LAGOON AND WETLAND TREATMENT AND DISPOSAL FEASIBILITY EVALUATION

FOR

CITY OF REDMOND, OREGON

Prepared for the
City of Redmond, Oregon

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2020

ANDERSON PERRY & ASSOCIATES, INC.

La Grande, Redmond, and Hermiston, Oregon
Walla Walla, Washington

Job No. 59-00

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Background

The City of Redmond, Oregon, recently completed a Wastewater Facilities Plan (WWFP) and a WWFP Update in November 2019. These planning documents recommended improvements totaling $44.6 million in 2018 dollars ($47.7 million in 2020 dollars) but did not consider improvement alternatives other than mechanical treatment. The WWFP and WWFP Update did not include other locations for the proposed improvements. The City believes it may be prudent to consider other improvement alternatives that could reduce the total life cycle costs to City residents and relocate the existing facilities out of the residential area. As an example of other possible improvements to consider, the City of Prineville, Oregon, has successfully implemented the use of lagoon technology with constructed wetland treatment and disposal, while substantially reducing the overall total cost to the City and providing public access to wetland/wildlife areas. The purpose of this feasibility evaluation is to evaluate the potential of using a lagoon treatment system with a constructed wetland treatment and disposal system as an alternative to meet the City's wastewater treatment and disposal needs.

Design Criteria

The design criteria used for this evaluation are taken from the WWFP Update. The design year 2045 was used with the following wastewater influent parameters:

- Population - 53,800
- Average Annual Flow - 3.49 million gallons per day (MGD)
- Maximum Month Flow - 3.76 MGD
- Average Annual Five-day Biochemical Oxygen Demand (BOD_5) - 14,500 pounds per day (ppd)
- Maximum Month BOD_5 - 19,000 ppd
- Average Annual Total Suspended Solids (TSS) - 9,600 ppd
- Maximum Month TSS - 14,400 ppd
- Average Annual Total Kjeldahl Nitrogen (TKN) - 1,900 ppd
- Maximum Month TKN - 2,400 ppd
- Total Dissolved Solids (TDS) - Approximately 320 milligrams per liter (mg/L)

The City's current Water Pollution Control Facilities (WPCF) Permit has wastewater effluent limits established for discharge into existing infiltration basins. These are as follows:

- BOD_5 and TSS - 20 mg/L
- Nitrate + Nitrite as Nitrogen - 6 mg/L
- Total Nitrogen - 9 mg/L
- pH - 6.0 to 9.0
- *E. coli* - 126 most probable number

The following monthly average groundwater limits apply to the down-gradient groundwater monitoring wells:

- Nitrate - 9 mg/L
- TDS - 500 mg/L

Although these design criteria considered only flows from the City of Redmond, they could be modified to include the community of Terrebonne. The following sizes and costs would be anticipated to be modified only slightly to include the expanded service area.

Lagoon Treatment

Lagoon treatment can be provided with a facultative lagoon, partially aerated lagoon, or aerated lagoon. Cost consideration is also given to an option that utilizes the existing capital investment in the treatment plant's Orbal oxidation ditches to reduce BOD_5 and, thus, lagoon size and aeration requirements. The purpose of the lagoon treatment is to provide for reduction in BOD_5 to the permit limits. Some total nitrogen reduction would also be realized for systems with front-loaded oxygen additions and facultative or anoxic zones at the end of the processes.

Facultative

A facultative lagoon provides oxygen for waste decomposition from an air/water interface area and algae photosynthesis. This system would be a minimum two-stage system operating between 3 and 7 feet in depth, with a minimum detention time of approximately 100 days. For this evaluation, an operating depth between 4 and 5 feet was assumed, and the detention time would be well in excess of 100 days due to the area needed for oxygen transfer. The first stage would need to be 290 acres and the second stage would be 190 acres, for a total lagoon size of 480 acres. For construction purposes, it is suggested to divide these lagoon cells into maximum 40-acre units. There would then be approximately 12 40-acre lagoons.

Solids handling would not be required for this option. Lagoon solids would be anticipated to be removed approximately once every 40 years, once the lagoons reach their design BOD_5 loading. A multi-cell lagoon system would allow a lagoon cell to be taken offline and solids to dry in the bottom of the lagoon for easy and cost-effective removal.

This lagoon type can reduce total nitrogen 40 to 95 percent. A removal efficiency of approximately 85 percent is needed to meet existing WPCF Permit limits. For this reason, adding a treatment wetland for effluent polishing would be recommended.

The estimated capital and 20-year lifecycle costs for this option are $43.4 million and $46.4 million, respectively (see Table 1).

Partially Aerated

A partially aerated lagoon would provide some of the oxygen requirements through an aeration system. For purposes of this evaluation, we would assume that the oxygen for the first stage of the facultative lagoon system would be provided through mechanical aeration. Approximately 2 pounds of oxygen per pound of BOD_5 removed is used in this evaluation to include both BOD_5 and nitrogen reduction, and approximately 2 pounds of oxygen per horsepower (Hp) per hour can be assumed for an aeration system. The first-stage aeration system would mainly be used to increase the dissolved oxygen in the wastewater so it is available for microbial use and provide oxygen that would be consumed during the time water is in this cell. The detention time in this lagoon would be approximately three days. This first stage of the lagoon would then be approximately 10 feet deep to provide for aeration. Approximately 360 Hp of aeration would be needed. This would require a first-stage lagoon of approximately 3.5 acres. The second stage would then be approximately 190 acres and

constructed mainly as a facultative system to provide both aerobic and anoxic microbial colonies, but this area would not provide enough oxygen for the BOD_5 loading, so approximately 240 Hp of additional aeration would still be needed in the second stage.

As with the facultative lagoons, solids handling would not be proposed for this system. Solids reduction would occur naturally in the second-stage lagoons, but solids removal from the lagoons may still be needed approximately every 30 years.

This lagoon type can reduce total nitrogen 40 to 95 percent. A removal efficiency of approximately 85 percent is needed to meet the existing WPCF Permit limits. For this reason, a treatment wetland would be recommended to be added for effluent polishing.

The estimated capital and 20-year lifecycle costs for this option are $23.9 million and $31.9 million, respectively (see Table 2).

Aerated

An aerated lagoon would provide sufficient oxygen through aeration systems. A partially mixed, aerated lagoon would consist of five cells with a total detention time of 20 days. The 20-day detention time is on the longer end of what would normally be anticipated, but it provides a factor of safety and capacity to realize increased reduction in total nitrogen. A total requirement of approximately 800 Hp is needed to provide the required oxygen. The depth of the lagoon cells would be approximately 10 feet. The total wet area needed would be approximately 23 acres.

Solids handling would not be anticipated for this option, as solids reduction occurs in the lagoon cells. It is still anticipated that solids removal would be needed approximately once every 20 years, once the flows and loadings reach design levels.

This lagoon type can reduce total nitrogen 60 to 95 percent. A removal efficiency of approximately 85 percent is needed to meet the existing WPCF Permit limits. For this reason, a treatment wetland would be recommended to be added for effluent polishing.

The estimated capital and 20-year lifecycle costs for this option are $10.6 million and $19.5 million, respectively (see Table 3).

Aerated Lagoon with Orbal Pre-Aeration

This alternative utilizes the existing capital investment in the Orbal aeration system to provide pre-aeration and reduce the total capital and operation and maintenance (O&M) requirements at the new lagoon site. The Orbal aeration system capacity provides enough oxygen to reduce the anticipated BOD_5 loads on the proposed lagoon treatment system to approximately 9,000 ppd. This alternative would abandon the existing treatment plant facilities except for the headworks, two Orbal units, and one clarifier and associated sludge pump. The clarifier would harvest biosolids (microorganisms) from the ditch effluent and send them back to the ditch. The effluent from the ditches and clarifier would then be combined with any raw wastewater not sent to the ditch. The combined flows would then be sent to the aerated lagoons. This would reduce the total required at the aerated lagoon to approximately 375 Hp, the required detention time to 15 days, and the lagoon size from 23 acres to 17 acres.

Solids handling and nitrogen reduction would be similar to the aerated lagoon option.

The estimated capital and 20-year lifecycle costs for this option are $6.3 million and $14.7 million, respectively (see Table 4).

Treatment Wetlands

After biologic stabilization of the waste is provided in the lagoon system, the lagoon effluent should be further "polished" in treatment wetlands to provide a more natural environment to further reduce pathogens and nutrients. The wetlands would provide a shallow surface flow system for increased exposure to light and encourage vegetation growth. The vegetation in the wetlands provides a substrate for attached growth microbial colonies that would provide for nitrification of any remaining ammonia. Denitrification would then be provided in the bottom anoxic layers of the wetlands and in deeper sections built into the environment. The treatment wetlands would be sized for a six-day detention time at an average depth of 12 inches. The treatment wetland would have a liner installed under 12 inches of native material in which vegetation would grow. The wetland would be seeded and planted. This would require a wetland complex with approximately 70 wet acres. Additional nitrogen reduction is provided in the wetlands, but nitrogen reduction is improved when multiple wetland cells constructed in series are provided. The estimated capital and 20-year lifecycle costs for this option are $9.8 million and $10.4 million, respectively (see Table 5).

Disposal Wetlands

The existing disposal system utilized by the City is through irrigation and seepage. The area proposed for facility construction contains a concrete sealed irrigation storage pond that holds water and a seepage area that leaks at a high rate. The size of disposal wetlands would depend on the seepage rate of the wetlands. Due to the function of the seepage area, it is assumed that the natural ground would provide very high infiltration rates. The existing seepage area has multiple cells with only one cell operated at a time. Based on current operation, the seepage area appears to have sufficient capacity to serve the City in the future.

The City could construct new disposal wetlands for wildlife and public use using the water reclaimed from the wetland treatment process. These would need to have more controlled seepage by removing the topsoil, treating the fractured rock with bentonite, and replacing the topsoil. The disposal wetlands would be of varying depths and configurations that would more closely follow the natural terrain and provide wildlife habitat and an aesthetically pleasing area that the public may enjoy. For reasons of realizing a beneficial use for the reclaimed water, a capital cost of $4 million is added for disposal wetlands and trails.

Other Beneficial Uses

The City could also utilize the treated effluent for additional beneficial uses such as irrigating turf grass for new sports fields in the area. Some added effluent polishing may be needed, depending on the proposed beneficial use.

Permit Limits

The effluent permit limits that merit further discussion in this evaluation are the BOD_5 and TSS limit of 20 mg/L, total nitrogen limit of 9 mg/L entering the infiltration basins, and TDS limit of 500 mg/L in the

monitoring wells. The limits entering the infiltration basins appear to have been established as technology-based effluent limits based on the activated sludge process employed in the existing treatment plant.

Biochemical Oxygen Demand and Total Suspended Solids

The treatment wetland would be susceptible to extensive algae growth that may limit the ability to consistently meet the 20 mg/L limit. This limit may be attainable with the aerated lagoon option prior to entering the treatment wetland. A discussion with the Oregon Department of Environmental Quality would need to occur to determine if the permit limit and/or monitoring location can be changed.

Nitrogen

The total nitrogen limit is achievable through a lagoon and wetland system, as the City of Prineville averaged a total nitrogen concentration of 7.0 mg/L from the lagoons throughout the 2019 season with nitrates in the monitoring wells being approximately 1 mg/L. The design of wetlands for nitrogen reduction has a large range of constants that could be used to achieve reduction efficiencies over a large range (i.e., 45 to 95 percent). This is due to the variability in plant and microbial colonies that can occur in different climatic regions and the type of waste entering the system. For this installation, data from the Cities of Prineville and La Grande, Oregon, lagoon and wetland treatment systems could be used to verify the design parameters. Some of the data that could be useful to verify the facility sizing are not currently being collected by the Cities. If this option is pursued further, additional testing from the Prineville facility would prove beneficial to confirm design parameters to reduce the risk associated with potential unknown design "constants."

Total Dissolved Solids

TDS data were collected for the existing treatment plant effluent. This TDS is also anticipated to be in the range of what would be expected for lagoon effluent. A mass balance was completed to estimate the TDS seeping into the groundwater by reducing the total seepage volume and increasing the total TDS due to evaporation. The amount of evaporation in the system would directly affect the difference in TDS between the influent and effluent, but this amount is small. TDS is expected to increase by less than 10 percent through the lagoon and wetland system.

Project Consideration

The City could consider three different alternatives to meet their future needs. These include expanding the existing mechanical treatment plant; using lagoons and wetlands to provide the treatment capacity needed for the future and continue using the headworks and office space at the existing facility; or moving the entire treatment system, offices, and shops to a new location. The decision-making process should consider Capital Cost, Life Cycle Cost, Land and Future Expandability, and Community Benefits.

Expand Existing Mechanical Treatment Plant at Existing Site

Capital Cost - This alternative was evaluated in the 2019 WWFP Update of the 2018 WWFP. The total capital cost for this alternative is $44.6 million (2018 dollars), which has been updated to $47.7 million (2020 dollars at 3.5 percent inflation).

Life Cycle Cost - This alternative has an estimated 20-year life cycle cost of approximately $62.0 million.

Land and Future Expandability - This alternative utilizes the existing site located in an area surrounded by residential housing. The options for future expandability are limited. Also, there is concern over having this industrial wastewater facility in the middle of a residential area with a public pathway through the area.

Community Benefits - This alternative will provide wastewater treatment for the City. The water is used for irrigating crops in the summertime but is disposed of in the wintertime through ground percolation. There may be opportunities for further reuse of the reclaimed water.

New Lagoons and Wetlands with Existing Facilities

This project alternative is shown on Figure 1. This alternative includes utilizing the existing headworks facility to provide screening of the influent. Raw wastewater would then flow down the existing pipelines to the proposed lagoon site at and/or adjacent to the existing irrigation area. Wastewater would then be treated in a five-cell, aerated lagoon system with chlorine disinfection. The disinfected lagoon effluent would then flow to the existing irrigation storage pond or into a 70-acre treatment wetland complex before entering a disposal wetland and infiltration basin area for evaporation and seepage into the groundwater. The total project cost for this system is summarized on the following table. The disinfection system evaluation was not part of this evaluation, but a cost estimate is included, assuming a chlorination system is used (see Table 6).

Capital Cost - The total estimated capital and associated life cycle cost is shown on the following table.

NEW LAGOON AND WETLANDS WITH EXISTING FACILITIES

Item	Estimated Capital Cost	Estimated 20-year Life Cycle Cost
Aerated Lagoon	$10.6 million	$19.5 million
Disinfection System	$1.7 million	$2.4 million
Treatment Wetlands	$9.8 million	$10.4 million
Disposal Wetlands	$4.0 million	$4.1 million
Support Facilities	$12.4 million	$16.4 million
Total	**$38.5 million**	**$52.8 million**

Note: Capital costs for Support Facilities taken from 2019 WWFP Update.

Life Cycle Cost - The 20-year life cycle cost shown above needs to be augmented to include the existing facilities that will be used as part of this alternative, and also includes the headworks and lift station. The revised total estimated life cycle cost assumes these facilities are new and is estimated at $37.0 million. Also, this alternative will split the treatment plant staff between two sites. This can provide O&M challenges.

Land and Future Expandability - The existing facilities would still be located in an area surrounded by residential homes with a walking path near the treatment plant. The lagoons and wetland areas are surrounded by undeveloped lands where future expansion could easily occur.

Community Benefits - Maintaining part of the existing treatment facilities will still have odor producing systems in the middle of the residential and pathway area. This alternative would provide a minimum of 70 acres of wetland environment that could provide plant and wildlife habitat. The City of Prineville uses its wetland area as part of their parks and trails and the City of Redmond could implement a similar community enhancement.

New Lagoon and Wetland Treatment Plant with Support Facilities at New Site

The development of new treatment facilities will provide the opportunity to move all of the treatment facilities to a new less populated area north of the City. Figures 2 and 3 show an initial potential layout for moving all of the treatment works. The additional facilities needed would include a main division building, maintenance building, generator building, operations building, vacuum truck dump, headworks screening, lift station, sludge drying beds, and associated roads and parking areas. The inclusion of sludge drying beds will allow lagoon sludge removal to be done by City staff using the drying beds and floating dredge. The drying beds can be completed as a second phase of the project, as lagoon sludge will not need to be removed for many years. The estimated cost for the headworks and support facilities, including the drying beds, is shown on Table 7.

Capital Cost and Life Cycle Cost - The total estimated capital and life cycle cost for moving the treatment plant is summarized on the following table.

NEW LAGOON AND WETLAND TREATMENT PLANT
WITH SUPPORT FACILITIES AT NEW SITE

Item	Estimated Capital Cost	Estimated 20-year Life Cycle Cost
Aerated Lagoon	$10.6 million	$19.5 million
Disinfection System	$1.7 million	$2.4 million
Treatment Wetlands	$9.8 million	$10.4 million
Disposal Wetlands	$4.0 million	$4.1 million
Headworks and Support Facilities	$15.5 million	$17.5 million
Total	**$41.6 million**	**$53.9 million**

Land and Future Expandability - This alternative locates all the wastewater treatment facilities in an undeveloped area where future expandability would be easier.

Community Benefits - This alternative would provide a wetland environment that could be made accessible to the public for bird watching, hiking, and cycling. It could also be tied into a City-wide trails system as an extension to Dry Canyon. The reuse of the reclaimed water in this manner provides an ancillary benefit to the City that is otherwise not realized.

Summary

The following table summarizes the project alternatives:

Summary of Project Alternatives

Alternative	Advantages	Disadvantages	Capital Cost	20-Year Life Cycle Cost	Life Expectancy
Expand Mechanical Treatment Plant at Existing Site	Use existing headworks and treatment systems.	Odors, limited expandability, older systems, treatment plant in residential area, higher costs.	$47.7 million	$62.0 million	Reused mechanical components will have shorter life. New mechanical components will need replaced approximately every 10 years.
New Lagoons and Wetlands with Existing Facilities	Use existing headworks.	Odors, older systems, two sites, treatment plant in residential area.	$38.5 million	$52.8 million	Unknown life for existing lift station and headworks but will most likely need to be rebuilt before 20 years.
New Lagoon and Wetland Treatment Plant with Support Facilities at New Site	Move out of residential and Dry Canyon Park area. Expandable. All new systems. Added wildlife habitat. Added trails system. Reduced biosolids handling. Increased tourism possibilities.		$41.6 million	$53.9 million	Lagoons and wetlands have a life expectancy in excess of 50 years.

TABLES

CITY OF REDMOND, OREGON
LAGOON AND WETLAND TREATMENT AND DISPOSAL FEASIBILITY EVALUATION
FACULTATIVE LAGOON
PRELIMINARY COST ESTIMATE
(YEAR 2020 COSTS)

NO.	DESCRIPTION	UNIT	UNIT PRICE	ESTIMATED QUANTITY	PRICE
1	Mobilization/Demobilization (3% of Construction Cost)	LS	$ 1,020,000	All Req'd	$ 1,020,000
2	Earthwork	CY	5	350,000	1,750,000
3	Rock Removal	CY	60	161,333	9,680,000
4	Liner	SF	1	21,000,000	21,000,000
5	Control Structures	EA	15,000	12	180,000
6	Piping	LF	60	5,600	336,000
7	Gravel	CY	20	8,100	162,000
8	Fencing	LF	6	21,000	126,000
9	Site Work	LS	50,000	All Req'd	50,000
				Sum of Estimated Construction Cost	**$ 34,304,000**
				Construction Contingency (15%)	5,146,000
				Subtotal Estimated Construction Cost	**$ 39,450,000**
				Administration, Legal, and Engineering (10%)	3,945,000
				TOTAL ESTIMATED PROJECT COST (2020 DOLLARS)	**$ 43,395,000**

PRESENT WORTH ANALYSIS (2020 DOLLARS)

Item	Description	Annual Cost
ADDITIONAL ANNUAL OPERATION, MAINTENANCE, AND REPLACEMENT (OM&R)		
1	Labor	$ 41,000
2	Supplies, Parts, Maintenance, and Repairs	1,000
3	Replacement	1,000
4	Lagoon Solids Removal	200,000
	Total OM&R	**$ 243,000**
	Present Worth Operation and Maintenance Cost (5%, 20 years)	3,029,000
	Total Present Worth (2020 Dollars)	**$ 46,424,000**

CITY OF REDMOND, OREGON
LAGOON AND WETLAND TREATMENT AND DISPOSAL FEASIBILITY EVALUATION
PARTIALLY AERATED LAGOON
PRELIMINARY COST ESTIMATE
(YEAR 2020 COSTS)

NO.	DESCRIPTION	UNIT	UNIT PRICE	ESTIMATED QUANTITY	PRICE
1	Mobilization/Demobilization (4% of Construction Cost)	LS	$ 800,000	All Req'd	$ 800,000
2	Earthwork	CY	5	172,000	860,000
3	Rock Removal	CY	60	64,600	3,876,000
4	Liner	SF	1	8,712,000	8,712,000
5	Control Structures	EA	15,000	5	75,000
6	Piping	LF	60	3,600	216,000
7	Gravel	CY	20	3,800	76,000
8	Diffusers	LS	1,200,000	All Req'd	1,200,000
9	Blowers	LS	650,000	All Req'd	650,000
10	Blower Building	SF	200	1,200	240,000
11	Electrical and Controls	LS	500,000	All Req'd	500,000
12	Fencing	LF	6	10,000	60,000
13	Site Work	LS	50,000	All Req'd	50,000
				Sum of Estimated Construction Cost	**$ 17,315,000**
				Construction Contingency (15%)	2,597,000
				Subtotal Estimated Construction Cost	**$ 19,912,000**
				Administration, Legal, and Engineering (20%)	3,982,000
				TOTAL ESTIMATED PROJECT COST (2020 DOLLARS)	**$ 23,894,000**

PRESENT WORTH ANALYSIS (2020 DOLLARS)

Item	Description	Annual Cost
	ADDITIONAL ANNUAL OPERATION, MAINTENANCE, AND REPLACEMENT (OM&R)	
1	Labor	$ 82,000
2	Supplies, Parts, Maintenance, and Repairs	2,000
3	Power (600 horsepower, $0.08 per kilowatt hour)	314,000
4	Replacement	62,000
5	Lagoon Solids Removal	180,000
	Total OM&R	**$ 640,000**
	Present Worth Operation and Maintenance Cost (5%, 20 years)	7,976,000
	Total Present Worth (2020 Dollars)	**$ 31,870,000**

CITY OF REDMOND, OREGON
LAGOON AND WETLAND TREATMENT AND DISPOSAL FEASIBILITY EVALUATION
AERATED LAGOON
PRELIMINARY COST ESTIMATE
(YEAR 2020 COSTS)

NO.	DESCRIPTION	UNIT	UNIT PRICE	ESTIMATED QUANTITY	PRICE
1	Mobilization/Demobilization (5% of Construction Cost)	LS	$ 430,000	All Req'd	$ 430,000
2	Earthwork	CY	6	113,000	678,000
3	Rock Removal	CY	60	32,000	1,920,000
4	Liner	SF	1	1,089,000	1,089,000
5	Control Structures	EA	15,000	4	60,000
6	Piping	LF	60	2,000	120,000
7	Gravel	CY	20	1,400	28,000
8	Diffusers	LS	1,500,000	All Req'd	1,500,000
9	Blowers	LS	800,000	All Req'd	800,000
10	Blower Building	SF	200	1,800	360,000
11	Electrical and Controls	LS	600,000	All Req'd	600,000
12	Fencing	LF	6	5,000	30,000
13	Site Work	LS	50,000	All Req'd	50,000
				Sum of Estimated Construction Cost	**$ 7,665,000**
				Construction Contingency (15%)	1,150,000
				Subtotal Estimated Construction Cost	**$ 8,815,000**
				Administration, Legal, and Engineering (20%)	1,763,000
				TOTAL ESTIMATED PROJECT COST (2020 DOLLARS)	**$ 10,578,000**

PRESENT WORTH ANALYSIS (2020 DOLLARS)

Item	Description	Annual Cost
	ADDITIONAL ANNUAL OPERATION, MAINTENANCE, AND REPLACEMENT (OM&R)	
1	Labor	$ 164,000
2	Supplies, Parts, Maintenance, and Repairs	10,000
3	Power (800 horsepower, $0.08 per kilowatt hour)	418,000
4	Replacement	82,000
5	Lagoon Solids Removal	42,000
	Total OM&R	**$ 716,000**
	Present Worth Operation and Maintenance Cost (5%, 20 years)	8,923,000
	Total Present Worth (2020 Dollars)	**$ 19,501,000**

CITY OF REDMOND, OREGON
LAGOON AND WETLAND TREATMENT AND DISPOSAL FEASIBILITY EVALUATION
ORBAL PLUS AERATED LAGOON
PRELIMINARY COST ESTIMATE
(YEAR 2020 COSTS)

NO.	DESCRIPTION	UNIT	UNIT PRICE	ESTIMATED QUANTITY	PRICE
1	Mobilization/Demobilization (5% of Construction Cost)	LS	$ 250,000	All Req'd	$ 250,000
2	Earthwork	CY	6	94,000	564,000
3	Rock Removal	CY	60	8,100	486,000
4	Liner	SF	1	828,000	828,000
5	Control Structures	EA	15,000	4	60,000
6	Piping	LF	60	2,000	120,000
7	Gravel	CY	20	1,100	22,000
8	Diffusers	LS	900,000	All Req'd	900,000
9	Blowers	LS	480,000	All Req'd	480,000
10	Blower Building	SF	200	1,200	240,000
11	Electrical and Controls	LS	500,000	All Req'd	500,000
12	Fencing	LF	6	5,000	30,000
13	Site Work	LS	50,000	All Req'd	50,000
				Sum of Estimated Construction Cost	**$ 4,530,000**
				Construction Contingency (15%)	680,000
				Subtotal Estimated Construction Cost	**$ 5,210,000**
				Administration, Legal, and Engineering (20%)	1,042,000
				TOTAL ESTIMATED PROJECT COST (2020 DOLLARS)	**$ 6,252,000**

PRESENT WORTH ANALYSIS (2020 DOLLARS)

Item	Description	Annual Cost
	ADDITIONAL ANNUAL OPERATION, MAINTENANCE, AND REPLACEMENT (OM&R)	
1	Labor	$ 165,000
2	Supplies, Parts, Maintenance, and Repairs	10,000
3	Power (800 horsepower, $0.08 per kilowatt hour)	418,000
4	Replacement	44,000
5	Lagoon Solids Removal	42,000
	Total OM&R	**$ 679,000**
	Present Worth Operation and Maintenance Cost (5%, 20 years)	8,462,000
	Total Present Worth (2020 Dollars)	**$ 14,714,000**

CITY OF REDMOND, OREGON
LAGOON AND WETLAND TREATMENT AND DISPOSAL FEASIBILITY EVALUATION
TREATMENT WETLANDS
PRELIMINARY COST ESTIMATE
(YEAR 2020 COSTS)

NO.	DESCRIPTION	UNIT	UNIT PRICE	ESTIMATED QUANTITY	PRICE
1	Mobilization/Demobilization (5% of Construction Cost)	LS	$ 400,000	All Req'd	$ 400,000
2	Earthwork	CY	6	67,000	402,000
3	Rock Removal	CY	60	32,400	1,944,000
4	Liner	SF	1	3,050,000	3,050,000
5	Control Structures	EA	15,000	6	90,000
6	Piping	LF	60	4,000	240,000
7	Gravel	CY	20	2,100	42,000
8	Top Soil Removal and Replacement	CY	8	113,000	904,000
9	Seeding and Planting	LS	20,000	All Req'd	20,000
10	Fencing	LF	6	7,000	42,000
				Sum of Estimated Construction Cost	**$ 7,134,000**
				Construction Contingency (15%)	1,070,000
				Subtotal Estimated Construction Cost	**$ 8,204,000**
				Administration, Legal, and Engineering (20%)	1,640,000
				TOTAL ESTIMATED PROJECT COST (2020 DOLLARS)	**$ 9,844,000**

PRESENT WORTH ANALYSIS (2020 DOLLARS)

Item	Description	Annual Cost
ADDITIONAL ANNUAL OPERATION, MAINTENANCE, AND REPLACEMENT (OM&R)		
1	Labor	$ 41,000
2	Supplies, Parts, Maintenance, and Repairs	1,000
3	Replacement	1,000
4	Vegetation Removal	2,000
	Total OM&R	**$ 45,000**
	Present Worth Operation and Maintenance Cost (5%, 20 years)	561,000
	Total Present Worth (2020 Dollars)	**$ 10,405,000**

CITY OF REDMOND, OREGON
LAGOON AND WETLAND TREATMENT AND DISPOSAL FEASIBILITY EVALUATION
DISINFECTION SYSTEM
PRELIMINARY COST ESTIMATE
(YEAR 2020 COSTS)

NO.	DESCRIPTION	UNIT	UNIT PRICE	ESTIMATED QUANTITY	PRICE
1	Mobilization/Demobilization (5% of Construction Cost)	LS	$ 66,000	All Req'd	$ 66,000
2	Building	SF	200	1,000	200,000
3	Chlorination Equipment	LS	40,000	All Req'd	40,000
4	Chlorine Contact Basin	LS	280,000	All Req'd	280,000
5	Electrical and Controls	LS	100,000	All Req'd	100,000
6	Piping	LF	60	200	12,000
7	Rock Removal	CY	60	1,000	60,000
8	Gravel	CY	20	100	2,000
9	Steel Building Over Basin	LS	500,000	All Req'd	500,000
				Sum of Estimated Construction Cost	**$ 1,260,000**
				Construction Contingency (15%)	189,000
				Subtotal Estimated Construction Cost	**$ 1,449,000**
				Administration, Legal, and Engineering (20%)	290,000
				TOTAL ESTIMATED PROJECT COST (2020 DOLLARS)	**$ 1,739,000**

PRESENT WORTH ANALYSIS (2020 DOLLARS)

Item	Description	Annual Cost
ADDITIONAL ANNUAL OPERATION, MAINTENANCE, AND REPLACEMENT (OM&R)		
1	Labor	$ 20,000
2	Supplies, Parts, Maintenance, and Repairs	30,000
3	Replacement	2,000
	Total OM&R	**$ 52,000**
	Present Worth Operation and Maintenance Cost (5%, 20 years)	649,000
	Total Present Worth (2020 Dollars)	**$ 2,388,000**

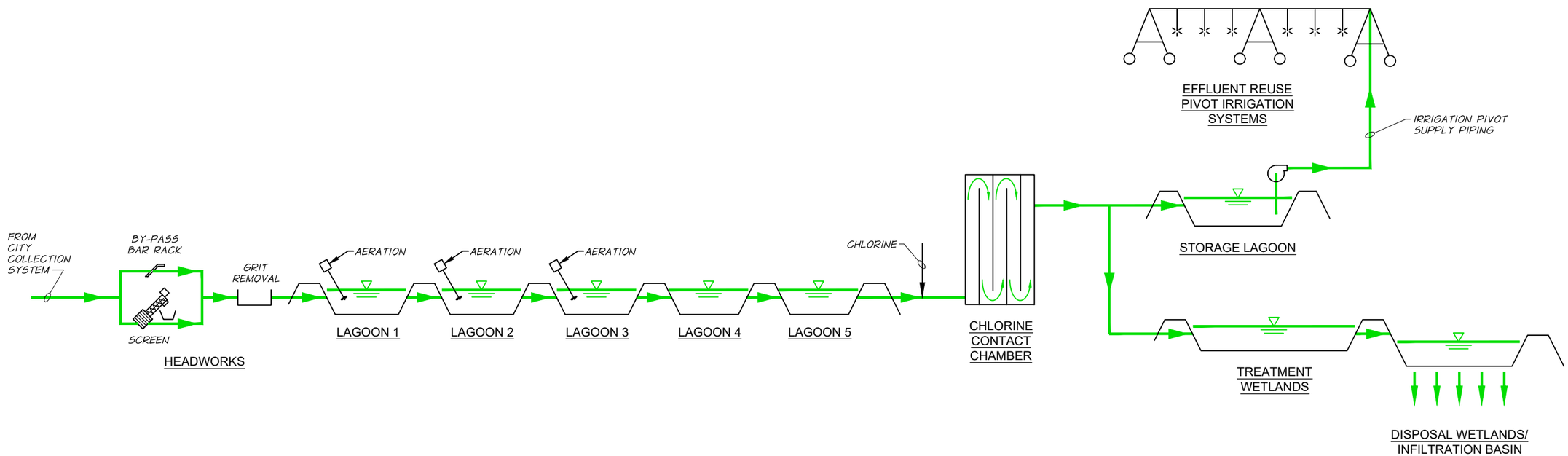
CITY OF REDMOND, OREGON
LAGOON AND WETLAND TREATMENT AND DISPOSAL FEASIBILITY EVALUATION
SUPPORT FACILITIES
PRELIMINARY COST ESTIMATE
(YEAR 2020 COSTS)

NO.	DESCRIPTION	UNIT	UNIT PRICE	ESTIMATED QUANTITY	PRICE
1	Mobilization/Demobilization (5% of Construction Cost)	LS	$ 600,500	All Req'd	$ 600,500
2	Main Division Building	SF	250	8,750	2,187,500
3	Maintenance Building	SF	175	12,000	2,100,000
4	Generator Building	SF	200	320	64,000
5	Roads and Parking	SY	22	16,000	352,000
6	Operations Building (Motor Control Center, Control Room, Lab)	SF	250	3,000	750,000
7	Lift Station	LS	400,000	All Req'd	400,000
8	Vacuum Truck/Septage Dump	LS	90,000	All Req'd	90,000
9	Sludge Drying Beds	Acre	750,000	3	2,250,000
10	Domestic Water	LF	40	10,000	400,000
11	Fencing/Site Work	LS	100,000	All Req'd	100,000
12	Headworks	LS	400,000	All Req'd	400,000
13	Rock Removal	CY	60	200	12,000
14	Electrical and Controls	LS	700,000	All Req'd	700,000
15	Site Piping	LF	60	4,000	240,000
16	Grit Chamber	LS	300,000	All Req'd	300,000
17	Rock Processing	LS	250,000	All Req'd	250,000
				Sum of Estimated Improvements Construction Cost	**$ 11,196,000**
				Construction Contingency (15%)	1,679,000
				Subtotal Estimated Improvements Construction Cost	**$ 12,875,000**
				Administration, Legal, and Engineering (20%)	2,575,000
				TOTAL ESTIMATED PROJECT COST (2020 DOLLARS)	**$ 15,450,000**

PRESENT WORTH ANALYSIS (2020 DOLLARS)

Item	Description	Annual Cost
ADDITIONAL ANNUAL OPERATION, MAINTENANCE, AND REPLACEMENT (OM&R)		
1	Labor (Headworks and Lift Station Only)	$ 126,000
2	Supplies, Parts, Maintenance, and Repairs	10,000
3	Replacement	30,000
	Total OM&R	**$ 166,000**
	Present Worth Operation and Maintenance Cost (5%, 20 years)	2,069,000
	Total Present Worth (2020 Dollars)	**$ 17,519,000**

FIGURES



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CITY OF
REDMOND, OREGON
RECLAIMED WATER WETLAND REUSE FEASIBILITY EVALUATION

TREATMENT PROCESS FLOW SCHEMATIC

FIGURE
1

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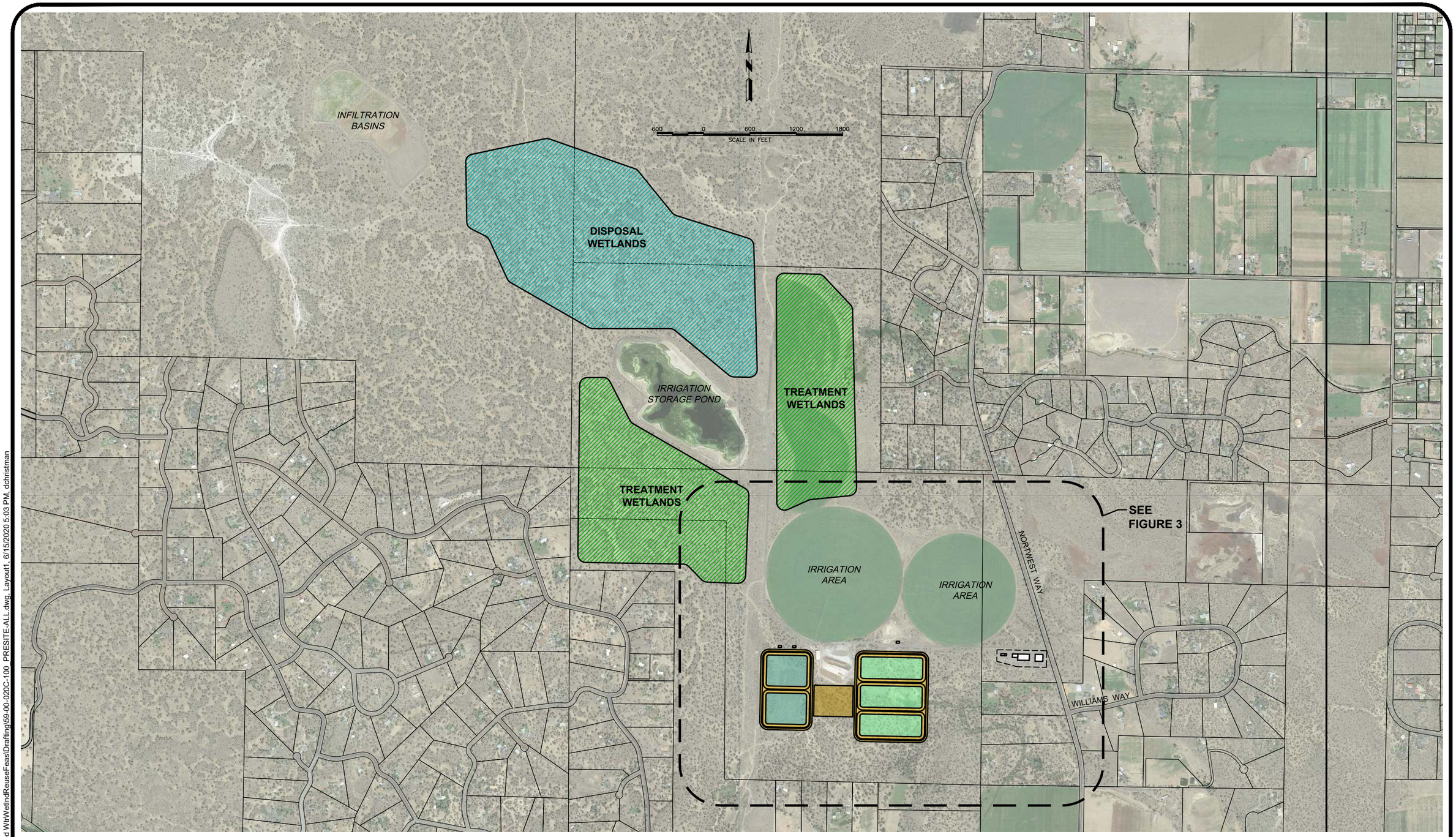

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CITY OF
REDMOND, OREGON
RECLAIMED WATER WETLAND REUSE FEASIBILITY EVALUATION

IMPROVEMENTS PLAN

FIGURE
2

IRRIGATION STORAGE POND

TREATMENT WETLANDS

TREATMENT WETLANDS

IRRIGATION AREA

IRRIGATION AREA

NORTWEST WAY

300 0 300 600 900
SCALE IN FEET

5 AC. SETTLING LAGOON CELL 1

5 AC. SETTLING LAGOON CELL 2

5 AC. AERATED LAGOON CELL 1

5 AC. AERATED LAGOON CELL 2

5 AC. AERATED LAGOON CELL 3

WILLIAMS WAY

IMPROVEMENTS SCHEDULE

1. MAIN DIVISION BUILDING (8,750 SQ. FT.)
2. MAINTENANCE BUILDING (12,000 SQ. FT.)
3. OPERATIONS BUILDING (3,000 SQ. FT.)
4. VAC-TRUCK/SEPTAGE DUMP
5. HEADWORKS (SCREENS AND LIFT STATION)
6. DISINFECTION BUILDING
7. BLOWER BUILDING
8. FUTURE SLUDGE DRYING BEDS
9. CHLORINE CONTACT BASIN

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CITY OF
REDMOND, OREGON
RECLAIMED WATER WETLAND REUSE FEASIBILITY EVALUATION

IMPROVEMENTS DETAIL PLAN

FIGURE
3

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