Project Review

Direction for Implementation

AZ Narrative Nutrient Standard

- R18-11-108A. A surface water shall be free from pollutants (nutrients in this case) in amounts that:
  - Settle to form bottom deposits that inhibit or prohibit the habitation, growth, or propagation of aquatic life;
  - Cause objectionable odor in the area in which the surface water is located;
  - Cause off-taste or odor in drinking water;
  - Cause off-flavor in aquatic organisms;
  - Are toxic to humans, animals, plants, or other organisms;
  - Cause the growth of algae or aquatic plants that inhibit or prohibit the habitation or other aquatic life or that impair recreational uses;
  - Cause or contribute to a violation of an aquifer water quality standard…;
  - Change the color of the surface water from natural background levels

Project Goals

- To help develop flexible *narrative nutrient criteria* and *associated implementation procedures* for Arizona's lakes that will maintain a consistent, scientifically-based means of compliance assessment.
- Avoid "one-size fits all" numeric criteria; i.e., consider how variability lake/watershed characteristics affects trophic responses.
- Link criteria/numeric targets with designated uses.

Derived Lake Classes

- Deep Lakes & Reservoirs
- Shallow Lakes
- Igneous Lakes
- Sedimentary/Mixed Lithology Lakes
- Urban Lakes

* **Please look over the handout; additional lakes to be added as category determined**

3 Prongs for implementation

- Trophic State Index for AZ
  - Secchi depth; chlorophyll-a, TKN, Total P
  - TKN and Total P ranges based on statistical relationships between secchi depth and chlorophyll-a for 5 lake classes
- Matrix of endpoints expressed as ranges, plus % blue-green algae
- Fisheries surveys and user surveys – ordinal rankings to support attainment of 1) fishery use and 2) recreation use

Trophic State Index (TSI)

- Relative measure of lake productivity (algae)
- A continuum, not discrete thresholds
- Descriptive Thresholds:
  - Oligotrophic: clear lakes w/low productivity
  - Mesotrophic: moderately productive lakes
  - Eutrophic: productive ("greener") lakes
  - Hypereutrophic: highly productive; light limited
  - Dystrophic: distinguished by suspended solids or humic acids causing color and limiting light for algal growth

Relationship of trophic parameters to designated uses in *Temperate* Lakes

TSI	SD	TP	Attributes	Water Supply	Recreation	Fisheries
<30 Oligotrophy	>8	<.006	Clear water with DO throughout the year in hypolimnion			Salmonid fisheries dominant
30-40	8-4	.006-.012	Hypolimnia of shallower lakes may become anoxic			Salmonid fisheries in deep lakes
40-50 Mesotrophy	4-2	.012-.024	Water moderately clear but increasing probability of hypolimnetic anoxia in summer	Iron and manganese evident in summer. THM precursors exceed 0.1 mg/L		Hypolimnetic anoxia results in loss of salmonids. Walleye may predominate
50-60 Eutrophy	2-1	.024-.028	Anoxic hypolimnia, macrophyte problems possible	Iron, manganese, taste and odor problems worsen		Warm-water fisheries only. Bass may be dominant
60-70	.5-1	.048-.096	Blue-green algae dominate, algal scums and macrophyte problems		Weeds, algal scums, and low transparency discourage swimming & boating	
70-80 Hypereutrophy	.25-.5	.096-.192	Light-limited rather than nutrient limited, dense algae and macrophytes			
>80	<.25	.192-.384	Algal scums, few macrophytes			Rough fish dominate, summer fish kills possible

Original TSI (Florida) vs. Revised TSI (Arizona)

TSI	Clor-a	Secchi (m)	Total P (mg/L) P-lim	Total P (mg/L) Co-lim	Total N (mg/L) N-lim	Total N (mg/L) Co-lim
< 30	<5	>3	<.010	<.013	<.25	
30-45	5-12	1.2-3	.010-.020	.013-.035	.25-.65	
45-65	12-20	0.6-1.2	.020-.040	.035-.065	.65-1.1	
>65	>20	<0.6	>.040	>.065	>1.1	

TSI	Chlor-a (ug/L)	Secchi (m)	Total-P (mg/L)	Total N (mg/L)	TKN (mg/L)
0	0.3	5.2	0.013	0.5	0.3
10	0.6	4.0	0.019	0.6	0.3
20	1.2	3.1	0.027	0.7	0.4
30	2.5	2.4	0.037	0.8	0.6
40	5.0	1.8	0.052	1.0	0.7
50	10	1.4	0.074	1.2	1.0
60	20	1.1	0.103	1.5	1.2
70	40	0.8	0.145	1.8	1.6
80	81	0.6	0.203	2.2	2.1
90	161	0.5	0.285	2.7	2.7
100	323	0.4	0.400	3.3	3.5

Examples of Arizona TSI Scores

Salt River Lakes	Uses	Lake Category	Chla range	SD range	TKN range	TP range	TSI	Status
Apache Lake	c/dom	Deep	0.0 - 8.5	0.8 - 4.9	0.0 - 4.0	0.0 - 0.415	38.4	mesotrophic
Roosevelt Lake	w/dom	Deep	0.0 - 58.4	0.1 - 5.3	0.2 - 1.0	0.016 - 0.265	47.5	eutrophic
Canyon Lake	c/dom	Deep	0.0 - 5.2	2.0 - 4.0	0.2 - 1.2	0.025 - 0.250	28.1	oligotrophic
Saguaro Lake	c/dom	Deep	0.0 - 32.6	1.2 - 4.3	0.2 - 2.5	0.007 - 0.213	39.3	mesotrophic
Big Lake	c	Deep	3.2 - 8.9	2.0 - 3.2	0.2 - 0.8	0.02 - 0.058	32.3	mesotrophic
Crescent Lake	c	Shallow	1.3 - 24.9	1.3 - 4.4	0.9 - 1.3	0.029 - 0.180	53.9	eutrophic

Verde Lakes		Lake Category	Chla range	SD range	TKN range	TP range		
Bartlett Lake	w/dom	Deep	1.1 - 9.3	0.9 - 3.7	0.2 - 1.0	0.009 - 0.447	42.0	mesotrophic
Horseshoe Reservoir	w/dom	Deep	5.6 - 16.7	0.7 - 1.7	0.7 - 1.8	0.048 - 0.333	60.1	eutrophic
J_D_ Dam Lake	c	Igneous	0.0 - 31.7	0.4 - 2.1	0.5 - 1.0	0.027 - 0.147	48.6	mesotrophic
Whitehorse Lake	c	Igneous	1.1 - 38.1	0.2 - 3.8	0.5 - 1.9	0.031 - 0.223	61.5	dystophic
Watson Lake	w/dom	Igneous	7.7 - 238.3	0.0 - 2.0	1.2 - 3.1	0.081 - 2.300	77.2	hypereutrophic
Peck's Lake	cool	Shallow	0.7 - 3.4	1.1 - 2.5	0.2 - 1.1	0.021 - 0.060	34.2	mesotrophic

More examples…

Urban Lakes		Lake Category	Chla range	SD range	TKN range	TP range	TSI	Status
Papago Park Ponds	w	Urban	2.4 - 6.3	0.4 - 1.1	0.9 - 1.0	0.023 - 0.057	51.2	eutrophic
Cortez Park Lake	w	Urban	0.0 - 14.4	0.6 - 2.2	0.6 - 1.0	0.005 - 0.062	42.9	mesotrophic
Tempe Town Lake	w	Urban	1.3 - 33.0	0.8 - 1.2	0.3 - 2.6	0.006 - 0.034	48.1	mesotrophic
Chaparral Park Lake	w	Urban	0.0 - 16.0	0.0 - 1.4	0.6 - 1.4	0.043 - 0.093	58.1	eutrophic
Kennedy Lake	w	Urban	1.9 - 24.0	0.0 - 9.9	0.8 - 1.4	0.024 - 0.260	50.5	eutrophic
Lakeside Lake	w	Urban	6.0 - 58.0	0.0 - 1.0	0.0 - 2.7	0.000 - 0.490	73.5	hypereutrophic
Alvord Park Lake	w	Urban	19.0 - 45.5	0.3 - 1.1	0.9 - 3.2	0.029 - 0.067	73.7	hypereutrophic

Misc Lakes		Lake Category	Chla range	SD range	TKN range	TP range		
Lake Havasu	w/dom	Deep	0.1 - 2.2	3.0 - 8.0	0.1 - 1.0	0.005 - 0.034	11.9	oligotrophic
Lake Pleasant	w/dom	Deep	1.7 - 16.8	0.0 - 6.0	0.3 - 0.9	0.00 - 0.113	29.3	oligotrophic
Alamo Lake	w/dom	Deep	0.0 - 35.4	0.0 - 4.1	0.0 - 1.3	0.0 - 0.087	32.5	mesotrophic
Luna Lake	c	Sedimentary	4.6 - 98.4	0.0 - 2.7	0.5 - 4.3	0.000 - 0.350	60.1	eutrophic
Woods Canyon Lake	c	Sedimentary	0.6 - 2.7	0.0 - 3.6	0.8 - 0.8	0.020 - 0.020	20.2	oligotrophic
Ashurst Lake	cool	Igneous	0.0 - 47.3	0.0 - 0.5	0.7 - 0.9	0.123 - 0.480	76.8	dystrophic
Pena Blanca Lake	w	Igneous	1.0 - 6.2	0.8 - 2.4	0.3 - 1.1	0.016 - 0.090	39.7	mesotrophic

EPA's National Nutrient Criteria

(based on 25th percentile of *all data/all seasons*)

- Aggregate Ecoregion II (AZ/NM Mountains LAKES):
  - TP (mg/L): 0.009
  - TN (mg/L): 0.10
  - Chl-a (ug/L): 1.9
  - Secchi (m): 4.5
- Aggregate Ecoregion III (remainder of AZ LAKES)
  - TP (mg/L): 0.017
  - TN (mg/L): 0.40
  - TKN (mg/L): 0.30
  - Chl-a (ug/L): 3.5
  - Secchi (m): 2.8
- Aggregate Ecoregion II (AZ/NM Mountains STREAMS)
  - TP (mg/L): 0.01
  - TN (mg/L): 0.12
  - Chl-a (ug/L): 1.08
  - Turbidity (NTU): 1.3
- Aggregate Ecoregion III (remainder of AZ STREAMS)
  - TP (mg/L): 0.022
  - TN (mg/L): 0.38
  - Chl-a (ug/L): 1.78
  - Turbidity (NTU): 2.34

Recommended Targets for Arizona's Lakes and Reservoirs

Beneficial Use	Lake Category	Chl-*a* (µg/L)	Secchi Depth (m)	Tot. Phos. (mg/L)	Tot. Nit. (mg/L)	TKN (mg/L)	Blue-Green Algae (per mL)	Blue-Green Algae (% of total count)
Recreation FBC PBC	Deep	10-15	1.5-2.5	.070-.090	1.2-1.4	1.0-1.1	20,000	--
	Shallow	10-15	1.5-2.0	.070-.090	1.2-1.4	1.0-1.1		--
	Igneous	20-30	0.5-1.0	.100-.125	1.5-1.7	1.2-1.4		--
	Mixed lithology	20-30	1.5-2.0	.100-.125	1.5-1.7	1.2-1.4		--
	Urban	20-30	0.5-1.0	.100-.125	1.5-1.7	1.2-1.4		--
Fisheries								
A&Wcoldwater	Any/All	5-15	1.5-2.0	.050-.090	1.0-1.4	0.7-1.1	--	<50
A&Wcoolwater	Any/All	15-30	0.8-2.0	.090-.125	1.4-1.7	1.1-1.4	--	
A&Wwarmwater	Any/All	25-40	0.8-1.0	.115-.140	1.6-1.8	1.3-1.6	--	
A&Wurban	Urban	30-50	0.7-1.0	.125-.160	1.7-1.9	1.4-1.7	--	
DWS	Any/All	10-20	0.5-1.5	.070-.100	1.2-1.5	1.0-1.2	20,000	--
FC*	NA	NA	NA	NA	NA	NA	*	*
AgI*	NA	NA	NA	NA	NA	NA	*	*
AgL*	NA	NA	NA	NA	NA	NA	*	*

Weight of Evidence*

Ranking of designated uses from most stringent to least stringent (generally):

1. DWS
2. Fishery (esp. cold and cool water)
3. Recreation (esp. deep and shallow)

*** Specific method will be completed by Fall 2005 and will be promulgated in Impaired Waters Rule; used for 305(b) Assessment & 303(d) Listing**

Interpretation of Ranges for 305(b) Water Quality Assessment

- Peak season* value > high end of range = count as an exceedance/non-attainment
- Peak season* value > low end of range = possible non-attainment/impairment; place on Planning List for additional sampling
  - Look to additional sources of info such as harmful algal blooms, fish kills, T&O, toxins
  - Look to user and fisheries surveys

* Peak season: May - Sept (cold & cool)
April – October (warm & most urban)

Tools for Tracking Trends

- Individual TSI scores: TP, TN, TKN, chl-a, secchi depth
- Hypoxic length: depth of very low oxygen (<2 mg/L)
- DO depth gradient: tied to max depth and strength of stratification
- Diel DO fluctuation: degree of flux in DO over a 24-hr period (also diel pH)

What's Ahead, 2005 & Beyond

- Goals for 2005
  - Finalize lake classes
  - Finalize matrix of endpoints by lake class
  - Chlorophyll
    - Secchi
    - TKN, TP, TN
    - % Bluegreen
    - Trophic response/TSI
    - Designated Use Attainment based on thresholds
  - Propose matrix in 2005 Triennial Review; revise uses as needed and ID lakes by category
  - Compile historic and current DO profile data for trends
- Goals for Future
  - More lakes, more data!
    - Refine classes and endpoints as needed
    - Develop phytoplankton index for lakes
    - Develop method for assessing macrophyte growth
  - Promulgate lake implementation in 303(d) rule
  - Work on narrative nutrient implementation for streams
  - Encourage watershed-wide collaboration to protect and enhance lakes, reservoirs & streams

Question?/Comments?

Please review handouts and submit responses to Susan Fitch at fitch.susan@azdeq.gov

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