Overview of Regulatory Drivers in Mine Water Treatment

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Goal is to Answer the Question:

What are My

Treatment Goals,

Design Criteria,

Effluent Limits*?**

***Not exactly the same.**

****Wherever you go, there you are.**

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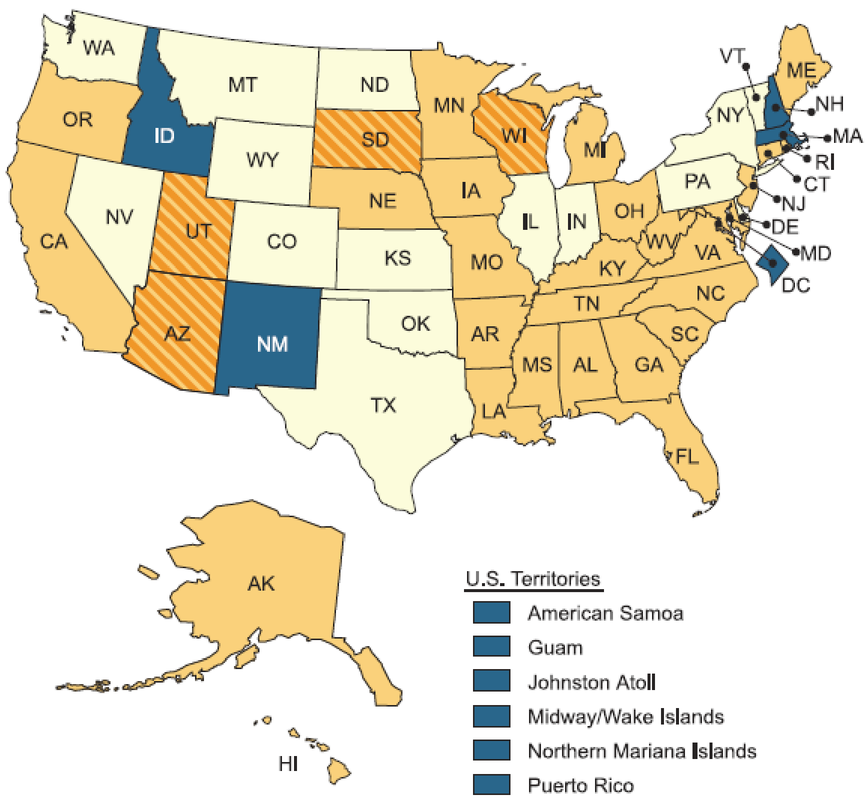
State NPDES Program Authority



State NPDES Program Status

- Fully authorized
- Fully authorized, including an approved biosolids program
- Partially authorized (click here for details)
- Unauthorized

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Big Picture, Limits Depend On:

- **Type** of "mine" water,
- **Uses** to which the water has been put,
- To **what** receiving waters the water is discharged,
- **Where**, **when, how** discharge occurs,
- Other esoterica …

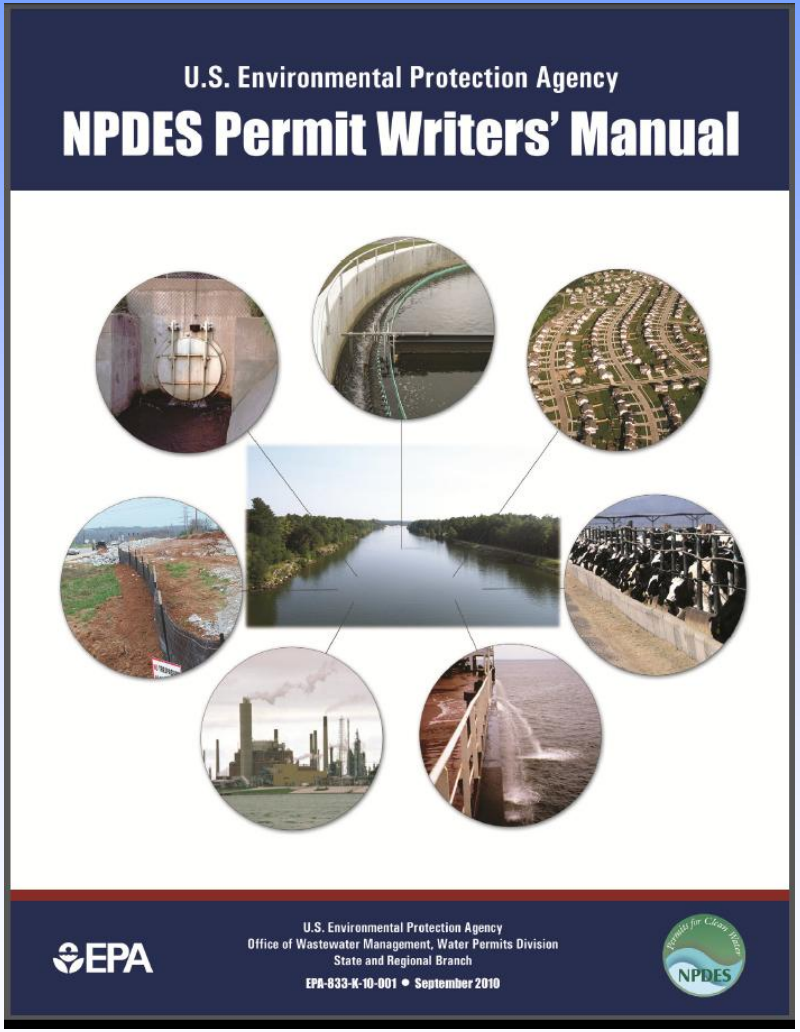
Regulatory Limits From

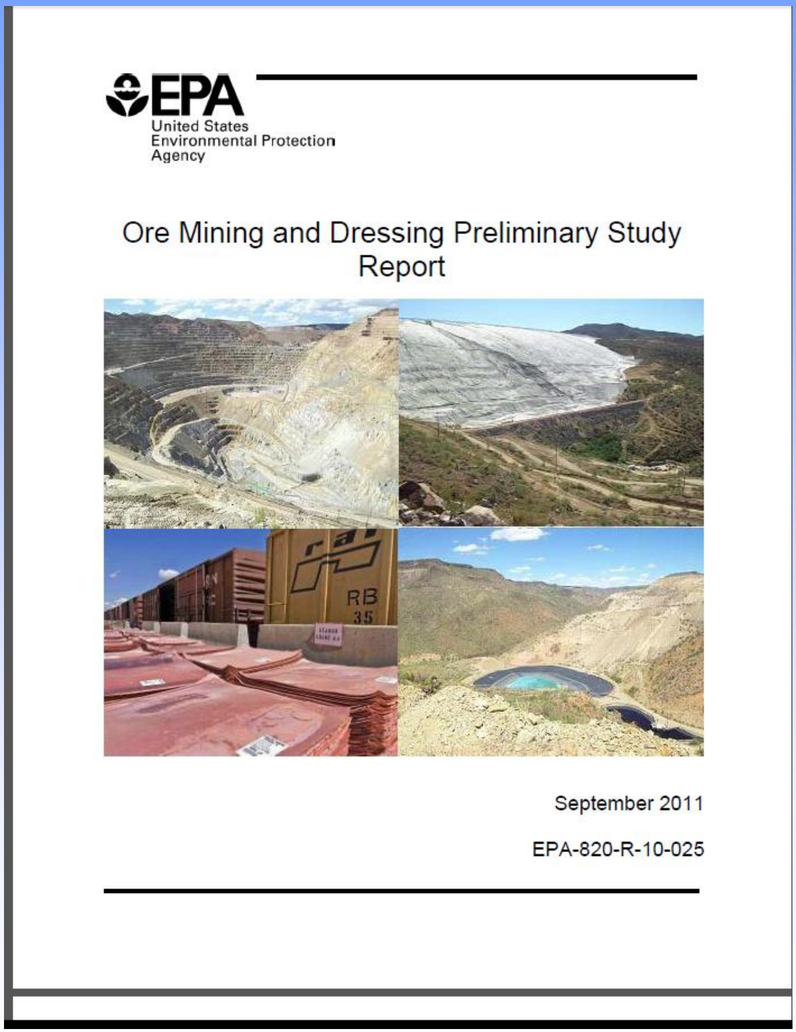
1. **NPDES Permits (or State equivalent) for Point Sources to Streams**
2. State Programs for Groundwater Discharges
3. Underground Injection Control Program (EPA or State)
4. NonPoint Source Controls (e.g. TMDLs, BMPs)

National Pollutant Discharge Elimination System (NPDES) Permits

1. Generally required for discharge of <u>pollutants</u> from any <u>point source</u> into <u>waters of U.S</u>.
2. License or contract for discharge of a specified amount of pollutant into waterbody under certain conditions.

Resources





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A *Pollutant* Is

Any type of industrial, municipal, or agricultural waste (including heat) discharged into water….

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Common Pollutants

1. Conventionals (BOD, TSS, pH, O&G)
2. Nonconventionals (chlorine, ammonia, COD)
3. Toxics – Metals, organic chemicals and other priority pollutants
4. Nutrients – nitrogen, phosphorous
5. Radiological
6. Asbestos
7. Heat

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A *Point Source* Is

Any discernible confined, and discrete conveyance from which pollutants are or may be discharged.

Examples include: pipe, ditch, leachate collection system, POTW (publicly owned treatment works).

Waters of the U.S. (or State)

1. Covers broad range of surface waters
2. May include hydrologically-connected groundwater
3. Scope has been subject of numerous court cases.

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NPDES Permit Conditions

1. **Effluent limitations (flow rate, concentrations, chemical mass, toxicity)**
2. Special Conditions (e.g., mixing zones, compliance schedules)
3. Monitoring Requirements
4. Prohibitions (e.g., bypass of treatment)
5. Re-opener and Report of Changes

NPDES Permit Limits

1. Technology-Based Effluent Limits (TBELs) (e.g., BAT);

And if required …

2. Water Quality-Based Effluent Limits or WQBELs

NPDES Permit Limits

1. Limits = Lower of TBELs & WQBELs + MOS
2. Margin Of Safety based on variation in treated water quality, sampling frequency, permit limit statistic (e.g., maximum daily, average monthly, acute vs chronic).
3. Treatment goals/design criteria likely include additional MOS.

Technology-Based Effluent Limits: TBELs

1. Maximum effluent concentration and/or mass that may be discharged;
2. Required regardless of effect of discharge on receiving water;
3. Based on application* of specified levels of technology controls (e.g., best available treatment or BAT).

Technology-Based Effluent Limits: TBELs

Easiest to Determine:

1. Find NAICS Number for mine type (2122);
2. Determine type of mine water;
3. Look up Effluent Limitations and Guidelines (ELGs) in 40 CFR Part 440 (or rarely, Part 122).

What is Mine Water?

- Mine Drainage and Beneficiation
  - ELGs in 40 CFR Part 440 Ore Mining and Dressing
- Refining Wastewater
  - ELGs in 40 CFR Part 421
- Stormwater
  - Not covered by ELGs; unless commingled with mine drainage or process water.

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Ore Mining and Dressing Effluent Guidelines (40 CFR Part 440)

- Subpart A: Iron Ore
- Subpart B: Aluminum Ore
- Subpart C: Uranium, Radium and Vanadium Ores
- Subpart D: Mercury Ore
- Subpart E: Titanium Ore
- Subpart F: Tungsten Ore
- Subpart G: Nickel Ore
- Subpart H: Vanadium Ore (Mined Alone and Not as a Byproduct)
- Subpart I: Antimony Ore
- Subpart J: Copper, Lead, Zinc, Gold, Silver, and Molybdenum Ores
- Subpart K: Platinum Ores
- Subpart M: Gold Placer Mining

Example: Subpart J – Copper, Lead, Zinc, Gold, Silver, Molybdenum Mines

1. Applicability and Description
2. Effluent Limits (ELGs) – Existing Sources
3. Effluent Limit (ELGs) – New Sources

Cu, Pb, Zn, Au, Ag, Mo Mines
Existing Sources

- ELGs = BPT & BAT;
- BPT = concentrations attainable by best practicable control technology currently available;
- BAT = best available technology economically achievable.

Cu, Pb, Zn, Au, Ag, Mo Mines – Existing Sources

Mine Drainage ELGs

Parameter	**Daily Maximum (mg/L)**	**30-day Average (mg/L)**
TSS	30	20
Cu	0.3	0.15
Zn	1.5	0.75
Pb	0.6	0.3
Hg	0.002	0.001
pH	6 to 9	6 to 9

Cu, Pb, Zn, Au, Ag, Mo Mines – Existing Sources
Froth Flotation Process Wastewater ELGs

Parameter	Daily Maximum (mg/L)	30-day Average (mg/L)
TSS	30	20
Cu	0.3	0.15
Zn	1.5	0.75
Pb	0.6	0.3
Hg	0.002	0.001
Cd	0.10	0.05
pH	6 to 9	6 to 9

Cu, Pb, Zn, Au, Ag, Mo Mines
Existing Sources

- BPT & BAT includes "zero discharge" in some cases.
- Zero discharge of cyanide leach or copper leach process wastewater except for amount equal to net precipitation.

Cu, Pb, Zn, Au, Ag, Mo Mines
New Sources

- **New Source Performance Standards**: ELGs = BADT
- BADT = concentrations attainable by best available demonstrated technology

Cu, Pb, Zn, Au, Ag, Mo Mines – New Sources

Mine Drainage & Froth Flotation Process Wastewater ELGs

Parameter	Daily Maximum (mg/L)	30-day Average (mg/L)
TSS	30	20
Cu	0.3	0.15
Zn	1.5	0.75
Pb	0.6	0.3
Hg	0.002	0.001
Cd	0.10	0.05
pH	6 to 9	6 to 9

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Copper, Lead, Zinc, Gold, Silver, Molybdenum Mines

- BADT includes "zero discharge" in some cases.
- Zero discharge of cyanide leach or copper leach, and <u>froth flotation</u> process wastewater except for …

Exception to NSPS Zero discharge of process wastewater:

1. Amount equal to net precipitation or;
2. As needed to prevent build-up of chemicals in recycle water that interfere with ore recovery.

NPDES Permit Limits

1. Technology-Based Effluent Limits or TBELs (e.g., BAT);

And if required …

2. **Water Quality-Based Effluent Limits or WQBELs**

Water Quality-Based Effluent Limits: WQBELs

1. Establish level of effluent quality necessary to protect water quality and ensure attainment of Water Quality Standards in receiving water.
2. Necessary when "reasonable potential" that TBELs alone will not meet Water Quality Standards.

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United States Environmental Protection Agency

Office Of Water (EN-336)

EPA/505/2-90-001
PB91-127415
March 1991

EPA

Technical Support Document For Water Quality-based Toxics Control

Box 3-2. Determining "Reasonable Potential" for Excursions Above Ambient Criteria Using Effluent Data Only

EPA recommends finding that a permittee has "reasonable potential" to exceed a receiving water quality standard if it cannot be demonstrated with a high confidence level that the upper bound of the lognormal distribution of effluent concentrations is below the receiving water criteria at specified low-flow conditions.

Step 1 Determine the number of total observations ("n") for a particular set of effluent data (concentrations or toxic units [TUs]), and determine the highest value from that data set.

Step 2 Determine the coefficient of variation for the data set. For a data set where n<10, the coefficient of variation (CV) is estimated to equal 0.6, or the CV is calculated from data obtained from a discharger. For a data set where n>10, the CV is calculated as standard deviation/mean (see Figure 3-1). For less than 10 items of data, the uncertainty in the CV is too large to calculate a standard deviation or mean with sufficient confidence.

Step 3 Determine the appropriate ratio from Table 3-1 or 3-2.

Step 4 Multiply the highest value from a data set by the value from Table 3-1 or 3-2. Use this value with the appropriate dilution to project a maximum receiving water concentration (RWC).

Step 5 Compare the projected maximum RWC to the applicable standard (criteria maximum concentration, criteria continuous concentration [CCC], or reference ambient concentration). EPA recommends that permitting authorities find reasonable potential when the projected RWC is greater than an ambient criterion.

Example

Consider the following results of toxicity measurements of an effluent that is being characterized: 5 TU_c, 2 TU_c, 9 TU_c, and 6 TU_c. Assume that the effluent is diluted to 2 percent at the edge of the mixing zone. Further assume that the CV is 0.6, the upper bound of the effluent distribution is the 99th percentile, and the confidence level is 99 percent.

Step 1 There are four samples, and the maximum value of the sample results is 9 TU_c.

Step 2 The value of the CV is 0.6.

Step 3 The value of the ratio for four pieces of data and a CV of 0.6 is 4.7.

Step 4 The value that exceeds the 99th percentile of the distribution (ratio times x_{max}) after dilution is calculated as:

$$[9\ TU_c \times 4.7 \times 0.02] = 0.85\ TU_c.$$

Step 5 0.85 TU_c is less than the ambient criteria concentration of 1.0 TU_c. There is no reasonable potential for this effluent to cause an excursion above the CCC.

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Water Quality-Based Limits

WQBELS = WQ Criteria +/- Modifiers

+ Dilution allowance (mixing zones)

+ Variances (relatively rare)

-- Antidegradation requirements

-- TMDL requirements

-- Whole Effluent Toxicity requirements

-- Margin of Safety

-- Anti-Backsliding

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Water Quality Standards

Required Elements:

1. Use Designation for waterbody (e.g., fishable, swimmable, drinkable);
2. Water quality criteria to protect uses (e.g., 10 ppb arsenic for drinking);
3. Antidegradation policy (e.g., policy to keep WQ better than criteria).

Water Quality Criteria

1. Human Health (drinking, recreation, fish ingestion)
2. Aquatic Life (salmonids, non-salmonids, marine, freshwater, vegetation)
3. Livestock
4. Wildlife

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Water Quality Criteria

1. Most initially developed by USEPA as National Criteria
2. Usually adopted by States and Tribes perhaps with some modification
3. Routinely re-evaluated by EPA

Circular DEQ-7

Montana Numeric Water Quality Standards

October 2012

Prepared by:
Water Quality Planning Bureau, Water Quality Standards Section
Montana Department of Environmental Quality
Water Quality Planning Bureau
1520 E. Sixth Avenue
P.O. Box 200901
Helena, MT 59620-0901

Pollutant Element / Chemical Compound or Condition §§ - Primary Synonym § - Other Names	CASRN numbers, NIOSH number, SAX Number (25) (26) (27)	Category (1) (2)	Aquatic Life Standards		Bio-concentration Factor (BCF) (5)	Human Health Standards (17) (16)		Trigger Value (22)	Required Reporting Value (19)
			Acute (3)	Chronic (4)		Surface Water	Ground Water		
Ammonium Sulfamate §§	7773-06-0	Toxic				2,000 HA	2,000 HA		200
Anthracene (PAH) §§ Paranaphthalene § Green Oil § Anthracin § Tetra Olive N2G	120-12-7 CA 9350000 APG500	Toxic			30	8,300 PP	2,100 HA	0.04	10
Antimony §§ Sb § Antimony Black § Antimony Regulus § C.I. 77050 § Stibium	7440-36-0 CC 4025000 AQB750	Toxic			1	5.6 PP	6 MCL	0.4	0.5
Arsenic (36) §§ As § Arsenicals § Arsenic-75 § Arsenic Black § Colloidal Arsenic § Grey Arsenic § Metallic Arsenic	7440-38-2 CG 0525000 ARA750	Carcinogen	340 PP	150 PP	44	10 MCL	10 MCL	N/A	1
Asbestos, fibers longer than 10 microns in length §§ § Amianthus § Amosite (Obs.) § Amphibole § Asbestos Fiber § Fibrous Grunerite § NCI CO8991 § Serpentine, includes Chrysotile, Actinolite, Aurosite, Anthophyllite, Crocidolite, and Tremolite	Multiple	Carcinogen				$7x10^6$ fibers /liter MCL	$7x10^6$ fibers /liter MCL	N/A	

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Water Quality Standards

Optional Policies:

1. Mixing Zones
2. Variances
3. Critical Low Flows

Mixing Zone Defined

A mixing zone is a limited area or volume of water where initial dilution of a discharge takes place and where certain numeric water quality criteria may be exceeded.

Mixing Zone Rationale

Sometimes it is possible to expose aquatic organisms to a pollutant concentration above a criterion for a short duration within a limited, clearly defined area of a waterbody while still maintaining the designated use of the waterbody as a whole.

Mixing Zone Requirements

- Do not impair waterbody as whole;
- Not lethal to passing organisms;
- No significant human health risks;
- Do not endanger critical areas (e.g., important habitat, sensitive biota, drinking water intakes, recreation areas).

Mixing Zone Restrictions

- Location;
- Size and Portion of Available Dilution;
- Shape;
- Outfall Design and Type;
- In-zone Water Quality (e.g., toxicity, objectionable materials, color, odor, taste).

Critical Low Flows

- Used to determine available dilution for WQBELs;
- Common (including MT) 7Q10 or lowest seven-consecutive day average flow expected to occur once every 10 years;
- 14Q5 for nutrients.

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Variances

- Time-limited use and criteria designation for specific water body that reflect highest attainable use during time period;
- MT – “Temporary Water Quality Standards” for select streams;
- MT – Nutrients.

Anti-degradation or Nondegradation

"Where the quality of the waters exceed levels necessary to support [beneficial uses] …

that quality shall be maintained and protected unless … allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located."

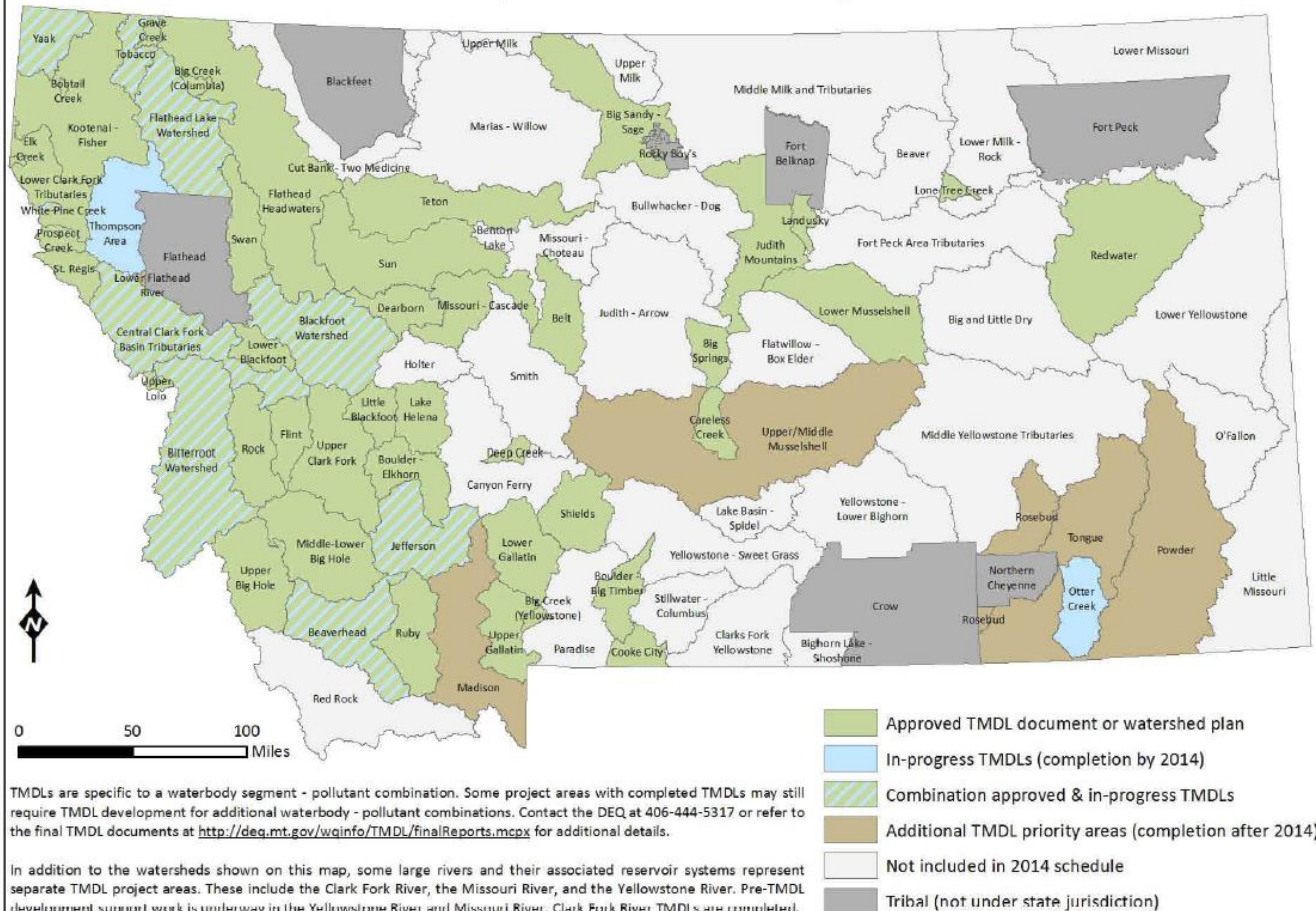
Anti-degradation or Nondegradation

1. Discharge can only use portion of assimilative capacity;
2. Amount of portion depends on type and strength of pollutant;
3. For some pollutants (e.g., carcinogens, bioaccumulaters, persistent), may be zero.

Total Maximum Daily Loads (TMDLs)

1. Required when stream does not fully support uses;
2. Point source limitations;
3. Non-point source BMPs or management requirements.

Montana TMDL Project Areas & 2014 TMDL Completion Schedule



TMDLs are specific to a waterbody segment - pollutant combination. Some project areas with completed TMDLs may still require TMDL development for additional waterbody - pollutant combinations. Contact the DEQ at 406-444-5317 or refer to the final TMDL documents at http://deq.mt.gov/wqinfo/TMDL/finalReports.mcpx for additional details.

In addition to the watersheds shown on this map, some large rivers and their associated reservoir systems represent separate TMDL project areas. These include the Clark Fork River, the Missouri River, and the Yellowstone River. Pre-TMDL development support work is underway in the Yellowstone River and Missouri River. Clark Fork River TMDLs are completed.

Map updated 5/30/2014

Whole Effluent Toxicity (WET) Requirements

EPA defines whole effluent toxicity as "the aggregate toxic effect of an effluent measured directly by an aquatic toxicity test."

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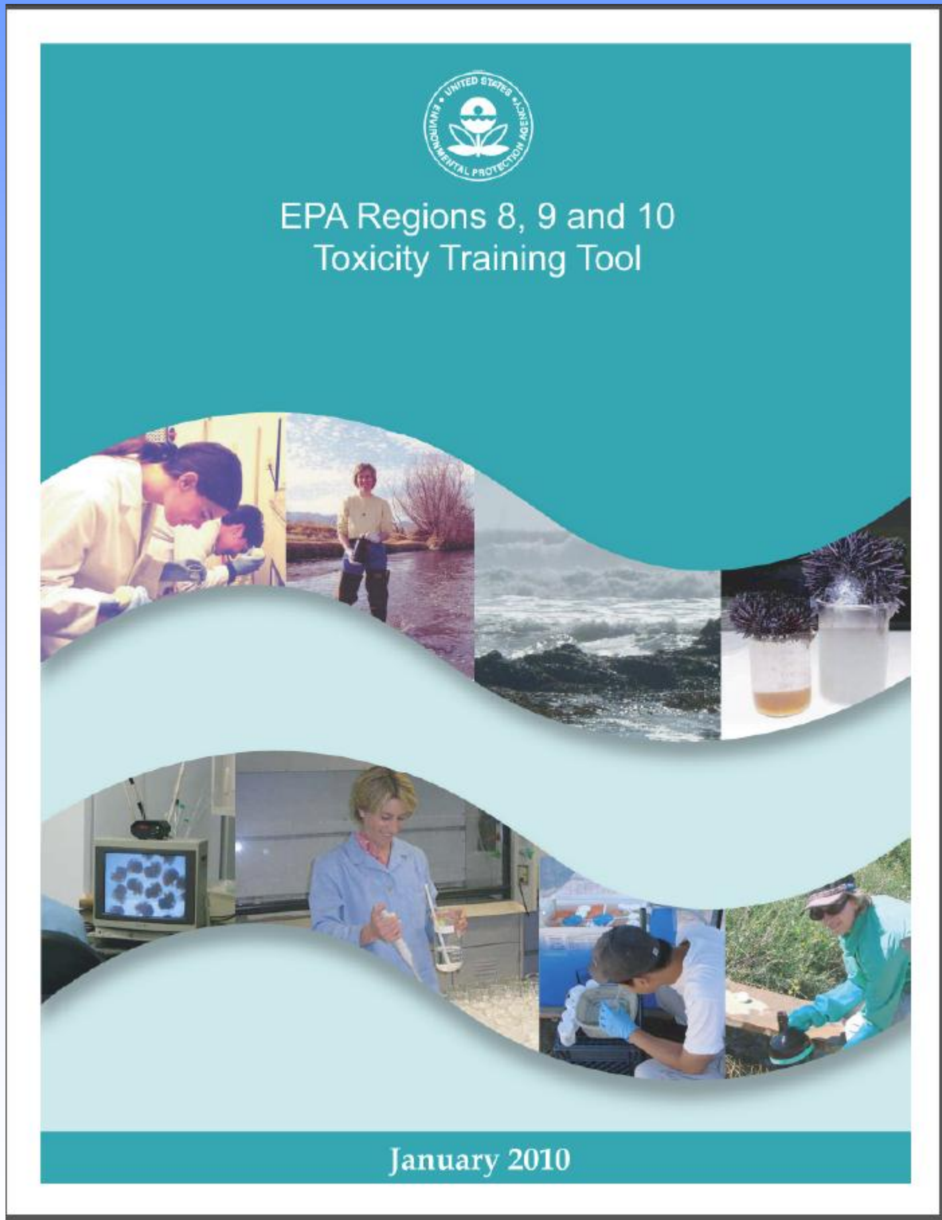

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Whole Effluent Toxicity (WET) Limits

1. Usually support or back up chemical-specific numeric limits;
2. Chronic (long-term) and/or acute (short);
3. Expressed as Toxicity Units (TUs) or percent lethality (e.g., % effluent @ LC_{50});
4. Failure can trigger TIE/TRE (toxicity identification/reduction evaluation).

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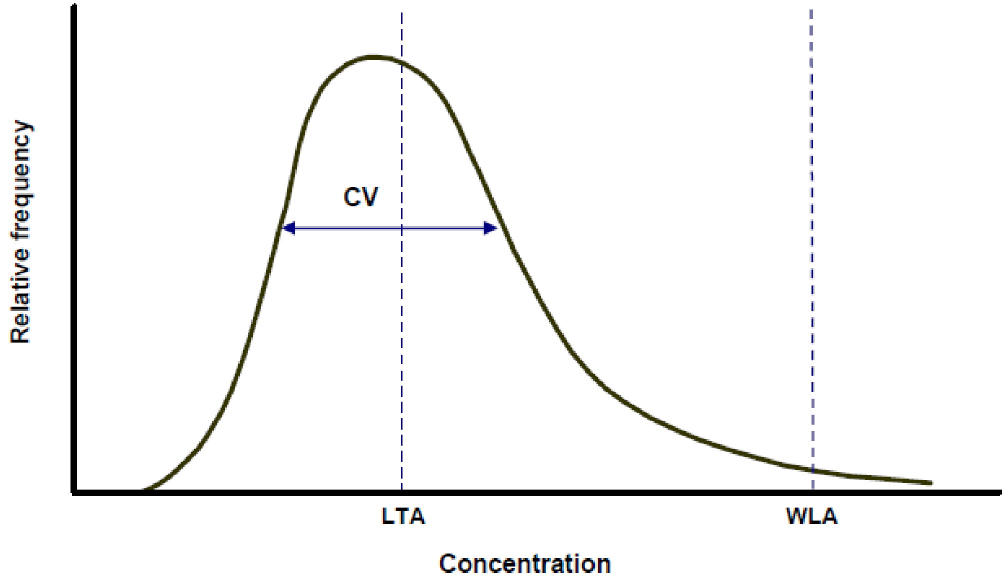
Margin of Safety

Exhibit 6-18 Example of lognormal distribution of effluent pollutant concentrations and calculation of LTA



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Box 5-2. Calculating Permit Limits Based on Two-Value Wasteload Allocation

To set maximum daily and average monthly permit limits based on acute and chronic wasteload allocations, use the following four steps:

1	Convert the acute wasteload allocation to chronic toxic units. Skip to Step 2 for chemical-specific limits.
2	Calculate the long-term average wasteload that will satisfy the acute and chronic wasteload allocations.
3	Determine the lower (more limiting) of the two long-term averages.
4	Calculate the maximum daily and average monthly permit limits using the lower (more limiting) long-term average.

Step 1 *(for whole effluent toxicity only)*

WLA_{ac} *(in TU_c)* = WLA_a *(in TU_a)* • ACR

Step 2 *(start here for chemical specific limits)*

$$LTA_{a,c} = WLA_{a,c} \bullet e^{[0.5\sigma^2 - z\sigma]}$$

where $\sigma^2 = \ln(CV^2+1)$
$z = 1.645$ for 95th percentile probability basis, and
$z = 2.326$ for 99th percentile probability basis

$$LTA_c = WLA_c \bullet e^{[0.5\sigma_4^2 - z\sigma_4]}$$

where $\sigma_4^2 = \ln(CV^2/4 + 1)$
$z = 1.645$ for 95th percentile probability basis, and
$z = 2.326$ for 99th percentile probability basis

Step 3

$$LTA = \min(LTA_c, LTA_{a,c})$$

Step 4

$$MDL = LTA \bullet e^{[z\sigma - 0.5\sigma^2]}$$

where $\sigma^2 = \ln(CV^2+1)$
$z = 1.645$ for 95th percentile probability basis, and
$z = 2.326$ for 99th percentile probability basis

$$AML = LTA \bullet e^{[z\sigma_n - 0.5\sigma_n^2]}$$

where $\sigma_n^2 = \ln(CV^2/n + 1)$
$z = 1.645$ for 95th percentile probability basis, and
$z = 2.326$ for 99th percentile probability basis

Term	Meaning
CV	Coefficient of variation
σ	Standard deviation
$WLA_{a,c}$	Acute wasteload allocation in chronic toxic units
WLA_a	Acute wasteload allocation in acute toxic units
WLA_c	Chronic wasteload allocation in chronic toxic units
LTA_{ac}	Acute long-term average wasteload in chronic units
LTA_c	Chronic long-term average wasteload
TU_a	Acute toxic units
TU_c	Chronic toxic units
ACR	Acute-to-chronic ratio
MDL	Maximum daily limit
AML	Average monthly limit
z	z statistic

*Full details of this procedure are found in Appendix E.

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Anti-Backsliding

1. Defined as relaxation of effluent limits in re-issued permit;
2. Usually not allowed for TBELs;
3. Allowable in some cases for WQBELs;
4. In all cases, water quality standards and applicable ELGs must be met.

Montana Numeric Nutrient Standards

- In 2014 Montana adopted numeric standards for Total Nitrogen and Total Phosphorous for wadeable streams (all but eight large rivers);
- Standards established in Statute 75-5-301, 302MCA and in Rule ARM 17.30.601-641;
- Includes site-specific standards for nine (9) stream reaches and the Yellowstone River downstream of the Bighorn confluence.

Montana Numeric Nutrient Standards

- Values for these standards vary based on location; six (6) ecoregions;
- Seasonal – apply during summer/fall;
- Critical Low Flow 14Q5;
- General and individual variances.

Table 12A-1. Base Numeric Nutrient Standards for Wadeable Streams in Different Montana Ecoregions.
If standards have been developed for level IV ecoregions (subcomponents of the level III ecoregions) they are shown in italics below the applicable level III ecoregion. Individual reaches are in the continuation of this table.

Ecoregion[1,2] (level III or IV) and Number	Ecoregion Level	Period When Criteria Apply[3]	Numeric Nutrient Standard[4] Total Phosphorus (µg/L)	Numeric Nutrient Standard[4] Total Nitrogen (µg/L)
Northern Rockies (15)	III	July 1 to September 30	25	275
Canadian Rockies (41)	III	July 1 to September 30	25	325
Idaho Batholith (16)	III	July 1 to September 30	25	275
Middle Rockies (17)	III	July 1 to September 30	30	300
Absaroka-Gallatin Volcanic Mountains (17i)	IV	July 1 to September 30	105	250
Northwestern Glaciated Plains (42)	III	June 16 to September 30	110	1300
Sweetgrass Upland (42l), Milk River Pothole Upland (42n), Rocky Mountain Front Foothill Potholes (42q), and Foothill Grassland (42r)	IV	July 1 to September 30	80	560
Northwestern Great Plains (43) and Wyoming Basin (18)	III	July 1 to September 30	150	1300
River Breaks (43c)	IV	See Endnote 5	See Endnote 5	See Endnote 5
*Non-calcareous Foothill Grassland (43s), Shields-Smith Valleys (43t), Limy Foothill Grassland (43u), Pryor-Bighorn Foothills (43v), and Unglaciated Montana High Plains (43o)**	IV	July 1 to September 30	33	440

*For the Unglaciated High Plains ecoregion (43o), criteria only apply to the polygon located just south of Great Falls, MT.

[1] See Endnote 1

[2] See Endnote 2

[3] See Endnote 3

[4] See Endnote 4

Nutrient Variances

- MT & EPA determined Limits of Technology are **70 µg/L TP** and **4,000 µg/L TN.**

- Since the numeric standards are less than the limits of technology and it has been determined that there would be **significant and widespread** economic impacts in trying to meet the standards, a variance system was included along with the standards.

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General Variance – Initial End-of-Pipe Limits

Discharge Flow	Total Nitrogen Monthly Average (mg/L)	Total Phosphorous Monthly Average (mg/L)
≥ 1 MGD	10	1
< 1 MGD	15	2
Lagoons not designed to actively remove nutrients	Maintain current performance	Maintain current performance

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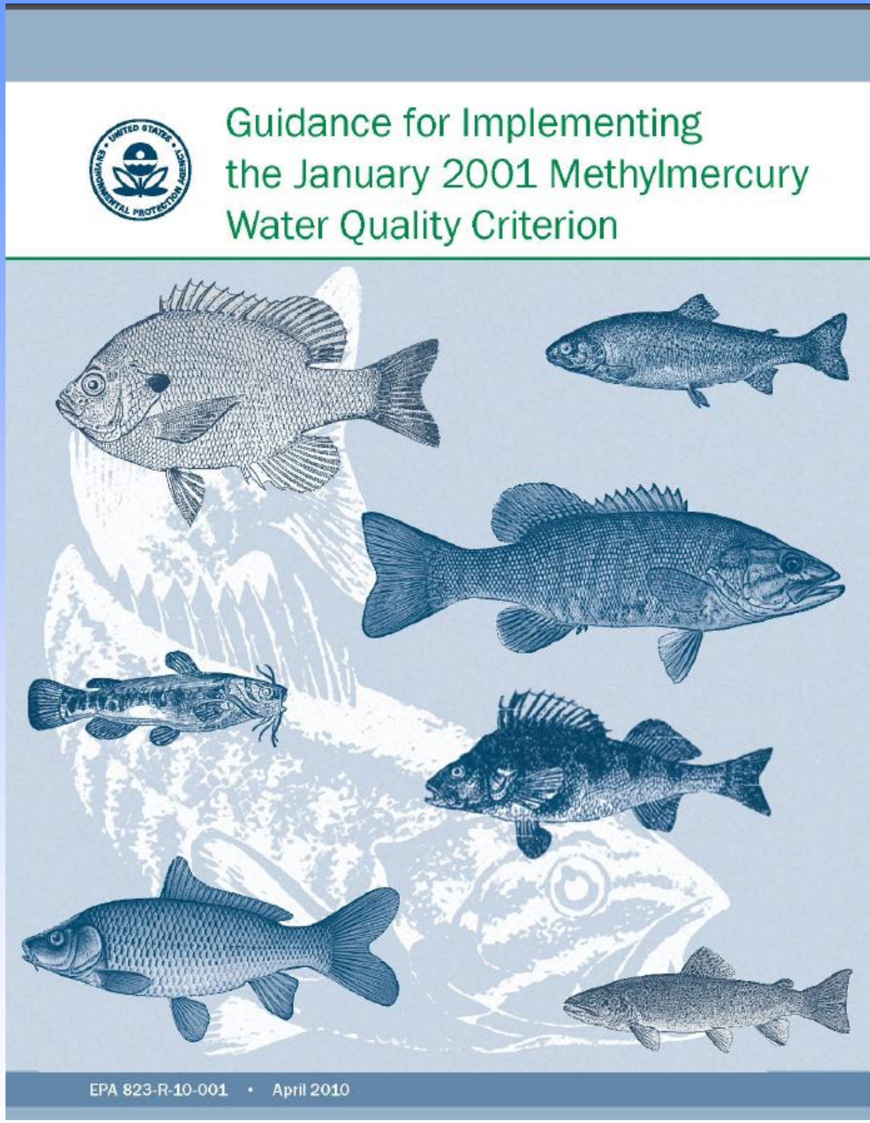
Guidance and Documentation

- Montana DEQ has provided extensive guidance and documentation related to the numeric nutrient standards- available on DEQs website http://www.deq.mt.gov/wqinfo/Standards/default.mcpx
  - Base Numeric Nutrient Standards Implementation Guidance
  - Department Circular DEQ-12A: Montana Base Numeric Nutrient Standards
  - Department Circular DEQ-12B: Nutrient Standards Variances

Potential Emerging COCs

- Methylmercury (NRWQC);
- Radon (EPA MCL under development);
- Cobalt, molybdenum, strontium, tellurium, vanadium (EPA CCL3);
- Sulfate, aluminum, chloride, iron, manganese, TDS (SDWS);
- EC & SAR (coalfields).


Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion

EPA 823-R-10-001 • April 2010

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END

Water Classifications

Waste Stream	Definition
Process wastewater	"...any water which, during manufacturing or processing, comes into direct contact with or results from the production or use of any raw material, intermediate product, finished product, byproduct, or waste product." (40 CFR 122.22)
Mine drainage	Mine drainage includes water drainage from refuse, storage piles, wastes, rock dumps, and mill tailings derived from the mining, cleaning, or concentration of metal ores. Mine drainage may include process water still contained in the mine. Stormwater runoff and infiltration can contribute to mine drainage. "...any water drained, pumped, or siphoned from a mine." (40 CFR 440.132)
Industrial stormwater	Stormwater means rain water runoff, snow melt runoff, surface runoff, and surface drainage. Industrial facilities are required to obtain permit coverage for stormwater if they have a point source stormwater discharge associated with an industrial or commercial activity from their property either directly to waters of the United States or to a municipal separate storm sewer system. "... the discharge from any conveyance which is used for collecting and conveying storm water and which is directly related to manufacturing, processing or raw materials storage areas at an industrial plant. ... (40 CFR 122.26)

Source: Adapted from EPA and Hardrock Mining: A Sourcebook for Industry in the Northwest and Alaska (EPA, 2003).