Joint Water Commission

Water Treatment Plant

Filter Loading Rate Study

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AWWA PNWS Conference

Eugene OR. May 9th, 2014

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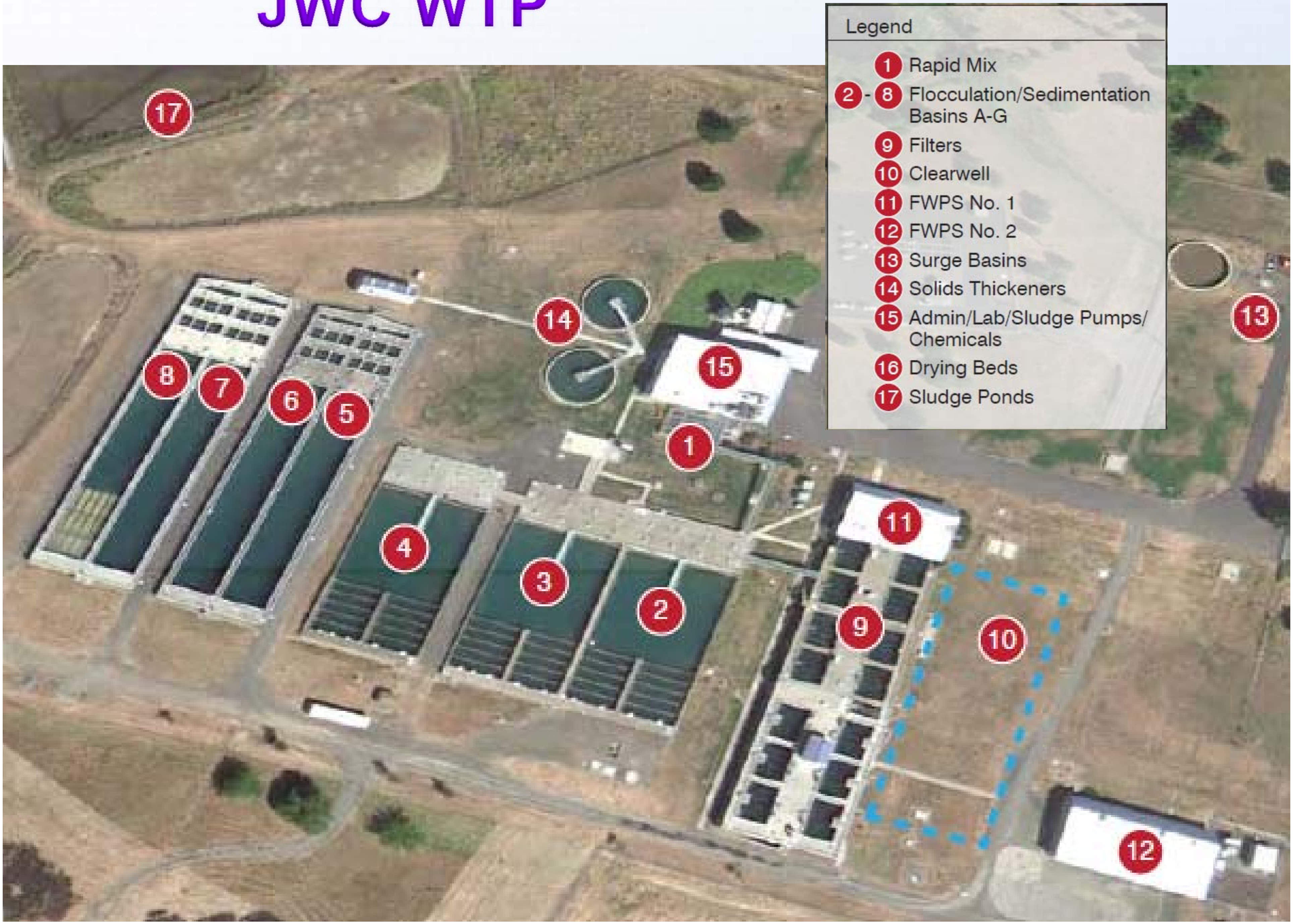
JWC WTP



Legend
1 Rapid Mix
2 - 8 Flocculation/Sedimentation Basins A-G
9 Filters
10 Clearwell
11 FWPS No. 1
12 FWPS No. 2
13 Surge Basins
14 Solids Thickeners
15 Admin/Lab/Sludge Pumps/ Chemicals
16 Drying Beds
17 Sludge Ponds
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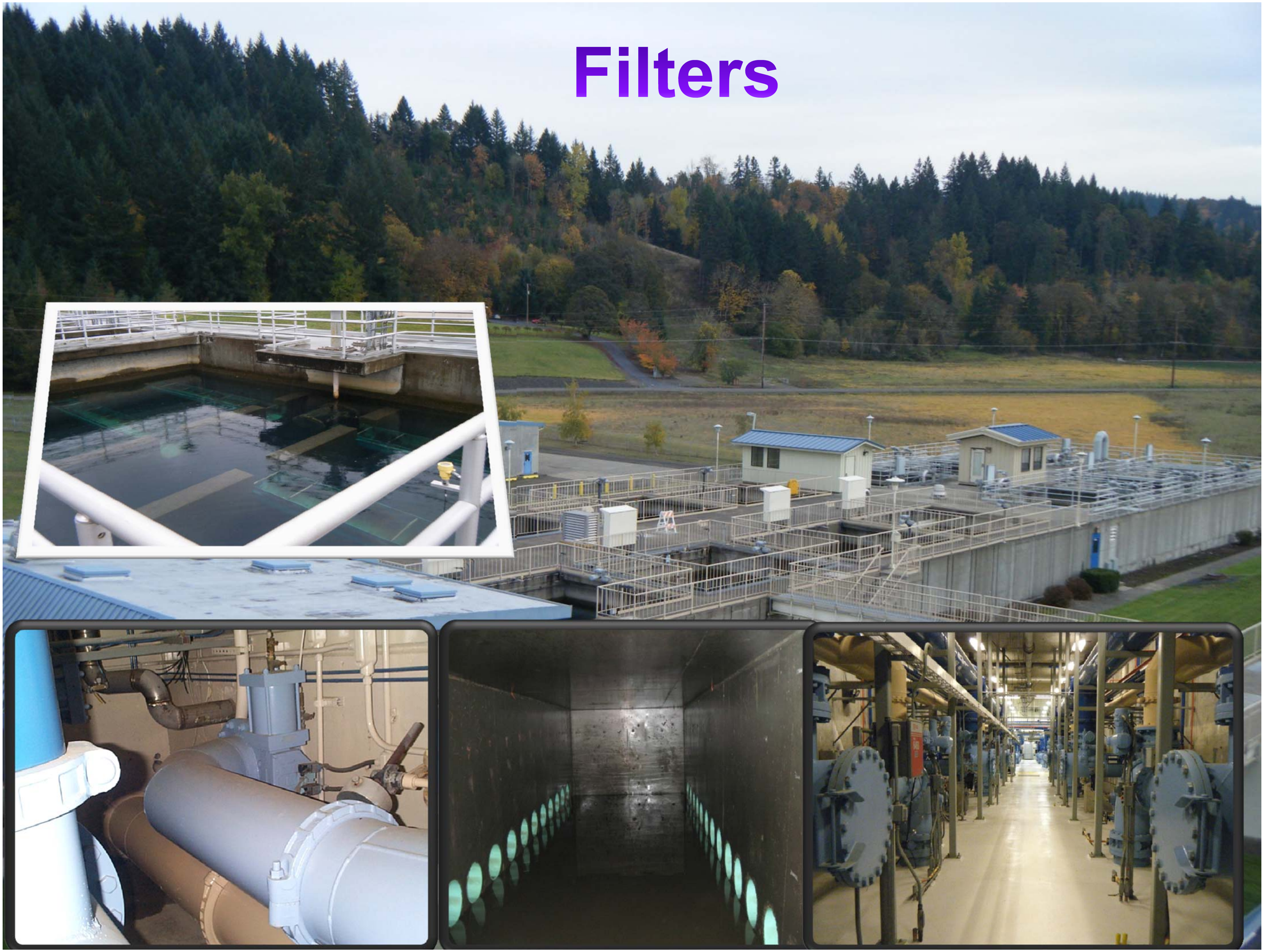
Filters



Why do a filter pilot study?

- JWC wants to expand plant capacity and has identified that a 7% increase in filter loading rate (FLR) would save the cost of one new filter - $4M
  - Increase FLR from 8.1 gpm/sf to 8.7 gpm/sf
- OHA requires filter pilot study for "high rate filtration" (FLRs > 6.0 gpm/sf) to demonstrate water quality
  - no filtered water to be distributed (for pilot and WTP filters that exceed approved rate)
- Evaluate impacts to plant operations and performance (UFRV, run times, residuals handling, etc)

OHA Requirements

- OHA does not have defined protocol for proposal/study
- OHA identified several requirements:
  - Seasonal changes must be represented
  - Use same source of water to be filtered – “flume”
  - Continuous monitoring for turbidity – never exceed MCL (0.3 NTU)
  - Replicate full scale filters with pilot filters
  - Establish WQ goals
  - Represent pre-treatment conditions and optimize coagulation
  - Particle Counts used for *Giardia* and *Crypto* removal

What did we propose?

- Run test during two-week periods in each season
- Pilot test existing (8.1 gpm/sf) and proposed (8.7 gpm/sf) FLRs
- Full scale testing of existing FLR to compare with pilot, evaluate full scale WTP systems
- Stress pre-treatment to simulate operation during peak flow
  - 7 Basins each rated 10-15 mgd (summer operation)
  - 70% of basin capacity during winter
  - 90% of basin capacity during summer
  - Add basin if settled water turbidity approaches 10 ntu

What did we propose? (cont'd)

- JWC Staff to operate and maintain pilot filters and instrumentation.
- Sampling and monitoring during testing:
  - Online monitoring for turbidity (RW, Flume, FE), particle count (RW, FE), flowrates, and headloss
  - Visual observations and checks
  - Chemical feed rates
  - Instrument calibration
  - No. basins online
  - Impacts to other plant processes

We conducted five tests…

Month	Test	Goal
Sept/Oct 2012	Start-up	Order and install pilot equipment. Load and test filter units.
Nov/Dec 2012	Test 1	Evaluate performance during changing water quality
Jan/Feb 2013	Test 2	Evaluate performance during colder, stable water
March 2013	Test 3	Repeat of Test 2, and attempt to capture Wapato pumping
May 2013	Test 4	Evaluate performance following spring storm events and warming temperatures
July 2013	Test 5	Evaluate performance during summertime conditions (peak demands, low turbidity)
Aug/Sept 2013	Report and OHA Review	Evaluate results and request OHA approval for higher rate if appropriate

What to evaluate during testing?

- Did we capture the desired period of varied raw water quality?
- Were the pretreatment processes stressed, and did they produce good settled water quality?
- Did the pilot filters produce water that meets regulations? (0.3 ntu)
- Did the pilot filters perform similar or different from the full-scale filter loaded at 8.1 gpm/sf?
- Was there a significant difference between the pilot filters?
- Particle removal through the plant.

Pilot System Set-up

- Build, purchase, or rent pilot filter unit
- Filter unit components
  - Two 6” diameter filter columns
  - 120” filter column height
  - 165-gal backwash supply tank
  - VFD filter feed pumps
  - BW pump and compressor
  - Online instruments:
    - Turbidity
    - Headloss
    - Particle count
  - Connections: power supply, drain, filter influent, SCADA

Pilot System Set-up: Procure media

- Same configuration as full scale filters:
  - 46” of 1.2 mm anthracite
  - 10” of 0.55 mm sand
- Collected media in situ from full scale filter with filter corer
- Performed sieve analysis to verify media characteristics (size and UC)

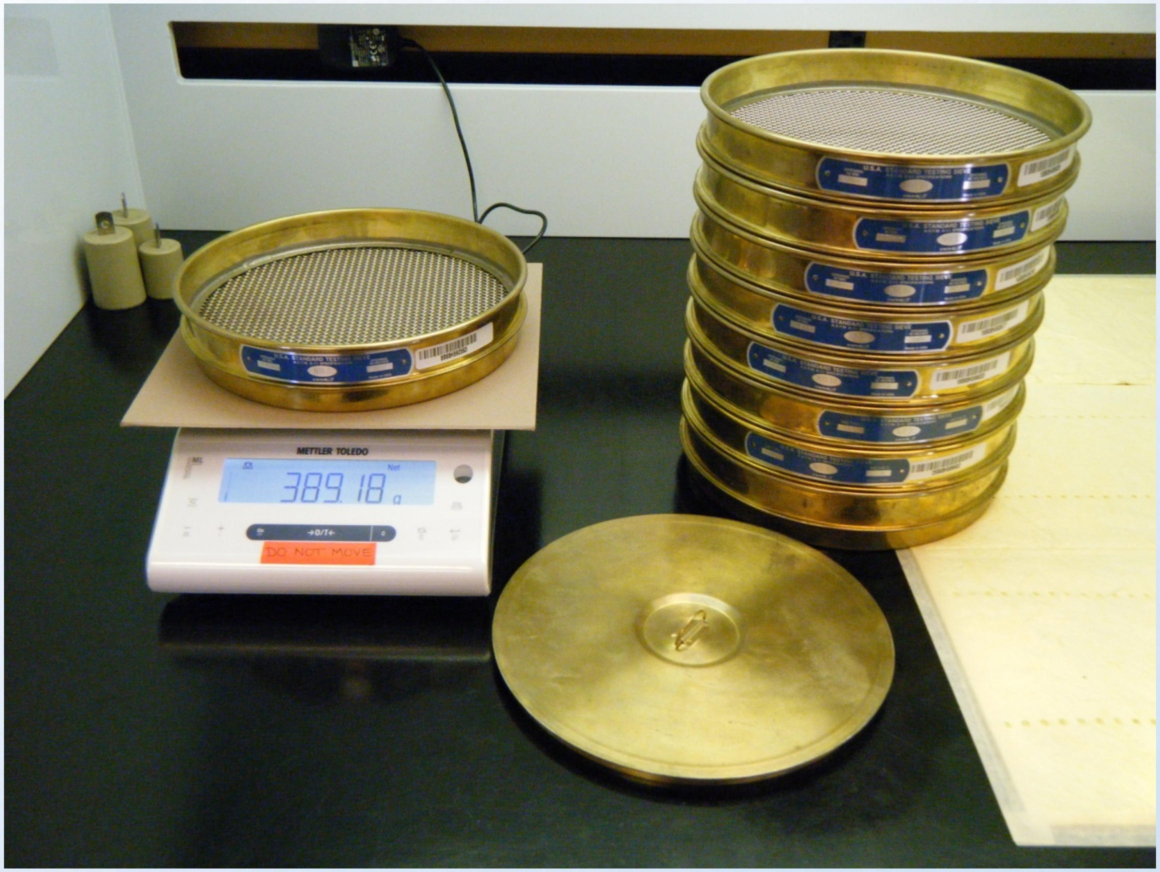
Sieve Testing Anthracite

Collect Anthracite Sample

- A PVC coring tool can be used to pull media from the filter.
- A sample of 500 to 1000g is sufficient.
- Media should be collected from each corner of the filter.
- The sample should be a mixture of anthracite from all the depths of the core.

Laboratory Drying Oven

Samples are placed inside the drying oven and dried to a constant mass at a temperature of 110 $\pm$ 5^{o}C.



ASTM E11 Standard Sieves and Top-loading Balance

Sieves are weighed empty and then nested from largest diameter at the top to smallest at the bottom before the anthracite is added.

Sieve Analysis Worksheet

Date Sampled: 10/11/13 Sample Type: Anthracite

Sample Location: Filter #12 Sample Depth: Mixed

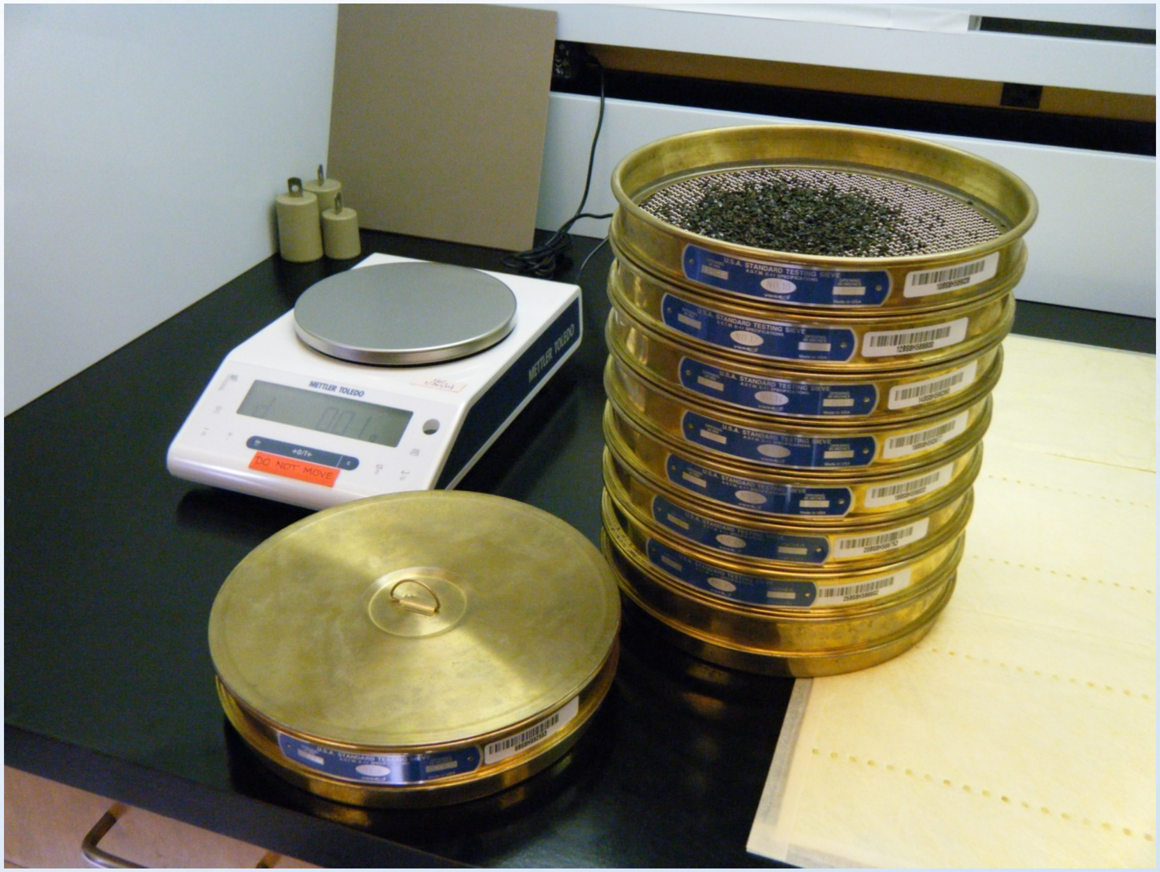
Original Sample Mass (g) ____

Sieve #	Diameter	Empty sieve mass (g)	Sieve + smpl. mass (g)	Sample mass retained (g)	Percent retained (%)	Cumulative retained (%)	Percent finer (%)
8	2.36mm	389.24					
10	2.00mm	381.02					
12	1.70mm	336.82					
14	1.40mm	337.16					
16	1.18mm	316.19					
18	1.00mm	307.97					
20	850μm	300.64					
25	710μm	285.69					
Pan	0	421.31					
			Sum =				

Percent difference of total mass = ((Original sample mass - Sum of retained mass)/Original sample mass) x 100

Percent diff. of total mass*

*If masses before and after sieving differ by more than 0.3% do not use the results.



Addition of anthracite to stacked sieves

About 500g of oven-dried sample is added to the top of the nested sieves, and then the lid is put in place.

Nested sieves in a sieve shaker

The sieves are placed in a shaker to shake for 5 ± 0.5 minutes. They are then removed and hand shaken an additional 2 minutes.

Sieve Analysis Worksheet

Date Sampled: 10/11/13
Sample Type: Anthracite
Sample Location: Filter #12
Sample Depth: Mixed

Original Sample Mass (g) 442.52

Sieve #	Diameter	Empty sieve mass (g)	Sieve + smpl. mass (g)	Sample mass retained (g)	Percent retained (%)	Cumulative retained (%)	Percent finer (%)
8	2.36mm	389.24	390.37				
10	2.00mm	381.02	398.70				
12	1.70mm	336.82	436.98				
14	1.40mm	337.16	505.59				
16	1.18mm	316.19	393.38				
18	1.00mm	307.97	344.47				
20	850µm	300.64	314.61				
25	710µm	285.69	293.94				
Pan	0	421.31	440.71				
			Sum =				

Percent difference of total mass = ((Original sample mass - Sum of retained mass)/Original sample mass) x 100

Percent diff. of total mass*

*If masses before and after sieving differ by more than 0.3% do not use the results.

Sieve Analysis Worksheet

Date Sampled: 10/11/13 Sample Type: Anthracite

Sample Location: Filter #12 Sample Depth: Mixed

Original Sample Mass (g) 442.52

Sieve #	Diameter	Empty sieve mass (g)	Sieve + smpl. mass (g)	Sample mass retained (g)	Percent retained (%)	Cumulative retained (%)	**Percent finer (%)**
8	2.36mm	389.24	390.37	1.13	0.26	0.26	99.74
10	2.00mm	381.02	398.70	17.68	3.99	4.25	95.75
12	1.70mm	336.82	436.98	100.16	22.62	26.87	73.13
14	1.40mm	337.16	505.59	168.43	38.04	64.91	35.09
16	1.18mm	316.19	393.38	77.19	17.44	82.35	17.65
18	1.00mm	307.97	344.47	36.50	8.24	90.59	9.41
20	850μm	300.64	314.61	13.97	3.16	93.75	6.25
25	710μm	285.69	293.94	8.25	1.86	95.61	4.39
Pan	0	421.31	440.71	19.40	4.38	99.99	0.01
			Sum =	442.71			

Percent difference of total mass = ((Original sample mass - Sum of retained mass)/Original sample mass) x 100

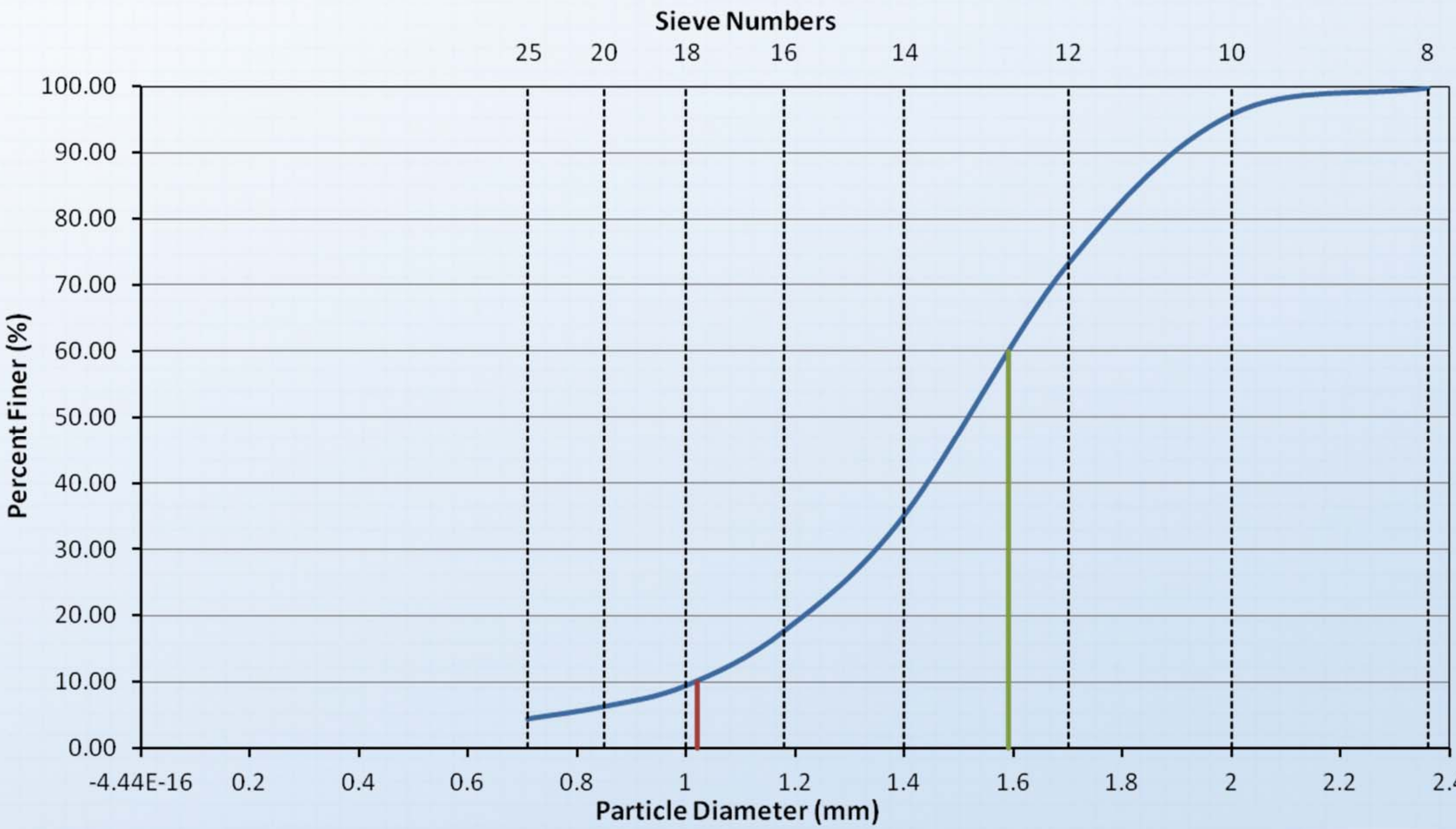
Percent diff. of total mass* 0.04%

*If masses before and after sieving differ by more than 0.3% do not use the results.

Sieve Analysis

Date Sampled: 10/11/13 Sample Type: Anthracite Sample Depth: Mixed

Sample Location: Filter #12



D_{10} = 1.02

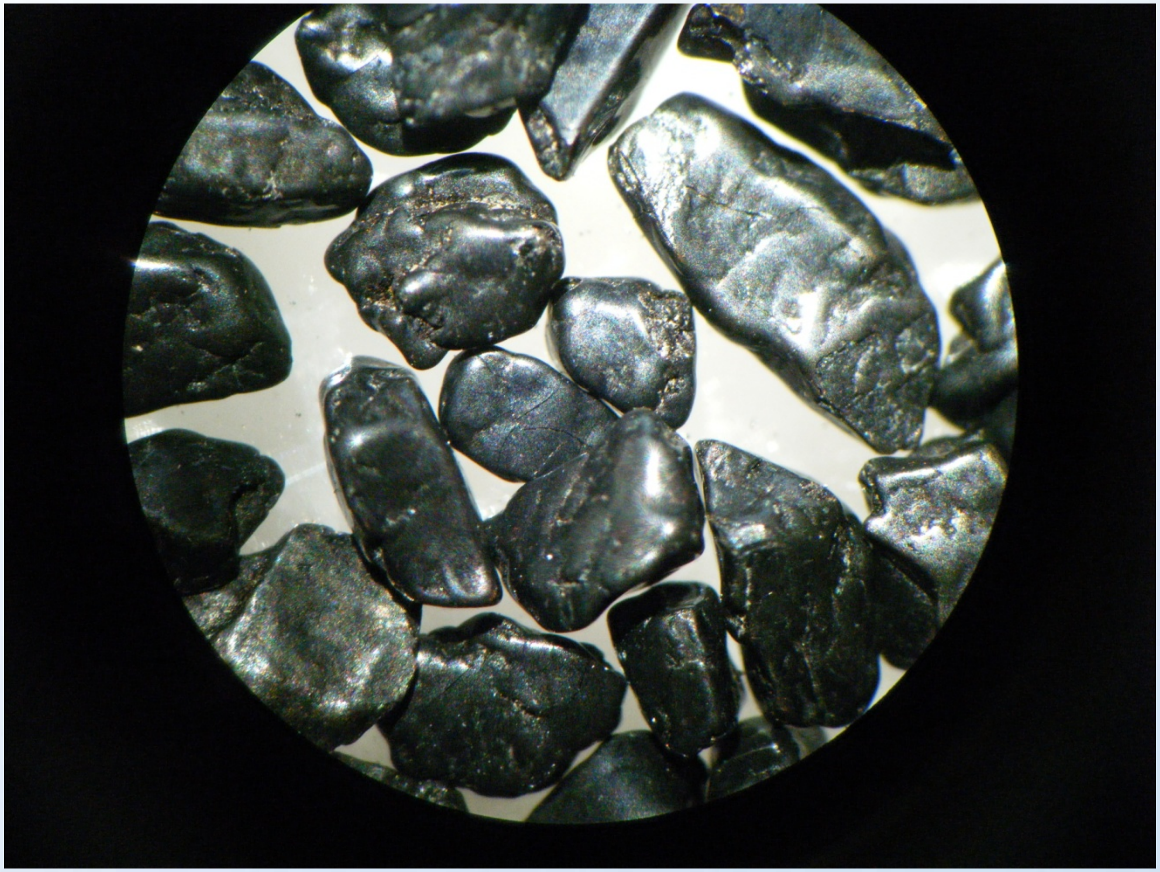
D_{60} = 1.59

Effective Size = 10% Finer = 1.0mm

Uniformity Coefficient = D_{60}/D_{10} = 1.6

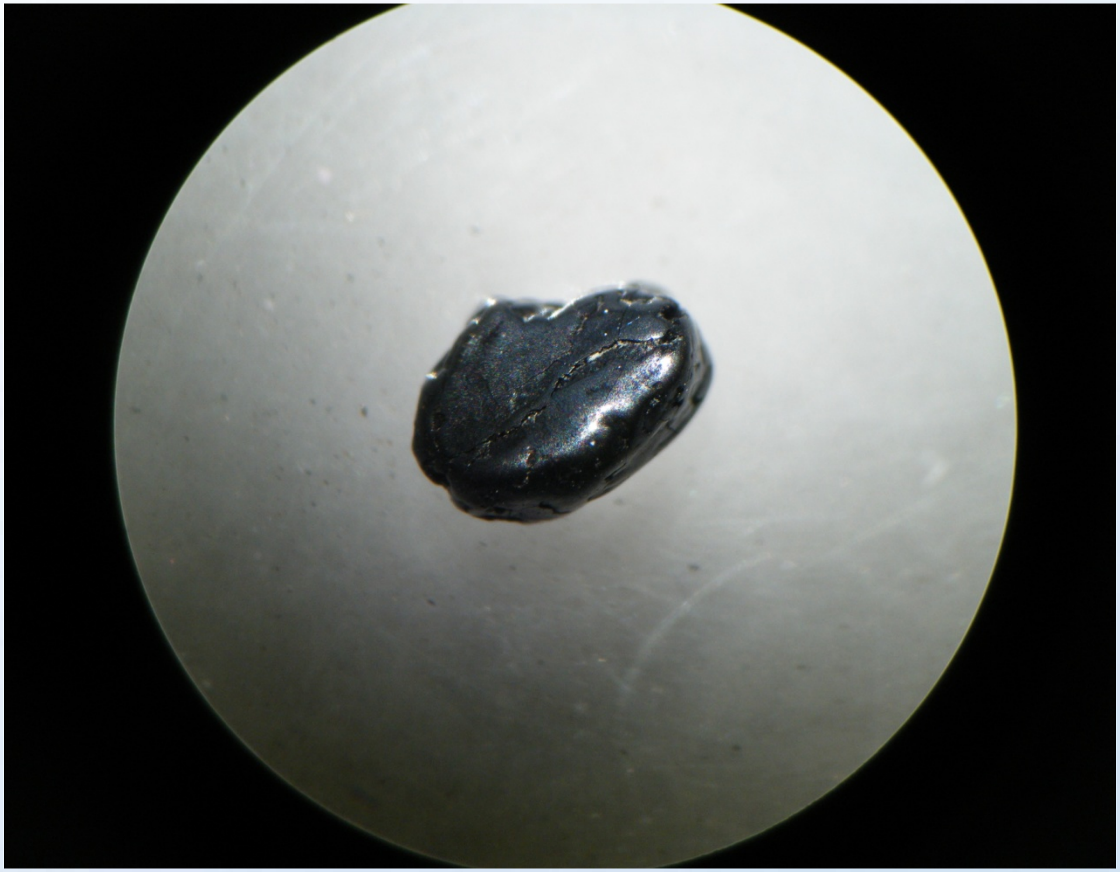
New Filter Media

This sample of anthracite came from a bag of unused, new media.

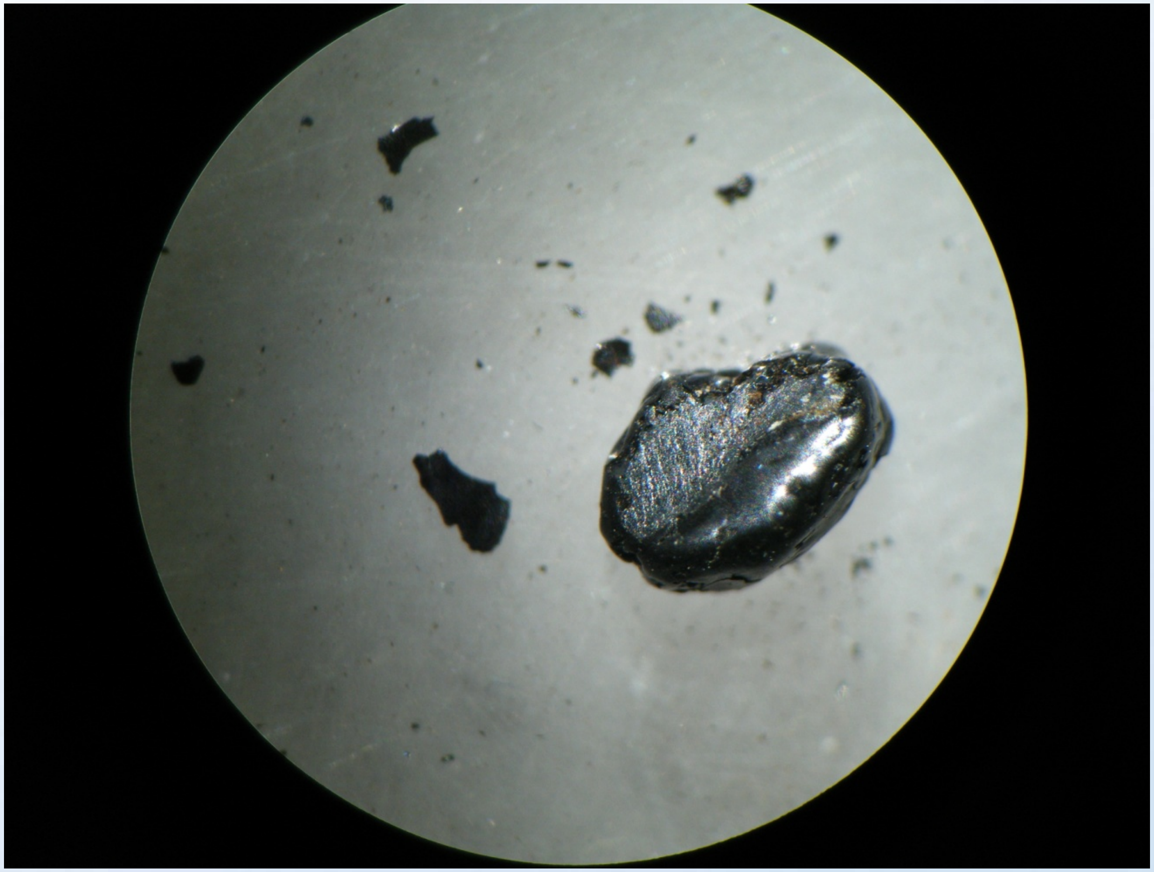


Used Filter Media

This sample of anthracite came from one of filters that has been in use since 1996.



A piece of used anthracite



Same anthracite with deposits broken off

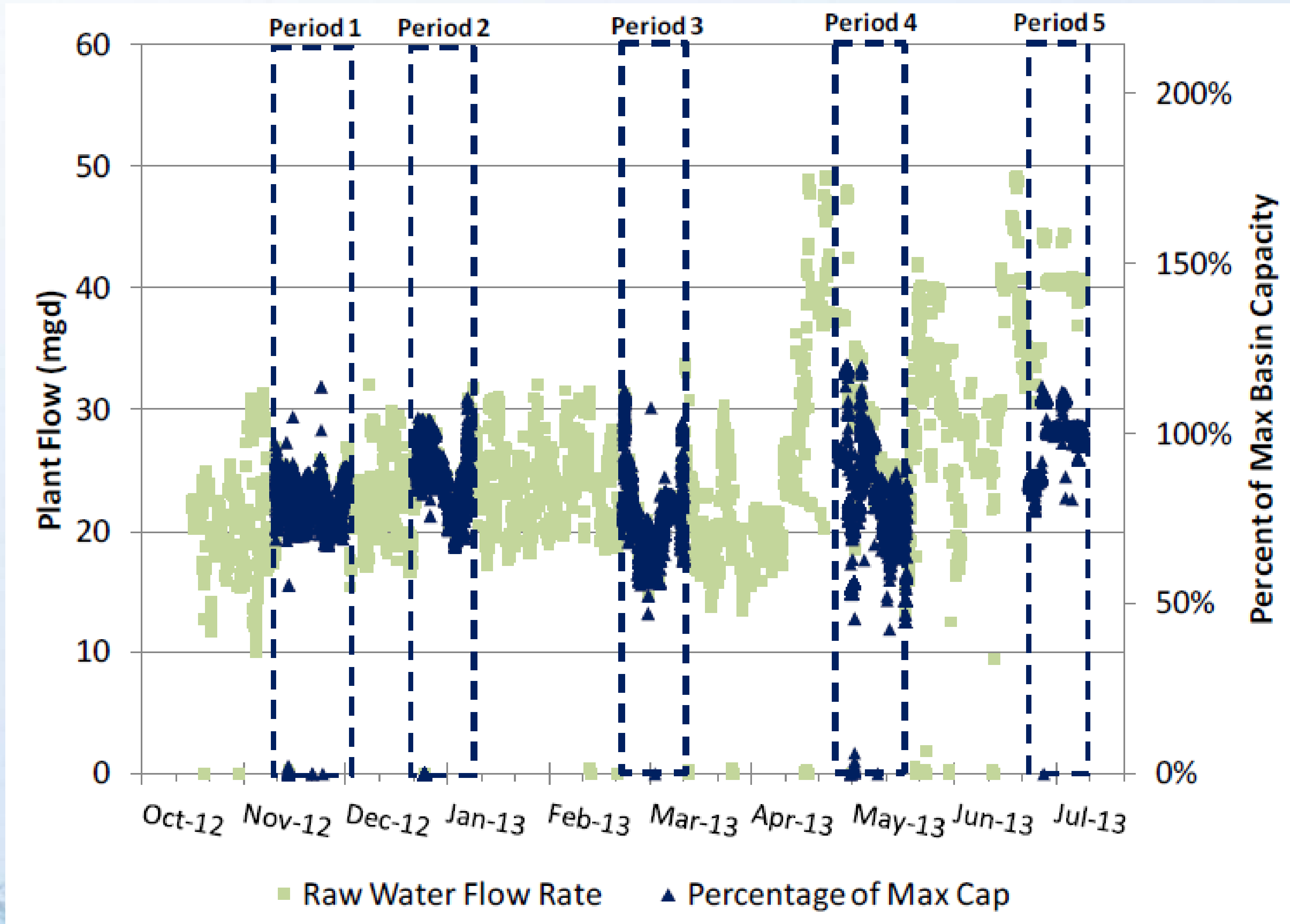
RESULTS OF ANTHRACITE SIEVE ANALYSIS

	Filter Average	New Media Specs
Effective Size (mm)	1.1	1.2
Uniformity Coefficient	1.5	<1.4

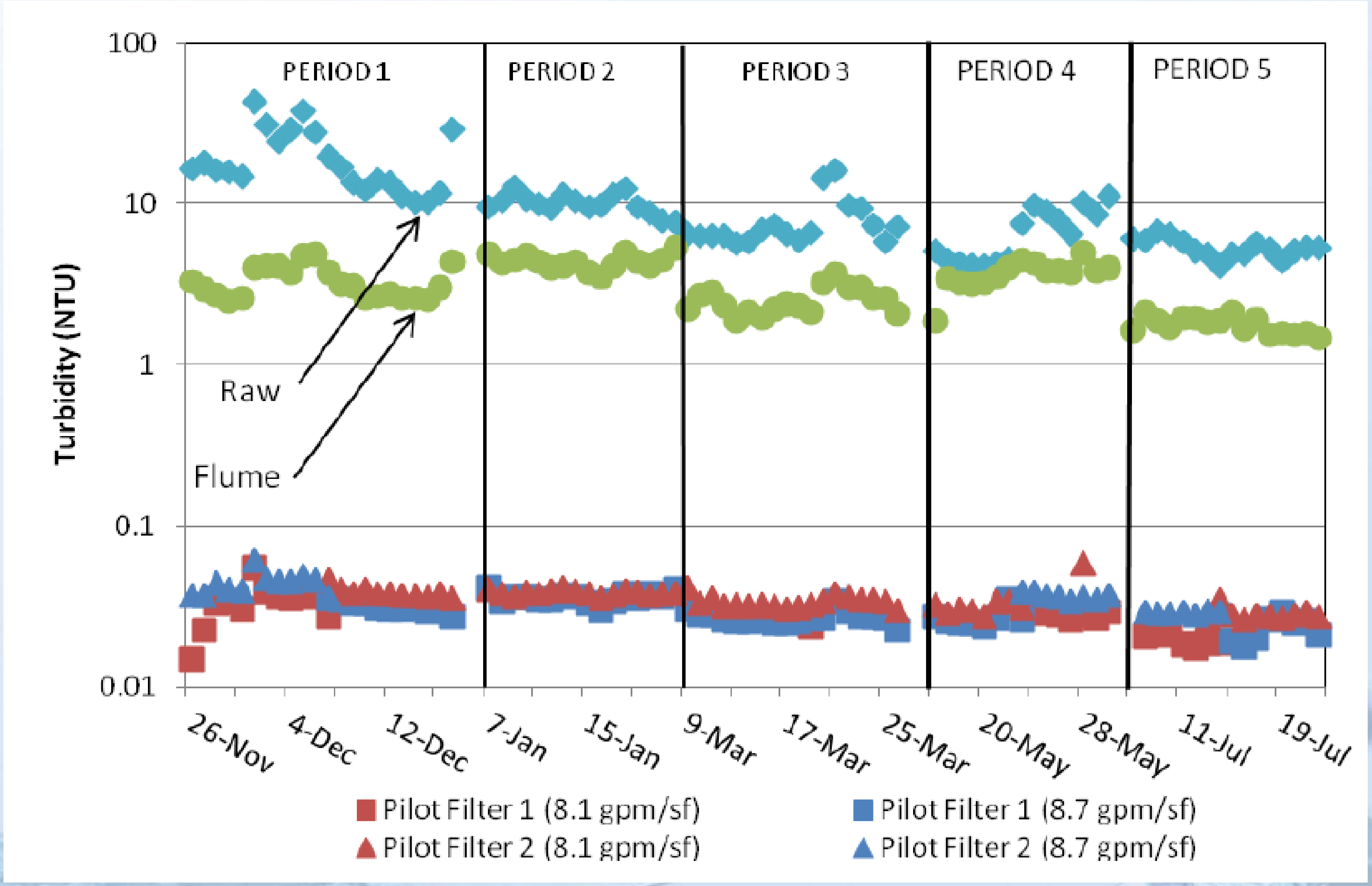
The average effective size and uniformity coefficient for the anthracite in all the filters varies only slightly from the original media specifications.

HOW DID THE PILOT STUDY GO?

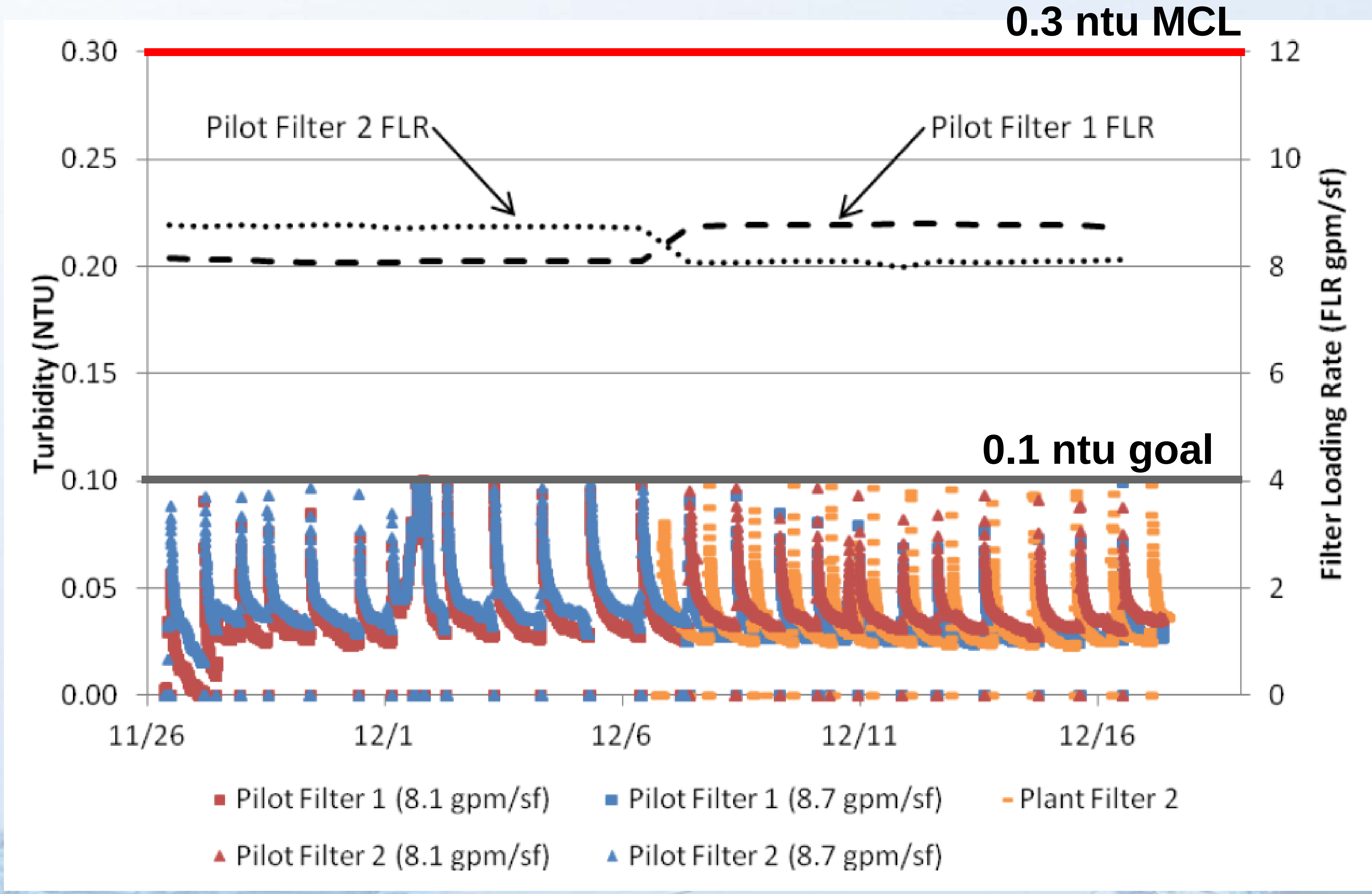
Basins were run at 70% (Winter) to 100% (Summer) of their capacity



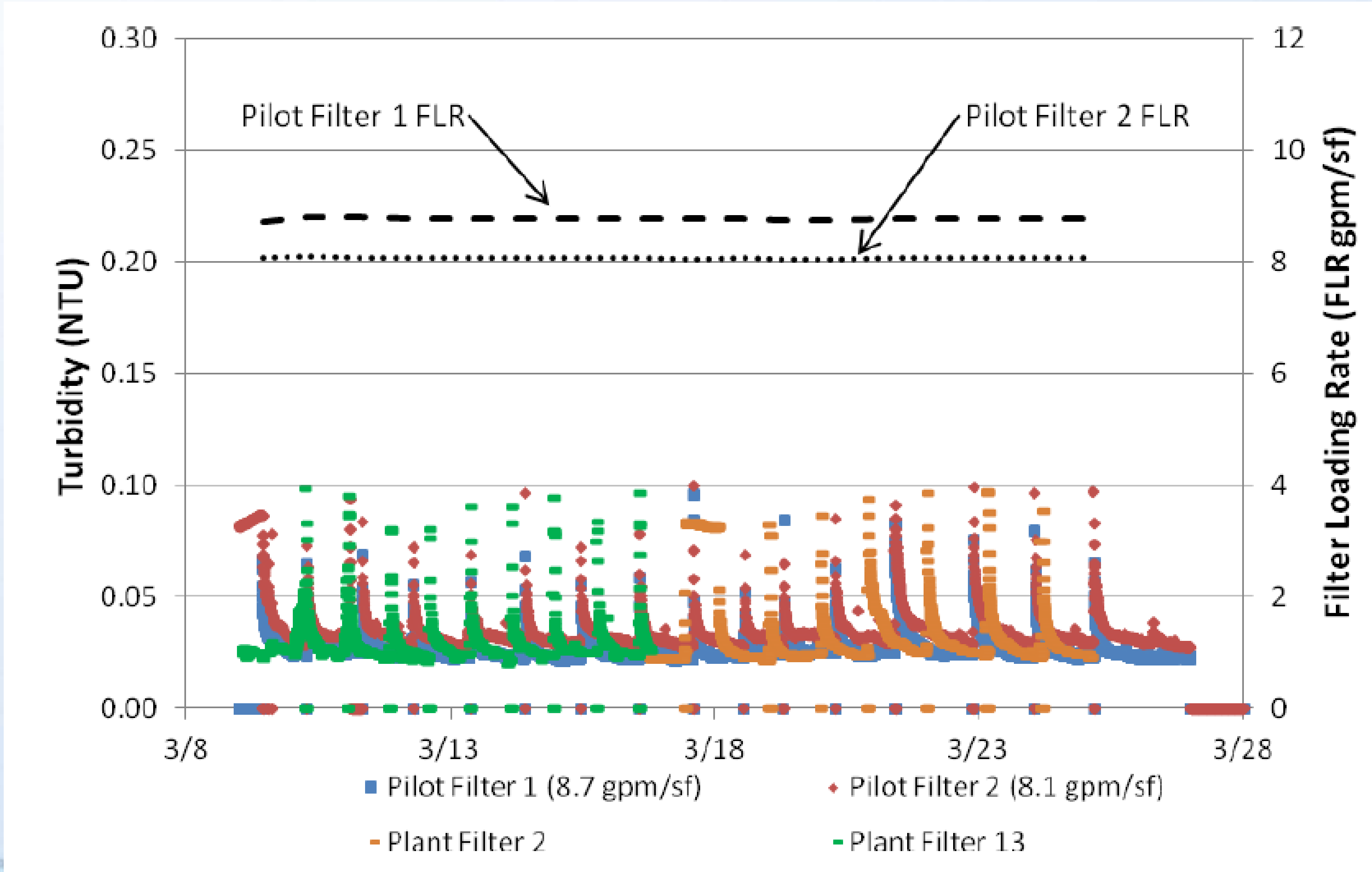
- Raw water quality conditions captured
- Settled water always <10 ntu, typically <5 ntu
- Pilot filter effluent consistently <0.1 ntu



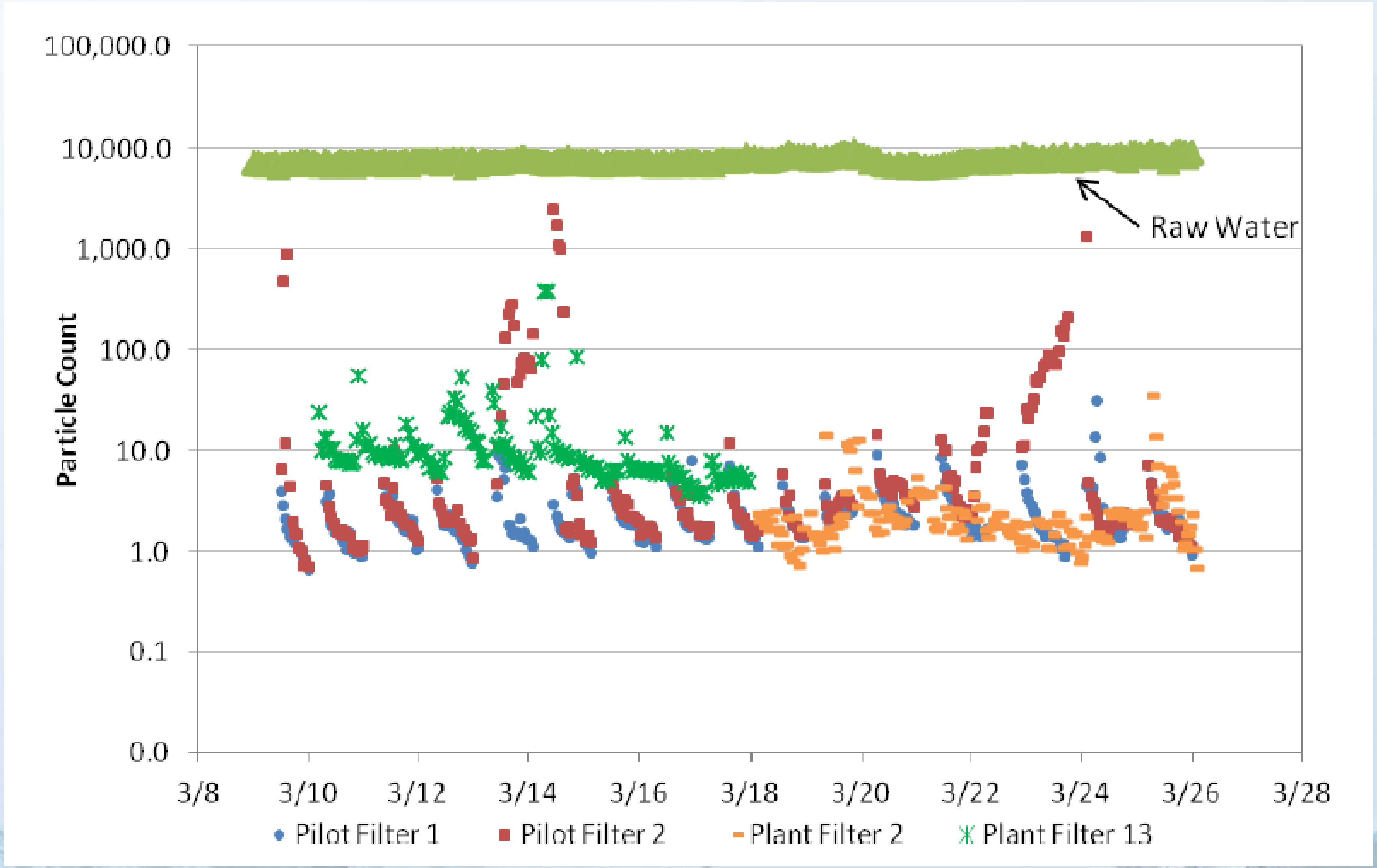
Pilot filters were representative of each other and the full scale plant filters



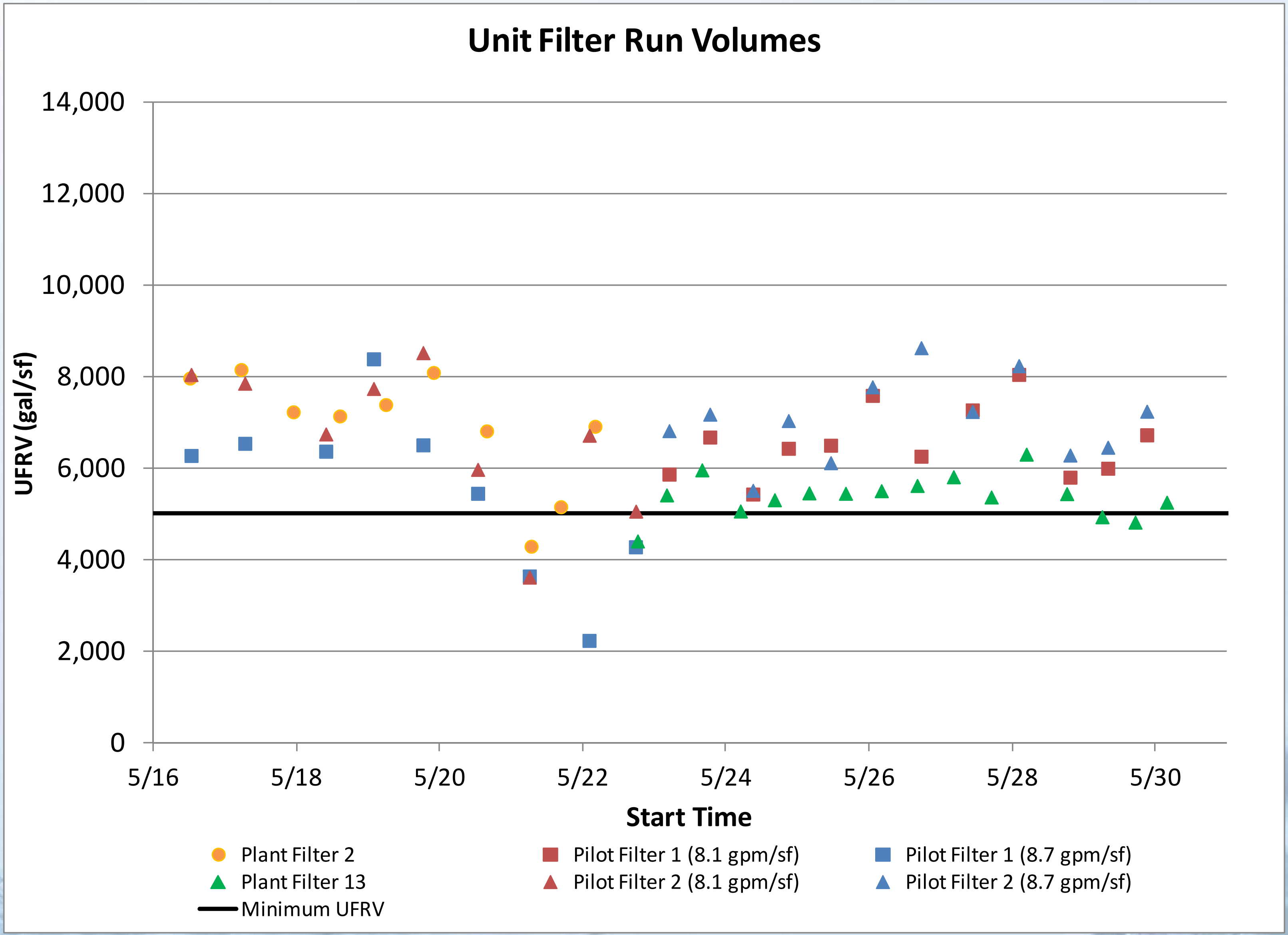
Annual Wapato drawdown not found to impact turbidity removal



Particle counts reduced from 10,000 to <20 particles/100 ml.



Filter loading rate did not have a significant impact on the UFRVs



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The tests confirmed:

- Captured the desired raw water quality conditions
- Safely stressed the WTP
  - Pretreatment processes are OK during the winter at 70% of summertime capacity
- The WTP and pilot filters performed well
- The 8.7 gpm/sf filter performed well
  - Turbidity (average <0.05 ntu)
  - Particle/log removal (>2-log in 2-15 um range)
  - Headloss was trigger for backwashes (breakthrough not observed)
  - Runtime (>15 hours) and UFRV (typically >8,000 gal/sf)

Results:

- Testing satisfied OHA and JWC objectives
- Water quality exceeded regulatory requirements
- Submitted FLR Study Report to OHA in September 2013
- Received approval from OHA in January approving new filter rate of 8.7 gpm/sq ft.
- Increasing from 8.1 to 8.7 gpm/sq ft increases our approved filtration capacity by 5.6 MGD (from 75.4 to 81 MGD)

What now?

- In order to meet future demands the City of Hillsboro and TVWD recently decided to build a new WTP in Wilsonville on the Willamette River.
- No definite plans for increasing the plant capacity of the JWC WTP in the future.

Thank you Carollo Engineers and HDR Engineering for their work on this project.

QUESTIONS?