

OPINION OF PROBABLE PROJECT COST

Client	City of Glendale
Project	Phase III Demonstration Testing for Cr(VI) Treatment
Item	10-gpm WBA System

Project No. 05337008.0000		
By T.D. & C.R.	Ckd: Y.W. & T.V.	Updated: Y.W.
Date 12/20/11	Date: 12/22/11	Date: 12/31/12

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
Equipment					
CO2 Feed System	1	LS	\$ 81,600	\$ 81,600	Quote from TOMCO; 1.5 lb/hr PSF and (2) 380 lb cylinders; adjusted to 2012 dollars.
CO2 Feed Water Pump	2	EA	\$ 7,321	\$ 14,641	Quote from ITT; centrifugal; 2 gpm @ 80 psi; 1 duty/1 stdby; adjusted to 2012 dollars.
Static Mixer	1	EA	\$ 337	\$ 337	Quotes from Komax & EWS; 1-inch; adjusted to 2012 dollars.
Bag Filters	2	EA	\$ 1,800	\$ 3,600	Quotes from FSI & Ryan Herco; 1 duty/ 1 stdby; adjusted to 2012 dollars.
Ion Exchange Equipment	1	LS	\$ 7,600	\$ 7,600	Quotes from Siemens; incl. first fill of resin; adjusted to 2012 dollars.
Backwash Waste Tank	1	EA	\$ 7,800	\$ 7,800	Quotes from Core-Rosion; 2,000 gal; adjusted to 2012 dollars.
Discharge Pumps	2	EA	\$ 4,929	\$ 9,857	Quotes from ITT & Cortech 100 gpm @ 15 ft; 1 duty/ 1 stdby; adjusted to 2012
Booster Pump	2	EA	\$ 6,201	\$ 12,401	Quote from Cortech, 10 gpm @ 15 ft; 1 duty/1 stdby; adjusted to 2012 dollars.
Aeration Equipment	1	LS	\$ 42,840	\$ 42,840	Quote from Siemens for an aluminum forced draft aerator (65 gpm), including blower, air distribution tray, and piping etc.; adjusted to 2012 dollars.
Exhaust Blowers	2	EA	\$ 35,571	\$ 71,143	Quote from EWS; 53 SCFM @ 2 psi; 1 duty/ 1 stdby; adjusted to 2012 dollars.
Off-Gas Treatment	1	LS	\$ 4,100	\$ 4,100	Cost from Glendale and quote from TIGG; 54 SCFM; (2) adsorbers in series; plus \$2,800 for one heater; adjusted to 2012 dollars.
Subtotal				\$ 256,000	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 76,800	Including tax, freight, installation and manufacturer services.
Equipment Concrete Pads	29	CY	\$ 1,275	\$ 36,686	\$1250/CY, adjusted to 2012 dollars
Subtotal (Installed Equipment Costs)				\$ 370,000	Rounded up to \$1000
General Requirements	7.5%			\$ 27,750	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 18,500	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 18,500	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 56,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 56,000	PLC and SCADA equipment to control
Total Direct Costs				\$ 547,000	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 109,400	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
Construction Total				\$ 656,000	Rounded up to \$1000
Project Level Allowance (contingency)	20%			\$ 131,200	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%			\$ 131,200	Includes permits, legal fees and engineering fees for design and construction
Project Total				\$ 919,000	
Low Estimate				\$ 643,000	-30%
High Estimate				\$ 1,379,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2012 dollars.
3. Costs for land or easements are not included.

OPINION OF PROBABLE PROJECT COST

Client	City of Glendale
Project	Phase III Demonstration Testing for Cr(VI) Treatment
Item	100-gpm WBA System

Project No. 05337008.0000		
By T.D. & C.R.	Ckd: Y.W. & T.V.	Updated: Y.W.
Date 12/20/11	Date: 12/22/11	Date: 12/31/12

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
Equipment					
CO2 Feed System	1	LS	\$ 160,000	\$ 160,000	Quote from TOMCO; 15 lb/hr PSF and 6 ton storage; adjusted to 2012 dollars.
CO2 Feed Water Pump	2	EA	\$ 7,321	\$ 14,641	Quote from ITT; centrifugal; 15 gpm @ 80 psi; 1 duty/1 stdby; adjusted to 2012 dollars.
Static Mixer	1	EA	\$ 867	\$ 867	Quotes from Komax & EWS; 3-inch; adjusted to 2012 dollars.
Bag Filters	2	EA	\$ 4,400	\$ 8,800	Quotes from FSI & Ryan Herco; 1 duty/ 1 stdby; adjusted to 2012 dollars.
Ion Exchange Equipment	1	LS	\$ 95,000	\$ 95,000	Quotes from Siemens; incl. first fill of resin; adjusted to 2012 dollars.
Backwash Waste Tank	1	EA	\$ 53,000	\$ 53,000	Quotes from Superior & BH; 19,000 gal; adjusted to 2012 dollars.
Discharge Pumps	2	EA	\$ 4,929	\$ 9,857	Quotes from ITT & Cortech 100 gpm @ 15 ft; 1 duty/ 1 stdby; adjusted to 2012 dollars.
Booster Pump	2	EA	\$ 7,870	\$ 15,741	Quote from ITT, 100 gpm @ 15 ft; 1 duty/1 stdby; adjusted to 2012 dollars.
Aeration Equipment	1	LS	\$ 42,840	\$ 42,840	Quote from Siemens for an aluminum forced draft aerator (100 gpm), including blower, air distribution tray, and piping etc.; adjusted to 2012 dollars.
Exhaust Blowers	2	EA	\$ 35,448	\$ 70,895	Quote from EWS; 267 SCFM @ 2 psi; 1 duty/ 1 stdby; adjusted to 2012 dollars.
Off-Gas Treatment	1	LS	\$ 11,000	\$ 11,000	Quote from TIGG; 270 SCFM; (2) adsorbers in series with one heater; adjusted to 2012 dollars.
Subtotal				\$ 483,000	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 144,900	Including tax, freight, installation and manufacturer services.
Equipment Concrete Pad	56	CY	\$ 1,275	\$ 71,936	\$1250/CY, adjusted to 2012 dollars
Subtotal (Installed Equipment Costs)				\$ 700,000	Rounded up to \$1000
General Requirements	7.5%			\$ 52,500	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 35,000	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 35,000	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 105,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 105,000	PLC and SCADA equipment to control
Total Direct Costs				\$ 1,033,000	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 206,600	includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
Construction Total				\$ 1,239,600	Rounded up to \$1000
Project Level Allowance (contingency)	20%			\$ 247,920	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%			\$ 247,920	Includes permits, legal fees and engineering fees for design and construction
Project Total				\$ 1,736,000	
Low Estimate				\$ 1,215,000	-30%
High Estimate				\$ 2,604,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2012 dollars.
3. Costs for land or easements are not included.

OPINION OF PROBABLE PROJECT COST

Client	City of Glendale
Project	Phase III Demonstration Testing for Cr(VI) Treatment
Item	500-gpm WBA System

Project No. 05337008.0000		
By T.D. & C.R.	Ckd: Y.W. & T.V.	Updated: Y.W.
Date 12/20/11	Date: 12/22/11	Date: 12/31/12

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
Equipment					
CO2 Feed System	1	LS	\$ 193,800	\$ 193,800	Quote from TOMCO; 75 lb/hr PSF and 14 ton storage; adjusted to 2012 dollars.
CO2 Feed Water Pump	2	EA	\$ 7,760	\$ 15,520	Quote from ITT; centrifugal; 75 gpm @ 80 psi; 1 duty/1 stdby; adjusted to 2012 dollars.
Static Mixers	1	EA	\$ 2,244	\$ 2,244	Quotes from Komax & EWS; 8-inch; adjusted to 2012 dollars.
Bag Filters	2	EA	\$ 12,800	\$ 25,600	Quotes from FSI & Ryan Herco; 1 duty/ 1 stdby; adjusted to 2012 dollars.
Ion Exchange Equipment	1	LS	\$ 400,000	\$ 400,000	Quotes from Siemens and Calgon; incl. first fill of resin; adjusted to 2012 dollars.
Backwash Waste Tank	1	EA	\$ 102,000	\$ 102,000	Quotes from Superior & BH; 95,000 gal; adjusted to 2012 dollars.
Discharge Pumps	2	EA	\$ 4,929	\$ 9,857	Quotes from ITT & Cortech 100 gpm @ 15 ft; 1 duty/ 1 stdby; adjusted to 2012 dollars.
Booster Pump	2	EA	\$ 11,141	\$ 22,283	Quote from ITT, 500 gpm @ 15 ft; 1 duty/1 stdby; adjusted to 2012 dollars.
Aeration Equipment	1	LS	\$ 47,940	\$ 47,940	Quote from Siemens for an aluminum forced draft aerator (500 gpm), including blower, air distribution tray, and piping etc.; adjusted to 2012 dollars.
Exhaust Blowers	2	EA	\$ 55,322	\$ 110,643	Quotes from EWS & Yardley; 1,500 SCFM @ 5 psi; 1 duty/ 1 stdby; adjusted to 2012
Off-Gas Treatment	1	LS	\$ 28,000	\$ 28,000	Quote from TIGG; 1,500 SCFM; (2) adsorbers in series with one heater; adjusted to 2012 dollars.
Subtotal				\$ 958,000	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 287,400	Including tax, freight, installation and manufacturer services.
Equipment Concrete Pad	159	CY	\$ 1,275	\$ 203,040	\$1250/CY, adjusted to 2012 dollars
Subtotal (Installed Equipment Costs)				\$ 1,449,000	Rounded up to \$1000
General Requirements	7.5%			\$ 108,675	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 72,450	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 72,450	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 218,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 218,000	PLC and SCADA equipment to control
Total Direct Costs				\$ 2,139,000	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 427,800	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
Construction Total				\$ 2,567,000	Rounded up to \$1000
Project Level Allowance (contingency)	20%			\$ 513,400	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%			\$ 513,400	Includes permits, legal fees and engineering fees for design and construction
Project Total				\$ 3,594,000	
Low Estimate				\$ 2,516,000	-30%
High Estimate				\$ 5,391,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2012 dollars.
3. Costs for land or easements are not included.

OPINION OF PROBABLE PROJECT COST

Client	City of Glendale
Project	Phase III Demonstration Testing for Cr(VI) Treatment
Item	2000-gpm WBA System

Project No. 05337008.0000		
By T.D. & C.R.	Ckd: Y.W. & T.V.	Updated: Y.W.
Date 12/20/11	Date: 12/22/11	Date: 12/31/12

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
Equipment					
CO2 Feed System	1	LS	\$ 280,000	\$ 280,000	Quote from TOMCO; 300 lb/hr and 50 ton storage; adjusted to 2012 dollars.
CO2 Feed Water Pump	2	EA	\$ 8,879	\$ 17,758	Quote from ITT; centrifugal; 305 gpm @ 80 psi; 1 duty/1 stdby; adjusted to 2012
Static Mixer	1	EA	\$ 4,284	\$ 4,284	Quotes from Komax & EWS; 14-inch; adjusted to 2012 dollars.
Bag Filters	2	EA	\$ 29,800	\$ 59,600	Quotes from FSI & Ryan Herco; 1 duty/ 1 stdby; adjusted to 2012 dollars.
Ion Exchange Equipment	1	LS	\$ 1,300,000	\$ 1,300,000	Quotes from Siemens and Calgon; incl. first fill of resin; adjusted to 2012 dollars.
Backwash Waste Tank	1	EA	\$ 150,000	\$ 150,000	Quotes from Superior & BH; 189,000 gal; adjusted to 2012 dollars.
Discharge Pumps	2	EA	\$ 4,929	\$ 9,857	Quotes from ITT & Cortech 100 gpm @ 15 ft; 1 duty/ 1 stdby; adjusted to 2012
Booster Pump	2	EA	\$ 24,380	\$ 48,760	Quote from Cortech, 2,000 gpm @ 15 ft; 1 duty/1 stdby; adjusted to 2012 dollars.
Aeration Equipment	1	LS	\$ 72,420	\$ 72,420	Quote from Siemens for an aluminum forced draft aerator (2000 gpm), including blower, air distribution tray, and piping etc.; adjusted to 2012 dollars.
Exhaust Blowers	2	EA	\$ 137,700	\$ 275,400	Quote from Yardley; 6,000 SCFM @ 5 psi; 1 duty/ 1 stdby; adjusted to 2012 dollars.
Off-Gas Treatment	1	LS	\$ 97,000	\$ 97,000	Quote from TIGG; 6,000 SCFM; (2) adsorbers in series with two 12kW heaters; adjusted to 2012 dollars.
Subtotal				\$ 2,316,000	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 694,800	Including tax, freight, installation and manufacturer services.
Equipment Concrete Pad	264	CY	\$ 1,275	\$ 336,995	\$1250/CY, adjusted to 2012 dollars
Subtotal (Installed Equipment Costs)				\$ 3,348,000	Rounded up to \$1000
General Requirements	7.5%			\$ 251,100	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 167,400	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 167,400	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 503,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 503,000	PLC and SCADA equipment to control
Total Direct Costs				\$ 4,940,000	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 988,000	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
Construction Total				\$ 5,928,000	Rounded up to \$1000
Project Level Allowance (contingency)	20%			\$ 1,185,600	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%			\$ 1,185,600	Includes permits, legal fees and engineering fees for design and construction
Project Total				\$ 8,300,000	
Low Estimate				\$ 5,810,000	-30%
High Estimate				\$ 12,450,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2012 dollars.
3. Costs for land or easements are not included.

Estimated WBA Lab and Field Analytical Costs

Flow Rate (gpm) 10
 Number of lead/lag trains 2

Sample Location	Lab																Field			
	Cr(VI)	Total Cr	Alkalinity	Turbidity	Sulfate	Nitrate	Phosphate	Total Iron	Silica	Uranium (water)	Uranium (solids)	Nitrosamines	BNA SVOC	Aldehydes/ Ketones	Bac-1 (E. coli, T coli and HPC)	TCLP (Metals)	CA WET (Metals)	pH	Temperature	Conductivity
Raw	1	1	1												1			4	4	
After pH reduction	4	4	1	1	1	1	1	1	1	1		At start-up	At start-up	At start-up	1			s	s	1
Lead vessel 50% port ¹	8	8																		
Lead vessel effluent ¹	8	8								1		At start-up	At start-up	At start-up				4	4	
Lag vessel 50% port ¹	8	8																		
Lag vessel effluent ¹	8	8								1		At start-up and monthly thereafter	At start-up and monthly thereafter	At start-up and monthly thereafter	4			4	4	
Combined IX effluent after pH increase	4	4	1	1	1	1	1	1	1						4			Continuous	Continuous	
Resin in lead vessel ^{1,2}											2									
Spent resin as residuals											At disposal					At disposal	At disposal			
Resin flush water as residuals ³														At disposal ⁴						
Sum of samples (# per month)	41	41	3	2	2	2	2	2	2	3	2.2	2.3	2.3	2.8	10	0.2	0.2	12	12	1
Unit cost (\$/sample)	\$54	\$14	\$15	\$13	\$15	\$15	\$15	\$14	\$14	\$23	\$128	\$372	\$288	\$212	\$59	\$245	\$429			
Sample analysis cost (\$/year)	\$26,347	\$6,775	\$551	\$318	\$367	\$367	\$367	\$330	\$330	\$826	\$3,290	\$10,275	\$7,953	\$6,984	\$7,038	\$441	\$773			
Annual shipping fee	\$1,560	One shipment per week, \$30 per shipment.																		
Sum of lab analysis cost (\$/year)	\$74,893	Average of two quotes, plus shipment.																		
Field meters	\$2,000	portable pH and conductivity meter																		
Field analytical cost (without labor)	\$1,000	Estimate for reagents and apparatus based on experience; not including labor for field analysis																		
Total analytical cost	\$75,893	Including lab and field analysis costs; not including labor and field meters																		

1. If there are multiple lead-lag trains, lead or lag vessels in each train should be monitored.
 2. A composite of top, middle and bottom resin bed layers
 3. Other analyses might be required by the sewer discharge permit.
 4. Three samples are estimated to be collected per resin changeout event for resin flush water disposal.
 BNA SVOC - base, neutral, acid semi-volatile organic compounds
 "Continuous" indicates the parameter(s) will be monitored by an online meter.
 dollars.

Estimated WBA Lab and Field Analytical Costs

Flow Rate (gpm) 100
 Number of lead/lag trains 1

Sample Location	Lab																	Field			
	Cr(VI)	Total Cr	Alkalinity	Turbidity	Sulfate	Nitrate	Phosphate	Total Iron	Silica	Uranium (water)	Uranium (solids)	Nitrosamines	BNA SVOC	Aldehydes/ Ketones	Bac-1 (E. coli, T coli and HPC)	TCLP (Metals)	CA WET (Metals)	pH	Temperature	Conductivity	
Raw	1	1	1												1			4	4		
After pH reduction	4	4	1	1	1	1	1	1	1	1		At start-up	At start-up	At start-up	1			s	s	1	
Lead vessel 50% port ¹	4	4																			
Lead vessel effluent ¹	4	4								1		At start-up	At start-up	At start-up				4	4		
Lag vessel 50% port ¹	4	4																			
Lag vessel effluent ¹	4	4								1		At start-up and monthly thereafter	At start-up and monthly thereafter	At start-up and monthly thereafter	4			4	4		
Combined IX effluent after pH increase	4	4	1	1	1	1	1	1	1						4			Continuous	Continuous		
Resin in lead vessel ^{1,2}											1										
Spent resin as residuals												At disposal					At disposal	At disposal			
Resin flush water as residuals ³														4							
Sum of samples (# per month)	25	25	3	2	2	2	2	2	2	2	3	1.2	1.4	1.4	1.9	10	0.2	0.2	12	12	1
Unit cost (\$/sample)	\$54	\$14	\$15	\$13	\$15	\$15	\$15	\$14	\$14	\$23	\$128	\$372	\$288	\$212	\$59	\$245	\$429				
Sample analysis cost (\$/year)	\$16,065	\$4,131	\$551	\$318	\$367	\$367	\$367	\$330	\$330	\$826	\$1,798	\$6,031	\$4,668	\$4,762	\$7,038	\$514	\$902				
Annual shipping fee	\$1,560	One shipment per week, \$30 per shipment.																			
Sum of lab analysis cost (\$/year)	\$50,927	Average of two quotes, plus shipment.																			
Field meters	\$2,000	portable pH and conductivity meter																			
Field analytical cost (without labor)	\$1,000	Estimate for reagents and apparatus based on experience; not including labor for field analysis																			
Total analytical cost	\$51,927	Including lab and field analysis costs; not including labor and field meters																			

1. If there are multiple lead-lag trains, lead or lag vessels in each train should be monitored.
 2. A composite of top, middle and bottom resin bed layers
 3. Other analyses might be required by the sewer discharge permit.
 4. Three samples are estimated to be collected per resin changeout event for resin flush water disposal.
 BNA SVOC - base, neutral, acid semi-volatile organic compounds
 "Continuous" indicates the parameter(s) will be monitored by an online meter.
 Costs are adjusted to 2012 dollars.

Estimated WBA Lab and Field Analytical Costs

Flow Rate (gpm) 500
 Number of lead/lag trains 1

Sample Location	Lab																	Field			
	Cr(VI)	Total Cr	Alkalinity	Turbidity	Sulfate	Nitrate	Phosphate	Total Iron	Silica	Uranium (water)	Uranium (solids)	Nitrosamines	BNA SVOC	Aldehydes/ Ketones	Bac-1 (E. coli, T coli and HPC)	TCLP (Metals)	CA WET (Metals)	pH	Temperature	Conductivity	
Raw	1	1	1												1			4	4		
After pH reduction	4	4	1	1	1	1	1	1	1	1		At start-up	At start-up	At start-up	1			s	s	1	
Lead vessel 50% port ¹	4	4																			
Lead vessel effluent ¹	4	4								1		At start-up	At start-up	At start-up				4	4		
Lag vessel 50% port ¹	4	4																			
Lag vessel effluent ¹	4	4								1		At start-up and monthly thereafter	At start-up and monthly thereafter	At start-up and monthly thereafter	4			4	4		
Combined IX effluent after pH increase	4	4	1	1	1	1	1	1	1						4			Continuous	Continuous		
Resin in lead vessel ^{1,2}											1										
Spent resin as residuals												At disposal					At disposal	At disposal			
Resin flush water as residuals ³														4							
Sum of samples (# per month)	25	25	3	2	2	2	2	2	2	2	3	1.2	1.4	1.4	1.9	10	0.2	0.2	12	12	1
Unit cost (\$/sample)	\$54	\$14	\$15	\$13	\$15	\$15	\$15	\$14	\$14	\$23	\$128	\$372	\$288	\$212	\$59	\$245	\$429				
Sample analysis cost (\$/year)	\$16,065	\$4,131	\$551	\$318	\$367	\$367	\$367	\$330	\$330	\$826	\$1,798	\$6,031	\$4,668	\$4,762	\$7,038	\$514	\$902				
Annual shipping fee	\$1,560	One shipment per week, \$30 per shipment.																			
Sum of lab analysis cost (\$/year)	\$50,927	Average of two quotes, plus shipment.																			
Field meters	\$2,000	portable pH and conductivity meter																			
Field analytical cost (without labor)	\$1,000	Estimate for reagents and apparatus based on experience; not including labor for field analysis																			
Total analytical cost	\$51,927	Including lab and field analysis costs; not including labor and field meters																			

1. If there are multiple lead-lag trains, lead or lag vessels in each train should be monitored.
 2. A composite of top, middle and bottom resin bed layers
 3. Other analyses might be required by the sewer discharge permit.
 4. Three samples are estimated to be collected per resin changeout event for resin flush water disposal.
 BNA SVOC - base, neutral, acid semi-volatile organic compounds
 "Continuous" indicates the parameter(s) will be monitored by an online meter.
 Costs are adjusted to 2012 dollars.

Estimated WBA Lab and Field Analytical Costs

Flow Rate (gpm) 2,000
 Number of lead/lag trains 2

Sample Location	Lab																Field			
	Cr(VI)	Total Cr	Alkalinity	Turbidity	Sulfate	Nitrate	Phosphate	Total Iron	Silica	Uranium (water)	Uranium (solids)	Nitrosamines	BNA SVOC	Aldehydes/Ketones	Bac-1 (E. coli, T coli and HPC)	TCLP (Metals)	CA WET (Metals)	pH	Temperature	Conductivity
Raw	1	1	1												1			4	4	
After pH reduction	4	4	1	1	1	1	1	1	1	1		At start-up	At start-up	At start-up	1			s	s	1
Lead vessel 50% port ¹	8	8																		
Lead vessel effluent ¹	8	8								1		At start-up	At start-up	At start-up				4	4	
Lag vessel 50% port ¹	8	8																		
Lag vessel effluent ¹	8	8								1		At start-up and monthly thereafter	At start-up and monthly thereafter	At start-up and monthly thereafter	4			4	4	
Combined IX effluent after pH increase	4	4	1	1	1	1	1	1	1						4			Continuous	Continuous	
Resin in lead vessel ^{1,2}											2									
Spent resin as residuals											At disposal					At disposal	At disposal			
Resin flush water as residuals ³														At disposal ⁴						
Sum of samples (# per month)	41	41	3	2	2	2	2	2	2	3	4.2	2.4	2.4	2.9	10	0.2	0.2	12	12	1
Unit cost (\$/sample)	\$54	\$14	\$15	\$13	\$15	\$15	\$15	\$14	\$14	\$23	\$128	\$372	\$288	\$212	\$59	\$245	\$429			
Sample analysis cost (\$/year)	\$26,347	\$6,775	\$551	\$318	\$367	\$367	\$367	\$330	\$330	\$826	\$6,388	\$10,499	\$8,126	\$7,302	\$7,038	\$514	\$902			
Annual shipping fee	\$1,560	One shipment per week, \$30 per shipment.																		
Sum of lab analysis cost (\$/year)	\$78,907	Average of two quotes, plus shipment.																		
Field meters	\$2,000	portable pH and conductivity meter																		
Field analytical cost (without labor)	\$1,000	Estimate for reagents and apparatus based on experience; not including labor for field analysis																		
Total analytical cost	\$79,907	Including lab and field analysis costs; not including labor and field meters																		

1. If there are multiple lead-lag trains, lead or lag vessels in each train should be monitored.
 2. A composite of top, middle and bottom resin bed layers
 3. Other analyses might be required by the sewer discharge permit.
 4. Three samples are estimated to be collected per resin changeout event for resin flush water disposal.
 BNA SVOC - base, neutral, acid semi-volatile organic compounds
 "Continuous" indicates the parameter(s) will be monitored by an online meter.
 Costs are adjusted to 2012 dollars.

Estimated WBA O&M Costs

(Resin Replacement and Spent Resin Disposal Based on Cr(VI) Treatment Target)

WBA System Size = 10 gpm

Potential Cr(VI) MCL (ppb)	Electricity*	Chemicals	VPGAC Replacement	Resin Replacement (Fresh Resin)	Spent Resin & Wastewater Disposal	Labor	Other Consumables (Bag Filters)	Maintenance and Spare Parts	Lab and Field Analysis &	Annual O&M
1	\$ 6,000	\$ 940	\$ 1,300	\$ 6,100	\$ 5,500	\$ 51,000	\$ 60	\$ 3,700	\$ 76,000	\$ 151,000
2	\$ 6,000	\$ 940	\$ 1,300	\$ 5,400	\$ 5,300	\$ 51,000	\$ 60	\$ 3,700	\$ 76,000	\$ 150,000
5	\$ 6,000	\$ 940	\$ 1,300	\$ 4,700	\$ 5,100	\$ 51,000	\$ 60	\$ 3,700	\$ 76,000	\$ 149,000
10	\$ 6,000	\$ 940	\$ 1,300	\$ 3,400	\$ 4,700	\$ 51,000	\$ 60	\$ 3,700	\$ 76,000	\$ 147,000
25	\$ 6,000	\$ 940	\$ 1,300	\$ 1,300	\$ 4,100	\$ 51,000	\$ 60	\$ 3,700	\$ 76,000	\$ 144,000

* Electricity includes approximately \$200 per year for aeration off-gas treatment.

& Lab and field analysis does not include cost for aeration off-gas analysis.

Costs are in 2012 dollars.

WBA System Size = 100 gpm

Potential Cr(VI) MCL (ppb)	Electricity*	Chemicals	VPGAC Replacement	Resin Replacement (Fresh Resin)	Spent Resin & Wastewater Disposal	Labor	Other Consumables (Bag Filters)	Maintenance and Spare Parts	Lab and Field Analysis &	Annual O&M
1	\$ 12,600	\$ 9,400	\$ 12,000	\$ 30,748	\$ 22,000	\$ 51,000	\$ 130	\$ 7,000	\$ 52,000	\$ 197,000
2	\$ 12,600	\$ 9,400	\$ 12,000	\$ 25,200	\$ 18,700	\$ 51,000	\$ 130	\$ 7,000	\$ 52,000	\$ 188,000
5	\$ 12,600	\$ 9,400	\$ 12,000	\$ 22,400	\$ 17,000	\$ 51,000	\$ 130	\$ 7,000	\$ 52,000	\$ 184,000
10	\$ 12,600	\$ 9,400	\$ 12,000	\$ 14,000	\$ 12,000	\$ 51,000	\$ 130	\$ 7,000	\$ 52,000	\$ 170,000
25	\$ 12,600	\$ 9,400	\$ 12,000	\$ 8,400	\$ 8,700	\$ 51,000	\$ 130	\$ 7,000	\$ 52,000	\$ 161,000

* Electricity includes approximately \$700 per year for aeration off-gas treatment.

& Lab and field analysis does not include cost for aeration off-gas analysis.

Costs are in 2012 dollars.

WBA System Size = 500 gpm

Potential Cr(VI) MCL (ppb)	Electricity*	Chemicals	VPGAC Replacement	Resin Replacement (Fresh Resin)	Spent Resin & Wastewater Disposal	Labor	Other Consumables (Bag Filters)	Maintenance and Spare Parts	Lab and Field Analysis &	Annual O&M
1	\$ 61,700	\$ 47,000	\$ 50,500	\$ 159,600	\$ 111,300	\$ 51,000	\$ 520	\$ 14,500	\$ 52,000	\$ 548,000
2	\$ 61,700	\$ 47,000	\$ 50,500	\$ 130,600	\$ 91,700	\$ 51,000	\$ 520	\$ 14,500	\$ 52,000	\$ 500,000
5	\$ 61,700	\$ 47,000	\$ 50,500	\$ 116,100	\$ 81,900	\$ 51,000	\$ 520	\$ 14,500	\$ 52,000	\$ 475,000
10	\$ 61,700	\$ 47,000	\$ 50,500	\$ 72,500	\$ 52,500	\$ 51,000	\$ 520	\$ 14,500	\$ 52,000	\$ 402,000
25	\$ 61,700	\$ 47,000	\$ 50,500	\$ 43,500	\$ 33,000	\$ 51,000	\$ 520	\$ 14,500	\$ 52,000	\$ 354,000

* Electricity includes approximately \$11,000 per year for aeration off-gas treatment.

& Lab and field analysis does not include cost for aeration off-gas analysis.

Costs are in 2012 dollars.

WBA System Size = 2,000 gpm

Potential Cr(VI) MCL (ppb)	Electricity*	Chemicals	VPGAC Replacement	Resin Replacement (Fresh Resin)	Spent Resin & Wastewater Disposal	Labor	Other Consumables (Bag Filters)	Maintenance and Spare Parts	Lab and Field Analysis &	Annual O&M
1	\$ 198,700	\$ 187,900	\$ 171,900	\$ 534,400	\$ 371,200	\$ 51,000	\$ 1,600	\$ 33,500	\$ 80,000	\$ 1,630,000
2	\$ 198,700	\$ 187,900	\$ 171,900	\$ 437,200	\$ 304,400	\$ 51,000	\$ 1,600	\$ 33,500	\$ 80,000	\$ 1,466,000
5	\$ 198,700	\$ 187,900	\$ 171,900	\$ 388,600	\$ 270,800	\$ 51,000	\$ 1,600	\$ 33,500	\$ 80,000	\$ 1,384,000
10	\$ 198,700	\$ 187,900	\$ 171,900	\$ 242,900	\$ 170,500	\$ 51,000	\$ 1,600	\$ 33,500	\$ 80,000	\$ 1,138,000
25	\$ 198,700	\$ 187,900	\$ 171,900	\$ 145,700	\$ 103,700	\$ 51,000	\$ 1,600	\$ 33,500	\$ 80,000	\$ 974,000

* Electricity includes approximately \$21,000 per year for aeration off-gas treatment.

& Lab and field analysis does not include cost for aeration off-gas analysis.

Costs are in 2012 dollars.

Estimated WBA O&M Costs

(Resin Replacement and Spent Resin Disposal Based on Cr(VI) Treatment Target)

Annual O&M Summary

WBA System Size (gpm)	Potential Cr(VI) MCL, ppb				
	1	2	5	10	25
10	\$ 151,000	\$ 150,000	\$ 149,000	\$ 147,000	\$ 144,000
100	\$ 197,000	\$ 188,000	\$ 184,000	\$ 170,000	\$ 161,000
500	\$ 548,000	\$ 500,000	\$ 475,000	\$ 402,000	\$ 354,000
2,000	\$ 1,630,000	\$ 1,466,000	\$ 1,384,000	\$ 1,138,000	\$ 974,000

Costs are in 2012 dollars.

Net Present Value for 20 Years (Rounded to two significant figures)

WBA System Size (gpm)	Potential Cr(VI) MCL, ppb				
	1	2	5	10	25
10	\$ 2,500,000	\$ 2,500,000	\$ 2,500,000	\$ 2,500,000	\$ 2,500,000
100	\$ 3,300,000	\$ 3,100,000	\$ 3,100,000	\$ 2,800,000	\$ 2,800,000
500	\$ 9,200,000	\$ 8,400,000	\$ 8,000,000	\$ 6,700,000	\$ 5,900,000
2,000	\$ 27,000,000	\$ 25,000,000	\$ 23,000,000	\$ 19,000,000	\$ 16,000,000

20-year NPV O&M based on 2.5% inflation and a 4.5% discount rate.

Costs are in 2012 dollars.

Estimated WBA O&M Costs (Resin Replacement and Spent Resin Disposal Based on Total Cr Treatment Target)

WBA System Size = 10 gpm

Potential Cr(VI) MCL (ppb)	Electricity	Chemicals	VPGAC Replacement	Resin Replacement (Fresh Resin)	Spent Resin & Wastewater Disposal	Labor	Other Consumables (Bag Filters)	Maintenance and Spare Parts	Lab and Field Analysis	Annual O&M
1	\$ 6,000	\$ 940	\$ 1,300	\$239,500	\$ 74,800	\$ 51,000	\$ 60	\$ 3,700	\$ 76,000	\$ 453,000
2	\$ 6,000	\$ 940	\$ 1,300	\$34,400	\$ 13,900	\$ 51,000	\$ 60	\$ 3,700	\$ 76,000	\$ 187,000
5	\$ 6,000	\$ 940	\$ 1,300	\$4,700	\$ 5,100	\$ 51,000	\$ 60	\$ 3,700	\$ 76,000	\$ 149,000
10	\$ 6,000	\$ 940	\$ 1,300	\$3,400	\$ 4,700	\$ 51,000	\$ 60	\$ 3,700	\$ 76,000	\$ 147,000
25	\$ 6,000	\$ 940	\$ 1,300	\$1,300	\$ 4,100	\$ 51,000	\$ 60	\$ 3,700	\$ 76,000	\$ 144,000

* Electricity includes approximately \$200 per year for aeration off-gas treatment.
& Lab and field analysis does not include cost for aeration off-gas analysis.
Costs are in 2012 dollars.

WBA System Size = 100 gpm

Potential Cr(VI) MCL (ppb)	Electricity	Chemicals	VPGAC Replacement	Resin Replacement (Fresh Resin)	Spent Resin & Wastewater Disposal	Labor	Other Consumables (Bag Filters)	Maintenance and Spare Parts	Lab and Field Analysis	Annual O&M
1	\$ 12,600	\$ 9,400	\$ 12,000	\$ 1,190,800	\$ 714,700	\$ 51,000	\$ 130	\$ 7,000	\$ 52,000	\$ 2,049,630
2	\$ 12,600	\$ 9,400	\$ 12,000	\$ 170,500	\$ 105,500	\$ 51,000	\$ 130	\$ 7,000	\$ 52,000	\$ 420,130
5	\$ 12,600	\$ 9,400	\$ 12,000	\$ 22,400	\$ 17,000	\$ 51,000	\$ 130	\$ 7,000	\$ 52,000	\$ 183,530
10	\$ 12,600	\$ 9,400	\$ 12,000	\$ 14,000	\$ 12,000	\$ 51,000	\$ 130	\$ 7,000	\$ 52,000	\$ 170,130
25	\$ 12,600	\$ 9,400	\$ 12,000	\$ 8,400	\$ 8,700	\$ 51,000	\$ 130	\$ 7,000	\$ 52,000	\$ 161,230

* Electricity includes approximately \$700 per year for aeration off-gas treatment.
& Lab and field analysis does not include cost for aeration off-gas analysis.
Costs are in 2012 dollars.

WBA System Size = 500 gpm

Potential Cr(VI) MCL (ppb)	Electricity	Chemicals	VPGAC Replacement	Resin Replacement (Fresh Resin)	Spent Resin & Wastewater Disposal	Labor	Other Consumables (Bag Filters)	Maintenance and Spare Parts	Lab and Field Analysis	Annual O&M
1	\$ 61,700	\$ 47,000	\$ 50,500	\$ 6,179,900	\$ 4,168,100	\$ 51,000	\$ 520	\$ 14,500	\$ 52,000	\$ 10,625,220
2	\$ 61,700	\$ 47,000	\$ 50,500	\$ 884,900	\$ 600,000	\$ 51,000	\$ 520	\$ 14,500	\$ 52,000	\$ 1,762,120
5	\$ 61,700	\$ 47,000	\$ 50,500	\$ 116,100	\$ 81,900	\$ 51,000	\$ 520	\$ 14,500	\$ 52,000	\$ 475,220
10	\$ 61,700	\$ 47,000	\$ 50,500	\$ 72,500	\$ 52,600	\$ 51,000	\$ 520	\$ 14,500	\$ 52,000	\$ 402,320
25	\$ 61,700	\$ 47,000	\$ 50,500	\$ 43,500	\$ 33,000	\$ 51,000	\$ 520	\$ 14,500	\$ 52,000	\$ 353,720

* Electricity includes approximately \$11,000 per year for aeration off-gas treatment.
& Lab and field analysis does not include cost for aeration off-gas analysis.
Costs are in 2012 dollars.

WBA System Size = 2,000 gpm

Potential Cr(VI) MCL (ppb)	Electricity	Chemicals	VPGAC Replacement	Resin Replacement (Fresh Resin)	Spent Resin & Wastewater Disposal	Labor	Other Consumables (Bag Filters)	Maintenance and Spare Parts	Lab and Field Analysis	Annual O&M
1	\$ 198,700	\$ 187,900	\$ 171,900	\$ 20,695,300	\$ 14,225,100	\$ 51,000	\$ 1,600	\$ 33,500	\$ 80,000	\$ 35,645,000
2	\$ 198,700	\$ 187,900	\$ 171,900	\$ 2,963,400	\$ 2,040,100	\$ 51,000	\$ 1,600	\$ 33,500	\$ 80,000	\$ 5,728,100
5	\$ 198,700	\$ 187,900	\$ 171,900	\$ 388,600	\$ 270,700	\$ 51,000	\$ 1,600	\$ 33,500	\$ 80,000	\$ 1,383,900
10	\$ 198,700	\$ 187,900	\$ 171,900	\$ 242,900	\$ 170,600	\$ 51,000	\$ 1,600	\$ 33,500	\$ 80,000	\$ 1,138,100
25	\$ 198,700	\$ 187,900	\$ 171,900	\$ 145,700	\$ 103,800	\$ 51,000	\$ 1,600	\$ 33,500	\$ 80,000	\$ 974,100

* Electricity includes approximately \$21,000 per year for aeration off-gas treatment.
& Lab and field analysis does not include cost for aeration off-gas analysis.
Costs are in 2012 dollars.

Estimated WBA O&M Costs
 (Resin Replacement and Spent Resin Disposal Based on Total Cr Treatment Target)

Annual O&M Summary

WBA System Size (gpm)	Potential Cr(VI) MCL, ppb				
	1	2	5	10	25
10	\$ 453,000	\$ 187,000	\$ 149,000	\$ 147,000	\$ 144,000
100	\$ 2,049,630	\$ 420,130	\$ 183,530	\$ 170,130	\$ 161,230
500	\$ 10,625,220	\$ 1,762,120	\$ 475,220	\$ 402,320	\$ 353,720
2,000	\$ 35,645,000	\$ 5,728,100	\$ 1,383,900	\$ 1,138,100	\$ 974,100

Costs are in 2012 dollars.

Net Present Value for 20 Years

WBA System Size (gpm)	Potential Cr(VI) MCL, ppb				
	1	2	5	10	25
10	\$ 7,600,000	\$ 3,100,000	\$ 2,500,000	\$ 2,500,000	\$ 2,500,000
100	\$ 34,300,000	\$ 7,000,000	\$ 3,100,000	\$ 2,800,000	\$ 2,800,000
500	\$ 178,000,000	\$ 30,000,000	\$ 8,000,000	\$ 7,000,000	\$ 6,000,000
2,000	\$ 597,000,000	\$ 96,000,000	\$ 23,000,000	\$ 19,000,000	\$ 16,000,000

20-year NPV O&M based on 2.5% inflation and a 4.5% discount rate.

Costs are in 2012 dollars.

OPINION OF PROBABLE PROJECT COST

Client City of Glendale
Project Phase III Demonstration Testing for Cr(VI) Treatment
Item 100-gpm RCF System (Granular Media Filter With Recycle)

Project No. 05337008.0000		
By T.D. & Y.W.	Ckd: Y.W. & T.V.	Updated: Y.W.
Date 12/9/11	Date: 1/18/12	Date: 12/31/12

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
Equipment					
FeSO ₄ Feed System					
Storage Tank	1	EA	\$ 2,700	\$ 2,700	Quotes from Ryan Herco & Core-Rosion; 100 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars
Metering Pumps	2	EA	\$ 3,100	\$ 6,200	Quotes from C.P. Crowley & HTP; 0.25 gph; 1 duty/ 1 stdby; adjusted to 2012 dollars
Static Mixers	1	EA	\$ 900	\$ 900	Quotes from Komax & EWS; 3-inch; adjusted to 2012 dollars
Reduction Tanks					
Tanks	3	EA	\$ 5,200	\$ 15,600	Quotes from Core-Rosion & Ryan Herco; 1,700 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars
Mixers	3	EA	\$ 4,800	\$ 14,400	Quotes from Core-Rosion & EWS; G = 60 per second; adjusted to 2012 dollars
Aeration System					
Tank	1	EA	\$ 3,700	\$ 3,700	Quotes from Core-Rosion & Ryan Herco; 700 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars
Diffusers	1	LS	\$ 400	\$ 400	Based on previous project experience; adjusted to 2012 dollars
Supply Blowers	2	EA	\$ 30,900	\$ 61,800	Quote from EWS; 53 SCFM @ 4 psi; 1 duty/ 1 stdby; incl. accessories; adjusted to 2012 dollars
Exhaust Blowers	2	EA	\$ 35,600	\$ 71,200	Quote from EWS; 53 SCFM @ 2 psi; 1 duty/ 1 stdby; incl. accessories; adjusted to 2012 dollars
Off-Gas Treatment	1	LS	\$ 4,100	\$ 4,100	Cost from Glendale and quotes from TIGG; 54 SCFM; (2) adsorbers in series with one heater; adjusted to 2012 dollars
Polymer Mixing Tank					
Rapid Mixing Tank	1	EA	\$ 3,700	\$ 3,700	Quotes from Core-Rosion & Ryan Herco; 700 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars
Mixer	1	EA	\$ 3,800	\$ 3,800	Quotes from Core-Rosion & EWS; G = 170 per second; adjusted to 2012 dollars
Filters					
Filter Equipment (Pressure Filters)	1	LS	\$ 286,000	\$ 286,000	Quotes from Coombs-Hopkins & Layne, including media; 3 gpm/sf, (2) 6.5 ft dia VPF, 1 duty/ 1 stdby; adjusted to 2012 dollars
Filter Drawdown Transfer Pump	2	EA	\$ 5,700	\$ 11,400	Quotes from DTI and Cortech; 55 gpm @ 70 ft; 1 duty/ 1 stdby; adjusted to 2012 dollars
Pumps					
Filter Feed Pumps (Progressive Cavity)	2	EA	\$ 13,000	\$ 26,000	Quotes from Cortech & Flow-Systems; 100 gpm @ 70 ft; 1 duty/ 1 stdby; adjusted to 2012 dollars
Polymer Feed Systems					
Polymer Feed System (Coagulant Aid)	1	LS	\$ 28,000	\$ 28,000	Quotes from Siemens & C.P. Crowley; adjusted to 2012 dollars
Polymer Feed System (Solids Settling Aid)	1	LS	\$ 11,000	\$ 11,000	Quotes from Siemens & C.P. Crowley; adjusted to 2012 dollars
Filtrate Tank for Backwash	1	EA	\$ 26,700	\$ 26,700	Quotes from Core-Rosion & Ryan Herco; 12,500 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars
Backwash Pumps	2	EA	\$ 9,000	\$ 18,000	Quotes from ITT & Cortech; 600 gpm @ 50 ft; 1 duty/ 1stdby; adjusted to 2012 dollars
Residuals Treatment System					
Gravity Thickener	2	EA	\$ 33,000	\$ 66,000	Quote from Plastic-Mart for 13,000-gallon cone bottom tank with stand; adjusted to 2012 dollars
Flo-Trend SludgeMate Container	2	EA	\$ 14,500	\$ 29,000	Quote from Flo-Trend for 6-CY SludgeMate container; adjusted to 2012 dollars
Pumps	1	LS	\$ 10,200	\$ 10,200	Includes all sludge pumps and recycle pumps, one duty and one standby; adjusted to 2012 dollars
Subtotal				\$ 701,000	Rounded up to \$1000

OPINION OF PROBABLE PROJECT COST

Client	City of Glendale
Project	Phase III Demonstration Testing for Cr(VI) Treatment
Item	100-gpm RCF System (Granular Media Filter With Recycle)

Project No. 05337008.0000		
By T.D. & Y.W.	Ckd: Y.W. & T.V.	Updated: Y.W.
Date 12/9/11	Date: 1/18/12	Date: 12/31/12

Equipment Installation Cost	30%			\$ 211,000	Including tax, freight, installation and manufacturer services.
Chemical Storage Containment	2	CY	\$ 1,275	\$ 2,550	\$1250/CY, adjusted to 2012 dollars
Equipment Concrete Pads	69	CY	\$ 1,275	\$ 87,975	\$1250/CY, adjusted to 2012 dollars
Subtotal (Installed Equipment Costs)				\$ 1,003,000	Rounded up to \$1000
General Requirements	7.5%			\$ 75,225	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 50,150	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 50,150	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 151,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 151,000	PLC and SCADA equipment to control
Total Direct Costs				\$ 1,481,000	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 296,200	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
Construction Total				\$ 1,777,000	Rounded up to \$1000
Project Level Allowance (contingency)	20%			\$ 355,400	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%			\$ 355,400	Includes permits, legal fees and engineering fees for design and construction
Project Total				\$ 2,488,000	
Low Estimate				\$ 1,742,000	-30%
High Estimate				\$ 3,732,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2012 dollars.
3. Costs for land or easements are not included.

OPINION OF PROBABLE PROJECT COST

Client	City of Glendale
Project	Phase III Demonstration Testing for Cr(VI) Treatment
Item	500-gpm RCF System (Granular Media Filter With Recycle)

Project No. 05337008.0000		
By T.D. & Y.W.	Ckd: Y.W. & T.V.	Updated: Y.W.
Date 12/9/11	Date: 1/18/12	Date: 12/31/12

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
Equipment					
FeSO ₄ Feed System					
Storage Tank	1	EA	\$ 3,400	\$ 3,400	Quotes from Core-Rosion & Ryan Herco; 500 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars.
Metering Pumps	2	EA	\$ 3,100	\$ 6,200	Quotes from C.P. Crowley & HTP; 1.3 gph; 1 duty/ 1 stdby; adjusted to 2012 dollars.
Static Mixers	1	EA	\$ 2,200	\$ 2,200	Quotes from Komax & EWS; 8-inch; adjusted to 2012 dollars.
Reduction Tanks					
Tanks	3	EA	\$ 20,000	\$ 60,000	Quotes from Core-Rosion & Ryan Herco; 8,000 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars.
Mixers	3	EA	\$ 9,000	\$ 27,000	Quotes from Core-Rosion & EWS; G = 60 per second; adjusted to 2012 dollars.
Aeration System					
Tanks	1	EA	\$ 6,400	\$ 6,400	Quotes from Core-Rosion & Ryan Herco; 3000 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars.
Diffusers	1	LS	\$ 2,000	\$ 2,000	Based on previous project experience; adjusted to 2012 dollars.
Supply Blowers	2	EA	\$ 47,200	\$ 94,400	Quote from EWS; 267 SCFM @ 7 psi; 1 duty/ 1 stdby; incl. accessories; adjusted to 2012 dollars.
Exhaust Blowers	2	EA	\$ 35,400	\$ 70,800	Quote from EWS; 267 SCFM @ 2 psi; 1 duty/ 1 stdby; incl. accessories; adjusted to 2012 dollars.
Off-Gas Treatment	1	LS	\$ 15,400	\$ 15,400	Quotes from Calgon and TIGG; 270 SCFM; (2) adsorbers in series with one heater; adjusted to 2012 dollars.
Polymer Mixing Tank					
Rapid Mixing Tank	1	EA	\$ 6,900	\$ 6,900	Quotes from Core-Rosion & Ryan Herco; 3000 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars.
Mixers	1	EA	\$ 4,500	\$ 4,500	Quotes from Core-Rosion & EWS; G = 170 per second; adjusted to 2012 dollars.
Filters					
Filter Equipment (Pressure Filters)	1	LS	\$ 475,000	\$ 475,000	Quotes from Coombs-Hopkins & Layne, including media; 3 gpm/sf; Coombs-Hopkins filters, 10' x 24' (4 cells, 3 duty/ 1 stdby); Layne filters, (2) 8" x 22', 1 duty/ 1 stdby; adjusted to 2012 dollars.
Filter Drawdown Transfer Pump	2	EA	\$ 4,900	\$ 9,800	Quotes from ITT and Cortech; 150 gpm @ 70 ft; 1 duty/ 1 stdby; adjusted to 2012 dollars.
Pumps					
Filter Feed Pumps (Progressive Cavity)	2	EA	\$ 39,000	\$ 78,000	Quotes from Cortech & Flow-Systems; 500 gpm @ 70 ft; 1 duty/ 1 stdby; adjusted to 2012 dollars.
Polymer Feed Systems					
Polymer Feed Systems (Coagulant Aid)	1	LS	\$ 10,700	\$ 10,700	Quotes from Siemens & C.P. Crowley; adjusted to 2012 dollars.
Polymer Feed Systems (Solids Settling Aid)	1	LS	\$ 11,600	\$ 11,600	Quotes from Siemens & C.P. Crowley; adjusted to 2012 dollars.
Filtrate Tank for Backwash	1	EA	\$ 41,000	\$ 41,000	Quotes from Superior; 22,000 gal; 15 ft dia x 16 ft height; adjusted to 2012 dollars.
Backwash Pumps	2	EA	\$ 14,600	\$ 29,200	Quotes from ITT & Cortech; 1,050 gpm @ 50 ft; 1 duty/ 1stdby; adjusted to 2012 dollars.
Residuals Treatment System					
Equalization Tank	1	EA	\$ 124,000	\$ 121,154	Adjusted installed costs from RS Means for 90,000-gal tank, which was divided by 1.3 to exclude installation cost (assuming a installation cost of 30%); adjusted to 2012 dollars.
Plate Settler	1	EA	\$ 60,000	\$ 60,000	Quote from Meurer Research, Inc. and Parkson for a system handles a 26-gpm sludge flow; adjusted to 2012 dollars.
Flo-Trend SludgeMate Container	3	EA	\$ 26,400	\$ 79,200	Quote from Flo-Trend for 15-CY SludgeMate container; adjusted to 2012 dollars.
Pumps	1	LS	\$ 15,300	\$ 15,300	Includes all sludge pumps and recycle pumps, one duty and one standby; adjusted to 2012 dollars.
Subtotal				\$ 1,231,000	Rounded up to \$1000

OPINION OF PROBABLE PROJECT COST

Client	City of Glendale
Project	Phase III Demonstration Testing for Cr(VI) Treatment
Item	500-gpm RCF System (Granular Media Filter With Recycle)

Project No. 05337008.0000		
By T.D. & Y.W.	Ckd: Y.W. & T.V.	Updated: Y.W.
Date 12/9/11	Date: 1/18/12	Date: 12/31/12

Equipment Installation Cost	30%			\$ 370,000	Including tax, freight, installation and manufacturer services.
Chemical Storage Containment	6	CY	\$ 1,275	\$ 7,650	\$1250/CY, adjusted to 2012 dollars
Equipment Concrete Pads	166	CY	\$ 1,275	\$ 211,650	\$1250/CY, adjusted to 2012 dollars
Subtotal (Installed Equipment Costs)				\$ 1,821,000	Rounded up to \$1000
General Requirements	7.5%			\$ 136,575	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 91,050	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 91,050	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 274,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 274,000	PLC and SCADA equipment to control
Total Direct Costs				\$ 2,688,000	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 537,600	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
Construction Total				\$ 3,226,000	Rounded up to \$1000
Project Level Allowance (contingency)	20%			\$ 645,200	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%			\$ 645,200	Includes permits, legal fees and engineering fees for design and construction
Project Total				\$ 4,517,000	
Low Estimate				\$ 3,162,000	-30%
High Estimate				\$ 6,776,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2012 dollars.
3. Costs for land or easements are not included.

OPINION OF PROBABLE PROJECT COST

Client City of Glendale
Project Phase III Demonstration Testing for Cr(VI) Treatment
Item 2000-gpm RCF System (Granular Media Filter With Recycle)

Project No. 05337008.0000		
By T.D. & Y.W.	Ckd: Y.W. & T.V.	Updated: Y.W.
Date 12/9/11	Date: 1/18/12	Date: 12/31/12

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
Equipment					
FeSO ₄ Feed System					
Storage Tank	1	EA	\$ 6,000	\$ 6,000	Quotes from Core-Rosion & Ryan Herco; 2,000 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars
Metering Pumps	2	EA	\$ 6,200	\$ 12,400	Quotes from C.P. Crowley & HTP; 5 gph; adjusted to 2012 dollars
Static Mixers	1	EA	\$ 4,300	\$ 4,300	Quotes from Komax & EWS; 14-inch; adjusted to 2012 dollars
Reduction Tanks					
Mixers	3	EA	\$ 24,000	\$ 72,000	Quotes from Core-Rosion & EWS; G = 60 per second; adjusted to 2012 dollars
Aeration System					
Diffuser	1	LS	\$ 8,200	\$ 8,200	Based on previous project experience and conversation w/ Brian Bubela; adjusted to 2012 dollars
Supply Blowers	2	EA	\$ 76,300	\$ 152,600	Quote from EWS; 1,070 SCFM @ 7 psi; 1 duty/ 1 stdby; incl. accessories; adjusted to 2012 dollars
Exhaust Blowers	2	EA	\$ 59,600	\$ 119,200	Quote from EWS; 1,070 SCFM @ 2 psi; 1 duty/ 1 stdby; incl. accessories; adjusted to 2012 dollars
Off-Gas Treatment	1	LS	\$ 25,800	\$ 25,800	Quotes from Calgon & TIGG; 1070 SCFM; (2) adsorbers in series with one heater; adjusted to 2012 dollars
Polymer Mixing Tanks					
Mixers	1	EA	\$ 17,300	\$ 17,300	Quotes from Core-Rosion & EWS; G = 170 per second; adjusted to 2012 dollars
Filters					
Filter Equipment (Pressure Filters)	1	LS	\$ 1,004,000	\$ 1,004,000	Quotes from Tonka & Layne, including media; 3 gpm/sf; Tonka filters, (2) 10' x 42', 4 cells per filter, 3 duty / 1 stdby; Layne filters, (4) 10' x 24', 3 duty/ 1 stdby; adjusted to 2012 dollars
Filter Drawdown Transfer Pump	2	EA	\$ 5,100	\$ 10,200	Quotes from ITT and Cortech; 150 gpm @ 70 ft; 1 duty/ 1 stdby; adjusted to 2012 dollars
Pumps					
Filter Feed Pumps (Progressive Cavity)	3	EA	\$ 56,000	\$ 168,000	Quotes from Cortech & Flow-Systems; 1,000 gpm @ 70 ft; 2 duty/ 1 stdby; adjusted to 2012 dollars
Polymer Feed Systems					
Polymer Feed Systems (Coagulant Aid)	1	LS	\$ 10,700	\$ 10,700	Quotes from Siemens & C.P. Crowley; adjusted to 2012 dollars
Polymer Feed Systems (Solids Settling Aid)	1	LS	\$ 11,600	\$ 11,600	Quotes from Siemens & C.P. Crowley; adjusted to 2012 dollars
Filtrate Tank for Backwash	1	EA	\$ 51,000	\$ 51,000	Quotes from Superior; 30,250 gal; 18 ft dia x 16 ft height; adjusted to 2012 dollars
Backwash Pumps	2	EA	\$ 21,900	\$ 43,800	Quotes from ITT & Cortech; 1,450 gpm @ 50 ft; 1 duty/ 1stdby; adjusted to 2012 dollars
Residuals Treatment System					
Equalization Tank	1	EA	\$ 140,000	\$ 137,385	Adjusted installed costs from RS Means for 280,000-gal tank, which was divided by 1.3 to exclude installation cost (assuming a installation cost of 30%);
Plate Settler	1	EA	\$ 79,000	\$ 79,000	Quote from Meurer Research, Inc. and Parkson for a system handles a 88-gpm sludge flow; adjusted to 2012 dollars
Flo-Trend SludgeMate Container	3	EA	\$ 39,200	\$ 117,600	Quote from Flo-Trend for 40-CY SludgeMate container; adjusted to 2012 dollars
Pumps	1	LS	\$ 22,000	\$ 22,000	Includes sludge pumps and recycle pumps for equalization tank and plate settlers, one duty and one standby; adjusted to 2012 dollars.
Subtotal				\$ 2,074,000	Rounded up to \$1000

OPINION OF PROBABLE PROJECT COST

Client	City of Glendale
Project	Phase III Demonstration Testing for Cr(VI) Treatment
Item	2000-gpm RCF System (Granular Media Filter With Recycle)

Project No. 05337008.0000		
By T.D. & Y.W.	Ckd: Y.W. & T.V.	Updated: Y.W.
Date 12/9/11	Date: 1/18/12	Date: 12/31/12

Equipment Installation Cost (30% of Equipment)	30%			\$	623,000	Including tax, freight, installation and manufacturer services.
Reduction Tanks						25 ft x 75 ft tank, including 3 sub-tanks with shared walls
Slab	140	CY	\$	714	\$	99,960 Based on 2 ft slab or wall; \$700/CY; adjusted to 2012 dollars.
Walls	155	CY	\$	816	\$	126,480 Based on 2 ft slab or wall; and 2 ft freeboard; \$800/CY; adjusted to 2012 dollars
Elevated Slab	140	CY	\$	1,122	\$	157,080 Based on 2 ft slab or wall; \$1100/CY; adjusted to 2012 dollars.
Aeration Tanks						15 ft x 15 ft tank
Slab	17	CY	\$	714	\$	12,138 Based on 2 ft slab or wall; \$700/CY; adjusted to 2012 dollars.
Walls	35	CY	\$	816	\$	28,560 Based on 2 ft slab or wall; and 2 ft freeboard; \$800/CY; adjusted to 2012 dollars
Elevated Slab	17	CY	\$	1,122	\$	19,074 Based on 2 ft slab or wall; \$1100/CY; adjusted to 2012 dollars.
Rapid Mixing Tanks						15 ft x 15 ft tank
Slab	17	CY	\$	714	\$	12,138 Based on 2 ft slab or wall; \$700/CY; adjusted to 2012 dollars.
Walls	35	CY	\$	816	\$	28,560 Based on 2 ft slab or wall; and 2 ft freeboard; \$800/CY; adjusted to 2012 dollars
Elevated Slab	17	CY	\$	1,122	\$	19,074 Based on 2 ft slab or wall; \$1100/CY; adjusted to 2012 dollars.
Chemical Storage Containment	16	CY	\$	1,275	\$	20,400 \$1250/CY, adjusted to 2012 dollars
Equipment Concrete Pads	291	CY	\$	1,275	\$	371,025 \$1250/CY, adjusted to 2012 dollars
Subtotal (Installed Equipment Costs)				\$	3,592,000	Rounded up to \$1000
General Requirements	7.5%			\$	269,400	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$	179,600	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$	179,600	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$	539,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$	539,000	PLC and SCADA equipment to control
Total Direct Costs				\$	5,299,000	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$	1,059,800	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
Construction Total				\$	6,358,800	
Project Level Allowance (contingency)	20%			\$	1,271,760	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%			\$	1,271,760	Includes permits, legal fees and engineering fees for design and construction
Project Total				\$	8,903,000	
Low Estimate				\$	6,232,000	-30%
High Estimate				\$	13,355,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2012 dollars.
3. Costs for land or easements are not included.

Estimated RCF Water Quality Monitoring (Number of Samples per Month)

 Flow Rate (gpm) 100
 Number of Duty Filters 1

Sample Location	Lab									Field					
	Total Fe	Cr(VI)	Total Cr	TSS	Silica	VOCs	Bac-T (E. Coli, T. Coli and HPC)	TCLP (Metals)	CA WET (Metals)	Cr(VI)*	Ferrous	Total Fe	Turbidity	pH	Temperature
Raw	1	4	4			1				4	1	1	1	4	4
After ferrous addition											4	4		continuous	continuous
After 1st reduction tank											4	4			4
After 2nd reduction tank											1	1			4
After 3rd reduction tank		4					1				4	4			4
Aeration off gas (raw)							1								
Aeration off gas (after first VPGAC)							1								
Aeration off gas (after 2nd VPGAC)							1								
Filter feed (after rapid mixing)				4			1								4
Filter effluent	4	4	4							4	4	4	continuous	1	1
Spent filter backwash	1	1	1	1											
Supernatant from thickener	1	1	1	1				4		1	1	1	1	1	1
Thickened sludge				1											
Filtrate from dewatering container	1	1	1	1				4		1	1	1	1	1	1
Dewatered solid residuals								At disposal	At disposal						
Number of samples per month^	8	15	11	8		1	5	8	1	1	10	20	20	3	23
Unit cost (\$/sample)	\$ 14	\$ 54	\$ 14	\$ 15	\$ 14	\$ 112	\$ 59	\$ 245	\$ 429						
Sample analysis Cost (\$/year)	\$ 1,322	\$ 9,639	\$ 1,818	\$ 1,469	\$ 165	\$ 6,732	\$ 5,630	\$ 2,938	\$ 5,153						
Shipping fee (\$/year)	\$ 1,560	One shipment per week, \$30 per shipment													
Sum of lab analysis cost (\$/year)	\$ 36,426	Sample analysis plus shipping fee													
Field meters	\$ 6,000	Hach Dr 3800, portable pH meter and turbidity meter													
Field analysis cost	\$ 2,000	Estimate for reagents and apparatus based on experience; not including labor for field analysis													
Total analysis cost	\$ 38,426	Including lab and field analysis costs; not including labor and field meters													

* Only if influent Cr(VI) is greater than 10 ppb, which is the method detection limit for field analysis (Hach Method).

Continuous monitoring indicates analyzed by online meter(s).

^ Assume TCLP and CA WET residuals analysis occur once a month, which is a conservative estimate.

TSS - total suspended solids; VOCs - volatile organic compounds; TCLP - toxicity characteristic leaching procedure; CA WET - California waste extraction test; VPGAC - vapor phase granular activated carbon

Costs are adjusted to 2012 dollars.

Estimated RCF Water Quality Monitoring (Number of Samples per Month)

Flow Rate (gpm) 500
 Number of Duty Filter Cells 3

Sample Location	Lab									Field					
	Total Fe	Cr(VI)	Total Cr	TSS	Silica	VOCs	Bac-T (E. Coli, T. Coli and HPC)	TCLP (Metals)	CA WET (Metals)	Cr(VI)*	Ferrous	Total Fe	Turbidity	pH	Temperature
Raw	1	4	4			1				4	1	1	1	4	4
After ferrous addition											4	4		continuous	continuous
After 1st reduction tank											4	4			4
After 2nd reduction tank											1	1			4
After 3rd reduction tank		4					1				4	4			4
Aeration off gas (raw)							1								
Aeration off gas (after first VPGAC)							1								
Aeration off gas (after 2nd VPGAC)							1								
Filter feed (after rapid mixing)				4			1								4
Filter effluent from each cell	4	4	4							4	4	4	continuous		1
Spent filter backwash	1	1	1	1											
Supernatant from thickener	1	1	1	1				4		1	1	1	1	1	1
Thickened sludge				1											
Filtrate from dewatering container	1	1	1	1				4		1	1	1	1	1	1
Dewatered solid residuals								At disposal	At disposal						
Number of samples per month^	16	23	19	8		1	5	8	1.5	1.5	18	28	28	3	25
Unit cost (\$/sample)	\$ 14	\$ 54	\$ 14	\$ 15	\$ 14	\$ 112	\$ 59	\$ 245	\$ 429						
Sample analysis Cost (\$/year)	\$ 2,644	\$ 14,780	\$ 3,140	\$ 1,469	\$ 165	\$ 6,732	\$ 5,630	\$ 4,406	\$ 7,730						
Shipping fee (\$/year)	\$ 1,560	One shipment per week, \$30 per shipment													
Sum of lab analysis cost (\$/year)	\$ 48,256	Sample analysis plus shipping fee													
Field meters	\$ 6,000	Hach Dr 3800, portable pH meter and turbidity meter													
Field analysis cost	\$ 3,000	Estimate for reagents and apparatus based on experience; not including labor for field analysis													
Total analysis cost	\$ 51,256	Including lab and field analysis costs; not including labor and field meters													

* Only if influent Cr(VI) is greater than 10 ppb, which is the method detection limit for field analysis (Hach Method).

Continuous monitoring indicates analyzed by online meter(s).

^ Assume TCLP and CA WET residuals analysis occur three times every two months, which is a conservative estimate.

TSS - total suspended solids; VOCs - volatile organic compounds; TCLP - toxicity characteristic leaching procedure; CA WET - California waste extraction test; VPGAC - vapor phase granular activated carbon

Costs are adjusted to 2012 dollars.

Estimated RCF Water Quality Monitoring (Number of Samples per Month)

 Flow Rate (gpm) 2,000
 Number of Duty Filter Cells 9

Sample Location	Lab									Field					
	Total Fe	Cr(VI)	Total Cr	TSS	Silica	VOCs	Bac-T (E. Coli, T. Coli and HPC)	TCLP (Metals)	CA WET (Metals)	Cr(VI)*	Ferrous	Total Fe	Turbidity	pH	Temperature
Raw	1	4	4			1				4	1	1	1	4	4
After ferrous addition											4	4		continuous	continuous
After 1st reduction tank											4	4			4
After 2nd reduction tank											1	1			4
After 3rd reduction tank		4					1				4	4			4
Aeration off gas (raw)							1								
Aeration off gas (after first VPGAC)							1								
Aeration off gas (after 2nd VPGAC)							1								
Filter feed (after rapid mixing)				4			1								4
Filter effluent from each cell	4	4	4							4	4	4	continuous		1
Spent filter backwash	1	1	1	1											
Supernatant from thickener	1	1	1	1				4		1	1	1	1	1	1
Thickened sludge				1											
Filtrate from dewatering container	1	1	1	1				4		1	1	1	1	1	1
Dewatered solid residuals								At disposal	At disposal						
Number of samples per month^	40	47	43	8		1	5	8	2	2	42	52	52	3	31
Unit cost (\$/sample)	\$ 14	\$ 54	\$ 14	\$ 15	\$ 14	\$ 112	\$ 59	\$ 245	\$ 429						
Sample analysis Cost (\$/year)	\$ 6,610	\$ 30,202	\$ 7,105	\$ 1,469	\$ 165	\$ 6,732	\$ 5,630	\$ 5,875	\$ 10,306						
Shipping fee (\$/year)	\$ 1,560	One shipment per week, \$30 per shipment													
Sum of lab analysis cost (\$/year)	\$ 75,655	Sample analysis plus shipping fee													
Field meters	\$ 6,000	Hach Dr 3800, portable pH meter and turbidity meter													
Field analysis cost	\$ 5,000	Estimate for reagents and apparatus based on experience; not including labor for field analysis													
Total analysis cost	\$ 80,655	Including lab and field analysis costs; not including labor and field meters													

* Only if influent Cr(VI) is greater than 10 ppb, which is the method detection limit for field analysis (Hach Method).

Continuous monitoring indicates analyzed by online meter(s).

^ Assume TCLP and CA WET residuals analysis occur twice every two months, which is a conservative estimate.

TSS - total suspended solids; VOCs - volatile organic compounds; TCLP - toxicity characteristic leaching procedure; CA WET - California waste extraction test; VPGAC - vapor phase granular activated carbon

Costs are adjusted to 2012 dollars.

Estimated RCF O&M Costs

RCF System Size = 100 gpm

Influent Cr(VI) Concentration (ppb)	Residuals Disposal	Chemicals	Labor	VPGAC Replacement	Filter Media Replacement	Maintenance and Spare Parts	Electricity*	Lab and Field Analysis &	Annual O&M
5	\$ 5,700	\$ 3,400	\$ 164,000	\$ 1,200	\$ 600	\$ 10,000	\$ 37,400	\$ 38,400	\$ 261,000
10	\$ 10,800	\$ 4,000	\$ 164,000	\$ 1,200	\$ 600	\$ 10,000	\$ 37,400	\$ 38,400	\$ 266,000
25	\$ 17,600	\$ 5,100	\$ 164,000	\$ 1,200	\$ 600	\$ 10,000	\$ 37,400	\$ 38,400	\$ 274,000
50	\$ 34,600	\$ 7,900	\$ 164,000	\$ 1,200	\$ 600	\$ 10,000	\$ 37,400	\$ 38,400	\$ 294,000

* Electricity includes approximately \$200 per year for aeration off-gas treatment.

& Lab and field analysis includes approximately \$4,000 per year for aeration off-gas analysis.

Costs are in 2012 dollars.

RCF System Size = 500 gpm

Influent Cr(VI) Concentration (ppb)	Residuals Disposal	Chemicals	Labor	VPGAC Replacement	Filter Media Replacement	Maintenance and Spare Parts	Electricity*	Lab and Field Analysis &	Annual O&M
5	\$ 28,400	\$ 8,800	\$ 238,000	\$ 22,000	\$ 2,600	\$ 18,200	\$ 101,000	\$ 51,300	\$ 470,000
10	\$ 53,800	\$ 13,000	\$ 238,000	\$ 22,000	\$ 2,600	\$ 18,200	\$ 101,000	\$ 51,300	\$ 500,000
25	\$ 88,100	\$ 18,500	\$ 238,000	\$ 22,000	\$ 2,600	\$ 18,200	\$ 101,000	\$ 51,300	\$ 540,000
50	\$ 173,200	\$ 32,300	\$ 238,000	\$ 22,000	\$ 2,600	\$ 18,200	\$ 101,000	\$ 51,300	\$ 639,000

* Electricity includes approximately \$700 for aeration off-gas treatment.

& Lab and field analysis includes approximately \$4,000 per year for aeration off-gas analysis.

Costs are in 2012 dollars.

RCF System Size = 2,000 gpm

Influent Cr(VI) Concentration (ppb)	Residuals Disposal	Chemicals	Labor	VPGAC Replacement	Filter Media Replacement	Maintenance and Spare Parts	Electricity*	Lab and Field Analysis &	Annual O&M
5	\$ 113,700	\$ 29,900	\$ 384,000	\$ 61,200	\$ 6,200	\$ 35,900	\$ 180,000	\$ 80,700	\$ 892,000
10	\$ 215,300	\$ 46,400	\$ 384,000	\$ 61,200	\$ 6,200	\$ 35,900	\$ 180,000	\$ 80,700	\$ 1,010,000
25	\$ 352,400	\$ 68,500	\$ 384,000	\$ 61,200	\$ 6,200	\$ 35,900	\$ 180,000	\$ 80,700	\$ 1,169,000
50	\$ 692,700	\$ 123,600	\$ 384,000	\$ 61,200	\$ 6,200	\$ 35,900	\$ 180,000	\$ 80,700	\$ 1,564,000

* Electricity includes approximately \$2,800 for aeration off-gas treatment.

& Lab and field analysis includes approximately \$4,000 per year for aeration off-gas analysis.

Costs are in 2012 dollars.

Annual O&M Summary

RCF System Size (gpm)	Influent Cr(VI) Concentration, ppb			
	5	10	25	50
100	\$ 261,000	\$ 266,000	\$ 274,000	\$ 294,000
500	\$ 470,000	\$ 500,000	\$ 540,000	\$ 639,000
2,000	\$ 892,000	\$ 1,010,000	\$ 1,169,000	\$ 1,564,000

Costs are in 2012 dollars.

Net Present Value for 20 Years (Rounded to two significant figures)

RCF System Size (gpm)	Influent Cr(VI) Concentration, ppb			
	5	10	25	50
100	\$ 4,400,000	\$ 4,500,000	\$ 4,600,000	\$ 4,900,000
500	\$ 7,900,000	\$ 8,400,000	\$ 9,000,000	\$ 11,000,000
2,000	\$ 15,000,000	\$ 17,000,000	\$ 20,000,000	\$ 26,000,000

20-year NPV O&M based on 2.5% inflation and a 4.5% discount rate

Costs are in 2012 dollars.

OPINION OF PROBABLE PROJECT COST

Client City of Glendale
Project Phase III Demonstration Testing for Cr(VI) Treatment
Item 100-gpm RCF System (Granular Media Filter Without Recycle)

Project No. 05337008.0000		
By T.D. & Y.W.	Ckd: Y.W. & T.V.	Updated: Y.W.
Date 12/9/11	Date: 1/18/12	Date: 1/10/13

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
Equipment					
FeSO ₄ Feed System					
Storage Tank	1	EA	\$ 2,700	\$ 2,700	Quotes from Ryan Herco & Core-Rosion; 100 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars
Metering Pumps	2	EA	\$ 3,100	\$ 6,200	Quotes from C.P. Crowley & HTP; 0.25 gph; 1 duty/ 1 stdby; adjusted to 2012 dollars
Static Mixers	1	EA	\$ 900	\$ 900	Quotes from Komax & EWS; 3-inch; adjusted to 2012 dollars
Reduction Tanks					
Tanks	3	EA	\$ 5,200	\$ 15,600	Quotes from Core-Rosion & Ryan Herco; 1,700 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars
Mixers	3	EA	\$ 4,800	\$ 14,400	Quotes from Core-Rosion & EWS; G = 60 per second; adjusted to 2012 dollars
Aeration System					
Tank	1	EA	\$ 3,700	\$ 3,700	Quotes from Core-Rosion & Ryan Herco; 700 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars
Diffusers	1	LS	\$ 400	\$ 400	Based on previous project experience; adjusted to 2012 dollars
Supply Blowers	2	EA	\$ 30,900	\$ 61,800	Quote from EWS; 53 SCFM @ 4 psi; 1 duty/ 1 stdby; incl. accessories; adjusted to 2012 dollars
Exhaust Blowers	2	EA	\$ 35,600	\$ 71,200	Quote from EWS; 53 SCFM @ 2 psi; 1 duty/ 1 stdby; incl. accessories; adjusted to 2012 dollars
Off-Gas Treatment	1	LS	\$ 4,100	\$ 4,100	Cost from Glendale and quotes from TIGG; 54 SCFM; (2) adsorbers in series with one heater; adjusted to 2012 dollars
Polymer Mixing Tank					
Rapid Mixing Tank	1	EA	\$ 3,700	\$ 3,700	Quotes from Core-Rosion & Ryan Herco; 700 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars
Mixer	1	EA	\$ 3,800	\$ 3,800	Quotes from Core-Rosion & EWS; G = 170 per second; adjusted to 2012 dollars
Filters					
Filter Equipment (Pressure Filters)	1	LS	\$ 286,000	\$ 286,000	Quotes from Coombs-Hopkins & Layne, including media; 3 gpm/sf, (2) 6.5 ft dia VPF, 1 duty/ 1 stdby; adjusted to 2012 dollars
Filter Drawdown Transfer Pump	2	EA	\$ 5,700	\$ 11,400	Quotes from DTI and Cortech; 55 gpm @ 70 ft; 1 duty/ 1 stdby; adjusted to 2012 dollars
Pumps					
Filter Feed Pumps (Progressive Cavity)	2	EA	\$ 13,000	\$ 26,000	Quotes from Cortech & Flow-Systems; 100 gpm @ 70 ft; 1 duty/ 1 stdby; adjusted to 2012 dollars
Polymer Feed System (Coagulant Aid)	1	LS	\$ 28,000	\$ 28,000	Quotes from Siemens & C.P. Crowley; adjusted to 2012 dollars
Filter Backwash					
Filtrate Tank for Backwash	1	EA	\$ 26,700	\$ 26,700	Quotes from Core-Rosion & Ryan Herco; 12,500 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars
Backwash Pumps	2	EA	\$ 9,000	\$ 18,000	Quotes from ITT & Cortech; 600 gpm @ 50 ft; 1 duty/ 1stdby; adjusted to 2012 dollars
Backwash Waste Storage Tank	1	EA	\$ 35,000	\$ 35,000	Based on previous quotes for various tank sizes, estimated for 21,000 gal, adjusted to 2012 dollars
Sewer Discharge Pumps	2	EA	\$ 5,000	\$ 10,000	Quote based upon 175 gpm Hydromatic Submergible pump, 1 duty/ 1 stdby
Subtotal				\$ 630,000	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 189,000	Including tax, freight, installation and manufacturer services.
Chemical Storage Containment	2	CY	\$ 1,275	\$ 2,550	\$1250/CY, adjusted to 2012 dollars
Equipment Concrete Pads	35	CY	\$ 1,275	\$ 44,625	\$1250/CY, adjusted to 2012 dollars
Subtotal (Installed Equipment Costs)				\$ 867,000	Rounded up to \$1000

OPINION OF PROBABLE PROJECT COST

Client City of Glendale
Project Phase III Demonstration Testing for Cr(VI) Treatment
Item 100-gpm RCF System (Granular Media Filter Without Recycle)

Project No. 05337008.0000		
By T.D. & Y.W.	Ckd: Y.W. & T.V.	Updated: Y.W.
Date 12/9/11	Date: 1/18/12	Date: 1/10/13

General Requirements	7.5%		\$ 65,025	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%		\$ 43,350	Excavation, backfill, and fill required to construct project
Site Improvements	5%		\$ 43,350	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%		\$ 131,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%		\$ 131,000	PLC and SCADA equipment to control
Total Direct Costs			\$ 1,281,000	Rounded up to \$1000
Contractor's Overhead and Profit	20%		\$ 256,200	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
Construction Total			\$ 1,537,000	Rounded up to \$1000
Project Level Allowance (contingency)	20%		\$ 307,400	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%		\$ 307,400	Includes permits, legal fees and engineering fees for design and construction
Project Total			\$ 2,152,000	
Low Estimate			\$ 1,506,000	-30%
High Estimate			\$ 3,228,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2012 dollars.
3. Costs for land or easements are not included.

OPINION OF PROBABLE PROJECT COST

Client City of Glendale
Project Phase III Demonstration Testing for Cr(VI) Treatment
Item 500-gpm RCF System (Granular Media Filter Without Recycle)

Project No. 05337008.0000		
By T.D. & Y.W.	Ckd: Y.W. & T.V.	Updated: Y.W.
Date 12/9/11	Date: 1/18/12	Date: 12/31/12

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
Equipment					
FeSO ₄ Feed System					
Storage Tank	1	EA	\$ 3,400	\$ 3,400	Quotes from Core-Rosion & Ryan Herco; 500 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars.
Metering Pumps	2	EA	\$ 3,100	\$ 6,200	Quotes from C.P. Crowley & HTP; 1.3 gph; 1 duty/ 1 stdby; adjusted to 2012 dollars.
Static Mixers	1	EA	\$ 2,200	\$ 2,200	Quotes from Komax & EWS; 8-inch; adjusted to 2012 dollars.
Reduction Tanks					
Tanks	3	EA	\$ 20,000	\$ 60,000	Quotes from Core-Rosion & Ryan Herco; 8,000 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars.
Mixers	3	EA	\$ 9,000	\$ 27,000	Quotes from Core-Rosion & EWS; G = 60 per second; adjusted to 2012 dollars.
Aeration System					
Tanks	1	EA	\$ 6,400	\$ 6,400	Quotes from Core-Rosion & Ryan Herco; 3000 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars.
Diffusers	1	LS	\$ 2,000	\$ 2,000	Based on previous project experience; adjusted to 2012 dollars.
Supply Blowers	2	EA	\$ 47,200	\$ 94,400	Quote from EWS; 267 SCFM @ 7 psi; 1 duty/ 1 stdby; incl. accessories; adjusted to 2012 dollars.
Exhaust Blowers	2	EA	\$ 35,400	\$ 70,800	Quote from EWS; 267 SCFM @ 2 psi; 1 duty/ 1 stdby; incl. accessories; adjusted to 2012 dollars.
Off-Gas Treatment	1	LS	\$ 15,400	\$ 15,400	Quotes from Calgon and TIGG; 270 SCFM; (2) adsorbers in series with one heater; adjusted to 2012 dollars.
Polymer Mixing Tank					
Rapid Mixing Tank	1	EA	\$ 6,900	\$ 6,900	Quotes from Core-Rosion & Ryan Herco; 3000 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars.
Mixers	1	EA	\$ 4,500	\$ 4,500	Quotes from Core-Rosion & EWS; G = 170 per second; adjusted to 2012 dollars.
Filters					
Filter Equipment (Pressure Filters)	1	LS	\$ 475,000	\$ 475,000	Quotes from Coombs-Hopkins & Layne, including media; 3 gpm/sf; Coombs-Hopkins filters, 10' x 24' (4 cells, 3 duty/ 1 stdby); Layne filters, (2) 8" x 22', 1 duty/ 1 stdby; adjusted to 2012 dollars.
Filter Drawdown Transfer Pump	2	EA	\$ 4,900	\$ 9,800	Quotes from ITT and Cortech; 150 gpm @ 70 ft; 1 duty/ 1 stdby; adjusted to 2012 dollars.
Pumps					
Filter Feed Pumps (Progressive Cavity)	2	EA	\$ 39,000	\$ 78,000	Quotes from Cortech & Flow-Systems; 500 gpm @ 70 ft; 1 duty/ 1 stdby; adjusted to 2012 dollars.
Polymer Feed Systems					
Polymer Feed Systems (Coagulant Aid)	1	LS	\$ 10,700	\$ 10,700	Quotes from Siemens & C.P. Crowley; adjusted to 2012 dollars.
Polymer Feed Systems (Solids Settling Aid)	0	LS	\$ 11,600	\$ -	Quotes from Siemens & C.P. Crowley; adjusted to 2012 dollars.
Filter Backwash					
Filtrate Tank for Backwash	1	EA	\$ 41,000	\$ 41,000	Quotes from Superior; 22,000 gal; 15 ft dia x 16 ft height; adjusted to 2012 dollars.
Backwash Pumps	2	EA	\$ 14,600	\$ 29,200	Quotes from ITT & Cortech; 1,050 gpm @ 50 ft; 1 duty/ 1stdby; adjusted to 2012 dollars.
Backwash Waste Storage Tank	1	EA	\$ 70,000	\$ 70,000	Based on previous quotes for various tank sizes, estimated for 85,000 gal, adjusted to 2012 dollars
Sewer Discharge Pumps	2	EA	\$ 5,000	\$ 10,000	Quote based upon 175 gpm Hydromatic Submergible pump, 1 duty/ 1 stdby
Subtotal				\$ 1,023,000	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 307,000	Including tax, freight, installation and manufacturer services.
Chemical Storage Containment	6	CY	\$ 1,275	\$ 7,650	\$1250/CY, adjusted to 2012 dollars
Equipment Concrete Pads	101	CY	\$ 1,275	\$ 128,775	\$1250/CY, adjusted to 2012 dollars
Subtotal (Installed Equipment Costs)				\$ 1,467,000	Rounded up to \$1000

OPINION OF PROBABLE PROJECT COST

Client City of Glendale
Project Phase III Demonstration Testing for Cr(VI) Treatment
Item 500-gpm RCF System (Granular Media Filter Without Recycle)

Project No. 05337008.0000		
By T.D. & Y.W.	Ckd: Y.W. & T.V.	Updated: Y.W.
Date 12/9/11	Date: 1/18/12	Date: 12/31/12

General Requirements	7.5%		\$ 110,025	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%		\$ 73,350	Excavation, backfill, and fill required to construct project
Site Improvements	5%		\$ 73,350	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%		\$ 221,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%		\$ 221,000	PLC and SCADA equipment to control
Total Direct Costs			\$ 2,166,000	Rounded up to \$1000
Contractor's Overhead and Profit	20%		\$ 433,200	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
Construction Total			\$ 2,599,000	Rounded up to \$1000
Project Level Allowance (contingency)	20%		\$ 519,800	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%		\$ 519,800	Includes permits, legal fees and engineering fees for design and construction
Project Total			\$ 3,639,000	
Low Estimate			\$ 2,547,000	-30%
High Estimate			\$ 5,459,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2012 dollars.
3. Costs for land or easements are not included.

OPINION OF PROBABLE PROJECT COST

Client City of Glendale
Project Phase III Demonstration Testing for Cr(VI) Treatment
Item 2000-gpm RCF System (Granular Media Filter Without Recycle)

Project No. 05337008.0000		
By T.D. & Y.W.	Ckd: Y.W. & T.V.	Updated: Y.W.
Date 12/9/11	Date: 1/18/12	Date: 12/31/12

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
Equipment					
FeSO ₄ Feed System					
Storage Tank	1	EA	\$ 6,000	\$ 6,000	Quotes from Core-Rosion & Ryan Herco; 2,000 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars
Metering Pumps	2	EA	\$ 6,200	\$ 12,400	Quotes from C.P. Crowley & HTP; 5 gph; adjusted to 2012 dollars
Static Mixers	1	EA	\$ 4,300	\$ 4,300	Quotes from Komax & EWS; 14-inch; adjusted to 2012 dollars
Reduction Tanks					
Mixers	3	EA	\$ 24,000	\$ 72,000	Quotes from Core-Rosion & EWS; G = 60 per second; adjusted to 2012 dollars
Aeration System					
Diffuser	1	LS	\$ 8,200	\$ 8,200	Based on previous project experience and conversation w/ Brian Bubela; adjusted to 2012 dollars
Supply Blowers	2	EA	\$ 76,300	\$ 152,600	Quote from EWS; 1,070 SCFM @ 7 psi; 1 duty/ 1 stdby; incl. accessories; adjusted to 2012 dollars
Exhaust Blowers	2	EA	\$ 59,600	\$ 119,200	Quote from EWS; 1,070 SCFM @ 2 psi; 1 duty/ 1 stdby; incl. accessories; adjusted to 2012 dollars
Off-Gas Treatment	1	LS	\$ 25,800	\$ 25,800	Quotes from Calgon & TIGG; 1070 SCFM; (2) adsorbers in series with one heater; adjusted to 2012 dollars
Polymer Mixing Tanks					
Mixers	1	EA	\$ 17,300	\$ 17,300	Quotes from Core-Rosion & EWS; G = 170 per second; adjusted to 2012 dollars
Filters					
Filter Equipment (Pressure Filters)	1	LS	\$ 1,004,000	\$ 1,004,000	Quotes from Tonka & Layne, including media; 3 gpm/sf; Tonka filters, (2) 10' x 42', 4 cells per filter, 3 duty / 1 stdby; Layne filters, (4) 10' x 24', 3 duty/ 1 stdby; adjusted to 2012 dollars
Filter Drawdown Transfer Pump	2	EA	\$ 5,100	\$ 10,200	Quotes from ITT and Cortech; 150 gpm @ 70 ft; 1 duty/ 1 stdby; adjusted to 2012 dollars
Pumps					
Filter Feed Pumps (Progressive Cavity)	3	EA	\$ 56,000	\$ 168,000	Quotes from Cortech & Flow-Systems; 1,000 gpm @ 70 ft; 2 duty/ 1 stdby; adjusted to 2012 dollars
Polymer Feed Systems					
Polymer Feed Systems (Coagulant Aid)	1	LS	\$ 10,700	\$ 10,700	Quotes from Siemens & C.P. Crowley; adjusted to 2012 dollars
Polymer Feed Systems (Solids Settling Aid)	0	LS	\$ 11,600	\$ -	Quotes from Siemens & C.P. Crowley; adjusted to 2012 dollars
Filter Backwash					
Filtrate Tank for Backwash	1	EA	\$ 51,000	\$ 51,000	Quotes from Superior; 30,250 gal; 18 ft dia x 16 ft height; adjusted to 2012 dollars
Backwash Pumps	2	EA	\$ 21,900	\$ 43,800	Quotes from ITT & Cortech; 1,450 gpm @ 50 ft; 1 duty/ 1stdby; adjusted to 2012 dollars
Backwash Waste Storage Tank	1	EA	\$ 168,000	\$ 168,000	Based on previous quotes for various tank sizes, estimated for 286,000 gal, adjusted to 2012 dollars
Sewer Discharge Pumps	2	EA	\$ 5,000	\$ 10,000	Quote based upon 175 gpm Hydromatic Submergible pump, 1 duty/ 1 stdby
Subtotal				\$ 1,884,000	Rounded up to \$1000
Equipment Installation Cost (30% of Equipment)	30%			\$ 566,000	Including tax, freight, installation and manufacturer services.
Reduction Tanks					25 ft x 75 ft tank, including 3 sub-tanks with shared walls
Slab	140	CY	\$ 714	\$ 99,960	Based on 2 ft slab or wall; \$700/CY; adjusted to 2012 dollars.
Walls	155	CY	\$ 816	\$ 126,480	Based on 2 ft slab or wall; and 2 ft freeboard; \$800/CY; adjusted to 2012 dollars
Elevated Slab	140	CY	\$ 1,122	\$ 157,080	Based on 2 ft slab or wall; \$1100/CY; adjusted to 2012 dollars.

OPINION OF PROBABLE PROJECT COST

Client City of Glendale
Project Phase III Demonstration Testing for Cr(VI) Treatment
Item 2000-gpm RCF System (Granular Media Filter Without Recycle)

Project No. 05337008.0000		
By T.D. & Y.W.	Ckd: Y.W. & T.V.	Updated: Y.W.
Date 12/9/11	Date: 1/18/12	Date: 12/31/12

Aeration Tanks					15 ft x 15 ft tank
Slab	17	CY	\$ 714	\$ 12,138	Based on 2 ft slab or wall; \$700/CY; adjusted to 2012 dollars.
Walls	35	CY	\$ 816	\$ 28,560	Based on 2 ft slab or wall; and 2 ft freeboard; \$800/CY; adjusted to 2012 dollars
Elevated Slab	17	CY	\$ 1,122	\$ 19,074	Based on 2 ft slab or wall; \$1100/CY; adjusted to 2012 dollars.
Rapid Mixing Tanks					15 ft x 15 ft tank
Slab	17	CY	\$ 714	\$ 12,138	Based on 2 ft slab or wall; \$700/CY; adjusted to 2012 dollars.
Walls	35	CY	\$ 816	\$ 28,560	Based on 2 ft slab or wall; and 2 ft freeboard; \$800/CY; adjusted to 2012 dollars
Elevated Slab	17	CY	\$ 1,122	\$ 19,074	Based on 2 ft slab or wall; \$1100/CY; adjusted to 2012 dollars.
Chemical Storage Containment	16	CY	\$ 1,275	\$ 20,400	\$1250/CY, adjusted to 2012 dollars
Equipment Concrete Pads	223	CY	\$ 1,275	\$ 284,325	\$1250/CY, adjusted to 2012 dollars
Subtotal (Installed Equipment Costs)				\$ 3,258,000	Rounded up to \$1000
General Requirements	7.5%			\$ 244,350	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 162,900	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 162,900	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 489,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 489,000	PLC and SCADA equipment to control
Total Direct Costs				\$ 4,806,000	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 961,200	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
Construction Total				\$ 5,767,200	
Project Level Allowance (contingency)	20%			\$ 1,153,440	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%			\$ 1,153,440	Includes permits, legal fees and engineering fees for design and construction
Project Total				\$ 8,075,000	
Low Estimate				\$ 5,653,000	-30%
High Estimate				\$ 12,113,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2012 dollars.
3. Costs for land or easements are not included.

Estimated RCF Water Quality Monitoring, Granular Media Filter Without Recycle (Number of Samples per Month)

Flow Rate (gpm) 100
 Number of Duty Filters 1

Sample Location	Lab									Field					
	Total Fe	Cr(VI)	Total Cr	TSS	Silica	VOCs	Bac-T (E. Coli, T. Coli and HPC)	TCLP (Metals)	CA WET (Metals)	Cr(VI)*	Ferrous	Total Fe	Turbidity	pH	Temperature
Raw	1	4	4			1				4	1	1	1	4	4
After ferrous addition											4	4		continuous	continuous
After 1st reduction tank											4	4			4
After 2nd reduction tank											1	1			4
After 3rd reduction tank		4					1				4	4			4
Aeration off gas (raw)							1								
Aeration off gas (after first VPGAC)							1								
Aeration off gas (after 2nd VPGAC)							1								
Filter feed (after rapid mixing)				4			1								4
Filter effluent	4	4	4							4	4	4	continuous		1
Spent filter backwash	1	1	1	1											
Supernatant from thickener															
Thickened sludge															
Filtrate from dewatering container															
Dewatered solid residuals															
Number of samples per month^	6	13	9	5		1	5	0	0	0	8	18	18	1	21
Unit cost (\$/sample)	\$ 14	\$ 54	\$ 14	\$ 15	\$ 14	\$ 112	\$ 59	\$ 245	\$ 429						
Sample analysis Cost (\$/year)	\$ 991	\$ 8,354	\$ 1,487	\$ 918	\$ 165	\$ 6,732	\$ -	\$ -	\$ -						
Shipping fee (\$/year)	\$ 1,560	One shipment per week, \$30 per shipment													
Sum of lab analysis cost (\$/year)	\$ 20,208	Sample analysis plus shipping fee													
Field meters	\$ 6,000	Hach Dr 3800, portable pH meter and turbidity meter													
Field analysis cost	\$ 2,000	Estimate for reagents and apparatus based on experience; not including labor for field analysis													
Total analysis cost	\$ 22,208	Including lab and field analysis costs; not including labor and field meters													

* Only if influent Cr(VI) is greater than 10 ppb, which is the method detection limit for field analysis (Hach Method).

Continuous monitoring indicates analyzed by online meter(s).

^ Assume TCLP and CA WET residuals analysis occur once a month, which is a conservative estimate.

TSS - total suspended solids; VOCs - volatile organic compounds; TCLP - toxicity characteristic leaching procedure; CA WET - California waste extraction test; VPGAC - vapor phase granular activated carbon

Costs are adjusted to 2012 dollars.

Estimated RCF Water Quality Monitoring, Granular Media Filter Without Recycle (Number of Samples per Month)

Flow Rate (gpm) 500
 Number of Duty Filter Cells 3

Sample Location	Lab									Field					
	Total Fe	Cr(VI)	Total Cr	TSS	Silica	VOCs	Bac-T (E. Coli, T. Coli and HPC)	TCLP (Metals)	CA WET (Metals)	Cr(VI)*	Ferrous	Total Fe	Turbidity	pH	Temperature
Raw	1	4	4			1				4	1	1	1	4	4
After ferrous addition											4	4		continuous	continuous
After 1st reduction tank											4	4			4
After 2nd reduction tank											1	1			4
After 3rd reduction tank		4					1				4	4			4
Aeration off gas (raw)							1								
Aeration off gas (after first VPGAC)							1								
Aeration off gas (after 2nd VPGAC)							1								
Filter feed (after rapid mixing)				4			1								4
Filter effluent from each cell	4	4	4							4	4	4	continuous		1
Spent filter backwash	1	1	1	1											
Supernatant from thickener															
Thickened sludge															
Filtrate from dewatering container															
Dewatered solid residuals															
Number of samples per month^	14	21	17	5		1	5	0	0	0	16	26	26	1	23
Unit cost (\$/sample)	\$ 14	\$ 54	\$ 14	\$ 15	\$ 14	\$ 112	\$ 59	\$ 245	\$ 429						
Sample analysis Cost (\$/year)	\$ 2,313	\$ 13,495	\$ 2,809	\$ 918	\$ 165	\$ 6,732	\$ -	\$ -	\$ -						
Shipping fee (\$/year)	\$ 1,560	One shipment per week, \$30 per shipment													
Sum of lab analysis cost (\$/year)	\$ 27,992	Sample analysis plus shipping fee													
Field meters	\$ 6,000	Hach Dr 3800, portable pH meter and turbidity meter													
Field analysis cost	\$ 3,000	Estimate for reagents and apparatus based on experience; not including labor for field analysis													
Total analysis cost	\$ 30,992	Including lab and field analysis costs; not including labor and field meters													

* Only if influent Cr(VI) is greater than 10 ppb, which is the method detection limit for field analysis (Hach Method).

Continuous monitoring indicates analyzed by online meter(s).

^ Assume TCLP and CA WET residuals analysis occur three times every two months, which is a conservative estimate.

TSS - total suspended solids; VOCs - volatile organic compounds; TCLP - toxicity characteristic leaching procedure; CA WET - California waste extraction test; VPGAC - vapor phase granular activated carbon

Costs are adjusted to 2012 dollars.

Estimated RCF Water Quality Monitoring, Granular Media Filter Without Recycle (Number of Samples per Month)

Flow Rate (gpm) 2,000
 Number of Duty Filter Cells 9

Sample Location	Lab									Field					
	Total Fe	Cr(VI)	Total Cr	TSS	Silica	VOCs	Bac-T (E. Coli, T. Coli and HPC)	TCLP (Metals)	CA WET (Metals)	Cr(VI)*	Ferrous	Total Fe	Turbidity	pH	Temperature
Raw	1	4	4			1				4	1	1	1	4	4
After ferrous addition											4	4		continuous	continuous
After 1st reduction tank											4	4			4
After 2nd reduction tank											1	1			4
After 3rd reduction tank		4					1				4	4			4
Aeration off gas (raw)							1								
Aeration off gas (after first VPGAC)							1								
Aeration off gas (after 2nd VPGAC)							1								
Filter feed (after rapid mixing)				4			1								4
Filter effluent from each cell	4	4	4							4	4	4	continuous		1
Spent filter backwash	1	1	1	1											
Supernatant from thickener															
Thickened sludge															
Filtrate from dewatering container															
Dewatered solid residuals															
Number of samples per month^	38	45	41	5		1	5	0	0	0	40	50	50	1	29
Unit cost (\$/sample)	\$ 14	\$ 54	\$ 14	\$ 15	\$ 14	\$ 112	\$ 59	\$ 245	\$ 429						
Sample analysis Cost (\$/year)	\$ 6,279	\$ 28,917	\$ 6,775	\$ 918	\$ 165	\$ 6,732	\$ -	\$ -	\$ -						
Shipping fee (\$/year)	\$ 1,560	One shipment per week, \$30 per shipment													
Sum of lab analysis cost (\$/year)	\$ 51,346	Sample analysis plus shipping fee													
Field meters	\$ 6,000	Hach Dr 3800, portable pH meter and turbidity meter													
Field analysis cost	\$ 5,000	Estimate for reagents and apparatus based on experience; not including labor for field analysis													
Total analysis cost	\$ 56,346	Including lab and field analysis costs; not including labor and field meters													

* Only if influent Cr(VI) is greater than 10 ppb, which is the method detection limit for field analysis (Hach Method).

Continuous monitoring indicates analyzed by online meter(s).

^ Assume TCLP and CA WET residuals analysis occur twice every two months, which is a conservative estimate.

TSS - total suspended solids; VOCs - volatile organic compounds; TCLP - toxicity characteristic leaching procedure; CA WET - California waste extraction test; VPGAC - vapor phase granular activated carbon

Costs are adjusted to 2012 dollars.

Estimated RCF O&M Costs (Granular Media Filters Without Recycle)

RCF System Size = 100 gpm

Influent Cr(VI) Concentration (ppb)	Wastewater Disposal	Chemicals	Labor	VPGAC Replacement	Filter Media Replacement	Maintenance and Spare Parts	Electricity*	Lab and Field Analysis &	Annual O&M
5	\$ 10,100	\$ 3,300	\$ 106,000	\$ 1,200	\$ 600	\$ 8,700	\$ 37,400	\$ 22,200	\$ 190,000
10	\$ 10,100	\$ 3,900	\$ 106,000	\$ 1,200	\$ 600	\$ 8,700	\$ 37,400	\$ 22,200	\$ 190,000
25	\$ 10,100	\$ 5,000	\$ 106,000	\$ 1,200	\$ 600	\$ 8,700	\$ 37,400	\$ 22,200	\$ 191,000
50	\$ 10,100	\$ 7,800	\$ 106,000	\$ 1,200	\$ 600	\$ 8,700	\$ 37,400	\$ 22,200	\$ 194,000

* Electricity includes approximately \$200 per year for aeration off-gas treatment.

& Lab and field analysis includes approximately \$4,000 per year for aeration off-gas analysis.

Costs are in 2012 dollars.

RCF System Size = 500 gpm

Influent Cr(VI) Concentration (ppb)	Wastewater Disposal	Chemicals	Labor	VPGAC Replacement	Filter Media Replacement	Maintenance and Spare Parts	Electricity*	Lab and Field Analysis &	Annual O&M
5	\$ 35,900	\$ 8,200	\$ 187,000	\$ 22,000	\$ 2,600	\$ 14,700	\$ 100,800	\$ 31,000	\$ 402,000
10	\$ 35,900	\$ 12,300	\$ 187,000	\$ 22,000	\$ 2,600	\$ 14,700	\$ 100,800	\$ 31,000	\$ 406,000
25	\$ 35,900	\$ 17,800	\$ 187,000	\$ 22,000	\$ 2,600	\$ 14,700	\$ 100,800	\$ 31,000	\$ 412,000
50	\$ 35,900	\$ 31,600	\$ 187,000	\$ 22,000	\$ 2,600	\$ 14,700	\$ 100,800	\$ 31,000	\$ 426,000

* Electricity includes approximately \$700 for aeration off-gas treatment.

& Lab and field analysis includes approximately \$4,000 per year for aeration off-gas analysis.

Costs are in 2012 dollars.

RCF System Size = 2,000 gpm

Influent Cr(VI) Concentration (ppb)	Wastewater Disposal	Chemicals	Labor	VPGAC Replacement	Filter Media Replacement	Maintenance and Spare Parts	Electricity*	Lab and Field Analysis &	Annual O&M
5	\$ 132,700	\$ 27,200	\$ 293,000	\$ 61,200	\$ 6,200	\$ 32,600	\$ 179,000	\$ 56,300	\$ 788,000
10	\$ 132,700	\$ 43,800	\$ 293,000	\$ 61,200	\$ 6,200	\$ 32,600	\$ 179,000	\$ 56,300	\$ 805,000
25	\$ 132,700	\$ 65,800	\$ 293,000	\$ 61,200	\$ 6,200	\$ 32,600	\$ 179,000	\$ 56,300	\$ 827,000
50	\$ 132,700	\$ 120,900	\$ 293,000	\$ 61,200	\$ 6,200	\$ 32,600	\$ 179,000	\$ 56,300	\$ 882,000

* Electricity includes approximately \$2,800 for aeration off-gas treatment.

& Lab and field analysis includes approximately \$4,000 per year for aeration off-gas analysis.

Costs are in 2012 dollars.

Annual O&M Summary

RCF System Size (gpm)	Influent Cr(VI) Concentration, ppb			
	5	10	25	50
100	\$ 190,000	\$ 190,000	\$ 191,000	\$ 194,000
500	\$ 402,000	\$ 406,000	\$ 412,000	\$ 426,000
2,000	\$ 788,000	\$ 805,000	\$ 827,000	\$ 882,000

Costs are in 2012 dollars.

Net Present Value for 20 Years (Rounded to two significant figures)

RCF System Size (gpm)	Influent Cr(VI) Concentration, ppb			
	5	10	25	50
100	\$ 3,200,000	\$ 3,200,000	\$ 3,200,000	\$ 3,200,000
500	\$ 6,700,000	\$ 6,800,000	\$ 6,900,000	\$ 7,000,000
2,000	\$ 13,000,000	\$ 13,000,000	\$ 14,000,000	\$ 15,000,000

20-year NPV O&M based on 2.5% inflation and a 4.5% discount rate

Costs are in 2012 dollars.

OPINION OF PROBABLE PROJECT COST

Client	City of Glendale
Project	Phase IIIA Microfiltration Pilot testing in RCF for Cr(VI) Treatment
Item	100-gpm RCF with MF System (Vacuum MF)

Project No. 20002.001
By B.P & Y.W. Ckd: Y.W. & N.B.
Date 12/31/12 Date: 1/11/13

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
Equipment					
FeSO ₄ Feed System					
Storage Tank	1	EA	\$ 2,700	\$ 2,700	Quotes from Ryan Herco & Core-Rosion; 100 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars.
Metering Pumps	2	EA	\$ 3,100	\$ 6,200	Quotes from C.P. Crowley & HTP; 0.25 gph; 1 duty/ 1 stdby; adjusted to 2012 dollars.
Static Mixers	1	EA	\$ 900	\$ 900	Quotes from Komax & EWS; 3-inch; adjusted to 2012 dollars.
Reduction Tanks					
Tanks	3	EA	\$ 5,200	\$ 15,600	Quotes from Core-Rosion & Ryan Herco; 1,700 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars.
Mixers	3	EA	\$ 4,800	\$ 14,400	Quotes from Core-Rosion & EWS; G = 60 per second; adjusted to 2012 dollars.
Aeration System					
Tank	1	EA	\$ 3,700	\$ 3,700	Quotes from Core-Rosion & Ryan Herco; 700 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars.
Diffusers	1	LS	\$ 400	\$ 400	Based on previous project experience
Supply Blowers	2	EA	\$ 30,900	\$ 61,800	Quote from EWS; 53 SCFM @ 4 psi; 1 duty/ 1 stdby; incl. accessories; adjusted to 2012 dollars.
Exhaust Blowers	2	EA	\$ 35,600	\$ 71,200	Quote from EWS; 53 SCFM @ 2 psi; 1 duty/ 1 stdby; incl. accessories; adjusted to 2012 dollars.
Off-Gas Treatment	1	LS	\$ 4,100	\$ 4,100	Cost from Glendale and quotes from TIGG; 54 SCFM; (2) adsorbers in series with one heater; adjusted to 2012 dollars.
NaOCl Feed System					
Storage Tank	1	LS	\$ 600	\$ 600	Quote from Polyprocessing; 55 gal, HDPE, outdoor, incl. seismic
Metering Pumps	2	EA	\$ 4,700	\$ 9,400	Quote from Prominent; 0.06 gph, 1 duty/ 1 stdby
Static Mixers	1	EA	\$ 900	\$ 900	Quotes from Komax & EWS; 3-inch; adjusted to 2012 dollars.
MF System					
MF Equipment Provided by GE/Zenon	1	LS	\$ 272,000	\$ 272,000	Quote from GE/Zenon.
Equalization Tank	1	EA	\$ 2,000	\$ 2,000	Quote from Polyprocessing; 545 gal, HDPE, outdoor, inc. seismic
Backwash Waste Storage Tank	1	EA	\$ 5,000	\$ 5,000	Quote from Polyprocessing; 1250 gal, HDPE, outdoor, incl. seismic
NaOCl Clean Waste Storage Tank	1	EA	\$ 7,000	\$ 7,000	Quote from Plas-Tanks; 800 gal, FRP, outdoor, incl. seismic
Acid Clean Waste Storage Tank	1	EA	\$ 7,000	\$ 7,000	Quote from Plas-Tanks; 800 gal, FRP, outdoor, incl. seismic
Backwash Waste Sewer Discharge Pumps	2	EA	\$ 5,000	\$ 10,000	Quote based Upon 175 gpm Hydromatic Submersible Pump, 1 duty/ 1 stdby
NaOCl Waste Sewer Discharge Pumps	2	EA	\$ 6,000	\$ 12,000	Quote based Upon 175 gpm Hydromatic Submersible Pump, 25% added for chemical resistance, 1 duty/ 1 stdby
Acid Waste Sewer Discharge Pumps	2	EA	\$ 6,000	\$ 12,000	Quote based Upon 175 gpm Hydromatic Submersible Pump, 25% added for chemical resistance, 1 duty/ 1 stdby
Subtotal				\$ 519,000	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 156,000	Including tax, freight, installation and manufacturer services.
Chemical Storage Containment	3	CY	\$ 1,275	\$ 3,953	\$1,250/CY. Adjusted to 2012 dollars.
Equipment Concrete Pads	18	CY	\$ 1,275	\$ 22,950	\$1,250/CY. Adjusted to 2012 dollars.
MF Building	320	SF	\$ 250	\$ 80,000	Previous project experience, adjusted to 2012 dollars.
Subtotal (Installed Equipment Costs)				\$ 782,000	Rounded up to \$1000
General Requirements	7.5%			\$ 58,650	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 39,100	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 39,100	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 118,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 118,000	PLC and SCADA equipment to control
Total Direct Costs				\$ 1,155,000	Rounded up to \$1000

OPINION OF PROBABLE PROJECT COST

Client	City of Glendale
Project	Phase IIIA Microfiltration Pilot testing in RCF for Cr(VI) Treatment
Item	100-gpm RCF with MF System (Vacuum MF)

Project No. 20002.001	
By B.P. & Y.W.	Ckd: Y.W. & N.B.
Date 12/31/12	Date: 1/11/13

Contractor's Overhead and Profit	20%			\$ 231,000	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
Construction Total				\$ 1,386,000	Rounded up to \$1000
Project Level Allowance (contingency)	20%			\$ 277,200	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%			\$ 277,200	Includes permits, legal fees and engineering fees for design and construction
Project Total				\$ 1,941,000	
Low Estimate				\$ 1,359,000	-30%
High Estimate				\$ 2,912,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2012 dollars.
3. Costs for land or easements are not included.

OPINION OF PROBABLE PROJECT COST

Client	City of Glendale
Project	Phase IIIA Microfiltration Pilot testing in RCF for Cr(VI) Treatment
Item	500-gpm RCF with MF System (Vacuum MF)

Project No. 20002.001	
By B.P. & Y.W.	Ckd: Y.W. & N.B.
Date 12/31/12	Date: 1/11/13

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
Equipment					
FeSO ₄ Feed System					
Storage Tank	1	EA	\$ 3,400	\$ 3,400	Quotes from Core-Rosion & Ryan Herco; 500 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars.
Metering Pumps	2	EA	\$ 3,100	\$ 6,200	Quotes from C.P. Crowley & HTP; 1.3 gph; 1 duty/ 1 stdby; adjusted to 2012 dollars.
Static Mixers	1	EA	\$ 2,200	\$ 2,200	Quotes from Komax & EWS; 8-inch; adjusted to 2012 dollars.
Reduction Tanks					
Tanks	3	EA	\$ 20,000	\$ 60,000	Quotes from Core-Rosion & Ryan Herco; 8,000 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars.
Mixers	3	EA	\$ 9,000	\$ 27,000	Quotes from Core-Rosion & EWS; G = 60 per second; adjusted to 2012 dollars.
Aeration System					
Tanks	1	EA	\$ 6,400	\$ 6,400	Quotes from Core-Rosion & Ryan Herco; 3000 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars.
Diffusers	1	LS	\$ 2,000	\$ 2,000	Based on previous project experience
Supply Blowers	2	EA	\$ 47,200	\$ 94,400	Quote from EWS; 267 SCFM @ 7 psi; 1 duty/ 1 stdby; incl. accessories; adjusted to 2012 dollars.
Exhaust Blowers	2	EA	\$ 35,400	\$ 70,800	Quote from EWS; 267 SCFM @ 2 psi; 1 duty/ 1 stdby; incl. accessories; adjusted to 2012 dollars.
Off-Gas Treatment	1	LS	\$ 15,400	\$ 15,400	Quotes from Calgon and TIGG; 270 SCFM; (2) adsorbers in series with one heater; adjusted to 2012 dollars.
NaOCl Feed System					
Storage Tank	1	EA	\$ 1,000	\$ 1,000	Quote from Polyprocessing; 115 gal, material, outdoor, incl. seismic
Metering Pumps	2	EA	\$ 4,700	\$ 9,400	Quote from Prominent; 0.30 gph, 1 duty/ 1 stdby
Static Mixers	1	EA	\$ 2,200	\$ 2,200	Quotes from Komax & EWS; 8-inch; adjusted to 2012 dollars.
MF System					
MF Equipment Provided by GE/Zenon	1	LS	\$ 625,000	\$ 625,000	Quote from GE/Zenon.
Equalization Tank	1	EA	\$ 9,000	\$ 9,000	Quote from Polyprocessing; 3000 gal, HDPE, outdoor, incl. seismic
Backwash Waste Storage Tank	1	EA	\$ 7,000	\$ 7,000	Quote from Polyprocessing; 2000 gal, HDPE, outdoor, incl. seismic
NaOCl Clean Waste Storage Tank	1	EA	\$ 8,000	\$ 8,000	Quote from Plas-Tanks; 1100 gal, FRP, outdoor, incl. seismic
Acid Clean Waste Storage Tank	1	EA	\$ 8,000	\$ 8,000	Quote from Plas-Tanks; 1100 gal, FRP, outdoor, incl. seismic
Backwash Waste Sewer Discharge Pumps	2	EA	\$ 5,000	\$ 10,000	Quote based Upon 175 gpm Hydromatic Submersible Pump, 1 duty/ 1 stdby
NaOCl Waste Sewer Discharge Pumps	2	EA	\$ 6,000	\$ 12,000	Quote based Upon 175 gpm Hydromatic Submersible Pump, 25% added for chemical resistance, 1 duty/ 1 stdby
Acid Waste Sewer Discharge Pumps	2	EA	\$ 6,000	\$ 12,000	Quote based Upon 175 gpm Hydromatic Submersible Pump, 25% added for chemical resistance, 1 duty/ 1 stdby
Subtotal				\$ 992,000	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 298,000	Including tax, freight, installation and manufacturer services.
Chemical Storage Containment	7	CY	\$ 1,275	\$ 9,180	\$1,250/CY. Adjusted to 2012 dollars.
Equipment Concrete Pads	33	CY	\$ 1,275	\$ 42,075	\$1,250/CY. Adjusted to 2012 dollars.
MF Building	1,000	SF	\$ 250	\$ 250,000	Previous project experience, adjusted to 2012 dollars.
Subtotal (Installed Equipment Costs)				\$ 1,592,000	Rounded up to \$1000
General Requirements	7.5%			\$ 119,400	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 79,600	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 79,600	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 239,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 239,000	PLC and SCADA equipment to control
Total Direct Costs				\$ 2,349,000	Rounded up to \$1000

OPINION OF PROBABLE PROJECT COST

Client	City of Glendale
Project	Phase IIIA Microfiltration Pilot testing in RCF for Cr(VI) Treatment
Item	500-gpm RCF with MF System (Vacuum MF)

Project No. 20002.001	
By B.P. & Y.W.	Ckd: Y.W. & N.B.
Date 12/31/12	Date: 1/11/13

Contractor's Overhead and Profit	20%		\$	469,800	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
Construction Total			\$	2,819,000	Rounded up to \$1000
Project Level Allowance (contingency)	20%		\$	563,800	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%		\$	563,800	Includes permits, legal fees and engineering fees for design and construction
Project Total			\$	3,947,000	
Low Estimate			\$	2,763,000	-30%
High Estimate			\$	5,921,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2012 dollars.
3. Costs for land or easements are not included.

OPINION OF PROBABLE PROJECT COST

Client	City of Glendale
Project	Phase IIIA Microfiltration Pilot testing in RCF for Cr(VI) Treatment
Item	2,000-gpm RCF with MF System (Vacuum MF)

Project No. 20002.001	
By B.P & Y.W.	Ckd: Y.W. & N.B.
Date 12/31/12	Date: 1/11/13

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
Equipment					
FeSO₄ Feed System					
Storage Tank	1	EA	\$ 6,000	\$ 6,000	Quotes from Core-Rosion & Ryan Herco; 2,000 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars.
Metering Pumps	2	EA	\$ 6,200	\$ 12,400	Quotes from C.P. Crowley & HTP; 5 gph; adjusted to 2012 dollars.
Static Mixers	1	EA	\$ 4,300	\$ 4,300	Quotes from Komax & EWS; 14-inch; adjusted to 2012 dollars.
Reduction Tanks					
Mixers	3	EA	\$ 24,000	\$ 72,000	Quotes from Core-Rosion & EWS; G = 60 per second; adjusted to 2012 dollars.
Aeration System					
Diffuser	1	LS	\$ 8,200	\$ 8,200	Based on previous project experience and conversation w/ Brian Bubela; adjusted to 2012 dollars.
Supply Blowers	2	EA	\$ 76,300	\$ 152,600	Quote from EWS; 1,070 SCFM @ 7 psi; 1 duty/ 1 stdby; incl. accessories; adjusted to 2012 dollars.
Exhaust Blowers	2	EA	\$ 59,600	\$ 119,200	Quote from EWS; 1,070 SCFM @ 2 psi; 1 duty/ 1 stdby; incl. accessories; adjusted to 2012 dollars.
Off-Gas Treatment	1	LS	\$ 25,800	\$ 25,800	Quotes from Calgon & TIGG; 1070 SCFM; (2) adsorbers in series with one heater; adjusted to 2012 dollars.
NaOCl Feed System					
Storage Tank	1	LS	\$ 2,300	\$ 2,300	Quote from Polyprocessing; 475 gal, HDPE, outdoor, incl. seismic
Metering Pumps	2	EA	\$ 4,700	\$ 9,400	Quote from Prominent; 1.22 gph, 1 duty/ 1 stdby
Static Mixers	1	EA	\$ 4,300	\$ 4,300	Quotes from Komax & EWS; 14-inch; adjusted to 2012 dollars.
MF System					
MF Equipment Provided by GE/Zenon	1	LS	\$ 1,202,500	\$ 1,202,500	Quote from GE/Zenon.
Equalization Tank	1	EA	\$ 23,000	\$ 23,000	Quote from Polyprocessing; 10300 gal, HDPE, outdoor, incl. seismic
Backwash Waste Storage Tank	1	EA	\$ 16,000	\$ 16,000	Quote from Polyprocessing; 5050 gal, HDPE, outdoor, incl. seismic
NaOCl Clean Waste Storage Tank	1	EA	\$ 12,000	\$ 12,000	Quote from Plas-Tanks; 3500 gal, FRP, outdoor, incl. seismic
Acid Clean Waste Storage Tank	1	EA	\$ 12,000	\$ 12,000	Quote from Plas-Tanks; 3500 gal, FRP, outdoor, incl. seismic
Backwash Waste Sewer Discharge Pumps	2	EA	\$ 5,000	\$ 10,000	Quote based Upon 175 gpm Hydromatic Submersible Pump, 1 duty/ 1 stdby
NaOCl Waste Sewer Discharge Pumps	2	EA	\$ 6,000	\$ 12,000	Quote based Upon 175 gpm Hydromatic Submersible Pump, 25% added for chemical resistance, 1 duty/ 1 stdby
Acid Waste Sewer Discharge Pumps	2	EA	\$ 6,000	\$ 12,000	Quote based Upon 175 gpm Hydromatic Submersible Pump, 25% added for chemical resistance, 1 duty/ 1 stdby
Subtotal				\$ 1,716,000	Rounded up to \$1000
Equipment Installation Cost (30% of Equipment)	30%			\$ 515,000	Including tax, freight, installation and manufacturer services.
Reduction Tanks					
Slab	140	CY	\$ 714	\$ 99,960	25 ft x 75 ft tank, including 3 sub-tanks with shared walls Based on 2 ft slab or wall; \$700/CY, adjusted to 2012 dollars.
Walls	155	CY	\$ 816	\$ 126,480	Based on 2 ft slab or wall; and 2 ft freeboard; \$800/CY, adjusted to 2012 dollars.
Elevated Slab	140	CY	\$ 1,122	\$ 157,080	Based on 2 ft slab or wall; \$1,100/CY, adjusted to 2012 dollars.
Aeration Tanks					
Slab	17	CY	\$ 714	\$ 12,138	15 ft x 15 ft tank Based on 2 ft slab or wall; \$700/CY, adjusted to 2012 dollars.
Walls	35	CY	\$ 816	\$ 28,560	Based on 2 ft slab or wall; and 2 ft freeboard; \$800/CY, adjusted to 2012 dollars.
Elevated Slab	17	CY	\$ 1,122	\$ 19,074	Based on 2 ft slab or wall; \$1,100/CY, adjusted to 2012 dollars.
Rapid Mixing Tanks					
Slab	17	CY	\$ 714	\$ 12,138	15 ft x 15 ft tank Based on 2 ft slab or wall; \$700/CY, adjusted to 2012 dollars.
Walls	35	CY	\$ 816	\$ 28,560	Based on 2 ft slab or wall; and 2 ft freeboard; \$800/CY, adjusted to 2012 dollars.
Elevated Slab	17	CY	\$ 1,122	\$ 19,074	Based on 2 ft slab or wall; \$1,100/CY, adjusted to 2012 dollars.
Chemical Storage Containment	19	CY	\$ 1,275	\$ 23,715	\$1,250/CY. Adjusted to 2012 dollars.
Equipment Concrete Pads	23	CY	\$ 1,275	\$ 29,325	\$1,250/CY. Adjusted to 2012 dollars.
MF Building	1,900	SF	\$ 250	\$ 475,000	Previous project experience, adjusted to 2012 dollars.

OPINION OF PROBABLE PROJECT COST

Client	City of Glendale
Project	Phase IIIA Microfiltration Pilot testing in RCF for Cr(VI) Treatment
Item	2,000-gpm RCF with MF System (Vacuum MF)

Project No. 20002.001	
By B.P & Y.W.	Ckd: Y.W. & N.B.
Date 12/31/12	Date: 1/11/13

Subtotal (Installed Equipment Costs)			\$ 3,263,000	Rounded up to \$1000
General Requirements	7.5%		\$ 244,725	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%		\$ 163,150	Excavation, backfill, and fill required to construct project
Site Improvements	5%		\$ 163,150	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%		\$ 490,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%		\$ 490,000	PLC and SCADA equipment to control
Total Direct Costs			\$ 4,814,000	Rounded up to \$1000
Contractor's Overhead and Profit	20%		\$ 962,800	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
Construction Total			\$ 5,776,800	
Project Level Allowance (contingency)	20%		\$ 1,155,360	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%		\$ 1,155,360	Includes permits, legal fees and engineering fees for design and construction
Project Total			\$ 8,088,000	
Low Estimate			\$ 5,662,000	-30%
High Estimate			\$ 12,132,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2012 dollars.
3. Costs for land or easements are not included.

Estimated RCF with Vacuum MF Water Quality Monitoring (Number of Samples per Month)

Flow Rate (gpm) 100

Number of MF Trains 1

Sample Location	Lab									Field					
	Total Fe	Cr(VI) & Total Cr	Alkalinity	Hardness	TSS	Silica	VOCs	DBPs	Bac-T (E. Coli, T. Coli and HPC)	Cr(VI)*	Ferrous	Total Fe	Turbidity	Free Chlorine	pH & Temperature
Raw	1	4	1	1		1				4	1	1	1		4
After ferrous addition											4	4			continuous
After 1st reduction tank											4	4			4
After 2nd reduction tank											1	1			4
After 3rd reduction tank		4						1			4	4			4
Aeration off gas (raw)								1							
Aeration off gas (after first VPGAC)								1							
Aeration off gas (after 2nd VPGAC)								1							
MF feed (after Cl ₂ injection)		4	1	1	4			1			4	4	continuous	continuous	continuous
MF permeate	4	4	1	1	4			1	4	4	4	4	continuous		continuous
MF backwash waste	1	1	1	1	1	1					1	1	4		4
MF maintenance clean waste	1	1	1	1	1	1		1		1	1	1	1	continuous	continuous
MF CIP NaOCl waste	1	1	1	1	1	1		1		1	1	1	1	continuous	continuous
MF CIP acid waste	1	1	1	1	1	1		1		1	1	1	1		continuous
Number of samples per month [^]	9	20	7	7	12	1	5	4	4	11	26	26	8		20
Unit cost (\$/sample)	\$ 14	\$ 67	\$ 15	\$ 15	\$ 15	\$ 14	\$ 112	\$ 150	\$ 59						
Sample analysis Cost (\$/year)	\$ 1,487	\$ 16,157	\$ 1,285	\$ 1,285	\$ 2,203	\$ 165	\$ 6,732	\$ 7,200	\$ 2,815						
Shipping fee (\$/year)	\$ 1,560	One shipment per week, \$30 per shipment													
Sum of lab analysis cost (\$/year)	\$ 40,890	Sample analysis plus shipping fee													
Field meters	\$ 6,000	Hach Dr 3800, portable pH meter and turbidity meter													
Field analysis cost	\$ 2,000	Estimate for reagents and apparatus based on experience; not including labor for field analysis													
Total analysis cost	\$ 42,890	Including lab and field analysis costs; not including labor and field meters													

* Only if influent Cr(VI) is greater than 10 ppb, which is the method detection limit for field analysis (Hach Method).

Continuous monitoring indicates analyzed by online meter(s).

TSS - total suspended solids; VOCs - volatile organic compounds; DBPs - disinfection byproducts; VPGAC - vapor phase granular activated carbon

Unit cost adjusted to 2012 dollars.

Estimated RCF with Vacuum MF Water Quality Monitoring (Number of Samples per Month)

Flow Rate (gpm)

500

Number of MF Trains

3

Sample Location	Lab									Field					
	Total Fe	Cr(VI) & Total Cr	Alkalinity	Hardness	TSS	Silica	VOCs	DBPs	Bac-T (E. Coli, T. Coli and HPC)	Cr(VI)*	Ferrous	Total Fe	Turbidity	Free Chlorine	pH & Temperature
Raw	1	4	1	1		1				4	1	1	1		4
After ferrous addition											4	4			continuous
After 1st reduction tank											4	4			4
After 2nd reduction tank											1	1			4
After 3rd reduction tank		4						1			4	4			4
Aeration off gas (raw)								1							
Aeration off gas (after first VPGAC)								1							
Aeration off gas (after 2nd VPGAC)								1							
MF feed (after Cl ₂ injection)		4	1	1	4			1			4	4	continuous	continuous	continuous
MF permeate (per train)	4	4	1	1	4			1	4	4	4	4	continuous		continuous
MF backwash waste	1	1	1	1	1	1					1	1	4		4
MF maintenance clean waste	1	1	1	1	1	1		1		1	1	1	1	continuous	continuous
MF CIP NaOCl waste	1	1	1	1	1	1		1		1	1	1	1	continuous	continuous
MF CIP acid waste	1	1	1	1	1	1		1		1	1	1	1		continuous
Number of samples per month [^]	17	28	9	9	20	1	5	6	12	19	34	34	8		20
Unit cost (\$/sample)	\$ 14	\$ 67	\$ 15	\$ 15	\$ 15	\$ 14	\$ 112	\$ 150	\$ 59						
Sample analysis Cost (\$/year)	\$ 2,809	\$ 22,620	\$ 1,652	\$ 1,652	\$ 3,672	\$ 165	\$ 6,732	\$ 10,800	\$ 8,446						
Shipping fee (\$/year)	\$ 1,560	One shipment per week, \$30 per shipment													
Sum of lab analysis cost (\$/year)	\$ 60,108	Sample analysis plus shipping fee													
Field meters	\$ 6,000	Hach Dr 3800, portable pH meter and turbidity meter													
Field analysis cost	\$ 3,000	Estimate for reagents and apparatus based on experience; not including labor for field analysis													
Total analysis cost	\$ 63,108	Including lab and field analysis costs; not including labor and field meters													

* Only if influent Cr(VI) is greater than 10 ppb, which is the method detection limit for field analysis (Hach Method).

Continuous monitoring indicates analyzed by online meter(s).

TSS - total suspended solids; VOCs - volatile organic compounds; DBPs - disinfection byproducts; VPGAC - vapor phase granular activated carbon

Unit cost adjusted to 2012 dollars.

Estimated RCF with Vacuum MF Water Quality Monitoring (Number of Samples per Month)

Flow Rate (gpm) 2,000

Number of MF Trains 2

Sample Location	Lab									Field					
	Total Fe	Cr(VI) & Total Cr	Alkalinity	Hardness	TSS	Silica	VOCs	DBPs	Bac-T (E. Coli, T. Coli and HPC)	Cr(VI)*	Ferrous	Total Fe	Turbidity	Free Chlorine	pH & Temperature
Raw	1	4	1	1		1				4	1	1	1		4
After ferrous addition											4	4			continuous
After 1st reduction tank											4	4			4
After 2nd reduction tank											1	1			4
After 3rd reduction tank		4						1			4	4			4
Aeration off gas (raw)								1							
Aeration off gas (after first VPGAC)								1							
Aeration off gas (after 2nd VPGAC)								1							
MF feed (after Cl ₂ injection)		4	1	1	4			1			4	4	continuous	continuous	continuous
MF permeate (per train)	4	4	1	1	4			1	4	4	4	4	continuous		continuous
MF backwash waste	1	1	1	1	1	1					1	1	4		4
MF maintenance clean waste	1	1	1	1	1	1		1		1	1	1	1	continuous	continuous
MF CIP NaOCl waste	1	1	1	1	1	1		1		1	1	1	1	continuous	continuous
MF CIP acid waste	1	1	1	1	1	1		1		1	1	1	1		continuous
Number of samples per month [^]	13	24	8	8	16	1	5	5	8	15	30	30	8		20
Unit cost (\$/sample)	\$ 14	\$ 67	\$ 15	\$ 15	\$ 15	\$ 14	\$ 112	\$ 150	\$ 59						
Sample analysis Cost (\$/year)	\$ 2,148	\$ 19,388	\$ 1,469	\$ 1,469	\$ 2,938	\$ 165	\$ 6,732	\$ 9,000	\$ 5,630						
Shipping fee (\$/year)	\$ 1,560	One shipment per week, \$30 per shipment													
Sum of lab analysis cost (\$/year)	\$ 50,499	Sample analysis plus shipping fee													
Field meters	\$ 6,000	Hach Dr 3800, portable pH meter and turbidity meter													
Field analysis cost	\$ 5,000	Estimate for reagents and apparatus based on experience; not including labor for field analysis													
Total analysis cost	\$ 55,499	Including lab and field analysis costs; not including labor and field meters													

* Only if influent Cr(VI) is greater than 10 ppb, which is the method detection limit for field analysis (Hach Method).
 Continuous monitoring indicates analyzed by online meter(s).
 TSS - total suspended solids; VOCs - volatile organic compounds; DBPs - disinfection byproducts; VPGAC - vapor phase granular activated carbon
 Unit cost adjusted to 2012 dollars.

Estimated RCF with Vacuum MF O&M Costs (in 2012 Dollars)

System Size (gpm)	Pre-Treatment				Vacuum MF System			Maintenance and Spare Parts	Wastewater Discharge	Labor	Lab and Field Analysis ⁵	Annual O&M
	Ferrous Sulfate ¹	Sodium Hypochlorite	VPGAC Replacement	Electricity ²	Membrane Replacement	Chemicals ³	Electricity ⁴					
100	\$ 5,300	\$ 1,000	\$ 1,200	\$ 36,000	\$ 900	\$ 600	\$ 1,000	\$ 19,000	\$ 14,400	\$ 103,000	\$ 42,900	\$ 225,000
500	\$ 23,000	\$ 2,200	\$ 22,000	\$ 96,000	\$ 4,200	\$ 2,200	\$ 4,800	\$ 39,000	\$ 57,400	\$ 187,000	\$ 63,100	\$ 501,000
2,000	\$ 89,000	\$ 7,600	\$ 61,000	\$ 161,000	\$ 13,000	\$ 7,500	\$ 16,800	\$ 81,000	\$ 218,700	\$ 313,000	\$ 55,500	\$ 1,024,000

1. Ferrous sulfate is based on a ferrous dose of 2.0 mg/L as Fe.
2. Electricity includes energy for aeration blowers and aeration off-gas treatment.
3. Chemicals do not include these for Maintenance Cleans for 100 and 500 gpm systems, as they are not expected necessary according to GE/Zenon. For 2000 gpm system, sodium hypochlorite is assumed for Maintenance Cleans.
4. Electricity includes energy process pump(s) and air compressor(s) based on a total dynamic head of 21.9 feet, as provided by GE/Zenon.
5. Lab and field analysis includes approximately \$4,000 per year for aeration off-gas analysis.

Net Present Value for 20 Years (Rounded to two significant figures)

System Size (gpm)	Net Present Value for 20 Years
100	\$ 3,800,000
500	\$ 8,400,000
2,000	\$ 17,000,000

20-year NPV O&M based on 2.5% inflation and a 4.5% discount rate

OPINION OF PROBABLE PROJECT COST

Client	City of Glendale
Project	Phase IIIA Microfiltration Pilot testing in RCF for Cr(VI) Treatment
Item	100-gpm RCF with MF System (Pressure MF)

Project No. 20002.001	
By B.P & Y.W.	Ckd: Y.W. & N.B.
Date 12/31/12	Date: 1/11/13

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
Equipment					
FeSO ₄ Feed System					
Storage Tank	1	EA	\$ 2,700	\$ 2,700	Quotes from Ryan Herco & Core-Rosion; 100 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars.
Metering Pumps	2	EA	\$ 3,100	\$ 6,200	Quotes from C.P. Crowley & HTP; 0.25 gph; 1 duty/ 1 stdb; adjusted to 2012 dollars.
Static Mixers	1	EA	\$ 900	\$ 900	Quotes from Komax & EWS; 3-inch; adjusted to 2012 dollars.
Reduction Tanks					
Tanks	3	EA	\$ 5,200	\$ 15,600	Quotes from Core-Rosion & Ryan Herco; 1,700 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars.
Mixers	3	EA	\$ 4,800	\$ 14,400	Quotes from Core-Rosion & EWS; G = 60 per second; adjusted to 2012 dollars.
Aeration System					
Tank	1	EA	\$ 3,700	\$ 3,700	Quotes from Core-Rosion & Ryan Herco; 700 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars.
Diffusers	1	LS	\$ 400	\$ 400	Based on previous project experience
Supply Blowers	2	EA	\$ 30,900	\$ 61,800	Quote from EWS; 53 SCFM @ 4 psi; 1 duty/ 1 stdb; incl. accessories; adjusted to 2012 dollars.
Exhaust Blowers	2	EA	\$ 35,600	\$ 71,200	Quote from EWS; 53 SCFM @ 2 psi; 1 duty/ 1 stdb; incl. accessories; adjusted to 2012 dollars.
Off-Gas Treatment	1	LS	\$ 4,100	\$ 4,100	Cost from Glendale and quotes from TIGG; 54 SCFM; (2) adsorbers in series with one heater; adjusted to 2012 dollars.
NaOCl Feed System					
Storage Tank	1	LS	\$ 600	\$ 600	Quote from Polyprocessing; 55 gal, HDPE, outdoor, incl. seismic
Metering Pumps	2	EA	\$ 4,700	\$ 9,400	Quote from Prominent; 0.06 gph, 1 duty/ 1 stdb
Static Mixers	1	EA	\$ 900	\$ 900	Quotes from Komax & EWS; 3-inch; adjusted to 2012 dollars.
MF System					
MF Equipment Provided by Pall	1	LS	\$ 371,000	\$ 371,000	Quote from Pall, incl one feed tank and one reverse filtration tank
Backwash Waste Storage Tank	1	EA	\$ 2,000	\$ 2,000	Quote from Polyprocessing; 475 gal, HDPE, outdoor, incl. seismic
NaOCl Clean Waste Storage Tank	1	EA	\$ 7,000	\$ 7,000	Quote from Plas-Tanks; 800 gal, FRP, outdoor, incl. seismic
Acid Clean Waste Storage Tank	1	EA	\$ 7,000	\$ 7,000	Quote from Plas-Tanks; 800 gal, FRP, outdoor, incl. seismic
Backwash Waste Sewer Discharge Pumps	2	EA	\$ 5,000	\$ 10,000	Quote based Upon 175 gpm Hydromatic Submersible Pump, 1 duty/ 1 stdb
NaOCl Waste Sewer Discharge Pumps	2	EA	\$ 6,000	\$ 12,000	Quote based Upon 175 gpm Hydromatic Submersible Pump, 25% added for chemical resistance, 1 duty/ 1 stdb
Acid Waste Sewer Discharge Pumps	2	EA	\$ 6,000	\$ 12,000	Quote based Upon 175 gpm Hydromatic Submersible Pump, 25% added for chemical resistance, 1 duty/ 1 stdb
Subtotal				\$ 613,000	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 184,000	Including tax, freight, installation and manufacturer services.
Chemical Storage Containment	5	CY	\$ 1,275	\$ 6,503	\$1,250/CY. Adjusted to 2012 dollars.
Equipment Concrete Pads	21	CY	\$ 1,275	\$ 26,775	\$1,250/CY. Adjusted to 2012 dollars.
MF Building	320	SF	\$ 250	\$ 80,000	Previous project experience, adjusted to 2012 dollars.
Subtotal (Installed Equipment Costs)				\$ 911,000	Rounded up to \$1000
General Requirements	7.5%			\$ 68,325	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 45,550	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 45,550	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 137,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 137,000	PLC and SCADA equipment to control
Total Direct Costs				\$ 1,344,000	Rounded up to \$1000

OPINION OF PROBABLE PROJECT COST

Client	City of Glendale
Project	Phase IIIA Microfiltration Pilot testing in RCF for Cr(VI) Treatment
Item	100-gpm RCF with MF System (Pressure MF)

Project No. 20002.001	
By B.P. & Y.W.	Ckd: Y.W. & N.B.
Date 12/31/12	Date: 1/11/13

Contractor's Overhead and Profit	20%		\$	268,800	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
Construction Total			\$	1,613,000	Rounded up to \$1000
Project Level Allowance (contingency)	20%		\$	322,600	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%		\$	322,600	Includes permits, legal fees and engineering fees for design and construction
Project Total			\$	2,259,000	
Low Estimate			\$	1,581,000	-30%
High Estimate			\$	3,389,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2012 dollars.
3. Costs for land or easements are not included.

OPINION OF PROBABLE PROJECT COST

Client	City of Glendale
Project	Phase IIIA Microfiltration Pilot testing in RCF for Cr(VI) Treatment
Item	500-gpm RCF with MF System (Pressure MF)

Project No. 20002.001	
By B.P & Y.W.	Ckd: Y.W. & N.B.
Date 12/31/12	Date: 1/11/13

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
Equipment					
FeSO ₄ Feed System					
Storage Tank	1	EA	\$ 3,400	\$ 3,400	Quotes from Core-Rosion & Ryan Herco; 500 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars.
Metering Pumps	2	EA	\$ 3,100	\$ 6,200	Quotes from C.P. Crowley & HTP; 1.3 gph; 1 duty/ 1 stdby; adjusted to 2012 dollars.
Static Mixers	1	EA	\$ 2,200	\$ 2,200	Quotes from Komax & EWS; 8-inch; adjusted to 2012 dollars.
Reduction Tanks					
Tanks	3	EA	\$ 20,000	\$ 60,000	Quotes from Core-Rosion & Ryan Herco; 8,000 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars.
Mixers	3	EA	\$ 9,000	\$ 27,000	Quotes from Core-Rosion & EWS; G = 60 per second; adjusted to 2012 dollars.
Aeration System					
Tanks	1	EA	\$ 6,400	\$ 6,400	Quotes from Core-Rosion & Ryan Herco; 3000 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars.
Diffusers	1	LS	\$ 2,000	\$ 2,000	Based on previous project experience
Supply Blowers	2	EA	\$ 47,200	\$ 94,400	Quote from EWS; 267 SCFM @ 7 psi; 1 duty/ 1 stdby; incl. accessories; adjusted to 2012 dollars.
Exhaust Blowers	2	EA	\$ 35,400	\$ 70,800	Quote from EWS; 267 SCFM @ 2 psi; 1 duty/ 1 stdby; incl. accessories; adjusted to 2012 dollars.
Off-Gas Treatment	1	LS	\$ 15,400	\$ 15,400	Quotes from Calgon and TIGG; 270 SCFM; (2) adsorbers in series with one heater; adjusted to 2012 dollars.
NaOCl Feed System					
Storage Tank	1	EA	\$ 1,000	\$ 1,000	Quote from Polyprocessing; 115 gal, HDPE, outdoor, incl. seismic
Metering Pumps	2	EA	\$ 4,700	\$ 9,400	Quote from Prominent; 0.30 gph; 1 duty/ 1 stdby
Static Mixers	1	EA	\$ 2,200	\$ 2,200	Quotes from Komax & EWS; 8-inch; adjusted to 2012 dollars.
MF System					
MF Equipment Provided by Pall	1	LS	\$ 495,000	\$ 495,000	Quote from Pall, incl. one feed tank and one reverse filtration tank
Backwash Waste Storage Tank	1	EA	\$ 4,000	\$ 4,000	Quote from Polyprocessing; 1500 gal, HDPE, outdoor, incl. seismic
NaOCl Clean Waste Storage Tank	1	EA	\$ 12,000	\$ 12,000	Quote from Plas-Tanks; 3,000 gal, FRP, outdoor, incl. seismic
Acid Clean Waste Storage Tank	1	EA	\$ 11,000	\$ 11,000	Quote from Plas-Tanks; 3,000 gal, FRP, outdoor, incl. seismic
Backwash Waste Sewer Discharge Pumps	2	EA	\$ 5,000	\$ 10,000	Quote based Upon 175 gpm Hydromatic Submersible Pump, 1 duty/ 1 stdby
NaOCl Waste Sewer Discharge Pumps	2	EA	\$ 6,000	\$ 12,000	Quote based Upon 175 gpm Hydromatic Submersible Pump, 25% added for chemical resistance, 1 duty/ 1 stdby
Acid Waste Sewer Discharge Pumps	2	EA	\$ 6,000	\$ 12,000	Quote based Upon 175 gpm Hydromatic Submersible Pump, 25% added for chemical resistance, 1 duty/ 1 stdby
Subtotal				\$ 857,000	Rounded up to \$1000
Equipment Installation Cost	30%			\$ 258,000	Including tax, freight, installation and manufacturer services.
Chemical Storage Containment	9	CY	\$ 1,275	\$ 10,838	\$1,250/CY. Adjusted to 2012 dollars.
Equipment Concrete Pads	31	CY	\$ 1,275	\$ 39,525	\$1,250/CY. Adjusted to 2012 dollars.
MF Building	1,000	SF	\$ 250	\$ 250,000	Previous project experience, adjusted to 2012 dollars.
Subtotal (Installed Equipment Costs)				\$ 1,416,000	Rounded up to \$1000
General Requirements	7.5%			\$ 106,200	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 70,800	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 70,800	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 213,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 213,000	PLC and SCADA equipment to control
Total Direct Costs				\$ 2,090,000	Rounded up to \$1000

OPINION OF PROBABLE PROJECT COST

Client	City of Glendale
Project	Phase IIIA Microfiltration Pilot testing in RCF for Cr(VI) Treatment
Item	500-gpm RCF with MF System (Pressure MF)

Project No. 20002.001	
By B.P. & Y.W.	Ckd: Y.W. & N.B.
Date 12/31/12	Date: 1/11/13

Contractor's Overhead and Profit	20%		\$ 418,000	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
Construction Total			\$ 2,508,000	Rounded up to \$1000
Project Level Allowance (contingency)	20%		\$ 501,600	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%		\$ 501,600	Includes permits, legal fees and engineering fees for design and construction
Project Total			\$ 3,512,000	
Low Estimate			\$ 2,458,000	-30%
High Estimate			\$ 5,268,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2012 dollars.
3. Costs for land or easements are not included.

OPINION OF PROBABLE PROJECT COST

Client	City of Glendale
Project	Phase IIIA Microfiltration Pilot testing in RCF for Cr(VI) Treatment
Item	2,000-gpm RCF with MF System (Pressure MF)

Project No. 20002.001	
By B.P. & Y.W.	Ckd: Y.W. & N.B.
Date 12/31/12	Date: 1/11/13

DESCRIPTION	QTY	UNIT MEAS.	UNIT COST	TOTAL COST	COMMENTS
Equipment					
FeSO₄ Feed System					
Storage Tank	1	EA	\$ 6,000	\$ 6,000	Quotes from Core-Rosion & Ryan Herco; 2,000 gal PE, outdoor, incl. seismic; adjusted to 2012 dollars.
Metering Pumps	2	EA	\$ 6,200	\$ 12,400	Quotes from C.P. Crowley & HTP; 5 gph; adjusted to 2012 dollars.
Static Mixers	1	EA	\$ 4,300	\$ 4,300	Quotes from Komax & EWS; 14-inch; adjusted to 2012 dollars.
Reduction Tanks					
Mixers	3	EA	\$ 24,000	\$ 72,000	Quotes from Core-Rosion & EWS; G = 60 per second; adjusted to 2012 dollars.
Aeration System					
Diffuser	1	LS	\$ 8,200	\$ 8,200	Based on previous project experience and conversation w/ Brian Bubela; adjusted to 2012 dollars.
Supply Blowers	2	EA	\$ 76,300	\$ 152,600	Quote from EWS; 1,070 SCFM @ 7 psi; 1 duty/ 1 stdby; incl. accessories; adjusted to 2012 dollars.
Exhaust Blowers	2	EA	\$ 59,600	\$ 119,200	Quote from EWS; 1,070 SCFM @ 2 psi; 1 duty/ 1 stdby; incl. accessories; adjusted to 2012 dollars.
Off-Gas Treatment	1	LS	\$ 25,800	\$ 25,800	Quotes from Calgon & TIGG; 1070 SCFM; (2) adsorbers in series with one heater; adjusted to 2012 dollars.
NaOCl Feed System					
Storage Tank	1	LS	\$ 2,300	\$ 2,300	Quote from Polyprocessing; 475 gal, HDPE, outdoor, incl. seismic
Metering Pumps	2	EA	\$ 4,700	\$ 9,400	Quote from Prominent; 1.22 gph, 1 duty/ 1 stdby
Static Mixers	1	EA	\$ 4,300	\$ 4,300	Quotes from Komax & EWS; 14-inch; adjusted to 2012 dollars.
MF System					
MF Equipment Provided by Pall	1	LS	\$ 1,100,000	\$ 1,100,000	Quote from Pall, incl. two feed tanks and two reserve filtration tanks.
Equalization Tank	1	EA	\$ 9,000	\$ 9,000	Quote from Polyprocessing; 3000 gal, HDPE, outdoor, incl. seismic
Backwash Waste Storage Tank	1	EA	\$ 9,000	\$ 9,000	Quote from Polyprocessing; 3000 gal, HDPE, outdoor, incl. seismic
NaOCl Clean Waste Storage Tank	1	EA	\$ 13,000	\$ 13,000	Quote from Plas-Tanks; 4000 gal, FRP, outdoor, incl. seismic
Acid Clean Waste Storage Tank	1	EA	\$ 13,000	\$ 13,000	Quote from Plas-Tanks; 4000 gal, FRP, outdoor, incl. seismic
Backwash Waste Sewer Discharge Pumps	2	EA	\$ 5,000	\$ 10,000	Quote based Upon 175 gpm Hydromatic Submersible Pump, 1 duty/ 1 stdby
NaOCl Waste Sewer Discharge Pumps	2	EA	\$ 6,000	\$ 12,000	Quote based Upon 175 gpm Hydromatic Submersible Pump, 25% added for chemical resistance, 1 duty/ 1 stdby
Acid Waste Sewer Discharge Pumps	2	EA	\$ 6,000	\$ 12,000	Quote based Upon 175 gpm Hydromatic Submersible Pump, 25% added for chemical resistance, 1 duty/ 1 stdby
Subtotal				\$ 1,595,000	Rounded up to \$1000
Equipment Installation Cost (30% of Equipment)	30%			\$ 479,000	Including tax, freight, installation and manufacturer services.
Reduction Tanks					
Slab	140	CY	\$ 714	\$ 99,960	25 ft x 75 ft tank, including 3 sub-tanks with shared walls Based on 2 ft slab or wall; \$700/CY, adjusted to 2012 dollars.
Walls	155	CY	\$ 816	\$ 126,480	Based on 2 ft slab or wall; and 2 ft freeboard; \$800/CY, adjusted to 2012 dollars.
Elevated Slab	140	CY	\$ 1,122	\$ 157,080	Based on 2 ft slab or wall; \$1,100/CY, adjusted to 2012 dollars.
Aeration Tanks					
Slab	17	CY	\$ 714	\$ 12,138	15 ft x 15 ft tank Based on 2 ft slab or wall; \$700/CY, adjusted to 2012 dollars.
Walls	35	CY	\$ 816	\$ 28,560	Based on 2 ft slab or wall; and 2 ft freeboard; \$800/CY, adjusted to 2012 dollars.
Elevated Slab	17	CY	\$ 1,122	\$ 19,074	Based on 2 ft slab or wall; \$1,100/CY, adjusted to 2012 dollars.
Rapid Mixing Tanks					
Slab	17	CY	\$ 714	\$ 12,138	15 ft x 15 ft tank Based on 2 ft slab or wall; \$700/CY, adjusted to 2012 dollars.
Walls	35	CY	\$ 816	\$ 28,560	Based on 2 ft slab or wall; and 2 ft freeboard; \$800/CY, adjusted to 2012 dollars.
Elevated Slab	17	CY	\$ 1,122	\$ 19,074	Based on 2 ft slab or wall; \$1,100/CY, adjusted to 2012 dollars.
Chemical Storage Containment	18	CY	\$ 1,275	\$ 23,460	\$1,250/CY. Adjusted to 2012 dollars.
Equipment Concrete Pads	22	CY	\$ 1,275	\$ 28,050	\$1,250/CY. Adjusted to 2012 dollars.

OPINION OF PROBABLE PROJECT COST

Client	City of Glendale
Project	Phase IIIA Microfiltration Pilot testing in RCF for Cr(VI) Treatment
Item	2,000-gpm RCF with MF System (Pressure MF)

Project No. 20002.001
By B.P. & Y.W. Ckd: Y.W. & N.B.
Date 12/31/12 Date: 1/11/13

MF Building	1,900	SF	\$ 250	\$ 475,000	Previous project experience, adjusted to 2012 dollars.
Subtotal (Installed Equipment Costs)				\$ 3,104,000	Rounded up to \$1000
General Requirements	7.5%			\$ 232,800	Division 1 requirements, including labor supervision, field offices, temporary utilities, health and safety, office supplies, clean up, photographs, survey, erosion control, coordination, testing services, and record documents
Earthwork	5%			\$ 155,200	Excavation, backfill, and fill required to construct project
Site Improvements	5%			\$ 155,200	Roadways, curb and gutter, sidewalk and landscaping
Valves, Piping, and Appurtenances	15%			\$ 466,000	Major system piping and valves
Electrical, Instrumentation and Controls	15%			\$ 466,000	PLC and SCADA equipment to control
Total Direct Costs				\$ 4,579,000	Rounded up to \$1000
Contractor's Overhead and Profit	20%			\$ 915,800	Includes bonds, mobilization and demobilization, insurance, overhead and profit, and management reserves
Construction Total				\$ 5,494,800	
Project Level Allowance (contingency)	20%			\$ 1,098,960	Budget item to cover change orders due to unforeseen conditions
Engineering, Legal and Administrative	20%			\$ 1,098,960	Includes permits, legal fees and engineering fees for design and construction
Project Total				\$ 7,693,000	
Low Estimate				\$ 5,385,000	-30%
High Estimate				\$ 11,540,000	+50%

Notes:

1. This opinion of probable cost is based on AACE Class 5 estimate guidelines. The high and low estimates fall into the acceptable range. These estimates are generally used to compare alternatives.
2. Opinion of Probable Cost in 2012 dollars.
3. Costs for land or easements are not included.

Estimated RCF with Pressure MF Water Quality Monitoring (Number of Samples per Month)

Flow Rate (gpm) 100

Number of MF Trains 1

Sample Location	Lab									Field					
	Total Fe	Cr(VI) & Total Cr	Alkalinity	Hardness	TSS	Silica	VOCs	DBPs	Bac-T (E. Coli, T. Coli and HPC)	Cr(VI)*	Ferrous	Total Fe	Turbidity	Free Chlorine	pH & Temperature
Raw	1	4	1	1		1				4	1	1	1		4
After ferrous addition											4	4			continuous
After 1st reduction tank											4	4			4
After 2nd reduction tank											1	1			4
After 3rd reduction tank		4						1			4	4			4
Aeration off gas (raw)								1							
Aeration off gas (after first VPGAC)								1							
Aeration off gas (after 2nd VPGAC)								1							
MF feed (after Cl ₂ injection)		4	1	1	4			1			4	4	continuous	continuous	continuous
MF permeate	4	4	1	1	4			1	4	4	4	4	continuous		continuous
MF backwash waste	1	1	1	1	1	1					1	1	4		4
MF maintenance clean waste	1	1	1	1	1	1		1		1	1	1	1	continuous	continuous
MF CIP NaOCl waste	1	1	1	1	1	1		1		1	1	1	1	continuous	continuous
MF CIP acid waste	1	1	1	1	1	1		1		1	1	1	1		continuous
Number of samples per month^	9	20	7	7	12	1	5	4	4	11	26	26	8		20
Unit cost (\$/sample)	\$ 14	\$ 67	\$ 15	\$ 15	\$ 15	\$ 14	\$ 112	\$ 150	\$ 59						
Sample analysis Cost (\$/year)	\$ 1,487	\$ 16,157	\$ 1,285	\$ 1,285	\$ 2,203	\$ 165	\$ 6,732	\$ 7,200	\$ 2,815						
Shipping fee (\$/year)	\$ 1,560	One shipment per week, \$30 per shipment													
Sum of lab analysis cost (\$/year)	\$ 40,890	Sample analysis plus shipping fee													
Field meters	\$ 6,000	Hach Dr 3800, portable pH meter and turbidity meter													
Field analysis cost	\$ 2,000	Estimate for reagents and apparatus based on experience; not including labor for field analysis													
Total analysis cost	\$ 42,890	Including lab and field analysis costs; not including labor and field meters													

* Only if influent Cr(VI) is greater than 10 ppb, which is the method detection limit for field analysis (Hach Method).

Continuous monitoring indicates analyzed by online meter(s).

TSS - total suspended solids; VOCs - volatile organic compounds; DBPs - disinfection byproducts; VPGAC - vapor phase granular activated carbon

Unit cost adjusted to 2012 dollars.

Estimated RCF with Pressure MF Water Quality Monitoring (Number of Samples per Month)

Flow Rate (gpm)

500

Number of MF Trains

1

Sample Location	Lab									Field					
	Total Fe	Cr(VI) & Total Cr	Alkalinity	Hardness	TSS	Silica	VOCs	DBPs	Bac-T (E. Coli, T. Coli and HPC)	Cr(VI)*	Ferrous	Total Fe	Turbidity	Free Chlorine	pH & Temperature
Raw	1	4	1	1		1				4	1	1	1		4
After ferrous addition											4	4			continuous
After 1st reduction tank											4	4			4
After 2nd reduction tank											1	1			4
After 3rd reduction tank		4						1			4	4			4
Aeration off gas (raw)								1							
Aeration off gas (after first VPGAC)								1							
Aeration off gas (after 2nd VPGAC)								1							
MF feed (after Cl ₂ injection)		4	1	1	4			1			4	4	continuous	continuous	continuous
MF permeate (per train)	4	4	1	1	4			1	4	4	4	4	continuous		continuous
MF backwash waste	1	1	1	1	1	1					1	1	4		4
MF maintenance clean waste	1	1	1	1	1	1		1		1	1	1	1	continuous	continuous
MF CIP NaOCl waste	1	1	1	1	1	1		1		1	1	1	1	continuous	continuous
MF CIP acid waste	1	1	1	1	1	1		1		1	1	1	1		continuous
Number of samples per month [^]	9	20	7	7	12	1	5	4	4	11	26	26	8		20
Unit cost (\$/sample)	\$ 14	\$ 67	\$ 15	\$ 15	\$ 15	\$ 14	\$ 112	\$ 150	\$ 59						
Sample analysis Cost (\$/year)	\$ 1,487	\$ 16,157	\$ 1,285	\$ 1,285	\$ 2,203	\$ 165	\$ 6,732	\$ 7,200	\$ 2,815						
Shipping fee (\$/year)	\$ 1,560	One shipment per week, \$30 per shipment													
Sum of lab analysis cost (\$/year)	\$ 40,890	Sample analysis plus shipping fee													
Field meters	\$ 6,000	Hach Dr 3800, portable pH meter and turbidity meter													
Field analysis cost	\$ 3,000	Estimate for reagents and apparatus based on experience; not including labor for field analysis													
Total analysis cost	\$ 43,890	Including lab and field analysis costs; not including labor and field meters													

* Only if influent Cr(VI) is greater than 10 ppb, which is the method detection limit for field analysis (Hach Method).

Continuous monitoring indicates analyzed by online meter(s).

TSS - total suspended solids; VOCs - volatile organic compounds; DBPs - disinfection byproducts; VPGAC - vapor phase granular activated carbon

Unit cost adjusted to 2012 dollars.

Estimated RCF with Pressure MF Water Quality Monitoring (Number of Samples per Month)

Flow Rate (gpm) 2,000

Number of MF Trains 2

Sample Location	Lab									Field					
	Total Fe	Cr(VI) & Total Cr	Alkalinity	Hardness	TSS	Silica	VOCs	DBPs	Bac-T (E. Coli, T. Coli and HPC)	Cr(VI)*	Ferrous	Total Fe	Turbidity	Free Chlorine	pH & Temperature
Raw	1	4	1	1		1				4	1	1	1		4
After ferrous addition											4	4			continuous
After 1st reduction tank											4	4			4
After 2nd reduction tank											1	1			4
After 3rd reduction tank		4						1			4	4			4
Aeration off gas (raw)								1							
Aeration off gas (after first VPGAC)								1							
Aeration off gas (after 2nd VPGAC)								1							
MF feed (after Cl ₂ injection)		4	1	1	4			1			4	4	continuous	continuous	continuous
MF permeate (per train)	4	4	1	1	4			1	4	4	4	4	continuous		continuous
MF backwash waste	1	1	1	1	1	1					1	1	4		4
MF maintenance clean waste	1	1	1	1	1	1		1		1	1	1	1	continuous	continuous
MF CIP NaOCl waste	1	1	1	1	1	1		1		1	1	1	1	continuous	continuous
MF CIP acid waste	1	1	1	1	1	1		1		1	1	1	1		continuous
Number of samples per month [^]	13	24	8	8	16	1	5	5	8	15	30	30	8		20
Unit cost (\$/sample)	\$ 14	\$ 67	\$ 15	\$ 15	\$ 15	\$ 14	\$ 112	\$ 150	\$ 59						
Sample analysis Cost (\$/year)	\$ 2,148	\$ 19,388	\$ 1,469	\$ 1,469	\$ 2,938	\$ 165	\$ 6,732	\$ 9,000	\$ 5,630						
Shipping fee (\$/year)	\$ 1,560	One shipment per week, \$30 per shipment													
Sum of lab analysis cost (\$/year)	\$ 50,499	Sample analysis plus shipping fee													
Field meters	\$ 6,000	Hach Dr 3800, portable pH meter and turbidity meter													
Field analysis cost	\$ 5,000	Estimate for reagents and apparatus based on experience; not including labor for field analysis													
Total analysis cost	\$ 55,499	Including lab and field analysis costs; not including labor and field meters													

* Only if influent Cr(VI) is greater than 10 ppb, which is the method detection limit for field analysis (Hach Method).

Continuous monitoring indicates analyzed by online meter(s).

TSS - total suspended solids; VOCs - volatile organic compounds; DBPs - disinfection byproducts; VPGAC - vapor phase granular activated carbon

Unit cost adjusted to 2012 dollars.

Estimated RCF with Pressure MF O&M Costs (in 2012 Dollars)

System Size (gpm)	Pre-Treatment				Pressure MF System			Maintenance and Spare Parts	Wastewater Discharge	Labor	Lab and Field Analysis ⁵	Annual O&M
	Ferrous Sulfate ¹	Sodium Hypochlorite	VPGAC Replacement	Electricity ²	Membrane Replacement	Chemicals ³	Electricity ⁴					
100	\$ 5,300	\$ 1,000	\$ 1,200	\$ 36,000	\$ 1,400	\$ 2,000	\$ 1,200	\$ 23,000	\$ 14,400	\$ 103,000	\$ 42,900	\$ 231,000
500	\$ 23,000	\$ 2,200	\$ 22,000	\$ 96,000	\$ 6,700	\$ 5,800	\$ 6,000	\$ 35,000	\$ 57,400	\$ 187,000	\$ 43,900	\$ 485,000
2,000	\$ 89,000	\$ 7,600	\$ 61,000	\$ 161,000	\$ 26,700	\$ 15,000	\$ 23,600	\$ 77,000	\$ 218,700	\$ 313,000	\$ 55,500	\$ 1,048,000

1. Ferrous sulfate is based on a ferrous dose of 2.0 mg/L as Fe.
2. Electricity includes energy for aeration blowers and aeration off-gas treatment.
3. Chemicals do not include these for Enhanced Flux Maintenance.
4. Electricity includes energy process pump(s) and air compressor(s) based on a filtration production of 15 psi and an overall pump efficiency of 70%, as provided by Pall.
5. Lab and field analysis includes approximately \$4,000 per year for aeration off-gas analysis.

Net Present Value for 20 Years (Rounded to two significant figures)

System Size (gpm)	Net Present Value for 20 Years
100	\$ 3,900,000
500	\$ 8,100,000
2,000	\$ 18,000,000

20-year NPV O&M based on 2.5% inflation and a 4.5% discount rate