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Technical Memorandum

Prepared for: City of Pittsburg

Project Title: Water Filter Rehabilitation

Project No.: 146044

Technical Memorandum

Subject: Filter Gallery Piping Evaluation

Date: June 18, 2015

To: Walter C. Pease, Director of Water Utilities

From: William K. Faisst, Ph.D., P.E., Vice President

Copy to: Jason Moser, Chief Operator

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Limitations:

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Executive Summary

About six years ago, the City of Pittsburg (City) Water Treatment Plant (WTP) experienced a pipe failure within the WTP filter gallery for Filter 7. City staff repaired the pipe and owing to the valve's age and deteriorating condition, also replaced the adjacent 16-inch butterfly valve. This failure raised questions about the condition of the piping, fittings, valves and appurtenances of other filters. Based on the design drawings, the gallery piping for filters 5, 6, 7, and 8 appear to be original, in service since the mid-1970s. The cast dates on the butterfly valves for those filters is 1973.

In June 2014, Brown and Caldwell (BC) performed pipe wall thickness testing on some exposed filter piping within the Filter Gallery. Specifically, BC measured wall thickness with an ultrasonic thickness gauge for piping for Filters 5, 6, 7 and 8 at select locations, focusing especially on Filter 7, since the City plans to rehabilitate that filter's media and underdrains soon. The gauge is capable of measuring the thickness of various materials with accuracy as high as ± 0.001 inches. BC completed spot testing at limited locations, intended to survey general pipe condition; it does not represent a comprehensive testing of all piping. During the field work, inspection revealed several areas where corrosion very likely had occurred as well as apparent external corrosion damage that may reflect internal corrosion. Table ES-1 summarizes findings from the limited testing.

Table ES-1 Summary of Various Filter Piping Condition

Filter	Inlet Elbows	Inlet Tees	Outlet Elbows	Outlet Tees
5	Not evaluated	Not evaluated	Thin spot detected and external corrosion observed	Not evaluated
6	Not evaluated	Not evaluated	Not evaluated	Thin spot detected and external corrosion observed
7	Corrosion	Corrosion	Thin spot detected and external corrosion observed	Not evaluated
8	Not evaluated	Thin spot and corrosion	Thin spot detected and external corrosion observed	Thin spot detected and external corrosion observed

Note: Not all portions of the piping were measured. Areas with visible corrosion were evaluated first.

According to the 1975 design drawings, the gallery piping was cement-mortar-lined, minimum 12-gage (0.109-inch wall thickness) welded steel. Measured wall thicknesses ranged from 0.06 to 0.18 inches. These values indicate that a thicker plate may have been used for parts of the gallery piping. Our findings suggest the actual thickness of some of the pipe may have originally been 7-gage (0.190 inch) or Schedule 10 (0.188 inch) piping. Since from the plans the specified 12-gage wall thickness was a minimum thickness, many pipe fabricators might have used thicker steel if they had thicker material in stock or available at a lower cost. Or the City may have altered the pipe wall thickness requirements during construction.

Piping and fittings tested for each filter examined showed at least one thin spot on each pipe. Based on limited field testing these thin spots occurred primarily at the top of the pipe at elbows and tees; measured thicknesses suggest that the piping has lost 40 to 70 percent of its original steel wall.

The valve cast dates indicate that valves are about 40 years old, comparable to that of the piping. Given their age, it is not surprising that several valves show evidence of significant deterioration, including leaking around valve stems. Similarly, the pneumatic cylinder operators are old and show some exterior deterioration. Based on field observations and discussions with City staff, BC initially recommended that the City replace filter piping, valves and pneumatic cylinders in the gallery. The estimated construction cost for each filter at an order-of-magnitude accuracy level is about $320,000, including a 30 percent contingency. A reasonable capital allowance would be $400,000 in current dollars per filter, including an allowance of 20 percent for engineering, legal and contingency costs.

Through discussion with City staff, we understand that a complete program of pipe and valve replacement is not feasible now given the current operating budget. In lieu of immediate replacement, BC recommends that the City perform the following activities:

1. Carry out additional investigations of all filter gallery piping to better assess its overall condition.
2. Make spot repairs to welded steel pipe and lining/coating as problems arise.
3. Confirm that the dimensions of the piping elbows and spool pieces are the same for each filter, as indicated in the plans.
4. Consider purchasing and storing a complete spare set of piping and appurtenances for one filter to allow quick repair of problem areas.

Peak production at the WTP typically reaches around 60 percent of the design capacity, which implies that that there is enough redundancy in the filter gallery to take one or more filters offline should any pipes spring a leak. When this happens, the City could swap out any leaking pipe(s) with the warehoused spare pieces. After the repair, the City should perform a complete condition assessment of the removed piece(s) and can elect repair (and storage for future use) or replacement as required.

Section 1: Background

In 2009, the City of Pittsburg (City) Water Treatment Plant (WTP) experienced a pipe failure within the WTP Filter Gallery for Filter 7. City staff repaired the pipe and owing to the valve's age and deteriorating condition, also replaced the adjacent 16-inch butterfly valve. The failure raised questions about the condition of the filter piping, fittings, valves and appurtenances of other filters. Figure 1-1 shows the recent spot repair and replacement valve at the Filter 7 backwash elbow.

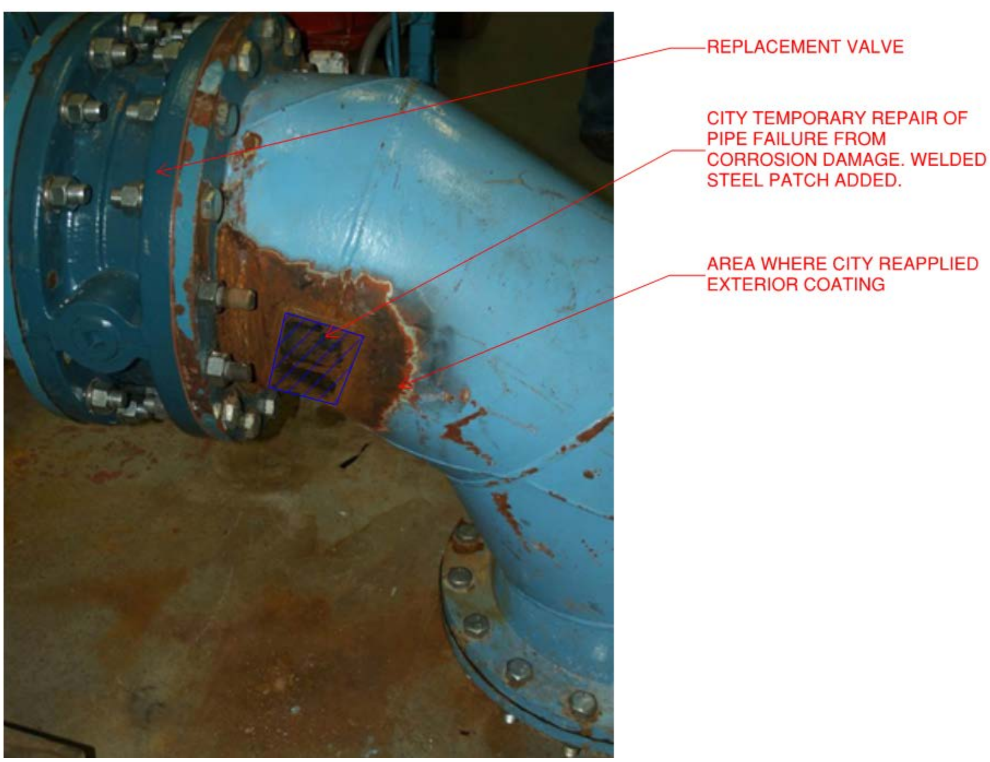

Figure 1-1. Repaired Filter 7 Backwash Inlet Elbow

The City plans to rehabilitate the media filters at its WTP as part of the ongoing, multi-year capital improvement program. Currently, this project only involves the removal of existing filter media, rehabilitating the filter underdrains, cleaning and recoating the filter boxes, and reinstalling filter media and support gravel. Since a failure to the filter gallery piping for Filter 7 occurred within the last five years, the City requested that Brown and Caldwell (BC) inspect and evaluate the piping, valves and fittings in conjunction with the filter rehabilitation project.

On June 16, 2014, BC performed pipe wall thickness testing on exposed filter piping within the Filter Gallery. BC spot tested wall thickness. We used a Checkline Ultrasonic Thickness Gauge to measure pipe wall thicknesses. We calibrated the thickness gauge before, during, and after testing using a vendor provided test coupon to maintain the accuracy of the results. The gauge is capable of measuring the thickness of various materials with accuracy as high as ± 0.001 inches. The reader should note that thickness test results can have interference due to the pipe lining causing irregular and inaccurate readings. Other errors may occur from measuring coated materials where the coating is insufficiently bonded to the material surface.

The 1975 City WTP design drawings indicate the original gallery piping is cement-mortar-lined, minimum 12-gage (0.109-inch wall thickness) welded steel. Our findings suggest the actual thickness of some of the pipe may have originally been 7-gauge (0.19 inch) or Schedule 10 (0.188 inch).

As steel pipe thicknesses are often designated with different units (gauge and schedule), Table 1-1 provides reference thicknesses for comparison.

Table 1-1. Typical Pipe Thicknesses

Description	Thickness (inches)
Schedule 5	0.165
Schedule 10	0.188
7 Gauge	0.190
10 Gauge	0.140
12 Gauge	0.109

BC assumes that the City's contractor would have used pipe material with the same wall thickness for all the pipes, but it is possible that the contractor used two or more different wall thicknesses. Based on the data gathered and reported in this technical memorandum (TM), this possible variation is not critical for the City's decision making.

Thickness testing focused only on the gallery piping for Filters 5, 6, 7 and 8. Based on the design drawings and discussions with City staff, the gallery piping for those filters appears to be original and has been in service since the mid 1970s. The cast dates on the butterfly valves associated with those filters is 1973.

Inspectors visually inspected the piping and performed random thickness spot checks on areas where they observed external corrosion or suspected internal corrosion owing to typical industry methods for pipe fabrication and interior lining application (e.g., manually lining of elbows and tees)—thinning typically occurs primarily at the elbows and tees of the piping. During the first filter inspection (Filter 7), it was determined that pipe thickness losses developed near the pipe crown pipe. Thus, subsequent inspections focused on checking for deficiencies near the pipe crowns.

Section 2: Thickness Testing Results

As discussed in Section 1, to measure pipe wall thicknesses within the Filter Gallery, BC selected several locations based on visible corrosion and common failure points. The filter piping appears to possibly be either 7-gauge or Schedule 10. This section summarizes evaluated piping measurements from Filters 5, 6, 7 and 8.

2.1 Filter 7

BC considered testing the Filter 7 piping first due to the pipe's failure and subsequent emergency repair. The City also plans to rehabilitate Filter 7 first owing to its deteriorated condition. Inspectors measured inlet and outlet piping wall thicknesses in straight runs and at tees and elbows. The results are summarized in Section 2.1.1, Tables 2-1 through 2-5 and Figures 2-1 through 2-5 below.

2.1.1 Filter 7 Measurements

Figure 2-1 shows the thickness testing locations listed in Table 2-1.

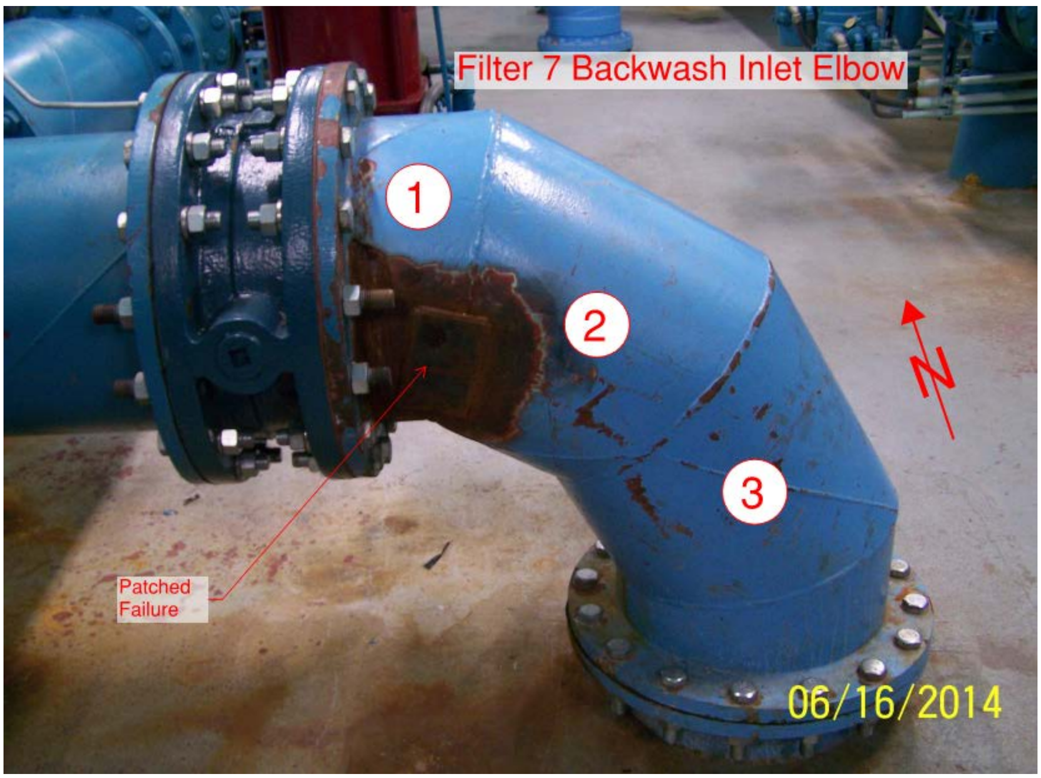

Figure 2-1. Filter 7 Backwash Inlet Elbow Measurement Locations

Table 2-1. Field Measurement of Backwash Inlet Elbow Thicknesses (inches)

Location	Top	South	Bottom	North
1	0.178	0.122	0.143	0.156
2	0.176	0.152	0.150	0.154
3	0.171	0.153	0.150	0.150

Figure 2-2 shows the thickness testing locations listed in Table 2-2.

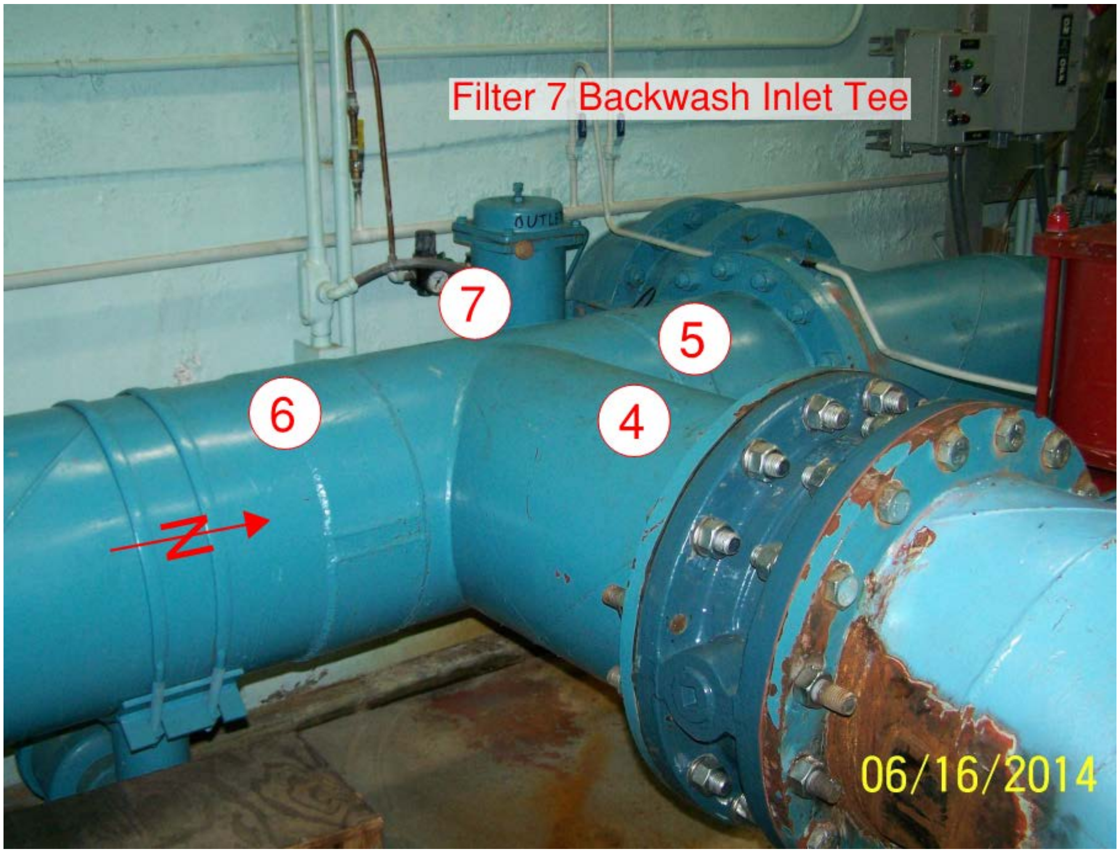

Figure 2-2. Filter 7 Backwash Inlet Tee Measurement Locations

Table 2-2. Field Measurement of Filter 7 Backwash Inlet Tee Thicknesses (inches)

Location	Top	South	Bottom	North
4	0.154	0.156	0.144	0.150
Location	Top	West	Bottom	East
5	0.174	0.154	0.176	0.150
6	0.148	0.146	0.150	0.152
7	0.157	0.161	0.150	-

Figure 2-3 shows the thickness testing locations listed in Table 2-3.

Figure 2-3. Filter 7 South Leg Measurement Locations

Table 2-3. Field Measurement of Filter 7 South Leg Thicknesses (inches)				
Location	Top	West	Bottom	East
Middle	0.151	0.144	0.150	0.143
6 inches North of Flange	0.164	0.145	0.148	0.148

Figure 2-4 shows the thickness testing locations listed in Table 2-4.

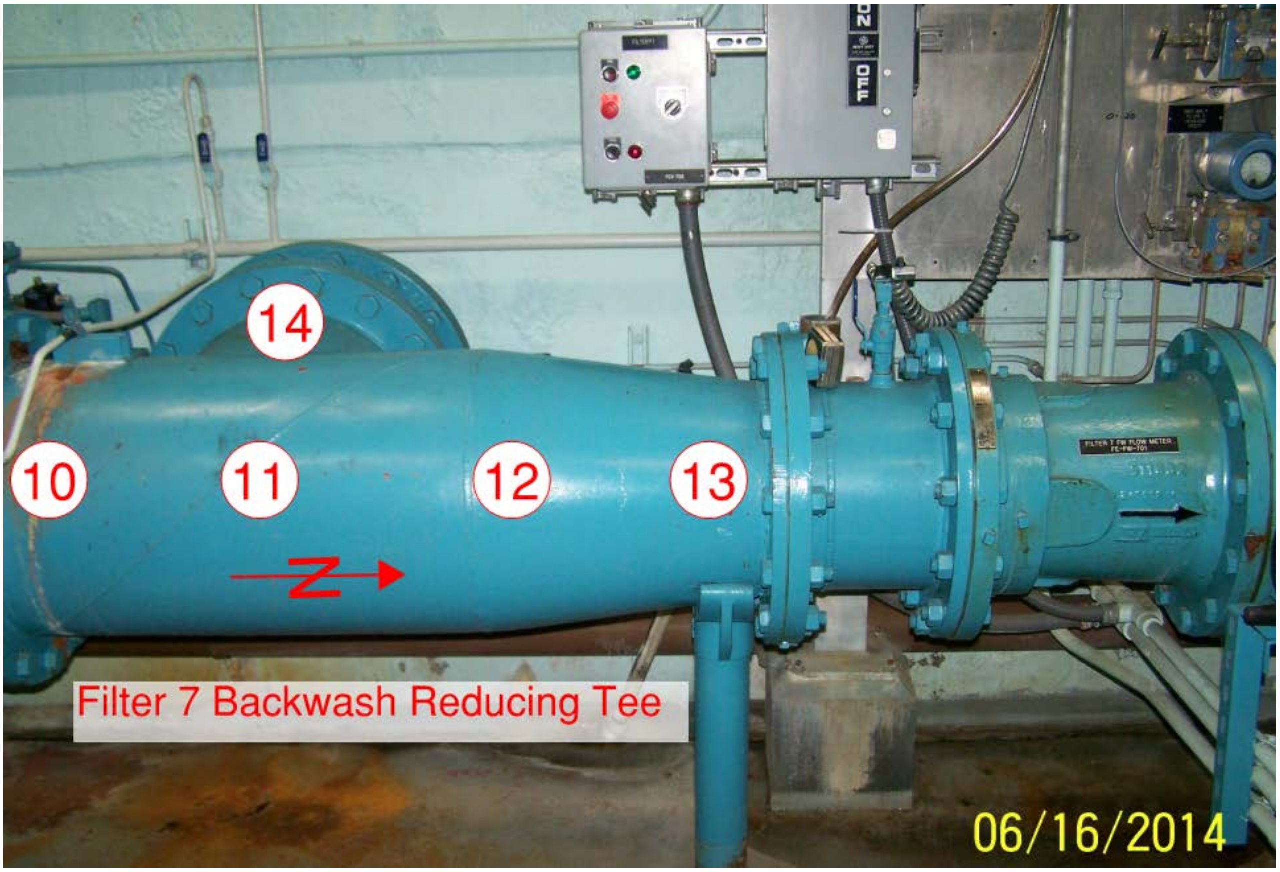

Figure 2-4. Filter 7 Backwash Reducing Tee Measurement Locations

Table 2-4. Field Measurement of Filter 7 Backwash Reducing Tee Thicknesses (inches)

Location	Top	West	Bottom	East
10	0.126	0.116	0.136	0.118
11	0.130	NA	0.130	0.114
12	0.114	0.112	0.115	0.111
13	0.112	0.117	0.110	0.114
14	0.126	0.135 (South)	0.133	-

Figure 2-5 shows the thickness testing locations listed in Table 2-5.

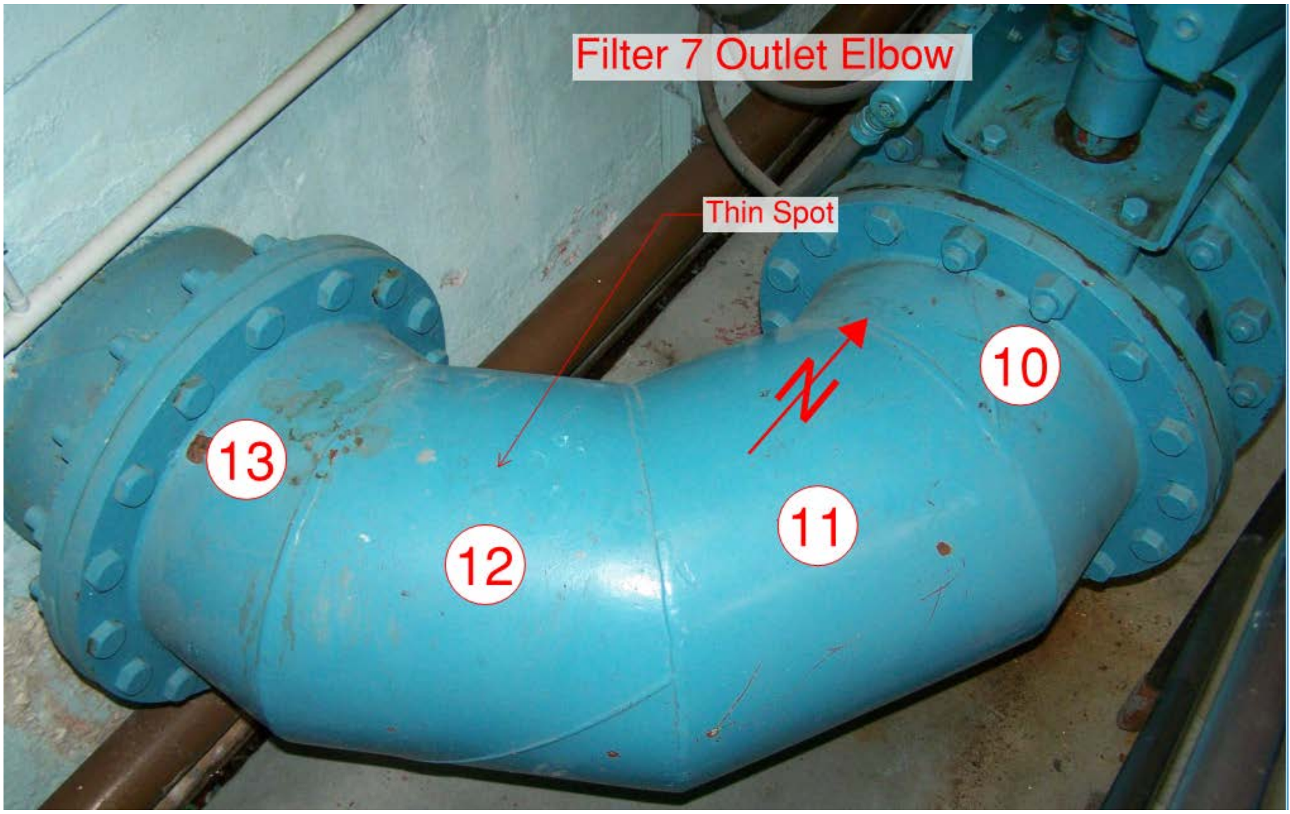

Figure 2-5. Filter 7 Outlet Elbow Measurement Locations

Table 2-5. Field Measurement of Filter 7 Outlet Elbow Thicknesses (inches)				
Location	Top	West	Bottom	East
10	0.163	-	-	-
11	0.164	-	0.143	-
12	0.064	0.169	0.171	0.154
13	0.168	0.150	-	0.150

2.1.2 Filter 7 Evaluation

Through testing the Filter 7 inlet and outlet piping, one severely thin spot was discovered on top of the outlet elbow (Location 12). Up to about 70 percent of the pipe thickness was lost (assuming that the original pipe wall thickness was approximately 0.19 inches). In addition to the thin spot, several locations with significant external corrosion were also observed.

2.2 Filter 8

Because the exposed Filter 8 gallery piping showed signs of exterior corrosion, BC performed testing at several inlet/outlet tees and elbows along the Filter 8 piping near the pipe crown to look for pipe wall thickness losses. As with Filter 7, the filter piping also appears to be 7-gauge or Schedule 10. The results are summarized in Section 2.2.1, Tables 2-6 through 2-8 and Figures 2-6 though 2-8 below.

2.2.1 Filter 8 Measurements

Figure 2-6 shows the thickness testing locations listed in Table 2-6.

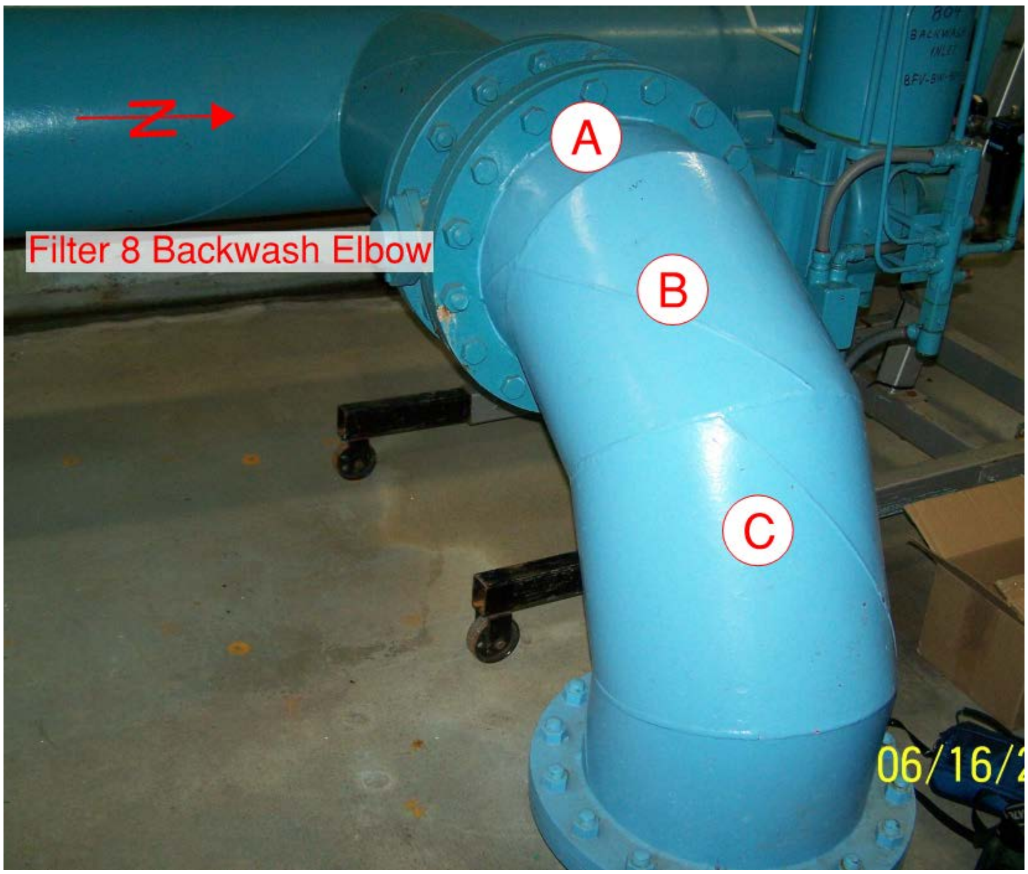

Figure 2-6. Filter 8 Backwash Elbow Measurement Locations

Table 2-6. Field Measurement of Filter 8 Backwash Elbow Thicknesses (inches)		
Top	A	0.172
	B	0.187
	C	0.178

Figure 2-7 shows the ultrasonic thickness gauge used to perform the testing. The gauge display indicates a thin spot discovered 4 inches from the flange of the Filter 8 outlet tee (see Table 2-7).

Figure 2-7. Filter 8 Outlet Tee with Ultrasonic Thickness Gage

Table 2-7. Field Measurement of Filter 8 Outlet Tee Thicknesses (inches)		
Top	0.102	0.105
	0.106	0.114
	0.066/0.059/0.067 (thin spot 4 inches from flange)	

Thin spots were measured on the filter piping at the crowns of the elbow and tee, as shown on Figures 2-8A and 2-8B and listed in Table 2-8.

Figure 2-8A. Ultrasonic Thickness Tester at Thin Spot at Filter 8 Tee

(Location with a measured thickness of less the 0.10 inches)

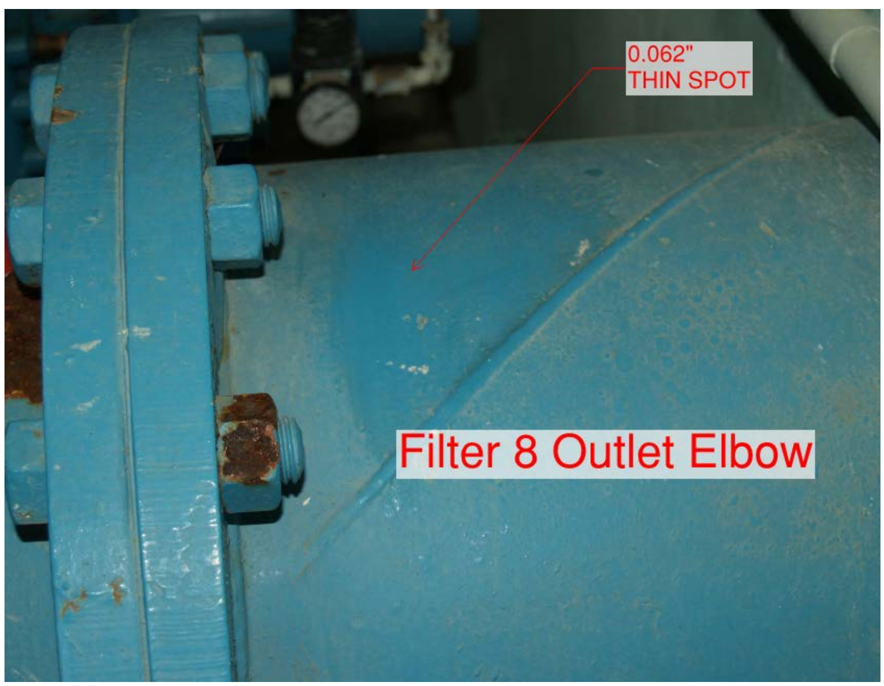

Figure 2-8B. Filter 8 Outlet Elbow with Measured Thin Spot Indicated

(Location with a measured thickness of less the 0.10 inches)

Table 2-8. Field Measurement of Filter 8 Outlet and Inlet Piping Thicknesses (inches)				
Filter 8: Backwash Inlet Tee (Top)				
Top	0.129	0.098	0.175	
Filter 8: Reducer				
Top	0.125/ 0.103/0.082			
West	0.107/ 0.117/ 0.108/ 0.105			
East	0.098/ 0.107/ 0.105/ 0.107			
Filter 8: Outlet Elbow Top				
Top	0.095	0.159	0.166	0.062

2.2.2 Filter 8 Evaluation

Measurements found multiple locations with thin pipe wall thicknesses along the exposed piping for Filter 8. In addition, external corrosion was observed in several areas throughout the piping system.

2.3 Filters 5 and 6

Filters 5 and 6 piping and valves exhibited visual signs of exterior corrosion. The filter piping also appears to be either 7-gauge or Schedule 10. BC measured pipe wall thicknesses along the piping for each filter. Findings are shown on Figures 2-9 and 2-10 and in Tables 2-9 and 2-10 below.

2.3.1 Filters 5 and 6 Measurements

Figure 2-9 shows a severe thin spot near the exterior corrosion on the Filter 6 outlet tee.

Figure 2-9. Filter 6 Outlet Tee

Table 2-9. Field Measurement of Filter 6 Outlet Tee Thicknesses (inches)	
Top of Outlet Tee	
Top	0.100
	0.167
	0.071
	0.067
	0.071
	0.137

Figure 2-10 shows the location of a thin area near some exterior corrosion along the Filter 5 outlet elbow.

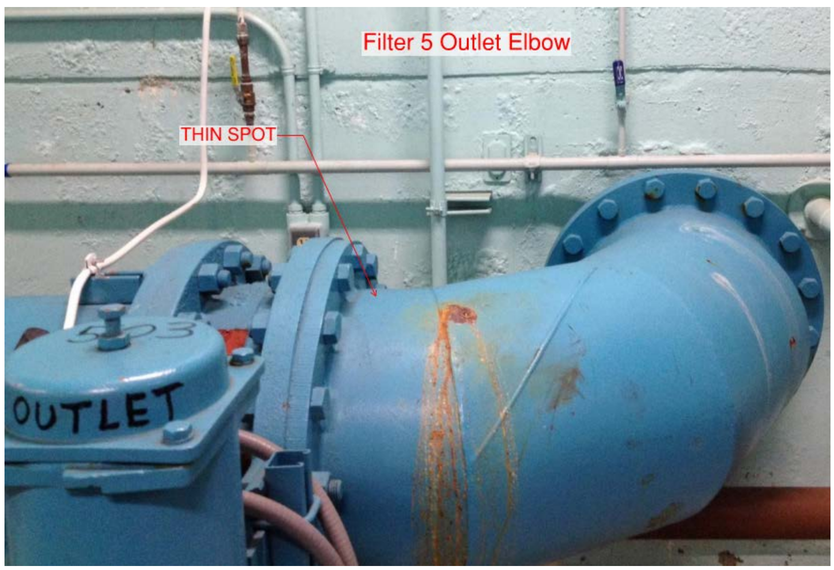

Figure 2-10. Filter 10 Outlet Elbow with Exterior Corrosion

Table 2-10. Field Measurement of Filter 5 Outlet Elbow Thicknesses (inches)				
Filter 5: Outlet Elbow Top Near Valve Around Corrosion				
Top	0.057	0.159	0.11	0.164

2.3.2 Filters 5 and 6 Evaluations

Portions of Filters 5 and 6 outlet piping showed distinct pipe wall thickness losses. These spots occurred at outlet elbows and tees near where we found external corrosion. The filter piping also appears to be 7-gauge or Schedule 10.

Section 3: Capital Costs

Based on field investigation and discussions with City staff, we recommend that the City make capital improvements in the filter gallery when capital improvement program scheduling allows. Table 3-1 provides the estimated capital costs for the replacement of the gallery filter piping and appurtenances. These include base construction costs, gallery filter piping, valving, and pneumatic cylinder replacement costs.

Table 3-1. Capital Costs of Gallery Filter Improvements

Bid Item	Costs (thousands)[a]
Base Construction Costs[a]	$31
Filter Piping and Valve Replacement	$190
Electrical/Instrumentation	$3
Construction Contingency[b]	$96
Subtotal	$320
Allowance[c]	$80
Total Capital Costs Per Filter[d]	$400

a. *The Base Construction Costs include site preparation, demolition, mobilization and demobilization.*

b. *The Construction Contingency is 30 percent.*

c. *The Allowance for engineering, legal, and contingency costs is 20 percent .*

d. *The Total Capital Cost is in current dollars (san Francisco Bay Area Summer 2014.*

The estimated construction cost for each filter is about $320,000, which includes a 30 percent construction contingency. With an additional 20 percent allowance for engineering, legal and contingency costs, the total estimated cost to replace each filter would be around $400,000.

Section 4: Conclusions and Recommendations

In general, of the examined exposed filter piping in the gallery,

Most of the filter gallery infrastructure measurements showed similar wall thicknesses, and visual inspections indicate that most are likely not significantly corroded. However, each filter had at least one thin spot in the piping. The thin spots measured only a third to perhaps one-half of the original pipe wall thickness. These thin areas ranged from 1 to 4 inches in width. The thinning that BC observed occurred predominantly at elbows and tees on the top (or crown) of the pipe. These thin spots could be attributed to uneven layers of coating or the result of corrosion at pinholes in the pipe coating spreading outward. It is evident that corrosion likely will lead to more pipe leaks. The butterfly valves also exhibit deterioration, including corrosion damage to metal and leaking valve stems.

BC recommends replacing the filter gallery piping as soon as budgeting allows it. In the interim, the City can perform spot repairs as more leaks develop. BC also recommends replacement of all exposed filter piping, valves, and pneumatic cylinders in the gallery with the exception of more recently installed modulating valves and isolation valves, which should be removed and remounted. To ensure future longevity, new pipe should have a minimum wall thickness of 0.25 inches, with cement mortar lining and epoxy coating.

Through discussion with City staff, we understand that a complete program of pipe and valve replacement is not feasible now given the current operating budget. In lieu of immediate replacement, BC recommends that the City perform the following activities:

1. Carry out additional investigations of all filter gallery piping to better assess its overall condition.
2. Make spot repairs to welded steel pipe and lining/coating as problems arise.
3. Confirm that the dimensions of the piping elbows and spool pieces are the same for each filter, as indicated in the plans.
4. Consider purchasing and storing a complete spare set of piping and appurtenances for one filter to allow quick repair of problem areas.

Peak production at the WTP typically reaches around 60 percent of the design capacity, which implies that that there is enough redundancy in the filter gallery to take one or more filters offline should any pipes spring a leak. When this happens, the City could swap out any leaking pipe(s) with the warehoused spare pieces. After the repair, the City should perform a complete condition assessment of the removed piece(s) and can elect repair (and storage for future use) or replacement as required.

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Attachment A: Original Field Notes

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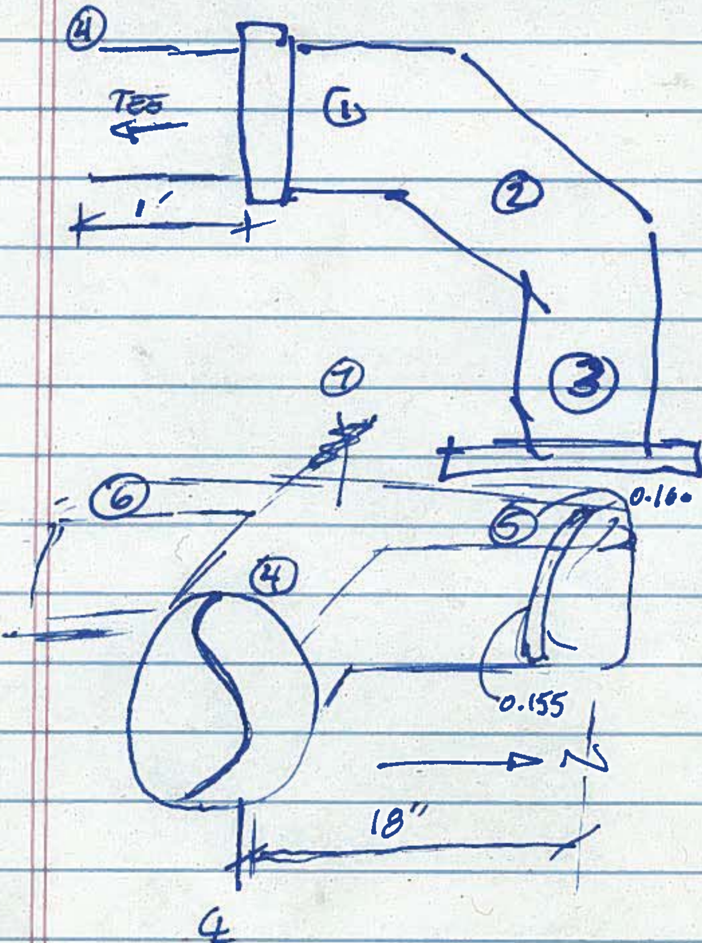
BACKWASH INLET EL



0.174 ON PATCH

	TOP	SOUTH	BOT	NORTH
1	0.178	0.122	0.143	0.156
2	0.176	0.152	.150	0.154
3	0.171	0.153	.150	0.150

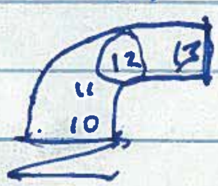
	TOP	SOUTH	BOT	NORTH
4	0.154	0.156	0.144	0.150
5	0.174	WEST 0.154	0.176	EAST 0.150
6	0.148	0.146	0.150	0.152
7	0.157	WEST 0.161	0.150	TEE

SOUTH LEG

~~MN~~ 1P
6 IN N OF FLANGE

	TOP	WEST	BOT	EAST
8	0.151	0.144	0.150	0.143
9	0.164	0.145 (0.142 CHIP IN PAINT)	0.148	0.148

OUTLET ELBOW (TOP



10	0.163			
11	0.164		0.143	
12	0.164	0.169	SOUTH 0.171	~~0.155~~ 0.154 0.150
13	0.168	0.150		

FILTER 8 TOP BACKWASH ELBOW

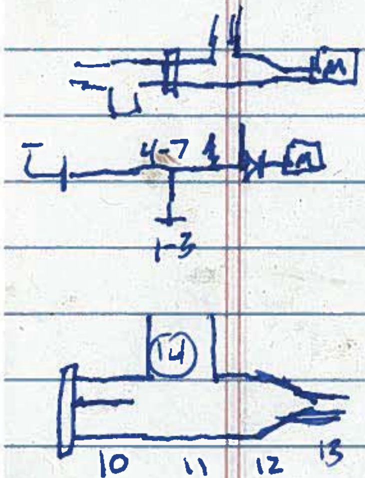
0.172

0.187

0.178

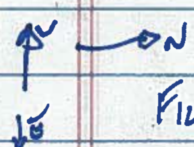
TOP OF OUTLET ELBOW

BACKWASH - REDUCING TEE:

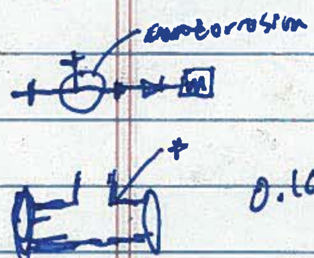


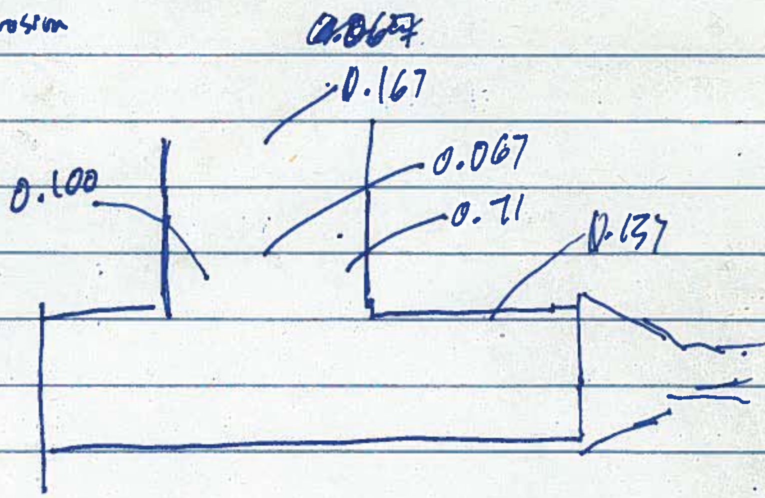
6" OFF FLANGE

	TOP	WEST	BOT	EAST
10	0.126	0.116	0.136	0.118
11	0.130	—	0.130	0.114
12	0.114	0.112	0.115	0.111
13	0.112	0.117	0.110	0.114
14	0.126	SOUTH 0.135	0.133	— TEE NORTH: 0.130



FILTER 6: OUTLET TEE:





Filter 8

Reducer

Top 0.125 / 0.103
West 0.107 / 0.117 / 0.108 / 0.105
East 0.098 / 0.107 / 0.105 / 0.107

Tee Outlet

Top 0.102 0.105 0.114
0.106 0.066

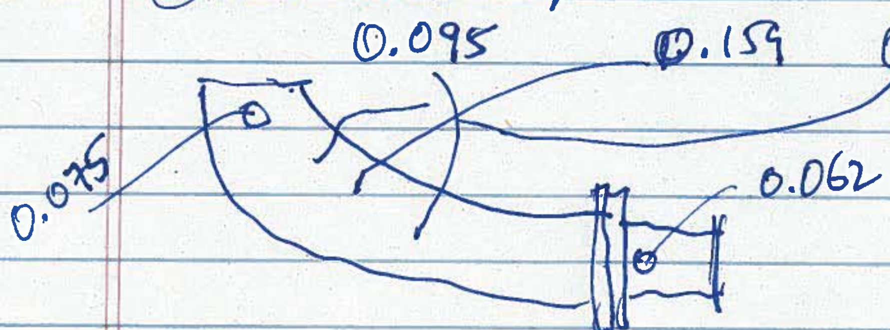
EAST
THIN SPOT
0.064
0.059

0.093
0.082
4 in from flange

BW Inlet Tee

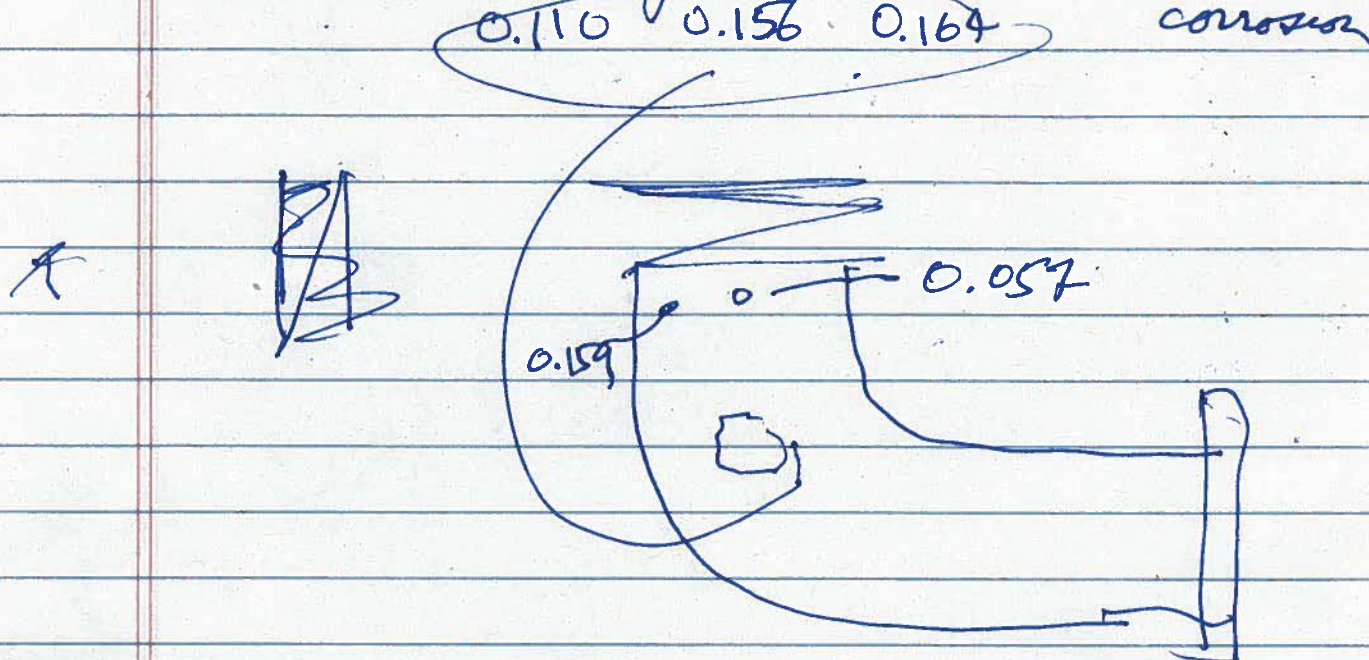
Top 0.129
0.175
0.086
0.97
0.

Outlet elbow top



Filter 5

Outlet elbow top near valve around corrosion



Attachment B: Original WTP Drawings (1975)

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PROJECT MANAGER Approved by: Date:
PROJECT ENGINEER Approved by: Date:
PLUMBING Approved by: Date:
HVAC Approved by: Date:
INSTRUMENTATION Approved by: Date:
ELECTRICAL Approved by: Date:
STRUCTURAL Approved by: Date:
ARCHITECTURAL Approved by: Date:

Description	Units	Value
Plant Design Capacity	mgd	32
Raw Water Pump Station		
Number of Pumps	number	6
Pump Design Capacity	gpm	3 at 3,600 3 at 6,000
Maximum Output	mgd	35
Pump Power	horsepower	3 at 50 2 at 100 1 at 125
Rapid Mixing		
Type: Mechanical		
Number of Mixer	number	1
Mixing Energy (g)	per second	575
Flocculation Basins		
Type: Compartmentalized, Baffled Flocculation		
Basins	number	5
Design Capacity (each)	mgd	6.4
Detention Time	minutes	22
Average Water Depth	feet	11
Total Basin Length and Width		
1953 & New	feet x feet	60 x 20
1976	feet x feet	40 x 30
Basin Volume	gallons	98,700
Flocculation Mixing Energy (G)	per second	35
Flocculation Gt	—	47,500
Sedimentation Basins		
Type: Rectangular, Horizontal Flow		
Basins	number	5
Design Capacity (each)	mgd	6.4
Surface Loading Rate	gpm/ft^2	0.55
Detention Time	hours	3.4
Horizontal Velocity	feet per minute	1.3
Overall Basin Dimensions	feet x feet	60 x 135
Average Water Depth	feet	15
Basin Volume	gallons	908,800
Sludge Equipment	—	None
Filters		
Type: Gravity, dual media with tile block underdrains and rotary arm surface wash systems		
Number of Filters	number	8
Filtration Rate (all filters)	gpm/ft^2	4.0
Filtration Rate (with one filter in backwash)	gpm/ft^2	4.5
Filter Inside Dimensions per Bay (2 bays per filter)	feet x feet	13 x 27
Media Area (per filter)	square feet	702
Maximum Filter Backwash Rate	gpm/ft^2	10
Maximum Filter Backwash Rate	gpm	6,250
Maximum Surface Wash Rate	gpm/ft^2	0.5
Maximum Surface Wash Rate	gpm	356
Filter Media		
Granular Activated Carbon		
Average Depth	inches	24
Average Effective Size	millimeters	1.0
Average Uniformity Coefficient	—	1.4
Average Specific Gravity	grams/cc	1.6
Sand		
Average Depth	inches	10
Average Effective Size	millimeters	0.5
Average Uniformity Coefficient	—	1.5
Specific Gravity	grams/cc	2.65
Sludge Pond		
Type: Earthen/Unlined		
Volume	million gallons	6.5
Surface Area	acres	2.1
Maximum Water Depth	feet	15
Sludge Storage Lagoon		
Type: Earthen/Unlined		
Volume	million gallons	2.5
Surface Area	acres	0.9
Maximum Water Depth	feet	15

Description	Units	Value
Filter Clearwell (Clear Water) Pumps		
Number of Pumps	number	6
Pump Design Capacity	gpm	3 at 2800 1 at 4000 2 at 6000
Maximum Output	mgd	35
Pump Power	horsepower	3 at 60 1 at 75 2 at 150
Finished Water Reservoir		
Capacity	million gallons	6.0
Diameter	feet	290
Maximum Water Depth	feet	15
Chemical Feed Rate (Average Dose at Design Flow)		
Anhydrous Ammonia		
Plant Influent (Flash Mixer)	ppd	320
Filtered Water	ppd	94
Anionic/Nonionic Polymer (0.5% solution, 0.04 lb/gal)		
Plant Influent (Flash Mixer or Post-Flash Mixer)	gph	139
Settled Water	gph	139
Backwash Water(2)	gph	43
Cationic Polymer (8.6 lb/gal)		
Plant Influent (Flash Mixer or Post-Flash Mixer)	gph	2.6
Settled Water	gph	2.6
Backwash Water(2)	gph	0.4
Chlorine		
Plant Influent (Flash Mixer)	ppd	667
Settled Water	ppd	267
Filtered Water	ppd	267
Corrosion Control		
Plant Influent (Flash Mixer)	gph	2
Filtered Water	gph	2
Hydrofluosilicic Acid		
Plant Influent (Flash Mixer)	gph	5
Filtered Water	gph	5
Liquid Alum (100% Solution, 5.4 lb/gal)		
Plant Influent (Flash Mixer or Post-Flash Mixer)	gph	51
Potassium Permanganate (1% solution, 0.08 lb/gal)		
Plant Influent (Flash Mixer)	gph	104
Powdered Activated Carbon (1 lb/gal slurry)		
Plant Influent (Flash Mixer)	gph	33
Flocculated Water	gph	33
Spare Chemical(3)		
Plant Influent (Flash Mixer)	gph	46
Settled Water	gph	26
Filtered Water	gph	42
Chemical Feed Equipment (Maximum Capacity)(1)		
Anhydrous Ammonia		
FD-C-901	ppd	500
FD-C-902	ppd	500
Anionic/Nonionic Polymer		
P-C-301	gph	20
P-C-302	gph	100
P-C-303 (Fixed Rate)	gph	50
P-C-304 (Fixed Rate)	gph	10
Cationic Polymer		
P-C-201	gph	10
P-C-202	gph	10
P-C-203 (Fixed Rate)	gph	10
P-C-204 (Fixed Rate) NIC	gph	50
Chlorine		
FD-C-001	ppd	500
FD-C-002	ppd	2000
FD-C-003	ppd	2000
Corrosion Control		
P-C-601	gph	10
Hydrofluosilicic Acid		
P-C-501	gph	10

Description	Units	Value
Liquid Alum		
P-C-101	gph	60
P-C-102	gph	60
Potassium Permanganate		
FD-C-401 (Fixed Rate)	ft^3/hr	1
P-C-401	gph	70
P-C-402	gph	70
Powdered Activated Carbon		
P-C-801	gph	90
P-C-802	gph	90
Spare Chemical		
P-C-701	gph	40
Chemical Storage Capacity (Average Dose at Design Flow)		
Anhydrous Ammonia		
Bulk Tank	number	1
Total Storage	pounds	4400
Days of Storage	days	10
Anionic/Nonionic Polymer		
Drums (55 gallon)	number	25
Total Storage	gallons	1375
Days of Storage	days	9
Cationic Polymer		
Bulk Tank	number	1
Total Storage	gallons	6500
Days of Storage	days	104
Chlorine		
One Ton Cylinders	number	9
Total Storage	pounds	18,000
Days of Storage	days	19
Corrosion Control		
Bulk Tank	number	1
Total Storage	gallons	6,500
Days of Storage	days	158
Hydrofluosilicic Acid		
Bulk Tank	number	1
Total Storage	gallons	6,500
Days of Storage	days	60
Liquid Alum		
Bulk Tank	number	2
Total Storage	gallons	26,000
Days of Storage	days	21
Potassium Permanganate		
Drums (110 lb/drum)	number	25
Total Storage	pounds	2,750
Days of Storage	days	14
Powdered Activated Carbon		
Bulk Tank (concrete)	number	1
Total Storage (1 lb/gal slurry)	gallons	40,000
Days of Storage	days	50
Spare Chemical(4)		
Bulk Tank	number	1
Total Storage	gallons	13,000
Days of Storage	days	12

Chemical Point of Application	Chemical Dosage (mg/l) Minimum	Average	Maximum
Anhydrous Ammonia			
Plant Influent (Flash Mixer)	0.5	1.2	1.6
Filtered Water Line	0	0.35	0.5
Anionic/Nonionic Polymer			
Plant Influent (Flash Mixer or Post-Flash Mixer)	0	0.5	1.5
Settled Water (Pipeline Inlet – 3 Locations)	0	0.5	1.5
Backwash Water (Rate of Flow Controller)(2)	0	0.5	1.0
Cationic Polymer			
Plant Influent (Flash Mixer or Post-Flash Mixer)	0	2.0	3.0
Settled Water (Pipeline Inlet – 3 Locations)	0	2.0	3.0
Backwash Water (Rate of Flow Controller)(2)	0	1.0	2.0
Chlorine			
Plant Influent (Flash Mixer)	1.0	2.5	5.0
Settled Water (Pipeline Inlet – 3 Locations)	0	1.0	5.0
Filtered Water (36" Dia. Pipeline)	0.25	1.0	1.5
Corrosion Control			
Plant Influent (Flash Mixer)	0.5	2.0	3.0
Filtered Water (36" Dia. Pipeline)	0.5	2.0	3.0
Hydrofluosilicic Acid			
Plant Influent (Flash Mixer)	1.0	1.0	1.0
Filtered Water (36" Dia. Pipeline)	1.0	1.0	1.0
Liquid Alum			
Plant Influent (Flash Mixer or Post-Flash Mixer)	15	25	50
Potassium Permanganate			
Plant Influent (Flash Mixer)	0	0.75	2.0
Powdered Activated Carbon			
Plant Influent (Flash Mixer)	1	3	25
Flocculated Water (Midpoint of Flocculation Basin – 5 Locations)	1	3	25
Spare Chemical(3)			
Plant Influent (Flash Mixer)	10	20	40
Settled Water (Pipeline Inlet – 3 Locations)	0	2	3
Filtered Water (36" Dia. Pipeline)	5	10	30

(1) All feed equipment is variable rate unless noted otherwise.
(2) Backwash water flow rate is 10 mgd.
(3) For spare chemical assume the following chemicals:
a. Plant influent use 40% $FeCl_3$, 4.8 lb/gal.
b. Settled water use 10% cationic polymer, 0.86 lb/gal.
c. Filtered water use 25% NaOH, 2.66 lb/gal.
(4) Use case a., above, for spare chemical storage.

AS-BUILT
PJM 5/10/91
SIGNATURE DATE

REGISTERED PROFESSIONAL ENGINEER
TINA EDWARDS
No. C042055
Exp. 3-31-92
STATE OF CALIFORNIA
Tina Edwards

Date	Ch'k'd	Revision

CITY OF PITTSBURG, CALIFORNIA

WATER TREATMENT PLANT EXPANSION 1988

DESIGN CRITERIA

Designed by: TCE
Drawn by: JH
Checked by: TLE
Approved by: PFM

Date: SEPT. 1988
Scale: NONE

CAMP DRESSER & McKEE INC.
710 South Broadway
Walnut Creek, CA 94596
CDM
environmental engineers, scientists, planners, & management consultants

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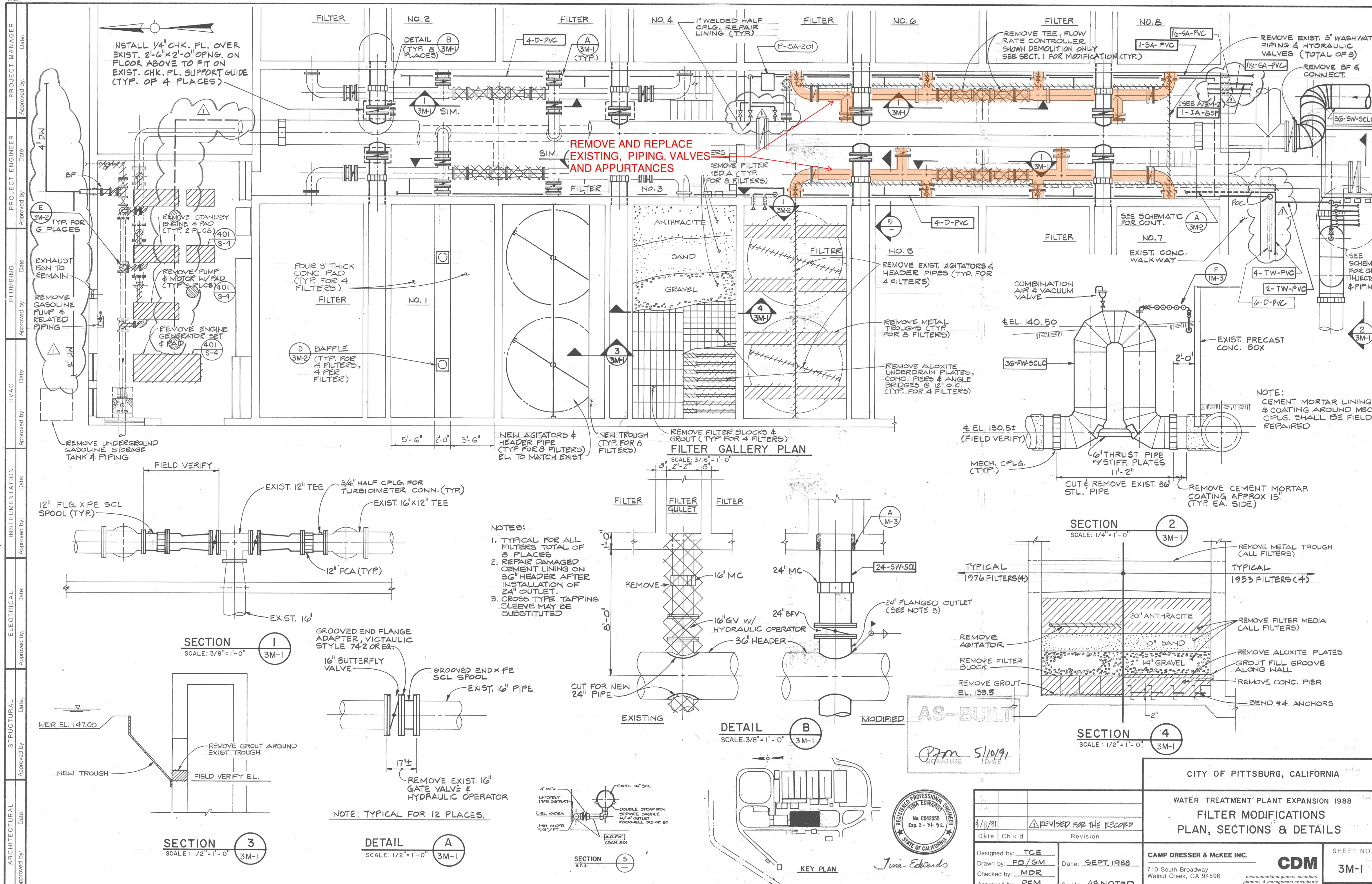

CITY OF PITTSBURG, CALIFORNIA

WATER TREATMENT PLANT EXPANSION 1988

FILTER MODIFICATIONS
PLAN, SECTIONS & DETAILS

Date	Ch'k'd	Revision
4/11/91		1 REVISED FOR THE RECORD

Designed by: TCE
Drawn by: FD/GM
Checked by: MDR
Approved by: PFM

Date: SEPT. 1988
Scale: AS NOTED

CAMP DRESSER & McKEE INC.
710 South Broadway
Walnut Creek, CA 94596

CDM
environmental engineers, scientists, planners, & management consultants

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