



**Southwestern Illinois
Flood Prevention District Council**
104 United Drive, Collinsville, Illinois

September 2018

METRO EAST SANITARY 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 Type	5
3.2	Replacement.....	7
4.0	Piezometers	9
4.1	Maintenance	9
4.2	Replacement.....	9
4.2.1	Transducer Replacement	11
5.0	Clay Caps.....	11
6.0	Relief Well Conveyance System Piping, Structures, and Check Valves	14
6.1	Maintenance	14
6.2	Replacement.....	15
7.0	Relief Well Pump Stations (4 Stations)	17
7.1	Maintenance	17
7.2	Replacement.....	18
7.3	Operation	19
8.0	Gravity Drains	21
9.0	Summary.....	22

List of Tables

Table 2-1 – Sluice Gates – Replacement Costs	4
Table 3-1 - Relief Wells - Maintenance Costs	5
Table 3-2 – Relief Wells – Replacement Costs.....	7
Table 4-1 – Piezometers – Replacement Costs.....	10
Table 4-2 – Piezometers – Transducer Costs.....	11
Table 5-1 – Clay Caps – Maintenance Costs.....	11
Table 6-1 – Pipe Systems – Maintenance Costs.....	15
Table 6-2 – Pipe Systems – Replacement Costs (Pipe).....	16
Table 6-3 – Pipe Systems – Replacement Costs (Structures)	16
Table 6-4 – Pipe Systems – Replacement Costs (Check Valves)	16
Table 7-1 – Pump Stations – Maintenance Costs	17
Table 7-2 – Pump Stations – Replacement Costs.....	19
Table 7-3 – Pump Stations – Operation Costs.....	19
Table 7-4 – Pump Stations – Total Annual Operation Costs	20
Table 9-1 – Annual Costs	23

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 Metro East Sanitary District (MESD), the “District.” The improvements to the MESD Segment of the East St. Louis and Vicinity Flood Protection Project Levee System were constructed as part of the following construction projects:

- Southwestern Illinois Levee Certification Design, Bid Package 2B
- Southwestern Illinois Levee Certification Design, Bid Package 2C
- Southwestern Illinois Levee Certification Design, Bid Package 4
- Southwestern Illinois Levee Certification Design, Bid Package 5
- Southwestern Illinois Levee Certification Design, Bid Package 5A

Assets transferred to the District as part of these projects include: sluice gates, relief wells, piezometers, clay caps, relief well conveyance systems, gravity drains, and pump stations. 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 the system wide O&M for further information).

The scope of this project included rehabilitating three (3) existing sluice gates (one (1) 54”, and two (2) 96”), adding or replacing electrical service, and installing electric actuators. These sluice gates are already in the District’s maintenance program and therefore, do not add additional maintenance costs to the District’s budget.

It is estimated that this rehabilitation extended the useful life of each gate by 20-years. Replacement costs have been estimated as shown in the table below.

Table 2-1 – Sluice Gates – Replacement Costs

Gate Size	Station	Gate Well NO.	Initial Cost	Installation	Useful Life	Planned Replacement	CAF (3%)	Replacement Cost
54"	798+00	N/A	\$ 75,000	2016	20	2036	1.806	\$ 135,450
96"	1384+50	GW-29	\$ 100,000	2017	20	2037	1.806	\$ 180,600
96"	1384+50	GW-29	\$ 100,000	2017	20	2037	1.806	\$ 180,600
Total:								\$ 496,650

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

Nine (9) existing wood-stave relief wells were first converted from Type “D” to Type “T” and tied into a relief well collector system. Later, these relief wells were re-converted to Type “D” and now discharge at the surface, at the same discharge elevation as originally designed.

Forty (40) existing relief wells (35 Wood-Stave and 5 Stainless Steel) were converted from Type “D” to Type “T” and tied into a relief well collector system.

Five (5) existing wood-stave relief wells were sleeved with a smaller diameter stainless steel well screen/casing to reduce the sanding rate.

All fifty-four (54) relief 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

Eighty-Seven (87) new stainless-steel relief wells (22 Type “D”, 65 Type “T”) were installed and sixty-two (62) existing relief wells were abandoned as part of these improvements. In theory, there is only a net increase of twenty-five (25) relief wells to the District’s program. However, the costs for adding all 87 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.

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	87	\$ 1,500	8	\$ 2,500.00	0	\$29,400
1	2019	1.030	\$ 206	87	\$ 1,545	8	\$ 2,575.00	0	\$30,282
2	2020	1.061	\$ 212	87	\$ 1,592	8	\$ 2,652.50	0	\$31,193
3	2021	1.093	\$ 219	87	\$ 1,640	9	\$ 2,732.50	0	\$33,774
4	2022	1.126	\$ 225	87	\$ 1,689	9	\$ 2,815.00	0	\$34,793
5	2023	1.159	\$ 232	87	\$ 1,739	9	\$ 2,897.50	0	\$35,813
6	2024	1.194	\$ 239	87	\$ 1,791	9	\$ 2,985.00	0	\$36,895
7	2025	1.230	\$ 246	87	\$ 1,845	9	\$ 3,075.00	0	\$38,007
8	2026	1.267	\$ 253	87	\$ 1,901	9	\$ 3,167.50	0	\$39,150
9	2027	1.305	\$ 261	87	\$ 1,958	9	\$ 3,262.50	0	\$40,325
10	2028	1.344	\$ 269	87	\$ 2,016	8	\$ 3,360.00	0	\$39,514
11	2029	1.384	\$ 277	87	\$ 2,076	8	\$ 3,460.00	0	\$40,690
12	2030	1.426	\$ 285	87	\$ 2,139	8	\$ 3,565.00	0	\$41,924
13	2031	1.469	\$ 294	87	\$ 2,204	9	\$ 3,672.50	0	\$45,392
14	2032	1.513	\$ 303	87	\$ 2,270	9	\$ 3,782.50	0	\$46,752
15	2033	1.558	\$ 312	87	\$ 2,337	9	\$ 3,895.00	0	\$48,142
16	2034	1.605	\$ 321	87	\$ 2,408	9	\$ 4,012.50	0	\$49,595
17	2035	1.653	\$ 331	87	\$ 2,480	9	\$ 4,132.50	0	\$51,078
18	2036	1.702	\$ 340	87	\$ 2,553	9	\$ 4,255.00	0	\$52,592
19	2037	1.754	\$ 351	87	\$ 2,631	9	\$ 4,385.00	0	\$54,199
20	2038	1.806	\$ 361	87	\$ 2,709	8	\$ 4,515.00	0	\$53,096
21	2039	1.860	\$ 372	87	\$ 2,790	8	\$ 4,650.00	0	\$54,684
22	2040	1.916	\$ 383	87	\$ 2,874	8	\$ 4,790.00	0	\$56,330
23	2041	1.974	\$ 395	87	\$ 2,961	9	\$ 4,935.00	0	\$60,997
24	2042	2.033	\$ 407	87	\$ 3,050	9	\$ 5,082.50	0	\$62,820
25	2043	2.094	\$ 419	87	\$ 3,141	9	\$ 5,235.00	87	\$520,150

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	
26	2044	2.157	\$ 431	87	\$ 3,236	9	\$ 5,392.50	0	\$66,651
27	2045	2.221	\$ 444	87	\$ 3,332	9	\$ 5,552.50	0	\$68,629
28	2046	2.288	\$ 458	87	\$ 3,432	9	\$ 5,720.00	0	\$70,699
29	2047	2.357	\$ 471	87	\$ 3,536	9	\$ 5,892.50	0	\$72,831
30	2048	2.427	\$ 485	87	\$ 3,641	8	\$ 6,067.50	0	\$71,354
31	2049	2.500	\$ 500	87	\$ 3,750	8	\$ 6,250.00	0	\$73,500
32	2050	2.575	\$ 515	87	\$ 3,863	8	\$ 6,437.50	0	\$75,705
33	2051	2.652	\$ 530	87	\$ 3,978	9	\$ 6,630.00	0	\$81,947
34	2052	2.732	\$ 546	87	\$ 4,098	9	\$ 6,830.00	0	\$84,419
35	2053	2.814	\$ 563	87	\$ 4,221	9	\$ 7,035.00	0	\$86,953
36	2054	2.898	\$ 580	87	\$ 4,347	9	\$ 7,245.70	0	\$89,557
37	2055	2.985	\$ 597	87	\$ 4,478	9	\$ 7,463.07	0	\$92,244
38	2056	3.075	\$ 615	87	\$ 4,612	9	\$ 7,686.96	0	\$95,011
39	2057	3.167	\$ 633	87	\$ 4,751	9	\$ 7,917.57	0	\$97,861
40	2058	3.262	\$ 652	87	\$ 4,893	8	\$ 8,155.09	0	\$95,904
41	2059	3.360	\$ 672	87	\$ 5,040	8	\$ 8,399.75	0	\$98,781
42	2060	3.461	\$ 692	87	\$ 5,191	8	\$ 8,651.74	0	\$101,744
43	2061	3.565	\$ 713	87	\$ 5,347	9	\$ 8,911.29	0	\$110,144
44	2062	3.671	\$ 734	87	\$ 5,507	9	\$ 9,178.63	0	\$113,448
45	2063	3.782	\$ 756	87	\$ 5,672	9	\$ 9,453.99	0	\$116,851
46	2064	3.895	\$ 779	87	\$ 5,843	9	\$ 9,737.61	0	\$120,357
47	2065	4.012	\$ 802	87	\$ 6,018	9	\$ 10,029.74	0	\$123,968
48	2066	4.132	\$ 826	87	\$ 6,198	9	\$ 10,330.63	0	\$127,687
49	2067	4.256	\$ 851	87	\$ 6,384	9	\$ 10,640.55	0	\$131,517
Totals:									\$ 3,895,345

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-32A	Type "D"	793+02	\$ 38,500	2015	50	2065	4.384	\$ 168,784
RW-79X	Type "T"	864+70	\$ 42,500	2015	50	2065	4.384	\$ 186,320
RW-81X	Type "T"	866+61	\$ 45,000	2015	50	2065	4.384	\$ 197,280
RW-87X	Type "T"	874+63	\$ 41,500	2015	50	2065	4.384	\$ 181,936
RW-92X	Type "T"	882+97	\$ 38,000	2015	50	2065	4.384	\$ 166,592
RW-95X	Type "T"	887+32	\$ 42,000	2015	50	2065	4.384	\$ 184,128
RW-119A	Type "D"	1113+50	\$ 48,000	2015	50	2065	4.384	\$ 210,432
RW-121A	Type "D"	1115+85	\$ 63,000	2015	50	2065	4.384	\$ 276,192
RW-135A	Type "D"	1133+77	\$ 60,000	2015	50	2065	4.384	\$ 263,040
RW-135B	Type "D"	1134+94	\$ 73,000	2015	50	2065	4.384	\$ 320,032
RW-137X	Type "T"	1211+31	\$ 37,000	2014	50	2064	4.384	\$ 162,208
RW-139X	Type "T"	1213+07	\$ 30,000	2014	50	2064	4.384	\$ 131,520
RW-140X	Type "T"	1214+62	\$ 49,000	2014	50	2064	4.384	\$ 214,816
RW-141XA	Type "T"	1215+33	\$ 49,000	2014	50	2064	4.384	\$ 214,816
RW-141XB	Type "T"	1216+02	\$ 65,000	2014	50	2064	4.384	\$ 284,960
RW-142X	Type "T"	1216+44	\$ 52,000	2014	50	2064	4.384	\$ 227,968
RW-143X	Type "T"	1217+16	\$ 48,000	2014	50	2064	4.384	\$ 210,432
RW-145X	Type "T"	1218+63	\$ 52,000	2015	50	2065	4.384	\$ 227,968
RW-147X	Type "T"	1220+11	\$ 74,000	2015	50	2065	4.384	\$ 324,416
RW-148X	Type "T"	1220+89	\$ 69,000	2015	50	2065	4.384	\$ 302,496
RW-149X	Type "T"	1221+64	\$ 49,000	2015	50	2065	4.384	\$ 214,816
RW-150X	Type "T"	1222+43	\$ 46,000	2015	50	2065	4.384	\$ 201,664
RW-153X	Type "T"	1224+87	\$ 66,000	2015	50	2065	4.384	\$ 289,344
RW-154X	Type "T"	1225+43	\$ 42,000	2015	50	2065	4.384	\$ 184,128
RW-155X	Type "T"	1226+34	\$ 49,000	2015	50	2065	4.384	\$ 214,816
RW-156X	Type "T"	1227+12	\$ 39,000	2015	50	2065	4.384	\$ 170,976
RW-157X	Type "T"	1227+65	\$ 37,000	2015	50	2065	4.384	\$ 162,208
RW-165A	Type "T"	1237+54	\$ 37,000	2015	50	2065	4.384	\$ 162,208
RW-166A	Type "T"	1239+49	\$ 44,000	2015	50	2065	4.384	\$ 192,896
RW-170X	Type "D"	1246+51	\$ 50,000	2015	50	2065	4.384	\$ 219,200
RW-177X	Type "D"	1253+36	\$ 49,000	2015	50	2065	4.384	\$ 214,816

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-182X	Type "D"	1257+87	\$ 44,000	2015	50	2065	4.384	\$ 192,896
RW-187X	Type "D"	1263+52	\$ 46,000	2015	50	2065	4.384	\$ 201,664
RW-189X	Type "D"	1265+95	\$ 60,000	2015	50	2065	4.384	\$ 263,040
RW-191A	Type "D"	1268+77	\$ 44,000	2015	50	2065	4.384	\$ 192,896
RW-192A	Type "D"	1270+00	\$ 54,000	2015	50	2065	4.384	\$ 236,736
RW-193A	Type "D"	1271+16	\$ 58,000	2015	50	2065	4.384	\$ 254,272
RW-194A	Type "D"	1272+40	\$ 53,000	2015	50	2065	4.384	\$ 232,352
RW-195X	Type "D"	1273+13	\$ 53,000	2015	50	2065	4.384	\$ 232,352
RW-195A	Type "D"	1273+59	\$ 59,000	2015	50	2065	4.384	\$ 258,656
RW-200X	Type "D"	1280+07	\$ 52,000	2015	50	2065	4.384	\$ 227,968
RW-202X	Type "D"	1283+59	\$ 67,000	2015	50	2065	4.384	\$ 293,728
RW-206X	Type "D"	1288+64	\$ 41,000	2015	50	2065	4.384	\$ 179,744
RW-207X	Type "D"	1290+54	\$ 41,000	2015	50	2065	4.384	\$ 179,744
RW-208X	Type "D"	1291+65	\$ 43,000	2015	50	2065	4.384	\$ 188,512
RW-209X	Type "D"	1292+56	\$ 41,000	2015	50	2065	4.384	\$ 179,744
RW-213X	Type "T"	1296+36	\$ 50,000	2015	50	2065	4.384	\$ 219,200
RW-218AX	Type "T"	1300+96	\$ 52,000	2015	50	2065	4.384	\$ 227,968
RW-219X	Type "T"	1301+78	\$ 45,000	2014	50	2064	4.384	\$ 197,280
RW-222X	Type "T"	1304+40	\$ 51,000	2014	50	2064	4.384	\$ 223,584
RW-222A	Type "T"	1304+80	\$ 46,000	2014	50	2064	4.384	\$ 201,664
RW-223X	Type "T"	1305+35	\$ 49,000	2014	50	2064	4.384	\$ 214,816
RW-223A	Type "T"	1305+77	\$ 48,000	2014	50	2064	4.384	\$ 210,432
RW-224X	Type "T"	1306+22	\$ 50,000	2014	50	2064	4.384	\$ 219,200
RW-224A	Type "T"	1306+63	\$ 66,000	2014	50	2064	4.384	\$ 289,344
RW-225X	Type "T"	1307+13	\$ 46,000	2014	50	2064	4.384	\$ 201,664
RW-225A	Type "T"	1307+54	\$ 64,000	2014	50	2064	4.384	\$ 280,576
RW-226X	Type "T"	1308+06	\$ 45,000	2014	50	2064	4.384	\$ 197,280
RW-226A	Type "T"	1308+49	\$ 62,000	2014	50	2064	4.384	\$ 271,808
RW-227X	Type "T"	1308+95	\$ 59,000	2014	50	2064	4.384	\$ 258,656
RW-238AX	Type "T"	1324+46	\$ 53,000	2014	50	2064	4.384	\$ 232,352
RW-239X	Type "T"	1325+06	\$ 50,000	2014	50	2064	4.384	\$ 219,200
RW-243B	Type "T"	1330+26	\$ 62,000	2014	50	2064	4.384	\$ 271,808
RW-244B	Type "T"	1331+04	\$ 49,000	2014	50	2064	4.384	\$ 214,816
RW-244C	Type "T"	1331+71	\$ 43,000	2014	50	2064	4.384	\$ 188,512
RW-245A	Type "T"	1332+55	\$ 52,000	2014	50	2064	4.384	\$ 227,968
RW-246X	Type "T"	1332+93	\$ 59,000	2014	50	2064	4.384	\$ 258,656
RW-246A	Type "T"	1333+31	\$ 62,000	2014	50	2064	4.384	\$ 271,808

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-247X	Type "T"	1333+68	\$ 65,000	2014	50	2064	4.384	\$ 284,960
RW-247A	Type "T"	1334+06	\$ 57,500	2015	50	2065	4.384	\$ 252,080
RW-248A	Type "T"	1334+74	\$ 56,000	2014	50	2064	4.384	\$ 245,504
RW-249A	Type "T"	1335+33	\$ 53,000	2014	50	2064	4.384	\$ 232,352
RW-250A	Type "T"	1335+91	\$ 46,000	2014	50	2064	4.384	\$ 201,664
RW-251A	Type "T"	1336+52	\$ 50,000	2014	50	2064	4.384	\$ 219,200
RW-252A	Type "T"	1337+25	\$ 61,000	2014	50	2064	4.384	\$ 267,424
RW-254A	Type "T"	1338+28	\$ 58,000	2014	50	2064	4.384	\$ 254,272
RW-255A	Type "T"	1338+87	\$ 64,000	2014	50	2064	4.384	\$ 280,576
RW-256A	Type "T"	1339+36	\$ 45,000	2014	50	2064	4.384	\$ 197,280
RW-257X	Type "T"	1339+96	\$ 66,000	2014	50	2064	4.384	\$ 289,344
RW-257A	Type "T"	1340+57	\$ 62,000	2014	50	2064	4.384	\$ 271,808
RW-258X	Type "T"	1341+16	\$ 58,000	2014	50	2064	4.384	\$ 254,272
RW-258B	Type "T"	1341+72	\$ 58,000	2014	50	2064	4.384	\$ 254,272
RW-258AX	Type "T"	1342+45	\$ 54,000	2014	50	2064	4.384	\$ 236,736
RW-258C	Type "T"	1342+92	\$ 57,000	2014	50	2064	4.384	\$ 249,888
RW-259X	Type "T"	1343+56	\$ 49,000	2014	50	2064	4.384	\$ 214,816
RW-273A	Type "T"	1478+20	\$ 64,000	2014	50	2064	4.384	\$ 280,576
RW-273B	Type "T"	1479+40	\$ 58,000	2014	50	2064	4.384	\$ 254,272
Total:			\$ 4,525,000					\$ 19,837,600

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

Thirty (30) new piezometers were installed and one existing piezometer was retro-fitted with a transducer. The piezometer itself (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-258L	Above Grade	258+00	\$12,000.00	2016	50	2066	4.384	\$ 52,608
PZ-258R	Above Grade	258+00	\$12,000.00	2016	50	2066	4.384	\$ 52,608
PZ-784L	Above Grade	784+00	\$12,000.00	2016	50	2066	4.384	\$ 52,608
PZ-784R	Above Grade	784+00	\$12,000.00	2016	50	2066	4.384	\$ 52,608
PZ-803L	Above Grade	802+83	\$12,000.00	2016	50	2066	4.384	\$ 52,608
PZ-803R	Above Grade	803+00	\$12,000.00	2016	50	2066	4.384	\$ 52,608
PZ-825L	Above Grade	825+50	\$12,000.00	2016	50	2066	4.384	\$ 52,608
PZ-825R	Above Grade	825+50	\$12,000.00	2016	50	2066	4.384	\$ 52,608
PZ-875R	Above Grade	875+10	\$12,000.00	2016	50	2066	4.384	\$ 52,608
PZ-875L	Above Grade	875+24	\$18,000.00	2016	50	2066	4.384	\$ 78,912
PZ-996L	Above Grade	996+00	\$12,000.00	2016	50	2066	4.384	\$ 52,608
PZ-996R	Above Grade	996+00	\$12,000.00	2016	50	2066	4.384	\$ 52,608
PZ-1212L	Above Grade	1212+00	\$9,000.00	2017	50	2067	4.384	\$ 39,456
PZ-1212R	Above Grade	1212+00	\$9,000.00	2017	50	2067	4.384	\$ 39,456
PZ-1217LX	Above Grade	1217+61	\$9,000.00	2017	50	2067	4.384	\$ 39,456
PZ-1221LX	Above Grade	1221+33	\$9,000.00	2017	50	2067	4.384	\$ 39,456
PZ-1223LX	Above Grade	1223+63	\$9,000.00	2017	50	2067	4.384	\$ 39,456
PZ-1223R	Above Grade	1223+63	\$9,000.00	2017	50	2067	4.384	\$ 39,456
PZ-1225LX	Above Grade	1225+64	\$9,000.00	2017	50	2067	4.384	\$ 39,456
PZ-1225R	Above Grade	1225+64	\$9,000.00	2017	50	2067	4.384	\$ 39,456
PZ-1228L1	Above Grade	1228+00	\$9,000.00	2017	50	2067	4.384	\$ 39,456
PZ-1228R	Above Grade	1228+00	\$9,000.00	2017	50	2067	4.384	\$ 39,456
PZ-1239L2	Above Grade	1239+01	\$9,000.00	2017	50	2067	4.384	\$ 39,456
PZ-1239L1	Above Grade	1239+01	\$9,000.00	2017	50	2067	4.384	\$ 39,456
PZ-1239R	Above Grade	1239+01	\$9,000.00	2017	50	2067	4.384	\$ 39,456
PZ-1344L	Above Grade	1344+20	\$12,000.00	2016	50	2066	4.384	\$ 52,608
PZ-1344R	Above Grade	1344+20	\$12,000.00	2016	50	2066	4.384	\$ 52,608
PZ-1480L	Above Grade	1470+00	\$12,000.00	2016	50	2066	4.384	\$ 52,608
PZ-1480R	Above Grade	1470+00	\$12,000.00	2016	50	2066	4.384	\$ 52,608
PZ-1499L	Above Grade	1499+50	\$12,000.00	2016	50	2066	4.384	\$ 52,608
PZ-1499R	Above Grade	1499+50	\$12,000.00	2016	50	2066	4.384	\$ 52,608
Total:			\$ 339,000					\$ 1,486,176

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.

Year No.	Year	CAF (3%)	Price	No. of PZs	Cost per Year
0	2016	1.000	\$ 1,000	0	\$ -
10	2026	1.344	\$ 1,344	31	\$ 41,664
20	2036	1.806	\$ 1,806	31	\$ 55,986
30	2046	2.427	\$ 2,427	31	\$ 75,237
40	2056	3.262	\$ 3,262	31	\$ 101,123
50	2066	Cost included in new Piezometer			
Total:					\$ 274,010

5.0 Clay Caps

Clay Caps shall be maintained in accordance with the system wide operation and maintenance manual. Clay Caps 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.

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	21	1	\$ 60	21	6	\$ 7,980
1	2019	1.030	\$ 21	21	1	\$ 62	21	6	\$ 8,219
2	2020	1.061	\$ 21	21	1	\$ 64	21	6	\$ 8,467
3	2021	1.093	\$ 22	21	1	\$ 66	21	6	\$ 8,722
4	2022	1.126	\$ 23	21	1	\$ 68	21	6	\$ 8,985
5	2023	1.159	\$ 23	21	1	\$ 70	21	6	\$ 9,249
6	2024	1.194	\$ 24	21	1	\$ 72	21	6	\$ 9,528
7	2025	1.230	\$ 25	21	1	\$ 74	21	6	\$ 9,815
8	2026	1.267	\$ 25	21	1	\$ 76	21	6	\$ 10,111

Table 5-1 – Clay Caps – Maintenance Costs

Year No.	Year	CAF (3%)	Rodent/Herbicide			Mowing			Cost per Year
			Price	Area (Ac)	Frequency/Year	Price	Area (Ac)	Frequency/Year	
9	2027	1.305	\$ 26	21	1	\$ 78	21	6	\$ 10,414
10	2028	1.344	\$ 27	21	1	\$ 81	21	6	\$ 10,725
11	2029	1.384	\$ 28	21	1	\$ 83	21	6	\$ 11,044
12	2030	1.426	\$ 29	21	1	\$ 86	21	6	\$ 11,379
13	2031	1.469	\$ 29	21	1	\$ 88	21	6	\$ 11,723
14	2032	1.513	\$ 30	21	1	\$ 91	21	6	\$ 12,074
15	2033	1.558	\$ 31	21	1	\$ 93	21	6	\$ 12,433
16	2034	1.605	\$ 32	21	1	\$ 96	21	6	\$ 12,808
17	2035	1.653	\$ 33	21	1	\$ 99	21	6	\$ 13,191
18	2036	1.702	\$ 34	21	1	\$ 102	21	6	\$ 13,582
19	2037	1.754	\$ 35	21	1	\$ 105	21	6	\$ 13,997
20	2038	1.806	\$ 36	21	1	\$ 108	21	6	\$ 14,412
21	2039	1.860	\$ 37	21	1	\$ 112	21	6	\$ 14,843
22	2040	1.916	\$ 38	21	1	\$ 115	21	6	\$ 15,290
23	2041	1.974	\$ 39	21	1	\$ 118	21	6	\$ 15,753
24	2042	2.033	\$ 41	21	1	\$ 122	21	6	\$ 16,223
25	2043	2.094	\$ 42	21	1	\$ 126	21	6	\$ 16,710
26	2044	2.157	\$ 43	21	1	\$ 129	21	6	\$ 17,213
27	2045	2.221	\$ 44	21	1	\$ 133	21	6	\$ 17,724
28	2046	2.288	\$ 46	21	1	\$ 137	21	6	\$ 18,258
29	2047	2.357	\$ 47	21	1	\$ 141	21	6	\$ 18,809
30	2048	2.427	\$ 49	21	1	\$ 146	21	6	\$ 19,367
31	2049	2.500	\$ 50	21	1	\$ 150	21	6	\$ 19,950
32	2050	2.575	\$ 52	21	1	\$ 155	21	6	\$ 20,549
33	2051	2.652	\$ 53	21	1	\$ 159	21	6	\$ 21,163
34	2052	2.732	\$ 55	21	1	\$ 164	21	6	\$ 21,801
35	2053	2.814	\$ 56	21	1	\$ 169	21	6	\$ 22,456
36	2054	2.898	\$ 58	21	1	\$ 174	21	6	\$ 23,128
37	2055	2.985	\$ 60	21	1	\$ 179	21	6	\$ 23,822
38	2056	3.075	\$ 61	21	1	\$ 184	21	6	\$ 24,537
39	2057	3.167	\$ 63	21	1	\$ 190	21	6	\$ 25,273
40	2058	3.262	\$ 65	21	1	\$ 196	21	6	\$ 26,031
41	2059	3.360	\$ 67	21	1	\$ 202	21	6	\$ 26,812
42	2060	3.461	\$ 69	21	1	\$ 208	21	6	\$ 27,616
43	2061	3.565	\$ 71	21	1	\$ 214	21	6	\$ 28,445
44	2062	3.671	\$ 73	21	1	\$ 220	21	6	\$ 29,298

Table 5-1 – Clay Caps – Maintenance Costs

Year No.	Year	CAF (3%)	Rodent/Herbicide			Mowing			Cost per Year
			Price	Area (Ac)	Frequency/Year	Price	Area (Ac)	Frequency/Year	
45	2063	3.782	\$ 76	21	1	\$ 227	21	6	\$ 30,177
46	2064	3.895	\$ 78	21	1	\$ 234	21	6	\$ 31,082
47	2065	4.012	\$ 80	21	1	\$ 241	21	6	\$ 32,015
48	2066	4.132	\$ 83	21	1	\$ 248	21	6	\$ 32,975
49	2067	4.256	\$ 85	21	1	\$ 255	21	6	\$ 33,965
50	2068	4.384	\$ 88	21	1	\$ 263	21	6	\$ 34,984
51	2069	4.516	\$ 90	21	1	\$ 271	21	6	\$ 36,034
52	2070	4.651	\$ 93	21	1	\$ 279	21	6	\$ 37,115
53	2071	4.791	\$ 96	21	1	\$ 287	21	6	\$ 38,228
54	2072	4.934	\$ 99	21	1	\$ 296	21	6	\$ 39,375
55	2073	5.082	\$ 102	21	1	\$ 305	21	6	\$ 40,556
56	2074	5.235	\$ 105	21	1	\$ 314	21	6	\$ 41,773
57	2075	5.392	\$ 108	21	1	\$ 324	21	6	\$ 43,026
58	2076	5.554	\$ 111	21	1	\$ 333	21	6	\$ 44,317
59	2077	5.720	\$ 114	21	1	\$ 343	21	6	\$ 45,647
60	2078	5.892	\$ 118	21	1	\$ 354	21	6	\$ 47,016
61	2079	6.068	\$ 121	21	1	\$ 364	21	6	\$ 48,426
62	2080	6.251	\$ 125	21	1	\$ 375	21	6	\$ 49,879
63	2081	6.438	\$ 129	21	1	\$ 386	21	6	\$ 51,376
64	2082	6.631	\$ 133	21	1	\$ 398	21	6	\$ 52,917
65	2083	6.830	\$ 137	21	1	\$ 410	21	6	\$ 54,504
66	2084	7.035	\$ 141	21	1	\$ 422	21	6	\$ 56,140
67	2085	7.246	\$ 145	21	1	\$ 435	21	6	\$ 57,824
68	2086	7.463	\$ 149	21	1	\$ 448	21	6	\$ 59,558
69	2087	7.687	\$ 154	21	1	\$ 461	21	6	\$ 61,345
70	2088	7.918	\$ 158	21	1	\$ 475	21	6	\$ 63,186
71	2089	8.156	\$ 163	21	1	\$ 489	21	6	\$ 65,081
72	2090	8.400	\$ 168	21	1	\$ 504	21	6	\$ 67,034
73	2091	8.652	\$ 173	21	1	\$ 519	21	6	\$ 69,045
74	2092	8.912	\$ 178	21	1	\$ 535	21	6	\$ 71,116
75	2093	9.179	\$ 184	21	1	\$ 551	21	6	\$ 73,249
76	2094	9.454	\$ 189	21	1	\$ 567	21	6	\$ 75,447
77	2095	9.738	\$ 195	21	1	\$ 584	21	6	\$ 77,710
78	2096	10.030	\$ 201	21	1	\$ 602	21	6	\$ 80,042
79	2097	10.331	\$ 207	21	1	\$ 620	21	6	\$ 82,443
80	2098	10.641	\$ 213	21	1	\$ 638	21	6	\$ 84,916

Table 5-1 – Clay Caps – Maintenance Costs

Year No.	Year	CAF (3%)	Rodent/Herbicide			Mowing			Cost per Year
			Price	Area (Ac)	Frequency/Year	Price	Area (Ac)	Frequency/Year	
81	2099	10.960	\$ 219	21	1	\$ 658	21	6	\$ 87,464
82	2100	11.289	\$ 226	21	1	\$ 677	21	6	\$ 90,088
83	2101	11.628	\$ 233	21	1	\$ 698	21	6	\$ 92,790
84	2102	11.977	\$ 240	21	1	\$ 719	21	6	\$ 95,574
85	2103	12.336	\$ 247	21	1	\$ 740	21	6	\$ 98,441
86	2104	12.706	\$ 254	21	1	\$ 762	21	6	\$ 101,394
87	2105	13.087	\$ 262	21	1	\$ 785	21	6	\$ 104,436
88	2106	13.480	\$ 270	21	1	\$ 809	21	6	\$ 107,569
89	2107	13.884	\$ 278	21	1	\$ 833	21	6	\$ 110,796
90	2108	14.301	\$ 286	21	1	\$ 858	21	6	\$ 114,120
91	2109	14.730	\$ 295	21	1	\$ 884	21	6	\$ 117,544
92	2110	15.172	\$ 303	21	1	\$ 910	21	6	\$ 121,070
93	2111	15.627	\$ 313	21	1	\$ 938	21	6	\$ 124,702
94	2112	16.096	\$ 322	21	1	\$ 966	21	6	\$ 128,443
95	2113	16.579	\$ 332	21	1	\$ 995	21	6	\$ 132,297
96	2114	17.076	\$ 342	21	1	\$1,025	21	6	\$ 136,265
97	2115	17.588	\$ 352	21	1	\$1,055	21	6	\$ 140,353
98	2116	18.116	\$ 362	21	1	\$1,087	21	6	\$ 144,564
99	2117	18.659	\$ 373	21	1	\$1,120	21	6	\$ 148,901
100	2118	19.219	\$ 384	21	1	\$1,153	21	6	\$ 153,368
Total:									\$ 4,999,633

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	2017	1.000	\$ 10	0	\$ 110	0	\$ -
5	2022	1.159	\$ 12	9600	\$ 127	0	\$ 111,264
10	2027	1.344	\$ 13	9600	\$ 148	0	\$ 129,024
15	2032	1.558	\$ 16	9600	\$ 171	0	\$ 149,568
20	2037	1.806	\$ 18	9600	\$ 199	0	\$ 173,376
25	2042	2.094	\$ 21	9600	\$ 230	0	\$ 201,024
30	2047	2.427	\$ 24	9600	\$ 267	0	\$ 232,992
35	2052	2.814	\$ 28	9600	\$ 310	0	\$ 270,144
40	2057	3.262	\$ 33	9600	\$ 359	0	\$ 313,152
45	2062	3.782	\$ 38	9600	\$ 416	0	\$ 363,072
50	2067	4.384	\$ 44	9600	\$ 482	9600	\$ 5,050,368
55	2072	5.082	\$ 51	9600	\$ 559	0	\$ 487,872
60	2077	5.892	\$ 59	9600	\$ 648	0	\$ 565,632
65	2082	6.830	\$ 68	9600	\$ 751	0	\$ 655,680
70	2087	7.918	\$ 79	9600	\$ 871	0	\$ 760,128
75	2092	9.179	\$ 92	9600	\$1,010	0	\$ 881,184
80	2097	10.641	\$ 106	9600	\$1,171	0	\$ 1,021,536
85	2102	12.336	\$ 123	9600	\$1,357	0	\$ 1,184,256
90	2107	14.300	\$ 143	9600	\$1,573	0	\$ 1,372,800
95	2112	16.578	\$ 166	9600	\$1,824	0	\$ 1,591,488
Total:							\$ 15,514,560

6.2 Replacement

These projects added nearly 9,600 linear feet of reinforced concrete pipe (RCP) and ductile iron pipe (DIP) of varying sizes. These systems are located at Site 12, Site 09, Site 10, and Site 16 pump stations as well as a few miscellaneous relief well laterals scattered throughout the MESD system.

The manufacturer of the RCP publishes a useful life of 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
Site 12 Collector System	783+00	787+00	\$ 205,923	2017	100	2117	19.219	\$ 3,957,638
Site 09 Collector System	1211+00	1240+50	\$1,531,290	2017	100	2117	19.219	\$ 29,429,857
Site 10 Collector System	1294+50	1314+50	\$1,039,425	2017	100	2117	19.219	\$ 19,976,709
Site 16 Collector System	1323+50	1345+50	\$1,458,560	2017	100	2117	19.219	\$ 28,032,071
Miscellaneous Laterals	Misc.	Misc.	\$ 57,418	2017	100	2117	19.219	\$ 1,103,519
Total:			\$4,292,616					\$ 82,499,794

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

System	Structure Type	QTY	Initial Cost	Installation	Useful Life	Planned Replacement	CAF (3%)	Replacement Cost
Site 12 Collector System	48" MH	4	\$ 32,000	2017	75	2092	9.179	\$ 293,728
	60" MH	1	\$ 9,500	2017	75	2092	9.179	\$ 87,201
Site 09 Collector System	48" MH	33	\$ 158,565	2017	75	2092	9.179	\$ 1,455,468
	60" MH	3	\$ 17,175	2017	75	2092	9.179	\$ 157,649
Site 10 Collector System	48" MH	11	\$ 88,000	2017	75	2092	9.179	\$ 807,752
	60" MH	13	\$ 123,500	2017	75	2092	9.179	\$ 1,133,607
Site 16 Collector System	48" MH	0	\$ -	2017	75	2092	9.179	\$ -
	60" MH	32	\$ 304,000	2017	75	2092	9.179	\$ 2,790,416
	72" MH	4	\$ 38,000	2017	75	2092	9.179	\$ 348,802
	96" MH	1	\$ 16,800	2017	75	2092	9.179	\$ 154,207
Miscellaneous Laterals	72" MH	2	\$ 19,000	2017	75	2092	9.179	\$ 174,401
	End Section	2	\$ 6,000	2017	75	2092	9.179	\$ 55,074
Total:			\$ 812,540					\$ 7,458,305

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

System	Type	QTY	Initial Cost	Installation	Useful Life	Planned Replacement	CAF (3%)	Replacement Cost
Miscellaneous Laterals	Duckbill	2	\$ 2,000	2017	35	2052	2.814	\$ 5,628
Total:			\$ 2,000					\$ 5,628

7.0 Relief Well Pump Stations (4 Stations)

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	2018	1.000	\$ 50	5	\$ 40,000	0	\$ 500	0	\$ 50,000	0	\$ 250
1	2019	1.030	\$ 52	5	\$ 41,200	0	\$ 515	0	\$ 51,500	0	\$ 258
2	2020	1.061	\$ 53	5	\$ 42,440	0	\$ 531	0	\$ 53,050	0	\$ 265
3	2021	1.093	\$ 55	5	\$ 43,720	0	\$ 547	0	\$ 54,650	0	\$ 273
4	2022	1.126	\$ 56	5	\$ 45,040	0	\$ 563	0	\$ 56,300	0	\$ 282
5	2023	1.159	\$ 58	5	\$ 46,360	0	\$ 580	12	\$ 57,950	0	\$ 7,244
6	2024	1.194	\$ 60	5	\$ 47,760	0	\$ 597	0	\$ 59,700	0	\$ 299
7	2025	1.230	\$ 62	5	\$ 49,200	0	\$ 615	0	\$ 61,500	0	\$ 308
8	2026	1.267	\$ 63	5	\$ 50,680	0	\$ 634	0	\$ 63,350	0	\$ 317
9	2027	1.305	\$ 65	5	\$ 52,200	0	\$ 653	0	\$ 65,250	0	\$ 326
10	2028	1.344	\$ 67	5	\$ 53,760	0	\$ 672	12	\$ 67,200	0	\$ 8,400
11	2029	1.384	\$ 69	5	\$ 55,360	0	\$ 692	0	\$ 69,200	0	\$ 346
12	2030	1.426	\$ 71	5	\$ 57,040	0	\$ 713	0	\$ 71,300	0	\$ 357
13	2031	1.469	\$ 73	5	\$ 58,760	0	\$ 735	0	\$ 73,450	0	\$ 367
14	2032	1.513	\$ 76	5	\$ 60,520	0	\$ 757	0	\$ 75,650	0	\$ 378
15	2033	1.558	\$ 78	5	\$ 62,320	0	\$ 779	12	\$ 77,900	0	\$ 9,738
16	2034	1.605	\$ 80	5	\$ 64,200	0	\$ 803	0	\$ 80,250	0	\$ 401
17	2035	1.653	\$ 83	5	\$ 66,120	0	\$ 827	0	\$ 82,650	0	\$ 413
18	2036	1.702	\$ 85	5	\$ 68,080	0	\$ 851	0	\$ 85,100	0	\$ 426

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	
19	2037	1.754	\$ 88	5	\$ 70,160	0	\$ 877	0	\$ 87,700	0	\$ 439
20	2038	1.806	\$ 90	5	\$ 72,240	0	\$ 903	12	\$ 90,300	0	\$ 11,288
21	2039	1.860	\$ 93	5	\$ 74,400	0	\$ 930	0	\$ 93,000	0	\$ 465
22	2040	1.916	\$ 96	5	\$ 76,640	0	\$ 958	0	\$ 95,800	0	\$ 479
23	2041	1.974	\$ 99	5	\$ 78,960	0	\$ 987	0	\$ 98,700	0	\$ 494
24	2042	2.033	\$ 102	5	\$ 81,320	0	\$ 1,017	0	\$ 101,650	0	\$ 508
25	2043	2.094	\$ 105	5	\$ 83,760	5	\$ 1,047	12	\$ 104,700	12	\$ 1,688,288
26	2044	2.157	\$ 108	5	\$ 86,280	0	\$ 1,079	0	\$ 107,850	0	\$ 539
27	2045	2.221	\$ 111	5	\$ 88,840	0	\$ 1,111	0	\$ 111,050	0	\$ 555
28	2046	2.288	\$ 114	5	\$ 91,520	0	\$ 1,144	0	\$ 114,400	0	\$ 572
29	2047	2.357	\$ 118	5	\$ 94,280	0	\$ 1,179	0	\$ 117,850	0	\$ 589
30	2048	2.427	\$ 121	5	\$ 97,080	0	\$ 1,214	12	\$ 121,350	0	\$ 15,169
31	2049	2.500	\$ 125	5	\$100,000	0	\$ 1,250	0	\$ 125,000	0	\$ 625
32	2050	2.575	\$ 129	5	\$103,000	0	\$ 1,288	0	\$ 128,750	0	\$ 644
33	2051	2.652	\$ 133	5	\$106,080	0	\$ 1,326	0	\$ 132,600	0	\$ 663
34	2052	2.732	\$ 137	5	\$109,280	0	\$ 1,366	0	\$ 136,600	0	\$ 683
35	2053	2.814	\$ 141	5	\$112,560	0	\$ 1,407	12	\$ 140,700	0	\$ 17,588
36	2054	2.898	\$ 145	5	\$115,931	0	\$ 1,449	0	\$ 144,914	0	\$ 725
37	2055	2.985	\$ 149	5	\$119,409	0	\$ 1,493	0	\$ 149,261	0	\$ 746
38	2056	3.075	\$ 154	5	\$122,991	0	\$ 1,537	0	\$ 153,739	0	\$ 769
39	2057	3.167	\$ 158	5	\$126,681	0	\$ 1,584	0	\$ 158,351	0	\$ 792
40	2058	3.262	\$ 163	5	\$130,482	0	\$ 1,631	12	\$ 163,102	0	\$ 20,388
41	2059	3.360	\$ 168	5	\$134,396	0	\$ 1,680	0	\$ 167,995	0	\$ 840
42	2060	3.461	\$ 173	5	\$138,428	0	\$ 1,730	0	\$ 173,035	0	\$ 865
43	2061	3.565	\$ 178	5	\$142,581	0	\$ 1,782	0	\$ 178,226	0	\$ 891
44	2062	3.671	\$ 184	5	\$146,858	0	\$ 1,836	0	\$ 183,573	0	\$ 918
45	2063	3.782	\$ 189	5	\$151,264	0	\$ 1,891	12	\$ 189,080	0	\$ 23,635
46	2064	3.895	\$ 195	5	\$155,802	0	\$ 1,948	0	\$ 194,752	0	\$ 974
47	2065	4.012	\$ 201	5	\$160,476	0	\$ 2,006	0	\$ 200,595	0	\$ 1,003
48	2066	4.132	\$ 207	5	\$165,290	0	\$ 2,066	0	\$ 206,613	0	\$ 1,033
49	2067	4.256	\$ 213	5	\$170,249	0	\$ 2,128	0	\$ 212,811	0	\$ 1,064
Total:											\$ 1,824,874

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							
Pump Station	Station	Initial Cost	Installation	Useful Life	Planned Replacement	CAF (3%)	Replacement Cost
Site 12	783+00	\$ 960,000	2017	50	2067	4.384	\$ 4,208,640
Site 09	1224+50	\$1,600,000	2017	50	2067	4.384	\$ 7,014,400
Site 10	1314+50	\$1,205,000	2017	50	2067	4.384	\$ 5,282,720
Site 16	1345+50	\$1,890,000	2017	50	2067	4.384	\$ 8,285,760
Total:							\$ 24,791,520

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 stations, the Flood of 1993 would have activated each 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, all duty pumps 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 combined operating costs for all newly constructed stations in the District are listed in Table 7-4 and estimated annually for the useful life of the stations.

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 09	30	20	2	110	164	85	334670	\$ 0.034360	\$ 11,499	\$ 27,057
Site 10	30	20	2	60	89	85	182547	\$ 0.034360	\$ 6,272	\$ 14,758
Site 12	30	20	1	45	34	85	68455	\$ 0.034360	\$ 2,352	\$ 5,534

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 16	30	20	3	140	313	85	638916	\$ 0.034360	\$ 21,953	\$ 51,654
Total:									\$ 42,077	\$ 99,004

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	\$ 42,077
1	2019	1.030	2017	50	\$ 43,339
2	2020	1.061	2017	50	\$ 44,639
3	2021	1.093	2017	50	\$ 45,979
4	2022	1.126	2017	50	\$ 47,358
5	2023	1.159	2017	50	\$ 48,779
6	2024	1.194	2017	50	\$ 50,242
7	2025	1.230	2017	50	\$ 51,749
8	2026	1.267	2017	50	\$ 53,302
9	2027	1.305	2017	50	\$ 54,901
10	2028	1.344	2017	50	\$ 56,548
11	2029	1.384	2017	50	\$ 58,244
12	2030	1.426	2017	50	\$ 59,992
13	2031	1.469	2017	50	\$ 61,791
14	2032	1.513	2017	50	\$ 63,645
15	2033	1.558	2017	50	\$ 65,555
16	2034	1.605	2017	50	\$ 67,521
17	2035	1.653	2017	50	\$ 69,547
18	2036	1.702	2017	50	\$ 71,633
19	2037	1.754	2017	50	\$ 73,782
20	2038	1.806	2017	50	\$ 75,996
21	2039	1.860	2017	50	\$ 78,276
22	2040	1.916	2017	50	\$ 80,624
23	2041	1.974	2017	50	\$ 83,043
24	2042	2.033	2017	50	\$ 85,534
25	2043	2.094	2017	50	\$ 88,100
26	2044	2.157	2017	50	\$ 90,743

Table 7-4 – Pump Stations – Total Annual Operation Costs					
Year No.	Year	CAF (3%)	Installation	Useful Life	Total (All Stations) Operation Cost
27	2045	2.221	2017	50	\$ 93,465
28	2046	2.288	2017	50	\$ 96,269
29	2047	2.357	2017	50	\$ 99,157
30	2048	2.427	2017	50	\$ 102,132
31	2049	2.500	2017	50	\$ 105,196
32	2050	2.575	2017	50	\$ 108,352
33	2051	2.652	2017	50	\$ 111,602
34	2052	2.732	2017	50	\$ 114,950
35	2053	2.814	2017	50	\$ 118,399
36	2054	2.898	2017	50	\$ 121,951
37	2055	2.985	2017	50	\$ 125,609
38	2056	3.075	2017	50	\$ 129,378
39	2057	3.167	2017	50	\$ 133,259
40	2058	3.262	2017	50	\$ 137,257
41	2059	3.360	2017	50	\$ 141,374
42	2060	3.461	2017	50	\$ 145,616
43	2061	3.565	2017	50	\$ 149,984
44	2062	3.671	2017	50	\$ 154,484
45	2063	3.782	2017	50	\$ 159,118
46	2064	3.895	2017	50	\$ 163,892
47	2065	4.012	2017	50	\$ 168,809
48	2066	4.132	2017	50	\$ 173,873
49	2067	4.256	2017	50	\$ 179,089
Total:					\$ 4,746,154

8.0 Gravity Drains

This project included rehabilitation of an existing 18” gravity drain with cured in place pipe (CIPP), rehabilitation of an existing 126” gravity drain by slip lining with fiberglass pipe, and rehabilitation of an existing 24” gravity drain by slip lining with smooth wall HDPE pipe. 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 experiences. 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 2067). 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 Wells Replacement	Relief Well Maintenance	PZ Replacement	PZ Maintenance	Clay Cap(s) Maintenance	Pipe Systems Replacement	Pipe Systems Maintenance	Pump Station Replacement	Pump Station Maintenance	Pump Station Operation	Total
2018			\$29,400			\$7,980				\$250	\$42,077	\$79,707
2019			\$30,282			\$8,219				\$258	\$43,339	\$82,098
2020			\$31,193			\$8,467				\$265	\$44,639	\$84,565
2021			\$33,774			\$8,722				\$273	\$45,979	\$88,748
2022			\$34,793			\$8,985		\$111,264		\$282	\$47,358	\$202,682
2023			\$35,813			\$9,249				\$7,244	\$48,779	\$101,084
2024			\$36,895			\$9,528				\$299	\$50,242	\$96,963
2025			\$38,007			\$9,815				\$308	\$51,749	\$99,879
2026			\$39,150		\$41,664	\$10,111				\$317	\$53,302	\$144,544
2027			\$40,325			\$10,414		\$129,024		\$326	\$54,901	\$234,990
2028			\$39,514			\$10,725				\$8,400	\$56,548	\$115,187
2029			\$40,690			\$11,044				\$346	\$58,244	\$110,324
2030			\$41,924			\$11,379				\$357	\$59,992	\$113,652
2031			\$45,392			\$11,723				\$367	\$61,791	\$119,273
2032			\$46,752			\$12,074		\$149,568		\$378	\$63,645	\$272,417
2033			\$48,142			\$12,433				\$9,738	\$65,555	\$135,867
2034			\$49,595			\$12,808				\$401	\$67,521	\$130,325
2035			\$51,078			\$13,191				\$413	\$69,547	\$134,229
2036	\$135,450		\$52,592		\$55,986	\$13,582				\$426	\$71,633	\$329,669
2037	\$361,200		\$54,199			\$13,997		\$173,376		\$439	\$73,782	\$676,992
2038			\$53,096			\$14,412				\$11,288	\$75,996	\$154,792
2039			\$54,684			\$14,843				\$465	\$78,276	\$148,267
2040			\$56,330			\$15,290				\$479	\$80,624	\$152,723
2041			\$60,997			\$15,753				\$494	\$83,043	\$160,285
2042			\$62,820			\$16,223		\$201,024		\$508	\$85,534	\$366,109
2043			\$520,150			\$16,710				\$1,688,288	\$88,100	\$2,313,247
2044			\$66,651			\$17,213				\$539	\$90,743	\$175,146
2045			\$68,629			\$17,724				\$555	\$93,465	\$180,373
2046			\$70,699		\$75,237	\$18,258				\$572	\$96,269	\$261,036
2047			\$72,831			\$18,809		\$232,992		\$589	\$99,157	\$424,379
2048			\$71,354			\$19,367				\$15,169	\$102,132	\$208,022
2049			\$73,500			\$19,950				\$625	\$105,196	\$199,271
2050			\$75,705			\$20,549				\$644	\$108,352	\$205,249
2051			\$81,947			\$21,163				\$663	\$111,602	\$215,375
2052			\$84,419			\$21,801	\$5,628	\$270,144		\$683	\$114,950	\$497,626
2053			\$86,953			\$22,456				\$17,588	\$118,399	\$245,395

Table 9-1 – Annual Costs

Year	Sluice Gates	Relief Wells Replacement	Relief Well Maintenance	PZ Replacement	PZ Maintenance	Clay Cap(s) Maintenance	Pipe Systems Replacement	Pipe Systems Maintenance	Pump Station Replacement	Pump Station Maintenance	Pump Station Operation	Total
2054			\$89,557			\$23,128				\$725	\$121,951	\$235,360
2055			\$92,244			\$23,822				\$746	\$125,609	\$242,421
2056			\$95,011		\$101,123	\$24,537				\$769	\$129,378	\$350,817
2057			\$97,861			\$25,273		\$313,152		\$792	\$133,259	\$570,337
2058			\$95,904			\$26,031				\$20,388	\$137,257	\$279,579
2059			\$98,781			\$26,812				\$840	\$141,374	\$267,807
2060			\$101,744			\$27,616				\$865	\$145,616	\$275,842
2061			\$110,144			\$28,445				\$891	\$149,984	\$289,464
2062			\$113,448			\$29,298		\$363,072		\$918	\$154,484	\$661,220
2063			\$116,851			\$30,177				\$23,635	\$159,118	\$329,782
2064		\$10,587,360	\$120,357			\$31,082				\$974	\$163,892	\$10,903,665
2065		\$9,250,240	\$123,968			\$32,015				\$1,003	\$168,809	\$9,576,034
2066			\$127,687	\$973,248		\$32,975				\$1,033	\$173,873	\$1,308,816
2067			\$131,517	\$512,928		\$33,965		\$5,050,368	\$24,791,520	\$1,064	\$179,089	\$30,700,451
2068						\$34,984						\$34,984
2069						\$36,034						\$36,034
2070						\$37,115						\$37,115
2071						\$38,228						\$38,228
2072						\$39,375		\$487,872				\$527,247
2073						\$40,556						\$40,556
2074						\$41,773						\$41,773
2075						\$43,026						\$43,026
2076						\$44,317						\$44,317
2077						\$45,647		\$565,632				\$611,279
2078						\$47,016						\$47,016
2079						\$48,426						\$48,426
2080						\$49,879						\$49,879
2081						\$51,376						\$51,376
2082						\$52,917		\$655,680				\$708,597
2083						\$54,504						\$54,504
2084						\$56,140						\$56,140
2085						\$57,824						\$57,824
2086						\$59,558						\$59,558
2087						\$61,345		\$760,128				\$821,473
2088						\$63,186						\$63,186
2089						\$65,081						\$65,081

Table 9-1 – Annual Costs

Year	Sluice Gates	Relief Wells Replacement	Relief Well Maintenance	PZ Replacement	PZ Maintenance	Clay Cap(s) Maintenance	Pipe Systems Replacement	Pipe Systems Maintenance	Pump Station Replacement	Pump Station Maintenance	Pump Station Operation	Total
2090						\$67,034						\$67,034
2091						\$69,045						\$69,045
2092						\$71,116	\$7,458,305	\$881,184				\$8,410,605
2093						\$73,249						\$73,249
2094						\$75,447						\$75,447
2095						\$77,710						\$77,710
2096						\$80,042						\$80,042
2097						\$82,443		\$1,021,536				\$1,103,979
2098						\$84,916						\$84,916
2099						\$87,464						\$87,464
2100						\$90,088						\$90,088
2101						\$92,790						\$92,790
2102						\$95,574		\$1,184,256				\$1,279,830
2103						\$98,441						\$98,441
2104						\$101,394						\$101,394
2105						\$104,436						\$104,436
2106						\$107,569						\$107,569
2107						\$110,796		\$1,372,800				\$1,483,596
2108						\$114,120						\$114,120
2109						\$117,544						\$117,544
2110						\$121,070						\$121,070
2111						\$124,702						\$124,702
2112						\$128,443		\$1,591,488				\$1,719,931
2113						\$132,297						\$132,297
2114						\$136,265						\$136,265
2115						\$140,353						\$140,353
2116						\$144,564						\$144,564
2117						\$148,901	\$82,499,794					\$82,648,695
2118						\$153,368						\$153,368