WASTEWATER FACILITY PLAN AMENDMENT - 2020

Prepared for the
City of Redmond, Oregon

anderson perry

1901 N. Fir Street, La Grande, Oregon
214 E. Birch Street, Walla Walla, Washington
2659 S.W. 4th Street, Suite 200, Redmond, Oregon
243 E. Main Street, Suite C, Hermiston, Oregon

WASTEWATER FACILITY PLAN AMENDMENT

FOR

CITY OF REDMOND, OREGON

2020

REGISTERED PROFESSIONAL ENGINEER
59632PE
OREGON
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ANDERSON PERRY & ASSOCIATES, INC.

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Job No. 59-00

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Preface

The City of Redmond, Oregon, contracted Anderson Perry & Associates, Inc., to conduct a Lagoon and Wetland Treatment and Disposal Feasibility Evaluation (Evaluation), completed in July 2020 for wastewater treatment alternatives and, subsequently, this Wastewater Facility Plan Amendment (Amendment) to their 2019 Update of the Wastewater Facility Plan (WWFP). This Amendment summarizes the results of the Evaluation and is intended to supplement and not replace the WWFP. Therefore, this Amendment will closely follow the outline of the WWFP to best synchronize the contents of each document. Detailed background on the City of Redmond's physical environment, planning and service area, and existing infrastructure can be found in the WWFP.

Sections that are not addressed in this Amendment can be referred to in the original WWFP.

A1.0 Basis of Planning

A1.1 Introduction and Need for the Project

The City recently completed a WWFP Update in November 2019. The WWFP established a basis of planning, existing facilities evaluation, regulatory requirements, alternatives analysis, and recommended improvements. Several alternatives were evaluated as seen in Section 4.0 of the WWFP; however, all considered alternatives included expanding the existing mechanical treatment plant at its current location. The City wished to also consider abandoning the constrained site of the existing mechanical treatment plant and evaluate the option of lagoon and wetland treatment and disposal. The purpose of this Amendment is to update the design criteria to the year 2045 and add an alternative for a lagoon treatment system with a constructed wetland treatment and disposal system to meet the City's needs.

A1.5 Existing and Future Population, Flows, and Loads

Remaining consistent with the WWFP, this Amendment uses the Portland State University: Oregon Population Forecast Program to estimate future population data. The data suggest the population in Redmond may increase to approximately 54,000 by the end of 2045.

Historic flow data used for this Amendment differ from that used in the WWFP due to a correction in data collected by the City. In October 2019, the City discovered the influent flowmeter was not reading correctly. This provided flows that were less than actual; therefore, the design criteria used in the WWFP were not accurate. The flowmeter has been recalibrated, and the following corrections have been made, along with clarifications:

- **Population - 53,800**. As used in the WWFP.
- **Average Annual Flow - 4.34 million gallons per day (MGD)**. A review of the influent flows between January 2015 and October 2019 showed the average per capita flow to be 65.2 gallons per capita per day (gpcd). This flow is a little lower than what would normally be expected. After the flowmeter was reset, the flows between November 2019 and June 2020 were 80.8 gpcd, which provided an increase of 15.6 gpcd. This is in the range normally seen for communities in this region. This increase was added to the flow records before October 2019 to obtain a more accurate indication of historic influent flows. The per

capita flow was then used with the design population to determine the average annual design flows.

- **Maximum Month Flow - 4.51 MGD**. The adjusted per capita flows noted above were used for the highest flow month of each year. These were then averaged and multiplied by the design population.
- **Average Annual Five-day Biochemical Oxygen Demand (BOD_5) - 501 milligrams per liter (mg/L), 18,134 pounds per day (ppd)**. The average annual concentration was used with the design flows to determine loadings.
- **Maximum Month BOD_5** - A review of the historic data show the maximum flow months produce less BOD_5 loading than the average. For this reason, the average annual loading of 18,134 ppd should be used.
- **Average Annual Total Suspended Solids (TSS) - 353 mg/L, 12,777 ppd**. The historic average concentration was used with the design flow.
- **Maximum Month TSS - 357 mg/L, 13,428 ppd**. The historic average concentrations from each of the annual maximum months were used with the design maximum month flow to obtain the loading.
- **Average Annual Total Kjeldahl Nitrogen (TKN) - 65 mg/L, 2,353 ppd**. The design concentration from the WWFP Update was used with the flow above.
- **Maximum Month TKN - 75 mg/L, 2,821 ppd**. The design concentration from the WWFP Update was used with the flow above.
- **Peak Hour Flow - 11.63 MGD**. The WWFP Update indicated the peak hour flow can be calculated using a peaking factor of 2.68 with the average annual flow.

A1.6 Summary

The updated projected flows and loads used in this Amendment compared to those used in the WWFP can be seen on Tables 1-1 and 1-2. The projections presented on Table 1-2 are used in the following sections.

TABLE 1-1
PROJECT FLOWS AND LOADS FROM THE WASTEWATER FACILITY PLAN

Year	Population	Average Annual Flow, MGD	Maximum Month BOD_5 Load, ppd	Maximum Month TSS Load, ppd	Maximum Month TKN Load, ppd
2017	28,800	1.90	9,800	7,000	1,200
2020	30,700	2.00	10,800	8,200	1,400
2025	34,400	2.20	12,100	9,200	1,500
2030	38,600	2.50	13,600	10,300	1,700
2035	43,200	2.80	15,200	11,600	2,000
2040	48,400	3.10	17,100	13,000	2,200
2045	53,800	3.50	19,000	14,400	2,400

TABLE 1-2
UPDATED PROJECT FLOWS AND LOADS

Year	Population	Average Annual Flow, MGD	Maximum Month BOD_5 Load, ppd	Maximum Month TSS Load, ppd	Maximum Month TKN Load, ppd
2017	28,800	2.33	10,088	7,188	1,510
2020	30,700	2.48	10,753	7,662	1,610
2025	34,400	2.78	12,049	8,586	1,804
2030	38,600	3.12	13,520	9,634	2,024
2035	43,200	3.49	15,131	10,782	2,265
2040	48,400	3.91	16,953	12,080	2,538
2045	53,800	4.34	18,134	13,428	2,821

A3.0 Regulatory Requirements

Section 3 of the WWFP outlines the current water quality standards under the Water Pollution Control Facilities (WPCF) Permit that the City must comply with, as well as potential future regulatory considerations. As this Amendment is focused on evaluating the alternative of lagoon and wetland treatment and disposal, regulatory considerations surrounding this alternative will be outlined.

The City's current WPCF Permit for the existing mechanical treatment plant would be modified or renewed with the construction of an entirely new treatment system. The existing mechanical treatment plant provides secondary treatment through the use of an activated sludge process with discharge to groundwater via an infiltration gallery. The system proposed in this Amendment would utilize aerated lagoons for secondary treatment, lined constructed wetlands for tertiary treatment, and unlined disposal wetlands with the existing infiltration basins for effluent disposal. The added wetland treatment and disposal areas will enhance water quality using more natural processes but will be completely different than the existing facilities. The new treatment system will require that a modified or renewed WPCF Permit be obtained. For this reason, an initial meeting was held with Oregon Department of Environmental Quality (DEQ) staff to discuss this treatment and disposal alternative with respect to a new permit. Generally, the DEQ is supportive of this option and feels that it can be permitted.

Since a new permit will be required but not yet obtained, the existing groundwater protection (Oregon Administrative Rules [OAR] 340-040) and effluent reuse rules (OAR 340-055) will be used for guidance in the evaluation of the lagoon and wetland alternative. The contaminate of specific note for groundwater protection from the proposed facility is a Nitrate - N limit of 10 mg/L. No other contaminates shown on OAR 340-040 Tables 1, 2, and 3 are anticipated to be at levels of concern in the treated effluent.

Effluent reuse is governed by OAR 340-055 and an approved Reclaimed Water Use Plan. Currently, the City irrigates crops not for human consumption using Class C effluent. This type of reuse only requires Class D or non-disinfected effluent based on the OARs. The existing WPCF Permit requires Class D effluent for discharge to the infiltration beds. The proposed treatment system would disinfect secondary effluent prior to discharging to treatment wetlands, then disposal wetlands, and ultimately an infiltration gallery. It is proposed that the wetland area be accessible to the public for non-contact use of adjacent walking paths for wildlife viewing and exercise. The area will be posted to prevent human contact with wetland water. A 10-foot setback is required by OAR 340-055. For this use, disinfecting the effluent to a Class D level prior to discharging to the treatment wetland is proposed. The natural wetland system and wildlife use would make disinfection limits after the treatment wetland unpredictable.

A4.0 Alternatives Analysis

The City conducted an extensive alternatives analysis as seen in Section 4.0 of the WWFP. Along with the preferred mechanical treatment plant expansion alternative, the City can consider two additional alternatives: 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. These three options will be compared considering capital cost, life cycle cost, land and future expandability, and community benefits.

A4.1 Lagoon Treatment

Lagoon treatment can be provided with a facultative lagoon, partially aerated lagoon, or aerated lagoon.

A4.1.1 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 360 acres and the second stage would need to be 160 acres, for a total lagoon size of 520 acres. For construction purposes, it is suggested to divide these lagoon cells into maximum 40-acre units. Then, there would be approximately 13 40-acre lagoons. See Appendix A for preliminary calculations.

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 (see Metcalf & Eddy, Wastewater Engineering, Third Edition). 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.

A4.1.2 Partially Aerated

A partially aerated lagoon would provide some of the oxygen requirements through an aeration system. For purposes of this evaluation, it was assumed 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 4 acres. The second stage would then be approximately 160 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 106 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 existing WPCF Permit limits. For this reason, it is recommended a treatment wetland be added for effluent polishing.

A4.1.3 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 755 Hp is needed to provide the required oxygen. The depth of the lagoon cells would be approximately 11 feet. The total wet area needed would be approximately 25 acres.

Solids handling would not be anticipated for this option, as solids reduction would occur in the lagoon cells. Solids removal is still anticipated to 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 existing WPCF Permit limits. For this reason, a treatment wetland would be recommended to be added for effluent polishing.

A4.1.4 Aerated Lagoon with Orbal 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 would provide 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 mechanical 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 it 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 10 days, and the lagoon size from 25 to 13 acres.

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

Table 4-1 shows a summary of costs for these treatment alternatives.

TABLE 4-1
SUMMARY OF LAGOON ALTERNATIVES

	Facultative Lagoon	**Partially Aerated Lagoon**	**Aerated Lagoon**	**Orbal Plus Aerated Lagoon**
Mobilization/Demobilization (5% of Construction Cost)	$1,020,000	$800,000	$430,000	$250,000
Earthwork	1,750,000	860,000	678,000	564,000
Rock Removal	9,680,000	3,876,000	1,920,000	486,000
Liner	21,000,000	8,712,000	1,089,000	828,000
Control Structures	180,000	75,000	60,000	60,000
Piping	336,000	216,000	120,000	120,000
Gravel	162,000	76,000	28,000	22,000
Diffusers	0	1,200,000	1,500,000	900,000
Blowers	0	650,000	800,000	480,000
Blower Building	0	240,000	360,000	240,000
Electrical and Controls	0	500,000	600,000	500,000
Fencing	126,000	60,000	30,000	30,000
Site Work	50,000	50,000	50,000	50,000
Sum of Estimated Construction Cost	$34,304,000	$17,315,000	$7,665,000	$4,530,000
Construction Contingency (15%)	5,146,000	2,597,000	1,150,000	680,000
Subtotal Estimated Construction Cost	39,450,000	19,912,000	8,815,000	5,210,000
Administration, Legal, and Engineering (10% to 20%)	3,945,000	3,982,000	1,763,000	1,042,000
Total Capital Costs	43,395,000	23,894,000	10,578,000	6,252,000
20-year Estimated O&M Cost	3,029,000	7,976,000	8,923,000	8,462,000
Total Estimated 20-year Life Cycle Cost (2020 Dollars)	**$46,424,000**	**$31,870,000**	**$19,501,000**	**$14,714,000**

As seen on Table 4-1, the option of using a facultative or partially aerated lagoon is cost prohibitive due to the overall size and amount of liner required. Further examination of the aerated lagoon and using the City's existing Orbal system plus an aerated lagoon is analyzed considering operational impacts, long-term maintenance, location, odor concerns, future flexibility, energy efficiency, and community benefits. This analysis indicates the aerated lagoon alternative should be pursued by the City. Results of the comparison are included in Section A4.5.

A4.2 Wetlands

Wetlands are a natural treatment system that provide an environment for the healthy growth of microbial colonies that decompose organic materials and return them to their basic molecular structures. For example, complex hydrocarbons found in organic materials are consumed by microbes for their stored energy and turned into carbon dioxide, water, nitrogen gas, and phosphorus. In general, wetlands provide food and shelter for a wide variety of microbes, macroinvertebrates, insects, amphibians, waterfowl, upland birds, mammals, and all forms of life in a complex ecosystem.

A4.2.1 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 would provide 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 would be provided in the wetlands, but nitrogen reduction would be improved when multiple wetland cells constructed in series are provided. See Table 4-2 for a preliminary estimated project cost for these improvements.

TABLE 4-2
TREATMENT WETLAND COST ESTIMATE

Mobilization/Demobilization (5% of Construction Cost)	$400,000
Earthwork	402,000
Rock Removal	1,944,000
Liner	3,050,000
Control Structures	90,000
Piping	240,000
Gravel	42,000
Topsoil Removal and Replacement	904,000
Seeding and Planting	20,000
Fencing	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**

A4.2.2 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 their seepage rate. Due to the function of the seepage area and the standing water from the irrigation ditch return water, it is assumed that the natural ground could provide very high infiltration rates or low infiltration rates. The existing seepage area has multiple cells with only one cell operating at a time. Based on current operation, the seepage area appears to have sufficient capacity to serve the City in the future. For this reason, the disposal wetlands are not necessarily needed, but there is an opportunity to beneficially use the effluent in a wetland environment that could be accessible to the public. This would provide a natural wildlife and park area. It is suggested to set aside approximately $4,000,000 for construction of publicly accessible wetland and wildlife park features as disposal wetlands between the treatment wetlands and the existing seepage area.

A4.3 Disinfection

After the wastewater is treated in the lagoon system, it would be disinfected. The alternatives for wastewater disinfection that would normally be considered include chlorine, ultraviolet (UV), and ozone. Using lagoon treatment prior to disinfection would make UV and ozone somewhat unreliable due to uncontrolled interferences with disinfection efficiency that come from the lagoon treatment system. For this reason, chlorine disinfection is recommended.

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 groundwater. The total project cost for this system is summarized on Table 4-3.

TABLE 4-3
DISINFECTION SYSTEM ESTIMATED PROJECT COST

Mobilization/Demobilization (5% of Construction Cost)	$66,000
Building	200,000
Chlorination Equipment	40,000
Chlorine Contact Basin	280,000
Electrical and Controls	100,000
Piping	12,000
Rock Removal	60,000
Gravel	2,000
Steel Building over Basin	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**

A4.4 Support Facilities

Support facilities are necessary for all three alternatives. As shown in the WWFP, recommended support facilities upgrades that apply to all alternatives total $7,100,000, as similar facilities are needed for both the Orbal and lagoon systems. However, the alternatives that abandon the Orbal system will require additional support facilities that include a new headworks, grit chamber, septage dump, etc. These are shown on Table 4-4, with the support facilities identified in the WWFP.

Table 4-4 also shows costs for constructing sludge drying beds to provide operator flexibility in being able to continually manage biosolids accumulation by wet dredging some biosolids as an alternative to taking a lagoon cell off line. The beds could also be used to dry grit. These drying beds could be constructed as part of the initial project or could be constructed as an additional phase after a few years of biosolids accumulation.

TABLE 4-4
SUPPORT FACILITIES COST ESTIMATE

Mobilization/Demobilization (5% of Construction Cost)	$600,500
Main Division Building	2,187,500
Maintenance Building	2,100,000
Generator Building	64,000
Roads and Parking	352,000
Operations Building (Motor Control Centers, Control Room, Lab)	750,000
Lift Station	400,000
Vacuum Truck/Septage Dump	90,000*
Sludge Drying Beds	2,250,000
Domestic Water	400,000
Fencing/Site Work	100,000
Headworks	400,000*
Rock Removal	12,000
Electrical and Controls	700,000
Site Piping	240,000
Grit Chamber	300,000*
Rock Processing	250,000
Sum of Estimated Construction Cost	$11,196,000
Construction Contingency (15%)	1,679,000
Subtotal Estimated Construction Cost	12,875,000
Administration, Legal, and Engineering (20%)	2,575,000
TOTAL ESTIMATED PROJECT COST (2020 DOLLARS)	**$15,450,000**

**Not included in the Orbal plus Aerated Lagoon option.*

A4.5 Ranking

The aerated lagoon, existing Orbal aeration system plus aerated lagoon, and recommended expansion of the existing mechanical treatment plant from the WWFP are considered the viable alternatives to be ranked for comparison purposes. The selection of a preferred alternative from a variety of viable alternatives should consider several factors. The factors could include capital cost, total life cycle cost, ease of operation, maintenance, construction risk, odor concerns, future flexibility, energy efficiency, community benefits, and location. Each of these factors does not bear the same level of importance, so a weight factor is also added to assign more value to the more important factors. The factors, their ranks, and the weighted rankings are shown on Table 4-5 below.

TABLE 4-5
ALTERNATIVE RANKINGS

	Ranking (Weighted Ranking)		
Criterion (Weight)	**Aerated Lagoon**	**Orbal Plus Aerated Lagoon**	**Expand Existing Mechanical Treatment Plant**
Capital Cost (2)	$41.6 million 2 (4)	$38.5 million 3 (6)	$47.7 million 1 (2)
Life Cycle Cost (3)	$53.9 million 2 (6)	$52.8 million 2 (6)	$62.0 million 1 (3)
Ease of Operation (1)	3 (3)	1 (1)	2 (2)
Maintenance (2)	3 (6)	2 (4)	1 (2)
Construction Risk (2)	1 (2)	1 (2)	2 (4)
Odors (2)	3 (6)	2 (4)	1 (2)
Future Flexibility (1)	2 (2)	2 (2)	1 (1)
Expandability (3)	3 (9)	3 (9)	1 (3)
Energy Efficiency (1)	3 (3)	2 (2)	1 (1)
Community Benefit (2)	3 (6)	2 (4)	1 (2)
Regulatory Flexibility (3)	3 (9)	2 (6)	1 (3)
Location (2)	3 (6)	2 (4)	1 (2)
Total (Weighted Total)	**31 (62)**	**24 (50)**	**14 (27)**

Notes:

1. Highest Ranking = 3, Intermediate Ranking = 2, Lowest Ranking = 1. Weighted ranking is obtained by multiplying the ranking by the weight.

2. Costs for expand mechanical treatment plant are taken from the WWFP and inflated 2 years at 3.5 percent

3. Capital and life cycle costs are taken from the Lagoon and Wetland Treatment and Disposal Feasibility Evaluation (see Appendix B).

A5.0 Recommended Improvements

Based on the alternative rankings on Table 4-5, the alternative to move the entire treatment system, offices, and shops to a new location is proposed. The improvements would include an aerated lagoon system for secondary treatment with a lined treatment wetland for effluent polishing. Disposal would be through irrigation reuse and reuse in an unlined wetland and the existing infiltration gallery. Primary treatment would be provided with screening and grit removal. Figure 1 shows the proposed treatment process flow schematic and the following details describe each process. Figures 2 and 3 show a conceptual layout on the proposed site. These figures show some of the improvements on property not owned by the City, yet the layout could be modified to utilize City-owned property for everything but the disposal wetlands and infiltration gallery (seepage beds).

The existing WPCF Permit is established for a 2.99 MGD activated sludge mechanical treatment plant and has process limits identified for water entering the constructed disposal area wetlands (seepage beds) that are defined as moderate rate infiltration basins (Outfall 001). These limits were set for the effluent from a 2.99 MGD activated sludge mechanical treatment plant directly entering Outfall 001. In addition, the Permit has limits on downgradient groundwater monitoring wells. The Permit will need to be modified for the new treatment process and treatment plant capacity of 4.34 MGD. The new, larger capacity lagoon and wetland treatment system will protect the groundwater resources, but the change in the system will require a change in permit limits prior to water entering the groundwater. The use of the wetland system for effluent polishing will improve water quality, but the wetlands will also be susceptible to algae blooms (as the existing seepage beds are). This will make it difficult to consistently meet the current TSS limit of 20 mg/L entering the seepage beds. The 20 mg/L TSS limit was appropriately established for the activated sludge mechanical treatment plant. It is proposed to modify the Permit to increase the monthly average daily flow to 4.34 MGD and maintain the current groundwater limits of 9 mg/L nitrate and 500 mg/L total dissolved solids. In addition, it is proposed to eliminate limits for Outfall 001 but impose appropriate limits for treatment equivalent to secondary (as defined in 40 Code of Federal Regulations 133) on the aerated lagoon effluent prior to entering the polishing wetlands.

A5.1 Headworks (Primary Treatment)

The headworks consists of a screening system to remove rags and debris in wastewater. The headworks would have two rotary drum screens sized for the peak hour flow. Moving the existing screens to the new location is proposed.

After screening, wastewater will flow through a grit chamber where grit would be settled and pumped to a grit classifier for dewatering and disposal in a landfill. An aerated grit chamber could be used since air should be available from the lagoon blowers. The aerated grit chamber would provide approximately three minutes of detention time at peak flow and be dual chambered with approximately 1,620 cubic feet in volume in each chamber. The basins would each be approximately 6 feet deep, 10 feet wide, and 30 feet long. Approximately 300 cubic feet per minute of air would be needed to run the chambers. A vortex pump would remove the settled grit from a sump in the bottom of the chamber and pump it to a dewatering system.

A lift station would be added to pump the screened and de-gritted wastewater to the aerated lagoons. This lift station would meet Level 2 reliability with approximately four submersible pumps each rated at 2,020 gallons per minute.

A5.2 Aerated Lagoon (Secondary Treatment)

A partially mixed, aerated lagoon would consist of five cells with a total detention time of 20 days. A total requirement of approximately 750 Hp would be needed to provide the required oxygen. The operating depth of the lagoon cells would be approximately 11 feet. The total wet area needed would be approximately 25 acres.

The five-cell aerated lagoon system would include a final settling cell area that is a minimum of 2 acres in size to provide adequate solids settling. To avoid needing to clean all ponds at one time, the City could install a small drying bed area with dredge piping from the lagoon cells to the drying beds. City crews could then operate a dredge to pump solids from the bottom of the lagoons to the drying beds on a regular maintenance interval. Even with these improvements, it is anticipated it will take several years before there is enough accumulated biosolids in the bottom of the lagoons to be removed with a dredge.

A treatment wetland for effluent polishing would be recommended. To provide added operator flexibility, improvements could be completed that would allow for a future low head recycle pump to be easily added to recycle nitrified effluent to the first aerated lagoon for denitrification and added total nitrogen reduction.

A5.3 Treatment Wetlands

After biologic stabilization of the waste is provided in the lagoon system, the lagoon effluent should be further "polished" in lined treatment wetlands to provide a more natural environment to further reduce pathogens and nutrients. The wetland would be seeded and planted. This would require a wetland complex with approximately 70 wet acres.

A5.4 Disposal Wetlands and Infiltration Gallery

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 an infiltration gallery that leaks at a high rate. The proposed construction site also contains two irrigation tailwater ponds that hold water. 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 could provide high infiltration rates, but the tailwater ponds indicate there are areas that could hold water. The existing seepage area has four cells with only one or two cells operated at a time. Based on current operation, the seepage area appears to have sufficient capacity to serve the City in the future. The capacity of the existing seepage area is currently adequate to dispose of the design rate of 4.34 MGD, so improvements to the infiltration gallery are not proposed, and the existing irrigation system is proposed to be maintained.

A5.5 Capital Cost and Life Cycle Cost

The total estimated capital and life cycle cost for moving the treatment plant is summarized on Table 5-1.

TABLE 5-1
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**

A5.6 Other Beneficial Uses

Although these recommended improvements focus on constructing new wastewater treatment and disposal facilities, considerations could be given to developing other beneficial uses with reclaimed water from the wastewater treatment plant.

The City could construct public trails, viewing areas, and parking for public access to the wetland areas that will be home to a variety of birds and other wildlife. This trail system through the wetland areas could also be tied to 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.

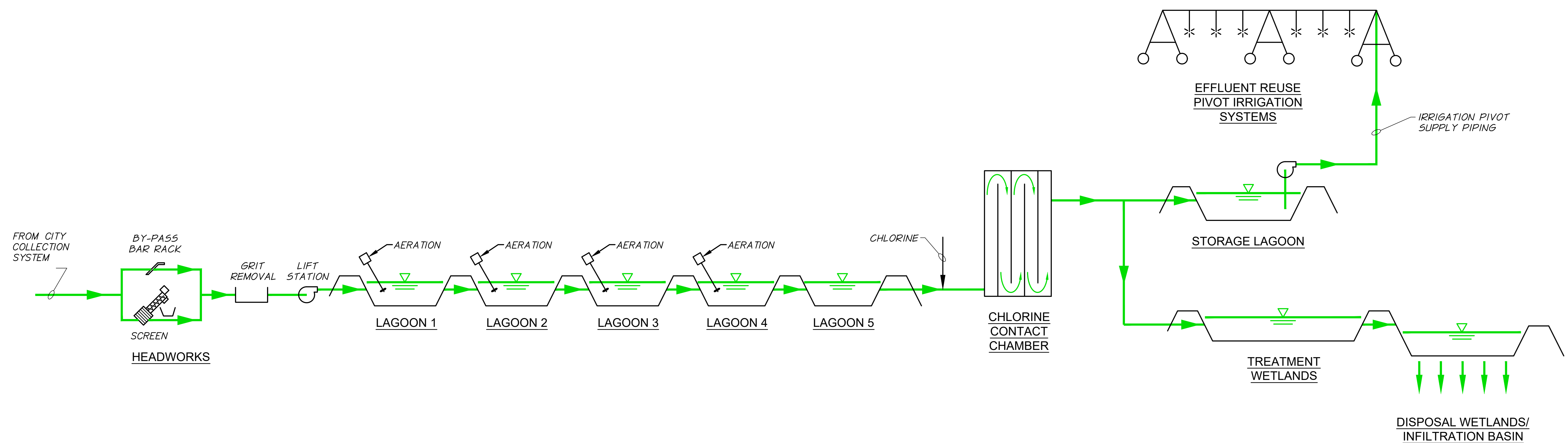
The City could also utilize treated effluent for additional beneficial uses such as irrigating turf grass for new sports fields in the area. Some added effluent polishing may be needed, depending on the proposed beneficial use. At this time, the City is not planning on changing the current irrigation practices.

As improvements are pursued for implementation, these other beneficial uses could be considered.

A6.0 Project Funding

The project will be paid for by user rates and system development charges (SDCs). The project is anticipated be financed (up to 100 percent) primarily through a DEQ loan. Up to $7.5 million of Wastewater Fund cash ($1.8 million operating/$5.7 million SDCs) will either be utilized to pay off higher interest existing debt ($850,000 of annual debt service) or support expansion project costs. The expansion debt will be paid primarily through SDCs, which equated to $2.3 million in fiscal year 2019-20. The Wastewater Fund is positioned to provide support to the expansion debt service as well. Over the past four years, the Wastewater Fund has seen surpluses, averaging approximately $400,000 per year. This surplus is expected to accelerate with the operating efficiencies (reduction in operating costs) gained from the expansion project. Current plant operating costs are approximately $2.5 million annually, which could conservatively see a 25 percent reduction, based on the new treatment concept planned in the expansion project. A five-year forecast is completed annually to evaluate operating needs and any rate increase that may be needed to support ongoing operations and debt service. Over the past five years, operating rates have, on average, increased 1.8 percent annually as part of the City's budget process. Those rate increases have received unanimous support by the Redmond City Council and remain very competitive relative to other public entities in the region.

FIGURES



anderson perry & associates, inc.

CITY OF
REDMOND, OREGON
WASTEWATER FACILITY PLAN AMENDMENT

TREATMENT PROCESS FLOW SCHEMATIC

FIGURE
1

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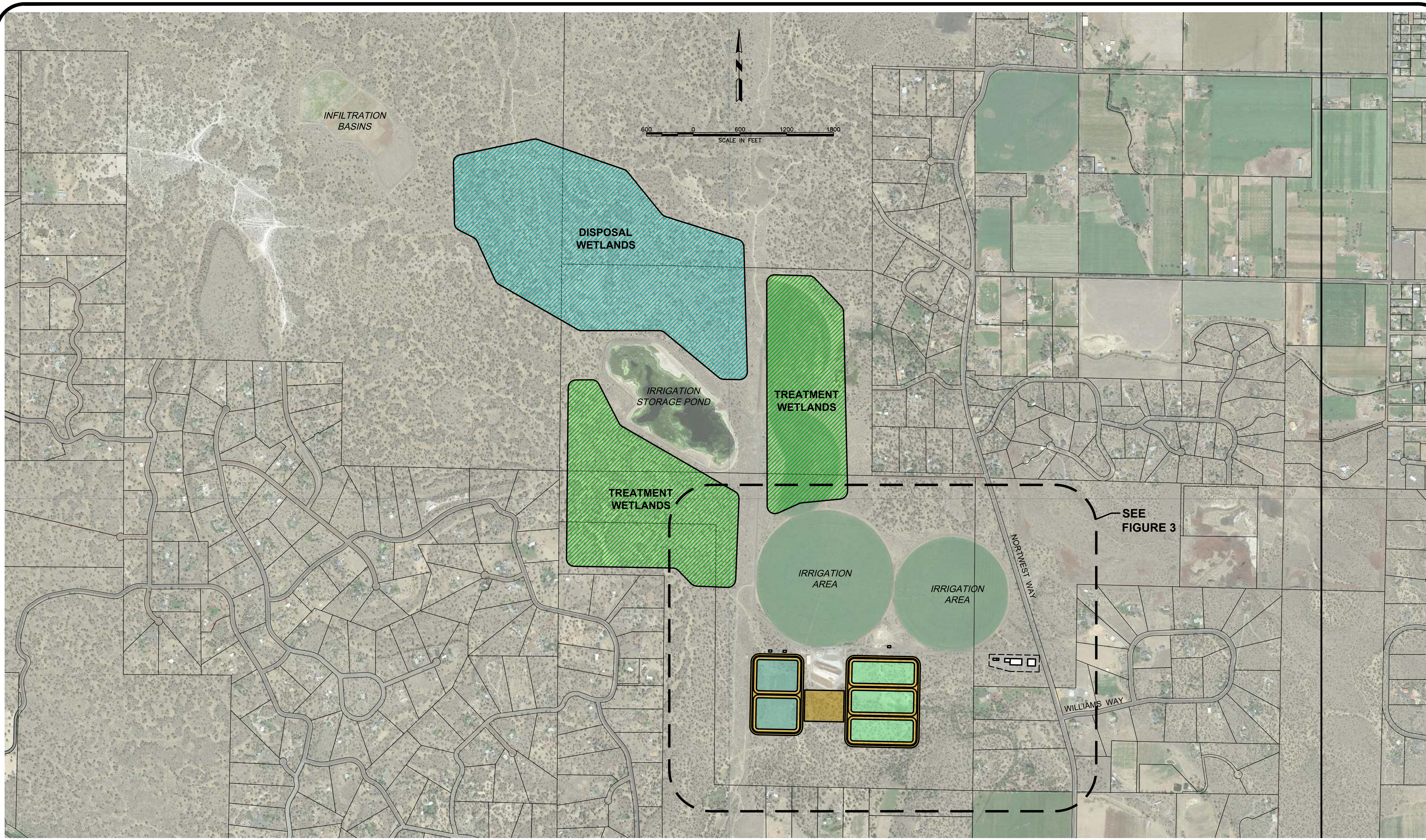

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CITY OF
REDMOND, OREGON
WASTEWATER FACILITY PLAN AMENDMENT

IMPROVEMENTS PLAN

FIGURE 2

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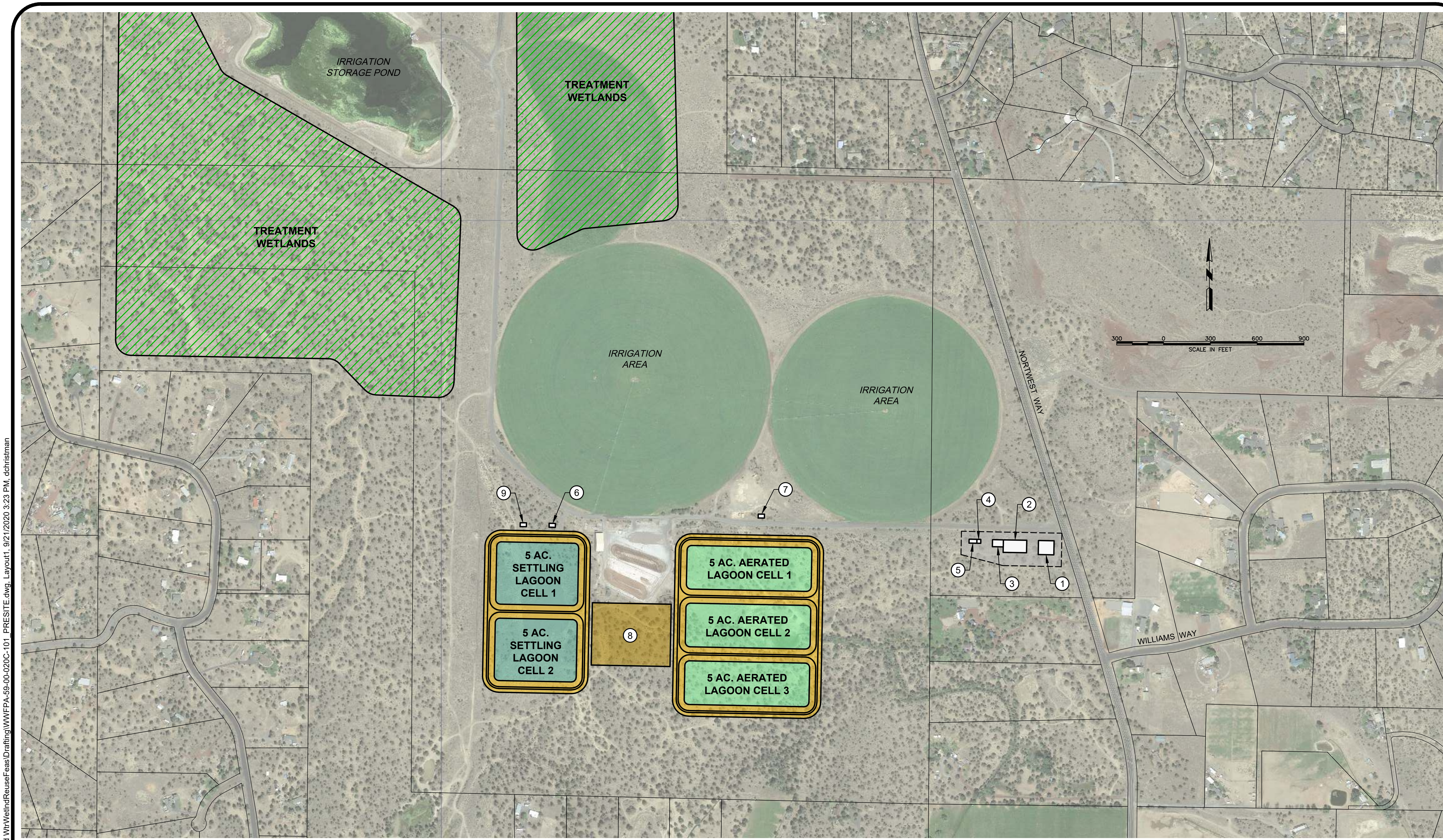

IMPROVEMENTS SCHEDULE

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
WASTEWATER FACILITY PLAN AMENDMENT

IMPROVEMENTS DETAIL PLAN

FIGURE
3

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APPENDIX A
Preliminary Calculations

anderson perry & associates, inc.

Client Redmond Job No.
Project Lagoon Sizing - Prelim.
Designed By BM Ck. By Date 12/20 Page 1 of 2

Facultative

BOD = 18,134 ppd Q = 4.34 MGD

t_{min} = 100 days primary pond loading = 50 ppd/ac.
total pond loading = 35 ppd/ac.

$\frac{18,134\ ppd}{50\ ppd/ac} = 360\ acres$ $\frac{18,134\ ppd}{35\ ppd/ac} = 520\ acres$

Partially Aerated

2 #O_2 / #BOD. 2 #O_2 / Hp-hr t = 3 days - Pre-air Cell
depth = 10 feet

Facultative First Stage = 360 acres @ 30 ppd/ac = 10,800 ppd for Pre-air

$\frac{10,800\ ppd}{24\ hrs} = 360\ Hp$ Vol = 4.34 MGD x 3 days = 13.02 MG
= 40.0 ac-Ft.

area = 40 ÷ 10 = 4 acres

Second Stage = 520 - 360 = 160 acres.
160 acres x 30 ppd/ac = 4,800 ppd

Total	Pre-air	Facultative	
18,134 ppd -	10,800 ppd -	4,800	= 2,534 ppd second stage air

$\frac{2,534\ \#pd}{24\ hrs} = 106\ Hp.$

PRELIMINARY

Partially Mixed aerated

$t = 20$ days $C_0 = 501$ mg/l BOD $C_n = ?$ mg/l BOD $n = 5$ stages

$k = 0.14$ @ 1°C $K = 0.276$ @ 20°C

$$\frac{C_n}{C_0} = \frac{1}{\left(1+\left(\frac{Kt}{n}\right)\right)^n} \Rightarrow \frac{1}{\left(1+\left(\frac{.276\times 20}{5}\right)\right)^5} \times 501 = C_n = 12 \text{ mg/l}$$

@ $C_n = 30$ mg/l $k = 0.189\ d^{-1}$ OK

$$\frac{18{,}134 \text{ ppd BOD}}{24 \text{ hr}} = 755 \text{ Hp}$$

4.51 MGD x 20 days = 90.2 MG
= 277 ac.ft

277 ac.ft / 11 Feet deep = 25 acres.

aerated w/ Orbal

BOD for Lagoons = 9,000 ppd. $\frac{9000 \text{ ppd}}{24 \text{ hrs}} = 375$ Hp 4.51 MGD

$$\frac{9{,}000 \text{ ppd}}{8.34 \times 4.51 \text{ MGD}} = 239 \text{ mg/l BOD}$$ @ $C_n = 30$ mg/l

$$\frac{C_n}{C_0} = \frac{1}{\left(1+\left(\frac{kt}{n}\right)\right)^n} \quad \left(\left(\frac{C_0}{C_n}\right)^{1/n} - 1\right)\frac{n}{K} = t = \left(\left(\frac{239}{30}\right)^{1/5} - 1\right)\left(\frac{5}{.276}\right) = 9.3 \Rightarrow 10 \text{ days}$$

PRELIMINARY

APPENDIX B
Lagoon and Wetland Treatment and Disposal Feasibility Evaluation

LAGOON AND WETLAND TREATMENT AND DISPOSAL FEASIBILITY EVALUATION

FOR

CITY OF REDMOND, OREGON

Prepared for the
City of Redmond, Oregon

anderson perry

1901 N. Fir Street, La Grande, Oregon
214 E. Birch Street, Walla Walla, Washington
2659 S.W. 4th Street, Suite 200, Redmond, Oregon

LAGOON AND WETLAND TREATMENT AND DISPOSAL

FEASIBILITY EVALUATION

FOR

CITY OF REDMOND, OREGON

2020

REGISTERED PROFESSIONAL ENGINEER
59632PE
OREGON
SEPT. 2, 1998
BRETT MOORE
7-8-2020
RENEWS 12-31-20

ANDERSON PERRY & ASSOCIATES, INC.

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

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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**

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CITY OF
REDMOND, OREGON
LAGOON AND WETLAND TREATMENT AND DISPOSAL FEASIBILITY EVALUATION
DISINFECTION SYSTEM
PRELIMINARY COST ESTIMATE

TABLE 6

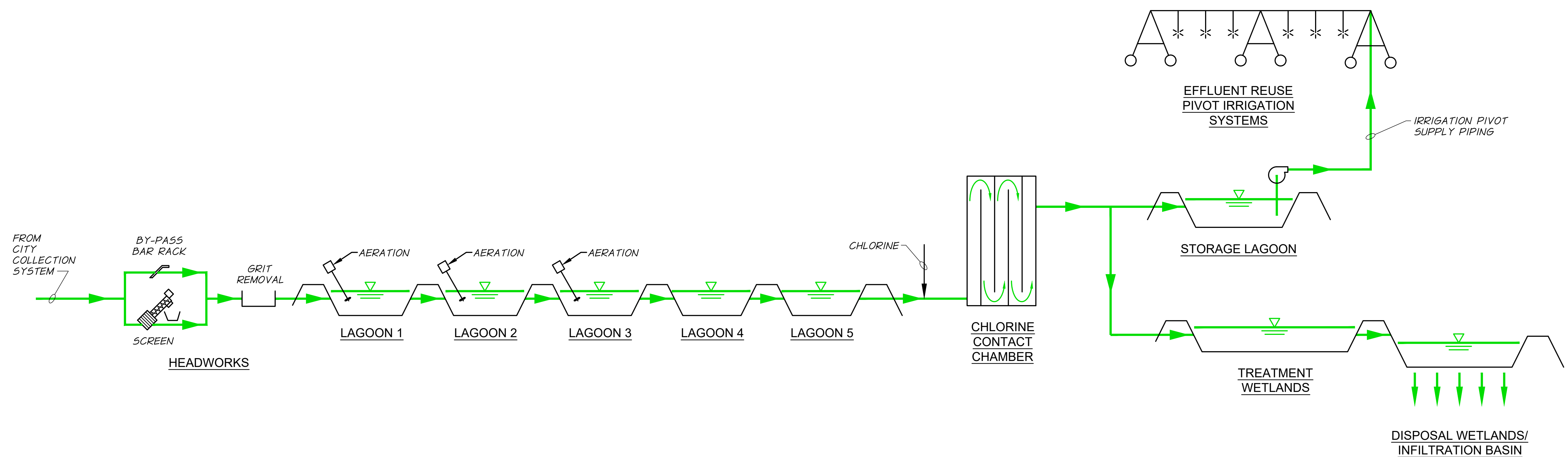
CITY OF REDMOND, OREGON
LAGOON AND WETLAND TREATMENT AND DISPOSAL FEASIBILITY EVALUATION
SUPPORT FACILITIES
PRELIMINARY COST ESTIMATE
(YEAR 2020 COSTS)

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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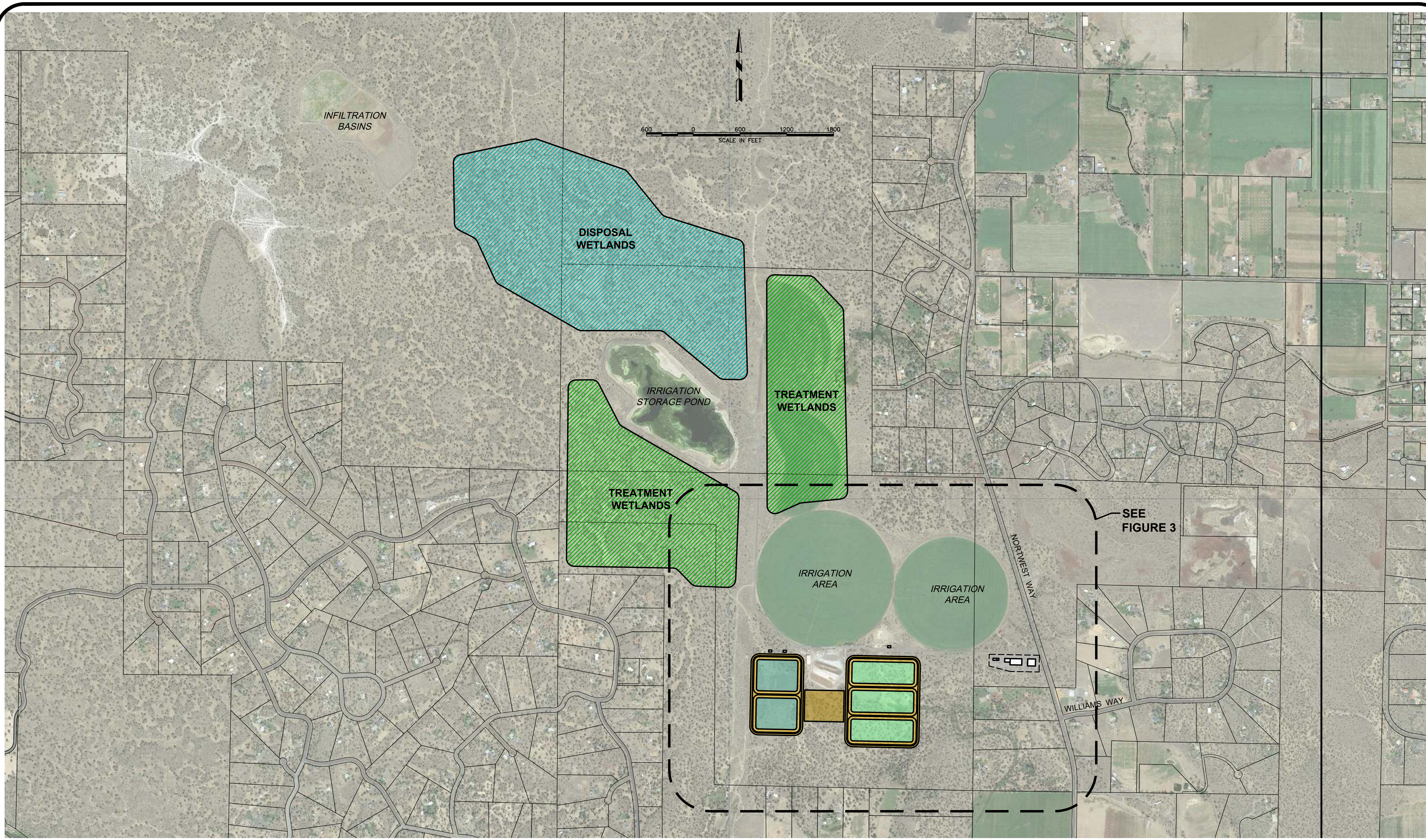
CITY OF
REDMOND, OREGON
RECLAIMED WATER WETLAND REUSE FEASIBILITY EVALUATION

TREATMENT PROCESS FLOW SCHEMATIC

FIGURE 1



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CITY OF
REDMOND, OREGON
RECLAIMED WATER WETLAND REUSE FEASIBILITY EVALUATION

IMPROVEMENTS PLAN

FIGURE 2

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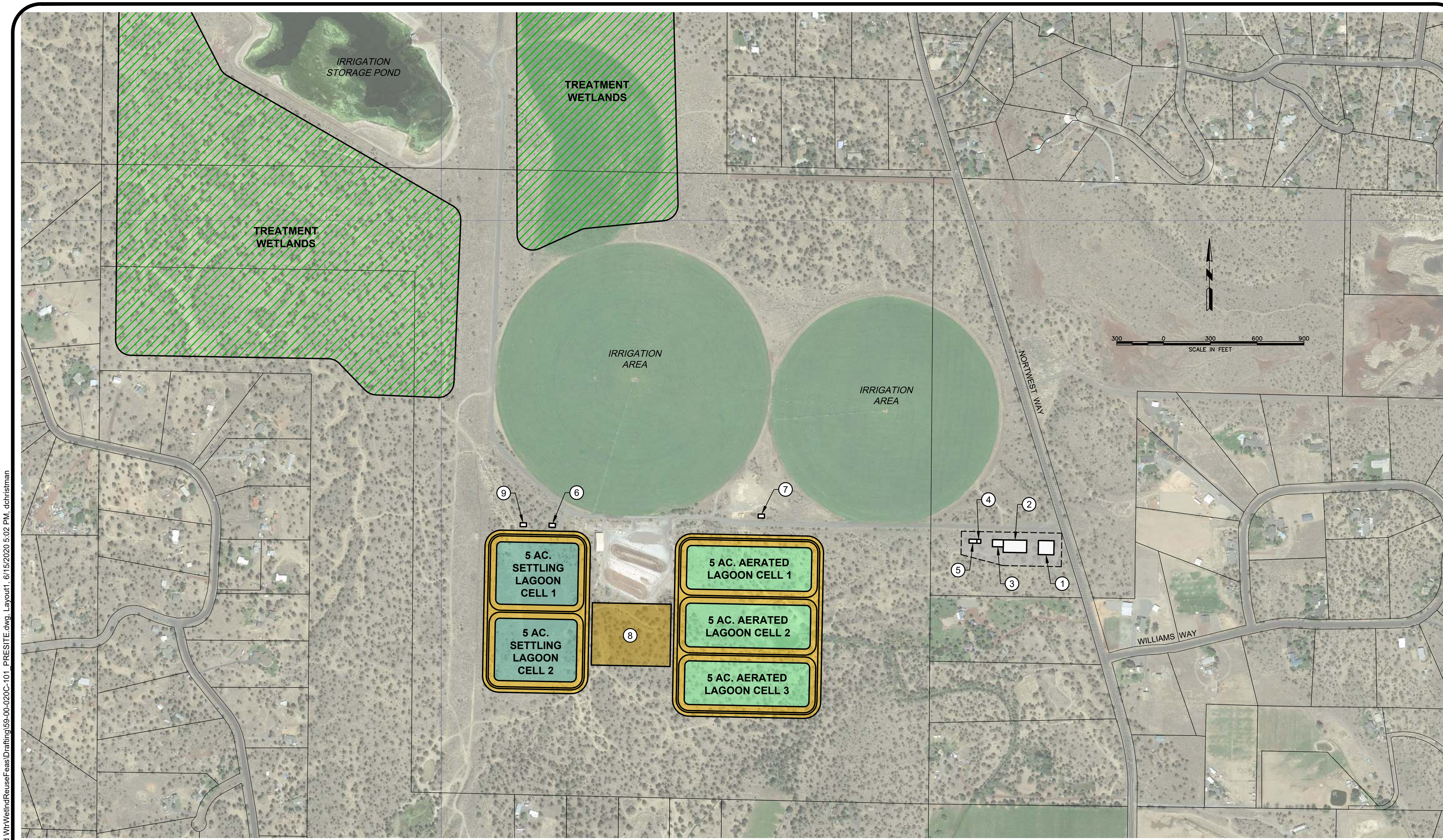

IMPROVEMENTS SCHEDULE

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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