LIFE CYCLE COST ANALYSIS FOR DECISION MAKING IN COLLECTION SYSTEM REHABILITATION

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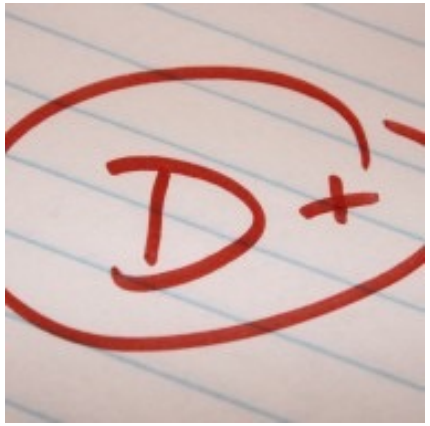
LIFE CYCLE COST ANALYSIS

- A Tool for Making Sound Project Decisions Between Alternatives
- Considers Both Capital and Operating Costs Over a Long Term Period
- Facilitates Supportable Business Case Decisions
- Commonly Applied to Treatment Plant or Pump Station Projects
- Equally Applicable to Collection System Projects
- LCC Analysis Is Required Under Section 602(b)(13) Of The Clean Water Act For Federally Funded and State Revolving Loan Projects

THE CHALLENGE

- Over 800,000 Miles of Public Sewers and 500,000 Miles of Private Laterals In the US
- All Susceptible to Structural Failure, Blockages and Overflow
- ASCE Grades US Collection System Infrastructure D+
- EPA Estimates That $51 Billion In Collection System Rehabilitation Is Needed in the Next 25 Years



WE MUST GET IT RIGHT THE FIRST TIME

- $ Budgets for R&R Are Limited
- $ We Can't Afford To Get It Wrong. We Can't Afford To Do The Same Projects Over Again
- $ We Must Choose Projects That Are Sustaina and Cost Less In The Long Run

WHAT IS LCC?

- ASTM International Defines LCC In ASTM Standard F1675-13:
- LCC Analysis Measures The Present Value Of All Relevant Costs To Install, Operate and Maintain Project Alternatives Over A Specified Period Of Time
- The Decision Maker Can Then Identify Alternatives With The Lowest Cost Based On Net Present Value
- The Alternatives Must Be Independent and Mutually Exclusive

COSTS CONSIDERED IN LCC ANALYSIS

- Initial Installed Cost
- Material Service Life
- Operating Costs
- Maintenance Costs
- Rehabilitation Costs
- Replacement Costs
- Terminal Value (commonly called salvage value)

DATA THAT SHOULD BE CONSIDERED IN LCC

- Job Site Reports
- Published Papers and Reports
- Manufacturer Product Data
- Local Experience With Alternatives

EXAMPLE LCC ANALYSIS

Rehabilitation of a Gravity Sewer Lateral

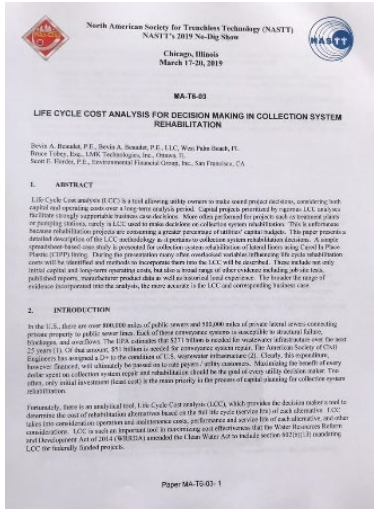
Three Independent, Mutually Exclusive Alternatives Analyzed:

- **Do Nothing Alternative**
- **CIPP Lined Lateral Using Hydrophilic Adhesive-Based Seals**
- **CIPP Lined Lateral Using Pre-Engineered, Hydrophilic, Molded Rubber Gaskets, ASTM F3240 Compliant Seals**

COSTS CONSIDERED IN EXAMPLE

- Initial Installation
- Periodic Replacement (if applicable)
- Conveyance and Treatment of Leakage Flow Volumes
- Periodic Maintenance of Lateral By CCTV Inspection, Cleaning and Grouting (if applicable)
- Costs Estimates Based On Case Studies, Utility Owner Experience and Recent Bids

DATA USED TO DETERMINE MATERIAL SERVICE LIFE



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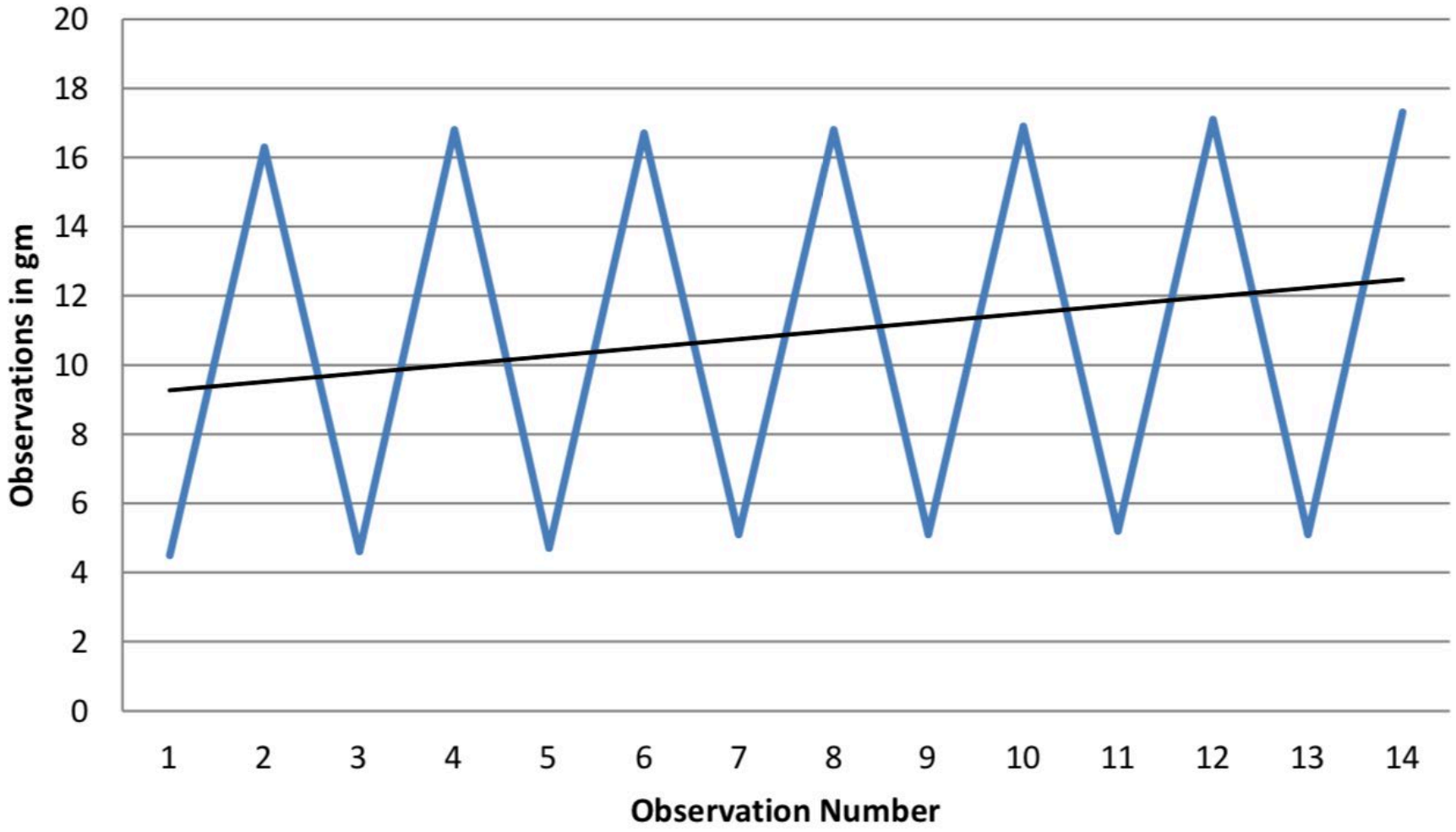
1. ABSTRACT

2. INTRODUCTION

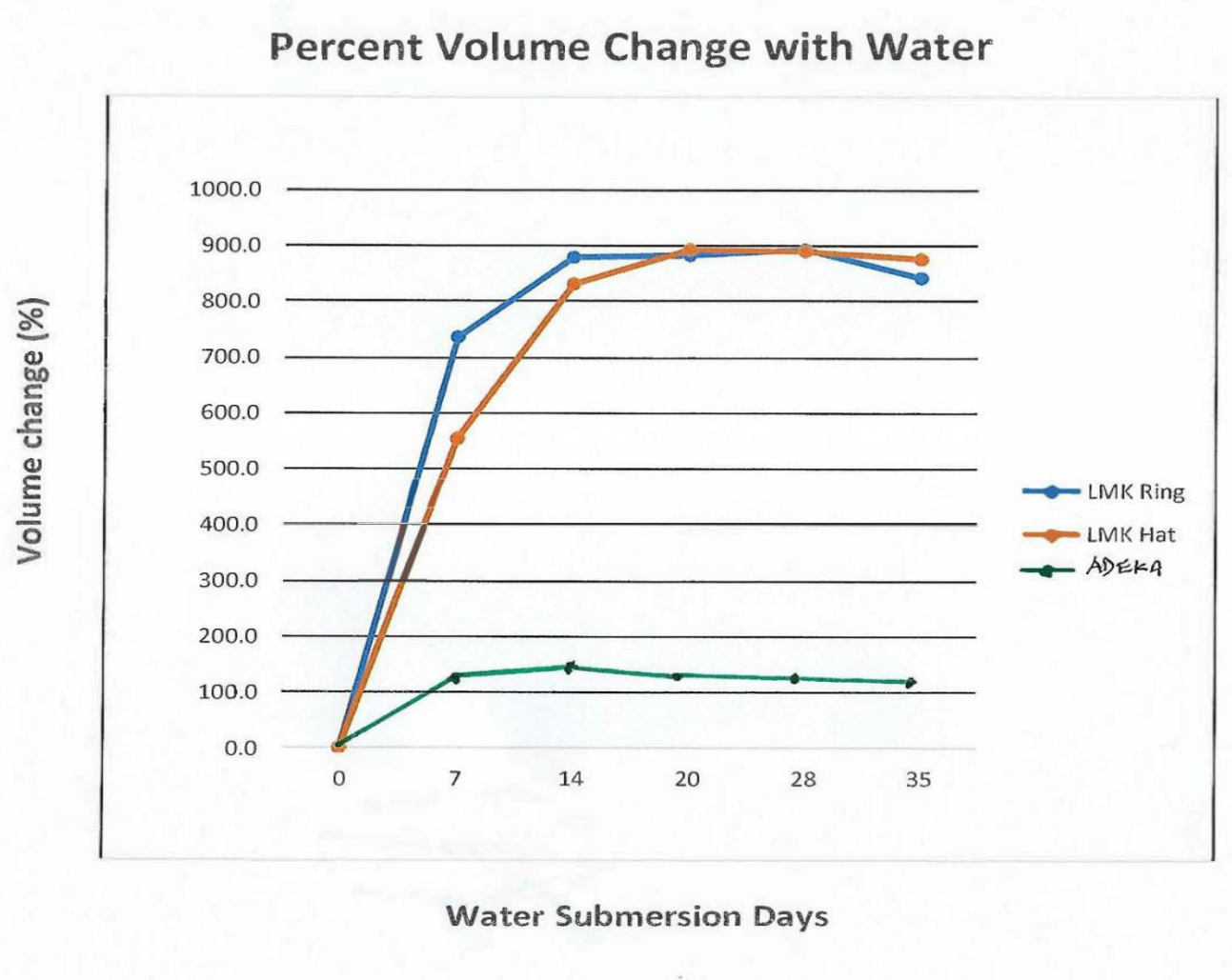
Paper MA-T6-03- 1

- Manufacturers Product Data
- Independent Laboratory Tests
- Numerous Case Studies
- Published Papers and Reports

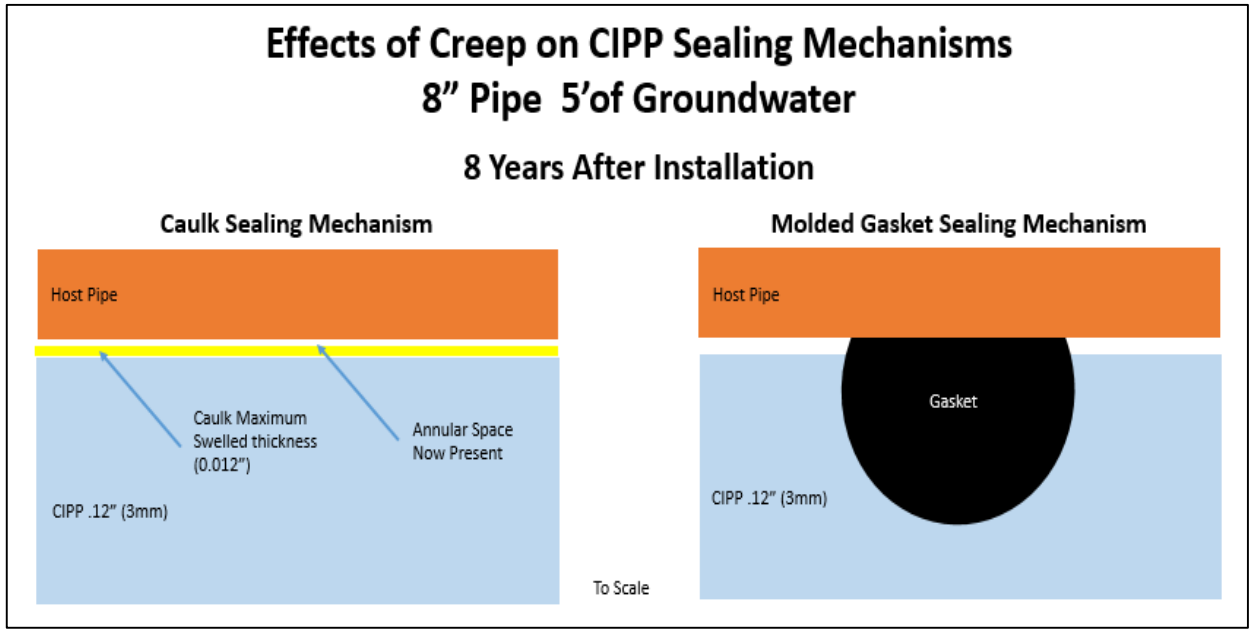
10,000 HOUR HYDRATION DE-HYDRATION TEST OF MOLDED RUBBER SEALS

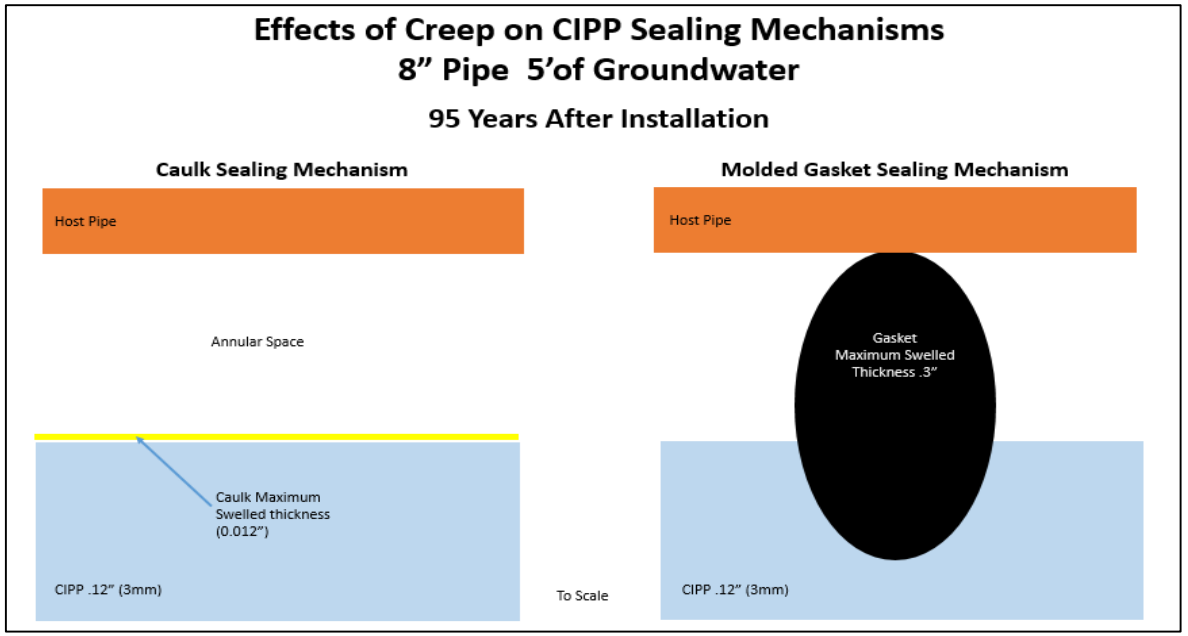


30-DAY IMMERSION TEST OF ASTM 3240 RUBBER SEALS AND ADHESIVE BASED SEALS



LONG-TERM CREEP CALCULATIONS





LCC Calculation Method

Equation [1] is the standard equation for determining inflated costs:

$$InflC = C * (1 + ir)^t$$

where: InflC = the cost after inflation at time
C = initial cost at time t = 0
t = time in years
ir = annual inflation rate

LCC Calculation Method - Continued

Equation [2] is the equation used for determining NPV:

$$NPV = \sum_{t=0}^{T} \frac{C_t}{(1+dr)^t}$$

where: NPV = the net present value of the stream of costs considered over the analysis period

Ct = all relevant costs during year t

dr = the discount rate expressed as a %

t = the time in years (t=0……T) (years)

T = the selected analysis period

An Annual Inflation Rate of 2.25% and a Discount Rate of 5.00% have been assumed for the example given below, The analysis period has been defined to be 50 years, the generally accepted service life for CIPP mainline lining. Salvage (Terminal) values have been defined based on straight-line depreciation. For instance, if an asset with a useful life of 20 years were only 10 years into its service life at the end of the analysis period, then 50% of its installation cost would be credited at the end of the analysis period

TABLE 1

No Action Alternative

Inflation Rate = 2.25% Discount Rate = 5.00%

Year	Installation Cost	I/I Treatment	Inspect/ Grout	Total Annual Cost	Present Value
0	$0.00				$0.00
1		$400.00		$400.00	$380.95
2		$409.00		$409.00	$370.98
3		$418.20		$418.20	$361.26
4		$427.61		$427.61	$351.80
5		$437.23	$524.68	$961.91	$753.68
6		$55.88		$55.88	$41.70
7		$114.28		$114.28	$81.22
8		$233.71		$233.71	$158.18
9		$358.45		$358.45	$231.06
10		$488.69	$586.42	$1,075.11	$660.02
11		$62.46		$62.46	$36.52
12		$127.73		$127.73	$71.13
13		$261.21		$261.21	$138.53
14		$400.63		$400.63	$202.35
15		$546.19	$655.43	$1,201.63	$578.00
16		$69.81		$69.81	$31.98
17		$142.76		$142.76	$62.29
18		$291.95		$291.95	$121.31
19		$447.78		$447.78	$177.20
20		$610.47	$732.56	$1,343.03	$506.17
21		$78.03		$78.03	$28.01
22		$159.56		$159.56	$54.55
23		$326.30		$326.30	$106.24
24		$500.47		$500.47	$155.18
25		$682.31		$682.31	$201.49
26		$697.66		$697.66	$196.21
27		$713.36		$713.36	$191.07
28		$729.41		$729.41	$186.07
29		$745.82		$745.82	$181.19
30		$762.60		$762.60	$176.45
31		$779.76		$779.76	$171.83
32		$797.30		$797.30	$167.33
33		$815.24		$815.24	$162.94
34		$833.58		$833.58	$158.68
35		$852.34		$852.34	$154.52
36		$871.52		$871.52	$150.47
37		$891.13		$891.13	$146.53
38		$911.18		$911.18	$142.70
39		$931.68		$931.68	$138.96
40		$952.64		$952.64	$135.32
41		$974.08		$974.08	$131.77
42		$995.99		$995.99	$128.32
43		$1,018.40		$1,018.40	$124.96
44		$1,041.32		$1,041.32	$121.69
45		$1,064.75		$1,064.75	$118.50
46		$1,088.70		$1,088.70	$115.40
47		$1,113.20		$1,113.20	$112.38
48		$1,138.25		$1,138.25	$109.43
49		$1,163.86		$1,163.86	$106.57
50		$1,190.04		$1,190.04	$103.78
NPV					$9,494.85

TABLE 2

CIPP Lined with Adhesive Seals Alternative

Inflation Rate = 2.25% Discount Rate = 5.00%

Year	Installation Cost	I/I Treatment	Inspect/ Grout	Lining Replacement	Total Annual Cost	Present Value
0	$1,290.00					$1,290.00
1		$0.00			$0.00	$0.00
2		$0.00			$0.00	$0.00
3		$0.00			$0.00	$0.00
4		$0.00			$0.00	$0.00
5		$0.00			$0.00	$0.00
6		$55.88			$55.88	$41.70
7		$85.71			$85.71	$60.91
8		$116.85			$116.85	$79.09
9		$179.22			$179.22	$115.53
10		$305.43	$586.42		$891.85	$547.52
11		$62.46			$62.46	$36.52
12		$95.80			$95.80	$53.34
13		$130.60			$130.60	$69.26
14		$200.32			$200.32	$101.17
15		$273.10			$273.10	$131.36
16		$349.05			$349.05	$159.90
17		$428.29			$428.29	$186.86
18		$510.91			$510.91	$212.29
19		$597.03			$597.03	$236.27
20		$610.47		$1,968.76	$2,579.23	$972.08
21		$0.00			$0.00	$0.00
22		$0.00			$0.00	$0.00
23		$0.00			$0.00	$0.00
24		$0.00			$0.00	$0.00
25		$0.00			$0.00	$0.00
26		$87.21			$87.21	$24.53
27		$133.75			$133.75	$35.83
28		$182.35			$182.35	$46.52
29		$279.68			$279.68	$67.95
30		$476.62	$915.12		$1,391.74	$322.02
31		$97.47			$97.47	$21.48
32		$149.49			$149.49	$31.37
33		$203.81			$203.81	$40.74
34		$312.59			$312.59	$59.50
35		$426.17			$426.17	$77.26
36		$544.70			$544.70	$94.05
37		$668.34			$668.34	$109.90
38		$797.28			$797.28	$124.86
39		$931.68			$931.68	$138.96
40		$952.64		$3,072.27	$4,024.91	$571.72
41		$0.00			$0.00	$0.00
42		$0.00			$0.00	$0.00
43		$0.00			$0.00	$0.00
44		$0.00			$0.00	$0.00
45		$0.00			$0.00	$0.00
46		$136.09			$136.09	$14.42
47		$208.72			$208.72	$21.07
48		$284.56			$284.56	$27.36
49		$436.45			$436.45	$39.96
50		$743.78	$1,428.05	($1,918.94)	$252.88	$22.05
NPV						$6,185.37

TABLE 3

CIPP Lined with ASTM 3240 Compliant Seals

Inflation Rate = 2.25% Discount Rate = 5.00%

Year	Installation Cost	I/I Treatment	Inspect	Lining Replacement	Total Annual Cost	Present Value
0	$2,440.00					$2,440.00
1		$0.00			$0.00	$0.00
2		$0.00			$0.00	$0.00
3		$0.00			$0.00	$0.00
4		$0.00			$0.00	$0.00
5		$0.00			$0.00	$0.00
6		$0.00			$0.00	$0.00
7		$0.00			$0.00	$0.00
8		$0.00			$0.00	$0.00
9		$0.00			$0.00	$0.00
10		$0.00	$277.94		$277.94	$170.63
11		$9.37			$9.37	$5.48
12		$9.58			$9.58	$5.33
13		$9.80			$9.80	$5.19
14		$10.02			$10.02	$5.06
15		$10.24			$10.24	$4.93
16		$10.47			$10.47	$4.80
17		$10.71			$10.71	$4.67
18		$10.95			$10.95	$4.55
19		$11.19			$11.19	$4.43
20		$11.45	$347.20		$358.65	$135.17
21		$15.61			$15.61	$5.60
22		$15.96			$15.96	$5.45
23		$16.32			$16.32	$5.31
24		$16.68			$16.68	$5.17
25		$17.06			$17.06	$5.04
26		$17.44			$17.44	$4.91
27		$17.83			$17.83	$4.78
28		$18.24			$18.24	$4.65
29		$18.65			$18.65	$4.53
30		$19.06	$433.73		$452.79	$104.77
31		$29.24			$29.24	$6.44
32		$29.90			$29.90	$6.27
33		$30.57			$30.57	$6.11
34		$31.26			$31.26	$5.95
35		$31.96			$31.96	$5.79
36		$32.68			$32.68	$5.64
37		$33.42			$33.42	$5.49
38		$34.17			$34.17	$5.35
39		$34.94			$34.94	$5.21
40		$35.72	$541.81		$577.54	$82.04
41		$48.70			$48.70	$6.59
42		$49.80			$49.80	$6.42
43		$50.92			$50.92	$6.25
44		$52.07			$52.07	$6.08
45		$53.24			$53.24	$5.93
46		$54.44			$54.44	$5.77
47		$55.66			$55.66	$5.62
48		$56.91			$56.91	$5.47
49		$58.19			$58.19	$5.33
50		$59.50	$676.84		$736.34	$64.21
NPV						$3,192.42

EXAMPLE LCC ANALYSIS RESULTS

- **Do Nothing Alternative: NPV = $9494.85**
- **Adhesive/Paste Based Liner: NPV = $$6185.37**
- **ASTM F3240 Compliant Liner: NPV = $3192.42**

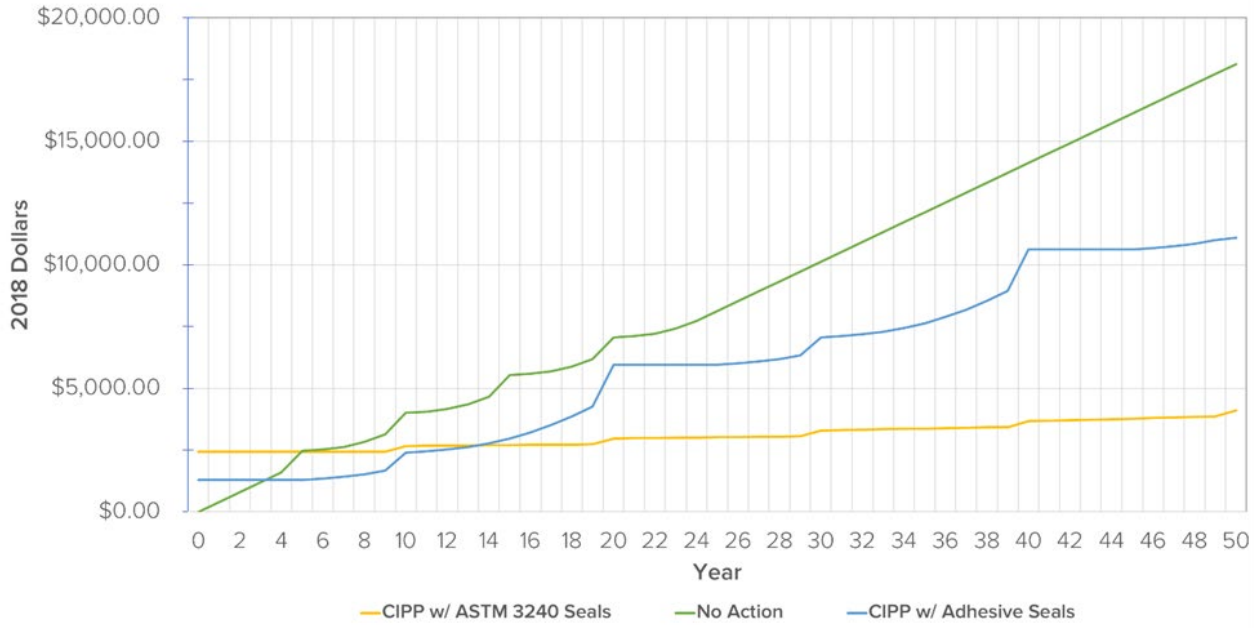


FIGURE 4
Cumulative Annual Costs (Uninflated)

CONCLUSIONS

- The ASTM F3240 Compliant Alternative, Although the Most Expensive in Initial Installation Cost, Is the Least Cost Alternative Over the 50-year Period – by a Factor of 2!
- The LCC Analysis Method Clearly Demonstrates To the Owner the Most Cost Effective Alternative Over the Long-Term
- LCC Analysis Provides a Clear Cut, Supportable Business Case For Decision Making

QUESTIONS?