Phase II Water Treatment Plant

SUMMARY

The Chandler Phase II Water Treatment Plant project consists of a new 3,000 gpm (4.32 MGD) iron and manganese removal groundwater treatment plant. The new water treatment plant project will include new filters with catalytic media, which will reduce chemical usage and backwash volumes. New service pumps utilizing premium efficiency motors and VFDs will pump finished water to the distribution system. New backwash pumps with premium efficiency motors and VFDs will provide backwash water.

Estimated SRF Loan Amount: $3,220,000

Total GPR Amount:

Construction Cost	
Filters	**$1,087,700**
Service Pumps and VFDs	**$165,000**
Backwash Pumps and VFDs	**$100,000**
Subtotal Construction Cost:	**$1,352,700**
Engineering Cost (7%):	**$94,700**
Total Estimated GPR Amount:	**$1,447,400**

GPR Environmental Innovation: $1,163,800
GPR Energy Efficiency: $283,600

Total Estimated GPR Percent: 45%

BACKGROUND

The Chandler Water Utility provides drinking water to about 6,000 customers in southwest and central Warrick County, Indiana. The utility is located in the rapidly growing area east of Evansville. Growth is continuing at a significant pace in the utility's customer base even with the economic slowdown.

Chandler's groundwater supply has high concentrations of iron and manganese. Chandler's existing water treatment plant is constructed as three independent treatment systems. Only one of the three treatment systems is designed with greensand media and potassium permanganate feed to remove manganese, and this system functions ineffectively. Water is pumped into the distribution system and filters are backwashed using 20-40 year old pumps and motors.

Chandler's Phase II water treatment plant was constructed to efficiently address increasing demand, improve water quality, and improve efficiency in the operations of the system. After review of available alternatives and pilot testing, the utility selected a manganese oxide catalytic media in conventional pressure filters for the treatment process.

Reduced Chemical Usage

The catalyic filter media requires only chlorine to treat both iron and manganese. Conventional treatment systems for manganese removal typically use a greensand media that requires potassium permanganate for both oxidation of manganese and regeneration of the manganese coating on the media.

Reduced Backwash Volumes

One of the characteristics of the catalytic filter media used in Chandler is a significantly quicker backwash time at a higher rate than with conventional filter media. The filters are less than one-half the size of filters with conventional media and the filter runs are shorter than with conventional media. The total backwash volumes for the catalytic media are, nevertheless, significantly less than for conventional media. The lower backwash volumes reduce groundwater withdrawals, power consumption for backwash, and discharges of settled backwash water to the receiving stream.

Reduced Power Consumption

The four service pumps and the two backwash pumps replace aging, worn, and inefficient pumps and motors in Chandler's existing water treatment plant. The new pumps are more efficient than worn pumps and are driven by NEMA premium efficiency motors.

CALCULATED SAVINGS

Savings are projected from reduced water production, higher energy efficiency, and reduced chemical usage. The water production savings are attributable to the reduced volume of backwash water required for the catalytic filter media. Energy efficiency savings are calculated for the increased efficiencies of the service and backwash motors and pumps. The LayneOx catalytic media process is environmentally innovative in that it has not been previously used in Indiana. Reduced chemical usage is calculated based on the elimination of use of potassium permanganate for manganese removal.

The SRF Loan interest rate of 2.92% approximates the projected inflation factor for the related electrical and chemical costs. Therefore, life-cycle cost savings are calculated as a direct multiplier of the current savings over the projected life of the equipment.

General

Given:

Average Current Service Pumping Rate:	1.6 MGD (1,120 gpm)
Projected 20-year Growth (fr. PER):	16%
Average Future Service Pumping Rate:	1,600,000 gallons/day x (1 + 0.16/2) = 1,728,000 gallons/day = 1,200 gpm
Average Service Pumping Rate Through Planning Period:	(1,600,000 + 1,728,000)/2 = 1,664,000 gallons per day = 1,555 gpm
Annual Average Service Pumping Volume:	1,664,000 gallons/day x 365 days/year = 607,360,000 gallons/year

Water Efficiency

Conventional Filter Backwash Volume:

Given:

Filter Run Time:	40 Hours
Backwash Rate:	15 gpm/SF

Filter Size (1,000 gpm filters at 3 gpm/SF loading rate):	334 SF each
Backwash Time:	15 minutes

Calculated:

Filter Run Production:	1,000 gpm x 40 hours x 60 min/hour = 2,400,000 gallons
Volume/Backwash:	15 gpm/SF x 334 SF x 15 minutes = 75,150 gallons/backwash
Backwashes/Year:	607,360,000 gpy / 2,400,000 gallons = 253 backwashes/year
Backwash Volume/Year:	75,150 gallons/backwash x 253 backwashes/year = 19,000,000 gallons/year

Catalytic Media Filter Backwash Volume:

Given:

Filter Run Time:	15 Hours
Backwash Rate:	25 gpm/SF
Filter Size, each (1,000 gpm filters at 6.25 gpm/SF loading rate):	160 SF
Backwash Time:	5 minutes

Calculated:

Filter Run Production:	1,000 gpm x 15 hours x 60 min/hour = 900,000 gallons
Volume/Backwash:	25 gpm/SF x 160 SF x 5 minutes = 20,000 gallons/backwash
Backwashes/Year:	607,360,000 gpy / 900,000 gallons = 675 backwashes/year
Backwash Volume/Year:	20,000 gallons/backwash x 675 backwashes/year = 13,500,000 gallons/year

Calculated Total Water Saved:

Given:

Projected equipment Life (limited to SRF loan term):	20 years

Calculated:

Savings in Water Efficiency:	19,000,000 gallons – 13,500,000 gallons = 5,500,000 gallons/year x 20 years = 110,000,000 gallons

Environmentally Innovative
-Reduced Chemical Usage

Given:

Average potassium permanganate feed rate:	1 mg/l (from Carus Corporation)
Average cost of potassium permanganate:	$2.25/lb (from US Peroxide)

Projected Equipment Life:	20 years
Calculated:	
Average Feed:	1.664 MGD x 8.34 x 1 mg/l = 13.9 lbs/day
Average Cost:	13.9 lbs/day x $2.25/lb = $31.25/day ≈ $11,400/yr
Total Projected Savings:	$11,400/year x 20 years = $228,000

Energy Efficiency

Service Pumps

Given:	
Existing Motor Efficiency (Estimated):	82%
Existing Pump Efficiency (Estimated):	65%
New Motor Efficiency (Premium Efficiency):	95.4%
New Pump Efficiency:	83%
Total Dynamic Head:	310’
Current Power Cost:	$0.095/kWh
Calculated:	
Power Requirements:	
Existing Service Pumps/Motors	(310’ x 0.00315) x (1,664,000/1,000) / (0.82 x 0.65) = 3,050 kWh/day x 365 days/year = 1,100,000 kWh/year x $0.095/kWh x 20 year = $2,090,000
New Service Pumps/Motors	(310’ x 0.00315) x (1,664,000/1,000) / (0.954 x 0.83) = 2,050 kWh/day x 365 days/year = 750,000 kWh/year x $0.095/kWh x 20 year = $1,425,000
Service Pump Savings	$2,090,000 - $1,425,000 = $665,000

Backwash Pumps

Given:

(Refer to Water Efficiency Section for Backwash Characteristics of Existing and New Filters)

Existing Backwash Pump Head (Estimated):	75 feet
Existing Motor Efficiency (Estimated):	82%
Existing Pump Efficiency (Estimated):	65%
New Backwash Pump Head:	118 feet
New Motor Efficiency (Premium Efficiency):	95.8%
New Pump Efficiency:	79.3%
Current Power Cost:	$0.095/kWh
Calculated:	
Existing Filter Backwash Pumps:	
Backwash Volume:	75,150 gallons
Backwash Losses:	75,150 gallons/2,400,000 gallons = 0.031 = 3.1%

Power Requirements:	
Existing Backwash Pumps/Motors	(75 x 0.00315) x (1,664,000 x 0.031 /1,000) / (0.82 x 0.65) = 23 kWh/day x 365 days/year = 8,400 kWh/year x $0.095/kWh x 20 year = $16,000
New Filters Backwash Pumps:	
Backwash Volume:	20,000 gallons
Backwash Losses:	20,000 gallons/900,000 gallons = 0.022 = 2.2%
Power Requirements:	
New Backwash Pumps/Motors	(118 x 0.00315) x (1,664,000 x 0.022 /1,000) / (0.958 x 0.753) = 18.9 kWh/day x 365 days/year = 6,900 kWh/year x $0.095/kWh x 20 year = $13,100
Energy Savings:	$16,000 - $13,100 = $2,900

CONCLUSION

- Utilization of the catalytic media filters, combined with more efficient service and backwash pumps, significantly reduces the power costs for operation of the water treatment plant.
- Reduced backwash volume requirements for the catalytic media filters significantly reduces the amount of groundwater withdrawal resulting in increased water efficiency.
- Effective oxidation of manganese within the catalytic media filters eliminates the use of additional chemicals, saving money and reducing potential environmental effects of a chemical spill, overfeeding of chemicals, and health issues for utility personnel related to handling of a hazardous chemical.

References:

Chandler Phase II Water Treatment Plant Contract Documents – Beam, Longest & Neff

Chandler Phase II Water Treatment Plant Submittals

Floway Pumps Catalog

Water Treatment Plant Design – AWWA/ASCE

Chandler Water Improvements Project Engineering Needs Assessment