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Appendix

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APPENDIX A
WATER QUALITY DATA SUMMARY TABLE

Appendix A
Water Quality Data Summary

Date	Parameter	Type	Location	Value	unit	MRL
8/16/2019	Alkalinity, Total(CaCO3)	Inorganics	B	46.00	mg/L	2
8/16/2019	Ammonia as N	Inorganics	B	ND	mg/L	0.1
8/16/2019	Biochemical Oxygen Demand	Inorganics	B	ND	mg/L	2
8/16/2019	Chemical Oxygen Demand	Inorganics	B	ND	mg/L	5
8/16/2019	Hardness	Inorganics	B	*Not measured*	mg/L	4
8/16/2019	Nitrate as N	Inorganics	B	ND	mg/L	0.1
8/16/2019	Nitrite as N	Inorganics	B	ND	mg/L	0.01
8/16/2019	Orthophosphate as P	Inorganics	B	ND	mg/L	0.1
8/16/2019	pH	Inorganics	B	7.50	pH Units	
8/16/2019	Phosphorus	Inorganics	B	ND	mg/L	0.05
8/16/2019	Total Dissolved Solids	Inorganics	B	55.00	mg/L	1.00
8/16/2019	Total Organic Carbon	Inorganics	B	0.66	mg/L	0.50
8/16/2019	Total Kjeldahl Nitrogen	Inorganics	B	0.70	mg/L	0.5
8/16/2019	Total Suspended Solids	Inorganics	B	5.00	mg/L	2
8/16/2019	Arsenic	Metals (total)	B	ND	mg/L	0.003
8/16/2019	Cadmium	Metals (total)	B	ND	mg/L	0.0005
8/16/2019	Chromium	Metals (total)	B	ND	mg/L	0.001
8/16/2019	Copper	Metals (total)	B	ND	mg/L	0.05
8/16/2019	Iron	Metals (total)	B	0.145	mg/L	0.05
8/16/2019	Lead	Metals (total)	B	ND	mg/L	0.002
8/16/2019	Manganese	Metals (total)	B	ND	mg/L	0.025
8/16/2019	Mercury	Metals (total)	B	ND	mg/L	0.0002
8/16/2019	Nickel	Metals (total)	B	ND	mg/L	0.0005
8/16/2019	Selenium	Metals (total)	B	ND	mg/L	0.005
8/16/2019	Silver	Metals (total)	B	ND	mg/L	0.05
8/16/2019	pH	Metals (total)	B	7.50	pH Units	
8/16/2019	Total Coliforms	Microbial Analysis	B	2420.00	MPN/100mL	1
8/16/2019	E. Coli	Microbial Analysis	B	20.00	MPN/100mL	1
8/16/2019	Fecal Coliform	Microbial Analysis	B	28.00	MPN/100mL	1.8
8/16/2019	Alkalinity, Total(CaCO3)	Inorganics	C	22.00	mg/L	2
8/16/2019	Ammonia as N	Inorganics	C	ND	mg/L	0.1
8/16/2019	Biochemical Oxygen Demand	Inorganics	C	ND	mg/L	2
8/16/2019	Chemical Oxygen Demand	Inorganics	C	5.00	mg/L	5
8/16/2019	Hardness	Inorganics	C	*Not measured*	mg/L	4
8/16/2019	Nitrate as N	Inorganics	C	ND	mg/L	0.1
8/16/2019	Nitrite as N	Inorganics	C	ND	mg/L	0.01
8/16/2019	Orthophosphate as P	Inorganics	C	ND	mg/L	0.1
8/16/2019	pH	Inorganics	C	7.00	pH Units	
8/16/2019	Phosphorus	Inorganics	C	ND	mg/L	0.05
8/16/2019	Total Dissolved Solids	Inorganics	C	69.00	mg/L	1.00

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Water Quality Data Summary

Date	Parameter	Type	Location	Value	unit	MRL
8/16/2019	Total Organic Carbon	Inorganics	C	0.57	mg/L	0.50
8/16/2019	Total Kjeldahl Nitrogen	Inorganics	C	0.70	mg/L	0.5
8/16/2019	Total Suspended Solids	Inorganics	C	6.00	mg/L	2
8/16/2019	Arsenic	Metals (total)	C	ND	mg/L	0.003
8/16/2019	Cadmium	Metals (total)	C	ND	mg/L	0.0005
8/16/2019	Chromium	Metals (total)	C	ND	mg/L	0.001
8/16/2019	Copper	Metals (total)	C	ND	mg/L	0.05
8/16/2019	Iron	Metals (total)	C	0.152	mg/L	0.05
8/16/2019	Lead	Metals (total)	C	ND	mg/L	0.002
8/16/2019	Manganese	Metals (total)	C	ND	mg/L	0.025
8/16/2019	Mercury	Metals (total)	C	ND	mg/L	0.0002
8/16/2019	Nickel	Metals (total)	C	ND	mg/L	0.0005
8/16/2019	Selenium	Metals (total)	C	ND	mg/L	0.005
8/16/2019	Silver	Metals (total)	C	ND	mg/L	0.05
8/16/2019	pH	Metals (total)	C	7.00	pH Units	
8/16/2019	Total Coliforms	Microbial Analysis	C	2420.00	MPN/100mL	1
8/16/2019	E. Coli	Microbial Analysis	C	17.00	MPN/100mL	1
8/16/2019	Fecal Coliform	Microbial Analysis	C	19.00	MPN/100mL	1.8
9/23/2019	Alkalinity, Total(CaCO3)	Inorganics	B	26.00	mg/L	2
9/23/2019	Ammonia as N	Inorganics	B	ND	mg/L	0.1
9/23/2019	Biochemical Oxygen Demand	Inorganics	B	ND	mg/L	2
9/23/2019	Chemical Oxygen Demand	Inorganics	B	ND	mg/L	5
9/23/2019	Hardness	Inorganics	B	48.00	mg/L	4
9/23/2019	Nitrate as N	Inorganics	B	ND	mg/L	0.1
9/23/2019	Nitrite as N	Inorganics	B	0.02	mg/L	0.01
9/23/2019	Orthophosphate as P	Inorganics	B	ND	mg/L	0.1
9/23/2019	pH	Inorganics	B	7.50	pH Units	
9/23/2019	Phosphorus	Inorganics	B	ND	mg/L	0.05
9/23/2019	Total Dissolved Solids	Inorganics	B	67.00	mg/L	1.00
9/23/2019	Total Organic Carbon	Inorganics	B	1.07	mg/L	0.50
9/23/2019	Total Kjeldahl Nitrogen	Inorganics	B	1.20	mg/L	0.5
9/23/2019	Total Suspended Solids	Inorganics	B	23.00	mg/L	2
9/23/2019	Arsenic	Metals (total)	B	ND	mg/L	0.003
9/23/2019	Cadmium	Metals (total)	B	ND	mg/L	0.0005
9/23/2019	Chromium	Metals (total)	B	ND	mg/L	0.001
9/23/2019	Copper	Metals (total)	B	ND	mg/L	0.05
9/23/2019	Iron	Metals (total)	B	0.245	mg/L	0.05
9/23/2019	Lead	Metals (total)	B	ND	mg/L	0.002
9/23/2019	Manganese	Metals (total)	B	ND	mg/L	0.025
9/23/2019	Mercury	Metals (total)	B	ND	mg/L	0.0002

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Date	Parameter	Type	Location	Value	unit	MRL
9/23/2019	Nickel	Metals (total)	B	ND	mg/L	0.0005
9/23/2019	Selenium	Metals (total)	B	ND	mg/L	0.005
9/23/2019	Silver	Metals (total)	B	ND	mg/L	0.05
9/23/2019	pH	Metals (total)	B	7.50	pH Units	
9/23/2019	Total Coliforms	Microbial Analysis	B	2420.00	MPN/100mL	1
9/23/2019	E. Coli	Microbial Analysis	B	59.00	MPN/100mL	1
9/23/2019	Fecal Coliform	Microbial Analysis	B	110.00	MPN/100mL	1.8
9/23/2019	Alkalinity, Total(CaCO3)	Inorganics	C	26.00	mg/L	2
9/23/2019	Ammonia as N	Inorganics	C	ND	mg/L	0.1
9/23/2019	Biochemical Oxygen Demand	Inorganics	C	ND	mg/L	2
9/23/2019	Chemical Oxygen Demand	Inorganics	C	ND	mg/L	5
9/23/2019	Hardness	Inorganics	C	50.00	mg/L	4
9/23/2019	Nitrate as N	Inorganics	C	ND	mg/L	0.1
9/23/2019	Nitrite as N	Inorganics	C	ND	mg/L	0.01
9/23/2019	Orthophosphate as P	Inorganics	C	ND	mg/L	0.1
9/23/2019	pH	Inorganics	C	7.50	pH Units	
9/23/2019	Phosphorus	Inorganics	C	ND	mg/L	0.05
9/23/2019	Total Dissolved Solids	Inorganics	C	73.00	mg/L	1.00
9/23/2019	Total Organic Carbon	Inorganics	C	1.12	mg/L	0.50
9/23/2019	Total Kjeldahl Nitrogen	Inorganics	C	1.20	mg/L	0.5
9/23/2019	Total Suspended Solids	Inorganics	C	19.00	mg/L	2
9/23/2019	Arsenic	Metals (total)	C	ND	mg/L	0.003
9/23/2019	Cadmium	Metals (total)	C	ND	mg/L	0.0005
9/23/2019	Chromium	Metals (total)	C	ND	mg/L	0.001
9/23/2019	Copper	Metals (total)	C	ND	mg/L	0.05
9/23/2019	Iron	Metals (total)	C	0.265	mg/L	0.05
9/23/2019	Lead	Metals (total)	C	ND	mg/L	0.002
9/23/2019	Manganese	Metals (total)	C	ND	mg/L	0.025
9/23/2019	Mercury	Metals (total)	C	ND	mg/L	0.0002
9/23/2019	Nickel	Metals (total)	C	ND	mg/L	0.0005
9/23/2019	Selenium	Metals (total)	C	ND	mg/L	0.005
9/23/2019	Silver	Metals (total)	C	ND	mg/L	0.05
9/23/2019	pH	Metals (total)	C	7.50	pH Units	
9/23/2019	Total Coliforms	Microbial Analysis	C	2420.00	MPN/100mL	1
9/23/2019	E. Coli	Microbial Analysis	C	68.00	MPN/100mL	1
9/23/2019	Fecal Coliform	Microbial Analysis	C	49.00	MPN/100mL	1.8
10/31/2019	Alkalinity, Total(CaCO3)	Inorganics	B	23.00	mg/L	2
10/31/2019	Ammonia as N	Inorganics	B	ND	mg/L	0.1
10/31/2019	Biochemical Oxygen Demand	Inorganics	B	ND	mg/L	2
10/31/2019	Chemical Oxygen Demand	Inorganics	B	ND	mg/L	5
10/31/2019	Hardness	Inorganics	B	32.00	mg/L	4

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Date	Parameter	Type	Location	Value	unit	MRL
10/31/2019	Nitrate as N	Inorganics	B	ND	mg/L	0.1
10/31/2019	Nitrite as N	Inorganics	B	0.01	mg/L	0.01
10/31/2019	Orthophosphate as P	Inorganics	B	ND	mg/L	0.1
10/31/2019	pH	Inorganics	B	7.30	pH Units	
10/31/2019	Phosphorus	Inorganics	B	ND	mg/L	0.05
10/31/2019	Total Dissolved Solids	Inorganics	B	72.00	mg/L	1.00
10/31/2019	Total Organic Carbon	Inorganics	B	0.80	mg/L	0.50
10/31/2019	Total Kjeldahl Nitrogen	Inorganics	B	ND	mg/L	0.5
10/31/2019	Total Suspended Solids	Inorganics	B	ND	mg/L	2
10/31/2019	Arsenic	Metals (total)	B	ND	mg/L	0.003
10/31/2019	Cadmium	Metals (total)	B	ND	mg/L	0.0005
10/31/2019	Chromium	Metals (total)	B	ND	mg/L	0.001
10/31/2019	Copper	Metals (total)	B	ND	mg/L	0.05
10/31/2019	Iron	Metals (total)	B	0.053	mg/L	0.05
10/31/2019	Lead	Metals (total)	B	ND	mg/L	0.002
10/31/2019	Manganese	Metals (total)	B	ND	mg/L	0.025
10/31/2019	Mercury	Metals (total)	B	ND	mg/L	0.0002
10/31/2019	Nickel	Metals (total)	B	ND	mg/L	0.0005
10/31/2019	Selenium	Metals (total)	B	ND	mg/L	0.005
10/31/2019	Silver	Metals (total)	B	ND	mg/L	0.05
10/31/2019	pH	Metals (total)	B	7.30	pH Units	
10/31/2019	Total Coliforms	Microbial Analysis	B	260.00	MPN/100mL	1
10/31/2019	E. Coli	Microbial Analysis	B	3.00	MPN/100mL	1
10/31/2019	Fecal Coliform	Microbial Analysis	B	4.50	MPN/100mL	1.8
10/31/2019	Alkalinity, Total(CaCO3)	Inorganics	C	22.00	mg/L	2
10/31/2019	Ammonia as N	Inorganics	C	ND	mg/L	0.1
10/31/2019	Biochemical Oxygen Demand	Inorganics	C	ND	mg/L	2
10/31/2019	Chemical Oxygen Demand	Inorganics	C	ND	mg/L	5
10/31/2019	Hardness	Inorganics	C	32.00	mg/L	4
10/31/2019	Nitrate as N	Inorganics	C	ND	mg/L	0.1
10/31/2019	Nitrite as N	Inorganics	C	ND	mg/L	0.01
10/31/2019	Orthophosphate as P	Inorganics	C	ND	mg/L	0.1
10/31/2019	pH	Inorganics	C	7.30	pH Units	
10/31/2019	Phosphorus	Inorganics	C	ND	mg/L	0.05
10/31/2019	Total Dissolved Solids	Inorganics	C	60.00	mg/L	1.00
10/31/2019	Total Organic Carbon	Inorganics	C	0.87	mg/L	0.50
10/31/2019	Total Kjeldahl Nitrogen	Inorganics	C	ND	mg/L	0.5
10/31/2019	Total Suspended Solids	Inorganics	C	ND	mg/L	2
10/31/2019	Arsenic	Metals (total)	C	ND	mg/L	0.003
10/31/2019	Cadmium	Metals (total)	C	ND	mg/L	0.0005
10/31/2019	Chromium	Metals (total)	C	ND	mg/L	0.001

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Date	Parameter	Type	Location	Value	unit	MRL
10/31/2019	Copper	Metals (total)	C	ND	mg/L	0.05
10/31/2019	Iron	Metals (total)	C	ND	mg/L	0.05
10/31/2019	Lead	Metals (total)	C	ND	mg/L	0.002
10/31/2019	Manganese	Metals (total)	C	ND	mg/L	0.025
10/31/2019	Mercury	Metals (total)	C	ND	mg/L	0.0002
10/31/2019	Nickel	Metals (total)	C	ND	mg/L	0.0005
10/31/2019	Selenium	Metals (total)	C	ND	mg/L	0.005
10/31/2019	Silver	Metals (total)	C	ND	mg/L	0.05
10/31/2019	pH	Metals (total)	C	7.30	pH Units	
10/31/2019	Total Coliforms	Microbial Analysis	C	308.00	MPN/100mL	1
10/31/2019	E. Coli	Microbial Analysis	C	5.00	MPN/100mL	1
10/31/2019	Fecal Coliform	Microbial Analysis	C	7.80	MPN/100mL	1.8
6/18/2020	Alkalinity, Total(CaCO3)	Inorganics	B	16.00	mg/L	2
6/18/2020	Ammonia as N	Inorganics	B	ND	mg/L	0.1
6/18/2020	Biochemical Oxygen Demand	Inorganics	B	ND	mg/L	2
6/18/2020	Chemical Oxygen Demand	Inorganics	B	ND	mg/L	5
6/18/2020	Hardness	Inorganics	B	32.00	mg/L	4
6/18/2020	Nitrate as N	Inorganics	B	ND	mg/L	0.1
6/18/2020	Nitrite as N	Inorganics	B	ND	mg/L	0.01
6/18/2020	Orthophosphate as P	Inorganics	B	ND	mg/L	0.1
6/18/2020	pH	Inorganics	B	5.80	pH Units	
6/18/2020	Phosphorus	Inorganics	B	0.12	mg/L	0.05
6/18/2020	Total Dissolved Solids	Inorganics	B	64.00	mg/L	1.00
6/18/2020	Total Kjeldahl Nitrogen	Inorganics	B	1.00	mg/L	0.5
6/18/2020	Total Organic Carbon	Inorganics	B	1.03	mg/L	0.5
6/18/2020	Total Suspended Solids	Inorganics	B	2.00	mg/L	2
6/18/2020	Arsenic	Metals (total)	B	ND	mg/L	0.003
6/18/2020	Cadmium	Metals (total)	B	ND	mg/L	0.0005
6/18/2020	Chromium	Metals (total)	B	ND	mg/L	0.001
6/18/2020	Copper	Metals (total)	B	ND	mg/L	0.05
6/18/2020	Iron	Metals (total)	B	0.095	mg/L	0.05
6/18/2020	Lead	Metals (total)	B	ND	mg/L	0.002
6/18/2020	Manganese	Metals (total)	B	ND	mg/L	0.025
6/18/2020	Mercury	Metals (total)	B	ND	mg/L	0.0002
6/18/2020	Nickel	Metals (total)	B	ND	mg/L	0.0005
6/18/2020	pH	Metals (total)	B	5.80	pH Units	
6/18/2020	Selenium	Metals (total)	B	ND	mg/L	0.005
6/18/2020	Silver	Metals (total)	B	ND	mg/L	0.05
6/18/2020	E. Coli	Microbial Analysis	B	13.00	MPN/100mL	1
6/18/2020	Fecal Coliform	Microbial Analysis	B	6.80	MPN/100mL	1
6/18/2020	Total Coliforms	Microbial Analysis	B	649.00	MPN/100mL	1.8

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Date	Parameter	Type	Location	Value	unit	MRL
6/18/2020	Alkalinity, Total(CaCO3)	Inorganics	C	16.00	mg/L	2
6/18/2020	Ammonia as N	Inorganics	C	0.10	mg/L	0.1
6/18/2020	Biochemical Oxygen Demand	Inorganics	C	ND	mg/L	2
6/18/2020	Chemical Oxygen Demand	Inorganics	C	ND	mg/L	5
6/18/2020	Hardness	Inorganics	C	32.00	mg/L	4
6/18/2020	Nitrate as N	Inorganics	C	0.11	mg/L	0.1
6/18/2020	Nitrite as N	Inorganics	C	ND	mg/L	0.01
6/18/2020	Orthophosphate as P	Inorganics	C	ND	mg/L	0.1
6/18/2020	pH	Inorganics	C	5.50	pH Units	
6/18/2020	Phosphorus	Inorganics	C	0.08	mg/L	0.05
6/18/2020	Total Dissolved Solids	Inorganics	C	56.00	mg/L	1.00
6/18/2020	Total Kjeldahl Nitrogen	Inorganics	C	0.70	mg/L	0.5
6/18/2020	Total Organic Carbon	Inorganics	C	1.08	mg/L	0.5
6/18/2020	Total Suspended Solids	Inorganics	C	ND	mg/L	2
6/18/2020	Arsenic	Metals (total)	C	ND	mg/L	0.003
6/18/2020	Cadmium	Metals (total)	C	ND	mg/L	0.0005
6/18/2020	Chromium	Metals (total)	C	ND	mg/L	0.001
6/18/2020	Copper	Metals (total)	C	ND	mg/L	0.05
6/18/2020	Iron	Metals (total)	C	0.111	mg/L	0.05
6/18/2020	Lead	Metals (total)	C	ND	mg/L	0.002
6/18/2020	Manganese	Metals (total)	C	ND	mg/L	0.025
6/18/2020	Mercury	Metals (total)	C	ND	mg/L	0.0002
6/18/2020	Nickel	Metals (total)	C	ND	mg/L	0.0005
6/18/2020	pH	Metals (total)	C	5.50	pH Units	
6/18/2020	Selenium	Metals (total)	C	ND	mg/L	0.005
6/18/2020	Silver	Metals (total)	C	ND	mg/L	0.05
6/18/2020	E. Coli	Microbial Analysis	C	15.00	MPN/100mL	1
6/18/2020	Fecal Coliform	Microbial Analysis	C	49.00	MPN/100mL	1
6/18/2020	Total Coliforms	Microbial Analysis	C	579.00	MPN/100mL	1.8
11/3/2020	Alkalinity, Total(CaCO3)	Inorganics	C	22.00	mg/L	2
11/3/2020	Ammonia as N	Inorganics	C	ND	mg/L	0.1
11/3/2020	Biochemical Oxygen Demand	Inorganics	C	ND	mg/L	2
11/3/2020	Chemical Oxygen Demand	Inorganics	C	ND	mg/L	5
11/3/2020	Hardness	Inorganics	C	36.00	mg/L	4
11/3/2020	Nitrate as N	Inorganics	C	ND	mg/L	0.1
11/3/2020	Nitrite as N	Inorganics	C	ND	mg/L	0.01
11/3/2020	Orthophosphate as P	Inorganics	C	ND	mg/L	0.1
11/3/2020	pH	Inorganics	C	7.00	pH Units	
11/3/2020	Phosphorus	Inorganics	C	ND	mg/L	0.05
11/3/2020	Total Dissolved Solids	Inorganics	C	60.00	mg/L	1.00
11/3/2020	Total Organic Carbon	Inorganics	C	0.88	mg/L	0.50

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Date	Parameter	Type	Location	Value	unit	MRL
11/3/2020	Total Kjeldahl Nitrogen	Inorganics	C	1.40	mg/L	0.5
11/3/2020	Total Suspended Solids	Inorganics	C	14.00	mg/L	2
11/3/2020	Arsenic	Metals (total)	C	ND	mg/L	0.003
11/3/2020	Cadmium	Metals (total)	C	ND	mg/L	0.0005
11/3/2020	Chromium	Metals (total)	C	ND	mg/L	0.001
11/3/2020	Copper	Metals (total)	C	ND	mg/L	0.05
11/3/2020	Iron	Metals (total)	C	0.116	mg/L	0.05
11/3/2020	Lead	Metals (total)	C	ND	mg/L	0.002
11/3/2020	Manganese	Metals (total)	C	ND	mg/L	0.025
11/3/2020	Mercury	Metals (total)	C	ND	mg/L	0.0002
11/3/2020	Nickel	Metals (total)	C	ND	mg/L	0.0005
11/3/2020	Selenium	Metals (total)	C	ND	mg/L	0.005
11/3/2020	Silver	Metals (total)	C	ND	mg/L	0.05
11/3/2020	pH	Metals (total)	C	7.00	pH Units	
11/3/2020	Total Coliforms	Microbial Analysis	C	461.00	MPN/100mL	1
11/3/2020	E. Coli	Microbial Analysis	C	2.00	MPN/100mL	1
11/3/2020	Fecal Coliform	Microbial Analysis	C	6.80	MPN/100mL	1.8
11/3/2020	Alkalinity, Total(CaCO3)	Inorganics	E	22.00	mg/L	2
11/3/2020	Ammonia as N	Inorganics	E	ND	mg/L	0.1
11/3/2020	Biochemical Oxygen Demand	Inorganics	E	ND	mg/L	2
11/3/2020	Chemical Oxygen Demand	Inorganics	E	ND	mg/L	5
11/3/2020	Hardness	Inorganics	E	24.00	mg/L	4
11/3/2020	Nitrate as N	Inorganics	E	ND	mg/L	0.1
11/3/2020	Nitrite as N	Inorganics	E	ND	mg/L	0.01
11/3/2020	Orthophosphate as P	Inorganics	E	ND	mg/L	0.1
11/3/2020	pH	Inorganics	E	7.00	pH Units	
11/3/2020	Phosphorus	Inorganics	E	ND	mg/L	0.05
11/3/2020	Total Dissolved Solids	Inorganics	E	73.00	mg/L	1.00
11/3/2020	Total Organic Carbon	Inorganics	E	0.86	mg/L	0.50
11/3/2020	Total Kjeldahl Nitrogen	Inorganics	E	0.80	mg/L	0.5
11/3/2020	Total Suspended Solids	Inorganics	E	16.00	mg/L	2
11/3/2020	Arsenic	Metals (total)	E	ND	mg/L	0.003
11/3/2020	Cadmium	Metals (total)	E	ND	mg/L	0.0005
11/3/2020	Chromium	Metals (total)	E	ND	mg/L	0.001
11/3/2020	Copper	Metals (total)	E	ND	mg/L	0.05
11/3/2020	Iron	Metals (total)	E	0.120	mg/L	0.05
11/3/2020	Lead	Metals (total)	E	ND	mg/L	0.002
11/3/2020	Manganese	Metals (total)	E	ND	mg/L	0.025
11/3/2020	Mercury	Metals (total)	E	ND	mg/L	0.0002
11/3/2020	Nickel	Metals (total)	E	ND	mg/L	0.0005
11/3/2020	Selenium	Metals (total)	E	ND	mg/L	0.005

Appendix A

Water Quality Data Summary

Date	Parameter	Type	Location	Value	unit	MRL
11/3/2020	Silver	Metals (total)	E	ND	mg/L	0.05
11/3/2020	pH	Metals (total)	E	7.00	pH Units	
11/3/2020	Total Coliforms	Microbial Analysis	E	387.00	MPN/100mL	1
11/3/2020	E. Coli	Microbial Analysis	E	4.00	MPN/100mL	1
11/3/2020	Fecal Coliform	Microbial Analysis	E	4.50	MPN/100mL	1.8

Acronyms:

mg/L – milligrams per liter
mL – milliliter
MPN – Most Probable Number
MRL – Minimum Reporting Limit
ND – Not Detected

APPENDIX B
LABORATORY RESULTS

Alexin Analytical
LABORATORIES, INC.
Professional Laboratory Services
13035 SW Pacific Hwy
Tigard, OR 97223
Tel.: (503) 639-9311 Fax: (503) 684-1588

ANALYSIS REPORT

Reported: 09/06/2019
Received: 08/16/2019
Sampled By: John Dvorsky
Work Order: 9228016

CLIENT
Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 19-2424
PWSID # :

Sampling Location: Sandy River Mile 22.0
Sample Matrix: Surface Water

Lab Number

9228016-01 **Sample Name:** SiteB - 2019.08.16
Sampled: 8/16/19 9:30 **Sample Composition:** Raw

		Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time	
	Metals (Total)									
A	*Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		08/21/19 14:48	
A	*Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		08/22/19 13:06	
A	*Chromium*	1020	EPA 200.8	mg/L	ND	0.001	0.1		08/23/19 00:35	**SUB-5**
A	*Copper*	1055	SM3111B	mg/L	ND	0.050	1.3		08/22/19 10:46	
	Iron	1028	SM3111B	mg/L	0.145	0.050	-	0.3	08/26/19 15:45	
A	*Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		08/23/19 15:04	
	Manganese	1032	SM3111B	mg/L	ND	0.025	-	0.05	08/26/19 15:54	
A	*Mercury*	1035	EPA 245.1	mg/L	ND	0.0005	0.002		08/21/19 12:55	
A	*Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		08/23/19 00:35	**SUB-5**
A	*Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		08/26/19 12:47	
	Silver	1050	SM 3111B	mg/L	ND	0.050	-	0.1	09/04/19 16:08	
	Inorganics									
	Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	46	2	-		08/22/19 17:00	
	Ammonia as N	1003	SM 4500-NH3F	mg/L	ND	0.1	-		08/20/19 14:00	
A	*Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		08/21/19 12:00	
	Chemical Oxygen Demand	1076	EPA 410.4	mg/L	ND	5.00	-		08/20/19 11:50	
A	*Nitrate as N*	1040	EPA 300.0	mg/L	ND	0.100	10		08/16/19 17:34	
A	*Nitrite as N*	1041	EPA 300.0	mg/L	ND	0.0100	1		08/16/19 17:34	
	Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		08/16/19 17:34	
	pH	1925	EPA 150.1	pH Units	7.5		-	8.5	08/16/19 16:10	**R**
	Phosphorus		EPA 365.3	mg/L	ND	0.05	-		08/20/19 13:00	
	Total Dissolved Solids		EPA 160.1	mg/L	55.0	1.00	-		08/19/19 09:05	
	Total Organic Carbon	2920	SM5310-C	mg/L	0.66	0.50	-		08/22/19 23:51	
	Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	0.7	0.5	-		08/20/19 14:30	
A	*Total Suspended Solids*	1063	EPA 160.2	mg/L	5	2	-		08/16/19 14:00	

Alexin Analytical
LABORATORIES, INC.
Professional Laboratory Services
13035 SW Pacific Hwy
Tigard, OR 97223
Tel.: (503) 639-9311 Fax. (503) 684-1588

ANALYSIS REPORT

Reported: 09/06/2019
Received: 08/16/2019
Sampled By: John Dvorsky
Work Order: 9228016

CLIENT
Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 19-2424
PWSID # :

Sampling Location: Sandy River Mile 22.0
Sample Matrix: Surface Water

Lab Number

9228016-02 **Sample Name:** SiteC - 2019.08.16
Sampled: 8/16/19 8:55 **Sample Composition:** Raw

		Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time	
	Metals (Total)									
A	*Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		08/21/19 14:48	
A	*Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		08/22/19 13:06	
A	*Chromium*	1020	EPA 200.8	mg/L	ND	0.001	0.1		08/23/19 00:39	SUB-5
A	*Copper*	1055	SM3111B	mg/L	ND	0.050	1.3		08/22/19 10:46	
	Iron	1028	SM3111B	mg/L	0.152	0.050	-	0.3	08/26/19 15:45	
A	*Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		08/23/19 15:04	
	Manganese	1032	SM3111B	mg/L	ND	0.025	-	0.05	08/26/19 15:54	
A	*Mercury*	1035	EPA 245.1	mg/L	ND	0.0005	0.002		08/21/19 12:55	
A	*Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		08/23/19 00:39	SUB-5
A	*Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		08/26/19 12:47	
	Silver	1050	SM 3111B	mg/L	ND	0.050	-	0.1	09/04/19 16:08	
	Inorganics									
	Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	22	2	-		08/22/19 17:00	
	Ammonia as N	1003	SM 4500-NH3F	mg/L	ND	0.1	-		08/20/19 14:00	
A	*Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		08/21/19 12:00	
	Chemical Oxygen Demand	1076	EPA 410.4	mg/L	5.00	5.00	-		08/20/19 11:50	
A	*Nitrate as N*	1040	EPA 300.0	mg/L	ND	0.100	10		08/16/19 17:51	
A	*Nitrite as N*	1041	EPA 300.0	mg/L	ND	0.0100	1		08/16/19 17:51	
	Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		08/16/19 17:51	
	pH	1925	EPA 150.1	pH Units	7.0		-	8.5	08/16/19 16:14	R
	Phosphorus		EPA 365.3	mg/L	ND	0.05	-		08/20/19 13:00	
	Total Dissolved Solids		EPA 160.1	mg/L	69.0	1.00	-		08/19/19 09:05	
	Total Organic Carbon	2920	SM5310-C	mg/L	0.57	0.50	-		08/23/19 00:32	
	Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	0.7	0.5	-		08/20/19 15:10	
A	*Total Suspended Solids*	1063	EPA 160.2	mg/L	6	2	-		08/16/19 14:00	

*This is a secondary standard and has no contaminant level. This is a guideline that is associated with aesthetic effects such as staining of plumbing fixtures, tastes, and odors.

Alexin Analytical Laboratories, Inc.
Professional Laboratory Services
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Tigard, OR 97223
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ANALYSIS REPORT

Reported: 09/06/2019
Received: 08/16/2019
Sampled By: John Dvorsky
Work Order: 9228016

CLIENT
Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 19-2424
PWSID # :

Sampling Location: Sandy River Mile 22.0
Sample Matrix: Surface Water

Lab Number

9228016-01 **Sample Name: SiteB - 2019.08.16** **Sampled:** 8/16/19 9:30
Sample Type: Grab

		Method	Units	Result	MRL	Date/ Time Analysis Begun
Microbiological Analysis						
A	*Total Coliforms*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	>2,420	1	08/16/19 15:45
A	*E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	20	1	08/16/19 15:45
	Fecal Coliform	SM 9223B 21st Ed.	MPN/100 mL	28	1	08/16/19 15:45

Analyzed: 08/17/19 10:45 Analyzed by: MKM

9228016-02 **Sample Name: SiteC - 2019.08.16** **Sampled:** 8/16/19 8:55
Sample Type: Grab

		Method	Units	Result	MRL	Date/ Time Analysis Begun
Microbiological Analysis						
A	*Total Coliforms*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	>2,420	1	08/16/19 15:45
A	*E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	17	1	08/16/19 15:45
	Fecal Coliform	SM 9223B 21st Ed.	MPN/100 mL	19	1	08/16/19 15:45

Analyzed: 08/17/19 10:45 Analyzed by: MKM

R Sample exceeded hold time and was analyzed per customer request.
SUB-5 This analysis was subcontracted to Neilson Research Corporation ORELAP ID# OR100016
ND = None detected at the MRL **MRL** = Minimum Reporting Limit **MCL** = Maximum Contamination Limit
A = All procedures for this analysis are accredited in accordance with NELAP standards. Lab Accreditation No. OR-100013

Approved by:
Adriana Gonzalez-Gray
Laboratory Director

Approved by:
Vandana Gade
Microbiology Technical Director

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Alexin Analytical LABORATORIES, INC.

Professional Laboratory Services

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ANALYSIS REPORT

Reported: 09/06/2019
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Sampled By: John Dvorsky
Work Order: 9228016

CLIENT
Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 19-2424
PWSID # :

Sampling Location: Sandy River Mile 22.0
Sample Matrix: Surface Water

Lab Number

9228016-02 **Sample Name:** SiteC - 2019.08.16
Sampled: 8/16/19 8:55 **Sample Composition:** Raw

	Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time
Metals (Total)								
A *Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		08/21/19 14:48
A *Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		08/22/19 13:06
A *Chromium*	1020	EPA 200.8	mg/L	ND	0.001	0.1		08/23/19 00:39 SUB-5
A *Copper*	1055	SM3111B	mg/L	ND	0.050	1.3		08/22/19 10:46
Iron	1028	SM3111B	mg/L	0.152	0.050	-	0.3	08/26/19 15:45
A *Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		08/23/19 15:04
Manganese	1032	SM3111B	mg/L	ND	0.025	-	0.05	08/26/19 15:54
A *Mercury*	1035	EPA 245.1	mg/L	ND	0.0005	0.002		08/21/19 12:55
A *Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		08/23/19 00:39 SUB-5
A *Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		08/26/19 12:47
Silver	1050	SM 3111B	mg/L	ND	0.050	-	0.1	09/04/19 16:08
Inorganics								
Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	22	2	-		08/22/19 17:00
Ammonia as N	1003	SM 4500-NH3F	mg/L	ND	0.1	-		08/20/19 14:00
A *Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		08/21/19 12:00
Chemical Oxygen Demand	1076	EPA 410.4	mg/L	5.00	5.00	-		08/20/19 11:50
A *Nitrate as N*	1040	EPA 300.0	mg/L	ND	0.100	10		08/16/19 17:51
A *Nitrite as N*	1041	EPA 300.0	mg/L	ND	0.0100	1		08/16/19 17:51
Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		08/16/19 17:51
pH	1925	EPA 150.1	pH Units	7.0		-	8.5	08/16/19 16:14 R
Phosphorus		EPA 365.3	mg/L	ND	0.05	-		08/20/19 13:00
Total Dissolved Solids		EPA 160.1	mg/L	69.0	1.00	-		08/19/19 09:05
Total Organic Carbon	2920	SM5310-C	mg/L	0.57	0.50	-		08/23/19 00:32
Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	0.7	0.5	-		08/20/19 15:10
A *Total Suspended Solids*	1063	EPA 160.2	mg/L	6	2	-		08/16/19 14:00

*This is a secondary standard and has no contaminant level. This is a guideline that is associated with aesthetic effects such as staining of plumbing fixtures, tastes, and odors.

Alexin Analytical LABORATORIES, INC.
Professional Laboratory Services
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ANALYSIS REPORT

Reported: 09/06/2019
Received: 08/16/2019
Sampled By: John Dvorsky
Work Order: 9228016

CLIENT
Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 19-2424
PWSID # :

Sampling Location: Sandy River Mile 22.0
Sample Matrix: Surface Water

Lab Number

9228016-01 **Sample Name:** SiteB - 2019.08.16
Sampled: 8/16/19 9:30 **Sample Composition:** Raw

	Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time
Metals (Total)								
A *Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		08/21/19 14:48
A *Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		08/22/19 13:06
A *Chromium*	1020	EPA 200.8	mg/L	ND	0.001	0.1		08/23/19 00:35 SUB-5
A *Copper*	1055	SM3111B	mg/L	ND	0.050	1.3		08/22/19 10:46
Iron	1028	SM3111B	mg/L	0.145	0.050	-	0.3	08/26/19 15:45
A *Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		08/23/19 15:04
Manganese	1032	SM3111B	mg/L	ND	0.025	-	0.05	08/26/19 15:54
A *Mercury*	1035	EPA 245.1	mg/L	ND	0.0005	0.002		08/21/19 12:55
A *Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		08/23/19 00:35 SUB-5
A *Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		08/26/19 12:47
Silver	1050	SM 3111B	mg/L	ND	0.050	-	0.1	09/04/19 16:08
Inorganics								
Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	46	2	-		08/22/19 17:00
Ammonia as N	1003	SM 4500-NH3F	mg/L	ND	0.1	-		08/20/19 14:00
A *Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		08/21/19 12:00
Chemical Oxygen Demand	1076	EPA 410.4	mg/L	ND	5.00	-		08/20/19 11:50
A *Nitrate as N*	1040	EPA 300.0	mg/L	ND	0.100	10		08/16/19 17:34
A *Nitrite as N*	1041	EPA 300.0	mg/L	ND	0.0100	1		08/16/19 17:34
Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		08/16/19 17:34
pH	1925	EPA 150.1	pH Units	7.5		-	8.5	08/16/19 16:10 R
Phosphorus		EPA 365.3	mg/L	ND	0.05	-		08/20/19 13:00
Total Dissolved Solids		EPA 160.1	mg/L	55.0	1.00	-		08/19/19 09:05
Total Organic Carbon	2920	SM5310-C	mg/L	0.66	0.50	-		08/22/19 23:51
Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	0.7	0.5	-		08/20/19 14:30
A *Total Suspended Solids*	1063	EPA 160.2	mg/L	5	2	-		08/16/19 14:00

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ANALYSIS REPORT

Reported: 09/06/2019
Received: 08/16/2019
Sampled By: John Dvorsky
Work Order: 9228016

CLIENT

Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 19-2424
PWSID # :

Sampling Location: Sandy River Mile 22.0
Sample Matrix: Surface Water

Lab Number

9228016-01

Sample Name: SiteB - 2019.08.16
Sample Type: Grab

Sampled: 8/16/19 9:30

	Method	Units	Result	MRL	Date/ Time Analysis Begun
Microbiological Analysis					
A *Total Coliforms*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	>2,420	1	08/16/19 15:45
A *E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	20	1	08/16/19 15:45
Fecal Coliform	SM 9223B 21st Ed.	MPN/100 mL	28	1	08/16/19 15:45

Analyzed: 08/17/19 10:45

Analyzed by: MKM

9228016-02

Sample Name: SiteC - 2019.08.16
Sample Type: Grab

Sampled: 8/16/19 8:55

	Method	Units	Result	MRL	Date/ Time Analysis Begun
Microbiological Analysis					
A *Total Coliforms*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	>2,420	1	08/16/19 15:45
A *E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	17	1	08/16/19 15:45
Fecal Coliform	SM 9223B 21st Ed.	MPN/100 mL	19	1	08/16/19 15:45

Analyzed: 08/17/19 10:45

Analyzed by: MKM

R Sample exceeded hold time and was analyzed per customer request.

SUB-5 This analysis was subcontracted to Neilson Research Corporation ORELAP ID# OR100016

ND = None detected at the MRL **MRL** = Minimum Reporting Limit **MCL** = Maximum Contamination Limit

A = All procedures for this analysis are accredited in accordance with NELAP standards. Lab Accreditation No. OR-100013

Approved by:
Adriana Gonzalez-Gray
Laboratory Director

Approved by:
Vandana Gade
Microbiology Technical Director

Alexin Analytical
LABORATORIES, INC.
Professional Laboratory Services
13035 SW Pacific Hwy
Tigard, OR 97223
Tel.: (503) 639-9311 Fax: (503) 684-1588

ANALYSIS REPORT

Reported: 10/15/2019
Received: 09/23/2019
Sampled By:
Work Order: 9266030

CLIENT
Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 19 - 2424
PWSID # :

Sampling Location: Sandy River Miler - 22.0
Sample Matrix: Surface Water

Lab Number

*** 80-100 mg/L is considered medium hard.

9266030-01 **Sample Name: SiteB - 2019.09.23**
Sample Type: Grab
Sampled: 9/23/19 9:18

		Method	Units	Result	MRL	Date/ Time Analysis Begun
Microbiological Analysis						
A	*Total Coliforms*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	2420	1	09/23/19 15:13
A	*E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	59	1	09/23/19 15:13
A	*Fecal Coliform*	SM 9221E 21st Ed.	MPN/100 mL	110.0	1.8	09/23/19 14:15

Analyzed: 09/24/19 12:28
Analyzed by: VG

9266030-02 **Sample Name: SiteC - 2019.09.23**
Sample Type: Grab
Sampled: 9/23/19 8:45

		Method	Units	Result	MRL	Date/ Time Analysis Begun
Microbiological Analysis						
A	*Total Coliforms*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	>2,420	1	09/23/19 15:13
A	*E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	68	1	09/23/19 15:13
A	*Fecal Coliform*	SM 9221E 21st Ed.	MPN/100 mL	49.0	1.8	09/23/19 14:15

Analyzed: 09/24/19 12:28
Analyzed by: VG

J The reported value is greater than the Method Detection Limit but less than the Reporting Limit.
R Sample exceeded hold time and was analyzed per customer request.
SUB-5 This analysis was subcontracted to Neilson Research Corporation ORELAP ID# OR100016
ND = None detected at the MRL **MRL** = Minimum Reporting Limit **MCL** = Maximum Contamination Limit
A = All procedures for this analysis are accredited in accordance with NELAP standards. Lab Accreditation No. OR-100013

Approved by:
Adriana Gonzalez-Gray
Laboratory Director

Approved by:
Vahdana Gade
Microbiology Technical Director

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ANALYSIS REPORT

Reported: 10/15/2019
Received: 09/23/2019
Sampled By:
Work Order: 9266030

C L I E N T

Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 19 - 2424
PWSID # :

Sampling Location: Sandy River Miler - 22.0
Sample Matrix: Surface Water

Lab Number

9266030-02 **Sample Name:** SiteC - 2019.09.23
Sampled: 9/23/19 8:45 **Sample Composition:** unfiltered

		Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time
	Metals (Total)								
A	*Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		09/26/19 13:55
A	*Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		10/09/19 16:29
A	*Chromium*	1020	EPA 200.8	mg/L	0.0007	0.0004	0.1		09/30/19 21:44 SUB-5
A	*Copper*	1055	SM3111B	mg/L	ND	0.050	1.3		10/01/19 11:30
	Iron	1028	SM3111B	mg/L	0.268	0.050	-	0.3	09/30/19 11:26
A	*Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		09/27/19 14:56
	Manganese	1032	SM3111B	mg/L	ND	0.025	-	0.05	09/30/19 11:38
A	*Mercury*	1035	EPA 245.1	mg/L	ND	0.0005	0.002		10/08/19 13:57
A	*Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		09/30/19 21:44 J, SUB-5
A	*Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		10/09/19 14:32
	Silver	1050	SM 3111B	mg/L	ND	0.100	-	0.1	10/14/19 16:23
	Inorganics								
	Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	26	2	-		09/27/19 13:00
	Ammonia as N	1003	SM 4500-NH3F	mg/L	ND	0.1	-		09/24/19 16:30
A	*Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		09/30/19 14:07
	Chemical Oxygen Demand	1076	EPA 410.4	mg/L	ND	5.00	-		10/01/19 11:47
	Hardness	1915	EPA 130.2	mg/L	50.0***	4.00	-	250	09/30/19 13:50
A	*Nitrate as N*	1040	EPA 300.0	mg/L	ND	0.100	10		09/24/19 13:28
A	*Nitrite as N*	1041	EPA 300.0	mg/L	ND	0.0100	1		09/24/19 13:28
	Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		09/24/19 13:28
	pH	1925	EPA 150.1	pH Units	7.5		-	8.5	09/23/19 15:09 R
	Phosphorus		EPA 365.3	mg/L	ND	0.05	-		09/24/19 13:00
	Total Dissolved Solids		EPA 160.1	mg/L	73.0	1.00	-		09/26/19 08:40
	Total Organic Carbon	2920	SM5310-C	mg/L	1.12	0.50	-		10/02/19 16:01
	Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	1.2	0.5	-		09/26/19 14:52
A	*Total Suspended Solids*	1063	EPA 160.2	mg/L	19	2	-		09/27/19 15:30

*This is a secondary standard and has no contaminant level. This is a guideline that is associated with aesthetic effects such as staining of plumbing fixtures, tastes, and odors.

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OCT 17 2019

ANALYSIS REPORT

Reported: 10/15/2019
Received: 09/23/2019
Sampled By:
Work Order: 9266030

CLIENT
Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 19 - 2424
PWSID # :

Sampling Location: Sandy River Miler - 22.0
Sample Matrix: Surface Water

Lab Number

9266030-01

Sample Name: SiteB - 2019.09.23
Sampled: 9/23/19 9:18 **Sample Composition:** unfiltered

	Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time
Metals (Total)								
A *Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		09/26/19 13:55
A *Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		10/09/19 16:29
A *Chromium*	1020	EPA 200.8	mg/L	ND	0.0004	0.1		09/30/19 21:40 J, SUB-5
A *Copper*	1055	SM3111B	mg/L	ND	0.050	1.3		10/01/19 11:30
Iron	1028	SM3111B	mg/L	0.245	0.050	-	0.3	09/30/19 11:26
A *Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		09/27/19 14:56
Manganese	1032	SM3111B	mg/L	ND	0.025	-	0.05	09/30/19 11:38
A *Mercury*	1035	EPA 245.1	mg/L	ND	0.0005	0.002		10/08/19 13:57
A *Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		09/30/19 21:40 J, SUB-5
A *Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		10/09/19 14:32
Silver	1050	SM 3111B	mg/L	ND	0.100	-	0.1	10/14/19 16:23
Inorganics								
Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	26	2	-		09/27/19 13:00
Ammonia as N	1003	SM 4500-NH3F	mg/L	ND	0.1	-		09/24/19 16:30
A *Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		09/30/19 14:07
Chemical Oxygen Demand	1076	EPA 410.4	mg/L	ND	5.00	-		10/01/19 11:47
Hardness	1915	EPA 130.2	mg/L	48.0***	4.00	-	250	09/30/19 13:50
A *Nitrate as N*	1040	EPA 300.0	mg/L	ND	0.100	10		09/24/19 13:10
A *Nitrite as N*	1041	EPA 300.0	mg/L	0.0163	0.0100	1		09/24/19 13:10
Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		09/24/19 13:10
pH	1925	EPA 150.1	pH Units	7.5		-	8.5	09/23/19 15:07 R
Phosphorus		EPA 365.3	mg/L	ND	0.05	-		09/24/19 13:00
Total Dissolved Solids		EPA 160.1	mg/L	67.0	1.00	-		09/26/19 08:40
Total Organic Carbon	2920	SM5310-C	mg/L	1.07	0.50	-		10/02/19 15:23
Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	1.2	0.5	-		09/26/19 14:52
A *Total Suspended Solids*	1063	EPA 160.2	mg/L	23	2	-		09/27/19 15:30

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ANALYSIS REPORT

Reported: 11/26/2019
Received: 10/31/2019
Sampled By:
Work Order: 9304009

CLIENT
Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: S
Project # : N/A
PWSID # :

Sampling Location: Sandy River
Sample Matrix: Surface Water

Lab Number

9304009-01 **Sample Name:** SlteB - 31Oct2019
Sampled: 10/31/19 8:30 **Sample Composition:** unfiltered

		Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time
	Metals (Total)								
A	*Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		11/07/19 14:43
A	*Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		11/13/19 15:03
A	*Chromium*	1020	EPA 200.8	mg/L	ND	0.0004	0.1		11/06/19 20:42 SUB-5
A	*Copper*	1055	5M3111B	mg/L	ND	0.050	1.3		11/08/19 15:31
	Iron	1028	5M3111B	mg/L	0.053	0.050	-	0.3	11/20/19 16:10
A	*Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		11/06/19 10:56
	Manganese	1032	5M3111B	mg/L	ND	0.025	-	0.05	11/20/19 16:25
A	*Mercury*	1035	EPA 245.1	mg/L	ND	0.0002	0.002		11/26/19 12:40
A	*Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		11/06/19 20:42 SUB-5
A	*Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		11/12/19 16:43
	Silver	1050	5M 3111B	mg/L	ND	0.050	-	0.1	11/12/19 13:54
	Inorganics								
	Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	23	2	-		10/31/19 15:15
	Ammonia as N	1003	SM 4500-NH3F	mg/L	ND	0.1	-		11/05/19 15:30
A	*Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		11/06/19 11:00
	Chemical Oxygen Demand	1076	EPA 410.4	mg/L	ND	5.00	-		11/06/19 13:59
	Hardness	1915	EPA 130.2	mg/L	32.0***	4.00	-	250	11/05/19 14:20
A	*Nitrate as N*	1040	EPA 300.0	mg/L	ND	0.100	10		10/31/19 16:52
A	*Nitrite as N*	1041	EPA 300.0	mg/L	0.0133	0.0100	1		10/31/19 16:52
	Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		10/31/19 16:52
	pH	1925	EPA 150.1	pH Units	7.3		-	8.5	10/31/19 14:15 R
	Phosphorus		EPA 365.3	mg/L	ND	0.05	-		11/05/19 11:00
	Total Dissolved Solids		EPA 160.1	mg/L	72.0	1.00	-		11/05/19 10:20
	Total Organic Carbon	2920	SM5310-C	mg/L	0.80	0.50	-		11/14/19 16:12
	Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	ND	0.5	-		11/06/19 13:43
A	*Total Suspended Solids*	1063	EPA 160.2	mg/L	ND	2	-		11/01/19 14:30

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ANALYSIS REPORT

Reported: 11/26/2019
Received: 10/31/2019
Sampled By:
Work Order: 9304009

C L I E N T

Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: S
Project # : N/A
PWSID # :

Sampling Location: Sandy River
Sample Matrix: Surface Water

Lab Number

9304009-02

Sample Name: SiteC - 31Oct2019
Sampled: 10/31/19 8:30 **Sample Composition:** unfiltered

	Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time
Metals (Total)								
A *Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		11/07/19 14:43
A *Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		11/13/19 15:03
A *Chromium*	1020	EPA 200.8	mg/L	ND	0.0004	0.1		11/06/19 20:47 SUB-5
A *Copper*	1055	SM3111B	mg/L	ND	0.050	1.3		11/08/19 15:31
Iron	1028	SM3111B	mg/L	ND	0.050	-	0.3	11/20/19 16:10
A *Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		11/06/19 10:56
Manganese	1032	SM3111B	mg/L	ND	0.025	-	0.05	11/20/19 16:25
A *Mercury*	1035	EPA 245.1	mg/L	ND	0.0002	0.002		11/26/19 12:40
A *Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		11/06/19 20:47 SUB-5
A *Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		11/12/19 16:43
Silver	1050	SM 3111B	mg/L	ND	0.050	-	0.1	11/12/19 13:54
Inorganics								
Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	22	2	-		10/31/19 15:15
Ammonia as N	1003	SM 4500-NH3F	mg/L	ND	0.1	-		11/05/19 15:30
A *Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		11/06/19 11:00
Chemical Oxygen Demand	1076	EPA 410.4	mg/L	ND	5.00	-		11/06/19 13:59
Hardness	1915	EPA 130.2	mg/L	32.0***	4.00	-	250	11/05/19 14:20
A *Nitrate as N*	1040	EPA 300.0	mg/L	ND	0.100	10		10/31/19 17:09
A *Nitrite as N*	1041	EPA 300.0	mg/L	ND	0.0100	1		10/31/19 17:09
Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		10/31/19 17:09
pH	1925	EPA 150.1	pH Units	7.3		-	8.5	10/31/19 14:19 R
Phosphorus		EPA 365.3	mg/L	ND	0.05	-		11/05/19 11:00
Total Dissolved Solids		EPA 160.1	mg/L	60.0	1.00	-		11/05/19 10:20
Total Organic Carbon	2920	SM5310-C	mg/L	0.87	0.50	-		11/14/19 16:50
Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	ND	0.5	-		11/06/19 14:45
A *Total Suspended Solids*	1063	EPA 160.2	mg/L	ND	2	-		11/01/19 14:30

*This is a secondary standard and has no contaminant level. This is a guideline that is associated with aesthetic effects such as staining of plumbing fixtures, tastes, and odors.

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ANALYSIS REPORT

Reported: 11/26/2019
Received: 10/31/2019
Sampled By:
Work Order: 9304009

CLIENT

Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: S
Project # : N/A
PWSID # :

Sampling Location: Sandy River
Sample Matrix: Surface Water

Lab Number

*** 80-100 mg/L is considered medium hard.

9304009-01

Sample Name: SiteB - 31Oct2019
Sample Type:

Sampled: 10/31/19 8:30

	Method	Units	Result	MRL	Date/ Time Analysis Begun
Microbiological Analysis					
A *Total Coliforms*	SM 9223B (colllert-18) 21st Ed.	MPN/100 mL	260	1	10/31/19 14:40
A *E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	3	1	10/31/19 14:40
A *Fecal Coliform*	SM 9221E 21st Ed.	MPN/100 mL	4.5	1.8	10/31/19 13:36

Analyzed: 11/01/19 12:15 Analyzed by: MKM

9304009-02

Sample Name: SiteC - 31Oct2019
Sample Type:

Sampled: 10/31/19 8:30

	Method	Units	Result	MRL	Date/ Time Analysis Begun
Microbiological Analysis					
A *Total Coliforms*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	308	1	10/31/19 14:40
A *E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	5	1	10/31/19 14:40
A *Fecal Coliform*	SM 9221E 21st Ed.	MPN/100 mL	7.8	1.8	10/31/19 13:36

Analyzed: 11/01/19 12:15 Analyzed by: MKM

R Sample exceeded hold time and was analyzed per customer request.
SUB-5 This analysis was subcontracted to Neilson Research Corporation ORELAP ID# OR100016
ND = None detected at the MRL **MRL** = Minimum Reporting Limit **MCL** = Maximum Contamination Limit
A = All procedures for this analysis are accredited in accordance with NELAP standards. Lab Accreditation No. OR-100013

Approved by:
Adriana Gonzalez-Gray
Laboratory Director

Approved by:
Vandana Gade
Microbiology Technical Director

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ANALYSIS REPORT

Reported: 07/21/2020
Received: 06/18/2020
Sampled By: PMD/JGC
Work Order: 0170015

CLIENT
Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 20-2776
PWSID # :

Sampling Location: Sandy River Mile 22.0
Sample Matrix: Surface Water

Lab Number

	Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time
0170015-01 **Sample Name:** SiteB - 2020.06.18 **Sampled:** 6/18/20 10:48 **Sample Composition:** Raw								
Metals (Total)								
A *Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		06/25/20 14:39
A *Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		07/07/20 12:44
A *Chromium*	1020	EPA 200.8	mg/L	ND	0.0004	0.1		06/25/20 18:07 **SUB-5**
A *Copper*	1055	SM3111B	mg/L	ND	0.020	1.3		07/01/20 12:15
Iron	1028	SM3111B	mg/L	0.095	0.050	-	0.3	07/09/20 14:32
A *Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		06/24/20 13:55
Manganese	1032	SM3111B	mg/L	ND	0.025	-	0.05	07/09/20 14:43
A *Mercury*	1035	EPA 245.1	mg/L	ND	0.0002	0.002		07/16/20 13:30
A *Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		06/25/20 18:07 **SUB-5**
A *Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		07/21/20 13:00
Silver	1050	SM 3111B	mg/L	ND	0.050	-	0.1	07/07/20 16:26
Inorganics								
Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	16	2	-		06/18/20 14:15
Ammonia as N	1003	SM 4500-NH3F	mg/L	ND	0.1	-		06/23/20 16:15
A *Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		06/24/20 10:23
Chemical Oxygen Demand	1076	EPA 410.4	mg/L	ND	5.00	-		06/26/20 12:32
Hardness	1915	EPA 130.2	mg/L	32.0***	4.00	-	250	06/18/20 14:54
A *Nitrate as N*	1040	EPA 300.0	mg/L	ND	0.100	10		06/18/20 17:19
A *Nitrite as N*	1041	EPA 300.0	mg/L	ND	0.0100	1		06/18/20 17:19
Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		06/18/20 17:19
pH	1925	EPA 150.1	pH Units	5.8		-	8.5	06/18/20 13:45 **R**
Phosphorus		EPA 365.3	mg/L	0.12	0.05	-		06/23/20 11:40
Total Dissolved Solids		EPA 160.1	mg/L	64.0	1.00	-		06/23/20 11:10
Total Organic Carbon	2920	SM5310-C	mg/L	1.03	0.50	-		06/26/20 01:06
Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	1.0	0.5	-		06/22/20 13:25
A *Total Suspended Solids*	1063	EPA 160.2	mg/L	2	2	-		06/19/20 14:30

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Tigard, OR 97223
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ANALYSIS REPORT

Reported: 07/21/2020
Received: 06/18/2020
Sampled By: PMD/JGC
Work Order: 0170015

CLIENT
Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 20-2776
PWSID # :

Sampling Location: Sandy River Mile 22.0
Sample Matrix: Surface Water

Lab Number

0170015-02 **Sample Name:** SiteCB - 2020.06.18
Sampled: 6/18/20 10:08 **Sample Composition:** Raw

		Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time
Metals (Total)									
A	*Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		06/25/20 14:39
A	*Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		07/07/20 12:44
A	*Chromium*	1020	EPA 200.8	mg/L	ND	0.0004	0.1		06/25/20 18:03 **SUB-S**
A	*Copper*	1055	SM3111B	mg/L	ND	0.020	1.3		07/01/20 12:15
	Iron	1028	SM3111B	mg/L	0.111	0.050	-	0.3	07/09/20 14:32
A	*Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		06/24/20 13:55
	Manganese	1032	SM3111B	mg/L	ND	0.025	-	0.05	07/09/20 14:43
A	*Mercury*	1035	EPA 245.1	mg/L	ND	0.0002	0.002		07/16/20 13:30
A	*Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		06/25/20 18:03 **SUB-5**
A	*Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		07/21/20 13:00
	Silver	1050	SM 3111B	mg/L	ND	0.050	-	0.1	07/07/20 16:26
Inorganics									
	Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	16	2	-		06/18/20 14:15
	Ammonia as N	1003	SM 4500-NH3F	mg/L	0.1	0.1	-		06/23/20 16:15
A	*Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		06/24/20 10:23
	Chemical Oxygen Demand	1076	EPA 410.4	mg/L	ND	5.00	-		06/26/20 12:32
	Hardness	1915	EPA 130.2	mg/L	32.0***	4.00	-	250	06/18/20 14:54
A	*Nitrate as N*	1040	EPA 300.0	mg/L	0.112	0.100	10		06/18/20 17:38
A	*Nitrite as N*	1041	EPA 300.0	mg/L	ND	0.0100	1		06/18/20 17:38
	Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		06/18/20 17:38
	pH	1925	EPA 150.1	pH Units	5.5		-	8.5	06/18/20 13:48 **R**
	Phosphorus		EPA 365.3	mg/L	0.08	0.05	-		06/23/20 11:40
	Total Dissolved Solids		EPA 160.1	mg/L	56.0	1.00	-		06/23/20 11:10
	Total Organic Carbon	2920	SM5310-C	mg/L	1.08	0.50	-		06/26/20 01:46
	Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	0.7	0.5	-		06/22/20 13:25
A	*Total Suspended Solids*	1063	EPA 160.2	mg/L	ND	2	-		06/19/20 14:30

*This is a secondary standard and has no contaminant level. This is a guideline that is associated with aesthetic effects such as staining of plumbing fixtures, tastes, and odors.

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ANALYSIS REPORT

Reported: 07/21/2020
Received: 06/18/2020
Sampled By: PMD/JGC
Work Order: 0170015

CLIENT

Murraysmith
Attn: Preston VanMeter
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : 20-2776
PWSID # :

Sampling Location: Sandy River Mile 22.0
Sample Matrix: Surface Water

Lab Number

*** 80-100 mg/L is considered medium hard.

0170015-01 **Sample Name: SiteB - 2020.06.18**
Sample Type: Grab
Sampled: 6/18/20 10:48

	Method	Units	Result	MRL	Date/ Time Analysis Begun
Microbiological Analysis					
A *Total Coliforms*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	649	1	06/18/20 13:48
A *E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	13	1	06/18/20 13:48
A *Fecal Coliform*	SM 9221E 21st Ed.	MPN/100 mL	6.8	1.8	06/18/20 13:21

Analyzed: 06/19/20 11:36 Analyzed by: VG

0170015-02 **Sample Name: SiteCB - 2020.06.18**
Sample Type: Grab
Sampled: 6/18/20 10:08

	Method	Units	Result	MRL	Date/ Time Analysis Begun
Microbiological Analysis					
A *Total Coliforms*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	579	1	06/18/20 13:48
A *E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	15	1	06/18/20 13:48
A *Fecal Coliform*	SM 9221E 21st Ed.	MPN/100 mL	49.0	1.8	06/18/20 13:21

Analyzed: 06/19/20 11:36 Analyzed by: VG

R Sample exceeded hold time and was analyzed per customer request.
SUB-5 This analysis was subcontracted to Neilson Research Corporation ORELAP ID# OR100016
ND = None detected at the MRL **MRL** = Minimum Reporting Limit **MCL** = Maximum Contamination Limit
A = All procedures for this analysis are accredited in accordance with NELAP standards. Lab Accreditation No. OR-100013

Approved by: ______
Adriana Gonzalez-Gray
Laboratory Director

Approved by: ______
Vandana Gade
Microbiology Technical Director

This report shall not be reproduced, except in full, without the written approval of the laboratory.

Alexin Analytical Laboratories, Inc.
Professional Laboratory Services

Chain of Custody Record

Laboratory Job Number: 0170015-01-02

Page 1 of 2

13035 SW Pacific Hwy Tigard, OR 97223 ph: 503.639.9311 fax: 503.684.1588 email:mail@alexinlabs.com

Client Contact Information	Results Reporting Information	Invoicing Information
Company/Client Name: Murraysmith	Project Manager: Preston Van Meter	Accounts Payable Contact: City of Sandy
Address: 888 SW 5th Ave, Suite 1170	Mailing Address: 888 SW 5th Ave, Suite 1170	Mailing Address: 39250 Pioneer Blvd.
City/State/Zip: Portland, OR 97204	City/State/Zip: Portland, OR 97204	City/State/Zip: Sandy, OR 97055
phone: 503-225-9010	phone: 503-225-9010	phone: 503-668-5533
fax or email: Preston.VanMeter@murraysmith.us	fax or email: Jessica.Cawley@murraysmith.us	fax or email: kmilne@ci.sandy.or.us

SAMPLING INFORMATION

Sampling Location: Sandy River Mile ~22.0
P.O. #:
PWSID #:
Sampled By: PMD / JCC
Project Name: Sandy WQ Study
Project #: ~~19-2424~~ 20-2776
Permit #:

Send results to OR State Health Division? (Please circle) Yes No

Lab ID Lab use only	Sample Identification Please enter a unique ID per line for each separate sample	Date Collected	(Begin-End if comp.) Time Collected	Sample Matrix*	# of cont. rec'd	Analysis Requested**								SEE ATTACHED	Sample Specific Notes/Field Data for *each* WW sample, specify **Grab** / **Composite** for *each* DW sample, specify **Raw** / **Treated**, **Source** / **Distribution**, **Single** / **Combined** WHERE APPLICABLE
-01	SiteB - ~~2019~~ 2020. 06.18	6/18/20	10:48	Surface Water	6									X	Grab, unfiltered
-02	SiteC - ~~2019~~ 2020. 06.18	6/18/20	10:08	Surface Water	6									X	Grab, unfiltered

Relinquished By (print):	Company:	Date/Time:	Signature:	Received By:	Company:	Date/Time:	Signature:
Patrick Davis	Murraysmith						
Relinquished By (print):	Company:	Date/Time:	Signature:	Received By:	Company:	Date/Time:	Signature:

The most current revision of SOP-10-003 was used when these samples were collected ☐

Received by Laboratory Log-In Staff: TMN Date/Time: 06/18/20 12:50 pm Temp. on receipt 11 °C On ice? [✓ Y] N
Containers Intact? [✓ Y] N **ID: TRM-10-** 022

* Drinking water (DW), effluent (EFF), ground water (GW), influent (INF), non-aqueous liquid (NAL), paint chips, raw water (RW), sludge, soil, solid, source water (SOURCE), spring, stormwater (SW), surface water, wastewater (WW), well water (WELL)

** Analyses for SOC, Radionuclide, Radon, and Asbestos are subcontracted out to other accredited laboratories.

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ANALYSIS REPORT

Reported: 11/23/2020
Received: 11/03/2020
Sampled By: KTH/JGC
Work Order: 0308007

CLIENT

Murraysmith
Attn: Matt Hickey
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : N/A
PWSID # :
PO # : 20-2776
Sampling Location: Sandy River
Sample Matrix: Surface Water

Lab Number

0308007-01 **Sample Name:** Site C - 2020.11.03
Sampled: 11/3/20 8:55 **Sample Composition:** unfiltered

		Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time
	Metals (Total)								
A	*Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		11/05/20 12:11
A	*Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		11/10/20 15:01
A	*Chromium*	1020	EPA 200.8	mg/L	ND	0.0004	0.1		11/12/20 05:07 SUB-5
A	*Copper*	1055	SM3111B	mg/L	ND	0.020	1.3		11/11/20 12:50
	Iron	1028	SM3111B	mg/L	0.116	0.050	-	0.3	11/04/20 14:59
A	*Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		11/11/20 11:59
	Manganese	1032	SM3111B	mg/L	ND	0.025	-	0.05	11/04/20 15:17
A	*Mercury*	1035	EPA 245.1	mg/L	ND	0.0002	0.002		11/04/20 12:49
A	*Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		11/12/20 05:07 SUB-5
A	*Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		11/20/20 16:41
	Silver	1050	SM 3111B	mg/L	ND	0.050	-	0.1	11/23/20 15:12
	Inorganics								
	Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	22	2	-		11/06/20 10:30
	Ammonia as N	1003	SM 4500-NH3F	mg/L	ND	0.1	-		11/03/20 15:50
A	*Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		11/09/20 13:12
	Chemical Oxygen Demand	1076	EPA 410.4	mg/L	ND	5.00	-		11/09/20 12:55
	Hardness	1915	EPA 130.2	mg/L	36.0***	4.00	-	250	11/04/20 13:15
A	*Nitrate as N*	1040	EPA 300.0	mg/L	ND	0.100	10		11/03/20 15:58
A	*Nitrite as N*	1041	EPA 300.0	mg/L	ND	0.0100	1		11/03/20 15:58
	Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		11/03/20 15:58
	pH	1925	EPA 150.1	pH Units	7.0		-	8.5	11/03/20 12:43 R
	Phosphorus		EPA 365.3	mg/L	ND	0.05	-		11/10/20 11:00
	Total Dissolved Solids		EPA 160.1	mg/L	60.0	1.00	-		11/03/20 12:40
	Total Organic Carbon	2920	SM5310-C	mg/L	0.88	0.50	-		11/05/20 17:05
	Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	1.4	0.5	-		11/06/20 09:22
A	*Total Suspended Solids*	1063	EPA 160.2	mg/L	14	2	-		11/04/20 13:30

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ANALYSIS REPORT

Reported: 11/23/2020
Received: 11/03/2020
Sampled By: KTH/JGC
Work Order: 0308007

CLIENT
Murraysmith
Attn: Matt Hickey
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : N/A
PWSID # :
PO # : 20-2776
Sampling Location: Sandy River
Sample Matrix: Surface Water

Lab Number

0308007-02 **Sample Name:** Revenue Bridge - 2020.11.03
Sampled: 11/3/20 9:45 **Sample Composition:** unfiltered

	Code	Method	Units	Result	MRL	EPA MCL	Secondary Standard*	Analysis Date/ Time
Metals (Total)								
A *Arsenic*	1005	EPA 200.9	mg/L	ND	0.003	0.01		11/05/20 12:11
A *Cadmium*	1015	SM 3113B	mg/L	ND	0.0005	0.005		11/10/20 15:01
A *Chromium*	1020	EPA 200.8	mg/L	ND	0.0004	0.1		11/12/20 05:11 **SUB-5**
A *Copper*	1055	SM3111B	mg/L	ND	0.020	1.3		11/11/20 12:50
Iron	1028	SM3111B	mg/L	0.120	0.050	-	0.3	11/04/20 14:59
A *Lead*	1030	EPA 200.9	mg/L	ND	0.002	0.015		11/11/20 11:59
Manganese	1032	SM3111B	mg/L	ND	0.025	-	0.05	11/04/20 15:17
A *Mercury*	1035	EPA 245.1	mg/L	ND	0.0002	0.002		11/04/20 12:49
A *Nickel*	1036	EPA 200.8	mg/L	ND	0.0005	0.1		11/12/20 05:11 **SUB-5**
A *Selenium*	1140	EPA 200.9	mg/L	ND	0.005	0.05		11/20/20 16:41
Silver	1050	SM 3111B	mg/L	ND	0.050	-	0.1	11/23/20 15:12
Inorganics								
Alkalinity, Total (CaCO3)	1067	EPA 310.1	mg/L	22	2	-		11/06/20 10:30
Ammonia as N	1003	SM 4500-NH3F	mg/L	ND	0.1	-		11/03/20 15:50
A *Biochemical Oxygen Demand*		EPA 405.1	mg/L	ND	2	-		11/09/20 13:12
Chemical Oxygen Demand	1076	EPA 410.4	mg/L	ND	5.00	-		11/09/20 12:55
Hardness	1915	EPA 130.2	mg/L	24.0***	4.00	-	250	11/04/20 13:15
A *Nitrate as N*	1040	EPA 300.0	mg/L	ND	0.100	10		11/03/20 16:17
A *Nitrite as N*	1041	EPA 300.0	mg/L	ND	0.0100	1		11/03/20 16:17
Orthophosphate as P		EPA 300.0	mg/L	ND	0.100	-		11/03/20 16:17
pH	1925	EPA 150.1	pH Units	7.0		-	8.5	11/03/20 12:44 **R**
Phosphorus		EPA 365.3	mg/L	ND	0.05	-		11/10/20 11:00
Total Dissolved Solids		EPA 160.1	mg/L	73.0	1.00	-		11/03/20 12:40
Total Organic Carbon	2920	SM5310-C	mg/L	0.86	0.50	-		11/05/20 17:45
Total Kjeldahl Nitrogen	1037	EPA 351.3	mg/L	0.8	0.5	-		11/06/20 09:22
A *Total Suspended Solids*	1063	EPA 160.2	mg/L	16	2	-		11/04/20 13:30

*This is a secondary standard and has no contaminant level. This is a guideline that is associated with aesthetic effects such as staining of plumbing fixtures, tastes, and odors.

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Professional Laboratory Services
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Tigard, OR 97223
Tel.: (503) 639-9311 Fax: (503) 684-1588

ANALYSIS REPORT

Reported: 11/23/2020
Received: 11/03/2020
Sampled By: KTH/JGC
Work Order: 0308007

CLIENT
Murraysmith
Attn: Matt Hickey
888 SW 5th Ave. Suite 1170
Portland OR, 97204
Phone: (503) 225-9010

Project: Sandy WQ Study
Project # : N/A
PWSID # :
PO # : 20-2776
Sampling Location: Sandy River
Sample Matrix: Surface Water

Lab Number

*** 80-100 mg/L is considered medium hard.

0308007-01

Sample Name: Site C - 2020.11.03
Sample Type: Grab
Sampled: 11/3/20 8:55

	Method	Units	Result	MRL	Date/ Time Analysis Begun
Microbiological Analysis					
A *Total Coliforms*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	461	1	11/03/20 12:50
A *E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	2	1	11/03/20 12:50
A *Fecal Coliform*	SM 9221E 21st Ed.	MPN/100 mL	6.8	1.8	11/03/20 12:32

Analyzed: 11/04/20 11:00
Analyzed by: VG

0308007-02

Sample Name: Revenue Bridge - 2020.11.03
Sample Type: Grab
Sampled: 11/3/20 9:45

	Method	Units	Result	MRL	Date/ Time Analysis Begun
Microbiological Analysis					
A *Total Coliforms*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	387	1	11/03/20 12:50
A *E. coli*	SM 9223B (colilert-18) 21st Ed.	MPN/100 mL	4	1	11/03/20 12:50
A *Fecal Coliform*	SM 9221E 21st Ed.	MPN/100 mL	4.5	1.8	11/03/20 12:32

Analyzed: 11/04/20 11:00
Analyzed by: VG

R Sample exceeded hold time and was analyzed per customer request.
SUB-5 This analysis was subcontracted to Neilson Research Corporation ORELAP ID# OR100016
ND = None detected at the MRL **MRL** = Minimum Reporting Limit **MCL** = Maximum Contamination Limit
A = All procedures for this analysis are accredited in accordance with NELAP standards. Lab Accreditation No. OR-100013

Approved by: ______
Adriana Gonzalez-Gray
Laboratory Director

Approved by: ______
Vandana Gade
Microbiology Technical Director

Technical Memorandum 7.1

Date:	March 01, 2021
Project:	City of Sandy – Detailed Discharge Alternative Evaluation
To:	Jordan Wheeler, City Manager Mike Walker, Public Works Director City of Sandy, Oregon
From:	Matt Hickey, PE Ken Vigil, PE Katie Husk, PE Murraysmith
Re:	Technical Memorandum 7.1 – Sandy River Outfall Siting Study

---

Introduction

This technical memorandum is a summary of Task 5: The Sandy River Outfall Siting Study, which is part of the larger Detailed Discharge Alternative Evaluation program. The purpose of Task 5 is to review alternative discharge locations on the Sandy River for placing the outfall from the proposed new membrane bioreactor treatment facility.

The reviewers conducted desktop and field studies to evaluate key river characteristics that would make for a good outfall site. These characteristics are itemized below and then summarized later in this technical memorandum and in attachments. More favorable outfall sites would include:

(1) river reaches with greater depth and velocity, which increase dilution and dispersion, to provide good water quality mixing conditions,

(2) locations with channel geologic/geomorphic stability, so that the river channel would not migrate away from the outfall over time,

(3) areas with less fish use for spawning and rearing, to minimize fisheries impacts/concerns,

(4) locations that are closer to the new treatment plant, for pipe economy, as described in Technical Memorandum 7.2, and

(5) river locations with outfall accessibility, for construction and operation and maintenance, and related characteristics.

Desktop Study

Approximately four outfall locations were immediately under consideration given the team's knowledge of the Sandy River in the project vicinity. These locations were near the City of Sandy River Park (at the large river oxbow), upstream and downstream from the park, and near the Ten Eyck Road crossing at Revenue Bridge.

Murraysmith's specialty subconsultant (Wolf Water Resources) began reviewing these sites using desktop analysis. They looked at aerial photographs, reviewed floodplain maps, and reviewed existing documentation and reports on local geology, geomorphology, and fisheries.

The results of these reviews are summarized in their Sandy River Outfall Siting Memo (see attached).

Stream Study

During the course of this study, team members have spent time in the in the field reviewing opportunities and constraints for siting the proposed outfall. Murraysmith staff and subconsultants have walked the riverbanks and viewed many potential outfall locations from various vantage points.

As part of their field reviews, Wolf Water Resources conducted stream surveys to evaluate site-specific conditions on the Sandy River study reach. They looked at stream stability, channel migration, river substrate, geometry, geomorphology, fisheries habitat, velocity, river depth, current mixing, and related conditions. The results of these stream surveys are summarized in their Sandy River Outfall Siting Memo (see attached).

Agency Coordination

On May 15, 2019, the project team held an in-person meeting to introduce the project to multiple resource agencies, including the Oregon Department of Environmental Quality, Oregon Department of State Lands, Oregon Department of Fish and Wildlife, U.S. Army Corps of Engineers, and the National Oceanic and Atmospheric Administration Fisheries. This "Kaizen" style meeting provided the City and consultant team with the opportunity to introduce the project and obtain immediate feedback from agency staff to help guide planning and preliminary design.

On June 30, 2020, the project team had a follow-up virtual coordination meeting with staff from these same agencies. They all have some jurisdiction over the proposed project as it relates to water quality, wetlands, fisheries, and other environmental programs.

The presenters summarized the results of some of the investigations done to date at the possible outfall sites. The consensus from the agencies was that they were concerned about the oxbow site and the downstream powerline site because of possible fisheries impacts and problems with geomorphic instability. The agency representatives all seemed to favor the upstream site near Ten Eyck Road crossing of the river (at Revenue Bridge). They thought that this location had better geomorphic stability and would have less impact on fisheries and water quality. This location is a stable, bedrock-defined reach of the river that anadromous fish would migrate through but not use for spawning or rearing.

The agency staff were interested in the possibility of applying the effluent to land during the summertime to reduce potential water quality impacts to the Sandy River. Additional information about land application of effluent at the site of the former Roslyn Lake is presented in Technical Memorandum 9-10.

Recommended Location and Outfall Configuration

Based on the results of Task 5 (The Sandy River Outfall Siting Study), the Ten Eyck Road and Revenue Bridge site is the recommended location for the new outfall. This site has several advantages over other alternatives including:

(1) this river reach is dominated by bedrock, so the channel does not migrate in this area, providing for greater geomorphic stability and consistent outfall operating conditions,

(2) this reach of the river is deep and has reasonable velocity (providing greater dilution and dispersion) and good water quality mixing characteristics,

(3) the area has less public accessibility than river reaches near the park and less potential for vandalism (although that possibility needs to be considered during final design),

(4) this location is upstream from the Cedar Creek fish hatchery, and therefore there would be less potential for impacts to hatchery fish,

(5) this reach is used for anadromous fish migration, not spawning or rearing, so anadromous fish would just be passing through,

(6) this site seems to have the greatest agency support based on preliminary meetings, and

(7) Revenue Bridge provides a good river crossing location for the effluent pipeline that would carry effluent to the Roslyn Lake area, where it could be reused for creating wetlands (as described in Tech Memo 9-10).

Again, refer to the attached memo by Wolf Water Resources for additional detail on these topics.

Figure 1 is an aerial image that shows the proposed location of the new outfall near Revenue Bridge and the proposed location of the new satellite treatment facility, for reference.

Figure 1 | Aerial Image

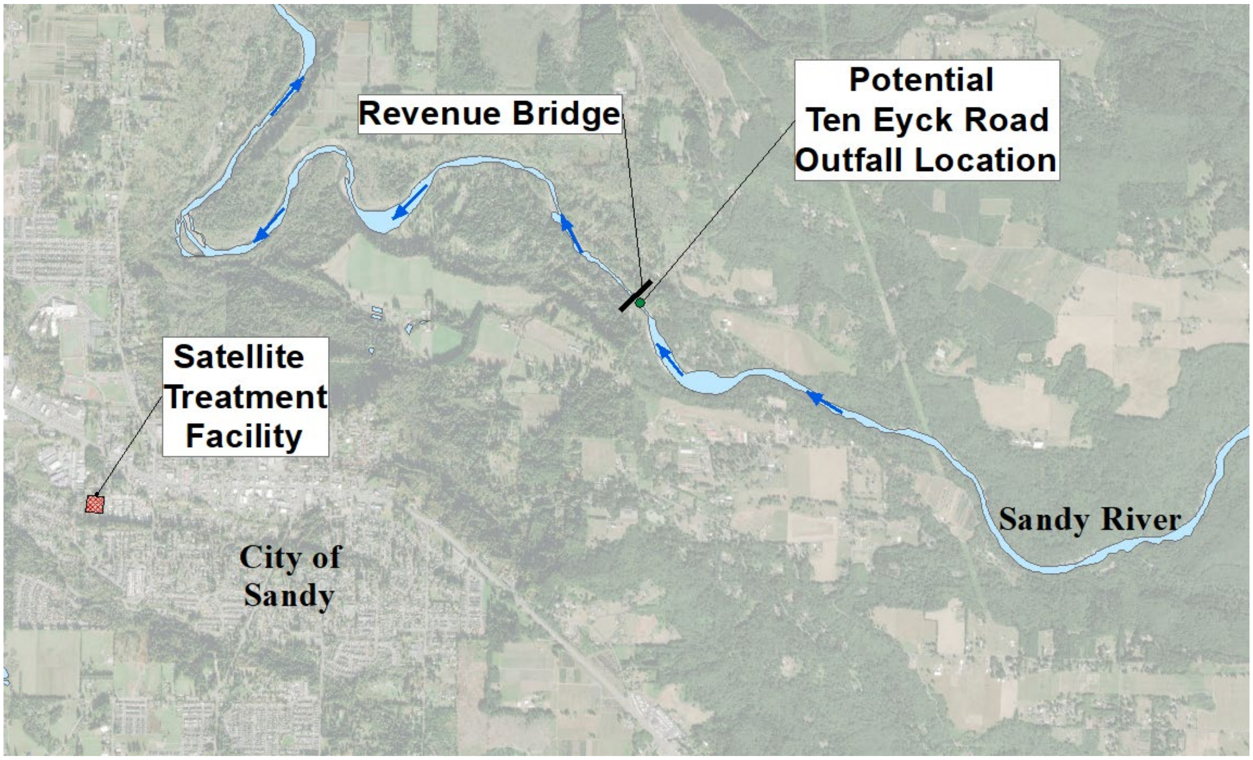

Figure 2 contains conceptual drawings of the proposed outfall and diffuser system. The proposed outfall could consist of an above-ground pipe anchored/secured to existing bedrock with concrete collars. Alternatively, portions of the pipeline could be bored through the existing bedrock and buried. However, additional site-specific geotechnical investigations will be needed to further review the option of burying the outfall pipe.

The Sandy River has substantial flows and assimilative capacity during both winter and summer months. With the proposed new discharge, the City's monthly effluent flows to the river would be less than 1% of the monthly river flows. This comparison is for general reference and is not a regulatory requirement.

This proposed in-water work would also need to be coordinated with resource agencies to obtain the required environmental permits. The proposed construction on and around the roadway and bridge would be coordinated with Clackamas County for infrastructure protection and traffic management.

Revenue Bridge Outfall Costs

Based on preliminary planning and site reviews, the cost for the outfall itself (for the recommended alternative outlined below) would be approximately $300,000 to $500,000. The outfall would consist of the pipeline and collars/attachments leading from approximately the bridge deck to the water, the end pipe, and the diffuser ports, as shown in **Figure 2** (presented later in this memo).

The biggest uncertainty in estimating costs for planning purposes is the cost of construction in rocky terrain. The area where the outfall would be placed is dominated by bedrock which makes it a good location for stability. However, until further, site-specific geotechnical investigations are conducted, we will not fully understand construction challenges and associated costs.

A summary of the alternative pipeline alignments and associated costs for conveying the effluent from the new treatment plant to the bridge is presented in Technical Memorandum 7.2.

Hydropower

The project team has been discussing very generally the possibility of using effluent for the purpose of generating hydro power. The location of the outfall would be important to determine the amount of elevation head (potential energy) that would be available. Several hundred feet of elevation drop exists between the proposed location of the new satellite treatment plant and the potential discharge and turbine locations (on either the Sandy or Bull Run River).

On June 2, 2020, members of the project team met with representatives from the Power Regeneration group at the historic Bull Run River powerhouse. This group now owns the historic powerhouse that was previously operated by Portland General Electric. They are in the process of renovating and re-purposing the powerhouse for various uses including historic preservation and education. We discussed the potential opportunity of creating micro hydropower at this site using effluent from the City's proposed new satellite plant. All parties were interested in the possibility of teaming on such a project in the future.

Conclusion

This technical memorandum and associated attachments provide a summary of Task 5: The Sandy River Outfall Siting Study.

After reviewing dozens of locations for the outfall generally, and four locations specifically, the recommended outfall location is near the Ten Eyck Road crossing of the Sandy River near Revenue Bridge.

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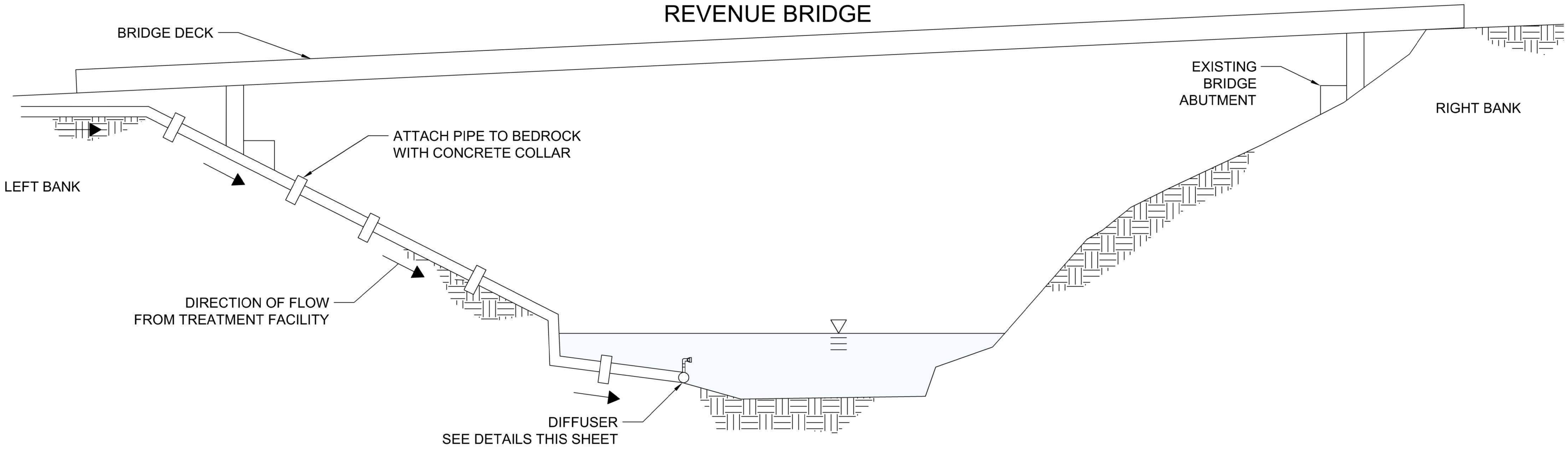
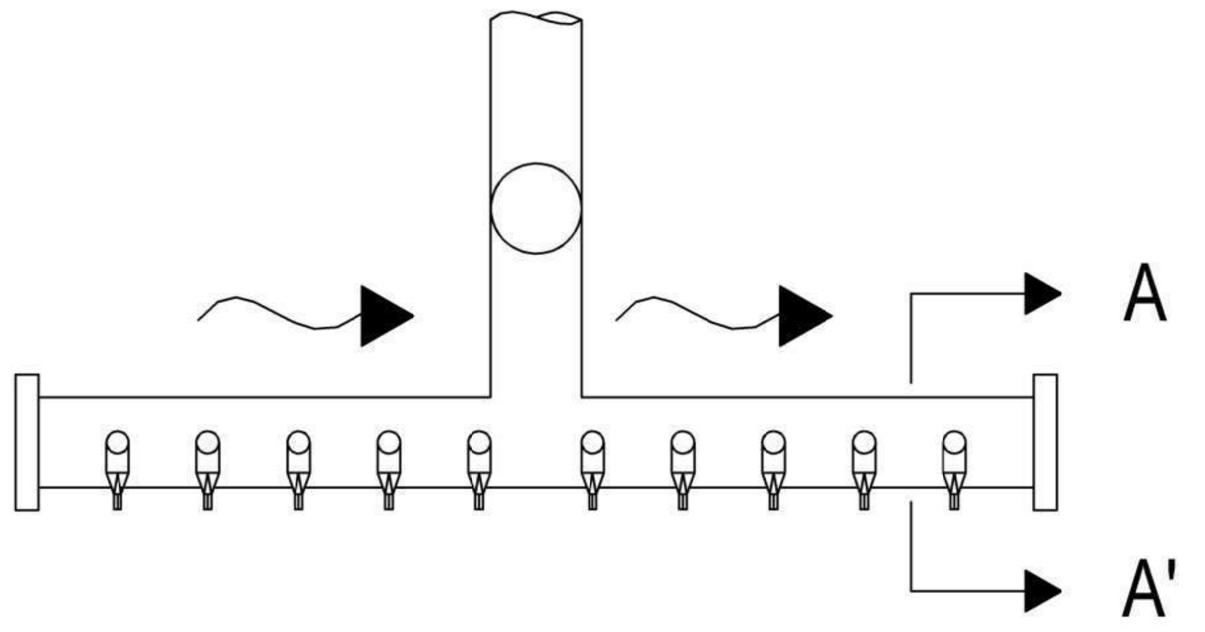
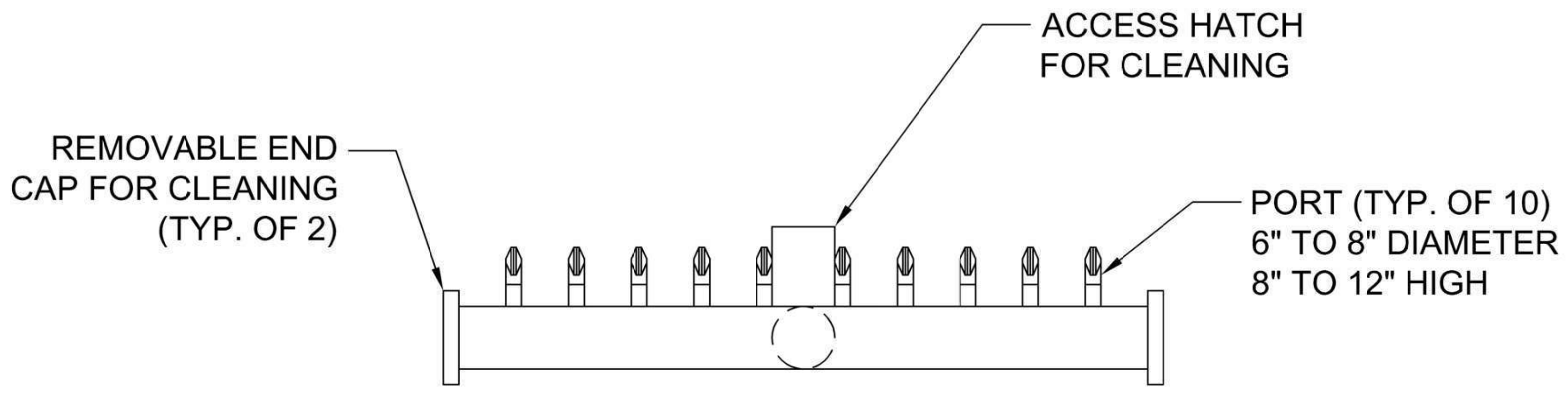


SANDY RIVER AT TEN EYCK ROAD PROFILE VIEW - NTS

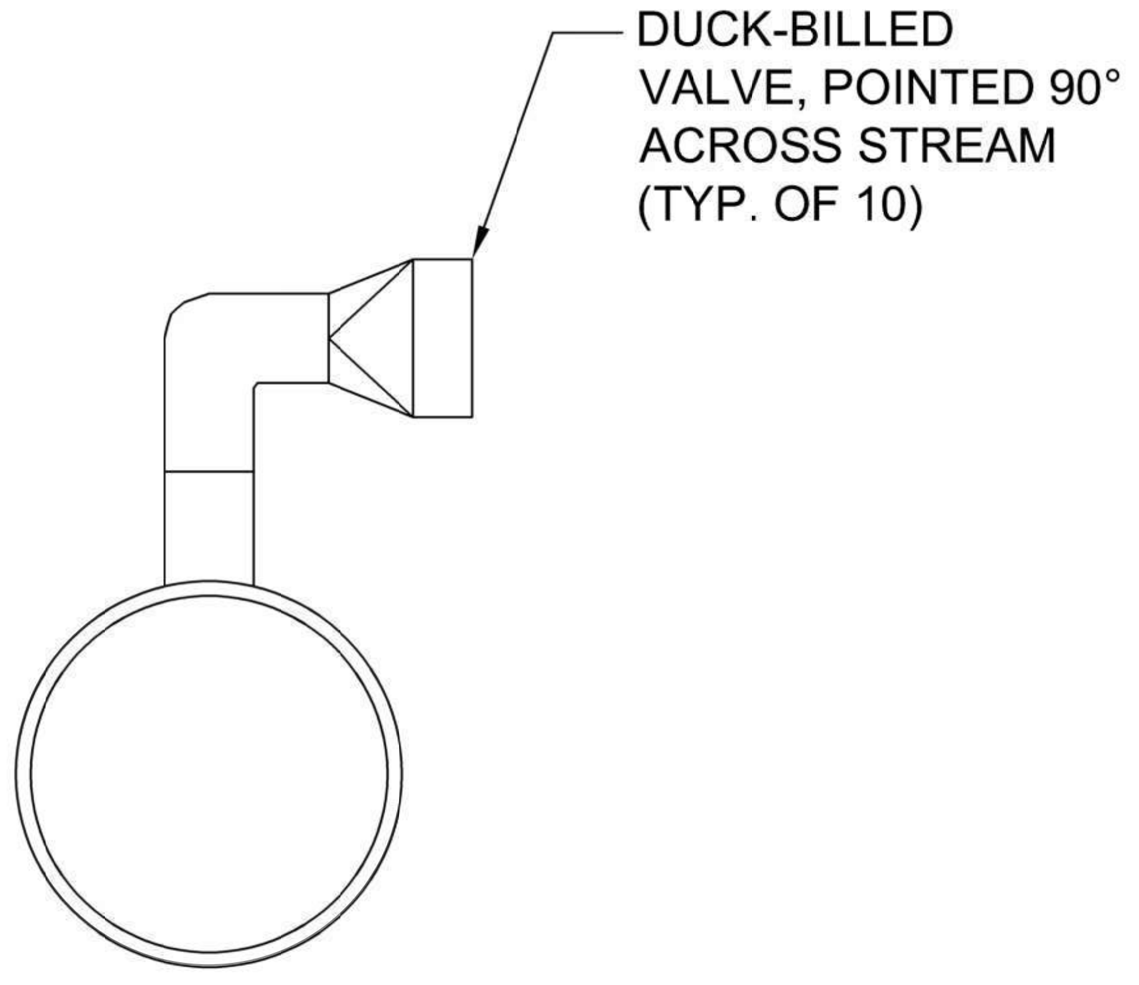


PLAN VIEW - DIFFUSER - NTS

RIVER FLOW DIRECTION PARALLEL TO DIFFUSER



PROFILE VIEW - DIFFUSER - NTS



SECTION A-A' - NTS

PRELIMINARY OUTFALL CONCEPT SUBJECT TO CHANGE

NO.	DATE	BY	REVISION

NOTICE
0 ½ 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

KMV
DESIGNED
KTH
DRAWN
CHECKED

PRELIMINARY ONLY
DO NOT USE FOR CONSTRUCTION
NOVEMBER 2020
Murraysmith
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SANDY
WHERE INNOVATION MEETS ELEVATION

PRELIMINARY OUTFALL CONCEPT SUBJECT TO CHANGE

FIGURE 2

SHEET
FIG 2
1 of 1

PROJECT NO.: 20-2776
SCALE:
DATE: NOV 2020

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Date:	September 25, 2020
To:	Ken Vigil, PE Principal Engineer Murraysmith
From:	Steven Rodriguez, PE Senior Engineer Wolf Water Resources
Project:	Sandy River Outfall Siting Evaluation
Subject:	Sandy River Outfall Siting Memo - FINAL

Technical Memorandum

Introduction

The City of Sandy is one of the fastest growing communities in Oregon, with a population that has doubled in the past 20 years and is projected to double again over the next 20. To accommodate past and future growth, the City is developing initial plans and designs to expand their wastewater system. A critical component to the new wastewater system is the siting for a proposed effluent discharge to the Sandy River.

Objectives

Wolf Water Resources (W2r), contracted by Murraysmith, has been tasked with evaluating potential wastewater outfall locations along the Sandy River to inform an appropriate site for the outfall through an evaluation of river processes (i.e. river stability, hydraulics, and fisheries biology). We understand that primary considerations in the siting of the proposed discharge locations for City of Sandy's wastewater system are:

- Channel stability (minimal erosion, deposition, and channel migration)
- Flood extents
- Adequate depth to allow for river boaters to pass over outfall infrastructure
- Avoidance of areas of high fisherperson use and high-quality fish habitat
- General constructability and feasibility of outfall infrastructure
- Hydraulic conditions that promote mixing of discharged water

W2rperformed a combination desktop and field analysis of multiple potential discharge sites to inform summary findings and recommendations.

Study Area and Potential Discharge Sites

Study Area Overview

The sites being considered for outfall alternatives are located along the Sandy River mainstem between river mile (RM)24 and RM20. This memo focuses on the geomorphic and fisheries characteristics of these sites to identify the opportunities and constraints in order to assist with the selection of a preferred location for a future discharge location for the City of Sandy's proposed wastewater facility upgrades. Initial concept designs include two potential river discharge locations (the Oxbow Site and Ten Eyck Road Crossing), and a land application at the Roslyn Lake wetland. Over the course of the investigation, three additional sites were identified as potential primary discharge locations or secondary discharge locations to be paired with land application at Roslyn Lake: the PGE Powerline Site, Upstream Oxbow Site, and Bull Run Micro-Hydro Site. At the time of this assessment, however, initial feasibility of the Bull Run Micro-Hydro was still under consideration so it was not included as part of this assessment.

This assessment covers the potential discharge sites located directly on the Sandy River mainstem and Roslyn Lake. The entire study area, along with the potential Sandy River discharge locations in addition to Roslyn Lake, are identified in Figure 1. This Vicinity Map shows each site along with potential pipeline alignments in relation to the Sandy River, the City of Sandy, the surrounding terrain, and property types. The pipeline alignments shown are preliminary in nature and will be further refined by the project team as the design progresses. A full-scale vicinity map is included as an attachment.

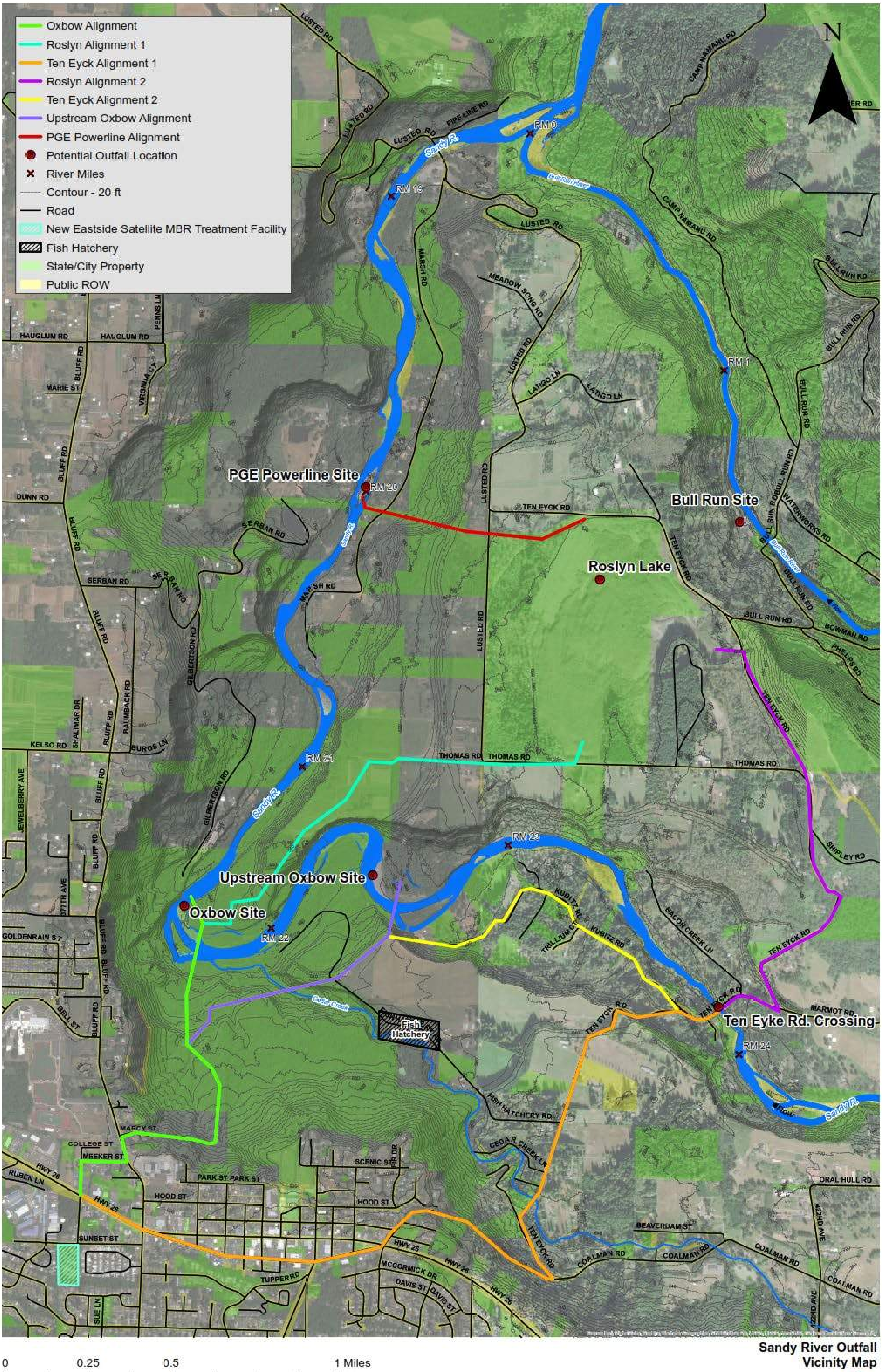

Figure 1. Sandy River Outfall Siting Evaluation Study Area and potential discharge locations and pipeline alignments. Full scale vicinity map included in attachments.

Fisheries

The Sandy River mainstem corridor has been identified as the priority anchor habitat for salmon and steelhead conservation in the basin (SRBWC 2017). The Sandy River mainstem supports four wild salmon and steelhead populations including Spring Chinook, fall Chinook, coho, and winter steelhead, all of which are listed under the Federal Endangered Species Act (ESA) as threatened. The study area primarily provides rearing and migration habitat for juvenile and adult salmonids; however, Spring Chinook and winter steelhead also spawn throughout the reach. The Sandy River Hatchery, operated by the Oregon Department of Fish and Wildlife (ODFW), maintains harvest programs for Spring Chinook, coho, and winter steelhead, in addition to summer steelhead, a popular sport fish introduced to the basin (ODFW 2020b). Other species of concern in the basin include Pacific lamprey, rainbow trout, coastal cutthroat trout, eulachon, and mountain whitefish.

Given its proximity to the Portland metro area, the Sandy River is a popular fishing and recreation destination. Heavy use by sport anglers is evident on the river. Although fishing by boat is prohibited within the study reach, boating to access bank fishing locations is common.

The Sandy Basin includes several river segments that do not attain water quality standards or support all designated beneficial uses. Oregon Department of Environmental Quality (DEQ) (2012) lists impaired waters on the Clean Water Act Section 303d list for multiple parameters within the basin. In 2005 a Total Maximum Daily Load (TMDL) Water Quality Management Plan (WQMP) was approved to reduce temperature and bacteria in the basin (DEQ 2019); however, water quality, especially high stream temperatures, is an ongoing limiting factor to fish populations.

Potential Discharge Types

With the exception of overland application at the Roslyn Lake site, the types of discharge this assessment considers are direct discharge via diffuser directly to the river within the water column and hyporheic discharge. The purpose of direct discharge diffusers is to maximize near-field mixing and dilution within the mixing zone as required by DEQ. Since diffusers can be designed in various configurations, they are not considered a factor affecting outfall siting. For that reason, no specific diffuser design was considered for this assessment.

The hyporheic zone is the region of sediment and porous space beneath and alongside a stream bed where the groundwater is sourced from the stream itself. Groundwater is supplied through water that “downwells” from the stream, commonly through bars, river islands, and underneath meander bends. Preliminary discussions with Murraysmith indicated hyporheic discharge within the river’s gravels, such as within a gravel bar along the inside bend of the Oxbow Site, was under consideration for its potential to improve mixing and provide a buffer for temperature effects from effluent discharge. It provides an added benefit of eliminating potential exposure to mobilized debris, people, or watercraft.

Considering the above direct and hyporheic types of discharge, discharge site evaluations took into consideration desirable hydraulic conditions for effluent mixing, potential disturbance to discharge facility such as impact (by debris), public interaction (by boat or wading), scour/exposure (for hyporheic discharges), and deposition/burial (for water column discharges).

Site Assessments

W2r assessed alternative discharge sites according to the following key criteria:

- General Constructability – Assessment of general site constraints relative to terrain, infrastructure, and river form.
- Geomorphology – Assessment of relative stability and potential for river change with potential to impact the discharge infrastructure within its general design life.
- Fisheries – Assessment of existing fisheries resources and potential impacts from proposed discharge infrastructure.

High Resolution aerial imagery was also collected for three of the potential sites during field assessments: Oxbow, Ten Eyck Road, and PGE Powerline. Orthomosaic images of these sites are included as attachments.

Oxbow Site

Site Information and General Constructability

The Oxbow site is located at RM 21.6 of the Sandy River, at the downstream extents of a meander bend approximately 2.3 river miles downstream of the Ten Eyck Road bridge crossing (Figure 2). Based on early conceptual designs, the most probable sewer main alignment to this discharge location would follow the existing Sandy River Trail alignment, situated on City of Sandy property, from SE Marcy Street down to the Sandy River. From here, the sewer line would cross under the Sandy River by directional boring to the right bank where it would be discharged either into the water column or in the hyporheic zone within the existing gravel bar.

Due to its location relative to the proposed treatment facility, the Oxbow site would likely provide the shortest potential sewer main alignment (Figure 2). Additionally, the existing Sandy River Trail corridor provides a potential pipeline alignment on City-owned property, eliminating constraints raised by the need for temporary or permanent private property access. The trail corridor is already cleared and graded, providing good construction access.

The Oxbow site involves a number of potential construction constraints. Steep terrain as the alignment approaches the river on both banks may create construction challenges with regard to length of directional boring and equipment access (Figure 3). Visual observations of rock outcrops along the river meander bend near this location also suggest that directional boring across the river may encounter rock. The dynamic nature of the site presents risk that the channel geometry at the outfall location could change over time, leaving it shallow and at risk of contact with debris, boat, or human interaction. As well, an outfall structure such as a diffuser could become buried in gravels as bar geometries and locations migrate over time.

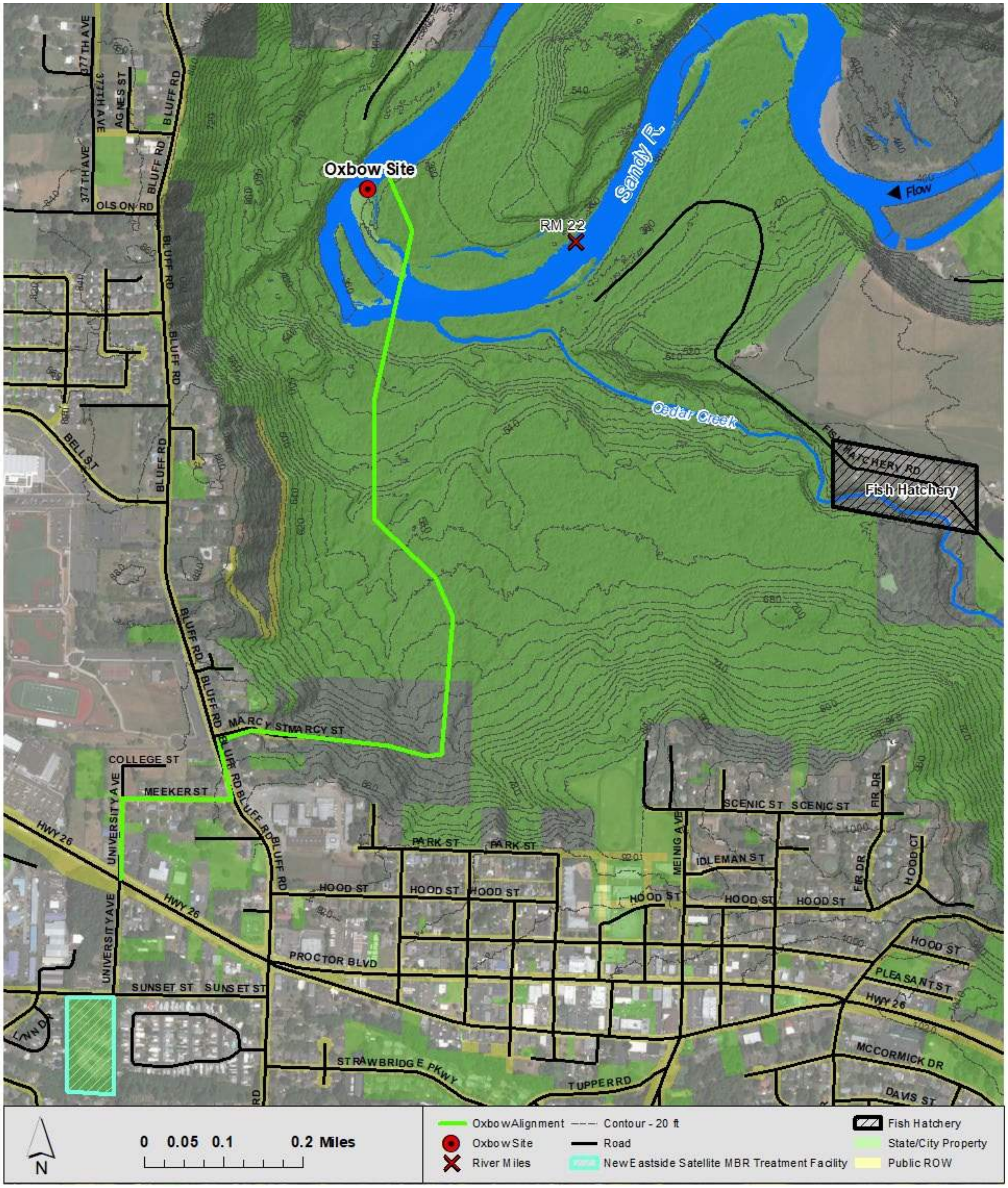

Figure 2. Vicinity map of proposed Oxbow discharge site with potential sewer main alignment (green).

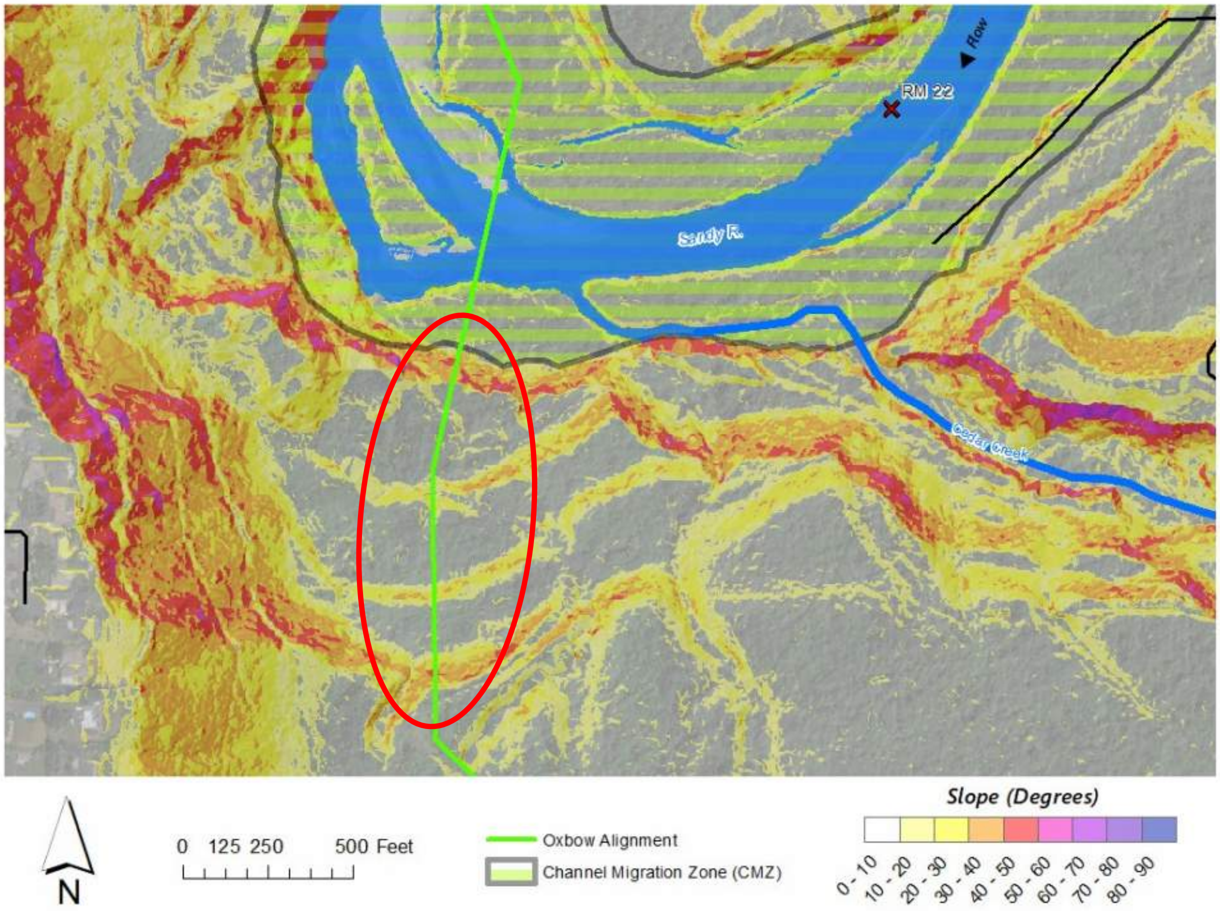

Figure 3. Steep terrain along potential Oxbow pipeline alignment (green).

Geomorphic Assessment

The Oxbow site is one of the most dynamic sites considered. Specifically, the Sandy River shows historical and present-day signs of lateral migration. Indications include major bars, active bank erosion (Figure 4) on the right floodplain, and a relatively broad (230-foot-wide) floodplain. With the exception of the east facing valley wall (comprised of fluvial mudstone, sandstone, and conglomerate from the Troutdale Formation as described by Madin (2004)), it should be assumed that the Sandy River could and likely will migrate within its floodplain within the design life of the proposed discharge infrastructure. Aerial photographs (Figure 5) show that the river has migrated modestly over the past couple decades; however, migration of the Sandy River has proved to be highly episodic in other reaches of the river. This episodic nature of migration is apparent at Metro's Oxbow Park (approximately 11 miles downstream of this site on the Sandy River mainstem) where river migration was quiescent for much of the historical record until rapid migration (of 100-200 feet per year) began threatening the park boat launch within just the last decade (W2r and KPFF, 2019). Based on this episodic river behavior, past migration should not necessarily be considered a reliable predictor of potential future migration rates or patterns when considering siting of outfall infrastructure.

Figure 4. Example of recent bank erosion at the Oxbow site.

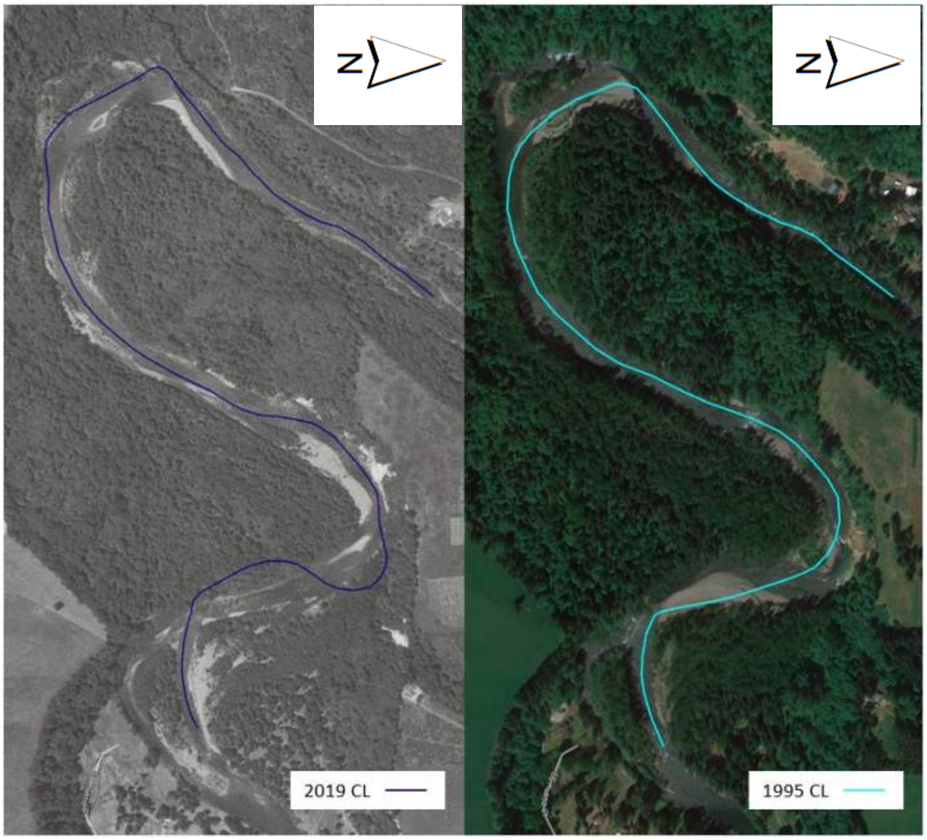

Figure 5. Aerial photograph comparison (1995 image on right; 2019 image on left) with river centerlines (CLs) shown for comparison.

DOGAMI (2017) has mapped a Channel Migration Zone (CMZ) which provides an estimate of where the river has likelihood of migrating over a 100-year timeframe (see Figure 6). Importantly, the CMZ incorporates areas likely to be impacted by both river migration and also geotechnical slope failures that may occur in response to the river migrating into high banks or valley walls along the river. In general, pipeline and infrastructure design should consider this potential migration extent to avoid conflicts into the future. These conflicts may occur as the river migrates into approach pipelines along valley margins or at the discharge point itself where changes in river thalweg location may diminish the desired mixing over time. Ultimately, the potential for these conflicts make this site a low priority site from a geomorphic perspective.

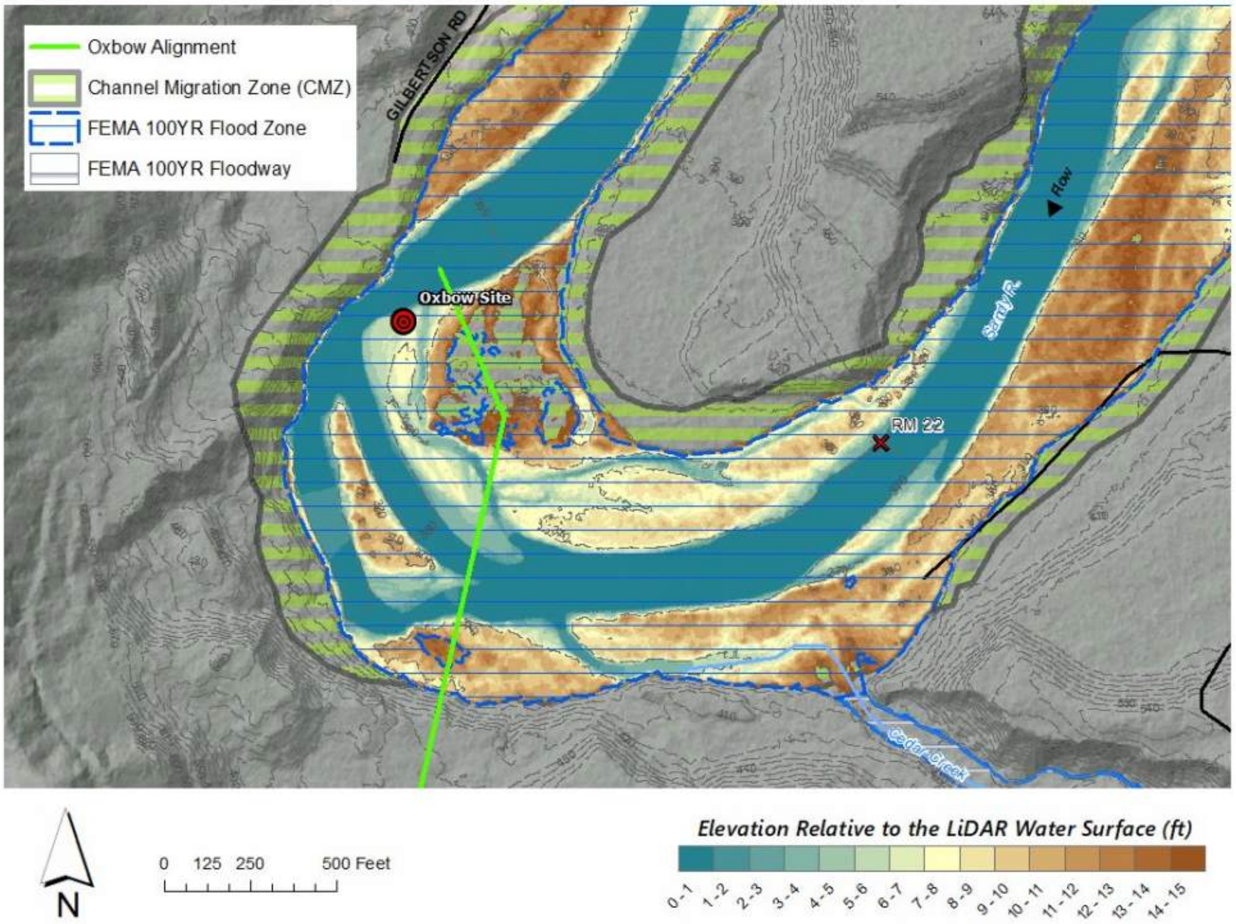

Figure 6. LiDAR map of floodplain and valley topography at the Oxbow site. Blue hatching shows the FEMA 100-year flood extent; green hatching shows the channel migration zone extent (mapped by DOGAMI).

Fisheries

The Oxbow alternative involves the pipeline crossing beneath the Sandy River at the upstream Oxbow bend and locating the outfall at the right bank of the downstream bend. The instream habitat in the vicinity of the Oxbow bends is plentiful and diverse. The Oxbow reach includes deep runs, pools, tail out riffles, and a mid-channel bar that splits the flow. Log jams are located along the banks and along gravel bars. Spawning-sized gravel substrate is plentiful, and the banks are lined with native riparian vegetation.

High fisherperson use is evident at the river crossing location. Public access to the river and the confluence with Cedar Creek, which is the intake to the ODFW Sandy fish Hatchery, is through Sandy River Park, owned by the City of Sandy. Due to the proximity to the hatchery, fish will accumulate at the base of Cedar Creek before migrating upstream. Several groups and individuals were observed fishing at this location during the site visit in June 2020. The excessive quantity of discarded fishing tackle along the banks also indicated high use.

Although the long-term impacts of the pipeline construction on the river will be minimal at the Oxbow site, care should be made toward reducing impacts to the banks and trail. Impacts and reduction of access to fishing and general recreation will be opposed by the fishing community.

The outfall location at the Oxbow site lacks direct access to the City-owned parcel and surrounding private properties. Directly at the outfall site is a popular fishing hole that is accessed by foot, from the Sandy River Park trail, or by boat. The instream habitat for salmonids at this location is also very high quality. The reach consists of deep runs and upstream side channel, and plentiful spawning gravels in the substrate. A mid-stream gravel bar is located on the right bank and the banks are lined with native riparian forests.

Communication with fisheries biologists from the National Marine Fisheries Service (NMFS) and ODFW has identified the greatest concerns regarding the Oxbow site include impacts to stream temperature, spawning gravel stabilities, and hatchery impacts. Temperature increases are a concern year-round that may affect all life stages of salmonids. The placement of the outfall in the deep pool/run located at the site would provide good mixing for water quality considerations; however, there is concern about the disruption of fish holding habitat. The high-quality holding pools at this site are important for both hatchery returns and fish migrating to spawning area further upstream. An outfall at this location sited near a pool tail-out and major riffle is inherently unstable and changes to the bed are expected. This highlights concerns of outfall exposure that could impact boating and disrupt spawning gravels. The location of the Oxbow site in proximity to the Sandy River hatchery, immediately upstream in Cedar Creek, paired with the cumulative effects of the above issues would likely impact fish returns to the hatchery.

Ten Eyck Road Crossing

Site Information and General Constructability

The Ten Eyck Road Crossing site is located at RM 23.9, where Ten Eyck Road crosses the Sandy River (Figure 7). The river is confined within bedrock as it passes under Ten Eyck Road (Figure 8). This provides a relatively stable section of river with hydraulic characteristics unlikely to change in a significant way over the life of the project. The channel is relatively deep, and velocities are fast, reducing risks of damage or conflicts with debris and boats. Private property surrounding the river in this location provides minimal public access, reducing potential for public interactions with any infrastructure in this location.

Based on early conceptual designs, one potential sewer main alignment to this discharge location would follow Ten Eyck Road from US Hwy 26. An alternative potential pipeline alignment would follow the Sandy River Trail from SE Marcy Street down to the Sandy River, then cross Cedar Creek towards the neighborhood accessed by SE Kubitz Road until it connects with Ten Eyck Road near the river (Figure 7).

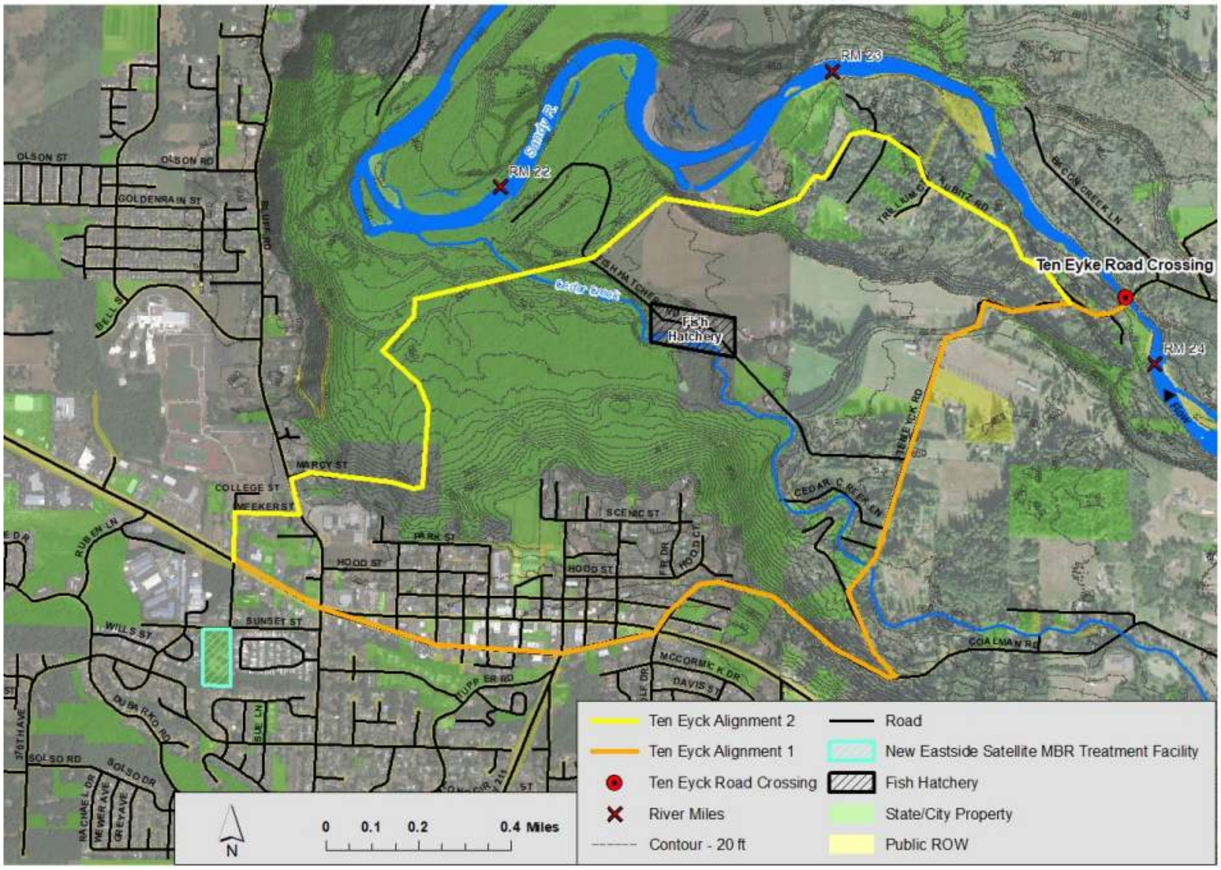

Figure 7. Vicinity map of proposed Ten Eyck Road discharge site with potential sewer main alignments (yellow and orange).

Figure 8. Sandy River channel below Ten Eyck Road crossing looking downstream (Photo courtesy of W2r). Bedrock lines the channel within this reach providing a stable, narrow and deep section of channel.

The two potential pipeline alignments are both approximately twice as long as a potential pipeline alignment to the Oxbow site. The first follows existing right-of-ways (US Hwy 26 and Ten Eyck Road) so it would not require any temporary or permanent access to private parcels, unless necessary for construction of the outfall facility at the crossing. The right-of-way provides accessibility for construction and ensures constraints related to terrain are unlikely to be encountered. Construction constraints that would accompany this proposed alignment are related to performing construction projects along existing roads and through a primary commercial and commuter corridor through the City of Sandy. Any potential alignment along US Hwy 26 and Ten Eyck Road will likely encounter numerous utility conflicts (water, gas, electric, etc.) as well as infrastructure (roads, sidewalks, etc.). These conflicts will require significant planning and coordination to mitigate, and resulting utility relocations and road repairs have the potential to increase construction costs. Construction along these primary travel corridors and through the city center also creates community nuisances in the form of road closures, detours, traffic delays, and noise, requiring traffic control planning and implementation. Although this alignment involves a number of constraints or conflicts, none are considered uncommon or cannot be mitigated.

The second potential alignment, similar to that for the Oxbow option, follows the Sandy River Trail on City-owned property, then crosses ODFW property as it turns east and crosses Cedar Creek. Once in the SE Kubitz Road neighborhood it would likely follow a road alignment until it reconnects to Ten Eyck Road. Most of this alignment, along existing trail and road corridors, is cleared and graded, which eases construction. This alignment may pose construction challenges in the form of steep terrain (Figure 9) as the alignment approaches the Sandy River and Cedar Creek. The Cedar Creek crossing would require directional boring or stream diversion and trenching. This area is uncleared and includes steep terrain, making construction access difficult. Similar to the Oxbow location, it is likely that trenching and/or directional boring to and across the Cedar Creek channel would encounter rock. Finally, based on preliminary review of County tax lots, it is likely that any alignment passing through the SE Kubitz neighborhood will require crossing private parcel(s). The portion of the alignment that follows SE Kubitz Road will likely encounter utility and infrastructure conflicts, resulting in similar constraints as the alignment following US Hwy 26 and Ten Eyck Road, but to a much lesser degree.

Completing either of these alignments and connecting to an outfall in the river from the Ten Eyck Road crossing will pose challenges. Private properties line the river in this location, providing access constraints, whether temporary or permanent. During field investigations, one nearby resident voiced negativity to siting a discharge in this location. Additionally, feasibility of design and construction of an outfall facility within a bedrock-lined channel such as this still needs determination.

If the potential Roslyn Lake land application alternative is pursued, the Ten Eyck Road site is conveniently located to function as a Sandy River discharge, a requirement of a land application alternative. To access Roslyn Lake, potential sewer main alignments would cross the Sandy River, potentially at Ten Eyck Road, then continue to Roslyn Lake. The overflow pipe alignment, if Ten Eyck is selected, could follow the same alignment as that used to Roslyn Lake, and potentially the same pipe, adding a construction cost benefit.

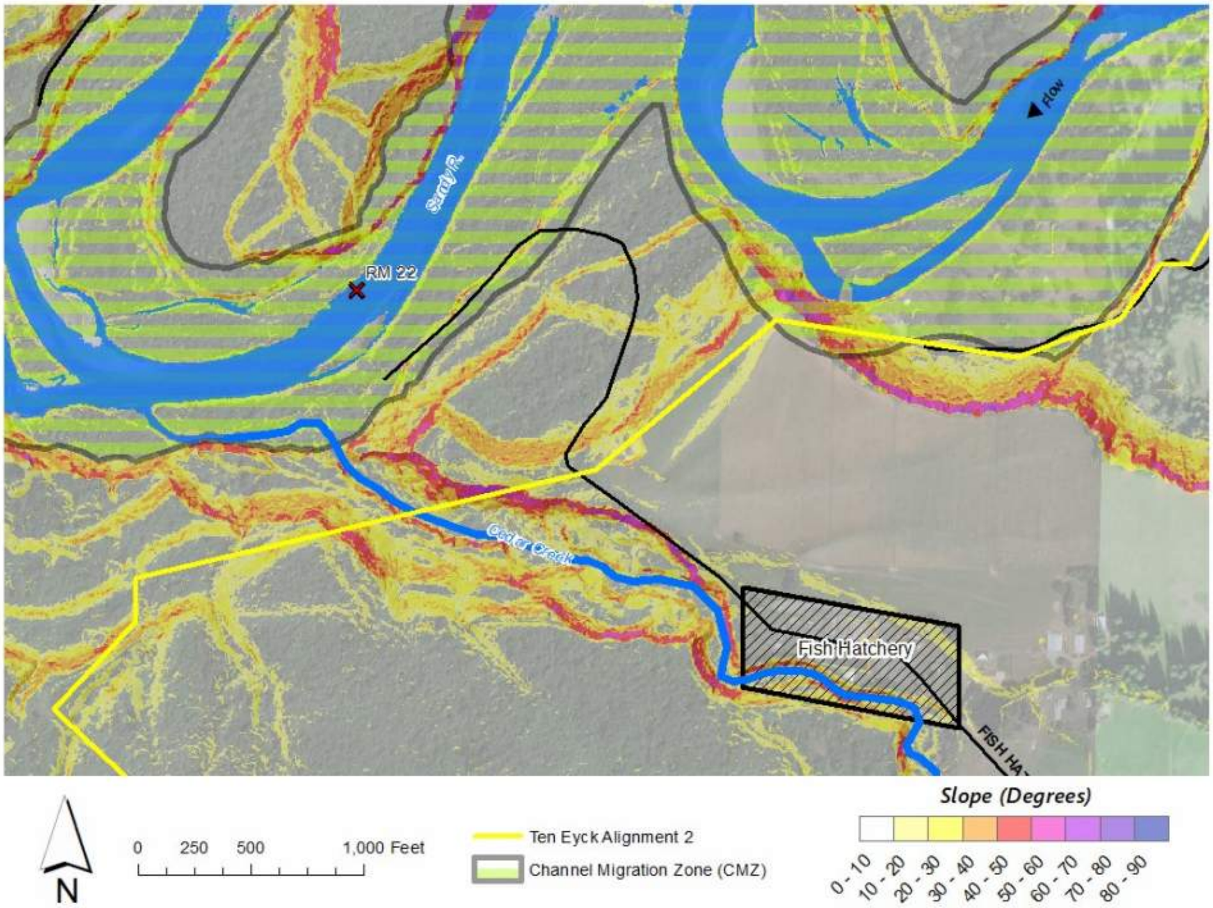

Figure 9. Steep terrain along potential Ten Eyck Road pipeline alignment (yellow).

Geomorphic Analysis

Ten Eyck Road crosses the Sandy River at a natural bedrock constriction. The bank material appears to be of volcanic origin with a welded nature and angular clasts or fragments. The bedrock in this reach is shown on the DOGAMI Geologic Map of Oregon as andesite from the Rhododendron Formation, as identified by Madin (2004). This erosion-resistant bedrock (which lines the stream bed and canyon side walls) provides significant stability, making the potential for lateral migration of the river negligible (rock fracture and failure may be a larger concern, but were not assessed). This site is the most stable of the sites considered, and thus is the highest priority site from a geomorphic perspective.

Fisheries

At the Ten Eyck Road Crossing location the Sandy River channel is confined with narrow bedrock walls, creating a high velocity single channel chute. The lack of off-channel or low flow areas within this reach provides little opportunity for fish holding. Thus, this location is primarily utilized as a transport reach for all fish species. The high velocity and deep channel would create a desirable mixing zone, so potential impacts to stream temperatures or other water quality constituents are expected to be relatively low. As a result, the impacts due to the construction of the outfall and likelihood of fish exposure to the effluent at this location is low.

Fishing opportunities are also minimal at the Ten Eyck location due to the relatively high velocity flows and channel structure, although bank angling is observed daily. The pathways from the road under the bridge provide a popular boat put-in.

Overall, the Ten Eyck Road outfall location would have fewer concerns than the other alternative sites with regard to fish habitat, fishery, and water quality impacts. Biologists from NMFS and ODFW have confirmed that this site is preferred over the Oxbow and other downstream sites.

PGE Powerline

Site Information and General Constructability

The PGE Powerline crossing site is located at RM 20 of the Sandy River, where the PGE powerlines cross over the Sandy River (Figure 10). Based on discussions with project planners and its distance from the proposed treatment facility relative to other potential discharge locations, we assume discharge at this location would function as a Sandy River discharge in conjunction with land application at Roslyn Lake. A potential overflow pipe alignment would follow the PGE powerline alignment west from Roslyn Lake to the Sandy River to its discharge location where it would be discharged either into the water column or in the hyporheic zone within the existing gravel bar.

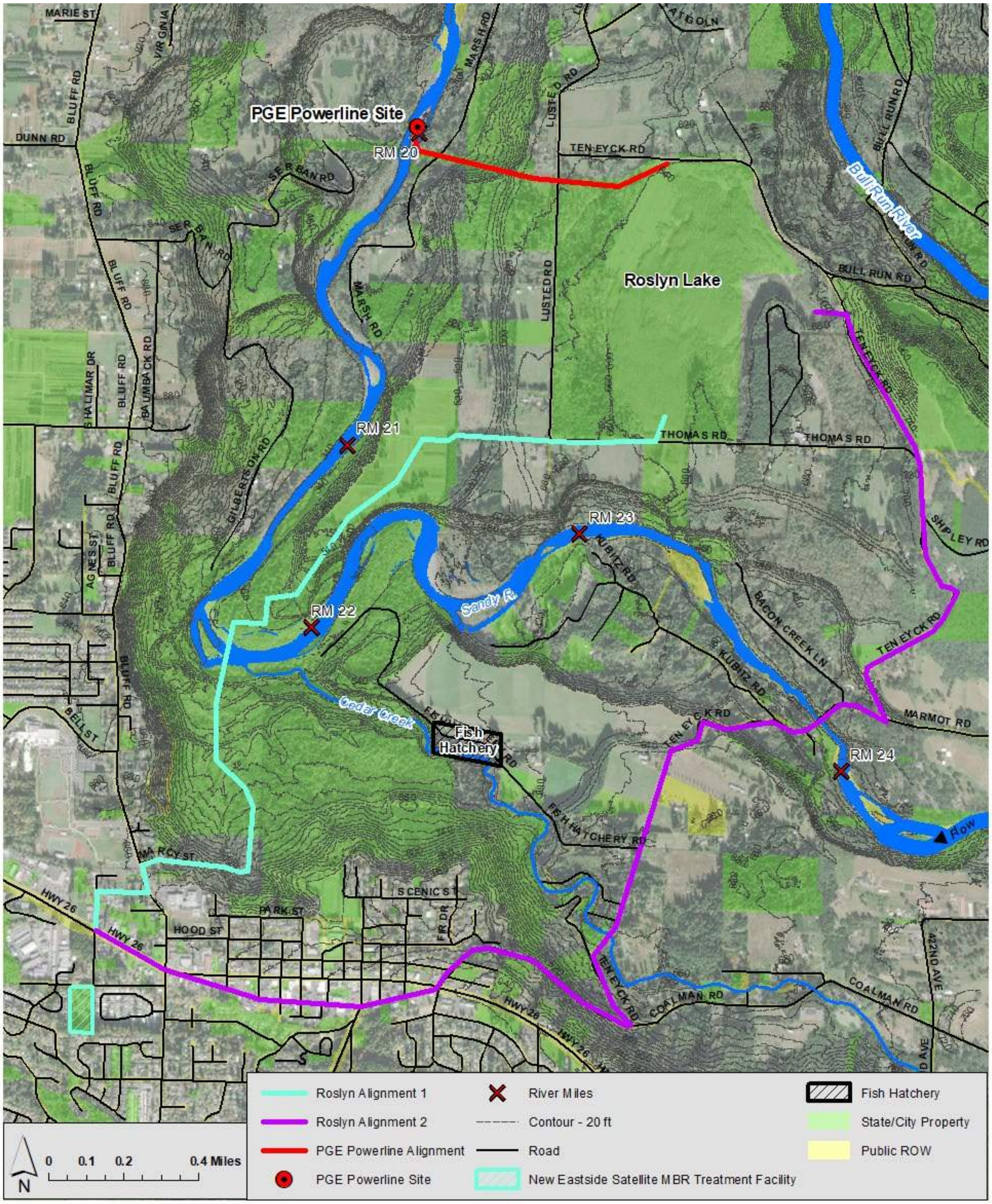

Figure 10. Vicinity map of proposed PGE Powerline discharge site with potential sewer main alignment (red) from Roslyn Lake following powerline corridor. Potential sewer main alignments for Roslyn Lake (cyan and purple) also shown.

A more detailed assessment of the Roslyn Lake discharge location alternative found later in this memorandum provides additional information on potential sewer main alignments from Sandy to Roslyn Lake. Because this discharge location would be in conjunction with an outfall at Roslyn Lake and would require pipe alignments both from the treatment facility to Roslyn Lake and from Roslyn Lake to this discharge location, this option would require the longest overall sewer main alignment regardless of alignment to Roslyn Lake (Figure 10). The existing Power Line corridor provides a potential pipe alignment with access already established for construction; however, access would need to be allowed by and coordinated with the utility. As can be seen in Figure 11, an alignment following this corridor would pass through steep terrain descending from the floodplain terrace to the river, posing construction challenges.

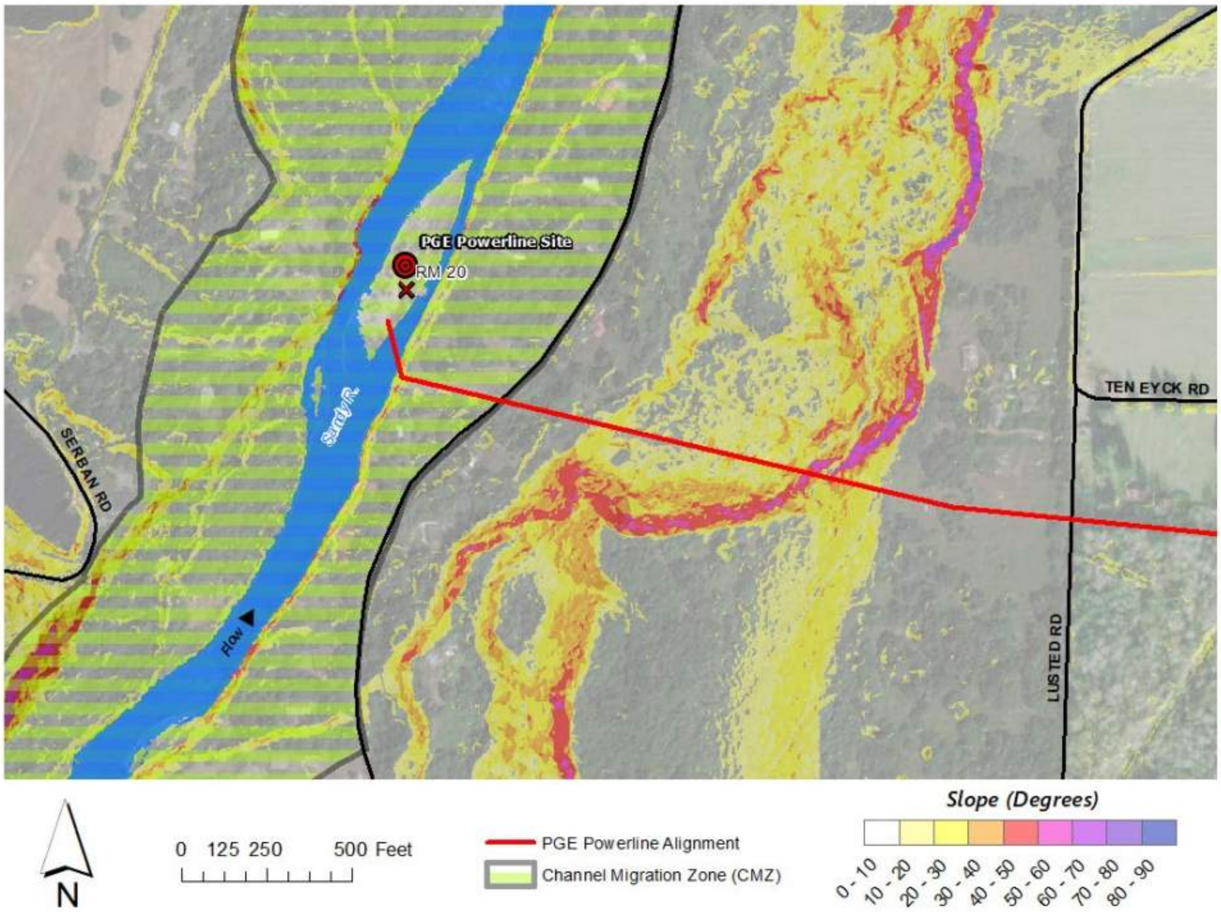

Figure 11. Terrain slopes along potential sewer main alignment from Roslyn Lake to PGE Powerline discharge site. Note steep terrain as alignment descends from floodplain terrace near Lusted Road to river.

Geomorphic Analysis

The PGE site was not accessed in the field and was assessed through aerial imagery and available geospatial information. Within recent decades aerial imagery reveals a significant mid-channel gravel bar that has changed in extent, as well as modest shifts in the river thalweg (see Figure 12). This potential site appears to have less migration potential generally than that of the Oxbow site (based on a straighter river planform overall); however, DOGAMI's CMZ mapping indicates a significant zone of potential migration into the future (Figure 13) which should be considered and generally avoided with the discharge infrastructure/pipe. Based on the moderate potential for river migration and the width of the CMZ in this location, this site is considered relatively low priority.

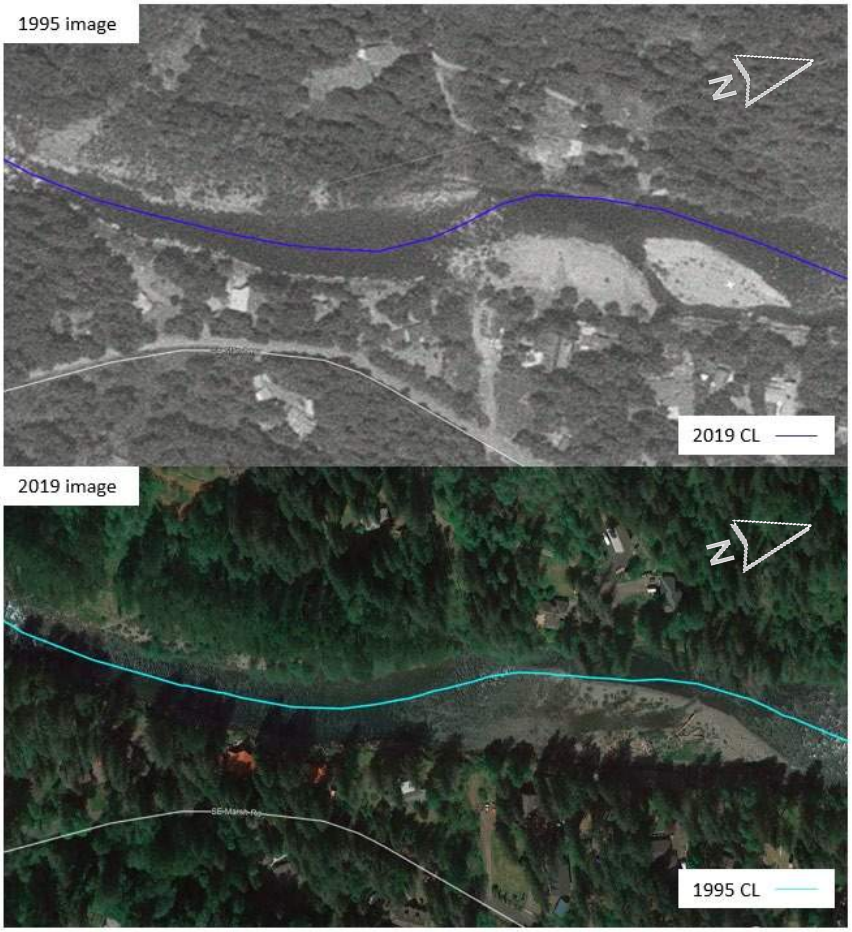

Figure 12. PGE site aerial photograph comparison (1995 image on top; 2019 image on bottom) with river centerlines (CLs) shown for comparison.

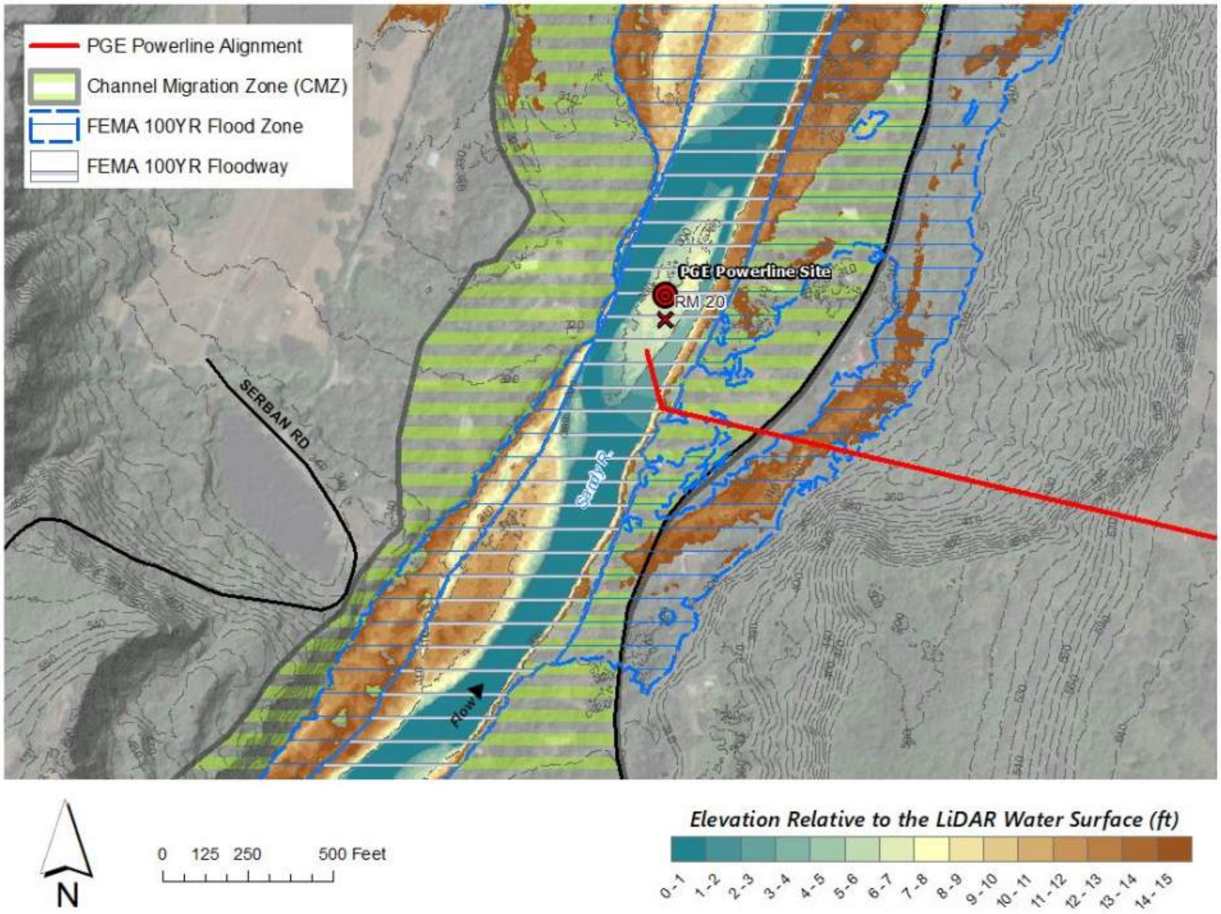

Figure 13. LiDAR map of floodplain and valley topography at the PGE site. Blue hatching shows the FEMA 100-year flood extent; green hatching shows the channel migration zone extent (mapped by DOGAMI).

Fisheries

The PGE site has similar concerns regarding potential impacts to the fishery as the Oxbow site, due to the quality of in-steam habitat identified at this location. This reach appears to be highly dynamic and complex with a continuously shifting gravel bar that adjusts flow through a single and multiple-thread channel. These characteristics would offer good low flow and off-channel habitat for holding and rearing fish. The lower depths across the gravels at this site may result in the discharge volume having a greater effect on stream dynamics, water quality, temperatures, and the stability and quality of potential spawning beds.

Fishing is popular within the pools just downstream of the discharge location. The site is commonly accessed via the riverbank from downstream Latourette Park.

Upstream Oxbow Location

Site Information and General Constructability

The Upstream Oxbow site was considered for an outfall location only after field investigations for other sites were completed. For this reason, findings for the upstream Oxbow location are based solely on desktop analysis. This location was initially recommended for consideration because it contains deep pools that are beneficial for mixing, it is not adjacent to the fish hatchery, and it offers potential pipeline alignments along public property. The Upstream Oxbow Site is located at RM 22.5 of the Sandy River, at the downstream extents of a meander bend approximately 1.4 river miles downstream of the Ten Eyck Road bridge crossing (Figure 14). Based on discussions with project planners, we assume the most probable sewer main alignment to this discharge location would follow the existing Sandy River Trail alignment situated on City of Sandy property from SE Marcy Street towards the Sandy River, where it would turn east and cross Cedar Creek, and then traverse northeast across ODFW property until it reached the Sandy River. At that point it would be directionally bored under the river to the right bank and discharged either into the water column or into the hyporheic zone within the existing gravel bar.

Due to its location relative to the proposed treatment facility, this discharge location would likely have a relatively short potential sewer main alignment compared to other discharge locations under consideration (Figure 14). Additionally, the existing Sandy River Trail corridor provides a potential alignment on City-owned property, eliminating the need for temporary or permanent private property access. The trail corridor is already cleared and graded, which eases construction.

Steep terrain as the alignment approaches the river and Cedar Creek (Figure 9) would pose construction challenges with regard to the length of directional boring and construction equipment access. Subsurface conditions are unknown at this site so it cannot be ruled out that directional boring and trenching across the river and Cedar Creek may encounter rock.

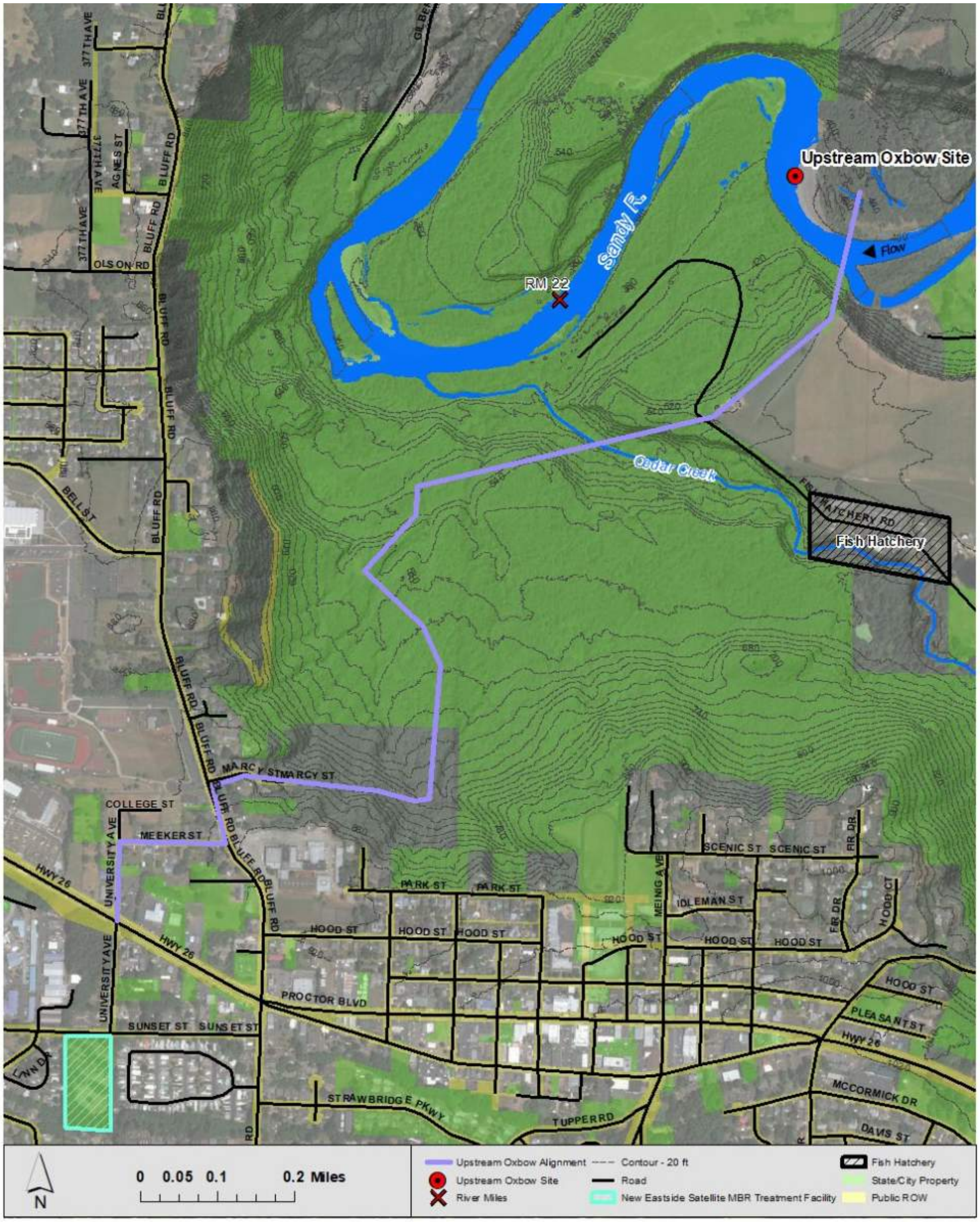

Figure 14. Upstream Oxbow Site vicinity with potential sewer main alignment (lavender).

Geomorphic Analysis

The Upper Oxbow site was not accessed directly in the field and was assessed through imagery and available geospatial information. As viewed in Figure 15, this site has the broadest active floodplain of the three sites and shows the most significant recent river migration (see Figure 5). This site, therefore, is likely the least stable of the sites considered and is considered low priority from a geomorphic perspective.

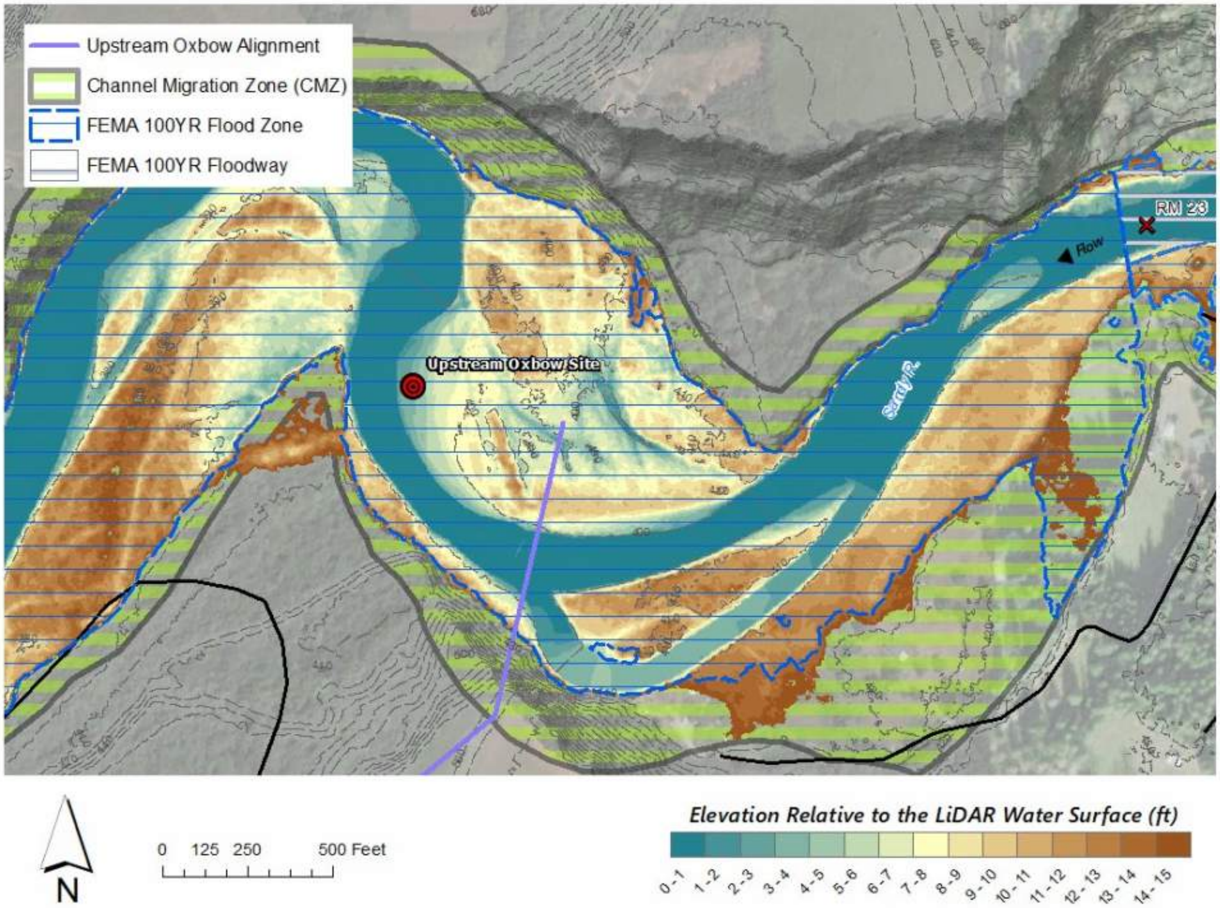

Figure 15. LiDAR map of floodplain and valley topography at the Upper Oxbow site. Blue hatching shows the FEMA 100-year flood extent; green hatching shows the channel migration zone extent (mapped by DOGAMI).

Fisheries

This site is similar to the downstream Oxbow site due to the quality of in-steam habitat identified at this location. The site is highly complex and includes a downstream gravel bar island, lateral gravel bars, and a multi-channel flow. These habitat features provide very important off-channel rearing and holding opportunities for fish. A prime native spring Chinook holding hole is located at this site that is a popular fishing spot and where ODFW nets most of their hatchery broodstock. Additionally, key off channel spawning habitat for native winter steelhead is located just upstream and downstream of the proposed outfall.

As the Upper Oxbow site is approximately 1.4 miles upstream from the hatchery, water quality impacts may be a concern if the mixing zone extends into the area where fish hold at the confluence with Cedar Creek, affecting hatchery returns.

Fishing use is heavy at the site due to the high quality of habitat supporting fish holding. Access is mostly via boat for bank angling.

Roslyn Lake Site

Site Information and General Constructability

In addition to potential discharges directly to the Sandy River, a land application alternative is being considered at the Roslyn Lake site. Since this site is not directly on the Sandy River, geomorphic and fisheries analyses were not performed for this site. Use of this site will require long term agreements to be in place with the property owner. It should also be noted that this site is not under consideration as a year-round discharge location because of heavy rainfall in the winter and spring, and it would mainly be considered for summertime discharge. And even in the summertime, because of soil capacities, a portion of the effluent would need to be discharged to the river. Because of this, a Roslyn Lake alternative would require a direct discharge to the Sandy River, such as Ten Eyck Road or PGE Powerline, in conjunction with the land application. The constructability review of potential sewer main alignments was performed considering this requirement for a Sandy River discharge site. Flow/discharge splits between land application and river discharge sites would need to be determined based on water quality needs and future permit requirements.

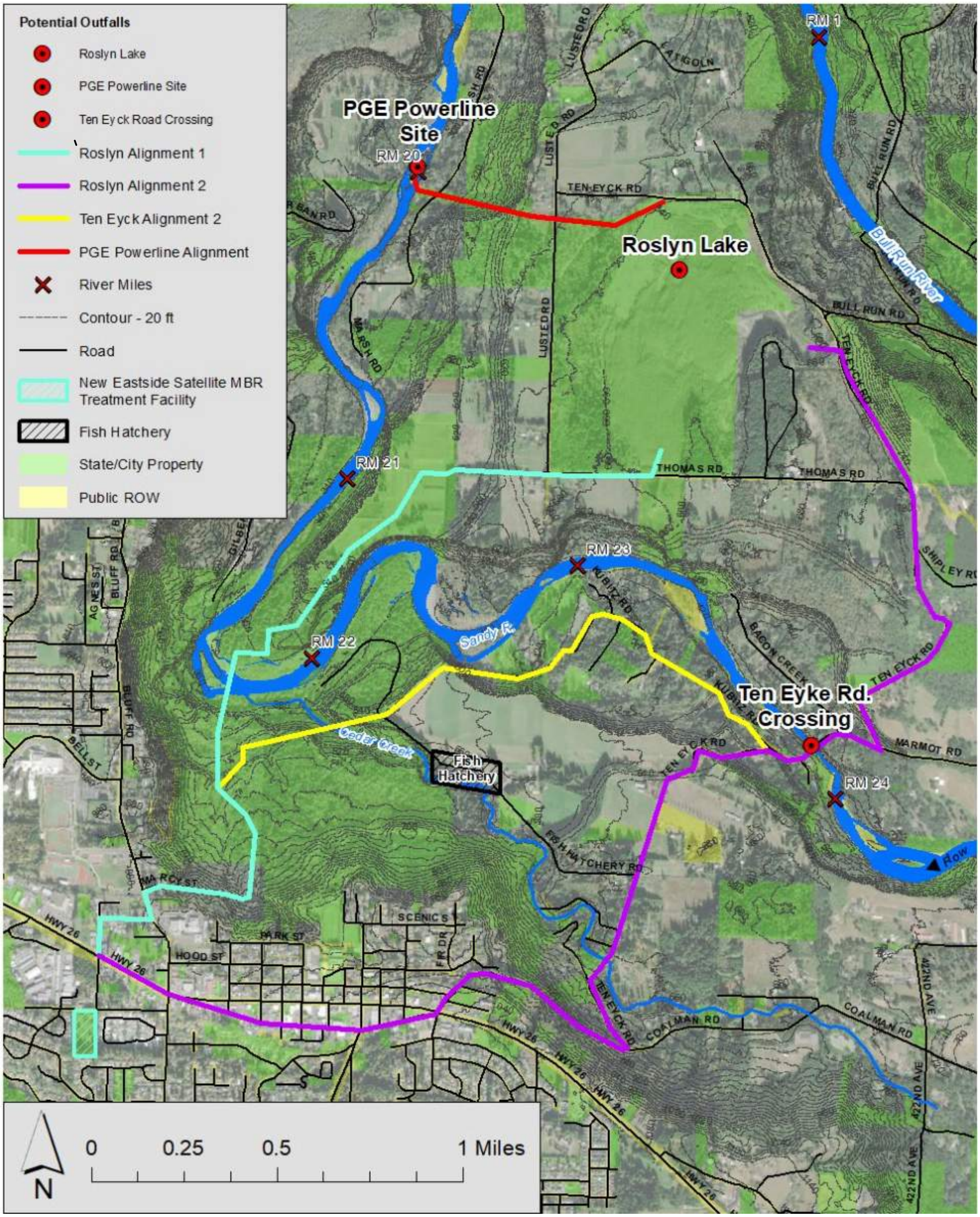

Figure 16. Roslyn Lake Site vicinity with potential pipeline alignments.

Based on early conceptual designs, two potential sewer main alignments were considered for the Roslyn Lake discharge location. The first follows the same alignment to Sandy River along the Sandy River Trail proposed for the Oxbow discharge location, where it crosses the Sandy River to the north side of the river and follows a path through private parcels to Thomas Road, from where it reaches Roslyn Lake (Figure 16). This alignment will encounter the same potential constraints with regard to terrain, potential rock, and boring across the river. On the north side of the river the alignment would cross steep terrain to reach the floodplain terrace, as well as pass through private properties until it reaches Thomas Road, which would require temporary and permanent access during and after construction.

The second alignment would follow an alignment similar to that proposed for Ten Eyck Road that follows US Hwy 26 and Ten Eyck Road to the Sandy River crossing. From there, it would continue to follow Ten Eyck Road until it reached a discharge location into the lake bed adjacent to Bull Run Road (Figure 16). Being located along existing roads, access would be good, though likely encounter numerous utility and infrastructure conflicts requiring coordination, relocation, and repairs. Significant construction inconveniences for the community may occur and traffic control would also be required. Although potentially costly, this alignment does not pose any identified unmitigable construction constraints.

Communications with NMFS and ODFW staff indicate that the Roslyn Lake alternative is preferred as this option primarily relies on land application for effluent discharge. The overflow discharge directly to the river, when needed, would be at a reduced rate compared to the other alternatives and expected fishery impacts would be reduced in kind. The overflow discharge to the river is expected to occur year-round due to land application constraints, with overflow during the winter months expected to be consistent. During the winter months the stream flows will be higher providing greater mixing and reduced thermal loading; therefore, the effects on fisheries will be lower than other times of the year. More detail of the seasonality of the overflow would be needed to have a better grasp of the fishery impacts.

ODFW and NMFS were interested in the educational opportunities with the Roslyn Lake option as there is an interesting story to be told around all the changes that have occurred in the basin over the years in regard to power generation and fisheries management. Coordination with the agencies is advised to determine if the Sandy River Habitat Conservation Plan would allow this use.

Conclusion

The focus of this assessment was to evaluate the suitability of potential treated wastewater effluent outfall locations for the City of Sandy's proposed wastewater treatment facility upgrades. Outfall locations were evaluated for channel stability, potential impacts to fisheries and public uses, and general constructability (Table 1).

Table 1 - Summary of Potential Sandy River Outfall Locations

Discharge Location	Relative Channel Stability	Potential Impact to Fisheries	Potential Impact to Public Uses	General Constructability		
				Cross Private Parcels? [1]	Channel Crossing	Relative Alignment Length
Oxbow	Low	High	High	No	Yes (Sandy River)	Short
Ten Eyck Road Crossing	High	Low	Low	Potentially[2]	Potentially[3]	Medium
PGE Powerline	Moderate	High	Moderate	Yes	Yes (Sandy River)	Long
Upstream Oxbow	Low	High	Moderate	Potentially[2]	Yes (Sandy River and Cedar Creek)	Short
Roslyn Lake	N/A	Low[4]	Low[4]	Potentially[2]	Yes (Sandy River)	Long

1. *Based on preliminary review of Clackamas County taxlot and GIS information.*
2. *Multiple potential pipe alignment considered, some of which cross private parcels based on preliminary review of available taxlot information.*
3. *Multiple potential pipe alignments considered, one of which crosses Cedar Creek.*
4. *Does not account for overflow discharge to Sandy River required in conjunction with Roslyn Lake land application.*

Three of the four potential discharge sites, Oxbow, PGE Powerline, and Upstream Oxbow, on the Sandy River mainstem corridor had similar characteristics in that they contain high value instream habitat for salmonids and have dynamic channel characteristics with likelihood of cross sectional change over the expected lifetime of the proposed treatment facility upgrades. The sites' habitat value increases the potential for impacts to fisheries and would likely receive the most resistance from the community and regulatory agencies. Additionally, two of these sites (Oxbow and Upstream Oxbow) would require directional boring across the mainstem Sandy River, increasing the complexity of construction. These characteristics are less desirable than those of the fourth potential mainstem site, Ten Eyck Road.

It is well understood that the use of Roslyn Lake for land application, which would minimize effluent discharge to the Sandy River and greatly reduce potential exposure and impacts to fisheries, is a desirable option, but is still in early phases of feasibility analysis and is not a definitive option for discharge at this time. A requirement of a land application alternative such as Roslyn Lake is that it is combined with a direct discharge site to the mainstem Sandy River.

The Ten Eyck Road potential discharge site is unique compared to the other sites in that it is a straight, bedrock-confined reach. The hydraulic characteristics of the site as a high velocity single thread chute, offers little holding habitat for fish, making it most likely only used as a transport reach, minimizing potential exposure to effluent. An additional benefit of the bedrock confinement is it provides a stable segment of channel, with little history or potential for dynamism. This site offers multiple feasible sewer main alignments, one of which is entirely within public right-of-way as it follows existing road corridors. A second alignment would require minimal private property access. The Ten Eyck Road crossing would also be well-suited to be the Sandy River discharge location in conjunction with the Roslyn Lake alternative based on the characteristics highlighted previously, as well as its location relative to a potential sewer main alignment to Roslyn Lake. Assuming design and construction of an outfall configuration within a channel with these physical characteristics (bedrock) is feasible, this site appears most suitable of those assessed for a mainstem outfall location.

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Attachments

Orthomosaic Imagery for Oxbow, Ten Eyck, and PGE Powerline Sites

Sandy River Outfall Vicinity Map

Sandy River Outfall Slope Map and Landslide Susceptibility

Sandy River Outfall Height Above Water Surface (HAWS) Map

DRAFT Technical Memorandum 7.2

Date: April 26, 2021

Project: City of Sandy – Detailed Discharge Alternative Evaluation

To: Jordan Wheeler, City Manager
Mike Walker, Director of Public Works
Thomas Fisher, Engineering Technician
City of Sandy, Oregon

From: Matt Hickey, PE
Jessica Cawley, PE
Katie Husk, PE
Murraysmith

Re: Outfall Pipeline Alignments and Costs TM-7.2

Introduction

This memorandum summarizes the evaluation and findings associated with routing the effluent pipeline from the proposed MBR Satellite Wastewater Treatment Plant to potential discharge locations identified on the Sandy River, and a recommended pipeline route from the river up to Roslyn Lake. The memorandum includes a summary of route selection criteria and a summary of potential alternatives. The preliminary cost estimates presented in this memorandum are a planning estimate to be used solely for the purpose of a detailed discharge alternatives evaluation for the City of Sandy. The memorandum also outlines, on a preliminary basis, pipeline routing considerations and conceptual design elements for the recommended route for the pipeline.

Purpose

The purpose of the study is to determine a practical route for the effluent pipe relative to the selected outfall locations and assist with developing conceptual level costs estimates. The purpose of documenting the alternatives and the preferred route is to evaluate the feasibility of routing the pipeline along various alignments and identify the challenges and required engineering to develop a final pipeline route. Other key considerations to develop final alignment recommendations and final routing concepts include permitting, easement and property acquisition needs, geotechnical considerations, pipe material selection, detailed hydraulic analysis, and final designs associated with the effluent pipe. It is anticipated that these elements will be further evaluated in subsequent permitting and preliminary design phases of the project. An overview map of the pipeline routing alternatives is shown in **Figure 1**.

Scope

The following items from Task 5.3 of the Scope of Work are included in this memo:

1. Develop pipeline alignments to preferred Sandy River outfall locations
2. Develop two potential pipeline alignments to Roslyn Lake
3. Estimate capital and 20-year lifecycle costs for each pipeline alignment

This memo also includes a figure showing the pipeline alternatives and property owner information in **Appendix A**, as well as criteria developed for assessing pipe routing alternatives.

Route Selection Criteria

To compare the potential options, the team developed a list of criteria to compare the various alternatives. The key criteria for assessing the potential pipeline routes are listed below.

- Costs – The capital cost factors include the length of pipe, surface restoration, traffic control, construction methods and type of pipe materials required. A rough cost breakdown for each option may be found in **Appendix B.**

- Environmental Impacts – Environmental factors include impacts to wetlands, streams, rivers, trees, and other environmental impacts and associated permitting.

- Impacts to the Public – Potential impact to the public include traffic impacts, impacts to businesses, construction noise and impacts to recreational activities.

- Property Acquisition and Easement Needs – Property acquisition and easement needs evaluation includes assessing the need for easements on private and public property.

- Required Agency Coordination and Permitting – Agency coordination includes potential coordination with ODOT and Clackamas County (County). Pipeline construction crossing under or installed within State and County rights-of-way will require right-of-way permits.

- Opportunity Projects – Opportunity projects may include opportunities to work with other agencies to construct a trail over the pipeline route or improve roadway surfacing following pipe installation. This is discussed further in the “Additional Considerations” subsection later in this report.

- Opportunities for Additional Uses for the Effluent – The Detailed Discharge Alternatives Analysis includes assessment of potential irrigation opportunities for additional use of the effluent. This is discussed further in the “Additional Considerations” subsection later in this report.

- Constructability – Constructability considerations include constructing in areas of steep topography or other geotechnical or topographical challenges. Also, construction in routes congested with utilities can present constructability challenges.

- Proximity to Selected Discharge Location – To economically convey the effluent to the discharge locations, the pipe routes follow the shortest feasible route to these sites. The two most viable sites are site at the large oxbow in the City Park and at Revenue Bridge along Ten Eyck Road. For more information on how these locations were selected, see TM 7.1 – Sandy River Outfall Siting Study.

- Opportunities for Hydro Power – Since there is significant elevation difference between the MBR site in the City and the two discharge locations, there is opportunity to generate hydropower. This is discussed further in the "Additional Considerations" subsection later in this report.

- Seismic/Landslide Considerations – As this is a critical facility for the City, the pipe should be designed along a route that will remain stable during a seismic event. Routes that included steeply sloping areas and areas that may include liquifiable soils will be avoided where possible. Risk maps used for this evaluation can be found in **Appendix C**.

- Land Use – Land use can impact the permitting for the pipeline. For example, Timber and Exclusive Farm Use allow for reconstruction of public roads and highways for the placement of subsurface utility facilities but provides only conditional use for a hydropower facility and would require land use permitting and approval.

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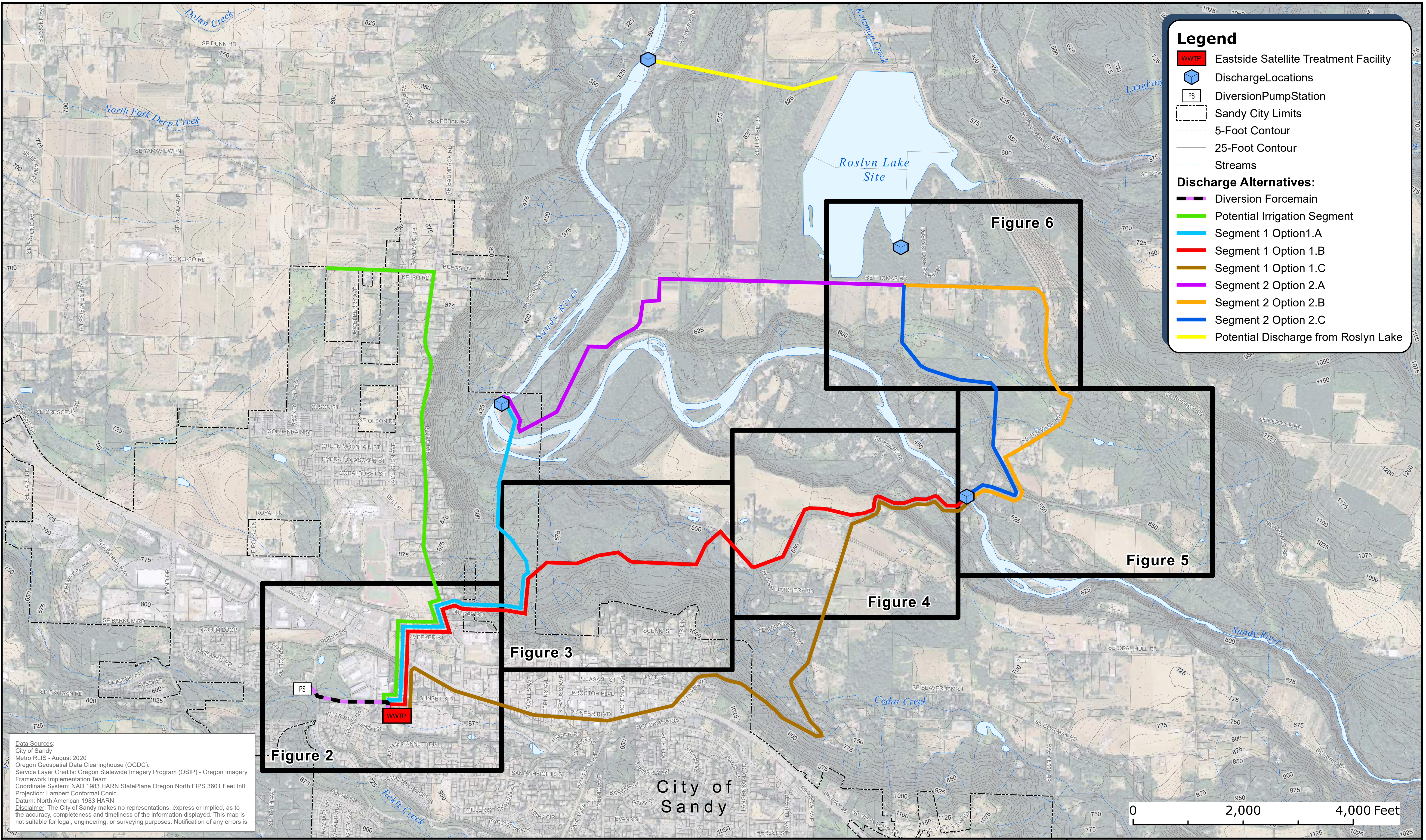

Data Sources:
City of Sandy
Metro RLIS - August 2020
Oregon Geospatial Data Clearinghouse (OGDC).
Service Layer Credits: Oregon Statewide Imagery Program (OSIP) - Oregon Imagery Framework Implementation Team
Coordinate System: NAD 1983 HARN StatePlane Oregon North FIPS 3601 Feet Intl
Projection: Lambert Conformal Conic
Datum: North American 1983 HARN
Disclaimer: The City of Sandy makes no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering, or surveying purposes. Notification of any errors is

murraysmith

SANDY
WHERE INNOVATION MEETS ELEVATION

City of Sandy, Oregon
Wastewater System Facility Plan

Figure 1
Overview Map

February 2021

20-2776

G:\PDX_Projects\20\2776 - Sandy - Detailed Discharge Alternatives Evaluation\GIS\Figures\KTH Figures\20-2776-OR-WWSFP-FIGURE 1.mxd 2/26/2021 3:43:50 PM katie.husk

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The following sections of this report are a discussion of each pipeline alternative along with advantages and disadvantages relative to the evaluation criteria outlined above.

Pipeline Route Alternatives from Eastside Satellite Facility to Sandy River (Segment 1)

The analysis of discharge alternatives favored two outfall locations: Option1 to the Oxbow below Sandy River Park and Option 2 near Revenue Bridge. The route alternatives from the Eastside Satellite Treatment Facility to the river outfall location are labeled with Segment 1. The route alternatives from the river outfall location to Roslyn Lake are labeled Segment 2.

Segment 1 Option 1.A (Oxbow Outfall Via City Park)

Segment 1 Option 1.A includes a pipeline from the Eastside Satellite Treatment Facility to a surface water discharge at the Oxbow below Sandy River Park.

- Alignment: from Sunset St. and University Ave; north along University Ave and continuing east on Meeker St; north on Bluff Road; east on SE Marcy Street to the Sandy River trail; cross country (XC) through Sandy River Park to the Sandy River Outfall.
- Approximately 3,270 linear feet of 16 to 18-inch force main (FM) in roadway; 1,270 linear feet of 16 to 18-inch FM on undeveloped land; and 3,910 linear feet of 24 to 30-inch pressure gravity line on undeveloped land.
- The pipeline crosses the following: public right of way (ROW), Highway (HWY) 26 perpendicular crossing, and City-owned property; an unknown number of stream crossings in Sandy River Park.
- Construction Methods: Crossing HWY 26 will likely include an auger bored casing and carrier pipe. The Sandy River crossing will likely include a Horizontal Directional Drilling (HDD). HDD could be high-density polyethylene (HDPE) or steel piping to address high pressures.
- **Advantages**:
    - Construction in public ROW and City-owned property;
    - requires few right-of-way permits as the route is mostly out of the roadway through the park; and
    - low impact to public as much of the alignment is out of the right-of-way.
- **Disadvantages:**
    - Constructability challenges associated with steep slopes, benches, streams, siphon design, and native soil types that include cobbles will impact potential for HDD;

  - potential for more permitting challenges associated with the river crossing;
  - frequently used recreational area near the outfall location;
  - route not to preferred outfall location: outfall location involves poor geomorphic stability and likelihood of river channel migration away from outfall construction over time;
  - limited maintenance access and no utilities on-site for hydropower facility;
  - landslide hazards likely along this route; and
  - higher cost due to HDD construction.
- Project Cost: $15.6 M

Segment 1 Option 1.B (Revenue Bridge Outfall Via City Park and Cross County Route)

Segment 1 Option 1.B includes a pipeline from the Eastside Satellite Treatment Facility to a surface water discharge below Revenue Bridge.

- Alignment: from Sunset St and University Ave; north along University Ave and continuing east on Meeker St.; north on Bluff Road; east on SE Marcy St to the Sandy River trail; east XC through Sandy River Park; east XC through Oregon Fish and Wildlife Property, east XC through private property; continuing onto SE Ten Eyck Rd to the Sandy River below Revenue Bridge.
- Approximately 3,280 linear feet of 16 to 18-inch force main (FM) in roadway; 2,030 linear feet of 24 to 30-inch gravity line in roadway; 8,690 linear feet of 24 to 30-inch gravity line on undeveloped land.
- Crossing: ODOT ROW, City-owned property; ODFW property; an unknown number of stream crossings in Sandy River Park; 3 private property crossings.
- Construction Methods: Crossing HWY 26 will likely include auger bored casing with carrier pipe.
- **Advantages**:
  - Opportunity project for trail creation and expansion of Sandy River Park trail system;
  - small scale irrigator potential uses of effluent;
  - route through the preferred discharge location at Revenue Bridge; and

    - favorable for hydropower as there is good access for maintenance and the hydropower unit is readily connected to PGE facilities as there is 3 phase power along Ten Eyck Road.

- Disadvantages:
    - Environmental impacts to streams including unnamed streams in the ODFW property and Cedar Creek near the fish hatchery;
    - private property easements required;
    - requires ROW permits and coordination with Clackamas County for Revenue Bridge crossing; and
    - potential landslide hazards likely along this route.
- Project Cost: $7.8 M

Segment 1 Option 1.C (Revenue Bridge Outfall Via Hwy 26 and Ten Eyck Road)

Segment 1 Option 1.C includes a pipeline from the Eastside Satellite Treatment Facility to a surface water discharge below Revenue Bridge.

- Alignment: from Sunset St and University Ave; north along University Ave and continuing east HWY 26; continuing onto SE Ten Eyck Rd to the Sandy River below Revenue Bridge.
- Approximately 7,200 linear feet of 16 to 18-inch force main (FM) in roadway; 8,810 linear feet of 24 to 30-inch gravity line in roadway.
- Crossing: public right of way (ROW).
- Construction Methods: Crossing HWY 26 will likely include an auger bored casing with carrier pipe.
- Advantages:
    - Construction in roadway ROW which minimizes required easements;
    - Potential opportunity projects for improving the road surfacing;
    - route through the preferred discharge location; and
    - good maintenance and utility access for hydro-power facility as 3 phase power is available along Ten Eyck Road.

- **Disadvantages:**
  - Public impacts to traffic on HWY 26;
  - higher costs for pavement repair;
  - construction in congested utility corridor in Hwy 26;
  - requires permitting and coordination with ODOT and Clackamas County for HWY 26 and Revenue Bridge crossing; and
  - potential landslide hazards likely along this route along Ten Eyck Road.
- Project Cost: $9.0 M

Pipeline Route Alternatives from Sandy River to Roslyn Lake (Segment 2)

This study also included routes from discharge locations on the Sandy River to Roslyn Lake. The route alternatives from the river outfall location to Roslyn Lake are labeled Segment 2.

Segment 2 Option 2.A (Oxbow Outfall to Roslyn Lake)

Segment 2 Option 2.A includes a pipeline from the Oxbow below Sandy River Park to Roslyn Lake.

- Alignment: from the Sandy River XC northeast through private property; east along SE Thomas Rd to Roslyn Lake.
- Approximately 4,430 linear feet of 10 to 12-inch pipe in roadway; 4,930 linear feet of 10 to 12-inch pipe on undeveloped private property.
- Crossing: One private property, Clackamas County ROW
- **Advantages**:
  - Lower impact to roadways and traveling public.
- **Disadvantages:**
  - Environmental impacts to stream crossings;
  - private property easements required;
  - constructability challenges associated with steep slopes, benches, streams, and native materials for HDD; siphon design required;
  - route is not through preferred discharge location;

  - limited maintenance and utility access for hydro-power facility; and
  - landslide hazards likely along this route.
- Project Cost: $6.0 M

Segment 2 Option 2.B (Revenue Bridge Outfall to Roslyn Lake)

Segment 2 Option 2.B includes a pipeline from Revenue Bridge to a created wetland at Roslyn Lake.

- Alignment: Follows Ten Eyck Road generally northbound to Thomas Road, west along SE Thomas Rd to Roslyn Lake.
- Approximately 8,380 linear feet of 10 to 12-inch pipe in roadway (and attached to Revenue Bridge)
- Crossing: Clackamas County ROW.
- **Advantages**:
  - Construction in roadway ROW results in no easement acquisition;
  - small scale irrigator potential uses of effluent;
  - route through the preferred discharge location;
  - good maintenance and utility access for hydro-power facility; and
  - moderate potential for landslide hazards along Ten Eyck Road (advantage relative to other routes).
- **Disadvantages:**
  - Public impacts to traffic on Ten Eyck Road; and
  - requires ROW permits and coordination with Clackamas County for Revenue Bridge crossing.
- Project Cost: $3.9 M

Segment 2 Option 2.C (Revenue Bridge Outfall Via Ten Eyck Road and Cross County Route)

Segment 2 Option 2.C includes a pipeline from Revenue Bridge to a created wetland at Roslyn Lake.

- Alignment: Follows Ten Eyck Road generally northbound, XC through private property to Roslyn Lake.
- Approximately 1,683 linear feet of 10 to 12-inch pipe in roadway (or attached to Revenue Bridge); 4,380 linear feet of 10 to 12-inch pipe on undeveloped private property.
- Crossing: Clackamas County ROW, six private properties, unknown number of stream crossings.
- **Advantages**:
    - Lower impact to roadways and the traveling public Route through preferred discharge location.
- **Disadvantages:**
    - Environmental impacts associated with stream crossings;
    - private property easements required;
    - requires ROW permits and coordination with Clackamas County for Revenue Bridge crossing;
    - extensive constructability challenges associated with steep slopes, benches, streams, and native materials;
    - more extensive landslide hazard potential likely along this route; and
    - higher cost due to more challenging construction, use of specialized pipe installation techniques.
- Project Cost: $13.0 M

Life Cycle Costs

Each of the options presented in this memorandum were evaluated on a comparative relative to the life cycle costs. Factors that may affect maintenance and life cycle costs include:

- Length of force main relative to pumping costs
- Overall length of pipe

- Location / maintenance accessibility
- Geological stability

Segment 1

Segment 1 Options 1.A and 1.B are expected to have similar life cycle costs relative to power costs associated with pumping the effluent since their force mains are approximately the same length. Option 1C has a longer force main than the other options, and therefore will require more power for pumping and a higher associated cost. Other life cycle cost considerations may include potentially lower maintenance since much of the alignment is in a stable roadway section which is less susceptible to landslides or seismic damage and the pipe may be more readily accessed for maintenance. However, these lower cost factors will be offset by higher cost to work in the roadway for maintenance which may involve traffic control and pavement restoration.

Segment 2

For Segment 2, Options 2.B and 2.C may have similar life cycle costs. Option B is longer than Option C and it is in the road right-of-way. This results in higher maintenance costs relative to length of pipe and the need for pavement restoration associated with maintenance, but lower cost relative to ease of access. Option C is shorter and out of the public right-of-way, which results in lower maintenance cost relative amount of pipe and there is no need to restore pavement following repairs. However, Option C is significantly more challenging to access and the steep hillsides and creek ravines may result in more frequent and extensive repair. Option 2.A is located in both paved and unpaved areas and would have similar cost factors as Option 2.B.

Based on the discussion above, it was concluded that life cycle cost was not a significant factor when comparing alternatives. Life cycle cost was therefore not used in determining the recommended pipe route.

Evaluation of Alternatives

To summarize the findings of the alternatives analysis, three tables were developed. These tables are described below and presented on the following pages.

Table 1 provides a qualitative comparison of the advantages and disadvantages for the pipeline alignments relative to the criteria described above. Relative advantages are highlighted in green and relative disadvantages are highlighted in yellow.

Table 2 provides numerical scoring to represent the relative advantages and disadvantages for Segments 1 and 2 relative to the criteria. This more quantitative approach uses a scale from 1 to 5, with 1 representing a negative score and 5 representing the highest positive score.

Table 3 summarizes the scoring criteria for the combined route alternatives. The highest scoring route includes Segment 1 Option 1.B and Segment 2 Option 2.B. As such, this combination of alignments is the preferred route. This route avoids the challenging and high cost of construction up the steep hillsides between the river and the upper bench and avoids the high cost and disruption of construction in HWY 26 routes through the most desirable discharge location at Revenue Bridge. This route also provides advantages including opportunity projects of trail systems and a hydropower facility with favorable access for maintenance and power supply. The combined cost summary is shown in **Table 4**.

The preferred route is Segment 1 Option 1.B and Segment 2 Option 2.B. A detailed pipe alignment for this route is shown in **Figures 2** through **6**. Conceptual design layouts for the Revenue Bridge Crossing and potential hydropower facility siting can be found in **Figures 7** through **9.** The preliminary layout for the control valve vault used to control flow for hydropower production is shown in **Figure 10.**

The preferred route key property owners are listed in **Appendix A**. Based on the recommended alternative, the City will make preliminary contact with private property owners.

Table 1 | Alternatives Evaluation Summary

	Cost	Environmental Impacts and Permitting	Impacts to the public	Property Acquisition	Required Agency Coordination	Opportunity Projects	Opportunities for Additional Uses for the Effluent	Constructability	Proximity to Selected Discharge Location	Opportunities for Hydro Power	Seismic Considerations	Land Use
Segment 1												
Segment 1 Option 1.A	See Table 4	Outfall environmental impacts and stream crossings	High use recreational area	ROW or City owned property	Requires City ROW permits			Some challenges associated with steep slopes, benches, streams, and native materials for HDD. Siphon design required	Route not through preferred discharge location	Limited maintenance access	Landslide potential	POS -Parks and Open Space (City of Sandy) - not specified
Segment 1 Option 1.B	See Table 4	Impacts to streams		Private property easements required	Requires City ROW permits and coordination with ODFW	Trails project	Small-scale irrigator potential		Route through preferred discharge location	Good maintenance access and location for hydro facility	Moderate landslide potential	POS -Parks and Open Space (City of Sandy) - not specified, TBR - Conditional Use subject to 406.05(A)(1) & (6), EFU- Allowed Use
Segment 1 Option 1.C	See Table 4	Few environmentally sensitive areas in ROW	Impacts traffic on HWY 26	ROW	Requires City ROW permits and ODOT for HWY 26 construction	Improving road surfacing			Route through preferred discharge location	Good maintenance access and location for hydro facility	Moderate landslide potential	RRFF5 - public utility facilities are a conditional use
Segment 2												
Segment 2 Option 2.A	See Table 4	Outfall environmental impacts and stream crossings		Private property easements required				Some challenges associated with steep slopes, benches, streams, and native materials for HDD. Siphon design required	Route not through preferred discharge location	Limited maintenance access	High landslide potential	POS -Parks and Open Space (City of Sandy) - not specified, TBR - Conditional Use subject to 406.05(A)(1) & (6), EFU- Allowed Use
Segment 2 Option 2.B	See Table 4	Few environmentally sensitive areas in ROW	Impacts traffic on Ten Eyck Rd	ROW	Requires county ROW permits, coordination with Clackamas County for Bridge Crossing and ROW permits	Improving road surfacing	Small-scale irrigator potential		Route through preferred discharge location	Good maintenance access	Moderate landslide potential	RRFF5 - public utility facilities are a conditional use
Segment 2 Option 2.C	See Table 4	Impacts to stream crossings		Private property easements required	Requires coordination with Clackamas County for Bridge Crossing			Some challenges associated with steep slopes, benches, streams, and native materials	Route through preferred discharge location	Good maintenance access	Very high landslide potential	RRFF5 - public utility facilities are a conditional use, TBR - Conditional Use subject to 406.05(A)(1) & (6)

- *Cells highlighted in green indicate advantages (relative to other options for that criteria).*
- *Cells highlighted in yellow indicate disadvantages (relative to other options for that criteria).*

Table 2 | Alternatives Evaluation Scoring

Criteria	Cost	Environmental Impacts and Permitting	Impacts to the public	Property Acquisition	Required Agency Coordination	Opportunity Projects	Opportunities for Additional Uses for the Effluent	Constructability	Proximity to Selected Discharge Location	Opportunities for Hydro Power	Seismic Considerations	Land Use	Total
Segment 1													
Segment 1 Option 1.A	1	1	2	2	3	3	3	1	1	1	1	3	22
Segment 1 Option 1.B	4	1	4	3	3	5	5	3	5	5	2	3	43
Segment 1 Option 1.C	3	3	1	5	1	4	2	4	5	5	3	3	39
Segment 2													
Segment 2 Option 2.A	5	1	3	1	3	3	3	1	1	3	1	3	28
Segment 2 Option 2.B	5	3	1	5	1	5	5	3	5	5	3	3	44
Segment 2 Option 2.C	1	1	3	1	1	3	3	1	5	5	1	3	28

Table 3 | Combined Criteria Scoring Summary

	Option A (Oxbow)	Options B and C (Revenue Bridge)			
		1.B + 2.B	1.B + 2.C	1.C + 2.B	1.C + 2.C
Score	49	80	66	77	63

Table 4 | Capital Cost Evaluation

1.A + 2.A	
Component	**Cost**
Segment 1 Option 1.A	$15.6 M
Segment 2 Option 2.A	$6.0 M
Hydropower Facility	$1.1 M
Hydropower Facility (Option 1 Power)	$0.04 M
Total	**$22.74 M**

1.B + 2.B		1.B + 2.C	
Component	**Cost**	**Component**	**Cost**
Segment 1 Option 1.B	$7.8 M	Segment 1 Option 1.B	$7.8 M
Segment 2 Option 2.B	$3.9 M	Segment 2 Option 2.C	$13 M
Hydropower Facility	$1.1 M	Hydropower Facility	$1.1 M
Total	**$12.8 M**	**Total**	**$21.9 M**

1.C + 2.B		1.C + 2.C	
Component	**Cost**	**Component**	**Cost**
Segment 1 Option 1.C	$9.0 M	Segment 1 Option 1.C	$9.0 M
Segment 2 Option 2.B	$3.9 M	Segment 2 Option 2.C	$13 M
Hydropower Facility	$1.1 M	Hydropower Facility	$1.1 M
Total	**$14.0 M**	**Total**	**$23.1 M**

Notes:

Cost estimates represent a Class 5 budget estimate in 2020 dollars, as established by the American Association of Cost Engineers. This preliminary estimate class is used for conceptual screening and assumes project definition maturity level below two percent. The expected accuracy range is -20 to -50 percent on the low end, and +50 to +100 percent on the high end, meaning the actual cost should fall in the range of 50 percent below the estimate to 100 percent above the estimate.

Additional Considerations

Additional Pipe Segments Evaluated Outside the Alternatives Analysis

Segment 3 (Potential Discharge from Roslyn Lake)

Segment 3, as shown in **Figure 1**, includes a pipeline from Roslyn Lake to an outfall on the Sandy River. This overflow from Roslyn Lake was originally considered as part of the overall concepts, however this outfall location was not recommended due to geological and geomorphological constraints including steep slopes, benches, streams, native materials, and liquefaction and landslide hazards. Additionally, the concepts for wetland creation at Roslyn Lake were developed to avoid discharging from the lake site back to the Sandy River, since water could be retained in the wetlands to maintain aquatic plant life and habitat. This approach is based on the evaluation that showed there is potentially enough area at Roslyn Lake to manage summertime flows without a discharge back to the river through evaporation, evapotranspiration and moderate infiltration into the soils at the site.

Irrigation

Multiple routes for irrigation reuse were also considered as part of the Detailed Discharge Alternatives Evaluation. A description of the routes and the market study findings can be found in TM 8 – Water Recycling Market Assessment. The most promising location for an irrigation pipeline was along Kelso Road, as shown in **Figure 1**. However, the market analysis concluded that there was not enough demand for recycled water at that location, and this option was determined to be impractical based on added cost and the lack of capacity to discharge a large portion of the effluent at this site.

Conceptual Design Considerations for Selected Route

Highway 26 Crossing

The proposed effluent force main crosses US Highway 26 along the pipeline alignment between the proposed satellite treatment facility and the proposed Sandy River outfall locations. This is a large, busy roadway, and an auger bore would likely be required to construct Segment 1 without significant disruption to traffic. This pipe installation technique would require a bore pit on the south side of the highway, a smaller receiving pit on the north side, as well as approximately 130 linear feet of bored casing along with a carrier pipe installed in the casing. Potential bore and receiving pit locations as well as the associated cost of this method of pipe installation were considered in the pipeline design and selected recommendation. Potential locations for the bore and receiving pits are shown on **Figure 2.**

Utility Congestion at University Avenue

Numerous utilities are located along University Avenue, where Segment 1 would likely need to be located. NW Natural recently installed a high-pressure gas main in University Avenue and Meeker Street which further reduces the available corridor for the effluent force main. In order to facilitate the wastewater effluent pipe installation, an existing 2-inch gas line may need to be moved.

Pipe Material

Pipe material may be selected for each individual segment based on cost and working pressures. For the force main portion of the pipeline which extends from the satellite plant to Bluff Road, AWWA C900 PVC or ductile iron are potential viable pipeline materials. HPDE for the force main may be a challenge in this area due the large number of utilities that makes it challenging to install long pipe segments which have had joints welded above ground. Preliminary calculations utilizing the Manning's Equation indicate that a 16-inch to 18-inch diameter pipe will be sufficient for this section. The gravity portion of the pipe which extends from Bluff Road to the Sandy River and from the Sandy River to the Roslyn Lake site could be AWWA C900 PVC, ductile iron, or HDPE. It is estimated that a 24-inch or 30-inch diameter pipe will be required for the gravity portion from the MBR to the Sandy River, and a 10 to 12-inch diameter pipe may be installed from the Sandy River outfall to Roslyn Lake. The pipe sizing between the MBR and the Sandy River is based on a maximum flow rate of 7 MGD, which is the maximum future capacity of the plant. The piping between the Sandy River and the Roslyn Lake site is sized for a flow rate of 2 MGD, which is the maximum effluent flow rate from the MBR calculated for 2040.

Some of the piping considered to be operating by gravity as it will generally not be pressurized from the effluent pump station. However, the pipe will be pressurized for much of its length between Bluff Road and the Roslyn Lake Site based on the pipe being configured as a siphon with the low point at the Sandy River. Also, it is anticipated that hydropower facilities will be installed at the Sandy River and at Roslyn Lake, and operations of these facilities will be configured to maintain pressure in the pipeline to promote power generation. The operating pressure of the pipeline will increase as it approaches the Sandy River. These pressures may range up to 250 psi. As the pressures exceed 200 psi, ductile iron pipe should be considered as pipe walls for PVC and HDPE become very thick, less cost effective and less hydraulically efficient. Additionally, ductile iron for these higher-pressure areas should be considered as the piping should all be restrained to provide improved seismic resiliency and the restraint system for PVC and flanges for HDPE have maximum working pressures around 200 psi.

Hydropower

Background and Piping Considerations

The elevation between the MBR site and the discharge sites at the Sandy River and at Roslyn Lake along with the anticipated flow rates from the MBR plant provide an opportunity to generate electricity from hydropower installations on the MBR discharge lines. See **Figure 11** for a drawing of one potential hydroturbine design. See **Figure 12** for a photo of this type of hydroturbine.

Another option could be to install the turbine in a vault, which would require implementation of confined space protocols.

The MBR will pump treated effluent from the plant through a force main to a point on Marcy Road where the effluent force main will discharge to a gravity main manhole. From there the effluent will flow by gravity through the City's Sandy River Park, then through Oregon Department of Fish and Wildlife property, then through private properties until the pipe meets Ten Eyck Road near Kubitz Road. From there the pipeline will follow Ten Eyck Road to Revenue Bridge where it will discharge to the Sandy River. See **Figures 2 through 6** for the proposed pipe route. The intersection of Ten Eyck Road and Kubitz Road provides an area on private property that is relatively level and large enough to accommodate a control valve vault and a building housing the hydro power mechanical and electrical equipment. The City would need to acquire the property or obtain an easement for the installation.

Power Generation Potential

The point at which the effluent piping force main discharges to the gravity main is at an elevation of 900 feet and the location of the turbine at the Sandy River outfall is at approximately 430 feet. The elevation of Roslyn Lake is approximately 630 feet, which provides an opportunity to generate power at this location as well.

At the control valve vault there will be piping that directs flow to the Sandy River hydro power unit, to a by-pass line around the power generation facility and to a pipeline that extends to Roslyn Lake. Since the pressure head will not be interrupted at the control valve vault at Kubitz Road before the flow is directed to the Roslyn Lake discharge pipeline, there will be opportunity to generate power at the Roslyn Lake site as well.

Power Sale/Recovery

The power can be either sold directly to the existing power grid near the site where it is generated or run back to the City's facilities at the MBR site. It is reported that PGE has 3 phase power along Ten Eyck Road. As such, power generated at the site can be readily directed to the grid which is required to be purchased by PGE at a set rate.

At the Roslyn Lake site, there is also PGE 3 phase power nearby where the power will be generated. Specifically, there is 3 phase power in Ten Eyck Road and there are existing facilities at the existing PGE hydro power facility on the Bull Run River. Power could be routed to these facilities and supplied to the grid.

System Control

To meet regulatory requirements relative to temperature impacts to the Sandy River, flows will need to be split between the Sandy River and the Roslyn Lake discharge points. During the dryer months when the Sandy River has less flow, the effluent can be directed to the Roslyn Lake site. During the wetter months, the Sandy River will have adequate flow to assimilate the effluent and avoid temperature increases that exceed the limits determined by DEQ. Also, during the wetter months, the Roslyn Lake site will have less capacity to accept flows due to rainfall and natural hydrology at the site.

To effectively split flows between the two discharge locations, a control strategy will need to be developed. The control strategy will involve varying flows to the two discharge points based on MBR effluent flow rates and temperatures, flows in the Sandy River and water levels at the Roslyn Lake site wetlands.

Dry Season Strategy

During the drier times of the year, flow will be routed to the Roslyn Lake site. If the water levels reach a level that could cause discharge from the lake to the downstream water way, the control valves at the hydropower facility will slow the flow to the Roslyn Lake site and allow flow to discharge to the Sandy River. It is anticipated that if Roslyn Lake levels increase due to rainfall, the Sandy River flows will increase and provide additional assimilative capacity and opportunity to discharge to the river.

Wet Season Strategy

During the wetter times of the year, the effluent flows will generally flow to the Sandy River, but the flows can still be diverted to the Roslyn Lake site until the water level reaches a preset high level. Once the water level reaches the preset level, more flow will be diverted to the Sandy River.

Control Signal Transmission

It is anticipated the signals to monitor and control the system will be transmitted through fiber optic lines conduit installed along the invert of the proposed effluent pipeline. The fiber optic can be connected to the City's fiber optic network on Bluff Road near Marcy Road.

Federal Energy Regulatory Commission (FERC) Approvals

All grid-connected, non-federal hydroelectric facilities, regardless of size, must receive approval of the Federal Energy Regulatory Commission (FERC). Small hydropower projects may apply for an exemption if the power generated is less than 5 megawatts. This project would be well under the 5 MW threshold.

Bridge Crossing

The preferred pipeline route includes a crossing on Revenue Bridge. This installation would require designs for pipe on the bridge and coordination with and permitting through the Clackamas County. The preliminary concepts for the bridge crossing are shown in **Figures 7 through 9**.

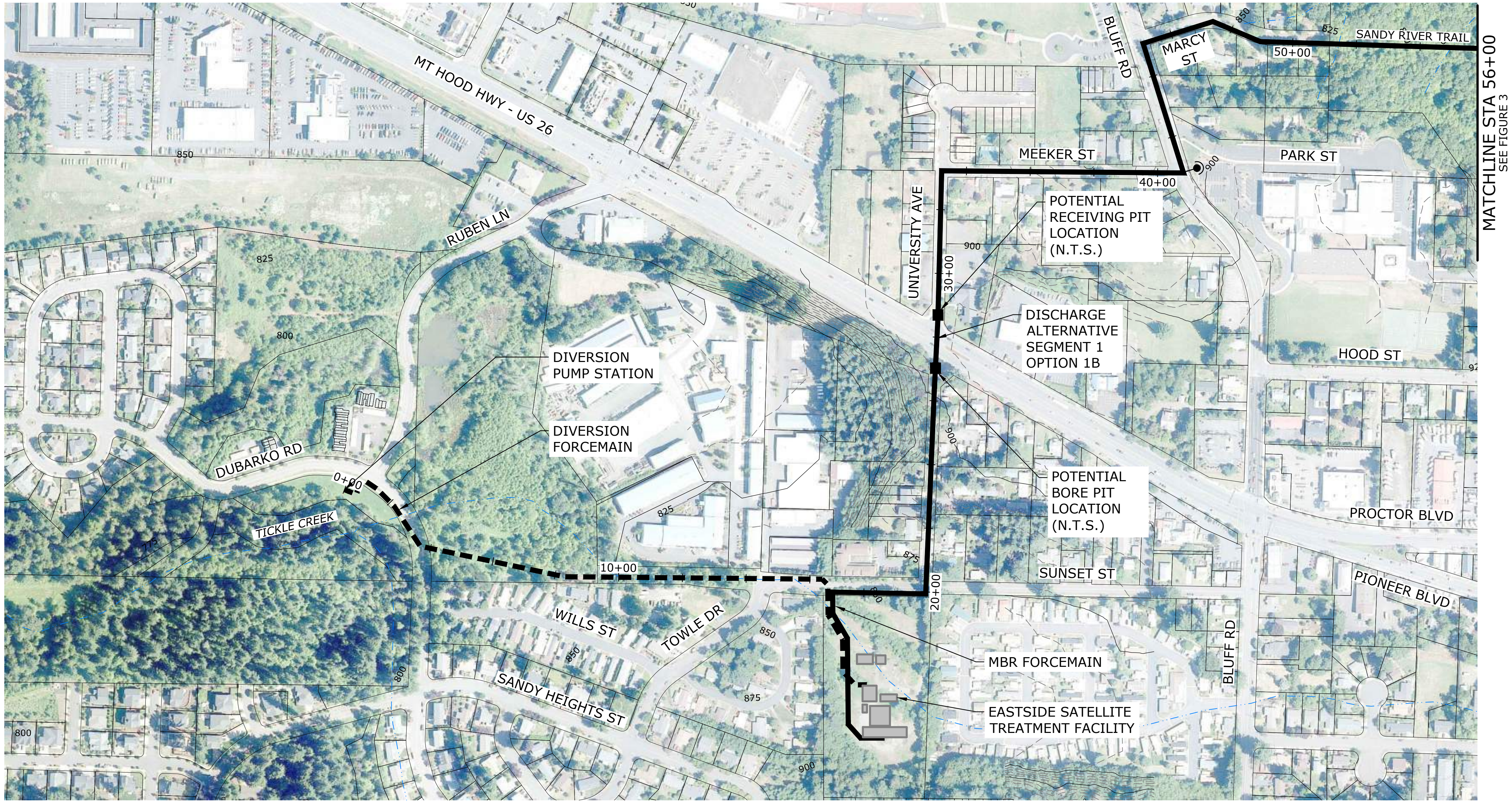
Potential Trail Construction

The preferred pipeline route crosses Oregon Department of Fish and Wildlife (ODFW) property east of the City Park. Installation of the pipeline along this alignment may present an opportunity to partner with ODFW to construct a trail along the pipeline route. The City currently maintains a trail in the Sandy River Park which is adjacent to the ODFW property. Based on a field visit in fall of 2020, it appears the trail in the City Park may be able to readily connect to a trail on the ODFW property. It appears a trail on the ODFW property would extend east to a point where it reaches private property. The City may consider including the trail in an easement that crosses private property and extends to Fish Hatchery Road. Extending the trail to this point would create a trail from the City Park to the Fish Hatchery. The design team has begun discussions with ODFW to further assess the feasibility of the trail and further coordination required to develop a trail along the pipeline route.

Conclusions and Recommendation

The purpose of this assessment was to evaluate options for routing an effluent pipeline between the proposed satellite MBR plant to the proposed Sandy River discharge and a discharge at Roslyn Lake. The team reviewed three options for routing the pipeline between the plant and the river (Segment 1) and three options between the river and the Roslyn Lake site (Segment 2). The alternatives were assessed relative to several criteria outlined above including construction at highway and bridge crossings, maintenance accessibility, system control, geological stability, opportunity projects, and the cost factors associated with each criterion. Based on the evaluation, the preferred route appears to include Segment 1 Option 1.B and Segment 2 Option 2.B. Segment 1 Option 1.B offers the best opportunity for additional projects, such as trail creation and hydropower generation, while minimizing the impacts to the public such as traffic disruption. Segment 2 Option 2.B. was found to be the best route to avoid major constructability challenges and related costs. Both segments were also chosen in relation to the selected outfall location. The estimated cost for this proposed pipeline is approximately $12.8 M.

Additional data collection and analysis is recommended to verify the concepts presented in this memorandum. Further evaluations should include geotechnical investigations, outreach to private property owners regarding easements, discussions with ODFW, ODOT and the County to confirm routing, opportunity projects and permit requirements.



PLAN

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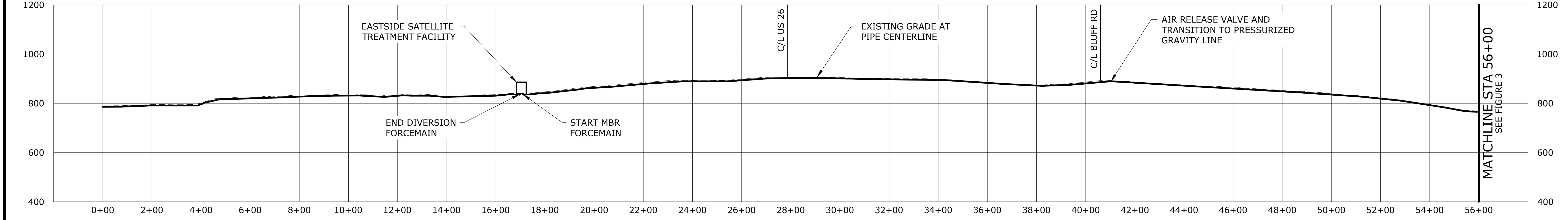

PROFILE

SCALE: 1"=400' HORIZ, 1"=400' VERT

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SANDY
WHERE INNOVATION MEETS ELEVATION

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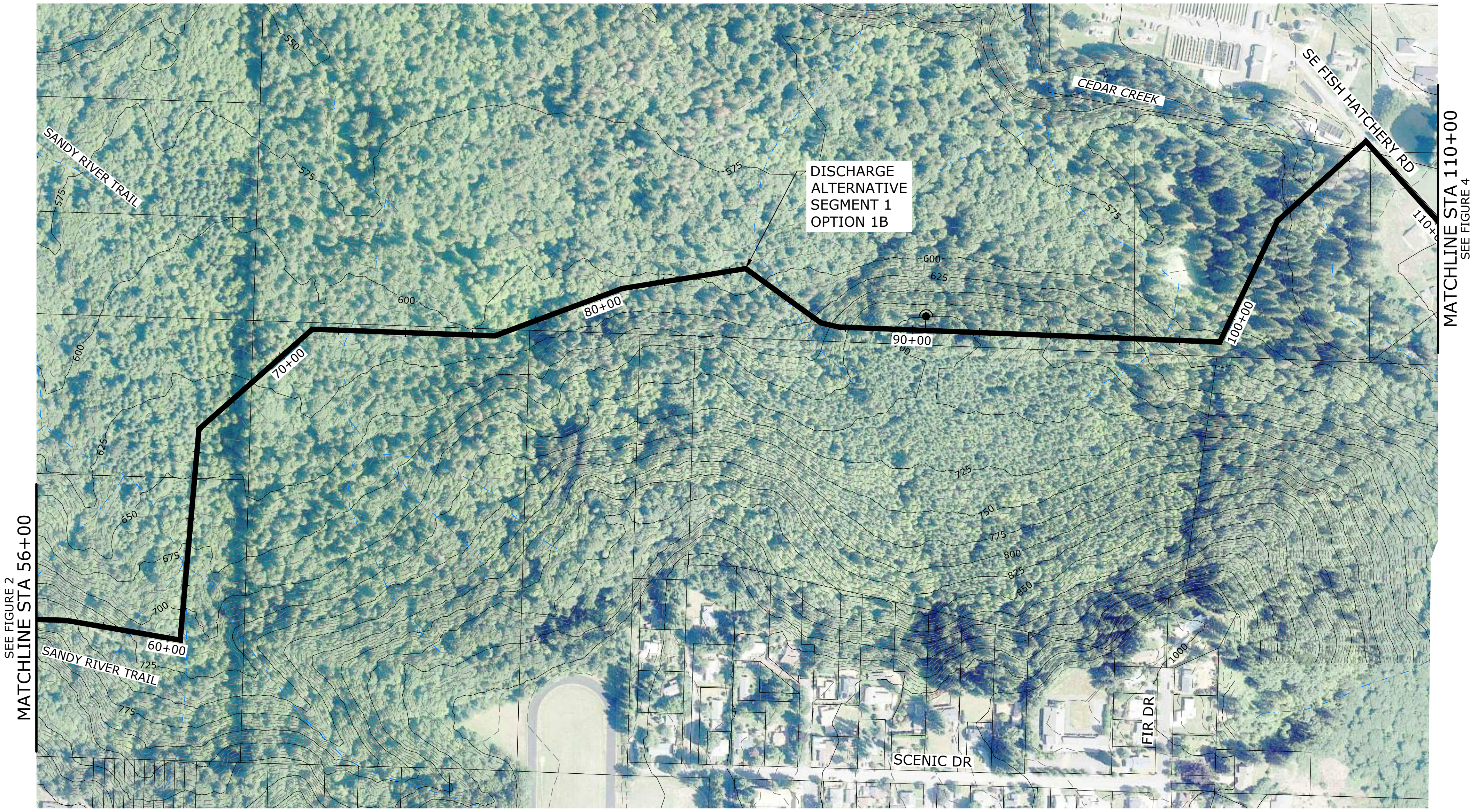
City of Sandy
Wastewater System Facility Plan

Figure 2
Plan and Profile

G:\PDX_Projects\20\2776 - Sandy - Detailed Discharge Alternatives Evaluation\CAD\Figures\PLAN AND PROFILES\20-2776-OR-PANDP FIGURES-2.dwg FIGURE 2 2/26/2021 3:43 PM KATIE.HUSK 23.0s (LMS Tech)



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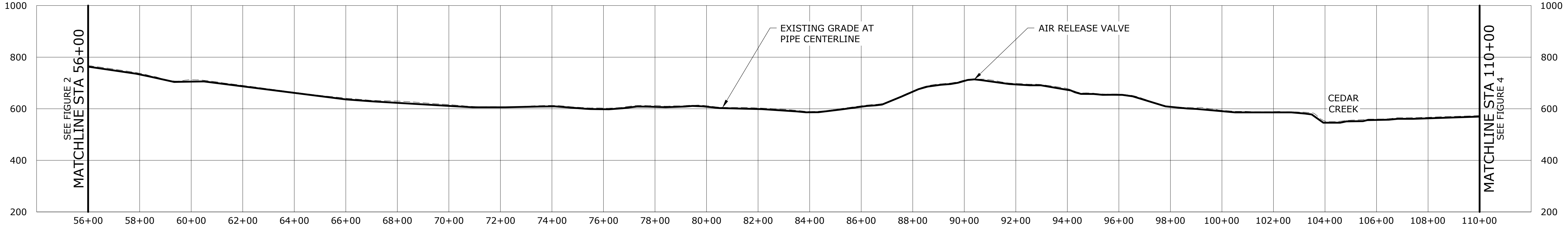


PROFILE

SCALE: 1"=400' HORIZ, 1"=400' VERT

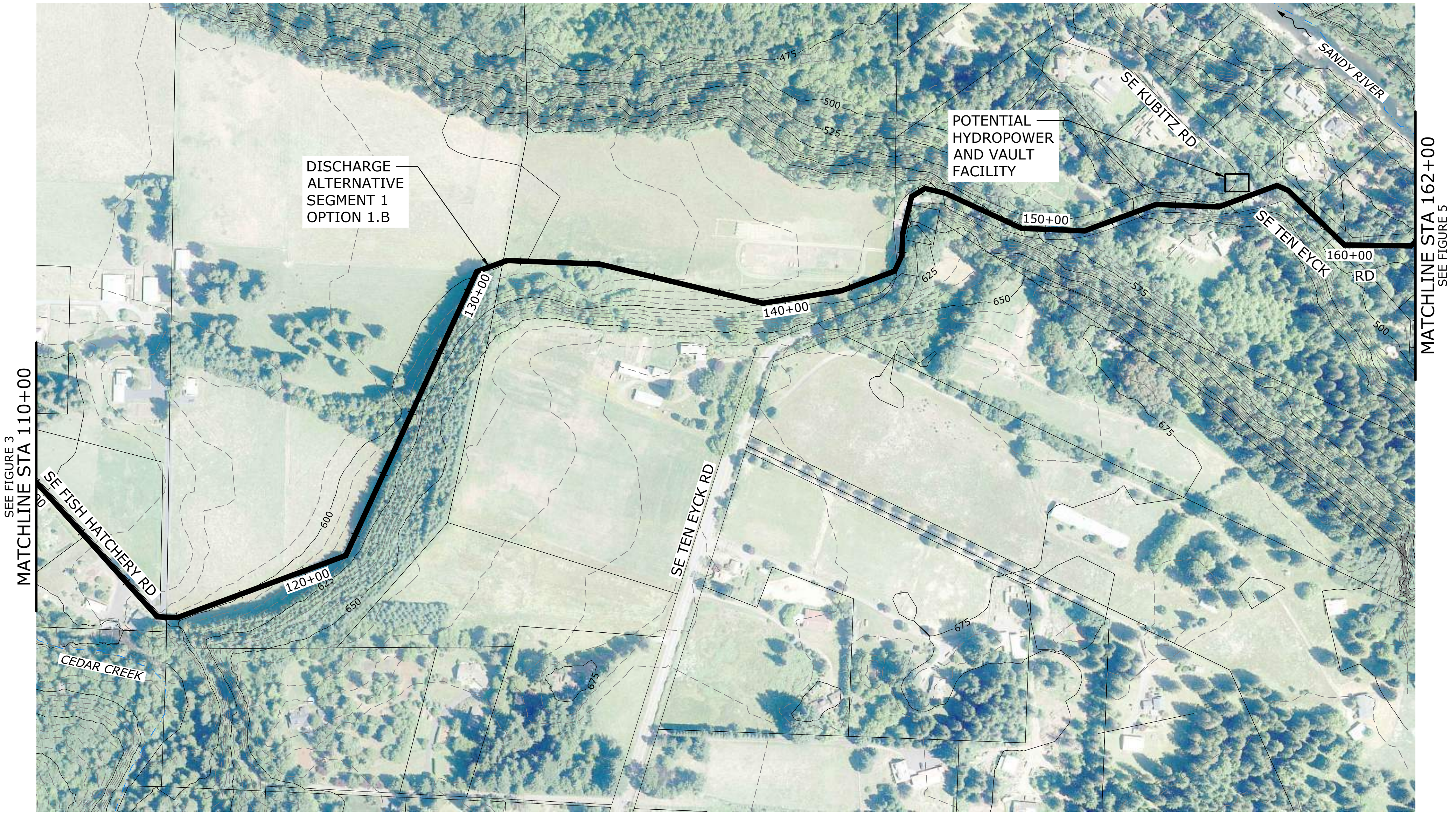
murraysmith

SANDY
WHERE INNOVATION MEETS ELEVATION

City of Sandy
Wastewater System Facility Plan

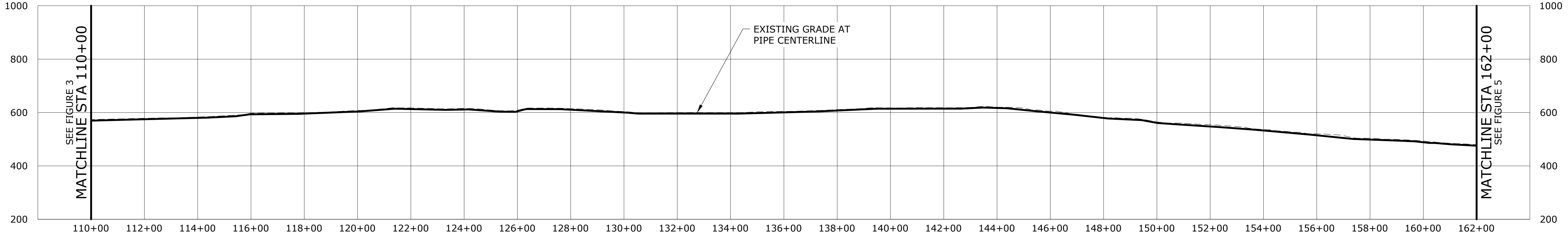
Figure 3
Plan and Profile

G:\PDX_Projects\20\2776 - Sandy - Detailed Discharge Alternatives Evaluation\CAD\Figures\PLAN AND PROFILES\20-2776-OR-PANDP FIGURES-2.dwg FIGURE 3 2/26/2021 3:43 PM KATIE.HUSK 23.0s (LMS Tech)



PLAN

SCALE: 1"=400'



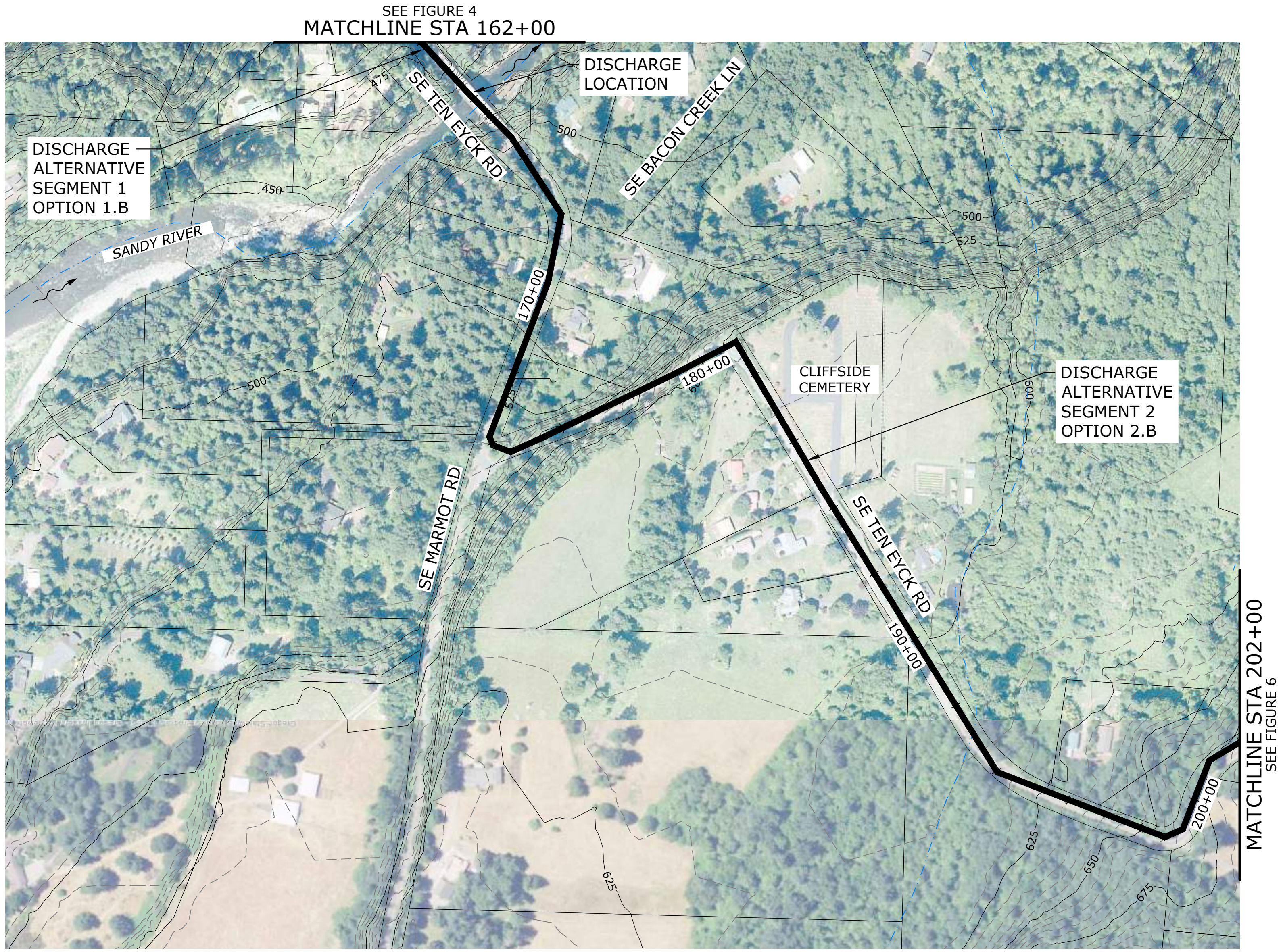
PROFILE

SCALE: 1"=400' HORIZ, 1"=400' VERT

City of Sandy
Wastewater System Facility Plan

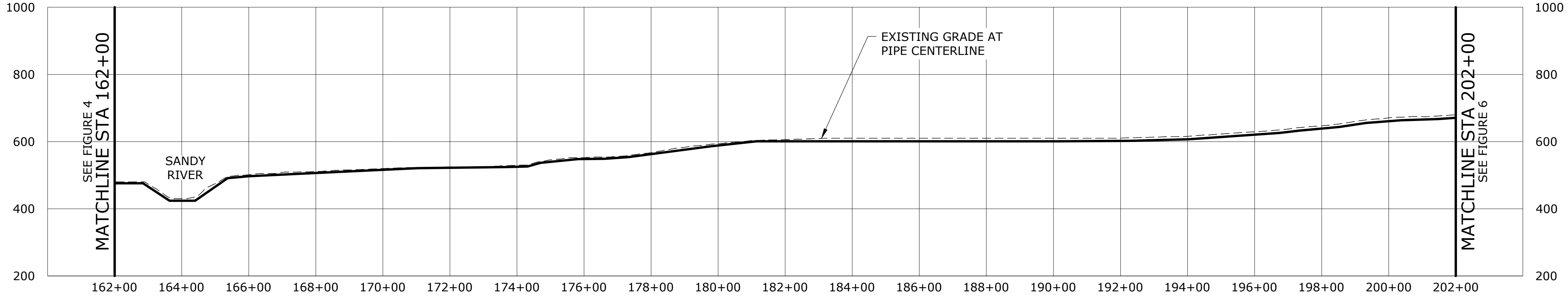
Figure 4
Plan and Profile

G:\PDX_Projects\20\2776 - Sandy - Detailed Discharge Alternatives Evaluation\CAD\Figures\PLAN AND PROFILES\20-2776-OR-PANDP FIGURES-2.dwg FIGURE 4 2/26/2021 3:43 PM KATIE.HUSK 23.0s (LMS Tech)



PLAN

SCALE: 1"=400'



PROFILE

SCALE: 1"=400' HORIZ, 1"=400' VERT

City of Sandy
Wastewater System Facility Plan

Figure 5
Plan and Profile

G:\PDX_Projects\20\2776 - Sandy - Detailed Discharge Alternatives Evaluation\CAD\Figures\PLAN AND PROFILES\20-2776-OR-PANDP FIGURES-2.dwg FIGURE 5 2/26/2021 3:43 PM KATIE.HUSK 23.0s (LMS Tech)

PLAN

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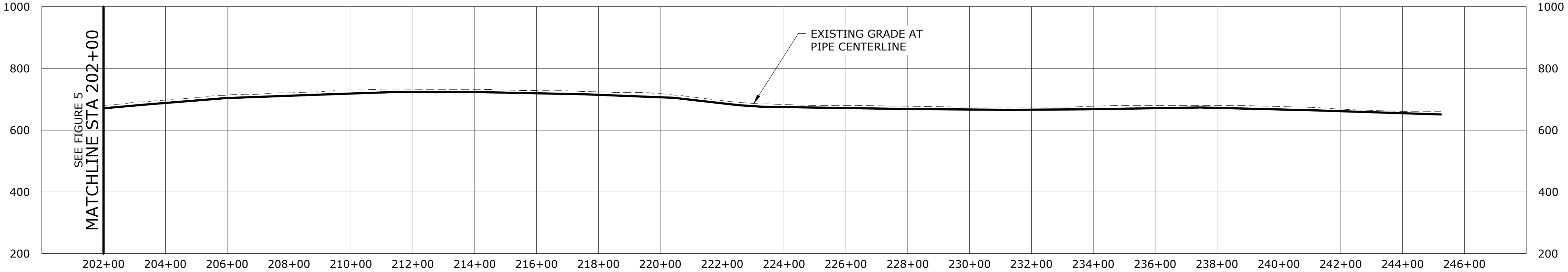

PROFILE

SCALE: 1"=400' HORIZ, 1"=400' VERT

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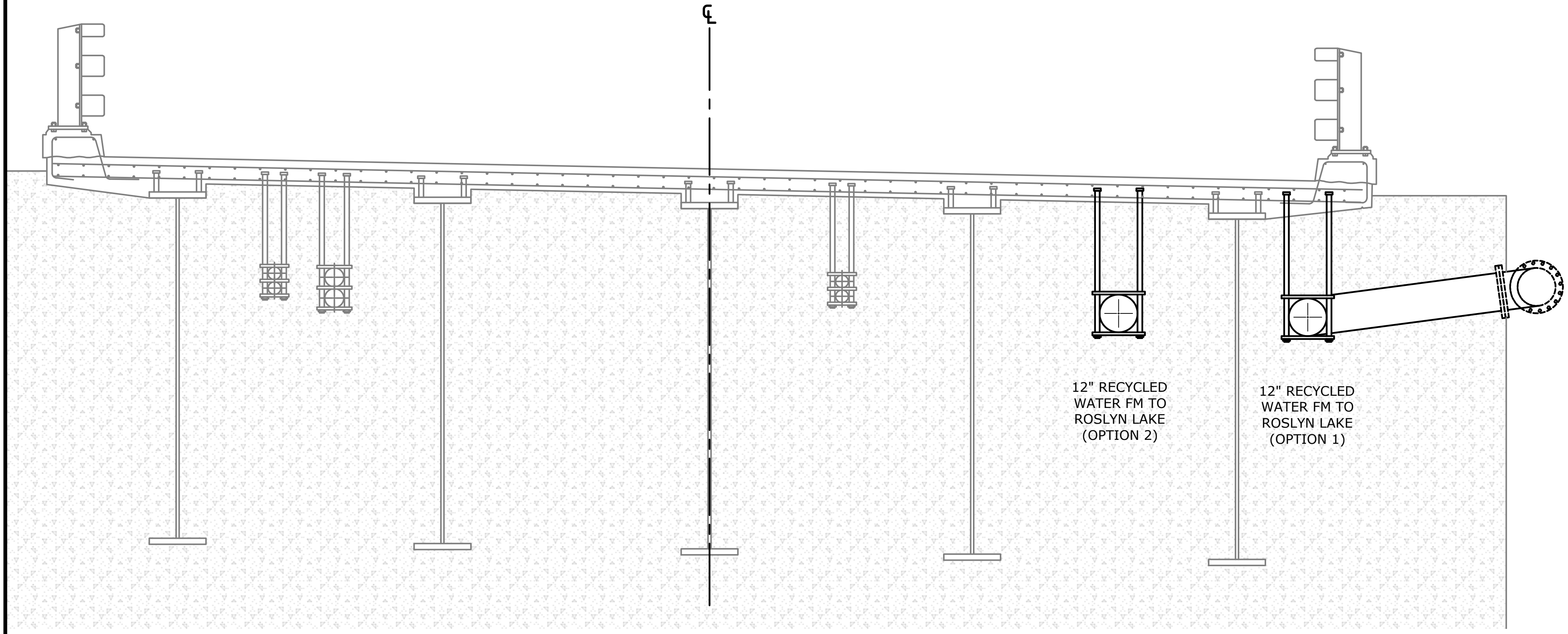
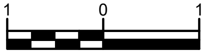
SANDY
WHERE INNOVATION MEETS ELEVATION

City of Sandy
Wastewater System Facility Plan

Figure 6
Plan and Profile

G:\PDX_Projects\20\2776 - Sandy - Detailed Discharge Alternatives Evaluation\CAD\Figures\PLAN AND PROFILES\20-2776-OR-PANDP FIGURES-2.dwg FIGURE 6 2/26/2021 3:43 PM KATIE.HUSK 23.0s (LMS Tech)





1/4 Inch = 1 Feet

SECTION (B / -)

SCALE: NTS

NOTE:

ALTERNATIVE UTILITY CROSSING LOCATION (OPTION 2) DEPENDENT ON COORDINATION WITH CLACKAMAS COUNTY AND ABILITY TO CORE INTO BRIDGE ABUTMENT.

SANDY

WHERE INNOVATION MEETS ELEVATION

FIGURE 7

DETAILED DISCHARGE ALTERNATIVE EVALUATION

REVENUE BRIDGE UTILITY CROSSING

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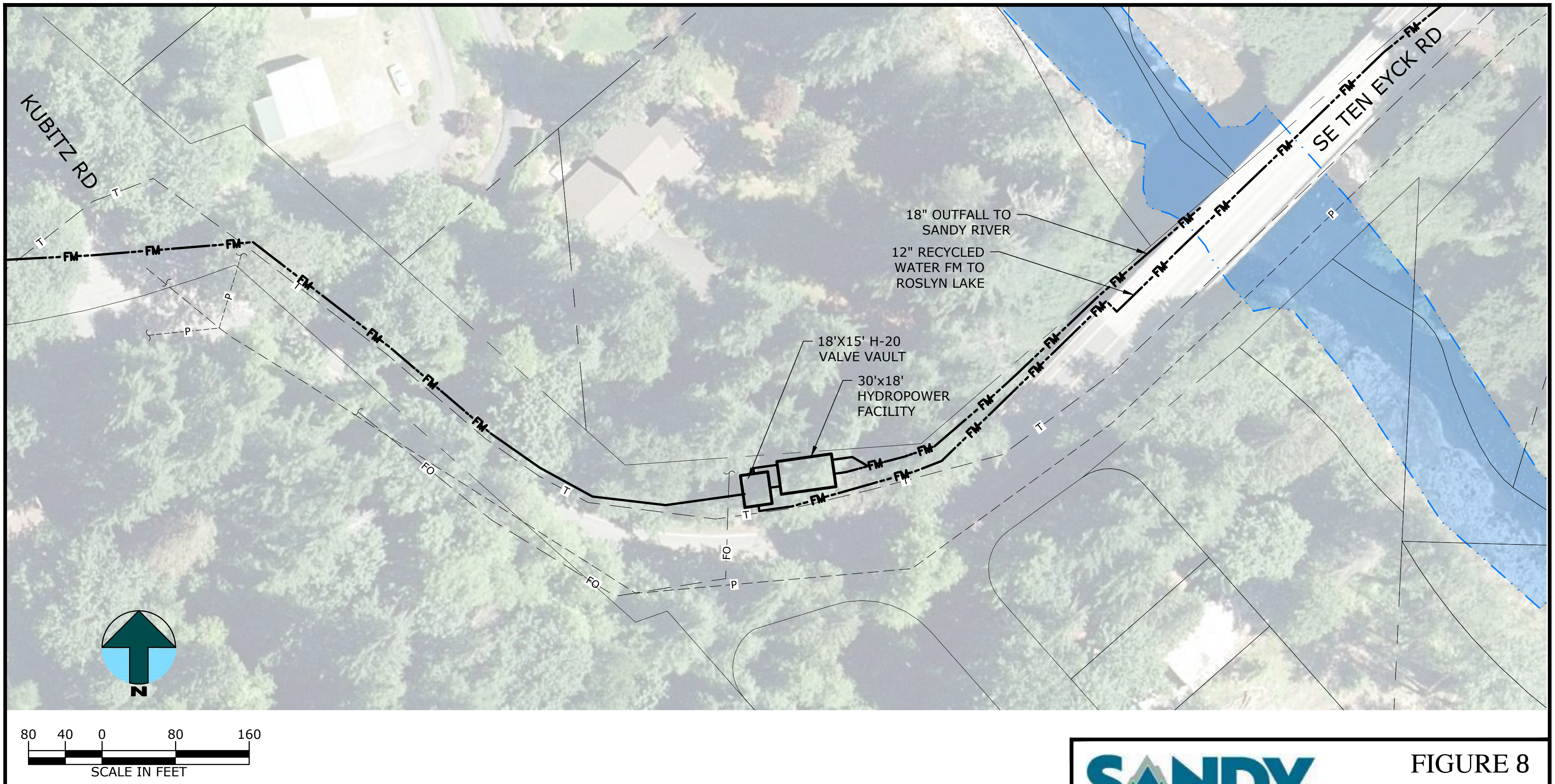
JANUARY 2021

20-2776

G:\PDX_Projects\20\2776 - Sandy – Detailed Discharge Alternatives Evaluation\CAD\Figures\PLAN AND PROFILES\20-2776-OR-SITE FIGURE-12-18-20.dwg FIGURE 2 (5) 1/7/2021 2:15 PM JESSICA.CAWLEY 23.0s (LMS Tech)



LEGEND:

	EXISTING	PROPOSED
OVERHEAD POWER	— — -P- — —	
UNDERGROUND TELEPHONE	— — -T- — —	
FIBER OPTIC	— — -FO- — —	
PROPERTY LINE	———	
RECYCLED WATER FORCE MAIN		——-FM-——-FM-
ROADWAY	▨	
BUILDING		▭

SANDY
WHERE INNOVATION MEETS ELEVATION

FIGURE 8

DETAILED DISCHARGE ALTERNATIVE EVALUATION

SANDY RIVER SITE PLAN

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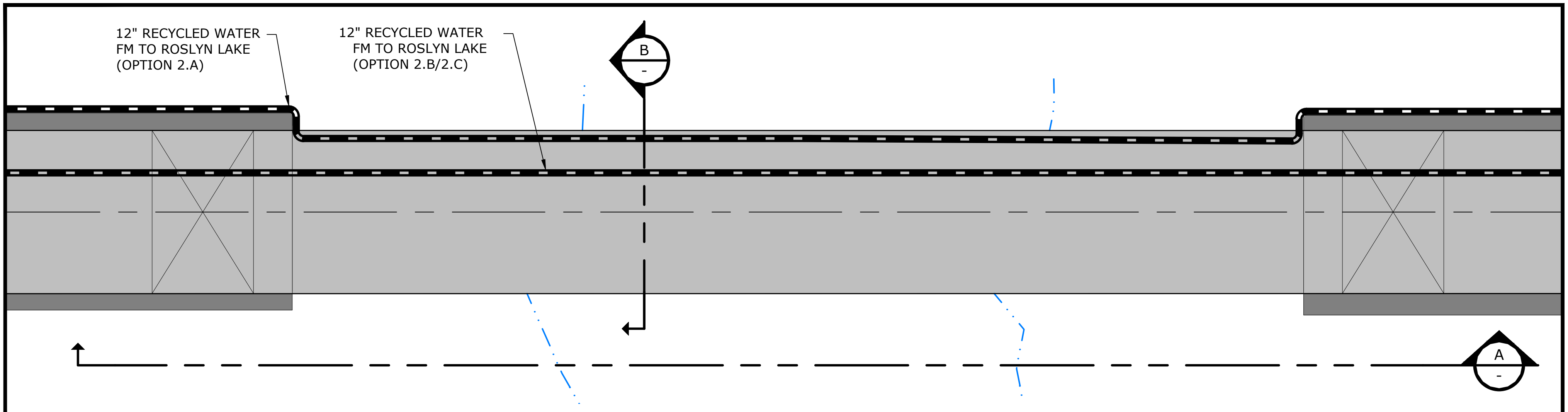
JANUARY 2021
20-2776



PLAN
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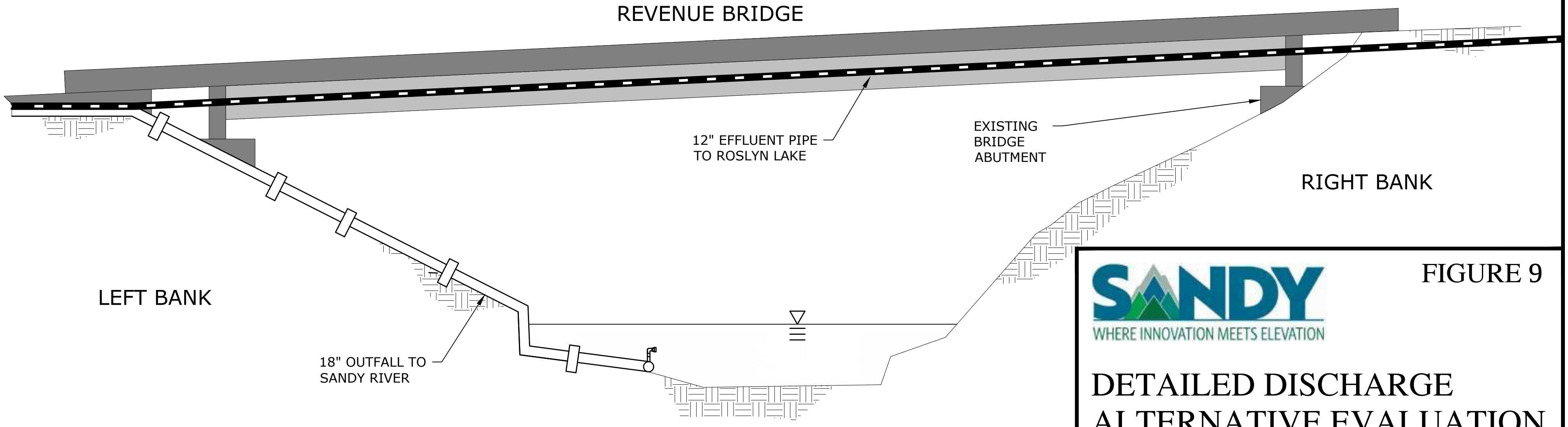

PROFILE
SCALE: NTS
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FIGURE 9

WHERE INNOVATION MEETS ELEVATION

DETAILED DISCHARGE ALTERNATIVE EVALUATION

REVENUE BRIDGE PLAN AND SECTION

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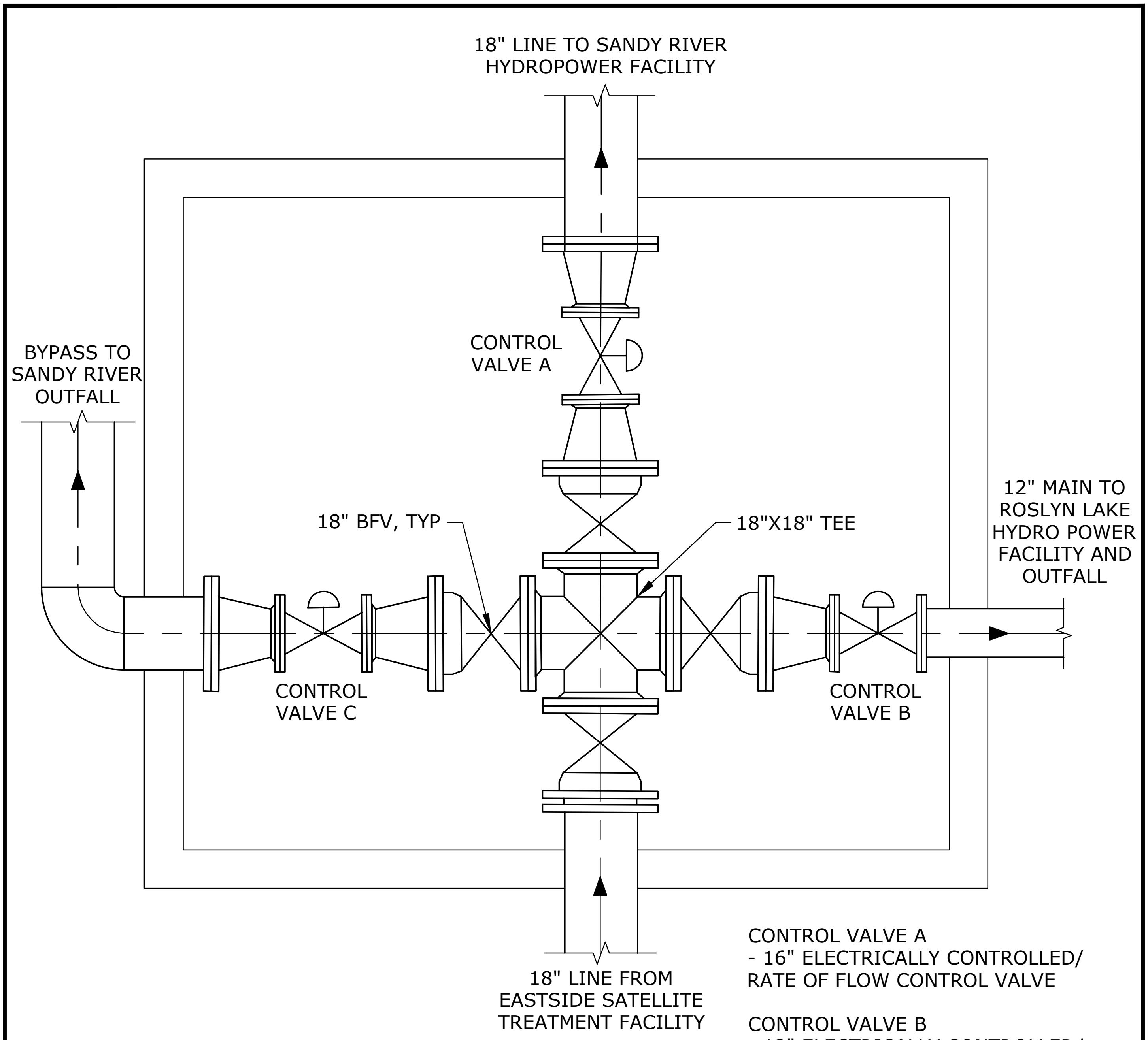
JANUARY 2021
20-2776



CONTROL VALVE A
- 16" ELECTRICALLY CONTROLLED/
RATE OF FLOW CONTROL VALVE

CONTROL VALVE B
- 12" ELECTRICALLY CONTROLLED/
RATE OF FLOW CONTROL VALVE

CONTROL VALVE C
- 16" ELECTRICALLY CONTROLLED
VALVE (OPEN CLOSE)
(COULD USE BFV FOR THIS)

CONCEPTUAL CONTROL STRATEGY

WINTER TIME OPERATION

- BASED ON LEVEL OF WATER AT ROSLYN LAKE, THE RATE OF FLOW CONTROL VALVE WILL RELEASE WATER TO ROSLYN LAKE. ONCE ROSLYN LAKE REACHES A CERTAIN LEVEL BUT STILL HAS A BUFFER TO ALLOW FOR RAINFALL IMPACTS, THE VALVE WILL CLOSE OR MODULATE TO SLOW THE FLOWS TO THE LAKE.

- BASED ON FLOW IN SANDY RIVER, CONTROL VALVE A WILL CONTROL RATE OF FLOW TO THE RIVER. IF THE WINTER TIME FLOWS DROP BELOW A CERTAIN LEVEL MORE FLOW WILL BE DIRECTED TO ROSLYN LAKE. IF ROSLYN LAKE IS FULL TO MAX LEVEL AND STILL ALLOWING A BUFFER, VALVE A WILL DISCHARGE MORE TO THE RIVER

- IF THE SANDY RIVER HYDRO POWER FACILITY IS BEING MAINTAINED, AND ALL THE FLOW CANNOT BE DISCHARGED TO ROSLYN LAKE, CONTROL VALVE C CAN BE OPENED FOR DIRECT DISCHARGE TO THE RIVER.

FIGURE 10

SANDY
WHERE INNOVATION MEETS ELEVATION

Detailed Discharge
Alternatives Evaluation

SANDY RIVER
CONTROL VALVE VAULT

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NOVEMBER 2020

20-2776

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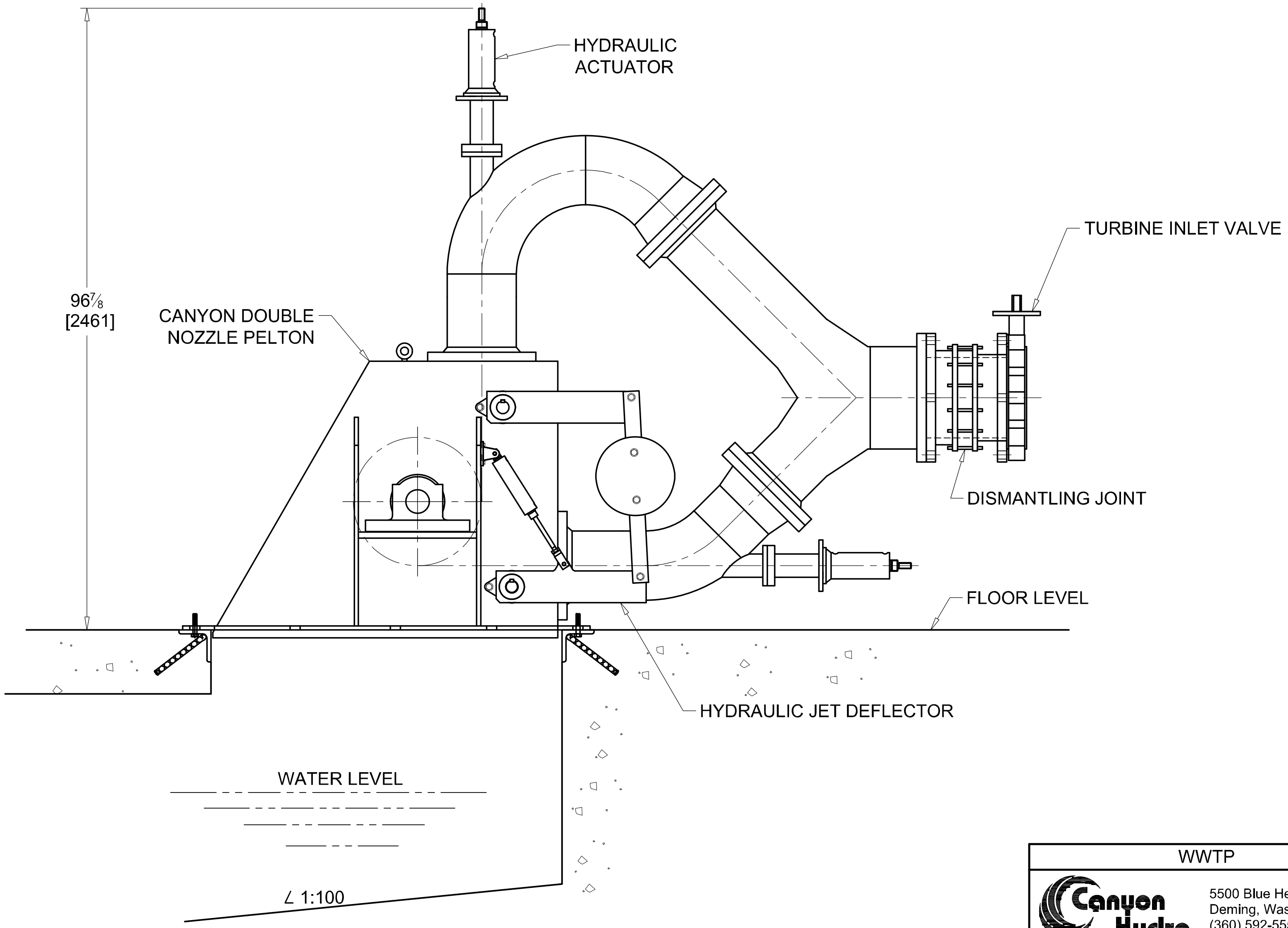

DIMENSIONS IN INCHES [mm] ARE APPROXIMATE
NOT INTENDED FOR CONSTRUCTION

WWTP

Canyon Hydro

5500 Blue Heron Lane
Deming, Washington 98244
(360) 592-5552

the water power division of Canyon Industries, Inc

FILE: ELEVATION VIEW	DATE: 2020-09-22

Figure 11

Figure 12

Appendix

APPENDIX A

ID	TAXLOT	PARCEL NUMBER	TAXPAYER	MAILING ADDRESS	MAILCITY	MAILSTATE	MAILZIP	SITUS ADDRESS	SITUS_CITY	SITUSZIP
1	100	00657033	CITY OF SANDY	39250 PIONEER BLV	SANDY	OR	97055	38275 MARCY ST	SANDY	97055
2	101	01345869	CITY OF SANDY	39250 PIONEER BLV	SANDY	OR	97055	NO SITUS	ADDRESS	0
3	701	01345850	CITY OF SANDY	39250 PIONEER BLV	SANDY	OR	97055	NO SITUS	ADDRESS	0
4	400	00655400	OREGON STATE G	3406 CHERRY AVE N	SALEM	OR	97303	NO SITUS	ADDRESS	0
5	900	00655516	CARMONY GLEN I	40191 SE FISH HATC	SANDY	OR	97055	40191 SE FISH HATCHE	SANDY	97055
6	1201	05024089	REIMER JUNE J	1456 TARA LN	TERRY	MS	39170	NO SITUS	ADDRESS	0
7	1200	00655534	REIMER JUNE J	1456 TARA LN	TERRY	MS	39170	40170 SE FISH HATCHE	SANDY	97055
8	1300	00655543	CARMONY MARIA	40191 SE FISH HATC	SANDY	OR	97055	NO SITUS	ADDRESS	0
9	4705	00687527	CARMONY GLEN I	40191 SE FISH HATC	SANDY	OR	97055	40205 SE FISH HATCHE	SANDY	97055
10	4703	00687509	TWIN SPRINGS LL	19779 SE LANGENS	SANDY	OR	97055	16261 SE TEN EYCK RD	SANDY	97055

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SANDY
WHERE INNOVATION MEETS ELEVATION

City of Sandy, Oregon
Wastewater System Facility Plan

LEGEND

● DischargeLocations

Discharge Alternatives:

- Diversion Forcemain
- Recycled Water Option
- Option 1a
- Option 1b
- Option 1c
- Option 2a
- Option 2b
- Option 2c

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Detailed Discharge Alternatives Evaluation

December 2020 20-2776

APPENDIX B

Appendix B

Segment 1 Option 1.A

DESCRIPTION	QTY	UNIT	UNIT COST	ITEM TOTAL
Mobilization, Bonds, Insurance, and Demob	1	LS	$450,000	$450,000
Erosion Control	1	LS	$25,000	$25,000
Clearing and Grubbing	1.5	AC	$15,000	$22,500
Furnish and Install 16-inch Force Main in Roadway	3270	LF	$285	$931,950
Furnish and Install 24-inch Gravity Main out of Roadway	5180	LF	$270	$1,398,600
Special Structures	10	EA	$20,000	$200,000
Surface Restoration Natural Areas	1.5	AC	$8,000	$12,000
HDD Installed Pipeline	1119	LF	$5,500	$6,154,500
Control Valve Station	1	LS	$55,000	$55,000
Electrical	1	LS	$12,000	$12,000
			Subtotal	**$9,261,550**
Construction Contingency			30%	$2,779,000
Construction Management:			15%	$1,390,000
Public Involvement/Permitting:			3%	$278,000
Engineering			20%	$1,853,000
			Total Project Cost[1]	**$15,561,550**

Appendix B

Segment 1 Option 1.B

DESCRIPTION	QTY	UNIT	UNIT COST	ITEM TOTAL
Mobilization, Bonds, Insurance, and Demob	1	LS	$230,000	$230,000
Erosion Control	1	LS	$25,000	$25,000
Clearing and Grubbing	1	AC	$15,000	$15,000
Easement	3	EA	$40,000	$120,000
Furnish and Install 24 to 30-inch Gravity Main in Roadway	2030	LF	$295	$598,850
Furnish and Install 16 to 18-inch Force Main in Roadway	3280	LF	$285	$934,800
Furnish and Install 24 to 30-inch Gravity Main out of Roadway	8690	LF	$270	$2,346,300
Special Structures	15	EA	$20,000	$300,000
Surface Restoration Natural Areas	2	AC	$9,000	$18,000
Control Valve Station	1	LS	$55,000	$55,000
Electrical	1	LS	$12,000	$12,000
			Subtotal	**$4,654,950**
		Construction Contingency	30%	$1,397,000
		Construction Management:	15%	$699,000
		Public Involvement/Permitting:	3%	$140,000
		Design:	20%	$931,000
			Total Project Cost[1]	**$7,821,950**

Appendix B

Segment 1 Option 1.C

DESCRIPTION	QTY	UNIT	UNIT COST	ITEM TOTAL
Mobilization, Bonds, Insurance, and Demob	1	LS	$310,000	$310,000
Erosion Control	1	LS	$25,000	$25,000
Furnish and Install 24 to 30-inch Gravity Main in Roadway	8810	LF	$295	$2,598,950
Furnish and Install 16 to 18-inch Force Main in Roadway	7200	LF	$285	$2,052,000
Special Structures	15	EA	$20,000	$300,000
Control Valve Station	1	LS	$55,000	$55,000
Electrical	1	LS	$12,000	$12,000
			Subtotal	**$5,352,950**
Construction Contingency			30%	$1,606,000
Construction Management:			15%	$803,000
Public Involvement/Permitting:			3%	$161,000
Design:			20%	$1,071,000
			Total Project Cost[1]	**$8,993,950**

Appendix B

Segment 2 Option 2.A

DESCRIPTION	QTY	UNIT	UNIT COST	ITEM TOTAL
Mobilization, Bonds, Insurance, and Demob	1	LS	$170,000	$170,000
Erosion Control	1	LS	$25,000	$25,000
Clearing and Grubbing	1.5	AC	$15,000	$22,500
Easement	1	EA	$40,000	$40,000
Furnish and Install 10 to 12-inch Pipe in Roadway	4430	LF	$215	$952,450
Furnish and Install 10 to 12-inch Pipe out of Roadway	4930	LF	$195	$961,350
Special Structures	15	EA	$20,000	$300,000
Additional cost for installtion of piping in steep hillside areas	500	LF	$2,000	$1,000,000
Surface Restoration Natural Areas	1.5	AC	$8,000	$12,000
Control Valve Station	1	LS	$55,000	$55,000
Electrical	1	LS	$12,000	$12,000
			Subtotal	**$3,550,300**
Construction Contingency			30%	$1,066,000
Construction Management:			15%	$533,000
Public Involvement/Permitting:			3%	$107,000
Design:			20%	$711,000
			Total Project Cost[1]	**$5,967,300**

Appendix B

Segment 2 Option 2.B

DESCRIPTION	QTY	UNIT	UNIT COST	ITEM TOTAL
Mobilization, Bonds, Insurance, and Demob	1	LS	$110,000	$110,000
Erosion Control	1	LS	$25,000	$25,000
Furnish and Install 10 to 12-inch Pipe in Roadway	8380	LF	$215	$1,801,700
Special Structures	15	EA	$20,000	$300,000
Control Valve Station	1	LS	$55,000	$55,000
Electrical	1	LS	$12,000	$12,000
			Subtotal	**$2,303,700**
Construction Contingency			30%	$692,000
Construction Management:			15%	$346,000
Public Involvement/Permitting:			3%	$70,000
Design:			20%	$461,000
			Total Project Cost[1]	**$3,872,700**

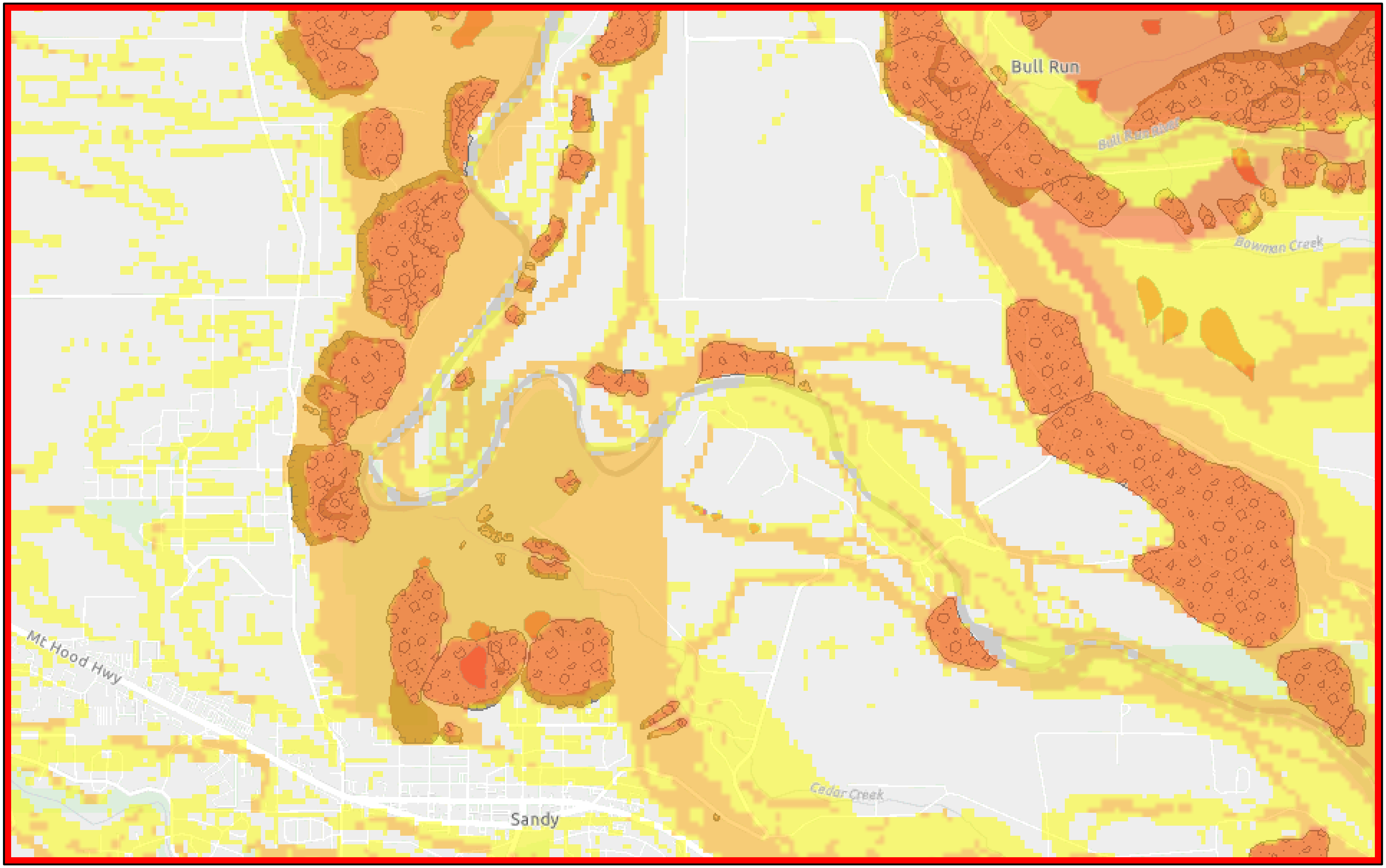
Appendix B

Segment 2 Option 2.C

DESCRIPTION	QTY	UNIT	UNIT COST	ITEM TOTAL
Mobilization, bonds, insurance, and demob	1	LS	$370,000	$370,000
Erosion Control	1	LS	$25,000	$25,000
Clearing and grubbing	1.5	AC	$15,000	$22,500
Easement	5	EA	$40,000	$200,000
Furnish and Install 10-inch Force Main in Roadway	1683	LF	$215	$361,845
Special structures	15	EA	$20,000	$300,000
Temporary Traffice Control	1	LS	$50,000	$50,000
Furnish and Install 10 to 12-inch Pipe out of Roadway	4380	LF	$195	$854,100
Trenchless or shaft for steep slope construction	1000	LF	$5,500	$5,500,000
Surface Restoration Natural Areas	1.5	AC	$8,000	$12,000
Control Valve Station	1	LS	$55,000	$55,000
Electrical	1	LS	$12,000	$12,000
			Subtotal	**$7,762,445**
Construction Contingency			30%	$2,329,000
Construction Management:			15%	$1,165,000
Public Involvement/Permitting:			3%	$233,000
Design:			20%	$1,553,000
			Total Project Cost[1]	**$13,042,445**

APPENDIX C

Landslide Hazards



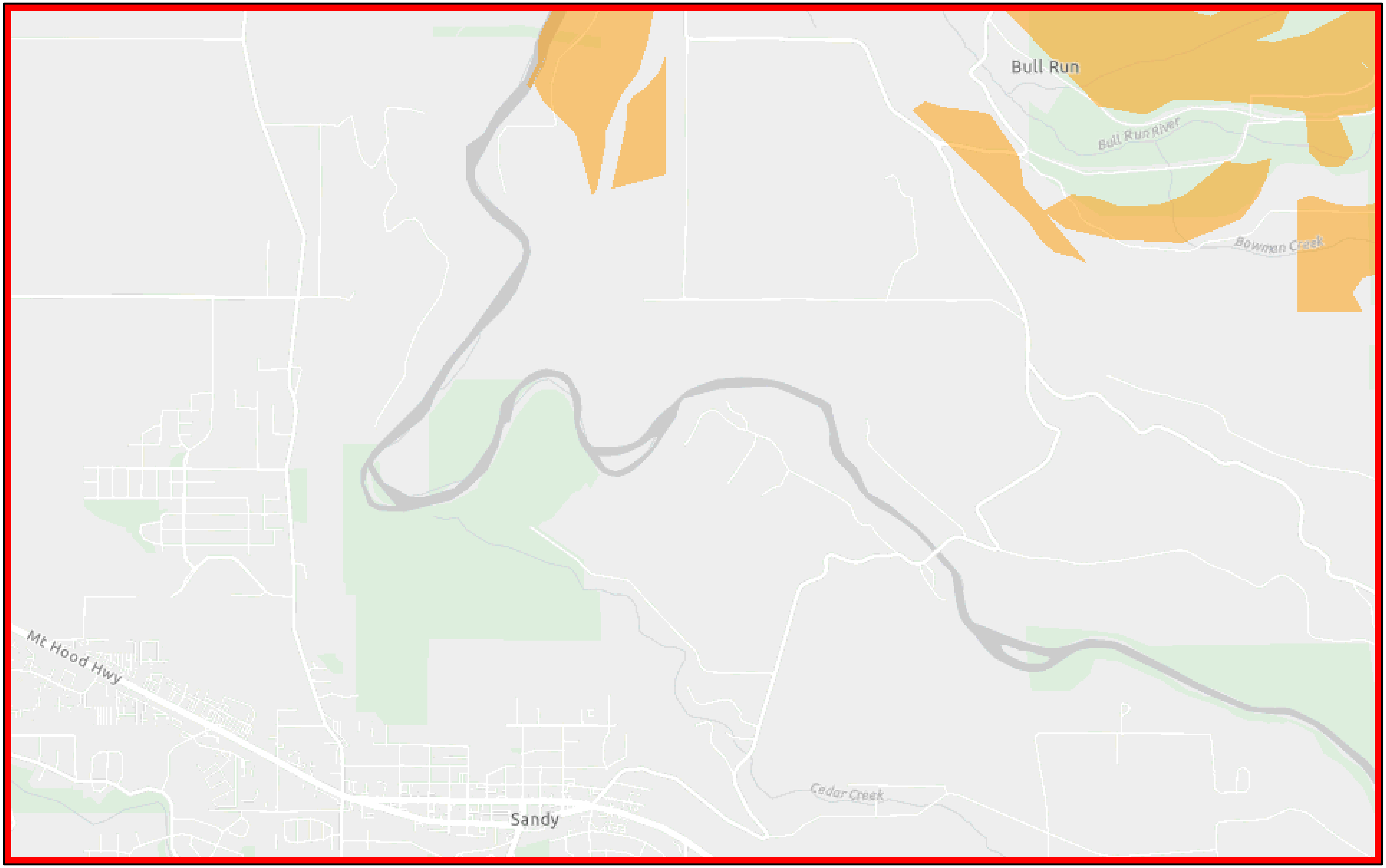
February 2, 2021

Landslide Hazard
- ☐ Low - Landsliding Unlikely
- 🟨 Moderate - Landsliding Possible
- 🟧 High - Landsliding Likely
- 🟧 Very High - Existing Landslide
- ┬┬┬ Scarp
- ▨ Head Scarp

Deposits
- ▨ Talus-Colluvium

1:36,000

Liquefaction Hazards



February 2, 2021

🟥 High 🟧 Moderate 🟩 Low

Technical Memorandum 8

Date: October 19, 2020

Project: City of Sandy – Detailed Discharge Alternative Evaluation

To: Jordan Wheeler,
Mike Walker, Director of Public Works
Thomas Fisher, Engineering Technician
City of Sandy, Oregon

From: Matt Hickey, PE
Jessica Cawley, PE
Murraysmith

Re: Water Recycling Market Assessment TM-8

Introduction

This memorandum contains a summary of information collected during the Water Recycling Program Customer Outreach study as part of the City's Detail Discharge Alternatives Evaluation. The initial Water Recycling Program Customer Outreach conducted by Barney & Worth, Inc. (B&W) evaluated several sites to determine if a property or properties near the City or along the proposed effluent pipe route had the irrigation demands to take all or most of the effluent from the City's proposed satellite wastewater treatment plant. The goal was to find an irrigator or irrigators which could take effluent during the summer and shoulder seasons (late spring and early fall) to help minimize the flows to the Sandy River during these times of year. The B&W memorandum is provided as an attachment to this document for reference. Additionally, this memorandum provides an analysis which evaluates the options for providing recycled water to potential customers including the pumping requirements, pipeline alignments, and capital and lifecycle costs. Eight options were initially considered relative to large irrigators and five options are considered for small use irrigators.

Purpose

The purpose of this memorandum is to document the evaluation of potential options and opportunities to expand the City's successful water recycling program based on effluent from the Eastside Satellite MBR Facility.

Scope

The evaluation will include a desktop study of potential water recycling customers and uses, outreach to property and business owners to gauge interest and an assessment of potential demands. Deliverables include the following:

- Prepare talking points for potential water recycling customers (**Attachment 1**)
- Characterize potential customers
- Inventory Current Water Sources
- Customer Interviews (**Attachment 2**)
- Water Recycling Opportunities Cost Analysis and Alternatives Comparison

Study Area

The study area included opportunities near the preferred pipeline alignments from the Eastside Satellite MBR Facility to preferred discharge locations. Murraysmith organized a team comprised of public outreach experts and agricultural specialists from B&W and Globalwise, Inc. They identified and investigated farm cluster sites with over 20 acres of irrigatable land and within a mile of the proposed pipeline alignments. After identifying potential sites, the team interviewed landowners to understand the market demand for recycled water.

Potential Large-Scale Water Recycling Customers

Farm clusters identified are shown in **Figure 1**. Below is a summary of the findings from the B&W study. It is noted that one site outside of the one-mile radius of the proposed pipeline alignments was identified as the Kelso Road Cluster as a potential for irrigation use of the effluent. For this evaluation, it will be considered "Farm Cluster 8".

Description of Farm Clusters

Farm Cluster 1 – West of Roslyn Lake

Over 200 acres of land zone for Exclusive Farm Use (EFU) in Clackamas County is referred to as Farm Cluster 1. Of this area, approximately 100 to 130 acres has suitable slopes and irrigatable land. Approximately 60 to 70 percent of this land is already irrigated for annual crop cultivation. Much of this land has a sustainable supply of ground water, water rights and irrigation wells to supply their irrigation demands. The three property owners in Farm Cluster 1 use 145 to 180-acre feet of water annually.

Soils in this area are principally Bull Run silt loam with 3 to 8 percent slopes. These are generally deep and well drained soils but can be prone to erosion on sloped fields.

After conducting interviews, the primary farmer from the cluster stated recycled water is not suitable for their "biodynamic growing methods" and organic certification and the farmer stated they are not interested in the City's treated water.

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

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murraysmith

SANDY
WHERE INNOVATION MEETS ELEVATION

City of Sandy, Oregon
Detailed Discharge Alternatives Evaluation

LEGEND

Discharge Alternatives

- Option 1a
- Option 1b
- Option 2a
- Option 2b
- Option 2c
- Option 2d
- Option 2e
- Irrigation Alternatives
- Urban Growth Boundary
- ● DischargeLocations
- Farm Cluster
- ▨ Satellite MBR

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Figure 1
Recycled Water Alternatives

October 2020 20-2776

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Farm Cluster 2 – West of Ten Eyck Road

Over 270 acres is zoned EFU in this area, however many of which are residential properties. The most applicable site in this area is a 39-acre site used for food crop agricultural production. They have a new irrigation well and no usage statistics were reported.

The soils in this area are also Bull Run silt loams with slopes up to 5 percent. After conducting interviews, one owner indicated no reason to consider supplemental irrigation, another indicated a reluctance to consider recycled water for their food crops because of their organic farming practices and concern for their consumers.

Farm Cluster 3 – Coalman Road and Oral Hull Road

Three properties totally 55 acres of pasture and hay production. These sites do not currently irrigate and are reported to have two springs which provide sufficient water for seepage irrigation. These properties are not recommended as a recycled water customer.

Farm Cluster 4 – Marmot Road

Five sites over 20-acres on Marmot Road are north of the Sandy River. These properties are currently used for pasture and hay production. These sites do not currently irrigate and are reported to have two springs which provide sufficient water for seepage irrigation. These properties are not recommended as a recycled water customer.

Farm Cluster 5 – Phelps Road

Three sites over 20-acres on Phelps Road are north of the Sandy River. These properties are currently used for agriculture. A limited supply of irrigation water is used on two of the properties. Based on the volume of water irrigated on these sites these properties are not recommended as a recycled water customer.

Farm Cluster 6 – Highway 26

Five sites over 20-acres south of Highway 26. These properties are currently used for agriculture, primarily Christmas tree production. These sites do not currently irrigate. These properties are not recommended as a recycled water customer.

Farm Cluster 7 – Highway 211

Three sites over 20-acres south of Highway 211. These properties are currently used for pasture or are otherwise unmanaged. These sites do not currently irrigate. These properties are not recommended as a recycled water customer.

Farm Cluster 8 – Kelso Road

Six sites ranging from 25-acres to 43-acres along Kelso Road north of Highway 26. New irrigation wells are prohibited in this area. Some irrigators in this area report that water levels drop in their wells in the hottest weeks of the summer when maximum groundwater pumping occurs. The six sites are described as Property A to E below.

- **Farm Cluster 8 - Property A** the first property for consideration to use recycled water, is an operating nursery currently for sale. It totals 88.8 acres with approximately 62 acres in irrigable nursery production. The table below estimates the potential total recycled water use. Four additional properties near Kelso Road are also prospects for Sandy recycled water:

- **Farm Cluster 8 - Property B** is a 39-acre parcel located south of Kelso Road, within Sandy's UGB. The property is in very low management and is suited for a container nursery. No irrigation well water is currently available.

- **Farm Cluster 8 - Property C** is a 43.2-acre parcel leased by a commercial nursery and managed for in-ground tree production. It has a groundwater well but could be improved with supplemental irrigation. About 41.5 acres is irrigable. This property is in the Sandy Urban Reserve.

- **Farm Cluster 8 - Property D** is in two parcels that together total 76.4 acres with about 68 acres irrigable. The land is leased by the same nursery that leases Property C and is also in ornamental tree production. This property is also served by a well.

- **Farm Cluster 8 - Property E** is a 25-acre container nursery located near Kelso Road and Orient Road. It has about 20 acres in container production at full capacity. This property has two wells, but the owner would consider adding City recycled water to enhance their irrigation requirements.

Cost Analysis for Large-Scale Irrigators

To evaluate the costs relative to the potential discharge rates, preliminary estimates to extend the pipelines to the farm clusters shown in **Figure 1** were developed. These costs are outlined below in **Table 1**. The design flow for any of these farm clusters is less than 0.4 cubic feet per second (0.26 MGD) assuming an irrigation season between May 1st and October 31st. The length of the force main is specified in the table below. The preliminary cost analysis includes a 0.5 million gallon per day pump station and a 4-inch force main. These costs include labor and installation costs and includes design, construction management, contractor overhead and profit, and construction contingency costs.

Table 1 | Preliminary Cost-Benefit Analysis for Large-Scale Irrigators

Potential Customer		Distance from Pipeline Alignment	Projected Annual Water Demand Quantity	Preliminary Cost	Percentage of Sandy WW Summer Flow	Demand for Recycled Water
Farm Cluster 1		352 ft	180 acre-feet	$1.23 M	31%	No
Farm Cluster 2		188 ft	0 acre-feet	$1.16 M	0%	No
Farm Cluster 3		7,145 ft	0 acre-feet	$3.94 M	0%	No
Farm Cluster 4		7,207 ft	0 acre-feet	$3.97 M	0%	No
Farm Cluster 5		4,310 ft	0 acre-feet	$2.81 M	0%	No
Farm Cluster 6		3,908 ft	0 acre-feet	$2.65 M	0%	No
Farm Cluster 7		7,441 ft	0 acre-feet	$4.06 M	0%	No
Farm Cluster 8	Property A	10,859 ft	34.3 to 50.5 acre-feet	$5.43 M	6% to 8.6%	Yes
Farm Cluster 8	Property B	10,859 ft	54 acre-feet	$5.43 M	9%	Maybe
Farm Cluster 8	Property C	10,859 ft	4 acre-feet	$5.43 M	1%	Yes
Farm Cluster 8	Property D	10,859 ft	7 acre-feet	$5.43 M	1%	Yes
Farm Cluster 8	Property E	10,859 ft	16 acre-feet	$5.43 M	3%	Yes

Summary of Large-Scale Irrigation Investigation

As shown above, the only viable Farm Cluster for recycled water irrigation, based on the current interest, is Farm Cluster 8. The preliminary cost for building a pipeline to serve this area would cost approximately $5.43 million dollars and the total percentage of the summer flow could be in the range of 1 to 22 percent. Since this option only uses a portion of the summer flows and requires a substantial capital investment, it is not as preferable as a discharge alternative than some of the other discharge alternatives considered in this study, and also prompted the investigation of a conglomeration of smaller-scale farms who are currently irrigating as discussed in the following section.

Potential Small-Scale Aggregated Water Recycling Customers

In addition to reviewing large-scale farm sites or clusters who might be able to receive the majority of flow, a study was done to evaluate current irrigators who are very close to preferred pipeline alignments and might benefit from recycled water and use a portion of the total flow. The Oregon Water Resources Department Water Rights Mapping Tool was used to determine current water rights used for Irrigation along the preferred pipeline alignments. A summary of the irrigators and the distance from the pipeline alignments are included in a cost-benefit analysis below however, no interviews with these property owners have been conducted so far. A map of these sites is shown in **Figure 2.**

Description of Small-Scale Irrigation Sites

Irrigation Site a – Ten Eyck Road

Site a is located at the intersection of Ten Eyck Road and Thomas Road north of the Sandy River. One well at *Site a* serves approximately 3.5 acres and is designated for irrigation. The property is currently zoned "TBR" for timber use. The quantity of water claimed and used is 12 gallons per minute.

Irrigation Site b – SE Phelps Road

Site b is located along SE Phelps Road, north of the Sandy River. Two wells at Site b serve approximately 16 acres and is designated for irrigation. The property is currently zoned "EFU" for exclusive farm use. The quantify of water claimed and used is 90 gallons per minute. The property owners of this site produce organic herbal supplements – based on experience from the large-scale irrigators, this property owner may be detracted from recycled water use due to public perception surrounding organic status.

Irrigation Site c – Cedar Creek Area

Site C is located east of the Sandy River Park, south of the Sandy River. One well at Site c serves approximately 6.8 acres; was originally used for gardening, pasture, and hay crops; and is designated for irrigation. The site is currently zone "TBR" for timber use. The quantity of water claimed and used is 30 gallons per minute.

Irrigation Site d – Sandy Bluff Park

One well at Site d currently serves approximately 50 acres for irrigation purposes. The original purpose was designated for irrigating plant nursery stock. The property is designated "R1" for residential use. As of the well report from 1978, only about one acre of canyard was supplied by this well. The quantity of water claimed and used is 43 gallons per minute.

Irrigation Site e – Sandy Union High School

Site e has a grounder water and surface water rights for irrigation use within the school and serves approximately 19 acres. The surface water point of diversion comes from Sump Springs. The quantity of water claimed and used is 25 gallons per minute. Of the total allocation, 5 gallons per minute are allocated for shower and sanitary facilities, and 20 gallons per minute are allocated for irrigation.

Cost Estimates for Supplying Effluent to Small-Scale Irrigators

Preliminary costs to extend the pipeline to the irrigation sites was estimated and are outlined below in **Table 2**. The design flow for the proposed satellite plant is approximately 0.5 MGD for the time of year when irrigation is feasible. With an average user rate of 0.06 MGD and a cumulative usage rate of 0.28 MGD, the farm clusters require only a portion of the design flow for the proposed satellite plant assuming an irrigation season between May 1st and October 31st. The length of the force main is specified in the table below. The preliminary cost analysis includes only a 4-inch force main. These costs include labor and installation costs a includes design, construction management, contractor overhead and profit, and construction contingency costs.

Table 2: | Preliminary Cost-Benefit Analysis to small-scall irrigators

Potential Customer	Distance from Pipeline Alignment	Projected Annual Water Demand Quantity	Preliminary Cost	Percentage of Sandy WW Summer Flow	Demand for Recycled Water
Irrigation Site a	0 ft	10 acre-feet	$0.00 M	2%	TBD
Irrigation Site b	4,310 ft	72 acre-feet	$1.73 M	12%	TBD
Irrigation Site c	0 ft	25 acre-feet	$0.00 M	4%	TBD
Irrigation Site d	5,152 ft	36 acre-feet	$2.07 M	6%	TBD
Irrigation Site e	1,806 ft	16 acre-feet	$0.73 M	3%	TBD
	Total		$4.53 M	27%	TBD

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Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

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City of Sandy, Oregon
Detailed Discharge Alternatives Evaluation

LEGEND

Discharge Alternatives

- Option 1a
- Option 1b
- Option 2a
- Option 2b
- Option 2c
- Option 2d
- Option 2e
- Small-scale Irrigators
- Urban Growth Boundary
- ● DischargeLocations
- ● Irrigator Site
- ▨ Satellite MBR

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Figure 2
Recycled Water Alternatives

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Review of Costs Relative to Discharge Rates

The cost to send flows to Kelso Road is $5.4M and only allows for 22% of the flow to be discharged while small irrigators costs $4.53M and potentially allows for 27% of the flows to use for irrigation. There is also more certainty with the small irrigators since we know they are currently irrigating. However, interest will have to be determined on a case-by-case basis. The range of costs per flow (in gallons per minute) to extend service to the large-scale irrigators is between $5k and $1.0M. The range of costs per flow (in gallons per minute) to extend service for the small scale-irrigates discussed is from less than $5k to $46k.

Recommendation

The alternatives outlined in this memo involve using recycled water to irrigate potential customers. Based on the analysis of cost and potential discharge rates, the large-scale irrigator sites didn't show real market demand for the recycled water and required larger capital investments because of the longer pipeline lengths required between the main effluent piping routed to the Sandy River and the potential irrigation sites. The small-scale irrigator sites showed greater current irrigation utilization rates and required a much smaller capital investment due to the shorter pipeline lengths from the preferred pipeline alignments.

It is recommended to pursue a recycled water program for irrigators close to the preferred pipeline alignment. Murraysmith recommends the City establish a fair basis to extend recycled water to interested users based on the length of pipe required for service and the total supply of recycled water requested. Some of these potential users of the recycled water will require little capital investment to connect to the main pipeline and these users will benefit from the availability of recycled water. Additionally, irrigation use of the recycled water will help reduce discharges to the Sandy river during the critical dry months of the year.

Cc: Matt Hickey, Murraysmith

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Technical Memorandum 9 and 10

Date: March 01, 2021

Project: City of Sandy – Detailed Discharge Alternative Evaluation

To: Jordan Wheeler, City Manager
Mike Walker, Public Works Director
City of Sandy, Oregon

From: Matt Hickey, PE
Ken Vigil, PE
Katie Husk, PE
Murraysmith

Re: Indirect Discharge and Roslyn Lake Alternatives Site Review (TM-9) and Analysis of Indirect Discharge (TM-10)

Introduction

Task 7 of the Detailed Discharge Alternatives Evaluation involves reviewing Indirect Discharge and Roslyn Lake Alternatives. The regulations surrounding indirect discharge (Technical Memorandum 9) and site reviews and analysis of indirect discharge (Technical Memorandum 10) are related. Thus, we are summarizing both aspects in this one document, calling it Technical Memorandum 9 and 10.

Discharge Options

The project team conducted a thorough review of indirect discharge options. These options included irrigation on crops, hyporheic flow (discharge into river gravels), infiltration ponds, and various constructed wetland options. Some of these options also provide opportunities for habitat enhancement and creation.

Please refer to Technical Memorandum 7.1 for a summary of direct discharge into the Sandy River options.

Indirect Discharge Locations

Murraysmith's subconsultant Barney & Worth (through Globalwise) started by conducting a market review of effluent reuse and possible land application sites in the general vicinity of the proposed new satellite treatment facility, as summarized in their 2020 report. That review focused on identifying properties and locations where effluent could be used beneficially on land, primarily for irrigation of crops. That review did not result in an ideal location or recommended alternative due in part to the abundance of rainfall in the area, resulting in less need for irrigation.

Through recommendations from the City, the consultant team also began reviewing options for land application of effluent near the historic Roslyn Lake, previously owned and managed by Portland General Electric. That location has become the primary site of interest as the project has moved forward and is the focus of this memorandum.

Regulatory Aspects

In order to apply effluent to land, the City must meet surface water and groundwater regulations and obtain applicable permits. The Oregon Department of Environmental Quality (DEQ) typically regulates discharges to land only with Water Pollution Control Facility (WPCF) permits. When effluent is discharged to surface waters, DEQ regulates those discharges through National Pollutant Discharge Elimination System (NPDES) permits. DEQ currently regulates the City's discharge to Tickle Creek and land application at the nursery both through one NDPES permit. DEQ will likely regulate the new discharge from the proposed satellite treatment facility through a single NPDES permit. It is not clear at this time if DEQ will issue a new NPDES permit to the City for the new satellite plant, or if DEQ will amend the existing Tickle Creek permit to add the new treatment facility and discharge options.

Murraysmith's specialty groundwater subconsultant (GSI Water Solutions, Inc. or GSI) reviewed the regulatory aspects of indirect discharge and summarized their findings in the attached technical memorandum titled "Regulatory Framework for Alternative Wastewater Discharge System Permitting, City of Sandy, Oregon", September 20, 2020.

Desktop and Field Studies

In addition to their regulatory review, GSI completed a desktop study (and limited field work) to further review soils, groundwater, and geologic conditions in the Roslyn Lake area. They found that the soils in the Roslyn Lake area are primarily Alspaugh Clay Loams and Bull Run Silt Loams. These soil groups reportedly have poor infiltration capacity. The underlying bedrock in the area is from the Springwater and Troutdale formations. GSI documented that several groundwater wells exist in the project area.

GSI's desktop study is summarized in the attached technical memorandum titled "Evaluation of Sites for Alternative Wastewater Discharge Systems, City of Sandy, Oregon", September 18, 2020.

Because of the importance of understanding infiltration at the site, GSI also conducted planning-level infiltration tests in the field at two test pits near the recommended alternative (outlined below). Those tests found higher infiltration rates in area soils than reported in the literature, as summarized in their attached technical memorandum titled "Infiltration Testing to Estimate Soil Permeability, Roslyn Lake, Sandy, Oregon", January 11, 2021. These results suggest that additional, design-level, soils and infiltration testing will be needed in the future to better understand the soil characteristics across the site. Soil amendments and compaction may be needed to control infiltration.

Recommended Alternative

The recommended indirect discharge alternative is conveying treated effluent to a series of constructed wetlands in the historic Roslyn Lake area. Figures 1 and 2 are plan and section views, respectively, of the recommended indirect discharge alternative. For reference, Technical Memorandum 7.1 outlines direct discharge into the Sandy River alternatives.

As shown in Figure 1, the initial concept is to create separate constructed wetlands. The City could construct these wetlands over time and as needed to manage costs. For example, the City may wish to construct Wetland A (about 28 acres as shown) and Wetland B (about 12 acres) in the first phase of construction. We have placed these wetlands in areas that take advantage of existing site topography and contours to minimize earthwork costs. With continued population growth, the City could construct Wetland C (approximately 10 acres) to add capacity. However, the natural topography is not as conducive for Wetland C and more earthwork would be required.

To protect existing habitat and preserve natural hydrology, the proposed wetlands are purposefully not connected to existing water features on the site (at this time). It seems reasonable to assume that the existing wetland/pond features on the site may need to be maintained separate from the proposed constructed wetlands. These existing features are currently providing habitat and are likely protected by wetland regulations. The existing flow channels currently pass water from the upper watershed through the site to downstream properties and habitat. These channels also likely need to be maintained.

As the design progresses, there may be an opportunity to consider enhancing the existing wetlands by providing additional effluent hydrology, particularly during the summer. The design team will explore these options with regulators in the future, to see if any wetland impacts could be mitigated by enhancing and expanding these natural wetland areas.

The exact size, number, and location of constructed wetlands will be determined after additional studies are completed. For example, the project team will need to prepare a new topographic survey, conduct additional soil infiltration tests, review existing regulated wetland boundaries, and further refine site hydrology and flow balance projections.

The section view of the proposed wetlands (Figure 2) illustrates how a diversity of native vegetation could be planted based on site hydrology (amount and depth of water), habitat creation objectives, and operation and maintenance needs. During final design, the project team would complete a planting plan for the area using desirable native species. The design could retain most of the conifers but replace the abundant monoculture of Cottonwood trees (currently dominating parts of the site) with a more diverse assemblage of native plants.

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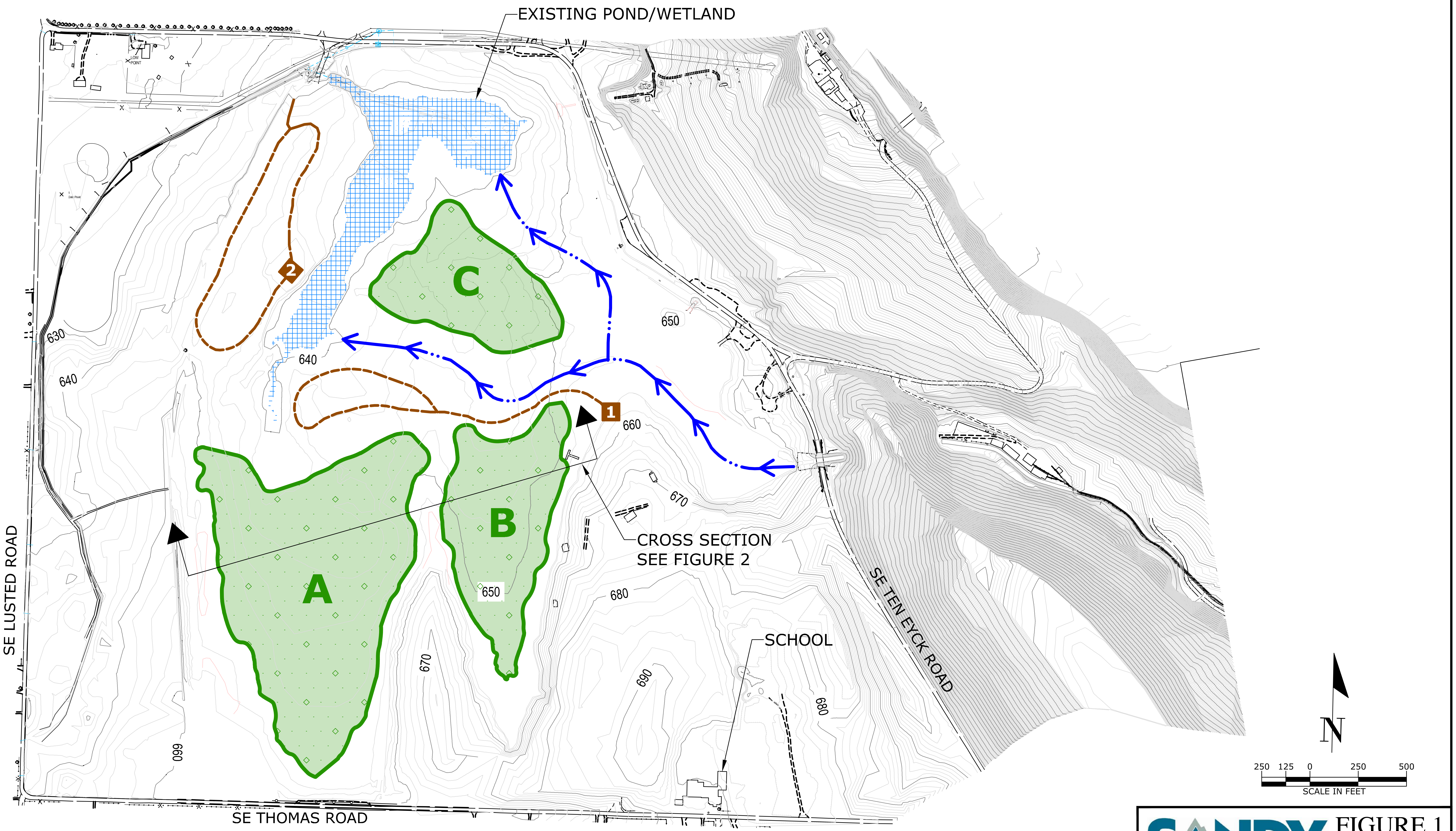

LEGEND

TRAILS - - - - - - -
WETLANDS ▬▬
VIEWING PLATFORM LOCATION ■
NATURAL WATERS ←·-·-·-

SANDY
WHERE INNOVATION MEETS ELEVATION

FIGURE 1

Detailed Discharge
Alternatives Evaluation

WETLAND CONCEPT PLAN

murraysmith

NOVEMBER 2020
20-2276

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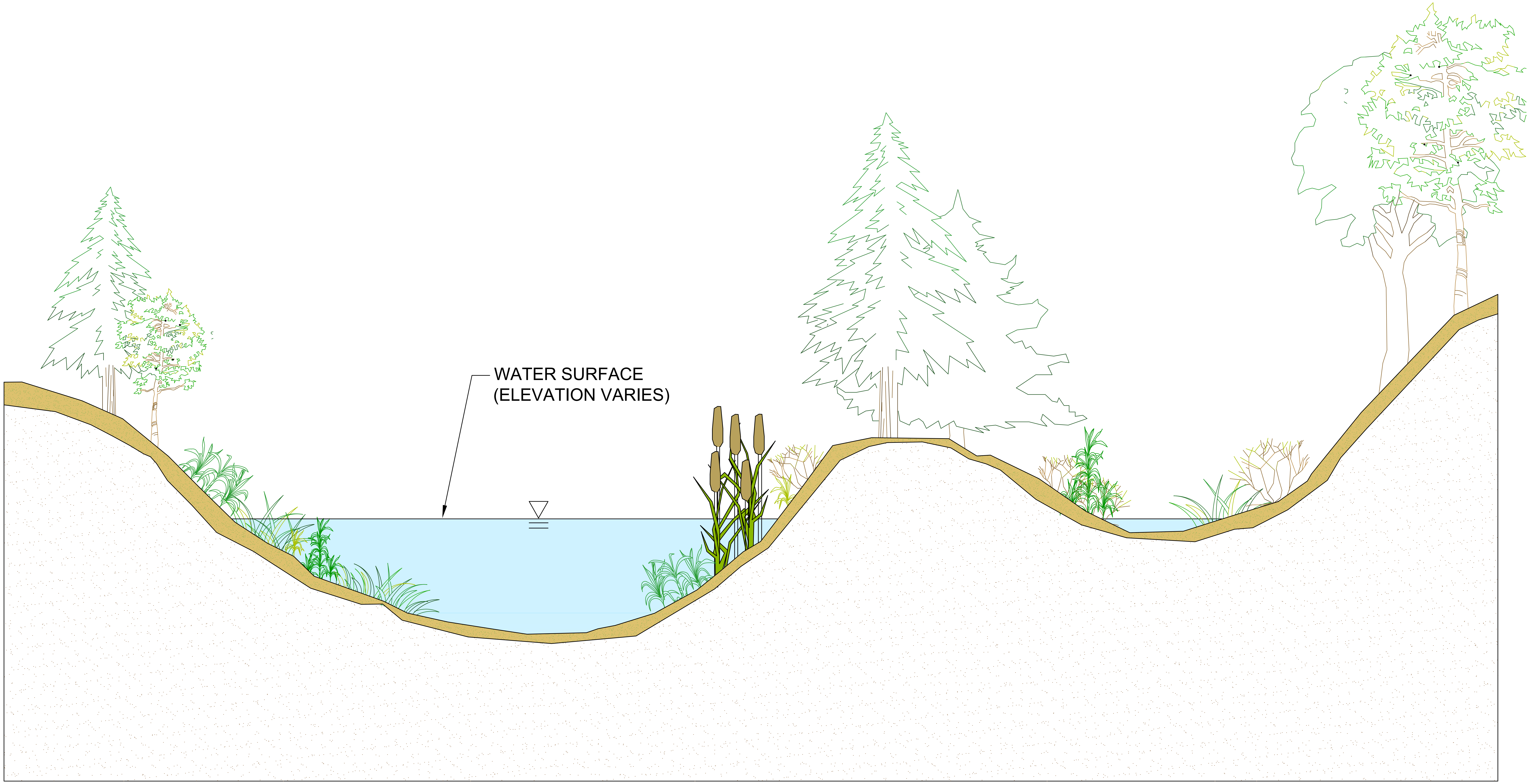

SANDY
WHERE INNOVATION MEETS ELEVATION

FIGURE 2

Detailed Discharge
Alternatives Evaluation

WETLAND CONCEPT SECTION

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Water Balance

The project team reviewed the inflows, outflows, and the amount of water that would be stored in the wetlands to determine a water balance for the system.

The engineers first calculated the amount of storage volume that could be needed in the wetlands to hold the recycle/reuse water as a preliminary estimate of the required wetland area. For example, if the City discharged about 0.5 Million Gallons per Day (MGD) of flow to the wetlands over a five-month period (approximately 150 days), then that volume of reuse water (approximately 230 acre-feet) would result in about 50 acres of wetland area at an average depth of about 4.6 feet.

In practice, the City would discharge recycled water into the constructed wetlands in a way that maintains a desirable depth of water in the wetlands to support the healthy growth of wetland vegetation. The depth would increase and decrease throughout the year based on the balance of four flow variables: (1) the amount of recycled water flow entering the wetlands, plus (2) the amount of freshwater flow falling on the wetlands as precipitation, minus (3) any flow that is infiltrating into the soils below the wetlands, and minus (4) evapotranspiration from the surface of the wetlands, including evaporation and plant uptake.

Table 1 is a summary of a preliminary annual water balance for a proposed 50-acre wetland area (Cells A, B, and C as shown in Figure 1).

Table 1 | Preliminary Annual Water Balance

Month	Recycle Water Inflow (gal/day)	Recycle Water Inflow (gal/mo)	Wetland Area (acres)	Recycle Water Depth (in/mo)	Precip[1] (in/mo)	Infil[2] (in/mo)	ET[3] (in/mo)	Difference (in/mo)	Wetland Water Depth (inches)
START DEPTH									24.0
JAN	0	0	50	0.00	10.2	5.0	0.4	4.80	**28.80**
FEB	0	0	50	0.00	8.0	5.0	0.9	2.10	**30.90**
MAR	0	0	50	0.00	8.1	5.0	2.2	0.90	**31.80**
APR	0	0	50	0.00	6.9	5.0	3.4	-1.50	**30.30**
MAY	0	0	50	0.00	5.7	5.0	5.4	-4.70	**25.60**
JUN	500,000	15,000,000	50	11.02	4.1	10.0	7.0	-1.88	**23.72**
JUL	500,000	15,500,000	50	11.39	1.3	10.0	8.6	-5.91	**17.81**
AUG	500,000	15,500,000	50	11.39	1.4	10.0	6.7	-3.91	**13.89**
SEP	500,000	15,000,000	50	11.02	3.6	10.0	4.0	0.62	**14.51**
OCT	500,000	15,500,000	50	11.39	6.5	10.0	1.8	6.09	**20.60**
NOV	0	0	50	0.00	11.2	5.0	0.6	5.60	**26.20**
DEC	0	0	50	0.00	11.2	5.0	0.3	5.90	**32.10**

1. Precipitation - USClimatedata.com for Sandy, OR
2. Infiltration - Estimate assuming soil amendment used to reduce infiltration rate of native soils
3. Evapotranspiration - US Bureau of Reclamation Agrimet, Dee Flat, OR

As shown in Table 1, the depth of water in the wetlands would increase and decrease throughout the year based on the four variables outlined above. The City would have control over how much recycled water to deliver to the wetlands. The design of the new wetlands is assumed to include using clay as an amendment to native soils to limit infiltration.

The project team will review these water balance variables in more detail during the design phase of the project. Moreover, the actual amount of monthly precipitation, infiltration, and evapotranspiration will always vary based on climatic conditions. Thus, the City's operation of the facilities will need to take into consideration changing weather conditions.

The desirable depth of water will depend on the type of wetland plants selected and habitat creation goals. It is likely that the three proposed wetland areas would all have different depths to provide more diversity of wetland habitat.

Based on the preliminary water balance reviews summarized above, Murraysmith engineers estimate that the City would want to build approximately 30 to 60 acres of constructed wetlands.

The City would discharge to the constructed wetlands during the summer period and also to the Sandy River through a new outfall. The Sandy River has substantial flows and assimilative capacity during both summer and winter months. For general reference, with the proposed new discharge, the City's monthly effluent flows to the river would be less than 1% of the monthly river flows.

Discharging to both the Roslyn Lake constructed wetlands and the Sandy River is consistent with the approach outlined in the recently completed antidegradation review for new proposed discharges into the Sandy River. Moreover, this approach provides the City with a more robust, flexible, long-term wastewater management program.

Costs and Benefits

As noted above, much of the cost of the constructed wetlands will be associated with the earthwork for excavation or berm building. For planning purposes, the project team has been using an older topographic map created for PGE a decade ago. That topographic information will need to be updated as the project moves towards final design. Based on our current understanding of the site and potential size and depth of a 50-acre wetland complex, we estimate that approximately 100,000 to 200,000 cubic yards of earthwork may be required for the project.

As the design moves forward, the team will have a better idea of final wetland locations/depths/topography, length of discharge pipe, number of control structures, type of plant species to be planted, and amount of existing vegetation (like cottonwood trees) to be removed, any access roads that will be needed, trails and signage, etc.

For planning purposes, we estimate that the construction cost of the proposed wetlands would be approximately $3 million to $6 million dollars.

For reference, the Fernhill South Wetlands project (which members of the project team have visited) created approximately 50 acres of new wetlands from 90 acres of old sewage lagoons. The construction cost for that project was approximately $3.6 million dollars in 2014. That project included approximately 200,000 cubic yards of earthwork, and it was constructed in an area with native clay soils and existing impoundments.

Although similar, these two projects have different initial site conditions. We anticipate that the cost of the Roslyn Lake wetlands will be higher since the existing soils are much more permeable. These more permeable soils will likely require soil amendments and some degree of compaction to help them retain water for wetland plants.

The benefits of this project are many, as itemized below.

- Beneficial use of high-quality effluent
- Recycle/Reuse of valuable resources (water and nutrients)
- Wetland enhancement and creation
- Habitat enhancement and creation
- Provides hydrology for new, desirable native plants and animals
- Minimizes or eliminates negative impacts to water quality from summertime discharges to the Sandy River
- Minimizes or eliminates negative impacts to fisheries on the Sandy River from summertime effluent discharges
- Further cooling and natural treatment of effluent
- Opportunities for environmental education/recreation
- Creation of trails and interpretive signs
- Possible use of the created wetlands for wetland mitigation banking

Property Owner Coordination

The Roslyn Lake site is owned by Trackers Earth, a company that specializes in outdoor and environmental education. Staff from Murraysmith first met with a representative of Trackers Earth at the Site in May of 2020. We walked portions of the site and discussed opportunities and constraints by looking at existing operations, site topography, existing wetlands and water features, native vegetation, and current access points and infrastructure.

Our specialty groundwater subconsultant (GSI) met with Trackers Earth to visit the site and conduct preliminary soils investigations on June 23, 2020. We have continued to coordinate with Trackers Earth through e-mails and phone calls as the project has progressed.

Because of the importance of the opportunity for teaming with Trackers Earth and to ensure good communication and cooperation, the City prepared a letter of Interest/Understanding with Tracker's Earth (see attached) and that letter was signed by both parties on September 8, 2020.

Additional Coordination

The consultant team has been coordinating with City staff and City elected officials throughout the course of the project. We have conducted virtual meetings with City staff every two weeks and these meetings have included discussions of the indirect discharge alternatives, including Roslyn Lake.

Murraysmith staff had a virtual workshop/meeting with City staff (Mike Walker and Jordan Wheeler) on July 23, 2020 for the purpose of reviewing the outfall location studies and work being done on the Roslyn Lake area wetland opportunities. The workshop was facilitated by a PowerPoint presentation that summarized progress to date.

On September 8, 2020, Murraysmith had a virtual workshop/meeting with the Sandy City Council and City Staff. This workshop/meeting was facilitated by a PowerPoint presentation and the public was invited (including interested citizens and members of the local watershed councils). Murraysmith staff again presented a summary of the overall project and focused on the possible outfall sites and opportunity for wetland creation using effluent near historic Roslyn Lake.

On October 16, 2020, the City invited State Representative Anna Williams to visit the Roslyn Lake area in cooperation with the property owner. The site visit gave City representatives the opportunity to thank Representative Williams for her earlier support of legislation to secure funding for this Detailed Discharge Alternatives Analysis. It also gave the team the opportunity to explain the proposed constructed wetland project for reusing the high-quality effluent from the new satellite treatment facility. That meeting also included coordination with representatives from the Sandy River Watershed Council and the Clackamas River Basin Council. Those attending the field meeting practiced social distancing and wearing of masks because of the pandemic.

The project team held a virtual workshop meeting with the Clackamas and Sandy River Councils on December 16, 2020. The presentation focused on reviewing project elements that would affect these two watersheds. For example, team members described upgrades to the existing treatment plant and collection system improvements. These improvements primarily affect the Clackamas River Basin because the existing plant discharges into Tickle Creek, a tributary of the Clackamas River. Other team members reviewed the proposed new satellite treatment plant, recommended Sandy River outfall location, and proposed constructed wetlands at Roslyn Lake. These project elements are all located in the Sandy River watershed.

On June 30, 2020, the project team had a virtual coordination meeting with agency representatives from: the Oregon Department of Environmental Quality, Oregon Department of State Lands, Oregon Department of Fish and Wildlife, U.S. Army Corps of Engineers, and the National Oceanic and Atmospheric Administration Fisheries. These agencies all have some jurisdiction over the proposed project as it relates to water quality, wetlands, fisheries, and other environmental programs.

The presenters summarized the results of some of the investigations done to date at the possible outfall sites. The agency representatives all seemed to favor the upstream site near Ten Eyck Road crossing of the river (at Revenue Bridge). Moreover, the agency staff were interested in the possibility of applying the effluent to land during the summertime (at the proposed Roslyn Lake wetland site), to reduce potential impacts to the Sandy River.

This meeting on June 30, 2020 was a follow-up to an earlier agency “Kaizen” style meeting held on May 15, 2019 where the project was initially introduced.

Conclusion

This technical memorandum summarizes Task 7 of the Detailed Discharge Alternatives Evaluation: Indirect Discharge and Roslyn Lake Alternatives. The regulations surrounding indirect discharge (Technical Memorandum 9) and site reviews and analysis of indirect discharge (Technical Memorandum 10) are related. Thus, we summarized both aspects in this one document, calling it Technical Memorandum 9 and 10.

Based on this review, we anticipate that DEQ will regulate the proposed discharge to the Sandy River and the Roslyn Lake constructed wetlands through a single NDPES permit. DEQ currently regulates the City’s discharge to Tickle Creek and the container nursery that way. It is not clear if DEQ will modify the existing Tickle Creek permit by adding the Sandy River and Roslyn Lake discharges, or if they will issue a new permit for the Sandy River and Roslyn Lake discharges.

The City has the opportunity to construct wetlands to beneficially recycle/reuse the high-quality effluent from the proposed satellite treatment plant. The Roslyn Lake site seems well suited for this approach and Trackers Earth (the property owner) is interested in partnering with the City on this type of a project, given successful negotiation of an agreement between both parties. The project team will need to conduct further reviews of soils/infiltration and of existing wetlands and waterways on the Roslyn Lake property as the project moves into final design to better understand associated opportunities and constraints.

Based on these planning level reviews, the City would need to construct approximately 30 to 60 acres of wetlands and the construction cost would be approximately $3 million to $6 million dollars.

TECHNICAL MEMORANDUM

Regulatory Framework for Alternative Wastewater Discharge System Permitting, City of Sandy, Oregon

To:	Ken Vigil, PE / Murraysmith Associates, Inc. Matt Hickey, PE / Murraysmith Associates, Inc. Jessica Cawley, PE / Murraysmith Associates, Inc.
From:	Dennis Orlowski, RG / GSI Water Solutions, Inc. Matt Kohlbecker, RG / GSI Water Solutions, Inc. Jason Melady, RG / GSI Water Solutions, Inc.
Date:	September 20, 2020

Exp: 5/1/2021

This technical memorandum (TM), prepared by GSI Water Solutions, Inc., (GSI), summarizes an evaluation of permitting requirements for municipal wastewater discharge systems that do not discharge directly to surface water. The TM considers a system that would be owned and operated by the City of Sandy (City), and is organized as follows:

- Section 1: Summarizes background information about the City's wastewater project.
- Section 2: Reviews Department of Environmental Quality (DEQ) permitting criteria for wastewater discharge systems.
- Section 3: Applies the DEQ permitting criteria to the City's Study Area.
- Section 4: Develops recommendations for determining the most likely DEQ permit requirements based on the wastewater discharge system location.

1 Project Background

The City of Sandy is evaluating discharge alternatives for treated wastewater in lieu of or in combination with a direct year-round discharge to the Sandy River. In this TM, treated wastewater discharge systems that *do not* directly discharge to surface water are called "alternative wastewater discharge systems." For example, one type of alternative wastewater discharge system discussed in this TM is an indirect discharge system. Indirect discharge systems are typically located adjacent to rivers, and enhance effluent quality through various natural physical, chemical, and biological processes in soil and groundwater by infiltrating wastewater and diffusely discharging the wastewater to surface water via groundwater.

The types of alternative wastewater discharge systems under consideration are infiltration basins with shallow groundwater discharge, constructed wetlands, evaporation ponds, and hyporheic discharge along the Sandy River or other stream corridors. The study area for the City's discharge alternatives evaluation is shown in Figure 1. Figure 1 also shows sites for alternative wastewater discharge systems currently under consideration by the City. The Roslyn Lake site is a candidate for infiltration basins and constructed wetlands, and the Sandy River Oxbow sites are candidates for hyporheic discharge.

Oregon law requires that wastewater discharge systems are authorized by a permit from the DEQ. There are two options permitting a wastewater discharge: (1) a National Pollutant Discharge Elimination System (NPDES) permit, or (2) a Water Pollution Control Facility (WPCF) permit. For a wastewater discharge system, the type of permit required depends fundamentally on whether or not the wastewater is to be discharged to surface water (directly or indirectly).

- NPDES permits: required for discharges of pollutants *to surface waters*, whether done so directly via an outfall, or *indirectly* via groundwater or within a hyporheic zone. An NPDES permit is a requirement of the Federal Clean Water Act and Oregon law [Oregon Administrative Rules (OAR) 340-045].
- WPCF permits: required for the discharge of wastewater to the ground; *discharge to surface water is not allowed*. The primary purposes of a WPCF permit are to prevent discharges to surface waters and to ensure that discharges to the ground meet Oregon's Groundwater Protection Rules (OAR 340-040).

There is often uncertainty related to whether an NPDES or WPCF permit is required to operate an alternative wastewater discharge system. Whether an NPDES permit would be required for discharges of wastes to groundwater with a direct or otherwise significant hydrological connection to surface water (i.e., an *indirect* discharge) is a nuanced question that depends on several site-specific factors. Because NPDES permits may contain limits on pollutant loading that are not found in WPCF permits (e.g., temperature), the type of permit required for an alternative wastewater discharge system is an important consideration that may affect project feasibility. This TM summarizes the site-specific criteria that inform whether an NPDES or WPCF permit is required for an alternative wastewater discharge system (Section 2), and apply the criteria to potential alternative discharge sites in the City of Sandy's study area (Section 3).

2 Permitting Criteria for Alternative Discharge Systems (NPDES or WPCF)

This section summarizes regulatory guidance documents (Section 2.1), a recent court decision (Section 2.2), and site-specific criteria (Section 2.3) that inform the type of permit that may be required for an alternative wastewater discharge system.

2.1 Regulatory Guidance Documents

Some of the uncertainty around permitting of alternative wastewater discharge systems was reduced in 2007, when DEQ issued an internal management directive (IMD) for disposal of municipal wastewater by indirect discharge to surface water. In the IMD, DEQ defined *indirect discharge systems* as those that "dispose of municipal wastewater plant effluent by indirect discharge to surface water via groundwater or hyporheic water" (DEQ, 2007). As such, indirect discharge systems are intentionally designed such that the wastewater effluent will ultimately discharge to a receiving surface water body. Based on DEQ's indirect discharge IMD, DEQ would require an NPDES permit rather than a WPCF permit for systems that intentionally discharge treated wastewater to surface water, albeit indirectly along a groundwater pathway.

2.2 Recent Court Decisions

A recent US Supreme Court decision is expected to eventually provide DEQ with future guidance and perhaps rule changes for the regulation and permitting of alternative wastewater discharge systems (*County of Maui, Hawaii v. Hawaii Wildlife Fund, et al.).* The case argued whether the Clean Water Act requires a permit when pollutants that originate from a waste disposal facility (in this case, an underground injection control that was permitted under the Safe Drinking Water Act) can be traced to reach navigable waters of the US through mechanisms such as groundwater transport, regardless of whether discharge to surface water was intended. On April 23, 2020, the Court ruled that such discharges must have an NPDES permit when they are the "functional equivalent of a direct discharge," a new test defined by the ruling. The Court decision will require the Environmental Protection Agency (EPA) to develop specific rules related to the “functional equivalent” test to be promulgated after public review. These federal rules will eventually be adopted by DEQ for implementation in Oregon. Alternative wastewater discharge systems could be the focus of a “functional equivalent” test. However, it will likely be years before such a test is developed and implemented into Oregon wastewater permitting regulations (pers. comm., Pat Heins/DEQ, 5/26/2020).

2.3 Site-Specific Criteria

Based on the recent Supreme Court decision, there may be alternative wastewater discharge systems that are not intended to function as an indirect discharge (such as infiltration basins located some distance from a stream), but for which there could be varying degrees of subsurface migration of effluent to a stream.

As discussed in Section 2.2, DEQ does not have *specific, formal* criteria or guidance to determine whether these types of alternative discharge systems would be considered either an indirect system subject to NPDES permitting requirements, or a system that is sufficiently hydraulically isolated from a surface water body (i.e., discharges to ground only) and subject to WPCF permit requirements. It should also be noted that project-specific factors will affect DEQ’s permitting decision. For example, an infiltration basin may require a WPCF permit at a given site; however, at the same site, a constructed wetland that is designed *not* to infiltrate water (i.e., due to low permeability or amended soils) and is a component of a surface water discharge system may require an NPDES permit. Consequently, DEQ will use site- and project-specific information to determine whether an NPDES permit or a WPCF permit is required (pers. comm., Pat Heins/DEQ, 5/26/2020). The site- and project-specific information would include evaluation of:

- Hydrologic conditions (whether stream reaches are gaining or losing).
- Hydrogeologic conditions (geologic units and hydraulic connection to surface water).
- Other considerations (e.g., fate and transport of pollutants in infiltrated effluent, which is affected by the physical setting of the system, and facility design and intent).

The following sections provide additional detail about this site-specific information. When making a determination about whether an alternative wastewater discharge system is subject to NPDES or WPCF permit requirements, DEQ will consider all of the criteria to make a permit determination based on multiple lines of evidence.

2.3.1 Hydrologic Conditions

Alternative wastewater discharge systems located near gaining streams (i.e., streams where groundwater seeps into the stream) are more likely to be considered an indirect discharge to surface water, and, therefore, permitted under the NPDES regulations. Alternatively, alternative wastewater discharge systems located near losing streams (i.e., streams where stream water seeps into the groundwater) may not be subject to NPDES permit requirements because an indirect discharge to the stream may not occur (unless the discharge system infiltrates a large volume of water that raises the groundwater table to a point where the stream becomes a gaining stream)[1]. However, both of these are generalized conditions that would depend not only on the relative proximity of an alternative discharge system to a stream, but also on other inter-related factors discussed in following sections.

2.3.2 Hydrogeologic Conditions

Geologic units are grouped into aquifers (units that transmit significant quantities of groundwater) and aquitards (units that do not transmit groundwater). The presence and spatial distribution of aquifers and aquitards can affect the degree of hydraulic connection between surface water and groundwater. Aquitards may act as barriers that limit the degree of hydraulic connection between groundwater and surface water. If an aquifer is separated from a stream by an aquitard, then DEQ may conclude that a WPCF permit is required

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[1] Note that wastewater discharge system may alter the local groundwater system by creating a water table mound beneath the discharge system, which could cause a losing stream to become a gaining stream.

for an alternative wastewater discharge system because the aquifer and stream are not hydraulically connected. Alternatively, if an aquifer is in direct contact with a stream, then DEQ is likely to conclude that an NPDES permit is required for an alternative wastewater discharge system due to the hydraulic connection.

2.3.3 Physical Setting

Whether an NPDES or WPCF permit is required also depends on the physical setting of the project. Alternative wastewater discharge systems located further from a stream would be less likely to require a NPDES permit because pollutants from the system are attenuated to varying degrees in the subsurface, and would thus be less likely to reach the stream. Alternative wastewater discharge systems located adjacent to a stream would be more likely to require an NPDES permit because pollutants do not travel sufficiently far through soil to be attenuated.

DEQ has not established a setback distance between a stream and an alternative wastewater discharge system for determining whether an indirect discharge condition exists. But a groundwater modeling analysis based on site-specific soil and aquifer properties can be used to estimate the expected attenuation of pollutants before reaching surface water.

3 Application of Permitting Criteria to Potential Sites in the Study Area

The City is evaluating potential sites for alternative wastewater discharge systems throughout the Study Area, which is shown in Figure 1. As discussed in Section 2.2, the permitting requirements (i.e., NPDES or WPCF) for the potential sites will be impacted by the hydrologic conditions (Section 3.1), hydrogeologic conditions (Section 3.2), and physical setting (Section 3.3) at each site. <u>It should also be noted that the alternative wastewater disposal system design may affect the fate and transport of pollutants and the volume and rate of infiltration, and should be considered in permitting determinations along with the permitting criteria discussed in the following sections.</u>

3.1 Hydrologic Conditions

In low-lying areas of the Willamette Valley, the depth to groundwater is generally shallow, and, as a result, streams are generally gaining. However, exceptions do exist (see Figure 15 in Conlon et al., 2005, for losing streams in low-lying areas of the Willamette Valley). Groundwater flow directions and seepage runs in the Study Area indicate that the streams are gaining. Specifically, groundwater flows towards streams (see groundwater elevation contour maps in Snyder [2008]) and seepage measurements presented in McFarland and Morgan (1996) indicate that groundwater discharges to surface water on the Sandy River, Deep Creek, and Tickle Creek. In other words, these three are all gaining streams.

3.2 Hydrogeologic Conditions

The geologic units in the study area are shown in Figure 2 (surficial geology) and Figure 3 (geologic cross section. The Quaternary Alluvium (Qal), Terrace Deposits (Qtg), and Springwater Formation (Qts) are present in the Study Area at ground surface and are characterized by relatively flat slopes. As such, these units comprise the surficial geology at candidate infiltration sites, and are described in the following bullets. Organized from youngest to oldest, the units are (Schlicker and Finlayson, 1979; Beaulieu, 1974):

- **Quaternary Alluvium (Qal).** The Quaternary Alluvium is comprised of recently-deposited sand, gravel and cobbles within the channel of the Sandy River.
- **Terrace Deposits (QTg).** Located just west and east of the Sandy River, the Terrace Gravels were deposited by the ancestral Sandy River during the Pleistocene Epoch[2], a time of relatively higher sea levels when the river was a lower-energy environment. The deposits are comprised of fluvial and glaciofluvial cobble to boulder gravels with relatively poor drainage[3].

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[2] The Pleistocene Epoch is a geologic timer period that lasted from about 2.6 million years ago to 12,000 years ago.

[3] Schlicker and Finlayson (1979) notes that the Terrace Deposits are not suitable for septic drainfields.

- **Springwater Formation (QTs).** Located west of the Sandy River, the Springwater Formation is comprised of mudflows and gravels that are deeply-weathered to a clayey soil characterized by poor drainage.

As shown on the cross section in Figure 3, the Quaternary Alluvium is directly connected to the Sandy River, while the Terrace Deposits are assumed to be mostly hydraulically isolated from the Sandy River due to the Sandy River Mudstone, which is a thick (over 200 feet) sequence of predominantly siltstone and claystone. As shown on Figure 2, the Springwater Formation is likely connected to the surface water features west of the Sandy River in much of the Study Area (i.e., Tickle Creek, Dolan Creek, etc.).

3.3 Physical Setting

The study area is large, and the City may be able to locate an alternative wastewater discharge system sufficiently far from surface water so that pollutants will be attenuated in soil and a WPCF permit is required. However, facility siting is more likely to be determined based on soil suitability for the type of disposal, property ownership, and existing pipeline alignments, as opposed to permitting implications.

4 Conclusions and Recommendations

DEQ will make a permitting determination (WPCF or NPDES) based on hydrologic conditions, hydrogeologic conditions, and the overall physical setting of the site for the alternative wastewater discharge system. DEQ will also consider the design of the system (i.e., whether the system is designed to infiltrate water). Because streams in the Study Area are gaining, it is more likely that DEQ will consider wastewater discharges to the ground as being an indirect discharge system, unless other physical factors or design factors suggest otherwise.

We make the following conclusions about DEQ's likely permitting determination based on the geologic unit where the facility is located and site setting:

- Discharge systems located in **Quaternary Alluvium**, which is the unconfined aquifer over which the Sandy River flows, will likely be considered to be strongly hydraulically connected to the river, and will be sufficiently close to the river that pollutants will not be fully attenuated prior to discharge. As such, wastewater discharge facilities in the Quaternary alluvium are likely to be permitted as an indirect discharge (i.e., NPDES permit). The Sandy River Oxbow No. 1 and Sandy River Oxbow No. 2 sites are located in the Quaternary Alluvium (see Figure 2).

- Discharge systems located in the **Springwater Formation**, which is an unconfined to semi-confined aquifer and features multiple creeks (e.g., Tickle Creek, Dolan Creek, Deep Creek, etc.) are also likely to be considered weakly hydraulically connected to surface water. If a weak hydraulic connection can be demonstrated and the facility is designed to infiltrate water, then DEQ may determine that a WPCF permit is required. In order demonstrate a weak hydraulic connection, the City would need to show that contaminants would not reach the surface water using site-specific data, or that infiltration is minimal [Schlicker and Finlayson (1979) indicate that the Springwater Formation is characterized by poor drainage, and the system design would also be an important consideration]. The City will be more likely to successfully demonstrate a weak hydraulic connection for facilities located further from surface water features, which affords greater time and distance for pollutants to attenuate. If the City could not demonstrate a weak hydraulic connection, then DEQ would likely make a NPDES permit determination for the Springwater Formation.

- Discharge systems located on **Terrace Deposits** above the river may be considered to be hydraulically isolated from the river due to the Sandy River Mudstone, which separates the terrace deposits from the river alluvium. In addition, because the Terrace Deposits are characterized by poor drainage (Schlicker and Finlayson, 1979), DEQ may not consider facilities in this unit to indirectly discharge to surface water along a groundwater pathway. Therefore, alternative discharge systems located on

Terrace Deposits may therefore require a WPCF permit, if the facility is designed to infiltrate water. Additional field investigation and data analysis will be required to demonstrate the lack of a hydraulic connection. The Roslyn Lake site is located on the Terrace Deposits (see Figure 2).

We recommend that the City continue to actively engage with DEQ as prospective sites and methods for an alternative wastewater discharge system are selected. In particular, any planned site characterization work should proceed with concurrence from DEQ. We recommend that the City collect the following data from candidate sites for an alternative wastewater discharge system, to inform the types of systems that may be feasible (i.e., whether or not a system would infiltrate water) at a candidate site, and to provide DEQ with data on which to make a permitting decision:

- Soil and water quality data from a candidate site, including permeability, groundwater quality, and factors affecting pollutant fate and transport (e.g., distribution coefficients, soil pH, etc.).
- Geologic and hydrogeologic information near the candidate infiltration site, including cross sections, groundwater table elevation maps, and maps showing surficial geology.
- An inventory of water wells near the candidate site.
- Modeling of contaminant attenuation to determine if pollutants from the discharge facility are likely to reach surface water.

5 References

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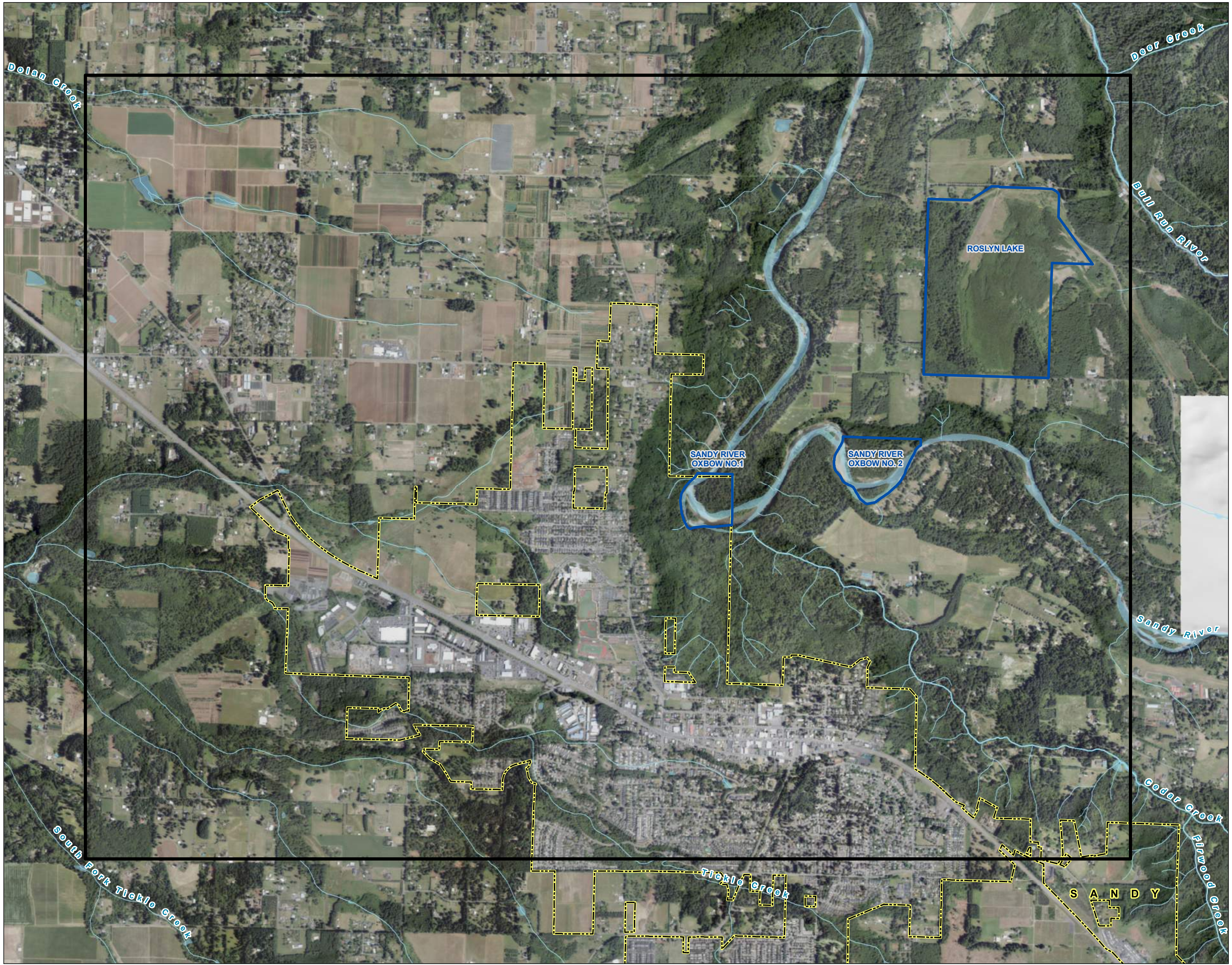
FIGURE 1

Study Area

City of Sandy
Wastewater Discharge
Alternatives Analysis



LEGEND

- ▢ Area of Interest
- □ Study Area
- ⬚ City Boundary
- ∼ Watercourse
- ≈ Waterbody

N

0 1,100 2,200 3,300
Feet

Date: July 30, 2020
Data Sources: USGS, COP Imagery Summer 2019, METRO

GSI Water Solutions, Inc.

Document Path: Y:\0116_MSA\Source_Figures\039_Sandy_WWTP_Infiltration_Eval\Figure1_Study_Area.mxd

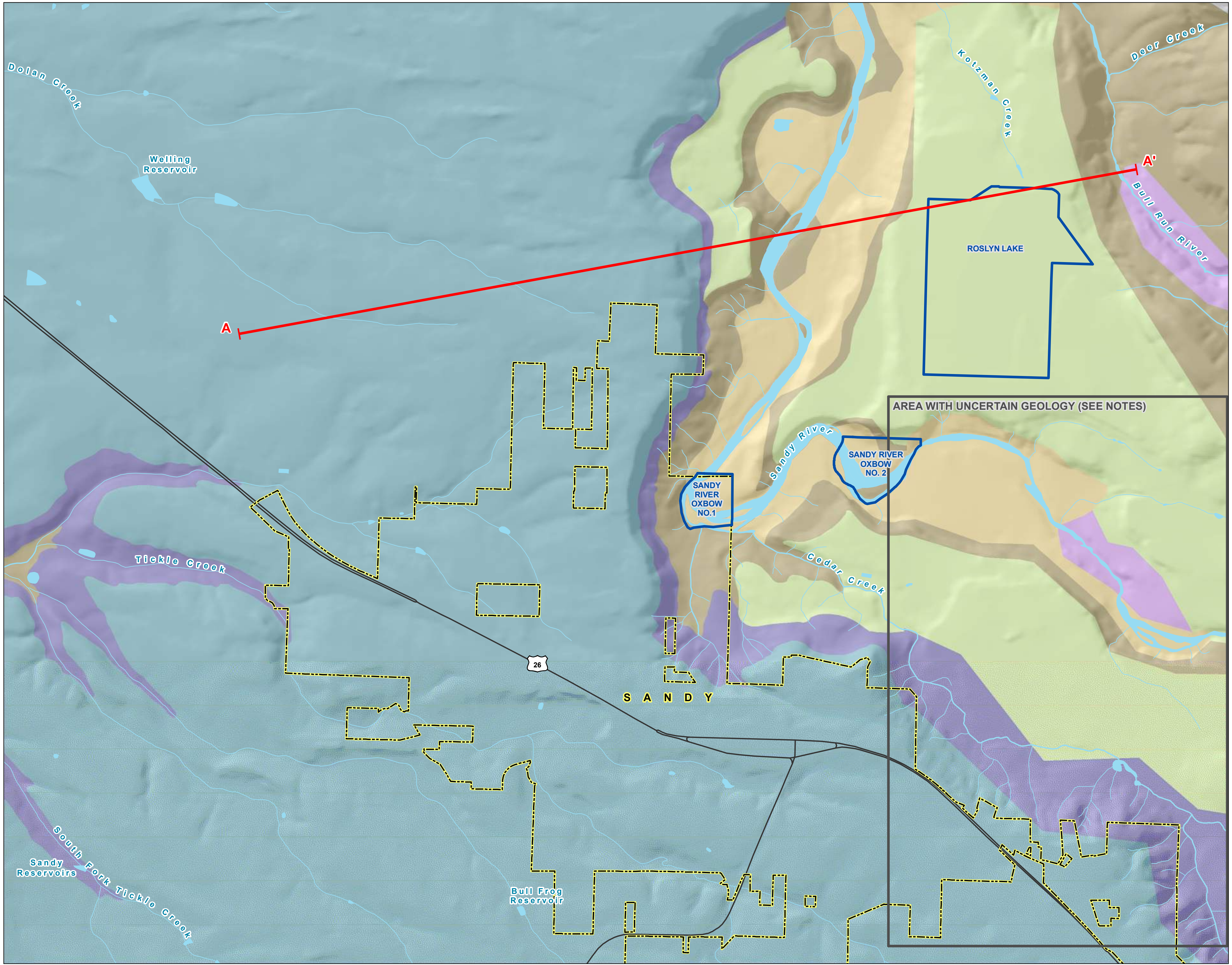


FIGURE 2

Geologic Map

City of Sandy
Wastewater Infiltration Analysis

LEGEND

Cross Section Line

Geology

- 🟨 Qal = Quarternary Alluvium
- 🟩 Qtg = Terrace Deposits
- 🟦 Qts = Springwater Formation
- 🟪 Tts = Troutdale Formation Sandstone
- 🟫 Ttm = Troutdale Formation Mudstone (Sandy River Mudstone)
- 🟪 Ta2 = Rhododendron Formation

All Other Features

- Area of Interest
- Study Area
- City Boundary
- Major Road
- Watercourse
- Waterbody

NOTE

Geologic maps lump units in this area into a single, undifferentiated sedimentary unit; geology is based on GSI extrapolating units from other maps into this area.

N

0 1,100 2,200 3,300
Feet

Date: August 7, 2020
Data Sources: USGS, Oregon Explorer OSIP, 2018.
Schlicker, 1963.

GSI Water Solutions, Inc.

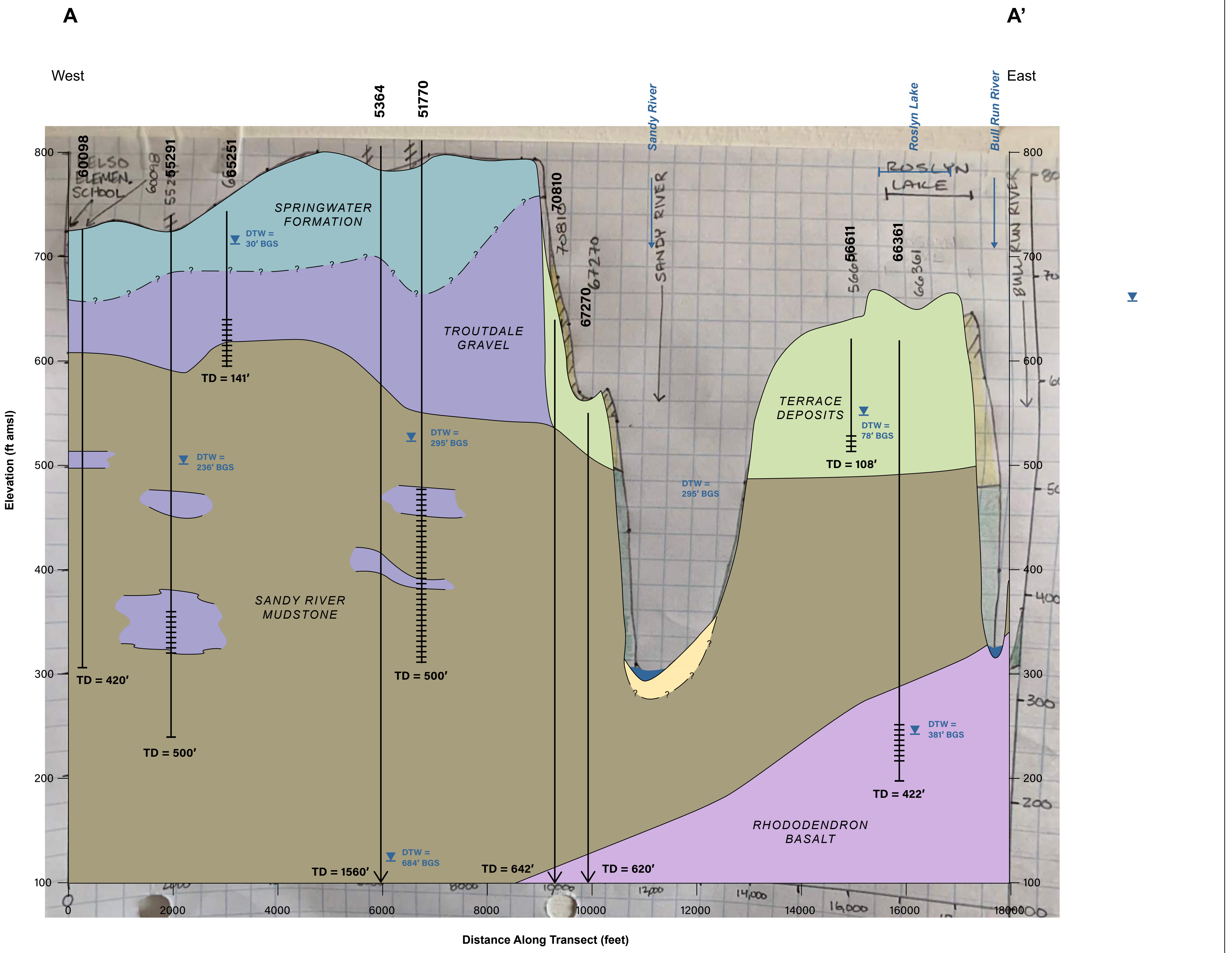


FIGURE 3

Cross Section A - A'

City of Sandy Wastewater
Infiltration Analysis

LEGEND

▼ Static Water Level

GEOLOGY LEGEND

- Quaternary Alluvium (Qal)
- Terrace Deposits (Qtg)
- Springwater Formation (Qts)
- Troutdale Formation Sandstone (Tts)
- Troutdale Formation Mudstone (Sandy River Mudstone) (Ttm)
- Rhododendron Formation (Ta2)

WELL LEGEND

Screen

TD = XXX'

NOTES

AMSL: Above Mean Sea Level
BGS: Below Ground Surface
DTW: Depth to Water
TD: Total Depth

GSI Water Solutions, Inc.

TECHNICAL MEMORANDUM

Evaluation of Sites for Alternative Wastewater Discharge Systems, City of Sandy, Oregon

To:	Ken Vigil, PE / Murraysmith Associates, Inc. Matt Hickey, PE / Murraysmith Associates, Inc. Jessica Cawley, PE / Murraysmith Associates, Inc.
From:	Matt Kohlbecker, RG / GSI Water Solutions, Inc. Dennis Orlowski, RG / GSI Water Solutions, Inc. Jason Melady, RG / GSI Water Solutions, Inc.
Date:	September 18, 2020

Exp: 5/1/2021

This technical memorandum (TM), prepared by GSI Water Solutions, Inc. (GSI), summarizes a desktop and limited field evaluation of sites for an alternative wastewater discharge system owned and operated by the City of Sandy (City). The TM is organized as follows:

- Section 1: Summarizes background information about the City's wastewater project.
- Section 2: Summarizes geology, hydrogeology, and shallow soil infiltration characteristics in the Study Area.
- Section 3: Summarizes results of a desktop and limited field evaluation at three candidate sites for an alternative wastewater discharge system, including soil infiltration characteristics with implications on facility type, likely Department of Environmental Quality (DEQ) water quality program permitting requirements, and recommended next steps for facility permitting and evaluation (data collection, modeling, etc.).
- Section 4: Conclusions.

1 Project Background

The City of Sandy is evaluating discharge alternatives for treated wastewater in lieu of or in combination with a direct year-round discharge to the Sandy River. In this TM, treated wastewater discharge systems that *do not* directly discharge to surface water are called "alternative wastewater discharge systems." For example, one type of alternative wastewater discharge system discussed in this TM is an indirect discharge system. Indirect discharge systems are typically located adjacent to rivers, and enhance effluent quality through various natural physical, chemical, and biological processes in soil and groundwater by infiltrating wastewater and diffusely discharging the wastewater to surface water via groundwater. The types of alternative wastewater discharge systems under consideration by the project team are infiltration basins with shallow groundwater discharge, constructed wetlands, evaporation ponds, and hyporheic discharge along the Sandy River or other stream corridors.

The overall Study Area for the City's discharge alternatives evaluation is shown in Figure 1. Figure 1 also shows three sites for alternative wastewater discharge systems currently under consideration by the City. The Roslyn Lake site is a candidate for infiltration basins and constructed treatment wetlands, and the Sandy River Oxbow sites are candidates for hyporheic discharge.

2 Geology, Hydrogeology, and Soil Conditions in the Study Area

This section provides an overview of the geologic and hydrogeologic setting, which is important because it affects permitting, feasibility of a certain type of system, and fate and transport of pollutants (Section 2.1), and surficial soil conditions, which are important because they affect feasibility of a certain type of system (Section 2.2).

2.1 Geologic and Hydrogeologic Setting in the Study Area

The Study Area is located on the eastern margin of the Portland Basin, which is a topographic and structural depression located in northwestern Oregon and southwestern Washington covering approximately 1,300 square miles. The sides of and bottom of the basin are formed by basalt bedrock, and, in the Study Area, the basin has been filled with between approximately 200 feet (eastern portion) to 1,000 feet (western portion) of unconsolidated sediments (Swanson et al., 1993).

The unconsolidated sediments in the Study Area have been grouped into geologic units, which are packages of soil or rock that share common features (e.g., age, lithology, origin, etc.). Geologic units in the Study Area are shown in Figure 2 (surficial geology) and Figure 3 (geologic cross section). The Quaternary Alluvium (Qal), Terrace Deposits (Qtg), and Springwater Formation (Qts) are present in the Study Area at ground surface and are characterized by relatively flat slopes (<10%). As such, these units comprise the surficial geology at candidate infiltration sites, and are described in the following bullets, which are organized from the youngest to the oldest geologic unit (Schlicker and Finlayson, 1979; Beaulieu, 1974):

- **Quaternary Alluvium (Qal).** The Quaternary Alluvium is comprised of recently-deposited sand, gravel and cobbles within the channel of the Sandy River.

- **Terrace Deposits (QTg).** Terrace deposits occur as benches above the Sandy River, and were deposited by the ancestral Sandy River during the Pleistocene Epoch[1], a time of relatively higher sea levels when the river was a lower-energy environment. The deposits are comprised of fluvial and glaciofluvial cobble- to boulder-sized gravels with relatively poor drainage due to extensive weathering.

- **Springwater Formation (QTs).** Located west of the Sandy River, the Springwater Formation is comprised of mudflows and gravels that are deeply-weathered to a clayey soil characterized by poor drainage.

As shown on the cross section in Figure 3, the Quaternary Alluvium is directly connected to the Sandy River, while the Terrace Deposits are hydraulically isolated from the Sandy River due to the underlying Sandy River Mudstone, which is a thick (over 200 feet) sequence of siltstone and claystone. As shown on Figure 2, the Springwater Formation is likely connected to the surface water features west of the Sandy River in much of the Study Area (i.e., Tickle Creek, Dolan Creek, etc.).

2.2 Surficial Soil Conditions in the Study Area

Figure 4 shows the ground slope, soil favorability to infiltration, and thickness of surficial silts and clays in the Study Area. Figure 4 is based on surficial soil data from the U.S. Department of Agriculture Natural Resources Conservation Service (USDA, 2020) and driller logs from the Oregon Water Resources Department on-line well

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[1] The Pleistocene Epoch is a geologic time period that lasted from about 2.6 million years ago to 12,000 years ago.

log query (OWRD, 2020)[2]. Note that surficial soil data from the USDA is a planning-level tool because the data is from a large-scale, generalized mapping effort, and soil types provided by USDA can thus vary from soil types at the site-scale. The following sections provide additional detail about ground slope (Section 2.2.1), surficial soil favorability to infiltration (Section 2.2.2), and thickness of surficial silts and clays (Section 2.2.3) in the Study Area. The soil properties were used to select candidate sites for a focused evaluation, in conjunction with an analysis conducted by Murraysmith that considered property ownership, existing pipeline alignments, and regulatory requirements (e.g., from the U.S. Army Corps of Engineers, etc.).

2.2.1 Ground Slope

Areas with steep ground slope are not ideal for an alternative wastewater disposal system, either because the slopes are too steep to accommodate a system or because significant earthwork would be required to grade the site. Hatched areas in Figure 4 indicate that ground slope exceeds 10%. Areas with ground slope exceeding 10% typically occur along hillsides that have been incised by rivers, and are typically characterized by slopes of over 40%.

2.2.2 Surficial Soil Favorability to Infiltration

The favorability of shallow soil to infiltration may affect whether a certain type of alternative wastewater discharge system is feasible at a site. Shallow soil favorability to infiltration is shown in Figure 4, and is based on saturated hydraulic conductivity (K_{sat}), a physical property that measures the ability of a soil to transmit water (specifically, the rate that a soil transmits water per unit area per unit hydraulic gradient).

In the Study Area, shallow soil favorability to infiltration ranges from “poor” (a K_{sat} of less than 0.5 inches per hour) to “good” (a K_{sat} of over 2 inches per hour). Areas with “good” infiltration correspond with the Quaternary Alluvium geologic unit that occurs adjacent to the Sandy River (see Figure 2). Most other shallow soil in the Study Area is characterized as “poor” to “moderate” favorability to infiltration, corresponding to the Terrace Deposits and Springwater Formation. The low saturated hydraulic conductivities of the Terrace Deposits and Springwater Formation are consistent with Schlicker and Finlayson (1979), who note that the Terrace Deposits are not suitable for septic drainfields, and that the Springwater Formation is characterized by poor drainage.

2.2.3 Thickness of Surface Silt/Clay

The poor and moderate infiltration favorability of shallow soil are caused by extensive weathering of the shallow Terrace Deposits and Springwater Formation to silt and clay (Schlicker and Finlayson, 1979; Beaulieu, 1974). The thickness of this surficial silt/clay is an important consideration in alternative wastewater discharge facility siting because thin surficial silts and clays may be removed with a moderate amount of earthwork. Conversely, thicker accumulations of silt and clay may preclude some types of systems, or make them less cost-effective to construct and/or operate (e.g., infiltration systems).

In order to evaluate the thickness of the shallow silt/clay, GSI downloaded water well driller logs from the OWRD well log database (OWRD, 2020), and, at each well location, classified the silt/clay thickness as “<15 feet” (green wells in Figure 4), “15 to 30 feet” (orange wells in Figure 4), or “>30 feet” (red wells in Figure 4). West of the Sandy River, where the Springwater Formation is present at ground surface, the shallow silt/clay soils are generally over 30 feet thick. East and just south of the Sandy River, where the Terrace Deposits are present at ground surface, the shallow silt/clay soils are typically less than 15 feet thick, although they are reported to be 15 to 30 feet thick in some areas.

3 Evaluation of Candidate Sites for an Alternative Wastewater Discharge System

The City of Sandy selected three (3) candidate sites for an alternative wastewater discharge system based on existing pipeline alignments, regulatory requirements (e.g., from DEQ, U.S. Army Corps, etc.), property

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[2] Only well logs that could be exactly located (i.e., to a property address or latitude/longitude) were used in this study.

ownership, and the soil conditions discussed in Section 2.2. The following sections summarize a desktop and limited field evaluation of these three sites, and include information about the soil infiltration characteristics, DEQ water quality program permitting requirements, potential fatal flaws, and recommended next steps for facility permitting with the DEQ water quality program. Refer to GSI (2020) for a detailed analysis of permitting an alternative wastewater discharge system with the DEQ water quality program.

3.1 Roslyn Lake

In 1912, an artificial lake was constructed at the Roslyn Lake site to provide water storage for the Bull Run power plant (Ebasco Infrastructure, 1992). In 2008, the lake was drained and regraded, resulting in a 285 acre basin defined by natural topography to the south and raised roadways and embankments to the east, west and north (MSA, 2009). The approximate footprint of the former lake, and the Roslyn Lake property boundary are shown in Figure 5.

3.1.1 Roslyn Lake Soils

As shown in Figure 5, three soil types are present at the site, all of which are characterized by the following drainage rates:

- The Alspaugh Clay Loam (2B and 2C) underlies the former Roslyn Lake footprint, and is characterized by saturated hydraulic conductivities ranging from 0.20 inches per hour (0.40 feet per day) to 0.57 inches per hour (1.14 feet per day),
- The Bull Run Silt Loam (9B) is present in the southwest corner of the property outside of the former Roslyn Lake footprint, and is characterized by saturated hydraulic conductivities ranging from 0.57 inches per hour (1.14 feet per day) to about 2 inches per hour (4 feet per day).

Note that saturated hydraulic conductivity, a measure of soil permeability, is not equivalent to infiltration rate. Hydraulic conductivity is the rate that water moves through soil per unit area per unit hydraulic gradient, infiltration rate is the rate that water moves through soil under a given set of head and facility design conditions.

On June 23, 2020, GSI staff collected soil samples at the Roslyn Lake site using a hand auger at the boring locations shown in Figure 5, and logged the soils in general accordance with the Unified Soil Classification System visual-manual method (ASTM, 2017). The observed soil types were generally consistent with the soils reported by the USDA. At boring B-1, shallow soils were a fine sand to 1.5 feet below ground surface (bgs) underlain by a light brown silt to the maximum depth explored (about 4 feet bgs). The fine sand was likely deposited by the inlet creek to Roslyn Lake, and is present in the northeast area of the former lake area (see tan area in the aerial photo in Figure 5). Soils in boring B-2 and boring B-3 were silt to the maximum depth explored at those locations (about 2 feet bgs).

3.1.2 Roslyn Lake Infiltration Potential

We used the Hantush (1967) equation to estimate the volume of treated wastewater that may be infiltrated at the Roslyn Lake. It is important to note that the Hantush (1967) infiltration estimate is a planning-level estimate that may change based on site-specific conditions (e.g., soil hydraulic conductivity, depth to groundwater, infiltration facility size, duration of infiltration, etc.). The Hantush (1967) infiltration estimate is based on the following assumptions:

- Infiltration occurs in a rectangular-shaped basin in the southwest corner of the former lake that is 475 feet by 675 feet and about 320,500 square feet in area (about 7.6 acres), shown in Figure 5.
- The unsaturated zone thickness is 96 feet, which is based on a depth to median groundwater of 120 feet from Snyder (2008) and a 20 percent factor of safety.

- Each year, the infiltration facility is operational (i.e., continuously infiltrating) for 180 days, followed by an inactive period of 180 days.

- The specific yield [i.e., the ratio of: (1) the volume of water that a saturated soil yields by gravity drainage to (2) the total volume of the soil] of the terrace deposits is 0.19[3], and the hydraulic conductivity of the terrace deposits is 4.03 feet per day[4].

According to the Hantush (1967) calculations, the Roslyn Lake site would infiltrate about 65,500 cubic feet per day (a little less than 0.5 million gallons per day). This relatively low infiltration rate is consistent with the fact that permeability of soils at the property were sufficiently low to create an artificial lake. This estimated infiltration rate could likely be refined by direct measurement of hydraulic conductivity at the site.

3.1.3 DEQ Water Quality Permitting Requirements

An alternative wastewater disposal system at the Roslyn Lake site would be hydraulically separated from surface water bodies (i.e., the Sandy River) by the low permeability Sandy River Mudstone (see the cross section in Figure 3). Therefore, DEQ's water quality program may require a WPCF permit for the Roslyn Lake site (as opposed to a NPDES permit) if the facility is designed to infiltrate treated wastewater. However, we recommend discussing the Roslyn Lake site with DEQ to understand the site-specific data that DEQ will require to support a DEQ permitting decision because, as discussed in GSI (2020), recent court decisions have created some uncertainty about whether a WPCF or a NPDES permit is required for a facility that infiltrates treated wastewater, and DEQ will require site- and project-specific information to inform the required permit type.

3.1.4 Next Steps

We recommend the following next steps at the Roslyn Lake site to help inform DEQ permitting decisions and the type of alternative wastewater disposal system that is feasible. Throughout each step, we recommend communication with DEQ to solicit regulator input.

- **Infiltration Testing.** Conduct infiltration tests to verify the suitability of the site for various alternative wastewater disposal systems (infiltration basins with shallow groundwater discharge, constructed treatment wetlands and evaporation ponds, etc.) and quantify the amount of water that is likely to infiltrate at the site. The infiltration test data may inform DEQ water quality program permitting requirements.

- **Antidegradation Evaluation.** If the alternative discharge system is designed to infiltrate water, then protection of groundwater quality is likely to be a focus of DEQ's permitting actions because several domestic water supply wells have been completed in the Terrace Deposits around Roslyn Lake (see Figure 5). DEQ will require that the facility meet the groundwater antidegradation requirements in Oregon Administrative Rules (OAR) 340-040. We recommend that the City evaluate whether the treated wastewater meets background groundwater quality, which will involve collecting groundwater samples from the Roslyn Lake site, and comparing groundwater quality to treated water quality. Groundwater samples could be collected from existing water wells (if access can be arranged) or from newly-installed monitoring wells installed at the site.

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[3] A typical specific yield for a gravel, from Heath (1983).

[4] Calculated from specific capacity data reported on driller logs at two wells completed in the Terrace Deposits near Roslyn Lake. The specific capacity of CLAC 6679 is 4.0 gallons per minute per foot (bailer test, 20 gpm, 5 feet of drawdown) and the specific capacity of CLAC 18013 is 0.33 gallons per minute per foot (air test, 10 gpm, 30 feet of drawdown). Specific capacity was used to calculate transmissivity using the exact equation for unconfined aquifers (Driscoll, 1986). All variables were from the CLAC 6679 or CLAC 18013 well log, with the exception of storage [taken from Heath (1983)] and the bottom of the Sandy River Mudstone (taken from CLAC 66361). The calculated hydraulic conductivity of CLAC 6679 was 7.81 feet per day, and the calculated hydraulic conductivity of CLAC 18013 was 0.26 feet per day; the median hydraulic conductivity was 4.03 feet per day.

> If constituent concentrations in treated wastewater exceed background concentrations, then DEQ may require the City to develop and implement a plan to evaluate whether the project meets DEQ's groundwater antidegradation requirements. The City can meet DEQ's groundwater antidegradation requirements by showing that constituents in treated wastewater exceeding groundwater background do not reach a compliance point that DEQ chooses (i.e., typically DEQ chooses a water well or the property boundary). The evaluation may be comprised of installing and sampling monitoring wells and/or contaminant fate and transport modeling. Because the depth to groundwater at the Roslyn Lake site is about 120 feet below ground surface (Snyder, 2008), it is likely that unsaturated soils will provide sufficient natural treatment to reduce concentrations of elevated constituents to below background. However, we recommend site-specific data collection and potentially modeling to confirm that unsaturated soils provide sufficient natural treatment.

3.2 Sandy River Oxbow No. 1 and Sandy River Oxbow No. 2

Alternative wastewater disposal systems at the Sandy River Oxbow sites would be intended to diffusely discharge treated wastewater to the Sandy River via groundwater; therefore, the Sandy River Oxbow sites comprise a hyporheic discharge. More specifically, DEQ has defined this type of alternative system as an *indirect discharge system*, by which municipal wastewater plant effluent is indirectly discharged to surface water via groundwater or hyporheic water. This classification has specific permitting implications discussed later in this section.

The Sandy River Oxbow sites (denoted by their property boundaries) are shown in Figure 5. On June 23, 2020, GSI staff visited the Sandy River Oxbow No. 1 site; no site visits have been made to the Sandy River Oxbow No. 2 site. The following analysis assumes that the soil types at the Sandy River Oxbow No. 1 and Sandy River Oxbow No. 2 sites are similar.

3.2.1 Sandy River Oxbow Soils

As shown in Figure 5, the course of the Sandy River as denoted by the soil survey (tan polygon with translucent blue fill) does not precisely match the course of the Sandy River in the aerial photo. The lack of a match occurs because rivers are dynamic systems that change over time, and the soil mapping was conducted at a relatively large scale (i.e., 1:20,000). However, it is reasonable to assume that the gravels that underlie the Sandy River Oxbow No. 1 and Sandy River Oxbow No. 2 are "73-Riverwash," which is a well-drained, stratified sand and gravel (USDA does not provide infiltration rate estimates for Riverwash). On June 23, 2020, GSI staff visited the Sandy River Oxbow No. 1 site and confirmed that the soils were comprised of clast-supported sandy gravel with clasts ranging from fine gravel to boulders.

The Sandy River Oxbow sites are situated on the Quaternary Alluvium geologic unit. GSI reviewed water well driller logs to estimate the thickness of the Quaternary Alluvium geologic unit, and found that it ranges from about 10 feet to 40 feet thick[5].

3.2.2 Sandy River Oxbow No. 1 and No. 2 Infiltration Potential

Although the USDA does not provide permeability data for the Riverwash in the Study Area, literature values of gravel hydraulic conductivity range from 40 in/hr to 4,000 in/hr (Domenico and Scwhartz, 1990) for clean gravels like the gravels observed during the June 23, 2020, site visit to the Sandy River Oxbow No. 1 site. Therefore, the Sandy River Oxbow sites are likely to have a high infiltration potential. Note that hydraulic conductivity, a measure of soil permeability, is not equivalent to infiltration rate; hydraulic conductivity is the rate that water moves through soil per unit area per unit hydraulic gradient.

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[5] See CLAC 73054 (9 feet thick) and CLAC 6688 (43 feet thick).

3.2.3 DEQ Water Quality Permitting Requirements for Sandy River Oxbow No. 1 and No. 2

Because an alternative waste disposal system at the Sandy River Oxbow No. 1 and No. 2 sites would dispose of municipal wastewater plant effluent by indirect discharge to surface water via groundwater or hyporheic water, the system would require an NPDES permit from DEQ's water quality program (see DEQ [2007] and GSI [2020]).

3.2.4 Next Steps

We recommend the following next steps at the Sandy River Oxbow sites to help inform DEQ permitting decisions and the type of alternative wastewater disposal system that is most feasible. Throughout each step, we recommend communication with DEQ to solicit regulator input.

- **Permitting Considerations.** An alternative waste disposal system on the Sandy River Oxbow site would be permitted under an NPDES permit. As such, we recommend that siting and design of a system consider NPDES permit conditions and discharge limitations on the Sandy River.

- **Sandy River Oxbow No. 2 Site Walk.** We recommend a site walk at the Sandy River Oxbow No. 2 site to verify that the soil conditions are similar to conditions at the Sandy River Oxbow No. 1 site.

- **Preliminary Evaluation of Sandy River Hydrologic Conditions.** The effectiveness and physical viability of a hyporheic (indirect) discharge system depends largely on the range of hydrologic conditions in the receiving stream, in this case the Sandy River. For example, seasonal stage fluctuations in the river will alter the hydraulic gradient between an indirect discharge system (e.g., infiltration galleries) and the river, such that discharge efficacy could be reduced, or even stopped, during high river stages. Also, potential flood conditions could significantly reduce the feasibility of a particular site. A preliminary evaluation of Sandy River hydrologic conditions, including a review of historic stage ranges and flood levels, is thus recommended as a next step for evaluating the Sandy River Oxbow sites.

4 Conclusions

The City of Sandy is considering alternative wastewater disposal systems at Roslyn Lake and at the Sandy River Oxbow sites (No. 1 and No. 2). Each site has unique soil conditions and permitting considerations that will affect the type of system that may be designed and constructed. The following sections summarize the results of the desktop and limited field evaluation. We recommend collecting site-specific data (e.g., infiltration tests) and engaging regulatory agencies on permitting framework to confirm these findings.

4.1 Roslyn Lake Site

- Surficial soils have a "poor" favorability to infiltration, and, based on several assumptions about soil and groundwater conditions, may infiltrate 0.5 MGD (planning-level estimate assuming a 7.6 acre infiltration basin). As such, alternative wastewater discharge systems that are not designed to infiltrate (e.g., constructed wetlands) are the most suitable types of systems at the site.

- If the facility is designed to infiltrate, then DEQ's water quality program may permit the facility under a WPCF permit. If the facility is not designed to infiltrate water (i.e., a constructed wetland created on low permeability or amended soils) and is a component of a surface water discharge system, then DEQ may permit the system under an NPDES permit.

- A key consideration for moving forward with development of the Roslyn Lake site is whether the system will be able to meet DEQ's groundwater antidegradation requirements, if a system is designed to infiltrate water. A comparison of treated water quality to native groundwater quality is the first step in this analysis; additional steps may involve pollutant fate and transport modeling and installation of monitoring wells.

It is important to implement the recommended next steps in Section 3.1.4 (for the Roslyn Lake site) and to successfully permit the site and design the alternative wastewater discharge system.

4.2 Sandy River Oxbow Sites

- Surficial soils have "good" favorability to infiltration, and are a strong candidate for a hyporheic discharge system.
- DEQ's water quality program will most likely permit the facility under an NPDES permit.
- Key considerations for moving forward with development of the Sandy River Oxbow sites will be to evaluate hydrologic conditions at the sites, and to understand how NPDES permitting regulations would affect the feasibility and operation of the system.

It is important to implement the recommended next steps in Section 3.2.4 (for the Sandy River Oxbow site) to successfully permit the site and design the alternative wastewater discharge system.

5 References

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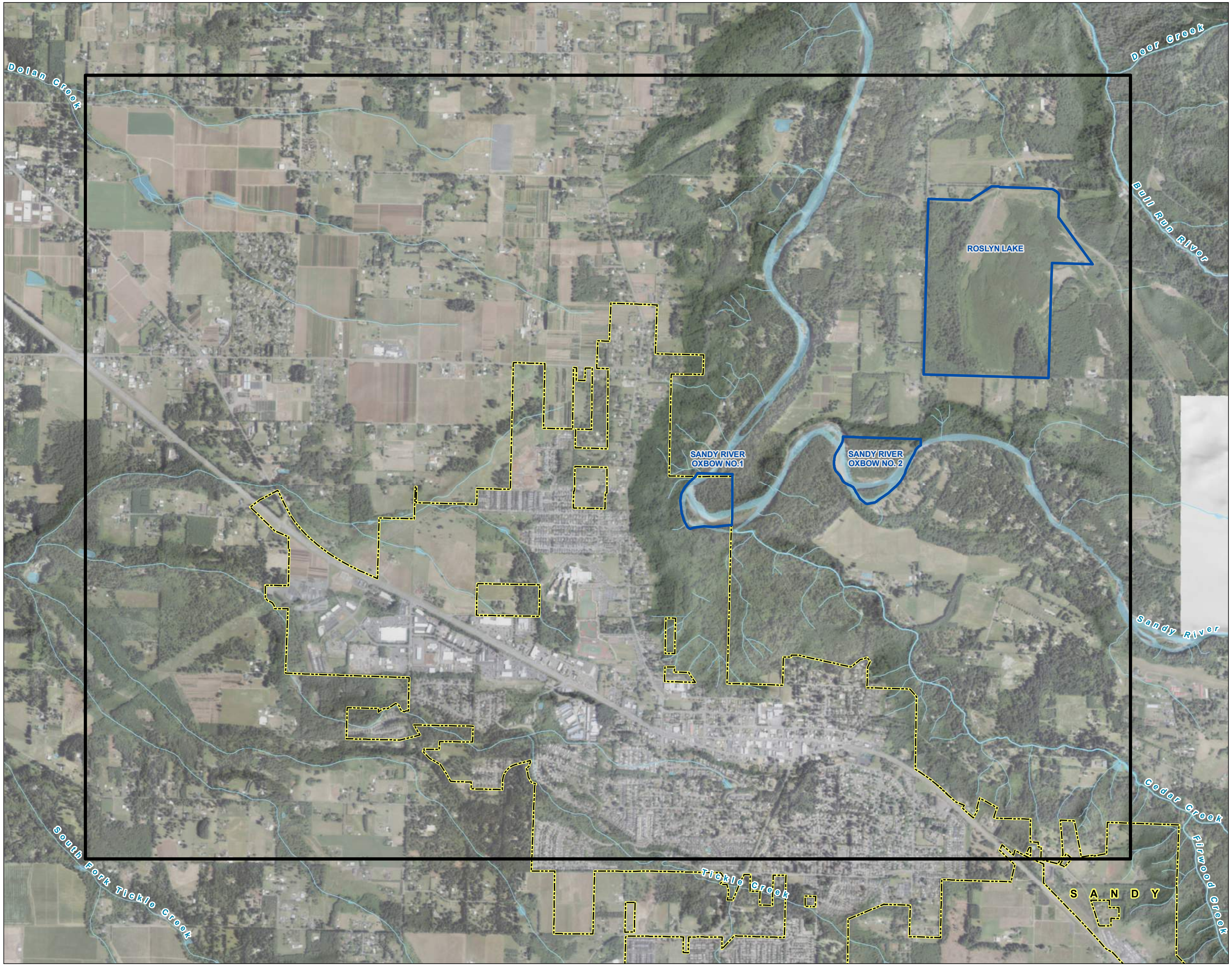

FIGURE 1

Study Area

Evaluation of Alternative Wastewater Discharge System Sites

LEGEND

- ▢ Area of Interest
- ▢ Study Area
- ▢ City Boundary
- ~ Watercourse
- ▨ Waterbody

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0 1,000 2,000 3,000
Feet

Date: September 1, 2020
Data Sources: USGS, COP Imagery Summer 2019, METRO

GSI Water Solutions, Inc.

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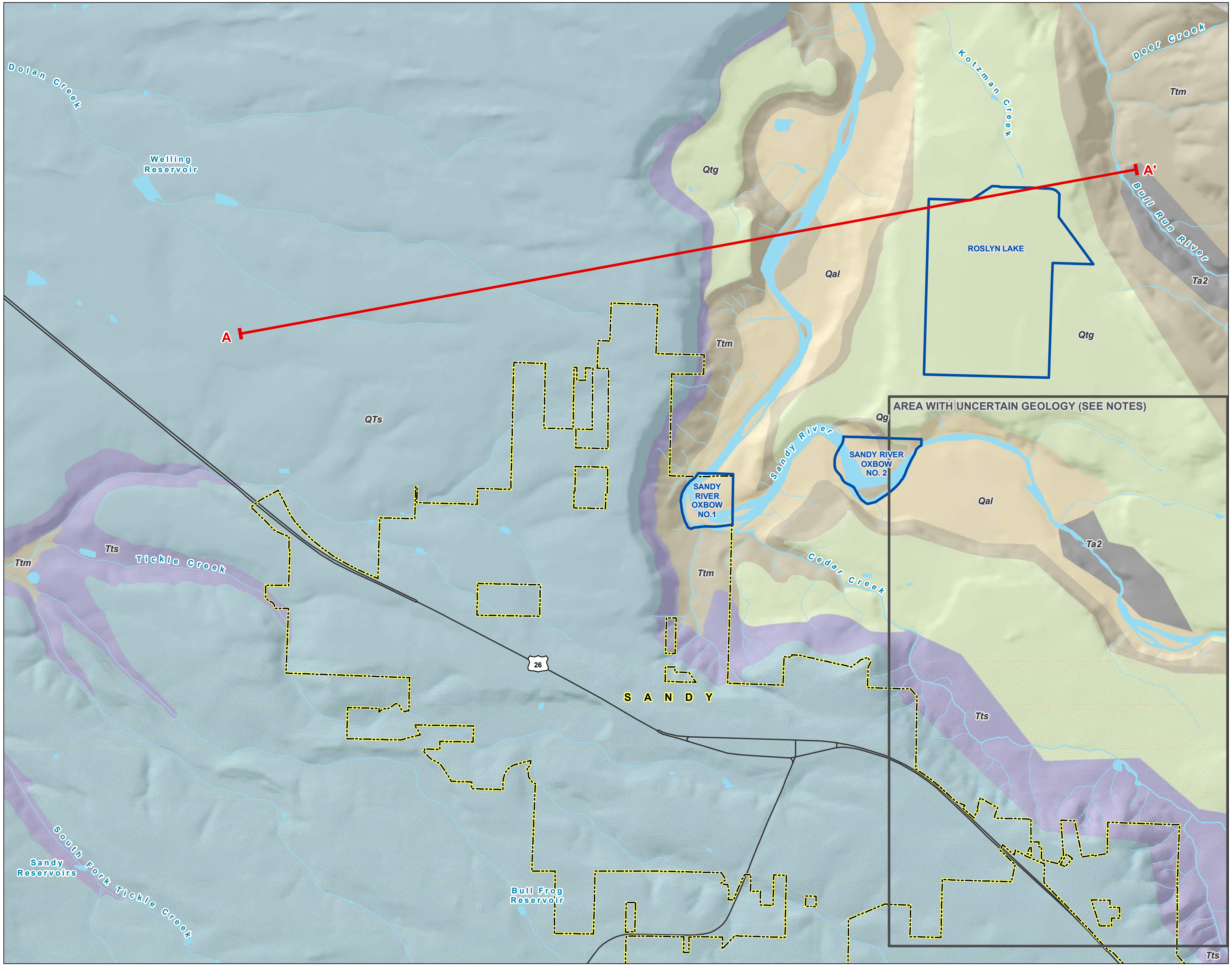

FIGURE 2

Geologic Map

Evaluation of Alternative
Wastewater Discharge System Sites

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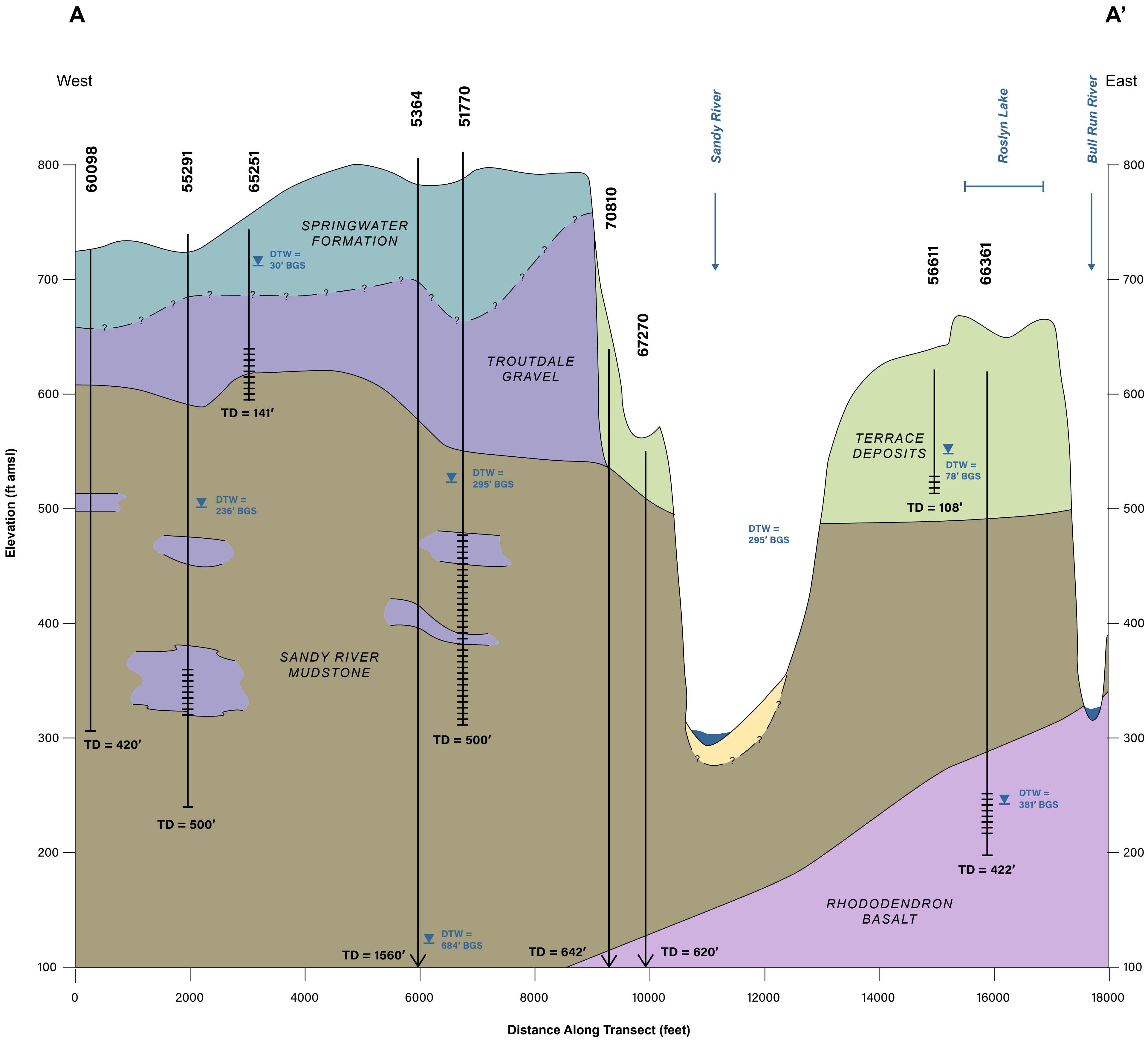

FIGURE 3

Cross Section A - A’

Evaluation of Alternative
Wastewater Discharge System Sites

LEGEND

▼ Static Water Level

GEOLOGY LEGEND

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TD: Total Depth

GSI Water Solutions, Inc.

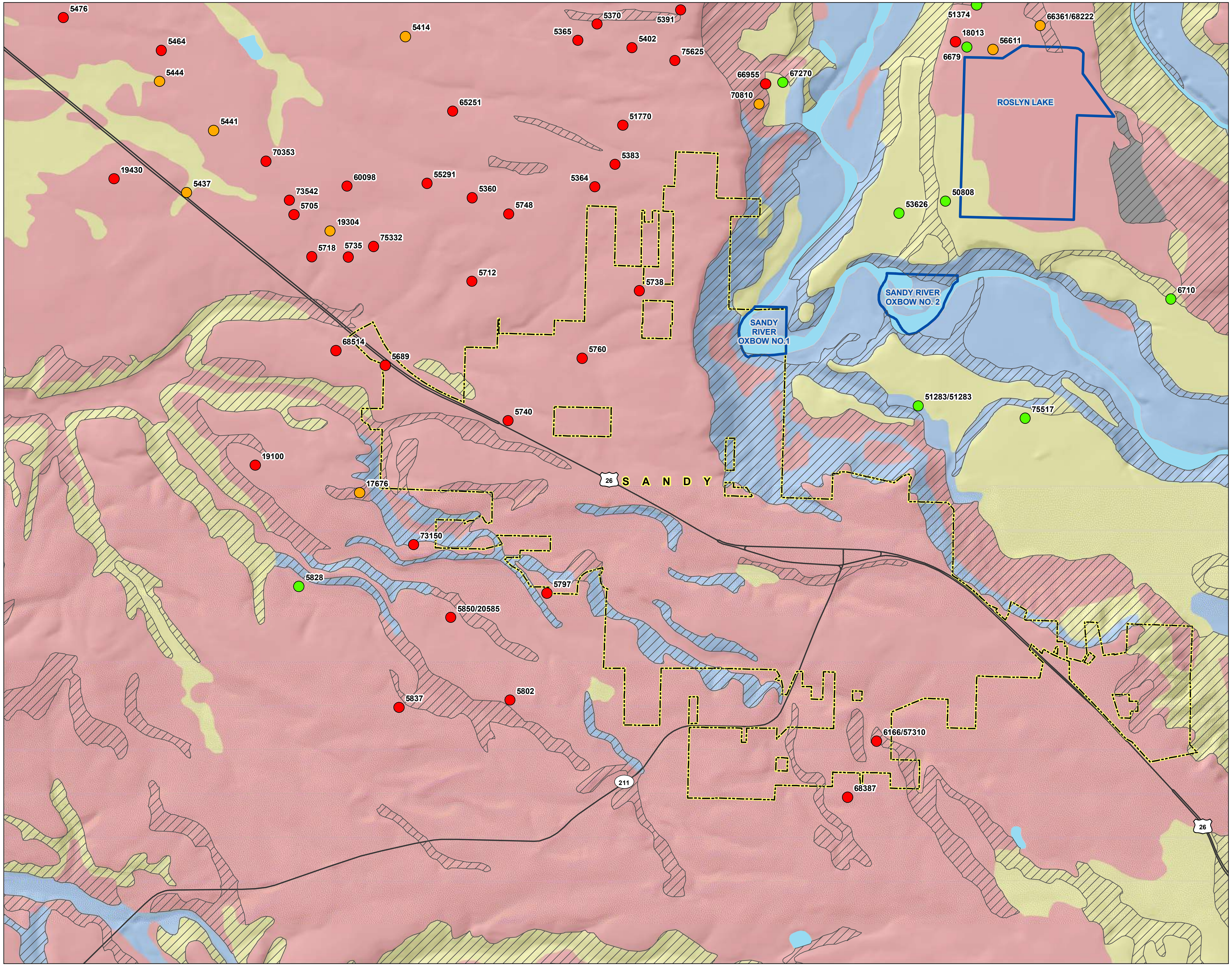


FIGURE 4

Favorability of Surficial Soils to Infiltration and Surficial Silt/Clay Thickness

Evaluation of Alternative Wastewater Discharge System Sites

LEGEND

Shallow Soil Favorability to Infiltration

🟥 Poor (Ksat from 0.0 to 0.5 in/hr)
🟨 Moderate (Ksat from 0.5 to 2 in/hr)
🟦 Good (Ksat >2 in/hr)

Surface Clay/Silt Thickness

🟩 <15 feet
🟧 15 to 30 feet
🟥 >30 feet

All Other Features

⬛ Gravel Pit
▨ Slope is Greater Than 10%
☐ Area of Interest
☐ City Boundary
〽 Major Road
～ Watercourse
🟦 Waterbody

NOTE

Soil data is representative of soils from ground surface to 6.5 feet below ground surface.

N

0 1,100 2,200 3,300
Feet

Date: September 1, 2020
Data Sources: NRCS, USGS

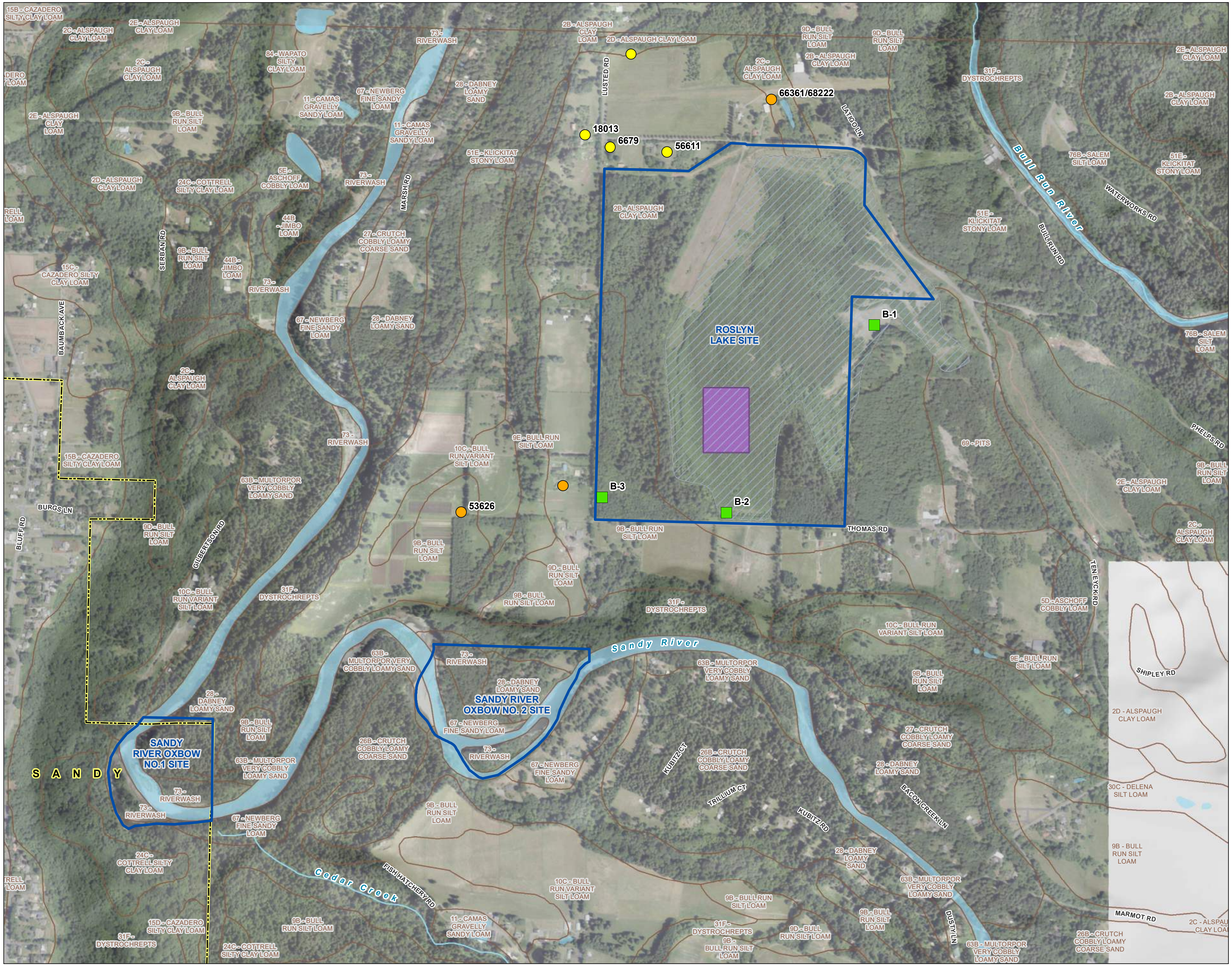
GSI Water Solutions, Inc.

Document Path: Y:\0116_MSA\Source_Figures\039_Sandy_WWTP_Infiltration_Eval\Focused_Evaluation_Memo\Figure4_Favorability_of_Surficial_Soils_to_Infiltration_Thickness.mxd

FIGURE 5

Roslyn Lake Site Detail

Evaluation of Alternative
Wastewater Discharge System Sites



LEGEND

🟩 Boring

Water Well Completed In:

🟡 Terrace Deposits

🟠 Rhododendron Deposits

All Other Features

▭ Soil Type

🟪 Recharge Basin

▭ Property Boundary

▭ City Boundary

▨ Former Lake Footprint

▬ Waterbody

Date: September 1, 2020
Data Sources: USGS

Water Solutions, Inc.

Document Path: Y:\0116_MSA\Source_Figures\039_Sandy_WWTP_Infiltration_Eval\Focused_Evaluation_Memo\Figure5_Roslyn_Lake_Site_Detail.mxd, npalmer

TECHNICAL MEMORANDUM

Infiltration Testing to Estimate Soil Permeability, Roslyn Lake, Sandy, Oregon

To:	Ken Vigil, PE / Murraysmith Associates, Inc. Katie Husk, PE / Murraysmith Associates, Inc. Matt Hickey, PE / Murraysmith Associates, Inc.
From:	Ellen Svadlenak, GIT / GSI Water Solutions, Inc. Matt Kohlbecker, RG / GSI Water Solutions, Inc. Jason Melady, RG / GSI Water Solutions, Inc. Josh Bale, PE / GSI Water Solutions, Inc.
Date:	January 12, 2021

Exp: 5/1/2021

This technical memorandum, prepared by GSI Water Solutions, Inc. (GSI), summarizes infiltration testing conducted to measure the permeability of soils at Roslyn Lake in Sandy, Oregon (Site), and discusses implications of the testing for developing constructed wetlands at the Site.

1. Introduction

Roslyn Lake was an artificial lake created in 1912 to provide water storage for the Bull Run power plant (Ebasco Infrastructure, 1992). In 2008, the lake was drained and regraded, resulting in a 285 acre basin defined by natural topography to the south and raised roadways and embankments to the west, north and east (MSA, 2009). The City of Sandy (City) is evaluating the site as a potential location for reuse of treated wastewater using constructed wetlands. Two of the wetlands ("Proposed Wetland A" and "Proposed Wetland B") are shown in Figure 1, and occupy natural topographic depressions within the former lake footprint.

Because the regional groundwater table at the Site is deep (about 120 feet below ground surface [Snyder, 2008]), constructed wetlands will require relatively low permeability surficial soils. If the permeability of native soils is too high, then soil permeability would need to be reduced (e.g., by adding a soil amendment) to support a constructed wetland. During the summer of 2020, GSI conducted a desktop evaluation and limited field investigation of the potential to dispose of treated wastewater at the Site assuming a variety of reuse methods (GSI, 2020). Based on regional-scale soil maps from the U.S. Department of Agriculture (USDA), the desktop evaluation assumed that the Asplaugh Clay Loam is the native soil type within the former Roslyn Lake footprint[1]. Table 1 shows the permeability profile for the Asplaugh Clay Loam as reported by the USDA. The USDA indicates that native soils at the Site are characterized by a relatively low permeability.

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[1] USDA soil surveys have not been updated to include Roslyn Lake since it was drained in 2008. Therefore, GSI assumed that the Asplaugh Clay Loam, which surrounds the former lake footprint, is also present beneath the former lake footprint.

Table 1. Roslyn Lake USDA Soil Properties

Property	USDA Soil Group	USDA Saturated Hydraulic Conductivity		USDA Average Saturated Hydraulic Conductivity*
		Depth	Saturated K	
Roslyn Lake	2B – Asplaugh Clay Loam	0" – 14" 14" – 43" 43" – 60"	0.6 – 2 in/hr 0.2 – 0.6 in/hr 0.2 – 0.6 in/hr	0.48 in/hr

Note:
* Average saturated hydraulic conductivity was calculated by taking the geometric mean of the soil horizons' midrange permeability
K = Saturated Hydraulic Conductivity

Because the USDA permeability profile is a regional-scale summary of soil properties, GSI recommended infiltration testing at the Site to verify suitability for various alternative wastewater reuse systems (e.g., constructed wetlands and evaporation ponds) and to inform Department of Environmental Quality (DEQ) water quality program permitting requirements. This memo documents the results of the infiltration testing, which was conducted on December 11, 2020.

2. Methods

GSI conducted two infiltration tests at the Site. Locations for the two infiltration tests were chosen to be as close to the footprints of the proposed wetlands as practical (i.e., based on accessibility by heavy equipment and to minimize disturbance to the Site). Test locations are shown in Figure 1. Both tests were located within the footprint of Proposed Wetland B.

The infiltration test data were used to estimate soil permeability at each test location in general accordance with the United States Department of the Interior (USDI) Test Pit Method (USDI, 1993). Specifically, the USDI test pit method measures saturated hydraulic conductivity, which is defined as infiltration rate per unit hydraulic gradient. The City of Sandy excavated test pits and a GSI geologist logged the soils in accordance with the Unified Soil Classification System (USCS) visual-manual method (ASTM, 2017). Test pits were excavated into native soils beneath the ancestral lakebed deposits, to a depth of up to four feet below ground surface. At each testing location, potable water was introduced into the test pit for up to 3 hours and measurements of water column height and flow rate were recorded every five minutes. The purpose of monitoring water column height and flow rate is to ensure that the measured saturated hydraulic conductivity is representative of flow under the saturated conditions that occur in soil beneath an infiltration facility. Specifically, due to matric (negative pressure) forces, water added to dry soils moves faster than water added to saturated soils; a stable flow rate and water column height indicates that matric forces have become negligible as soils have become saturated, and that gravity is the primary force causing infiltration (USDA, 1982; Iowa DNR, 2020). After infiltration rate and water column height had stabilized for at least 20 minutes, the saturated hydraulic conductivity was calculated using Equation (4) of USDI (pg. 103, 1993):

$$K = \frac{1{,}440(Q)}{(C)(a)(D)} \tag{1}$$

Where:

K is saturated hydraulic conductivity in feet per day,
1,440 is a conversion factor to convert minutes to days,
Q is the flow rate into the test pit during the test in cubic feet per minute,
D is the water column height in the test pit in feet,
a is the smallest surface dimension of the test pit in feet, and
C is the conductivity coefficient, which is a constant based on the shape of the test pit (i.e., rectangle, square, or circle) and ratio of water column height to test pit surface dimension (i.e., *D* / *a*).

Following the infiltration test, excavated soils were returned to the pit and soils were tamped down using the excavator.

3. Results

As shown in the test pit logs (Attachment A), subsurface soils were comprised of Lakebed Sediments overlying Native Soil. Lakebed sediments were silts and silty sands, and ranged from one foot thick (RL-TP-2) to 1.6 feet thick (RL-TP-1). Native soils ranged from a sandy silt to a sand.

Flow rate and water column height stabilized about 30 minutes (RL-TP-1) to 90 minutes (RL-TP-2) into the infiltration test (see infiltration test data sheets in Attachment B). Table 2 shows the variables that were used to calculate saturated hydraulic conductivity at each test pit location, and the values of saturated hydraulic conductivity calculated using Equation (1). The calculated saturated hydraulic conductivities ranged from 31.6 inches per hour to 432.7 inches per hour, which are two to three orders of magnitude higher than the range provided by USDA the soil survey (0.48 inches per hour). The higher calculated hydraulic conductivities are consistent with the fact that the native soils were coarser than described in the USDA soil survey (i.e., sandy silt and sand in Attachment A as compared to a clayey silt in the USDA soil survey). Note that the calculated saturated hydraulic conductivities are reasonable given the expected range for hydraulic conductivity of a poorly graded sand (SP) and sandy silt (ML) (see permeability ranges in Anderson and Woessner, Table 3.3, 1992)[2].

Table 2. Tested Sites and Calculated Soil Properties

Test Location	USCS Classification	Flow Rate, *Q*	Conductivity Coefficient, *C*	Surface Dimension, *a*	Water Column Height, *D*	Saturated Hydraulic Conductivity, *K*	Saturated Hydraulic Conductivity, *K*
RL-IT-1*	Poorly Graded SAND (SP)	2.975 gpm 0.398 ft^3/min	5.294	1.0 ft	0.125 ft	865.4 ft/day	432.7 in/hr
RL-IT-2	Sandy SILT (ML)	1.689 gpm 0.31 ft^3/min	5.914	1.5 ft	0.583 ft	63.1 ft/day	31.6 in/hr

Notes

*K calculated based on about 2 hours of infiltration. After 2 hours, a constant flow rate could no longer be maintained due to a decrease in head in the portable water tanks that supplied water to the test pit.
ft^3/min = cubic feet per minute
ft/day = feet per day
in/hr = inches per hour
ft = feet
gpm = gallons per minute
USDA = United States Department of Agriculture
USCS = Unified Soil Classification System

4. Conclusions and Recommendations

This technical memorandum provides estimates of soil permeability (hydraulic conductivity) at Roslyn Lake based on testing at two locations that were selected due to ease of access and to minimize disturbance to the Site. These estimates are intended as a planning-level data; additional soil permeability characterization is necessary to guide future implementation efforts for constructed wetlands (specifically, higher-resolution soil permeability will need to be measured within the footprints of the proposed wetlands). We make the following conclusions based on this analysis:

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[2] According to Anderson and Woessner (Table 3.3, 1992), the hydraulic conductivity of a “clean sand” is between 1 feet/day and 750 feet/day, and the hydraulic conductivity of a “silty sand” is between 0.1 feet/day and 50 feet/day.

- Infiltration testing targeted native soils that were inferred to be relatively impermeable based on USDA soil surveys. The infiltration testing revealed that soils at the locations tested within the Site are in fact more coarse-grained and permeable than reported by the USDA.

- Native soils are heterogeneous across the site, ranging from a sandy silt to a sand, with saturated hydraulic conductivities ranging from about 60 feet per day to 860 feet per day.

We make the following recommendations for implementing a constructed wetland project at Roslyn Lake:

- This memo provides estimates for the *hydraulic conductivity* of soils at the former Roslyn Lake property. Constructed wetland design will be based on assumptions about the *infiltration rate* of soil. As discussed earlier, hydraulic conductivity is not necessarily the same as infiltration rate (specifically, hydraulic conductivity is the infiltration rate under a hydraulic gradient of 1.0). For constructed wetland design purposes, we recommend calculating an infiltration rate that assumes a unit hydraulic gradient <u>or less,</u> depending on the desired level of conservatism involved in the design[3]. Note that a factor safety should also be applied to the infiltration rate to account for reductions in infiltration over the lifetime of the infiltration facility (e.g., clogging of soil pores due to sediment).

- To assist in evaluating the extent of modification necessary to reduce soil permeability to a level that can support wetland development, GSI recommends conducting additional infiltration testing and soil profiles to determine the depth and spatial distribution of permeable soils. Testing should occur within the footprints of “Proposed Wetland Area A” and Proposed Wetland Area B,” which are currently the wetland areas proposed for development.

- Soils at the Roslyn Lake site are permeable. Therefore, it may be necessary to reduce the soil permeability in order to: (1) establish wetlands at the site and (2) meet the Department of Environmental Quality’s groundwater protection rules.

    - **Permeability Reduction.** Permeability reduction can be achieved in a variety of ways. One option for reducing permeability is compacting site soil, either by stripping soil to a design depth and recompacting in lifts or simply applying sheep-foot or smooth drum roller compaction at sufficient ground pressure. However, permeability reduction may be limited by the soil types present in surface soil, and creating a highly compacted surface may increase runoff rates to unacceptable levels and inhibit growth of plant media in the short- or long-term. Another option for permeability reduction is blending a soil amendment into native soils to a design depth. However, soil amendments must be weighed against geochemical changes in the soil, physical and/or chemical changes in run-off characteristics, nutrient needs of re-stablished plant communities, and compatibility with the plant communities that are to be re-established. A third option for reducing soil permeability is to install impermeable or low-permeability engineered layers (geosynthetics or low-permeability blankets) (EPA, 1995) to limit or prevent infiltration. However, installation of engineered layers involves significant construction activities, will likely change the geochemistry of any soil present

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[3] According to the equation that relates hydraulic conductivity to infiltration rate, hydraulic conductivity and infiltration rate are positively correlated at a 1:1 ratio (i.e., doubling the hydraulic gradient would double the infiltration rate). However, in practice, the relationship between hydraulic conductivity and infiltration rate is non-linear due to the increased presence of non-laminar flow and other hydraulic factors as hydraulic gradient increases. As such, doubling the hydraulic gradient would increase, but not double, the infiltration rate.

above the layer, and may interfere with the natural wetting and drying cycles that most plants, including wetland plants, experience.

- **DEQ Groundwater Protection Rules.** DEQ's groundwater protection rules[4] require that groundwater quality beneath the Site not be degraded by application of treated wastewater. Given the highly permeable soils at the site, it is possible that residual levels of highly mobile pollutants in the treated wastewater (e.g., nitrate) may migrate to groundwater. DEQ may require fate and transport modeling and/or groundwater quality monitoring to demonstrate that the project meets the groundwater protection rules. However, if soil permeability is reduced, then DEQ may not require additional work to demonstrate that the project meets the groundwater protection rules because permeability reduction may reduce or eliminate infiltration of treated wastewater.

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[4] Oregon Administrative Rules 340-040

5. References

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USDI. 1993. Drainage Manual: A Water Resources Technical Publication. U.S. Department of the Interior, Bureau of Reclamation. 340 pp.

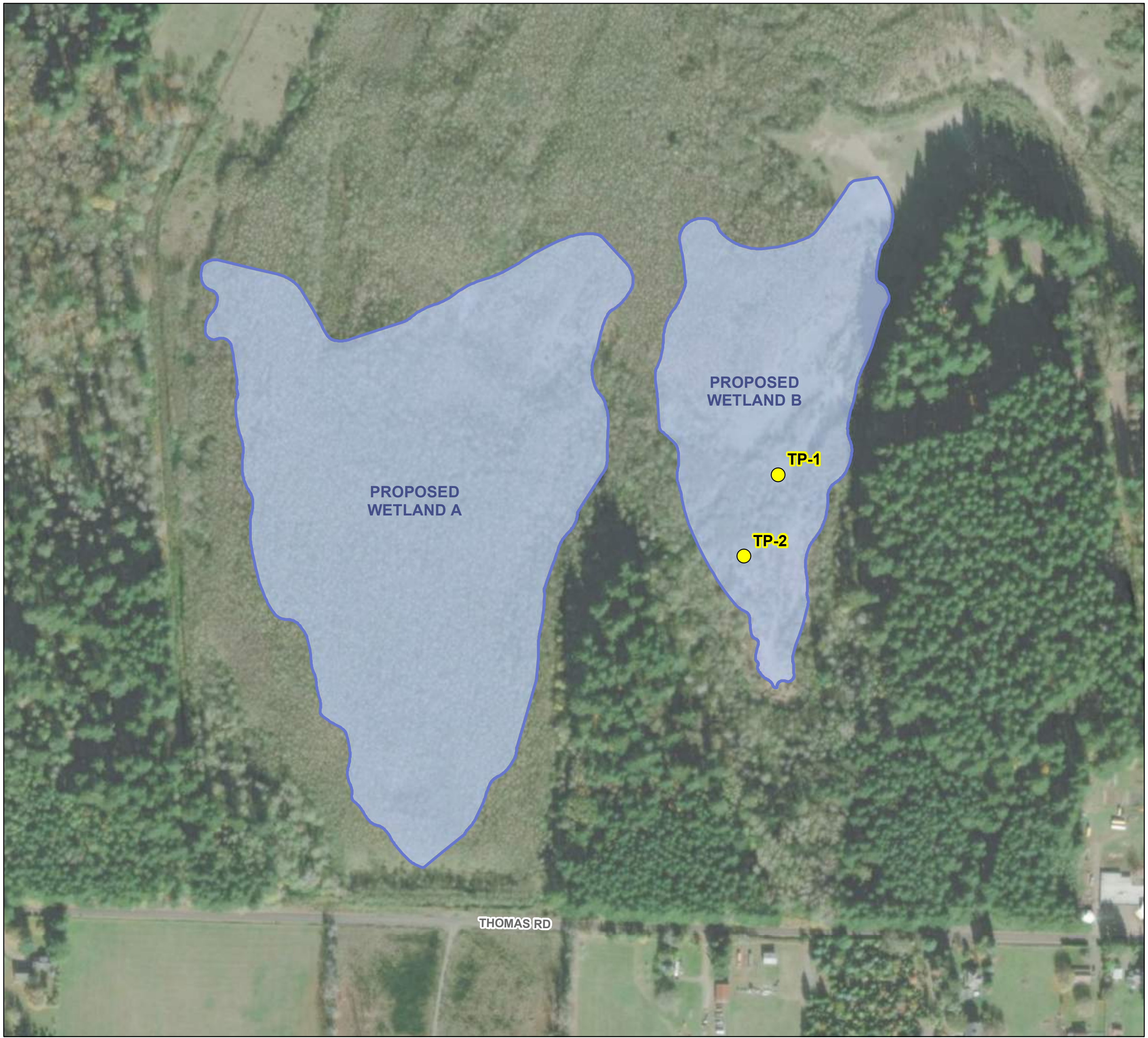


FIGURE 1

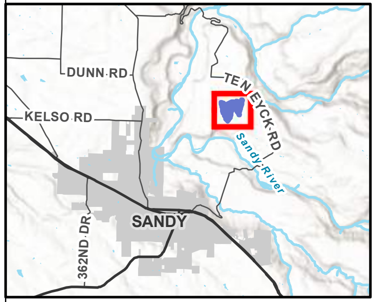
Locations of Test Pits and Proposed Wetlands

Roslyn Lake
Infiltration Testing

LEGEND

- ● Test Pit
- ▨ Proposed Wetland
- ☐ Tax Lot
- 〜 Watercourse

LOCATOR MAP



N

0 200 400
Feet

Date: December 21, 2020
Data Sources: USGS, ESRI

GSI Water Solutions, Inc.

Document Path: Y:\0116_MSA\Source_Figures\039_Sandy_WWTP_Infiltration_Eval\Figure1_TestPits_ProposedWetlands.mxd, abarry

ATTACHMENT A

Test Pit Logs

GSI Water Solutions, Inc.

Test Pit ID: RL-IT-1

PROJECT: Sandy WWTP Infiltration Evaluation

GROUND SURFACE ELEVATION AND DATUM: 656 ft (WGS84)

LOCATION: Roslyn Lake, Sandy, OR

TOTAL DEPTH (ft): 4.2

DATE STARTED: 12/11/2020

EXCAV. CONTRACTOR: City of Sandy

LOGGED BY: E. Svadlenak, M. Kohlbecker

DATE FINISHED: 12/11/2020

SAMPLING METHOD: Grab samples

DEPTH TO WATER (ft bgs) **FIRST:** **COMPLETED:**

EXCAVATION METHOD: Backhoe

DEPTH (feet)	**SAMPLES** Sample ID	Sample Interval	**SAMPLE DESCRIPTION** Density, color, moisture, modifiers and MAJOR CONSTITUENT (USCS), grain size, shape, and gradation, dtructure, bedding, cementation, minerology, organics, odor, (FORMATION ACRONYM)		**NOTES**
0.0			**ML**	Soft, brown, moist, SILT (ML), some clay, abundant roots [TOPSOIL]	*Soil log is from a 3 foot wide, 6 foot long, 4.2 foot deep test pit located about 15 feet south from the 1 foot wide, 2 foot long, 2.4 foot deep test pit where the infiltration test was conducted.
0.5 1.0			**SM**	Loose, gray, moist, silty SAND (SM), poorly graded [LAKEBED SEDIMENTS]	
1.5			**ML**	Stiff, brown, moist, SILT (ML), some clay, medium plasticity, red/orange mottling [LAKEBED SEDIMENTS]	
2.0 2.5 3.0 3.5 4.0			**SP**	Very loose, gray, moist, poorly graded SAND (SP), sand is fine to medium, subrounded, with trace silt [NATIVE SOIL]	
4.5 5.0					

Test Pit ID: RL-IT-2

PROJECT:	Sandy WWTP Infiltration Evaluation	**GROUND SURFACE ELEVATION AND DATUM:** 656 ft (WGS84)	
LOCATION:	Roslyn Lake, Sandy, OR	**TOTAL DEPTH (ft):** 2.2	DATE STARTED: 12/11/2020
EXCAV. CONTRACTOR:	City of Sandy	**LOGGED BY:** E. Svadlenak	**DATE FINISHED:** 12/11/2020
SAMPLING METHOD:	Grab samples	**DEPTH TO WATER (ft bgs)** **FIRST:**	**COMPLETED:**
EXCAVATION METHOD:	Backhoe		

DEPTH (feet)	**SAMPLES**			**SAMPLE DESCRIPTION** Density, color, moisture, modifiers and MAJOR CONSTITUENT (USCS), grain size, shape, and gradation, dtructure, bedding, cementation, minerology, organics, odor, (FORMATION ACRONYM)	**NOTES**
	Sample ID	Sample Interval			
0.0					
0.5			**ML**	Soft, light brown, moist clayey SILT (ML) with some clay and little fine sand,medium plasticity, faint iron mottling, abundant roots in top 4 inches [LAKEBED SILTS]	
1.0					
1.5			**ML**	Very soft, dark brown, moist sandy SILT (ML), some fine sand, trace clay, trace gravel (cobbles <1" to 3" size), low to medium plasticity [NATIVE SOIL]	
2.0					
2.5					
3.0					
3.5					
4.0					
4.5					
5.0					

ATTACHMENT B

Infiltration Test Data Sheets

Infiltration Test Pit Measurements

Project ~~RL TP-2b~~ Sandy Infiltration
Site ID Roslyn Lake

Page 1 of 2
Date 12/11/20

Test ID RL-TP-~~2b~~ 1
Test Start 0910 (pre-soak)
Test Stop 1206
Initial Water Level 0
Final Water Level
Measuring Point Descrip. Staff gage
Remarks
2 x 250 gal totes available

Pit Depth 2.4' ft
Pit Area 1 X 2 ft

Date/Time	Elapsed Time (min)	Water Depth (ft)	Totalizer Reading (x___ gal)	Flow Rate gpm	Comments
910	0	0	19.6	~2.25	water on
0915	5	1.75''	29.9	2.258	
0918	8		~~4~~	~~3.222~~	↑@ to ~3.2 gpm
0920	10	2.5''	40.9	3.222	
0925	15	~2.6''	56.9	3.164	
0930	20	~2.5''	72.8	3.139	
0935	25	2.5''	88.4	3.098	
0940	30	2.5''	104.0	3.057	
0945	35	2.5''	119.1	3.024	
0950	40	2.5''	134.2	2.983	↑@ to 3.02 gpm
0955	hose	disconnected	from	tank,	down for
	repairs				
1005		WL = 0			lifted gage back to 0
1010	60	"		3.009	running again @ 3 gpm
1015	65	~1"	161.5	3.041	
1020	70	1.5''	177.2	3.024	
1025	75	1.5''	192.3	2.975	↑@ back to 3
1030	80	1.5''	207.1	2.975	↑@ back to 3.016
1035	85	1.5''	222.8	3.008	
1040	90	1.5''	237.1	2.958	↑@ to 3.024
1045	95	1.5''	252.3	2.991	
1050	100	1.5''	267.3	2.999	
1055	105	1.5''	282.2	2.905	↑@ to 3.024
1100	110	1.5''	298.1	2.983	

Infiltration Test Pit Measurements

Project Sandy WWTP
Site ID RL-TP-~~3~~1

Page 2 of 2
Date 12/11/20

Date/Time 12/11/20	Elapsed Time (min)	Water Depth level (~~ft~~) in	Totalizer Reading (x___ gal)	Flow Rate gpm	Comments
1105	115	1.5"	317.6	2.975	
1110	120	1.25"-1.5"	328.2	2.966	↑Q to 3.024
1115	125	~1.4"	344.4	2.983	* late reading
1120	130	~1.4"	358.7	2.958	valve fully open
1125	135	~1.4"	374.3	2.909	
1130	140	~1.4"	386.9	2.868	
1135	145	~1.3"	400.9	2.836	(had to switch ~~[illegible]~~ totes
1140	150	1.25"	411.8	2.835	WL dropped to ~1")
1145	155	1.25"	426.0	2.785	valve fully open
1150	160	1.25"	446.1	2.736	
1155	165	1.25"	454.2	2.703	
1200	170	1"	467.3	2.662	
1205	175	1"	480.5	2.620	
1206	176				water off
1207		0"			

Infiltration Test Pit Measurements

Project Sandy WWTP
Site ID RL-TP-1a

Page 1 of
Date 12/11/20

Test ID RL-TP-1
Test Start 840 (pre soak)
Test Stop
Initial Water Level
Final Water Level
Measuring Point Descrip.
Remarks
250 gal totes x 2

Pit Depth 4.2' ft
Pit Area 2 x 4 'ft

Date/Time 12/11/20	Elapsed Time (min)	Water Depth (ft)	Totalizer Reading (x___ gal)	Flow Rate gpm	Comments
0839	0	0	0	0	
0840	0	0	0	3.75gpm	start
08[illegible]	still	0		4gpm	
	↳ cancel test, dig smaller pit				

Infiltration Test Pit Measurements

Project Sandy WWTP
Site ID Roslyn Lake

Page 1 of 2
Date 12/11

Test ID RL-TP-2
Test Start 1315
Test Stop 1550
Initial Water Level 0
Final Water Level 7"
Measuring Point Descrip. staff gage
Remarks
2x 250 gal totes available

Pit Depth 2.2' ft
Pit Area 1.5 X 3 ft

Date/Time	Elapsed Time (min)	Water Depth (ft)	Totalizer Reading (x___ gal)	Flow Rate gpm	Comments
1314	pre-test		482.7	0	
1315	0	0	482.7	~3.2	water on
1320	5	5.75"	492.7	3.197	
1325	10	7.25"	509.0	2.192	↓Q to ~2.2gpm @ 1322
1330	15	7"	518.6	1.829	↓Q to ~1.8 @ 1327
1335	20	6.75"	527.9	1.838	
1340	25	7"	537.0	1.829	
1345	30	7"	546.5	1.805	
1350	35	7"	555.2	1.780	
1355	40	7"	564.1	1.772	
1400	45	7"	572.9	1.760	
1410	55	7"	590.4	1.739	
1415	60	7"	599.6	1.730	
1425	70	7"	616.4	1.714	↓Q to 1.6 gpm
1430	75	6.75"	624.7	1.648	↑Q back to 1.7 gpm
1435	80	6.75"	633.4	1.755	
1440	85	7"	642.4	1.747	target Q closer to 1.7
1445	90	7"	651.0	1.689	
1450	95	7"	659.6	1.681	
1455	100	7"	668.0	1.664	
1500	105	7"	676.2	1.640	↑Q to 1.706 gpm
1505	110	7"	685.6	1.681	slightly late read
1510	115	7"	693.1	1.643	↑Q to 1.714 gpm
1515	120				missed

Infiltration Test Pit Measurements

Project Sandy
Site ID RL-TP-2

Page 2 of 2
Date 12/11/20

Date/Time 12/11/20	Elapsed Time (min)	Water Depth (ft)	Totalizer Reading (x__ gal)	Flow Rate gpm	Comments
1520	125	7"	710.1	1.697	
1525	130	7"	718.4	1.689	
1530	135	7"	727.1	1.656	↑Q to 1.730
1535	140	7"	735.5	1.714	
1540	145	7"	744.2	1.689	
1545	150	7"	753.8	1.614	
1550	155	~7"	761	0.634	Tote pretty much out of water
1551	156	END			Water off, disconnect
1552		6"			falling head
1553		5.5"			
1554		5.25"			
1555		4.75"			
1556		4.5"			
1557		4"			
1558		3.75"			
1559		3.5"			
1600		3.25"			

SANDY
WHERE INNOVATION MEETS ELEVATION

39250 Pioneer Blvd
Sandy, OR 97055
503-668-5533

September 8, 2020

Tony Deis
Molly Strand Deis
Trackers Earth
41515 SE Thomas Rd
Sandy, OR 97055

RE: Letter of Mutual Interest for Roslyn Lake Wetlands Exploration

Dear Tony and Molly,

Thank you for continuing to work with the City of Sandy on the possibility of constructing wetlands and enhancing habitat on your property (the former Roslyn Lake). This letter outlines our joint interest in the city further exploring the possibility with your close involvement.

Since this effort will require city resources, site access, and coordination with you to conduct the studies, executing this letter of mutual interest provides a level of certainty for us in moving forward with the project. Additionally, the city's project team will soon be presenting the findings of our discharge alternatives analysis to the City Council which will include the recommendation to further study the Roslyn Lake option. Acknowledging our mutual interest studying this alternative is important before proceeding on a process that will soon become more public. If the studies confirm the project is feasible and approved by City Council, a formal long-term agreement would be negotiated with you for the use and delivery of recycled water to your property.

The city has been analyzing alternatives for discharging the highly treated wastewater that would be produced by a new wastewater treatment plant in the City of Sandy. High level planning efforts indicate that the concept to pipe the highly treated effluent from a state-of-the-art treatment new plant to a few constructed wetlands at the former Roslyn Lake site would conceptually work. This is a more sustainable, environmentally and habitat friendly alternative than only piping the effluent from a new discharge into the Sandy River. As we have discussed, it can also provide benefits to your operations and plans at the property with regards to outdoor education and recreation and natural area restoration. Early concepts show a potential need of 30-60 acres to construct the wetlands and native vegetation.

This letter of mutual interest outlines the commitments between the city and you, the property owner, in our carrying out of the feasibility work for this project.

Purpose

The city’s contracted engineers and consultants will be conducting a feasibility review of applying highly treated effluent on the property for the purposes of creating a wetland habitat.

Project Coordination

The city and its project consultants will coordinate with the property owner throughout the process.

Site Access

During the term of this letter of interest, the property owner agrees to allow access to the property for the city to conduct its feasibility studies. This may include reviews of soils, vegetation, hydrology, topography, and surveys of existing infrastructure. However, to the extent that any investigations, surveys or other work is to be performed on the property, the city will provide reasonable written advance notice and obtain the property owner’s, which consent shall not be unreasonably withheld, conditioned or delayed. The city shall restore the properties and improvements to the same condition they were in prior to any inspections, investigations, surveys, or other work by the city, its contractors, or its agents. The city shall indemnify, hold harmless, and defend the property owner from all liens, costs, and expenses, including reasonable attorneys' fees and experts' fees, arising from or relating to the city’s, its contractors', or its agents' entry on and inspections investigations, surveys, or other work of the property, including all testing activities. This agreement to restore, indemnify, hold harmless, and defend the property owner shall survive closing or any termination of this letter of interest.

Schedule and Termination

The feasibility study is expected to take 6 months. The city will inform the property owner of any changes to the anticipated timeline. Either party can terminate this letter of mutual interest without cause by notifying the other in writing.

Long Term Agreement

If the feasibility study determines that enhancing or creating wetlands and a natural habitat at the site is feasible, the intention of the parties is to enter into a long-term agreement.

Thank you again for working with us on this exciting opportunity for this important project. If these terms are agreeable to you, please sign and date on the following page.

City of Sandy

____ _09/8/2020__
Jordan Wheeler Date
City Manager, City of Sandy
39250 SE Pioneer Blvd
Sandy, OR 97055

Trackers Conservation Properties, LLC

By:______________________________________ 9/8/2020
Molly Strand Deis, Manager Date

Bull Run Educational Properties, LLC

By:______________________________________ 9/8/2020
Molly Strand Deis, Manager Date

Trackers Ranch, LLC

By:______________________________________ 9/8/2020
Molly Strand Deis, Manager Date

murraysmith

City of Sandy, Oregon

Antidegradation Review

For Proposed Discharges to the Sandy River

December 2020

SANDY
WHERE INNOVATION MEETS ELEVATION

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Appendix A: Sandy River Historic Data

Appendix B: Sandy River Temperature Monitoring Locations

Appendix C: Sandy River Sampling Plan

Acronyms & Abbreviations

A	
ACOE	Army Corps of Engineers
B	
BAT	Best Available Technology
BOD	Biochemical Oxygen Demand
C	
C	Celsius
CFS	Cubic Feet per Second
CW/CWA	Clean Water Act
D	
DADM	7-Day running average of daily maximum values
DEQ	Department of Environmental Quality
DMR	Discharge Monitoring Report
DO	Dissolved Oxygen
E	
EMZ	Edge of Mixing Zone
EPA	Environmental Protection Agency
F	
F	Fahrenheit
FERC	Federal Energy Regulatory Commission
I	
IMD	Internal Management Directive
L	
L	Liter
LUCS	Land Use Compatibility Statement
M	
MBR	Membrane Bioreactor
MGD	Million Gallons per Day
mg	milligrams
N	
ND	Not Detected
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Units
O	
OAR	Oregon Administrative Rule
ODEQ	Oregon Department of Environmental Quality
R	
RM	River Mile

T	
TMDL	Total Maximum Daily load
TSS	Total Suspended Solids
U	
USFWS	United States Fish and Wildlife Service
USFG	United States Federal Government
USGS	United States Geological Survey
UV	Ultraviolet
V	
VOCs	Volatile Organic Contaminants
W	
WQLW	Water Quality Limited Waters
WWTP	Wastewater Treatment Plant

Executive Summary

Executive Summary

The City of Sandy is proposing to construct new wastewater treatment facilities to meet the needs of their growing community and make other wastewater system improvements. Some of these improvements will be at the existing treatment plant where they have a permitted discharge to Tickle Creek.

They also propose to construct a new satellite treatment facility, using best available technology, where some of the community's wastewater would be treated. This membrane bioreactor (MBR) facility would require a new, permitted discharge to the Sandy River.

Under the terms of the State of Oregon's surface water antidegradation policy, this proposed new discharge to the Sandy River is subject to an antidegradation review, the subject of this report.

The project engineers have completed that review. They found that the proposed discharge would not exceed the State's antidegradation thresholds for temperature and dissolved oxygen with the present (2020) effluent flows. However, as the community grows and effluent flows from the MBR increase, the City will need to land apply a portion of the effluent (during some summer and fall months) to meet the antidegradation thresholds.

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Section **1**

Section 1

Introduction

1.1 Introduction

The City of Sandy plans to construct a new, best available technology (BAT) satellite wastewater treatment facility using a membrane biological reactor (MBR). They propose to discharge the high-quality effluent into the Sandy River year-round. However, during the summer and early fall they plan to land apply a portion of the effluent for beneficial purposes. The land application part of the project is still in the planning phases. However, it is likely that the highly treated effluent will be used to create constructed wetlands on a site that was formerly called Roslyn Lake (an artificial impoundment originally created by Portland General Electric, drained some years ago). That land is now undeveloped woods and fields. Based on preliminary site reviews and discussions with the current property owner, the reuse water could be used to create wetland and open water features that enhance the existing wetlands and natural resources features of the site.

The City may also reuse some of the highly treated effluent for creating renewable energy from hydropower. The topography of the area would result in the City having a steady flow of water with substantial elevation head (hydrostatic energy). Micro-hydropower generation, in particular, may be feasible using effluent. There is an existing powerhouse in the project vicinity on the Bull Run River, which is owned and managed by a non-profit organization that has expressed interest in partnering with the City on a micro-hydro project. It is also possible that the City could generate hydropower from effluent and discharge into the Sandy River at a different site. The small amount of hydropower that would be generated would not require licensing by the Federal Energy Regulatory Commission (FERC).

Sandy River Basin streams are water quality limited and covered by the terms of the Total Maximum Daily Load (TMDL) study for the basin (ODEQ, 2005).

Based on the City's planned approach and this review, the proposed action would not result in a lowering of water quality on the Sandy River as explained in this report.

1.2 Purpose

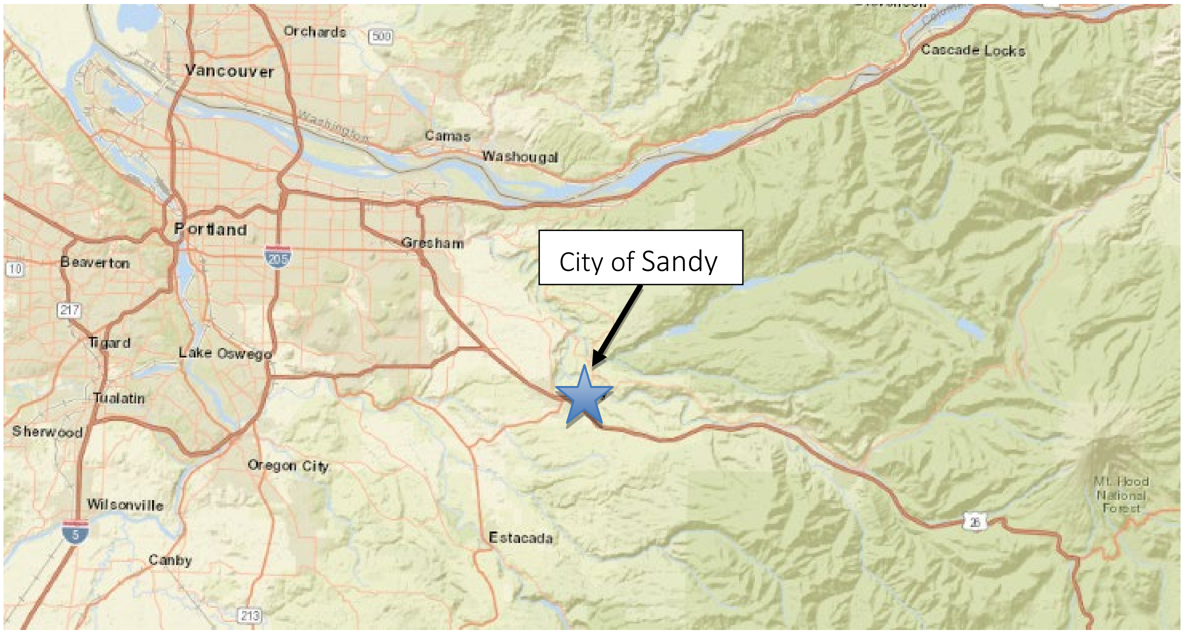
This report describes the proposed satellite wastewater treatment plant and the proposed discharge into the Sandy River. The discharge into the Sandy River would constitute a new, permitted effluent discharge. Therefore, the proposed project is subject to a water quality antidegradation review (OAR-340-041-0026). Furthermore, since the proposed discharge would be to a water quality limited waterbody, the antidegradation review would follow the approach outlined for these waterbodies in the Internal Management Direct (IMD) for antidegradation reviews (ODEQ, 2001).

The purpose of this report is to describe the proposed project and summarize the antidegradation review and findings.

1.3 Geography

The City of Sandy is in Clackamas County, Oregon, located between the Sandy and Clackamas Rivers (see **Figure 1-1**). The City covers a total area of 3.6 square miles and has an average elevation of about 1,000 feet above mean sea level. Sandy is located approximately 25 miles southeast of the City of Portland along Oregon State Highway 26. Neighboring communities include Boring and the City of Gresham to the northwest, and Eagle Creek and Estacada to the south.

Figure 1-1
Vicinity Map



1.2 Regulatory Compliance

The City's proposal to construct and operate a new satellite treatment facility is subject to the key regulatory programs listed in **Table 1-1** below, and others.

Table 1–1
Key Regulatory Programs

Program	Responsible Agency
Antidegradation	DEQ/EPA
Sandy River Basin TMDL	DEQ/EPA
National Pollutant Discharge Elimination System (NPDES) Permit	DEQ/EPA
Water Quality Certification (CWA Sec. 401)	DEQ/EPA
Endangered Species Act	NMFS/USFWS
National Environmental Policy Act	NMFS/ACOE
Wetlands Protection (CWA Sec. 404)	ACOE
Fill and Removal (State Statutes)	Oregon Department of State Lands

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Section 2

Section 2

Existing Conditions

1.1 Introduction

Recorded data on the Sandy River gives insight into how the river changes on a seasonal basis and how it may be affected by discharges from a new wastewater treatment plant. The Sandy River was previously monitored in the 1990s as a potential receiving water for the City of Sandy wastewater effluent and additional data are being collected now for the purpose of this project.

2.2 Prior Analysis of the Sandy River

The City of Sandy investigated the concept of a new outfall into the Sandy River in the 1990s. The Oregon DEQ and the Bureau of Land Management (BLM) established a water quality sampling program and collected samples throughout the summer and fall of 1992. These samples were collected at the following five locations along the Sandy river:

- RM 3.0 – Lewis and Clark State Park
- RM 6.0 – Dabney State Park
- RM 12.0 – Oxbow County Park
- RM 18.4 – USGS Gaging Station, Dodge Park
- RM 22.0 – below confluence with Cedar Creek

Samples at these locations were analyzed for the parameters listed in **Table 2-1** below. The data collected during this study can be found in the tables included in **Appendix A.**

Table 2–1
Previous Water Quality Sampling Parameters

Parameter		
Temperature	Alkalinity	Boron
Dissolved Oxygen	pH	Cadmium
Biochemical Oxygen Demand	Electrical Conductivity	Chromium
Chemical Oxygen Demand	Fecal Coliform	Copper
Kjeldahl Nitrogen (TKN)	Enterococci	Iron
Ammonia	Chlorophyll-a	Lead
Nitrate and Nitrite	Phaeophytin	Manganese
Total Phosphorus	Total Solids	Selenium
Orthophosphate	Turbidity	Silver
Total Suspended Solids	Total Organic Carbon	Zinc
Total Dissolved Solids	Barium	

2.3 Sandy River Sampling Plan

Murraysmith and Waterways Consulting, Inc. developed a new water quality sampling plan for the Sandy River. We began sampling in 2019 and will continue through 2024. The purpose of this program is to validate the river flows at the proposed outfall locations, monitor the temperatures, and evaluate additional water quality parameters for the Sandy River. A copy of this sampling plan may be found in **Appendix C.**

2.4 Terms of Sandy River Basin TMDL

The Sandy River Basin Total Maximum Daily Load (TMDL) study places restrictions on temperature for the Sandy River. The maximum cumulative temperature increase for point and nonpoint sources combined is listed as 0.3 °C. The cumulative temperature change of all point sources must not result in a maximum stream temperature increase of 0.2 °C. The TMDL methodology assumes that 25% of the stream would be mixed with the higher temperature wastewater flows.

The antidegradation policy provides a temperature threshold of 0.14 °C (0.25 °F) increase in receiving stream temperature, for a new discharge.

2.5 Existing Data

2.5.1 Flow Rates

A multi-faceted approach was developed by Murraysmith and Waterways for reviewing flow rates on the Sandy River, whereby a series of flow rate measurements would be taken over the course of five years. Waterways Consulting took the first flow measurement in 2019 as a wading sample, where measurements were taken at approximately 20 points across a single cross section using a Price AA Flow Meter. Four additional wading measurements were conducted by Waterways near the Oxbow location in the summer and fall of 2019. These flow measurements were used as a calibration measure for reviewing the accuracy of data being recorded by the U. S. Geological Survey (USGS).

The closest long-term USGS river gage is located approximately 5.5 miles downstream of the proposed outfall site at Ten Eyck Road. Additional flows from the Bull Run River enter the Sandy River between the project site and the gaging station. The USGS and the City of Portland monitor these flows so reliable flow data is available. The Bull Run River gauging station is also located upstream of the Little Sandy River confluence, which is also monitored by USGS. The project engineers subtracted the flow rates from the Bull Run River and the Little Sandy River gaging stations to estimate the discharge rates for the Sandy River upstream of the Bull Run confluence (where the proposed outfall would be located). **Figure 2-1** illustrates the locations of each of the gauging stations used in these calculations. **Table 2-2** summarizes the recorded 7Q10 flow rates in the Sandy River, calculated for each month.

Figure 2-1
River Gauging Stations on Sandy River and Adjacent Tributaries

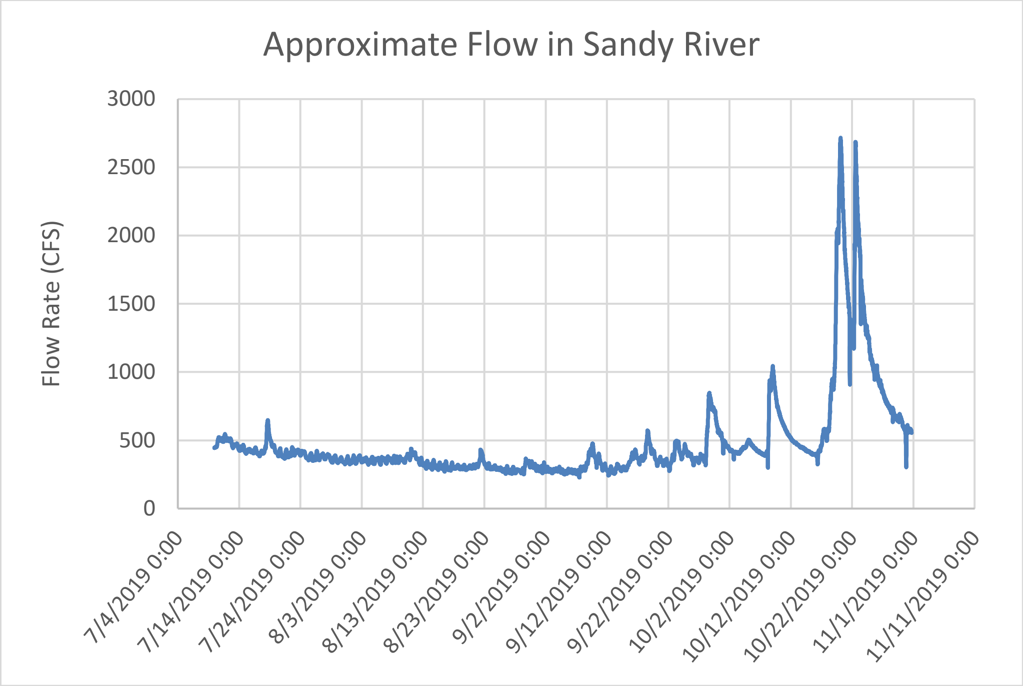
Table 2–2
Estimated 7Q10 Flows in Sandy River at Proposed Outfall

Month	River Flow (CFS)	River Flow[1] (MGD)
January	940	607
February	899	581
March	655	423
April	1177	760
May 1 – May 15	765	494
May 16 – May 31	730	471
June	415	268
July	331	214
August	269	174
September	245	158
Oct 1 – Oct 14	236	152
Oct 15 – Oct 31	245	158
November	381	246
December	442	285

1. 7Q10 flow at downstream of USGS gauging station, calculated for approximately 10-year time period from 2010-2019 (Bull Run River and Little Sandy River flows subtracted).

Figure 2-2 is a graph of USGS flow data captured in 15-minute intervals from July through October of 2019. These flows represent the flows at the confluence of the Sandy River and the Bull run river (in the reach where the new outfall would be located), with the Bull Run River and the Little Sandy River flows subtracted. Therefore, the flows listed in Table 2-2 and shown in Figure 2-2 are comparable.

Figure 2-2
Approximate Flows in Sandy River, July 09, 2019 to October 31, 2019 at Proposed Outfall Location

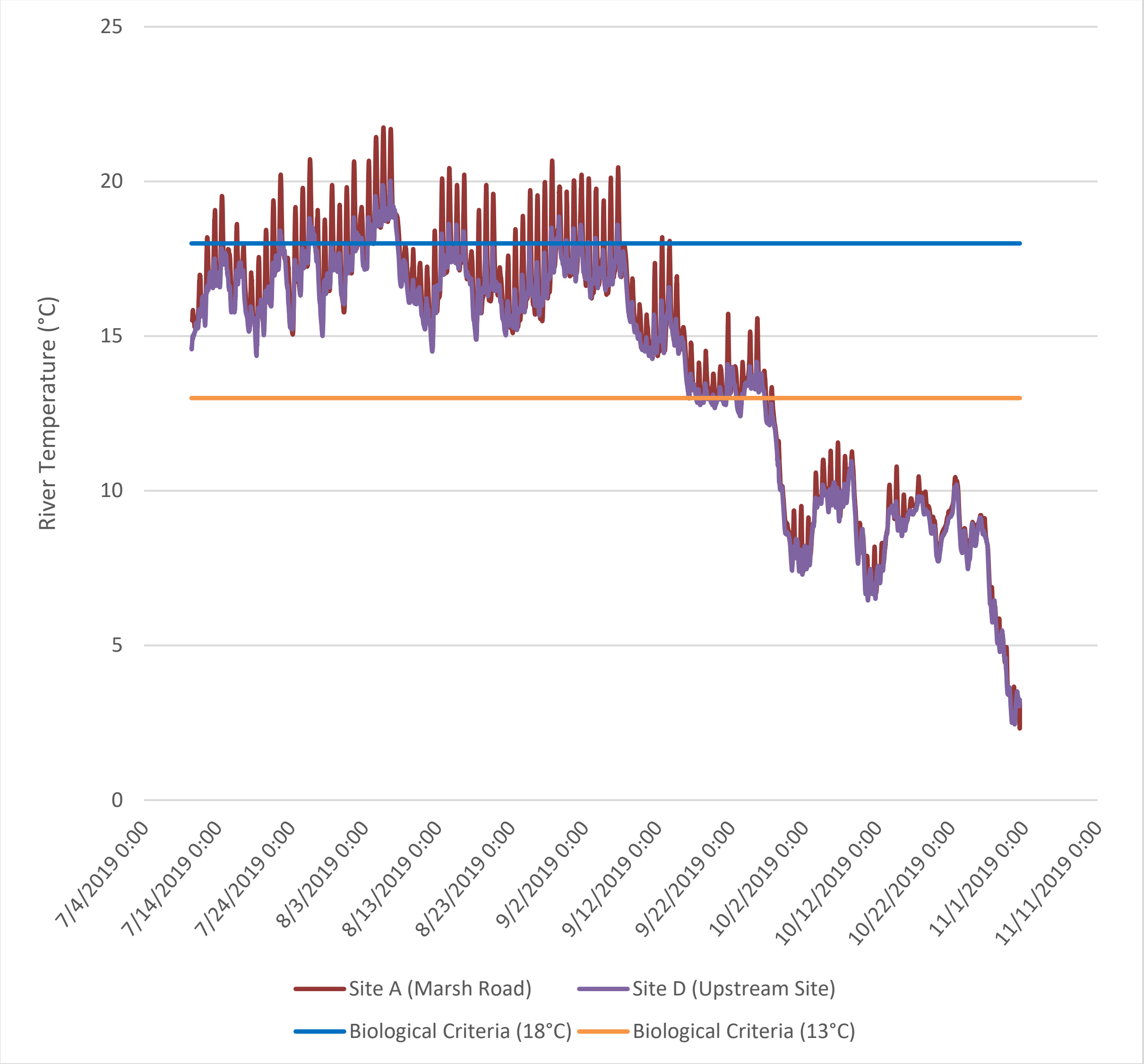


2.5.2 Temperature

Waterways Consulting, Inc. recorded temperature data on the Sandy River by installing temperature probes. They installed these probes upstream and downstream of the Sandy River Oxbow and set them to continuously record temperature data.

See **Appendix B** for a map of the temperature gaging locations. Site A is located near Marsh Road, which is downstream and to the north of the project site. Site D is located approximately 1 mile upstream of the Sandy River Oxbow. Waterways will continue to deploy, download, and report the results of the temperature monitoring twice each year through 2024. A sample of this data from summer of 2019 may be found in **Figure 2-3** below.

Figure 2-3
Temperature Data for the Sandy River, July 10 – October 31, 2019



These results strongly suggest a seasonality for stream temperatures (and flows), as would be expected. Continuous temperature data also shows fluctuations throughout the day, with temperatures trending higher for the summer (mid-July through mid-October) and lower river temperatures for the rest of the year. The variation in temperature between the upstream and downstream sites (Sites D and A, respectively) on the same day is significant. Biological temperature criteria are shown in the above figure for context. This difference can be observed in greater detail in **Figure 2-4** and **Figure 2-5** below. During the warmest part of the day, the difference in stream temperature between the two sites can be two or more degrees. Site D (the site with the lower temperatures) is approximately 2.5 miles upstream from Site A, suggesting better receiving water temperatures further upstream for any future discharge.

Figure 2-4
Daily Temperature at 15:00 for Month of August

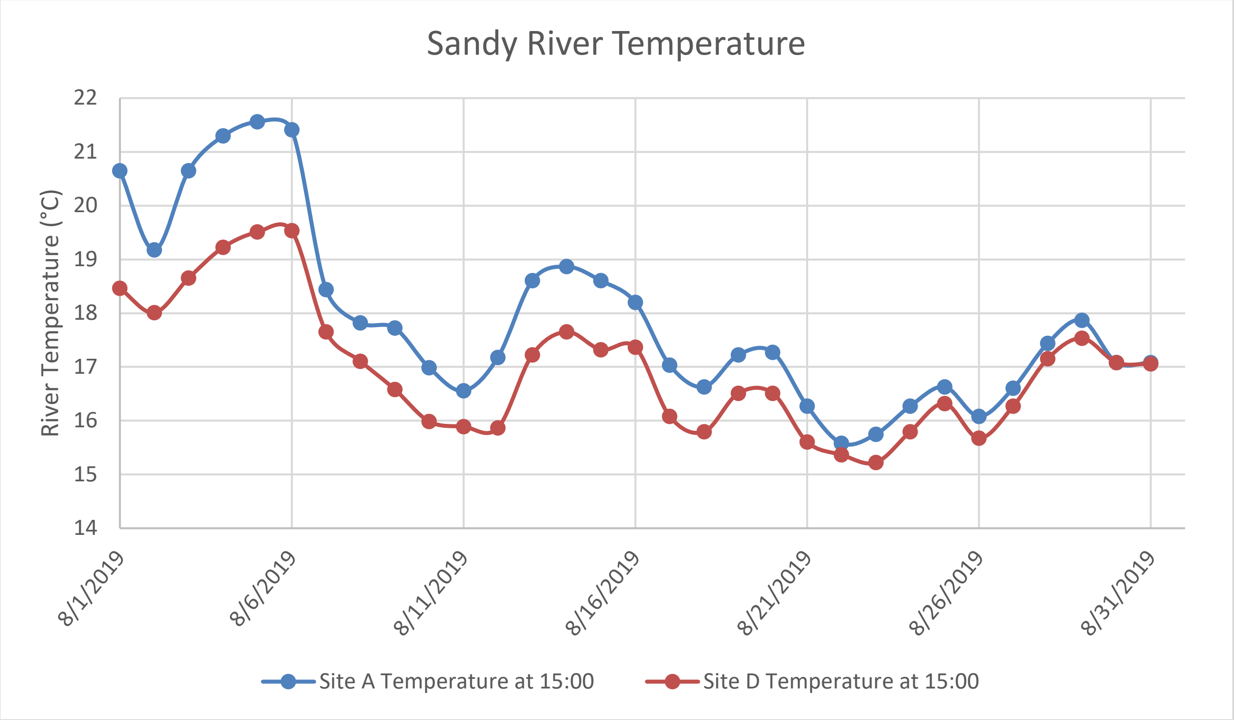
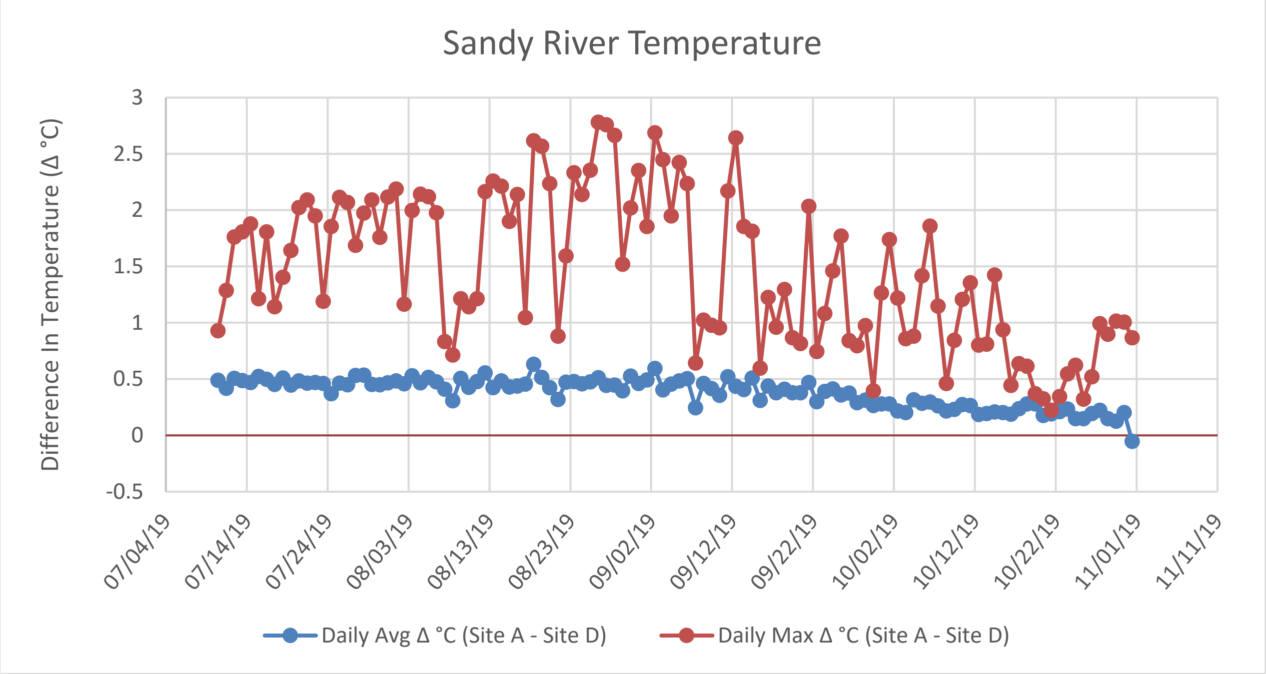


Figure 2-5
Daily Temperature Differences Between Site A and Site D, 2019



Section **3**

Section 3

Proposed Activity

3.1 Introduction

To determine a good solution for the City of Sandy's increasing wastewater treatment needs, the design engineers at Murraysmith evaluated numerous options based on cost, regulatory compliance, and constructability. The Wastewater Facilities Plan (Murraysmith, 2019) concluded that the best option would be to make improvements to the existing facility and to build a satellite wastewater treatment plant with Membrane Bioreactor (MBR) technology. The existing plant, which discharges into Tickle Creek in the Clackamas River Basin, will be upgraded to produce effluent that meets regulatory requirements. More information on these upgrades may be found in the referenced Wastewater Facilities Plan. **Because the existing plant already has a permitted discharge and will not produce any new discharge into Tickle Creek, this antidegradation report focuses solely on the discharge from the new MBR facility.** This MBR satellite plant will produce high quality effluent and discharge into the Sandy River. This plan for a new discharge into the Sandy River requires compliance with the state water quality antidegradation policies.

3.2 Alternatives Evaluation

3.2.1 Overview of Alternatives

The project engineers previously developed and evaluated four alternative options for wastewater treatment plant (WWTP) improvements. The four alternatives were as follows:

<u>Alternative A</u> – Expansion of the existing WWTP treatment process including upgrades to the headworks, new aeration basins, new secondary clarifiers, expansion of the cloth-media tertiary filtration system, replacement and expansion of UV disinfection, dewatering system rehabilitation and the addition of a new solids dryer allowing the existing covered cake storage area to be utilized long-term.

<u>Alternative B</u> – Construction of a new membrane bioreactor (MBR) facility for secondary and tertiary treatment of approximately 7 MGD at the existing WWTP site, operating in parallel with the existing WWTP. Other upgrades include expansion of the headworks, dewatering upgrades and addition of a solids dryer.

<u>Alternative C</u> – Conversion of the existing WWTP to incorporate primary clarification and anaerobic digestion to better utilize the limited site footprint, reduce solids production through increased volatile solids destruction and reduce energy consumption by expanding the headworks, adding primary clarifiers, reduced aeration basin expansion, new secondary clarifiers, expansion

of the cloth-media tertiary filtration system, replacement and expansion of UV disinfection, dewatering system rehabilitation and the addition of a new solids dryer.

Alternative D – Construction of a new Eastside Satellite Treatment Facility for an ultimate peak design flow of approximately 7 MGD with existing WWTP upgrades primarily focused on the needed improvements for treating and processing solids from both facilities including expansion of the headworks, addition of primary clarifiers, tertiary filtration system rehabilitation, UV system rehabilitation, solids dewatering system rehabilitation and the addition of a new solids dryer.

Section 10.3 of the Final Facilities Plan shows an analysis and comparison of these four alternatives. Alternative D was ultimately selected as the best long-term approach for the City based on a weighted comparison of both cost and non-cost factors, which is included in **Table 3-1** below and in greater detail within the Final Facilities Plan.

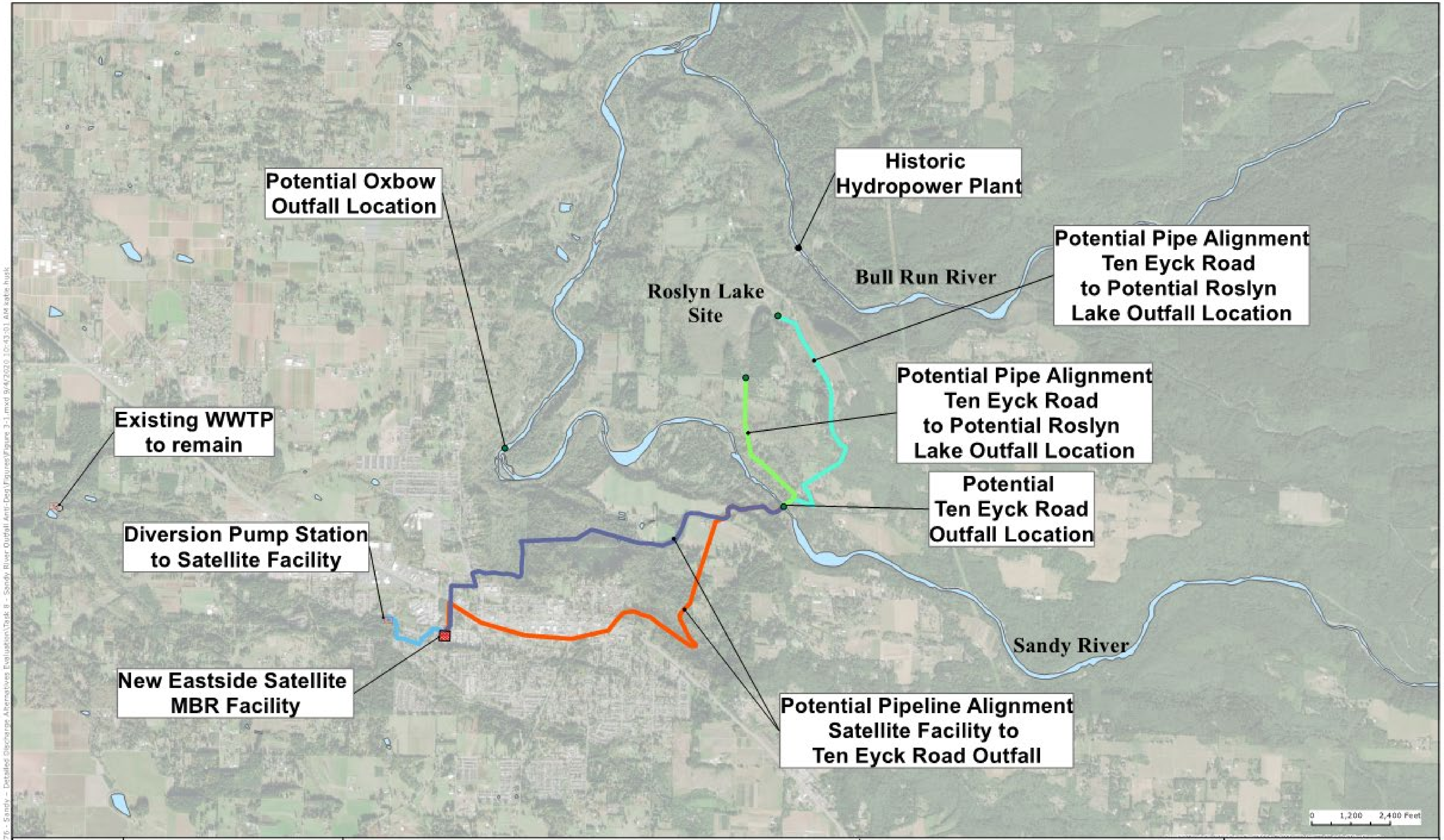
Table 3-1
Alternative Scoring based on Cost and Non-Cost Factors

	Weight	Alt A	Alt B	Alt C	Alt D
Capital Cost	30%	3.0	2.0	2.5	3.5
20-year Life-Cycle Cost	20%	2.5	2.5	2.5	3.5
Regulatory Compliance	20%	2.0	2.5	2.5	3.0
Environmental Permitting	10%	2.0	2.5	2.5	3.0
Constructability	10%	2.0	2.0	2.0	3.5
Reliability/Resiliency	5%	2.0	2.5	2.5	3.0
Phasing	5%	2.0	2.0	2.0	4.0
Total	**100%**	**2.4**	**2.3**	**2.4**	**3.4**

As shown in Table 3-1, Alternative D ranked highest in this matrix evaluation, and was selected by the City as the preferred alternative. Therefore, this antidegradation report focuses solely on reviewing Alternative D, the satellite MBR facility.

3.2.2 Overview of Selected Alternative

The new satellite treatment facility would be constructed in two stages along with construction of a new outfall to the Sandy River. Following completion of the permitting process for the new outfall, the satellite facility would operate year-round, discharging highly treated effluent to the Sandy River while sending waste solids from the new facility back to the existing WWTP for solids process and disposal. During summer and fall months, when river temperatures are higher, a portion of the effluent would be land-applied to reduce potential for river temperature increases. The City is also considering the option of diverting some effluent to a separate facility for power generation. **Figure 3-1** is a site map with the relative locations of each of these proposed alternatives. **Figure 3-2** is a schematic of a typical MBR wastewater treatment facility.



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City of Sandy, Oregon
Antidegradation Review
Site Overview

Figure 3-1

September 2020 20-2776

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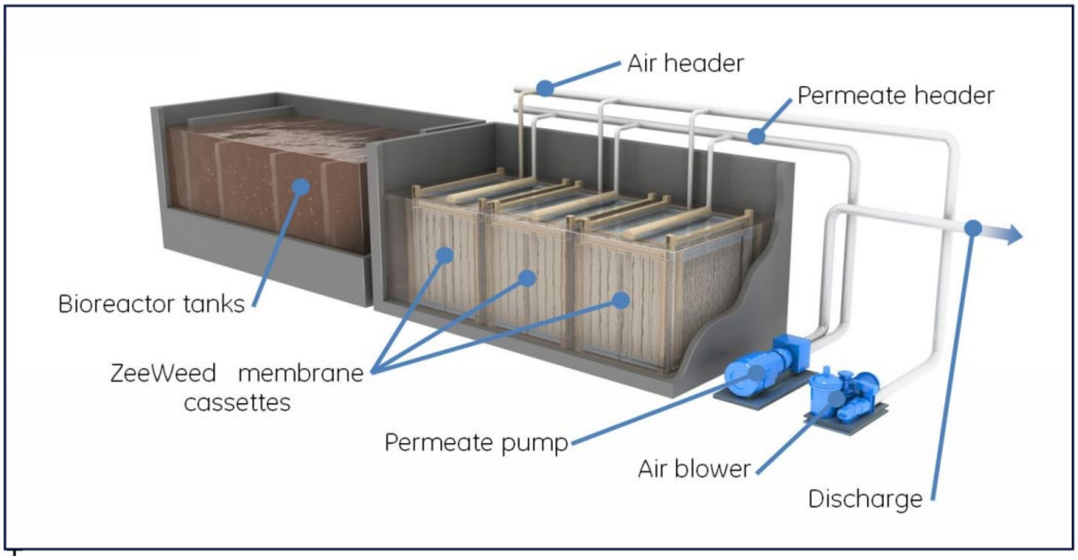
Figure 3-2
MBR Facility Schematic



3.2.3 Eastside Satellite Treatment Facility

The new satellite treatment facility will include 4 trains, each with 1.75 MGD instantaneous peak flow capacity and will be built in 2 stages. Stage 1 (design and construction of a new diversion pump station and 3.5 MGD satellite wastewater treatment facility on the east side of the City) will be completed by 2026. The treatment facility will be constructed on a 4.5-acre City-owned parcel and will provide liquids stream treatment only. Solids from the Eastside Satellite Treatment Facility will be pumped downstream from the new diversion pump station for treatment at the existing WWTP. Stage 2 would be constructed as needed after 2026.

The satellite treatment plant will use MBR technology, which produces high-quality effluent. The post-treatment water is considered Class A wastewater, which is suitable for most reuse purposes. Typical effluent quality from a MBR facility is shown in **Table 3-2** below (USBR 2000, Murraysmith 2020). The current and projected wastewater flow rates associated with the City of Sandy along with the flow rate that will be diverted to the MBR facility are included in **Table 3-3.**

Table 3-2
Typical MBR Effluent Quality

Parameter	Effluent Quality	% Removal
BOD_5	<5 mg/L	98%
Total Nitrogen	<10 mg/L	99%
TSS	<1 mg/L	99%
Total Phosphorus	<1 mg/L	99%
Total Coliform	ND	ND
Turbidity	<0.2 NTU	

Table 3-3
City of Sandy Wastewater Flow Rates

Present (2020) Flow Rates			Future (2040) Flow Rates		
Month	Overall City of Sandy Wastewater Flow[1] (MGD)	Flow to MBR[2] (MGD)	Month	Overall City of Sandy Wastewater Flow[1] (MGD)	Flow to MBR[2] (MGD)
January	1.58	0.79	January	3.28	1.64
February	1.45	0.73	February	3.07	1.54
March	1.61	0.81	March	3.33	1.67
April	1.43	0.72	April	3.2	1.60
May 1 – May 15	1.4	0.70	May 1 – May 15	2.99	1.50
May 16 – May 31	1.4	0.70	May 16 – May 31	2.99	1.50
June	1.1	0.55	June	2.61	1.31
July	0.76	0.38	July	2.19	1.10
August	0.69	0.35	August	2.08	1.04
September	0.73	0.37	September	2.14	1.07
Oct 1 – Oct 14	1.41	0.71	Oct 1 – Oct 14	3.13	1.57
Oct 15 – Oct 31	1.41	0.71	Oct 15 – Oct 31	3.13	1.57
November	1.75	0.88	November	3.99	2.00
December	1.66	0.83	December	3.63	1.82

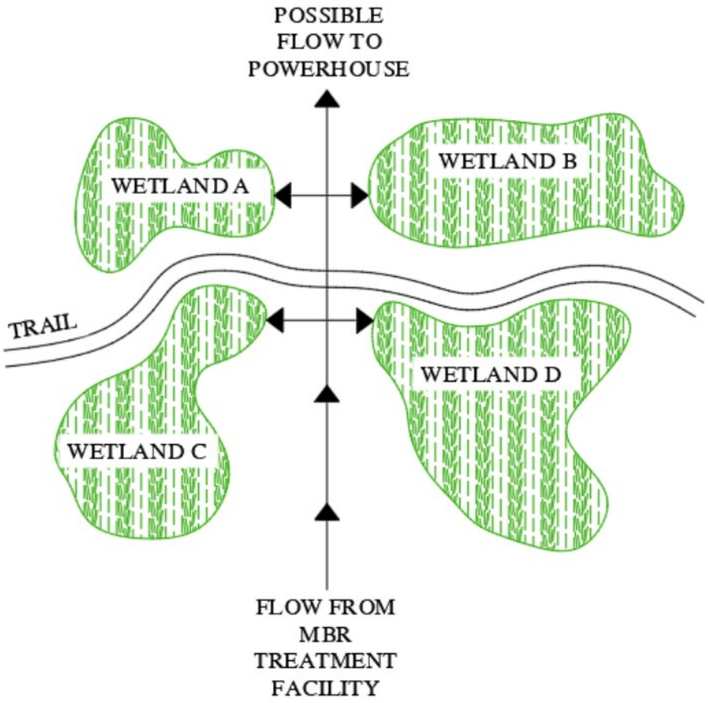
Notes:

1. Estimated wastewater system average monthly flows using Murraysmith hydraulic model.
2. Estimated flows to MBR facility, approximately ½ of overall wastewater flow.

3.2.4 Land Application of Effluent

As the City grows and wastewater flows increase, water quality calculations indicate that effluent discharge from the new MBR facility during the summer and fall months could potentially increase the Sandy River temperature beyond the antidegradation threshold (See Chapter 4). One promising option for limiting these discharges would be land application of treated wastewater. This approach would reduce discharges into the Sandy River and provide for beneficial use of the high-quality effluent, perhaps creating wetlands and otherwise improving natural resources conditions at an appropriate site. A simple schematic of this concept is shown in **Figure 3-3** below.

Figure 3-3
Constructed Wetlands Concept



3.2.5 Hydropower Generation

There is also potential for power generation from the wastewater effluent from this satellite treatment plant. A small, historic powerhouse exists in the project vicinity on the Bull Run River, as shown in **Figure 3-1**. This undertaking would provide additional power supply for the area without directing any additional flows away from the Sandy or Bull Run Rivers, and simultaneously repurpose a historic site. The City could also investigate building a new power generating facility with outflow to the Sandy River. The small amount of power generated through a possible micro-hydropower project would not likely require Federal Energy Regulation Commission (FERC) licensing or review.

3.2.6 New Sandy River Outfall

The project team has reviewed multiple locations for placing the outfall from the satellite treatment facility. The two primary locations are at the oxbow of the Sandy River (near the City's Sandy River Park), and further upstream where Ten Eyck Road crosses the River. **Figure 3-1** shows both potential locations and the associated force mains through the City. Recent discussions and analysis favor the outfall located at Ten Eyck Road.

While this location requires a longer force main to be constructed, it provides benefits over the oxbow location. First, the Ten Eyck Road outfall location has a riverbed largely consisting of exposed bedrock, which is much less likely to migrate over time than the loose material at the oxbow. Additionally, the Ten Eyck Road location is characterized by a channel that is much narrower, deeper, and with higher velocities than the oxbow, meaning that the natural mixing potential of the Ten Eyck location is better (Wolf Water Resources, 2020). Finally, the Ten Eyck Road location would have less possible impact to fisheries since it is in a migration corridor (not spawning and rearing area) and away from the Cedar Creek fish hatchery.

Section 4

Section 4

Water Quality Analysis and Review

4.2 Introduction

The proposed new discharge to the Sandy River is subject to an antidegradation review. Therefore, the engineers reviewed the impact on water quality from the proposed discharge, focusing on the antidegradation thresholds for temperature and dissolved oxygen.

4.3 Water Quality Analysis

4.3.1 Water Quality Limited Waters

As defined in OAR 340-041-0006(30), Water Quality Limited Waters (WQLW) are those which: a) do not meet the water quality standards during the entire year or defined season even after implementation of standard technology, b) only meet water quality standards through the use of higher than standard technology, or c) insufficient information exists to determine if water quality standards are being met. Observations and existing data indicate that the Sandy River is a Water Quality Limited Water. To address these water quality deficiencies, DEQ completed a Total Maximum Daily Load (TMDL) study for the Sandy River Basin (ODEQ, 2005).

Furthermore, the engineers followed the methodology outlined in DEQ's antidegradation internal management directive for Water Quality Limited TMDL waters to complete this antidegradation review.

4.3.2 Temperature

Based on OAR 340-041-0026(3)(a)(F)(ii), an activity that results in more than 0.25°F change in temperature (at the edge of the mixing zone, if existing) will constitute a lowering of water quality. **Therefore, 0.25°F is the antidegradation threshold for temperature used in this analysis.**

4.3.2.1 Temperature Analysis

The water quality engineers at Murraysmith used the same approach for this water quality analysis as done by DEQ for the TMDL study. That is, we have assumed that 25% of the Sandy River stream flow would be mixed with effluent, and then used mass balance calculations to estimate the resultant mixed temperature and river temperature change. Moreover, we have used the biological temperature criteria as an estimate for stream temperatures because that approach yields the appropriate river temperature change/response for evaluating biological effects. **Table 4-1** below summarizes the calculated overall temperature effect of effluent flow mixing under present (2020) flow conditions. **Table 4-2** summarizes temperature conditions in twenty years, when effluent flows from the satellite wastewater treatment plant are higher and assuming the flows in the Sandy River would be approximately the same.

Table 4–1
Temperature Evaluation: Present (2020) MBR Effluent Flows

Month	WWTP Flow[1] (MGD)	WWTP Temp[2] (°C)	River Flow[3] (MGD)	River Temp[4] (°C)	Delta T at EMZ[5] (°C)	Delta T at EMZ (°F)
JAN	0.79	15.40	607	13.00	0.01	0.02
FEB	0.73	16.20	581	13.00	0.02	0.03
MAR	0.81	15.70	423	13.00	0.02	0.04
APR	0.72	16.40	760	13.00	0.01	0.02
MAY 1-14	0.70	17.40	494	13.00	0.02	0.04
MAY 15-31	0.70	17.90	471	18.00	0.00	0.00
JUN	0.55	20.90	268	18.00	0.02	0.04
JUL	0.38	21.90	214	18.00	0.03	0.05
AUG	0.35	22.80	174	18.00	0.04	0.07
SEP	0.37	22.40	158	18.00	0.04	0.07
OCT 1-14	0.71	21.20	152	18.00	0.06	0.10
OCT 15-31	0.71	20.50	158	13.00	0.13	0.24
NOV	0.88	20.00	246	13.00	0.10	0.18
DEC	0.83	16.70	285	13.00	0.04	0.08

Notes:

1. Estimated wastewater system flow diversion using Murraysmith hydraulic model.
2. Maximum of the 7-day average daily maximum (7 DADM) temps from existing WWTP DMRs.
3. 7Q10 flow at discharge location (USGS data for Sandy River, with Bull Run River and Little Sandy River flows subtracted).
4. Biological temperature criteria used for river temperature.
5. Estimated temperature increase based on 25% of river flow at edge of assumed mixing zone (EMZ).

Table 4–2
Temperature Evaluation: Future (2040) MBR Effluent Flows

Month	WWTP Flow[1] (MGD)	WWTP Temp[2] (°C)	River Flow[3] (MGD)	River Temp[4] (°C)	Delta T at EMZ[5] (°C)	Delta T at EMZ (°F)
JAN	1.64	15.40	607	13.00	0.03	0.05
FEB	1.54	16.20	581	13.00	0.03	0.06
MAR	1.67	15.70	423	13.00	0.04	0.08
APR	1.60	16.40	760	13.00	0.03	0.05
MAY 1-14	1.50	17.40	494	13.00	0.05	0.09
MAY 15-31	1.50	17.90	471	18.00	0.00	0.00
JUN	1.31	20.90	268	18.00	0.06	0.10
JUL	1.10	21.90	214	18.00	0.08	0.14
AUG	1.04	22.80	174	18.00	0.11	0.20
SEP	1.07	22.40	158	18.00	0.12	0.21
OCT 1-14	1.57	21.20	152	18.00	0.13	0.23
OCT 15-31	1.57	20.50	158	13.00	0.29	0.51
NOV	2.00	20.00	246	13.00	0.22	0.40
DEC	1.82	16.70	285	13.00	0.09	0.17

Notes:

1. Estimated wastewater system flow diversion using Murraysmith hydraulic model.
2. Maximum of the 7-day average daily maximum (7 DADM) temps from existing WWTP DMRs.
3. 7Q10 flow at discharge location (USGS data for Sandy River, with Bull Run River and Little Sandy River flows subtracted).
4. Biological temperature criteria used for river temperature.
5. Estimated temperature increase based on 25% of river flow at edge of assumed mixing zone (EMZ).

As shown in Tables 4-1 and 4-2, the increase in temperature associated with the City's proposed discharge into the Sandy River would be minimal during the winter and spring months for both existing and future conditions. Greater impacts could occur during the summer and fall months for future conditions. Discharges to the Sandy River during the fall could result in exceedances of the 0.25 °F antidegradation policy threshold for future conditions as flows from the plant increase.

Therefore, the City would propose to reduce effluent discharges into the Sandy River during the summer and fall months to mitigate future temperature impacts as described below.

4.3.2.2 Temperature Management Plan

To protect aquatic organisms and meet regulatory requirements, the City proposes to provide new treatment and discharge facilities (and flow controls) that do not exceed the antidegradation thresholds. Thus, the City is planning to discharge into the Sandy River when temperatures in the effluent from the plant would not increase river temperatures beyond the 0.25 °F threshold. They plan to employ land application of some amount of effluent at other times. In general, the City would discharge into the Sandy River year-round but would also land apply a portion of the effluent during the summer and fall months. The results of the revised 2040 temperature analysis (with the effluent flow into the Sandy River reduced to about 0.75 to 1.0 MGD during the summer and fall) can be viewed in **Table 4-3** below.

Table 4–3
Temperature Evaluation: Future (2040) With Reduced MBR Effluent Flows

Month	WWTP Flow[1] (MGD)	WWTP Temp[2] (°C)	River Flow[3] (MGD)	River Temp[4] (°C)	Delta T at EMZ[5] (°C)	Delta T at EMZ (°F)
AUG	1.00	22.80	174	18.00	0.11	0.19
SEP	1.00	22.40	158	18.00	0.11	0.20
OCT 1-14	1.00	21.20	152	18.00	0.08	0.15
OCT 15-31	0.75	20.50	158	13.00	0.14	0.25
NOV	1.00	20.00	246	13.00	0.11	0.20

Notes:

1. Wastewater system flow diversion capped at specified flow rate.
2. Maximum of the 7-day average daily maximum (7 DADM) temps from existing WWTP DMRs.
3. 7Q10 flow at discharge location (USGS data for Sandy River, with Bull Run River and Little Sandy River flows subtracted).
4. Biological temperature criteria used for river temperature.
5. Estimated temperature increase based on 25% of river flow at edge of assumed mixing zone (EMZ).

The exact flow rates for stream discharge and land application (and associated time periods) will be determined as part of the final design of the new wastewater facilities, and through the National Pollutant Discharge Elimination System (NPDES) permitting process.

1.3.3 Dissolved Oxygen

Dissolved oxygen (DO) concentration is an important indicator of the suitability of a water body for maintaining the health of aquatic life. In the 2005 Sandy River Basin TMDL, the lower Sandy River downstream of the former site of the Marmot Dam was listed as impaired due to low dissolved oxygen levels, which were below the threshold listed by OAR 340-041-0016. Because no anthropogenic sources of DO depletion were identified, ODEQ proposed to remove this listing. Regardless of the existence of an active TMDL for DO, any new inflows into the Sandy River need sufficient DO concentrations to provide healthy habitat for aquatic life.

Based on OAR 340-041-0026(3)(a)(C)(iii), an activity that results in more than 0.10 mg/L decrease in dissolved oxygen (at the edge of the mixing zone, if existing) will constitute a lowering of water quality. **Therefore, 0.10 mg/L is the antidegradation threshold for dissolved oxygen used in this review.**

4.3.2.3 Dissolved Oxygen Analysis

Murraysmith completed a similar mass balance evaluation for dissolved oxygen (DO) as we did for temperature. We evaluated potential changes in DO in the Sandy River due to monthly effluent discharges from the new membrane biological reactor (MBR) facilities. The DO concentrations in the effluent were estimated based on process design capabilities (providing aeration, for example). Thus, we estimated that DO concentrations in the effluent can reliably be maintained as high as 6 mg/L, as needed.

The results of this analysis are shown in **Tables 4-4 and 4-5** for existing and future conditions, respectively. The effect of dissolved oxygen discharges would be greatest during low flow summer and fall conditions (similar to temperature effects). With higher stream temperatures, this is also the period where dissolved oxygen concentrations in the stream are at their lowest. During the winter and spring months, the effect of the discharge would be minimal, and below the 0.1 mg/L antidegradation threshold for existing and future conditions. For future conditions, there is some possibility that the City could exceed the antidegradation threshold if all the effluent were discharged into the Sandy River. However, as noted in the temperature evaluation, some of the effluent would be land applied in the summer and fall months to not exceed the antidegradation threshold.

Table 4–4
Dissolved Oxygen Evaluation: Present (2020) MBR Effluent

Month	WWTP Flow[1] (MGD)	WWTP DO[2] (mg/L)	River Flow[3] (MGD)	River Temp[4] (°C)	100% Saturation DO[5] (mg/L)	Delta DO at EMZ[6] (mg/L)
JAN	0.79	2.00	607	13.00	10.53	-0.04
FEB	0.73	2.00	581	13.00	10.53	-0.04
MAR	0.81	2.00	423	13.00	10.53	-0.06
APR	0.72	2.00	760	13.00	10.53	-0.03
MAY 1-15	0.70	2.00	494	13.00	10.53	-0.05
MAY 16-31	0.70	2.00	471	18.00	9.44	-0.04
JUN	0.55	2.00	268	18.00	9.44	-0.06
JUL	0.38	2.00	214	18.00	9.44	-0.05
AUG	0.35	6.00	174	18.00	9.44	-0.03
SEP	0.37	6.00	158	18.00	9.44	-0.03
OCT 1-14	0.71	6.00	152	18.00	9.44	-0.06
OCT 15-31	0.71	6.00	158	13.00	10.53	-0.08
NOV	0.88	6.00	246	13.00	10.53	-0.06
DEC	0.83	6.00	285	13.00	10.53	-0.05

Notes

1. Estimated wastewater system flow diversion using Murraysmith hydraulic model.
2. DO in MBR effluent, estimated by Murraysmith.
3. 7Q10 flow at discharge location (USGS data for Sandy River, with Bull Run River and Little Sandy River flows subtracted).
4. Biological temperature criteria used for river temperature.
5. DO in Sandy River, at assumed saturation concentration based on temperature.
6. Calculated change in river DO based on 25% of river flow, at edge of assumed mixing zone.

Table 4–5
Dissolved Oxygen Evaluation: Future (2040) MBR Effluent

Month	WWTP Flow[1] (MGD)	WWTP DO[2] (mg/L)	River Flow[3] (MGD)	River Temp[4] (°C)	100% Saturation DO[5] (mg/L)	Delta DO at EMZ[6] (mg/L)
JAN	1.64	4.00	607	13.00	10.53	-0.07
FEB	1.54	4.00	581	13.00	10.53	-0.07
MAR	1.67	4.00	423	13.00	10.53	-0.10
APR	1.60	4.00	760	13.00	10.53	-0.05
MAY 1-15	1.50	4.00	494	13.00	10.53	-0.08
MAY 16-31	1.50	4.00	471	18.00	9.44	-0.07
JUN	1.31	4.00	268	18.00	9.44	-0.10
JUL	1.10	6.00	214	18.00	9.44	-0.07
AUG	1.04	6.00	174	18.00	9.44	-0.08
SEP	1.07	6.00	158	18.00	9.44	-0.09
OCT 1-14	1.57	6.00	152	18.00	9.44	-0.14
OCT 15-31	1.57	6.00	158	13.00	10.53	-0.17
NOV	2.00	6.00	246	13.00	10.53	-0.14
DEC	1.82	6.00	285	13.00	10.53	-0.11

Notes:

1. Estimated wastewater system flow diversion using Murraysmith hydraulic model.
2. DO in MBR effluent, estimated by Murraysmith.
3. 7Q10 flow at discharge location (USGS data for Sandy River, with Bull Run River and Little Sandy River flows subtracted).
4. Biological temperature criteria used for river temperature.
5. DO in Sandy River, at assumed saturation concentration based on temperature.
6. Calculated change in river DO based on 25% of river flow, at edge of assumed mixing zone.

4.3.2.4 Dissolved Oxygen Management Plan

The DO management plan would have two major components: (1) aerating the effluent to provide higher concentrations of DO, as needed, and (2) reducing the quantity of effluent discharged to the Sandy River by discharging to land during the summer and fall months.

As noted above for temperature management, effluent flows above about 0.8 to 1.0 MGD would be land applied, as needed, during summer and fall to mitigate DO impacts. The results of the revised 2040 DO analysis with the effluent flow into the Sandy River below about 0.8 to 1.0 MGD can be viewed in **Table 4-6** below.

Table 4–6
Dissolved Oxygen Evaluation: Future (2040) With Reduced MBR Effluent Flows

Month	WWTP Flow[1] (MGD)	WWTP DO[2] (mg/L)	River Flow[3] (MGD)	River Temp[4] (°C)	100% Saturation DO[5] (mg/L)	Delta DO at EMZ[6] (mg/L)
AUG	1.04	6.00	174	18.00	9.44	-0.08
SEP	1.07	6.00	158	18.00	9.44	-0.09
OCT 1-14	1.00	6.00	152	18.00	9.44	-0.09
OCT 15-31	0.80	6.00	158	13.00	10.53	-0.09
NOV	1.00	6.00	246	13.00	10.53	-0.07
DEC	1.00	6.00	285	13.00	10.53	-0.06

Notes:

1. Estimated wastewater system flow diversion using Murraysmith hydraulic model.
2. DO in MBR effluent, estimated by Murraysmith.
3. 7Q10 flow at discharge location (USGS data for Sandy River, with Bull Run River and Little Sandy River flows subtracted).
4. Biological temperature criteria used for river temperature.
5. DO in Sandy River, at assumed saturation concentration based on temperature.
3. Calculated change in river DO based on 25% of river flow, at edge of assumed mixing zone.

The exact flow rates for stream discharge and land application (and associated time periods) will be determined as part of the final design of the new wastewater facilities, and through the National Pollutant Discharge Elimination System (NPDES) permitting process.

4.3.3 Other Parameters

The antidegradation guidance from DEQ (the internal management directive) focuses on temperature and dissolved oxygen, which are the two main parameters assessed in this report. The membranes within the MBR facilities have been observed to capture and remove a large percentage of constituents that adhere to the membrane surface, including the particulate fraction of nutrients, toxics, and heavy metals. Additional analysis for these other parameters will be provided, as needed, during the forthcoming NPDES permitting process. The exact location of the proposed, new outfall will be better known at that time, as will the mixing zone boundaries and dilution values.

4.4 Additional Considerations

DEQ's internal management directive (IMD) for antidegradation mentions several other topics that are not applicable here. The City will be addressing these topics later as the project moves forward, and as needed.

4.4.1 Land Use

The City will be doing a land use review and securing the appropriate Land Use Compatibility Statement (LUCS) from their own planning department as the project progresses. They would also conduct a land use review for any project elements located outside of the City limits, with Clackamas County, for example, for land application of effluent.

4.4.2 Social Benefits Versus Environmental Costs

An economic review of social benefits versus environmental costs is not needed since the City is proposing to meet the antidegradation thresholds for DO and temperature.

4.4.3 Other Regulatory Programs

As noted in the introduction, the City is aware of the many additional regulatory approvals required for this project. They will be working with the various local, state, and federal agencies for review and approval of land use, Clean Water Act, Endangered Species Act, and related regulations.

Section **5**

Section 5

Summary and Conclusions

The City of Sandy is proposing to construct new wastewater treatment facilities to meet the needs of their growing community and make other wastewater system improvements. Some of these improvements will be at the existing treatment plant where they have a permitted discharge to Tickle Creek.

They also propose to construct a new satellite treatment facility, using best available technology, where some of the community's wastewater would be treated. This membrane bioreactor (MBR) facility would require a new, permitted discharge to the Sandy River.

Under the terms of the State of Oregon's antidegradation policy, this proposed new discharge is subject to an antidegradation review. The following conclusions are based on the results of that review.

1. The new MBR facility would discharge into the Sandy River using a new pipeline and outfall. The final pipe alignment and outfall location are currently being determined.
2. The new MBR facility would generate high-quality effluent using modern technology.
3. The project engineers have evaluated the potential impacts from the proposed discharge using DEQ's methodology for evaluating discharges into the Sandy River from the Sandy River Basin TMDL (assuming 25% of the 7Q10 river flows mix with effluent).
4. The antidegradation thresholds under review include: (1) no greater than 0.25 °F temperature increase, and (2) no greater than 0.1 mg/L decrease in dissolved oxygen, after mixing at the end of an assumed mixing zone.
5. With estimated effluent flows from the MBR for existing (2020) conditions, the discharge would not exceed the antidegradation thresholds for temperature or dissolved oxygen.
6. With estimated flows from the MBR for future (2040) conditions (as the community grows), the discharge would start to exceed the antidegradation thresholds for temperature and dissolved oxygen during the summer and fall months.
7. The City proposes a temperature management plan where they would land apply a portion of the high-quality effluent during summer and fall to prevent possible thermal impacts to the river.
8. The exact months and amount of effluent to be land applied will be determined during final design and through the NPDES permitting process.

9. To prevent possible impacts to dissolved oxygen, the City proposes a DO management plan where they would land apply a portion of the effluent during the summer and fall, and also oxygenate the effluent as needed.

10. The exact months and amount of effluent to be land applied will be determined during final design and through the NPDES permitting process.

11. The review of other water quality parameters will occur, as needed, during the NPDES permitting process once a new outfall location has been identified and when mixing zone boundaries and estimated dilution are better known.

12. Other environmental reviews for the project under local, state, and federal regulations will progress as the project moves from the planning to design phases.

Section **6**

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Appendix

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APPENDIX A
SANDY RIVER HISTORIC DATA

Table 8-9
Sandy River Water Quality, June 1992 (DEQ)

Constituent	Troutdale RM 3.0	Dabney State Park RM 6.0	USGS Gage RM 18.4	Near Cedar Creek RM 22.0
Temperature, °C	17.5	17.0	16.0	15.0
DO, mg/L	8.7	9.0	9.9	10.1
DO, percent saturation	91	93	99	99
BODY, mg/L	1.3	1.3	1. 1	1.4
$CBOD_5$, mg/L	0.2	0.0	0.1	0.2
TKN, mg/L	0.30	0.20	0.50	< 0.20
NH_3 as N, mg/L	0.020	0.030	< 0.020	< 0.020
NO_2 + NO_3 as N, mg/L	0.040	0.030	< 0.020	4 0.020
Total P as P, mg/L	0.020	0.020	0.020	0.020
Ortho PO_4 as P, mg/L	0.007	0.006	0.008	0.009
TSS, mg/L	< 1	< 1	< 1	< 1
TDS, mg/L	50	47	52	54
Alkalinity as $CaCO_3$, mg/L	19	19	19	19
pH	7.1	7.1	7.2	7.4
Ec, field, μmohs/cm	61	61	61	62
Fecal Coliform (FC), MPN/100 mL	33	110	49	240
Enterococci, #/100 mL	5	20	< 5	15
Chlorophyll-a, μg/L	2.2	2.1	2.0	1.7
Phaeophytin; μg/L	2.1	2.1	2.6	2.4
TS, mg/L	62	64	67	72
Turbidity, NTU	1	1	1	1
COD, mg/L	< 5	< 5	< 5	< 5
TOC, mg/L	1	< 1	< 1	< 1

Data sources include
CH2M Hill, DEQ, BLM

Table 8-10
Sandy River Water Quality, August 1992 (CH2M Hill)

Constituent	Troutdale	Dabney State Park	USGS Gage	Near Cedar Creek
	RM 1.5	RM 6.0	RM 18.4	RM 22.0
Temperature, °C	20.8	19.9	[a]	[a]
DO, mg/L	8.8	9.2	[a]	[a]
DO, percent saturation	98.5	102.7	[a]	[a]
BOD_5, mg/L	< 3	< 3	< 3	< 3
TKN, mg/L	0.42	< 0.10	< 0.10	< 0.10
NH_3 as *N,* mg/L	< 0.06	< 4	0.06	< 0.06
NO_2 + NO_3 as N, mg/L	0.030	0.020	0.113	0.087
Total P as P, mg/L	0.050	< 0.03	< 0.03	0.030
Ortho PO_4 as P, mg/L	< 0.032	< 0.032	40.032	< 0.032
TSS, mg/L	5	4	< 3	6
TDS, mg/L	41	67	6d	64
Alkalinity as $CaCO_3$, mg/L	27	25	23	23
pH, field	7.5	7.8	[a]	[a]
pH, lab	7.6	7.7	7.8	7.8
Ec, field, μmohs/cm	68	62	[a]	[a]
Ec, lab, μmohs/cm	74	66	65	65
Fecal Coliform (FC), MPN/100 mL	140	2	4	8
Fecal Streptococci (FS), #/100 mL	1500	100	200	200
Enterococci, #/100 mL	700	100	200	100
FC/FS Ratio	0.09	0.02	0.02	0.04
Chlorophyll-a, μg/L	-	-	-	-
Periphyton, g/m^2 (dry weight)	0.134	0.175	0.444	0.04

[a] Data logger not working.

Table 8-11
Sandy River Water Quality, September 1992 (DEQ)

Constituent	Troutdale RM 1.5	Dabney State Park RM 6.0	USGS Gage RM 18.4	Near Cedar RM 22.0	Oxbow Park RM 12.0
Temperature, °C	16.0	15.0	12.0	12.5	15.5
DO, mg/L	12.0	11.8	11.0	10.8	11.5
DO, percent saturation	121	116	101	101	115
BOD_5, mg/L	1.7	1.6	1.3	1.1	1.4
$CBOD_5$, mg/L	-	-	-	-	-
TKN, mg/L	< 0.020	< 0.20	< 0.20	< 0.20	< 0.20
NH_3 as N, mg/L	< 0.020	< 0.020	0.020	0.020	0.020
NO_2 + NO_3 as N, mg/L	< 0.020	< 0.020	< 0.020	< 0.020	<0.02
Total PO_4 as P, mg/L	0.040	0.030	0.040	0.060	0.030
Ortho PO_4 as P, mg/L	0.009	0.009	0.013	0.016	0.011
TSS, mg/L	2	5	7	11	6
TDS, mg/L	75	71	78	76	68
Alkalinity as $CaCO_3$, mg/L	-	-	-	-	-
pH	8.6	8.3	7.7	7.8	8.3
Ec, μmohs/cm	73	73	71	73	70
Fecal Coliform (FC), MPN/100 mL	49	11	170	240	23
Enterococci, #/100 mL	20	5	55	50	10
Chlorophyll-a, μg/L	-	-	-	-	-
Phaeophytin, μg/L	-	-	-	-	-
TS, mg/L	77	76	85	87	74
Turbidity, NTU	3	3	4	6	4
COD, mg/L	< 5	7	7	7	< 5
TOC, mg/L	1	1	1	< 1	1

Table 8-12
Hydraulic Sampling Data for the Sandy River—June 1992 (DEQ)

Sampling Site No.	Date	Measured Q, cfs	Cross-Section Area, ft^2	Range of Measured Velocity, fps	Flow Balance[a] Q, cfs	Computed Average[b] Velocity, fps
2 (RM 3.1)	6/11/1992	530	147	1.2 to 5.2	540	3.7
3 (RM 5.9)	6/11/1992	575	179	0.3 to 5.2	540	3.0
5 (RM 12.6)	6/10/1992	492	492	0.4 to 3.3	522	1.1
6 (RM 18.8)	6/10/1992	500	246	0.5 to 3.2	456	1.9
7 (RM 23.8)	6/10/1992	560	299	0.6 to 2.5	420	1.4

[a] Approximate Sandy River flow at specified station was based on preliminary 1992 USGS gage records and tributary flows referenced to the 1988 sampling of ungaged tributaries by the USGS. Both 1988 and 1992 were considered low flow years.

[b] Average cross-section velocity computed from Flow Balance Q/Cross-Section Area.

Table 8-13
Hydraulic Sampling Data for the Sandy River-July 1992 (CH2M HILL)

Sampling Site No.	Date	Measured Q, cfs	Cross-Section Area, ft^2	Range of Measured Velocity, fps	Flow Balance[a] Q, cfs	Computed Average[b] Velocity, fps
1 (RM 1.5)	7/17/1992	416	302	0.7 to 1.9	420	1.4
2 (RM 3.0)	7/17/1992	434	236	1.4 to 2.1	419	1.8
3 (RM 6.0)	7/16/1992	389	371	0.1 to 1.7	419	1.1
4 (RM 10.0)	7/16/1992	432	358	0.1 to 2.2	413	1.2
5 (RM 12.0)	7/15/1992	274	1,526	0.1 to 0.2	413	0.3
6 (RM 18.4)	7/15/1992	319	757	0.1 to 0.6	391	0.5
7 (RM 22.0)	7/16/1992	334	164	1.0 to 2.5	214	1.3

[a] Approximate Sandy River flow at specified station was based on preliminary 1992 USGS gage records and tributary flows referenced to the 1988 sampling of ungaged tributaries by the USGS. Both 1988 and 1992 were considered low flow years.

[b] Average cross-section velocity computed from Flow Balance Q/Cross-Section Area.

Table 8-14
Mean Flow (cfs) Summary for Sandy River and Four Similar Rivers (USGS 1990)

Month	Proposed Minimum Flows for the Sandy River[a]	Sandy River at Oxbow Park D.A. = 600 mi^2 (1927-1980)	Clackamas River near Clackamas D.A. = 930 mi^2 (1963-1983)	North Santiam River at Mehama D.A. = 655 mi^2 (1954-1987)	South Santiam River at Waterloo D.A. = 640 mi^2 (1967-1987)	McKenzie River at Coburg D.A. = 930 mi^2 (1969-1987)
January	1,900	4,044	7,020	5,610	5,790	6,170
February	1,900	3,489	5,500	4,140	4,090	5,020
March	2,000	3,317	4,620	3,370	3,250	4,510
April	2,000	3,567	4,300	3,200	2,670	4,000
May	2,000	3,315	4,210	3,550	2,300	4,450
June	1700/1500	2,111	2,660	2,590	1,580	3,710
July	800/700	1,091	1,360	1,430	782	2,790
August	550	807	1,000	1,310	816	2,860
September	550	747	1,070	2,040	1,420	2,680
October	700	1,465	1,610	2,780	2,250	2,890
November	1,700	3,322	3,870	5,400	4,900	4,870
December	1,700	4,385	6,910	6,480	6,730	6,700

[a] Several beneficial uses were considered in this 1992 recommendation including recreation, boating, and fishery.

Note: D.A. = Drainage Area.

Source: USGS, 1990 Open File Report 90-118. Statistical Summaries of Streamflow Data in Oregon: Volume 1.

Table 8-15
Fisheries Water Quality Summary for Sandy River and Four Similar Rivers (DEQ 1992)

Water Quality Parameters	Optimal Salmonid *Range*	Sandy River at Various Locations (1965-1992)	Clackamas River at High Rocks (1987-1992)	North Santiam River at Green's Bridge (1987-1992)	South Santiam River at Crabtree (1987-1992)	McKenzie River at Coburg Road (1987-1992)
Temperature (°C)	2.2 to 10.0	2.0 to 25.0	1.5 to 24.0	3.S to 22.0	4.5 to 20.8	4.0 to 22.1
Dissolved Oxygen (mg/l)	> 5.0	7.9 to 14.2	7.2 to 14.2	8.3 to 13.2	8.8 to 13.2	8.8 to 13.1
pH (units)	6.5 to 8.5	6.1 to 8.1	6.7 to 8.7	6.6 to 8.6	6.7 to 8.2	6.9 to 8.6
Alkalinity (mg/l as $CaCO_3$)	NA	5 to 113	10 to 35	2 to 22	14 to 23	17 to 30
Total Ammonia (mg/l)	< 1.5	0.01 to 0.58	0.02 to 0.15	0.02 to 0.40	0.02 to 0.23	0.02 to 0.07
Nitrate and Nitrite (mg/l)	< 0.5	0.02 to 0.30	0.02 to 0.76	0.03 to 0.61	0.02 to 0.35	0.02 to 0.14
Total Kjeldahl Nitrogen (mg/l)	NA	0.10 to 0.80	0.20 to 0.90	0.20 to 0.80	0.01 to 0.40	0.20 to 0.70
Total Phosphorus (mg/l)	NA	0.01 to 0.65	0.01 to 0.14	0.01 to 0.12	0.01 to 0.14	0.03 to 0.12

Source: Oregon DEQ 1992. Storet Retrieval System.

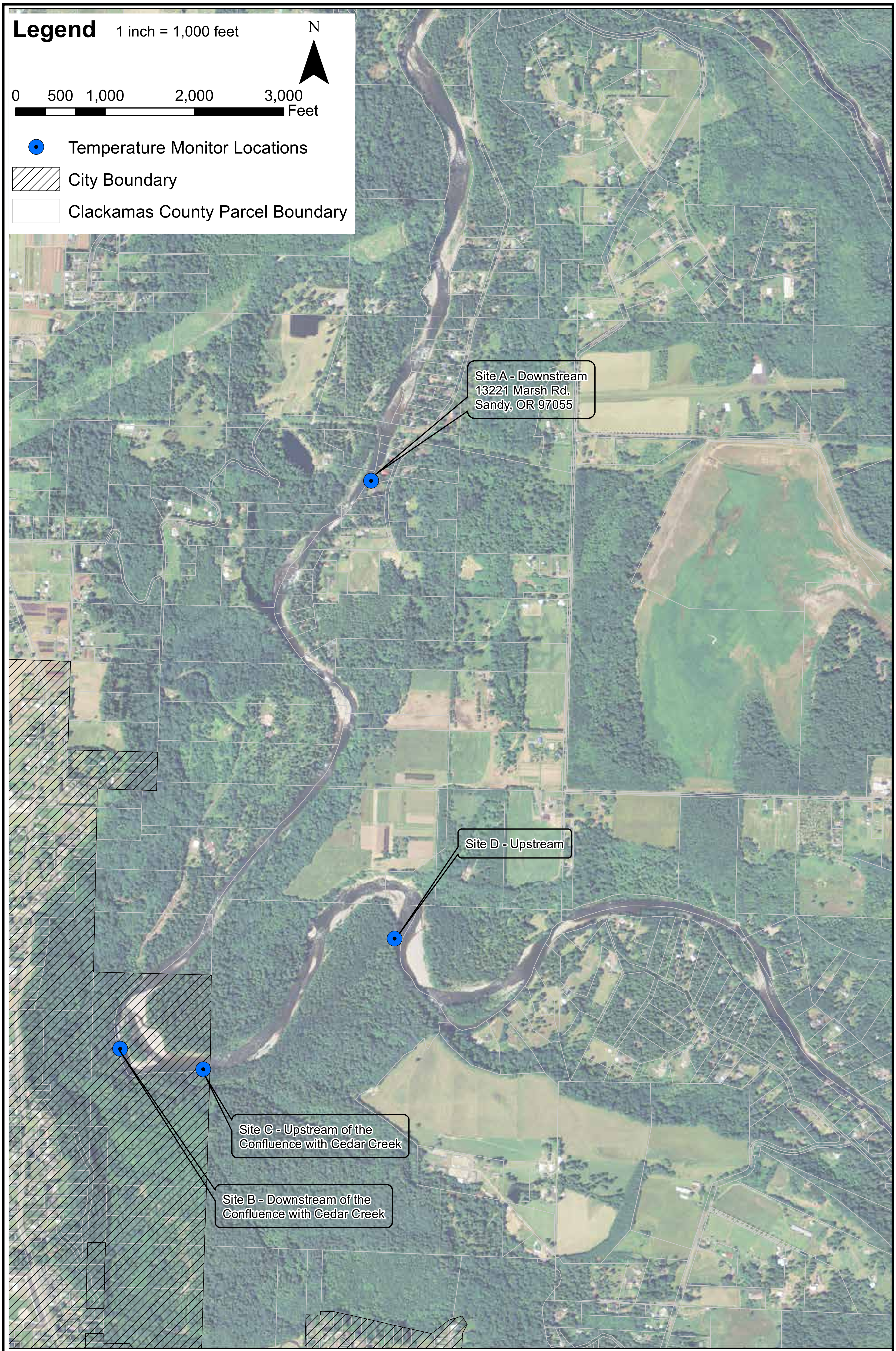
Table 8-16
Sandy River Metals Data - Near Troutdale, RM 2.8 (BLM ~1983)

Metal, Total[a]	Annual Average, (μg/L)			Water Quality Criteria[b] (μg/L)		
				Toxicity to Aquatic Life		Human Health
	1979	1980	1981	Acute	Chronic	
Barium, Ba	< 100	< 1004	100	--	--	1,000.0
Boron, B	< 200	< 200	< 200	-	-	-
Cadmium, Cd	< 1	< 2	< 1	3.9	1.1	10.0
Chromium, Cr	< 50	< 2	< 2	16.0	11.0	30.0
Copper, C	< 50	<30	< 2	18.0	12.0	-
Iron, Fe	< 50	98	88	-	1,000.0	300.0
Lead, Pb	< 10	<10	< 10	82.0	3.2	50.0
Manganese, Mn	< 20	<70	< 20	-	-	50.0
Selenium, Se	< 5	<5	-	260.0	35.0	10.0
Silver, Ag	< 10	< 1	< 1	4.1	0.12	50.0
Zinc, Zn	< 10	< 10	< 25	120.0	110.0	-

[a] Storet Retrieval by Bureau of Land Management, John Barber.

[b] Toxic metals limits for aquatic life and human health, OAR Chapter 340, Division 41, Table 20 data.

APPENDIX B
SANDY RIVER TEMPERATURE MONITORING LOCATIONS



Sandy River Temperature Gage Locations for Effluent Pipe Project

Sandy River Effluent
Pipe Gaging

August 2019

WATERWAYS
CONSULTING, INC.
Santa Cruz, CA | watways.com | Portland, OR

FIGURE
3

APPENDIX C
SANDY RIVER SAMPLING PLAN

Memorandum

Date: August 7, 2019

Project: City of Sandy WSFP – Continuing Services

To: Mike Walker, Sandy Public Works Director
Public Works Director
City of Sandy, OR

From: Preston Van Meter, Project Manager
Jason Flowers, Project Engineer
Jessica Cawley, Staff Engineer

Review: Matt Hickey, Principal-in-Charge

Re: Sandy River Anti-degradation Evaluation – WQ Sampling and Testing Program

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Introduction & Purpose

The purpose of this memo is to summarize the proposed ambient Sandy River water quality sampling and testing program in support of a completing a river anti-degradation evaluation as part of the City's application for a new NPDES discharge permit and outfall on the Sandy River. These data collection efforts are three-fold:

1. **Sandy River Flows.** River flows at the proposed new Sandy River outfall location will be estimated through a local validation process and comparison with historical gauging stations on the Sandy River to provide a long-term flow record to support permitting-related evaluations.
2. **Sandy River Ambient Temperature.** Temperature data will be collected at four locations upstream and downstream of the proposed new Sandy River outfall location during lower flow and critical periods in the spring, summer and fall months over the next 5 years.
3. **Other Sandy River Water Quality Parameters.** Potential water quality (WQ) impacts of the City's proposed new Sandy River outfall will also be assessed in the anti-degradation evaluation by collecting water quality data for other pollutants of concern identified in the river.

Background

In 2019, Murraysmith prepared the City of Sandy Wastewater System Facilities Plan (WSFP) that determined the City's current discharge to Tickle Creek is not a viable long-term option due to the limited flow in the creek and the strict limitations on increasing mass load limits associated with Oregon's Three Basin Rule.

Following a detailed evaluation of cost and a non-cost factors, the recommended long-term alternative involves construction of a new satellite membrane bioreactor (MBR) treatment facility and new year-round discharge to the Sandy River that is not subject to the Three Basin Rule limitations. The proposed Sandy River outfall location is shown in **Figure 1**.

This concept of a new Sandy River outfall was previously investigated by the City in the early 1990's as part of a previous facilities planning effort (CH2M 1994). This previous evaluation included a similar Sandy River water quality sampling and testing program, which included documented historical Sandy River water quality data collected by the Oregon Department of Environment Quality (DEQ) and the Bureau of Land Management (BLM) at five Sandy River locations summarized below. These Sandy River WQ sampling locations are shown in **Figure 2** are summarized as follows:

- RM 3.0 – Lewis and Clark State Park
- RM 6.0 – Dabney State Park
- RM 12.0 – Oxbow County Park
- RM 18.4 – USGS Gaging Station, Dodge Park
- RM 22.0 – Below confluence with Cedar Creek

These previous data are included in **Attachment A**. The previous water quality sampling included the parameters summarized in **Table 1**.

Table 1 – Previous Water Quality Sampling Parameters

Parameters		
Temperature	Alkalinity	Boron
Dissolved Oxygen	pH	Cadmium
Biochemical Oxygen Demand	Electrical conductivity	Chromium
Chemical Oxygen Demand	Fecal Coliform	Copper
Kjeldahl Nitrogen (TKN)	Enterococci	Iron
Ammonia	Chlorophyll-a	Lead
Nitrate and Nitrite	Phaeophytin	Manganese
Total Phosphorus	Total Solids	Selenium
Orthophosphate	Turbidity	Silver
Total Suspended Solids	Total Organic Carbon	Zinc
Total Dissolved Solids	Barium	

This proposed new Sandy River sampling and testing program builds on the previous data collection efforts, but also expanded to include additional water quality parameters as summarized in Oregon's 2012 Integrated Report and 303(d) list, as well as constituents of emerging concern (CECs) that are known at the present time. The 2012 Integrated Report includes the following listings for the Sandy River in the vicinity of the proposed new outfall location:

- **Category 4a (Impaired):** temperature and dissolved oxygen.
- **Category 3 (insufficient data):** iron, lead, copper, alkalinity, chlorophyll-a, manganese, and total suspended solids.
- **Category 2 (partially attaining):** pH, chlorophyll-a, fecal coliform, zinc, nickel, cadmium, dissolved oxygen, E. Coli, ammonia, silver, selenium, arsenic, chromium, and phosphate phosphorus.

Proposed Sandy River Flow and WQ Sampling and Testing Program

The proposed Sandy River sampling and testing program includes three primary elements:

1. Validation of river flows at the proposed outfall location;
2. Long-term temperature monitoring; and
3. Additional water quality parameters.

These data will then be used to support the completion of the anti-degradation evaluation required by Oregon DEQ as part of the permitting process for the City's proposed new Sandy River outfall from the future satellite MBR treatment facility.

Each of these program elements is discussed in the sections that follow.

Sandy River Flow

To establish flow monitoring data, Waterways Consulting, Inc. has been contracted to conduct a site validation of Sandy River flows at the City's proposed new Sandy River outfall location on five occasions over the next year. These data will then be compared to the continuous flow measurements on USGS gauging stations on the Sandy River upstream, approximately 3.5 miles downstream, the Bull Run River, and Little Sandy River. These measurements will then be used to adjust the historical gauge data to estimate flows at the proposed new outfall location. A copy of the proposal from Waterways Consulting (Waterways) for completion of flow estimates is included in **Attachment B.**

Sandy River Temperature

Sandy River temperature will be collected by thermistors placed at four (4) different locations upstream and downstream of the proposed new outfall location. The thermistors will log temperature data continuously from May through October. The Sandy River locations where thermistors have been deployed is shown in **Figure 3**.

The temperature monitoring will be completed by Waterways Consulting on a contract basis with the City over the next five (5) years. The proposal from Waterways Consulting included in

Attachment B also includes a summary the proposed temperature data collection program in addition to the flow validation support previously noted.

Additional Water Quality Parameters

As part of the antidegradation analysis, water quality (WQ) data collection will include the same data collected back in the previous 1990's era sampling and testing program as well as additional parameters included on the 303(d)-list summarized previously. The proposed ambient WQ sampling and testing program will include the WQ parameters summarized in **Table 2**.

Additional Sandy River WQ Data Collection – Costs and Schedule

This section summarizes cost and other coordination items for the proposed Sandy River ambient water quality sampling and testing program. River flow and temperature data collection will be provided by Waterways Consulting, with a total proposed cost of summarized in **Attachment B**.

The schedule for collection of these additional data is based on both near- and long-term goals:

1. **Near-Term Goal:** conduct river water quality sampling and testing events once per month over the next 3 months to support preparation of the Sandy River anti-degradation evaluation for the NPDES Permit application. Near-term river sampling events will be conducted in early August, September and October 2019.
2. **Long-Term Goal:** continue monitoring river water quality through quarterly sampling events in 2020 and 2021 to validate assumptions in the river anti-degradation evaluation. Four river sampling events will be conducted each year.

It is recommended that testing be conducted both upstream and downstream of Cedar Creek (Site B and Site C) as shown in **Figure 3**, allowing an assessment of the impact of the Cedar Creek fish hatchery seasonally on Sandy River water quality.

The additional WQ parameters recommended to be monitored on the Sandy River is summarized in **Table 2** along with the number of samples and lab testing costs for each parameter. This list is informed by the previous testing summarized in Table 1, additional WQ parameters included in the 2012 Integrated Report and current constituents of emerging concern (CECs).

Table 2 – Estimated Sampling and Testing Costs

Parameter	Locations Sampled	2019 Sampling events	2020/21 Sampling Events	Total Samples Collected	Lab Testing Cost/Sample	Lab Cost
Total Organic Carbon (TOC) as $CaCO_3$	2	3	8	22	$55	$1,210
Chlorophyll-a	2	3	8	22	-	-

Parameter	Locations Sampled	2019 Sampling events	2020/21 Sampling Events	Total Samples Collected	Lab Testing Cost/Sample	Lab Cost
Alkalinity as $CaCO_3$	2	3	8	22	$25	$550
Biochemical oxygen demand (BOD_5)	2	3	8	22	$45	$990
Chemical oxygen demand (COD)	2	3	8	22	$30	$660
Bacteria - Fecal Coliform	2	3	8	22	$60	$1,320
Bacteria - E. Coli	2	3	8	22	$40	$880
Bacteria - Enterococci	2	3	8	22	$50	$1,100
pH	2	3	8	22	$10	$220
Total Suspended Solids (TSS)	2	3	8	22	$20	$440
Ammonia, as N	2	3	8	22	$25	$550
Dissolved oxygen	2	3	8	22	$15	$330
Nitrate, as N	2	3	8	22	$25	$550
Nitrite, as N	2	3	8	22	$25	$550
Kjeldahl nitrogen (TKN), as N	2	3	8	22	$45	$990
Phosphorus (Total), as P	2	3	8	22	$30	$660
Orthophosphate, as P	2	3	8	22	$25	$550
Total dissolved solids (TDS)	2	3	8	22	$20	$440
Arsenic	2	3	8	22	$30	$660
Chromium, total	2	3	8	22	$30	$660
Cadmium	2	3	8	22	$20	$440
Copper	2	3	8	22	$15	$330
Iron (Total)	2	3	8	22	$15	$330
Lead	2	3	8	22	$20	$440
Manganese	2	3	8	22	$15	$330
Mercury	2	3	8	22	$35	$770
Nickel	2	3	8	22	$25	$550
Selenium	2	3	8	22	$20	$440
Silver	2	3	8	22	$15	$330
TOTAL					**$785**	**$17,270**

In addition to the lab testing fees summarized in Table 1 above, other costs for implementation of the Sandy River Flow and WQ sampling and testing program are summarized in **Table 3**. For each river WQ sampling event, it is proposed that Murraysmith will coordinate with the testing laboratory and Waterways will collect the river samples.

Table 3 – Sandy River Sampling and Testing Program Costs

Description	Cost
Year 1 Temperature Probe Install and Flow Measurements	$16,700
Year 2 through 5 (2020-2024) Temperature Monitoring and Reporting	$13,100
Analytical testing laboratory	$17,270
River sample collection, lab coordination, and data validation	$27,500
Total Estimated Program Cost	**$74,570**

Other Considerations and Next Steps

Following City review, this proposed plan will be submitted to DEQ for review. Concurrence with DEQ regarding the proposed flow, temperature and additional WQ parameterswill support the preparation of a river anti-degradation evaluation required as part of the City's application for a new Sandy River NPDES Permit.

Concurrent with DEQ review, it is recommended the City complete the August river sampling event. Any modifications of the additional WQ testing parameters would then be implemented in the second or third 2019 sampling events.

References

CH2M Hill. (1994) *Sewerage System Facilities Plan.* City of Sandy.

PLVM:jjf

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