Current Issues in Water Quality Management from A to Z

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July 31, 2012
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Everything from Arsenic to Zero Discharge

...with a monsoon of letters in between...

CWA  TMDL  CAFO
EQA  BADCT  GPL
SDWA  CERCLA  BRP
LUST  WQARF

Regulating Water Quality—the Feds

Pop Quiz!

• US Environmental Protection Agency
  • Established 19__ under President ________

Regulating Water Quality—the Feds

• US Environmental Protection Agency
  • Established 1970 under President Richard M. Nixon

A Trip Back in Time—“The Black Lagoon Beneath Our Feet”

• Environmental Quality Act of 1986 establishes ADEQ
• ADEQ becomes independent agency on July 1, 1987
• Three new state water quality programs established
  – Aquifer Protection Permit (APP) Program
  – Water Quality Assurance Revolving Fund (WQARF)
  – Pesticide Contamination Prevention Program

**Regulatory Classes of Water**

- Drinking Water
- Surface Water
- Groundwater
- Reclaimed Water
  - Treated wastewater
  - Gray water

**Current Water Quality Issues**

A is for...

- Arizona Pollutant Discharge Elimination System (AZPDES) program
- Aquifer Protection Permit (APP) program
- Arsenic and more – the Safe Drinking Water Program
- Beyond the A’s

**Clean Water Act (CWA) and AZPDES**

- CWA protects the quality of “waters of the US”
  - essentially surface waters
- Primary federal law for controlling water pollution
- In 2002, ADEQ became the 45th state to gain primacy for federal CWA authorities
- AZPDES: Arizona’s name for the NPDES (National Pollutant Discharge Elimination System) permit

**CWA Purpose**

“...to restore and maintain the chemical, physical, and biological integrity of the Nation’s waters.”

**CWA National Goals**

“Zero discharge,” or the elimination of polluting discharges to the nation’s waters, by 1985

- Restore waters to “fishable and swimmable”
- “No toxics in toxic amounts”
**CWA and AZPDES**
- Program is evolving due to past success
- Traditional emphasis:
  - Chemical pollutants
  - Point sources
- Now, increasing emphasis on:
  - Biological and physical integrity
  - Nonpoint sources
  - Watershed approach to meeting standards (TMDL or Total Maximum Daily Load)

**AZPDES (CWA) Program Components**
- Individual permits
- General permits
- Pretreatment
- Biosolids / sewage sludge
- Surface water quality standards

**AZPDES Individual Permits**
- Issued to all major facilities discharging to a water of the US (164 facilities in AZ)
  - WWTPs (about 75% of all permits)
  - Industrial facilities including power plants
  - Mines
- Permit requires discharge to meet SWQS
- Self-monitoring is the cornerstone of all environmental programs, including AZPDES
  - Random audits of monitoring reports
  - Regular site inspections

**AZPDES General Permits**
- Developed for numerous & generally smaller discharges
- Stormwater general permits
  - EPA: 30% of surface water pollution in US is due to stormwater runoff
  - Industrial facilities
    - 1019 permits issued
    - Municipalities (MS4)
      - 8 Large (>100,000 pop.) and 41 Small
      - Construction sites (generally >1 acre)
        - 10,024 issued to date
    - Must comply with stormwater pollution prevention plan (SWPP)

**AZPDES CAFO* General Permit**
- About 150 CAFOs in AZ
  - 29 feedlots (cattle going to slaughter)
  - 2 poultry
  - 1 piggery
  - rest are dairies
- Aimed at protecting/restoring surface waters, but collateral groundwater benefits, too
- Must contain all wastewater onsite & protect from a 25 yr / 24 hr storm event
- Nutrient management plan
- Pond liner requirements
*Concentrated Animal Feeding Operation

**Impaired Waters**
- ADEQ assesses surface waters every 2 yrs for meeting standards
  - lists impaired waters every 2 yrs (CWA Sec. 303d list)
  - 78 listed impaired waters in AZ
- Primary pollutants causing impairment in AZ
  1. Metals
  2. Turbidity/sediment
  3. Nutrients (nitrogen, phosphorus)
     - irrigation return flows
     - manure handling
  4. Microbial contamination
  5. Pesticides (e.g., DDT)
  6. Low oxygen, low pH
**TMDL Program**

- **Goal:** Return impaired waters to meeting standards
- ADEQ determines loads and load allocations of pollutants
  - Point sources (end-of-pipe)
  - Nonpoint sources
- TMDL implementation plan for load reductions
- Follow up monitoring for effectiveness

**M is for Mercury**

- Increasing data on mercury bioaccumulation in AZ lakes
- Fish advisories now issued for 14 waterbodies
  - Roosevelt Lake, Lake Pleasant, Lake Mary, Parker Canyon, Peña Blanca, Alamo, Lyman, Tonto Cr. below Bear Flats
- Potential sources
  - Atmospheric fallout from power plants
  - Abandoned mine workings, tailings
  - Natural concentrations in rocks & soils
  - Mercury in wastewater discharges
- Atmospheric fallout now appearing dominant

**Mercury Strategy**

- TMDL required for all Hg-impaired waters
- Long-term strategy:
  - Determine source contributions and loads
    - ADEQ has funded fate & transport studies by NAU and UA
  - Prevent new sources from entering environment
  - Reduce contributions from existing sources

**Aquifer Protection Permits**

- **Objective:** Protect aquifers for drinking water use
  - All aquifers in Arizona are classified for drinking water protected use
- **Mechanism:** Permits to control discharges (APPs)

**Aquifer Protection Permits**

- **Individual APPs**
  - Mines
  - Power plants & other industrial facilities
  - Sewage treatment plants (306)
- **General APPs**
  - On-site wastewater treatment facilities
    - Serve 20% of AZ population
    - Permit applies to septic tank & alternative systems up to 3000 gpd
    - More stringent permit for 3-24,000 gpd: Requires nitrogen removal
    - 12,000 new systems permitted per year during housing boom
    - Now about 6000 systems approved per year
  - Sewage collection systems
  - Other small miscellaneous discharges

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**Septic Tanks**

- Linked to both groundwater & surface water contamination by nitrogen/nitrate
- Cause usually is high densities (more than 1 per acre in populated areas)
- APP program requires alternative system technologies that reduce nitrogen in new, high-density developments

**The Twin Pillars of APP Protection**

1. Facility must not exceed any AWQS at a point of compliance (POC) in the aquifer
   - If AWQS is already exceeded, no further degradation is allowed at the POC
   - POC is usually set in the aquifer at the limit of where pollutants are placed (e.g., dike, impoundment, etc.)

2. Facility must employ Best Available Demonstrated Control Technology (BADCT)
   - Example: BADCT for new or expanding WWTPs
     - Pathogen-free effluent
     - Nitrogen removal
     - Clear (non-turbid) discharge
     - Odor control

**Size of Wastewater Treatment Plants Permitted Under APP**

- **Greatest Design Flow:**
  - 230 mgd (Phoenix 91st Ave WWTP)
- **WWTP Sizes**
  - ≥10 mgd = 20
  - 5-9.9 mgd = 7
  - 1-4.9 mgd = 68
  - 0.1-0.99 mgd = 109
  - <0.1 mgd = 96

**Reclaimed Water Use in Arizona**

- 90% of reuse occurs in just four states, Arizona being one

**AZ Pesticide Contamination Prevention Program**

- Established in original EQA
  - To prevent groundwater pollution, such as the major DBCP and EDB problems discovered in the late 1970’s

Source: Western Water, July/August 2008
**Arizona’s Pesticide Program**
- Ag pesticides are screened for mobility & persistence
- If too mobile or persistent, listed on Groundwater Protection List
  - Strict field application and reporting requirements for GPL pesticides
- 69 pesticides currently listed on GPL, mostly herbicides
- Intensive soil & groundwater monitoring for listed pesticides
- Wildly successful—no significant groundwater contamination problems since program inception

**Drywell Regulation**
- Used for stormwater runoff control
- Almost unique to Arizona
- Caused major groundwater contamination problems prior to regulation under EQA

**Safe Drinking Water**
- ADEQ administers the federal Safe Drinking Water Act (SDWA) in AZ for EPA
- 1600 regulated public water systems in AZ serve more than 5,000,000 people
- Maximum Contaminant Levels (MCLs) are set for about 100 contaminants

**Drinking Water Current Issues**
- Mopping up compliance for lowered arsenic MCL in 2006
  - Still 20 systems under unilateral orders or consent orders
- EPA going forward on setting perchlorate MCL again
- EPA revising Total Coliform Rule
  - Total Coliform Bacteria MCL eliminated
  - Replace with treatment technology requirements
  - Fecal coliform & E. coli MCLs stay
**The Disinfection By-Product Challenge**

- New EPA regulations for DBPs worry water utilities
- MCL for total trihalomethane (Total THM) lowered from 100 ppb to 80 ppb
- MCLs for new DBPs added
- Beginning in 2012 for larger systems, results can’t be averaged within system
  - compliance is required at most susceptible locations

**Chloroform**

- Carcinogenic DBPs form during disinfection by Cl & other disinfectants
- DBP levels are higher when dissolved and particulate organic precursors are in source water
- Alternative disinfectants may form new and even more potent DBPs
- This is the most challenging and costly hurdle DW utilities face in coming years

**Disinfection By-Products & Forest Fires**

- Arizona State University is conducting fire impact study
- Dissolved and particulate organic matter will be sampled in Salt River reservoir system
- Organic levels and transformations will be modeled
- Goal: Predict DBP impacts at drinking water treatment plants on downstream canal system

**Drinking Water Issues on the Horizon**

- Total Chromium and Chromium-6
  - current MCL of 100 μg/l is for Total Cr
  - however, Cr-6 is the toxic valence
  - speculation is that EPA will set a separate MCL for Cr-6 of 3-10 μg/l
  - would put many systems in NW & central AZ out of compliance

**Drinking Water Issues on the Horizon**

- Fluoride MCL (currently 4 mg/l)
  - Current MCL applies only to “community water systems”
  - EPA may lower MCL
  - EPA may extend MCL to “non-transient, non-community systems”
    - schools, businesses, etc., with own water systems
  - Could put many AZ systems out of compliance

**Arizona Drinking Water Violations**

(ranked by number of NOVs)

1. Disinfection byproducts (Monitoring & Reporting)
2. Disinfection (mostly M&R for chlorine levels)
3. Consumer Confidence Reports
4. Lead/copper (M&R)
5. Chemical/radiological constituents (M&R)
6. Chemical/radiological exceedances
   - mostly for arsenic
7. Total coliform (M&R)
8. Total coliform exceedances
**Water Quality Standards Setting**

- **Drinking water standards (MCLs)**
  - EPA promulgates, then ADEQ adopts
- **Surface water quality standards**
  - Stds are developed for different uses (DW, Ag, Aquatic & Wildlife, etc.)
- **Aquifer Water Quality Standards**
  - Essentially same as drinking water MCLs
- **Reclaimed Water Quality Standards**
  - 5 reclaimed water quality classes (A+, A, B+, B, C)

**Emerging Contaminants**

Again, stay tuned!

More later.

**Salinity: The perennial contaminant!**

- But not well addressed by regulatory programs
- Salt buildup has been an issue since prehistoric times
- Irrigated agriculture & other water uses concentrate salts in soils, groundwater, and surface water in desert basins
- EPA recommends levels below 500 ppm for drinking
  - CAP water already is 500 – 700 ppm
  - Pumped groundwater used in AZ up to:
    - 1000 ppm or more for drinking
    - 3000 ppm or more for irrigation

**The Curse of Salinity**

- Central AZ salt imbalance: 1M tons/yr of added salt
  - Imported in surface waters (CAP, Salt, Verde)
  - Imported for water softeners
- One cycle of city use increases salinity in reclaimed water by 200 – 500 ppm
  - Home water softeners are big contributors in newer residential areas
- Salinity impacts
  - Early piping and appliance failure
  - Higher industrial water treatment costs
  - Lower crop yields and reduced crop types
  - “Burning” of turf
  - Groundwater rendered unusable for drinking
- Central Arizona Salinity Study (CASS) is developing strategies
- Desalination is still very costly

**Remedial Programs**

- Cleanup of sites with soil and groundwater contamination
- Rely on Responsible Parties (RPs) whenever possible
- Three key programs
  - Federal Superfund (CERCLA) (Comprehensive Environmental Response, Compensation and Liability Act)
  - State Superfund (WQARF) (Water Quality Assurance Revolving Fund)
  - Tanks Program for USTs

**Federal Superfund (CERCLA)**

- Comprehensive Environmental Response, Compensation, and Liability Act of 1980
- Currently 9 “Superfund” (aka National Priorities List or NPL) sites in AZ
  - Apache Nitrogen Products, Benson
  - Hassayampa Landfill, southwest of Buckeye
  - N&S Indian Bend Wash, Scottsdale & Tempe
  - Motorola 52nd St, Phoenix
  - Phoenix-Goodyear Airport, Goodyear
  - Williams APB, Mesa
  - Yuma Marine Corps Air Center
  - Tucson Airport Area
  - Iron King Mine-Humboldt Smelter
State Superfund (WQARF)

- Water Quality Assurance Fund
- Established by EQA amid publicity of many discoveries of solvent-contaminated groundwater plumes in early 1980s
- Hazardous substance cleanup of contaminated soil, groundwater, and surface water
- Funded by legislative appropriations, cost recovery, and special taxes and fees
  - Fund has been repeatedly swept by Legislature to balance budget

Solvent cleanup of groundwater at West Van Buren Area WQARF Site

Solvent and metals are primary contaminants
- 35 sites listed on WQARF Registry
  - 22 in greater Phoenix area
  - 7 in Tucson area
  - 6 in rest of state

Drilling monitor well and preparing for aquifer pump test at Tyson Wash WQARF Site, Quartzsite

UST and LUST: ADEQ’s Tank Program

- Addresses petroleum fuel tanks
  - Generally not covered by CERCLA & WQARF
- LUST sites are everywhere – metro and rural!
- Gasoline/diesel are main primary fuels
- Fuel additives complicate cleanup
  - Octane enhancers: BTEX (benzene, ethylbenzene, xyylene, toluene)
  - 1,2-DCA (a recalcitrant chlorinated solvent once added as a lead scavenger)
  - Oxygenates (mainly MTBE)

UST and LUST: ADEQ’s Tank Program

- Cleanups must address soil vapor, dissolved, and NAPL (non-aqueous phase liquid)
- Cumulative LUST cases: 8523
- LUST closures to date: 7557 (89%)
- Open cleanup cases: 966 (11%)
- Most leaks occurred before 1998

Impact of Climate Change on Water Quality: A Hierarchy of Modeling and Predictions

- Greenhouse gas trends ▼
- Temperature modeling ▼
- Precipitation predictions ▼
- Water supply impacts ▼
- Water quality impacts ▼

Water Quality Impacts of Climate Change

- Still poorly studied
- Current status: mostly hypothetical statements & generalized predictions
- Learn from current analogues (e.g., Australia)
- Incorporate water quality into adaptive management scenarios
Temperatures in the Southwest
- Models predict global average rise of 6-7 °F by 2100
- Southwest is considered a “loser” in climate change
- AZ showing the fastest temperature increases in the US
- Avg. increase predicted to be 8-12°F
- 10% chance of 20 °F increase by 2100

Precipitation Modeling
- Higher temperatures evaporate more water
- Harder to get a saturated air mass, but more moisture in atmosphere for precipitation
- More extreme flood and drought extremes

Projected Soil Moisture and Dry Days
- Drier soils
- More dry days
- Reduced snowpack
- Rise in snow line
- Earlier runoff
- More evaporation
- Increased sublimation
- More variable precipitation

Water Supply Implications
- Extreme drought likely to increase from less than 3% of the globe today to 30% by 2100
  - Hadley Center, UK
- Potential permanent drought by 2050 throughout the Southwest if CO₂ rises to 450 ppm and above
  - a 1930s Dust Bowl would stretch from Kansas to California
  - Science, 2007
- US Southwest is one of 7 regions in world facing permanent Dust Bowl
  - NOAA, 2009

Water Supply Implications for the Southwest
- Overall reduced water supply
- More intense precipitation events
- Increased risk of flash floods; infrastructure failures
- Seasonal shifts in runoff patterns
- Reduced groundwater recharge

Implications for the Colorado River
- All models agree that there will be 5-40% less water in the Colorado R.
  - U of A believes most likely scenario is 20% less water by 2050
  - U of A believes there is a 30% chance Lakes Powell and Mead will be empty by 2050 if we don’t start taking steps today
  - If this happens, the CAP will no longer be able to deliver water
  - Temperature affects both supply and demand
Southwest Water Quality Considerations

- Higher water temperatures
  - reduced dissolved oxygen
  - stress on aquatic species
  - reduced habitat for cold water species
  - increased severity of algal blooms
- Reduced flows, especially in summer
  - higher pollutant concentrations
  - ecosystem impacts
- Increased sediment, wildfire runoff & dust deposition
- Increased surface water salinity
- Increased salinity to groundwater

Increased suspended solids and organic carbon in surface waters will have very negative impact on drinking water treatment
  - Sediment
  - nutrients
  - fire-related runoff
  - increased average & extreme concentrations
- More severe taste and odor problems from algal blooms

Switch to groundwater pumping may impose other treatment requirements
  - Nitrate, arsenic, salinity
- High water temperatures may aid growth of dangerous emerging pathogens
  - Naegleria fowleri
  - Vibrio cholerae
  - Legionella pneumophila
  - Mycobacterium avium

- Better monitoring data, monitoring approaches, data capture, and research are needed to properly assess:
  - watershed conditions
  - reclaimed water usage
  - occurrence and impact of emerging contaminants
  - impacts of drought/climate change
- Drought/climate change and water quality impacts will become increasingly entangled
- No lack of career possibilities to address the current and emerging water quality issues from A to Z
- Critical need to translate these complex issues to the general citizenry

Water Quality from A – Z

Or else, e-mail me at: cgg@azdeq.gov