



**Southwestern Illinois
Flood Prevention District Council**

104 United Drive, Collinsville, Illinois

September 2018

FISH LAKE DRAINAGE AND LEVEE DISTRICT
FEMA LEVEL IMPROVEMENTS – LIFE CYCLE COSTS



Table of Contents

1.0	Introduction	3
2.0	Sluice Gates.....	3
3.0	Relief Wells	4
3.1	Maintenance	4
3.1.1	Existing Relief Wells	4
3.1.2	New Relief Wells	4
3.1.3	Relief Well Maintenance	4
3.2	Replacement.....	6
4.0	Piezometers	7
4.1	Maintenance	7
4.2	Replacement.....	7
4.2.1	Transducer Replacement	8
5.0	Seepage Berms	8
6.0	Relief Well Conveyance System Piping, Structures, and Check Valves	11
6.1	Maintenance	11
6.2	Replacement.....	12
7.0	Stumpf (Site 01) Pump Station.....	13
7.1	Maintenance	13
7.2	Replacement.....	15
7.3	Operation	15
8.0	Gravity Drains	18
9.0	Summary.....	18

List of Tables

Table 2-1 – Sluice Gates – Replacement Costs	3
Table 3-1 – Relief Wells – Maintenance Costs	5
Table 3-2 – Relief Wells – Replacement Costs.....	6
Table 4-1 – Piezometers – Replacement Costs.....	7
Table 4-2 – Piezometers – Transducer Costs.....	8
Table 5-1 – Seepage Berms – Maintenance Costs.....	9
Table 6-1 – Pipe Systems – Maintenance Costs	12
Table 6-2 – Pipe Systems – Replacement Costs (Pipe).....	13
Table 6-3 – Pipe Systems – Replacement Costs (Structures)	13
Table 6-4 – Pipe Systems – Replacement Costs (Check Valves)	13
Table 7-1 – Pump Stations – Maintenance Costs	14
Table 7-2 – Pump Stations – Replacement Costs.....	15
Table 7-3 – Pump Stations – Operation Costs.....	16
Table 7-4 – Pump Stations – Total Annual Operation Costs	17
Table 9-1 – Annual Costs	20

1.0 Introduction

In December of 2017, the Southwestern Illinois Flood Prevention District Council (FPD Council) officially turned over the assets constructed as part of the “100-Year” or “FEMA-Level” projects to the Fish Lake Drainage and Levee District (the “District”). These improvements to the Fish Lake Levee System of the Prairie du Pont and Fish Lake Flood Risk Reduction Project were constructed as part of the following construction projects:

- Southwestern Illinois Levee Certification Design, Bid Package 2A
- Southwestern Illinois Levee Certification Design, Bid Package 06

Assets transferred to the district as part of these projects include: sluice gates, relief wells, piezometers, seepage berms, relief well conveyance systems, gravity drains, and a pump station. The following paragraphs outline a brief description of maintenance requirements, an estimated cost associated with maintaining the new asset, and an estimated replacement cost.

The costs represented are estimates that were calculated using single payment compound amount factors based on initial installation costs; compound adjustment factors (CAFs) for 3-percent interest rates are shown in each table. The useful life of each feature has been estimated based on manufacturers’ literature and recommendations from the U.S. Army Corps of Engineers (USACE). Maintenance costs are estimated only up to the useful life of the improvement. The useful life is highly dependent upon diligent maintenance by the District as outlined in the System Wide Operation and Maintenance Manual.

2.0 Sluice Gates

Sluice gates are to be examined, greased, and trial-operated through a complete open/close cycle at least once every 90 days. (See your system wide O&M for further information).

The scope of this project included replacing three (3) existing 84” sluice gates at the end of their useful life. Sluice gates at these locations are already in the District’s maintenance program and therefore, do not add additional maintenance costs to the District’s budget.

The manufacturer of these sluice gates estimates a 30-year useful life. Replacement costs have been estimated as shown in the table below.

Gate Size	Station	Gate Well NO.	Initial Cost	Installation	Useful Life	Planned Replacement	CAF (3%)	Replacement Cost
84"	624+50	GW-6	\$ 65,667	2016	30	2046	2.427	\$ 159,373
84"	624+50	GW-6	\$ 65,667	2016	30	2046	2.427	\$ 159,373
84"	624+50	GW-6	\$ 65,667	2016	30	2046	2.427	\$ 159,373
Total:								\$ 478,119

3.0 Relief Wells

3.1 Maintenance

Relief wells should be kept free of sand, silt, organic matter, or any other material that will retard flow. Wells should be inspected once per year, preferably prior to normal high-water season. Particular attention should be directed to inspecting the condition of the neoprene gaskets on the underside of the check valves. Each well should be sounded annually, and after each major high-water event, to see if the well is free of debris or any other obstruction. All wells that require removal of sediment should be pump-tested after cleanout to see if there has been any appreciable loss of efficiency as a result of foreign material entering the well. In addition, all wells should be pump-tested periodically in accordance with a program that will result in at least 10 percent of all the wells being pumped each year. This annual pumping should be rotated so that in a period of five years, all wells will have been pump tested.

3.1.1 Existing Relief Wells

Eleven (11) existing, wood-stave relief wells are located within the footprint of newly constructed seepage berms. The discharge elevations of these wells were raised to 6” above the new finished grade elevation with a stainless-steel riser and capped with a gasketed, flanged cover.

All 11 wells were existing and consequently already in the District’s maintenance program. Therefore, these assets do not add additional maintenance to the District’s budget.

3.1.2 New Relief Wells

Twenty (20) new stainless-steel relief wells (15 Type “D”, 5 Type “T”) were installed and fifteen (15) existing relief wells were abandoned as part of these improvements. In theory, there is only a net increase of five (5) relief wells to the District’s program. However, the costs for adding all 20 wells are shown below.

3.1.3 Relief Well Maintenance

Regardless of the construction material (wood-stave or stainless-steel) or discharge type (Type “D” or Type “T”), the annual inspection and periodic pump testing requirements are the same, with the only exception being that wood stave wells require cleaning/filtering of the standing water within the column of the well prior to pump testing. Relief well rehabilitation, if needed, may include mechanical or chemical treatment of the screen; rehabilitation is estimated to occur at the mid-life of the relief well. Maintenance costs have been estimated as shown in the table below.

Table 3-1 – Relief Wells – Maintenance Costs

Year No.	Year	CAF (3%)	Annual Sounding		10-Year Pump Testing		Mid-Life Rehabilitation		Cost per Year
			Price	No. of RWs	Price	No. of RWs	Price	No. of RWs	
0	2018	1.000	\$ 200	20	\$ 1,500.00	2	\$ 2,500.00	0	\$7,000
1	2019	1.030	\$ 206	20	\$ 1,545.00	2	\$ 2,575.00	0	\$7,210
2	2020	1.061	\$ 212	20	\$ 1,591.50	2	\$ 2,652.50	0	\$7,427
3	2021	1.093	\$ 219	20	\$ 1,639.50	2	\$ 2,732.50	0	\$7,651
4	2022	1.126	\$ 225	20	\$ 1,689.00	2	\$ 2,815.00	0	\$7,882
5	2023	1.159	\$ 232	20	\$ 1,738.50	2	\$ 2,897.50	0	\$8,113
6	2024	1.194	\$ 239	20	\$ 1,791.00	2	\$ 2,985.00	0	\$8,358
7	2025	1.230	\$ 246	20	\$ 1,845.00	2	\$ 3,075.00	0	\$8,610
8	2026	1.267	\$ 253	20	\$ 1,900.50	2	\$ 3,167.50	0	\$8,869
9	2027	1.305	\$ 261	20	\$ 1,957.50	2	\$ 3,262.50	0	\$9,135
10	2028	1.344	\$ 269	20	\$ 2,016.00	2	\$ 3,360.00	0	\$9,408
11	2029	1.384	\$ 277	20	\$ 2,076.00	2	\$ 3,460.00	0	\$9,688
12	2030	1.426	\$ 285	20	\$ 2,139.00	2	\$ 3,565.00	0	\$9,982
13	2031	1.469	\$ 294	20	\$ 2,203.50	2	\$ 3,672.50	0	\$10,283
14	2032	1.513	\$ 303	20	\$ 2,269.50	2	\$ 3,782.50	0	\$10,591
15	2033	1.558	\$ 312	20	\$ 2,337.00	2	\$ 3,895.00	0	\$10,906
16	2034	1.605	\$ 321	20	\$ 2,407.50	2	\$ 4,012.50	0	\$11,235
17	2035	1.653	\$ 331	20	\$ 2,479.50	2	\$ 4,132.50	0	\$11,571
18	2036	1.702	\$ 340	20	\$ 2,553.00	2	\$ 4,255.00	0	\$11,914
19	2037	1.754	\$ 351	20	\$ 2,631.00	2	\$ 4,385.00	0	\$12,278
20	2038	1.806	\$ 361	20	\$ 2,709.00	2	\$ 4,515.00	0	\$12,642
21	2039	1.860	\$ 372	20	\$ 2,790.00	2	\$ 4,650.00	0	\$13,020
22	2040	1.916	\$ 383	20	\$ 2,874.00	2	\$ 4,790.00	0	\$13,412
23	2041	1.974	\$ 395	20	\$ 2,961.00	2	\$ 4,935.00	0	\$13,818
24	2042	2.033	\$ 407	20	\$ 3,049.50	2	\$ 5,082.50	0	\$14,231
25	2043	2.094	\$ 419	20	\$ 3,141.00	2	\$ 5,235.00	20	\$119,358
26	2044	2.157	\$ 431	20	\$ 3,235.50	2	\$ 5,392.50	0	\$15,099
27	2045	2.221	\$ 444	20	\$ 3,331.50	2	\$ 5,552.50	0	\$15,547
28	2046	2.288	\$ 458	20	\$ 3,432.00	2	\$ 5,720.00	0	\$16,016
29	2047	2.357	\$ 471	20	\$ 3,535.50	2	\$ 5,892.50	0	\$16,499
30	2048	2.427	\$ 485	20	\$ 3,640.50	2	\$ 6,067.50	0	\$16,989
31	2049	2.500	\$ 500	20	\$ 3,750.00	2	\$ 6,250.00	0	\$17,500
32	2050	2.575	\$ 515	20	\$ 3,862.50	2	\$ 6,437.50	0	\$18,025
33	2051	2.652	\$ 530	20	\$ 3,978.00	2	\$ 6,630.00	0	\$18,564
34	2052	2.732	\$ 546	20	\$ 4,098.00	2	\$ 6,830.00	0	\$19,124

Table 3-1 – Relief Wells – Maintenance Costs									
Year No.	Year	CAF (3%)	Annual Sounding		10-Year Pump Testing		Mid-Life Rehabilitation		Cost per Year
			Price	No. of RWs	Price	No. of RWs	Price	No. of RWs	
35	2053	2.814	\$ 563	20	\$ 4,221.00	2	\$ 7,035.00	0	\$19,698
36	2054	2.898	\$ 580	20	\$ 4,347.42	2	\$ 7,245.70	0	\$20,288
37	2055	2.985	\$ 597	20	\$ 4,477.84	2	\$ 7,463.07	0	\$20,897
38	2056	3.075	\$ 615	20	\$ 4,612.18	2	\$ 7,686.96	0	\$21,523
39	2057	3.167	\$ 633	20	\$ 4,750.54	2	\$ 7,917.57	0	\$22,169
40	2058	3.262	\$ 652	20	\$ 4,893.06	2	\$ 8,155.09	0	\$22,834
41	2059	3.360	\$ 672	20	\$ 5,039.85	2	\$ 8,399.75	0	\$23,519
42	2060	3.461	\$ 692	20	\$ 5,191.04	2	\$ 8,651.74	0	\$24,225
43	2061	3.565	\$ 713	20	\$ 5,346.78	2	\$ 8,911.29	0	\$24,952
44	2062	3.671	\$ 734	20	\$ 5,507.18	2	\$ 9,178.63	0	\$25,700
45	2063	3.782	\$ 756	20	\$ 5,672.39	2	\$ 9,453.99	0	\$26,471
46	2064	3.895	\$ 779	20	\$ 5,842.57	2	\$ 9,737.61	0	\$27,265
47	2065	4.012	\$ 802	20	\$ 6,017.84	2	\$ 10,029.74	0	\$28,083
48	2066	4.132	\$ 826	20	\$ 6,198.38	2	\$ 10,330.63	0	\$28,926
49	2067	4.256	\$ 851	20	\$ 6,384.33	2	\$ 10,640.55	0	\$29,794
Totals:									\$894,299

3.2 Replacement

USACE recommends relief well replacement after 50 years; therefore, a 50-year useful life was assumed. Replacement costs have been estimated as shown in the table below.

Table 3-2 – Relief Wells – Replacement Costs								
Relief Well No.	Relief Well Type	Station	Initial Cost	Installation	Useful Life	Planned Replacement	CAF (3%)	Replacement Cost
RW-104X	Type "D"	564+00	\$62,000.00	2015	50	2065	4.384	\$271,808
RW-106X	Type "D"	565+75	\$66,000.00	2015	50	2065	4.384	\$289,344
RW-107A	Type "D"	567+35	\$59,000.00	2015	50	2065	4.384	\$258,656
RW-108X	Type "D"	568+17	\$54,000.00	2015	50	2065	4.384	\$236,736
RW-109X	Type "D"	569+00	\$61,000.00	2015	50	2065	4.384	\$267,424
RW-110X	Type "D"	569+81	\$55,000.00	2015	50	2065	4.384	\$241,120
RW-111X	Type "D"	570+77	\$62,000.00	2015	50	2065	4.384	\$271,808
RW-112X	Type "D"	571+94	\$62,000.00	2015	50	2065	4.384	\$271,808
RW-115X	Type "D"	575+50	\$68,000.00	2015	50	2065	4.384	\$298,112

Table 3-2 – Relief Wells – Replacement Costs

Relief Well No.	Relief Well Type	Station	Initial Cost	Installation	Useful Life	Planned Replacement	CAF (3%)	Replacement Cost
RW-118X	Type "D"	578+50	\$55,000.00	2015	50	2065	4.384	\$241,120
RW-121X	Type "D"	581+80	\$60,000.00	2015	50	2065	4.384	\$263,040
RW-123X	Type "D"	584+69	\$53,000.00	2015	50	2065	4.384	\$232,352
RW-129X	Type "D"	595+00	\$49,000.00	2015	50	2065	4.384	\$214,816
RW-130X	Type "D"	597+45	\$59,000.00	2015	50	2065	4.384	\$258,656
RW-131X	Type "D"	599+10	\$58,000.00	2015	50	2065	4.384	\$254,272
RW-200X	Type "T"	623+86	\$67,000.00	2015	50	2065	4.384	\$293,728
RW-145A	Type "T"	624+93	\$56,000.00	2015	50	2065	4.384	\$245,504
RW-147G	Type "T"	678+55	\$63,000.00	2015	50	2065	4.384	\$276,192
RW-148A	Type "T"	683+56	\$57,000.00	2015	50	2065	4.384	\$249,888
RW-149A	Type "T"	684+66	\$65,000.00	2015	50	2065	4.384	\$284,960
Total:			\$1,191,000.00					\$5,221,344

4.0 Piezometers

4.1 Maintenance

The site of piezometers should be kept clear of weeds and brush and cared for in the same manner as described for relief wells. The District should report any damaged or destroyed piezometers to the Geotechnical Branch, St. Louis District, USACE. General maintenance of piezometers is the responsibility of USACE personnel. Therefore, these assets do not add additional maintenance to the District’s budget.

4.2 Replacement

Nine (9) new piezometers outfitted with transducers were installed. Each piezometer (stainless steel screen and riser and filter pack) is estimated to have a useful life of 50 years. Replacement costs have been estimated as shown in the table below.

Table 4-1 – Piezometers – Replacement Costs

PZ No.	PZ Type	Station	Initial Cost	Installation	Useful Life	Planned Replacement	CAF (3%)	Replacement Cost
PZ-566L	Above Grade	566+18	\$12,000.00	2016	50	2066	4.384	\$52,608
PZ-566R	Above Grade	566+20	\$12,000.00	2016	50	2066	4.384	\$52,608
PZ-596-2L	Above Grade	596+35	\$12,000.00	2016	50	2066	4.384	\$52,608
PZ-596-1L	Above Grade	596+36	\$12,000.00	2016	50	2066	4.384	\$52,608

Table 4-1 – Piezometers – Replacement Costs								
PZ No.	PZ Type	Station	Initial Cost	Installation	Useful Life	Planned Replacement	CAF (3%)	Replacement Cost
PZ-596R	Above Grade	596+40	\$12,000.00	2016	50	2066	4.384	\$52,608
PZ-679L	Above Grade	678+92	\$12,000.00	2016	50	2066	4.384	\$52,608
PZ-679R	At Grade	679+30	\$12,000.00	2016	50	2066	4.384	\$52,608
PZ-680R	Above Grade	680+30	\$12,000.00	2016	50	2066	4.384	\$52,608
PZ-682L	Above Grade	682+80	\$12,000.00	2016	50	2066	4.384	\$52,608
Total:			\$108,000.00					\$473,472

4.2.1 Transducer Replacement

Each new and retrofitted piezometer was equipped with a transducer. The manufacturer estimates a useful life of 10 years. Replacement costs for the transducers throughout the life of the Piezometer have been estimated as shown in the table below.

Table 4-2 – Piezometers – Transducer Costs					
Year No.	Year	CAF (3%)	Price	No. of PZs	Cost per Year
0	2016	1.000	\$ 1,000.00	0	\$ -
10	2026	1.344	\$ 1,344.00	9	\$ 12,096
20	2036	1.806	\$ 1,806.00	9	\$ 16,254
30	2046	2.427	\$ 2,427.00	9	\$ 21,843
40	2056	3.262	\$ 3,262.04	9	\$ 29,358
50	2066	Cost included in new Piezometer			
Total:					\$ 79,551

5.0 Seepage Berms

Seepage berms shall be maintained in accordance with the system wide operation and maintenance manual. Seepage berms have a relatively indefinite life and do not require replacement. However, they do require periodic maintenance, such as mowing, herbicide application, and rodent abatement. Maintenance costs have been estimated as shown in the table below.

Table 5-1 – Seepage Berms – Maintenance Costs

Year No.	Year	CAF (3%)	Rodent/Herbicide			Mowing			Cost per Year
			Price	Area (Ac)	Frequency/Year	Price	Area (Ac)	Frequency/Year	
0	2018	1.000	\$ 20	9.9	1	\$ 60.00	9.9	4	\$2,574
1	2019	1.030	\$ 21	9.9	1	\$ 61.80	9.9	4	\$2,651
2	2020	1.061	\$ 21	9.9	1	\$ 63.66	9.9	4	\$2,731
3	2021	1.093	\$ 22	9.9	1	\$ 65.58	9.9	4	\$2,813
4	2022	1.126	\$ 23	9.9	1	\$ 67.56	9.9	4	\$2,898
5	2023	1.159	\$ 23	9.9	1	\$ 69.54	9.9	4	\$2,983
6	2024	1.194	\$ 24	9.9	1	\$ 71.64	9.9	4	\$3,073
7	2025	1.230	\$ 25	9.9	1	\$ 73.80	9.9	4	\$3,166
8	2026	1.267	\$ 25	9.9	1	\$ 76.02	9.9	4	\$3,261
9	2027	1.305	\$ 26	9.9	1	\$ 78.30	9.9	4	\$3,359
10	2028	1.344	\$ 27	9.9	1	\$ 80.64	9.9	4	\$3,459
11	2029	1.384	\$ 28	9.9	1	\$ 83.04	9.9	4	\$3,562
12	2030	1.426	\$ 29	9.9	1	\$ 85.56	9.9	4	\$3,671
13	2031	1.469	\$ 29	9.9	1	\$ 88.14	9.9	4	\$3,781
14	2032	1.513	\$ 30	9.9	1	\$ 90.78	9.9	4	\$3,894
15	2033	1.558	\$ 31	9.9	1	\$ 93.48	9.9	4	\$4,010
16	2034	1.605	\$ 32	9.9	1	\$ 96.30	9.9	4	\$4,131
17	2035	1.653	\$ 33	9.9	1	\$ 99.18	9.9	4	\$4,255
18	2036	1.702	\$ 34	9.9	1	\$ 102.12	9.9	4	\$4,381
19	2037	1.754	\$ 35	9.9	1	\$ 105.24	9.9	4	\$4,515
20	2038	1.806	\$ 36	9.9	1	\$ 108.36	9.9	4	\$4,649
21	2039	1.860	\$ 37	9.9	1	\$ 111.60	9.9	4	\$4,788
22	2040	1.916	\$ 38	9.9	1	\$ 114.96	9.9	4	\$4,932
23	2041	1.974	\$ 39	9.9	1	\$ 118.44	9.9	4	\$5,081
24	2042	2.033	\$ 41	9.9	1	\$ 121.98	9.9	4	\$5,233
25	2043	2.094	\$ 42	9.9	1	\$ 125.64	9.9	4	\$5,390
26	2044	2.157	\$ 43	9.9	1	\$ 129.42	9.9	4	\$5,552
27	2045	2.221	\$ 44	9.9	1	\$ 133.26	9.9	4	\$5,717
28	2046	2.288	\$ 46	9.9	1	\$ 137.28	9.9	4	\$5,889
29	2047	2.357	\$ 47	9.9	1	\$ 141.42	9.9	4	\$6,067
30	2048	2.427	\$ 49	9.9	1	\$ 145.62	9.9	4	\$6,247
31	2049	2.500	\$ 50	9.9	1	\$ 150.00	9.9	4	\$6,435
32	2050	2.575	\$ 52	9.9	1	\$ 154.50	9.9	4	\$6,628
33	2051	2.652	\$ 53	9.9	1	\$ 159.12	9.9	4	\$6,826
34	2052	2.732	\$ 55	9.9	1	\$ 163.92	9.9	4	\$7,032
35	2053	2.814	\$ 56	9.9	1	\$ 168.84	9.9	4	\$7,243
36	2054	2.898	\$ 58	9.9	1	\$ 173.90	9.9	4	\$7,460
37	2055	2.985	\$ 60	9.9	1	\$ 179.11	9.9	4	\$7,684
38	2056	3.075	\$ 61	9.9	1	\$ 184.49	9.9	4	\$7,914
39	2057	3.167	\$ 63	9.9	1	\$ 190.02	9.9	4	\$8,152
40	2058	3.262	\$ 65	9.9	1	\$ 195.72	9.9	4	\$8,396
41	2059	3.360	\$ 67	9.9	1	\$ 201.59	9.9	4	\$8,648
42	2060	3.461	\$ 69	9.9	1	\$ 207.64	9.9	4	\$8,908

Table 5-1 – Seepage Berms – Maintenance Costs

Year No.	Year	CAF (3%)	Rodent/Herbicide			Mowing			Cost per Year
			Price	Area (Ac)	Frequency/Year	Price	Area (Ac)	Frequency/Year	
43	2061	3.565	\$ 71	9.9	1	\$ 213.87	9.9	4	\$9,175
44	2062	3.671	\$ 73	9.9	1	\$ 220.29	9.9	4	\$9,450
45	2063	3.782	\$ 76	9.9	1	\$ 226.90	9.9	4	\$9,734
46	2064	3.895	\$ 78	9.9	1	\$ 233.70	9.9	4	\$10,026
47	2065	4.012	\$ 80	9.9	1	\$ 240.71	9.9	4	\$10,327
48	2066	4.132	\$ 83	9.9	1	\$ 247.94	9.9	4	\$10,636
49	2067	4.256	\$ 85	9.9	1	\$ 255.37	9.9	4	\$10,956
50	2068	4.384	\$ 88	9.9	1	\$ 263.04	9.9	4	\$11,284
51	2069	4.516	\$ 90	9.9	1	\$ 270.93	9.9	4	\$11,623
52	2070	4.651	\$ 93	9.9	1	\$ 279.06	9.9	4	\$11,972
53	2071	4.791	\$ 96	9.9	1	\$ 287.43	9.9	4	\$12,331
54	2072	4.934	\$ 99	9.9	1	\$ 296.05	9.9	4	\$12,701
55	2073	5.082	\$ 102	9.9	1	\$ 304.94	9.9	4	\$13,082
56	2074	5.235	\$ 105	9.9	1	\$ 314.08	9.9	4	\$13,474
57	2075	5.392	\$ 108	9.9	1	\$ 323.51	9.9	4	\$13,878
58	2076	5.554	\$ 111	9.9	1	\$ 333.21	9.9	4	\$14,295
59	2077	5.720	\$ 114	9.9	1	\$ 343.21	9.9	4	\$14,724
60	2078	5.892	\$ 118	9.9	1	\$ 353.50	9.9	4	\$15,165
61	2079	6.068	\$ 121	9.9	1	\$ 364.11	9.9	4	\$15,620
62	2080	6.251	\$ 125	9.9	1	\$ 375.03	9.9	4	\$16,089
63	2081	6.438	\$ 129	9.9	1	\$ 386.28	9.9	4	\$16,572
64	2082	6.631	\$ 133	9.9	1	\$ 397.87	9.9	4	\$17,069
65	2083	6.830	\$ 137	9.9	1	\$ 409.81	9.9	4	\$17,581
66	2084	7.035	\$ 141	9.9	1	\$ 422.10	9.9	4	\$18,108
67	2085	7.246	\$ 145	9.9	1	\$ 434.77	9.9	4	\$18,651
68	2086	7.463	\$ 149	9.9	1	\$ 447.81	9.9	4	\$19,211
69	2087	7.687	\$ 154	9.9	1	\$ 461.24	9.9	4	\$19,787
70	2088	7.918	\$ 158	9.9	1	\$ 475.08	9.9	4	\$20,381
71	2089	8.156	\$ 163	9.9	1	\$ 489.33	9.9	4	\$20,992
72	2090	8.400	\$ 168	9.9	1	\$ 504.01	9.9	4	\$21,622
73	2091	8.652	\$ 173	9.9	1	\$ 519.13	9.9	4	\$22,271
74	2092	8.912	\$ 178	9.9	1	\$ 534.71	9.9	4	\$22,939
75	2093	9.179	\$ 184	9.9	1	\$ 550.75	9.9	4	\$23,627
76	2094	9.454	\$ 189	9.9	1	\$ 567.27	9.9	4	\$24,336
77	2095	9.738	\$ 195	9.9	1	\$ 584.29	9.9	4	\$25,066
78	2096	10.030	\$ 201	9.9	1	\$ 601.82	9.9	4	\$25,818
79	2097	10.331	\$ 207	9.9	1	\$ 619.87	9.9	4	\$26,592
80	2098	10.641	\$ 213	9.9	1	\$ 638.47	9.9	4	\$27,390
81	2099	10.960	\$ 219	9.9	1	\$ 657.62	9.9	4	\$28,212
82	2100	11.289	\$ 226	9.9	1	\$ 677.35	9.9	4	\$29,058
83	2101	11.628	\$ 233	9.9	1	\$ 697.67	9.9	4	\$29,930
84	2102	11.977	\$ 240	9.9	1	\$ 718.60	9.9	4	\$30,828
85	2103	12.336	\$ 247	9.9	1	\$ 740.16	9.9	4	\$31,753

Table 5-1 – Seepage Berms – Maintenance Costs

Year No.	Year	CAF (3%)	Rodent/Herbicide			Mowing			Cost per Year
			Price	Area (Ac)	Frequency/Year	Price	Area (Ac)	Frequency/Year	
86	2104	12.706	\$ 254	9.9	1	\$ 762.36	9.9	4	\$32,705
87	2105	13.087	\$ 262	9.9	1	\$ 785.23	9.9	4	\$33,687
88	2106	13.480	\$ 270	9.9	1	\$ 808.79	9.9	4	\$34,697
89	2107	13.884	\$ 278	9.9	1	\$ 833.05	9.9	4	\$35,738
90	2108	14.301	\$ 286	9.9	1	\$ 858.05	9.9	4	\$36,810
91	2109	14.730	\$ 295	9.9	1	\$ 883.79	9.9	4	\$37,914
92	2110	15.172	\$ 303	9.9	1	\$ 910.30	9.9	4	\$39,052
93	2111	15.627	\$ 313	9.9	1	\$ 937.61	9.9	4	\$40,223
94	2112	16.096	\$ 322	9.9	1	\$ 965.74	9.9	4	\$41,430
95	2113	16.579	\$ 332	9.9	1	\$ 994.71	9.9	4	\$42,673
96	2114	17.076	\$ 342	9.9	1	\$ 1,024.55	9.9	4	\$43,953
97	2115	17.588	\$ 352	9.9	1	\$ 1,055.29	9.9	4	\$45,272
98	2116	18.116	\$ 362	9.9	1	\$ 1,086.95	9.9	4	\$46,630
99	2117	18.659	\$ 373	9.9	1	\$ 1,119.56	9.9	4	\$48,029
100	2118	19.219	\$ 384	9.9	1	\$ 1,153.14	9.9	4	\$49,470
Total:									\$ 1,612,664

6.0 Relief Well Conveyance System Piping, Structures, and Check Valves

6.1 Maintenance

Relief well conveyance systems are to be inspected periodically to ensure that the pipes, structures, and check valves are in good condition and that there is not an accumulation of silt, trash, and debris in the conveyance pipes, manholes, or at the outfall structures. At a minimum, conveyance systems shall be televised via CCTV every 5 years to ensure that there are no obstructions, rips, tears, or deformations in the pipe and that the structural integrity of the pipe has not been compromised in any way. It is estimated that half way through the useful life, the pipe may require some sort of pipe rehab such as a cured in place liner. Maintenance costs have been estimated as shown in the table below.

Table 6-1 – Pipe Systems – Maintenance Costs							
Year No.	Year	CAF (3%)	Cleaning/CCTV		Pipe Rehab		Cost per Year
			Price	LF of Pipe	Price	LF of Pipe	
0	2016	1.000	\$ 10	0	\$ 140.00	0	\$ -
5	2021	1.159	\$ 12	1000	\$ 162.26	0	\$ 11,590
10	2026	1.344	\$ 13	1000	\$ 188.16	0	\$ 13,440
15	2031	1.558	\$ 16	1000	\$ 218.12	0	\$ 15,580
20	2036	1.806	\$ 18	1000	\$ 252.84	0	\$ 18,060
25	2041	2.094	\$ 21	1000	\$ 293.16	0	\$ 20,940
30	2046	2.427	\$ 24	1000	\$ 339.78	0	\$ 24,270
35	2051	2.814	\$ 28	1000	\$ 393.96	0	\$ 28,140
40	2056	3.262	\$ 33	1000	\$ 456.68	0	\$ 32,620
45	2061	3.782	\$ 38	1000	\$ 529.48	0	\$ 37,820
50	2066	4.384	\$ 44	1000	\$ 613.76	1000	\$ 657,600
55	2071	5.082	\$ 51	1000	\$ 711.48	0	\$ 50,820
60	2076	5.892	\$ 59	1000	\$ 824.88	0	\$ 58,920
65	2081	6.830	\$ 68	1000	\$ 956.20	0	\$ 68,300
70	2086	7.918	\$ 79	1000	\$ 1,108.52	0	\$ 79,180
75	2091	9.179	\$ 92	1000	\$ 1,285.06	0	\$ 91,790
80	2096	10.641	\$ 106	1000	\$ 1,489.74	0	\$ 106,410
85	2101	12.336	\$ 123	1000	\$ 1,727.04	0	\$ 123,360
90	2106	14.300	\$ 143	1000	\$ 2,002.00	0	\$ 143,000
95	2111	16.578	\$ 166	1000	\$ 2,320.92	0	\$ 165,780
Total:							\$ 1,747,620

6.2 Replacement

These projects added nearly 1,000 linear feet of high-density polyethylene (HDPE) pipe of varying sizes. These systems are located at the Type “T” relief wells near Palmer Creek Pump Station and at Stumpf (Site 01) Pump Station.

The manufacturer of the HDPE Pipe publishes a useful life of at least 100 years. The manufacturer of the reinforced concrete structures publishes a useful life of 75 to 100 years. The manufacturer of the rubber check valves publishes a useful life of 35-50 years. Replacement costs have been estimated as shown in the table below.

Table 6-2 – Pipe Systems – Replacement Costs (Pipe)

System	Start Station	End Station	Initial Cost	Installation	Useful Life	Planned Replacement	CAF (3%)	Replacement Cost
Type "T" Relief Well Outlet Works	623+86	624+93	\$ 1,948	2016	100	2116	19.219	\$37,447
Stumpf (Site 1) Relief Well Collector	678+00	689+00	\$ 61,428	2016	100	2116	19.219	\$1,180,592
Total:			\$ 63,377					\$1,218,039

Table 6-3 – Pipe Systems – Replacement Costs (Structures)

System	Structure Type	QTY	Initial Cost	Installation	Useful Life	Planned Replacement	CAF (3%)	Replacement Cost
Type "T" Relief Well Outlet Works	End Section	2	\$ 6,140	2016	75	2091	9.179	\$56,359
Stumpf (Site 1) Relief Well Collector	48" MH	1	\$ 2,250	2016	75	2091	9.179	\$20,653
	60" MH	1	\$ 2,950	2016	75	2091	9.179	\$27,078
Totals:			\$ 11,340					\$104,090

Table 6-4 – Pipe Systems – Replacement Costs (Check Valves)

System	Type	QTY	Initial Cost	Installation	Useful Life	Planned Replacement	CAF (3%)	Replacement Cost
Type "T" Relief Well Outlet Works	Duckbill	2	\$ 2,000	2016	35	2051	2.814	\$5,628
Total:			\$ 2,000					\$5,628

7.0 Stumpf (Site 01) Pump Station

7.1 Maintenance

Periodic inspections of the pump station shall be made to ensure that concrete, miscellaneous metals, riprap, pipes, gates and operating mechanisms are in good condition. Metal parts are to be adequately covered with paint and kept free from rust. Machine-finished surfaces shall be protected from rusting by applying a coating of lubricant. Care is being exercised to prevent the accumulation of silt, trash, and debris near or within the structure. Sluice gates within the wet well are to be maintained as described in the System Wide Operation and Maintenance Manual. Pumps, controls, and other instrumentation are to be maintained per the Operation and Maintenance Manual for each pump station. Over the long term, the pump station may need to be rehabilitated. For example, several mechanical components may be worn or broken, and electronic components may become obsolete. If a major rehabilitation is needed, the sponsor should coordinate with USACE to discuss the technical plans and the timing of the work. If parts of the pump station or gravity drain structures have been damaged or worn to the point where they should be replaced rather than repaired, the replacement parts should be the same as those shown on the as-built drawings. Maintenance costs have been estimated as shown in the table below.

Table 7-1 – Pump Stations – Maintenance Costs											
Year No.	Year	CAF (3%)	Sluice Gate		Sluice Gate Rehab		Pumps/Controls		Pumps/Controls Rehab		Cost per Year
			Price	QTY	Price	QTY	Price	QTY	Price	QTY	
0	2014	1.000	\$ 50	1	\$ 30,000	0	\$ 500	0	\$ 50,000	0	\$ 50
1	2015	1.030	\$ 52	1	\$ 30,900	0	\$ 515	0	\$ 51,500	0	\$ 52
2	2016	1.061	\$ 53	1	\$ 31,830	0	\$ 531	0	\$ 53,050	0	\$ 53
3	2017	1.093	\$ 55	1	\$ 32,790	0	\$ 547	0	\$ 54,650	0	\$ 55
4	2018	1.126	\$ 56	1	\$ 33,780	0	\$ 563	0	\$ 56,300	0	\$ 56
5	2019	1.159	\$ 58	1	\$ 34,770	0	\$ 580	2	\$ 57,950	0	\$ 1,217
6	2020	1.194	\$ 60	1	\$ 35,820	0	\$ 597	0	\$ 59,700	0	\$ 60
7	2021	1.230	\$ 62	1	\$ 36,900	0	\$ 615	0	\$ 61,500	0	\$ 62
8	2022	1.267	\$ 63	1	\$ 38,010	0	\$ 634	0	\$ 63,350	0	\$ 63
9	2023	1.305	\$ 65	1	\$ 39,150	0	\$ 653	0	\$ 65,250	0	\$ 65
10	2024	1.344	\$ 67	1	\$ 40,320	0	\$ 672	2	\$ 67,200	0	\$ 1,411
11	2025	1.384	\$ 69	1	\$ 41,520	0	\$ 692	0	\$ 69,200	0	\$ 69
12	2026	1.426	\$ 71	1	\$ 42,780	0	\$ 713	0	\$ 71,300	0	\$ 71
13	2027	1.469	\$ 73	1	\$ 44,070	0	\$ 735	0	\$ 73,450	0	\$ 73
14	2028	1.513	\$ 76	1	\$ 45,390	0	\$ 757	0	\$ 75,650	0	\$ 76
15	2029	1.558	\$ 78	1	\$ 46,740	0	\$ 779	2	\$ 77,900	0	\$ 1,636
16	2030	1.605	\$ 80	1	\$ 48,150	0	\$ 803	0	\$ 80,250	0	\$ 80
17	2031	1.653	\$ 83	1	\$ 49,590	0	\$ 827	0	\$ 82,650	0	\$ 83
18	2032	1.702	\$ 85	1	\$ 51,060	0	\$ 851	0	\$ 85,100	0	\$ 85
19	2033	1.754	\$ 88	1	\$ 52,620	0	\$ 877	0	\$ 87,700	0	\$ 88
20	2034	1.806	\$ 90	1	\$ 54,180	0	\$ 903	2	\$ 90,300	0	\$ 1,896
21	2035	1.860	\$ 93	1	\$ 55,800	0	\$ 930	0	\$ 93,000	0	\$ 93
22	2036	1.916	\$ 96	1	\$ 57,480	0	\$ 958	0	\$ 95,800	0	\$ 96
23	2037	1.974	\$ 99	1	\$ 59,220	0	\$ 987	0	\$ 98,700	0	\$ 99
24	2038	2.033	\$ 102	1	\$ 60,990	0	\$ 1,017	0	\$ 101,650	0	\$ 102
25	2039	2.094	\$ 105	1	\$ 62,820	1	\$ 1,047	2	\$ 104,700	2	\$ 274,419
26	2040	2.157	\$ 108	1	\$ 64,710	0	\$ 1,079	0	\$ 107,850	0	\$ 108
27	2041	2.221	\$ 111	1	\$ 66,630	0	\$ 1,111	0	\$ 111,050	0	\$ 111
28	2042	2.288	\$ 114	1	\$ 68,640	0	\$ 1,144	0	\$ 114,400	0	\$ 114
29	2043	2.357	\$ 118	1	\$ 70,710	0	\$ 1,179	0	\$ 117,850	0	\$ 118
30	2044	2.427	\$ 121	1	\$ 72,810	0	\$ 1,214	2	\$ 121,350	0	\$ 2,548
31	2045	2.500	\$ 125	1	\$ 75,000	0	\$ 1,250	0	\$ 125,000	0	\$ 125
32	2046	2.575	\$ 129	1	\$ 77,250	0	\$ 1,288	0	\$ 128,750	0	\$ 129
33	2047	2.652	\$ 133	1	\$ 79,560	0	\$ 1,326	0	\$ 132,600	0	\$ 133
34	2048	2.732	\$ 137	1	\$ 81,960	0	\$ 1,366	0	\$ 136,600	0	\$ 137
35	2049	2.814	\$ 141	1	\$ 84,420	0	\$ 1,407	2	\$ 140,700	0	\$ 2,955
36	2050	2.898	\$ 145	1	\$ 86,948	0	\$ 1,449	0	\$ 144,914	0	\$ 145

Table 7-1 – Pump Stations – Maintenance Costs											
Year No.	Year	CAF (3%)	Sluice Gate		Sluice Gate Rehab		Pumps/Controls		Pumps/Controls Rehab		Cost per Year
			Price	QTY	Price	QTY	Price	QTY	Price	QTY	
37	2051	2.985	\$ 149	1	\$ 89,557	0	\$ 1,493	0	\$ 149,261	0	\$ 149
38	2052	3.075	\$ 154	1	\$ 92,244	0	\$ 1,537	0	\$ 153,739	0	\$ 154
39	2053	3.167	\$ 158	1	\$ 95,011	0	\$ 1,584	0	\$ 158,351	0	\$ 158
40	2054	3.262	\$ 163	1	\$ 97,861	0	\$ 1,631	2	\$ 163,102	0	\$ 3,425
41	2055	3.360	\$ 168	1	\$100,797	0	\$ 1,680	0	\$ 167,995	0	\$ 168
42	2056	3.461	\$ 173	1	\$103,821	0	\$ 1,730	0	\$ 173,035	0	\$ 173
43	2057	3.565	\$ 178	1	\$106,936	0	\$ 1,782	0	\$ 178,226	0	\$ 178
44	2058	3.671	\$ 184	1	\$110,144	0	\$ 1,836	0	\$ 183,573	0	\$ 184
45	2059	3.782	\$ 189	1	\$113,448	0	\$ 1,891	2	\$ 189,080	0	\$ 3,971
46	2060	3.895	\$ 195	1	\$116,851	0	\$ 1,948	0	\$ 194,752	0	\$ 195
47	2061	4.012	\$ 201	1	\$120,357	0	\$ 2,006	0	\$ 200,595	0	\$ 201
48	2062	4.132	\$ 207	1	\$123,968	0	\$ 2,066	0	\$ 206,613	0	\$ 207
49	2063	4.256	\$ 213	1	\$127,687	0	\$ 2,128	0	\$ 212,811	0	\$ 213
Total:											\$ 298,106

7.2 Replacement

The estimated life of this pump station is approximately 50 years. Performing periodic and annual maintenance as described in the Operation and Maintenance Manual may prolong the useful life, especially if the sluice gates and pumps are rehabilitated after 25 years as shown above. However, full replacement will undoubtedly be necessary at some point. Replacement costs have been estimated as shown in the table below.

Table 7-2 – Pump Stations – Replacement Costs							
System	Station	Initial Cost	Installation	Useful Life	Planned Replacement	CAF (3%)	Replacement Cost
Stumpf (Site 01)	689+00	\$ 800,000	2014	50	2064	4.384	\$ 3,507,200
Total:		\$ 800,000					\$ 3,507,200

7.3 Operation

Operation costs have been estimated on a yearly basis. Using available data for the Mississippi River Gage at St. Louis, the number and duration of “activating” events were evaluated to deduce a reasonable pumping duration. It was determined that there is no correlation between an event’s magnitude and its duration (i.e. 2-yr flood events can and tend to last nearly as long as 50-yr and 100-yr flood events, etc.). An operating duration of 85 days was chosen to capture both the average days in operation per year (80) and the maximum duration that can represent 75% of the events (85). The

last recorded event that exceeded a 100-yr event was the Flood of 1993, which was an approximately 300-yr event. According to operational levels of the constructed pump station, the Flood of 1993 would have activated the station for 200 consecutive days. While not expected each year, the increased operating costs for flood events of such magnitude should be anticipated.

Costs included in Table 7-3 assume that during an operating event, the duty pump will run simultaneously, and continuously for the event duration. Additionally, the table below includes the cost for 200-day duration. It is recommended that this amount be held on reserve in the event of a high-magnitude flood event or duration. Electrical costs, per kilowatt hour, were obtained from Site 16 invoices in Cahokia, IL between May 2015 and May 2018. The operating costs are listed annually for the useful life of the stations in Table 7-4.

Table 7-3 – Pump Stations – Operation Costs

Pump Station Site	Starting River Level (ft)	Ending River Level (ft)	No. of Duty Pumps	Rated Horsepower (per Pump)	Total Kilowatts	Average Days in Operation	Total Kilowatt Hours / Year	Energy Cost Per Kilowatt Hour	Cost Per Year	200-Day Reserve
Site 01	30	20	1	45	34	85	68455	\$ 0.034360	\$ 2,352	\$ 5,534
Total:									\$ 2,352	\$ 5,534

Table 7-4 – Pump Stations – Total Annual Operation Costs					
Year No.	Year	CAF (3%)	Installation	Useful Life	Total (All Stations) Operation Cost
0	2018	1.000	2017	50	\$ 2,352
1	2019	1.030	2017	50	\$ 2,423
2	2020	1.061	2017	50	\$ 2,495
3	2021	1.093	2017	50	\$ 2,570
4	2022	1.126	2017	50	\$ 2,647
5	2023	1.159	2017	50	\$ 2,727
6	2024	1.194	2017	50	\$ 2,808
7	2025	1.230	2017	50	\$ 2,893
8	2026	1.267	2017	50	\$ 2,979
9	2027	1.305	2017	50	\$ 3,069
10	2028	1.344	2017	50	\$ 3,161
11	2029	1.384	2017	50	\$ 3,256
12	2030	1.426	2017	50	\$ 3,353
13	2031	1.469	2017	50	\$ 3,454
14	2032	1.513	2017	50	\$ 3,558
15	2033	1.558	2017	50	\$ 3,664
16	2034	1.605	2017	50	\$ 3,774
17	2035	1.653	2017	50	\$ 3,887
18	2036	1.702	2017	50	\$ 4,004
19	2037	1.754	2017	50	\$ 4,124
20	2038	1.806	2017	50	\$ 4,248
21	2039	1.860	2017	50	\$ 4,375
22	2040	1.916	2017	50	\$ 4,507
23	2041	1.974	2017	50	\$ 4,642
24	2042	2.033	2017	50	\$ 4,781
25	2043	2.094	2017	50	\$ 4,925
26	2044	2.157	2017	50	\$ 5,072
27	2045	2.221	2017	50	\$ 5,224
28	2046	2.288	2017	50	\$ 5,381
29	2047	2.357	2017	50	\$ 5,543
30	2048	2.427	2017	50	\$ 5,709
31	2049	2.500	2017	50	\$ 5,880
32	2050	2.575	2017	50	\$ 6,057
33	2051	2.652	2017	50	\$ 6,238
34	2052	2.732	2017	50	\$ 6,425

Table 7-4 – Pump Stations – Total Annual Operation Costs					
Year No.	Year	CAF (3%)	Installation	Useful Life	Total (All Stations) Operation Cost
35	2053	2.814	2017	50	\$ 6,618
36	2054	2.898	2017	50	\$ 6,817
37	2055	2.985	2017	50	\$ 7,021
38	2056	3.075	2017	50	\$ 7,232
39	2057	3.167	2017	50	\$ 7,449
40	2058	3.262	2017	50	\$ 7,672
41	2059	3.360	2017	50	\$ 7,902
42	2060	3.461	2017	50	\$ 8,140
43	2061	3.565	2017	50	\$ 8,384
44	2062	3.671	2017	50	\$ 8,635
45	2063	3.782	2017	50	\$ 8,894
46	2064	3.895	2017	50	\$ 9,161
47	2065	4.012	2017	50	\$ 9,436
48	2066	4.132	2017	50	\$ 9,719
49	2067	4.256	2017	50	\$ 10,011
Total:					\$ 265,298

8.0 Gravity Drains

This project included lining of three existing 84” gravity drains near the Palmer Creek Pump Station. Whereas this rehabilitation did add to the useful life of the corrugated metal gravity drains, it does not add additional maintenance costs to the District’s budget.

9.0 Summary

The costs represented above are the best estimate of the engineer at the time of this study. An interest rate of 3-percent was chosen and applied at a constant rate, though it should be expected that this value will fluctuate over the useful life of the improvements. Costs detailed in this study constitute major routine (predictable) costs; any incidental or unpredictable costs shall be considered by the District based on past experience. These estimates do not provide a guarantee of cost values that will be incurred, but shall be used to anticipate the necessity for inevitable and periodic maintenance and replacement. The total cost estimated per year is only inclusive of newly installed features that are still within their useful life (e.g. maintenance costs for piezometers and relief wells, which have estimated useful lives of 50 years, are not included in the year costs behind 2066). The useful life of the improvements is highly dependent upon the diligent maintenance by the District, as outlined in the

System Wide Operation and Maintenance Manual. The District is encouraged to engage their financial advisor in any budgetary modifications to ensure that funds are available to maintain the system.

Table 9-1 – Annual Costs

Year	Sluice Gates	Relief Well Replacement	Relief Well Maintenance	PZ Replacement	PZ Maintenance	Seepage Berm Maintenance	Pipe Systems Replacement	Pipe Systems Maintenance	Pump Station Replacement	Pump Station Maintenance	Pump Station Operation	Total
2014										\$50		\$50
2015										\$52		\$52
2016										\$53		\$53
2017										\$55		\$55
2018			\$7,000			\$2,574				\$56	\$2,352	\$11,982
2019			\$7,210			\$2,651				\$1,217	\$2,423	\$13,501
2020			\$7,427			\$2,731				\$60	\$2,495	\$12,713
2021			\$7,651			\$2,813		\$11,590		\$62	\$2,570	\$24,686
2022			\$7,882			\$2,898				\$63	\$2,647	\$13,491
2023			\$8,113			\$2,983				\$65	\$2,727	\$13,888
2024			\$8,358			\$3,073				\$1,411	\$2,808	\$15,651
2025			\$8,610			\$3,166				\$69	\$2,893	\$14,738
2026			\$8,869		\$12,096	\$3,261		\$13,440		\$71	\$2,979	\$40,717
2027			\$9,135			\$3,359				\$73	\$3,069	\$15,636
2028			\$9,408			\$3,459				\$76	\$3,161	\$16,104
2029			\$9,688			\$3,562				\$1,636	\$3,256	\$18,142
2030			\$9,982			\$3,671				\$80	\$3,353	\$17,086
2031			\$10,283			\$3,781		\$15,580		\$83	\$3,454	\$33,181
2032			\$10,591			\$3,894				\$85	\$3,558	\$18,128
2033			\$10,906			\$4,010				\$88	\$3,664	\$18,668
2034			\$11,235			\$4,131				\$1,896	\$3,774	\$21,037
2035			\$11,571			\$4,255				\$93	\$3,887	\$19,806
2036			\$11,914		\$16,254	\$4,381		\$18,060		\$96	\$4,004	\$54,709
2037			\$12,278			\$4,515				\$99	\$4,124	\$21,016
2038			\$12,642			\$4,649				\$102	\$4,248	\$21,640
2039			\$13,020			\$4,788				\$274,419	\$4,375	\$296,602
2040			\$13,412			\$4,932				\$108	\$4,507	\$22,958
2041			\$13,818			\$5,081		\$20,940		\$111	\$4,642	\$44,592
2042			\$14,231			\$5,233				\$114	\$4,781	\$24,359
2043			\$119,358			\$5,390				\$118	\$4,925	\$129,790
2044			\$15,099			\$5,552				\$2,548	\$5,072	\$28,272
2045			\$15,547			\$5,717				\$125	\$5,224	\$26,613
2046	\$478,119		\$16,016		\$21,843	\$5,889		\$24,270		\$129	\$5,381	\$551,647
2047			\$16,499			\$6,067				\$133	\$5,543	\$28,241
2048			\$16,989			\$6,247				\$137	\$5,709	\$29,082
2049			\$17,500			\$6,435				\$2,955	\$5,880	\$32,770

Table 9-1 – Annual Costs

Year	Sluice Gates	Relief Well Replacement	Relief Well Maintenance	PZ Replacement	PZ Maintenance	Seepage Berm Maintenance	Pipe Systems Replacement	Pipe Systems Maintenance	Pump Station Replacement	Pump Station Maintenance	Pump Station Operation	Total
2050			\$18,025			\$6,628				\$145	\$6,057	\$30,855
2051			\$18,564			\$6,826	\$5,628	\$28,140		\$149	\$6,238	\$65,546
2052			\$19,124			\$7,032				\$154	\$6,425	\$32,735
2053			\$19,698			\$7,243				\$158	\$6,618	\$33,718
2054			\$20,288			\$7,460				\$3,425	\$6,817	\$37,990
2055			\$20,897			\$7,684				\$168	\$7,021	\$35,770
2056			\$21,523		\$29,358	\$7,914		\$32,620		\$173	\$7,232	\$98,821
2057			\$22,169			\$8,152				\$178	\$7,449	\$37,948
2058			\$22,834			\$8,396				\$184	\$7,672	\$39,087
2059			\$23,519			\$8,648				\$3,971	\$7,902	\$44,041
2060			\$24,225			\$8,908				\$195	\$8,140	\$41,467
2061			\$24,952			\$9,175		\$37,820		\$201	\$8,384	\$80,531
2062			\$25,700			\$9,450				\$207	\$8,635	\$43,992
2063			\$26,471			\$9,734				\$213	\$8,894	\$45,312
2064			\$27,265			\$10,026			\$3,507,200		\$9,161	\$3,553,652
2065		\$5,221,344	\$28,083			\$10,327					\$9,436	\$5,269,190
2066			\$28,926	\$473,472		\$10,636		\$657,600			\$9,719	\$1,180,353
2067			\$29,794			\$10,956					\$10,011	\$50,760
2068						\$11,284						\$11,284
2069						\$11,623						\$11,623
2070						\$11,972						\$11,972
2071						\$12,331		\$50,820				\$63,151
2072						\$12,701						\$12,701
2073						\$13,082						\$13,082
2074						\$13,474						\$13,474
2075						\$13,878						\$13,878
2076						\$14,295		\$58,920				\$73,215
2077						\$14,724						\$14,724
2078						\$15,165						\$15,165
2079						\$15,620						\$15,620
2080						\$16,089						\$16,089
2081						\$16,572		\$68,300				\$84,872
2082						\$17,069						\$17,069
2083						\$17,581						\$17,581
2084						\$18,108						\$18,108
2085						\$18,651						\$18,651

Table 9-1 – Annual Costs

Year	Sluice Gates	Relief Well Replacement	Relief Well Maintenance	PZ Replacement	PZ Maintenance	Seepage Berm Maintenance	Pipe Systems Replacement	Pipe Systems Maintenance	Pump Station Replacement	Pump Station Maintenance	Pump Station Operation	Total
2086						\$19,211		\$79,180				\$98,391
2087						\$19,787						\$19,787
2088						\$20,381						\$20,381
2089						\$20,992						\$20,992
2090						\$21,622						\$21,622
2091						\$22,271	\$104,090	\$91,790				\$218,151
2092						\$22,939						\$22,939
2093						\$23,627						\$23,627
2094						\$24,336						\$24,336
2095						\$25,066						\$25,066
2096						\$25,818		\$106,410				\$132,228
2097						\$26,592						\$26,592
2098						\$27,390						\$27,390
2099						\$28,212						\$28,212
2100						\$29,058						\$29,058
2101						\$29,930		\$123,360				\$153,290
2102						\$30,828						\$30,828
2103						\$31,753						\$31,753
2104						\$32,705						\$32,705
2105						\$33,687						\$33,687
2106						\$34,697		\$143,000				\$177,697
2107						\$35,738						\$35,738
2108						\$36,810						\$36,810
2109						\$37,914						\$37,914
2110						\$39,052						\$39,052
2111						\$40,223		\$165,780				\$206,003
2112						\$41,430						\$41,430
2113						\$42,673						\$42,673
2114						\$43,953						\$43,953
2115						\$45,272						\$45,272
2116						\$46,630	\$1,218,039					\$1,264,670
2117						\$48,029						\$48,029
2118						\$49,470						\$49,470