

OTCO Water Workshop  
March 5, 2014



# ALMU – Doing More for Less for Four Decades

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Municipal Utilities



**MWH**<sup>®</sup>

*BUILDING A BETTER WORLD*

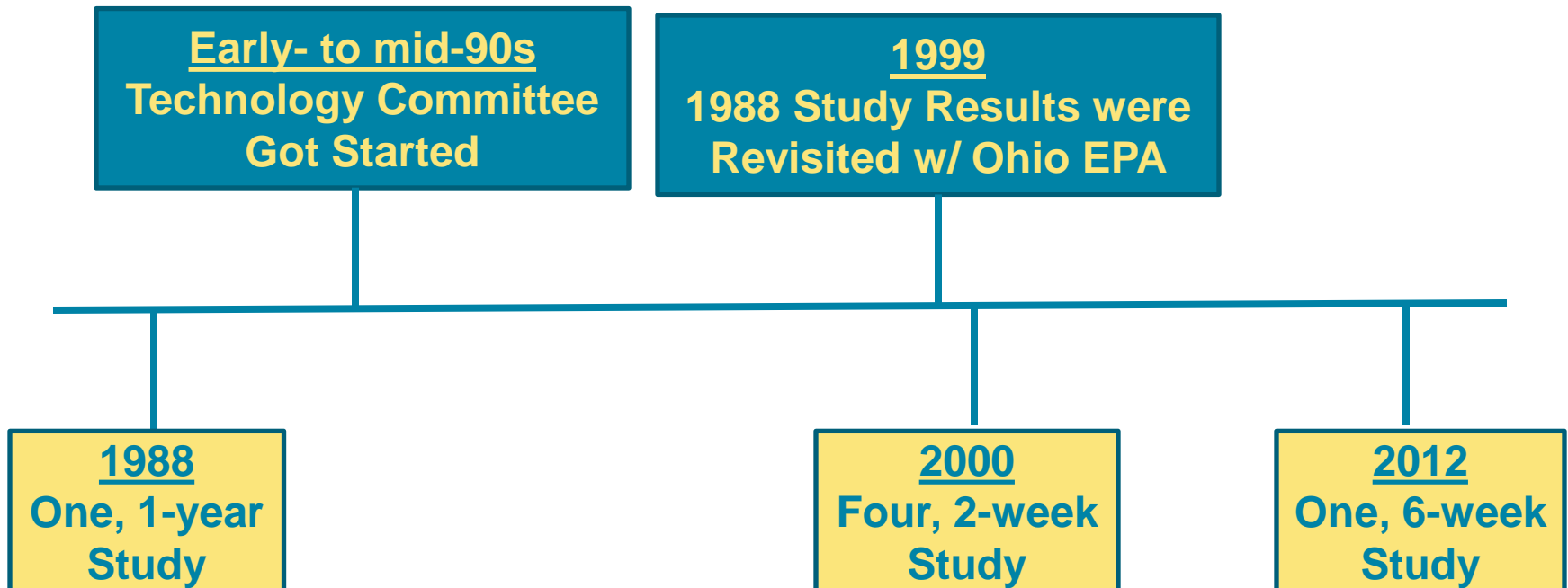
# Items to be Discussed



- **Past Expansion / Upgrade Projects**
- **Recent Expansion / Upgrade Projects**
  - Construction project implementation
  - Water master plan update
  - Demonstration study completion
- **Future Expansion / Upgrade Alternatives**
  - Expansion of Approved Capacity to 60 MGD
  - Capacity of Sites north and south of Lake Road

# ALMU has Successfully Completed High-rate Full-scale, Demo Studies for . . .

- One, 1-year period
- Four, 2-week seasonal periods, and
- One, 6-week period (with challenging source water)



# ALMU Demo Studies have Proven Reliable Treatment Farther & Farther from TSSs

ALMU WFP Components	Ten State Standards Criteria	1988 Demo Study	1999 1988 Study Revisited	2000 Demo Study	2012 Demo Study
Flocculation	30-min DT	30-min DT	25-min DT	14-min DT	12-min DT
Clarification (Tube Settlers)	4-hr DT None, and, now 2 gpm/sf	2.2-hr DT 1.9 gpm/sf	1.9-hr DT 2.0 gpm/sf	0.97-hr DT 2.2 gpm/sf	0.85-hr DT 2.7 gpm/sf
Filtration	2 gpm/sf and, now 4 gpm/sf	3 gpm/sf	4 gpm/sf	6 gpm/sf	6 gpm/sf
Clearwell (CT Capacity)	None and, now LT-2	CT values were not required	Plans laid for baffled clearwells	Tracer for larger EVF, Season CTs	Time for additional clearwells

# Each Demo Study has Led to an Expansion Project at \$0.3 - \$0.5 M per MGD of Capacity

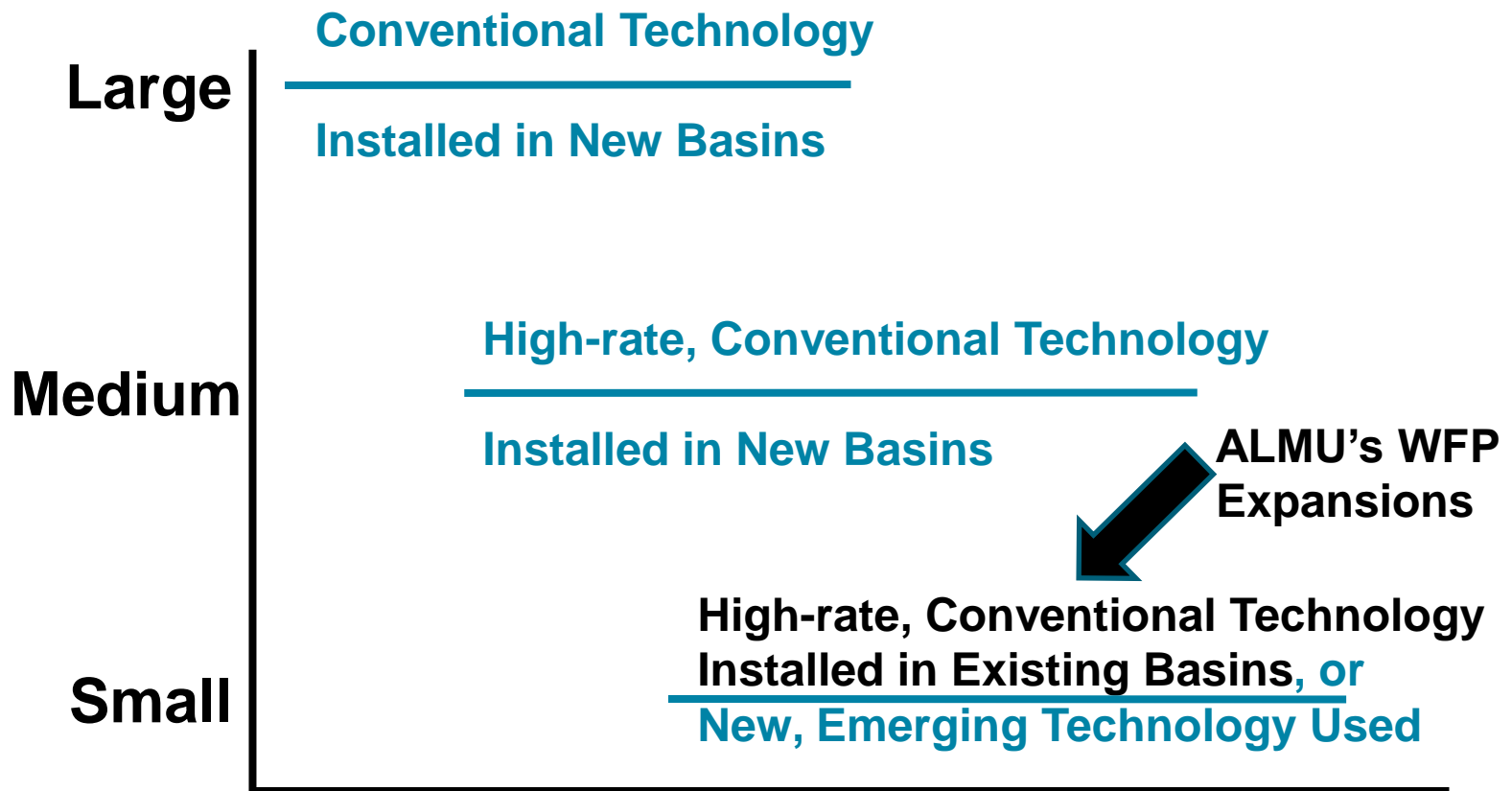
- 1988 Demo Study
  - 1990 : WFP's Appr. Cap. increased from 14.5 to 24 MGD
  - 1999 : 1988 Demo Study revisited, Appr. Cap. of 27 MGD
- 2000 Demo Study
  - 2000 : WFP's Appr. Cap. increased from 27 to 40+ MGD
  - 2012 : WFP's Appr. Cap. increased from 40+ to 50+ MGD
- 2012 Demo Study
  - 2012 : WFP's Floc / Sed Component Capacity increased to 60+ MGD (only cost was conducting the demo study)

# Three, Ohio EPA-Approved Demo Studies over 25 Years have Allowed ALMU to . . .

- Save \$50 M to \$75 M in capital costs at the WFP
- Maintain some of the lowest water rates in Ohio
- Provide drinking water to RLCWA and its customers as far south as Medina
- Reserve space on the sites north and south of Lake Road for additional WFP treatment capacity

# Full-scale, Demonstration Studies to High Rate Existing WFPs Can Save Significant Capital \$

Capital Cost (\$ M) per MGD  
of Additional Capacity



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# In 1980 - Avon Lake Water Filtration Plant (WFP) was Expanded to 13.5 MGD

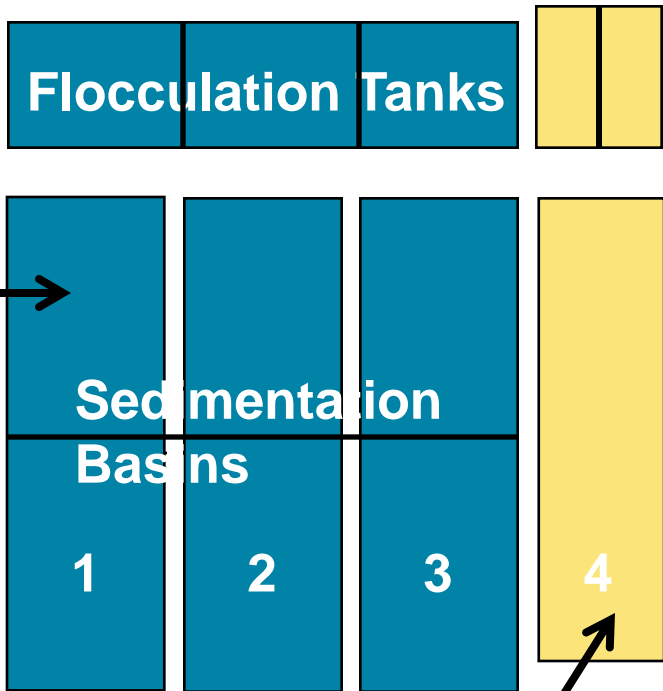
- **Additions to WFP:**

- Three (3) new flocculation tanks/sedimentation basins with a component capacity of 4.5 MGD, each
- Tube-settler modules installed in front half of Sedimentation Basin No. 1 - **for future high-rating potential**
- Four new filters (No. 13 – 16) , twelve old filters (No. 1 – 12)

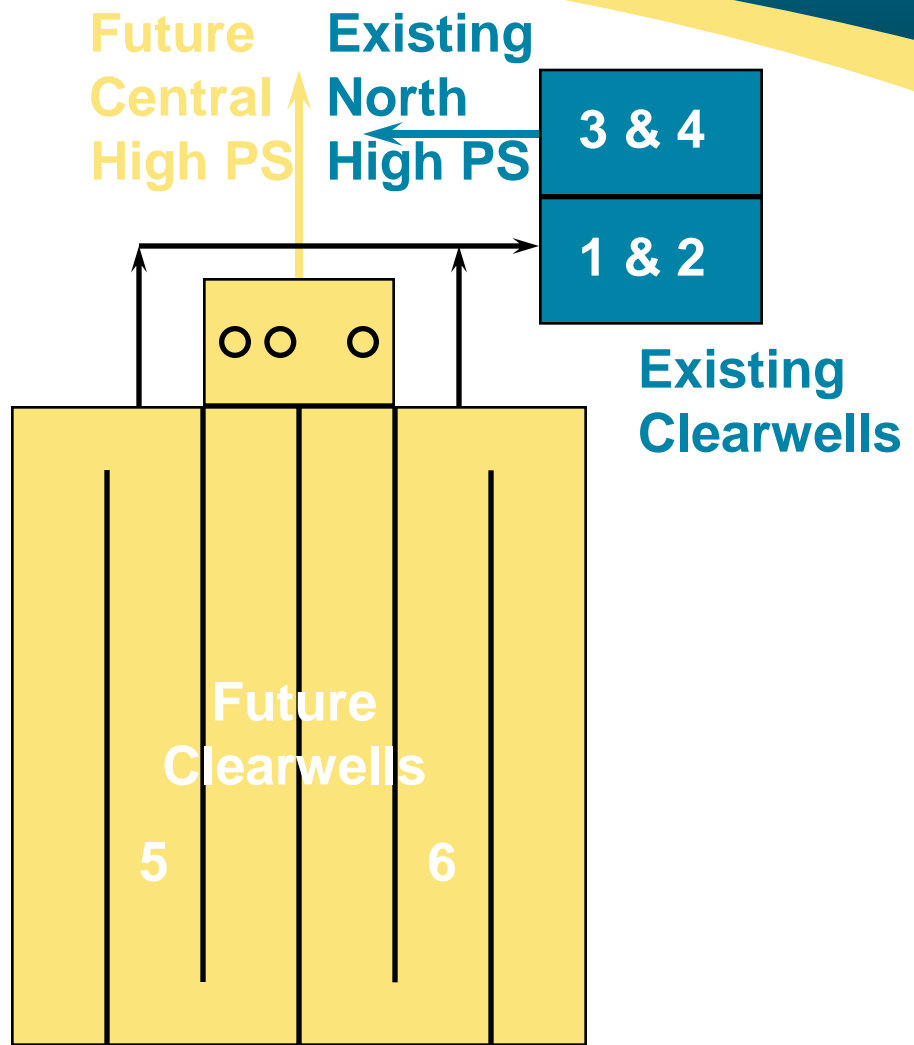
# These First Three, Floc Tanks / Sed Basins have Since been High Rated more than Once

Cap. = 13.5 MGD  
= 4.5 + 4.5 + 4.5

Tube Settlers, but not part of 4.5-MGD Capacity



Future Floc Tank / Sed Basin



# First Demonstration Study was Completed w/o Benefit of Tech Comm or “Guidelines”

- **1988** - Full-scale Demonstration Study conducted for an entire year to high rate:
  - Floc Tank/Sed Basin No. 1 (with tube-settler modules in front half) from 4.5 MGD to **6.0 MGD**, and
  - Filters from 2.0 gpm/sf to **4.0 gpm/sf**
- Ohio EPA approved:
  - Floc Tank/Sed Basin No. 1 at **5.0 MGD**, and
  - Filters at **3.0 gpm/sf (1)**

**(1) In the 1990s, an Ohio AWWA / EPA Technology Committee was formed to develop “Guidelines” to establish criteria for conducting Bench-, Pilot- and Full-scale Demonstration Studies.**

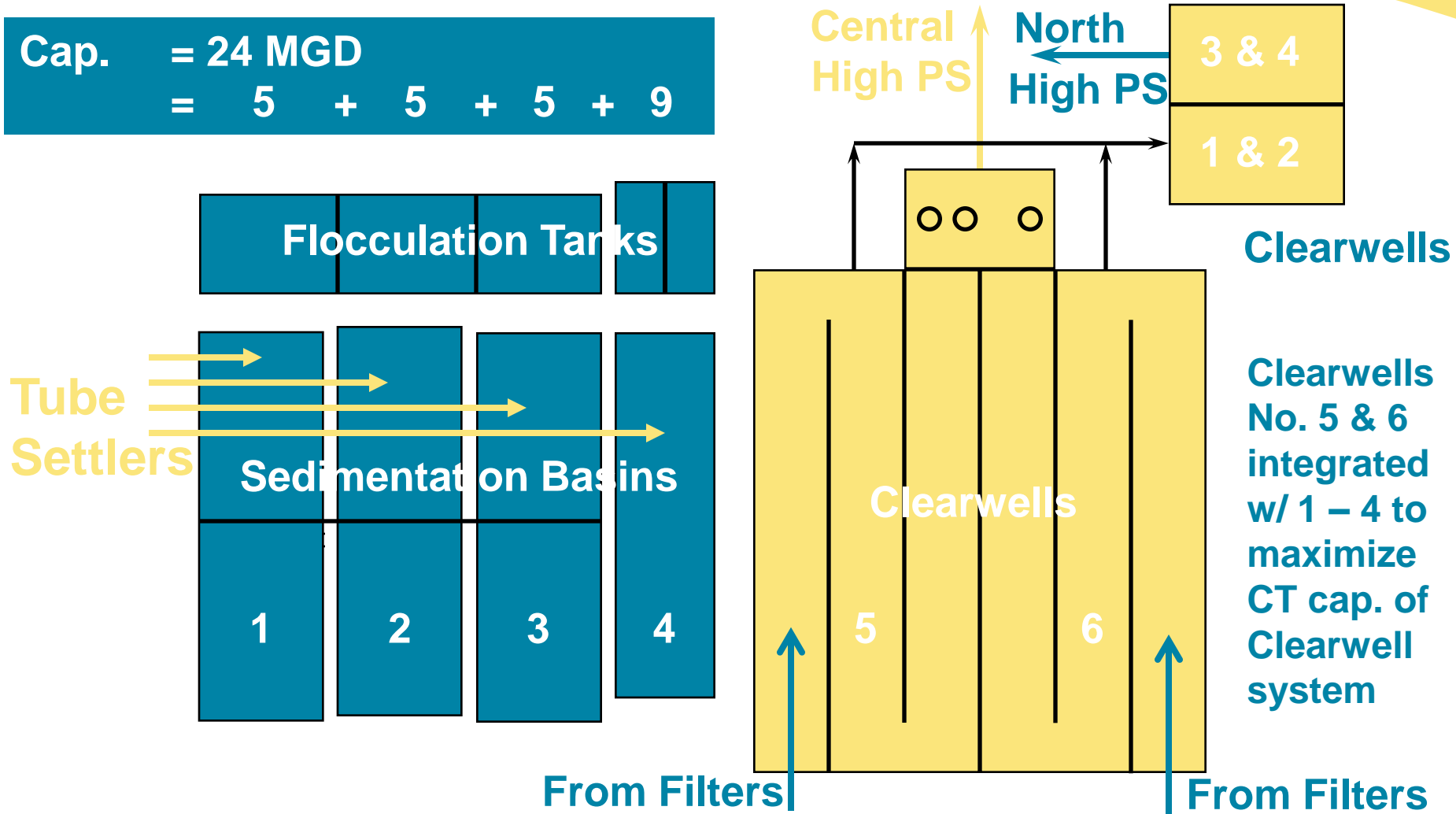
# Based on 1988 Study – in 1990 ALMU's WFP was Expanded from 13.5 to 24 MGD

## Additions to WFP:

- Tube-settler modules installed in front half of Sedimentation Basins No. 2 and 3
- New, 9-MGD Flocculation Tank / Sedimentation Basin No. 4 installed (with tube-settler modules)
- Four new, filters installed (No. 17 – 20); now sixteen older filters (No. 1 – 12, and 13 – 16)
- Two new baffled, clearwells installed (No. 5 & 6), and integrated with four old clearwells (No. 1 – 4)
- New, Central-high PS installed; and old South-high PS abandoned

# 24-MGD Approved Capacity was Achieved for Avon Lake WFP in 1990 Expansion

Cap. = 24 MGD  
= 5 + 5 + 5 + 9



# In 1999 – Revisiting Results from 1988 Study with Ohio EPA Increased WFP by 3 MGD

- Floc Tanks/Sed Basins No. 1, No. 2 and No. 3 approved at 6.0 MGD each (up from 5.0), and
- Filters approved at 4.0 gpm/sf (up from 3.0)

## **More importantly:**

- Approved capacity of the Avon Lake WFP increased from:
  - 24 MGD (5 + 5 + 5 + 9), to
  - 27 MGD (6 + 6 + 6 + 9) **(1)**

**(1) “Guidelines for High-rate Clarification / Filtration” had been developed by the Ohio AWWA / EPA Technology Committee that was formed earlier in the 1990s.**

# Eleven Years Later – This First Technology Comm “Guidelines” Proved to be Helpful

THIS POLICY DOES NOT HAVE THE FORCE OF LAW

## **GUIDELINES FOR CLARIFIER AND FILTER RATINGS AT SURFACE WATER TREATMENT PLANTS**

Division: DDAGW  
Number: ENG-01-002  
Category: Final  
Issued: December 8, 1999

### **This document:**

- **Established requirements prior to performing a Demo Study,**
- **Suggested procedures for conducting a Study, and**
- **Defined Approval Criteria for obtaining Ohio EPA acceptance.**

To establish the standard design criteria for clarifier and filter loading rates and the requirements necessary to justify higher clarification and filtration rates than those allowed under the standard design criteria adopted by the Ohio Environmental Protection Agency (Ohio EPA). These

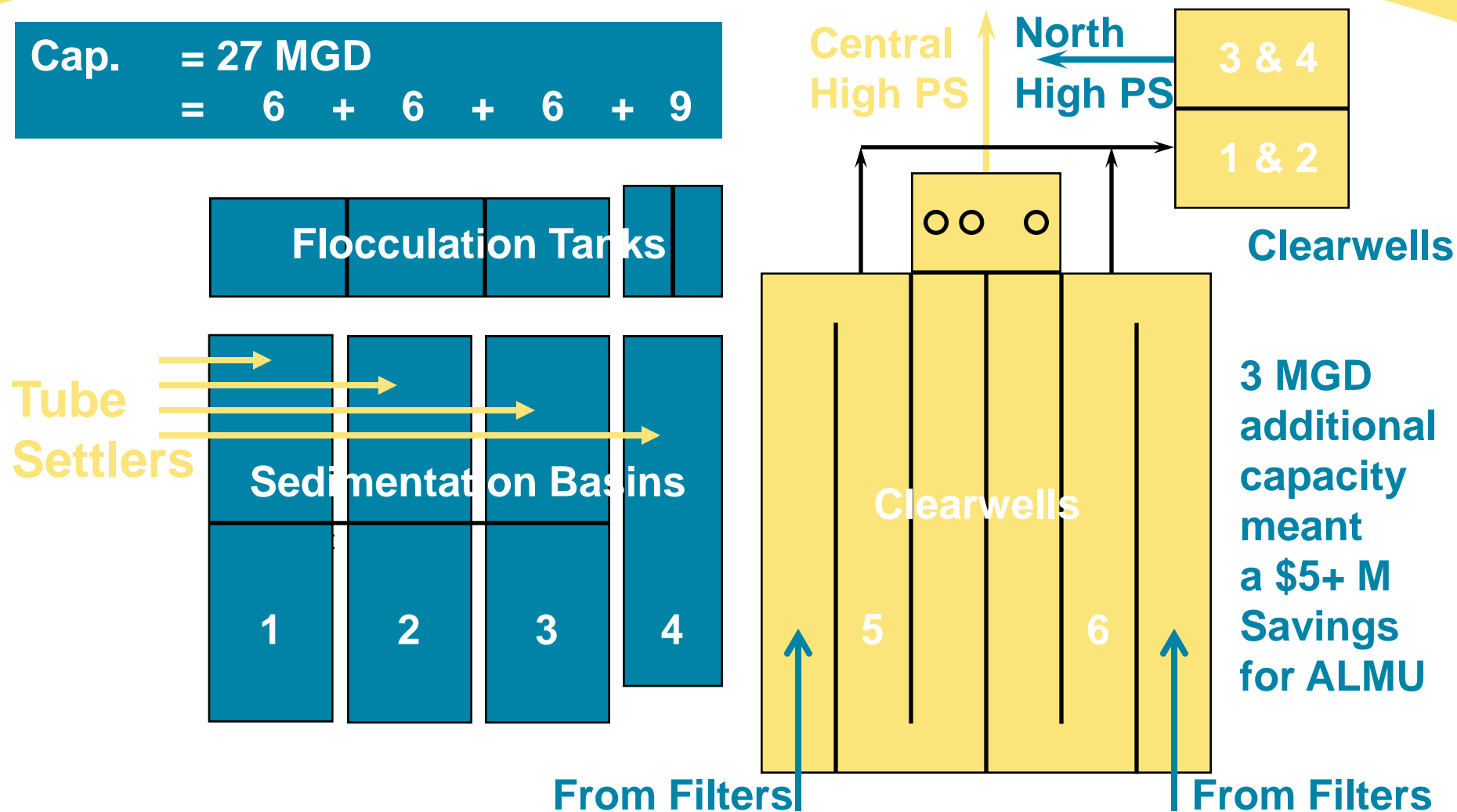
**And, the document explained:** filter loading rates approved by the Director.

It is intended that the successful application of these guidelines will result in the design of a treatment system that will provide drinking water meeting or exceeding the requirements of the Surface Water Treatment Rule (SWTR) at reasonable cost. Every surface water treatment plant

# Clarification of 1988 Demo Study Results

## Increased WFP's Approved Cap. to 27 MGD

Cap. = 27 MGD  
= 6 + 6 + 6 + 9



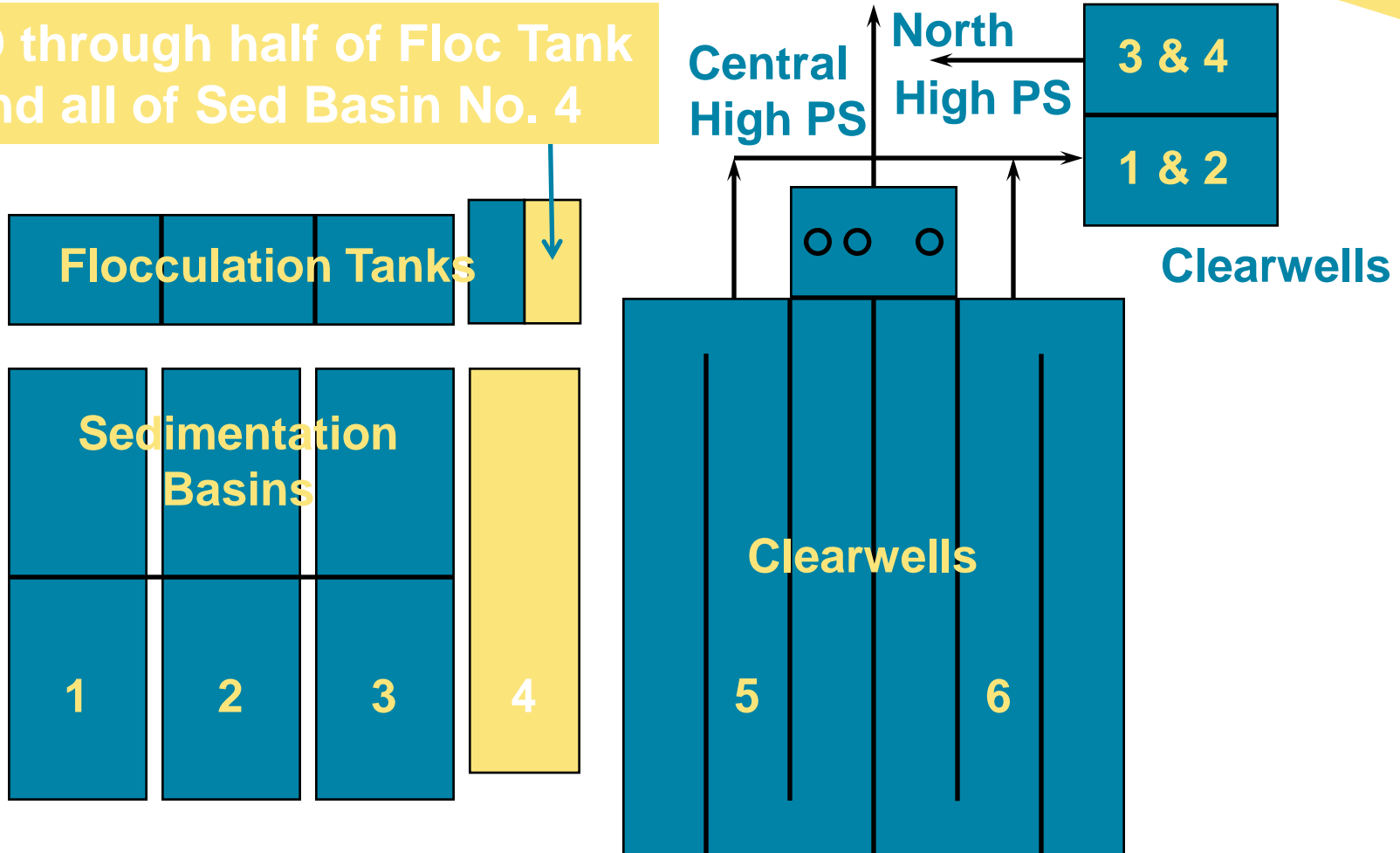


# In 2000 - a Four, 2-week Full-scale, Demo Study was Performed by . . .

- Operating the WFP with 10 MGD through:
  - half of Floc Tank No. 4, and
  - all of Sedimentation Basin No. 4;and, passing all other production needs through either Floc Tanks/Sedimentation Basins No. 1 or 2
- Operating two, newer filters at 5 and 6 gpm/sf
- Utilizing On-line particle monitors and metering equipment that were installed as required
- Performing the appropriate required monitoring

# This Demonstration Study Used ½ of Floc Tank No. 4 and all of Sed Basin No. 4

10 MGD through half of Floc Tank No. 4 and all of Sed Basin No. 4



# The “Guideline” was Available to Describe Ohio EPA Appr. Criteria for 2000 Demo Study

## – Clarifiers

- Effluent turbidity (average)  $< 2$  NTU, and (95% of the time)  $< 5$  NTU,
- Production efficiency  $> 90\%$ ,
- **OR**, Gross water production  $> 5,000$  gal/sf-run

## – Filters

- Filtered-water turbidity (95% of the time)  $< 0.5$  NTU **(1)**,
- Filtered-water turbidity (at all times)  $< 5$  NTU **(2)**,
- **AND**, Total particle-count ( $> 2$  um in dia.) removal (95% of the time)  $> 2$  log **(3)**

**(1) Now 0.3 NTU**

**(2) Now 1 NTU**

**(3) No longer a criterion**

# Results from the 2000 Full-scale Demo Study Obtained Ohio EPA Approval for . . .

- 6-MGD Flocculation Tanks No. 1 – 3  
at **10 MGD ea.**
- 10-MGD Flocculation Tank No. 4  
at **20 MGD**
- 9-MGD Sedimentation Basin No. 4  
at **10 MGD**
- Filtration rate of 4 gpm/sf for twenty, existing filters  
at 5 and **6 gpm/sf**

## Study increased Component Capacities of:

- **Flocculation to 50 MGD [  $(10 \times 3) + 20 = 50$  MGD ], and**
- **Clarification to 50 MGD [  $(13.3 \times 3) + 10 = 50$  MGD ]**

# Before the 2000 Demonstration Study, the Filter Component Capacity was 30 MGD

- Filtration rate of 4 gpm/sf:
  - Filters 1 - 12 = 12.7 MGD
  - Filters 13 - 16 = 8.1
  - Filters 17 - 20 = 13.4
  - Capacity <sup>(1)</sup> = 30.1 MGD

**(1) Component Capacity means largest filter out-of-service**

# After the Demo Study, the Filter Component Capacity became 46 MGD

- 5 gpm/sf

- Filters 1 - 12 = 15.9 MGD
- Filters 13 - 16 = 10.1
- Filters 17 - 20 = 16.7
- **Capacity = 38.5 MGD**

- 6 gpm/sf

- Filters 1 - 12 = 19.1 MGD
- Filters 13 - 16 = 12.1
- Filters 17 - 20 = 20.0
- **Capacity = 46.2 MGD**

# Only Significant Improvement Required to Increase WFP's Appr. Cap to 40+ MGD was:

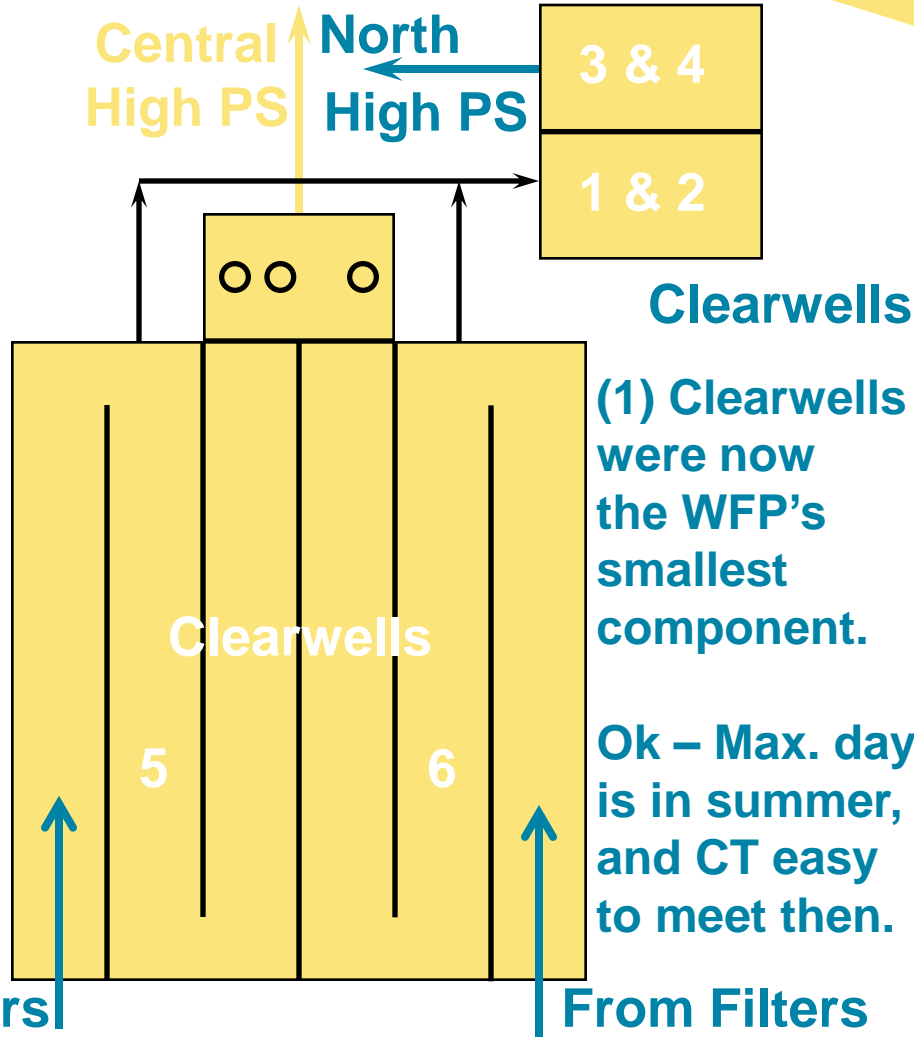
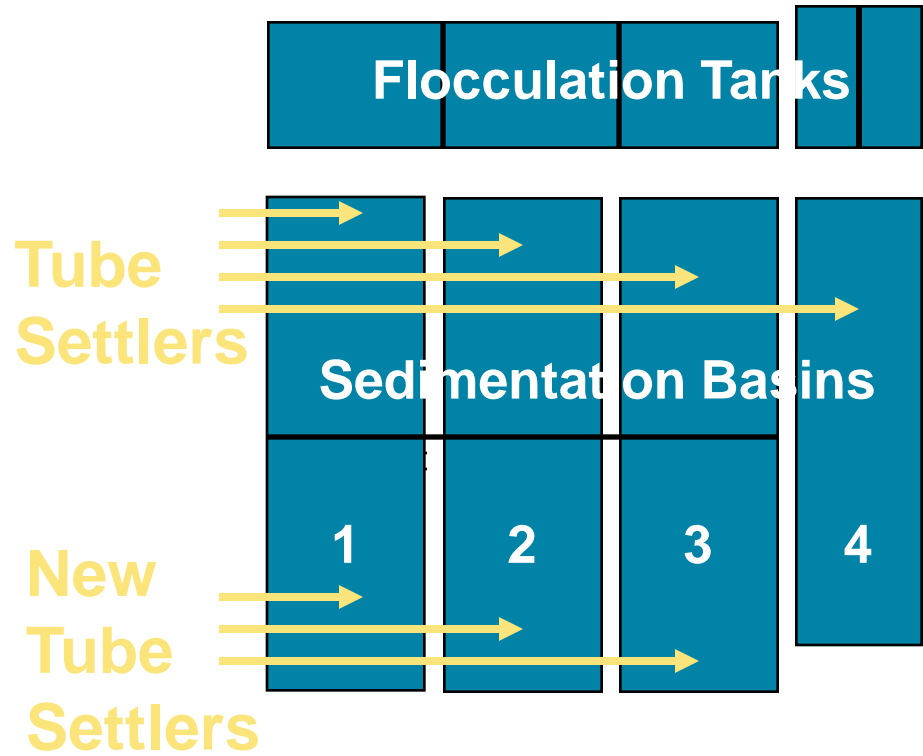
- Tube-settler modules were installed in the back half of Sedimentation Basins No. 1 to 3

## Also

- Extensive electrical-system upgrades, etc. were completed

# Study and Minor Improvements Increased WFP's Appr. Cap. from 27 to 40+ MGD (1)

Cap. = 50 MGD  
 = 10 + 10 + 10 + 20



From Filters

From Filters



# A Clearwell Tracer Study was Completed to Obtain Ohio EPA Approval for . . .

1. Larger effective volume factor (EVF) for the Clearwell system – **i.e., the larger EVF associated with Clearwells operating in-series must be demonstrated in Ohio**
2. Seasonal (i.e., winter / summer) CT component capacities for the Clearwell system **(significant since ALMU's Max.-day production is larger in the summer than in the winter, and CT is much easier to meet in the summer)**

# The Demo and Tracer Studies, and Minor Improvements Made Appr. Cap. 40+ MGD

**For a second time ALMU's WFP was Cost-effectively Expanded:**

- **13 MGD** of additional capacity, etc. for roughly **\$4 M**  
Similar to the first ALMU WFP expansion (i.e., \$0.3 M to \$0.5 M per MGD of additional capacity)

# The 2000 Demo Study was also the Basis for the Following Capital Improvements:

- WFP was Expanded by adding four additional filters (No. 21 – 24); now twenty older filters (No. 1 – 12, and No. 13 – 20)
  - Filter component capacity increased to **61 MGD**:
    - 61.3 MGD @ 6 gpm/sf
    - 51.1 MGD @ 5 gpm/sf
- WFP was Upgraded by adding pump station and force main to convey residuals to City's wastewater treatment plant

# Items to be Discussed



- Past Expansion / Upgrade Projects
- **Recent Expansion / Upgrade Projects**
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# Capital Improvements Included in the 2012, 50-MGD WFP Construction Project

- Most of the Source-water pumps were upgraded and expanded
- Central-high, finished-water pumps were upgraded and expanded
- Chlorine storage-and-feed facilities were upgraded and expanded
- Electrical upgrades were implemented

# These Latest Improvements Increased the WFP's Approved Cap to 50+ MGD

1	2	3	4	5	6	7	8
Component	Number and Size of Units	Design Standards	Design Criteria (TSS)	Required/Recommended	Component Capacity (MGD)	Flow basis of Component Cap./Ratio	Equivalent Max-Day Capacity (MGD)
<b>Water-Supply Source</b>							
Source	1 (Lake Erie)		ODNR Permit	Required	64	avg day 1.65	<b>105</b>
Intake Structure	2		0.5 ft/sec in Intake Structure	Required	62.1	max day 1.0	<b>62.1</b>
Intake Pipe	2 (One 54" Intake and One 36" Intake)		3.906 ft/sec		58	max day 1.0	<b>58</b>
Source-water Pumps	7 (Four @ 10 MGD, Two @ 6 MGD, One @ 4.5 MGD, One @ 15 MGD)		Largest out of service	Required	56.5	max day 1.0	<b>56.5</b>
<b>Water Treatment Plant</b>							
Rapid Mixers	2 (36" In-line Mixers)		Detention time < 30 sec	Recommended	50	max day 1.0	
			G value > 750 fps/ft	Recommended			
Flocculation Tanks	4 (Three @ 0.1 MG each, One @ 0.21 MG; Total Volume = 0.52 MG)		Detention time > 30 min	Recommended	50	max day 1.0	
			0.5 fpm ≤ Flow-through velocity ≤ 1.5 fpm	Recommended	-		
Sedimentation Basins	4 Tube Settler Basins (Three @ 4,590 sf each, One @ 3,150 sf; Total Area = 16,920 sf)		Surface Overflow Rate ≤ 2 gpm/sf	Required	53.6	max day 1.0	<b>53.6</b>

# Only Clearwells (in the winter) have an Equivalent Max.-Day Capacity < 50 MGD (1)

1	2	3	4	5	6	7	8
Component	Number and Size of Units	Design Standards	Design Criteria (TSS)	Required/Recommended	Component Capacity (MGD)	Flow basis of Component Cap./Ratio	Equivalent Max-Day Capacity (MGD)
Filters	24 (Twelve @ 184 sf each, Four @ 351 sf each, Eight @ 580 sf each; Total Area = 8,252 sf)		Max day w/o largest Filtration Rate $\leq$ 4 gpm/sf	Required	61.3	max day 1.0	<b>61.3</b>
Clearwells (Summer)	6 (No. 1 & 2: 0.16 MG each - EVF = 0.2, No. 3 & 4: 0.25 MG each - EVF = 0.2, No. 5: 0.88 MG - EVF = 0.7, No. 6: 0.79 MG - EVF = 0.7)		CT for 0.5-log Giardia inactivation	Required	70	peak-hour treatment 1.16	<b>60.3</b>
Clearwells (Winter)					44	peak-hour treatment 1.16	<b>38</b>
Finished Water Pumps	6 (Central-High: Four @ 16 MGD; North-High: One @ 7 MGD, One @ 6 MGD, One @ 3 MGD)		Peak-hour without largest per pressure zone	Required	64	peak-hour production 1.16	<b>55.2</b>

**(1) Therefore, additional clearwells are being considered before Max-day production (winter) reaches 40 MGD.**

**Note: “Production” refers to the rate at which water leaves the WFP, and “Demand” refers to the rate at which water leaves the distribution system.**

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# Interactive Workshops Optimized ALMU's Input during Water Master Plan Update

- **Workshop No. 1**

- Prepare for Ohio EPA Preliminary Meeting
- Consider Individual Unit Process Options

- **Workshop No. 2**

- Develop Alternatives for Both Current and Future WFP Expansions

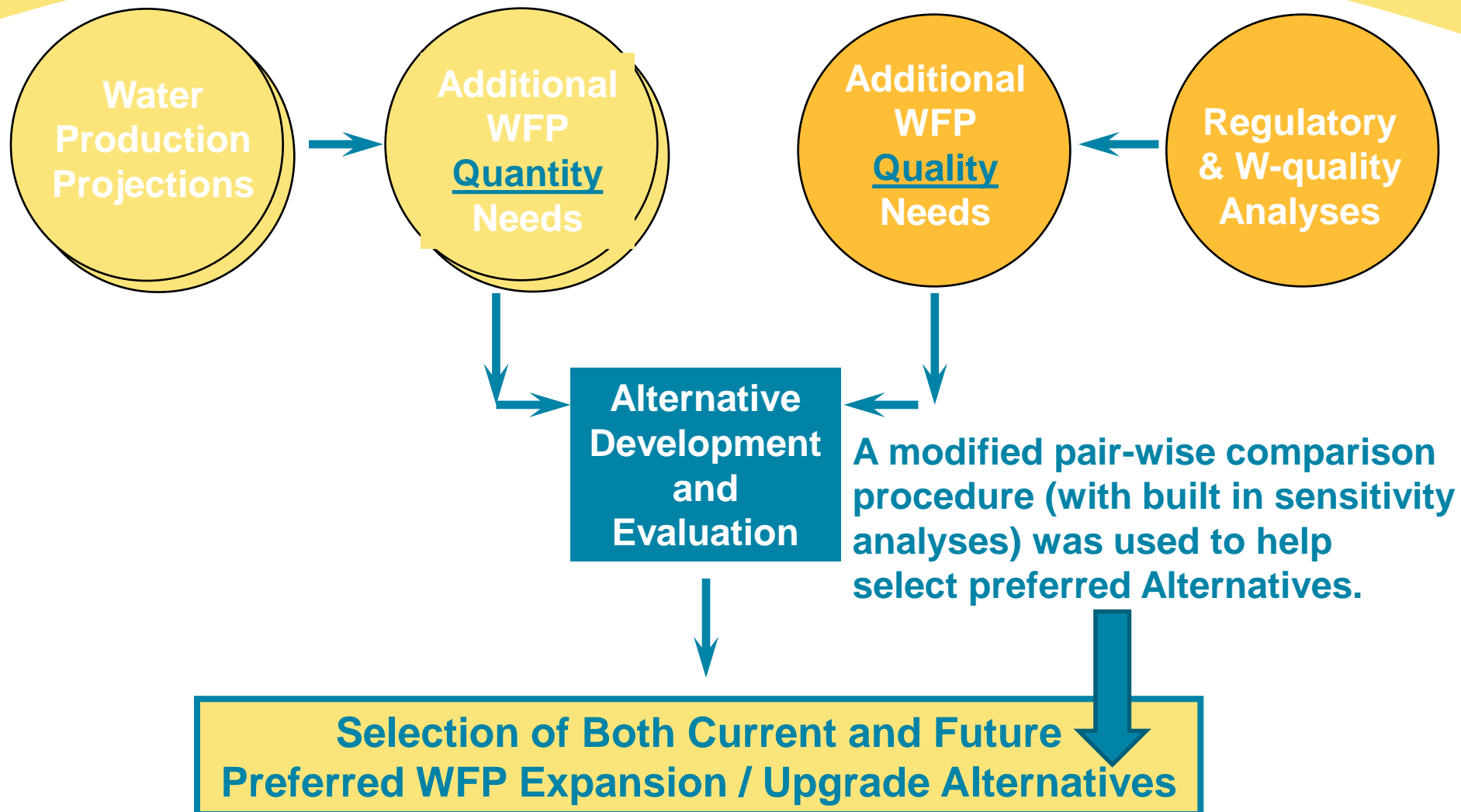
- **Workshop No. 3**

- Evaluate, and Select Preferred Alternative(s)



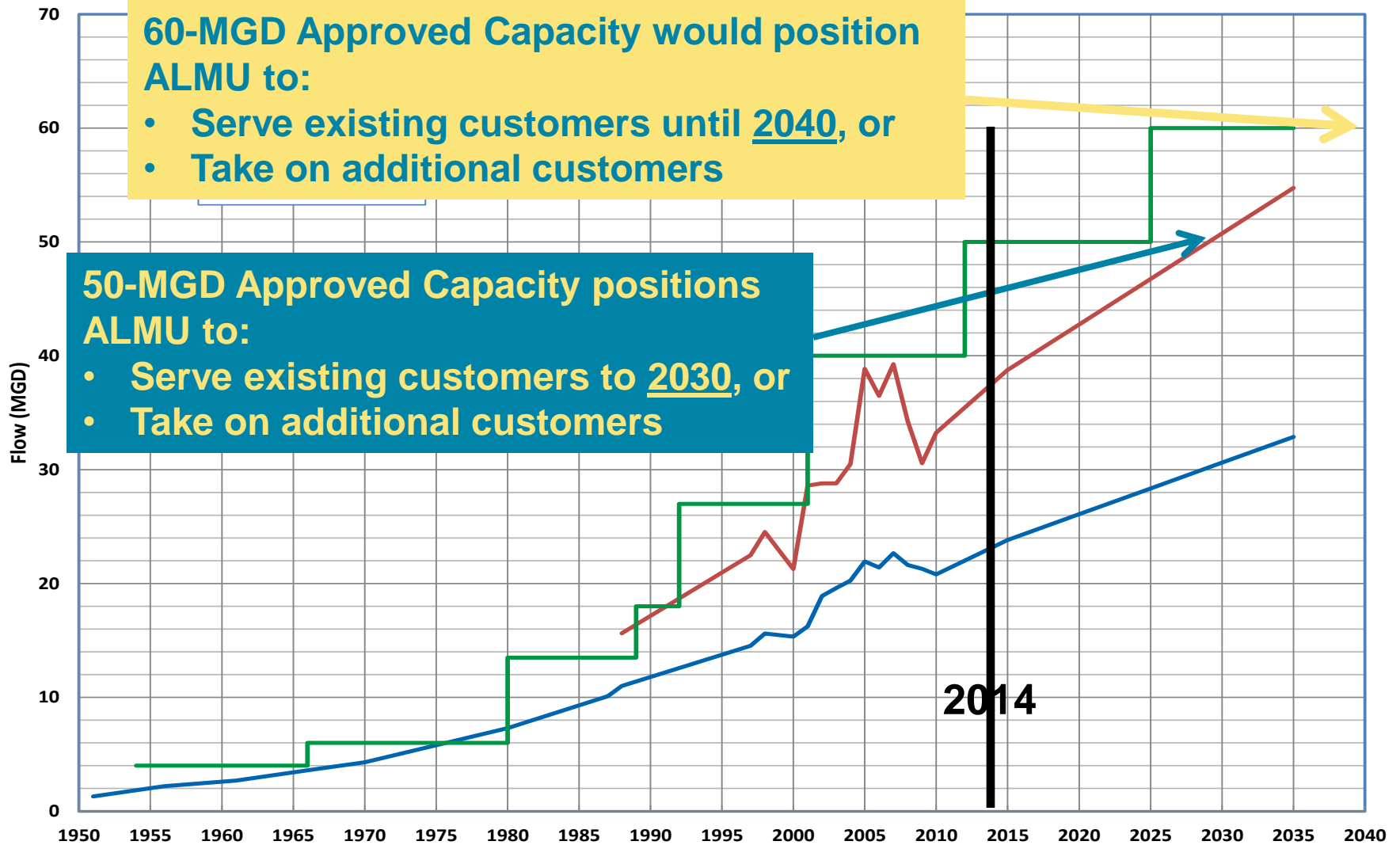
Master Plan Project Team  
ALMU (board and staff),  
and MWH staff

# Interactive Workshops Helped Ensure both Water Quantity and Quality Needs were Met



# As Production Again Nears 40 MGD - ALMU is Constructing 50 MGD & Planning for 60 MGD

Figure 3.4 Water Production Projections



# Items to be Discussed



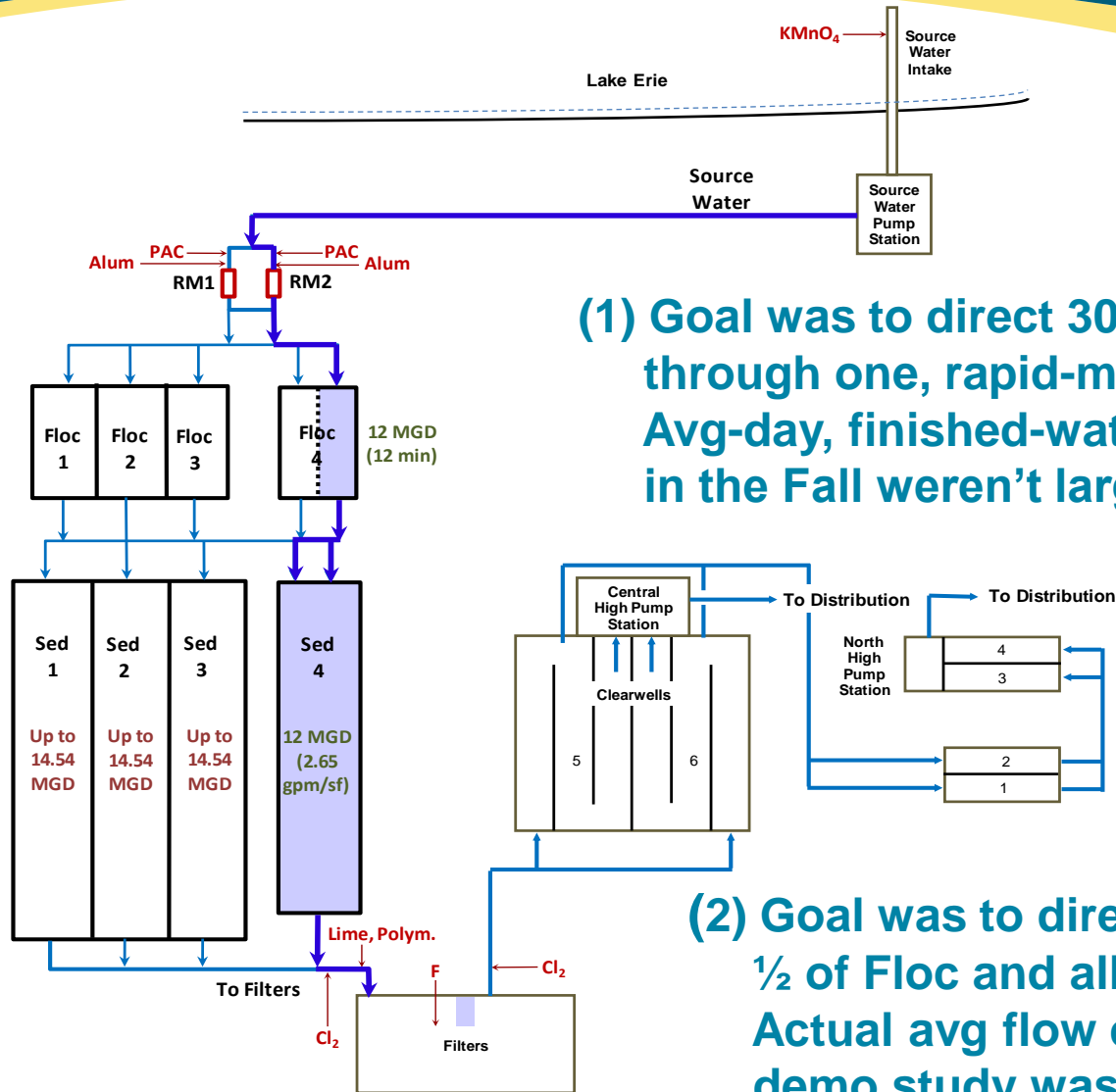
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# Most Recent (2012) Full-scale Demo Study was Conducted for One, 6-week Period

- Selected 6-week study period based on critical (challenging) period for source water
- High rated pre-treatment from a component capacity of 50+ to at least 60 MGD
- Demonstrated at 60+ MGD:
  - Flocculation
  - Sedimentation

# 25 MGD<sup>(1)</sup> was Directed thru One Rapid-mix Unit and 12.2 MGD<sup>(2)</sup> thru Floc / Sed No. 4

Figure 2. Demonstration Study Operation Schematic



(1) Goal was to direct 30 MGD through one, rapid-mix unit; but Avg-day, finished-water demands in the Fall weren't large enough

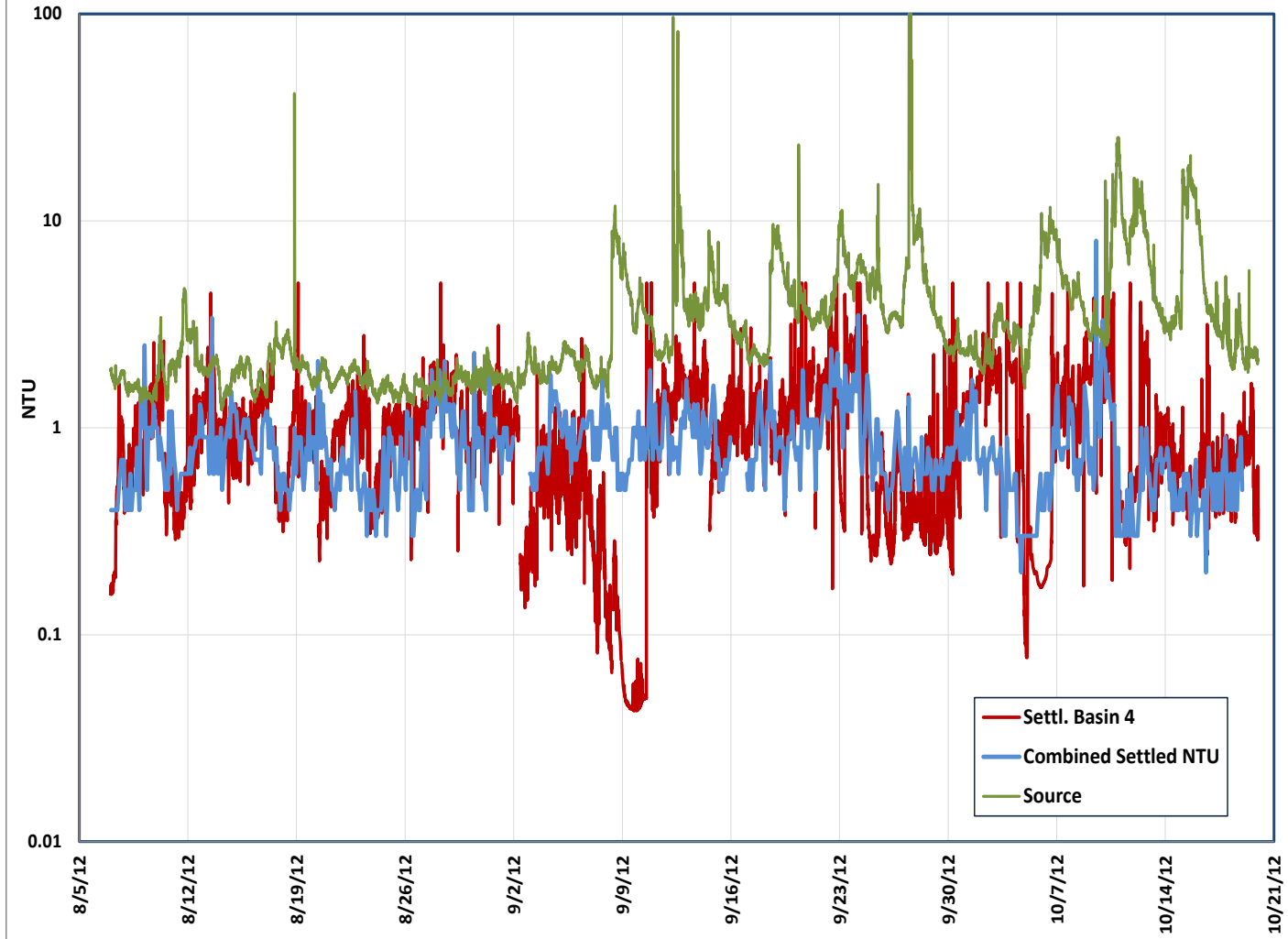
(2) Goal was to direct 12 MGD thru 1/2 of Floc and all of Sed No. 4; Actual avg flow during 6-wk demo study was 12.2 MGD

# Demonstration Study Monitoring Schedules were Based on Latest “Guidelines”

Parameter	WFP Influent	Sedimentation Basin Effluent (High-rate Train)	High-rate Filter Effluent
Flow Rate	Every 8 hours	Every 8 hours	Every 8 hours
Water Temperature	Every Day	-	-
Turbidity	Every 4 hours	Continuous	Continuous
pH	Every Day	Every Day	Every Day
Total Hardness	Every Day	Every Week	Every Week
Total Alkalinity	Every Day	Every Week	Every Week
Total Organic Carbon	Every Week	Every Week	Every Week
Dissolved Organic Carbon	Every Week	Every Week	Every Week
UV <sub>254</sub>	Every Week	Every Week	Every Week
SUVA	Every Week	Every Week	Every Week
Beginning of Filter Run Time	-	-	Every Run
End of Filter Run Time	-	-	Every Run
Filter Headloss	-	-	Initial, Terminal
Backwash Volume	-	-	Every Backwash
Filterability Index	-	Every Day	-
Chemical Doses / Calibrate	Every Day	-	-
Turbidity Meter Calibration		Every Week	Every Week

# “Settled-water Turbidity” Values Met the Demo Study Acceptance Criteria

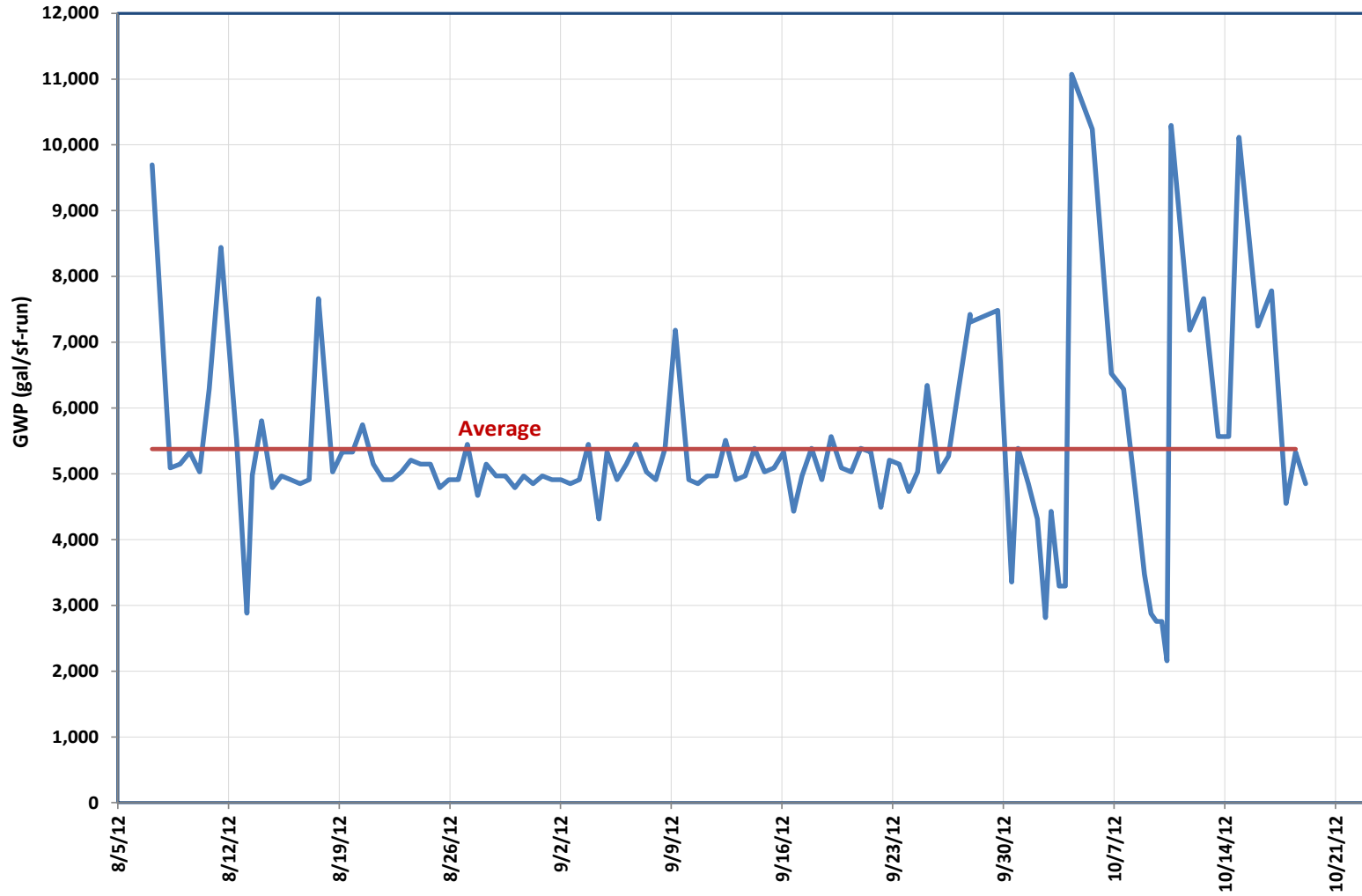
Figure 4. Source and Settled Water Turbidities





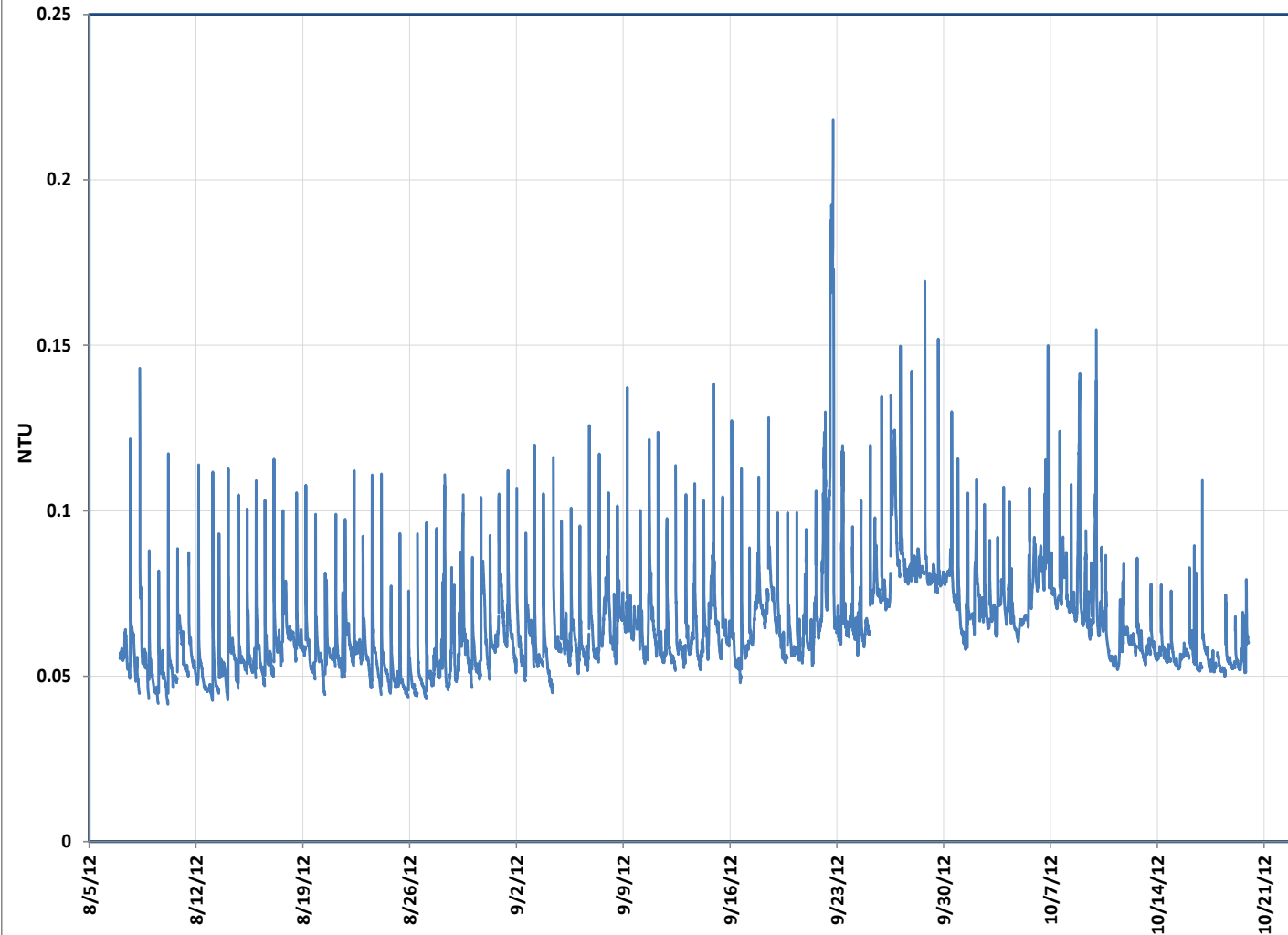
# “GWP” Values also Met Acceptance Criteria for both Filters No. 22 and 24

Figure 9. Filter 24 Gross Water Production



# “Filtered-water Turbidity” Values Met the Acceptance Criteria for Filters 22 & 24

Figure 6. Filter 24 Effluent Turbidity



# New Component Capacity for Pre-Treatment Positions ALMU for Next Expansion

- Rapid mix - 2 @ 25 MGD, ea.

Total = **50 MGD (1)**

(1) avg-day, finished-water demands were not high enough in the Fall over the 6-week period to demonstrate a higher component capacity

- Floc Tanks - 3 @ 11.9 MGD, ea.  
- 1 @ 24.4 MGD

Total = **60.1 MGD**

- Sed Basins - 3 @ 17.8 MGD, ea.  
- 1 @ 12.3 MGD

Total = **65.8 MGD**

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# Successful Full-scale, Demonstration Study Led to 60-MGD Comp. Cap. for Pre-Treatment

## The following improvements would be required for the next logical WFP Expansion to 60 MGD:

- Replace last remaining 4.5-MGD, source-water pump with a new, 10-MGD pump
- Construct new, clearwells south of Lake Road; and Convert existing clearwells No. 1 – 4 to serve a more useful function
- Install corresponding new, south finished-water pump station south of Lake Road; and Abandon existing, north finished-water pump station
- Implement minor chemical storage-and-feed expansions



**Floc  
Tanks  
1 - 4**

**Central  
F-w P.S.**

**North  
F-w P. S.**

**CW's  
1 - 4**

**Sed  
Basins  
1 - 4**

**Filters  
13 - 24**

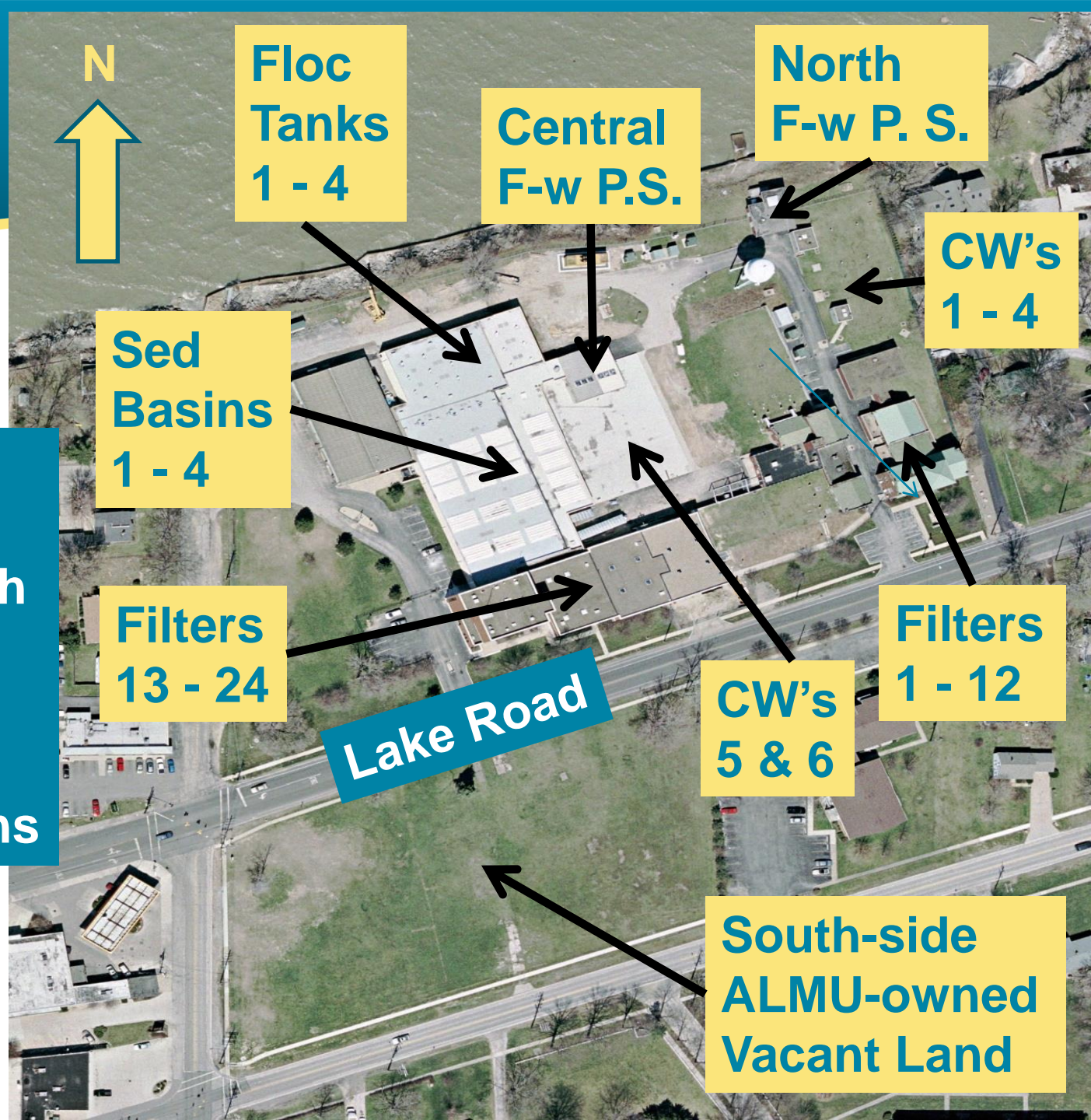
**Lake Road**

**CW's  
5 & 6**

**Filters  
1 - 12**

**South-side  
ALMU-owned  
Vacant Land**

**ALMU owns  
adequate land  
North and South  
of Lake Road  
to facilitate  
several future  
WFP Expansions**





# ALMU's Historical Planning Philosophy has Been to . . .

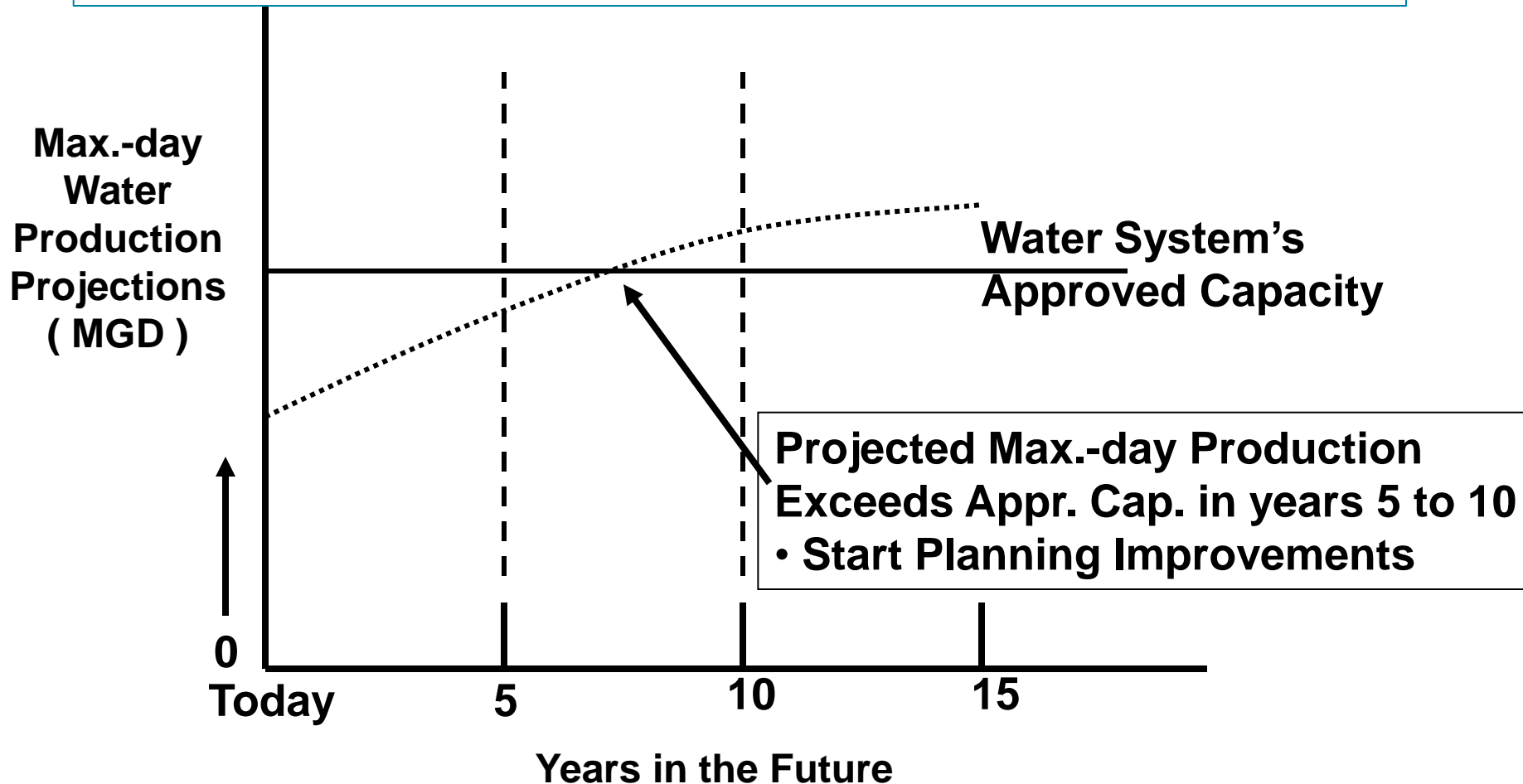
- Conduct a Demonstration Study to establish the boundaries of existing WFP components (future, max.-day capacity – i.e., Approved Capacity);
- Project the future, max.-day production needs;

## And

- Prior to reaching that projected, max.-day production:
  - Document in a General Plan capital improvements that might be needed, and
  - Implement the “required” capital improvements

# ALMU Continues to Follow Planning Steps of Ohio EPA's "Approved Capacity Document"

ALMU is Matching Approved Capacity with Production Needs





# Other Possible, Future Avon Lake WFP Upgrade Alternatives Include:

1. Intermediate ozonation, with or without biologically-active filtration, could be added to:
  - Inactivate 0.5 log of *Cryptosporidium*
2. Post-filter ultraviolet (UV) disinfection could be added to:
  - Inactivate 3.0 log of *Crypto* (**i.e., total back-up**)
3. Post-filter GAC adsorption could be added to:
  - Remove additional 0.5-log of *Crypto*

## AND . . .

- All three of these treatment processes could also:
  - Address any taste-and-odor episodes, and
  - Provide several other water-quality benefits

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# Future Expansions Could Continue with Conventional, or Add Emerging Technology

- **Worst-Case Scenario**

- **120 MGD** - Ultimate Capacity of North/South Sites with Conventional Treatment In-series with Microfiltration (i.e., low-pressure membranes)

- **More-Likely Scenario**

- **300 MGD** - Ultimate Capacity of North/South Sites with Conventional Treatment In-parallel with Microfiltration

# Either way - ALMU has Sufficient Capacity Available on the Sites N and S of Lake Rd

- Conventional in series with low-pressure membranes • **120 MGD**
- Totally conventional • **160 MGD**
- Conventional in parallel with low-pressure membranes • **300 MGD**

# Items that were Discussed



- **Past Expansion / Upgrade Projects**
- **Recent Expansion / Upgrade Projects**
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- **Future Expansion / Upgrade Alternatives**
  - Expansion of Approved Capacity to 60 MGD
  - Capacity of Sites north and south of Lake Road

# Acknowledgements

- The 30+ year, vision for ALMU to serve RLCWA and beyond was that of John Kniepper
- ALMU's Board members (past and present) have embraced and continuously enhanced that vision
- ALMU's WFP staff (past and present) have successfully conducted three demonstration studies and “a few” tracer studies
- MWH staff (past and present) have worked closely with ALMU to generate innovative solutions

## And

- Todd Danielson continues ALMU's vision to consistently provide its customers with good-quality drinking water, of adequate quantity and pressure – at a fair and reasonable cost