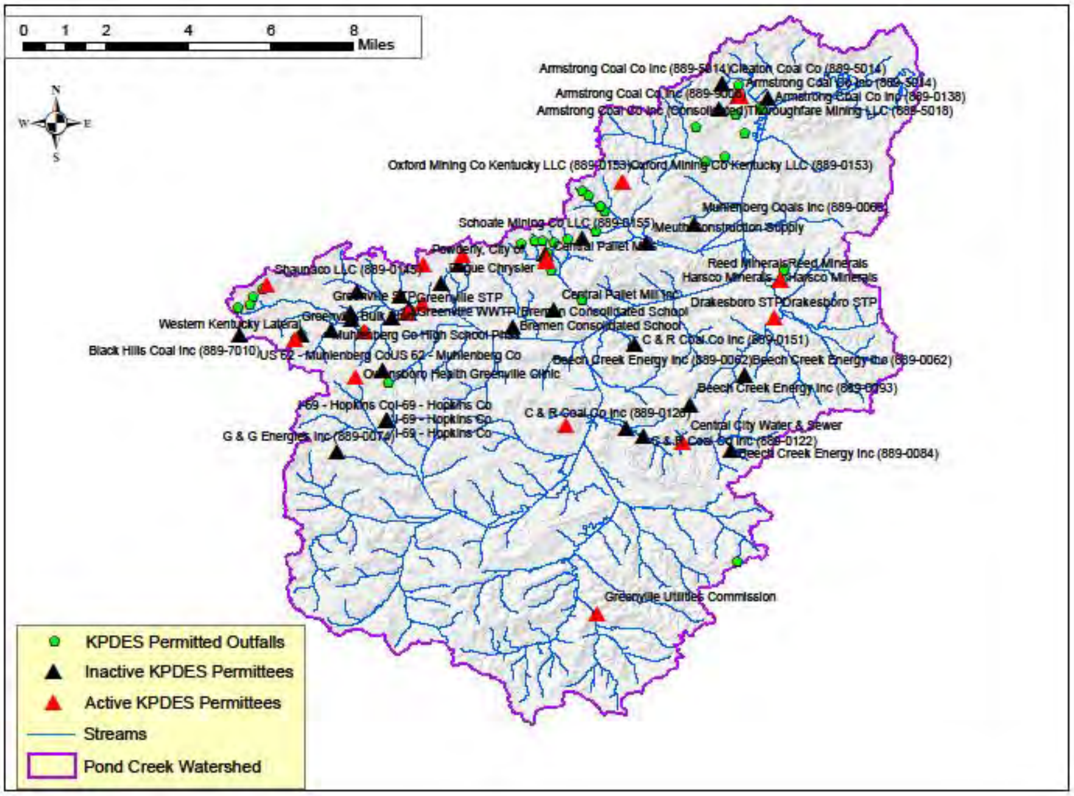


**Figure 5.1 KPDES Permittees within the Pond Creek Watershed**

**Table 5.1 KPDES Permittees within the Pond Creek Watershed**

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutant Limits/Requirement in the Permit |
|---|---|---|---|---|---|---|
| KY0020010 | Greenville STP | Yes | 1.31 | 37.219167 | -87.169444 | bacteria, pH, Cd, Cu, Pb, Zn |
| KY0066575 | Drakesboro STP | Yes | 0.165 | 37.217222 | -87.040833 | bacteria, pH, Cd, Cu, Pb, Zn |
| KY0108537 | Shaunaco LLC (889-0145) | Yes | 0 | 37.228611 | -87.218889 | pH, Cd, Cu, Fe, Pb, Ni, Zn |
| KY0109606 | Greenville Bulk Plant | Yes | 0 | 37.212500 | -87.184700 | pH |
| KY0111996 | Oxford Mining Co Kentucky LLC (889-0153) | Yes | 0 | 37.265000 | -87.094056 | pH, Fe |
| KYG045755 | Oxford Mining Co Ky LLC (889-0156) | Yes | 0 | 37.179722 | -87.113889 | pH, Fe |
| KYG046498 | Oxford Mining Co Kentucky LLC (889-0153) | Yes | 0 | 37.265000 | -87.094056 | pH, Fe |

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutant Limits/Requirement in the Permit |
|---|---|---|---|---|---|---|
| KYG640029 | Central City Water & Sewer | Yes | 0.0005 | 37.173800 | -87.073000 | pH, Fe |
| KYG640108 | Greenville Utilities Commission | Yes | 0.027 | 37.113900 | -87.103200 | pH, Fe |
| KYGW40011 | Thoroughfare Mining LLC (889-5018) | Yes | 0 | 37.294720 | -87.053060 | bacteria, pH, Fe |
| KYGW40062 | Armstrong Coal Co Inc (Consolidated) | Yes | 0 | 37.294990 | -87.052770 | pH, Fe |
| KYP000064 | Powderly, City of | Yes | 0 | 37.235833 | -87.163889 | discharge to Greenville WWTP |
| KYR003239 | Central Pallet Mills | Yes | 0 | 37.237167 | -87.121083 | pH and to develop a SWPPP |
| KYR004015 | Carl Mitchell & Son Implement - Paradise Rd | Yes | 0 | 37.238014 | -87.120822 | pH and to develop a SWPPP |
| KYR004021 | Harsco Minerals | Yes | 0 | 37.230667 | -87.038861 | pH and to develop a SWPPP |
| KYR10J469 | Muhlenberg County Airport | Yes | 0 | 37.222067 | -87.164333 | to develop a SWPPP |
| KYR10K083 | Owensboro Health Greenville Clinic | Yes | 0 | 37.196391 | -87.187716 | to develop a SWPPP |
| KYR10K315 | Western Kentucky Lateral | Yes | 0 | 37.209464 | -87.209069 | to develop a SWPPP |
| KYR10K433 | Owensboro Health Muhlenberg Healthplex | Yes | 0 | 37.238889 | -87.150189 | to develop a SWPPP |
| KY0023329 | Bremen Consolidated School | No | 0.008 | 37.214000 | -87.132800 | bacteria |
| KY0099538 | Texas Gas Transmission LLC - West Greenville | No | 0 | 37.211111 | -87.206944 | pH |
| KY0106046 | C & R Coal Co Inc (889-0151) | No | 0 | 37.208333 | -87.090000 | pH, Fe |
| KY0107701 | Armstrong Coal Co Inc (889-5014) | No | 0 | 37.298889 | -87.059167 | pH, Cd, Cu, Fe, Pb, Ni, Zn |
| KYG043169 | Black Hills Coal Inc (889-7010) | No | 0 | 37.211111 | -87.228611 | pH, Fe |

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutant Limits/Requirement in the Permit |
|---|---|---|---|---|---|---|
| KYG043563 | Beech Creek Energy Inc (889-0062) | No | 0 | 37.196944 | -87.051389 | pH, Fe |
| KYG043825 | Muhlenberg Coals Inc (889-0066) | No | 0 | 37.250278 | -87.068889 | pH, Fe |
| KYG044318 | Armstrong Coal Co Inc (889-0138) | No | 0 | 37.294167 | -87.043333 | pH, Fe |
| KYG044386 | Beech Creek Energy Inc (889-0062) | No | 0 | 37.196944 | -87.051389 | pH, Fe |
| KYG044486 | G & G Energies Inc (889-0074) | No | 0 | 37.170457 | -87.194335 | pH, Fe |
| KYG044573 | Friendship Energy Inc (889-0079) | No | 0 | 37.217528 | -87.175069 | pH, Fe |
| KYG044789 | Beech Creek Energy Inc (889-0084) | No | 0 | 37.170833 | -87.056111 | pH, Fe |
| KYG044998 | Beech Creek Energy Inc (889-0093) | No | 0 | 37.186944 | -87.070556 | pH, Fe |
| KYG045704 | Schoate Mining Co LLC (889-0155) | No | 0 | 37.245000 | -87.108333 | pH, Fe |
| KYG046025 | C & R Coal Co Inc (889-0126) | No | 0 | 37.178333 | -87.092778 | pH, Fe |
| KYG046026 | C & R Coal Co Inc (889-0122) | No | 0 | 37.175833 | -87.086944 | pH, Fe |
| KYG046617 | Armstrong Coal Co Inc (889-9005) | No | 0 | 37.290278 | -87.060278 | pH, Fe |
| KYG046775 | Armstrong Coal Co Inc (889-5014) | No | 0 | 37.295000 | -87.053600 | pH, Fe |
| KYR000524 | Central Pallet Mill Inc | No | 0 | 37.220000 | -87.118333 | pH and to develop a SWPPP |
| KYR000918 | Harsco Minerals | No | 0 | 37.230667 | -87.038861 | pH and to develop a SWPPP |
| KYR001665 | Carl Mitchell & Son Implement | No | 0 | 37.239428 | -87.121152 | pH and to develop a SWPPP |
| KYR001693 | Meuth Construction Supply | No | 0 | 37.243362 | -87.085699 | pH and to develop a SWPPP |
| KYR00A008 | Reed Minerals | No | 0 | 37.230667 | -87.038861 | pH and to develop a SWPPP |
| KYR00A009 | Reed Minerals | No | 0 | 37.230667 | -87.038861 | pH and to develop a SWPPP |

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutant Limits/Requirement in the Permit |
|---|---|---|---|---|---|---|
| KYR10E810 | Muhlenberg Co High School Phas 3 | No | 0 | 37.216500 | -87.189224 | to develop a SWPPP |
| KYR10E960 | Muhlenberg County Emergency SE | No | 0 | 37.235680 | -87.151550 | to develop a SWPPP |
| KYR10F821 | Muhlenberg Co High School | No | 0 | 37.218839 | -87.189686 | to develop a SWPPP |
| KYR10G145 | Greenville WWTP | No | 0 | 37.220472 | -87.169111 | to develop a SWPPP |
| KYR10G154 | Knight Construction & Excavating Inc | No | 0 | 37.212776 | -87.196388 | to develop a SWPPP |
| KYR10G285 | Pogue Chrysler | No | 0 | 37.229353 | -87.157828 | to develop a SWPPP |
| KYR10G428 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G429 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G456 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G458 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G631 | US 62 - Muhlenberg Co | No | 0 | 37.198889 | -87.178333 | to develop a SWPPP |
| KYR10G632 | US 62 - Muhlenberg Co | No | 0 | 37.198889 | -87.178333 | to develop a SWPPP |
| KYR10H138 | Muhlenberg Co High School | No | 0 | 37.218839 | -87.189686 | to develop a SWPPP |
| KYR10H705 | Muhlenberg County Park Phase I | No | 0 | 37.226610 | -87.187427 | to develop a SWPPP |
| KYR10I149 | Pogue Electric Service Inc. | No | 0 | 37.224749 | -87.172138 | to develop a SWPPP |
| KYG044105 | Cleaton Coal Co (889-5014) | No | 0 | 37.298889 | -87.059167 | pH, Fe |
| KYG050000* | N/A | N/A | N/A | N/A | N/A | N/A |

* KYG050000 is the Inactive Mine Lands General Permit, see Section 1 of the KPDES Permit KYG050000 for more information regarding the permit coverage eligibility and exclusions. As long as the permittees make good faith effort to comply with the permit, they are considered to be compliant with the TMDL. KYG050000 is not listed in the Section 8 (Individual Segments TMDL Calculations).
N/A: Not Applicable

### 5.1.1 *E. coli*

#### *5.1.1.1 Sanitary Wastewater Systems*

Sanitary Wastewater System(s) include all facilities with a design flow which are permitted to discharge bacteria. This includes Wastewater Treatment Plants (WWTPs), Sewage Treatment Plants (STPs), package plants, and home units.

#### *5.1.1.2 Concentrated Animal Feeding Operations (CAFO)*

Operations that are defined as a CAFO pursuant to 401 KAR 5:002 are required to obtain a KPDES permit. Once defined as a CAFO, the operation can be permitted under a KPDES General Permit or a KPDES Individual Permit depending upon the nature of the operation. Conditions of both types of permits include no discharge to surface waters; however, holders of a KPDES Individual Permit may discharge to surface waters during a 25-year (24-hour) or greater storm event. There are no known regulated CAFOs in the Pond Creek watershed. However, there could be non-point source animal operations or small farm operations that do not require a KDOW permit.

### 5.1.2 pH and Metals

The KPDES-permitted facilities with pH/metal discharge limits within the Pond Creek watershed include WWTPs, industry facilities, stormwater, and coal mining. Urban stormwater runoff is a substantial source of pH and metals, such as building siding and roofs, automobile brakes, oil leakage and tires, as well as dry and wet atmospheric depositions.

There is an extensive amount of coal mining in the watershed, so the coal mining is discussed below in detail.

#### *5.1.2.1 Coal Mining Sources*

According to EPA (2014a), "coal mining employs basically the same traditional mining techniques used in hard rock mining - underground and surface ("strip") mining....[Strip mining] is analogous to the open pit mining techniques used in hard rock mining whereby the soil and rock above the coal seam are removed to expose the seam. The seam is then blasted and the coal is scooped up by huge front end loaders or electric shovels and transported to a coal processing plant. These coal preparation plants use a variety of physical (e.g., screening) and chemical (e.g., flotation using high gravity liquids) methods to separate the raw coal from all of the non-combustible waste rock and minerals (e.g., pyrite). The coarser waste rock is piled up adjacent to the mined out area and the finer coal tailings coming from the preparation plant are discharged as a thick slurry into a man-made impoundment. After coal mining operations have ceased, the mine is reclaimed by dumping the waste rock into the pit, re-grading the area to the approximate original contours of the land and then replanting the area using native grasses and trees."

While not all mine runoff is acidic, coal mining can produce AMD as rainwater percolates through mine spoils and the porous strata of underground mines. EPA (2014b) characterizes

AMD as "…the formation and movement of highly acidic water rich in heavy metals. This acidic water forms through the chemical reaction of surface water (rainwater, snowmelt, pond water) and shallow subsurface water with rocks that contain sulfur-bearing minerals, resulting in sulfuric acid. Heavy metals can be leached from rocks that come in contact with the acid, a process that may be substantially enhanced by bacterial action. The resulting fluids may be highly toxic and, when mixed with groundwater, surface water and soil, may have harmful effects on humans, animals and plants." AMD discharges were common to mining prior to the passage of SMCRA; see Section 9.4.2 for further discussion.

#### *5.1.2.2 WLA Mining Sources*

Prior to the beginning of operation, mining facilities must obtain a KPDES permit, either a Coal General or an Individual Permit. Facilities with a current KPDES permit are placed in the WLA. KPDES permits require monitoring of effluent quality and submittal of DMR data monthly or quarterly to Kentucky Department for Natural Resources (KDNR). Some basic facility data is available on EPA's Integrated Compliance Information System (ICIS), which are available to the public at http://www.epa.gov/enviro/facts/pcs-icis/search.html, but currently DMR data must be requested through KDNR. In the future, DMR data will be available through ICIS, and DMRs will be submitted to KDOW instead of KDNR. Further information on KPDES permitting information can be found at http://water.ky.gov/permitting/Pages/Mining.aspx.

Mining facilities, unlike many industrial and wastewater facilities, do not have permitted design flows, and while they monitor flow, flow limits are not a condition of their permits. This is because mining sources generally discharge from impoundments or ponds in response to precipitation events, although the impoundments do have retention time requirements built in as necessary to treat the influent.

There are 5 active KPDES mining permittees within Pond Creek watershed (as of June 2016), see Table 5.2 and Figure 5.2. Those active facilities with a KPDES permit are placed in the WLA, while other sources are placed in the LA, see Sections 5.2.2.1 and 5.2.2.2, or are illegal, see Section 5.3.

**Table 5.2 Active KPDES-Permitted Mining in the Pond Creek Watershed**

| KPDES Permit # | KDNR Permit # | Permittee Name | Date Issued |
|---|---|---|---|
| KY0108537 | 889-0145 | Shaunaco LLC | 12/1/2011 |
| KYG046498 | 889-0153 | Oxford Mining Co Kentucky LLC | 8/4/2010 |
| KYGW40011 | 889-5018 | Thoroughfare Mining LLC | 5/21/2015 |
| KYG045755 | 889-0156 | Oxford Mining Co Ky LLC | 7/1/2009 |
| KY0111996 | 889-0153 | Oxford Mining Co Kentucky LLC | Pending |

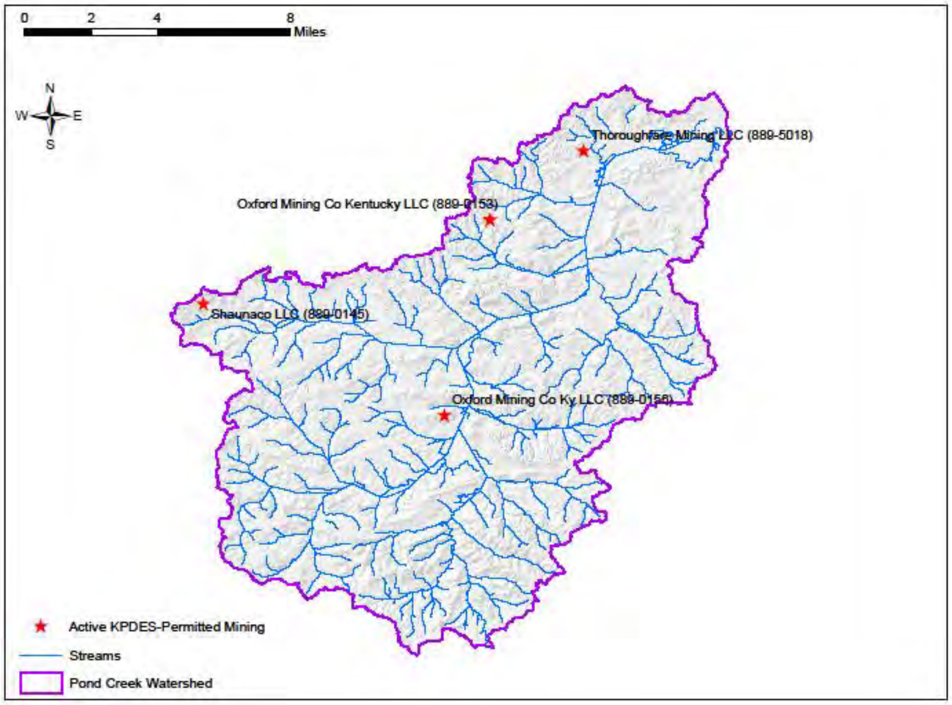


**Figure 5.2 Active KPDES-Permitted Mining in the Pond Creek Watershed**

## 5.2 Non-KPDES-Permitted Sources

Non-KPDES-permitted sources include all sources not permitted by the KPDES permitting program and are often associated with land use. The loads to surface water from non-KPDES-permitted sources are regulated by laws such as the Kentucky Agricultural Water Quality Act (AWQA, KRS 224.71-100 through 224.71-145, i.e., implementation of individual agriculture water quality plans and corrective measures), the federal CWA (i.e., the TMDL process) and 401 KAR 5:037 (Groundwater Protection Plans), among others. Unlike KPDES-permitted sources, non-KPDES-permitted sources typically discharge pollutants to surface water in response to rain events. A LA is assigned to non-KPDES-permitted sources.

### 5.2.1 *E. coli*

#### *5.2.1.1 Kentucky No Discharge Operating Permits*

As stated in 401 KAR 5:005, facilities with agricultural waste handling systems are required to obtain a Kentucky No Discharge Operating Permit (KNDOP) from the KDOW prior to construction and operation. Animal Feeding Operations (AFOs) receive KNDOP permits. These operations handle liquid waste in a storage component of the operation (e.g. lagoon, pit, or tank) and may land apply the waste via spray irrigation or injection to cropped acreages. Land application of the waste that results in runoff to a stream is prohibited. Facilities that handle animal waste as a liquid are required to submit a Short Form B, construction plans, and a Comprehensive Nutrient Management Plan to the KDOW. Also included in KNDOP requirements are golf courses and some industrial operations with spray-irrigate.

There is one KNDOP agriculture facility with hog/pig farming in the Pond Creek watershed (Figure 5.3 and Table 5.3).

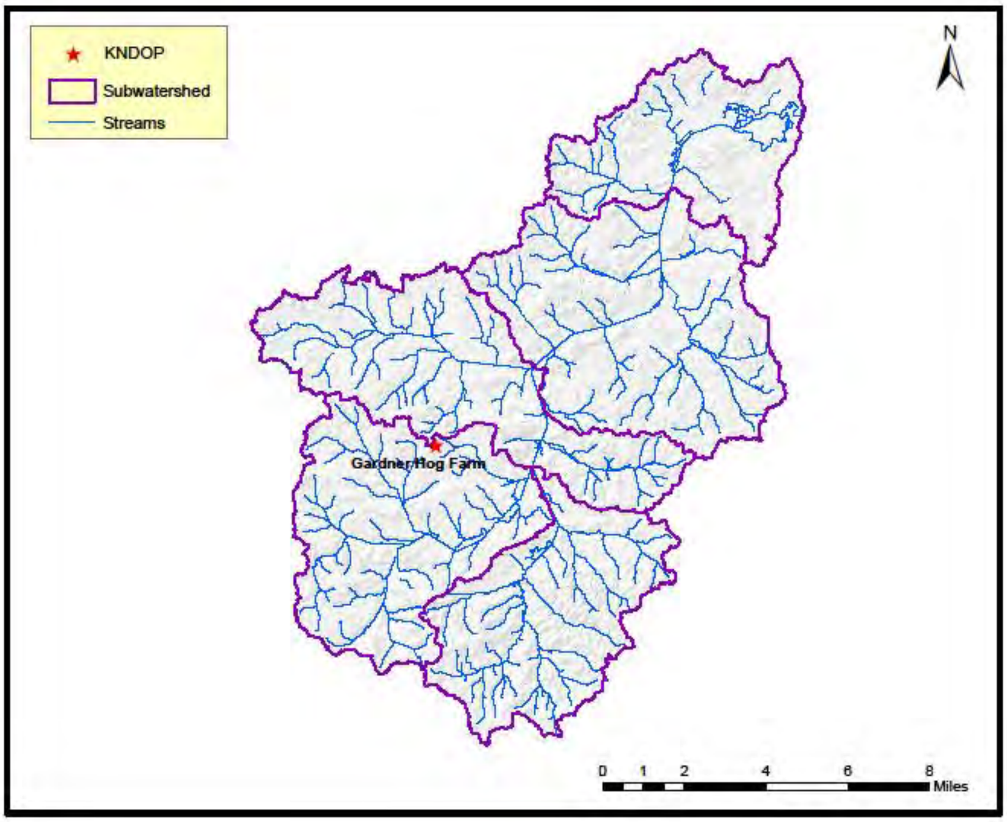


**Figure 5.3 KNDOP Facility in the Pond Creek Watershed**

**Table 5.3 KNDOP Facility in the Pond Creek Watershed**

| KNDOP # | Facility Type | Latitude | Longitude |
|---|---|---|---|
| 03004073 | AGR-Hog & Pig Farming | 37.180833 | -87.150278 |

### *5.2.1.2 Agriculture*

The Kentucky AWQA was passed by the 1994 General Assembly. The law focuses on the protection of surface water and groundwater resources from agricultural and silvicultural activities. The Act created the Kentucky AWQA, a 15-member peer group comprising farmers and representatives from various agencies and organizations. The Act requires farms greater than 10 acres in size to adhere to the Best Management Practices (BMPs) specified in the Kentucky Agriculture Water Quality Plan. Specific BMPs have been designated for all operations.

The USDA National Agricultural Statistics Service compiles Census of Agriculture data by County for virtually every facet of U.S. agriculture (USDA, 2012). Selected agricultural data from the latest Census of Agriculture reports for Muhlenberg County are listed in Table 5.4. These data are based on County-wide data with no assumptions made on a watershed level. The percentage of agricultural types of land cover was calculated in Table 3.3 in Section 3.3.

**Table 5.4 Agricultural Statistics from the 2012 USDA Agricultural Census**

| | Muhlenberg County |
|---|---|
| Farms (number/acres) | 630/128,761 |
| Total Cropland (acres) | 67,127 |
| Cattle and Calves Inventory (total number) | 12,904 |
| Beef Cows (total number) | (D) |
| Milk Cows (total number) | (D) |
| Horses and Ponies (total number) | - |
| Goats (total number) | - |
| Hogs and Pigs (total number) | (D) |
| Sheep and Lamb (total number) | 222 |
| Poultry Layers (total number) | (D) |
| Poultry Broilers (total number) | 5,622,085 |
| Corn for grain (acres) | 15,481 |
| Wheat for grain (acres) | 2,537 |
| Corn for Silage (acres) | 173 |
| Forage (acres) | - |
| (D) = data withheld to avoid disclosing data for individual farms<br>- = No data | |

### *5.2.1.3 Wildlife*

Wildlife contributes bacteria to the Pond Creek watershed. Table 5.5 shows the estimates of deer density and population in Muhlenberg County, as provided by the Kentucky Department of Fish and Wildlife Resources (Kentucky Department of Fish and Wildlife Resources, 2012). Estimates on numbers of other types of animals are not available. Although wildlife contributes bacteria to surface water, such contributions represent natural background conditions, and do not receive a reduction as part of the TMDL.

**Table 5.5 Number of Deer in Muhlenberg County**

| County | Deer Per Square Mile | Number of Deer |
|---|---|---|
| Muhlenberg | 23 | 10,562 |

#### *5.2.1.4 Human Waste*

Human waste disposal is of particular concern in rural areas. Areas not served by sewers either employ OSTDSs or do not treat their sewage. OSTDSs, including septic tank systems, are commonly used in areas where providing a centralized sewage collection and treatment system is not cost-effective or practical. When properly sited, designed, constructed, maintained, and operated, septic systems are an effective means of disposing and treating domestic waste. The effluent from a well-functioning OSTDS is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, they can be a source of *E. coli* to both groundwater and surface water, see Section 5.3, Illegal Sources, for further discussion of failing OSTDSs. The soils information presented in Section 3.1 indicates that the soils in Pond Creek watershed are not ideal for installation of properly functioning septic systems.

Another type of non-KPDES-permitted source that may exist in the watershed is straight-pipes, which are discrete conveyances that discharge sewage, gray water (i.e., water from household sinks, laundry, etc.), and stormwater to the surface waters of the Commonwealth without treatment.

Figure 5.4 shows the 2010 census blocks of population data. The existing and proposed sewer lines in Pond Creek watershed are presented in Figure 5.5.

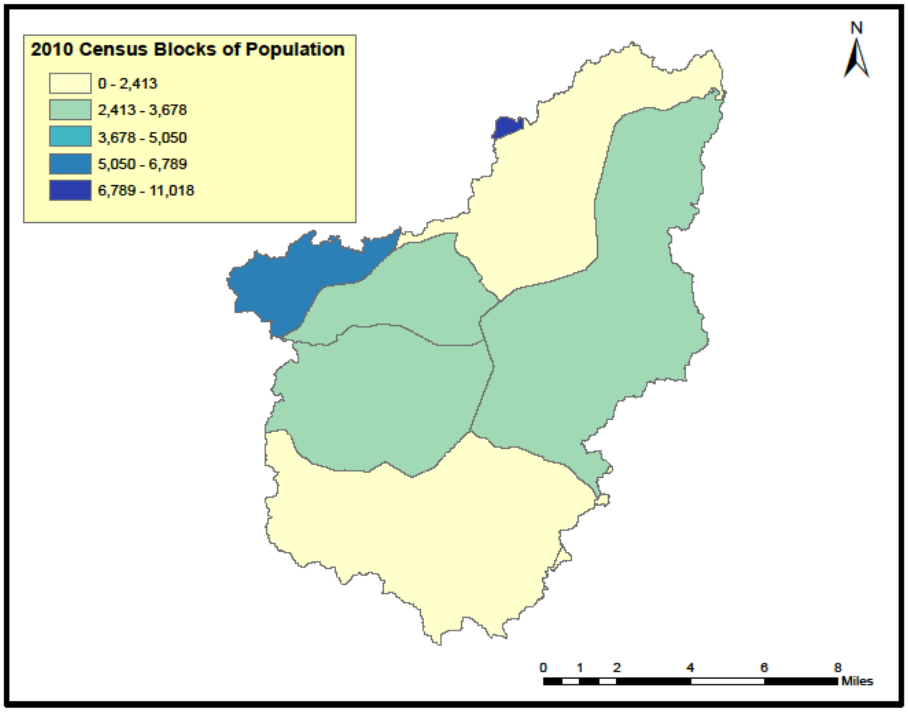


**Figure 5.4 2010 Census Blocks of Population of the Pond Creek Watershed**

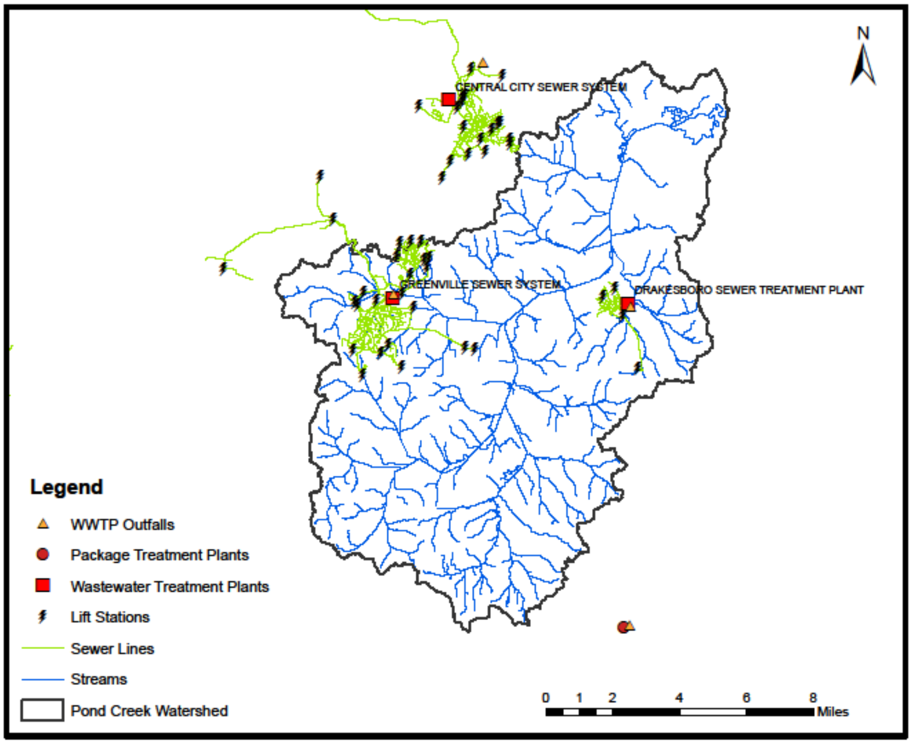


**Figure 5.5 Existing and Proposed Sewer Lines in the Pond Creek Watershed**

#### *5.2.1.5 Household Pets*

Although household pets undoubtedly exist in this watershed, their contribution to the LA is deemed to be minimal compared to other sources. Pet waste may, however, be a larger contributor to bacteria runoff in areas where there is a higher density of households and less-permeable surfaces.

### 5.2.2 pH and Metals

#### *5.2.2.1 LA Mining Sources*

The unregulated storm water runoff from the pre-SMCRA mine lands, which is not covered under KYG050000, is part of the LA. As stated, much of the mining in the watershed is pre-law, but inadequate recordkeeping means maps of pre-law mines are often unavailable.

#### *5.2.2.2 LA Natural Background*

Pollutants addressed in this document can all be present in surface water under natural background conditions. pH normally varies from a value of 7.0; iron may be present at higher than trace amounts. Natural background levels for pH and metals were not established for this report. Any natural background is part of the LA.

## 5.3 Illegal Sources

Both KPDES-permitted and non-KPDES-permitted sources can discharge pollutants to surface water illegally. This includes sources that are illegal simply by their existence, such as straight-pipes and Sanitary System Overflows, which receive no allocation; or mining activities without an approved KPDES permit. There may also be legal sources that are operating illegally (e.g., outside of regulations, permit limits or conditions, etc.), such as a WWTP bypass or a failing OSTDS, which receive no allocation above that of a properly functioning system (see Section 7.0 for TMDL allocations).

Another potential illegal source is livestock on farms that have no BMPs (as required under the AWQA), as well as farms where BMPs are present but are insufficient or failing in a manner that causes or contributes to surface water impairment; such farms receive no allocation above that of a farm with properly installed and functioning BMPs. Also included are KNDOPs, AFOs and CAFOs not in compliance with the appropriate regulations that cause or contribute to surface water impairment.

KDOW expects implementation of these TMDLs to begin with the elimination of illegal sources. This is intended to prevent legally operating sources from having to effect reductions in order to accommodate the pollutant loading of illegal sources. Note, this section of the TMDL is not intended to summarize the universe of potential illegal sources that may discharge pollutants into surface waters, nor does it attempt to summarize the universe of legal sources that may be operating illegally. Instead, it gives examples of illegal sources known to be present or that could be present in the watersheds (e.g., straight-pipes).

# 6.0 Water Quality Criteria

## 6.1 Water Quality Criteria

The CWA requires states to designate uses for surface waters within their jurisdiction. The designated uses assigned to waterbodies in Kentucky can be found in 401 KAR 10:026. Designated uses impaired in the waterbodies addressed by this TMDL include Warm Water Aquatic Habitat, Primary Contact Recreation and Secondary Contact Recreation, whose definitions are found in 401 KAR 10:001:

1. WAH waters are those with surface water and associated substrate capable of supporting indigenous warm water aquatic life. WAH can be impaired by metals, pH and reduced alkalinity in addition to other pollutants. WAH criteria are in effect year-round.
2. PCR waters are those designated for full body contact recreation (e.g., swimming). PCR criteria are in effect during the recreation season of May 1 through October 31.
3. SCR waters are those designated for partial immersion (e.g., wading or boating). SCR criteria are in effect year-round.

The term *limit* is often used interchangeably with the terms *WQC* and *criterion*. WQCs are found in 401 KAR 10:031. Below are the WQCs for *E. coli*, metals, pH, alkalinity and limits on the relative concentration of alkalinity and acidity:

### 6.1.1 *E. coli*

The WQC in 401 KAR 10:031 (Kentucky's Surface Water Standards) for the PCR use are based on *E. coli* per 401 KAR 10:031:

*"The following criteria shall apply to waters designated as primary contact recreation use during the primary contact recreation season of May 1 through October 31: Fecal coliform content or* Escherichia coli *content shall not exceed 200 colonies per 100 ml or 130 colonies per 100 ml respectively as a geometric mean based on not less than five (5) samples taken during a thirty (30) day period. Content also shall not exceed 400 colonies per 100 ml in twenty (20) percent or more of all samples taken during a thirty (30) day period for fecal coliform or 240 colonies per 100 ml for* Escherichia coli.*"*

When there are insufficient *E. coli* measurements to calculate a 5-sample, 30-day geometric mean, the instantaneous criterion of 240 colonies/100 ml is applied to calculate allowable loadings to bring the watershed into compliance with the PCR designated use.

### 6.1.2 pH

The pH of water may result in impairment for WAH, PCR and SCR. The pH shall not be less than six and zero-tenths (6.0) nor more than nine and zero-tenths (9.0) standard units and shall not fluctuate more than one and zero-tenths (1.0) pH unit over a period of twenty-four (24) hours.

### 6.1.3 Metals

Metals impair for WAH. Metals WQCs are given in terms of chronic and acute limits. The chronic criterion is the highest instream concentration of a toxic substance or an effluent to which organisms are able to be exposed for ninety-six (96) hours without causing an unacceptable harmful effect. The acute criterion is the highest instream concentration of a toxic substance or an effluent to which an organism can be exposed for one (1) hour without causing an unacceptable harmful effect.

#### *6.1.3.1 Non-Hardness-Dependent Metals (Iron)*

The WQCs for iron are not hardness-dependent. Iron is the only metal whose chronic criterion varies depending on whether aquatic life has been adversely affected. The chronic iron limit is 3.5 mg/L where aquatic life has not been shown to be adversely affected and 1.0 mg/L where aquatic life has been adversely affected. The acute iron limit is 4.0 mg/L for all streams. Iron WQCs are shown in Table 6.1.

**Table 6.1 Iron WQCs**

| Limit Type | Iron WQC, mg/L |
|---|---|
| Chronic–aquatic life is adversely affected | 1.0 |
| Chronic–aquatic life has not been shown to be adversely affected | 3.5 |
| Acute | 4.0 |

#### *6.1.3.2 Hardness-Dependent Metals (Cadmium, Copper, Lead, Nickel, Zinc)*

It has been demonstrated that a number of elements that are metals, including cadmium, copper, lead, nickel and zinc, are less toxic to aquatic life as water hardness increases (EPA, 1986). Hardness refers to the dissolved mineral content of water. In residential plumbing, these minerals cause scale development. They also interfere with foam formation from soap—the soap forms a solid precipitate instead of a lather and it loses its surfactant property; this makes it ‘hard’ to clean clothing (Hach, 2014). When minerals constituting hardness dissolve in water they form a cation (with positive charge) and an anion (with negative charge). More specifically, hardness is the presence of divalent cations (i.e., those with a charge of 2+) (Lloyd and Heathcote, 1985). Mostly hardness comes from calcium and magnesium ions, but other metals can contribute, including barium, iron, manganese, strontium and zinc (WHO, 2003). The two most important anions associated with the cations that cause hardness are bicarbonate ($HCO_3^-$) and carbonate ($CO_3^{2-}$), see alkalinity, below. These ions normally originate in limestone or dolomite rock made more acidic by the incorporation of atmospheric carbon dioxide into rainwater (EPA, 1986). Even though hardness indicates only the presence of cations, it is measured in mg/L of calcium carbonate ($CaCO_3$). However, this does not mean calcium is the only cation being measured; other cations contribute to hardness as described above: but for measurement purposes, all contributors are reported as an equivalent molecular weight of $CaCO_3$.

Excess hardness may lower the toxicity of certain metals to aquatic organisms by combining with the metals to form less toxic compounds. Because of the variable toxicity of these metals, unlike most other WQCs the limits are not fixed, but vary as the hardness varies. Therefore the WQC equations employ the natural log of hardness, or ln(hardness), where hardness is in units of mg/L as $CaCO_3$, and *e*, which is an irrational number (i.e., it has an infinite number of digits to the right of the decimal point) referred to as Euler's number; *e* is approximately equal to 2.71828. Of the hardness-dependent metals included in this TMDL, zinc is the only metal with an identical chronic and acute criterion. Tables 6.2 through Table 6.5 show the WQCs for these metals.

**Table 6.2 Cadmium WQC**

| Limit Type | Cadmium WQC, µg/L |
|---|---|
| Chronic | $e^{(0.7409*(\ln(\text{hardness}))-4.719)}$ |
| Acute | $e^{(1.0166*(\ln(\text{hardness}))-3.924)}$ |

**Table 6.3 Copper WQC**

| Limit Type | Copper WQC, µg/L |
|---|---|
| Chronic | $e^{(0.8545*(\ln(\text{hardness}))-1.702)}$ |
| Acute | $e^{(0.9422*(\ln(\text{hardness}))-1.700)}$ |

**Table 6.4 Lead WQC**

| Limit Type | Lead WQC, µg/L |
|---|---|
| Chronic | $e^{(1.273*(\ln(\text{hardness}))-4.705)}$ |
| Acute | $e^{(1.273*(\ln(\text{hardness}))-1.460)}$ |

**Table 6.5 Nickel WQC**

| Limit Type | Nickel WQC, µg/L |
|---|---|
| Chronic | $e^{(0.846*(\ln(\text{hardness}))+0.0584)}$ |
| Acute | $e^{(0.846*(\ln(\text{hardness}))+2.255)}$ |

**Table 6.6 Zinc WQC**

| Limit Type | Zinc WQC, µg/L |
|---|---|
| Chronic | $e^{(0.8473*(\ln(\text{hardness}))+0.884)}$ |
| Acute | $e^{(0.8473*(\ln(\text{hardness}))+0.884)}$ |

### 6.1.3.3 Alkalinity

Lowered alkalinity can impair for WAH. Alkalinity is the ability to neutralize an acid, and is quantified by titration; titration in this case is the iterative additions of an acid to the sample until a pH endpoint of 4.5 is reached (standard method 2320, APHA *et al.*, 2012). This is because below a pH of 4.5, carbonate alkalinity is neutralized: Carbonate alkalinity is the primary species present in natural systems, although other types, such as phosphorus or nitrogen species can also exist.

Alkalinity can also be thought of as a measurement of the buffering capacity of water, or its ability to resist change in pH. Unlike hardness, which is the presence of mineral cations, alkalinity is the presence of anions, mainly carbonate, bicarbonate and hydroxide but also potentially including borate, phosphate, silicate, nitrate, dissolved ammonia, sulfide, and the conjugate bases of organic acids, minus free hydrogen ions. Alkalinity in water is divided into two anion fractions based on the presence of the carbonate and bicarbonate anions; these fractions are known as carbonate and non-carbonate, although as stated the carbonate fraction contributes the majority of alkalinity, especially in limestone-dominated systems. These anions resist lowering pH by taking up free hydrogen ions (Stumm and Morgan, 1996). Alkalinity, like hardness, is measured as an equivalent molecular weight of $CaCO_3$. 401 KAR 10:031 states the instream alkalinity cannot be reduced by more than 25%, unless the natural alkalinity is 20 mg/L as $CaCO_3$ or less, in which case it shall not be reduced at all.

### 6.1.3.4 Acidity

Acidity does not have a specific limit set under 401 KAR 10:031. Acidity is the ability to neutralize a base and is quantified by titration, which in this case is the iterative additions of a base to the sample until a pH endpoint is reached; the endpoint may vary based on the constituents contributing to acidity, but is normally 3.7 to 8.3 (standard method 2310B, APHA *et al.*, 2012). Acidity is increased by the presence of dissolved carbon dioxide and carbonic acid ($H_2CO_3$), metals undergoing hydrolysis (see Section 6.2) and free hydrogen ions, among other constituents. Sulfide molecules such as pyrite in contact with air and water release hydrogen ions and increase acidity (Morel and Hering, 1993). Acidity, like alkalinity and hardness, is measured as an equivalent molecular weight of $CaCO_3$. Acidity can cause lowering of pH depending on other factors such as the presence of a buffer (i.e., alkalinity), but acidity and pH are not identical, see Section 6.2; this section also describes the specific application of standard method 2310B to AMD.

## 6.2 Metals Hydrolysis

Metallic cations in AMD, including zinc, copper, iron, aluminum and manganese, are precipitated during treatment. This process involves the free ionic (or dissolved) form of the metal binding to hydroxides (the $OH^-$ molecule) provided by treating the runoff with a chemical alkaline addition or from hydrolysis if the pH in the receiving water is high enough. Hydrolysis means the breaking of chemical bonds by the addition of water; the water molecule itself may also have its molecular bonds broken during the process (Morel and Hering, 1993).

The metal hydroxides form insoluble compounds that then precipitate from the water. This process of precipitation is represented in the following equation using manganese, where the metal hydroxide (i.e., the manganese bound to OH through hydrolysis) forms the insoluble compound, manganese hydroxide, which then precipitates:

$$Mn^{2+} + 2H_2O \dashrightarrow Mn(OH)_2 + 2H^+$$

The hydrolysis reaction releases hydrogen ions, which can decrease pH (which is defined as the presence of hydrogen ions) if not enough excess hydroxide is present in the system to buffer the reaction. Other metals besides manganese undergo a similar reaction. This phenomenon makes it problematic to rely on pH as a sole indicator of the acidity of AMD, as treated mine effluent which meets the acceptable pH range of 6.0 to 9.0 standard units can be unstable (Kirby and Cravotta, 2005), and the final pH can fall below this range after discharge if not enough alkalinity is available in the water to buffer the total acidity.

This instability means special methods are needed to measure the acidity of AMD. To enhance metal precipitation in the laboratory, especially during titrations, heat and oxidation are used to speed up the reaction. More specifically, the addition of stronger bases like NaOH, and the use of heat and oxidation can improve the efficiency and speed of metal precipitation. For AMD, the determination of acidity by titration (2310B in Standard Methods, 2012) mandates that a hot peroxide treatment be employed (2310B.4*a*), called hot acidity or digested acidity.

In the environment, the primary metals of concern for AMD treatment are aluminum, iron and manganese. This is because other metals associated with AMD, including copper, nickel, and zinc normally drop out of solution in the process of properly treating AMD for iron and manganese. AMD generally has a low pH, and as the pH in the treatment pond is increased through addition of lime or limestone, the metals begin precipitating in the following order: ferric iron (i.e., $Fe^{3+}$) precipitates at a pH 3.0 to 3.5; aluminum precipitates at a pH of around 4.5, while copper and zinc precipitate at a pH of 7.0 to 8.0. Ferrous iron (i.e., $Fe^{2+}$) precipitates at around 8.0 to 8.5, but most treatment operations treat ferrous iron more quickly and economically by aerating the water to convert ferrous iron to ferric iron, and in this way a pH of only 3.0 to 4.0 is needed to precipitate the iron. Manganese precipitates at a much higher pH of 9.0 to 10.5, although the final numbers for these metals can vary based on field conditions and ionic composition. Because manganese precipitates last it is an indicator of the completeness of precipitation of other metals; this is the reason there is an effluent limit for manganese. However, aluminum can re-enter solution after initial precipitation at a pH of around 9.0 and thus can contribute hydrogen ions via hydrolysis even though it was initially removed earlier in the treatment process (Balintova and Petrilakova, 2011; Balintova *et al*., 2012).

The potential drop in pH due to hydrolysis reactions with metals can be calculated using the following equations, which use the acute permitted discharge limits of iron and manganese, which are both 4.0 mg/L as stated in Table 6.2:

$$(\text{Iron, } 4.0 \text{ mg/L}) \times (1/55.845 \text{ g/mol}) \times (1 \text{ g}/1000 \text{ mg}) = 7.1627\text{E-}5 \text{ mol/L}$$

Equation 6.1.

(Manganese, 4.0 mg/L) × (1/54.938 g/mol) × (1 g/1000 mg) = 7.2809E-5 mol/L
Equation 6.2.

As stated, any aluminum present contributes hydrogen ions as well. In the treatment pond system, iron is more often in the form $Fe^{3+}$ unless conditions are anaerobic, and most AMD treatment ponds are designed as aerobic environments (Costello, 2003). Manganese is solely in the form $Mn^{2+}$. The amount of hydrogen ions generated during metal hydrolysis is therefore equal to the results of Equations 6.1 and 6.2 multiplied by the valence number of the metals, or 3 for iron and 2 for manganese, then summing these results. This figure is 3.60499E-4 mol/L of $H^+$. Since pH is defined specifically as the negative logarithm of the concentration of $H^+$ ions in solution in units of mol/L, the resultant pH from Equation 6.1 and 6.2 is equivalent of 3.44, which is far lower than the acceptable pH range of 6.0 to 9.0 standard units. If aluminum was also present, the potential pH drop would be even larger.

Metals hydrolysis can be countered by adding alkalinity to the solution. The amount of alkalinity necessary to neutralize the acidity generated by aluminum, iron and manganese at a specific pH can be calculated by the following equation, from Hedin, *et al*. (1991), which conservatively assumes all iron is in the form of $Fe^{3+}$:

$$\text{Calculated Acidity, mg/L as } CaCO_3 = 50 \times ((10^{(3\text{-pH})}) + (3 \times \text{Fe mg/L}/55.8) + (2 \times \text{Mn mg/L}/54.9) + (3 \times \text{Al mg/L}/27.0))$$

Equation 6.3.

Solving Equation 6.3 gives the net alkalinity which must be present in solution to buffer metals hydrolysis (i.e., net alkalinity is defined as the alkalinity present in solution minus the calculated acidity). Three of the variables, pH, iron and manganese, have effluent limits. Aluminum does not have an effluent limit, so it must be reported when the other constituents are reported: The calculated acidity will then be determined and compared to the alkalinity present in solution. The alkalinity must equal or exceed the calculated acidity, or in other words the net alkalinity must be greater than or equal to zero.

# 7.0 Total Maximum Daily Load

EPA defines a TMDL as "a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources. Water quality standards are set by States, Territories, and Tribes. They identify the uses for each waterbody, for example, drinking water supply, contact recreation, and aquatic life support, and the scientific criteria to support that use. A TMDL is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. The calculation must include a margin of safety to ensure that the waterbody can be used for the purposes the State has designated. The calculation must also account for seasonal variation in water quality. The Clean Water Act, Section 303, establishes the water quality standards and TMDL programs (EPA, 2008)."

## 7.1 TMDL Equation and Definitions

A TMDL calculation is performed as follows:

$$TMDL = WLA + LA + MOS$$

Equation 7.1

Where:
**TMDL:** the WQC, expressed as a load.
**MOS:** the Margin of Safety, which can be an implicit or explicit additional reduction applied to sources of pollutants that accounts for uncertainties in the relationship between effluent limits and water quality. For this TMDL, the MOS is implicit.
**WLA:** the Wasteload Allocation, which is the allowable loading of pollutants into the stream from Kentucky Pollutant Discharge Elimination System (KPDES) permitted sources.
**KPDES-WLA:** the WLA for the existing KPDES-permitted facilities which have discharge limits for the pollutants of concern.
**MS4-WLA:** the WLA for KPDES-permitted municipal separate stormwater sewer systems (MS4) (including cities, counties, roads and right-of-ways owned by the Kentucky Transportation Cabinet, universities and military bases). There is no MS4 community within this watershed area.
**LA:** the Load Allocation, which is the allowable loading of pollutants into the stream from sources not permitted by KPDES and from natural background.
**Seasonality:** yearly factors that affect the relationship between pollutant inputs and the ability of the stream to meet its designated uses.
**Critical Condition:** the time period when the pollutant conditions are expected to be at their worst.
**Existing Conditions**: the load that exists in the watershed at the time of TMDL development (i.e., sampling) and is causing the impairment.
**Load**: concentration * flow * conversion factor.

**Concentration**: colonies per 100 milliliter (*E. coli*), milligrams per liter (mg/L) (iron, alkalinity, acidity), micrograms per liter (ug/L) (cadmium, copper, lead, nickel, zinc) or standard units (pH).
**Flow (i.e., stream discharge)**: cubic feet per second (cfs).

## 7.2 TMDLs by Pollutant

The following sections set the loading associated with each pollutant addressed by this TMDL. The MOS, which is implicit, is discussed in Section 7.3. TMDLs are allocated to sources in Section 7.7.

However, despite the requirement that all pollutants be expressed as a load with a TMDL (D.C. Cir, 2006), KDOW and KDNR expect *E. coli*, metals and pH compliance to be evaluated in terms of concentration, not load.

### 7.2.1 *E. coli*

**Table 7.1 *E. coli* WQCs and TMDL Load**

| Condition | WQC (Colonies/100ml) | TMDL Load(1) (Colonies/day) |
|---|---|---|
| Instantaneous | 240 | $Q_S \times 240 \times 24{,}465{,}758.4$ |
| Geomean | 130 | $Q_S \times 130 \times 24{,}465{,}758.4$ |
| (1) $Q_S$ is the flow in the stream in cfs. | | |

The number 24,465,758.4 is a conversion factor which changes the multiple of flow and the WQC into units of load in colonies/day.

### 7.2.2 pH

The acceptable range for pH is 6.0 ≤ pH ≤ 9.0 standard units. In order to express this as a range of loads, pH can be converted to hydrogen ion concentration and then into load, where a pH of 6.0 equals a hydrogen ion concentration of 1.00E-6 mol/L and a pH of 9.0 equals a hydrogen ion concentration of 1.00E-9 mol/L (Milanco, 2014). Because the molecular weight of a hydrogen ion is 1.0 g/mol, the concentration of hydrogen ions in mol/L is the same as its concentration in g/L, or 1.0. Using the following equation, these hydrogen ion concentrations can be turned into load for any value of streamflow, $Q_S$:

$$(Q_S\ ft^3/s) \times (1E\text{-}6\ g/L) \times (86{,}400\ s/day) \times (28.31685\ L/ft^3) = \text{pH TMDL Load (hydrogen ions g/day)}$$

Equation 7.3 (pH = 6.0)

$$(Q_S\ ft^3/s) \times (1E\text{-}9\ g/L) \times (86{,}400\ s/day) \times (28.31685\ L/ft^3) = \text{pH TMDL Load (hydrogen ions g/day)}$$

Equation 7.4 (pH = 9.0)

Equation 7.3 simplifies to a TMDL Load for pH of $Q_S \times 2.44657$ g/day of hydrogen ions. Equation 7.4 simplifies to $Q_S \times 2.44657E\text{-}3$ g/day of hydrogen ions. However, KDOW regulates pH by the hydrogen ion activity as read by a pH meter. The actual hydrogen ion concentration is related to hydrogen ion activity through the following equation:

$$\{H^+\} = [H^+] \times \gamma$$
Equation 7.5

where $\{H^+\}$ is hydrogen ion activity, $[H^+]$ is the actual hydrogen ion concentration, and $\gamma$ is the activity coefficient.

The activity coefficient of hydrogen ions in turn depends on ionic strength $\mu$ as shown in Figure 7.1 (Snoeyink and Jenkins, 1980). Figure 7.1 shows that the activity of hydrogen ions ($\gamma$) decreases with increasing ionic strength ($\mu$) of the source water. This is because other ions limit the mobility of the hydrogen ions based on their charge and concentration. Ionic strength is a measure of total ion concentration and charge in a solution and is defined as:

$$\mu = 0.5 \times \Sigma m_i Z_i^2$$
Equation 7.6

where $m_i$ is the molar concentration of each ion and $Z_i$ is charge of each ion. Direct measurements of ionic strength require concentrations of each ion dissolved in water. Ionic strength can also be estimated indirectly. According to Snoeyink and Jenkins (1980), the ionic strength $\mu$ can be determined using the specific conductance (SC, also known as conductivity) of the source water in units of microSiemens per centimeter (µS/cm) with the following equation:

$$\mu = 1.6E\text{-}5 \times SC$$
Equation 7.7

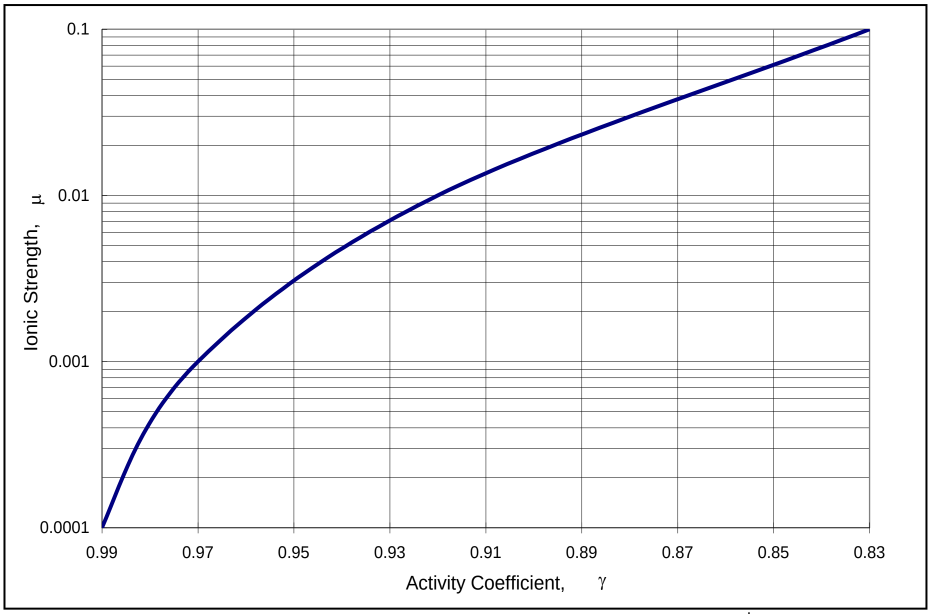


**Figure 7.1 Ionic Strength vs. Activity Coefficient of $H^+$ Ions**

Using the maximum SC measured in the watershed, which is 4250 μS/cm recorded on 10/20/2011 at DOW03011030 on Plum Creek, yields an ionic strength μ of approximately 0.068. Using Figure 7.1, the activity coefficient γ is approximately 0.842. Therefore the range of hydrogen ion loads between a pH of 6.0 and 9.0 is derived by dividing the result of Equations 7.3 and 7.4 by γ, or 0.842. This leaves the TMDL load range shown in Table 7.2:

**Table 7.2 Range of Hydrogen Ion TMDL Loads Corresponding to a pH Range of 6.0 to 9.0**

| pH WQC, pH standard units | TMDL Load, Hydrogen Ions, g/day(1) |
|---|---|
| 6.0 (upper limit of hydrogen ion loading) | $Q_S \times 2.906$ |
| 9.0 (lower limit of hydrogen ion loading) | $Q_S \times 2.906E\text{-}3$ |
| (1) $Q_S$ is the flow in the stream in cfs. | |

### 7.2.3 Metals

Since both the acute and chronic criteria must be met, TMDL loads for metals are set using both the chronic and acute WQCs. For metals with WQCs given in mg/L, the concentration is converted to load in pounds per day using the following equation:

$$(\text{WQC mg/L}) \times (Q_S\ \text{ft}^3/\text{s}) \times (1\ \text{lb}/453{,}592.4\ \text{mg}) \times (86{,}400\ \text{s/day}) \times (28.31685\ \text{L/ft}^3) = \text{TMDL Load (pounds/day)}$$

Equation 7.8

The conversion factor for Equation 7.8 simplifies to 5.3938.

For metals with WQCs given in µg/L, the concentration is converted to load in pounds per day using the following equation:

(WQC µg/L) × (1 mg/1000µg) × ($Q_S$ ft$^3$/s) × (1 lb/453,592.4 mg) × (86,400 s/day) × (28.31685 L/ft$^3$) = TMDL Load (pounds/day)
Equation 7.9

The conversion factor for Equation 7.9 simplifies to 0.005394.

Metals are divided into two categories, those whose toxicity is not hardness-dependent, and those whose toxicity is hardness-dependent.

#### *7.2.3.1 Non-Hardness-Dependent Metals*

Since the WQCs for iron are given in concentrations of mg/L, the following loads were derived from Equation 7.8:

**Table 7.3 Iron WQCs and TMDL Load**

| Limit Type | Iron WQC, mg/L | Iron TMDL Load, pounds/day[1] |
|---|---|---|
| Chronic–aquatic life is adversely affected | 1.0 | $Q_S \times 5.3938$ |
| Chronic- aquatic life has not been shown to be adversely affected | 3.5 | $Q_S \times 18.8783$ |
| Acute | 4.0 | $Q_S \times 21.5752$ |
| [1] $Q_S$ is the flow in the stream in cfs. | | |

#### *7.2.3.2 Hardness-Dependent Metals*

The WQCs for hardness-dependent metals are given in µg/L instead of mg/L, so the TMDL loads were derived using Equation 7.9. As stated, zinc is the only metal with identical chronic and acute criteria.

**Table 7.4 Cadmium WQC and TMDL Load**

| Limit Type | Cadmium WQC, µg/L[1] | Cadmium TMDL Load, pounds/day[2] |
|---|---|---|
| Chronic | $e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ |
| Acute | $e^{(1.0166*(\ln(hardness))-3.924)}$ | $Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ |
| [1] Hardness is in units of mg/L.<br>[2] $Q_S$ is the flow in the stream in cfs. | | |

**Table 7.5 Copper WQC and TMDL Load**

| Limit Type | Cadmium WQC, µg/L[(1)] | Copper TMDL Load, pounds/day[(2)] |
|---|---|---|
| Chronic | $e^{(0.8545*(\ln(hardness))-1.702)}$ | $Q_S \times 0.005394 \times e^{(0.8545*(\ln(hardness))-1.702)}$ |
| Acute | $e^{(0.9422*(\ln(hardness))-1.700)}$ | $Q_S \times 0.005394 \times e^{(0.9422*(\ln(hardness))-1.700)}$ |
| [(1)] Hardness is in units of mg/L.<br>[(2)] $Q_S$ is the flow in the stream in cfs. | | |

**Table 7.6 Lead WQC and TMDL Load**

| Limit Type | Cadmium WQC, µg/L[(1)] | Lead TMDL Load, pounds/day[(2)] |
|---|---|---|
| Chronic | $e^{(1.273*(\ln(hardness))-4.705)}$ | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ |
| Acute | $e^{(1.273*(\ln(hardness))-1.460)}$ | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ |
| [(1)] Hardness is in units of mg/L.<br>[(2)] $Q_S$ is the flow in the stream in cfs. | | |

**Table 7.7 Nickel WQC and TMDL Load**

| Limit Type | Nickel WQC, µg/L[(1)] | Nickel TMDL Load, pounds/day[(2)] |
|---|---|---|
| Chronic | $e^{(0.846*(\ln(hardness))+0.0584)}$ | $Q_S \times 0.005394 \times e^{(0.846*(\ln(hardness))+0.0584)}$ |
| Acute | $e^{(0.846*(\ln(hardness))+2.255)}$ | $Q_S \times 0.005394 \times e^{(0.846*(\ln(hardness))+2.255)}$ |
| [(1)] Hardness is in units of mg/L.<br>[(2)] $Q_S$ is the flow in the stream. | | |

**Table 7.8 Zinc WQC and TMDL Load**

| Limit Type | Zinc WQC, µg/L[(1)] | Zinc TMDL Load, pounds/day[(2)] |
|---|---|---|
| Chronic | $e^{(0.8473*(\ln(hardness))+0.884)}$ | $Q_S \times 0.005394 \times e^{(0.8473*(\ln(hardness))+0.884)}$ |
| Acute | $e^{(0.8473*(\ln(hardness))+0.884)}$ | $Q_S \times 0.005394 \times e^{(0.8473*(\ln(hardness))+0.884)}$ |
| [(1)] Hardness is in units of mg/L.<br>[(2)] $Q_S$ is the flow in the stream in cfs. | | |

### 7.2.4 Net Alkalinity

As stated in Section 6.2, net alkalinity, or the alkalinity minus the calculated acidity, must be greater than or equal to zero to buffer metals hydrolysis. This concentration can be converted into a load as follows:

$$(\text{Net Alkalinity, mg/L as } CaCO_3) \times (Q_S \text{ ft}^3/\text{s}) \times (1 \text{ lb}/453{,}592.4 \text{ mg}) \times (86{,}400 \text{ s/day}) \times (28.31685 \text{ L/ft}^3) = \text{TMDL Load (pounds/day)}$$

Equation 7.10

This simplifies to a target load equal to or greater than zero pounds/day of net alkalinity as $CaCO_3$, which must be met at all times. Like metals and pH, KDOW expects compliance to be evaluated in terms of concentration, not load.

## 7.3 Margin of Safety

The MOS can be an implicit (using conservative assumptions) or explicit (a reserved portion) additional reduction applied to the WLA, LA or to both types of sources that accounts for uncertainties in the relationship between effluent limits and water quality. For this document, an implicit MOS has been incorporated by applying the following conservative assumptions:

1. All discharges are at the WQC at any given time; not all sources discharge at the WQC at the same time; some sources discharge below the WQC creating dilution water.
2. KPDES mining alkaline treatment pond systems normally over-treat the AMD before discharge, both in terms of precipitating metals by raising pH and leaving adequate alkalinity in the system as a buffer (EPA, 1982). Therefore, mine ponds discharge below their permitted effluent limits as a result of the need to retain adequate alkalinity. The WLAs for these sources were established at the water quality criteria, not below it.
3. Equation 6.3 for calculated acidity conservatively assumes that all iron is in the form of $Fe^{3+}$ as opposed to $Fe^{2+}$. Using $Fe^{3+}$ yields a greater calculated acidity, which results in a higher measured alkalinity necessary to maintain a net alkalinity greater than or equal to zero.
4. Allowable hydrogen ion loads (Table 7.2) were calculated using the greatest specific conductance measured within the Pond Creek watershed. Higher specific conductance values result in lower allowable hydrogen ion loads, thus the allowable hydrogen ion load range was set at a minimum level for the Pond Creek watershed.
5. The WLA for. *E. coli* from sanitary wastewater sources is set at the WQC. Due to the disinfection process, these sources frequently discharge below the allowable WQC.

## 7.4 Allocations

The TMDL load is divided up among the WLA (for current KDPES-permitted sources) and the LA (including natural background, non-KPDES-permitted sources and any mining source in operation prior to May 3, 1978). These sources receive allocations proportional to the flow each contributes to the surface water system at any given point. The instream flow can be divided among the various sources as follows:

$$Q_S = Q_{KPDES} + Q_{LA}$$

Equation 7.11

Where $Q_S$ is the flow in the stream, $Q_{KPDES}$ is the KPDES-related flow, and $Q_{LA}$ is the flow from LA sources. The flow unit is cfs. Like the TMDL itself, allocations must be presented in terms of load. The TMDL was already expressed in terms of load in Tables 7.1 through 7.8 for *E. coli*, pH and metals, and in Section 7.2.4 for a net alkalinity. The flows for each source in Equation 7.11 were expressed in terms of allocated load by multiplying all the flows by the WQC for each pollutant (or target, in terms of net alkalinity) and by a conversion factor, i.e., using the same procedure that generated the TMDL loads found in Tables 7.1 through 7.8 and Section 7.2.4. Table 7.9 shows the final allocations for all impaired segments in the TMDL watershed.

Expressing the TMDL allocations using variables for flow and hardness means that each source must achieve the WQCs for their portion of the instream flow at all times, under all flow conditions and all conditions of hardness. With all sources meeting their individual allocations, the TMDL will also be met at all times, under all flow conditions and all conditions of hardness, including the critical condition, see Sections 7.6 and 8.2.

## 7.5 Seasonality

Seasonality is defined as yearly factors such as temporal variations in source behavior and stream loading that can affect the relationship between pollutant inputs and the ability of the stream to meet its designated uses. A TMDL calculation must take into account seasonality, including a description of the method chosen for including seasonal variations.

### 7.5.1 *E. coli*

KPDES-permitted sanitary wastewater facilities, like those that exist in the Pond Creek watershed, are required to disinfect the wastewater stream prior to discharge. The concentration of bacteria in the discharge is thus dependent upon the effectiveness of the disinfection process and is not expected to show any specific seasonal trend.

Bacteria deposited on land surfaces may die off or re-grow. A review of factors important in the survival of bacteria in soils showed, in general, longer bacteria survival time under moist, cool and low sunlight conditions (reviewed in Gerba *et al*., 1975); thus, more bacteria may survive and be available for runoff from land surfaces during the late fall through early spring. Soil erosion and water runoff can both move bacteria to a stream or to groundwater. Precipitation averages for Central City, KY, which is located in Muhlenberg County just north of the Pond Creek watershed, indicate the highest average precipitation in the spring during the month of May (5 inches) and the lowest average precipitation in the fall during the month of October (2.9 inches) (http://countrystudies.us/united-states/weather/kentucky/ accessed 4/13/2016).

The criteria for *E. coli* only apply during the PCR season May 1 through October 31. Seasonality is addressed in the bacteria TMDL calculations by requiring KPDES-permitted sanitary wastewater facilities to meet the WCQ for *E. coli* at the outlet of their discharge pipe at all times (a permit requirement). For storm water and nonpoint sources, seasonality is addressed by requiring the *E. coli* criteria to be met in-stream during the entire PCR season under all flow conditions.

### 7.5.2 pH and Metals

KPDES-permitted mining sources generally discharge in response to precipitation events, but treatment ponds are built to achieve a certain retention time. Ponds that are on a mine bench are usually designed to capture a 24-hour storm event with a 10-year recurrence interval, thus they should only discharge following large rainfall events (greater than 4 inches within 24-hours).

Ponds that are within the stream channel have a discharge that is more continuous and correlated with stream flow conditions. Acidic mine seeps discharge based upon groundwater flow, which is expected to be driven by groundwater recharge in response to rainfall events.

Precipitation over western Kentucky is acidic, with typical pH values in the 4s and 5s. Although rainfall pH in western Kentucky varies monthly, with higher pH values tending to occur in the spring/summer, there was enough yearly variability that no specific seasonal trend could be discerned (http://nadp.sws.uiuc.edu/data/sites/list/?net=NTN stations KY99 and KY10, accessed 5/17-18/2016). Additionally, even with this variability, the rainfall remained in the acidic range throughout various seasons.

If acidic precipitation falls on soils, it can be buffered to a more neutral pH by soil alkalinity. In the acidic state, it can leach metals from soil or exposed rock and carry it to a stream. Acidic rainfall that falls on metal-containing structures, including asphalt, buildings, roofs, fences, etc., can leach metals from these materials. Even neutral rainfall can move metals deposited on surfaces from atmospheric deposition, automobile brake dust or corrosion and other sources to streams.

Rainfall is greatest during the spring (see Section 7.5.1); therefore, the instances of low pH and metal loadings from rainfall related sources would be more frequent in the spring. However, more continuous discharges, such as may occur from an acid mine seep or an in-stream mine pond, may show no seasonal loading trend.

Seasonality is addressed in the pH TMDL calculations by requiring KPDES-permitted sources to discharge at a pH between 6.0 and 9.0, inclusive, and in metals calculations by requiring them to meet the applicable acute and chronic metals criteria at all times. For unregulated storm water and nonpoint sources, seasonality is addressed by requiring the pH and metals criteria to be met in-stream at all times during all types of precipitation and flow events.

## 7.6 Critical Condition

For TMDL purposes, the critical condition is defined as the period when the pollutant conditions or effects are expected to be at their worst. TMDLs are required to identify the critical conditions for both point and nonpoint source loadings and to protect designated uses during these conditions.

### 7.6.1 *E. coli*

As mentioned under the Seasonality Section, KPDES-permitted sanitary wastewater facilities are required to disinfect their discharge year-round. However, the relative contribution of fecal bacteria from sanitary wastewater dischargers versus other sources is expected to be greatest during dry periods when storm water sources are not contributing to the load and during periods of low stream flow when dilution is minimized. Therefore, the critical conditions for sanitary wastewater facilities are defined as dry events (i.e. during periods of no rainfall) and low stream flow conditions.

The critical condition for storm water and nonpoint source bacteria loadings is typically an extended dry period followed by a rainfall event that moves bacteria to a stream via soil erosion or storm water runoff. During the dry weather period, bacteria build up on the land surface and are washed off by subsequent rainfall. The critical condition for nonpoint and storm water source loading of bacteria is thus identified as rainfall-related events.

Once in a stream, fecal bacteria are known to sorb to soil particles and settle into the sediments of the stream bed. These soil-sorbed bacteria can become resuspended in the water column during turbulent water flow conditions. This resuspension of fecal bacteria along with rainfall-related source contributions frequently results in high fecal bacteria concentrations measured following rainfall events.

The TMDL calculations contained within this document protect the PCR use during the identified critical conditions by requiring in-stream concentrations of fecal bacteria to meet the WQC under all flow and precipitation conditions during the months of May through October.

### 7.6.2 pH and Metals

Acidic pH discharges can be buffered by alkalinity either on land or in a stream. Data from the Pond Creek watershed indicates that low pH (below 6.0) tends to occur in streams when in-stream alkalinity is non-detect.

It has been demonstrated that a number of metallic elements, including cadmium, nickel and zinc, are less toxic to aquatic life as water hardness increases (EPA, 1986). Excess hardness may lower the toxicity of certain metals to aquatic organisms by combining with the metals to form less toxic compounds. Also cations (likely calcium, perhaps others) may have an antagonistic effect on the metals in question by taking up binding sites on ion-regulating proteins, possibly in the organism's gills, which interferes with the uptake of metals. Several researchers suggest that both alkalinity and the associated cations synergistically contribute to the reduction in toxicity (Wurts and Perschbacher, 1994).

Although permitted mining sources generally discharge in response to precipitation events, this discharge may not immediately follow rainfall events as treatment ponds are built to achieve a certain retention time. Rainfall events may also cause surface runoff from the abandoned mine lands, which may exacerbate pH and metals in the stream. At low flow conditions, commonly occurring during the dry weather periods, the stream receives its base flow from groundwater, which may bring discharges from underground mining to the stream. The TMDLs within this document protect the human recreation activities and aquatic life habitats during the critical conditions by requiring KPDES-permitted sources to discharge at a pH between 6.0 and 9.0, inclusive, and to maintain a net alkalinity equal to or greater than 0.0 mg/L and in metals calculations by requiring them to meet the applicable acute and chronic metals criteria at all times. For unregulated storm water and nonpoint sources, critical conditions are addressed by requiring the pH and metals criteria to be met in-stream at all times under all rainfall conditions.

## 7.7 TMDL Allocations

Table 7.9 gives TMDL allocations for all pollutants for all impaired waterbodies addressed by this TMDL.

**Table 7.9 TMDLs and Allocations by Impaired Segments**

| Pollutant | Units | TMDL[1] | MOS[2] | KPDES-WLA[3] | LA[4] |
|---|---|---|---|---|---|
| **Bat East Creek 0.0 to 3.4** | | | | | |
| *E. coli* | colonies/day | $Q_S$×WQC×24,465,758.4 | Implicit | $Q_{KPDES}$× WQC×24,465,758.4 | $Q_{LA}$× WQC×24,465,758.4 |
| Copper (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.8545*(\ln(hardness))-1.702)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.8545*(\ln(hardness))-1.702)}$ | $Q_{LA} \times 0.005394 \times e^{(0.8545*(\ln(hardness))-1.702)}$ |
| Copper (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(0.9422*(\ln(hardness))-1.700)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.9422*(\ln(hardness))-1.700)}$ | $Q_{LA} \times 0.005394 \times e^{(0.9422*(\ln(hardness))-1.700)}$ |
| Lead (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ | $Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ |
| Lead (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ | $Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ |
| **Beech Creek 0.0 to 3.9** | | | | | |
| Cadmium (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ |
| Cadmium (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | $Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ |
| Iron (Chronic)[5] | pounds/day | $Q_S$×5.3938 | Implicit | $Q_{KPDES}$×5.3938 | $Q_{LA}$×5.3938 |
| Iron (Acute) | pounds/day | $Q_S$×21.575 | Implicit | $Q_{KPDES}$×21.575 | $Q_{LA}$×21.575 |
| Nickel (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.846*(\ln(hardness))+ 0.0584)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.846*(\ln(hardness))+ 0.0584)}$ | $Q_{LA} \times 0.005394 \times e^{(0.846*(\ln(hardness))+ 0.0584)}$ |
| Nickel (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(0.846*(\ln(hardness))+2.255)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.846*(\ln(hardness))+2.255)}$ | $Q_{LA} \times 0.005394 \times e^{(0.846*(\ln(hardness))+2.255)}$ |
| Zinc ( Acute and Chronic)[6] | pounds/day | $Q_S \times 0.005394 \times e^{(0.8473*(\ln(hardness))+ 0.884)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.8473*(\ln(hardness))+ 0.884)}$ | $Q_{LA} \times 0.005394 \times e^{(0.8473*(\ln(hardness))+ 0.884)}$ |
| **Boggess Creek 0.0 to 3.0** | | | | | |
| *E. coli* | colonies/day | $Q_S$×WQC×24,465,758.4 | Implicit | $Q_{KPDES}$× WQC×24,465,758.4 | $Q_{LA}$× WQC×24,465,758.4 |
| **Caney Creek 0.0 to 3.6** | | | | | |

| Pollutant | Units | TMDL[1] | MOS[2] | KPDES-WLA[3] | LA[4] |
|---|---|---|---|---|---|
| *E. coli* | colonies/day | $Q_S$×WQC×24,465,758.4 | Implicit | $Q_{KPDES}$× WQC×24,465,758.4 | $Q_{LA}$× WQC×24,465,758.4 |
| Cadmium (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ |
| Cadmium (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | $Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ |
| **Caney Creek 3.6 to 7.6** | | | | | |
| *E. coli* | colonies/day | $Q_S$×WQC×24,465,758.4 | Implicit | $Q_{KPDES}$× WQC×24,465,758.4 | $Q_{LA}$× WQC×24,465,758.4 |
| Cadmium (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ |
| Cadmium (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | $Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ |
| Lead (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ | $Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ |
| Lead (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ | $Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ |
| **Carters Creek 0.0 to 3.1** | | | | | |
| *E. coli* | colonies/day | $Q_S$×WQC×24,465,758.4 | Implicit | $Q_{KPDES}$× WQC×24,465,758.4 | $Q_{LA}$× WQC×24,465,758.4 |
| **Opossum Run 0.0 to 1.6** | | | | | |
| *E. coli* | colonies/day | $Q_S$×WQC×24,465,758.4 | Implicit | $Q_{KPDES}$× WQC×24,465,758.4 | $Q_{LA}$× WQC×24,465,758.4 |
| **Plum Creek 0.0 to 1.65** | | | | | |
| *E. coli* | colonies/day | $Q_S$×WQC×24,465,758.4 | Implicit | $Q_{KPDES}$× WQC×24,465,758.4 | $Q_{LA}$× WQC×24,465,758.4 |
| Cadmium (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ |
| Cadmium (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | $Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ |
| **Plum Creek 1.65 to 3.9** | | | | | |
| *E. coli* | colonies/day | $Q_S$×WQC×24,465,758.4 | Implicit | $Q_{KPDES}$× WQC×24,465,758.4 | $Q_{LA}$× WQC×24,465,758.4 |

| Pollutant | Units | TMDL[1] | MOS[2] | KPDES-WLA[3] | LA[4] |
|---|---|---|---|---|---|
| pH[7] | standard units | $6.0 \leq pH \leq 9.0$ | Implicit | $6.0 \leq pH \leq 9.0$ | $6.0 \leq pH \leq 9.0$ |
| Alkalinity, Acidity[8] | mg/L as $CaCO_3$ | Net Alkalinity $\geq 0$ | Implicit | Net Alkalinity $\geq 0$ | Net Alkalinity $\geq 0$ |
| Cadmium (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ |
| Cadmium (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | $Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ |
| Nickel (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.846*(\ln(hardness))+ 0.0584)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.846*(\ln(hardness))+ 0.0584)}$ | $Q_{LA} \times 0.005394 \times e^{(0.846*(\ln(hardness))+ 0.0584)}$ |
| Nickel (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(0.846*(\ln(hardness))+2.255)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.846*(\ln(hardness))+2.255)}$ | $Q_{LA} \times 0.005394 \times e^{(0.846*(\ln(hardness))+2.255)}$ |
| Zinc ( Acute and Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.8473*(\ln(hardness))+ 0.884)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.8473*(\ln(hardness))+ 0.884)}$ | $Q_{LA} \times 0.005394 \times e^{(0.8473*(\ln(hardness))+ 0.884)}$ |
| **Pond Creek 0.0 to 5.0** | | | | | |
| Iron (Chronic)[9] | pounds/day | $Q_S \times 18.878$ | Implicit | $Q_{KPDES} \times 18.878$ | $Q_{LA} \times 18.878$ |
| Iron (Acute) | pounds/day | $Q_S \times 21.575$ | Implicit | $Q_{KPDES} \times 21.575$ | $Q_{LA} \times 21.575$ |
| **Pond Creek 5.0 to 7.5** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24{,}465{,}758.4$ | $Q_{LA} \times WQC \times 24{,}465{,}758.4$ |
| Cadmium (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ |
| Cadmium (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | $Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ |
| Iron (Chronic)[5] | pounds/day | $Q_S \times 5.3938$ | Implicit | $Q_{KPDES} \times 5.3938$ | $Q_{LA} \times 5.3938$ |
| Iron (Acute) | pounds/day | $Q_S \times 21.575$ | Implicit | $Q_{KPDES} \times 21.575$ | $Q_{LA} \times 21.575$ |
| **Pond Creek 7.5 to 11.7** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24{,}465{,}758.4$ | $Q_{LA} \times WQC \times 24{,}465{,}758.4$ |

| Pollutant | Units | TMDL[1] | MOS[2] | KPDES-WLA[3] | LA[4] |
|---|---|---|---|---|---|
| Cadmium (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ |
| Cadmium (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | $Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ |
| Iron (Chronic)[5] | pounds/day | $Q_S \times 5.3938$ | Implicit | $Q_{KPDES} \times 5.3938$ | $Q_{LA} \times 5.3938$ |
| Iron (Acute) | pounds/day | $Q_S \times 21.575$ | Implicit | $Q_{KPDES} \times 21.575$ | $Q_{LA} \times 21.575$ |
| **Pond Creek 11.7 to 14.4** | | | | | |
| Cadmium (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ |
| Cadmium (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | $Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ |
| Iron (Chronic)[5] | pounds/day | $Q_S \times 5.3938$ | Implicit | $Q_{KPDES} \times 5.3938$ | $Q_{LA} \times 5.3938$ |
| Iron (Acute) | pounds/day | $Q_S \times 21.575$ | Implicit | $Q_{KPDES} \times 21.575$ | $Q_{LA} \times 21.575$ |
| **Pond Creek 14.4 to 18.1** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24{,}465{,}758.4$ | $Q_{LA} \times WQC \times 24{,}465{,}758.4$ |
| Lead (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ | $Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ |
| Lead (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ | $Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ |
| **Pond Creek 18.1 to 18.7** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24{,}465{,}758.4$ | $Q_{LA} \times WQC \times 24{,}465{,}758.4$ |
| **Saltlick Creek 0.0 to 3.7** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24{,}465{,}758.4$ | $Q_{LA} \times WQC \times 24{,}465{,}758.4$ |
| **Sandlick Creek 0.0 to 4.05** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24{,}465{,}758.4$ | $Q_{LA} \times WQC \times 24{,}465{,}758.4$ |

| Pollutant | Units | TMDL(1) | MOS(2) | KPDES-WLA(3) | LA(4) |
|---|---|---|---|---|---|
| Iron (Chronic)(5) | pounds/day | $Q_S \times 5.3938$ | Implicit | $Q_{KPDES} \times 5.3938$ | $Q_{LA} \times 5.3938$ |
| Iron (Acute) | pounds/day | $Q_S \times 21.575$ | Implicit | $Q_{KPDES} \times 21.575$ | $Q_{LA} \times 21.575$ |
| Lead (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ | $Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ |
| Lead (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ | $Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ |
| **UT of Bat East Creek 0.0 to 1.9** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24{,}465{,}758.4$ | $Q_{LA} \times WQC \times 24{,}465{,}758.4$ |
| **UT of Bat East Creek 0.0 to 3.55** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24{,}465{,}758.4$ | $Q_{LA} \times WQC \times 24{,}465{,}758.4$ |
| **UT of Caney Creek 0.0 to 2.6** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24{,}465{,}758.4$ | $Q_{LA} \times WQC \times 24{,}465{,}758.4$ |
| Lead (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ | $Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ |
| Lead (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ | $Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ |
| **UT of Caney Creek 0.0 to 2.35** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24{,}465{,}758.4$ | $Q_{LA} \times WQC \times 24{,}465{,}758.4$ |
| Lead (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ | $Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(hardness))-4.705)}$ |
| Lead (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ | $Q_{LA} \times 0.005394 \times e^{(1.273*(\ln(hardness))-1.460)}$ |
| **UT of Plum Creek 0.0 to 2.45** | | | | | |
| pH(7) | standard units | $6.0 \leq pH \leq 9.0$ | Implicit | $6.0 \leq pH \leq 9.0$ | $6.0 \leq pH \leq 9.0$ |
| Alkalinity, Acidity(8) | mg/L as $CaCO_3$ | Net Alkalinity ≥ 0 | Implicit | Net Alkalinity ≥ 0 | Net Alkalinity ≥ 0 |

| Pollutant | Units | TMDL(1) | MOS(2) | KPDES-WLA(3) | LA(4) |
|---|---|---|---|---|---|
| Cadmium (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ |
| Cadmium (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | $Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ |
| Iron (Chronic)(5) | pounds/day | $Q_S \times 5.3938$ | Implicit | $Q_{KPDES} \times 5.3938$ | $Q_{LA} \times 5.3938$ |
| Iron (Acute) | pounds/day | $Q_S \times 21.575$ | Implicit | $Q_{KPDES} \times 21.575$ | $Q_{LA} \times 21.575$ |
| Nickel (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.846*(\ln(hardness))+0.0584)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.846*(\ln(hardness))+0.0584)}$ | $Q_{LA} \times 0.005394 \times e^{(0.846*(\ln(hardness))+0.0584)}$ |
| Nickel (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(0.846*(\ln(hardness))+2.255)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.846*(\ln(hardness))+2.255)}$ | $Q_{LA} \times 0.005394 \times e^{(0.846*(\ln(hardness))+2.255)}$ |
| Zinc ( Acute and Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.8473*(\ln(hardness))+0.884)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.8473*(\ln(hardness))+0.884)}$ | $Q_{LA} \times 0.005394 \times e^{(0.8473*(\ln(hardness))+0.884)}$ |
| **UT of Pond Creek 0.0 to 2.4** | | | | | |
| Iron (Chronic)(5) | pounds/day | $Q_S \times 5.3938$ | Implicit | $Q_{KPDES} \times 5.3938$ | $Q_{LA} \times 5.3938$ |
| Iron (Acute) | pounds/day | $Q_S \times 21.575$ | Implicit | $Q_{KPDES} \times 21.575$ | $Q_{LA} \times 21.575$ |
| **UT of Pond Creek 2.4 to 4.2** | | | | | |
| *E. coli* | colonies/day | $Q_S \times WQC \times 24{,}465{,}758.4$ | Implicit | $Q_{KPDES} \times WQC \times 24{,}465{,}758.4$ | $Q_{LA} \times WQC \times 24{,}465{,}758.4$ |
| Cadmium (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ |
| Cadmium (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ | $Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(hardness))-3.924)}$ |
| pH(7) | standard units | $6.0 \leq pH \leq 9.0$ | Implicit | $6.0 \leq pH \leq 9.0$ | $6.0 \leq pH \leq 9.0$ |
| Alkalinity, Acidity(8) | mg/L as $CaCO_3$ | Net Alkalinity ≥ 0 | Implicit | Net Alkalinity ≥ 0 | Net Alkalinity ≥ 0 |
| **UT of Pond Creek 0.0 to 1.4** | | | | | |
| Cadmium (Chronic) | pounds/day | $Q_S \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ | $Q_{LA} \times 0.005394 \times e^{(0.7409*(\ln(hardness))-4.719)}$ |

| Pollutant | Units | TMDL[(1)] | MOS[(2)] | KPDES-WLA[(3)] | LA[(4)] |
|---|---|---|---|---|---|
| Cadmium (Acute) | pounds/day | $Q_S \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$ | Implicit | $Q_{KPDES} \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$ | $Q_{LA} \times 0.005394 \times e^{(1.0166*(\ln(\text{hardness}))-3.924)}$ |

1) TMDLs for *E. coli* are expressed as the flow in the stream, $Q_S$ in $ft^3/s$, multiplied by the WQCs: i) 240 *E. coli* colonies/100 ml which must be met in at least 80% of all samples taken within a 30-day period during the Primary Contact Recreational season of May through October; ii) 130 *E. coli* colonies/100 ml as a geometric mean based on not less than 5 samples taken within a 30-day period during the Primary Contact Recreational season of May through October. Then the multiple of Qs and WQC is converted into *E. coli* load (colonies/day) by multiplying the conversion factor of 24,465,758.4. TMDLs for metals are expressed as the flow in the stream, $Q_S$ in $ft^3/s$, multiplied by the WQC in mg/L or µg/L and the appropriate conversion factor to convert the multiple of flow and the WQC into to units of load (pounds/day). The conversion factors are: iron, chronic = 5.3938 (when the WQC of 1.0 mg/L is applied) or 18.8782 (when the WQC of 3.5 mg/L is applied); iron, acute = 21.575; cadmium, copper, lead, nickel and zinc, chronic and acute = 0.005394. Also, pH must remain between 6.0 and 9.0 standard units, inclusive.
2) The MOS is implicit, see Section 7.3.
3) The KPDES-WLA for *E. coli* is expressed as the flow in the stream due to KPDES-permitted sources with *E. coli* permit limits, $Q_{KPDES}$ in $ft^3/s$, multiplied by the WQCs and the conversion factor to convert the multiple of flow and the WQC into the unit of load (colonies/day). All KPDES-permitted dischargers must meet both instantaneous and geomean *E. coli* WQCs. The KPDES-WLA for metals is expressed as the flow in the stream due to KPDES-permitted sources with permit limits for the pollutants addressed by this TMDL, $Q_{KPDES}$, in $ft^3/s$, multiplied by the WQC and the appropriate conversion factor. All KPDES-permitted dischargers must meet both the chronic and acute criteria for pollutants addressed by this TMDL whose WQCs are expressed in both chronic and acute terms. New or expanded KPDES-permitted dischargers with reasonable potential will be allowed contingent upon them meeting WQCs of the pollutants addressed in this document.
4) The LA is expressed as the flow in the stream from natural background or due to legal but non-KPDES-permitted sources of the pollutants addressed by this TMDL, $Q_{LA}$, in $ft^3/s$, multiplied by the WQC and the appropriate conversion factor, see Section 5.2.
5) The chronic iron WQC is 1.0 mg/L since the aquatic life is adversely affected. The acute iron WQC is not dependent on impacts to aquatic life; it is 4.0 mg/L in all streams.
6) The chronic and acute WQCs for zinc are identical.
7) pH can be converted to a range of allowable loads of hydrogen ions in units of g/day (gram per day); a pH of 6.0 represents a maximum allowable load of hydrogen ions equal to $Q_S \times 2.906$ g/day, and a pH of 9.0 represents a minimum allowable load of $Q_S \times 2.906E\text{-}3$ g/day, where $Q_S$ is the flow in the stream in $ft^3/s$. The TMDL can then be allocated to the KPDES-WLA and the LA based on the fraction of the streamflow each contributes.
8) Net alkalinity is defined as the alkalinity in mg/L as $CaCO_3$ minus the calculated acidity; the calculated acidity is determined using the following equation: Calculated Acidity, mg/L as $CaCO_3 = 50 \times ((10^{(3\text{-pH})}) + (3 \times \text{Fe mg/L}/55.8) + (2 \times \text{Mn mg/L}/54.9) + (3 \times \text{Al mg/L}/27))$. Monitoring and reporting of net alkalinity will be required both instream and at outfalls at the same frequency as iron and manganese are monitored and reported. Aluminum must be added to KPDES mining permits as report-only in order to determine the calculated acidity. Net alkalinity must be greater than or equal to zero (in both mg/L and pounds/day) in order to buffer metals hydrolysis which can lower pH below acceptable levels.
9) The chronic iron WQC is 3.5 mg/L since the aquatic life has not been shown to be adversely affected. The acute iron WQC is not dependent on impacts to aquatic life; it is 4.0 mg/L in all streams.

# 8.0 Individual Segments TMDL Calculations

This section presents data collected by the TMDL Section and includes an individual analysis of each impaired stream segment. The maps in this document are developed by the KDOW TMDL Section and most of the spatial data can be accessed and downloaded from the KYGEONET (http://kygeonet.ky.gov).

**Data Validation**

1. Quality Analysis/Quality Control samples (e.g., duplicates) were not considered during TMDL analysis.
2. Only samples collected from a flowing stream were considered in analysis.
3. Some samples were reported using either the *less than* (denoted using the "<") symbol or the *greater than* (denoted using the ">") symbol, indicating the true concentration was unknown but was either below or above the reported value, respectively. For these samples, the reported value was used verbatim. For *greater than* values, the exact value of the exceedance is unknown and likely higher than the number reported, however the sample still provides insight into the status of the waterbody at the time the sample was taken.
4. J-flagged data, which are those results above the detection limit but below the limit of quantitation, were reported verbatim.

As stated in Sections 2.1 and 7.4, the data were used to assess the streams for the impairments but not used to set a unique TMDL for any segment. This is because the TMDL is constructed using variables for flow and hardness (for some metals); this means the TMDL is valid at all times, under all flow conditions and all conditions of hardness, including the critical condition for each segment.

**General Information**

Hydrology and monitoring results from 2010-2014 are discussed for each segment, which are presented alphabetically. Only data for the pollutants that impair a given segment are shown in this document.

Bacteria and flow data collected by TMDL staff are presented for each *E. coli* impaired segment. Metals, pH and flow data collected by TMDL staff are presented for the impaired segments. For pH and iron, the concentrations were presented without further analysis beyond flagging for exceedances of the WQCs (i.e., pH below 6.0 standard units, and iron above the chronic or acute criterion). However, for the hardness-dependent metals, further columns were added. These include the hardness, the WQC, which was calculated based on the hardness, and another column showing the amount by which the instream metal concentration exceeded the WQC. This last column was included because knowing the concentration of the metal by itself often gives little to no understanding of its toxicity at the time the sample was collected; on a day with low hardness, a low concentration of the metal may pose more of a risk to aquatic life than a higher concentration of the metal on a day with significantly higher hardness. This is because hardness mitigates the toxicity of these metals, as described in Section 7.6.2. The amount by which the concentration of the hardness-dependent metal exceeded the WQC will be referred to as 'the (cadmium/copper/lead/nickel/zinc) difference' in places to avoid repetition. It is presented as a negative number when the concentration of the metal did not exceed the WQC.

### 8.1 Bat East Creek 0.0 to 3.4

The pollutants addressed in this document for Bat East Creek 0.0 to 3.4 are *E. coli*, copper and lead. Bat East Creek is a fourth order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 22.06 square miles. There is one TMDL monitoring site on the Bat East Creek 0.0 to 3.4 segment, DOW03011007, located at RM 1.35 with the drainage area of 21.44 square miles, see Figure 8.1.1 and Table 8.1.1. This subwatershed consists primarily of forest (59.6%) and agricultural land (31.8%), see Figure 8.1.2 and Table 8.1.2.

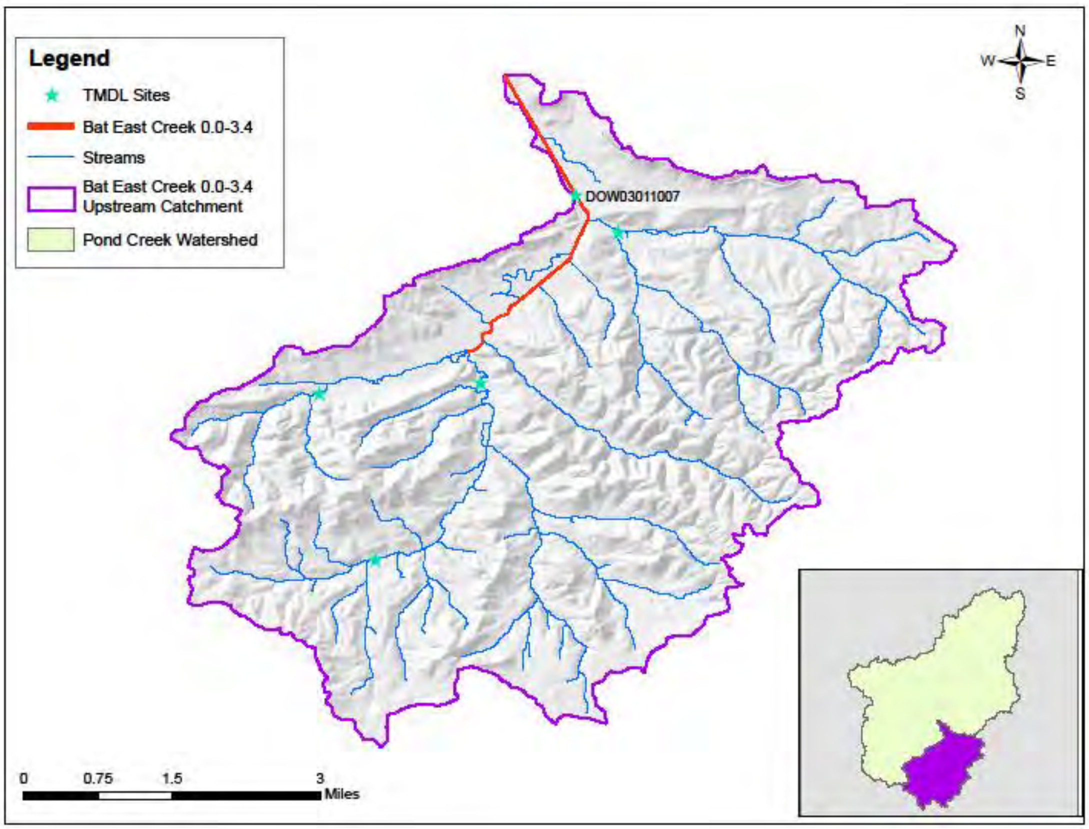


**Figure 8.1.1 TMDL Monitoring Location and the Drainage Area of Bat East Creek 0.0 to 3.4**

**Table 8.1.1 Bat East Creek 0.0 to 3.4 Segment/Upstream Catchment Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY486462_01 | Bat East Creek 0.0 to 3.4 | 4 | Muhlenberg | 22.06 | 14120.4 |

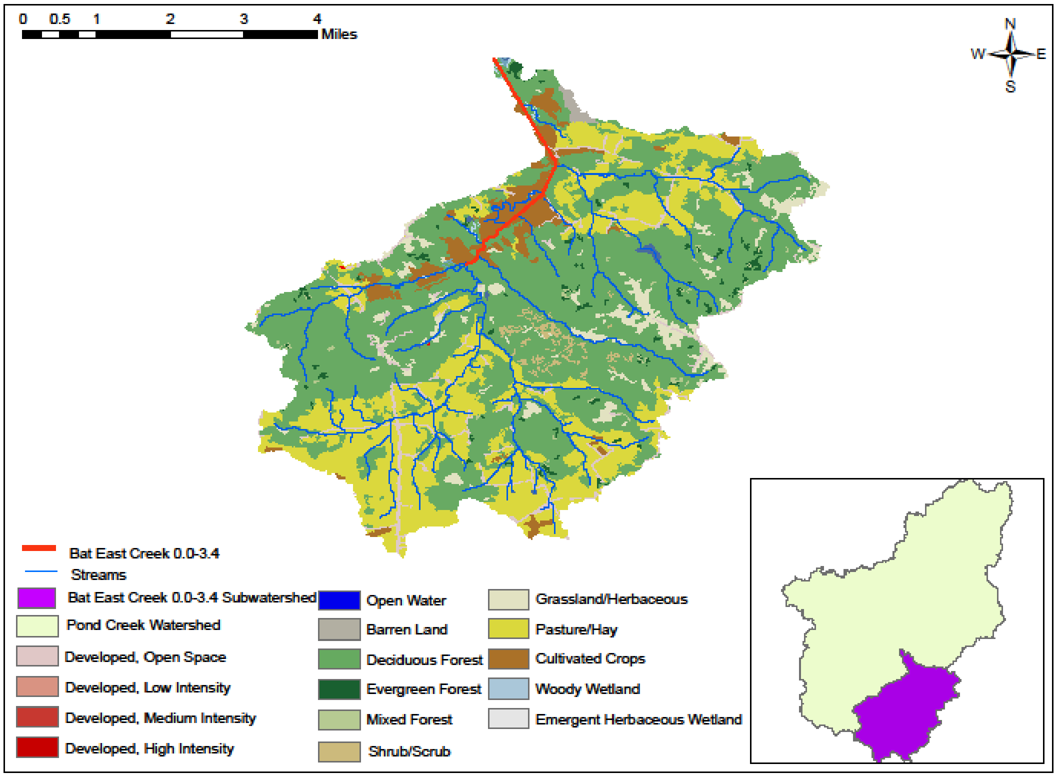


**Figure 8.1.2 Land Cover in the Bat East Creek 0.0 to 3.4 Subwatershed**

**Table 8.1.2 Land Cover in the Bat East Creek 0.0 to 3.4 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 0.76 | 484.4 | 3.5 |
| Agriculture | 6.96 | 4452.5 | 31.8 |
| Forest | 13.05 | 8350.2 | 59.6 |
| Barren Land | 0.05 | 32.0 | 0.2 |
| Grassland/Herbaceous | 0.99 | 632.3 | 4.5 |
| Wetlands | 0.03 | 20.4 | 0.1 |
| Water | 0.06 | 36.3 | 0.3 |
| Shrub/Scrub | 0.18 | 112.7 | 0.8 |

There is one active KPDES- permitted facility in this subwatershed, see Figure 8.1.3 and Table 8.1.3. There are no active KPDES mining permits in this subwatershed, and a small portion of downstream watershed is licensed mining areas, see Figure 8.1.4 (see Section 9.4.3 for more information). Tables 8.1.4 to 8.1.6 show *E. coli*, copper, lead and flow data collected by TMDL staff at DOW03011007.

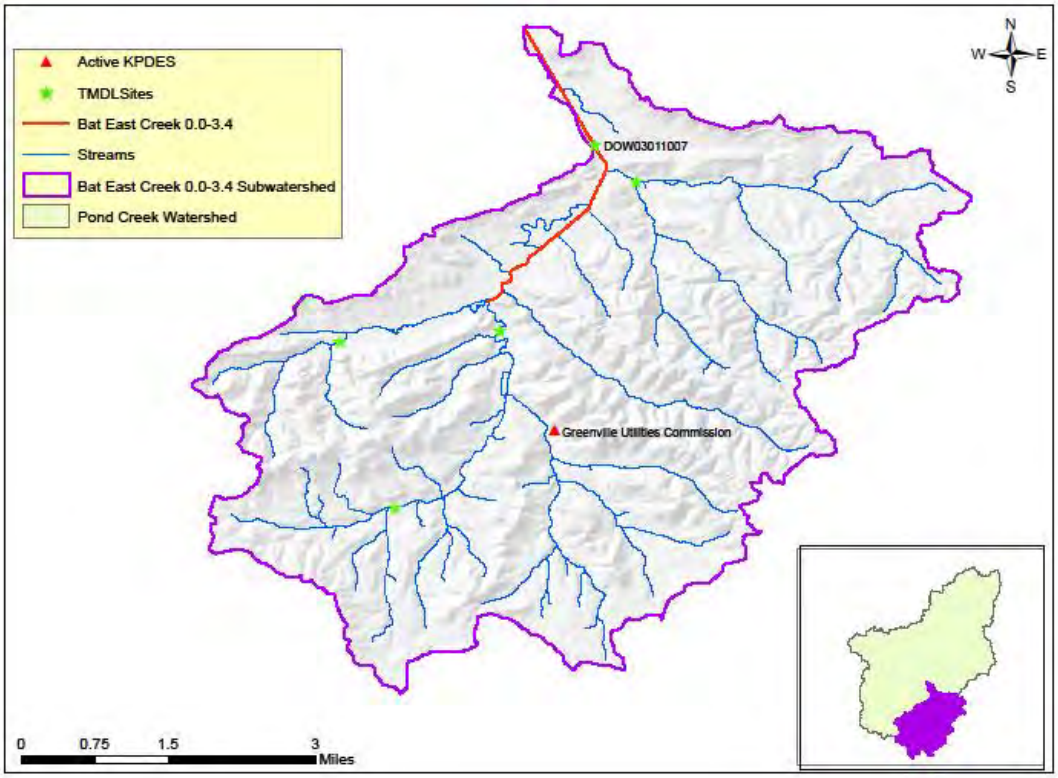


**Figure 8.1.3 KPDES Permittee in the Subwatershed**

**Table 8.1.3 KPDES Permittee in the Subwatershed**

| KPDES | Status | Permit Name | Latitude | Longitude | Pollutants with Discharge Limit |
|---|---|---|---|---|---|
| KYG640108 | Active | Greenville Utilities Commission | 37.1139 | -87.1032 | pH, Iron |

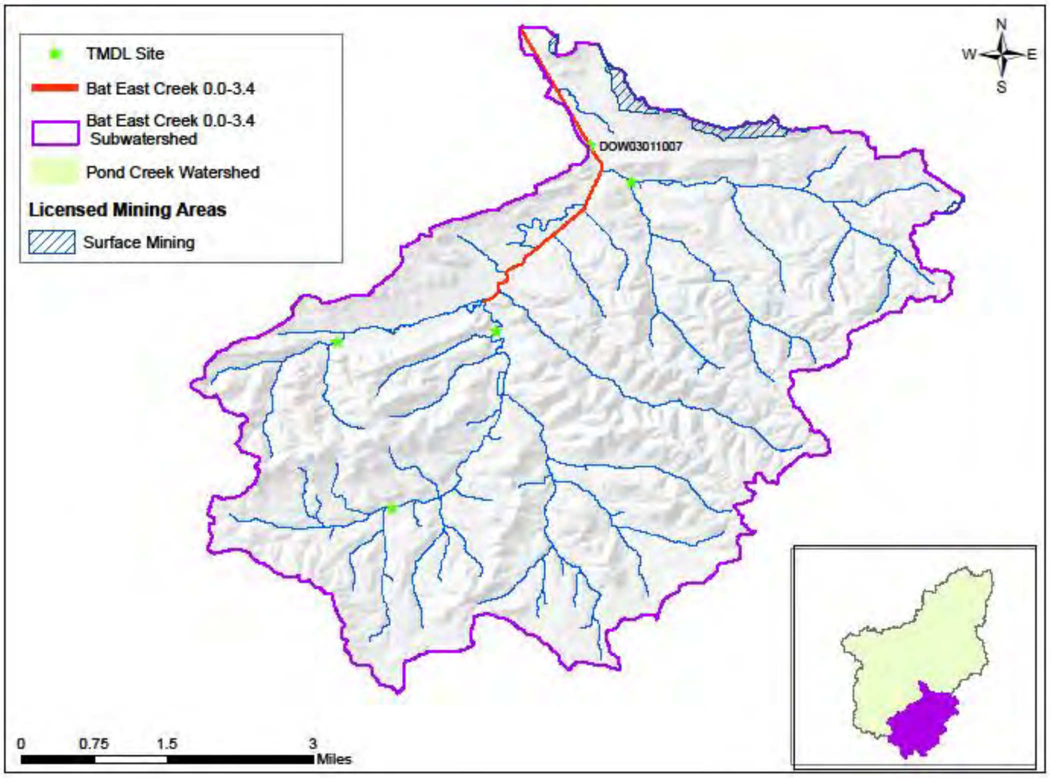


**Figure 8.1.4 Data from the Department of Natural Resources on Licensed Mining Areas in the Subwatershed**

**Table 8.1.4 *E. coli* and Flow Data Collected at DOW03011007**

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 5/11/2011 | 308 | ** |
| 5/12/2011 | 292 | ** |
| 5/24/2011 | > 2420 | ** |
| 5/25/2011 | 816 | ** |
| 5/26/2011 | > 2420 | ** |
| 6/15/2011 | 111 | ** |
| 6/16/2011 | > 2420 | ** |
| 6/21/2011 | 866 | ** |
| 6/22/2011 | 1203 | ** |
| 6/23/2011 | > 2420 | ** |
| 7/12/2011 | 14 | ** |
| 7/13/2011 | 118 | ** |

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 7/14/2011 | > 2420 | ** |
| 9/27/2011 | > 2420 | ** |
| 9/28/2011 | 1986 | ** |
| 9/29/2011 | 235 | ** |
| Exceeds the instantaneous *E. coli* limit | | |

**Table 8.1.5 Copper and Flow Data Collected at DOW03011007**

| Date | Copper (µg/L) | Hardness, Total (mg/L) | Copper Chronic Limit (µg/L) | Copper Acute Limit (µg/L) | Difference between the Copper Concentration and the Copper Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 11/17/2010 | 2.86 | 951 | 63.93 | 116.88 | -61.07 | ** |
| 1/4/2011 | 0.507 (J) | 64.2 | 6.39 | 9.22 | N/A | ** |
| 1/5/2011 | 0.53 (J) | 61.5 | 6.16 | 8.85 | N/A | ** |
| 1/6/2011 | < 1.0 (U) | 62.9 | 6.28 | 9.04 | N/A | ** |
| 2/15/2011 | 0.546 (J) | 55.3 | 5.62 | 8.01 | N/A | ** |
| 2/16/2011 | 0.536 (J) | 57.7 | 5.83 | 8.34 | N/A | ** |
| 2/17/2011 | 0.594 (J) | 59.4 | 5.98 | 8.57 | N/A | ** |
| 3/8/2011 | 0.936 (J) | 43.9 | 4.62 | 6.45 | N/A | ** |
| 3/9/2011 | 3.21 | 25.4 | 2.89 | 3.85 | 0.32 | ** |
| 3/10/2011 | 0.895 (J) | 35.9 | 3.89 | 5.33 | N/A | ** |
| 4/26/2011 | 1.04 (J) | 36 | 3.90 | 5.35 | N/A | ** |
| 4/27/2011 | 5.24 | 23 | 2.66 | 3.51 | 2.58 | ** |
| 4/28/2011 | 1.16 (J) | 31.6 | 3.49 | 4.73 | N/A | ** |
| 5/10/2011 | 0.669 (J) | 46.2 | 4.82 | 6.76 | N/A | ** |
| 5/11/2011 | 0.635 (J) | 48.9 | 5.06 | 7.13 | N/A | ** |
| 5/12/2011 | 0.948 (J) | 279 | 22.42 | 36.81 | N/A | ** |
| 6/15/2011 | 1.83 | 69.6 | 6.84 | 9.95 | -5.01 | ** |
| 6/16/2011 | 11.5 | 62.3 | 6.23 | 8.96 | 5.27 | ** |
| 7/12/2011 | 1.24 | 131 | 11.75 | 18.05 | -10.51 | ** |
| 7/13/2011 | 1.71 | 73.2 | 7.15 | 10.43 | -5.44 | ** |
| 7/14/2011 | 3.86 (JD) | 68.5 | 6.75 | 9.80 | N/A | ** |

| Date | Copper (µg/L) | Hardness, Total (mg/L) | Copper Chronic Limit (µg/L) | Copper Acute Limit (µg/L) | Difference between the Copper Concentration and the Copper Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|

(orange) Exceeds the acute limit
(pink) Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
D = Reanalyzed at a Higher Dilution
J = Estimated Value
U = Analyte Not Detected
N/A: Not Applicable

**Table 8.1.6 Lead and Flow Data Collected at DOW03011007**

| Date | Lead (µg/L) | Hardness, Total (mg/L) | Lead Chronic Limit (µg/L) | Lead Acute Limit (µg/L) | Difference between the Lead Concentration and the Lead Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 11/17/2010 | 0.791 | 951 | 55.96 | 1435.99 | -55.17 | ** |
| 1/4/2011 | < 0.50 (U) | 64.2 | 1.81 | 46.44 | N/A | ** |
| 1/5/2011 | < 0.50 (U) | 61.5 | 1.71 | 43.97 | N/A | ** |
| 1/6/2011 | < 0.50 (U) | 62.9 | 1.76 | 45.25 | N/A | ** |
| 2/15/2011 | < 0.50 (U) | 55.3 | 1.50 | 38.41 | N/A | ** |
| 2/16/2011 | < 0.50 (U) | 57.7 | 1.58 | 40.54 | N/A | ** |
| 2/17/2011 | 0.528 | 59.4 | 1.64 | 42.07 | -1.11 | ** |
| 3/8/2011 | 0.371 (J) | 43.9 | 1.12 | 28.63 | N/A | ** |
| 3/9/2011 | 3.71 | 25.4 | 0.56 | 14.27 | 3.15 | ** |
| 3/10/2011 | 0.728 | 35.9 | 0.86 | 22.16 | -0.14 | ** |
| 4/26/2011 | 0.651 | 36 | 0.87 | 22.24 | -0.22 | ** |
| 4/27/2011 | 7.29 | 23 | 0.49 | 12.57 | 6.80 | ** |
| 4/28/2011 | 0.828 | 31.6 | 0.73 | 18.84 | 0.09 | ** |
| 5/10/2011 | 0.395 (J) | 46.2 | 1.19 | 30.55 | N/A | ** |
| 5/11/2011 | 0.281 (J) | 48.9 | 1.28 | 32.84 | N/A | ** |
| 5/12/2011 | 0.405 (J) | 279 | 11.75 | 301.43 | N/A | ** |
| 6/15/2011 | 0.791 | 69.6 | 2.01 | 51.47 | -1.21 | ** |
| 6/16/2011 | 14.1 | 62.3 | 1.74 | 44.70 | 12.36 | ** |
| 7/12/2011 | 0.734 | 131 | 4.49 | 115.14 | -3.75 | ** |
| 7/13/2011 | 1.24 | 73.2 | 2.14 | 54.88 | -0.90 | ** |

| Date | Lead (µg/L) | Hardness, Total (mg/L) | Lead Chronic Limit (µg/L) | Lead Acute Limit (µg/L) | Difference between the Lead Concentration and the Lead Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 7/14/2011 | 3.45 | 68.5 | 1.97 | 50.44 | 1.48 | ** |

(shaded) Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
J = Estimated Value
U = Analyte Not Detected
N/A: Not Applicable

## 8.2 Beech Creek 0.0 to 3.9

The pollutants addressed in this document for Beech Creek 0.0 to 3.9 are cadmium, iron, nickel and zinc. A pH TMDL was developed for the segment of Beech Creek 0.0 to 3.4 and was approved by EPA in 2006. However, TMDL sampling data indicate that the stream was still impaired for pH at the time of data collection, see Table 8.2.5.

Beech Creek 0.0 to 3.9 is a third order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 5.38 square miles. There is one TMDL monitoring site in the subwatershed, DOW03011015, located at RM 2.7 with the drainage area of 1.67 square miles, see Figure 8.2.1 and Table 8.2.1. This subwatershed consists primarily of forest (50.3%) and agricultural land (26.5%), see Figure 8.2.2 and Table 8.2.2.

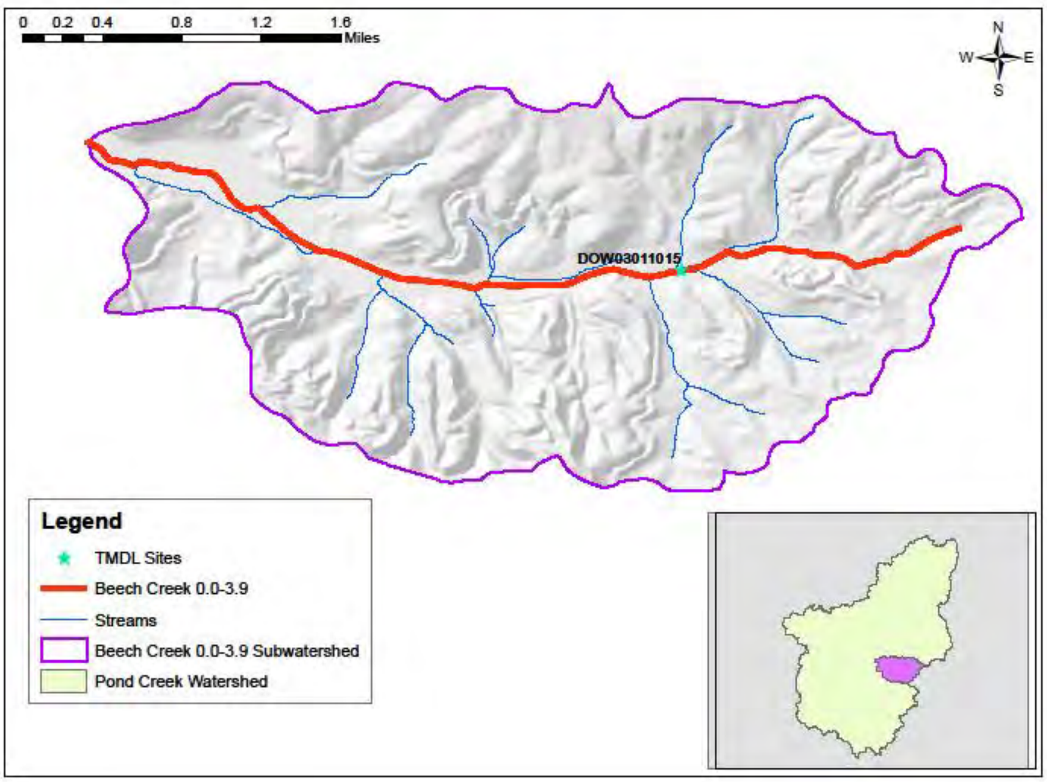


**Figure 8.2.1 TMDL Monitoring Location and the Drainage Area of Beech Creek 0.0 to 3.9**

**Table 8.2.1 Beech Creek 0.0 to 3.9 Segment/Subwatershed Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY486697_01 | Beech Creek 0.0 to 3.9 | 3 | Muhlenberg | 5.38 | 3443 |

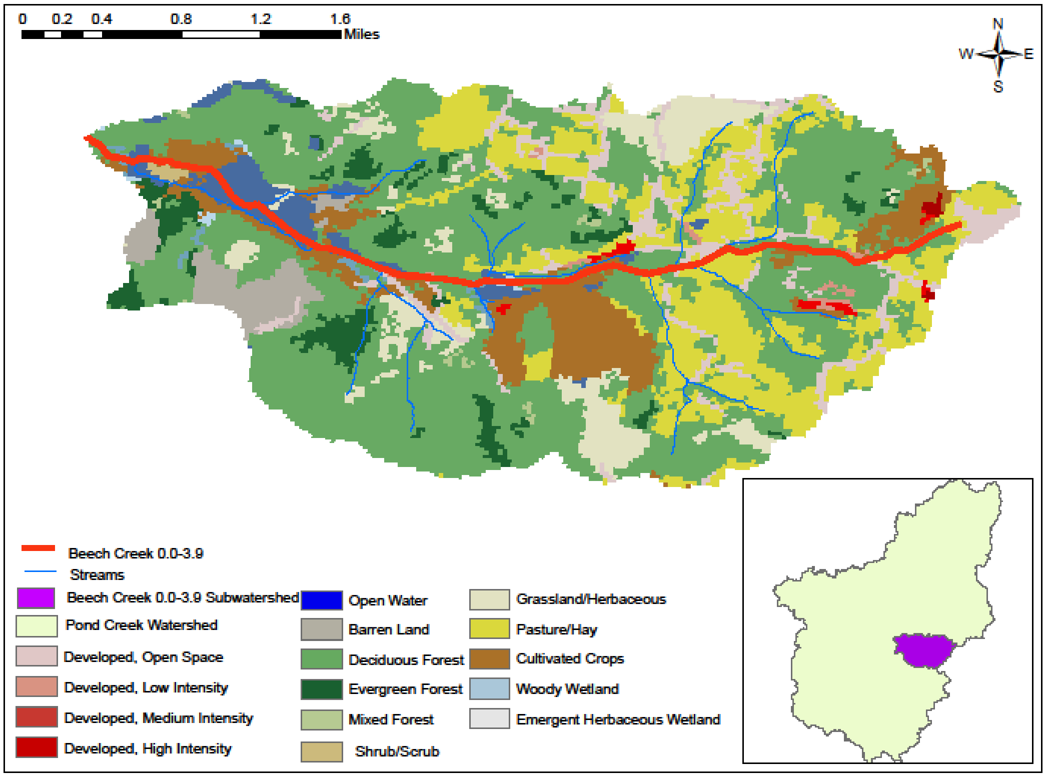


**Figure 8.2.2 Land Cover in the Beech Creek 0.0 to 3.9 Subwatershed**

**Table 8.2.2 Land Cover within the Beech Creek 0.0 to 3.9 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 0.38 | 240.9 | 7.0 |
| Agriculture | 1.42 | 909.5 | 26.5 |
| Forest | 2.70 | 1727.5 | 50.3 |
| Barren Land | 0.30 | 191.0 | 5.6 |
| Grassland/Herbaceous | 0.38 | 243.6 | 7.1 |
| Wetlands | 0.01 | 6.8 | 0.2 |
| Water | 0.18 | 117.7 | 3.4 |
| Shrub/Scrub | 0.01 | 6.3 | 0.2 |

There are one active and three inactive KPDES-permitted facilities in this subwatershed, see Figure 8.2.3 and Table 8.2.3. Although those inactive KPDES facilities were active during the data collection period and may have contributed to the impairments of the Beech Creek 0.0 to 3.9, inactive KPDES permittee will not receive a WLA. There are no active KPDES mining permits in this subwatershed, but the majority of the watershed is covered by licensed mining areas, see Figure 8.2.4 (see Section 9.4.3 for more information). Tables 8.2.4 through 8.2.8 show pH and metals data collected by TMDL staff at DOW03011015.

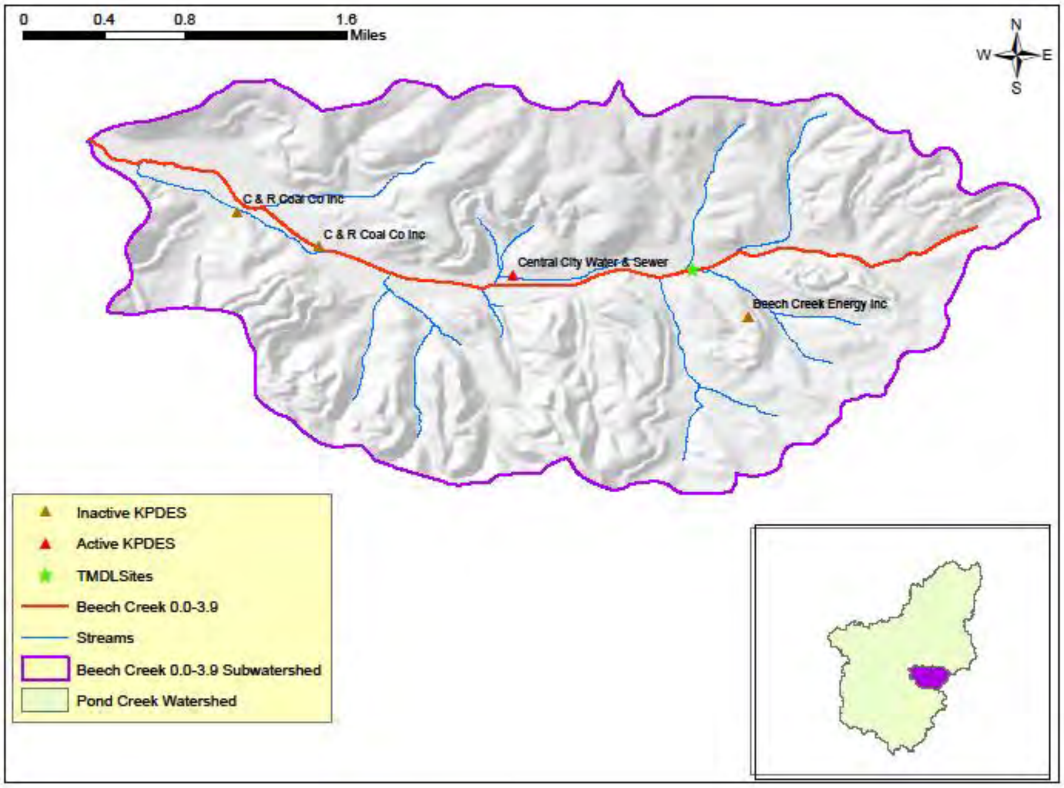


**Figure 8.2.3 KPDES Permittees in the Subwatershed**

**Table 8.2.3 KPDES Permittees in the Subwatershed**

| KPDES | Status | Permit Name | Latitude | Longitude | Pollutants with Discharge Limit |
|---|---|---|---|---|---|
| KYG044789 | Inactive | Beech Creek Energy Inc | 37.170833 | 87.056111 | pH, Iron |
| KYG640029 | Active | Central City Water & Sewer | 37.173800 | 87.073000 | pH, Iron |
| KYG046025 | Inactive | C & R Coal Co Inc | 37.178333 | 87.092778 | pH, Iron |
| KYG046026 | Inactive | C & R Coal Co Inc | 37.175833 | 87.086944 | pH, Iron |

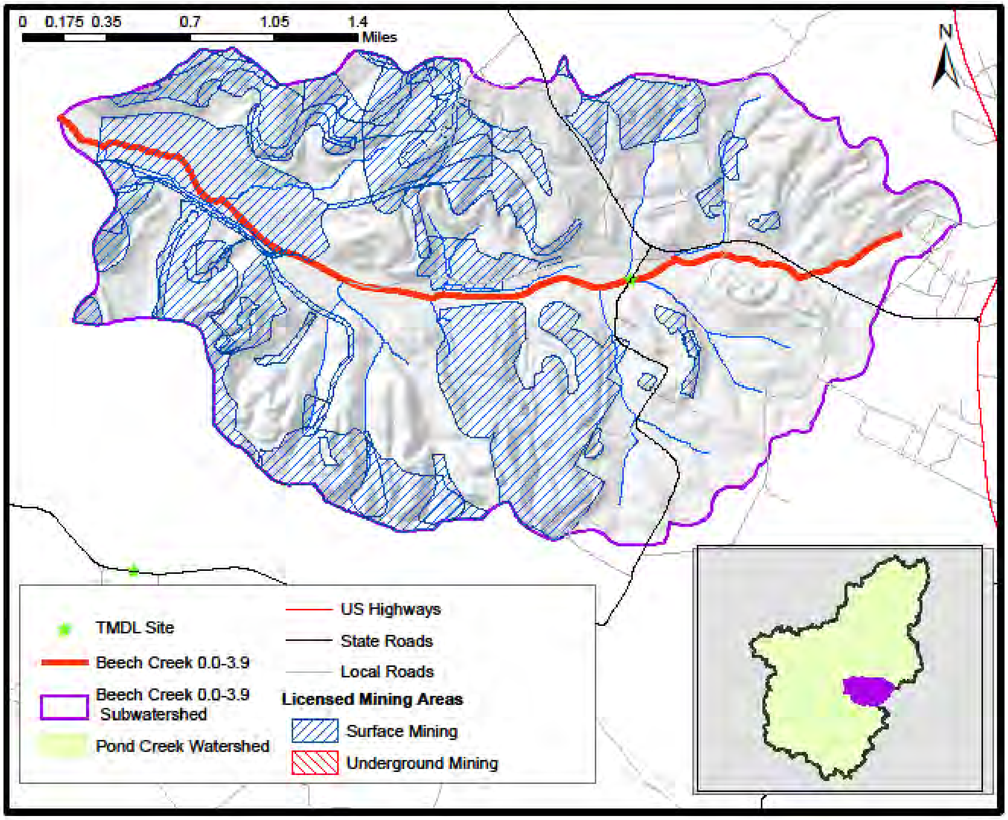


**Figure 8.2.4 Data from the Department of Natural Resources on Licensed Mining Areas in the Subwatershed**

**Table 8.2.4 pH and Flow Data Collected at DOW03011015**

| Date | pH (standard units) | Flow (cfs) |
|---|---|---|
| 11/17/2010 | 3.12 | ** |
| 1/05/2011 | 5.04 | 0.676 |
| 5/11/2011 | 5.02 | 0.903 |
| 3/9/2011 | 5.57 | ** |
| 4/27/2011 | 5.39 | ** |
| 5/11/2011 | 3.03 | 1.934 |
| 5/25/2011 | 2.91 | ** |
| 6/15/2011 | 2.68 | 0.167 |
| 6/22/2011 | 4.01 | ** |
| 7/13/2011 | 2.77 | 0.135 |
| 7/27/2011 | 3.08 | ** |
| 9/28/2011 | 5.08 | 0.087 |

| Date | pH (standard units) | Flow (cfs) |
|---|---|---|
| 10/19/2011 | 5.85 | 0.059 |
| 3/26/2013 | 5.03 | 2.560 |
| 4/24/2013 | 6.24 | ** |
| 5/9/2013 | 3.33 | ** |
| 6/27/2013 | 2.82 | 0.419 |
| 7/17/2013 | 2.93 | 0.209 |
| 8/6/2013 | 3.13 | ** |
| 10/10/2013 | 3.86 | 0.293 |
| 11/13/2013 | 3.67 | 0.159 |
| 12/17/2013 | 5.29 | 0.843 |
| 3/18/2014 | 3.49 | 1.521 |
| 4/15/2014 | 5.12 | 3.973 |
| 5/21/2014 | 3.39 | 0.495 |
| 6/5/2014 | 4.76 | 0.902 |
| 10/29/2014 | 4.61 | ** |
| 11/19/2014 | 4.63 | ** |
| 12/23/2014 | 5.27 | 0.643 |

Exceeds the pH limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

**Table 8.2.5 Iron and Flow Data Collected at DOW03011015**

| Date | Iron (mg/L) (1) | Flow (cfs) |
|---|---|---|
| 11/17/2010 | 4.2 | ** |
| 1/5/2011 | 6.39 | 0.676 |
| 2/16/2011 | 5.25 | 0.903 |
| 3/9/2011 | 7.35 | ** |
| 4/27/2011 | 5.77 | ** |
| 5/11/2011 | 301 (D) | 1.934 |
| 6/15/2011 | 110 (D) | 0.167 |
| 7/13/2011 | 0.151 (B) | 0.135 |
| 3/26/2013 | 0.0151 | 2.560 |
| 4/24/2013 | 3.62 | ** |
| 5/9/2013 | 27 | ** |
| 6/27/2013 | 56.4 | 0.419 |
| 7/17/2013 | 20.3 | 0.209 |
| 8/6/2013 | 6.69 | ** |
| 10/10/2013 | 1.56 | 0.293 |

| Date | Iron (mg/L) [1] | Flow (cfs) |
|---|---|---|
| 11/13/2013 | 1.73 | 0.159 |
| 12/17/2013 | 5.53 | 0.843 |
| 3/18/2014 | 27.4 (D) | 1.521 |
| 4/15/2014 | 11.4 (D) | 3.973 |
| 5/21/2014 | 14.3 (D) | 0.495 |
| 6/5/2014 | 4.26 | 0.902 |
| 10/29/2014 | 1.37 | ** |
| 11/19/2014 | 0.468 | ** |
| 12/23/2014 | 2.83 | 0.643 |

(1)Chronic limit is 1.0 mg/L since aquatic life is adversely affected
Exceeds the acute limit
Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
B = Analyte in Method Blank
D = Reanalyzed at a Higher Dilution

**Table 8.2.6 Cadmium, Hardness and Flow Data Collected at DOW03011015**

| Date | Cadmium (µg/L) | Hardness, Total (mg/L) | Cadmium Chronic Limit (µg/L) | Cadmium Acute Limit (µg/L) | Difference between the Cadmium Concentration and the Cadmium Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 11/17/2010 | 29 (DL) | 779 | 1.24 | 17.19 | 27.76 | ** |
| 1/5/2011 | 13.9 (DL) | 386 | 0.74 | 8.42 | 13.16 | 0.676 |
| 2/16/2011 | 10.6 (DL) | 330 | 0.66 | 7.18 | 9.94 | 0.903 |
| 3/9/2011 | 4.25 (DJ) | 117 | 0.30 | 2.50 | N/A | ** |
| 4/27/2011 | 4.23 (DJ) | 97.9 | 0.27 | 2.09 | N/A | ** |
| 5/11/2011 | 222 (L) | 1400 | 1.91 | 31.20 | 220.09 | 1.934 |
| 6/15/2011 | 116 (DL) | 1310 | 1.82 | 29.16 | 114.18 | 0.167 |
| 7/13/2011 | 68.2 (DL) | 417 | 0.78 | 9.11 | 67.42 | 0.135 |
| 3/26/2013 | 6.38 | 169 | 0.40 | 3.64 | 5.98 | 2.560 |
| 4/24/2013 | 2.15 | 107 | 0.28 | 2.29 | 1.87 | ** |
| 6/27/2013 | 29.4 | 923 | 1.40 | 20.43 | 28.00 | 0.419 |
| 7/17/2013 | 28.1 | 415 | 0.78 | 9.06 | 27.32 | 0.209 |
| 8/6/2013 | 20.1 | 803 | 1.27 | 17.73 | 18.83 | ** |
| 10/10/2013 | 6.85 | 425 | 0.79 | 9.29 | 6.06 | 0.293 |

| Date | Cadmium (µg/L) | Hardness, Total (mg/L) | Cadmium Chronic Limit (µg/L) | Cadmium Acute Limit (µg/L) | Difference between the Cadmium Concentration and the Cadmium Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 11/13/2013 | 10.6 | 625 | 1.05 | 13.74 | 9.55 | 0.159 |
| 12/17/2013 | 5 | 324 | 0.65 | 7.05 | 4.35 | 0.843 |
| 3/18/2014 | 13.3 (DL) | 408 | 0.77 | 8.91 | 12.53 | 1.521 |
| 4/15/2014 | 4.52 (DJ) | 262 | 0.55 | 5.68 | 3.97 | 3.973 |
| 5/21/2014 | 9.27 (DL) | 531 | 0.93 | 11.65 | 8.34 | 0.495 |
| 6/5/2014 | 4.94 (D) | 370 | 0.71 | 8.07 | 4.23 | 0.902 |
| 10/29/2014 | 7.52 (DL) | 588 | 1.01 | 12.92 | 6.51 | ** |
| 11/19/2014 | 5.93 (DL) | 608 | 1.03 | 13.36 | 4.90 | ** |
| 12/23/2014 | 4.9 (D) | 435 | 0.80 | 9.51 | 4.10 | 0.643 |

Exceeds the acute limit
Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
D = Reanalyzed at a Higher Dilution
J = Estimated Value
L = Exceeds MCL or Action Limit
N/A: Not Applicable

**Table 8.2.7 Nickel, Hardness and Flow Data Collected at DOW03011015**

| Date | Nickel (µg/L) | Hardness, Total (mg/L) | Nickel Chronic Limit (µg/L) | Nickel Acute Limit (µg/L) | Difference between the Nickel Concentration and the Nickel Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 11/17/2010 | 504 (D) | 779 | 296.21 | 2664.23 | 207.79 | ** |
| 1/5/2011 | 229 | 386 | 163.54 | 1470.91 | 65.46 | 0.676 |
| 2/16/2011 | 190 | 330 | 143.23 | 1288.23 | 46.77 | 0.903 |
| 3/9/2011 | 72 | 117 | 59.57 | 535.82 | 12.43 | ** |
| 4/27/2011 | 66.5 | 97.9 | 51.23 | 460.82 | 15.27 | ** |
| 5/11/2011 | 3380 | 1400 | 486.39 | 4374.78 | 2893.61 | 1.934 |
| 6/15/2011 | 2590 | 1310 | 459.80 | 4135.64 | 2130.20 | 0.167 |
| 7/13/2011 | 1640 (D) | 417 | 174.58 | 1570.24 | 1465.42 | 0.135 |
| 3/26/2013 | 222 | 169 | 81.31 | 731.35 | 140.69 | 2.560 |
| 4/24/2013 | 62.1 | 107 | 55.24 | 496.81 | 6.86 | ** |
| 6/27/2013 | 657 | 923 | 341.92 | 3075.33 | 315.08 | 0.419 |

| Date | Nickel (µg/L) | Hardness, Total (mg/L) | Nickel Chronic Limit (µg/L) | Nickel Acute Limit (µg/L) | Difference between the Nickel Concentration and the Nickel Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 7/17/2013 | 891 | 415 | 173.87 | 1563.87 | 717.13 | 0.209 |
| 8/6/2013 | 815 | 803 | 303.91 | 2733.51 | 511.09 | ** |
| 10/10/2013 | 272 | 425 | 177.41 | 1595.69 | 94.59 | 0.293 |
| 11/13/2013 | 360 | 625 | 245.85 | 2211.29 | 114.15 | 0.159 |
| 12/17/2013 | 181 | 324 | 141.02 | 1268.39 | 39.98 | 0.843 |
| 3/18/2014 | 333 | 408 | 171.39 | 1541.52 | 161.61 | 1.521 |
| 4/15/2014 | 148 | 262 | 117.83 | 1059.78 | 30.17 | 3.973 |
| 5/21/2014 | 406 | 531 | 214.19 | 1926.47 | 191.81 | 0.495 |
| 6/5/2014 | 184 | 370 | 157.78 | 1419.16 | 26.22 | 0.902 |
| 10/29/2014 | 232 | 588 | 233.48 | 2100.03 | -1.48 | ** |
| 11/19/2014 | 303 | 608 | 240.18 | 2160.30 | 62.82 | ** |
| 12/23/2014 | 181 | 435 | 180.94 | 1627.40 | 0.06 | 0.643 |

Exceeds the acute limit
Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
D = Reanalyzed at a Higher Dilution

**Table 8.2.8 Zinc, Hardness and Flow Data Collected at DOW03011015**

| Date | Zinc (µg/L) | Hardness, Total (mg/L) | Zinc Chronic Limit (µg/L) | Zinc Acute Limit (µg/L) | Difference between the Zinc Concentration and the Zinc Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 11/17/2010 | 1360 (D) | 779 | 682.20 | 682.20 | 677.80 | ** |
| 1/5/2011 | 782 (D) | 386 | 376.30 | 376.30 | 405.70 | 0.676 |
| 2/16/2011 | 545 (D) | 330 | 329.50 | 329.50 | 215.50 | 0.903 |
| 3/9/2011 | 209 (D, J) | 117 | 136.86 | 136.86 | N/A | ** |
| 4/27/2011 | 190 (D, J) | 97.9 | 117.68 | 117.68 | N/A | ** |
| 5/11/2011 | 7880 | 1400 | 1121.06 | 1121.06 | 6758.94 | 1.934 |
| 6/15/2011 | 5770 (D) | 1310 | 1059.69 | 1059.69 | 4710.31 | 0.167 |
| 7/13/2011 | 3930 (D) | 417 | 401.75 | 401.75 | 3528.25 | 0.135 |
| 3/26/2013 | 580 | 169 | 186.90 | 186.90 | 393.10 | 2.560 |
| 4/24/2013 | 135 | 107 | 126.89 | 126.89 | 8.11 | ** |
| 6/27/2013 | 2150 | 923 | 787.64 | 787.64 | 1362.36 | 0.419 |

| Date | Zinc (µg/L) | Hardness, Total (mg/L) | Zinc Chronic Limit (µg/L) | Zinc Acute Limit (µg/L) | Difference between the Zinc Concentration and the Zinc Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 7/17/2013 | 2540 | 415 | 400.12 | 400.12 | 2139.88 | 0.209 |
| 8/6/2013 | 1830 | 803 | 699.97 | 699.97 | 1130.03 | ** |
| 10/10/2013 | 618 | 425 | 408.27 | 408.27 | 209.73 | 0.293 |
| 11/13/2013 | 1170 | 625 | 566.06 | 566.06 | 603.94 | 0.159 |
| 12/17/2013 | 395 | 324 | 324.41 | 324.41 | 70.59 | 0.843 |
| 3/18/2014 | 1090 (D) | 408 | 394.39 | 394.39 | 695.61 | 1.521 |
| 4/15/2014 | 418 (D) | 262 | 270.98 | 270.98 | 147.02 | 3.973 |
| 5/21/2014 | 1230 (D) | 531 | 493.05 | 493.05 | 736.95 | 0.495 |
| 6/5/2014 | 467 (D) | 370 | 363.04 | 363.04 | 103.96 | 0.902 |
| 10/29/2014 | 592 (D) | 588 | 537.54 | 537.54 | 54.46 | ** |
| 11/19/2014 | 668 (D) | 608 | 552.99 | 552.99 | 115.01 | ** |
| 12/23/2014 | 449 (D) | 435 | 416.40 | 416.40 | 32.60 | 0.643 |

[shaded] Exceeds the acute limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
D = Reanalyzed at a Higher Dilution
J = Estimated Value
N/A: Not Applicable

## 8.3 Boggess Creek 0.0 to 3.0

The pollutant addressed in this document for Boggess Creek 0.0 to 3.0 is *E. coli*. Boggess Creek is a third order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 2.37 square miles. There is one TMDL monitoring site on the Boggess Creek 0.0 to 3.0 segment, DOW03011024, located at RM 1.4 with the drainage area of 1.3 square miles, see Figure 8.3.1 and Table 8.3.1. This subwatershed consists primarily of forest (58.5%) and agricultural land (31.2%), see Figure 8.3.2 and Table 8.3.2.

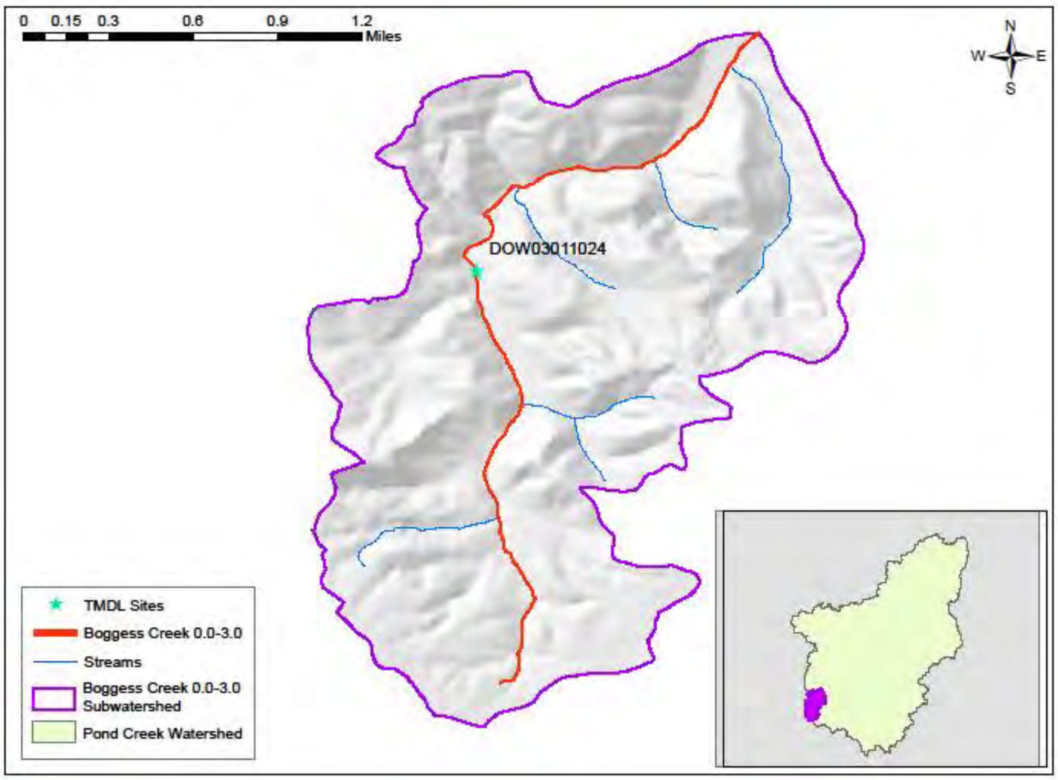


**Figure 8.3.1 TMDL Monitoring Location and the Drainage Area of Boggess Creek 0.0 to 3.0**

**Table 8.3.1 Boggess Creek 0.0 to 3.0 Segment/Upstream Catchment Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY487614_01 | Boggess Creek 0.0 to 3.0 | 3 | Muhlenberg | 2.37 | 1517 |

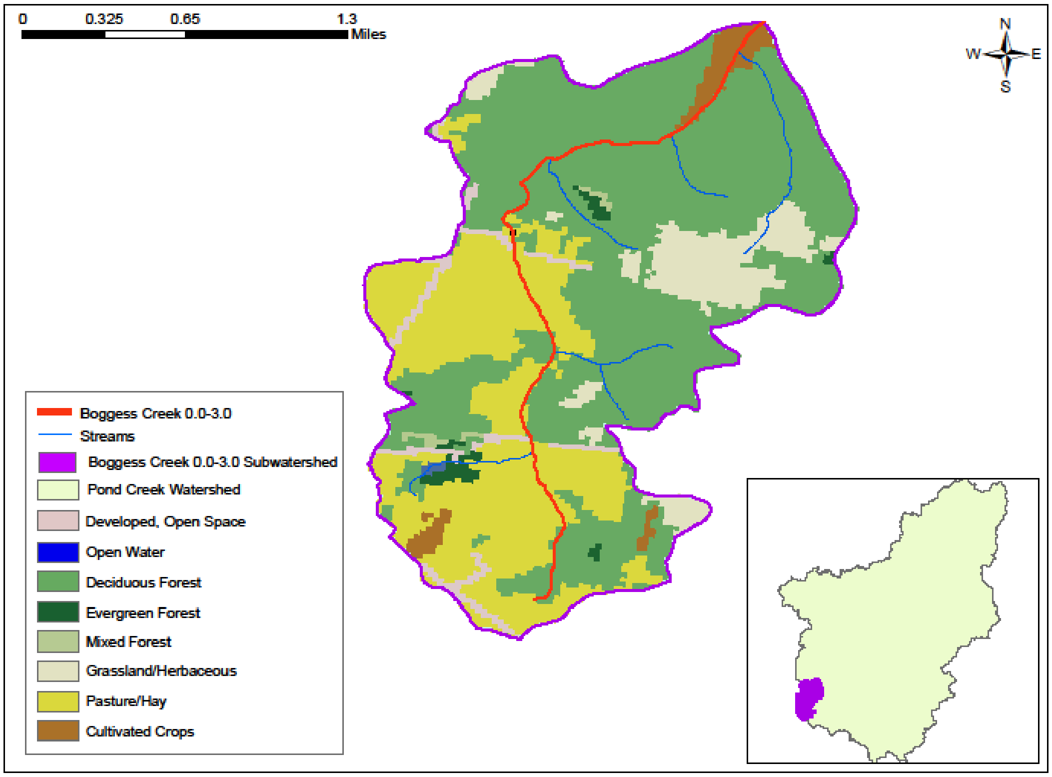


**Figure 8.3.2 Land Cover in the Boggess Creek 0.0 to 3.0 Subwatershed**

**Table 8.3.2 Land Cover in the Boggess Creek 0.0 to 3.0 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 0.06 | 36.7 | 2.4 |
| Agriculture | 0.74 | 472.6 | 31.2 |
| Forest | 1.39 | 887.0 | 58.5 |
| Barren Land | 0 | 0 | 0 |
| Grassland/Herbaceous | 0.19 | 118.8 | 7.8 |
| Wetlands | 0 | 0 | 0 |
| Water | 0.003 | 1.8 | 0.1 |
| Shrub/Scrub | 0 | 0 | 0 |

There are no KPDES permittees in this subwatershed. *E. coli* and flow data monitored at DOW03011024 are shown in Table 8.3.3.

**Table 8.3.3 *E. coli* and Flow Data, DOW03011024**

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 5/10/2011 | 461 | 0.892 |
| 6/21/2011 | 1553 | ** |
| 5/8/2013 | 548 | ** |
| 5/9/2013 | 613 | ** |
| 5/23/2013 | 411 | ** |
| 5/29/2013 | 687 | ** |
| 6/6/2013 | 1733 | ** |
| 6/27/2013 | 411 | 0.078 |
| 8/6/2013 | 62 | 0.031 |
| 8/15/2013 | 197 | 0.170 |
| 10/10/2013 | 285 | 0.139 |

[highlighted] Exceeds the instantaneous *E. coli* limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

## 8.4 Caney Creek 0.0 to 3.6

The pollutants addressed in this document for Caney Creek 0.0 to 3.6 are *E. coli* and cadmium. Caney Creek is a third order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 19.03 square miles. There is one TMDL monitoring site on the Caney Creek 0.0 to 3.6 segment, DOW03011001, located at RM 2.35 with the drainage area of 10.43 square miles, see Figure 8.4.1 and Table 8.4.1. This subwatershed consists primarily of forest (40.5%) and agricultural land (40.2%), see Figure 8.4.2 and Table 8.4.2.

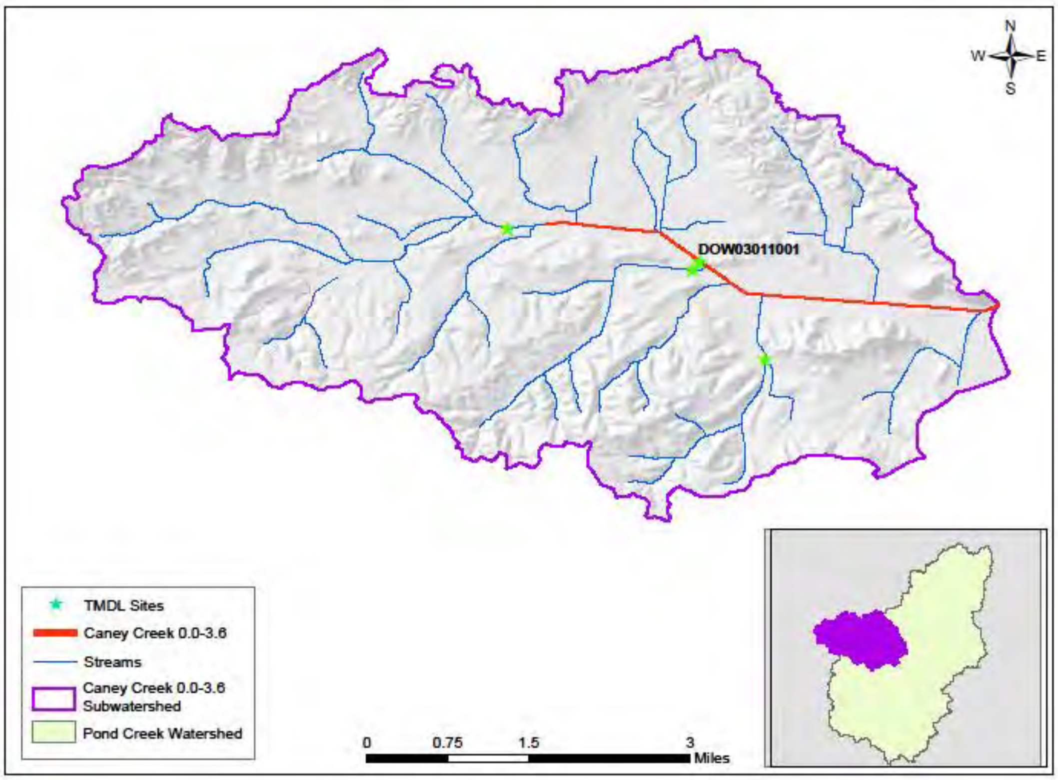


**Figure 8.4.1 TMDL Monitoring Locations and the Drainage Area of Caney Creek 0.0 to 3.6**

**Table 8.4.1 Caney Creek 0.0 to 3.6 Segment/Upstream Catchment Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY488838_01 | Caney Creek 0.0 to 3.6 | 3 | Muhlenberg | 19.03 | 12179 |

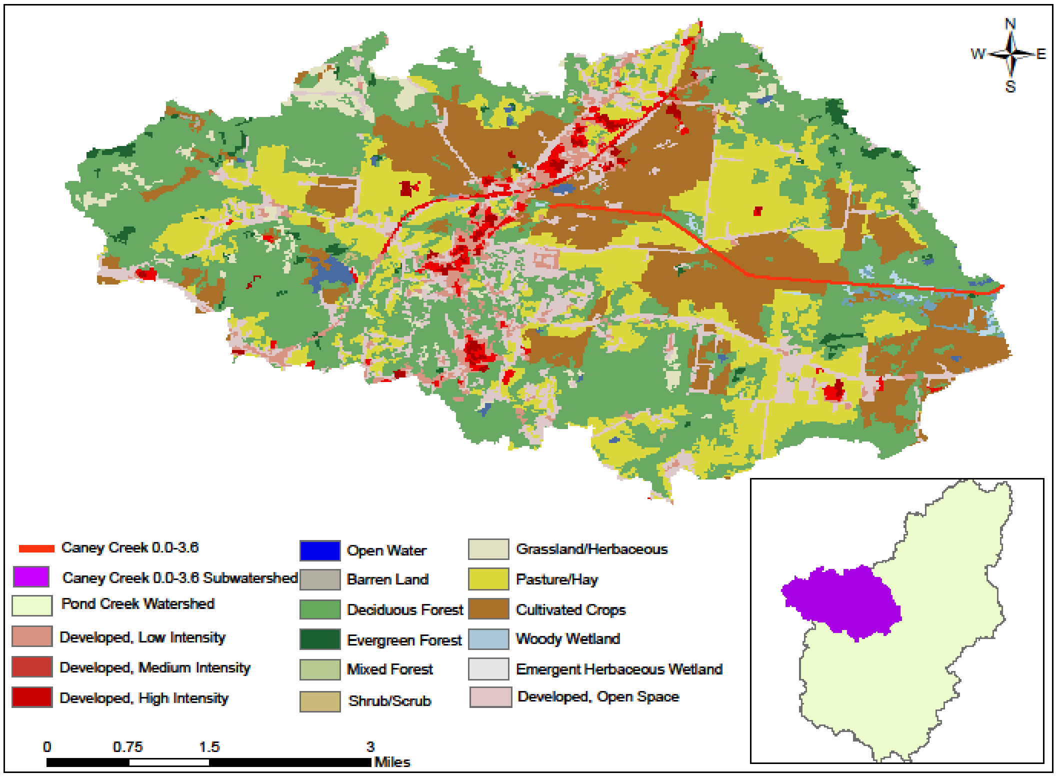


**Figure 8.4.2 Land Cover in the Caney Creek 0.0 to 3.6 Subwatershed**

**Table 8.4.2 Land Cover in the Caney Creek 0.0 to 3.6 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 2.95 | 1887.4 | 15.5 |
| Agriculture | 7.65 | 4894.1 | 40.2 |
| Forest | 7.70 | 4926.8 | 40.5 |
| Barren Land | 0.02 | 12.1 | 0.1 |
| Grassland/Herbaceous | 0.48 | 309.3 | 2.5 |
| Wetlands | 0.11 | 68.5 | 0.6 |
| Water | 0.12 | 73.6 | 0.6 |
| Shrub/Scrub | 0.01 | 8.1 | 0.1 |

There are seven active and sixteen inactive KPDES permittees within the Caney Creek 0.0 to 3.6 subwatershed, see Figure 8.4.3 and Table 8.4.3. Although those inactive facilities were active during the data collection period and may have contributed to the impairments of this the Caney Creek 0.0 to 3.6, inactive KPDES permittee will not receive a WLA.

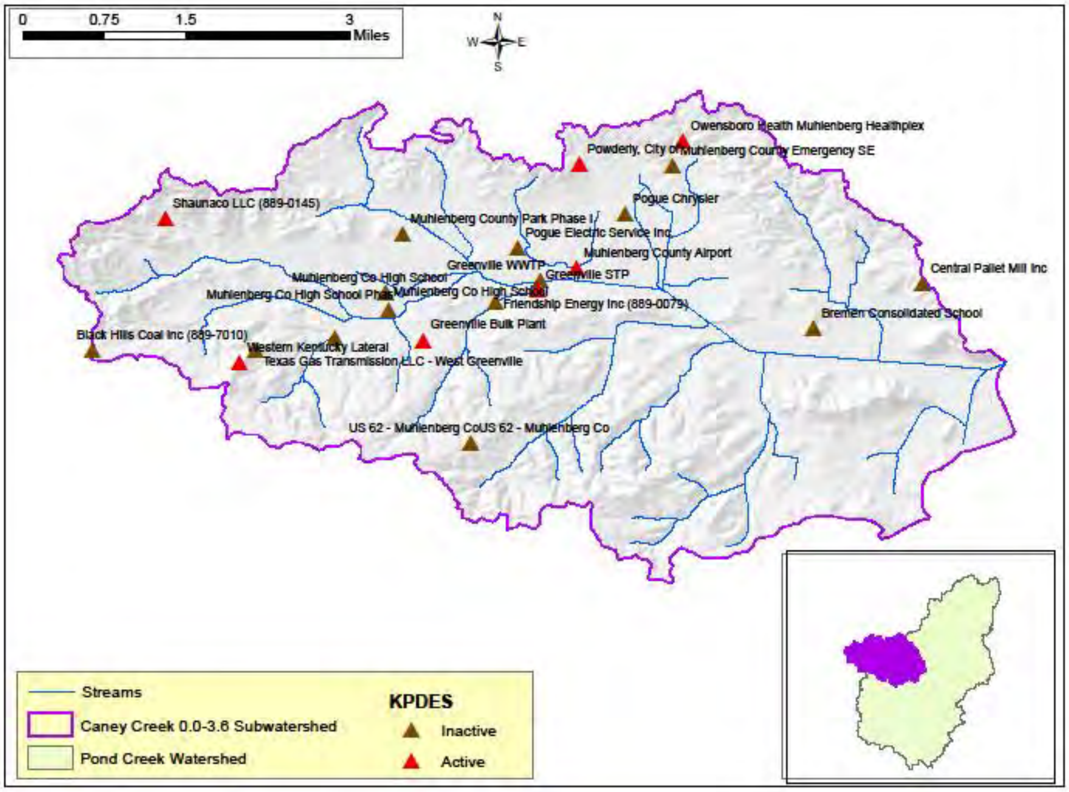


**Figure 8.4.3 KPDES Permittees in the Caney Creek 0.0 to 3.6 Subwatershed**

**Table 8.4.3 KPDES Permittees in the Caney Creek 0.0 to 3.6 Subwatershed**

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutants Limits /Requirements in Permit |
|---|---|---|---|---|---|---|
| KY0020010 | Greenville STP | Yes | 1.31 | 37.219167 | -87.169444 | bacteria, pH, Cd, Cu, Pb, Zn |
| KY0108537 | Shaunaco LLC (889-0145) | Yes | 0 | 37.228611 | -87.218889 | pH, Cd, Cu, Fe, Pb, Ni, Zn |
| KY0109606 | Greenville Bulk Plant | Yes | 0 | 37.212500 | -87.184700 | pH |
| KYP000064 | Powderly, City of | Yes | 0 | 37.235833 | -87.163889 | discharge to Greenville WWTP |
| KYR10J469 | Muhlenberg County Airport | Yes | 0 | 37.222067 | -87.164333 | to develop a SWPPP |
| KYR10K315 | Western Kentucky Lateral | Yes | 0 | 37.209464 | -87.209069 | to develop a SWPPP |

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutants Limits /Requirements in Permit |
|---|---|---|---|---|---|---|
| KYR10K433 | Owensboro Health Muhlenberg Healthplex | Yes | 0 | 37.238889 | -87.150189 | to develop a SWPPP |
| KY0023329 | Bremen Consolidated School | No | 0.008 | 37.214000 | -87.132800 | bacteria |
| KY0099538 | Texas Gas Transmission LLC - West Greenville | No | 0 | 37.211111 | -87.206944 | pH |
| KYG043169 | Black Hills Coal Inc (889-7010) | No | 0 | 37.211111 | -87.228611 | pH, Fe |
| KYG044573 | Friendship Energy Inc (889-0079) | No | 0 | 37.217528 | -87.175069 | pH, Fe |
| KYR000524 | Central Pallet Mill Inc | No | 0 | 37.220000 | -87.118333 | pH and to develop a SWPPP |
| KYR10E810 | Muhlenberg Co High School Phas 3 | No | 0 | 37.216500 | -87.189224 | to develop a SWPPP |
| KYR10E960 | Muhlenberg County Emergency SE | No | 0 | 37.235680 | -87.151550 | to develop a SWPPP |
| KYR10F821 | Muhlenberg Co High School | No | 0 | 37.218839 | -87.189686 | to develop a SWPPP |
| KYR10G145 | Greenville WWTP | No | 0 | 37.220472 | -87.169111 | to develop a SWPPP |
| KYR10G154 | Knight Construction & Excavating Inc | No | 0 | 37.212776 | -87.196388 | to develop a SWPPP |
| KYR10G285 | Pogue Chrysler | No | 0 | 37.229353 | -87.157828 | to develop a SWPPP |
| KYR10G631 | US 62 - Muhlenberg Co | No | 0 | 37.198889 | -87.178333 | to develop a SWPPP |
| KYR10G632 | US 62 - Muhlenberg Co | No | 0 | 37.198889 | -87.178333 | to develop a SWPPP |
| KYR10H138 | Muhlenberg Co High School | No | 0 | 37.218839 | -87.189686 | to develop a SWPPP |
| KYR10H705 | Muhlenberg County Park Phase I | No | 0 | 37.226610 | -87.187427 | to develop a SWPPP |
| KYR10I149 | Pogue Electric Service Inc. | No | 0 | 37.224749 | -87.172138 | to develop a SWPPP |

There is one active KPDES mining permittee in this subwatershed, see Figure 8.4.4 and Table 8.4.4. A small portion of this subwatershed is covered by licensed mining areas, see Figure 8.4.5 (see Section 9.4.3 for more information). Tables 8.4.5 and 8.4.6 show *E. coli*, cadmium and flow data collected by TMDL staff at DOW03011001.

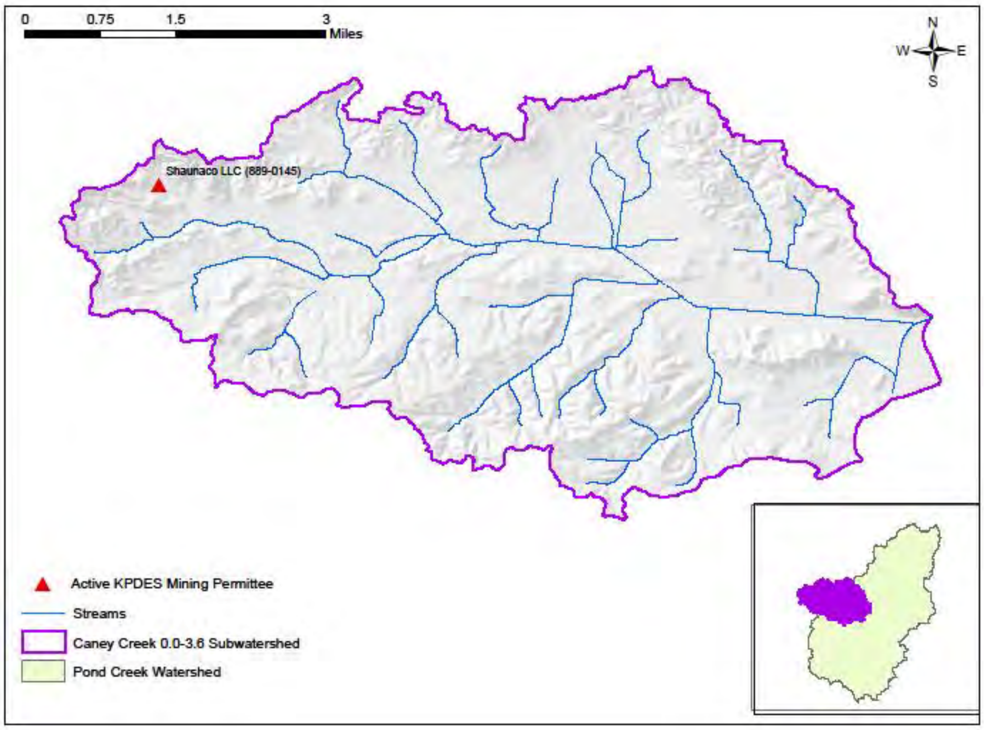


**Figure 8.4.4 Active KPDES Mining Permittee in the Subwatershed**

**Table 8.4.4 Active KPDES Mining Permittee in the Subwatershed**

| KPDES Permit # | KDNR Permit # | Permittee Name | Date Issued |
|---|---|---|---|
| KY0108537 | 889-0145 | Shaunaco LLC | 12/1/2011 |

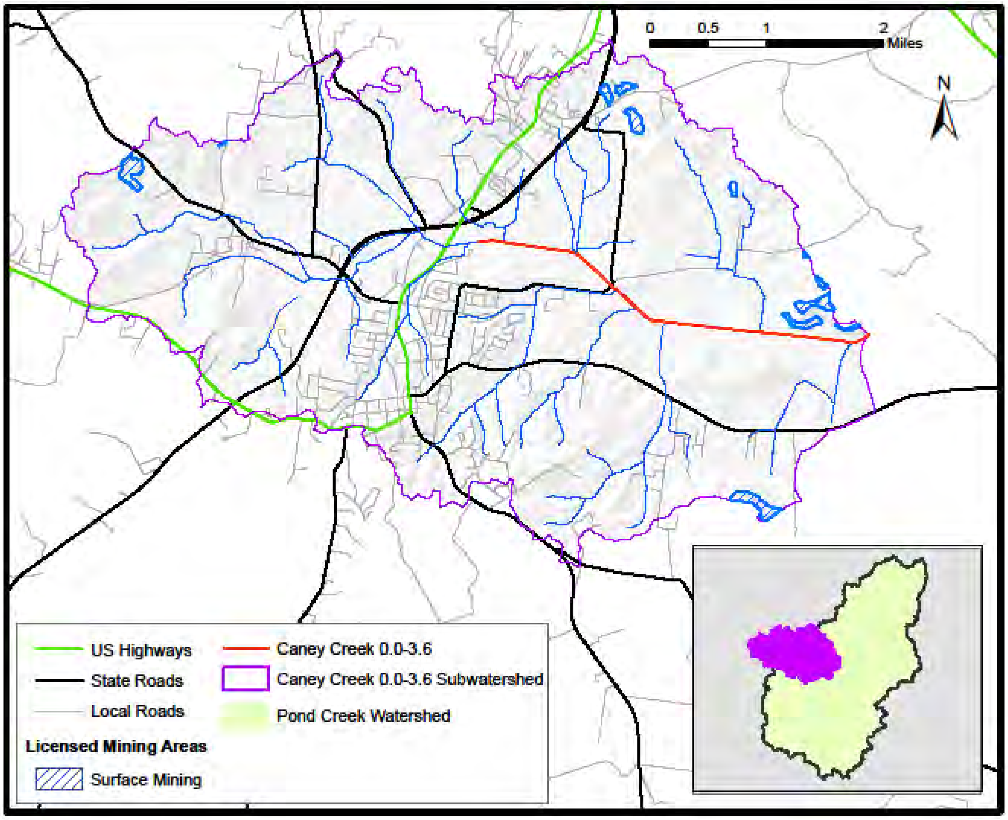


**Figure 8.4.5 Data from the Department of Natural Resources on Licensed Mining Areas in the Subwatershed**

**Table 8.4.5 *E. coli* and Flow Data, DOW03011001**

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 6/22/2011 | > 2420 | ** |
| 10/19/2011 | 1414 | ** |
| 5/8/2013 | 120 | ** |
| 5/9/2013 | 69 | ** |
| 5/20/2013 | 91 | ** |
| 5/23/2013 | 197 | ** |
| 5/29/2013 | 128 | ** |
| 6/6/2013 | > 2420 | ** |
| 6/26/2013 | 22 | 1.813 |
| 7/16/2013 | 54 | 1.578 |
| 7/30/2013 | 125 | 0.624 |
| 8/8/2013 | 727 | 0.433 |

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 8/15/2013 | 206 | 2.200 |
| 9/10/2013 | 218 | 0.626 |
| 9/24/2013 | 326 | 2.095 |
| 10/9/2013 | 285 | 2.181 |
| 10/14/2013 | 548 | 1.101 |

Exceeds the instantaneous *E. coli* limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

**Table 8.4.6 Cadmium, Hardness and Flow Data Collected at DOW03011001**

| Date | Cadmium (µg/L) | Hardness, Total (mg/L) | Cadmium Chronic Limit (µg/L) | Cadmium Acute Limit (µg/L) | Difference between the Cadmium Concentration and the Cadmium Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 11/17/2010 | < 0.80 (U) | 205 | 0.46 | 4.43 | N/A | ** |
| 1/5/2011 | 0.602 (J) | 263 | 0.55 | 5.70 | N/A | 4.591 |
| 2/16/2011 | 0.567 (J) | 248 | 0.53 | 5.37 | N/A | 6.929 |
| 3/21/2013 | 0.51 | 242 | 0.52 | 5.24 | -0.01 | 10.939 |
| 4/18/2013 | < 0.40 (U) | 328 | 0.65 | 7.14 | N/A | 4.415 |
| 5/8/2013 | 0.38 | 225 | 0.49 | 4.86 | -0.11 | ** |
| 6/26/2013 | 0.28 | 337 | 0.67 | 7.34 | -0.39 | 1.813 |
| 7/16/2013 | < 0.50 (U) | 259 | 0.55 | 5.61 | N/A | 1.578 |
| 8/8/2013 | 0.49 | 216 | 0.48 | 4.67 | 0.01 | 0.433 |
| 9/10/2013 | < 0.50 (U) | 203 | 0.46 | 4.38 | N/A | 0.626 |
| 10/9/2013 | < 0.50 (U) | 214 | 0.48 | 4.62 | N/A | 2.181 |
| 11/13/2013 | 0.27 | 234 | 0.51 | 5.06 | -0.24 | 1.649 |
| 12/17/2013 | 0.35 | 254 | 0.54 | 5.50 | -0.19 | 7.531 |

Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
J = Estimated Value
U = Analyte Not Detected
N/A: Not Applicable

## 8.5 Caney Creek 3.6 to 7.6

The pollutants addressed in this document for Caney Creek 3.6 to 7.6 are *E. coli*, cadmium and lead. Caney Creek 3.6 to 7.6 is a third order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 7.14 square miles. There is one TMDL monitoring site on the Caney Creek 3.6 to 7.6 segment, DOW03011014, located at RM 3.9 with the drainage area of 6.28 square miles, see Figure 8.5.1 and Table 8.5.1. This subwatershed consists primarily of forest (49.0%), agricultural land (27.5%), and developed area (17.9%), see Figure 8.5.2 and Table 8.5.2.

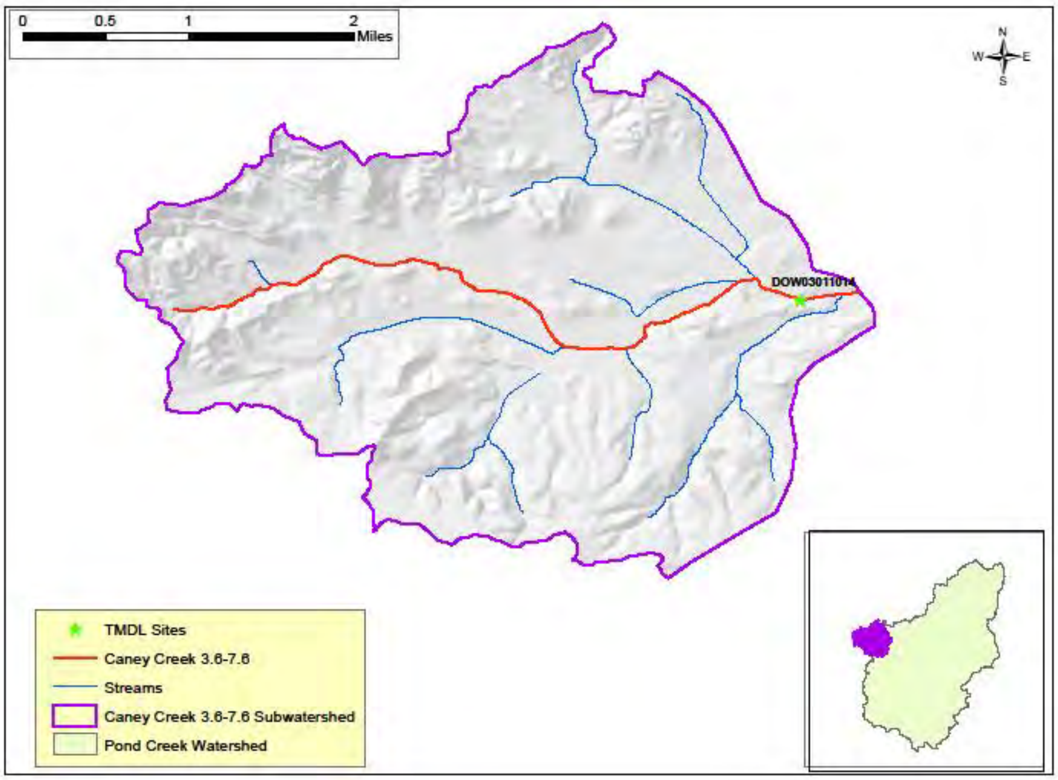


**Figure 8.5.1 TMDL Monitoring Location and the Drainage Area of Caney Creek 3.6 to 7.6**

**Table 8.5.1 Caney Creek 3.6 to 7.6 Segment/Upstream Catchment Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY488838_02 | Caney Creek 3.6 to 7.6 | 3 | Muhlenberg | 7.14 | 4567 |

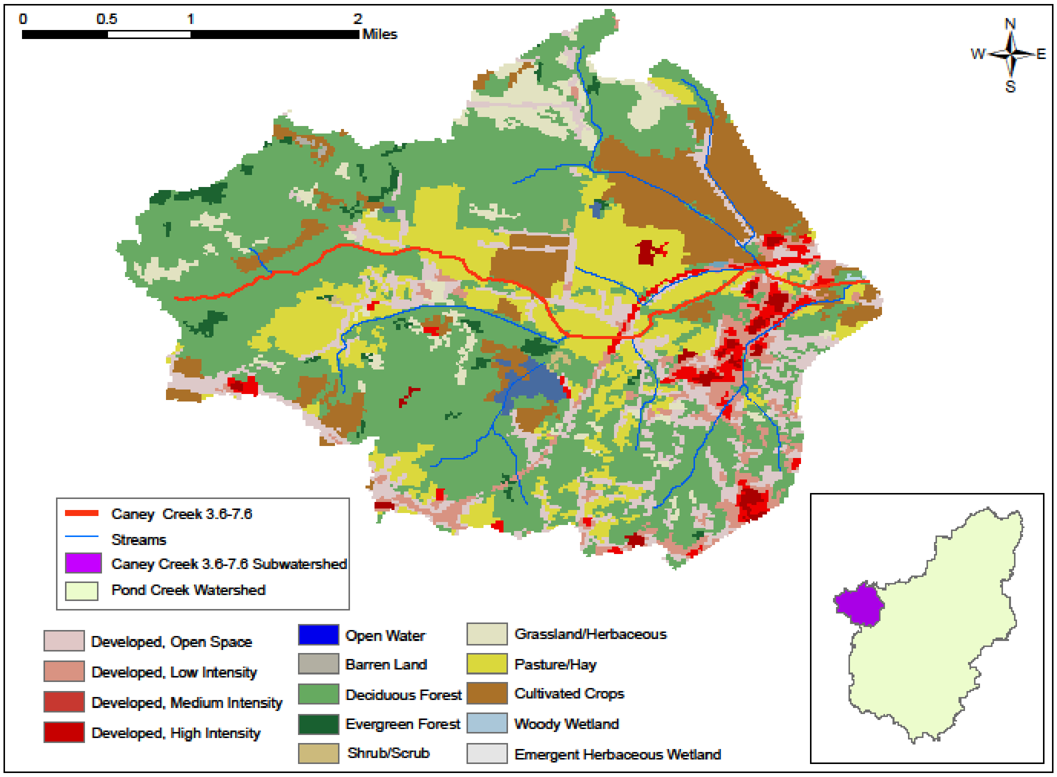


**Figure 8.5.2 Land Cover in the Caney Creek 3.6 to 7.6 Subwatershed**

**Table 8.5.2 Land Cover in the Caney Creek 3.6 to 7.6 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 1.28 | 816.2 | 17.9 |
| Agriculture | 1.96 | 1257.0 | 27.5 |
| Forest | 3.51 | 2245.2 | 49.0 |
| Barren Land | 0.00 | 3.0 | 0.1 |
| Grassland/Herbaceous | 0.32 | 205.0 | 4.5 |
| Wetlands | 0.00 | 1.3 | 0.03 |
| Water | 0.06 | 39.3 | 0.9 |
| Shrub/Scrub | 0.01 | 6.4 | 0.1 |

There are four active and ten inactive KPDES-permitted facilities within the Caney Creek 3.6 to 7.6 subwatershed, see Figure 8.5.3 and Table 8.5.3. Although those inactive facilities were active during the data collection period and may have contributed to the impairments of this waterbody, inactive KPDES permittee will not receive a WLA.

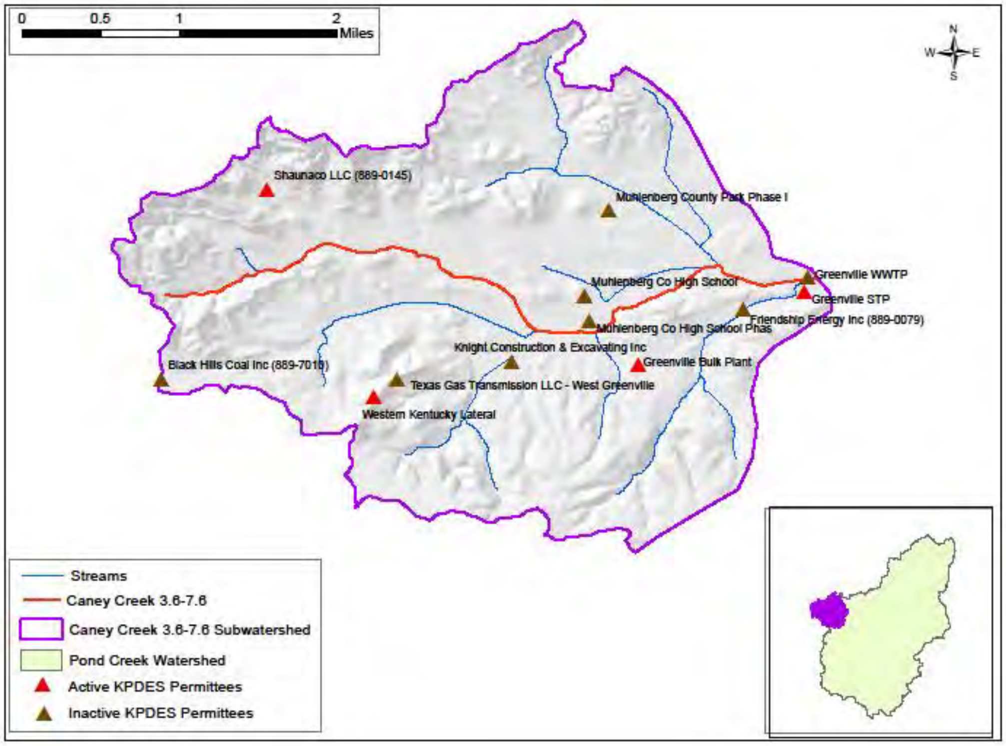


**Figure 8.5.3 KPDES Permittees in the Caney Creek 3.6 to 7.6 Subwatershed**

**Table 8.5.3 KPDES Permittees in the Caney Creek 3.6 to 7.6 Subwatershed**

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutants Limits /Requirements in Permit |
|---|---|---|---|---|---|---|
| KY0020010 | Greenville STP | Yes | 1.31 | 37.219167 | -87.169444 | bacteria, pH, Cd, Cu, Pb, Zn |
| KY0108537 | Shaunaco LLC (889-0145) | Yes | 0 | 37.228611 | -87.218889 | pH, Cd, Cu, Fe, Pb,Ni, Zn |
| KY0109606 | Greenville Bulk Plant | Yes | 0 | 37.212500 | -87.184700 | pH |
| KYR10K315 | Western Kentucky Lateral | Yes | 0 | 37.209464 | -87.209069 | to develop a SWPPP |
| KY0099538 | Texas Gas Transmission LLC - West Greenville | No | 0 | 37.211111 | -87.206944 | pH |

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutants Limits /Requirements in Permit |
|---|---|---|---|---|---|---|
| KYG043169 | Black Hills Coal Inc (889-7010) | No | 0 | 37.211111 | -87.228611 | pH, Fe |
| KYG044573 | Friendship Energy Inc (889-0079) | No | 0 | 37.217528 | -87.175069 | pH, Fe |
| KYR10E810 | Muhlenberg Co High School Phas 3 | No | 0 | 37.216500 | -87.189224 | to develop a SWPPP |
| KYR10F821 | Muhlenberg Co High School | No | 0 | 37.218839 | -87.189686 | to develop a SWPPP |
| KYR10G145 | Greenville WWTP | No | 0 | 37.220472 | -87.169111 | to develop a SWPPP |
| KYR10G154 | Knight Construction & Excavating Inc | No | 0 | 37.212776 | -87.196388 | to develop a SWPPP |
| KYR10H138 | Muhlenberg Co High School | No | 0 | 37.218839 | -87.189686 | to develop a SWPPP |
| KYR10H705 | Muhlenberg County Park Phase I | No | 0 | 37.226610 | -87.187427 | to develop a SWPPP |

There is one active KPDES mining permittee in this subwatershed, see Figure 8.5.4 and Table 8.5.4. A small portion of upstream watershed is licensed mining areas, see Figure 8.5.5 (see Section 9.4.3 for more information). Tables 8.5.5 to 8.5.7 show *E. coli*, cadmium, lead and flow data collected by TMDL staff at DOW03011014.

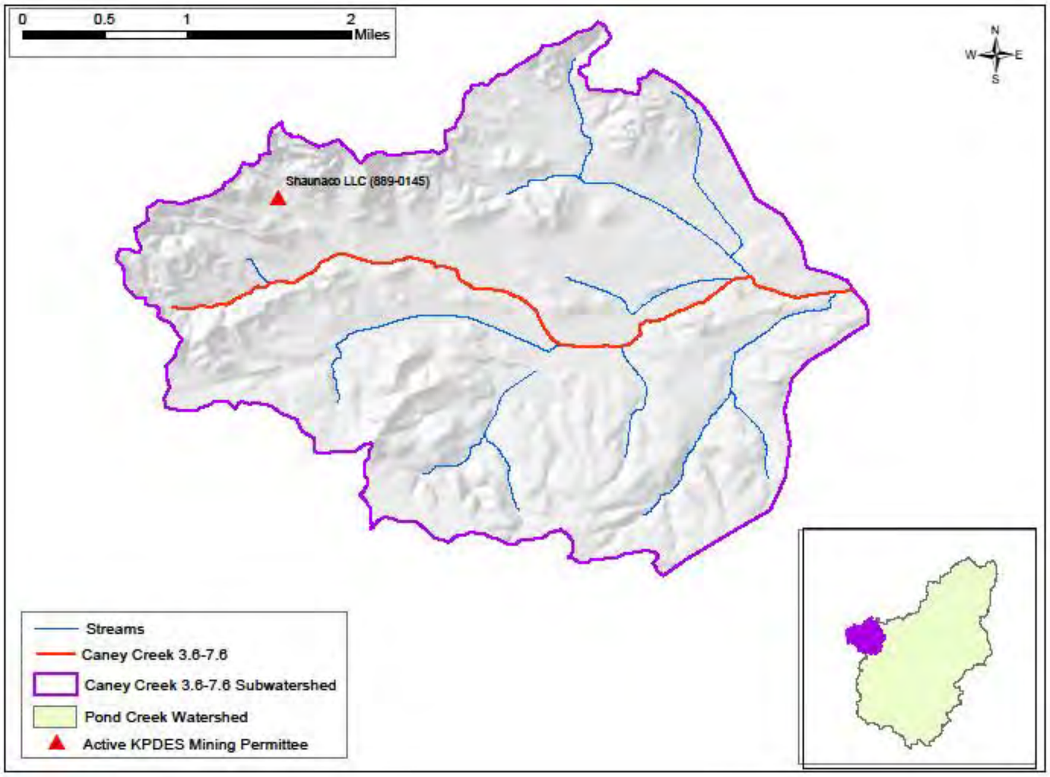


**Figure 8.5.4 Active KPDES Mining Permittee in the Subwatershed**

**Table 8.5.4 Active KPDES Mining Permittee in the Subwatershed**

| KPDES Permit # | KDNR Permit # | Permittee Name | Date Issued |
|---|---|---|---|
| KY0108537 | 889-0145 | Shaunaco LLC | 12/1/2011 |

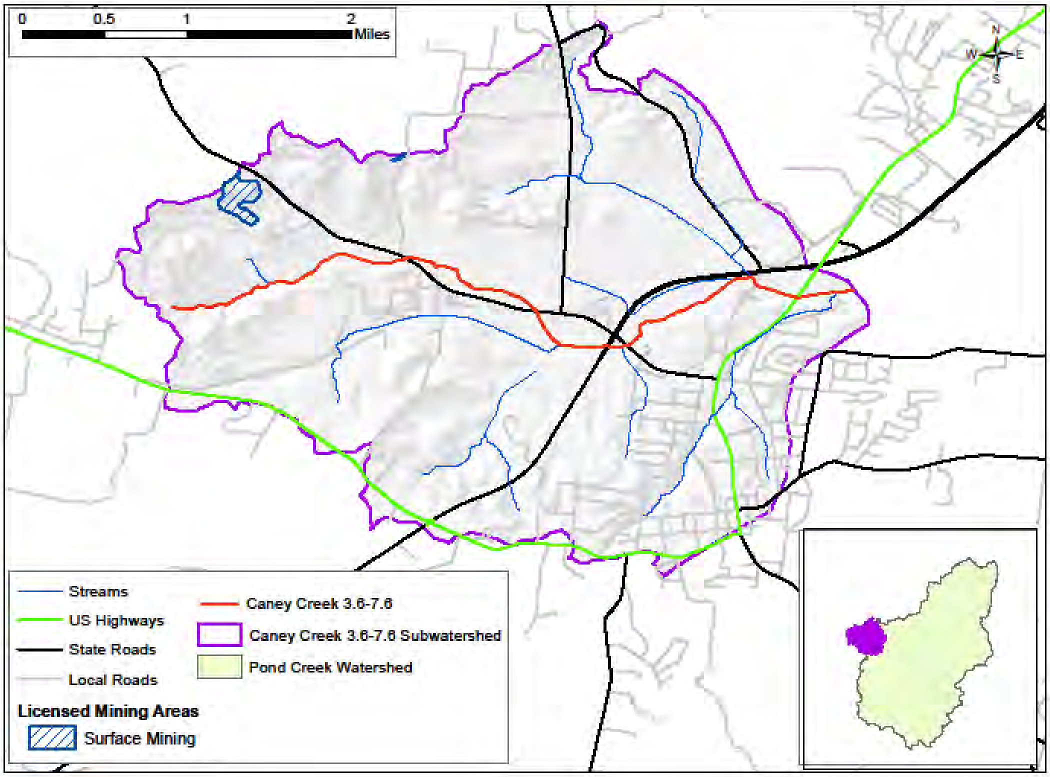


**Figure 8.5.5 Data from the Department of Natural Resources on Licensed Mining Areas in the Subwatershed**

**Table 8.5.5 *E. coli* and Flow Data, DOW03011014**

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 5/11/2011 | 39 | ** |
| 5/25/2011 | 110 | ** |
| 6/22/2011 | 1203 | ** |
| 7/13/2011 | 461 | ** |
| 9/28/2011 | 411 | ** |
| 10/19/2011 | > 2420 | ** |
| 5/8/2013 | 317 | ** |
| 5/9/2013 | 101 | ** |
| 5/20/2013 | 73 | ** |
| 5/23/2013 | 37 | ** |
| 5/29/2013 | 272 | ** |
| 6/6/2013 | > 2420 | ** |

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 6/26/2013 | 261 | ** |
| 7/16/2013 | 178 | ** |
| 8/15/2013 | 74 | ** |
| 9/24/2013 | > 2420 | ** |
| 10/9/2013 | 411 | ** |
| 10/14/2013 | 96 | ** |

[shaded] Exceeds the instantaneous *E. coli* limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

**Table 8.5.6 Cadmium, Hardness and Flow Data Collected at DOW03011014**

| Date | Cadmium (µg/L) | Hardness, Total (mg/L) | Cadmium Chronic Limit (µg/L) | Cadmium Acute Limit (µg/L) | Difference between the Cadmium Concentration and the Cadmium Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 11/17/2010 | < 0.80 (U) | 112 | 0.29 | 2.39 | N/A | ** |
| 1/5/2011 | 1.66 | 350 | 0.68 | 7.62 | 0.98 | ** |
| 2/16/2011 | 1.16 | 274 | 0.57 | 5.94 | 0.59 | ** |
| 3/9/2011 | < 0.80 (U) | 75.1 | 0.22 | 1.59 | N/A | ** |
| 4/27/2011 | < 0.80 (U) | 56.6 | 0.18 | 1.20 | N/A | ** |
| 5/11/2011 | 10.7 (L) | 529 | 0.93 | 11.60 | 9.77 | ** |
| 7/13/2011 | 0.898 | 343 | 0.67 | 7.47 | 0.22 | ** |

[shaded] Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
L = Exceeds MCL or Action Limit
U = Analyte Not Detected
N/A: Not Applicable

**Table 8.5.7 Lead, Hardness and Flow Data Collected at DOW03011014**

| Date | Lead (µg/L) | Hardness, Total (mg/L) | Lead Chronic Limit (µg/L) | Lead Acute Limit (µg/L) | Difference between the Lead Concentration and the Lead Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 11/17/2010 | 0.926 | 112 | 3.68 | 94.32 | -2.75 | ** |
| 1/5/2011 | 0.245 (J) | 350 | 15.68 | 402.28 | N/A | ** |

| Date | Lead (µg/L) | Hardness, Total (mg/L) | Lead Chronic Limit (µg/L) | Lead Acute Limit (µg/L) | Difference between the Lead Concentration and the Lead Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 2/16/2011 | < 0.50 (U) | 274 | 11.48 | 294.57 | N/A | ** |
| 3/9/2011 | 2.74 | 75.1 | 2.21 | 56.70 | 0.53 | ** |
| 4/27/2011 | 2.14 | 56.6 | 1.54 | 39.56 | 0.60 | ** |
| 5/11/2011 | 0.537 | 529 | 26.52 | 680.59 | -25.98 | ** |
| 7/13/2011 | < 0.50 (U) | 343 | 15.28 | 392.06 | N/A | ** |

Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
J = Estimated Value
U = Analyte Not Detected
N/A: Not Applicable

## 8.6 Carters Creek 0.0 to 3.1

The pollutant addressed in this document for Carters Creek 0.0 to 3.1 is *E. coli*. Carters Creek is a second order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 2.38 square miles. There is one TMDL monitoring site on the Carters Creek 0.0 to 3.1 segment, DOW03011017, located at RM 1.55 with the drainage area of 1.25 square miles, see Figure 8.6.1 and Table 8.6.1. This subwatershed consists primarily of forest (77.8%) and agricultural land (14.8%), see Figure 8.6.2 and Table 8.6.2.

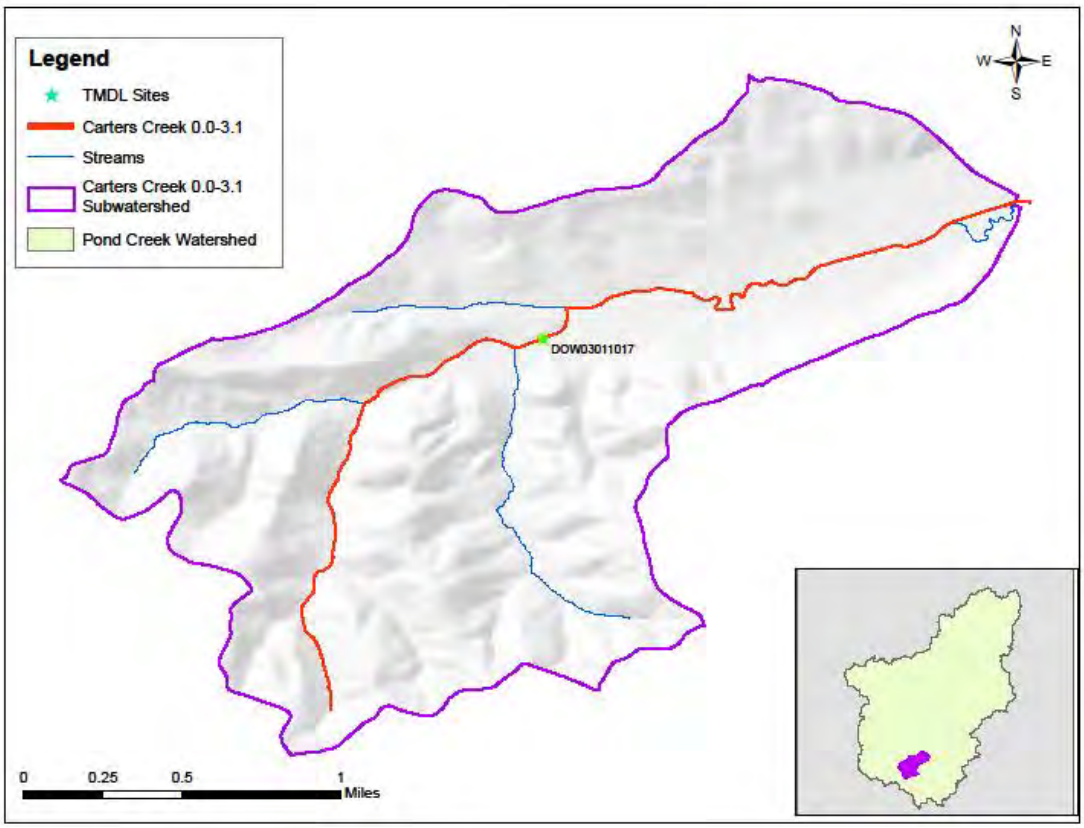


**Figure 8.6.1 TMDL Monitoring Site and the Drainage Area of Carters Creek 0.0 to 3.1**

**Table 8.6.1 Carters Creek 0.0 to 3.1 Segment/Upstream Catchment Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY489022_01 | Carters Creek 0.0 to 3.1 | 2 | Muhlenberg | 2.38 | 1522 |

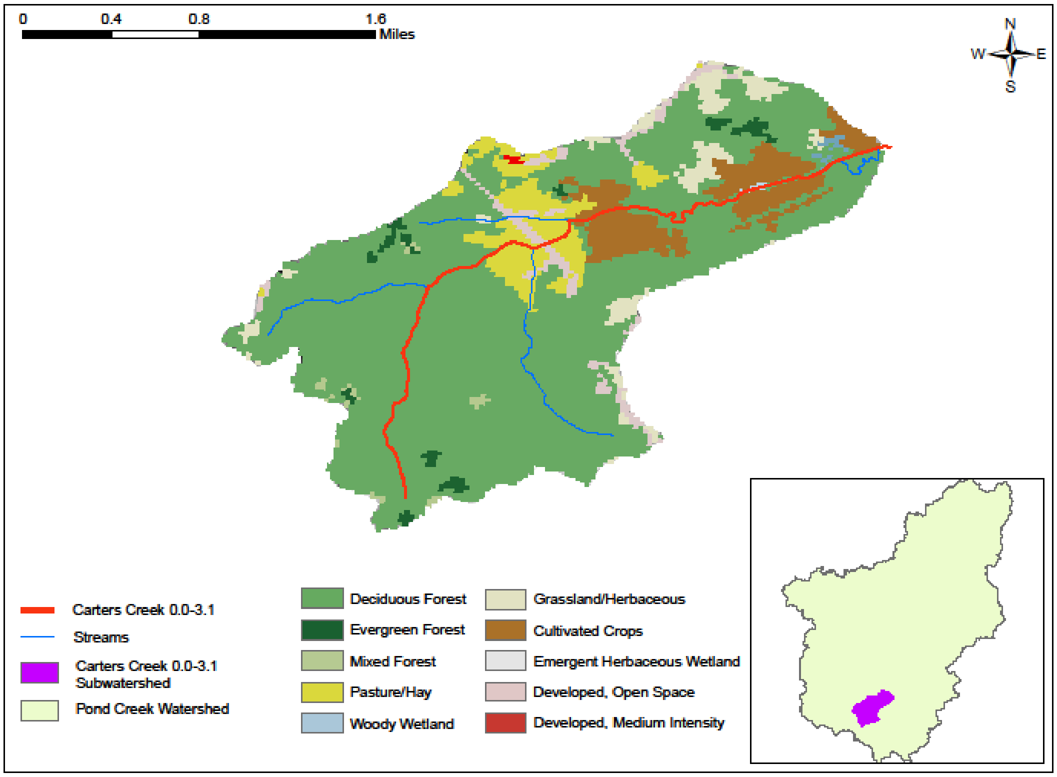


**Figure 8.6.2 Land Cover in the Carters Creek 0.0 to 3.1 Subwatershed**

**Table 8.6.2 Land Cover in the Carters Creek 0.0 to 3.1 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 0.07 | 44.5 | 2.9 |
| Agriculture | 0.35 | 223.9 | 14.8 |
| Forest | 1.84 | 1180.6 | 77.8 |
| Barren Land | 0 | 0 | 0 |
| Grassland/Herbaceous | 0.10 | 66.5 | 4.4 |
| Wetlands | 0 | 1.5 | 0.1 |
| Water | 0 | 0 | 0 |
| Shrub/Scrub | 0 | 0 | 0 |

There are no KPDES permittees in this subwatershed. *E. coli* and flow data monitored at DOW03011017 are in Table 8.6.3.

**Table 8.6.3 *E. coli* and Flow Data, DOW03011017**

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 5/10/2011 | 39 | 0.553 |
| 5/24/2011 | 78 | ** |
| 6/21/2011 | 579 | ** |
| 7/12/2011 | 866 | 0.114 |
| 5/8/2013 | 30 | ** |
| 5/9/2013 | 165 | ** |
| 5/20/2013 | 79 | N/A |
| 5/23/2013 | 99 | ** |
| 5/29/2013 | 40 | ** |
| 6/6/2013 | 435 | ** |
| 6/27/2013 | 365 | 0.001 |
| 7/30/2013 | 140 | ** |
| 8/15/2013 | 133 | 0.20 |
| 10/10/2013 | 65 | ** |

(shaded) Exceeds the instantaneous *E. coli* limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

## 8.7 Opossum Run 0.0 to 1.6

The pollutant addressed in this document for Opossum Run 0.0 to 1.6 is *E. coli*. Opossum Run 0.0 to 1.6 is a third order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 1.798 square miles. There is one TMDL monitoring site on the Opossum Run 0.0 to 1.6 segment, DOW03011021, located at RM 0.30 with the drainage area of 1.17 square miles, see Figure 8.7.1 and Table 8.7.1. This subwatershed consists primarily of agricultural land (60.8%) and forest (24.2%), see Figure 8.7.2 and Table 8.7.2.

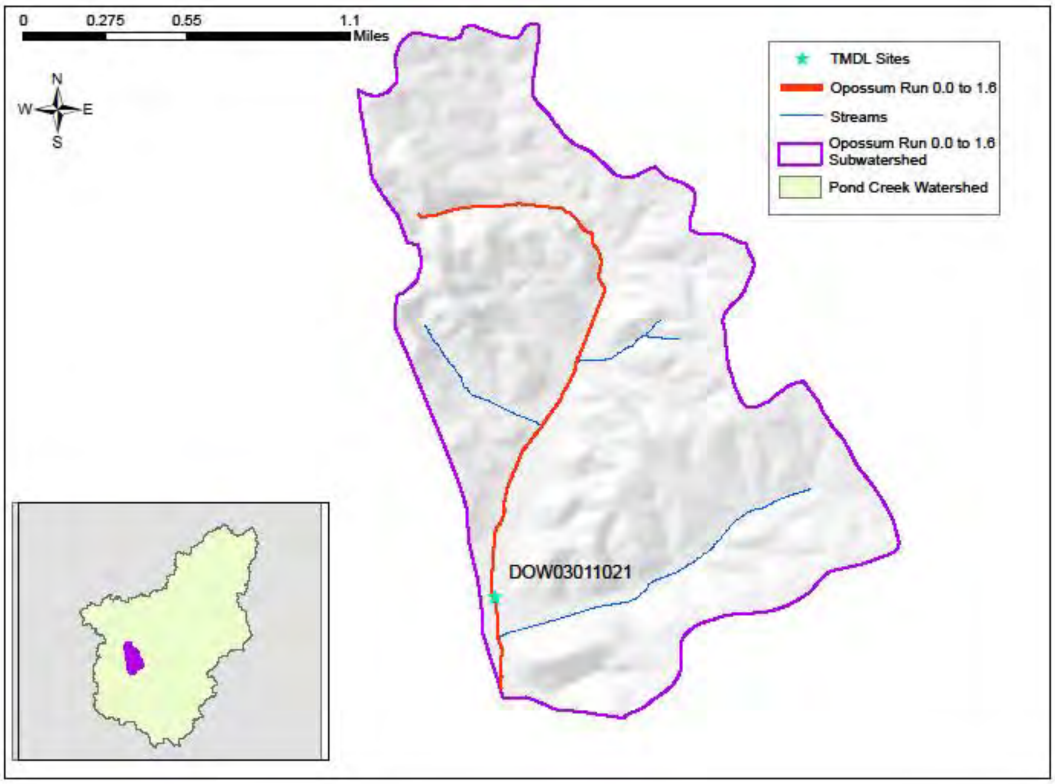


**Figure 8.7.1 TMDL Monitoring Site and the Drainage Area of Opossum Run 0.0 to 1.6**

**Table 8.7.1 Opossum Run 0.0 to 1.6 Segment/Upstream Catchment Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY499964_01 | Opossum Run 0.0 to 1.6 | 3 | Muhlenberg | 1.798 | 1151 |

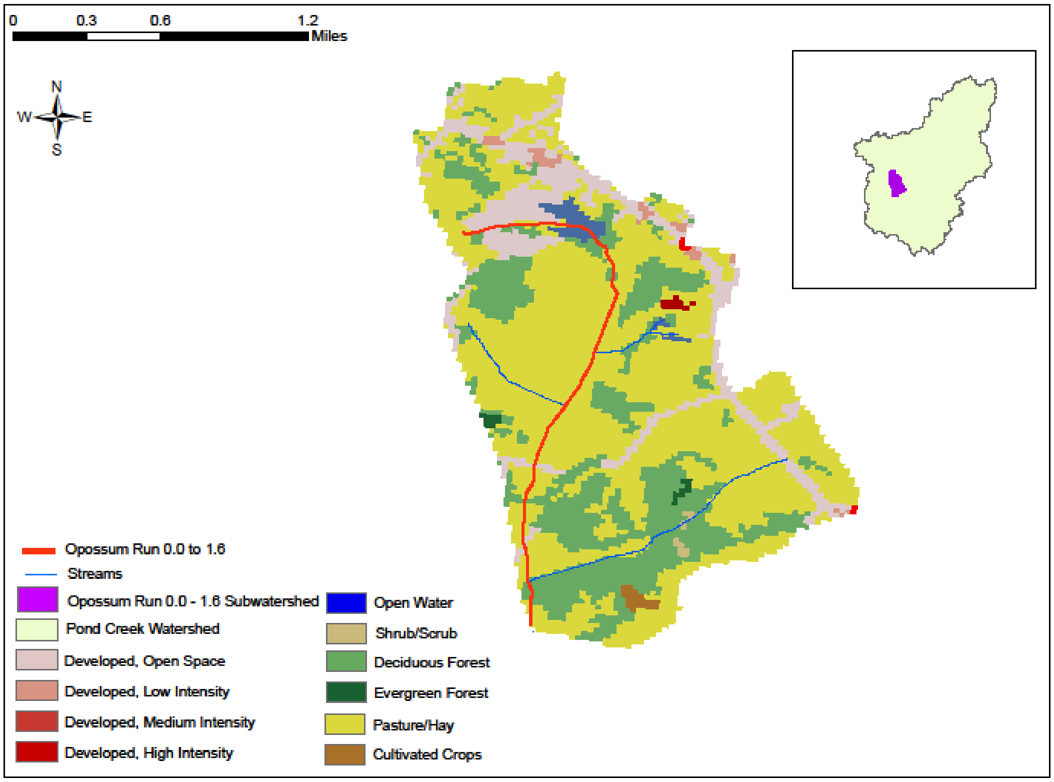


**Figure 8.7.2 Land Cover in the Opossum Run 0.0 to 1.6 Subwatershed**

**Table 8.7.2 Land Cover in the Opossum Run 0.0 to 1.6 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 0.24 | 155.8 | 13.5 |
| Agriculture | 1.10 | 701.6 | 60.8 |
| Forest | 0.44 | 278.9 | 24.2 |
| Barren Land | 0 | 0 | 0 |
| Grassland/Herbaceous | 0 | 0 | 0 |
| Wetlands | 0 | 0 | 0 |
| Water | 0.02 | 14.6 | 1.3 |
| Shrub/Scrub | 0.003 | 2.1 | 0.2 |

There are no KPDES permittees within the Opossum Run 0.0 to 1.6 subwatershed. Table 8.7.3 shows *E. coli* and flow data collected by TMDL staff at DOW03011021.

**Table 8.7.3 *E. coli* and Flow Data, DOW03011021**

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 5/10/2011 | 137 | 0.690 |
| 5/24/2011 | 488 | ** |
| 5/8/2013 | 124 | ** |
| 5/9/2013 | 118 | ** |
| 5/20/2013 | 186 | ** |
| 5/23/2013 | 179 | ** |
| 5/29/2013 | 6 | ** |
| 6/6/2013 | > 2420 | ** |
| 6/27/2013 | 387 | 0.127 |
| 7/30/2013 | 206 | 0.016 |
| 8/15/2013 | 167 | 0.18 |
| 9/24/2013 | 866 | 0.011 |
| 10/10/2013 | 548 | 0.181 |

(shaded) Exceeds the instantaneous *E. coli* limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

### 8.8 Plum Creek 0.0 to 1.65

The pollutants addressed in this document for Plum Creek 0.0 to 1.65 are *E. coli* and cadmium. Plum Creek 0.0 to 1.65 is a third order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 12.24 square miles. There is one TMDL monitoring site on the Plum Creek 0.0 to 1.65 segment, DOW03011030, located at RM 0.65 with the drainage area of 10.40 square miles, see Figure 8.8.1 and Table 8.8.1. This subwatershed consists primarily of forest (49.5%), herbaceous land (22.1%), and agricultural land (16.5%), see Figure 8.8.2 and Table 8.8.2.

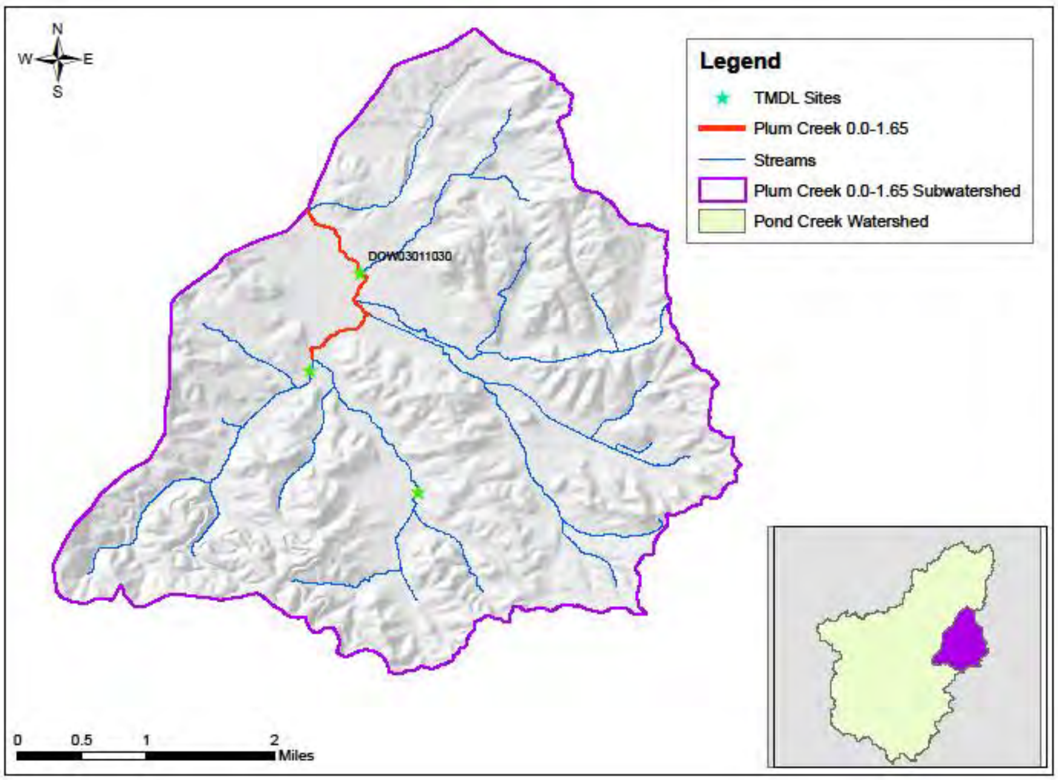


**Figure 8.8.1 TMDL Monitoring Locations and the Drainage Area of Plum Creek 0.0 to 1.65**

**Table 8.8.1 Plum Creek 0.0 to 1.65 Segment/Upstream Catchment Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY500964_01 | Plum Creek 0.0 to 1.65 | 3 | Muhlenberg | 12.24 | 7835 |

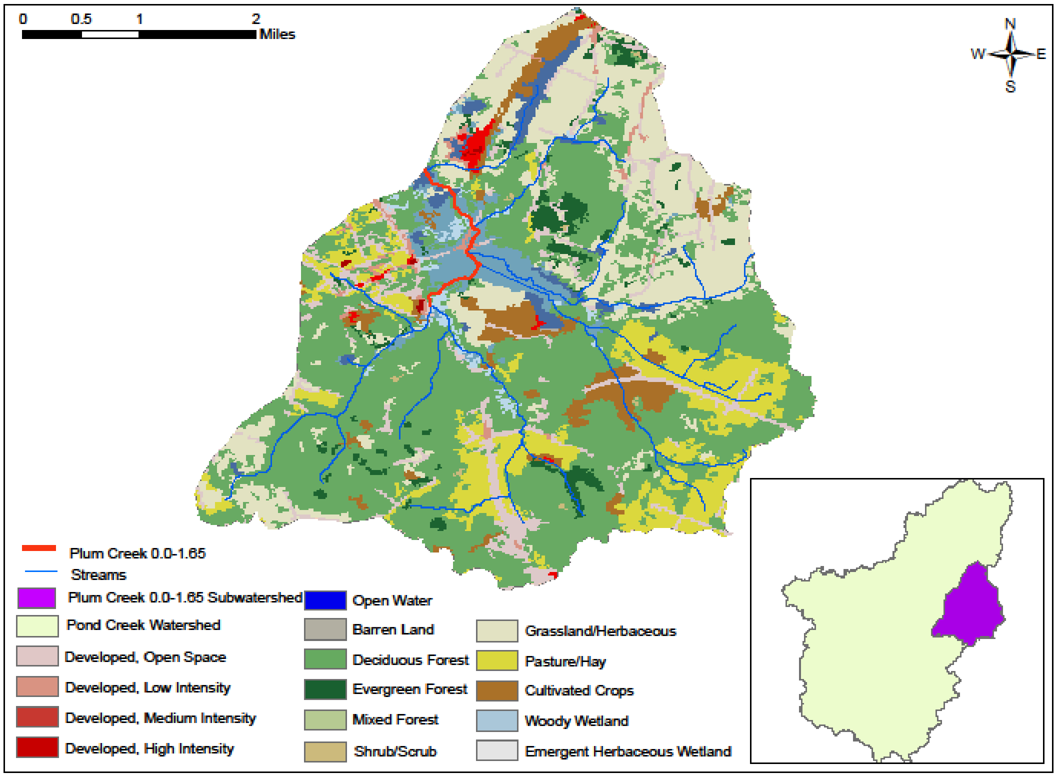


**Figure 8.8.2 Land Cover in the Plum Creek 0.0 to 1.65 Subwatershed**

**Table 8.8.2 Land Cover in the Plum Creek 0.0 to 1.65 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 1.02 | 649.6 | 8.3 |
| Agriculture | 2.02 | 1294.4 | 16.5 |
| Forest | 6.08 | 3882.0 | 49.5 |
| Barren Land | 0.00 | 1.6 | 0.0 |
| Grassland/Herbaceous | 2.71 | 1734.5 | 22.1 |
| Wetlands | 0.13 | 85.6 | 1.1 |
| Water | 0.28 | 179.5 | 2.3 |
| Shrub/Scrub | 0.01 | 8.5 | 0.1 |

There are two active KPDES permittees and six inactive KPDES permittees within the Plum Creek 0.0 to 1.65 subwatershed, see Figure 8.8.3 and Table 8.8.3. Although those inactive facilities were active during the data collection period and may have contributed to the impairments of this waterbody, inactive KPDES permittee will not receive a WLA.

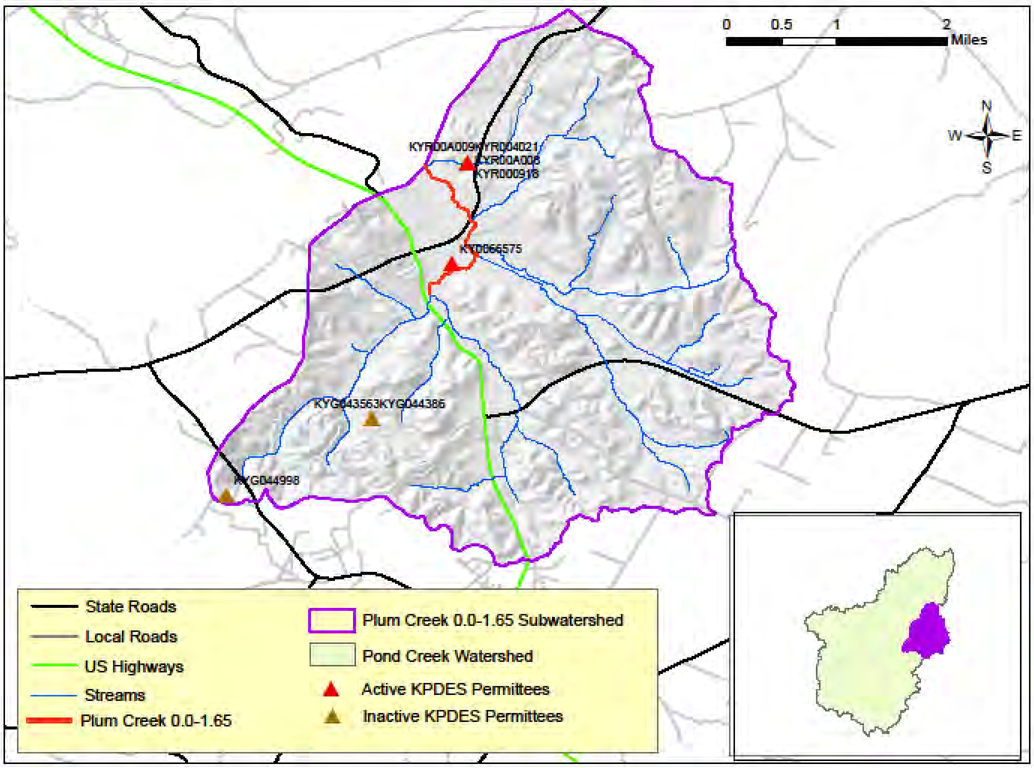


**Figure 8.8.3 KPDES Permittees in the Plum Creek 0.0 to 1.65 Subwatershed**

**Table 8.8.3 KPDES Permittees in the Plum Creek 0.0 to 1.65 Subwatershed**

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutants in Permit |
|---|---|---|---|---|---|---|
| KY0066575 | Drakesboro STP | Yes | 0.165 | 37.21722 | -87.04083 | bacteria, pH, Cd, Cu, Pb, Zn |
| KYR004021 | Harsco Minerals | Yes | 0 | 37.23067 | -87.03886 | pH and to develop a SWPPP |
| KYG043563 | Beech Creek Energy Inc | No | 0 | 37.19694 | -87.05139 | pH, Fe |
| KYG044386 | Beech Creek Energy Inc | No | 0 | 37.19694 | -87.05139 | pH, Fe |
| KYR000918 | Harsco Minerals | No | 0 | 37.230667 | -87.038861 | pH and to develop a SWPPP |
| KYG044998 | Beech Creek Energy Inc | No | 0 | 37.18694 | -87.07056 | pH, Fe |
| KYR00A008 | Reed Minerals | No | 0 | 37.230667 | -87.038861 | pH and to develop a SWPPP |

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutants in Permit |
|---|---|---|---|---|---|---|
| KYR00A009 | Reed Minerals | No | 0 | 37.230667 | -87.038861 | pH and to develop a SWPPP |

There are no active KPDES mining permittees in this subwatershed, but the majority of downstream watershed is licensed mining areas, see Figure 8.8.4 (see Section 9.4.3 for more information). Tables 8.8.4.and 8.8.5 show *E. coli*, cadmium and flow data collected by TMDL staff at DOW03011030.

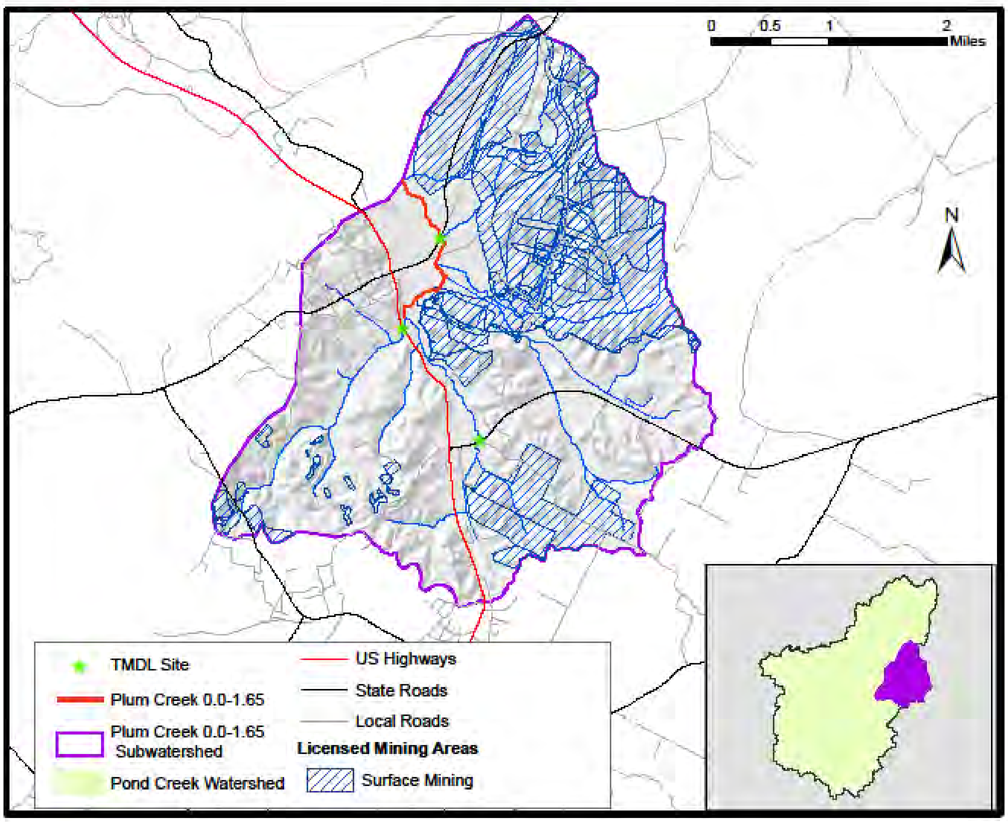


**Figure 8.8.4 Data from the Department of Natural Resources on Licensed Mining Areas in the Subwatershed**

**Table 8.8.4 *E. coli* and Flow Data, DOW03011030**

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 5/12/2011 | 40 | ** |
| 5/26/2011 | 649 | ** |
| 6/16/2011 | 32 | ** |
| 6/23/2011 | 166 | ** |

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 7/14/2011 | 16 | ** |
| 7/28/2011 | 122 | ** |
| 8/11/2011 | 1120 | ** |
| 8/25/2011 | 548 | ** |
| 9/15/2011 | 260 | ** |
| 9/29/2011 | 122 | ** |
| 10/13/2011 | > 2420 | ** |
| 10/20/2011 | 206 | ** |

(shaded) Exceeds the instantaneous *E. coli* limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

**Table 8.8.5 Cadmium, Hardness and Flow Data Collected at DOW03011030**

| Date | Cadmium (µg/L) | Hardness, Total (mg/L) | Cadmium Chronic Limit (µg/L) | Cadmium Acute Limit (µg/L) | Difference between the Cadmium Concentration and the Cadmium Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 11/18/2010 | < 0.80 (U) | 1140 | 1.64 | 25.32 | N/A | ** |
| 1/6/2011 | 0.851 (J) | 397 | 0.75 | 8.66 | N/A | ** |
| 2/17/2011 | 1.34 | 406 | 0.76 | 8.86 | 0.58 | ** |
| 3/10/2011 | 3.69 | 128 | 0.32 | 2.74 | 3.37 | ** |
| 4/28/2011 | 2.67 | 93 | 0.26 | 1.98 | 2.41 | ** |
| 5/12/2011 | 2.66 | 159 | 0.38 | 3.42 | 2.28 | ** |
| 6/16/2011 | < 0.80 (U) | 928 | 1.41 | 20.54 | N/A | ** |
| 7/14/2011 | < 0.80 (U) | 752 | 1.21 | 16.59 | N/A | ** |
| 8/11/2011 | < 0.80 (U) | 1070 | 1.57 | 23.74 | N/A | ** |
| 9/15/2011 | < 0.80 (U) | 1260 | 1.77 | 28.03 | N/A | ** |
| 10/13/2011 | < 0.80 (U) | 1120 | 1.62 | 24.87 | N/A | ** |

(orange) Exceeds the acute limit
(pink) Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
U = Analyte Not Detected
J = Estimated Value
N/A: Not Applicable

## 8.9 Plum Creek 1.65 to 3.9

The pollutants addressed in this document for Plum Creek 1.65 to 3.9 are *E. coli*, pH, cadmium, nickel and zinc. Plum Creek 1.65 to 3.9 is a second order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 2.71 square miles. There is one TMDL monitoring site on the Plum Creek 1.65 to 3.9 segment, DOW03011029, located at RM 3.0 with the drainage area of 1.46 square miles, see Figure 8.9.1 and Table 8.9.1. This subwatershed consists primarily of forest (68.0%), and agricultural land (17.5%), see Figure 8.9.2 and Table 8.9.2.

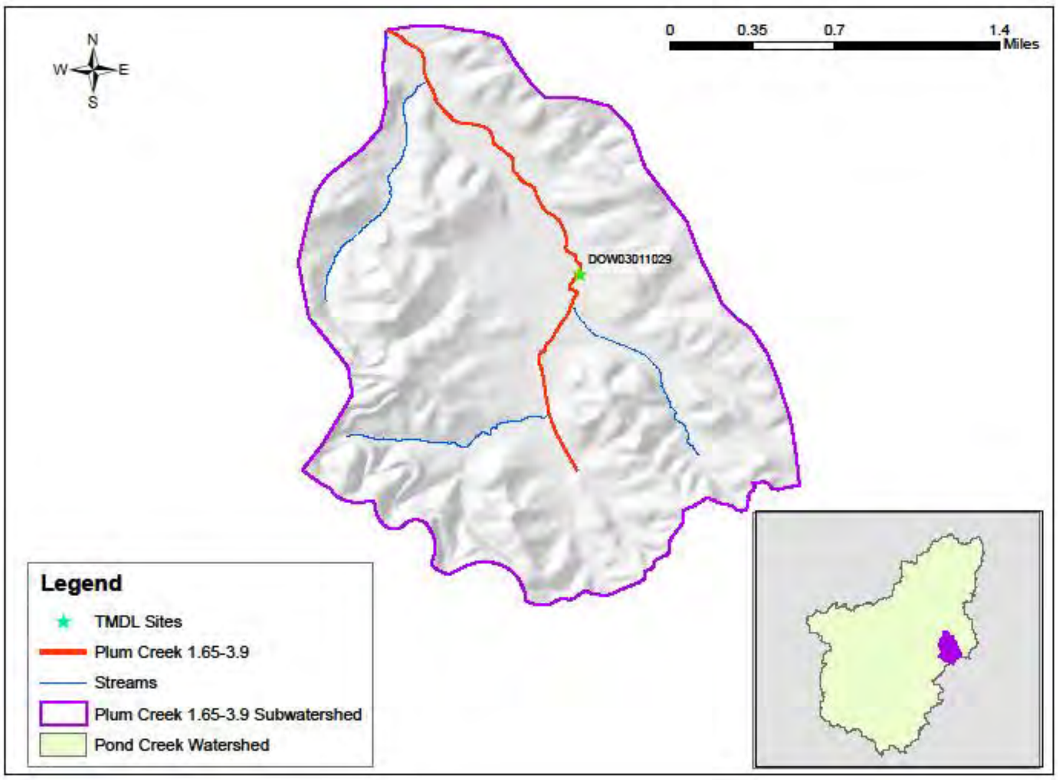


**Figure 8.9.1 TMDL Monitoring Locations and the Drainage Area of Plum Creek 1.65 to 3.9**

**Table 8.9.1 Plum Creek 1.65 to 3.9 Segment/Upstream Catchment Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY500964_02 | Plum Creek 1.65 to 3.9 | 2 | Muhlenberg | 2.71 | 1735 |

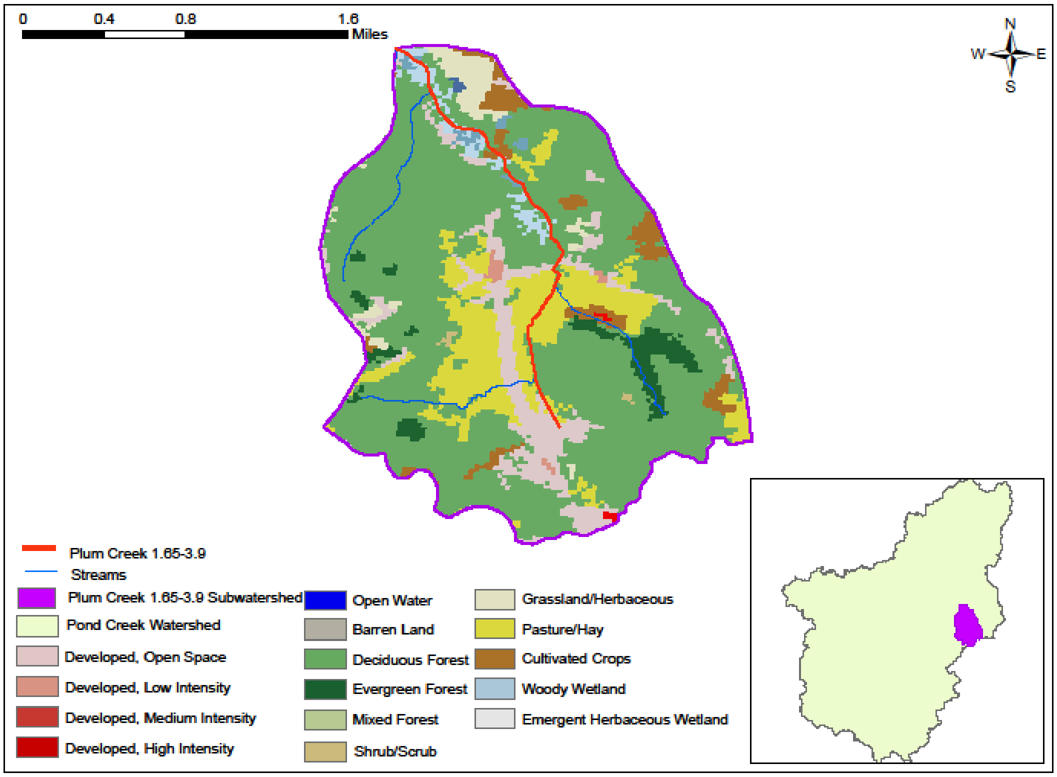


**Figure 8.9.2 Land Cover in the Plum Creek 1.65 to 3.9 Subwatershed**

**Table 8.9.2 Land Cover in the Plum Creek 1.65 to 3.9 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 0.25 | 158.5 | 9.1 |
| Agriculture | 0.48 | 304.4 | 17.5 |
| Forest | 1.85 | 1180.3 | 68.0 |
| Barren Land | 0 | 0 | 0 |
| Grassland/Herbaceous | 0.09 | 56.0 | 3.2 |
| Wetlands | 0.05 | 31.4 | 1.8 |
| Water | 0.003 | 1.9 | 0.1 |
| Shrub/Scrub | 0.003 | 2.2 | 0.1 |

There are no KPDES permittees in this subwatershed. Some of the watershed is licensed mining areas, see Figure 8.9.3 (see Section 9.4.3 for more information). Table 8.9.3 to Table 8.9.7 show *E. coli*, pH, metals and flow data collected by TMDL staff at DOW03011029.

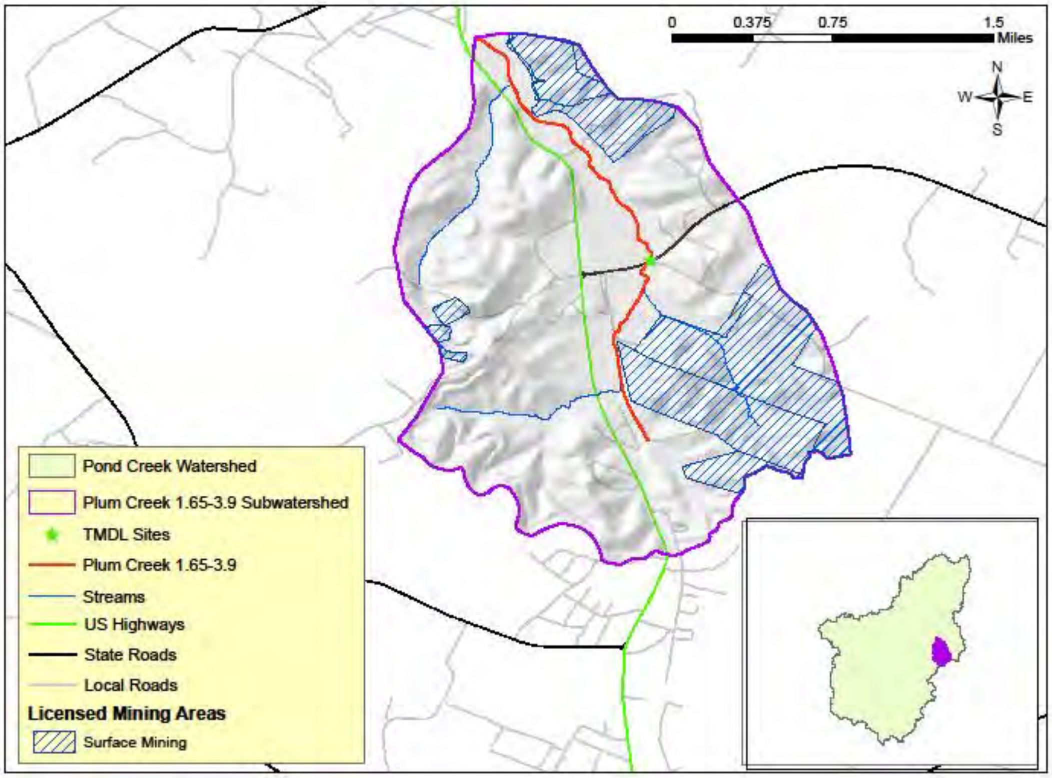


**Figure 8.9.3 Data from the Department of Natural Resources on Licensed Mining Areas in the Subwatershed**

**Table 8.9.3 *E. coli* and Flow Data, DOW03011029**

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 5/12/2011 | 6 | ** |
| 5/26/2011 | 397 | ** |
| 6/16/2011 | > 2420 | ** |
| 6/23/2011 | 185 | ** |
| 7/14/2011 | 248 | ** |
| 9/29/2011 | 261 | ** |
| 10/13/2011 | > 2420 | ** |

(shaded) Exceeds the instantaneous *E. coli* limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

**Table 8.9.4 pH and Flow Data Collected at DOW03011029**

| Collection Date | pH (standard units | Discharge (cfs) |
|---|---|---|
| 11/18/2010 | 6.86 | ** |
| 1/6/2011 | 6.64 | ** |
| 2/17/2011 | 5.25 | ** |
| 3/10/2011 | 5.65 | ** |
| 4/28/2011 | 5.66 | ** |
| 5/12/2011 | 5.86 | ** |
| 5/26/2011 | 5.91 | ** |
| 6/16/2011 | 7.25 | ** |
| 6/23/2011 | 6.96 | ** |
| 7/14/2011 | 5.80 | ** |
| 9/29/2011 | 8.49 | ** |
| 10/13/2011 | 8.86 | ** |

Exceeds the pH limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

**Table 8.9.5 Cadmium, Hardness and Flow Data Collected at DOW03011029**

| Date | Cadmium (µg/L) | Hardness, Total (mg/L) | Cadmium Chronic Limit (µg/L) | Cadmium Acute Limit (µg/L) | Difference between the Cadmium Concentration and the Cadmium Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 11/18/2010 | 1.32 | 138 | 0.34 | 2.96 | 0.98 | ** |
| 1/6/2011 | 41.6 (DL) | 236 | 0.51 | 5.11 | 41.09 | ** |
| 2/17/2011 | 28.8 (DL) | 197 | 0.45 | 4.25 | 28.35 | ** |
| 3/10/2011 | 17.9 (DL) | 115 | 0.30 | 2.46 | 17.60 | ** |
| 4/28/2011 | 12.2 (L) | 96.7 | 0.26 | 2.06 | 11.94 | ** |
| 5/12/2011 | 19.7 (DL) | 149 | 0.36 | 3.20 | 19.34 | ** |
| 6/16/2011 | 6.47 (L) | 158 | 0.38 | 3.40 | 6.09 | ** |
| 7/14/2011 | 1.8 | 218 | 0.48 | 4.71 | 1.32 | ** |
| 10/13/2011 | 0.689 (J) | 106 | 0.28 | 2.26 | N/A | ** |

Exceeds the acute limit
Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
D = Reanalyzed at a Higher Dilution
J = Estimated Value
L = Exceeds MCL or Action Limit
N/A: Not Applicable

**Table 8.9.6 Nickel, Hardness and Flow Data Collected at DOW03011029**

| Date | Nickel (µg/L) | Hardness, Total (mg/L) | Nickel Chronic Limit (µg/L) | Nickel Acute Limit (µg/L) | Difference between the Nickel Concentration and the Nickel Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 11/18/2010 | 5.33 | 138 | 68.50 | 616.13 | -63.17 | ** |
| 1/6/2011 | 150 | 236 | 107.86 | 970.10 | 42.14 | ** |
| 2/17/2011 | 127 | 197 | 92.57 | 832.63 | 34.43 | ** |
| 3/10/2011 | 81.5 | 115 | 58.71 | 528.06 | 22.79 | ** |
| 4/28/2011 | 73 | 96.7 | 50.70 | 456.04 | 22.30 | ** |
| 5/12/2011 | 148 | 149 | 73.09 | 657.43 | 74.91 | ** |
| 6/16/2011 | 54.1 | 158 | 76.81 | 690.87 | -22.71 | ** |
| 7/14/2011 | 20.4 | 218 | 100.85 | 907.12 | -80.45 | ** |
| 10/13/2011 | 6.89 | 106 | 54.80 | 492.88 | -47.91 | ** |

Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

**Table 8.9.7 Zinc, Hardness and Flow Data Collected at DOW03011029**

| Date | Zinc (µg/L) | Hardness, Total (mg/L) | Zinc Chronic Limit (µg/L) | Zinc Acute Limit (µg/L) | Difference between the Zinc Concentration and the Zinc Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 11/18/2010 | 16.3 (J) | 138 | 157.41 | 157.41 | N/A | ** |
| 1/6/2011 | 562 (D) | 236 | 248.02 | 248.02 | 313.98 | ** |
| 2/17/2011 | 408 (D) | 197 | 212.82 | 212.82 | 195.18 | ** |
| 3/10/2011 | 606 (D) | 115 | 134.88 | 134.88 | 471.12 | ** |
| 4/28/2011 | 190 | 96.7 | 116.46 | 116.46 | 73.54 | ** |
| 5/12/2011 | 347 (D) | 149 | 167.98 | 167.98 | 179.02 | ** |
| 6/16/2011 | 127 | 158 | 176.54 | 176.54 | -49.54 | ** |
| 7/14/2011 | 26.1 | 218 | 231.89 | 231.89 | -205.79 | ** |
| 10/13/2011 | 18.9 | 106 | 125.88 | 125.88 | -106.98 | ** |

Exceeds the limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
D = Reanalyzed at a Higher Dilution
J = Estimated Value
N/A: Not Applicable

## 8.10 Pond Creek 0.0 to 5.0

The pollutant addressed in this document for Pond Creek 0.0 to 5.0 is iron. Pond Creek 0.0 to 5.0 is a fifth order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 127.2 square miles, which covers the entire Pond Creek watershed. There is one TMDL monitoring site on the Pond Creek 0.0 to 5.0 segment, DOW03011031, located at RM 1.85 with the drainage area of 121.9 square miles, see Figure 8.10.1 and Table 8.10.1. This subwatershed consists primarily of forest (50.3%), and agricultural land (28.1%), see Figure 8.10.2 and Table 8.10.2.

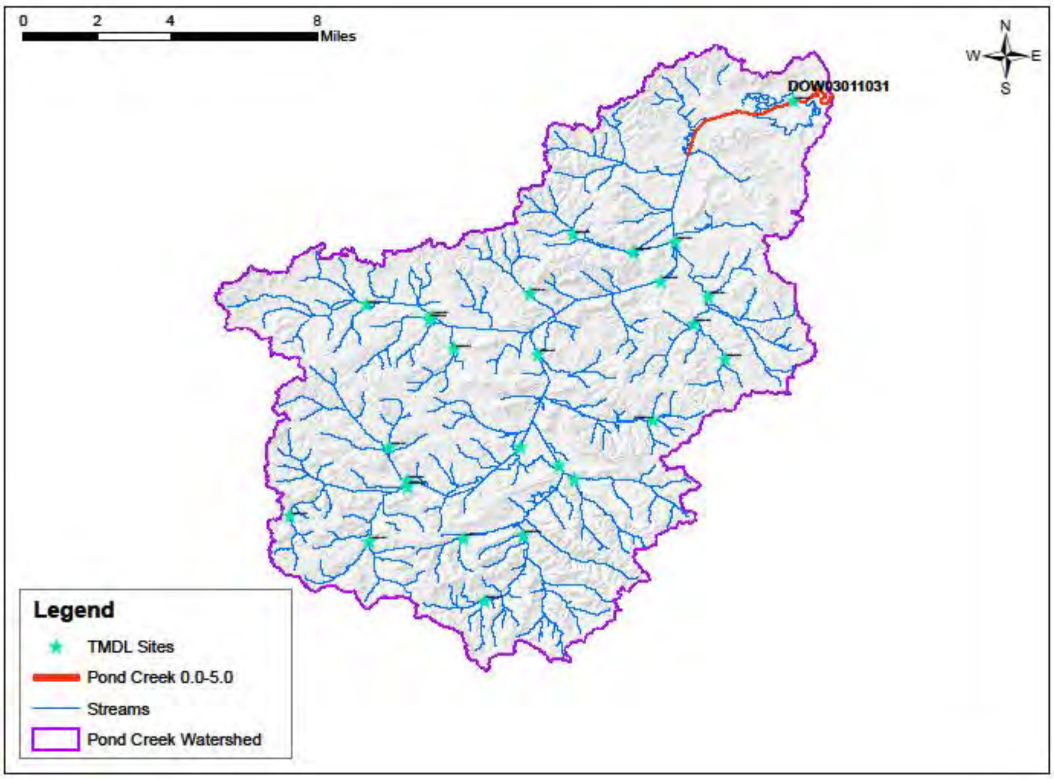


**Figure 8.10.1 TMDL Monitoring Sites and the Drainage Area of Pond Creek Watershed**

**Table 8.10.1 Pond Creek 0.0 to 5.0 Segment/Upstream Catchment Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY501042_01 | Pond Creek 0.0 to 5.0 | 5 | Muhlenberg | 127.2 | 81395 |

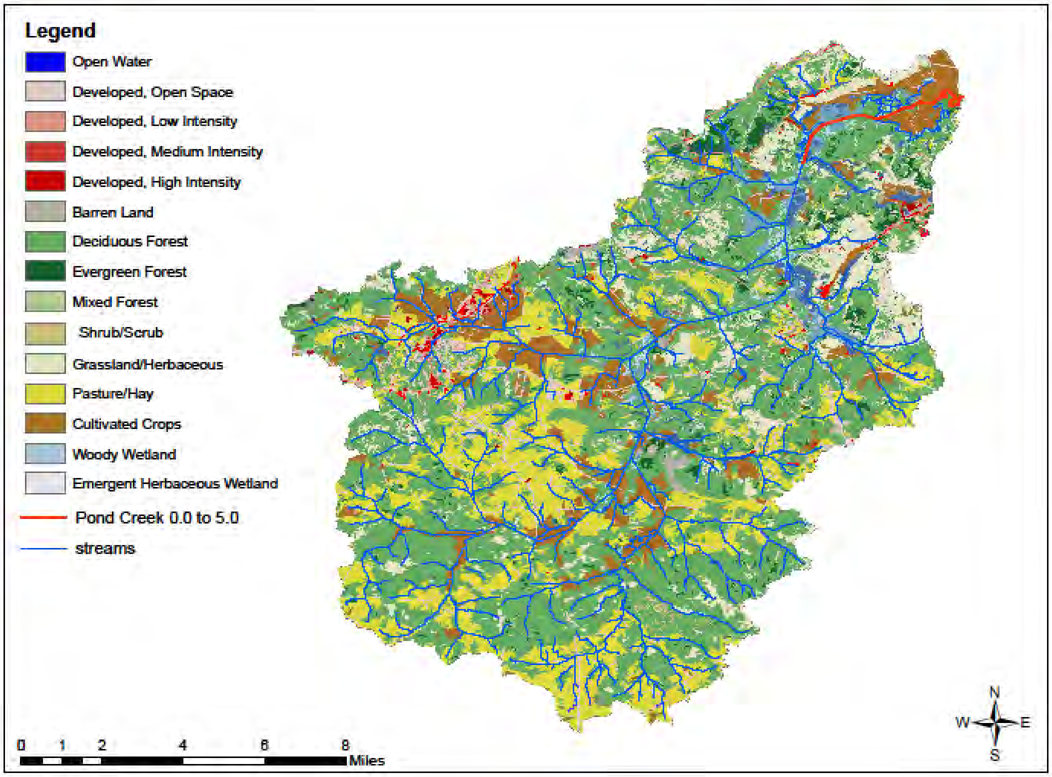


**Figure 8.10.2 Land Cover in the Pond Creek Watershed**

**Table 8.10.2 Land Cover in the Pond Creek Watershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 8.95 | 5727.3 | 7.0 |
| Water | 2.61 | 1672.2 | 2.1 |
| Barren Land | 0.72 | 459.6 | 0.6 |
| Forest | 64.0 | 40960.9 | 50.3 |
| Grassland | 10.93 | 6995.2 | 8.6 |
| Agriculture | 35.78 | 22899.3 | 28.1 |
| Wetland | 3.88 | 2481.2 | 3.0 |
| Shrub/Scrub | 0.30 | 199.5 | 0.2 |

There are nineteen active and forty inactive KPDES permittees within the Pond Creek watershed, see Figure 5.1 and Table S.8. Although those inactive KPDES facilities were active during the data collection period and may have contributed to the impairments of this waterbody, inactive KPDES permittee will not receive a WLA.

There are five active KPDES mining permittees in the Pond Creek watershed, see Figure 5.2 and Table 5.1. Some of the Pond Creek watershed is licensed mining areas, see Figure 9.2 and Table 9.2. Tables 8.10.3 show iron and flow data collected by TMDL staff at DOW03011031.

**Table 8.10.3 Iron and Flow Data Collected at DOW03011031**

| Date | Iron(mg/L) [(1)] | Flow (cfs) |
|---|---|---|
| 3/21/2013 | 0.877 | ** |
| 4/18/2013 | 1.19 | ** |
| 5/8/2013 | 1.32 | ** |
| 6/26/2013 | 0.897 | ** |
| 7/16/2013 | 0.604 | ** |
| 8/6/2013 | 0.861 | ** |
| 9/10/2013 | 0.722 | ** |
| 10/9/2013 | 0.876 | ** |
| 11/13/2013 | 1.15 | ** |
| 12/17/2013 | 1.31 | ** |
| 3/18/2014 | 1.61 | ** |
| 4/15/2014 | 7.95 | ** |
| 5/21/2014 | 0.766 | ** |
| 6/5/2014 | 1.87 | ** |
| 7/23/2014 | 0.577 | ** |
| 8/13/2014 | 0.538 | ** |
| 9/11/2014 | 0.915 | ** |
| 10/29/2014 | 0.736 | ** |
| 11/19/2014 | 6.82 | ** |
| 12/23/2014 | 1.32 | ** |

[(1)]Chronic limit is 3.5 mg/L since aquatic life has not been shown to be adversely affected
[orange shading] Exceeds the acute limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

### 8.11 Pond Creek 5.0 to 7.5

The pollutants addressed in this document for Pond Creek 5.0 to 7.5 are *E. coli*, cadmium, and iron. Pond Creek 5.0 to 7.5 is a fifth order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 113.60 square miles. There is one TMDL monitoring site on the Pond Creek 5.0 to 7.5 segment, DOW03011009, located at RM 7.4 with the drainage area of 99.68 square miles, see Figure 8.11.1 and Table 8.11.1. This subwatershed consists primarily of forest (50.8%), and agricultural land (29.4%), see Figure 8.11.2 and Table 8.11.2.

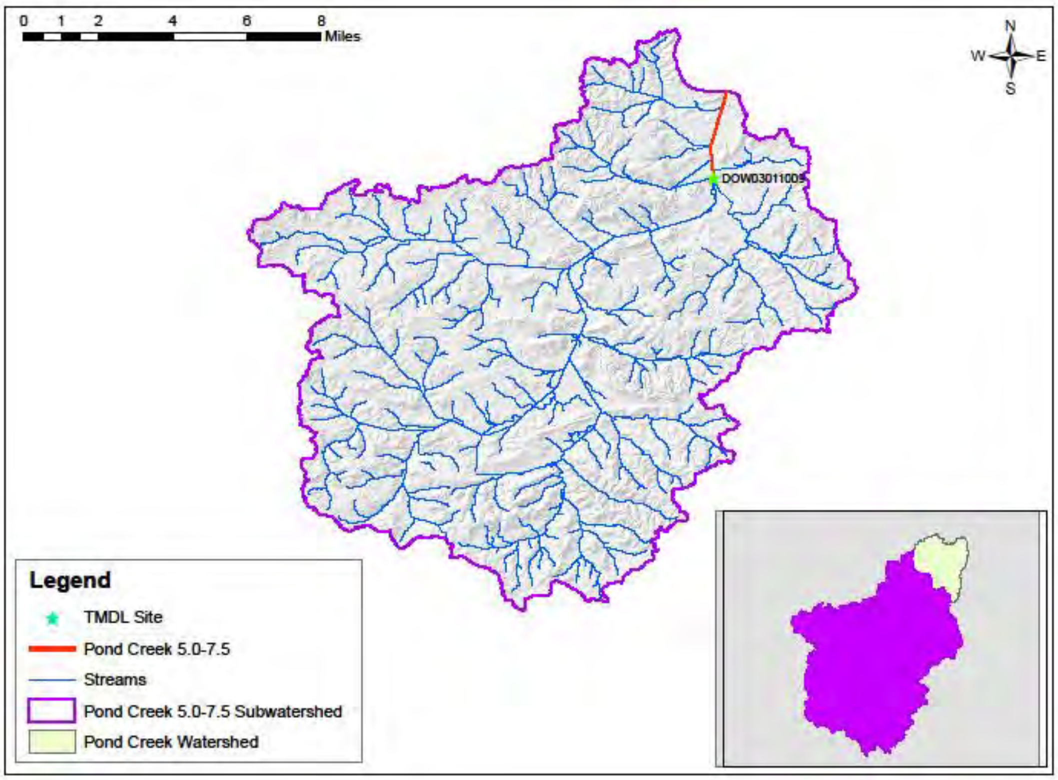


**Figure 8.11.1 TMDL Monitoring Locations and the Drainage Area of Pond Creek 5.0 to 7.5**

**Table 8.11.1 Pond Creek 5.0 to 7.5 Segment/Upstream Catchment Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY501042_02 | Pond Creek 5.0 to 7.5 | 5 | Muhlenberg | 113.60 | 72701 |

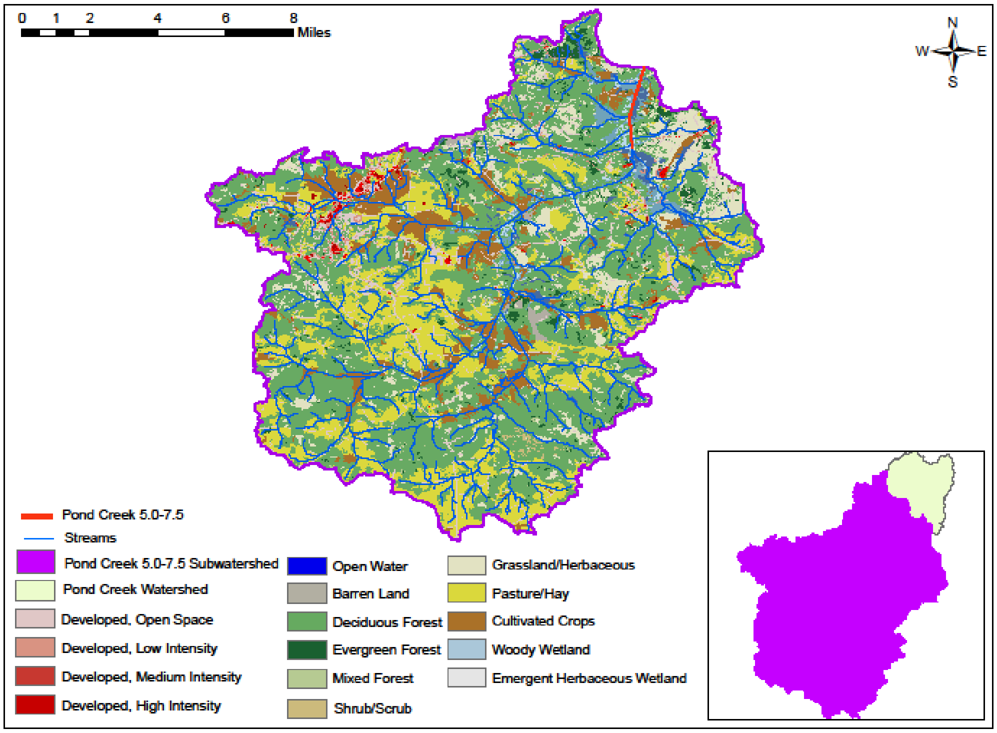


**Figure 8.11.2 Land Cover in the Pond Creek 5.0 to 7.5 Subwatershed**

**Table 8.11.2 Land Cover in the Pond Creek 5.0 to 7.5 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 8.05 | 5153.7 | 7.1 |
| Agriculture | 33.35 | 21342.6 | 29.4 |
| Forest | 57.93 | 36910.7 | 50.8 |
| Barren Land | 1.04 | 663.8 | 0.9 |
| Grassland/Herbaceous | 10.57 | 6767.7 | 9.3 |
| Wetlands | 0.95 | 607.8 | 0.8 |
| Water | 1.71 | 1091.6 | 1.5 |
| Shrub/Scrub | 0.26 | 166.4 | 0.2 |

There are seventeen active and thirty-five inactive KPDES permittees within this subwatershed, see Figure 8.11.3 and Table 8.11.3. Although those inactive KPDES facilities were active during the data collection period and may have contributed to the impairments of this waterbody, inactive KPDES permittee will not receive a WLA.

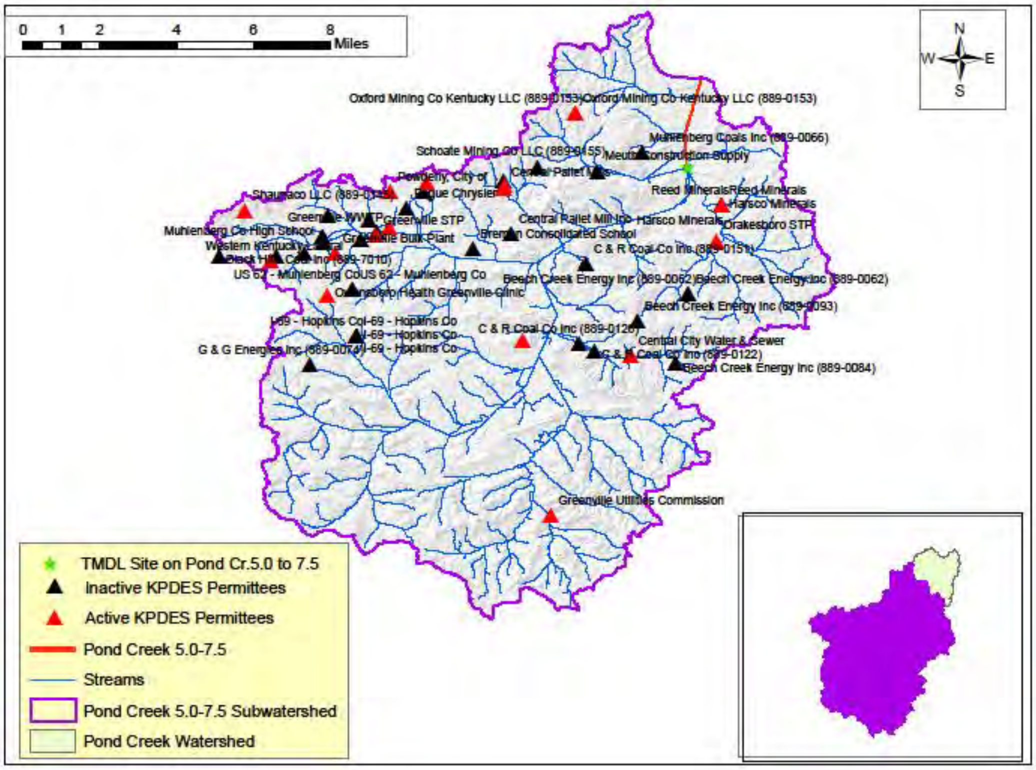


**Figure 8.11.3 KPDES Permittees in the Pond Creek 5.0 to 7.5 Subwatershed**

**Table 8.11.3 KPDES Permittees in the Pond Creek 5.0 to 7.5 Subwatershed**

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutant Limits/Requirement in the Permit |
|---|---|---|---|---|---|---|
| KY0020010 | Greenville STP | Yes | 1.31 | 37.219167 | -87.169444 | bacteria, pH, Cd, Cu, Pb, Zn |
| KY0066575 | Drakesboro STP | Yes | 0.165 | 37.217222 | -87.040833 | bacteria, pH, Cd, Cu, Pb, Zn |
| KY0108537 | Shaunaco LLC (889-0145) | Yes | 0 | 37.228611 | -87.218889 | pH, Cd, Cu, Fe, Pb,Ni, Zn |
| KY0109606 | Greenville Bulk Plant | Yes | 0 | 37.212500 | -87.184700 | pH |
| KY0111996 | Oxford Mining Co Kentucky LLC (889-0153) | Yes | 0 | 37.265000 | -87.094056 | pH, Fe |
| KYG045755 | Oxford Mining Co Ky LLC (889-0156) | Yes | 0 | 37.179722 | -87.113889 | pH, Fe |
| KYG046498 | Oxford Mining Co Kentucky LLC (889-0153) | Yes | 0 | 37.265000 | -87.094056 | pH, Fe |

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutant Limits/Requirement in the Permit |
|---|---|---|---|---|---|---|
| KYG640029 | Central City Water & Sewer | Yes | 0.0005 | 37.173800 | -87.073000 | pH, Fe |
| KYG640108 | Greenville Utilities Commission | Yes | 0.027 | 37.113900 | -87.103200 | pH, Fe |
| KYP000064 | Powderly, City of | Yes | 0 | 37.235833 | -87.163889 | discharge to Greenville WWTP |
| KYR003239 | Central Pallet Mills | Yes | 0 | 37.237167 | -87.121083 | pH and to develop a SWPPP |
| KYR004015 | Carl Mitchell & Son Implement - Paradise Rd | Yes | 0 | 37.238014 | -87.120822 | pH and to develop a SWPPP |
| KYR004021 | Harsco Minerals | Yes | 0 | 37.230667 | -87.038861 | pH and to develop a SWPPP |
| KYR10J469 | Muhlenberg County Airport | Yes | 0 | 37.222067 | -87.164333 | to develop a SWPPP |
| KYR10K083 | Owensboro Health Greenville Clinic | Yes | 0 | 37.196391 | -87.187716 | to develop a SWPPP |
| KYR10K315 | Western Kentucky Lateral | Yes | 0 | 37.209464 | -87.209069 | to develop a SWPPP |
| KYR10K433 | Owensboro Health Muhlenberg Healthplex | Yes | 0 | 37.238889 | -87.150189 | to develop a SWPPP |
| KY0023329 | Bremen Consolidated School | No | 0.008 | 37.214000 | -87.132800 | bacteria |
| KY0099538 | Texas Gas Transmission LLC - West Greenville | No | 0 | 37.211111 | -87.206944 | pH |
| KY0106046 | C & R Coal Co Inc (889-0151) | No | 0 | 37.208333 | -87.090000 | pH, Fe |
| KYG043169 | Black Hills Coal Inc (889-7010) | No | 0 | 37.211111 | -87.228611 | pH, Fe |
| KYG043563 | Beech Creek Energy Inc (889-0062) | No | 0 | 37.196944 | -87.051389 | pH, Fe |
| KYG043825 | Muhlenberg Coals Inc (889-0066) | No | 0 | 37.250278 | -87.068889 | pH, Fe |
| KYG044386 | Beech Creek Energy Inc (889-0062) | No | 0 | 37.196944 | -87.051389 | pH, Fe |
| KYG044486 | G & G Energies Inc (889-0074) | No | 0 | 37.170457 | -87.194335 | pH, Fe |
| KYG044573 | Friendship Energy Inc (889-0079) | No | 0 | 37.217528 | -87.175069 | pH, Fe |
| KYG044789 | Beech Creek Energy Inc (889-0084) | No | 0 | 37.170833 | -87.056111 | pH, Fe |

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutant Limits/Requirement in the Permit |
|---|---|---|---|---|---|---|
| KYG044998 | Beech Creek Energy Inc (889-0093) | No | 0 | 37.186944 | -87.070556 | pH, Fe |
| KYG045704 | Schoate Mining Co LLC (889-0155) | No | 0 | 37.245000 | -87.108333 | pH, Fe |
| KYG046025 | C & R Coal Co Inc (889-0126) | No | 0 | 37.178333 | -87.092778 | pH, Fe |
| KYG046026 | C & R Coal Co Inc (889-0122) | No | 0 | 37.175833 | -87.086944 | pH, Fe |
| KYR000524 | Central Pallet Mill Inc | No | 0 | 37.220000 | -87.118333 | pH and to develop a SWPPP |
| KYR000918 | Harsco Minerals | No | 0 | 37.230667 | -87.038861 | pH and to develop a SWPPP |
| KYR001665 | Carl Mitchell & Son Implement | No | 0 | 37.239428 | -87.121152 | pH and to develop a SWPPP |
| KYR001693 | Meuth Construction Supply | No | 0 | 37.243362 | -87.085699 | pH and to develop a SWPPP |
| KYR00A008 | Reed Minerals | No | 0 | 37.230667 | -87.038861 | pH and to develop a SWPPP |
| KYR00A009 | Reed Minerals | No | 0 | 37.230667 | -87.038861 | pH and to develop a SWPPP |
| KYR10E810 | Muhlenberg Co High School Phas 3 | No | 0 | 37.216500 | -87.189224 | to develop a SWPPP |
| KYR10E960 | Muhlenberg County Emergency SE | No | 0 | 37.235680 | -87.151550 | to develop a SWPPP |
| KYR10F821 | Muhlenberg Co High School | No | 0 | 37.218839 | -87.189686 | to develop a SWPPP |
| KYR10G145 | Greenville WWTP | No | 0 | 37.220472 | -87.169111 | to develop a SWPPP |
| KYR10G154 | Knight Construction & Excavating Inc | No | 0 | 37.212776 | -87.196388 | to develop a SWPPP |
| KYR10G285 | Pogue Chrysler | No | 0 | 37.229353 | -87.157828 | to develop a SWPPP |
| KYR10G428 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G429 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G456 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G458 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G631 | US 62 - Muhlenberg Co | No | 0 | 37.198889 | -87.178333 | to develop a SWPPP |

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutant Limits/Requirement in the Permit |
|---|---|---|---|---|---|---|
| KYR10G632 | US 62 - Muhlenberg Co | No | 0 | 37.198889 | -87.178333 | to develop a SWPPP |
| KYR10H138 | Muhlenberg Co High School | No | 0 | 37.218839 | -87.189686 | to develop a SWPPP |
| KYR10H705 | Muhlenberg County Park Phase I | No | 0 | 37.226610 | -87.187427 | to develop a SWPPP |
| KYR10I149 | Pogue Electric Service Inc. | No | 0 | 37.224749 | -87.172138 | to develop a SWPPP |

There are four active KPDES mining permits in this subwatershed, see Figure 8.11.4 and Table 8.11.4. Some of this subwatershed is licensed mining areas, see Figure 8.11.5 (see Section 9.4.3 for more information). Tables 8.11.5 to Table 8.11.7 show *E. coli*, cadmium, iron and flow data collected by TMDL staff at DOW03011009.

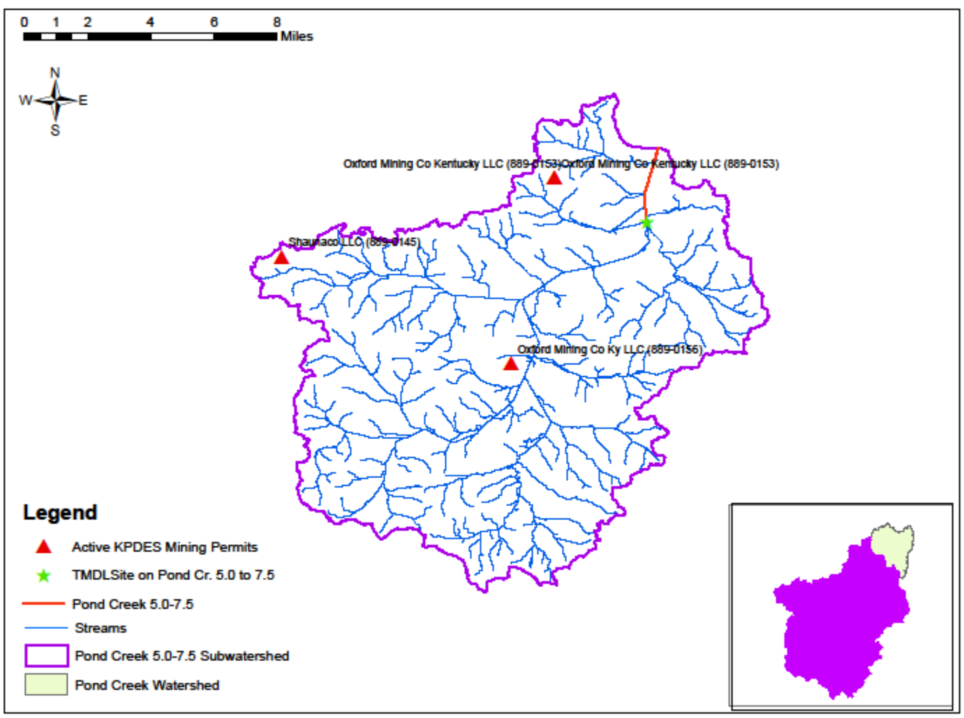


**Figure 8.11.4 Active KPDES-Permitted Mining in the Subwatershed**

**Table 8.11.4 Active KPDES-Permitted Mining in the Pond Creek Watershed**

| KPDES Permit # | KDNR Permit # | Permittee Name | Date Issued |
|---|---|---|---|
| KY0108537 | 889-0145 | Shaunaco LLC | 12/1/2011 |
| KYG046498 | 889-0153 | Oxford Mining Co Kentucky LLC | 8/4/2010 |
| KYG045755 | 889-0156 | Oxford Mining Co Ky LLC | 7/1/2009 |
| KY0111996 | 889-0153 | Oxford Mining Co Kentucky LLC | Pending |

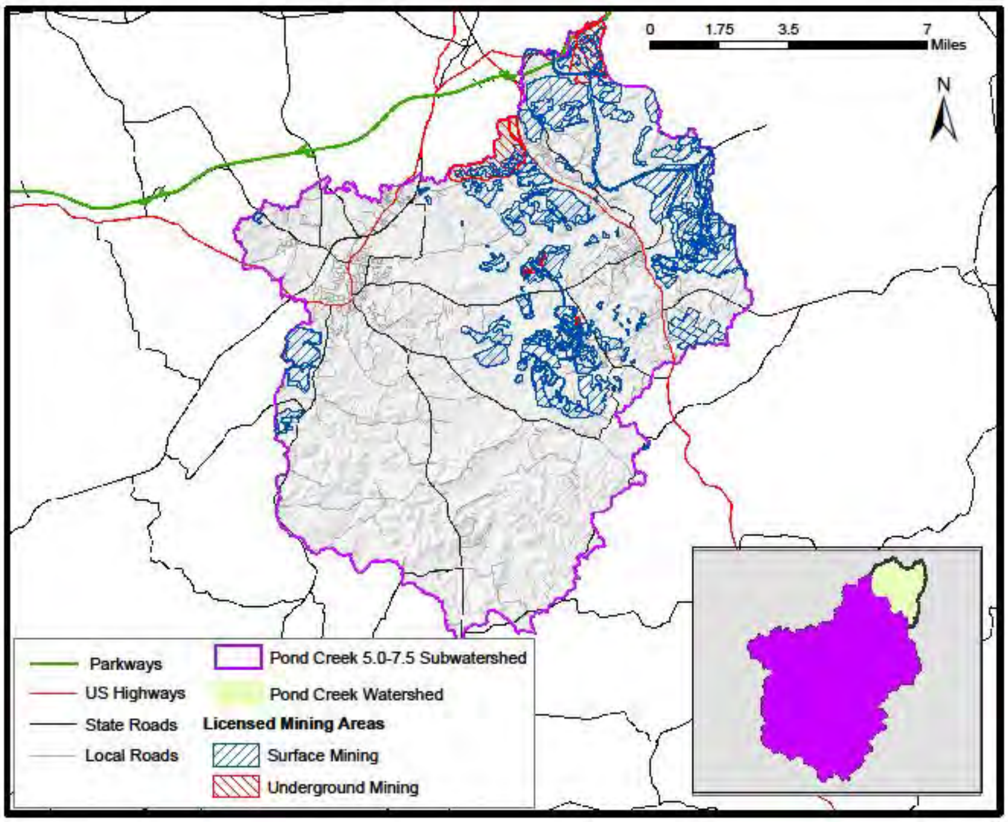


**Figure 8.11.5 Data from the Department of Natural Resources on Licensed Mining Areas in the Subwatershed**

**Table 8.11.5 *E. coli* and Flow Data, DOW03011009**

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 5/12/2011 | 58 | ** |
| 5/26/2011 | >2420 | ** |

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 6/16/2011 | 16 | ** |
| 6/23/2011 | 261 | ** |
| 7/14/2011 | 1 (U) | ** |
| 7/28/2011 | 70 | ** |
| 8/11/2011 | 18 | ** |
| 8/25/2011 | 47 | ** |
| 9/15/2011 | 166 | ** |
| 9/29/2011 | 50 | ** |
| 10/13/2011 | 1986 | ** |
| 10/20/2011 | 1 | ** |

Exceeds the instantaneous *E. coli* limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
U = Analyte Not Detected

**Table 8.11.6 Cadmium, Hardness and Flow Data Collected at DOW03011009**

| Date | Cadmium (µg/L) | Hardness, Total (mg/L) | Cadmium Chronic Limit (µg/L) | Cadmium Acute Limit (µg/L) | Difference between the Cadmium Concentration and the Cadmium Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 11/18/2010 | 2.32 | 1160 | 1.66 | 25.77 | 0.66 | ** |
| 1/6/2011 | 1.68 | 503 | 0.90 | 11.02 | 0.78 | ** |
| 2/17/2011 | 1.19 | 411 | 0.77 | 8.98 | 0.42 | ** |
| 3/10/2011 | 0.59 (J) | 115 | 0.30 | 2.46 | N/A | ** |
| 4/28/2011 | < 0.80 (U) | 79.3 | 0.23 | 1.69 | N/A | ** |
| 5/12/2011 | 3.05 | 183 | 0.42 | 3.94 | 2.63 | ** |
| 6/16/2011 | 1.88 | 1640 | 2.15 | 36.65 | -0.27 | ** |
| 7/14/2011 | < 16 (DU) | 996 | 1.49 | 22.07 | N/A | ** |
| 8/11/2011 | 2.49 | 1780 | 2.28 | 39.83 | 0.21 | ** |
| 9/15/2011 | < 0.80 (U) | 1340 | 1.85 | 29.84 | N/A | ** |
| 10/13/2011 | 0.418 (J) | 1220 | 1.73 | 27.13 | N/A | ** |

| Date | Cadmium (µg/L) | Hardness, Total (mg/L) | Cadmium Chronic Limit (µg/L) | Cadmium Acute Limit (µg/L) | Difference between the Cadmium Concentration and the Cadmium Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|

Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
D = Reanalyzed at a Higher Dilution
J = Estimated Value
U = Analyte Not Detected
N/A: Not Applicable

**Table 8.11.7 Iron and Flow Data Collected at DOW03011009**

| Date | Iron (mg/L) [(1)] | Flow (cfs) |
|---|---|---|
| 11/18/2010 | 6.72 | ** |
| 1/6/2011 | 2.68 | ** |
| 2/17/2011 | 2.4 | ** |
| 3/10/2011 | 1.14 | ** |
| 4/28/2011 | 1.1 | ** |
| 5/12/2011 | 2.28 | ** |
| 6/16/2011 | 5.33 | ** |
| 7/14/2011 | 18.5 | ** |
| 8/11/2011 | 1.9 | ** |
| 9/15/2011 | 0.342 | ** |
| 10/13/2011 | 1.12 | ** |

[(1)] the chronic limit is 1.0 mg/L since aquatic life has been adversely affected
Exceeds the acute limit
Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

### 8.12 Pond Creek 7.5 to 11.7

The pollutants addressed in this document for Pond Creek 7.5 to 11.7 are *E. coli*, cadmium, and iron. A pH TMDL was developed for the Pond Creek segments and was approved by EPA in 2007. TMDL sampling data indicate that this segment had no impairment for pH during the data collection period; as a result, the pH will be delisted for Pond Creek 7.5 to 11.7 in 2016 303(d).

Pond Creek 7.5 to 11.7 is a fifth order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 99.62 square miles. There is one TMDL monitoring site on the Pond Creek 7.5 to 11.7 segment, DOW03011026, located at RM 8.6 with the drainage area of 86.43 square miles, see Figure 8.12.1 and Table 8.12.1. This subwatershed consists primarily of forest (50.3%) and agricultural land (32.2%), see Figure 8.12.2 and Table 8.12.2.

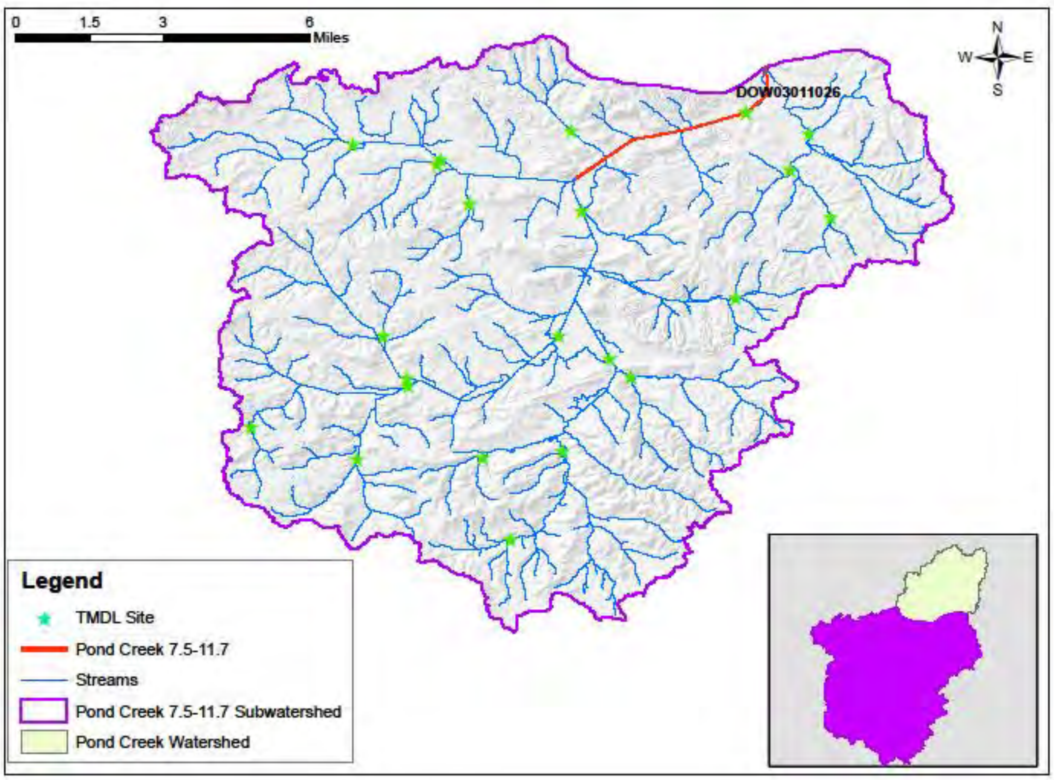


**Figure 8.12.1 TMDL Monitoring Locations and the Drainage Area of Pond Creek 7.5 to 11.7**

**Table 8.12.1 Pond Creek 7.5 to 11.7 Segment/Upstream Catchment Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY501042_03 | Pond Creek 7.5 to 11.7 | 5 | Muhlenberg | 99.62 | 63757 |

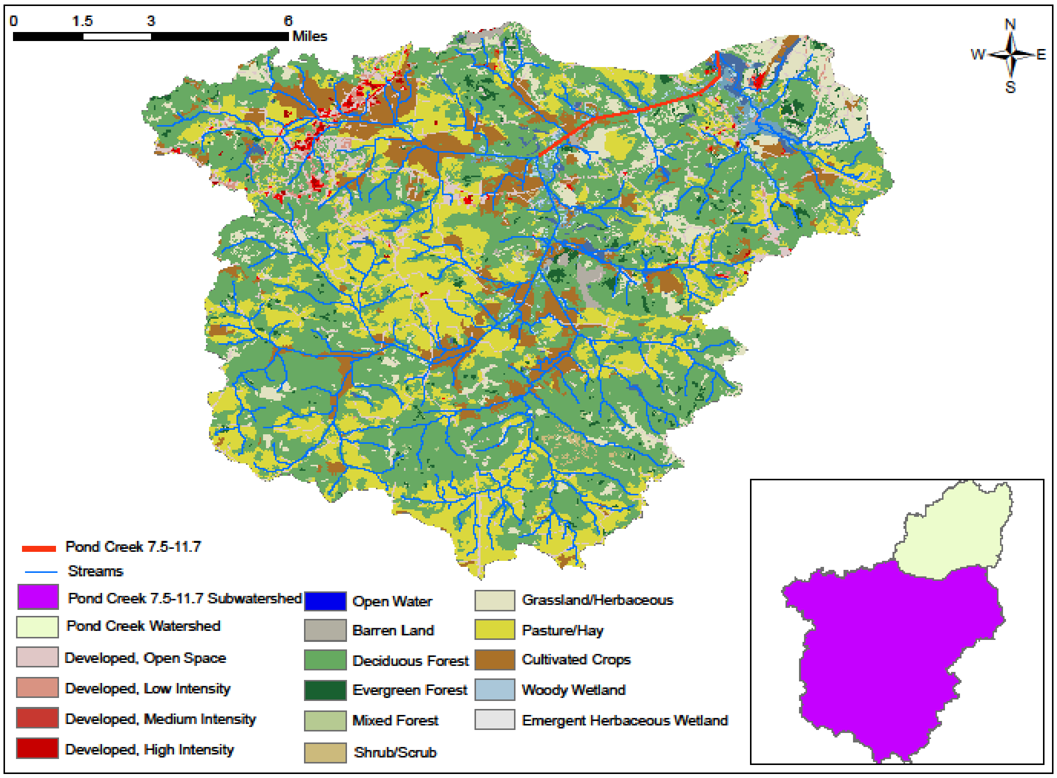


**Figure 8.12.2 Land Cover in the Pond Creek 7.5 to 11.7 Subwatershed**

**Table 8.12.2 Land Cover in the Pond Creek 7.5 to 11.7 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 7.04 | 4502.5 | 7.1 |
| Agriculture | 32.05 | 20512.9 | 32.2 |
| Forest | 50.07 | 32041.9 | 50.3 |
| Barren Land | 0.76 | 483.3 | 0.8 |
| Grassland/Herbaceous | 7.65 | 4896.4 | 7.7 |
| Wetlands | 0.61 | 388.7 | 0.6 |

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Water | 1.21 | 772.3 | 1.2 |
| Shrub/Scrub | 0.3 | 161.2 | 0.3 |

There are fifteen active and thirty-two inactive KPDES permittees within this subwatershed, see Figure 8.12.3 and Table 8.12.3. Although those inactive KPDES permittees were active during the data collection period and may have contributed to the impairments of the Pond Creek 7.5 to 11.7, inactive KPDES permittee will not receive a WLA.

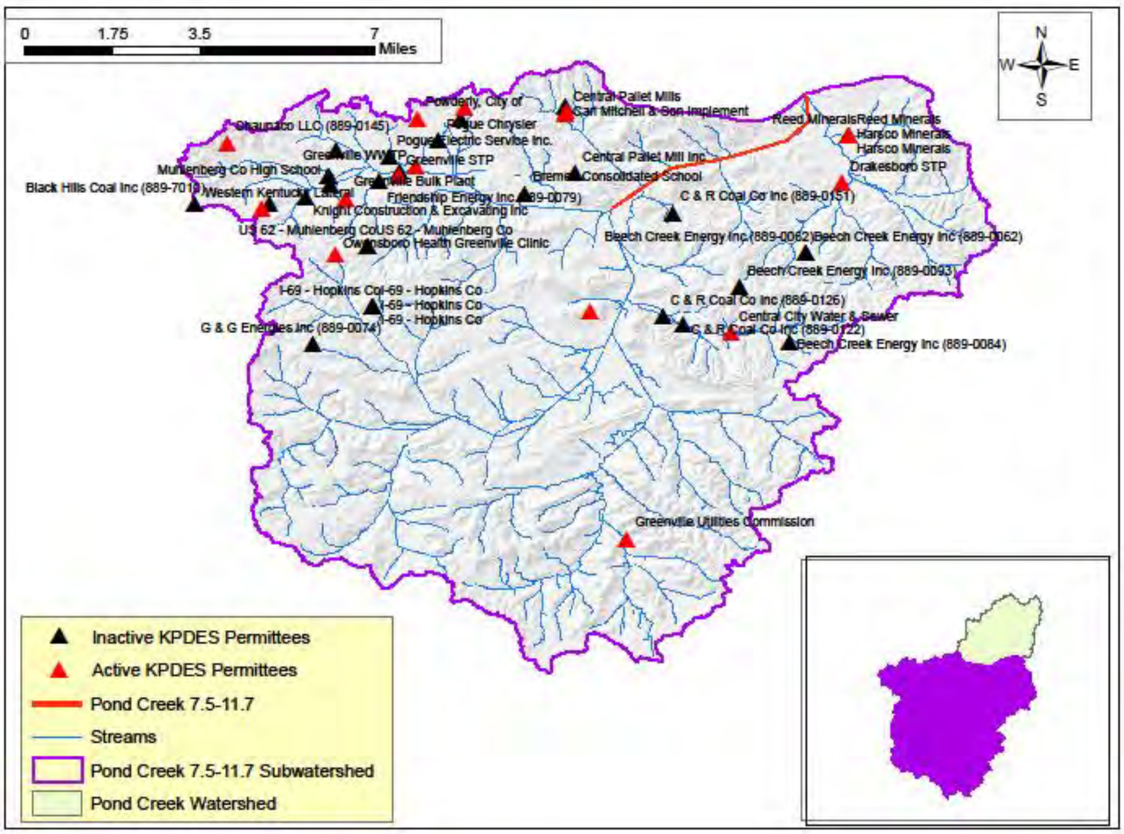


**Figure 8.12.3 KPDES Permittees in the Pond Creek 7.5 to 11.7 Subwatershed**

**Table 8.12.3 KPDES Permittees in the Pond Creek 7.5 to 11.7 Subwatershed**

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutant Limits/Requirement in the Permit |
|---|---|---|---|---|---|---|
| KY0020010 | Greenville STP | Yes | 1.31 | 37.219167 | -87.169444 | bacteria, pH, Cd, Cu, Pb, Zn |
| KY0066575 | Drakesboro STP | Yes | 0.165 | 37.217222 | -87.040833 | bacteria, pH, Cd, Cu, Pb, Zn |
| KY0108537 | Shaunaco LLC (889-0145) | Yes | 0 | 37.228611 | -87.218889 | pH, Cd, Cu, Fe, Pb,Ni, Zn |
| KY0109606 | Greenville Bulk Plant | Yes | 0 | 37.212500 | -87.184700 | pH |
| KYG045755 | Oxford Mining Co Ky LLC (889-0156) | Yes | 0 | 37.179722 | -87.113889 | pH, Fe |
| KYG640029 | Central City Water & Sewer | Yes | 0.0005 | 37.173800 | -87.073000 | pH, Fe |
| KYG640108 | Greenville Utilities Commission | Yes | 0.027 | 37.113900 | -87.103200 | pH, Fe |
| KYP000064 | Powderly, City of | Yes | 0 | 37.235833 | -87.163889 | discharge to Greenville WWTP |
| KYR003239 | Central Pallet Mills | Yes | 0 | 37.237167 | -87.121083 | pH and to develop a SWPPP |
| KYR004015 | Carl Mitchell & Son Implement - Paradise Rd | Yes | 0 | 37.238014 | -87.120822 | pH and to develop a SWPPP |
| KYR004021 | Harsco Minerals | Yes | 0 | 37.230667 | -87.038861 | pH and to develop a SWPPP |
| KYR10J469 | Muhlenberg County Airport | Yes | 0 | 37.222067 | -87.164333 | to develop a SWPPP |
| KYR10K083 | Owensboro Health Greenville Clinic | Yes | 0 | 37.196391 | -87.187716 | to develop a SWPPP |
| KYR10K315 | Western Kentucky Lateral | Yes | 0 | 37.209464 | -87.209069 | to develop a SWPPP |
| KYR10K433 | Owensboro Health Muhlenberg Healthplex | Yes | 0 | 37.238889 | -87.150189 | to develop a SWPPP |
| KY0023329 | Bremen Consolidated School | No | 0.008 | 37.214000 | -87.132800 | bacteria |
| KY0099538 | Texas Gas Transmission LLC - West Greenville | No | 0 | 37.211111 | -87.206944 | pH |
| KY0106046 | C & R Coal Co Inc (889-0151) | No | 0 | 37.208333 | -87.090000 | pH, Fe |
| KYG043169 | Black Hills Coal Inc (889-7010) | No | 0 | 37.211111 | -87.228611 | pH, Fe |
| KYG043563 | Beech Creek Energy Inc (889-0062) | No | 0 | 37.196944 | -87.051389 | pH, Fe |

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutant Limits/Requirement in the Permit |
|---|---|---|---|---|---|---|
| KYG044386 | Beech Creek Energy Inc (889-0062) | No | 0 | 37.196944 | -87.051389 | pH, Fe |
| KYG044486 | G & G Energies Inc (889-0074) | No | 0 | 37.170457 | -87.194335 | pH, Fe |
| KYG044573 | Friendship Energy Inc (889-0079) | No | 0 | 37.217528 | -87.175069 | pH, Fe |
| KYG044789 | Beech Creek Energy Inc (889-0084) | No | 0 | 37.170833 | -87.056111 | pH, Fe |
| KYG044998 | Beech Creek Energy Inc (889-0093) | No | 0 | 37.186944 | -87.070556 | pH, Fe |
| KYG046025 | C & R Coal Co Inc (889-0126) | No | 0 | 37.178333 | -87.092778 | pH, Fe |
| KYG046026 | C & R Coal Co Inc (889-0122) | No | 0 | 37.175833 | -87.086944 | pH, Fe |
| KYR000524 | Central Pallet Mill Inc | No | 0 | 37.220000 | -87.118333 | pH and to develop a SWPPP |
| KYR000918 | Harsco Minerals | No | 0 | 37.230667 | -87.038861 | pH and to develop a SWPPP |
| KYR001665 | Carl Mitchell & Son Implement | No | 0 | 37.239428 | -87.121152 | pH and to develop a SWPPP |
| KYR00A008 | Reed Minerals | No | 0 | 37.230667 | -87.038861 | pH and to develop a SWPPP |
| KYR00A009 | Reed Minerals | No | 0 | 37.230667 | -87.038861 | pH and to develop a SWPPP |
| KYR10E810 | Muhlenberg Co High School Phas 3 | No | 0 | 37.216500 | -87.189224 | to develop a SWPPP |
| KYR10E960 | Muhlenberg County Emergency SE | No | 0 | 37.235680 | -87.151550 | to develop a SWPPP |
| KYR10F821 | Muhlenberg Co High School | No | 0 | 37.218839 | -87.189686 | to develop a SWPPP |
| KYR10G145 | Greenville WWTP | No | 0 | 37.220472 | -87.169111 | to develop a SWPPP |
| KYR10G154 | Knight Construction & Excavating Inc | No | 0 | 37.212776 | -87.196388 | to develop a SWPPP |
| KYR10G285 | Pogue Chrysler | No | 0 | 37.229353 | -87.157828 | to develop a SWPPP |
| KYR10G428 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G429 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G456 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G458 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutant Limits/Requirement in the Permit |
|---|---|---|---|---|---|---|
| KYR10G631 | US 62 - Muhlenberg Co | No | 0 | 37.198889 | -87.178333 | to develop a SWPPP |
| KYR10G632 | US 62 - Muhlenberg Co | No | 0 | 37.198889 | -87.178333 | to develop a SWPPP |
| KYR10H138 | Muhlenberg Co High School | No | 0 | 37.218839 | -87.189686 | to develop a SWPPP |
| KYR10H705 | Muhlenberg County Park Phase I | No | 0 | 37.226610 | -87.187427 | to develop a SWPPP |
| KYR10I149 | Pogue Electric Service Inc. | No | 0 | 37.224749 | -87.172138 | to develop a SWPPP |

There are two active KPDES mining permittees in this subwatershed, see Figure 8.12.4 and Table 8.12.4. Some of this subwatershed is licensed mining areas, see Figure 8.12.5 (see Section 9.4.3 for more information). Tables 8.12.5 to 8.12.7 show *E. coli*, cadmium, iron and flow data collected by TMDL staff at DOW03011026.

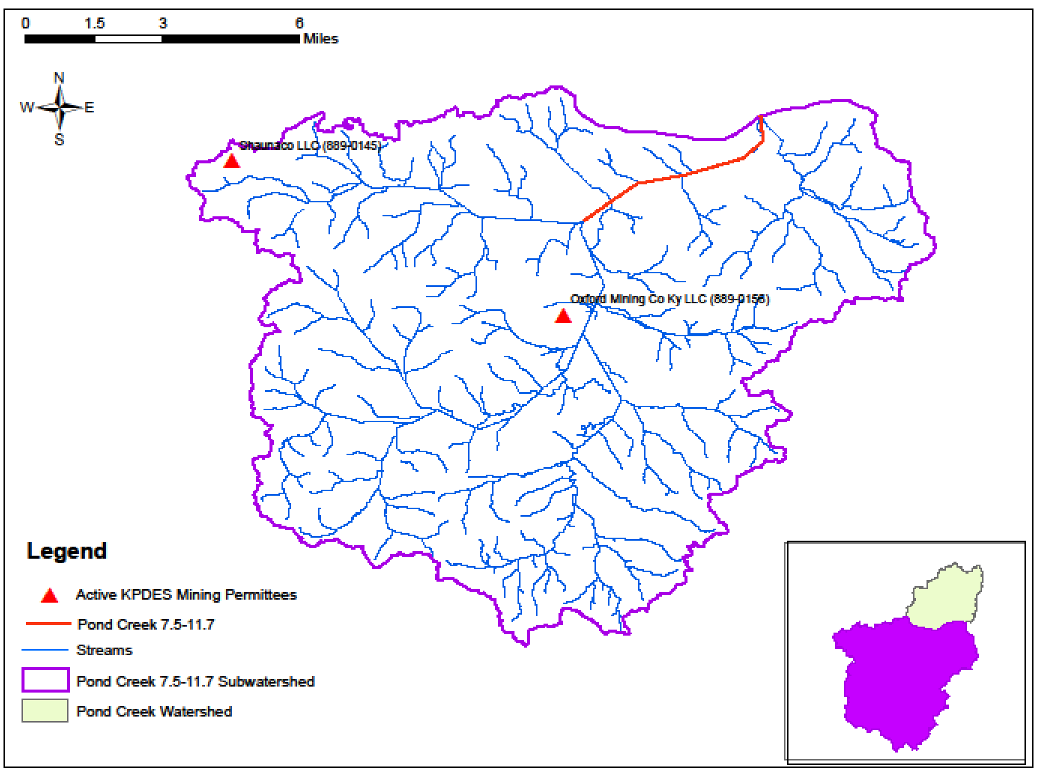


**Figure 8.12.4 Active KPDES-Permitted Mining in the Subwatershed**

**Table 8.12.4 Active KPDES-Permitted Mining in the Subwatershed**

| KPDES Permit # | KDNR Permit # | Permittee Name | Date Issued |
|---|---|---|---|
| KY0108537 | 889-0145 | Shaunaco LLC | 12/1/2011 |
| KYG045755 | 889-0156 | Oxford Mining Co Ky LLC | 7/1/2009 |

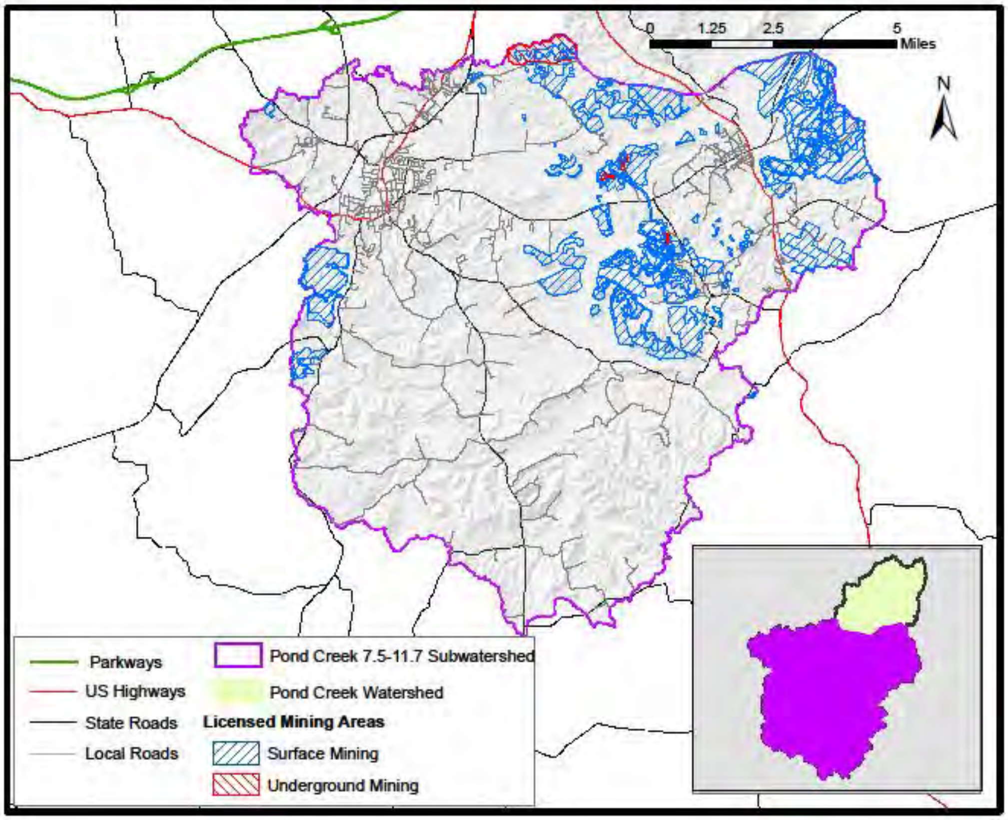


**Figure 8.12.5 Data from the Department of Natural Resources on Licensed Mining Areas in the Subwatershed**

**Table 8.12.5 *E. coli* and Flow Data, DOW03011026**

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 5/11/2011 | 30 | ** |
| 5/12/2011 | 86 | ** |
| 5/25/2011 | 63 | ** |
| 5/26/2011 | >2420 | ** |
| 6/15/2011 | 727 | ** |

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 6/16/2011 | 86 | ** |
| 6/22/2011 | 1300 | ** |
| 6/23/2011 | 517 | ** |
| 7/13/2011 | 411 | ** |
| 7/14/2011 | 4 | ** |
| 7/27/2011 | 15 | ** |
| 7/28/2011 | 17 | ** |
| 8/10/2011 | 13 | ** |
| 8/11/2011 | 28 | ** |
| 8/24/2011 | 69 | ** |
| 8/25/2011 | 115 | ** |
| 9/14/2011 | 18 | ** |
| 9/15/2011 | 125 | ** |
| 9/28/2011 | 20 | ** |
| 9/29/2011 | 62 | ** |
| 10/12/2011 | 88 | ** |
| 10/13/2011 | 727 | ** |
| 10/20/2011 | 6 | ** |

(shaded) Exceeds the instantaneous *E. coli* limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

**Table 8.12.6 Cadmium, Hardness and Flow Data Collected at DOW03011026**

| Date | Cadmium (µg/L) | Hardness, Total (mg/L) | Cadmium Chronic Limit (µg/L) | Cadmium Acute Limit (µg/L) | Difference between the Cadmium Concentration and the Cadmium Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 11/17/2010 | < 8.0 (DU) | 944 | 1.43 | 20.90 | N/A | ** |
| 11/18/2010 | < 0.80 (U) | 1070 | 1.57 | 23.74 | N/A | ** |
| 1/5/2011 | 2.08 | 381 | 0.73 | 8.31 | 1.35 | ** |
| 1/6/2011 | 2.24 | 390 | 0.74 | 8.51 | 1.50 | ** |
| 2/16/2011 | 1.41 | 268 | 0.56 | 5.81 | 0.85 | ** |
| 2/17/2011 | 1.53 | 294 | 0.60 | 6.38 | 0.93 | ** |
| 3/9/2011 | 0.402 (J) | 80.4 | 0.23 | 1.71 | N/A | ** |
| 3/10/2011 | 0.56 (J) | 96.7 | 0.26 | 2.06 | N/A | ** |
| 4/27/2011 | < 0.80 (U) | 106 | 0.28 | 2.26 | N/A | ** |

| Date | Cadmium (µg/L) | Hardness, Total (mg/L) | Cadmium Chronic Limit (µg/L) | Cadmium Acute Limit (µg/L) | Difference between the Cadmium Concentration and the Cadmium Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 4/28/2011 | < 0.80 (U) | 62.1 | 0.19 | 1.31 | N/A | ** |
| 5/11/2011 | 8.23 (L) | 595 | 1.01 | 13.07 | 7.22 | ** |
| 5/12/2011 | < 0.80 (U) | 171 | 0.40 | 3.68 | N/A | ** |
| 6/15/2011 | 1.31 | 1520 | 2.03 | 33.92 | -0.72 | ** |
| 6/16/2011 | 2.47 | 1610 | 2.12 | 35.97 | 0.35 | ** |
| 7/13/2011 | 5.31 (J,D,L) | 1070 | 1.57 | 23.74 | N/A | ** |
| 7/14/2011 | < 8.0 (DU) | 1080 | 1.58 | 23.97 | N/A | ** |
| 8/10/2011 | 2.98 | 1810 | 2.31 | 40.51 | 0.67 | ** |
| 8/11/2011 | 2.27 | 1690 | 2.20 | 37.78 | 0.07 | ** |
| 9/14/2011 | 1.21 | 1350 | 1.86 | 30.07 | -0.65 | ** |
| 9/15/2011 | < 0.80 (U) | 1250 | 1.76 | 27.81 | N/A | ** |
| 10/12/2011 | 0.499 (J) | 1360 | 1.87 | 30.30 | N/A | ** |
| 10/13/2011 | 0.515 (J) | 1280 | 1.79 | 28.49 | N/A | ** |
| 6/25/2014 | 0.26 (J) | 708 | 1.15 | 15.60 | N/A | 11.64 |

(shaded) Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
D = Reanalyzed at a Higher Dilution
J = Estimated Value
U = Analyte Not Detected
L = Exceeds MCL or Action Limit
N/A: Not Applicable

**Table 8.12.7 Iron and Flow Data Collected at DOW03011026**

| Date | Iron (mg/L) [1] | Flow (cfs) |
|---|---|---|
| 11/17/2010 | 7.67 | ** |
| 11/18/2010 | 9.96 | ** |
| 1/5/2011 | 3.44 | ** |
| 1/6/2011 | 3.78 | ** |
| 2/16/2011 | 2.87 | ** |
| 2/17/2011 | 2.83 | ** |
| 3/9/2011 | 1.99 | ** |
| 3/10/2011 | 1.12 | ** |
| 4/27/2011 | 1.07 | ** |
| 4/28/2011 | 1.15 | ** |
| 5/11/2011 | 7.12 | ** |

| Date | Iron (mg/L) [(1)] | Flow (cfs) |
|---|---|---|
| 5/12/2011 | 5.97 | ** |
| 6/15/2011 | 6.13 | ** |
| 6/16/2011 | 9.77 | ** |
| 7/13/2011 | 12.5 | ** |
| 7/14/2011 | 35.3 (D) | ** |
| 8/10/2011 | 3.6 | ** |
| 8/11/2011 | 1.78 | ** |
| 9/14/2011 | 2.7 | ** |
| 9/15/2011 | 0.645 | ** |
| 10/12/2011 | 0.775 | ** |
| 10/13/2011 | 1.75 | ** |
| 6/25/2014 | 3.57 | 11.64 |

[(1)]Chronic limit is 1.0 mg/L since aquatic life is adversely affected
(orange) Exceeds the acute limit
(pink) Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
D = Reanalyzed at a Higher Dilution

## 8.13 Pond Creek 11.7 to 14 .4

The pollutants addressed in this document for Pond Creek 11.7 to 14.4 are cadmium and iron. A pH TMDL was developed for Pond Creek segments and was approved by EPA in 2007. However, TMDL sampling data indicate this segment was still impaired for pH during data collection period, see Table 8.13.5.

Pond Creek 11.7 to 14.4 is a fourth order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 56.2 square miles. There is one TMDL monitoring site on the Pond Creek 11.7 to 14.4 segment, DOW03011027, located at RM 12.45 with the drainage area of 56.0 square miles, see Figure 8.13.1 and Table 8.13.1. This subwatershed consists primarily of forest (53.2%) and agricultural land (35.8%), see Figure 8.13.2 and Table 8.13.2.

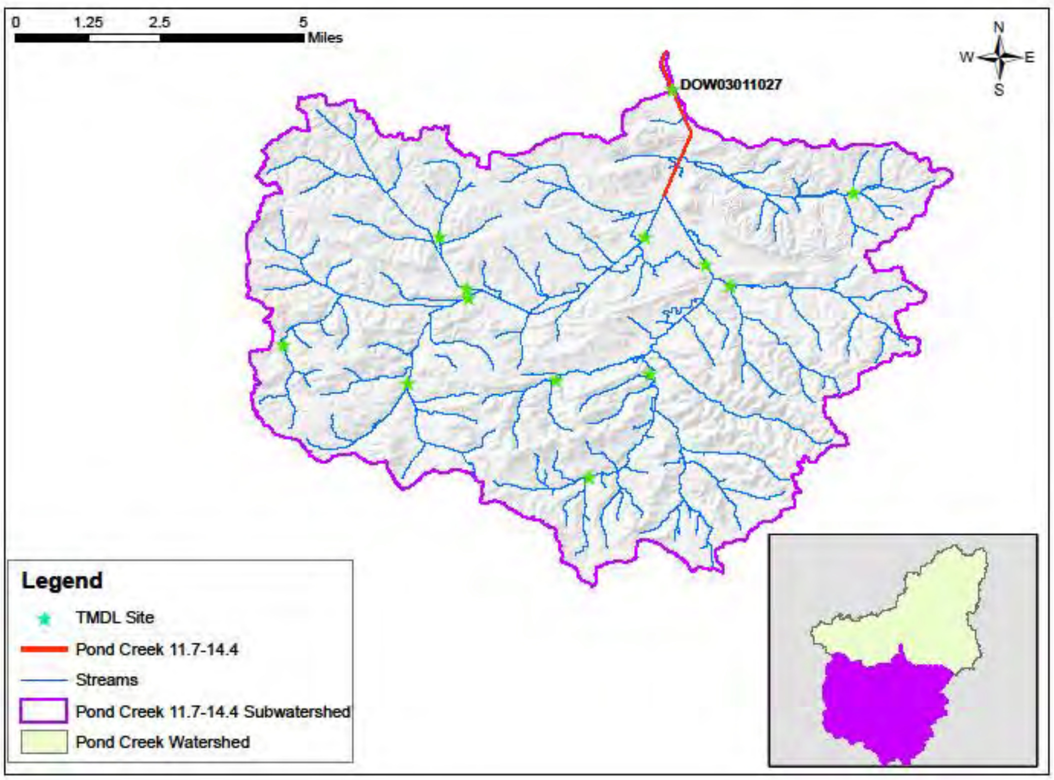


**Figure 8.13.1 TMDL Monitoring Locations and the Drainage Area of Pond Creek 11.7 to 14.4**

**Table 8.13.1 Pond Creek 11.7 to 14.4 Segment/Upstream Catchment Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY501042_04 | Pond Creek 11.7 to 14.4 | 4 | Muhlenberg | 56.2 | 35978 |

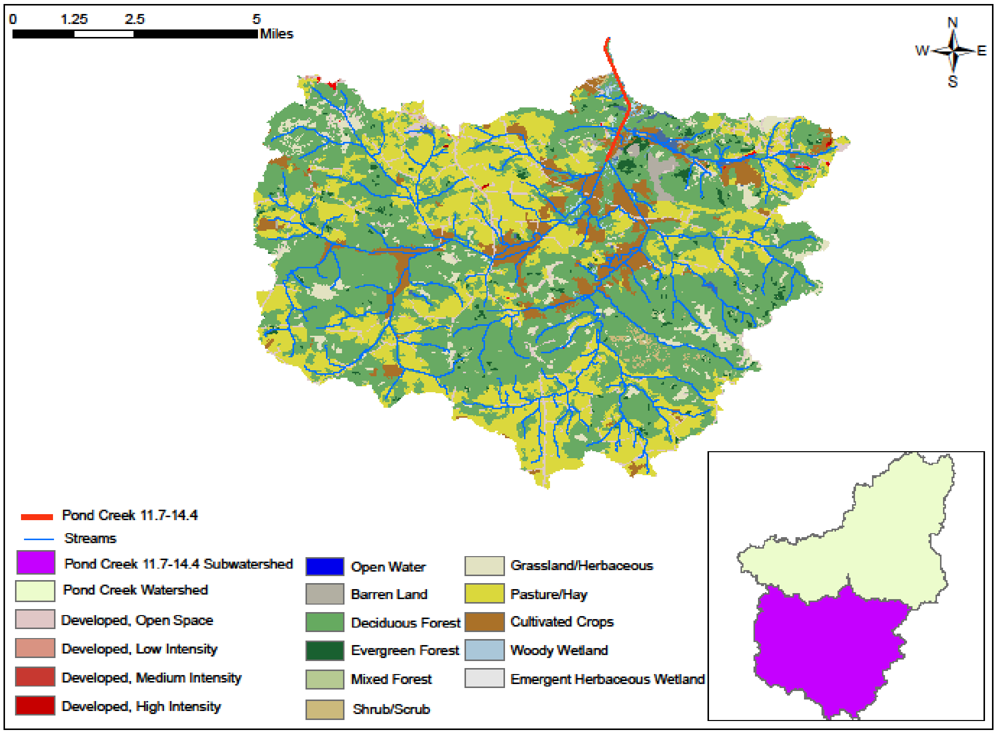


**Figure 8.13.2 Land Cover in the Pond Creek 11.7 to 14.4 Subwatershed**

**Table 8.13.2 Land Cover in the Pond Creek 11.7 to 14.4 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 2.46 | 1576.5 | 4.4 |
| Agriculture | 20.12 | 12879.2 | 35.8 |
| Forest | 29.9 | 19134.7 | 53.2 |
| Barren Land | 0.50 | 317.2 | 0.9 |
| Grassland/Herbaceous | 2.54 | 1626.2 | 4.5 |
| Wetlands | 0.17 | 109.5 | 0.3 |
| Water | 0.31 | 201.2 | 0.6 |
| Shrub/Scrub | 0.2 | 134.6 | 0.4 |

There are four active and eight inactive KPDES-permitted facilities within this subwatershed, see Figure 8.13.3 and Table 8.13.3. Although those inactive KPDES facilities were active during the data collection period and may have contributed to the pollutants on the Pond Creek 11.7 to 14.4, inactive KPDES permittee will not receive a WLA.

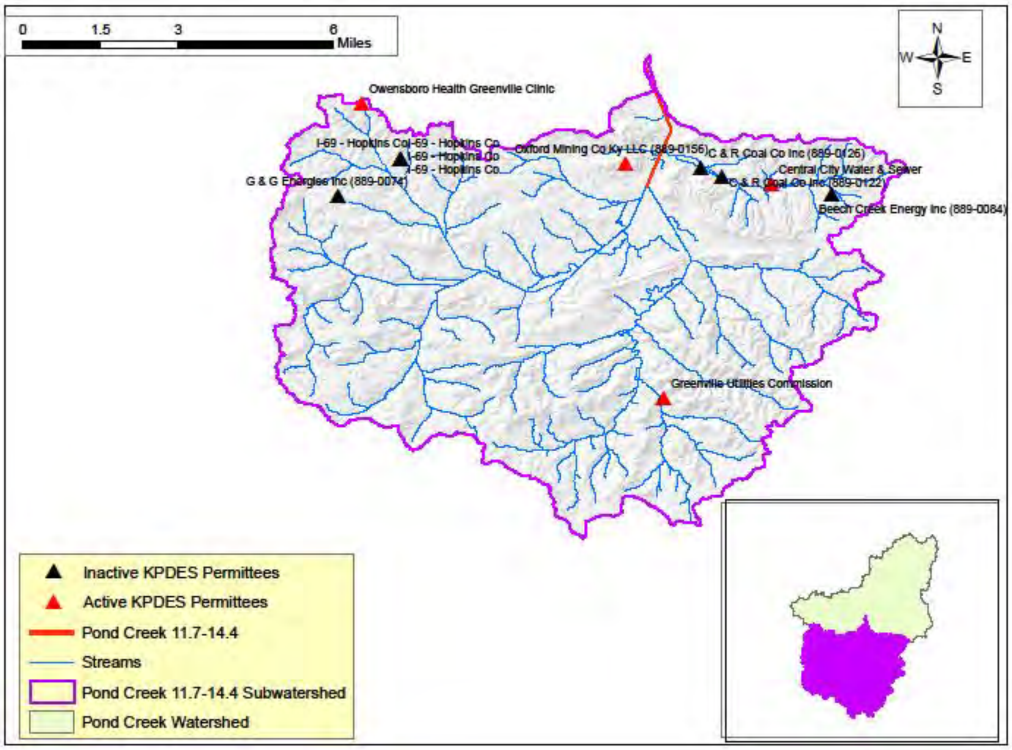


**Figure 8.13.3 KPDES Permittees in the Pond Creek 11.7 to 14.4 Subwatershed**

**Table 8.13.3 KPDES Permittees in the Pond Creek 11.7 to 14.4 Subwatershed**

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutant Limits/Requirement in the Permit |
|---|---|---|---|---|---|---|
| KYG045755 | Oxford Mining Co Ky LLC (889-0156) | Yes | 0 | 37.179722 | -87.113889 | pH, Fe |
| KYG640029 | Central City Water & Sewer | Yes | 0.0005 | 37.173800 | -87.073000 | pH, Fe |
| KYG640108 | Greenville Utilities Commission | Yes | 0.027 | 37.113900 | -87.103200 | pH, Fe |
| KYR10K083 | Owensboro Health Greenville Clinic | Yes | 0 | 37.196391 | -87.187716 | to develop a SWPPP |
| KYG044486 | G & G Energies Inc (889-0074) | No | 0 | 37.170457 | -87.194335 | pH, Fe |

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutant Limits/Requirement in the Permit |
|---|---|---|---|---|---|---|
| KYG044789 | Beech Creek Energy Inc (889-0084) | No | 0 | 37.170833 | -87.056111 | pH, Fe |
| KYG046025 | C & R Coal Co Inc (889-0126) | No | 0 | 37.178333 | -87.092778 | pH, Fe |
| KYG046026 | C & R Coal Co Inc (889-0122) | No | 0 | 37.175833 | -87.086944 | pH, Fe |
| KYR10G428 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G429 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G456 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G458 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |

There is one active KPDES mining permittee in this subwatershed, see Figure 8.13.4 and Table 8.13.4. Some of the subwatershed is licensed mining areas, see Figure 8.13.5 (see Section 9.4.3 for more information). Tables 8.13.6 to 8.13.7 show cadmium, iron and flow data collected by TMDL staff at DOW03011027.

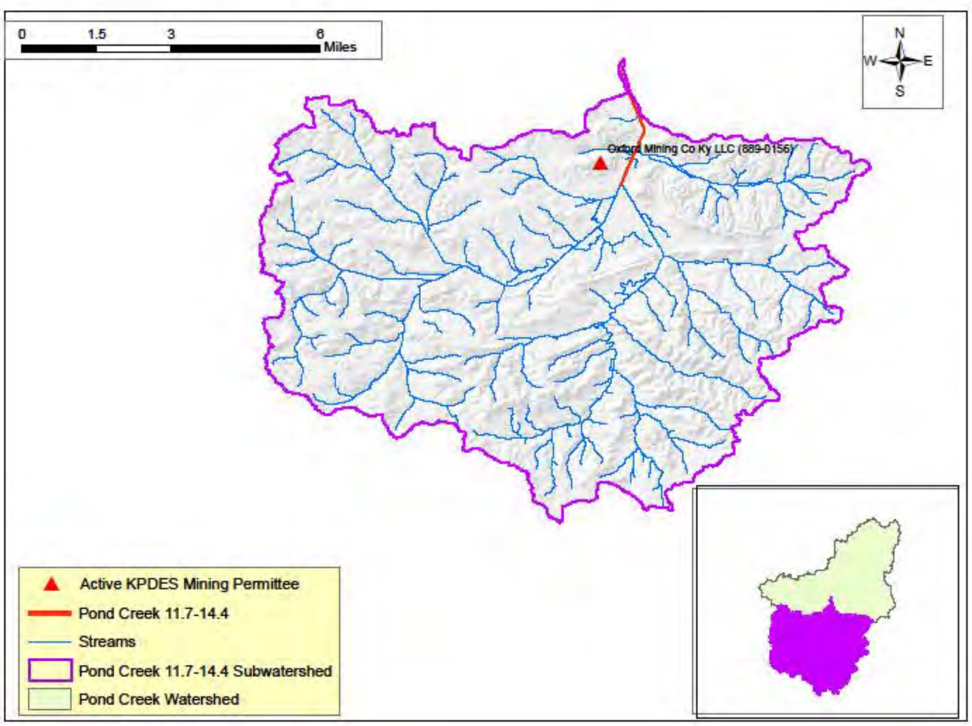


**Figure 8.13.4 Active KPDES-Permitted Mining in the Subwatershed**

**Table 8.13.4 Active KPDES-Permitted Mining in the Subwatershed**

| KPDES Permit # | KDNR Permit # | Permittee Name | Date Issued |
|---|---|---|---|
| KYG045755 | 889-0156 | Oxford Mining Co Ky LLC | 7/1/2009 |

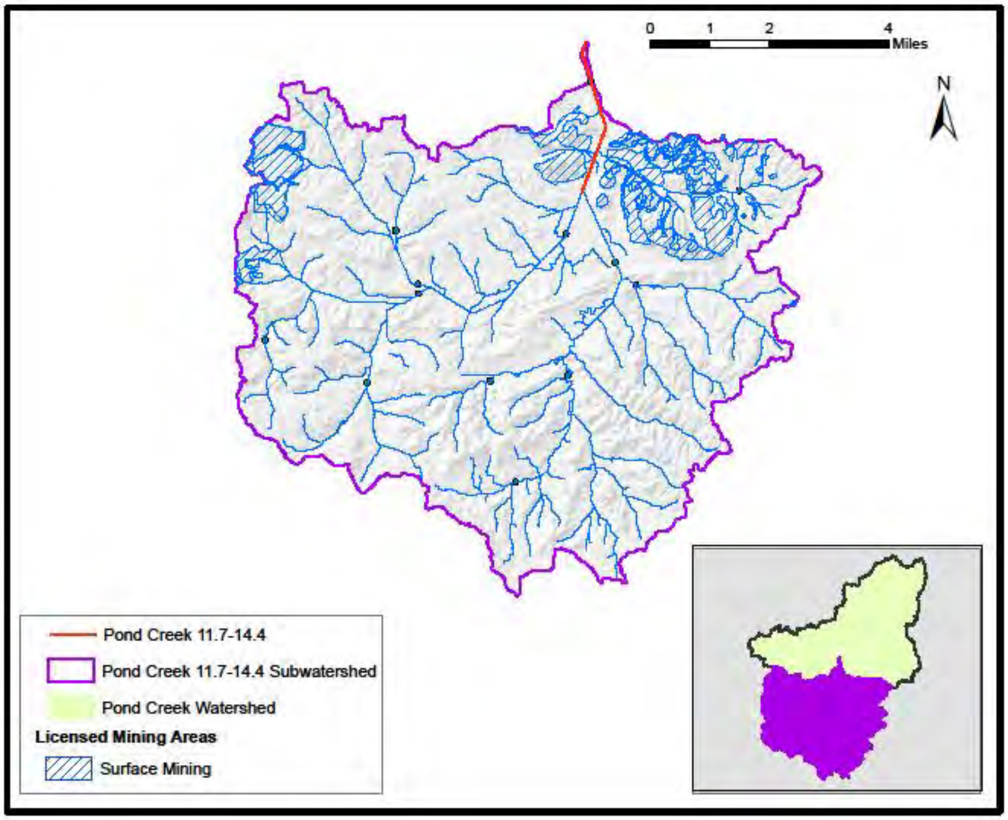


**Figure 8.13.5 Data from the Department of Natural Resources on Licensed Mining Areas in the Subwatershed**

**Table 8.13.5 pH and Flow Data Collected at DOW03011027**

| Date | pH (standard units) | Flow (cfs) |
|---|---|---|
| 11/17/10 | 5.46 | ** |
| 1/5/11 | 6.61 | ** |
| 2/16/11 | 6.38 | ** |
| 5/11/11 | 4.93 | ** |
| 6/22/11 | 6.01 | ** |
| 7/13/11 | 5.69 | ** |
| 7/27/11 | 5.89 | ** |
| 8/10/11 | 8.64 | ** |

| Date | pH (standard units) | Flow (cfs) |
|---|---|---|
| 8/24/11 | 9.41 | ** |
| 9/14/11 | 9.91 | ** |
| 9/28/11 | 5.69 | ** |
| 10/12/11 | 9.78 | ** |
| 10/19/11 | 6.49 | ** |
| 3/21/13 | 7.34 | ** |
| 4/24/13 | 6.47 | ** |
| 5/8/13 | 6.94 | ** |
| 6/26/13 | 6.80 | ** |
| 7/16/13 | 6.21 | ** |
| 8/6/13 | 6.68 | ** |
| 9/10/13 | 6.76 | ** |
| 10/9/13 | 6.66 | ** |
| 11/13/13 | 7.42 | ** |
| 12/17/13 | 7.09 | ** |
| 3/18/14 | 6.01 | ** |
| 4/15/14 | 7.05 | ** |
| 5/21/14 | 6.01 | ** |
| 6/5/14 | 6.37 | ** |
| 7/23/14 | 7.73 | ** |
| 8/13/14 | 7.61 | ** |
| 9/11/14 | 8.29 | ** |
| 10/29/14 | 6.45 | ** |
| 11/19/14 | 6.47 | ** |
| 12/23/14 | 6.45 | ** |

Exceeds the pH limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

**Table 8.13.6 Cadmium, Hardness and Flow Data Collected at DOW03011027**

| Date | Cadmium (µg/L) | Hardness, Total (mg/L) | Cadmium Chronic Limit (µg/L) | Cadmium Acute Limit (µg/L) | Difference between the Cadmium Concentration and the Cadmium Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 11/17/2010 | 4.57 (JD) | 1600 | 2.11 | 35.74 | N/A | ** |
| 1/5/2011 | 2.25 | 365 | 0.71 | 7.96 | 1.54 | ** |

| Date | Cadmium (µg/L) | Hardness, Total (mg/L) | Cadmium Chronic Limit (µg/L) | Cadmium Acute Limit (µg/L) | Difference between the Cadmium Concentration and the Cadmium Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 2/16/2011 | 1.13 | 241 | 0.52 | 5.22 | 0.61 | ** |
| 5/11/2011 | 21.3 (L) | 832 | 1.30 | 18.38 | 20.00 | ** |
| 7/13/2011 | 1.91 | 1460 | 1.97 | 32.56 | -0.06 | ** |
| 8/10/2011 | 3.2 (D) | 1880 | 2.38 | 42.11 | 0.82 | ** |
| 9/14/2011 | < 8.0 (DU) | 1500 | 2.01 | 33.47 | N/A | ** |
| 10/12/2011 | 2.16 | 2010 | 2.50 | 45.07 | -0.34 | ** |
| 3/21/2013 | 1.2 | 190 | 0.44 | 4.10 | 0.76 | ** |
| 4/24/2013 | 0.64 | 248 | 0.53 | 5.37 | 0.11 | ** |
| 5/8/2013 | 0.57 | 218 | 0.48 | 4.71 | 0.09 | ** |
| 6/26/2013 | 1.01 | 1050 | 1.55 | 23.29 | -0.54 | ** |
| 7/16/2013 | 0.62 | 1010 | 1.50 | 22.39 | -0.88 | ** |
| 8/6/2013 | 0.36 | 1460 | 1.97 | 32.56 | -1.61 | ** |
| 9/10/2013 | 0.24 | 909 | 1.39 | 20.11 | -1.15 | ** |
| 10/9/2013 | 0.96 | 591 | 1.01 | 12.98 | -0.05 | ** |
| 11/13/2013 | < 0.50 (U) | 597 | 1.02 | 13.12 | N/A | ** |
| 12/17/2013 | 0.52 | 252 | 0.54 | 5.46 | -0.02 | ** |
| 3/18/2014 | 0.73 | 265 | 0.56 | 5.75 | 0.17 | ** |
| 4/15/2014 | < 0.50 (U) | 118 | 0.31 | 2.52 | N/A | ** |
| 5/21/2014 | < 0.50 (U) | 597 | 1.02 | 13.12 | N/A | ** |
| 6/5/2014 | 0.23 (J) | 493 | 0.88 | 10.80 | N/A | ** |
| 7/23/2014 | < 0.50 (U) | 1580 | 2.09 | 35.28 | N/A | ** |
| 8/13/2014 | 0.55 | 2120 | 2.60 | 47.58 | -2.05 | ** |
| 9/11/2014 | 0.31 (J) | 1680 | 2.19 | 37.56 | N/A | ** |
| 10/29/2014 | 0.76 | 1220 | 1.73 | 27.13 | -0.97 | ** |
| 11/19/2014 | 0.47 (J) | 1060 | 1.56 | 23.52 | N/A | ** |
| 12/23/2014 | 0.48 (J) | 726 | 1.18 | 16.01 | N/A | ** |

Exceeds the acute limit
Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
D = Reanalyzed at a Higher Dilution
J = Estimated Value
L = Exceeds MCL or Action Limit
U = Analyte Not Detected
N/A: Not Applicable

**Table 8.13.7 Iron and Flow Data Collected at DOW03011027**

| Date | Iron (mg/L) [1] | Flow (cfs) |
|---|---|---|
| 11/17/2010 | 3 | ** |
| 1/5/2011 | 1.64 | ** |
| 2/16/2011 | 1.28 | ** |
| 5/11/2011 | 12.4 | ** |
| 7/13/2011 | 1.82 | ** |
| 8/10/2011 | 3.67 | ** |
| 9/14/2011 | 0.694 | ** |
| 10/12/2011 | 0.325 | ** |
| 3/21/2013 | 1.07 | ** |
| 4/24/2013 | 5.76 | ** |
| 5/8/2013 | 1.42 | ** |
| 6/26/2013 | 6.67 | ** |
| 7/16/2013 | 10.4 | ** |
| 8/6/2013 | 14.8 | ** |
| 9/10/2013 | 4.47 | ** |
| 10/9/2013 | 4.42 | ** |
| 11/13/2013 | 4.62 | ** |
| 12/17/2013 | 0.919 | ** |
| 3/18/2014 | 1.53 | ** |
| 4/15/2014 | 3.33 | ** |
| 5/21/2014 | 1.72 | ** |
| 6/5/2014 | 2.19 | ** |
| 7/23/2014 | 1.29 | ** |
| 8/13/2014 | 4.35 | ** |
| 9/11/2014 | 0.513 | ** |
| 10/29/2014 | 1.58 | ** |
| 11/19/2014 | 5.73 | ** |
| 12/23/2014 | 8.08 | ** |

[1]Chronic limit is 1.0 mg/L since aquatic life is adversely affected
Exceeds the acute limit
Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

### 8.14 Pond Creek 14.4 to 18.1

The pollutants addressed in this document for Pond Creek 14.4 to 18.1 are *E. coli* and lead. A pH TMDL was developed for the Pond Creek segments and was approved by EPA in 2007. TMDL sampling data indicate this segment had no impairment for pH during the data collection period; as a result, the pH for the Pond Creek 14.4 to 18.1 was delisted in 2014 303(d).

Pond Creek 14.4 to 18.1 is a fourth order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 26.95 square miles. There is one TMDL monitoring site on the Pond Creek 14.4 to 18.1 segment, , located at RM 15.20 with the drainage area of 23.78 square miles, see Figure 8.14.1 and Table 8.14.1. This subwatershed consists primarily of forest (48.5%) and agricultural land (42.3%), see Figure 8.14.2 and Table 8.14.2.

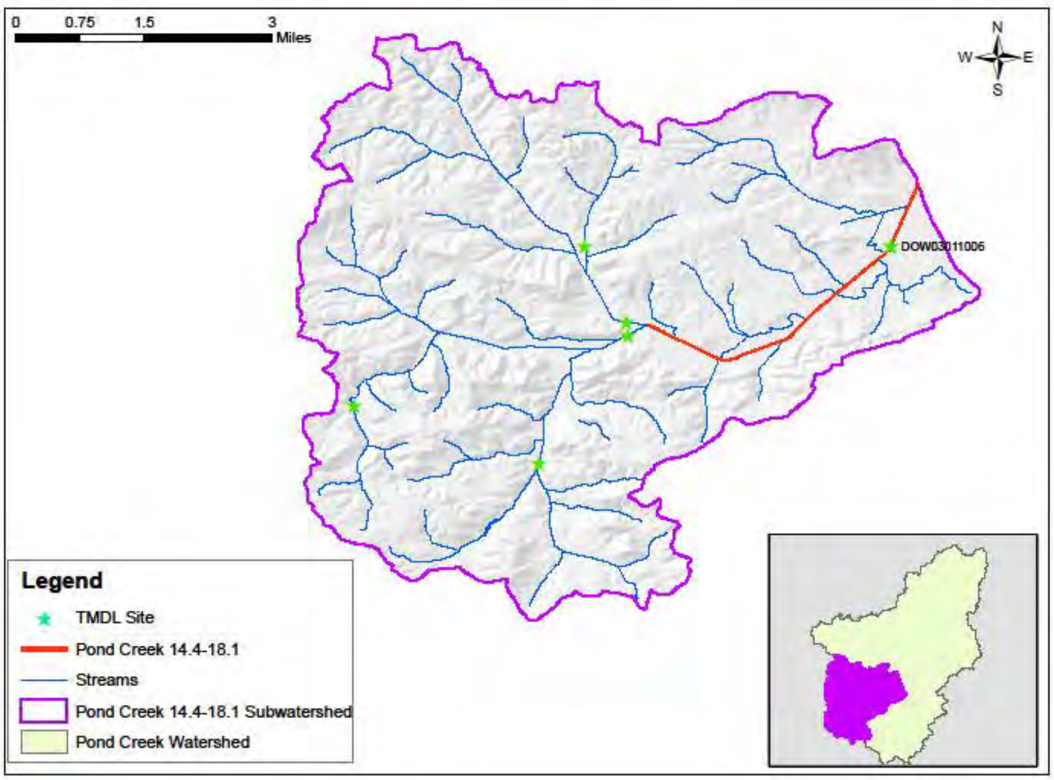


**Figure 8.14.1 TMDL Monitoring Locations and the Drainage Area of Pond Creek 14.4 to 18.1**

**Table 8.14.1 Pond Creek 14.4 to 18.1 Segment/Upstream Catchment Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY501042_05 | Pond Creek 14.4 to 18.1 | 4 | Muhlenberg | 26.95 | 17246 |

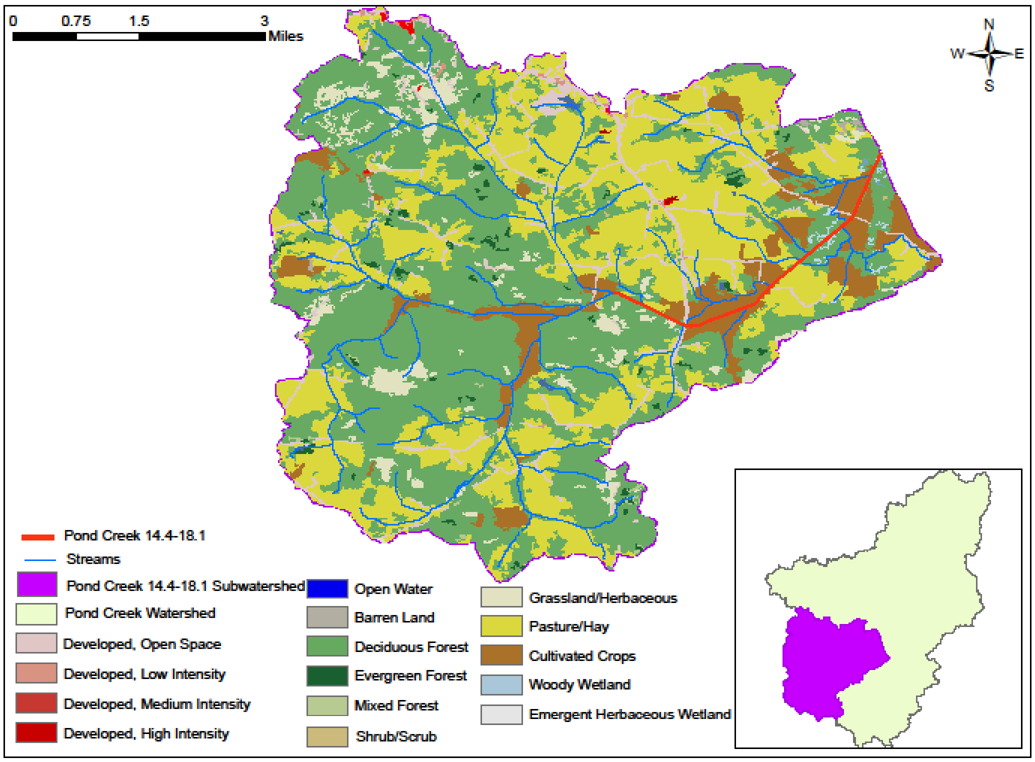


**Figure 8.14.2 Land Cover in the Pond Creek 14.4 to 18.1 Subwatershed**

**Table 8.14.2 Land Cover in the Pond Creek 14.4 to 18.1 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 1.28 | 818.4 | 4.7 |
| Agriculture | 11.39 | 7288.0 | 42.3 |
| Forest | 13.08 | 8369.9 | 48.5 |
| Barren Land | 0.06 | 37.5 | 0.2 |
| Grassland/Herbaceous | 1.03 | 657.3 | 3.8 |
| Wetlands | 0.06 | 40.0 | 0.2 |
| Water | 0.05 | 30.9 | 0.2 |
| Shrub/Scrub | 0.01 | 4.5 | 0.03 |

There are two active and five inactive KPDES facilities within this subwatershed, see Figure 8.14.3 and Table 8.14.3. Although those inactive KPDES permittees were active during the data collection period and may have contributed to the impairment in the Pond Creek 14.4 to 18.1, inactive KPDES permittee will not receive a WLA.

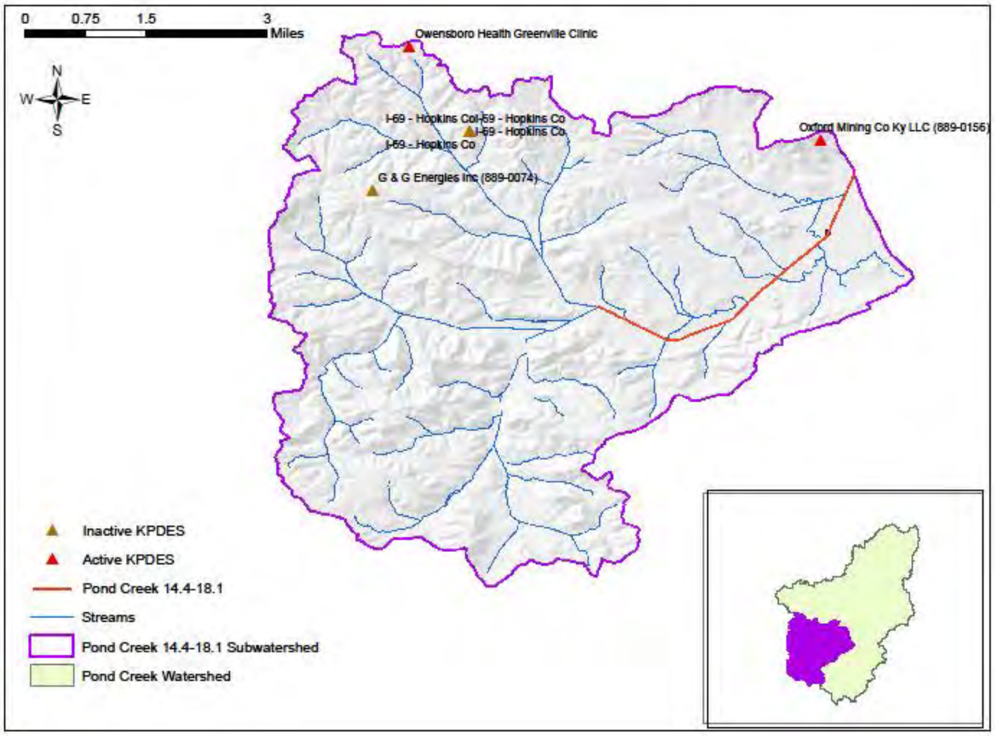


**Figure 8.14.3 KPDES Permittees in the Subwatershed**

**Table 8.14.3 KPDES Permittees in the Subwatershed**

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutant Limits/Requirement in the Permit |
|---|---|---|---|---|---|---|
| KYG045755 | Oxford Mining Co Ky LLC (889-0156) | Yes | 0 | 37.179722 | -87.113889 | pH, Fe |
| KYR10K083 | Owensboro Health Greenville Clinic | Yes | 0 | 37.196391 | -87.187716 | to develop a SWPPP |
| KYG044486 | G & G Energies Inc (889-0074) | No | 0 | 37.170457 | -87.194335 | pH, Fe |
| KYR10G428 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G429 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G456 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G458 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |

There is one active KPDES-permitted mining in this subwatershed, see Figure 8.14.4 and Table 8.14.4. A small portion of watershed, mainly in upstream, is licensed mining areas, see Figure 8.14.5 (see Section 9.4.3 for more information). Table 8.14.5 and 8.14.6 shows *E. coli*, lead and flow data collected by TMDL staff at DOW03011006.

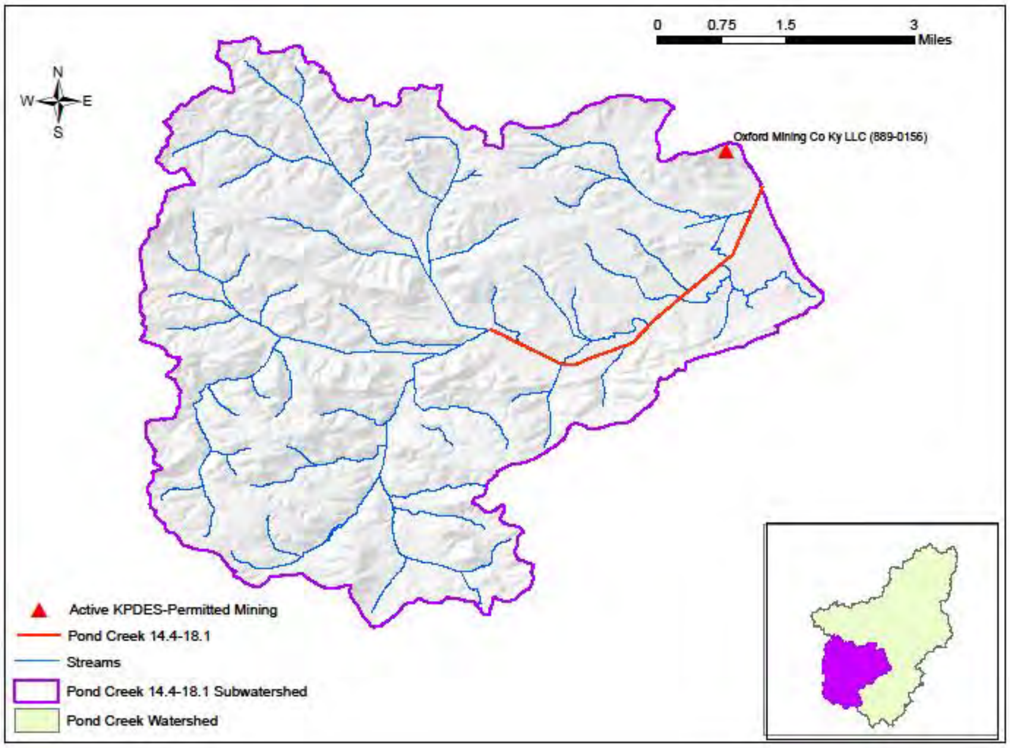


**Figure 8.14.4 Active KPDES-Permitted Mining in the Subwatershed**

**Table 8.14.4 Active KPDES-Permitted Mining in the Subwatershed**

| KPDES Permit # | KDNR Permit # | Permittee Name | Date Issued |
|---|---|---|---|
| KYG045755 | 889-0156 | Oxford Mining Co Ky LLC | 7/1/2009 |

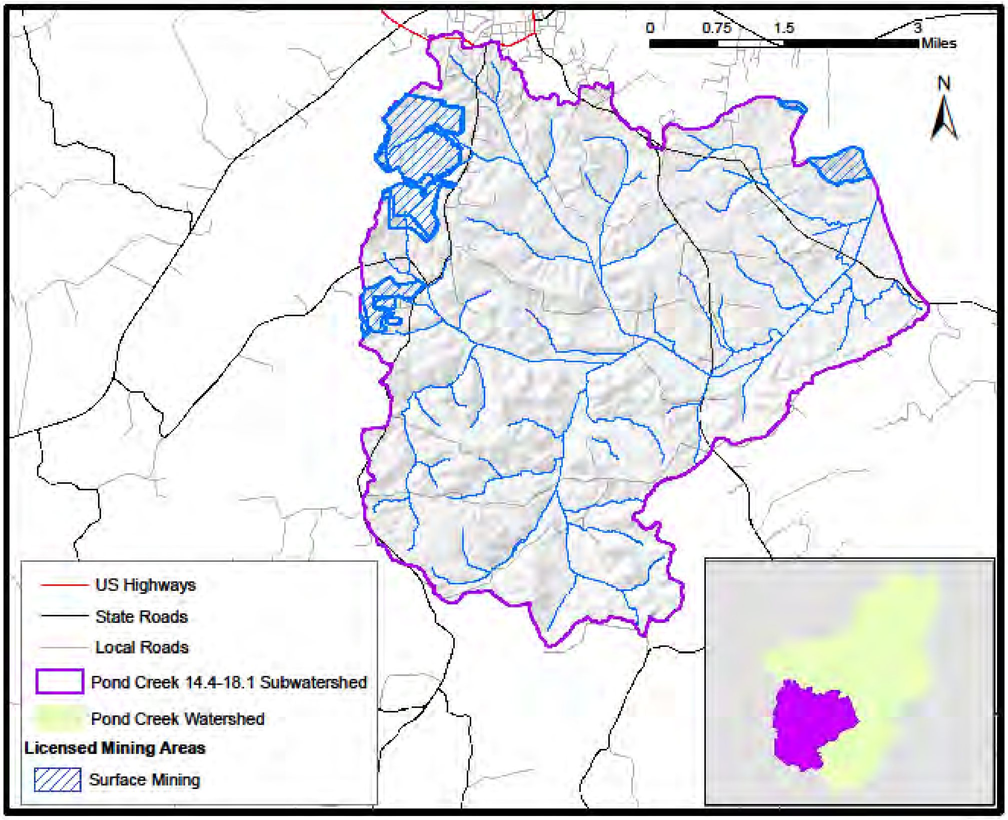


**Figure 8.14.5 Data from the Department of Natural Resources on Licensed Mining Areas in the Subwatershed**

**Table 8.14.5 *E. coli* and Flow Data, DOW03011006**

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 5/10/2011 | 89 | ** |
| 5/11/2011 | 81 | ** |
| 5/12/2011 | 145 | ** |
| 5/24/2011 | 201 | ** |
| 5/25/2011 | 152 | ** |
| 5/26/2011 | >2420 | ** |
| 6/21/2011 | 687 | ** |
| 6/22/2011 | 1733 | ** |
| 6/23/2011 | > 2420 | ** |
| 7/12/2011 | 131 | ** |
| 7/13/2011 | 120 | ** |
| 7/14/2011 | 131 | ** |

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 9/27/2011 | > 2420 | ** |
| 9/28/2011 | 272 | ** |
| 9/29/2011 | 155 | ** |

Exceeds the instantaneous *E. coli* limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

**Table 8.14.6 Lead, Hardness and Flow Data Collected at DOW03011006**

| Date | Lead (µg/L) | Hardness, Total (mg/L) | Lead Chronic Limit (µg/L) | Lead Acute Limit (µg/L) | Difference between the Lead Concentration and the Lead Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 1/4/2011 | 0.44 (J) | 92.2 | 2.87 | 73.63 | N/A | ** |
| 1/5/2011 | 0.237 (J) | 102 | 3.26 | 83.73 | N/A | ** |
| 1/6/2011 | 0.324 (J) | 105 | 3.39 | 86.88 | N/A | ** |
| 2/15/2011 | 0.29 (J) | 77.9 | 2.32 | 59.41 | N/A | ** |
| 2/16/2011 | < 0.50 (U) | 78.8 | 2.35 | 60.28 | N/A | ** |
| 2/17/2011 | < 0.50 (U) | 86.4 | 2.64 | 67.78 | N/A | ** |
| 3/8/2011 | 0.489 (J) | 70.4 | 2.04 | 52.23 | N/A | ** |
| 3/9/2011 | 5.65 | 30.6 | 0.70 | 18.08 | 4.95 | ** |
| 3/10/2011 | 1.54 | 42.6 | 1.07 | 27.55 | 0.47 | ** |
| 4/26/2011 | 1.18 | 40.4 | 1.00 | 25.75 | 0.18 | ** |
| 4/27/2011 | 5.77 | 24.1 | 0.52 | 13.34 | 5.25 | ** |
| 4/28/2011 | 1.18 | 35.9 | 0.86 | 22.16 | 0.32 | ** |
| 5/10/2011 | 0.414 (J) | 90.1 | 2.79 | 71.50 | N/A | ** |
| 5/11/2011 | 0.322 (J) | 92.1 | 2.87 | 73.52 | N/A | ** |
| 5/12/2011 | 0.251 (J) | 133 | 4.57 | 117.38 | N/A | ** |
| 7/12/2011 | < 0.50 (U) | 129 | 4.40 | 112.90 | N/A | ** |
| 7/13/2011 | < 0.50 (U) | 136 | 4.71 | 120.76 | N/A | ** |
| 7/14/2011 | 0.221 (J) | 153 | 5.47 | 140.29 | N/A | ** |

Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
D = Reanalyzed at a Higher Dilution
J = Estimated Value
U = Analyte Not Detected
N/A: Not Applicable

## 8.15 Pond Creek 18.1 to 18.7

The pollutant addressed in this document for Pond Creek 18.1 to 18.7 is E. *coli*. A pH TMDL was developed for the segment of Pond Creek 16.3 to 20.0 and was approved by EPA in 2007. Pond Creek 18.1 to 18.7 is a fourth order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 18.73 square miles. There is one TMDL monitoring site on the Pond Creek 18.1 to 18.7 segment, DOW03011020, located at RM 18.35 with the drainage area of 11.89 square miles, see Figure 8.15.1 and Table 8.15.1. This subwatershed consists primarily of forest (56.5%) and agricultural land (34.1%), see Figure 8.15.2 and Table 8.15.2.

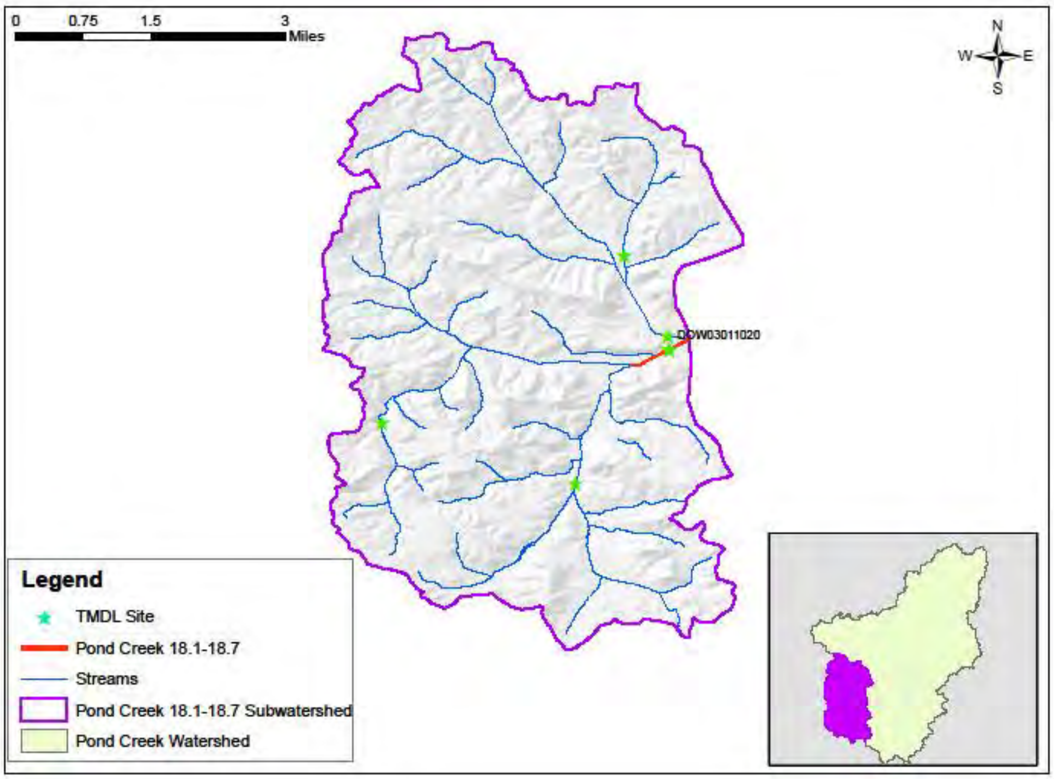


**Figure 8.15.1 TMDL Monitoring Sites and the Drainage Area of Pond Creek 18.1 to 18.7**

**Table 8.15.1 Pond Creek 18.1 to 18.7 Segment/Upstream Catchment Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY501042_06 | Pond Creek 18.1-18.7 | 4 | Muhlenberg | 18.73 | 11990 |

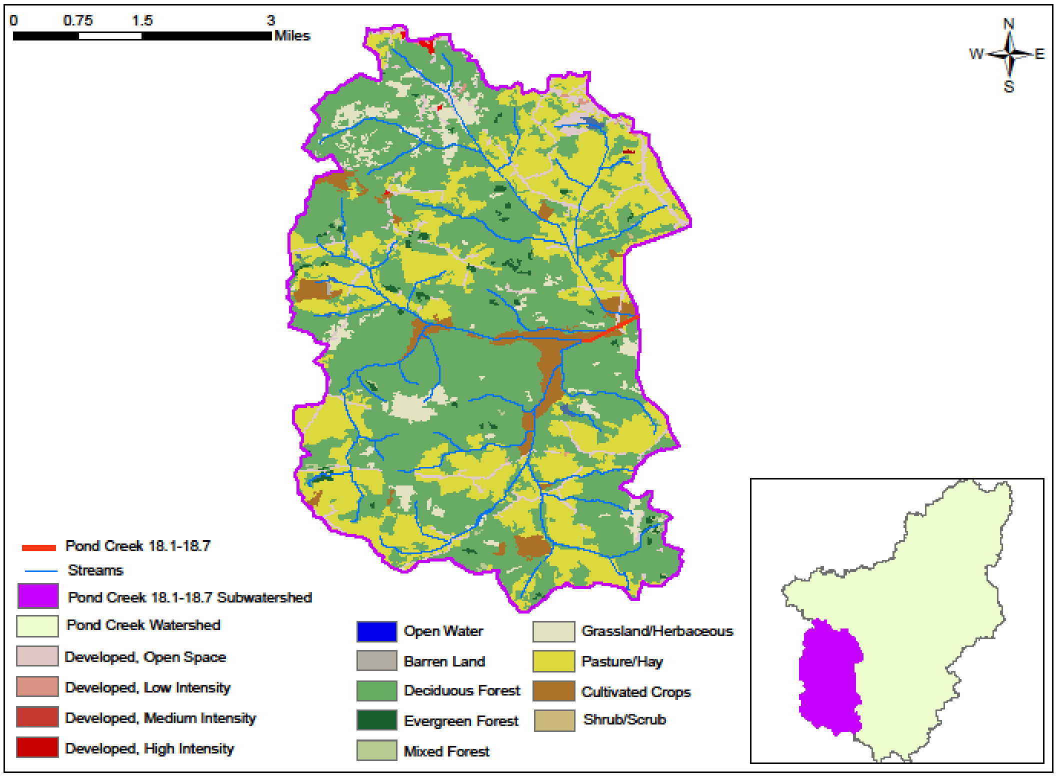


**Figure 8.15.2 Land Cover in the Pond Creek 18.1 to 18.7 Subwatershed**

**Table 8.15.2 Land Cover in the Pond Creek 18.1 to 18.7 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 0.84 | 537.4 | 4.5 |
| Agriculture | 6.39 | 4092.2 | 34.1 |
| Forest | 10.59 | 6778.6 | 56.5 |
| Barren Land | 0.01 | 4.0 | 0.03 |
| Grassland/Herbaceous | 0.86 | 547.4 | 4.6 |
| Wetland | 0 | 0 | 0 |
| Water | 0.04 | 27.4 | 0.2 |
| Shrub/Scrub | 0.01 | 3.4 | 0.03 |

There are one active and five inactive KPDES facilities within this subwatershed, see Figure 8.15.3 and Table 8.15.3. Although those five inactive KPDES permittees were active during the data collection period and may have contributed to the impairments in the Pond Creek 18.1 to

18.8, inactive KPDES permittee will not receive a WLA. *E. coli* and flow data monitored at DOW03011020 are in Table 8.15.4.

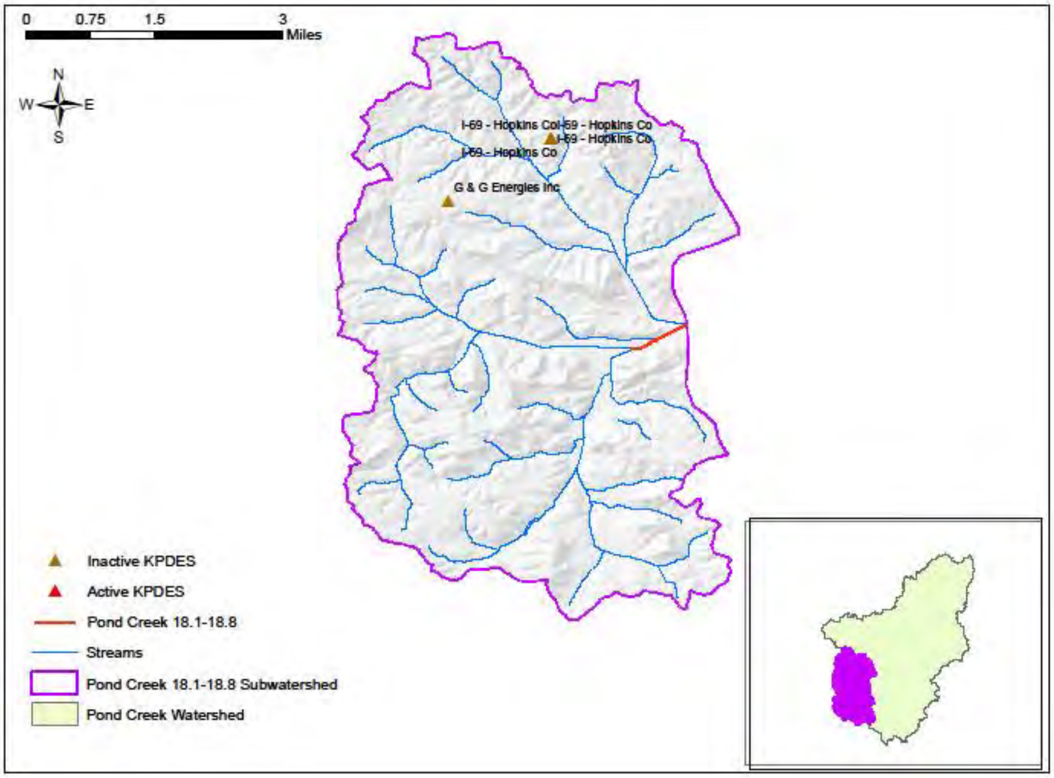


**Figure 8.15.3 KPDES Permittees in the Subwatershed**

**Table 8.15.3 KPDES Permittees in the Subwatershed**

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutant Limits/Requirement in the Permit |
|---|---|---|---|---|---|---|
| KYR10K083 | Owensboro Health Greenville Clinic | Yes | 0 | 37.196391 | -87.187716 | to develop a SWPPP |
| KYG044486 | G & G Energies Inc (889-0074) | No | 0 | 37.170457 | -87.194335 | pH, Fe |
| KYR10G428 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G429 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G456 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G458 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |

**Table 8.15.4 *E. coli* and Flow Data, DOW03011020**

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 5/10/2011 | 435 | ** |
| 5/24/2011 | 135 | ** |
| 6/14/2011 | 7 | ** |
| 6/21/2011 | 299 | ** |
| 7/12/2011 | 192 | ** |
| 9/27/2011 | > 2420 | ** |
| 5/8/2013 | 193 | ** |
| 5/9/2013 | 326 | ** |
| 5/20/2013 | 206 | ** |
| 5/23/2013 | 105 | ** |
| 5/29/2013 | 101 | ** |
| 6/6/2013 | > 2420 | ** |
| 6/27/2013 | 548 | ** |
| 7/17/2013 | 113 | ** |
| 7/30/2013 | 145 | ** |
| 8/6/2013 | 461 | ** |
| 8/15/2013 | 240 | ** |
| 9/11/2013 | 48 | ** |
| 9/24/2013 | 179 | ** |
| 10/10/2013 | 816 | ** |
| 10/14/2013 | 133 | ** |

(shaded) Exceeds the instantaneous *E. coli* limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

### 8.16 Saltlick Creek 0.0 to 3.7

The pollutant addressed in this document for Saltlick Creek 0.0 to 3.7 is *E. coli*. Saltlick Creek 0.0 to 3.7 is a third order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 5.95 square miles. There is one TMDL monitoring site on the Saltlick Creek 0.0 to 3.7 segment, DOW03011023, located at RM 1.55 with the drainage area of 3.44 square miles, see Figure 8.16.1 and Table 8.16.1. This subwatershed consists primarily of forest (57.8%) and agricultural land (36.6%), see Figure 8.16.2 and Table 8.16.2.

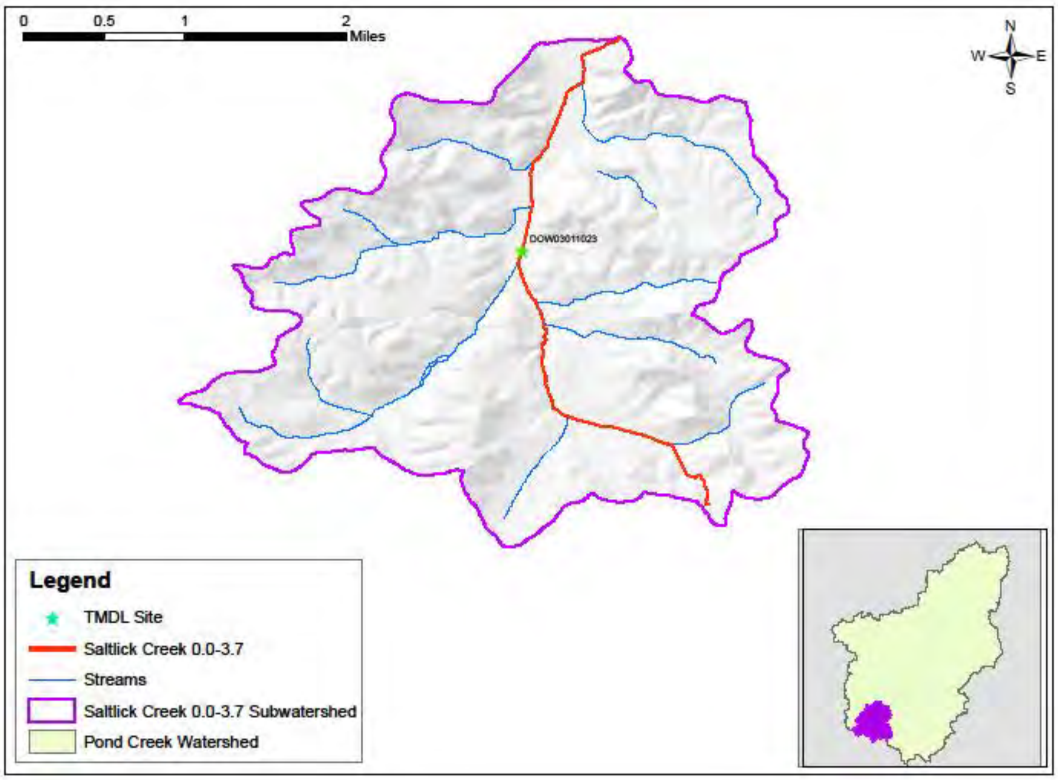


**Figure 8.16.1 TMDL Monitoring Locations and the Drainage Area of Saltlick Creek 0.0 to 3.7**

**Table 8.16.1 Saltlick Creek 0.0 to 3.7 Segment/Upstream Catchment Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY502844_01 | Saltlick Creek 0.0 to 3.7 | 3 | Muhlenberg | 5.95 | 3807 |

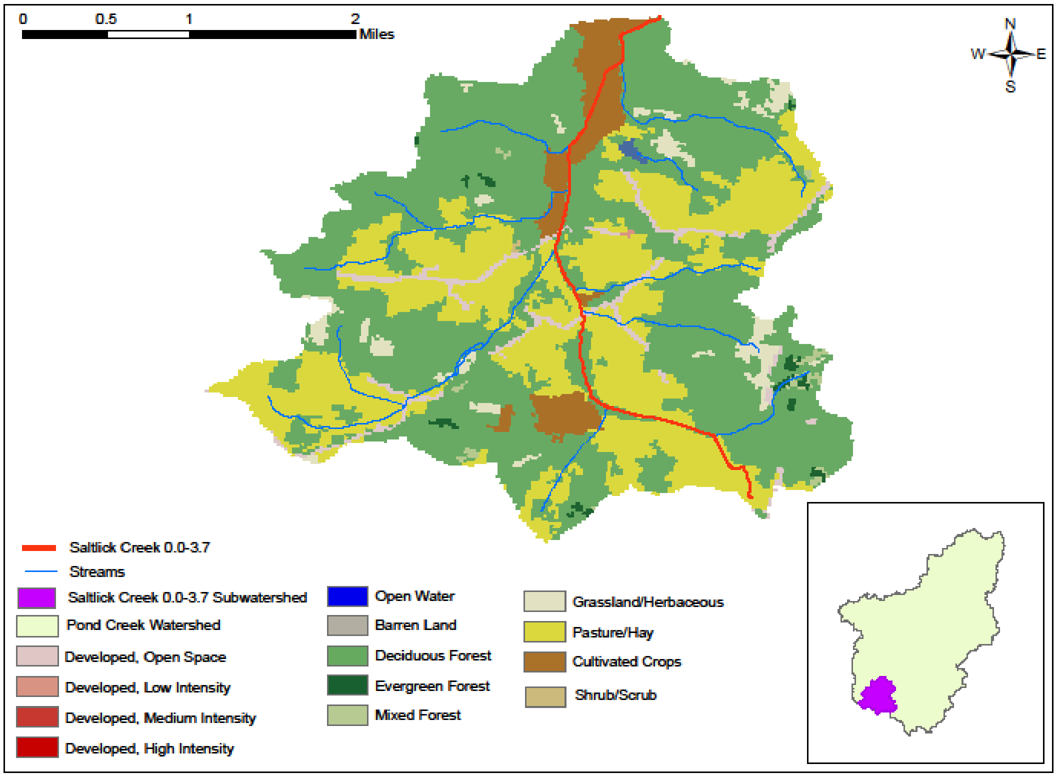


**Figure 8.16.2 Land Cover in the Saltlick Creek 0.0 to 3.7 Subwatershed**

**Table 8.16.2 Land Cover in the Saltlick Creek 0.0 to 3.7 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 0.16 | 100.0 | 2.6 |
| Agriculture | 2.17 | 1391.9 | 36.6 |
| Forest | 3.44 | 2201.7 | 57.8 |
| Barren Land | 0 | 0 | 0 |
| Grassland/Herbaceous | 0.17 | 105.9 | 2.8 |
| Water | 0.01 | 6.3 | 0.2 |
| Wetland | 0 | 0 | 0 |
| Shrub/Scrub | 0.002 | 1.3 | 0.03 |

There are no KPDES permittees in this subwatershed. *E. coli* and flow data monitored at DOW03011023 are in Table 8.16.3.

**Table 8.16.3 *E. coli* and Flow Data, DOW03011023**

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 5/10/2011 | 1414 | 0.988 |
| 5/24/2011 | 727 | ** |
| 5/8/2013 | 326 | ** |
| 5/9/2013 | 231 | ** |
| 5/23/2013 | 172 | ** |
| 6/6/2013 | > 2420 | ** |
| 6/27/2013 | 145 | 0.057 |
| 7/30/2013 | 153 | 0.042 |
| 8/6/2013 | 365 | 0.148 |
| 8/15/2013 | 411 | ** |
| 10/10/2013 | 248 | 0.524 |

[shaded] Exceeds the instantaneous *E. coli* limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

### 8.17 Sandlick Creek 0.0 to 4.05

The pollutants addressed in this document for Sandlick Creek 0.0 to 4.05 are *E. coli,* iron and lead. Sandlick Creek 0.0 to 4.05 is a third order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 6.68 square miles. There is one TMDL monitoring site on the Sandlick Creek 0.0 to 4.05 segment, DOW03011004, located at RM 0.20 with the drainage area of 6.64 square miles, see Figure 8.17.1 and Table 8.17.1. This subwatershed consists primarily of forest (51.3%) and agricultural land (34.5%), see Figure 8.17.2 and Table 8.17.2.

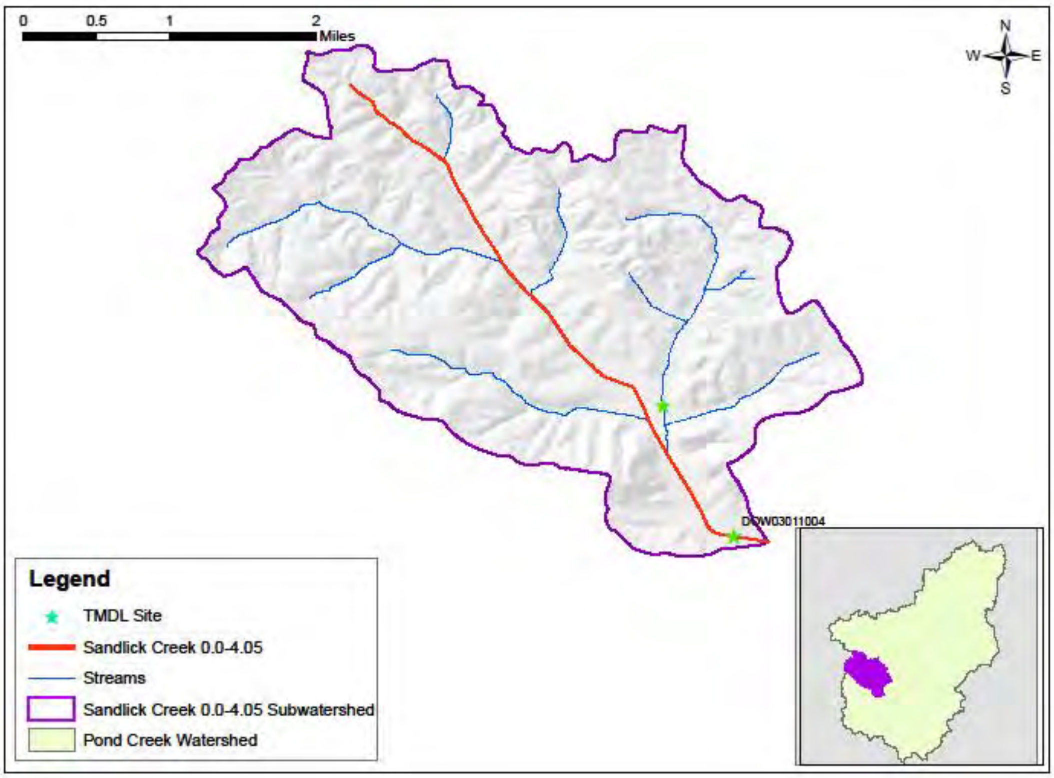


**Figure 8.17.1 TMDL Monitoring Locations and the Drainage Area of Sandlick Creek 0.0 to 4.05**

**Table 8.17.1 Sandlick Creek 0.0 to 4.05 Segment/Upstream Catchment Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY502963_01 | Sandlick Creek 0.0 to 4.05 | 3 | Muhlenberg | 6.68 | 4270 |

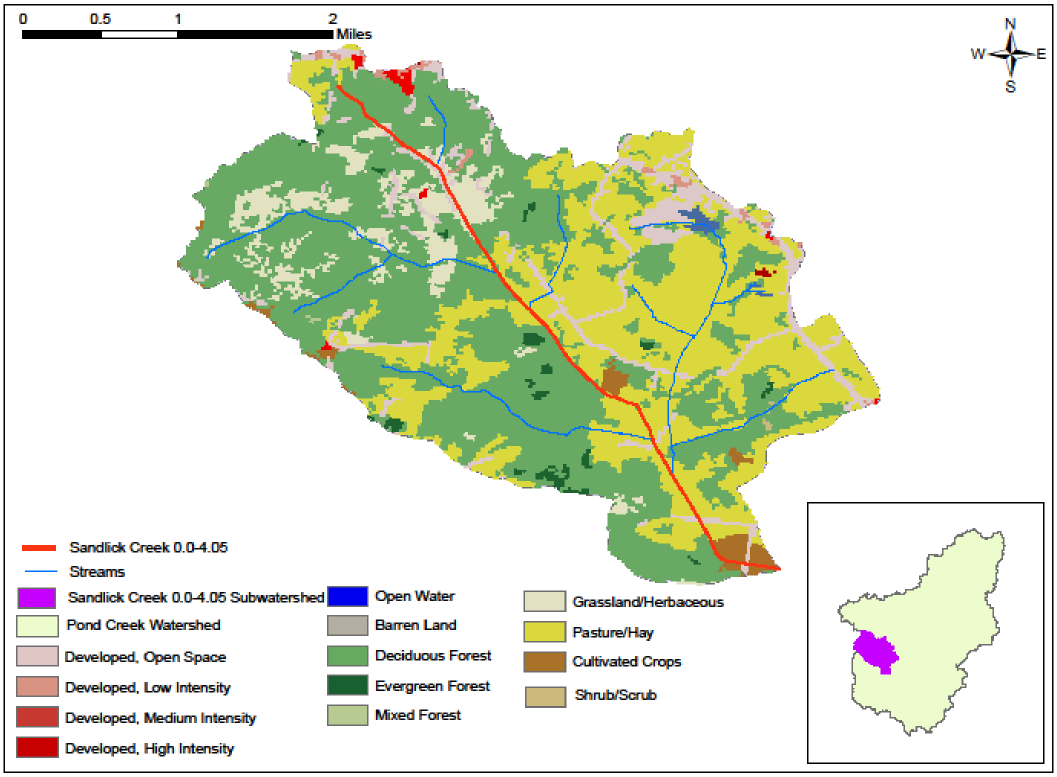


**Figure 8.17.2 Land Cover in the Sandlick Creek 0.0 to 4.05 Subwatershed**

**Table 8.17.2 Land Cover in the Sandlick Creek 0.0 to 4.05 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 0.52 | 330.4 | 7.7 |
| Agriculture | 2.30 | 1471.9 | 34.5 |
| Forest | 3.42 | 2191.3 | 51.3 |
| Barren Land | 0 | 0 | 0 |
| Grassland/Herbaceous | 0.41 | 260.3 | 6.1 |
| Water | 0.02 | 14.6 | 0.3 |
| Wetland | 0 | 0 | 0 |
| Shrub/Scrub | 0.003 | 2.1 | 0.1 |

There are one active and five inactive KPDES facilities within this subwatershed, see Figure 8.17.3 and Table 8.17.3. Although those five inactive KPDES permittees were active during the data collection period and may have contributed to the impairments in the Sandlick 0.0 to 4.05, inactive KPDES permittee will not receive a WLA.

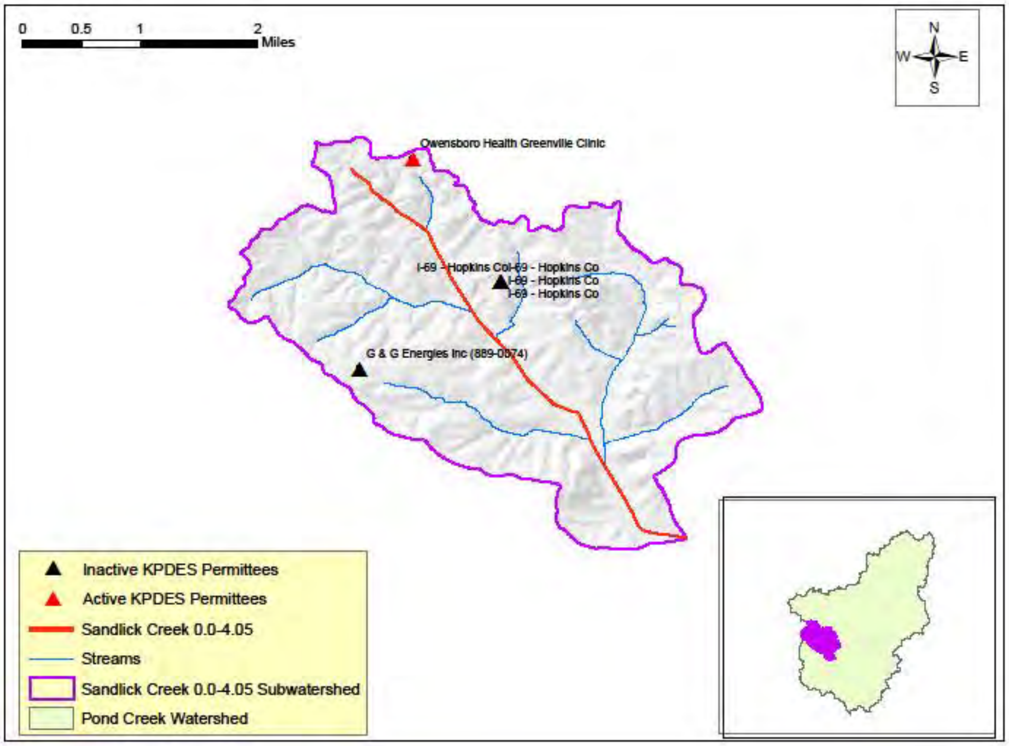


**Figure 8.17.3 KPDES Permittees in the Subwatershed**

**Table 8.17.3 KPDES Permittees in the Subwatershed**

| KPDES# | Permit Name | Active | Design Flow | Latitude | Longitude | Pollutant Limits/Requirement in the Permit |
|---|---|---|---|---|---|---|
| KYR10K083 | Owensboro Health Greenville Clinic | Yes | 0 | 37.196391 | -87.187716 | to develop a SWPPP |
| KYG044486 | G & G Energies Inc (889-0074) | No | 0 | 37.170457 | -87.194335 | pH, Fe |
| KYR10G428 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G429 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G456 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |
| KYR10G458 | I-69 - Hopkins Co | No | 0 | 37.181100 | -87.176900 | to develop a SWPPP |

There are no active KPDES mining permits in this subwatershed. A small portion of the upstream watershed is licensed mining areas, see Figure 8.17.4 (see Section 9.4.3 for more information). Tables 8.17.4 to 8.17.6 show *E. coli*, iron, lead and flow data collected by TMDL staff at DOW03011004.

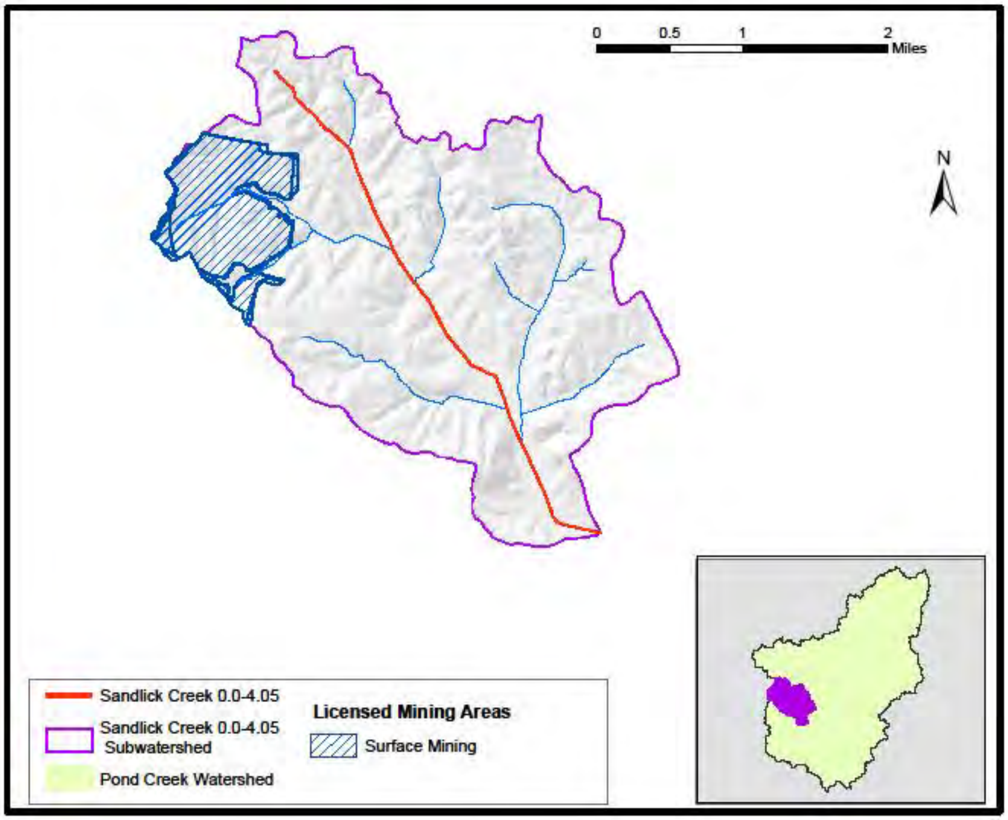


**Figure 8.17.4 Data from the Department of Natural Resources on Licensed Mining Areas in the Subwatershed**

**Table 8.17.4 *E. coli* and Flow Data, DOW03011004**

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 5/10/2011 | 93 | ** |
| 5/24/2011 | 291 | ** |
| 6/14/2011 | 68 | ** |
| 6/21/2011 | 225 | ** |
| 7/12/2011 | 124 | ** |
| 9/27/2011 | 1986 | ** |
| 5/8/2013 | 236 | ** |
| 5/9/2013 | 194 | ** |

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 5/20/2013 | 194 | ** |
| 5/23/2013 | 84 | ** |
| 5/29/2013 | 78 | ** |
| 6/6/2013 | > 2420 | ** |
| 6/27/2013 | 219 | ** |
| 7/17/2013 | 113 | ** |
| 7/30/2013 | 120 | ** |
| 8/15/2013 | 488 | ** |
| 8/20/2013 | > 2420 | ** |
| 9/11/2013 | 27 | ** |
| 9/24/2013 | 387 | ** |
| 10/10/2013 | 461 | ** |
| 10/14/2013 | 411 | ** |

(shaded) Exceeds the instantaneous *E. coli* limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

**Table 8.17.5 Iron and Flow Data Collected at DOW03011004**

| Date | Iron (mg/L) (1) | Flow (cfs) |
|---|---|---|
| 1/4/2011 | 0.184 | ** |
| 2/15/2011 | 0.135 | 7.196 |
| 3/8/2011 | 0.173 | ** |
| 4/26/2011 | 0.673 | ** |
| 5/10/2011 | 0.322 | ** |
| 6/14/2011 | 0.192 | ** |
| 7/12/2011 | 2.34 | ** |
| 3/26/2013 | 0.317 | ** |
| 4/24/2013 | 0.739 | ** |
| 5/9/2013 | 0.305 | ** |
| 6/27/2013 | 0.287 | ** |
| 7/17/2013 | 0.174 | ** |
| 8/20/2013 | 0.992 | ** |
| 9/11/2013 | 0.216 | ** |
| 10/10/2013 | 0.22 | ** |
| 11/13/2013 | 0.121 | ** |
| 12/17/2013 | 0.262 | ** |
| 3/18/2014 | 0.297 | 7.174 |
| 4/15/2014 | 1.87 | ** |

| Date | Iron (mg/L) [1] | Flow (cfs) |
|---|---|---|
| 5/21/2014 | 0.162 | 1.693 |
| 6/5/2014 | 0.691 | ** |
| 12/23/2014 | 0.226 | ** |

[1]Chronic limit is 1.0 mg/L since aquatic life is adversely affected
Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

**Table 8.17.6 Lead, Hardness and Flow Data Collected at DOW03011004**

| Date | Lead (µg/L) | Hardness, Total (mg/L) | Lead Chronic Limit (µg/L) | Lead Acute Limit (µg/L) | Difference between the Lead Concentration and the Lead Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 1/4/2011 | 0.201 (J) | 59.9 | 1.66 | 42.52 | N/A | ** |
| 2/15/2011 | < 0.50 (U) | 87.2 | 2.67 | 68.58 | N/A | 7.196 |
| 3/8/2011 | 0.292 (J) | 80 | 2.39 | 61.46 | N/A | ** |
| 4/26/2011 | 1.02 | 54 | 1.45 | 37.26 | -0.43 | ** |
| 5/10/2011 | 0.242 (J) | 106 | 3.43 | 87.93 | N/A | ** |
| 6/14/2011 | < 0.50 (U) | 241 | 9.75 | 250.17 | N/A | ** |
| 7/12/2011 | < 0.50 (U) | 80.8 | 2.43 | 62.24 | N/A | ** |
| 3/26/2013 | 0.23 | 71.9 | 2.09 | 53.65 | -1.86 | ** |
| 4/24/2013 | 2.54 | 49 | 1.28 | 32.93 | 1.26 | ** |
| 5/9/2013 | 0.23 | 77.5 | 2.30 | 59.02 | -2.07 | ** |
| 6/27/2013 | 0.27 | 115 | 3.80 | 97.54 | -3.53 | ** |
| 7/17/2013 | < 0.50 (U) | 159 | 5.74 | 147.34 | N/A | ** |
| 8/20/2013 | 4.08 | 106 | 3.43 | 87.93 | 0.65 | ** |
| 9/11/2013 | < 0.50 (U) | 184 | 6.91 | 177.44 | N/A | ** |
| 10/10/2013 | < 0.50 (U) | 113 | 3.72 | 95.39 | N/A | ** |
| 11/13/2013 | < 0.50 (U) | 157 | 5.65 | 144.98 | N/A | ** |
| 12/17/2013 | 0.22 | 102 | 3.26 | 83.73 | -3.04 | ** |
| 3/18/2014 | 0.22 (J) | 78.5 | 2.34 | 59.99 | N/A | 7.174 |
| 4/15/2014 | 0.83 | 57 | 1.56 | 39.92 | -0.73 | ** |
| 5/21/2014 | < 0.50 (U) | 67.3 | 1.92 | 49.32 | N/A | 1.693 |
| 6/5/2014 | 2.09 | 117 | 3.89 | 99.71 | -1.80 | ** |
| 12/23/2014 | < 0.50 (U) | 172 | 6.35 | 162.84 | N/A | ** |

| Date | Lead (µg/L) | Hardness, Total (mg/L) | Lead Chronic Limit (µg/L) | Lead Acute Limit (µg/L) | Difference between the Lead Concentration and the Lead Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|

(shaded) Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
D = Reanalyzed at a Higher Dilution
J = Estimated Value
U = Analyte Not Detected
N/A: Not Applicable

### 8.18 UT of Bat East Creek 0.0 to 1.9

The pollutant addressed in this document for UT of Bat East Creek 0.0 to 1.9 is *E. coli*. This segment is a third order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 2.35 square miles. There is one TMDL monitoring site on the UT of Bat East Creek 0.0 to 1.9 segment, DOW03011019, located at RM 0.43 with the drainage area of 2.11 square miles, see Figure 8.18.1 and Table 8.18.1. This subwatershed consists primarily of agricultural land (64.3%) and forest (29.5%), see Figure 8.18.2 and Table 8.18.2.

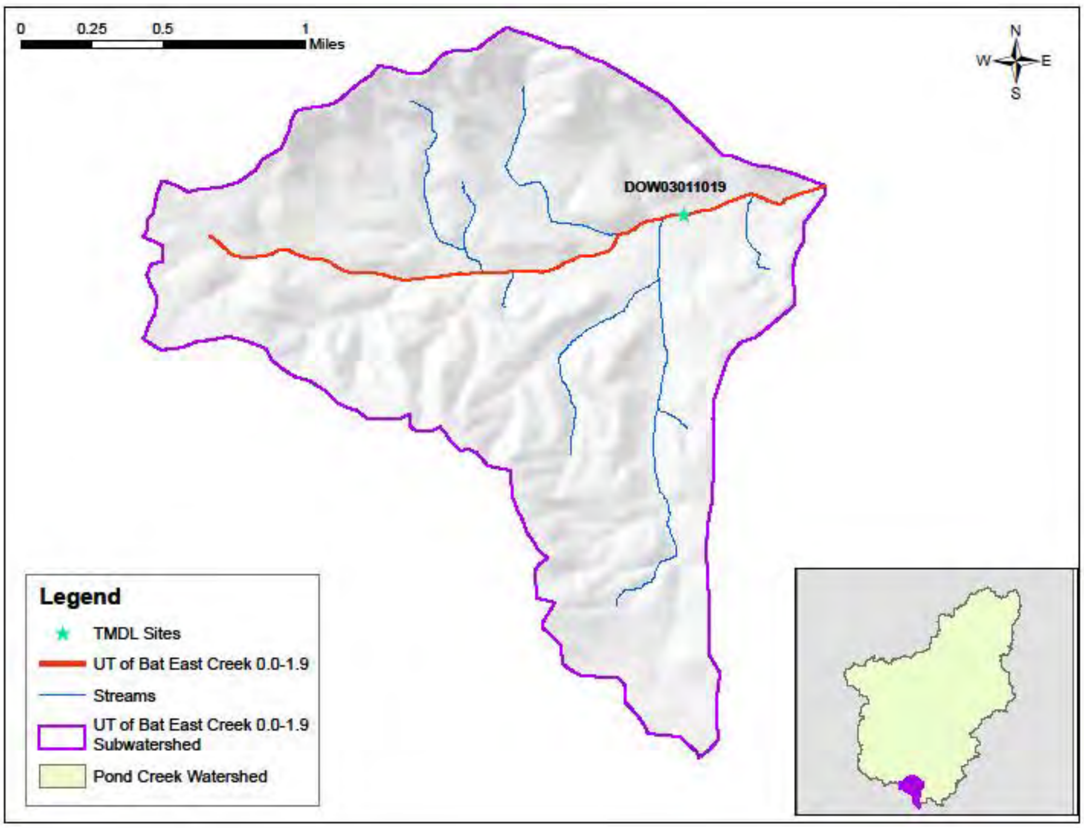


**Figure 8.18.1 TMDL Monitoring Sites and the Drainage Area of UT of Bat East Creek 0.0 to 1.9**

**Table 8.18.1 UT of Bat East Creek 0.0 to 1.9 Segment/Upstream Catchment Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY486462-6.1_01 | UT of Bat East Creek 0.0 to 1.9 | 3 | Muhlenberg | 2.35 | 1504 |

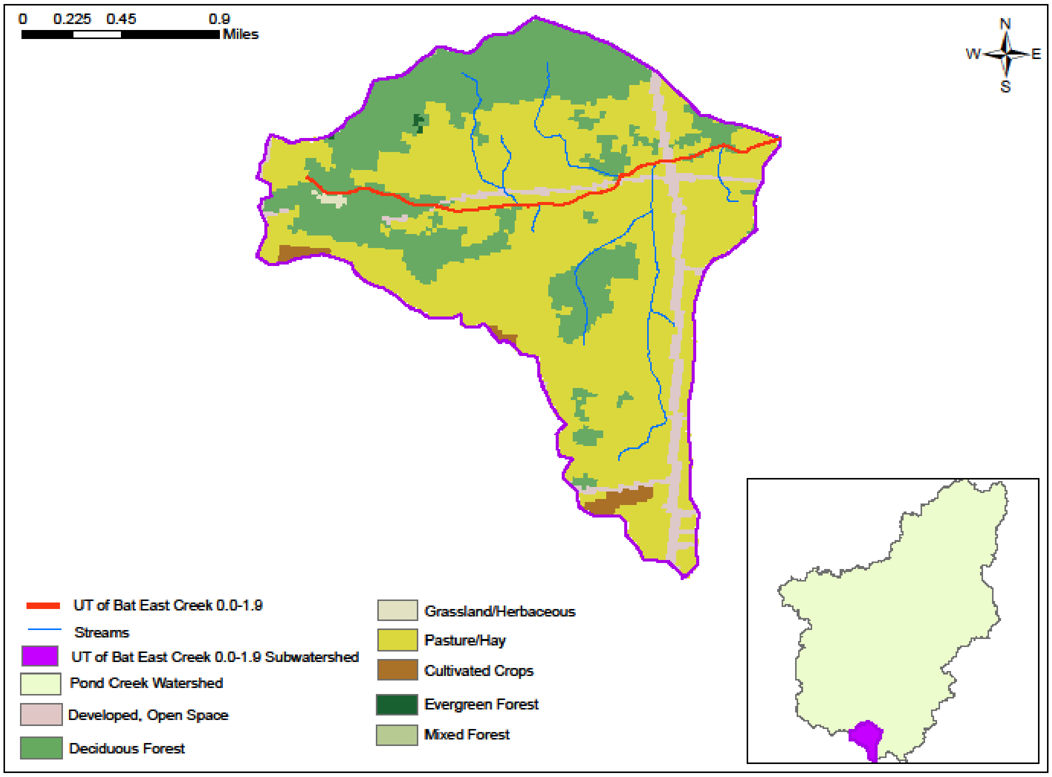


**Figure 8.18.2 Land Cover in the UT of Bat East Creek 0.0 to 1.9 Subwatershed**

**Table 8.18.2 Land Cover in the UT of Bat East Creek 0.0 to 1.9 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 0.14 | 89.0 | 5.9 |
| Agriculture | 1.51 | 967.4 | 64.3 |
| Forest | 0.69 | 444.4 | 29.5 |
| Grassland/Herbaceous | 0.01 | 3.2 | 0.2 |
| Wetland | 0.01 | 3.2 | 0.2 |
| Water | 0 | 0 | 0 |
| Shrub/Scrub | 0 | 0 | 0 |
| Barren Land | 0 | 0 | 0 |

There are no KPDES permittees in this subwatershed. *E. coli* and flow data monitored at DOW03011019 are presented in Table 8.18.3.

**Table 8.18.3 *E. coli* and Flow Data, DOW03011019**

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 5/10/2011 | 291 | 0.828 |
| 5/24/2011 | 1046 | ** |
| 5/8/2013 | 548 | ** |
| 5/9/2013 | 249 | ** |
| 5/23/2013 | 78 | ** |
| 6/6/2013 | 1553 | ** |
| 8/15/2013 | 65 | ** |

[shaded] Exceeds the instantaneous *E. coli* limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

### 8.19 UT of Bat East Creek 0.0 to 3.55

The pollutant addressed in this document for UT of Bat East Creek 0.0 to 3.55 is *E. coli*. This segment is a third order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 5.52 square miles. There is one TMDL monitoring site on the UT of Bat East Creek 0.0 to 3.55 segment, DOW03011016, located at RM 0.31 with the drainage area of 5.47 square miles, see Figure 8.19.1 and Table 8.19.1. This subwatershed consists primarily of forest (68.6%) and agricultural land (21.1%), see Figure 8.19.2 and Table 8.19.2.

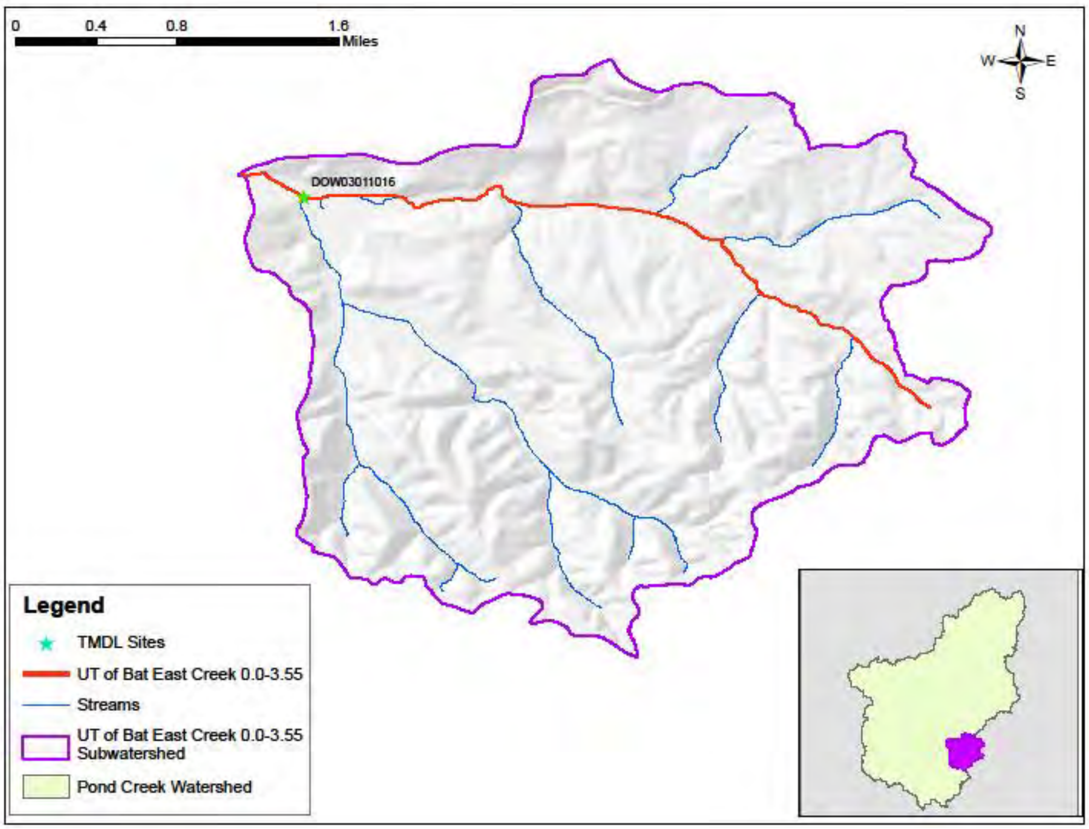


**Figure 8.19.1 TMDL Monitoring Locations and the Drainage Area of UT of Bat East Creek 0.0 to 3.55**

**Table 8.19.1 UT of Bat East Creek 0.0 to 3.55 Segment/Upstream Catchment Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY486462-1.6_01 | UT of Bat East Creek 0.0 to 3.55 | 3 | Muhlenberg | 5.52 | 3533 |

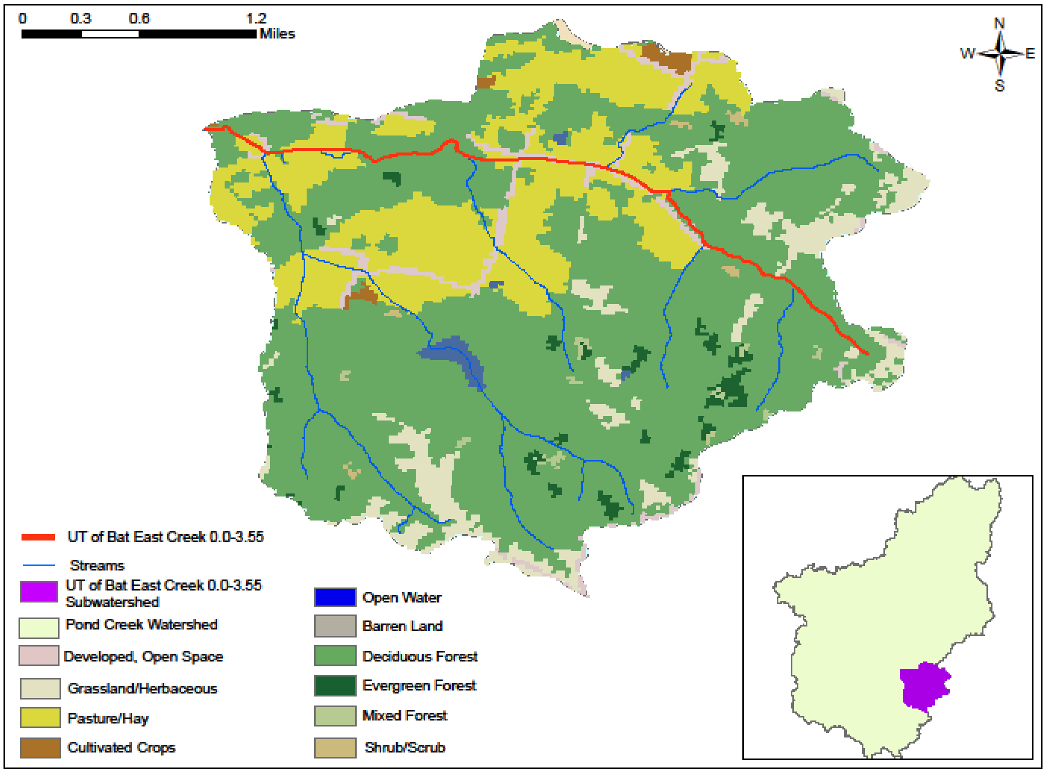


**Figure 8.19.2 Land Cover in the UT of Bat East Creek 0.0 to 3.55 Subwatershed**

**Table 8.19.2 Land Cover in the UT of Bat East Creek 0.0 to 3.55 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 0.15 | 93.3 | 2.6 |
| Agriculture | 1.16 | 743.6 | 21.1 |
| Forest | 3.78 | 2419.7 | 68.6 |
| Barren Land | 0.01 | 6.1 | 0.2 |
| Grassland/Herbaceous | 0.36 | 231.7 | 6.6 |
| Water | 0.04 | 24.0 | 0.7 |
| Wetland | 0 | 0 | 0 |
| Shrub/Scrub | 0.01 | 7.2 | 0.2 |

There are no KPDES permittees in this subwatershed. *E. coli* and flow data monitored at DOW03011016 are in Table 8.19.3.

**Table 8.19.3 *E. coli* and Flow Data, DOW03011016**

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 5/10/2011 | > 2420 | ** |
| 5/24/2011 | > 2420 | ** |
| 6/21/2011 | > 2420 | ** |
| 5/8/2013 | 248 | ** |
| 5/9/2013 | 365 | ** |
| 5/20/2013 | 1986 | ** |
| 5/23/2013 | 866 | ** |
| 5/28/2013 | >2420 | ** |
| 6/27/2013 | 1733 | ** |
| 7/17/2013 | 830 | ** |
| 7/30/2013 | 687 | ** |
| 8/6/2013 | 980 | ** |
| 8/15/2013 | 272 | ** |
| 9/24/2013 | > 2420 | ** |
| 10/10/2013 | > 2420 | ** |
| 10/14/2013 | > 2420 | ** |

(shaded) Exceeds the instantaneous *E. coli* limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

## 8.20 UT of Caney Creek 0.0 to 2.6

The pollutants addressed in this document for UT of Caney Creek 0.0 to 2.6 are *E. coli* and lead. This segment is a second order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 1.88 square miles. There is one TMDL monitoring site on the UT of Caney Creek 0.0 to 2.6 segment, DOW03011013, located at RM 0.12 with the drainage area of 1.82 square miles, see Figure 8.20.1 and Table 8.20.1. This subwatershed consists primarily of forest (35.6%) and agricultural land (41.8%), see Figure 8.20.2 and Table 8.20.2.

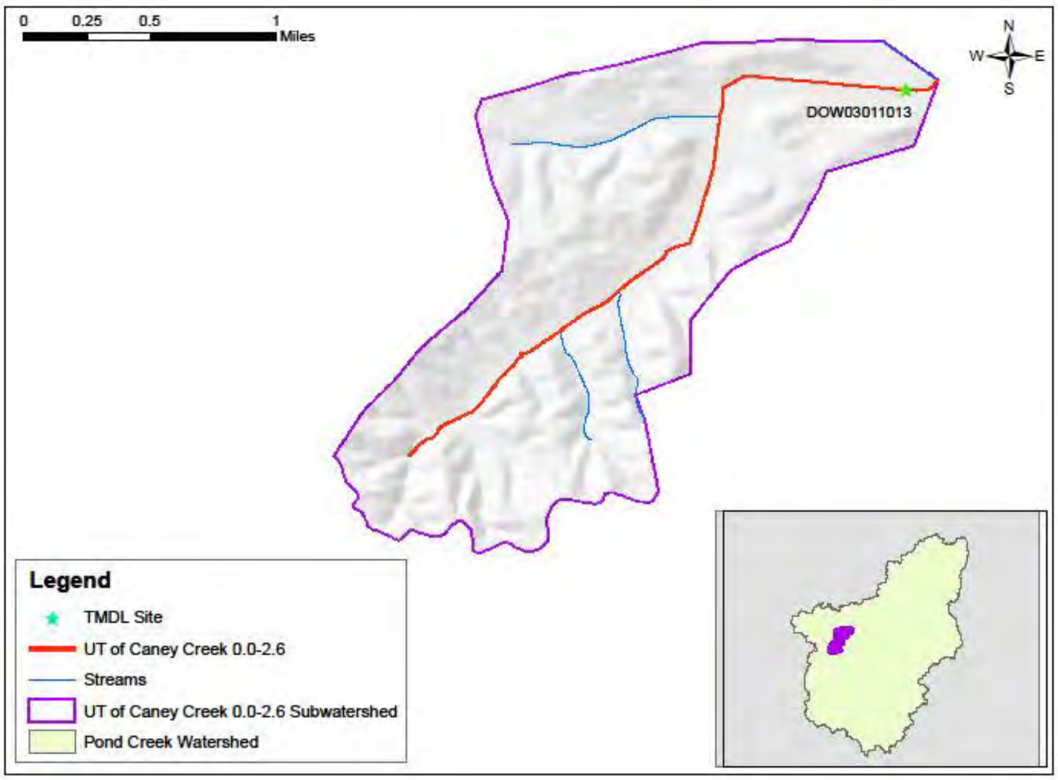


**Figure 8.20.1 TMDL Monitoring Locations and the Drainage Area of UT of Caney Creek 0.0 to 2.6**

**Table 8.20.1 UT of Caney Creek 0.0 to 2.6 Segment/Upstream Catchment Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY488838-2.3_01 | UT of Caney Creek 0.0 to 2.6 | 2 | Muhlenberg | 1.88 | 1200 |

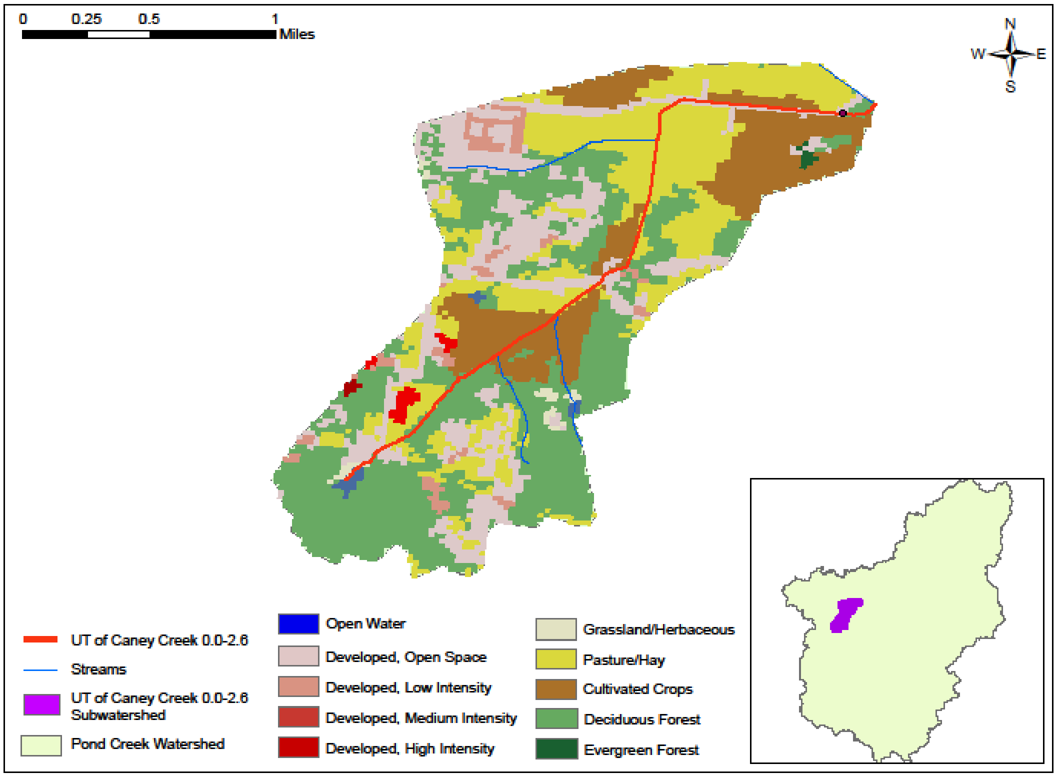


**Figure 8.20.2 Land Cover in the UT of Caney Creek 0.0 to 2.6 Subwatershed**

**Table 8.20.2 Land Cover in the UT of Caney Creek 0.0 to 2.6 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 0.40 | 258.0 | 21.5 |
| Agriculture | 0.78 | 501.5 | 41.8 |
| Forest | 0.67 | 427.1 | 35.6 |
| Grassland/Herbaceous | 0.01 | 7.5 | 0.6 |
| Water | 0.01 | 5.5 | 0.5 |
| Barren Land | 0 | 0 | 0 |
| Wetland | 0 | 0 | 0 |
| Shrub/Scrub | 0 | 0 | 0 |

There are no KPDES permittees in this subwatershed. There are no licensed mining records from the Department of Natural Resources for this subwatershed. *E. coli*, lead and flow data monitored at DOW03011013 are in Table 8.20.3 and 8.20.4.

**Table 8.20.3 *E. coli* and Flow Data, DOW03011013**

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 5/11/2011 | 24 | 0.595 |
| 5/25/2011 | 517 | ** |
| 6/22/2011 | 1733 | ** |
| 5/8/2013 | 146 | ** |
| 5/9/2013 | 58 | ** |
| 5/23/2013 | 124 | ** |
| 5/29/2013 | 15 | ** |
| 6/6/2013 | > 2420 | ** |
| 6/26/2013 | 93 | 0.027 |
| 8/15/2013 | 44 | 0.209 |
| 9/10/2013 | 179 | ** |
| 9/24/2013 | > 2420 | 0.030 |
| 10/9/2013 | 173 | ** |
| 10/14/2013 | 87 | 0.098 |

(shaded) Exceeds the instantaneous *E. coli* limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

**Table 8.20.4 Lead, Hardness and Flow Data Collected at DOW03011013**

| Date | Lead (µg/L) | Hardness, Total (mg/L) | Lead Chronic Limit (µg/L) | Lead Acute Limit (µg/L) | Difference between the Lead Concentration and the Lead Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 11/17/2010 | 0.354 (J) | 103 | 3.30 | 84.78 | N/A | ** |
| 1/5/2011 | 0.236 (J) | 118 | 3.93 | 100.79 | N/A | 0.783 |
| 2/16/2011 | 0.625 | 123 | 4.14 | 106.26 | -3.52 | 1.303 |
| 3/9/2011 | 2.1 | 45.4 | 1.16 | 29.88 | 0.94 | ** |
| 4/27/2011 | 3.38 | 46.4 | 1.20 | 30.72 | 2.18 | ** |
| 5/11/2011 | 0.394 (J) | 103 | 3.30 | 84.78 | N/A | 0.595 |
| 3/21/2013 | 0.25 | 96.1 | 3.02 | 77.61 | -2.77 | ** |
| 4/18/2013 | 0.89 | 125 | 4.23 | 108.47 | -3.34 | 0.869 |
| 5/8/2013 | 0.27 | 110 | 3.59 | 92.18 | -3.32 | ** |
| 6/26/2013 | 3.36 | 114 | 3.76 | 96.46 | -0.40 | 0.027 |
| 9/10/2013 | 0.79 | 102 | 3.26 | 83.73 | -2.47 | ** |
| 10/9/2013 | 0.68 | 137 | 4.75 | 121.89 | -4.07 | ** |

| Date | Lead (µg/L) | Hardness, Total (mg/L) | Lead Chronic Limit (µg/L) | Lead Acute Limit (µg/L) | Difference between the Lead Concentration and the Lead Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 11/13/2013 | 0.5 | 138 | 4.79 | 123.03 | -4.29 | ** |
| 12/17/2013 | < 0.50 (U) | 120 | 4.01 | 102.97 | N/A | ** |
| 4/1/2014 | 0.41 (J) | 116 | 3.84 | 98.62 | N/A | 1.853 |

Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
D = Reanalyzed at a Higher Dilution
J = Estimated Value
U = Analyte Not Detected
N/A: Not Applicable

### 8.21 UT of Caney Creek 0.0 to 2.35

The pollutants addressed in this document for UT of Caney Creek 0.0 to 2.35 are *E. coli* and lead. This segment is a second order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 2.01 square miles. There is one TMDL monitoring site on the UT of Caney Creek 0.0 to 2.35 segment, DOW03011012, located at RM 0.64 with the drainage area of 1.52 square miles, see Figure 8.21.1 and Table 8.21.1. This subwatershed consists primarily of agricultural land (52.5%), forest (32.2%) and developed urban area (14.7%), see Figure 8.21.2 and Table 8.21.2.

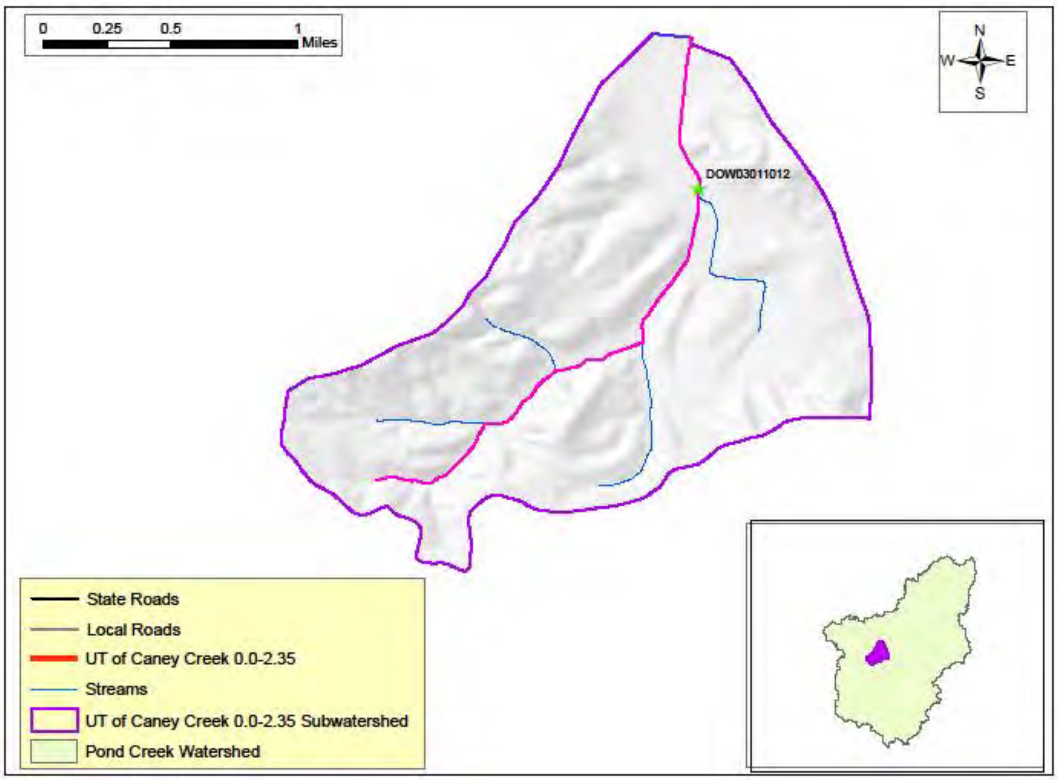


**Figure 8.21.1 TMDL Monitoring Locations and the Drainage Area of UT of Caney Creek 0.0 to 2.35**

**Table 8.21.1 UT of Caney Creek 0.0 to 2.35 Segment/Upstream Catchment Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY488838-1.8_01 | UT of Caney Creek 0.0 to 2.35 | 2 | Muhlenberg | 2.01 | 1286 |

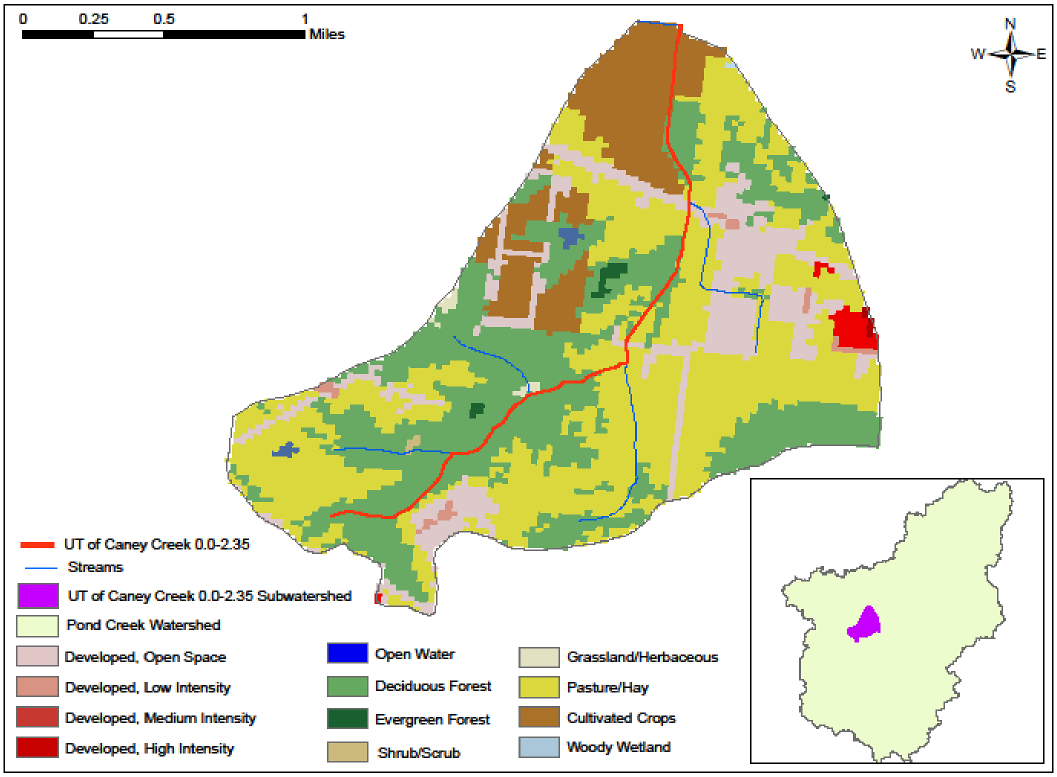


**Figure 8.21.2 Land Cover in the UT of Caney Creek 0.0 to 2.35 Subwatershed**

**Table 8.21.2 Land Cover in the UT of Caney Creek 0.0 to 2.35 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 0.30 | 189.0 | 14.7 |
| Agriculture | 1.06 | 675.3 | 52.5 |
| Forest | 0.65 | 414.3 | 32.2 |
| Grassland/Herbaceous | 0.01 | 3.2 | 0.3 |
| Wetlands | 0.00 | 0.1 | 0.006 |
| Water | 0.01 | 3.5 | 0.3 |
| Barren Land | 0 | 0 | 0 |
| Shrub/Scrub | 0.001 | 0.9 | 0.1 |

There are no KPDES permittees in this subwatershed. There are no licensed mining records from the Department of Natural Resources for this subwatershed. Tables 8.21.3 and 8.21.4 show *E. coli*, lead and flow data collected by TMDL staff at DOW03011012.

**Table 8.21.3 *E. coli* and Flow Data, DOW03011012**

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 5/11/2011 | 275 | 0.580 |
| 5/25/2011 | 435 | ** |
| 6/22/2011 | 1986 | ** |
| 5/8/2013 | 199 | ** |
| 5/9/2013 | 192 | ** |
| 5/20/2013 | 649 | ** |
| 5/23/2013 | 345 | ** |
| 5/29/2013 | 102 | ** |
| 6/6/2013 | > 2420 | ** |
| 6/26/2013 | 1553 | 0.202 |
| 8/15/2013 | 517 | ** |
| 10/9/2013 | 1733 | 0.212 |

[shaded] Exceeds the instantaneous *E. coli* limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

**Table 8.21.4 Lead, Hardness and Flow Data Collected at DOW03011012**

| Date | Lead (µg/L) | Hardness, Total (mg/L) | Lead Chronic Limit (µg/L) | Lead Acute Limit (µg/L) | Difference between the Lead Concentration and the Lead Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 1/5/2011 | < 0.50 (U) | 110 | 3.59 | 92.18 | N/A | 0.721 |
| 2/16/2011 | < 0.50 (U) | 616 | 32.19 | 826.16 | N/A | 1.274 |
| 3/9/2011 | 1.11 | 33.3 | 0.78 | 20.14 | 0.33 | ** |
| 4/27/2011 | 2.73 | 30.3 | 0.70 | 17.86 | 2.03 | ** |
| 5/11/2011 | 2.08 | 79.4 | 2.37 | 60.87 | -0.29 | 0.580 |
| 3/21/2013 | < 0.50 (U) | 66.9 | 1.91 | 48.94 | N/A | 2.011 |
| 4/18/2013 | < 0.50 (U) | 84.7 | 2.58 | 66.09 | N/A | 0.702 |
| 5/8/2013 | 0.38 | 59.6 | 1.65 | 42.25 | -1.27 | ** |
| 6/26/2013 | 0.31 | 92.5 | 2.88 | 73.93 | -2.57 | 0.202 |
| 10/9/2013 | 0.25 | 98.9 | 3.14 | 80.50 | -2.89 | 0.212 |
| 12/17/2013 | < 0.50 (U) | 112 | 3.68 | 94.32 | N/A | 1.131 |
| 3/26/2014 | < 0.50 (U) | 106 | 3.43 | 87.93 | N/A | 0.52 |

| Date | Lead (µg/L) | Hardness, Total (mg/L) | Lead Chronic Limit (µg/L) | Lead Acute Limit (µg/L) | Difference between the Lead Concentration and the Lead Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| (shaded) Exceeds the chronic limit | | | | | | |
| ** Unable to obtain flow because of water depth, swiftness, or lack of access | | | | | | |
| D = Reanalyzed at a Higher Dilution | | | | | | |
| J = Estimated Value | | | | | | |
| U = Analyte Not Detected | | | | | | |
| N/A: Not Applicable | | | | | | |

## 8.22 UT of Plum Creek 0.0 to 2.45

The pollutants addressed in this document for UT of Plum Creek 0.0 to 2.45 are pH, cadmium, iron, nickel and zinc. This segment is a third order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 4.99 square miles. There is one TMDL monitoring site in the subwatershed, DOW03011003, located at RM 0.10 with the drainage area of 2.18 square miles, see Figure 8.22.1 and Table 8.22.1. This subwatershed consists primarily of forest (67.1%) and agricultural land (14.3%), see Figure 8.22.2 and Table 8.22.2.

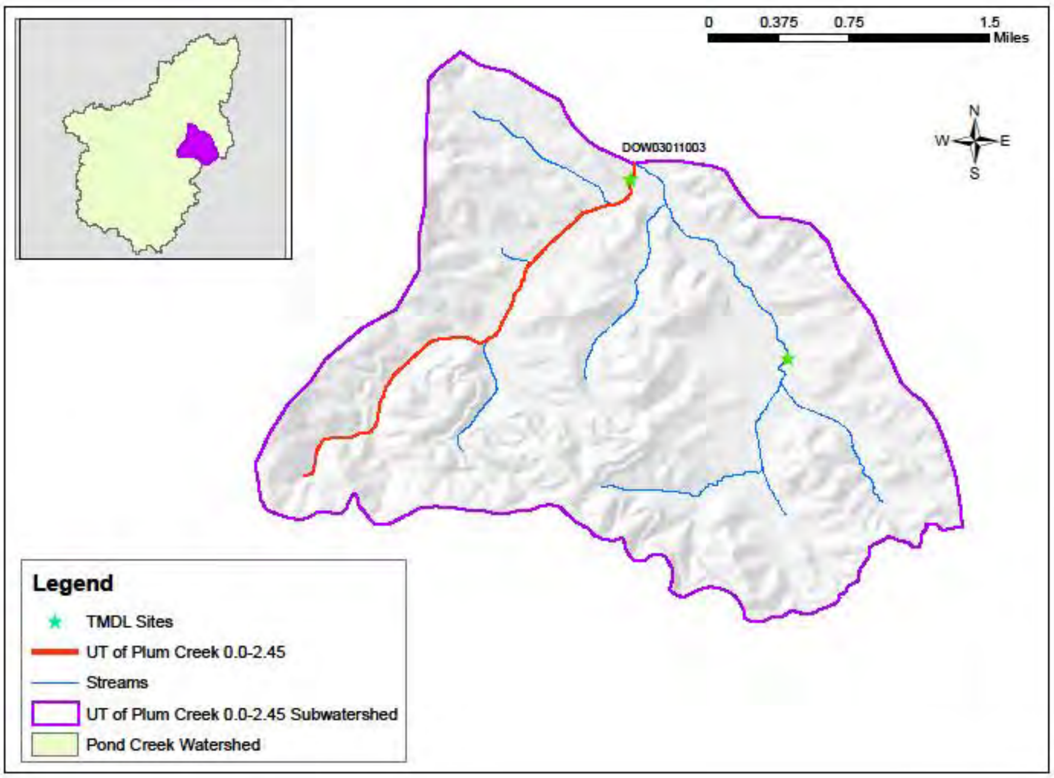


**Figure 8.22.1 TMDL Monitoring Location and Impaired Segment in the UT of Plum Creek 0.0 to 2.45 Subwatershed**

**Table 8.22.1 UT of Plum Creek 0.0 to 2.45 Segment/Subwatershed Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY500964-1.65_01 | UT of Plum Creek 0.0 to 2.45 | 3 | Muhlenberg | 4.99 | 3193 |

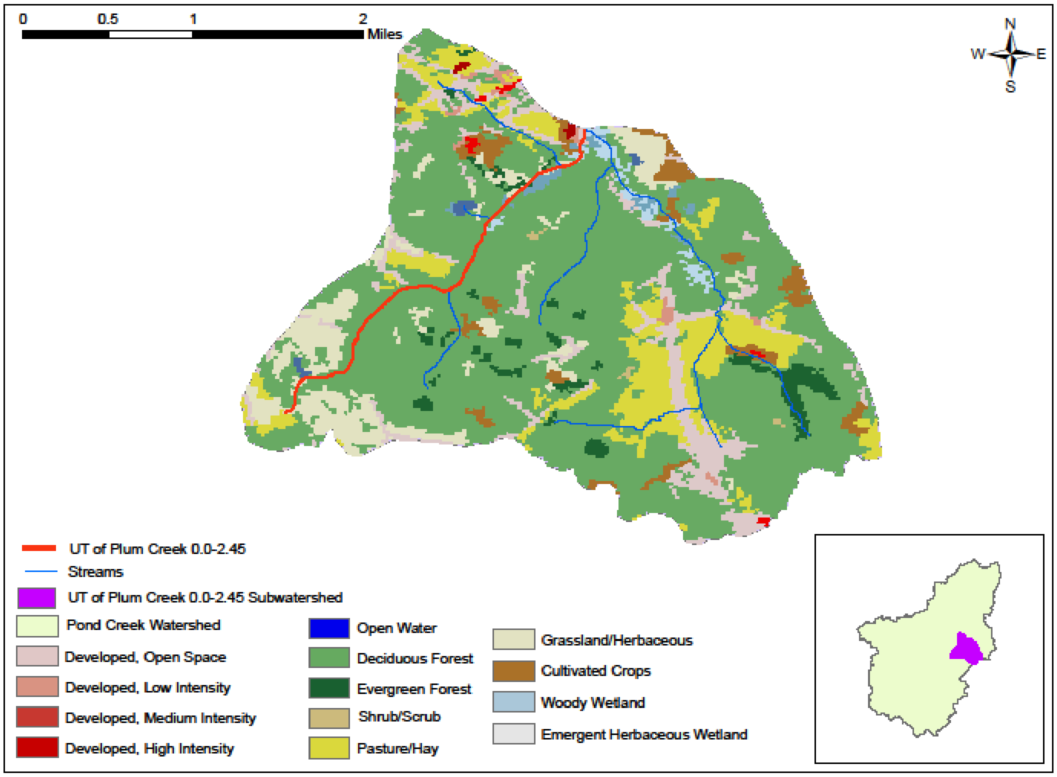


**Figure 8.22.2 Land Cover in the UT of Plum Creek 0.0 to 2.45 Subwatershed**

**Table 8.22.2 Land Cover within the UT of Plum Creek 0.0 to 2.45 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 0.44 | 281.9 | 8.8 |
| Agriculture | 0.71 | 456.2 | 14.3 |
| Forest | 3.35 | 2141.7 | 67.1 |
| Grassland/Herbaceous | 0.41 | 263.8 | 8.3 |
| Wetlands | 0.06 | 35.8 | 1.1 |
| Water | 0.02 | 9.6 | 0.3 |
| Barren Land | 0 | 0 | 0 |
| Shrub/Scrub | 0.01 | 3.8 | 0.1 |

There are three inactive KPDES permittees in this subwatershed, see Figure 8.22.3 and Table 8.22.3. Although those three inactive KPDES facilities were active during the data collection period and may have contributed to the impairments of this waterbody, inactive KPDES will not receive a WLA.

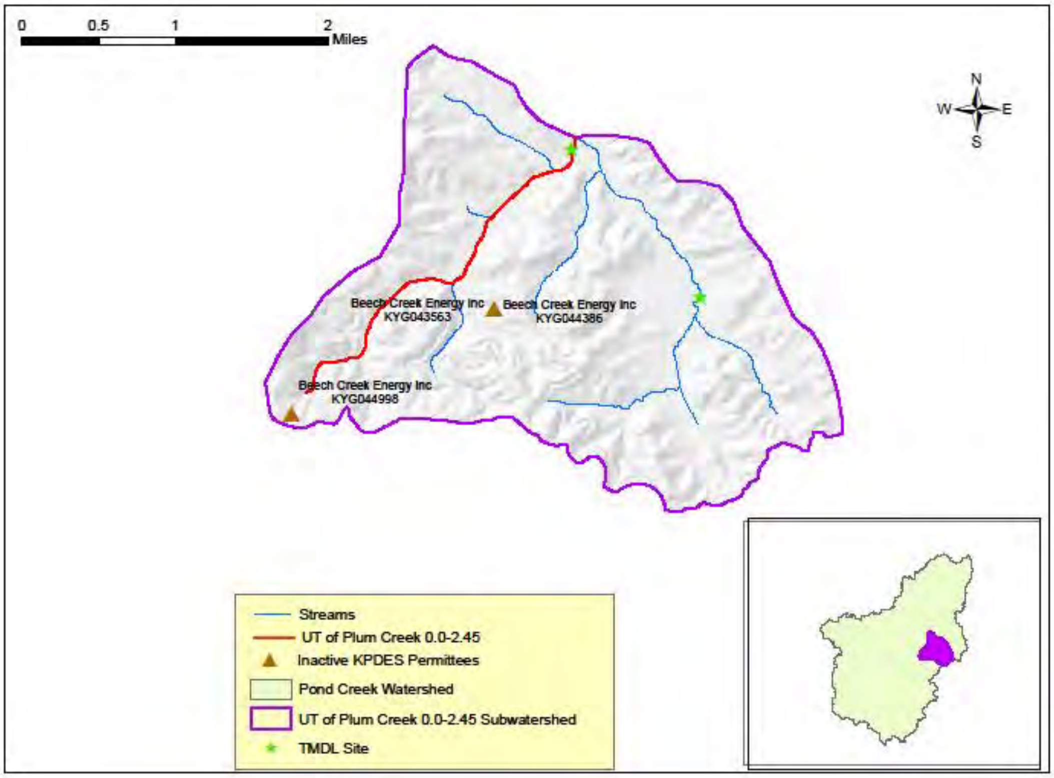


**Figure 8.22.3 KPDES Permittees in the Subwatershed**

**Table 8.22.3 KPDES Permittees in the Subwatershed**

| KPDES | Status | Permit Name | Latitude | Longitude | Pollutants with Discharge Limit |
|---|---|---|---|---|---|
| KYG043563 | Inactive | Beech Creek Energy Inc | 37.196944 | -87.051389 | pH, Iron |
| KYG044386 | Inactive | Beech Creek Energy Inc | 37.196944 | -87.051389 | pH, Iron |
| KYG044998 | Inactive | Beech Creek Energy Inc | 37.186944 | -87.070556 | pH, Iron |

There are no active KPDES mining permits in this subwatershed, but some of the watershed is licensed mining areas, see Figure 8.22.4 (see Section 9.4.3 for more information). Tables 8.22.4 through 8.22.8 show pH and metals data collected by TMDL staff at DOW03011003.

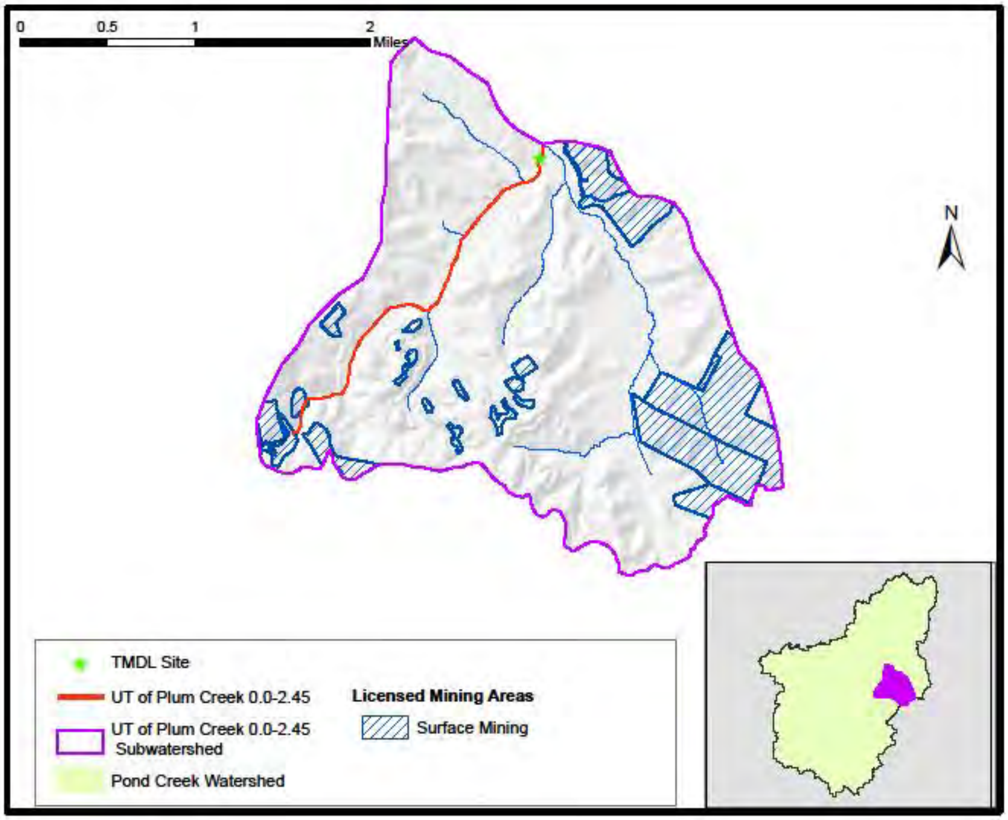


**Figure 8.22.4 Data from the Department of Natural Resources on Licensed Mining Areas in the Subwatershed**

**Table 8.22.4 pH and Flow Data Collected at DOW03011003**

| Date | pH (standard units) | Flow (cfs) |
|---|---|---|
| 1/6/2011 | 4.89 | 0.340 |
| 2/17/2011 | 4.92 | ** |
| 3/10/2011 | 5.45 | ** |
| 4/28/2011 | 5.15 | ** |
| 5/12/2011 | 3.88 | ** |
| 5/26/2011 | 4.19 | ** |
| 6/23/2011 | 3.79 | ** |
| 7/14/2011 | 3.60 | ** |
| 7/28/2011 | 4.86 | ** |
| 5/8/2013 | 4.85 | ** |
| 5/9/2013 | 4.39 | ** |
| 5/20/2013 | 4.01 | ** |

| Date | pH (standard units) | Flow (cfs) |
|---|---|---|
| 5/23/2013 | 4.46 | ** |
| 6/6/2013 | 5.88 | ** |
| 6/26/2013 | 3.40 | 0.141 |
| 8/15/2013 | 3.40 | ** |

Exceeds the pH limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

**Table 8.22.5 Cadmium, Hardness and Flow Data Collected at DOW03011003**

| Date | Cadmium (µg/L) | Hardness, Total (mg/L) | Cadmium Chronic Limit (µg/L) | Cadmium Acute Limit (µg/L) | Difference between the Cadmium Concentration and the Cadmium Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 1/6/2011 | 36.2 (DL) | 315 | 0.63 | 6.85 | 35.57 | 0.340 |
| 2/17/2011 | 30.3 (DL) | 323 | 0.65 | 7.03 | 29.65 | ** |
| 3/10/2011 | 9.97 (DL) | 165 | 0.39 | 3.55 | 9.58 | ** |
| 4/28/2011 | 9.47 (L) | 154 | 0.37 | 3.31 | 9.10 | ** |
| 5/12/2011 | 17.5 (DL) | 282 | 0.58 | 6.12 | 16.92 | ** |
| 7/14/2011 | < 16 (DU) | 303 | 0.62 | 6.58 | N/A | ** |

Exceeds the acute limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
D = Reanalyzed at a Higher Dilution
L = Exceeds MCL or Action Limit
U = Analyte Not Detected
N/A: Not Applicable

**Table 8.22.6 Iron and Flow Data Collected at DOW03011003**

| Date | Iron (mg/L) (1) | Flow (cfs) |
|---|---|---|
| 1/6/2011 | 0.16 | 0.340 |
| 2/17/2011 | 0.145 | ** |
| 3/10/2011 | 0.164 | ** |
| 4/28/2011 | 0.404 | ** |
| 5/12/2011 | 3.72 | ** |
| 7/14/2011 | 5.56 | ** |

| Date | Iron (mg/L) [(1)] | Flow (cfs) |
|---|---|---|
| [(1)]Chronic limit is 3.5 mg/L since aquatic life has not been shown to be adversely affected | | |
| (orange) Exceeds the acute limit | | |
| (pink) Exceeds the chronic limit | | |
| ** Unable to obtain flow because of water depth, swiftness, or lack of access | | |

**Table 8.22.7 Nickel, Hardness and Flow Data Collected at DOW03011003**

| Date | Nickel (µg/L) | Hardness, Total (mg/L) | Nickel Chronic Limit (µg/L) | Nickel Acute Limit (µg/L) | Difference between the Nickel Concentration and the Nickel Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 1/6/2011 | 174 | 315 | 137.70 | 1238.52 | 36.30 | 0.340 |
| 2/17/2011 | 208 | 323 | 140.65 | 1265.08 | 67.35 | ** |
| 3/10/2011 | 75.4 | 165 | 79.68 | 716.68 | -4.28 | ** |
| 4/28/2011 | 101 | 154 | 75.16 | 676.04 | 25.84 | ** |
| 5/12/2011 | 421 | 282 | 125.39 | 1127.83 | 295.61 | ** |
| 7/14/2011 | 222 (D) | 303 | 133.25 | 1198.48 | 88.75 | ** |

(pink) Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
D = Reanalyzed at a Higher Dilution

**Table 8.22.8 Zinc, Hardness and Flow Data Collected at DOW03011003**

| Date | Zinc (µg/L) | Hardness, Total (mg/L) | Zinc Chronic Limit (µg/L) | Zinc Acute Limit (µg/L) | Difference between the Zinc Concentration and the Zinc Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 1/6/2011 | 788 (D) | 315 | 316.76 | 316.76 | 471.24 | 0.340 |
| 2/17/2011 | 767 (D) | 323 | 323.57 | 323.57 | 443.43 | ** |
| 3/10/2011 | 1210 (D) | 165 | 183.14 | 183.14 | 1026.86 | ** |
| 4/28/2011 | 291 | 154 | 172.74 | 172.74 | 118.26 | ** |
| 5/12/2011 | 1240 (D) | 282 | 288.41 | 288.41 | 951.59 | ** |
| 7/14/2011 | 410 (D) | 303 | 306.51 | 306.51 | 103.49 | ** |

(orange) Exceeds the acute limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
D = Reanalyzed at a Higher Dilution

## 8.23 UT of Pond Creek 0.0 to 2.4

The pollutant addressed in this document for UT of Pond Creek 0.0 to 2.4 is iron. This segment is a second order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 4.21 square miles. There is one TMDL monitoring site in the subwatershed, DOW03011028, located at RM 1.15 with the drainage area of 3.62 square miles, see Figure 8.23.1 and Table 8.23.1. This subwatershed consists primarily of forest (57.2%) and grassland (16.4%), see Figure 8.23.2 and Table 8.23.2.

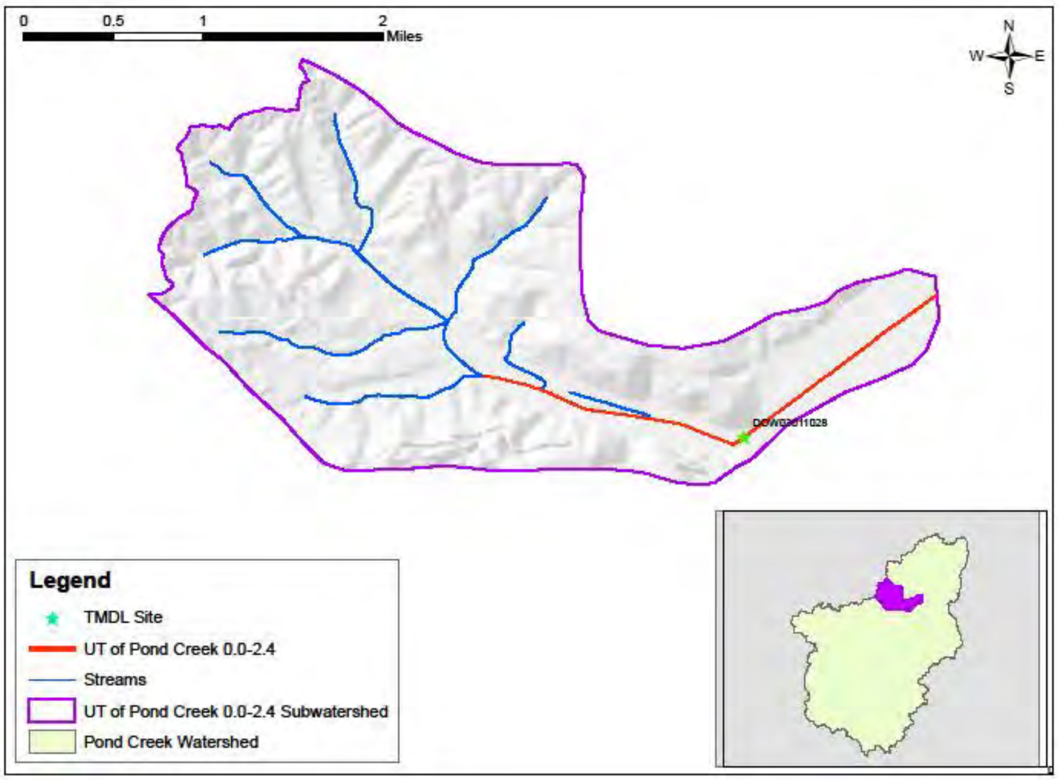


**Figure 8.23.1 TMDL Monitoring Location and Impaired Segment in the UT of Pond Creek 0.0 to 2.4 Subwatershed**

**Table 8.23.1 UT of Pond Creek 0.0 to 2.4 Segment/Subwatershed Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY501042-6.9_01 | UT of Pond Creek 0.0 to 2.4 | 2 | Muhlenberg | 4.21 | 2691 |

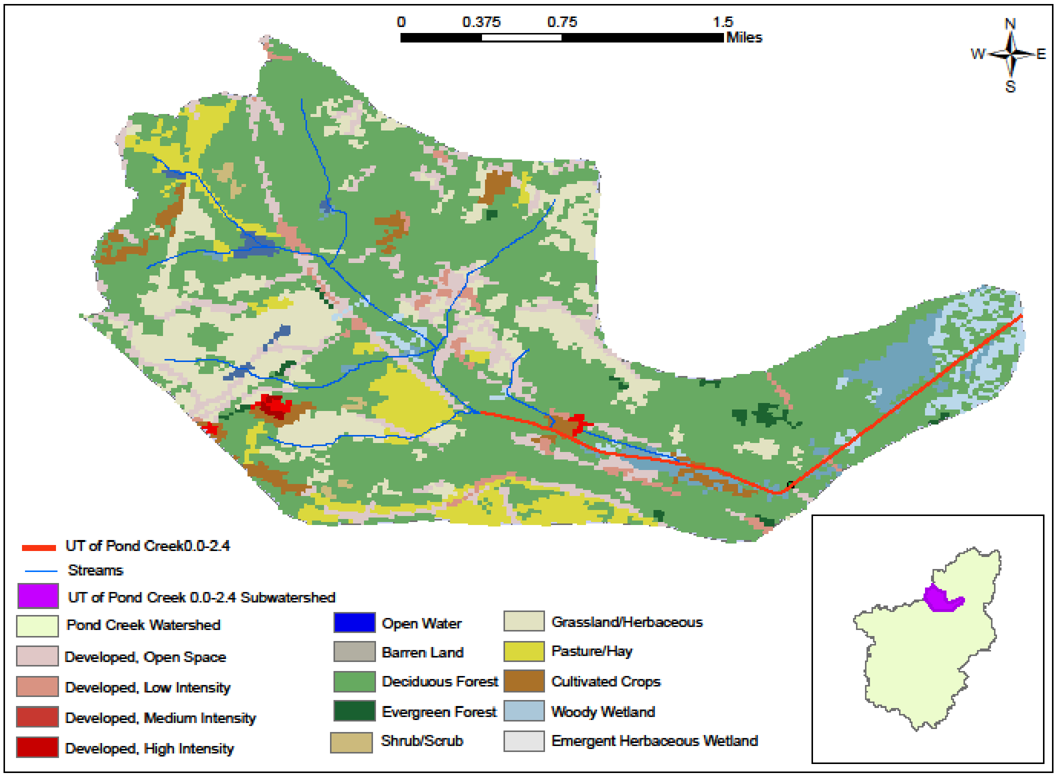


**Figure 8.23.2 Land Cover in the UT of Pond Creek 0.0 to 2.4 Subwatershed**

**Table 8.23.2 Land Cover within the UT of Pond Creek 0.0 to 2.4 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 0.40 | 253.8 | 9.4 |
| Agriculture | 0.35 | 226.2 | 8.4 |
| Forest | 2.41 | 1539.6 | 57.2 |
| Barren Land | 0.22 | 139.7 | 5.2 |
| Grassland/Herbaceous | 0.69 | 441.5 | 16.4 |
| Wetlands | 0.11 | 70.8 | 2.6 |
| Water | 0.03 | 16.6 | 0.6 |
| Shrub/Scrub | 0.01 | 3.6 | 0.1 |

There are two inactive KPDES-permitted facilities in this subwatershed, see Figure 8.23.3 and Table 8.23.3. Although those two inactive KPDES facilities were active during the data collection period and may have contributed to the pollutants in the UT of Pond Creek 0.0 to 2.4, inactive KPDES permittee will not receive a WLA.

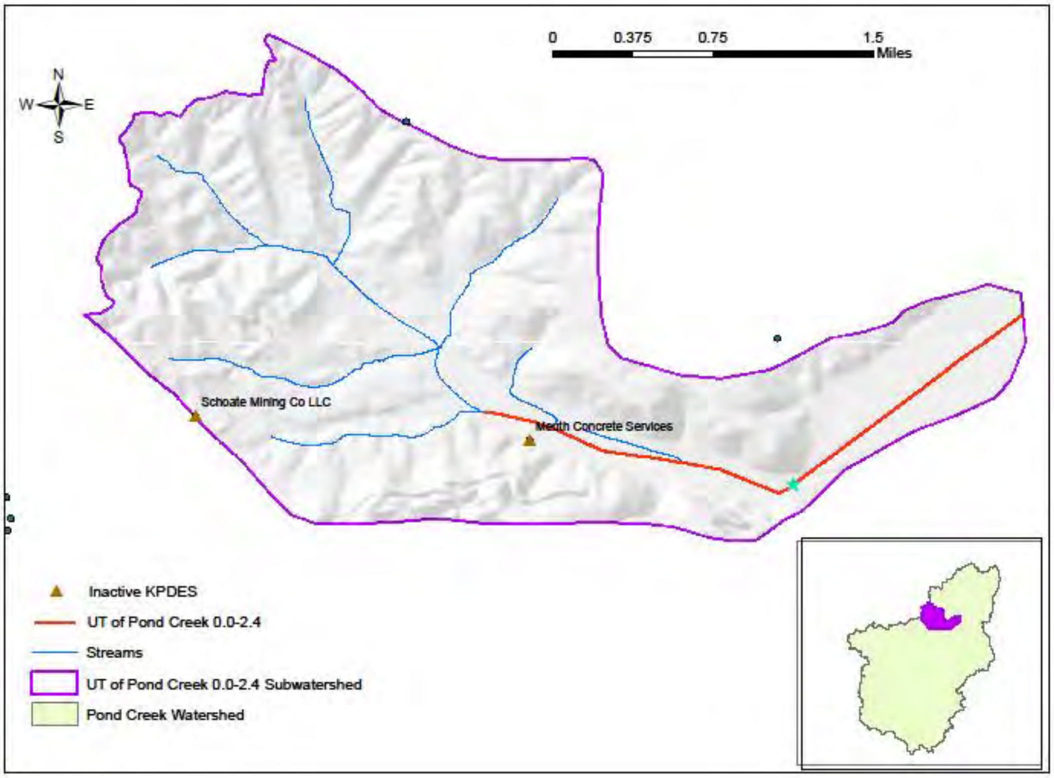


**Figure 8.23.3 KPDES Facilities in the Subwatershed**

**Table 8.23.3 KPDES Facilities in the Subwatershed**

| KPDES | Status | Permit Name | Latitude | Longitude | Pollutants with Discharge Limit |
|---|---|---|---|---|---|
| KYG045704 | Inactive | Schoate Mining Co LLC | 37.245000 | -87.108333 | pH, Iron |
| KYR001693 | Inactive | Meuth Concrete Services | 37.243362 | -87.085699 | pH |

There are no active KPDES mining permittees in this subwatershed, but the majority of the subwatershed is licensed mining areas, see Figure 8.23.4 (see Section 9.4.3 for more information). Table 8.23.4 displays iron and flow data collected by TMDL staff at DOW03011028.

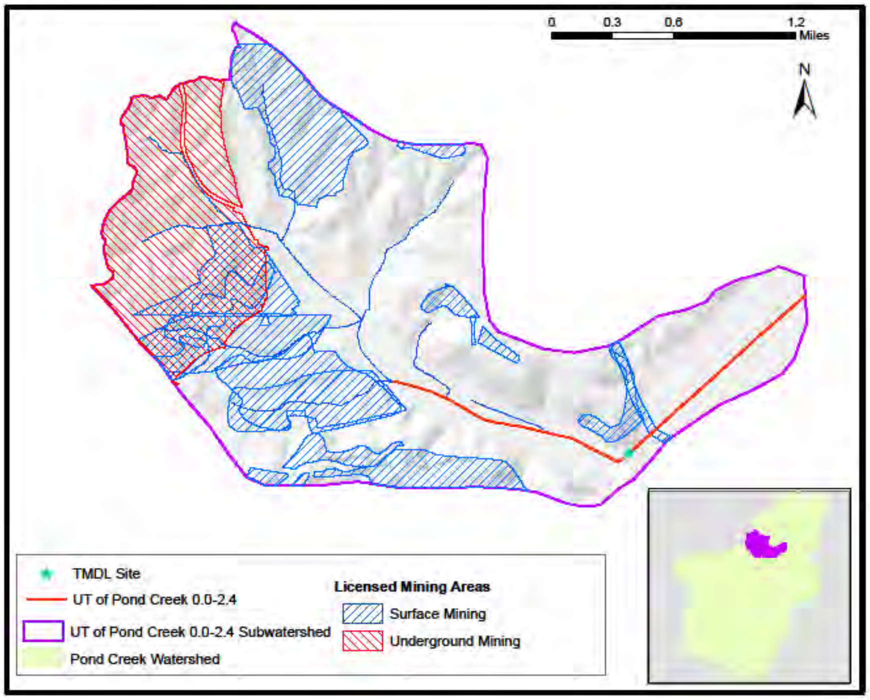


**Figure 8.23.4 Data from the Department of Natural Resources on Licensed Mining Areas in the Subwatershed**

**Table 8.23.4 Iron and Flow Data Collected at DOW03011028**

| Date | Iron (mg/L) [1] | Flow (cfs) |
|---|---|---|
| 11/18/2010 | 2.84 | ** |
| 1/6/2011 | 1.08 | ** |
| 2/17/2011 | 0.93 | ** |
| 3/10/2011 | 0.884 | ** |
| 4/28/2011 | 1.75 | ** |
| 5/12/2011 | 6.19 | ** |
| 6/16/2011 | 5.65 | ** |
| 7/14/2011 | 10.5 | ** |
| 9/15/2011 | 19.7 | ** |
| 10/13/2011 | 30.7 (D) | ** |

[1]Chronic limit is 1.0 mg/L since aquatic life is adversely affected
(orange) Exceeds the acute limit
(pink) Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
D = Reanalyzed at a Higher Dilution

## 8.24 UT of Pond Creek 2.4 to 4.2

The pollutants addressed in this document for UT of Pond Creek 2.4 to 4.2 are *E. coli*, pH and cadmium. This segment is a second order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 2.56 square miles. There is one TMDL monitoring site in the subwatershed, DOW03011002, located at RM 2.6 with the drainage area of 2.18 square miles, see Figure 8.24.1 and Table 8.24.1. This subwatershed consists primarily of forest (52.1%) and grassland (17.9%), see Figure 8.24.2 and Table 8.24.2.

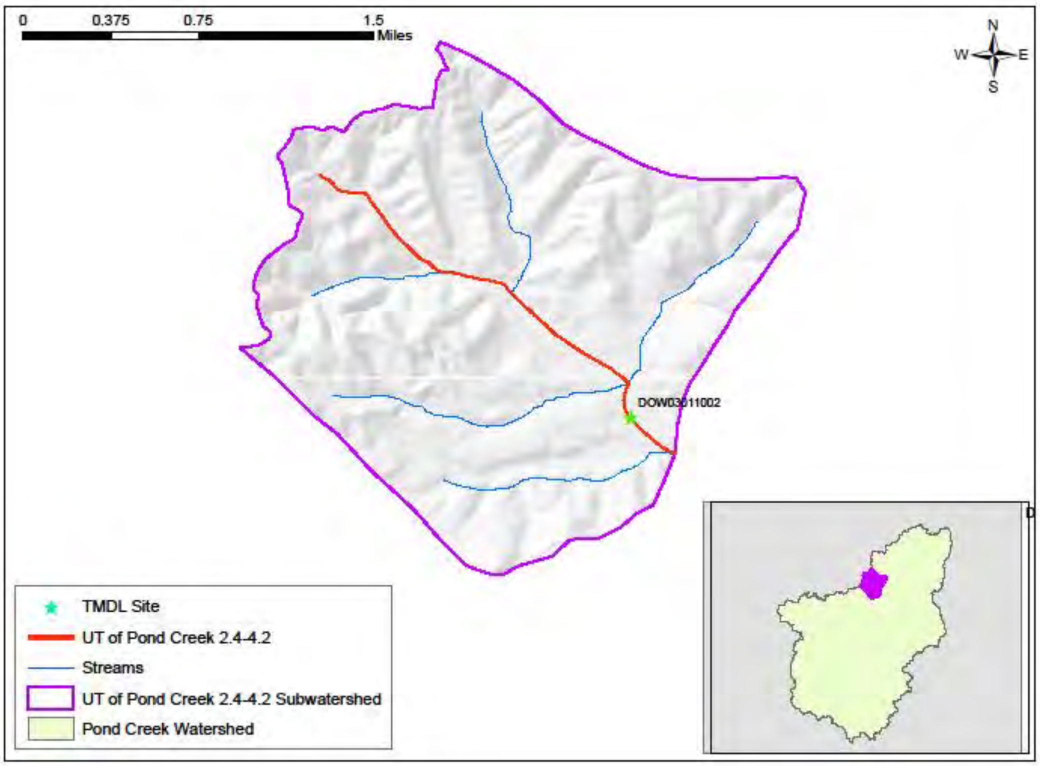


**Figure 8.24.1 TMDL Monitoring Location and Impaired Segment in the UT of Pond Creek 2.4 to 4.2 Subwatershed**

**Table 8.24.1 UT of Pond Creek 2.4 to 4.2 Segment/Subwatershed Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY501042-6.9_02 | UT of Pond Creek 2.4-4.2 | 2 | Muhlenberg | 2.56 | 1637 |

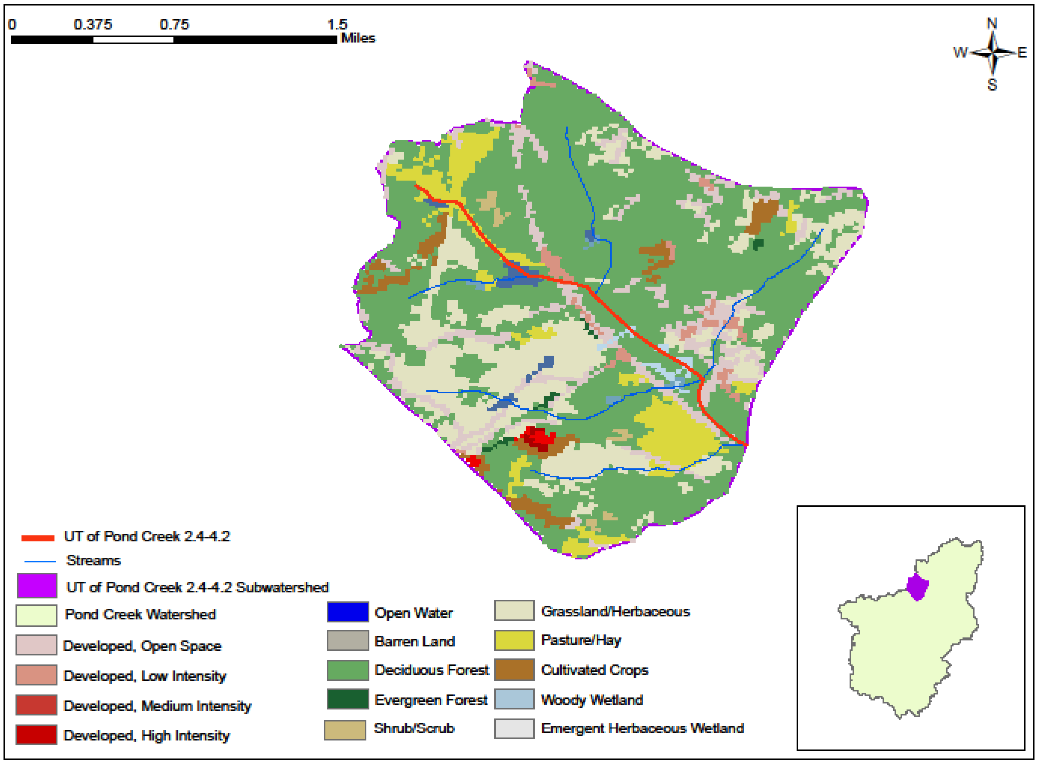


**Figure 8.24.2 Land Cover in the UT of Pond Creek 2.4 to 4.2 Subwatershed**

**Table 8.24.2 Land Cover within the UT of Pond Creek 2.4 to 4.2 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 0.27 | 170.1 | 10.4 |
| Agriculture | 0.24 | 152.8 | 9.3 |
| Forest | 1.33 | 853.3 | 52.1 |
| Barren Land | 0.22 | 139.7 | 8.5 |
| Grassland/Herbaceous | 0.46 | 293.1 | 17.9 |
| Wetlands | 0.01 | 8.4 | 0.5 |
| Water | 0.03 | 16.6 | 1.0 |
| Shrub/Scrub | 0.01 | 3.6 | 0.2 |

There is one inactive KPDES permittee in this subwatershed, see Figure 8.24.3 and Table 8.24.3. Although this inactive KPDES facility was active during the data collection period and may have contributed the impairments in the UT of Pond Creek 2.4 to 4.2, inactive KPDES will not receive a WLA.

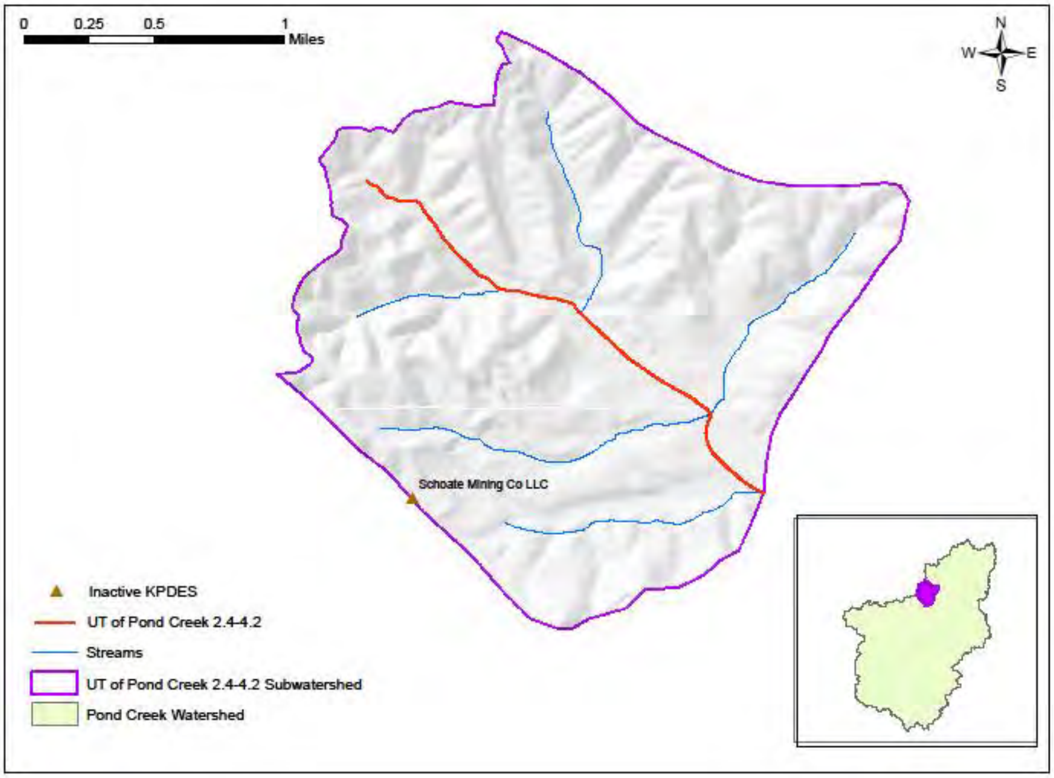


**Figure 8.24.3 KPDES Permittee in the Subwatershed**

**Table 8.24.3 KPDES Permittee in the Subwatershed**

| KPDES | Status | Permit Name | Latitude | Longitude | Pollutants with Discharge Limit |
|---|---|---|---|---|---|
| KYG045704 | Inactive | Schoate Mining Co LLC | 37.245000 | -87.108333 | pH, Iron |

There are no active KPDES mining permittees in this subwatershed, but the majority of this subwatershed is licensed mining areas, see Figure 8.24.4 (see Section 9.4.3 for more information). Table 8.24.4 to 8.24.6 8display *E. coli*, pH, cadmium and flow data collected by TMDL staff at DOW03011002.

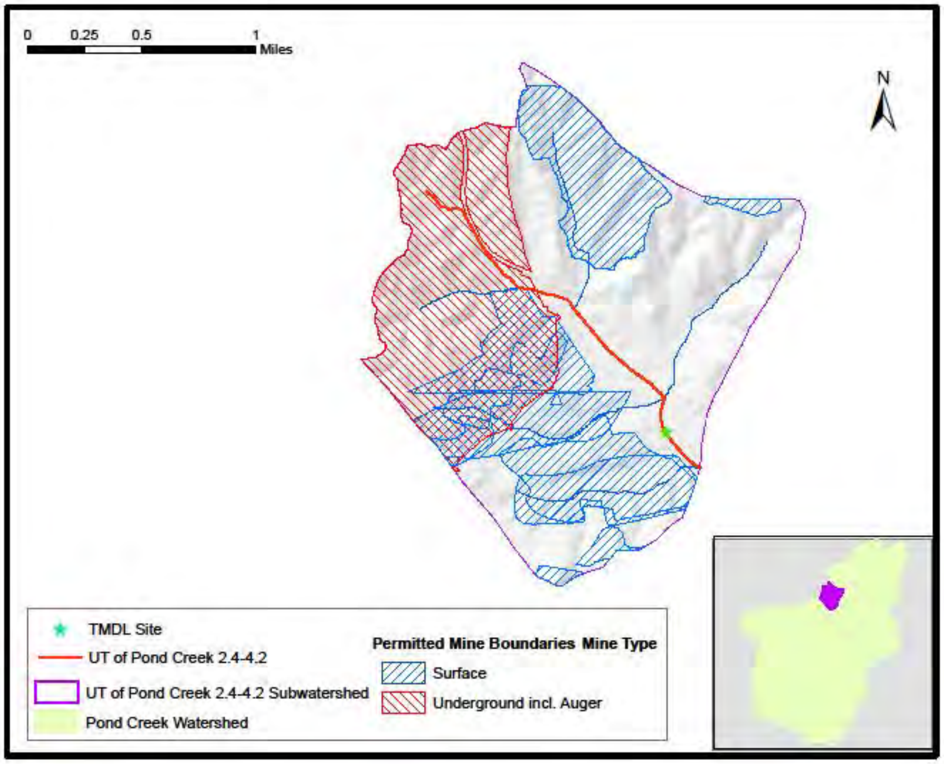


**Figure 8.24.4 Data from the Department of Natural Resources on Licensed Mine Areas in the Subwatershed**

**Table 8.24.4 *E. coli* and Flow Data, DOW03011002**

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 5/12/2011 | 365 | ** |
| 5/26/2011 | 2420 | ** |
| 6/16/2011 | 613 | ** |
| 6/23/2011 | 866 | ** |
| 7/14/2011 | 260 | ** |
| 7/28/2011 | 980 | ** |
| 8/11/2011 | 387 | ** |
| 9/15/2011 | 122 | ** |
| 9/29/2011 | 261 | ** |
| 10/13/2011 | 1120 | ** |
| 10/20/2011 | 101 | ** |

[shaded] Exceeds the *E. coli* limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

**Table 8.24.5 Cadmium, Hardness and Flow Data Collected at DOW03011002**

| Date | Cadmium (µg/L) | Hardness, Total (mg/L) | Cadmium Chronic Limit (µg/L) | Cadmium Acute Limit (µg/L) | Difference between the Cadmium Concentration and the Cadmium Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 11/18/2010 | 0.994 (J) | 708 | 1.15 | 15.60 | N/A | ** |
| 1/6/2011 | 1.06 | 478 | 0.86 | 10.46 | 0.20 | 1.788 |
| 2/17/2011 | 1.05 | 589 | 1.01 | 12.94 | 0.04 | ** |
| 3/10/2011 | 0.618 (J) | 300 | 0.61 | 6.52 | N/A | ** |
| 4/28/2011 | < 0.80 (U) | 305 | 0.62 | 6.63 | N/A | ** |
| 5/12/2011 | < 0.80 (U) | 652 | 1.09 | 14.35 | N/A | ** |
| 6/16/2011 | < 0.80 (U) | 1240 | 1.75 | 27.58 | N/A | ** |
| 7/14/2011 | < 0.80 (U) | 575 | 0.99 | 12.63 | N/A | ** |
| 8/11/2011 | < 0.80 (U) | 1030 | 1.52 | 22.84 | N/A | ** |
| 9/15/2011 | < 0.80 (U) | 992 | 1.48 | 21.98 | N/A | ** |
| 10/13/2011 | < 0.80 (U) | 644 | 1.08 | 14.17 | N/A | ** |
| 5/8/2013 | 0.4 | 424 | 0.79 | 9.26 | -0.39 | ** |
| 3/21/2013 | 0.72 | 252 | 0.54 | 5.46 | 0.18 | ** |
| 4/18/2013 | < 0.40 (U) | 600 | 1.02 | 13.19 | N/A | 1.588 |
| 6/26/2013 | < 0.50 (U) | 485 | 0.87 | 10.62 | N/A | 1.441 |
| 7/16/2013 | < 0.50 (U) | 471 | 0.85 | 10.31 | N/A | 1.080 |
| 8/6/2013 | < 0.50 (U) | 814 | 1.28 | 17.98 | N/A | 0.311 |
| 9/10/2013 | < 0.50 (U) | 684 | 1.12 | 15.06 | N/A | 0.338 |
| 10/9/2013 | < 0.50 (U) | 373 | 0.72 | 8.13 | N/A | 1.268 |
| 11/13/2013 | < 0.50 (U) | 643 | 1.07 | 14.15 | N/A | ** |
| 12/17/2013 | 0.25 | 518 | 0.92 | 11.36 | -0.67 | 1.383 |

(shaded) Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
D = Reanalyzed at a Higher Dilution
L = Exceeds MCL or Action Limit
U = Analyte Not Detected
N/A: Not Applicable

**Table 8.24.6 pH and Flow Data, DOW03011002**

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 11/18/2010 | 7.47 | ** |
| 1/6/2011 | 7.99 | 1.788 |
| 2/17/2011 | 7.79 | ** |

| Collection Date | *E coli* (colonies/100ml) | Discharge (cfs) |
|---|---|---|
| 3/10/2011 | 7.81 | ** |
| 4/28/2011 | 7.85 | ** |
| 5/12/2011 | 7.95 | ** |
| 5/26/2011 | 8.09 | ** |
| 6/16/2011 | 8.30 | ** |
| 6/23/2011 | 7.45 | ** |
| 7/14/2011 | 7.88 | ** |
| 7/28/2011 | 8.65 | ** |
| 8/11/2011 | 8.56 | ** |
| 9/15/2011 | 9.64 | ** |
| 9/29/2011 | 8.86 | ** |
| 10/13/2011 | 9.29 | ** |
| 10/20/2011 | 8.86 | ** |
| 5/8/2013 | 7.03 | ** |
| 3/21/2013 | 7.80 | ** |
| 4/18/2013 | 9.08 | 1.588 |
| 6/26/2013 | 7.64 | 1.441 |
| 7/16/2013 | 7.62 | 1.080 |
| 8/6/2013 | 8.07 | 0.311 |
| 9/10/2013 | 7.93 | 0.338 |
| 10/9/2013 | 7.64 | 1.268 |
| 11/13/2013 | 7.75 | ** |
| 12/17/2013 | 7.62 | 1.383 |

Exceeds the pH limit
** Unable to obtain flow because of water depth, swiftness, or lack of access

## 8.25 UT of Pond Creek 0.0 to 1.4

The pollutant addressed in this document for UT of Pond Creek 0.0 to 1.4 is cadmium. This segment is a second order stream based on the 1:24,000-scale NHD, with a total drainage area of approximately 3.08 square miles. There is one TMDL monitoring site in the subwatershed, DOW03011011, located at RM 0.85 with the drainage area of 2.59 square miles, see Figure 8.25.1 and Table 8.25.1. This subwatershed consists primarily of forest (51.4%), agricultural land (22.6%) and grassland (11.7%), see Figure 8.25.2 and Table 8.25.2.

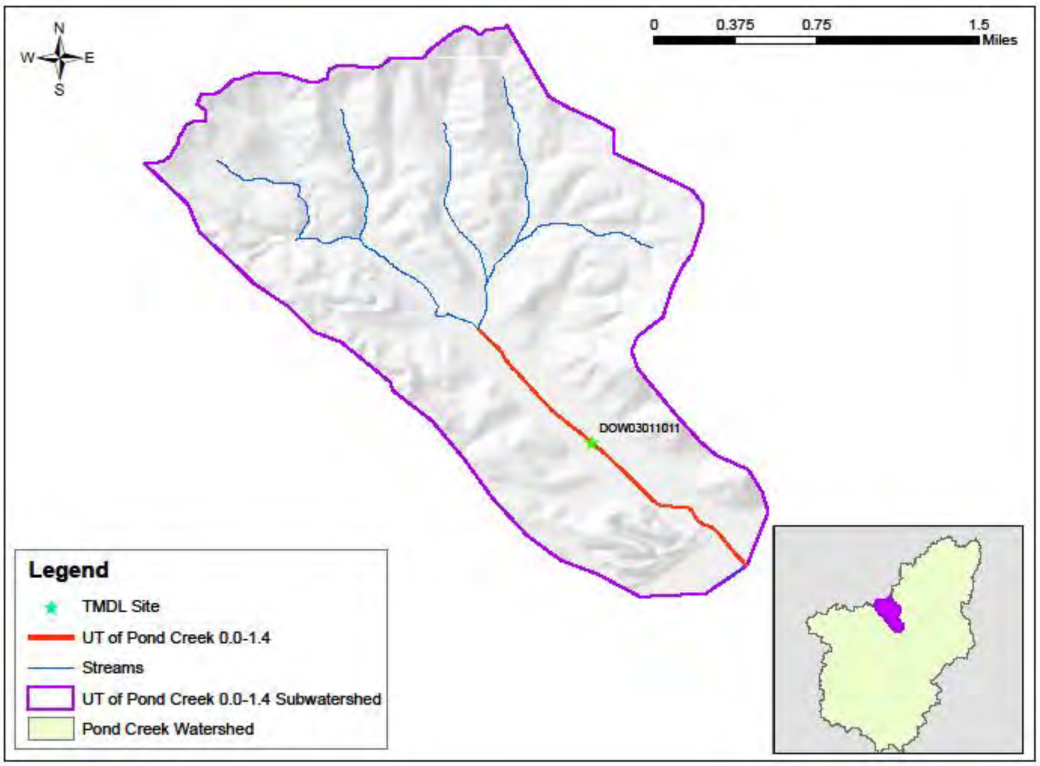


**Figure 8.25.1 TMDL Monitoring Location and Impaired Segment in the UT of Pond Creek 0.0 to 1.4 Subwatershed**

**Table 8.25.1 UT of Pond Creek 0.0 to 1.4 Segment/Subwatershed Information**

| GNIS Number | Stream Segment | Stream Order | County | Watershed Area (square mile) | Watershed Area (acres) |
|---|---|---|---|---|---|
| KY501042-11.1_01 | UT of Pond Creek 0.0 to 1.4 | 2 | Muhlenberg | 3.08 | 1974 |

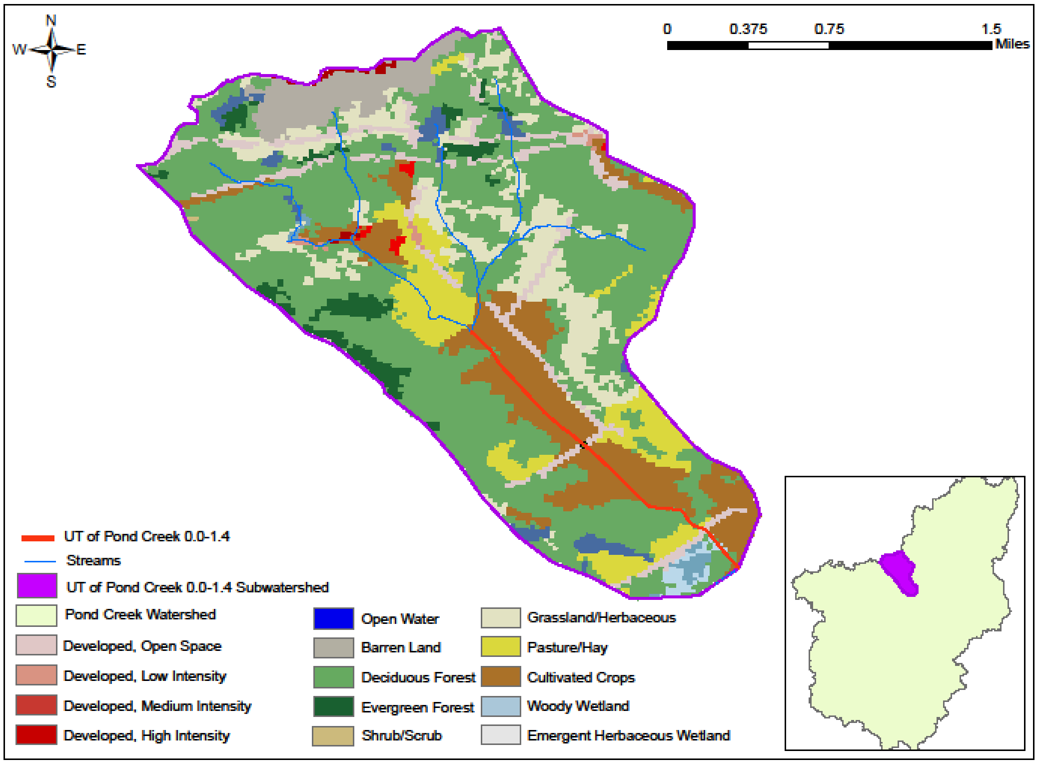


**Figure 8.25.2 Land Cover in the UT of Pond Creek 0.0 to 1.4 Subwatershed**

**Table 8.25.2 Land Cover within the UT of Pond Creek 0.0 to 1.4 Subwatershed**

| Land Cover | Square Miles | Acres | Percent (%) |
|---|---|---|---|
| Developed | 0.19 | 122.8 | 6.2 |
| Agriculture | 0.70 | 445.7 | 22.6 |
| Forest | 1.58 | 1013.8 | 51.4 |
| Barren Land | 0.17 | 107.7 | 5.5 |
| Grassland/Herbaceous | 0.36 | 231.8 | 11.7 |
| Wetlands | 0.02 | 11.6 | 0.6 |
| Water | 0.06 | 39.8 | 2.0 |
| Shrub/Scrub | 0.0005 | 0.3 | 0.02 |

There are two active and two inactive KPDES facilities with the pH and/or metals discharge limits, see Figure 8.25.3 and Table 8.25.3. Although those two inactive KPDES facilities were active during the data collection period and may have contributed to the impairments on the UT of Pond Creek 0.0 to 1.4, inactive KPDES will not receive a WLA.

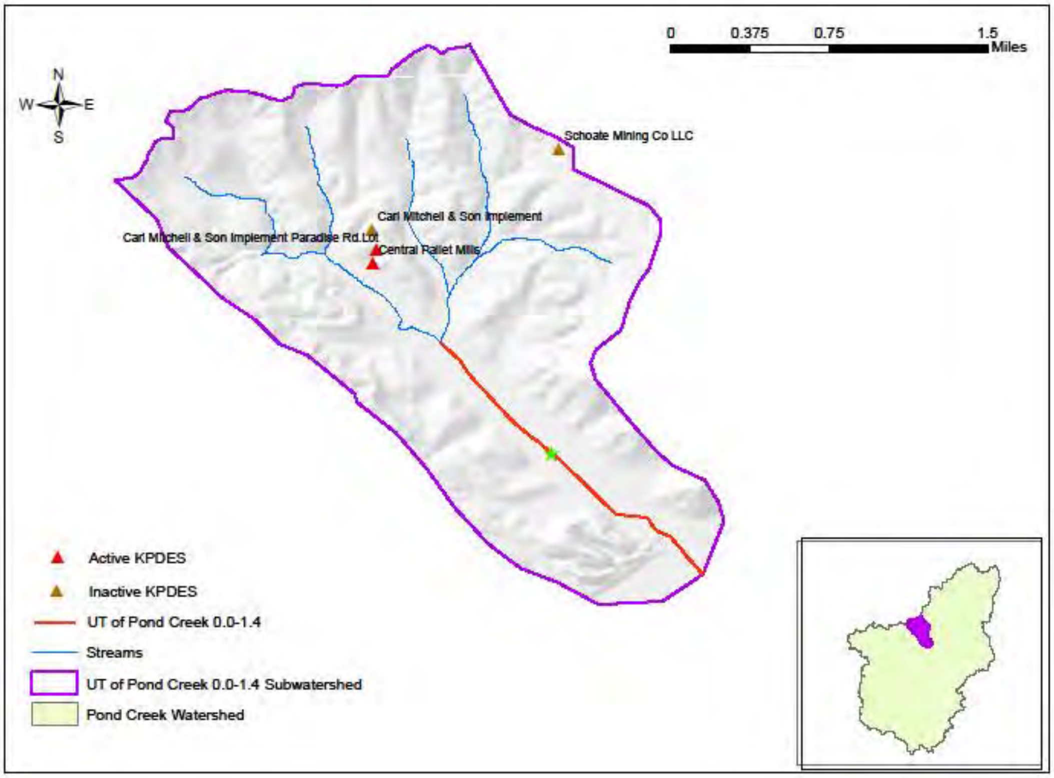


**Figure 8.25.3 KPDES Permittees in the Subwatershed**

**Table 8.25.3 KPDES Permittees in the Subwatershed**

| KPDES | Status | Permit Name | Latitude | Longitude | Pollutants with Discharge Limit |
|---|---|---|---|---|---|
| KYR003239 | Active | Central Pallet Mills | 37.237167 | -87.121083 | pH |
| KYR004015 | Active | Carl Mitchell & Son Implement Paradise Rd. Lot | 37.238014 | -87.120822 | pH |
| KYG045704 | Inactive | Schoate Mining Co | 37.245000 | -87.108333 | pH, Iron |
| KYR001665 | Inactive | Carl Mitchell & Son | 37.239428 | -87.121152 | pH |

There are no active KPDES mining permits in this subwatershed, but the majority of upstream subwatershed is licensed mining areas, see Figure 8.25.4 (see Section 9.4.3 for more information). Tables 8.25.4 displays cadmium and flow data collected by TMDL staff at DOW03011011.

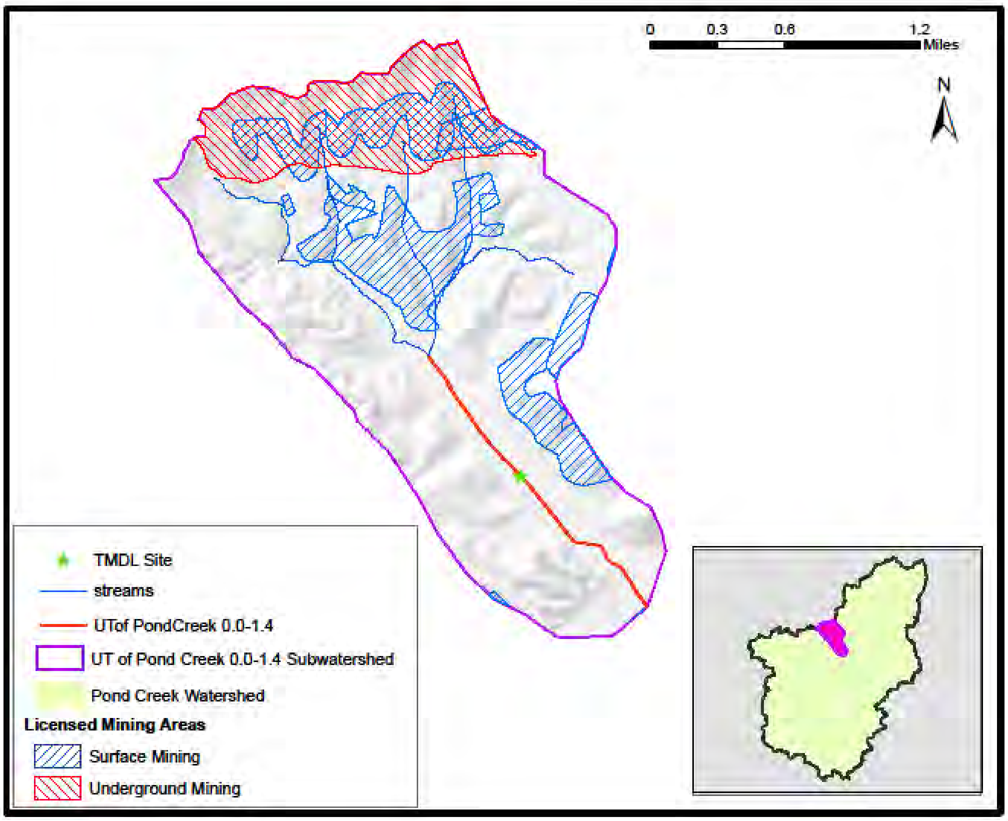


**Figure 8.25.4 Data from the Department of Natural Resources on Licensed Mining Areas in the Subwatershed**

**Table 8.25.4 Cadmium, Hardness and Flow Data Collected at DOW03011011**

| Date | Cadmium (µg/L) | Hardness, Total (mg/L) | Cadmium Chronic Limit (µg/L) | Cadmium Acute Limit (µg/L) | Difference between the Cadmium Concentration and the Cadmium Chronic Limit (µg/L) | Flow (cfs) |
|---|---|---|---|---|---|---|
| 11/17/2010 | 5.29 (J,D,L) | 1550 | 2.06 | 34.60 | N/A | ** |
| 1/5/2011 | 2.27 | 1080 | 1.58 | 23.97 | 0.69 | 1.835 |
| 2/16/2011 | 3.41 | 1080 | 1.58 | 23.97 | 1.83 | 1.794 |
| 3/9/2011 | < 8.0 (DU) | 326 | 0.65 | 7.09 | N/A | ** |
| 4/27/2011 | 1.9 | 269 | 0.56 | 5.83 | 1.34 | ** |
| 5/11/2011 | 2.22 | 1010 | 1.50 | 22.39 | 0.72 | ** |

(shaded) Exceeds the chronic limit
** Unable to obtain flow because of water depth, swiftness, or lack of access
D = Reanalyzed at a Higher Dilution
J = Estimated Value
L = Exceeds MCL or Action Limit
U = Analyte Not Detected
N/A: Not Applicable

# 9.0 Implementation Options

## 9.1 Watershed Plan

Section 303(e) of the Clean Water Act and 40 CFR Part 130, Section 130.5, require states to have a continuing planning process (CPP) composed of several parts specified in the Act and the regulation. The CPP provides an outline of agency programs and the available authority to address water issues. Under the CPP umbrella, the Watershed Management Branch of KDOW will provide technical support and leadership with developing and implementing watershed plans to address water quality and quantity problems and threats. Developing watershed plans enables more effective targeting of limited restoration funds and resources, thus improving environmental benefit, protection and recovery.

Watershed plans provide an integrative approach for identifying and describing how, when, who and what actions should be taken in order to meet water quality standards. At this time, a comprehensive watershed restoration plan for the Pond Creek watershed has not been developed. This TMDL may assist with developing a detailed watershed plan to guide watershed restoration efforts.

A watershed plan for the Pond Creek watershed should address both point and nonpoint sources of pollution in the watershed and should build on existing efforts as well as evaluate new approaches. A watershed plan should incorporate all available restoration and protection mechanisms. A comprehensive watershed plan should consider both voluntary and regulatory approaches to meet water quality standards. When such a plan is developed, pollutant trading may be a viable management strategy to consider for meeting the TMDL load reduction goals.

## 9.2 Kentucky Watershed Management Framework

A watershed management framework approach to water quality management was adopted by the KDOW in 1998. The plan divides Kentucky's major drainage basins into five groups of basins which are cycled through a five year staggered process which involves monitoring, assessment, prioritization, plan development, and plan implementation. As part of the process, a basin coordinator is assigned to each river basin to work with the citizens of the basin to develop a local watershed management team associated with each priority watershed. For more information about the river basins see: http://water.ky.gov/watershed/Pages/default.aspx

### 9.3 Non-Governmental Organizations

There are several Non-Governmental Organizations that may be operating in the Pond Creek watershed that may help to implement the TMDL, particularly with regard to nonpoint source issues. These organizations include Watershed Watch groups in Kentucky and Kentucky Waterways Alliance.

#### 9.3.1 Watershed Watch in Kentucky

Watershed Watch is a citizen's water monitoring effort that relies exclusively on volunteers to provide administration, training, and volunteer and equipment coordination. The volunteers measure basic parameters of stream health to determine whether streams meet important "uses" under the Clean Water Act including aquatic life, human recreation, and drinking water.

Several water quality measurements are taken annually by Watershed Watch groups. Volunteers collect physical measurements, such as temperature, pH, dissolved oxygen, and conductivity. Stream monitoring may also include macroinvertebrate and habitat assessments. Data from annual monitoring is routinely used to help identify problems in the watershed, and assist with prioritizing streams for restoration and protection activities.

For more information about Watershed Watch see: http://water.ky.gov/wsw/Pages/default.aspx.

#### 9.3.2 Kentucky Waterways Alliance

The formation of Kentucky Waterways Alliance (KWA) was the result of a series of meetings sponsored by the Kentucky Environmental Quality Commission. The KWA has a mission to protect and restore Kentucky's waterways and their watersheds through alliances for watershed stewardship. This includes strengthening community and governmental stewardship for the restoration and preservation of Kentucky's water resources. The Alliance promotes networking, communication and mutual support among groups, government agencies, and businesses working on waterway issues.

For more information about KWA see: http://www.kwalliance.org.

### 9.4 Mining Related Implementations

#### 9.4.1 Kentucky Division of Abandoned Mine Lands

The Kentucky Division of Abandoned Mine Lands (AML) within KDNR is charged with reclaiming land affected by mining before the passage of SMCRA. SMCRA Title IV authorized a reclamation fee which is charged on every ton of coal mined in the United States since 1977 and continuing through 2021. The money collected is kept in an account called the Abandoned Mine Reclamation Fund. SMCRA Title IV sets priorities for reclamation: Priority 1 and 2 are related to human health and safety. Priority 3 is AMD. The universe of AML projects also includes those post-SMCRA projects funded by forfeit bond money. AML projects can involve responding to emergencies such as threats to human health or imminent loss of property, often from landslides or subsidences. However, AML funds are also spent on water line extensions to provide drinking water to communities whose groundwater supply has been impacted by mining. Other projects include closing mine openings, and all facets of work concerning AMD, which may include covering refuse (i.e., rejected coal), installing treatment ponds, eliminating rills and gullies, armoring channels, liming and re-vegetation. Pond Creek area has been funded for AML projects since early 1980s; Table 9.1 and Figures 9.1 to 9.3 present the AML projects dollars spends and their locations. Bond forfeiture sites are not shown.

**Table 9.1 AML Projects within the Pond Creek Watershed**

| Project Name | Cost, Thousands | Awarded Year |
|---|---|---|
| Bilbro Slide | 50 | 1983 |
| Depoy | 1647 | 1984 |
| Pond Creek - Browder | 450 | 1984 |
| Pond Creek - Dboro 2 | 79 | 1986 |
| Pond Creek - Dboro II | 241 | 1985 |
| Pond Creek - Dboro IMP | 1937 | 1984 |
| Pond Creek - Luzerne | 615 | 1986 |
| Pond Creek - Nonnell | 435 | 1985 |
| Pond Creek - Wilson Prop | 35 | 1987 |
| Pond Creek - Beech | 608 | 1985 |
| Pond Creek - Caney IMP | 1363 | 1986 |
| Pond Creek - Impoundments | 2040 | 1985 |
| Phoenix (4) | 902 | 1987 |
| Phoenix County Park | 347 | 1989 |
| Browder Trestle | 4 | * |
| Ebenezer AMD | 2924 | 2012 |
| Luzerne I AMD | 678 | 2010 |
| Luzerne II AMD | 221 | 2010 |
| Drakesboro Tipple | 134 | 2003 |
| Caney Creek Mine | 85 | 2014 |
| Bryan -Piper Highwalls | 369 | 2008 |
| HWY431 AMD | 83 | 2011 |
| *: No Information | | |

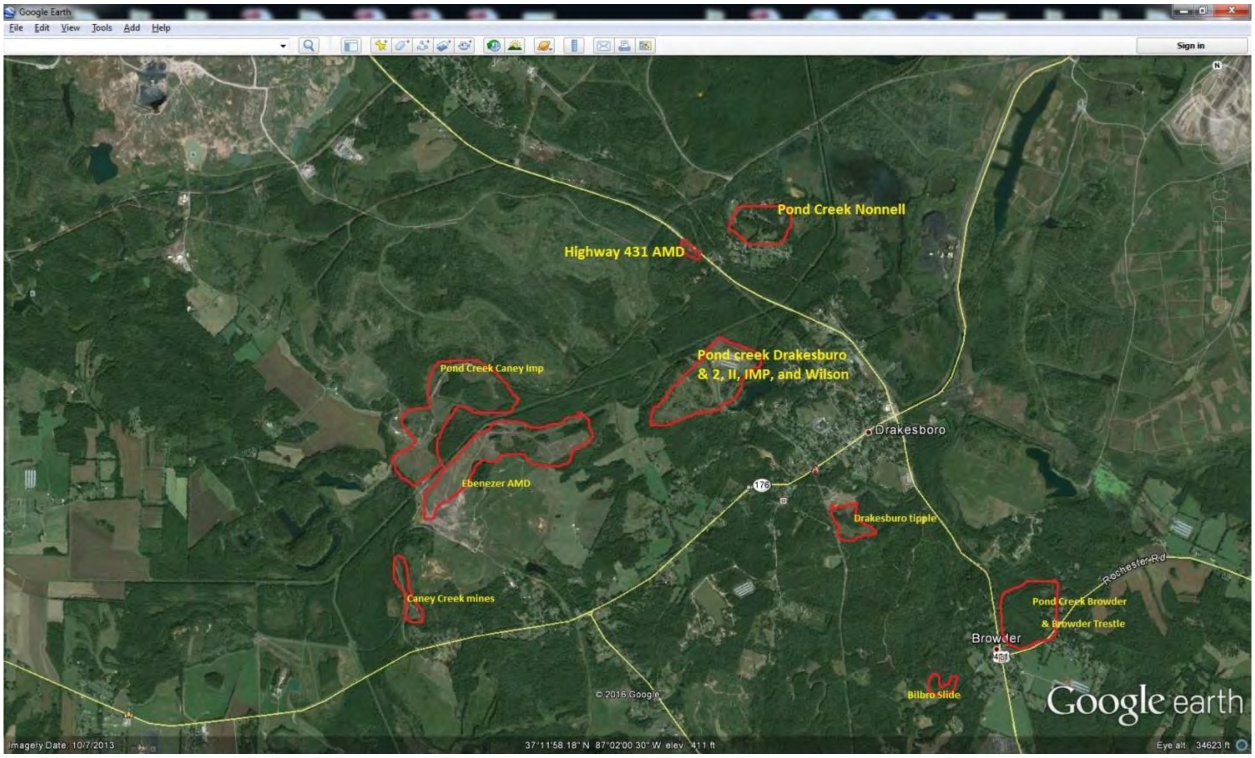


**Figure 9.1 AML Projects within the Pond Creek Watershed – Part1**

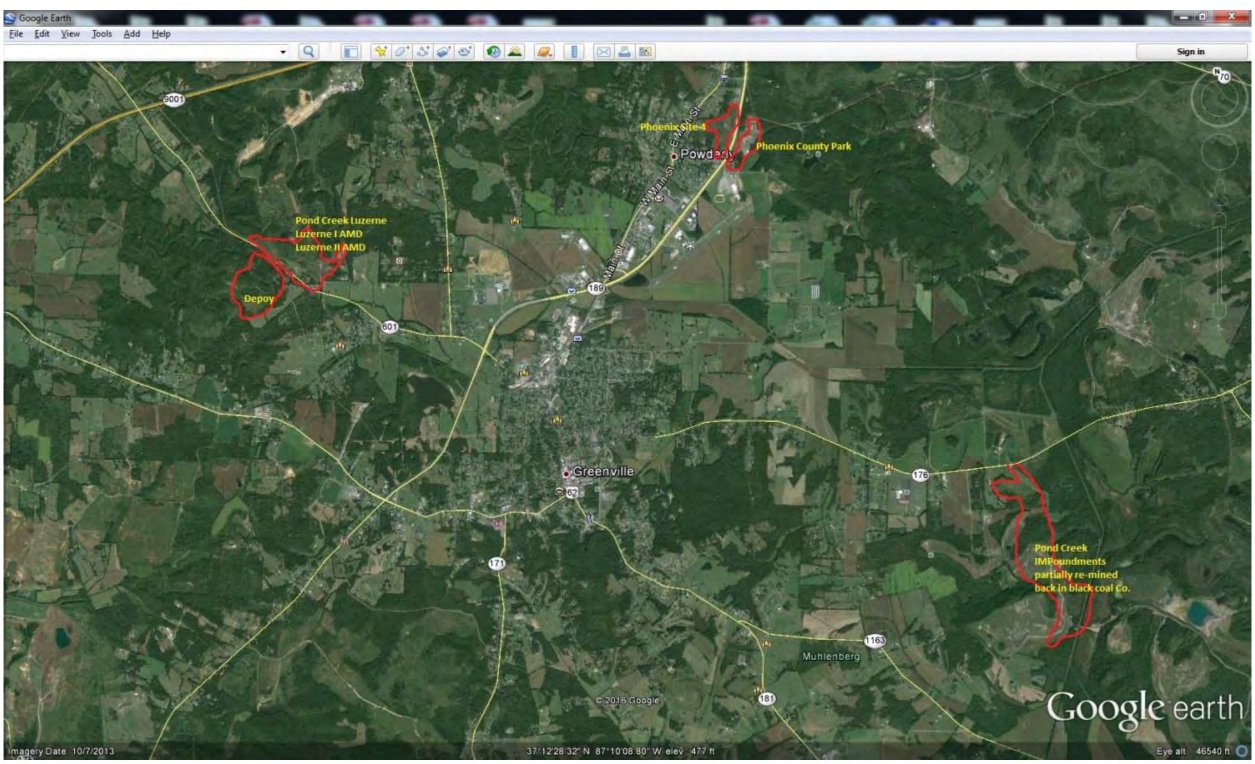


**Figure 9.2 AML Projects within the Pond Creek Watershed – Part II**

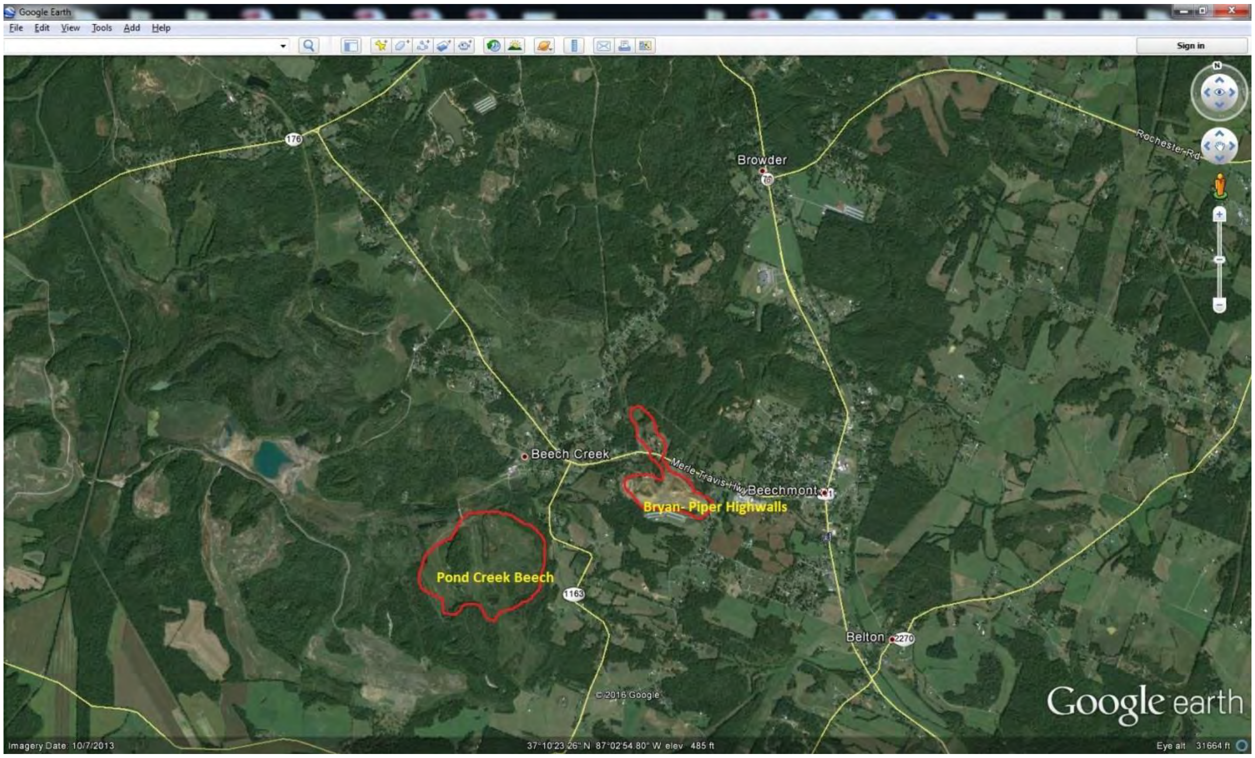


**Figure 9.3 AML Projects within the Pond Creek Watershed – Part III**

### 9.4.2 Kentucky Division of Mine Permits

Coal mining in Kentucky requires a permit from the KDMP within KDNR as mandated by Title V of the 1977 SMCRA, for which Kentucky has primacy, or primary responsibility for regulation of surface coal mining, the surface effects of underground mining, as well as mine reclamation. Prior to SMCRA, there were no environmental requirements for mines relative to earth disturbance. SMCRA requirements were phased in beginning in 1978: KDOW *et al.*, (2003) states “Mining permits [as opposed to KPDES permits] in Kentucky are classified on the basis of whether the original permit was issued prior to May 3, 1978 (pre-law permit), after January 18, 1983 (post-Kentucky primacy) or in-between these dates (interim period).” Under SMCRA the regulatory standards for issuance of a permit require that the operation be designed to prevent adverse changes in downstream water quantity or quality sufficient to cause material damage (401 KAR 8:10, Section 14, (3)). The permit review is designed to place burden on the applicant to either demonstrate that no potential source of degradation will be associated with operations or that operations have been designed to appropriately treat or remediate any adverse impact.

A SMCRA permit allows the earth disturbance associated with mining, requires measures to preclude offsite impacts during mining, and requires land reclamation at the conclusion of mining, but by itself does not allow the discharge of mine wastewater to waters of the

Commonwealth; this requires a separate KPDES permit, see Section 5.1.2.2. Although KDMP permits mines from an environmental perspective, the permit also requires safe mine operation.

Under SMCRA, KDMP cannot issue permits for mining operations that will knowingly create AMD. The primary goal is to identify and isolate potential acid-producing materials and target them for special handling to prevent acid production. Permit reviews conduct acid-base accounting of the levels of potential acidity and the neutralization potential of each stratum from submitted corehole data to prevent the production of AMD. All runoff from coal mining performed under SMCRA (excepting small areas qualifying for exemption or alternate controls) is captured in a pond where it is monitored. Where the monitoring reflects the presence of AMD despite these controls, the runoff is treated then discharged to surface water, see Section 5.1.2.2.

Environmental monitoring is also a requirement. SMCRA permit applicants must submit 6 water quality samples collected throughout a one-year period that capture both high and low flow events. SMCRA permittees must also collect quarterly water quality monitoring results (surface and ground water) beginning when mining commences through complete bond release. Depending on affected stream assessments, permittees may also be required to conduct benthic macroinvertebrate and/or fish surveys and calculate appropriate biological indices, such as the MBI and KIBI (Kentucky Index of Biotic Integrity) for fish. This sampling is independent of that required under the facility's KPDES permit.

Also, SMCRA permits regulate the production of coal to minimize environmental impacts following cessation of mining activities. Coal spoils or leavings that are expected to produce AMD when exposed to water and oxygen must be addressed by special handling plans: examples include burying spoils below the permanent water table, or encapsulating them within the mine backfill. For these reasons, KDOW believes most of the pollution in the watershed is due to mining operations that existed prior to the passage of SMCRA, or 'pre-law' mines.

As stated, KDMP issues permits related to earth disturbance and reclamation, and KDMP's permit numbers are 7-digit numbers in the format XXX-XXXX; these are commonly known as the KDNR permit number, see Appendix B for additional information. Each KDNR permit number is typically associated with one KPDES permit. KDMP maintains archived files by permit number; each file contains information relative to a single permit, including the application, final permit, reclamation plans, bond information, and associated data and maps. Any enforcement activity is also included. While the information in these files has historically been submitted and stored on paper, KDMP now requires new submissions to be made electronically. Information specific to KDMP permitting can be obtained from the Surface Mining Information System (SMIS), at http://minepermits.ky.gov/Pages/SurfaceMiningInformationSystem.aspx. Using the information in SMIS, KDMP publishes and maintains two types of GIS layer files of licensed coal mining areas available on the KyGeoportal (http://kygisserver.ky.gov/geoportal/catalog/main/home.page). One layer file shows all licensed mining areas, active and inactive, and Figure 9.2 shows this layer clipped with the Pond Creek watershed boundary. The other shows only the active mining permits (issued by KDMP), see Figure 3.11 which is clipped with the Pond Creek watershed boundary. While the KPDES permit numbers associated with the KDNR permit numbers are not included in the layers, within

KDOW the KPDES permit number is normally associated with the KDMP permit number within the TEMPO database.

### 9.4.3 Kentucky Division of Mine Reclamation and Enforcement

The Division of Mine Reclamation and Enforcement (DMRE) within KDNR is responsible for mine inspection, enforcement, and bond release/forfeiture. KDOW *et al.,* (2003) also state, "All permits are secured through reclamation bonds. A reclamation bond is a financial document submitted to the KDNR prior to mine permit issuance. A bond guarantees mining and reclamation operations will be conducted by mining companies according to regulations and the terms of the approved permit. If a coal company cannot comply with these conditions, the bond is "forfeited" (paid to the KDNR) for eventual use by the Division of Abandoned Mine Lands in reclaiming the mined area. Reclamation bonds may be submitted in the forms of cash, certificate of deposit, letter of credit or surety (insurance policy).

A reclamation bond may be returned to a coal company by either of two methods: administrative or phase (on-ground reclamation). Administrative releases occur when new bonds are substituted for the original bonds. Administrative releases are also given for areas of a mine site that are permitted but never disturbed by mining or for areas that are included under a second more recently issued permit.

Phase releases occur in three stages and according to specific reclamation criteria: Phase One – all mining is complete, and backfilling, grading and initial seeding of mined areas has occurred. Phase Two – a minimum of two years of growth on vegetated areas since initial seeding, the vegetation is of sufficient thickness to prevent erosion and pollution of areas outside the mine area with mine soils, and any Permanent water impoundments have met specifications for future maintenance by the landowner. Phase Three – a minimum of five years of vegetative growth since initial seeding and the successful completion of reclamation operations in order for the mined area to support the approved post-mining land use. Up to 60 percent of the original bond amount is released at phase one. An additional 25 percent is returned at phase two, with the remainder of the reclamation bond released at phase three. Once a permit is released and the reclamation bond returned, the state cannot require additional remediation action by the mining company unless it is determined that fraudulent documentation was submitted as part of the remediation process." Bonds are not released if the water quality does not meet WQCs.

Figure 9.4 displays the licensed mining areas within the Pond Creek watershed from KDNR/KDMP, and Table 9.2 presents their status (as of June 2016).

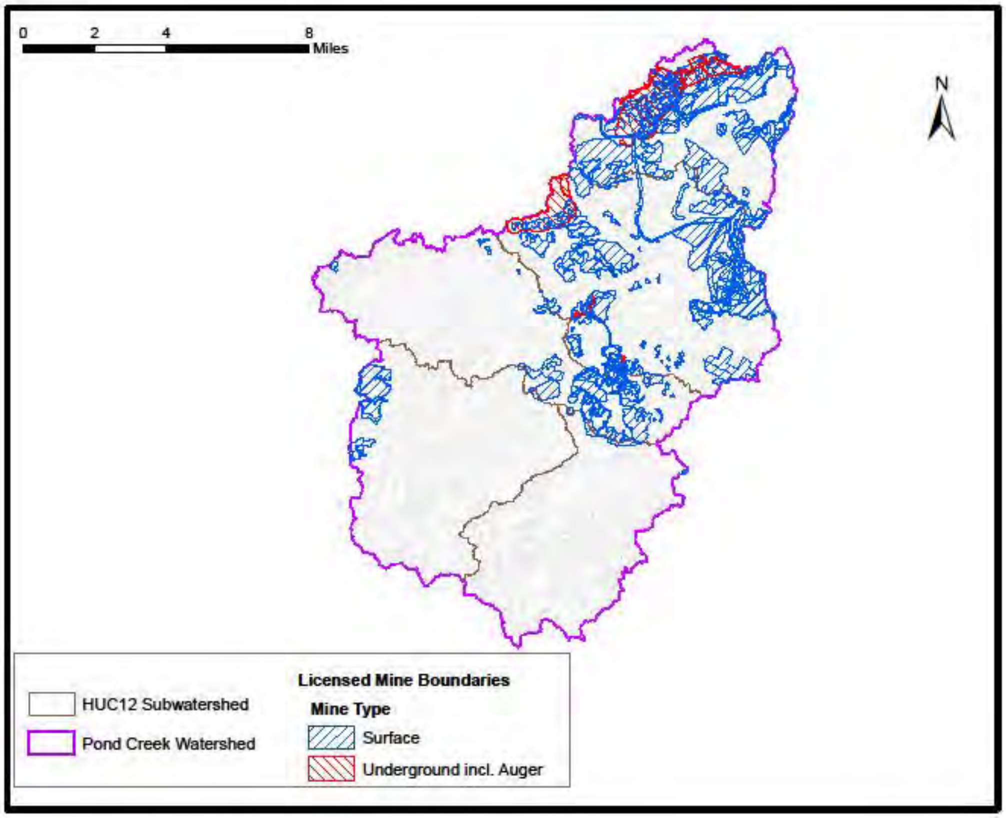


**Figure 9.4 Data from the Department of Natural Resources on Licensed Mine Areas in the Pond Creek Watershed**

**Table 9.2 Data from the Department of Natural Resources on Licensed Mine Areas in the Pond Creek Watershed**

| KDNR Permit # | Mine Status(1) | Permit Name | Active/Inactive | Date Issued | Permit Type | Original Permit # |
|---|---|---|---|---|---|---|
| 2890133 | RC | West Ken Coal Corp | Released | 12/9/1974 | Interim | 2890133 |
| 2890167 | RC | Peabody Coal Company | Released | 7/8/1976 | Interim | 2890167 |
| 2890352 | RC | Peabody Coal Company | Released | 6/22/1979 | Interim | 2890352 |
| 2890354 | RC | Badgett Mine Stripping | Released | 2/14/1978 | Interim | 2890354 |
| 0890021 | RC | Peabody Coal Company | Released | 12/1/1978 | Interim | 890021 |
| 0890025 | RC | Peabody Coal Company | Released | 4/20/1979 | Interim | 890025 |
| 0890026 | RC | West Ken Coal Corp | Released | 6/26/1979 | Interim | 890026 |
| 0890033 | RC | West Ken Coal Corp | Released | 2/28/1980 | Interim | 890033 |
| 0890034 | RC | Arch On The Green Inc | Released | 4/1/1980 | Interim | 890034 |
| 0890038 | RC | Peabody Coal Company | Released | 7/1/1980 | Interim | 890038 |
| 0890043 | RC | Peabody Coal Company | Released | 10/14/1980 | Interim | 890043 |
| 0890044 | RC | West Ken Coal Corp | Released | 12/11/1980 | Interim | 890044 |

| KDNR Permit # | Mine Status[(1)] | Permit Name | Active/Inactive | Date Issued | Permit Type | Original Permit # |
|---|---|---|---|---|---|---|
| 0890045 | RC | Arch On The Green Inc | Released | 5/29/1981 | Interim | 890045 |
| 0890046 | RC | Pond Creek Coal Co Inc | Released | 12/11/1981 | Interim | 890046 |
| 0890048 | RC | Gibraltar Coal Corp | Released | 11/11/1981 | Interim | 890048 |
| 0897000 | RC | Peabody Coal Company | Released | 3/26/1979 | Interim | 897000 |
| 577876X | - | - | - | - | - | - |
| 113476X | - | - | - | - | - | - |
| 118367X | - | - | - | - | - | - |
| 282572X | RC | Thornberry Const Co Inc | Released | 3/5/1973 | Pre Law | 282572X |
| 282574X | FF | Thornberry Const Co Inc | Released | 1/14/1975 | Pre Law | 282574X |
| 2897005 | RC | Peabody Coal Company | Released | 11/27/1979 | Interim | 2897005 |
| 8890107 | RC | Andalex Resources Inc | Released | 5/4/2000 | Permanent | 890026 |
| 530976X | RC | Amax Coal Co | Released | 1/5/1977 | Pre Law | 530976X |
| 561676X | FF | Thornberry Const Co Inc | Released | 4/15/1977 | Pre Law | 561676X |
| 16463 | - | - | - | - | - | - |
| 16464 | - | - | - | - | - | - |
| 16465 | - | - | - | - | - | - |
| 16469 | - | - | - | - | - | - |
| 1865 | - | - | - | - | - | - |
| 1866 | - | - | - | - | - | - |
| 1867 | - | - | - | - | - | - |
| 1868 | - | - | - | - | - | - |
| 1869 | - | - | - | - | - | - |
| 1870 | - | - | - | - | - | - |
| 1873 | - | - | - | - | - | - |
| 200968X | - | - | - | - | - | - |
| 203369X | - | - | - | - | - | - |
| 203473X | - | - | - | - | - | - |
| 203474X | - | - | - | - | - | - |
| 203475X | - | - | - | - | - | - |
| 210171X | - | - | - | - | - | - |
| 268771X | - | - | - | - | - | - |
| 268774X | - | - | - | - | - | - |
| 271171X | - | - | - | - | - | - |
| 277372X | - | - | - | - | - | - |
| 336274X | - | - | - | - | - | - |
| 40763 | - | - | - | - | - | - |
| 40765 | - | - | - | - | - | - |
| 40766 | - | - | - | - | - | - |
| 40767 | - | - | - | - | - | - |

| KDNR Permit # | Mine Status[1] | Permit Name | Active/Inactive | Date Issued | Permit Type | Original Permit # |
|---|---|---|---|---|---|---|
| 40768 | - | - | - | - | - | - |
| 40769 | - | - | - | - | - | - |
| 40770 | - | - | - | - | - | - |
| 40771 | - | - | - | - | - | - |
| 40773 | - | - | - | - | - | - |
| 45367 | - | - | - | - | - | - |
| 597577X | FF | Thornberry Const Co Inc | Released | 7/11/1977 | Pre Law | 597577X |
| 637777X | RC | Amax Coal Co | Released | 11/7/1977 | Pre Law | 637777X |
| 642577X | RC | Amax Coal Co | Released | 11/16/1977 | Pre Law | 642577X |
| 8890162 | RC | Armstrong Coal Company Inc | Active | 6/18/2013 | Permanent | 8890007 |
| 710069X | - | - | - | - | - | - |
| 74864X | - | - | - | - | - | - |
| 74865 | - | - | - | - | - | - |
| 74866 | - | - | - | - | - | - |
| 74867 | - | - | - | - | - | - |
| 74868 | - | - | - | - | - | - |
| 74872 | - | - | - | - | - | - |
| 74873 | - | - | - | - | - | - |
| 74874 | - | - | - | - | - | - |
| 74875 | - | - | - | - | - | - |
| 87163 | - | - | - | - | - | - |
| 8890012 | RC | Peabody Coal Company | Released | 10/13/1983 | Permanent | 8890012 |
| 8890016 | RC | West Ken Coal Corp | Released | 1/30/1984 | Permanent | 8890016 |
| 8890032 | RC | Peabody Coal Company, LLC | Released | 8/30/1985 | Permanent | 8890032 |
| 8890035 | RC | West Ken Coal Corp | Released | 2/6/1986 | Permanent | 8890035 |
| 8890037 | RC | Apogee Coal Company | Released | 3/10/1986 | Permanent | 8890037 |
| 8890057 | RC | Crown Energy Corp | Released | 1/19/1990 | Permanent | 8890038 |
| 8890040 | RC | West Ken Coal Corp | Released | 7/17/1987 | Permanent | 8890040 |
| 8890041 | RC | West Ken Coal Corp | Released | 7/17/1987 | Permanent | 8890041 |
| 8890043 | RC | West Ken Coal Corp | Released | 7/15/1987 | Permanent | 8890043 |
| 8890045 | RC | Taylor/Thomson-Joint Venture | Released | 7/15/1988 | Permanent | 8890045 |
| 8890046 | FF | Pond Creek Coal Co Inc | Released | 1/11/1989 | Permanent | 8890046 |
| 8890049 | RC | West Ken Coal Corp | Released | 12/21/1988 | Permanent | 8890049 |
| 8890051 | RC | Taylor/Thomson-Joint Venture | Released | 8/25/1989 | Permanent | 8890051 |
| 8890053 | RC | Crown Energy Corp | Released | 12/8/1989 | Permanent | 8890052 |
| 8890061 | RC | Canyon Coals Inc | Released | 5/3/1990 | Permanent | 8890061 |
| 8890062 | FF | Beech Creek Energy Inc | Released | 4/4/1991 | Permanent | 8890062 |
| 8890066 | RC | Muhlenberg Coals Inc | Released | 1/30/1991 | Permanent | 8890066 |

| KDNR Permit # | Mine Status[1] | Permit Name | Active/Inactive | Date Issued | Permit Type | Original Permit # |
|---|---|---|---|---|---|---|
| 8890067 | RC | Black Magic Resources Inc | Released | 1/30/1991 | Permanent | 8890067 |
| 8890069 | FF | Pond Creek Coal Co Inc | Released | 6/27/1991 | Permanent | 8890069 |
| 8890071 | RC | Hawkins/Thomson Partnership | Released | 9/24/1992 | Permanent | 8890071 |
| 8890076 | RC | Canyon Coals Inc | Released | 11/4/1993 | Permanent | 8890076 |
| 8890079 | RC | Friendship Energy Inc | Released | 11/18/1994 | Permanent | 8890076 |
| 8890084 | FF | Beech Creek Energy Inc | Released | 11/20/1995 | Permanent | 8890084 |
| 8890092 | RC | Beech Creek Energy Inc | Released | 12/3/1996 | Permanent | 8890092 |
| 8890101 | RC | Marine Coal Sales Company | Released | 12/22/1998 | Permanent | 8890101 |
| 8890138 | P2 | Armstrong Coal Company Inc | Released | 8/24/2007 | Permanent | 8890032 |
| 8890138 | P2 | Armstrong Coal Company Inc | Released | 8/24/2007 | Permanent | 8890032 |
| 8890142 | RC | Cyprus Creek Land Company | Released | 9/29/2008 | Permanent | 8890007 |
| 8890150 | VF | C & R Coal Company Inc | Released | 6/9/2009 | Permanent | 8890092 |
| 8890151 | VF | C & R Coal Company Inc | Released | 6/8/2009 | Permanent | 8890124 |
| 8890151 | VF | C & R Coal Company Inc | Released | 6/8/2009 | Permanent | 8890124 |
| 8890152 | VF | C & R Coal Company Inc | Released | 6/4/2009 | Permanent | 8890126 |
| 8890153 | D6 | Oxford Mining Company-Kentucky LLC | Active | 6/25/2010 | Permanent | 8890153 |
| 8890155 | D6 | Oxford Mining Company-Kentucky LLC | Active | 1/27/2010 | Permanent | 8890112 |
| 8890156 | A2 | Oxford Mining Company-Kentucky LLC | Released | 3/25/2010 | Permanent | 8890114 |
| 8895008 | RC | Peabody Coal Company | Released | 3/8/1991 | Permanent | 895003 |
| 8898001 | RC | West Ken Coal Corp | Released | 8/24/1984 | Permanent | 8898001 |
| 8899001 | RC | West Ken Coal Corp | Released | 2/17/1984 | Permanent | 8899001 |
| 8899003 | RC | Peabody Coal Company | Released | 11/7/1989 | Permanent | 8899003 |
| 8899005 | A1 | Armstrong Coal Company Inc | Active | 4/6/2011 | Permanent | 8899005 |
| 8890133 | RC | Schoate Mining Co LLC | Released | 9/27/2006 | Permanent | 8890101 |
| 8897006 | RC | Friendship Energy Inc | Released | 2/3/1995 | Permanent | 8897004 |
| 8895014 | AP | Armstrong Coal Company Inc | Active | 4/24/2007 | Permanent | 895003 |
| 8897011 | A1 | Armstrong Coal Company Inc | Active | 7/23/2013 | Permanent | 8897011 |
| 8890139 | P1 | Armstrong Coal Company Inc | Active | 7/30/2007 | Permanent | 8890011 |
| 8890060 | FF | Pond Creek Coal Co Inc | Released | 2/23/1990 | Permanent | 8890049 |
| 8890063 | FF | Pond Creek Coal Co Inc | Released | 2/4/1991 | Permanent | 8890040 |
| Unknown | - | - | - | - | - | - |
| Unknown | - | - | - | - | - | - |
| Unknown | - | - | - | - | - | - |
| 8890093 | RC | Beech Creek Energy Inc | Released | 3/4/1996 | Permanent | 8890093 |
| 8890093 | RC | Beech Creek Energy Inc | Released | 3/4/1996 | Permanent | 8890093 |
| 8895014 | AP | Armstrong Coal Company Inc | Active | 4/24/2007 | Permanent | 895003 |
| [1] Mine Status Codes: | | | | | | |

| KDNR Permit # | Mine Status(1) | Permit Name | Active/Inactive | Date Issued | Permit Type | Original Permit # |
|---|---|---|---|---|---|---|
| A1 = Active, Currently Being Mined.<br>A2 = Coal Removal Complete, Reclamation Action Only<br>AP = Actively Producing Coal<br>D6 = Six-month Reclamation Deferred<br>FF = Final Forfeiture.<br>O1 = Active Permits in Forfeiture<br>P1 = Phase I Release<br>P2 = Phase 2 Release<br>RC = Permit Completely Released (Result of Transfer or Phase III Bond Release).<br>VF = Voluntary Forfeiture<br>-: No Information | | | | | | |

### 9.4.4 Kentucky Division of Water

#### *9.4.4.1 Coal General Permits*

KDOW has two general coal mining permits, KYGE40000 for mines in eastern Kentucky and KYGW40000 for mines in western Kentucky. Under these permits, permittees have limits for pH, total suspended solids, iron and manganese. They are also required to report flow, total sulfate and specific conductivity. Table 9.3 shows the effluent limits taken from the current KYGE40000 and KYGW40000 General Permits.

**Table 9.3 Coal General Permit Limits and Reporting**

| Effluent Characteristics | Reported Discharge | | Proposed Limits | | Applicable Water Quality Criteria and/or Effluent Guidelines |
|---|---|---|---|---|---|
| | Monthly Average | Daily Maximum | Monthly Average | Daily Maximum | |
| Flow (MGD)(1) | Variable | Variable | Report | Report | 401 KAR 5:065, Section 2(4) |
| Total Sulfate (as SO4) (mg/l) | Variable | Variable | Report | Report | 401 KAR 5:065, Section 2(4) |
| Specific Conductivity (µS/cm)(2) | Variable | Variable | Report | Report | 401 KAR 5:070, Section 3 |
| Total Recoverable Iron | Variable | Variable | 3.0 mg/l | 4.0 mg/l | 401 KAR 10:031, Section 4, 401 KAR 5:065, Section 2(4), and 2(9) |
| Total Recoverable Manganese | Variable | Variable | 2.0 mg/l | 4.0 mg/l | 401 KAR 5:065, Sections 2(4), and2(9) |
| Total Suspended Solids | Variable | Variable | 35mg/l | 70mg/l | 401 KAR 5:065, Sections 2(4) and 2(9) |
| pH(3) Standard Units | Variable | Variable | 6.0 (min.) | 9.0 (max.) | 401 KAR 10:031, Section 4<br>401 KAR 5:065, Sections 2(4) and 2(9) |

(1) MGD: million gallons per day
(2) µS/cm: microsiemens per centimeter
(3) These types of discharges shall not cause the pH of the receiving stream to fluctuate more that 1.0 standard unit over a period of 24 hours.

#### *9.4.4.2 Individual Permits*

Individual permits are those who are excluded from coverage under the general permit. The following are excluded from coverage under the general permit:

1) Coal mining and/or processing operations that directly discharge to or propose to directly discharge to a receiving water body that has been categorized as an "Impaired Water" for a pollutant or pollutants of concern that may be associated with such activities and for which an approved TMDL has been developed;
2) Coal mining and/or processing operations that directly discharge to or propose to directly discharge to a receiving water body that has been designated as Cold Water Aquatic Habitat (CAH) as listed in Table C of 401 KAR 10:026, Section 5;
3) Coal mining and/or processing operations that directly discharge to or propose to directly discharge to a receiving water body that has been designated as an Outstanding State Resource Water (OSRW) due its support of a federally listed Threatened or Endangered Species as listed in Table C of 401 KAR 10:026, Section 5;
4) Coal mining and/or processing operations that directly discharge to or propose to directly discharge to a receiving water body that has been categorized as an Outstanding National Resource Water (ONRW) as listed in 401 KAR 10:030, Section 1;
5) New or expanded coal mining and/or processing operations that propose to discharge within five (5) miles upstream of any existing domestic water supply intake listed in 401 KAR 10:026, Section 5(2)(b) Table B;
6) Coal mining and processing activities that KDOW has determined would be more appropriately addressed by an individual permit or an alternate general permit;
7) KYGW40000 adds the eligibility condition that they do not have a continuous discharge, which is defined as a discharge that occurs without interruption or has an average discharge duration of 96 hours or more.

#### *9.4.4.3 Monitoring*

General and Individual Permits require monthly monitoring for the effluent characteristics in Table 9.3. In-stream monitoring and trend sampling are required for new or expanded in-stream outfalls in eastern Kentucky, and for all outfalls in western Kentucky that discharge to a receiving stream that is impaired for Conductivity. Whole Effluent Toxicity (WET) testing is required for in-stream structures.

Whole Effluent Toxicity Testing. WET testing is performed by exposing live representative macroinvertebrates and/or fishes to effluent water in a laboratory setting to determine the toxic effects of the effluent on aquatic life, if any. WET testing is done quarterly. The Acute WET test requirements consist of two 48-hour static non-renewal toxicity tests (the same test water is used throughout) with water flea (Ceriodaphnia dubia, Daphnia magna, or Daphnia pulex) and two 48-hour static non-renewal toxicity tests with fathead minnow (Pimephales promelas) performed on discrete grab samples of 100% effluent, including maintaining control organisms which are not exposed to the effluent. Methods must comply with Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, EPA-821-R-02-012 ($5^{th}$ edition), the most recently published edition of this publication, or another method approved in advance by KDOW.

Trend Sampling. After discharge commences, additional annual physiochemical and biological sampling is required to determine trends; this sampling continues to reclamation status. Trend sampling involves both quarterly and annual monitoring, see Tables 9.4 and 9.5.

**Table 9.4 Quarterly Instream Monitoring Frequency and Limitations**

| Instream Characteristic | Units | Minimum | Monthly Average | Daily Maximum | Maximum | Frequency | Sample Type |
|---|---|---|---|---|---|---|---|
| Flow | MGD | N/A [(1)] | Report | Report | N/A | 1/Quarter | Instantaneous |
| Total Suspended Solids | mg/l | N/A | Report | Report | N/A | 1/Quarter | Grab |
| Specific Conductivity | µS/cm | N/A | Report | Report | N/A | 1/Quarter | Grab |
| Total Sulfate (as $SO_4$) | mg/l | N/A | Report | Report | N/A | 1/Quarter | Grab |
| [(1)] N/A: Not Applicable | | | | | | | |

**Table 9.5 Annual Instream Monitoring Frequency and Limitations**

| INSTREAM MONITORING REQUIREMENTS | | | | | | | MONITORING REQUIREMENTS | |
|---|---|---|---|---|---|---|---|---|
| **Instream Characteristic** | **STORET Code** | **Units** | **Minimum** | **Monthly Average** | **Daily Maximum** | **Maximum** | **Frequency** | **Sample Type** |
| Flow | 00061 | MGD | N/A | Report | Report | N/A | 1/Year | Instantaneous |
| Total Suspended Solids | 00530 | mg/l | N/A | Report | Report | N/A | 1/Year | Grab |
| Total Recoverable Iron | 00980 | mg/l | N/A | Report | Report | N/A | 1/Year | Grab |
| pH | 00400 | SU | Report | N/A | N/A | Report | 1/Year | Grab |
| Specific Conductivity | 00095 | µS/cm | N/A | Report | Report | N/A | 1/Year | Grab |
| Total Sulfate (as $SO_4$) | 00945 | mg/l | N/A | Report | Report | N/A | 1/Year | Grab |
| Total Recoverable Selenium | 00981 | µg/l | N/A | Report | Report | N/A | 1/Year | Grab |
| Turbidity | 00070 | NTU | N/A | Report | Report | N/A | 1/Year | Grab |
| Alkalinity (as $CaCO_3$) | 00410 | mg/l | N/A | Report | Report | N/A | 1/Year | Grab |
| Dissolved Oxygen | 00300 | mg/l | Report | N/A | N/A | N/A | 1/Year | Grab |
| Temperature | 00011 | $^oF$ | N/A | Report | Report | N/A | 1/Year | Grab |
| Total Hardness (as $CaCO_3$) | 00900 | mg/l | N/A | Report | Report | N/A | 1/Year | Grab |

| INSTREAM MONITORING REQUIREMENTS | | | | | | | MONITORING REQUIREMENTS | |
|---|---|---|---|---|---|---|---|---|
| **Instream Characteristic** | **STORET Code** | **Units** | **Minimum** | **Monthly Average** | **Daily Maximum** | **Maximum** | **Frequency** | **Sample Type** |
| Biological Index Score[1] | | None | XX[2] | Report | Report | N/A | 1/Year | Grab |
| [1]See Section 7.5 of the permit for more information regarding this stream characteristic and the sampling requirement.<br>[2]Category minimum (See the Background Biological Conditions Table of the permit) | | | | | | | | |

Effluent Monitoring. Each discharge is subject to effluent monitoring. Effluent monitoring parameters are determined by the type of discharge; mine drainage (influent) to the treatment system (ponds) can be either acid or alkaline. 401 KAR 5:065, Section 2(9) and 40 CFR 434.11 define alkaline drainage as having pH ≥6.0 and total recoverable iron less than 10.0 mg/L. However, within the KPDES permitting program, the default assumption is that discharge consists of acid mine drainage, which has pH<6.0 or total recoverable iron greater than 10.0 mg/L.

Table 9.6 shows the Effluent Limitations and Monitoring Requirements for instream or continuous flow sediment control structures in the eastern and western coal fields.

**Table 9.6 Effluent Limitations and Monitoring Requirements**

| KPDES Outfalls | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **EFFLUENT LIMITATIONS** | | | | | | | **MONITORING REQUIREMENTS** | |
| **Effluent Characteristic** | **STORET Code** | **Units** | **Minimum** | **Monthly Average** | **Daily Maximum** | **Maximum** | **Frequency** | **Sample Type** |
| Flow | 50050 | MGD | N/A | Report | Report | N/A | 2/Month | Instantaneous |
| Total Suspended Solids[1] | 00530 | mg/L | N/A | 35 | 70 | N/A | 2/Month | Grab |
| Total Recoverable Iron | 00980 | mg/L | N/A | 3.0 | 4.0 | N/A | 2/Month | Grab |
| Total Recoverable Manganese[1] | 11123 | mg/L | N/A | 2.0 | 4.0 | N/A | 2/Month | Grab |
| pH | 00400 | SU | 6.0 | N/A | N/A | 9.0 | 2/Month | Grab |
| Chronic WET[2] | TT000 | $TU_C$ | N/A | N/A | N/A | 1.00 | 1/Quarter | ([2]) |
| Specific Conductivity | 00095 | µS/cm | N/A | Report | Report | N/A | 2/Month | Grab |
| Total Sulfate (as $SO_4$) | 00945 | mg/L | N/A | Report | Report | N/A | 2/Month | Grab |
| Total Recoverable Selenium | 00981 | µg/L | N/A | 5.0[3] | 20 | N/A | 2/Month | Grab |
| Total Recoverable Selenium (Fish Tissue) | 01148 | mg/Kg dry weight | N/A | N/A | N/A | 8.6 | ([3]) | ([3]) |
| Precipitation Volume | 79777 | Inches | N/A | N/A | N/A | Report | ([4]) | Grab |

| KPDES Outfalls | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| EFFLUENT LIMITATIONS | | | | | | | MONITORING REQUIREMENTS | |
| Effluent Characteristic | STORET Code | Units | Minimum | Monthly Average | Daily Maximum | Maximum | Frequency | Sample Type |

[1] See Section 4 of the permit for alternate monitoring and effluent limitations available for a qualifying precipitation event (for subsurface mines, this applies only to combined flows, which are those combining two or more types of drainage, i.e., groundwater discharge with surface water discharge).
[2] See Section 3 of the permit for additional requirements related to WET Testing including sampling requirements.
[3] Should the monthly average concentration of total recoverable selenium exceed 5.0 µg/L; see Section 2.9 of the permit for additional requirements.
[4] Precipitation volume required only when applying for APELs(Alternate Precipitation Effluent Limits), which are authorized by the coal ELGs (Effluent Limit Guidelines) and are alternate limits and monitoring requirements on manganese and total suspended solids effective during high precipitation events; APELs will be considered on a case-by-case basis for surface mines and underground mines with comingled discharge.

Table 9.7 shows the Effluent Limitations and Monitoring Requirements reclamation areas in the eastern and western coal fields.

**Table 9.7 Effluent Limitations and Monitoring Requirements**

| KPDES Outfalls | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| EFFLUENT LIMITATIONS | | | | | | | MONITORING REQUIREMENTS | |
| Effluent Characteristic | STORET Code | Units | Minimum | Monthly Average | Daily Maximum | Maximum | Frequency | Sample Type |
| Flow | 50050 | MGD | N/A | Report | Report | N/A | 2/Month | Instantaneous |
| Settleable Solids[1] | 00530 | mg/L | N/A | N/A | N/A | 0.5 | 2/Month | Grab |
| pH | 00400 | SU | 6.0 | N/A | N/A | 9.0 | 2/Month | Grab |
| Specific Conductivity | 00095 | µS/cm | N/A | Report | Report | N/A | 2/Month | Grab |
| Total Sulfate (as $SO_4$) | 00945 | mg/L | N/A | Report | Report | N/A | 2/Month | Grab |
| Precipitation Volume | 79777 | Inches | N/A | N/A | N/A | Report | ([2]) | Grab |

[1] See Section 4 of the permit for alternate monitoring and effluent limitations available for a qualifying precipitation event (for subsurface mines, this applies only to combined flows, which are those combining two or more types of drainage, i.e., groundwater discharge with surface water discharge).
[2] Precipitation volume required only when applying for APELs, which are authorized by the coal ELGs and are alternate limits and monitoring requirements on manganese and total suspended solids effective during high precipitation events; APELs will be considered on a case-by-case basis for surface mines and underground mines with comingled discharge.

# 10.0 Public Participation

This TMDL was published for a 30-day public comment beginning November 10, 2016 and ending December 10, 2016. A notification was sent via Commonwealth of Kentucky Energy and Environment Cabinet press release. The notification was also sent to local newspapers (*Central City Times Argus* and *Central City Leader News*). Additionally, the public notice was distributed electronically through the 'Nonpoint Source Pollution Control' mailing list http://water.ky.gov/nsp/Pages/MailingList.aspx) of persons interested in water quality issues, and was emailed to the TMDL Listserv, which is a list of persons interested in TMDL-related issues.

Comments received during the public notice period should be incorporated into the administrative record for this TMDL. Revisions should be made to the final TMDL report. There were no comments received during public notice period for this TMDL.

# 11.0 References

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# Appendix A Land Cover Definitions (NLCD2011)

11. **Open Water** - areas of open water, generally with less than 25% cover of vegetation or soil.

12. **Perennial Ice/Snow** - areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover.

21. **Developed, Open Space** - areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.

22. **Developed, Low Intensity** - areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% percent of total cover. These areas most commonly include single-family housing units.

23. **Developed, Medium Intensity** - areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas most commonly include single-family housing units.

24**. Developed, High Intensity** - highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover.

31. **Barren Land (Rock/Sand/Clay)** - areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.

41. **Deciduous Forest** - areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.

42. **Evergreen Forest** - areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage.

43. **Mixed Forest** - areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover.

51. **Dwarf Scrub** - Alaska only areas dominated by shrubs less than 20 centimeters tall with shrub canopy typically greater than 20% of total vegetation. This type is often co-associated with grasses, sedges, herbs, and non-vascular vegetation.

52. **Shrub/Scrub** - areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.

71. **Grassland/Herbaceous** - areas dominated by gramanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.

72. **Sedge/Herbaceous** - Alaska only areas dominated by sedges and forbs, generally greater than 80% of total vegetation. This type can occur with significant other grasses or other grass like plants, and includes sedge tundra, and sedge tussock tundra.

73. **Lichens** - Alaska only areas dominated by fruticose or foliose lichens generally greater than 80% of total vegetation.

74. **Moss -** Alaska only areas dominated by mosses, generally greater than 80% of total vegetation.

81. **Pasture/Hay** - areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.

82. **Cultivated Crops** - areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.

90. **Woody Wetlands** - areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

95. **Emergent Herbaceous Wetlands** - Areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

# Appendix B Division of Mine Permits Numbering System

XXXX-XX Permit issued prior to May 3, 1978. Ex. 1357-76. The first four numbers represent the mine number. The last two numbers represent the year of issuance.

XXX-XXXX Permit issued after Ma/*0y 3, 1978. The first three numbers indicate the location of the mine by county and the timing of the original permit issuance.

If the first three numbers correspond to the county number, the permit was originally issued during the interim program.

If 200 has been added to the county number, the permit was originally issued prior to May 3, 1978, and carried through into the interim program.

If 400 has been added to the county number the permit was issued prior to the Permanent Program and was to remain active after January 18, 1983.

If 800 has been added to the county number: (1) the application is for a permit after January 18, 1983 or (2) two or more previously permitted areas have been combined into a single permit.

The last four numbers indicate the type of mining activity being permitted:

COAL

| | |
|---|---|
| 0000-4999 | Surface Mining |
| 5000-5999 | Underground Mine |
| 6000-6999 | Crush/Load Facility |
| 7000-7999 | Haul Road Only |
| 8000-8999 | Preparation Plant |
| 9000-9399 | Refuse Disposal |

NON COAL

| | |
|---|---|
| 9400-9499 | Limestone |
| 9500-9599 | Clay |
| 9600-9699 | Sand/Gravel |
| 9700-9799 | Oil Shale |
| 9800-9899 | Fluorspar |