

## TECHNICAL MEMORANDUM

DATE: December 5, 2018

TO: DuPage River Salt Creek Work Group (DRSCW)

FROM: Dan Bounds, P.E.

SUBJECT: Planning Level Cost Estimate for Additional BOD & Ammonia Removal at WRRFs tributary to Salt Creek

A planning level cost estimate has been developed for hypothetical upgrades to Water Resource Recovery Facilities (WRRF) tributary to Salt Creek in the DRSCW program area. The estimate represents an order of magnitude cost for design and construction of WRRF improvements to meet 5.0 mg/L BOD<sub>5</sub> and 1.0 mg/L NH<sub>3</sub> water quality effluent limits. This memorandum presents the planning level cost estimate, and the basis and assumptions used. The cost estimates presented were produced for high level planning purposes and should not be used for capital improvement planning or engineering and construction estimates.

### Planning Level Cost Estimate

The WRRFs and associated data included in the estimate are shown in the following table. The total upgrade cost is estimated at \$189 Million to meet 5.0 mg/L BOD<sub>5</sub> and a 1.0 mg/L NH<sub>3</sub> effluent limits.

Plant	Design	Design	BOD <sub>5</sub>	AMMONIA (NH <sub>3</sub> )		Cost
	Average	Max	(Disc Filters)	(Sec. Clars.)	(Aer. Tanks)	Per Plant
	Flow, MGD	Flow, MGD	@ DMF	@ DMF	@ DAF	Total
MWRD Egan	15.06	37.65	\$18,400,000	\$59,900,000	\$24,800,000	<b>\$103,100,000</b>
Nordic Park	0.11	0.27	\$100,000	\$400,000	\$200,000	<b>\$700,000</b>
Itasca	3.20	8.20	\$4,000,000	\$13,000,000	\$5,300,000	<b>\$22,300,000</b>
Roselle/Devlin	1.97	3.93	\$1,900,000	\$6,200,000	\$3,300,000	<b>\$11,400,000</b>
Wood Dale N.	0.84	2.10	\$1,000,000	\$3,300,000	\$1,400,000	<b>\$5,700,000</b>
Wood Dale S	0.23	0.56	\$300,000	\$900,000	\$400,000	<b>\$1,600,000</b>
Addison N.	1.10	2.74	\$1,300,000	\$4,400,000	\$1,800,000	<b>\$7,500,000</b>
Addison S.	0.71	1.77	\$900,000	\$2,800,000	\$1,200,000	<b>\$4,900,000</b>
Salt Creek SD	1.29	3.23	\$1,600,000	\$5,100,000	\$2,100,000	<b>\$8,800,000</b>
Elmhurst	3.36	8.40	\$4,100,000	\$13,400,000	\$5,500,000	<b>\$23,000,000</b>
						<b>\$189,000,000</b>

The Cost per Plant totals were developed by first estimating a unit price for the hypothetical improvements in \$ per 1 MGD of design average or design maximum flow, then multiplying that unit price by the design average or design maximum flow for each facility shown in the above table. Economies of scale were not taken into account.

The annual operation and maintenance calculations for these capital improvements includes additional manpower required to operate the systems, additional electrical power consumption, and

additional costs for maintenance of the systems and replacement parts for the equipment. A 1-year and 20-year breakdown of O&M costs are shown in the tables below.

### 1-YEAR O&M COSTS

Plant	Design Average Flow, MGD	Desing Max Flow, MGD	Filtration @ DAF	Secondary Clarification @ DMF	Aeration Tanks @ DAF	Per Plant Total
Egan	15.06	37.65	\$640,000	\$1,620,000	\$1,370,000	\$3,630,000
Nordic Park	0.11	0.27	\$0	\$10,000	\$10,000	\$20,000
Itasca	3.20	8.20	\$140,000	\$350,000	\$290,000	\$780,000
Roselle/Devlin	1.97	3.93	\$70,000	\$170,000	\$180,000	\$420,000
Wood Dale N	0.84	2.10	\$40,000	\$90,000	\$80,000	\$210,000
Wood Dale S	0.23	0.56	\$10,000	\$20,000	\$20,000	\$50,000
Addison N	1.10	2.74	\$50,000	\$120,000	\$100,000	\$270,000
Addison S	0.71	1.77	\$30,000	\$80,000	\$60,000	\$170,000
SC SD	1.29	3.23	\$50,000	\$140,000	\$120,000	\$310,000
Elmhurst	3.36	8.40	\$140,000	\$360,000	\$310,000	\$810,000
						<b>\$6,670,000</b>

### 20-YEAR O&M COSTS

Plant	Design Average Flow, MGD	Desing Max Flow, MGD	Filtration @ DAF	Secondary Clarification @ DMF	Aeration Tanks @ DAF	Per Plant Total
Egan	15.06	37.65	\$7,980,000	\$42,690,000	\$17,080,000	\$67,750,000
Nordic Park	0.11	0.27	\$60,000	\$310,000	\$120,000	\$490,000
Itasca	3.20	8.20	\$1,740,000	\$9,300,000	\$3,630,000	\$14,670,000
Roselle/Devlin	1.97	3.93	\$830,000	\$4,460,000	\$2,230,000	\$7,520,000
Wood Dale N	0.84	2.10	\$450,000	\$2,380,000	\$950,000	\$3,780,000
Wood Dale S	0.23	0.56	\$120,000	\$640,000	\$260,000	\$1,020,000
Addison N	1.10	2.74	\$580,000	\$3,110,000	\$1,240,000	\$4,930,000
Addison S	0.71	1.77	\$380,000	\$2,010,000	\$800,000	\$3,190,000
SC SD	1.29	3.23	\$680,000	\$3,660,000	\$1,460,000	\$5,800,000
Elmhurst	3.36	8.40	\$1,780,000	\$9,520,000	\$3,810,000	\$15,110,000
						<b>\$124,260,000</b>

The 1-year (first-year) O&M costs include the manpower, power consumption, and maintenance activities required for the capital equipment and structures included with the additional BOD and Ammonia removal improvements. These values were calculated in \$/MGD. Manpower was reviewed on a per-day basis to determine what additional activities were required in an average operator's rounds to perform day-to-day maintenance, system checks, and the treatment process. Manpower

was assumed to operate for 40 hours per week, 52 weeks per year, at a dollar value that included overhead for benefits.

Additional power consumption costs were calculated through the additional equipment motor sizes that would be required for equipment, as well as additional structural lighting and heating requirements. These values were divided on a \$/MGD basis in attempt to appropriately associate electrical costs for both smaller and larger WRRFs.

Maintenance activities were calculated based on cost to repair, rehabilitate, or replace certain aspects of the equipment and structures including material and labor costs. These activities are such that surpass the daily maintenance activities and would require more significant time and funds to complete. The maintenance costs were calculated using a determined frequency over the life of the equipment and maintenance costs at the time of the activity, and calculated on a per year basis, then again as \$/MGD. All costs calculated were on a \$/MGD basis and were added together to provide a single first-year operations and maintenance cost per million gallons of wastewater treated per day.

The 20-year O&M cost was calculated assuming an average inflation rate of the US dollar of 5%. The 20-yr O&M cost is presented at present value.

### Biochemical Oxygen Demand (BOD<sub>5</sub>) Removal Cost Approach

An improvement cost for BOD<sub>5</sub> removal was estimated at a cost per MGD of peak flow capacity. For this estimate, it was assumed that each WRRF would have to add disc filters to meet the 5.0 mg/L BOD<sub>5</sub> effluent limit. The filters would increase removal of suspended solids, and their BOD<sub>5</sub>. The costs associated with the construction of these improvements is outlined below. A cost factor of 25% was added to account for potential impacts on each plant’s solids handling system. The total cost for BOD<sub>5</sub> removal improvements through the use of filtration is estimated at \$490,000 per MGD of peak flow capacity, based on design maximum flow.

<u>Item</u>		<u>Cost/MGD</u>
Disc Filter Equipment		\$90,000
Disc Filter Building		\$120,000
Disc Filter Piping		\$20,000
	SUBTOTAL	\$230,000
Impact on Solids Handling System	25%	\$60,000
	SUBTOTAL	\$290,000
Electrical	5%	\$15,000
Instrumentation	5%	\$15,000
General Conditions	3.5%	\$10,000
Site Work	4.5%	\$13,000
	Total Construction Cost per MGD	\$340,000
Contingencies @ 20%	20%	\$70,000
	SUBTOTAL	\$410,000
Engineering		

Design & Bid Receiving	10%	\$40,000
Construction	10%	\$40,000
Legal & Administrative	1%	\$4,000
<b>Total Filtration Capital Cost per MGD</b>		<b>\$490,000</b>

### Ammonia Removal Cost Approach

An improvement cost for Ammonia removal was estimated at a cost per million gallons of wastewater treated per day. For this analysis, we assumed that each WRRF would have to expand aeration tank volume and increase secondary clarifier surface area to meet the 1.0 mg/L ammonia effluent limit. The aeration tank volume would increase detention time required for nitrification. The clarifier would reduce the surface settling rate to capture slower settling flocs, and thereby improve retention of nitrifiers. It was also assumed that IEPA would require the WRRF to denitrify as well as nitrify, i.e. convert to Biological Nutrient Removal activated sludge. This has been IEPA's standard practice. Consequently, our cost estimate includes baffle walls, mixers, mixed liquor recycle pumps, modifications to air diffusers, motor actuated air control valves, blowers, aeration controls, and process control equipment.

A cost factor of 25% was added to account for potential impacts on each plant's solids handling system. The costs associated with the construction of these ammonia-related improvements is outlined in the table below and the table on Page 4.

The total cost for Ammonia removal improvements would equate to approximately \$1,590,000 per million gallons of wastewater treated per day, based on design maximum flow for the increase in secondary clarifiers surface area; and another approximately \$1,650,000 per million gallon of wastewater treated per day, based on design average flow for improvements to the aeration tanks and aeration system.

### Secondary Clarifiers

<u>Item</u>		<u>Cost/MGD</u>
Secondary Clarifier (structure & equipment)		\$690,000
SUBTOTAL		\$690,000
Impact on Solids Handling System	25%	\$170,000
SUBTOTAL		\$860,000
Electrical	15%	\$130,000
Instrumentation	5%	\$40,000
General Conditions	3.5%	\$30,000
Site Work	4.5%	\$40,000
Total Construction Cost per MGD		\$1,100,000
Contingencies @ 20%	20%	\$220,000
SUBTOTAL		\$1,320,000
Engineering		

Design & Bid Receiving	10%	\$130,000
Construction	10%	\$130,000
Legal & Administrative	1%	\$10,000
<b>Total Secondary Clarifier Capital Cost per MGD</b>		<b>\$1,590,000</b>

### Aeration Tanks

<u>Item</u>		<u>Cost/MGD</u>
Aeration Tank Piping		\$50,000
Aeration Tank Earthwork		\$50,000
Blower Building		\$30,000
Coatings (ML)		\$2,000
Aeration Tank Rebar & Construction		\$460,000
Aeration Tank Equipment		\$140,000
Aeration Tank Controls		\$10,000
Aeration Tank Electrical		\$30,000
	SUBTOTAL	\$770,000
Impact on Solids Handling System	25%	\$190,000
	SUBTOTAL	\$960,000
Electrical	5%	\$50,000
Instrumentation	5%	\$50,000
General Conditions	3.5%	\$30,000
Site Work	4.5%	\$40,000
	Total Construction Cost per MGD	\$1,130,000
Contingencies @ 20%	20%	\$230,000
	SUBTOTAL	\$1,360,000
Engineering		
Design & Bid Receiving	10%	\$140,000
Construction	10%	\$140,000
Legal & Administrative	1%	\$10,000
<b>Total Aeration Tank Capital Cost per MGD</b>		<b>\$1,650,000</b>