5. Analysis and Concepts Under Consideration

Water Quality Standards Task Force

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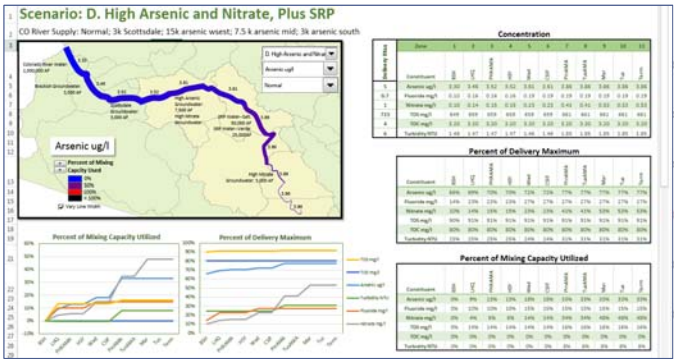
CAP
CENTRAL ARIZONA PROJECT

Considerations for WQ Analysis

- Characteristics of the introduced non-Project Water supplies
  - Volumes
  - Timing
  - Location
  - Water quality "profile"
- Status of the Colorado River supply & recovery
  - Shortage reductions and direct recovery volumes
- Characteristics of the CAP system
  - Physical characteristics
  - Distribution of demands and associated flow rates

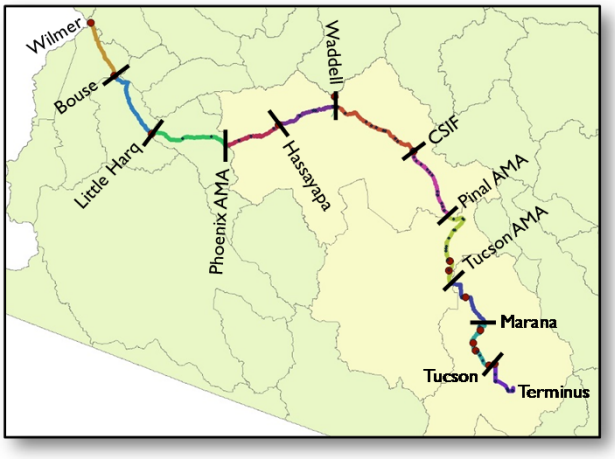
Water Quality Concentration Model

- Goal was to develop a tool to analyze and visualize how introduced water supplies could affect water quality in the CAP system
  - Suitable for testing and comparing a wide range of scenarios, including CAP shortage
  - Appropriate for evaluating different policy options, including implementation of the proposal from the WQSTF stakeholder group
  - NOT suitable for detailed evaluation of an actual project, or for real-time operations



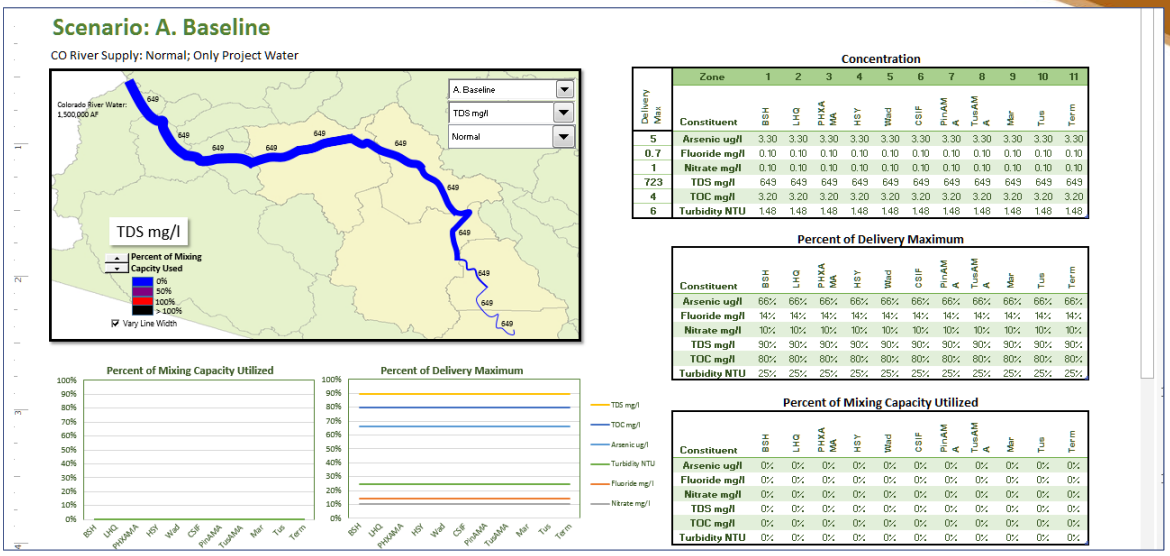
Model Design & Assumptions

- Annual time step
- The CAP system is divided into 11 approximately equal zones
- Full mixing within a zone
- Assumes the relative distribution of future demands is similar to current demands
  - Alternate scenarios are possible
  - Supplies can "move" upstream through exchange



Modeling Steps

- Define water quality parameters for introduced supplies
  - Can be based on known or speculative supply types
- Create non-Project water supply scenarios
  - Volume, by supply type, by zone
- Select CAP supply volume
- Select specific constituent for mapping



Delivery Max	Zone	1	2	3	4	5	6	7	8	9	10	11
	Constituent	BSH	LHQ	PHXA MA	HSY	Wad	CSIF	PinAM A	TusAM A	Mar	Tus	Term
5	Arsenic ug/l	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30	3.30
0.7	Fluoride mg/l	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
1	Nitrate mg/l	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
723	TDS mg/l	649	649	649	649	649	649	649	649	649	649	649
4	TOC mg/l	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
6	Turbidity NTU	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48

Percent of Delivery Maximum

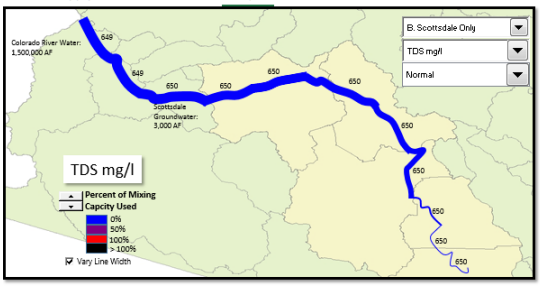
Constituent	BSH	LHQ	PHXA MA	HSY	Wad	CSIF	PinAM A	TusAM A	Mar	Tus	Term
Arsenic ug/l	66%	66%	66%	66%	66%	66%	66%	66%	66%	66%	66%
Fluoride mg/l	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%
Nitrate mg/l	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
TDS mg/l	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
TOC mg/l	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
Turbidity NTU	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%

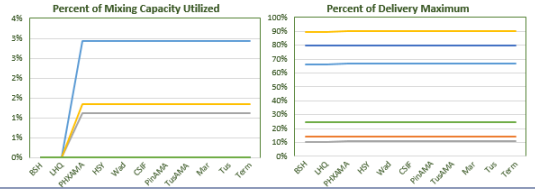
Percent of Mixing Capacity Utilized

Constituent	BSH	LHQ	PHXA MA	HSY	Wad	CSIF	PinAM A	TusAM A	Mar	Tus	Term
Arsenic ug/l	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Fluoride mg/l	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Nitrate mg/l	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
TDS mg/l	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
TOC mg/l	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Turbidity NTU	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Scenario: B. Scottsdale Only

CO River Supply: Normal; 3,000 AF from Harquahala





Concentration

Delivery Max	Zone	1	2	3	4	5	6	7	8	9	10	11
	Constituent	BSH	LHQ	PHXA MA	HSY	Wad	CSIF	PinAM A	TusAM A	Mar	Tus	Term
5	Arsenic ug/l	3.30	3.30	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35	3.35
0.7	Fluoride mg/l	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
1	Nitrate mg/l	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
723	TDS mg/l	649	649	650	650	650	650	650	650	650	650	650
4	TOC mg/l	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
6	Turbidity NTU	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48

Percent of Delivery Maximum

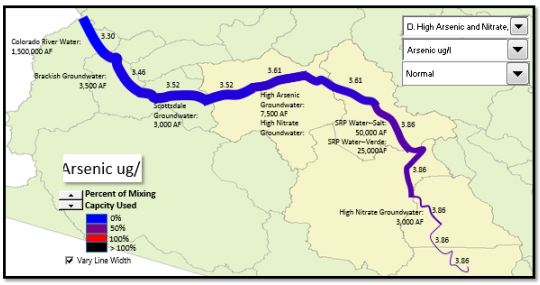
Constituent	BSH	LHQ	PHXA MA	HSY	Wad	CSIF	PinAM A	TusAM A	Mar	Tus	Term
Arsenic ug/l	66%	66%	67%	67%	67%	67%	67%	67%	67%	67%	67%
Fluoride mg/l	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%	14%
Nitrate mg/l	10%	10%	11%	11%	11%	11%	11%	11%	11%	11%	11%
TDS mg/l	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%	90%
TOC mg/l	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
Turbidity NTU	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%

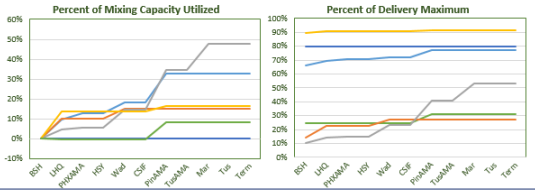
Percent of Mixing Capacity Utilized

Constituent	BSH	LHQ	PHXA MA	HSY	Wad	CSIF	PinAM A	TusAM A	Mar	Tus	Term
Arsenic ug/l	0%	0%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Fluoride mg/l	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Nitrate mg/l	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%
TDS mg/l	0%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%
TOC mg/l	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Turbidity NTU	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Scenario: D. High Arsenic and Nitrate, Plus SRP

CO River Supply: Normal; 3k Scottsdale; 15k arsenic wsest; 7.5 k arsenic mid; 3k arsenic south





Concentration

Delivery Max	Zone	1	2	3	4	5	6	7	8	9	10	11
	Constituent	BSH	LHQ	PHXA MA	HSY	Wad	CSIF	PinAM A	TusAM A	Mar	Tus	Term
5	Arsenic ug/l	3.30	3.46	3.52	3.52	3.61	3.61	3.86	3.86	3.86	3.86	3.86
0.7	Fluoride mg/l	0.10	0.16	0.16	0.16	0.19	0.19	0.19	0.19	0.19	0.19	0.19
1	Nitrate mg/l	0.10	0.14	0.15	0.15	0.23	0.23	0.41	0.41	0.53	0.53	0.53
723	TDS mg/l	649	659	659	659	659	659	661	661	661	661	661
4	TOC mg/l	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
6	Turbidity NTU	1.48	1.47	1.47	1.47	1.46	1.46	1.85	1.85	1.85	1.85	1.85

Percent of Delivery Maximum

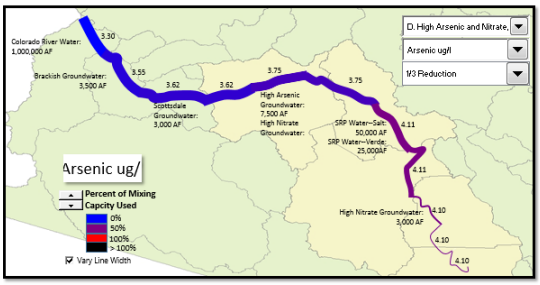
Constituent	BSH	LHQ	PHXA MA	HSY	Wad	CSIF	PinAM A	TusAM A	Mar	Tus	Term
Arsenic ug/l	66%	69%	70%	70%	72%	72%	77%	77%	77%	77%	77%
Fluoride mg/l	14%	23%	23%	23%	27%	27%	27%	27%	27%	27%	27%
Nitrate mg/l	10%	14%	15%	15%	23%	23%	41%	41%	53%	53%	53%
TDS mg/l	90%	91%	91%	91%	91%	91%	91%	91%	91%	91%	91%
TOC mg/l	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
Turbidity NTU	25%	25%	25%	25%	24%	24%	31%	31%	31%	31%	31%

Percent of Mixing Capacity Utilized

Constituent	BSH	LHQ	PHXA MA	HSY	Wad	CSIF	PinAM A	TusAM A	Mar	Tus	Term
Arsenic ug/l	0%	9%	13%	13%	18%	18%	33%	33%	33%	33%	33%
Fluoride mg/l	0%	10%	10%	10%	15%	15%	15%	15%	15%	15%	15%
Nitrate mg/l	0%	4%	6%	6%	14%	14%	34%	34%	48%	48%	48%
TDS mg/l	0%	14%	14%	14%	14%	14%	16%	16%	16%	16%	16%
TOC mg/l	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Turbidity NTU	0%	0%	0%	0%	0%	0%	8%	8%	8%	8%	8%

Scenario: D. High Arsenic and Nitrate, Plus SRP

CO River Supply: 1/3 Reduction; 3k Scottsdale; 15k arsenic wsest; 7.5 k arsenic mid; 3k arsenic south



Concentration

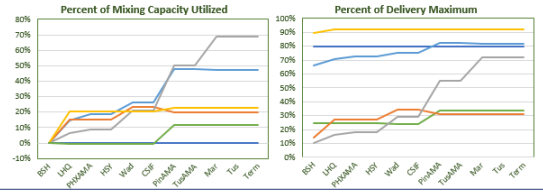
Delivery Max	Zone	1	2	3	4	5	6	7	8	9	10	11
	Constituent	BSH	LHQ	PHXAMA	HSY	Wad	CSIF	PinAMA	TusAMA	Mar	Tus	Term
5	Arsenic ug/l	3.30	3.55	3.62	3.62	3.75	3.75	4.11	4.11	4.10	4.10	4.10
0.7	Fluoride mg/l	0.10	0.19	0.19	0.19	0.24	0.24	0.22	0.22	0.22	0.22	0.22
1	Nitrate mg/l	0.10	0.16	0.18	0.18	0.29	0.29	0.55	0.55	0.72	0.72	0.72
723	TDS mg/l	643	664	664	664	664	664	666	666	666	666	666
4	TOC mg/l	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
6	Turbidity NTU	1.48	1.46	1.46	1.46	1.45	1.45	2.02	2.02	2.01	2.01	2.01

Percent of Delivery Maximum

Constituent	BSH	LHQ	PHXAMA	HSY	Wad	CSIF	PinAMA	TusAMA	Mar	Tus	Term
Arsenic ug/l	66%	71%	72%	72%	75%	75%	82%	82%	82%	82%	82%
Fluoride mg/l	14%	27%	27%	27%	34%	34%	31%	31%	31%	31%	31%
Nitrate mg/l	10%	16%	18%	18%	29%	29%	55%	55%	72%	72%	72%
TDS mg/l	90%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%
TOC mg/l	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
Turbidity NTU	25%	24%	24%	24%	24%	24%	34%	34%	34%	34%	34%

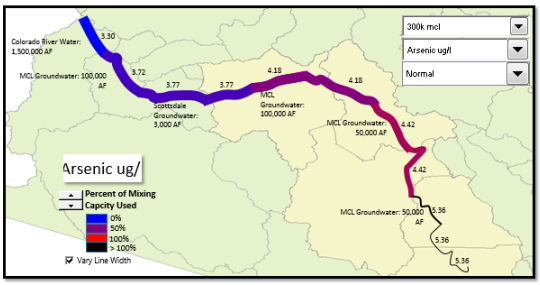
Percent of Mixing Capacity Utilized

Constituent	BSH	LHQ	PHXAMA	HSY	Wad	CSIF	PinAMA	TusAMA	Mar	Tus	Term
Arsenic ug/l	0%	15%	19%	19%	26%	26%	48%	48%	47%	47%	47%
Fluoride mg/l	0%	15%	15%	15%	23%	23%	20%	20%	20%	20%	20%
Nitrate mg/l	0%	7%	9%	9%	21%	21%	50%	50%	69%	69%	69%
TDS mg/l	0%	20%	20%	20%	20%	20%	23%	23%	23%	23%	23%
TOC mg/l	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Turbidity NTU	0%	0%	0%	0%	-1%	-1%	12%	12%	12%	12%	12%



Scenario: 300k mcl

CO River Supply: Normal; Only Project Water



Concentration

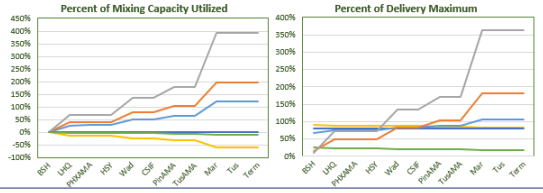
Delivery Max	Zone	1	2	3	4	5	6	7	8	9	10	11
	Constituent	BSH	LHQ	PHXAMA	HSY	Wad	CSIF	PinAMA	TusAMA	Mar	Tus	Term
5	Arsenic ug/l	3.30	3.72	3.77	3.77	4.18	4.18	4.42	4.42	5.36	5.36	5.36
0.7	Fluoride mg/l	0.10	0.34	0.34	0.34	0.58	0.58	0.73	0.73	1.28	1.28	1.28
1	Nitrate mg/l	0.10	0.72	0.73	0.73	1.34	1.34	1.70	1.70	3.63	3.63	3.63
723	TDS mg/l	649	640	640	640	631	631	625	625	604	604	604
4	TOC mg/l	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20	3.20
6	Turbidity NTU	1.48	1.39	1.39	1.39	1.30	1.30	1.24	1.24	1.03	1.03	1.03

Percent of Delivery Maximum

Constituent	BSH	LHQ	PHXAMA	HSY	Wad	CSIF	PinAMA	TusAMA	Mar	Tus	Term
Arsenic ug/l	66%	74%	75%	75%	84%	84%	88%	88%	107%	107%	107%
Fluoride mg/l	14%	49%	49%	49%	83%	83%	104%	104%	183%	183%	183%
Nitrate mg/l	10%	72%	73%	73%	134%	134%	170%	170%	####	####	####
TDS mg/l	90%	89%	89%	89%	87%	87%	86%	86%	84%	84%	84%
TOC mg/l	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
Turbidity NTU	25%	23%	23%	23%	22%	22%	21%	21%	17%	17%	17%

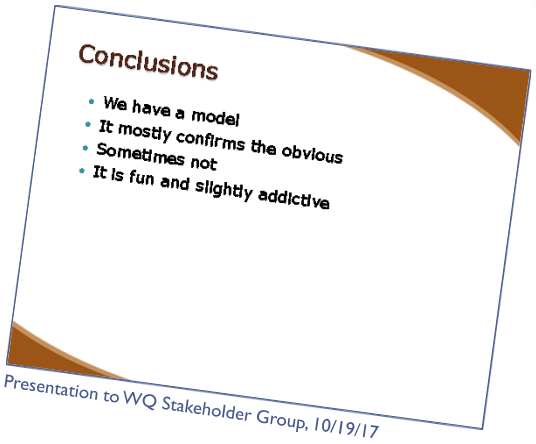
Percent of Mixing Capacity Utilized

Constituent	BSH	LHQ	PHXAMA	HSY	Wad	CSIF	PinAMA	TusAMA	Mar	Tus	Term
Arsenic ug/l	0%	25%	28%	28%	52%	52%	66%	66%	121%	121%	121%
Fluoride mg/l	0%	40%	40%	40%	80%	80%	105%	105%	197%	197%	197%
Nitrate mg/l	0%	63%	70%	70%	138%	138%	178%	178%	####	####	####
TDS mg/l	0%	-12%	-12%	-12%	-24%	-24%	-32%	-32%	-61%	-61%	-61%
TOC mg/l	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Turbidity NTU	0%	-2%	-2%	-2%	-4%	-4%	-5%	-5%	-10%	-10%	-10%

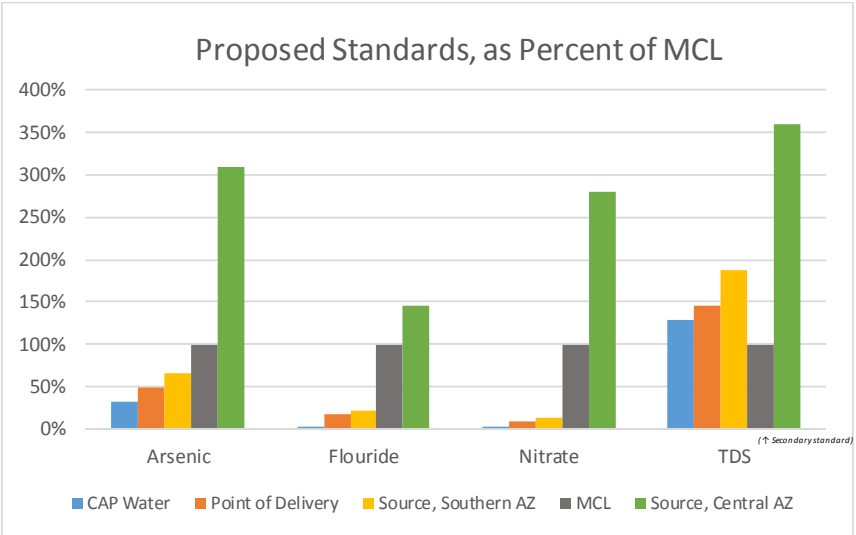


Role of the Model

- The model is a helpful <u>tool</u> for evaluating future scenarios and policy options
- It can provide *insights* into the policy choices, but does not *determine* policy choices
  - The policy choices themselves have many other dimensions (e.g., equity, risk, etc.)
  - One potentially useful insight has to do with the relationship between the current water quality and the "point of delivery" standards from the Stakeholder proposal

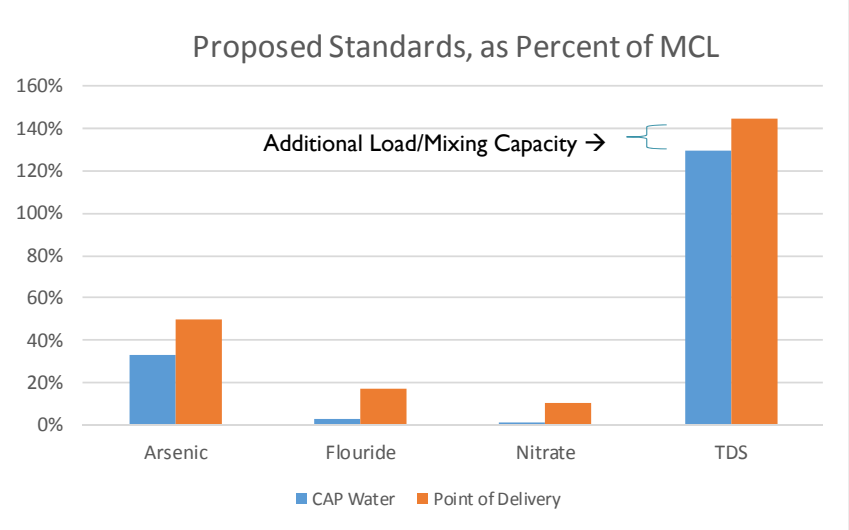


Comparison Chart



Based on revised Stakeholder Proposal

Current vs. Delivery Max

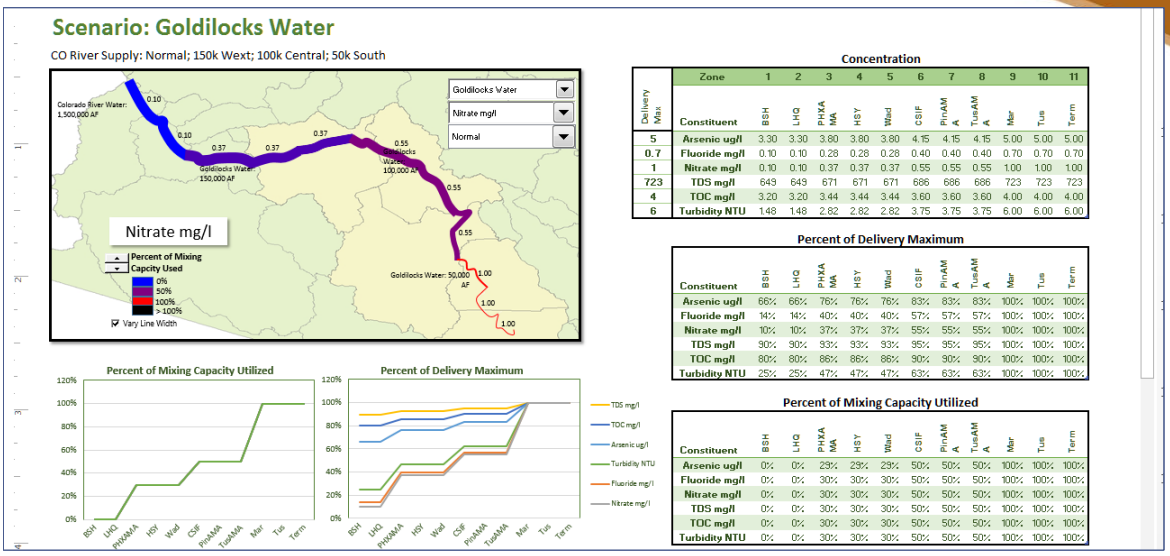


Mixing Capacity

- Ideally, water quality standards/program would sustainably manage that mixing capacity
  - Allow benefits of mixing (i.e., cost savings for reduced treatment)
  - Ensure that mixing capacity is available for later projects
- *Is there an analytical way to determine the "sweet spot"?*
  - One approach is to consider a "buildout" scenario

Buildout Scenario

- What "composite" supply results in 100% of the mixing capacity being used when the last non-Project supply is introduced?
- This can be determined analytically, provided the following two questions are addressed:
  - What is the maximum realistic volume of introduced supplies?
  - How are those supplies distributed along the CAP system?



Scenario: Goldilocks Water

CO River Supply: Normal; 150k Wext; 100k Central; 50k South

Concentration

Delivery Max	Zone	1	2	3	4	5	6	7	8	9	10	11
	Constituent	BSH	LHQ	PHXA MA	HSY	Wad	CSIF	PinAM A	TusAM A	Mar	Tus	Term
5	Arsenic ug/l	3.30	3.30	3.80	3.80	3.80	4.15	4.15	4.15	5.00	5.00	5.00
0.7	Fluoride mg/l	0.10	0.10	0.28	0.28	0.28	0.40	0.40	0.40	0.70	0.70	0.70
1	Nitrate mg/l	0.10	0.10	0.37	0.37	0.37	0.55	0.55	0.55	1.00	1.00	1.00
723	TDS mg/l	649	649	671	671	671	686	686	686	723	723	723
4	TOC mg/l	3.20	3.20	3.44	3.44	3.44	3.60	3.60	3.60	4.00	4.00	4.00
6	Turbidity NTU	1.48	1.48	2.82	2.82	2.82	3.75	3.75	3.75	6.00	6.00	6.00

Percent of Delivery Maximum

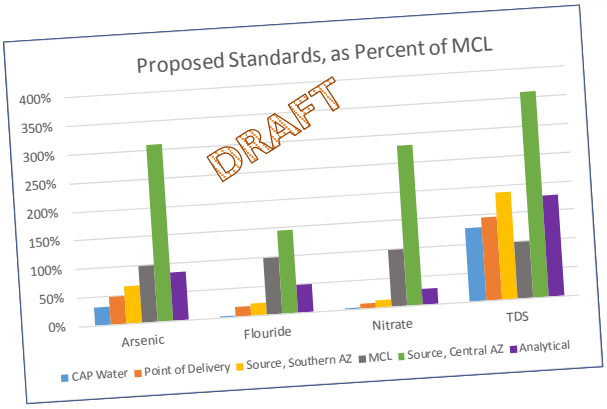
Constituent	BSH	LHQ	PHXA MA	HSY	Wad	CSIF	PinAM A	TusAM A	Mar	Tus	Term
Arsenic ug/l	66%	66%	76%	76%	76%	83%	83%	83%	100%	100%	100%
Fluoride mg/l	14%	14%	40%	40%	40%	57%	57%	57%	100%	100%	100%
Nitrate mg/l	10%	10%	37%	37%	37%	55%	55%	55%	100%	100%	100%
TDS mg/l	90%	90%	93%	93%	93%	95%	95%	95%	100%	100%	100%
TOC mg/l	80%	80%	86%	86%	86%	90%	90%	90%	100%	100%	100%
Turbidity NTU	25%	25%	47%	47%	47%	63%	63%	63%	100%	100%	100%

Percent of Mixing Capacity Utilized

Constituent	BSH	LHQ	PHXA MA	HSY	Wad	CSIF	PinAM A	TusAM A	Mar	Tus	Term
Arsenic ug/l	0%	0%	29%	29%	29%	50%	50%	50%	100%	100%	100%
Fluoride mg/l	0%	0%	30%	30%	30%	50%	50%	50%	100%	100%	100%
Nitrate mg/l	0%	0%	30%	30%	30%	50%	50%	50%	100%	100%	100%
TDS mg/l	0%	0%	30%	30%	30%	50%	50%	50%	100%	100%	100%
TOC mg/l	0%	0%	30%	30%	30%	50%	50%	50%	100%	100%	100%
Turbidity NTU	0%	0%	30%	30%	30%	50%	50%	50%	100%	100%	100%

Buildout Scenario

- The primary *insight* that is gained has to do with how tight or loose each of the parameters is
- By themselves, the numbers are not suitable for direct translation into introduction standards, but they can help inform the discussion of tradeoffs



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