Introduction to Wasteload Analysis



Nicholas von Stackelberg, P.E.

December 4, 2012

UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY

Water Quality Standards consist of:

DESIGNATED USES: management objectives for surface waters, e.g., protection and propagation of aquatic life and recreation in and on the water

CRITERIA: numeric values and/or narrative statements that represent a level of water quality that supports the designated uses

ANTIDEGRADATION POLICY AND PROCEDURES: to maintain and protect existing water quality

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EFFLUENT LIMITS

1) **Technology Based Effluent Limits (TBEL)** - EPA identifies the best available technology that is economically achievable for that industry and sets regulatory requirements based on the performance of that technology. Also referred to as Categorical Limits.
2) **Secondary Standards** - All point sources must meet minimum effluent standards for BOD, SS, Bacteria and pH.
3) **Water Quality Based Effluent Limits (WQBEL)** - A permit limit for a pollutant which limits the concentration such that it will not cause a violation of water quality standards. The limit may include a dilution factor. Calculated by wasteload allocation process.

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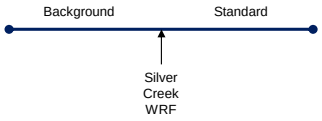
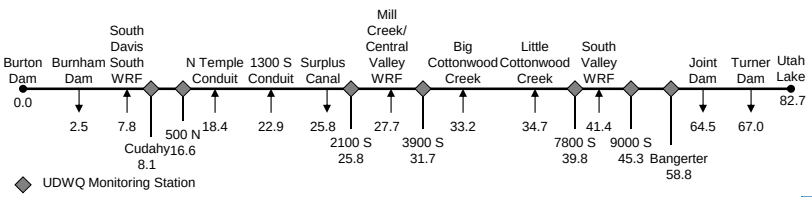
INDIVIDUAL VS. WATERSHED BASED PERMITTING

Silver Creek



Jordan River



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Determining Water Quality Based Effluent Limits

1) Identify Applicable Water Quality Standards
2) Characterize the Effluent and Receiving Water
3) Determine the Allowable Mixing Zone
4) Calculate Chemical Specific WQBELs

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Identify Applicable Water Quality Standards

1) Identify the receiving water
2) Determine the designated beneficial uses
   - http://wq.deq.utah.gov/
   - Utah Administrative Code R317-2-13
3) Determine the applicable numeric criteria
   - Utah Administrative Code R317-2-14
4) Downstream analysis

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IDENTIFY APPLICABLE WATER QUALITY STANDARDS

Aquatic Life Criteria

- Designed to protect aquatic organisms, including animals and plants
- Criteria are developed based on tests measuring effects on aquatic life
- Typically two types of aquatic life criteria
  - acute
  - Chronic

Must also protect for Recreation, Agriculture and Domestic Water Uses

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IDENTIFY APPLICABLE WATER QUALITY STANDARDS

Generally, aquatic life criteria have three components:

- **Magnitude**: concentration of concern of the pollutant
- **Duration**: time period that aquatic organisms would be exposed to the pollutant at the concentration of concern
- **Frequency**: how often aquatic organisms would be exposed to the concentration of concern for the duration of concern

Example:

- the 4-day average concentration (*duration*)
- should not exceed 10 µg/L (*magnitude*)
- more than once in 3 years on average (*frequency*)

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Identify Applicable Water Quality Standards

Some of EPA's recommended aquatic life criteria are dependent on other environmental factors

- Metals
  - most criteria are a function of ambient hardness
- Ammonia
  - acute criteria are a function of pH
  - chronic criteria are a function of pH and temperature and the presence or absence of early life stages of fish
- Dissolved Oxygen
  - criteria are a function of the presence or absence of early life stages of fish

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Characterize the Effluent and Receiving Water

1) Identify parameters of concern
   - With an applicable technology-based effluent limitation (TBEL)
   - With a wasteload allocation from a TMDL
   - Identified as needing a WQBEL or monitoring in the previous permit
   - Identified as present in the effluent through monitoring
   - Otherwise expected to be present in the discharge

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Characterize the Effluent and Receiving Water

2) Determine critical conditions
   - Typically summer low flow
     - 7Q10: 7-day avg. low flow with 10-year recurrence
   - Wet weather flow for stormwater
   - Acquire data
     - USGS
     - Utah Water Rights
     - Other agencies (county, city)
     - DWQ
   - Analyze data
     - Continuous long term record: EPA DFLOW program
     - Continuous short term record; lowest 7-day avg. in record
     - Spot measurements: 20th percentile
     - Predictive: USGS StreamStats

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Characterize the Effluent and Receiving Water

3) Characterize effluent
   - Flow
     - Max. daily and avg. monthly
     - Design capacity or projected 5-year
   - Water Quality
     - Temperature
     - pH
     - Alkalinity
     - Hardness
     - Seasonal avg.
     - CURRENT: Request from DWQ
     - FUTURE: Public access to DWQ Water Quality Database

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Characterize the Effluent and Receiving Water

4) Characterize receiving water quality
   - All parameters of concern
     - Seasonal average for conventional parameters
     - 80th percentile for toxics
   - Acquire data
     - CURRENT: Request data from DWQ
     - FUTURE: Public access to DWQ Water Quality Database
   - Often no data for metals
     - Assume background ½ water quality standard

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Determine the Allowable Mixing Zone

- UAC R317-2-5
- Rapid and complete mixing – no mixing zone allowed
  - Assumed where the discharge has a mean daily flow greater than or equal to half the critical low flow (the 7Q10) of the receiving stream
  - Allowable dilution is 100 percent of the critical low flow

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Determine the Allowable Mixing Zone

- Incomplete mixing – mixing zone may be allowed
  - Chronic aquatic life and human health criteria:
    - Rivers: shall not exceed 2,500 feet
    - Reservoirs: shall not exceed 200 feet
  - Acute aquatic life criteria
    - Rivers: shall not exceed 50% of stream width nor have a residency time of greater than 15 minutes
    - Reservoirs: shall not exceed 35 feet
- Zone of Initial Dilution (ZID) is that part of a receiving water where it is permissible to exceed the magnitude of an acute numeric criterion

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Determine the Allowable Mixing Zone

- Determining where complete mixing occurs
  - Field observation
    - Use specific conductivity or add conservative tracer to effluent
    - Measure along cross-section
    - Move downstream until uniform along cross-section
  - Model: simulate the plume using modeling tools
    - CORMIX
    - Spreadsheet tools

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Determine the Allowable Mixing Zone

Individual mixing zones may be further limited or disallowed in consideration of the following factors in the area affected by the discharge:

a) Bioaccumulation in fish tissues or wildlife,
b) Biologically important areas such as fish spawning/nursery areas or segments with occurrences of federally listed threatened or endangered species,
c) Potential human exposure to pollutants resulting from drinking water or recreational activities,
d) Attraction of aquatic life to the effluent plume, where toxicity to the aquatic life is occurring.
e) Toxicity of the substance discharged,
f) Zone of passage for migrating fish or other species (including access to tributaries), or
g) Accumulative effects of multiple discharges and mixing zones.

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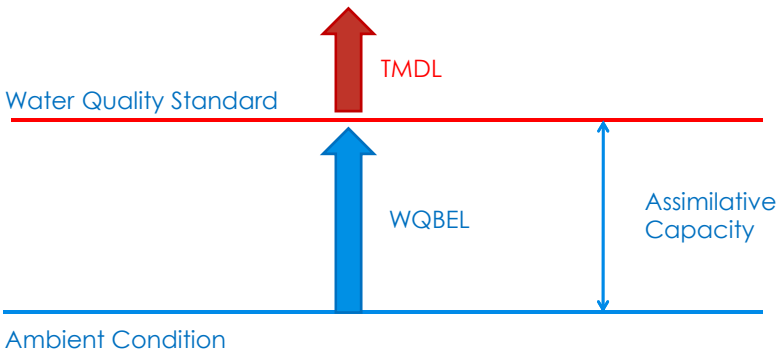
Calculate Chemical Specific WQBELs



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Calculate Chemical Specific WQBELs

Conservative Parameters

For most conservative constituents, a simple mass balance is calculated:

background + discharge = downstream standard

$$Q_bC_b + Q_oC_o = (Q_b + Q_o)C_s$$

Solving for discharge concentration, C_o

$$C_o = WLA = [(Q_b + Q_o)C_s - Q_bC_b / Q_o$$

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Calculate Chemical Specific WQBELs

Eutrophication and Non-Conservative Parameters

- CURRENT: QUAL2Kw Model
- PAST: Utah Stream DO Model

Bioaccumulative Parameters and Great Salt Lake

- Ecological risk based approach

No Dilution

- Intermittent streams
- Ephemeral washes
- Wetlands
- Meet water quality standards end-of-pipe

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WQBELs to Permit Limits

When must a permit writer establish effluent limitations using water quality criteria?

Limitations must be established in permits to control all pollutants or pollutant parameters that are or may be discharged at a level that will cause, have the ***reasonable potential*** to cause, or contribute to an excursion above any state water quality standard [40 CFR 122.44(d)(1)(i)]

Reasonable Potential Analysis: statistical comparison of effluent characteristics to WQBELs

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WQBELs to Permit Limits

- Compare:
  - WQBELs based on individual facility WLAs with
  - TBELs or other existing limitations with
  - WQBELs based on a TMDL or other watershed-based requirements
- The most stringent limitations for each parameter are the new, calculated final effluent limitations for that parameter
- Final effluent limitations in the permit must meet antidegradation and anti-backsliding requirements

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RESOURCES

- DWQ Developing Permit Limits Web Page
  http://www.waterquality.utah.gov/WQM/WQlimits.htm
- DWQ (2012) *Utah Wasteload Analysis Procedures Version 1.0*
- EPA Water Quality Standards Academy: NPDES Permit including calculating WQBELs:
  http://water.epa.gov/learn/training/standardsacademy/permit_index.cfm
- EPA Web-based NPDES Permit Writer's Training including calculating WQBELs:
  http://cfpub.epa.gov/npdes/outreach/training/pwtraining.cfm
- EPA (2010) *NPDES Permit Writer's Manual: Chapter 6 Water Quality Based Effluent Limits*. EPA 8330-K-10-001
- EPA (1991) *Technical Support Document for Water Quality-Based Toxics Control*. EPA 505/2-90-001