SEWER PIPE CALCULATIONS

This memo provides support documentation for sewer investment values included on the Reclaim60 website. Methodology and example calculations for cost estimating are outlined in this document.

Current population, length of existing sewer pipe, and average age of sewer collection system were collected from municipalities and service districts via a survey. Municipalities and service districts were contacted by email and phone during September 2019. District managers, city engineers, and public works directors provided information.

1.1 POPULATION

If population information was not obtained directly from cities or municipalities, 2012 Baseline Projections from the Utah Governor's Office of Management and Budget (GOMB) were used to estimate 2020 and 2060 populations for individual municipalities. This was used instead of the Kem C. Gardner Policy Institute projections from 2015 because the Gardner study does not provide detail below the county level. Population by municipality was essential to be able to calculate sewer pipe needs by municipality.

In any case where population supplied by a municipality disagreed significantly with that of the GOMB estimate, the estimate from the municipality was used for analysis.

In some counties, notably Davis and Salt Lake Counties, service districts covered portions of several different municipalities. In this case, populations supplied by the districts were compared to values from the GOMB estimate to ensure that population was not double counted. The population growth was also projected according to county growth rates calculated from the GOMB projections.

1.2 EXISTING LENGTH OF SEWER PIPE

In the cases where the length of existing sewer pipe was not obtained directly from the municipality, a method for estimating length of existing sewer pipe was developed. Data from reporting municipalities was used to develop a per capita length of sewer pipe. This was done by dividing the length of sewer pipe provided in the surveys by the serviced population, which resulted in 17ft/capita sewer pipe. This value was used to estimate the number of miles of sewer pipe in a town. An example calculation is below:

City: Anytown
Type: Urban
2020 Population (GOMB): 22,292
Per Capita Sewer Pipe: 17 ft/cap

$$(22{,}292\ capita) * \frac{17\ ft}{capita} * \frac{1\ mile}{5280\ ft} = 72\ miles\ of\ collection\ pipe$$

In rural municipalities, due to the wider geographic spread of population, 20 ft/capita was used to estimate length of sewer pipe.

Many rural communities in Utah do not have sewer systems. This study assumed that if a town did not have a wastewater permit from the Utah Department of Environmental Quality (DEQ), sewage was managed via septic systems and, therefore, the town had no sewer collection pipe. Additionally, the balance of the population in a county (not included in towns and cities) was assumed to be on septic systems, except in the case of Salt Lake, Davis, Washington, and Utah Counties.

1.3 REPLACEMENT & RELINING NEEDS

The average age of the collection system was used to determine how much of the system would need to be replaced by 2060. The lifespan of a typical sewer pipe is 70 years. If the average age of a system is 30 years, 50% of the system will reach 70 years old by 2060 and will need to be replaced or relined. Using this relationship, the percentage of pipe that would need replacement or relining (R&R) was determined as illustrated in Table 1. Ages of the systems were rounded to the nearest increment of 5 years for simplicity.

Table 1. Age Based Replacement Schedule

Age (years)	Replaced or Relined (%)
0	0%
5	8%
10	17%
15	25%
20	33%
25	42%
30	50%
35	58%
40	67%
45	75%
50	83%
55	92%
60	100%
65	100%
70	100%
75	100%
80	100%

In cases where the age of the system was unknown, an average age of 35 years was assumed. An example calculation is as follows:

City: Anytown
Type: Urban
Length of Sewer Pipe: 72 miles
Average Age of Sewer Pipe: 35 years

$$(72\ miles) * 58\%\ R\&R = \ 42\ miles\ R\&R$$

Thus, by 2060, the municipality will need to replace or reline 42 miles of existing sewer collection pipe.

1.4 NEW INSTALLATION

Population growth necessitates installation of new sewer pipe to ensure continued quality of living. The projection for future sewer pipe length was calculated by taking the difference between 2060 and 2020 population. The difference was then multiplied by the 17 or 20 ft of sewer pipe per capita factor for urban or rural municipalities, respectively. An example calculation is shown below:

City: Anytown
Type: Urban
2020 Population: 22,292
2060 Population: 42,417
Per Capita Sewer Pipe: 17 ft/cap

$$(42{,}417 - 22{,}292\ capita) * \frac{17\ ft}{capita} * \frac{1\ mile}{5280\ ft} = \ 65\ miles\ additional\ pipe\ by\ 2060$$

Many small towns currently operate with septic systems but may need treatment plants and sewer collection systems in the future. A breakpoint population was selected to project which towns would likely adopt sewer systems by 2060. To choose the breakpoint population, several towns with Non-Discharging Lagoon (NDL) permits were used to see typical populations where small towns had sewer systems. Populations of 1000 and 3500 were the most frequently occurring populations as seen in Figure 1.

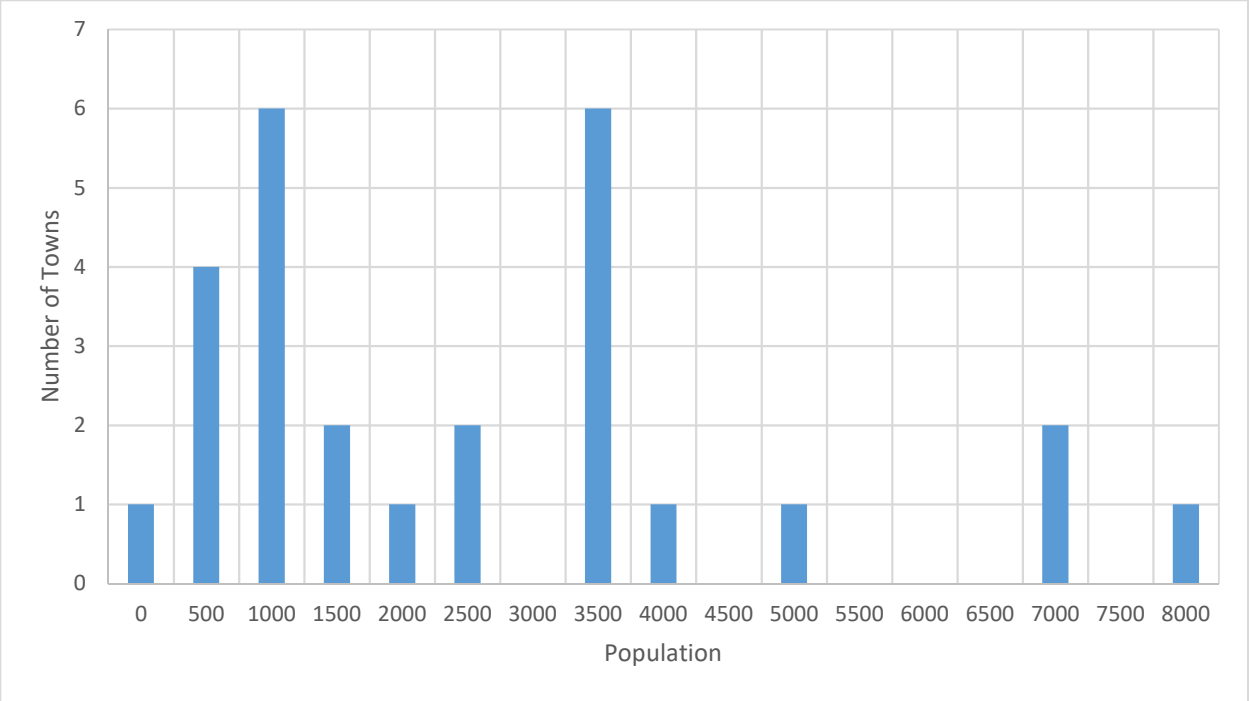


Figure 1. Frequency of Population with NDL Permits

The breakpoint population selected was 2000, which is on the lower end of the two most frequently occurring populations. If the population of a town exceeded 2000 by 2060, the entire population was assumed to get sewer pipe. An example calculation is shown below:

Town: Anytown
Type: Rural
2020 Population: 1,129
2020 Length of Sewer Pipe: 0 miles
2060 Population: 2,257
Per Capita Sewer Pipe: 20 ft/cap

$$(2{,}257\ capita) * \frac{20\ ft}{capita} * \frac{1\ mile}{5280\ ft} = 9\ miles\ of\ collection\ pipe\ in\ 2060$$

If the population of a town did not exceed 2000 by 2060 and the town did not already have sewer pipe, it was assumed that no new sewer pipe would be installed.

1.5 COST ESTIMATING

The cost of installing new infrastructure is shared by municipalities and developers. In most cases, developers carry the bulk of the cost. To calculate the portion paid by municipalities, a ratio of 25/75 was assumed, with municipalities covering the cost of 25% of newly installed pipe. To replace existing pipe, however, the municipalities cover 100% of the cost.

Two unit costs were developed to estimate the price of rehabilitating existing sewer pipe. Replacing existing sewer involves digging up and removing old pipe. Relining pipe is less invasive and involves inserting a flexible liner that can be cured in place. A PVC sewer pipe size of 10 inches in a 10-foot deep, 5300-foot long trench governed the cost for both scenarios. For replacement of existing pipe, cutting and replacing roadways and sidewalks was included, and existing manholes were assumed to remain in place. Attachment A in the Appendix summarizes the items used to obtain the $71/foot unit cost for replacing existing pipe. Attachment B in the Appendix summarizes the costs for relining existing pipe, which is $74/foot.

The condition, location, and accessibility of the pipe can influence which method is used to rehabilitate damaged pipe. For this study, 50% of sewer rehabilitation was assumed to be replaced while the remaining 50% was relined. An example calculation for the cost of replacing and relining existing sewer pipe is as follows:

City: Anytown
Sewer Pipe Needing Replacement: 42 miles
Unit Cost for Replacement: $71/ft
Unit Cost for Relining: $74/ft
Portion Replaced: 50%
Portion Relined: 50%
Portion of Cost Paid: 100%

$$\left(\left(42\ miles\ pipe * 50\% * \frac{\$71}{ft}\right) + \left(42\ miles\ pipe * 50\% * \frac{\$74}{ft}\right)\right) * \frac{5280\ ft}{mile} * 100\% = \$16.1\ million$$

Replacing and relining existing sewer pipe in this municipality will cost $16.1 million.

For new installation, it was assumed that the pipes would be installed before laying asphalt or concrete for roads and sidewalks. A PVC sewer pipe size of 12 inches in a 12-foot deep, 5300-foot long trench governed the cost for this scenario. New manholes were also included in the cost, which came out to be $97/foot. Attachment C in the Appendix summarizes the values used to obtain the unit cost for new installation.

City: Anytown
New Pipe to Meet Future Demand: 65 miles
Unit Cost: $97/ft
Portion of Cost Paid: 25%

$$(65\ miles\ pipe) * \frac{\$97}{ft} * \frac{5280\ ft}{mile} * 25\% = \$8.3\ million$$

Meeting future demand for sewer pipe in this municipality will cost about $8.3 million. The total cost for replacing, relining, and installing new sewer pipe in this municipality is expected to be

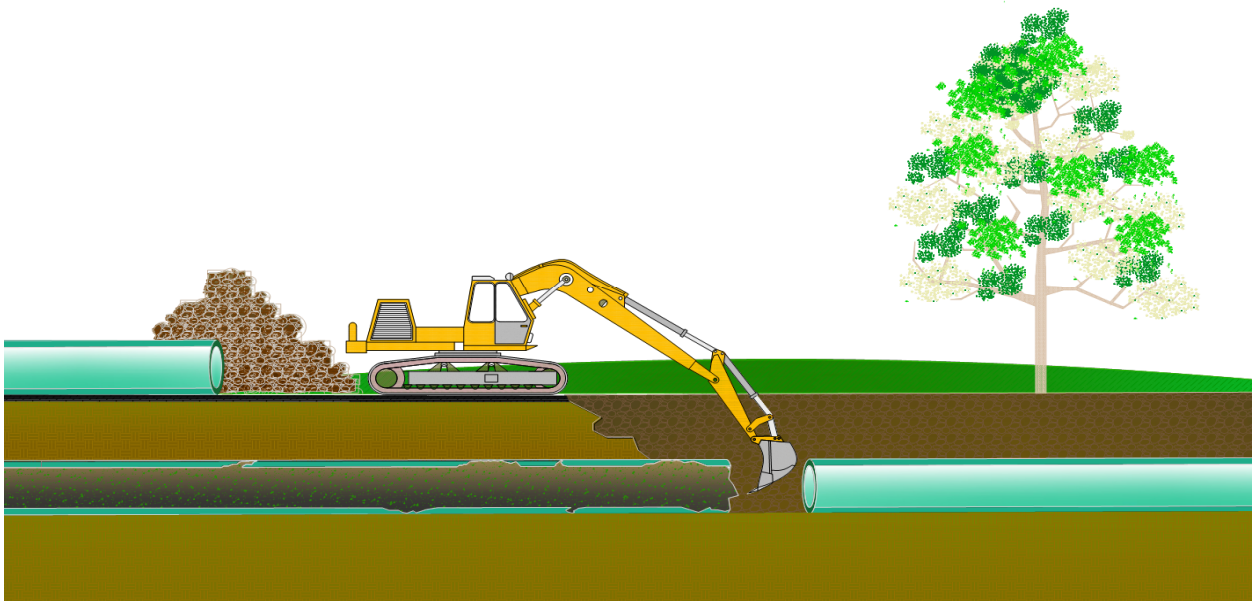
about $24.4 million. This same methodology was applied to all municipalities in the state and resulted in an overall cost of $4.3 billion. The projected cost by county for sewer pipe is summarized in Attachment D in the Appendix.

APPENDIX

ATTACHMENT A: SEWER PIPE REPLACEMENT

Opinion of Probable Costs
Statewide Sewer Cost Survey
Complete Pipe Replacement (10" at 10' Deep, 5300' Long Trench)

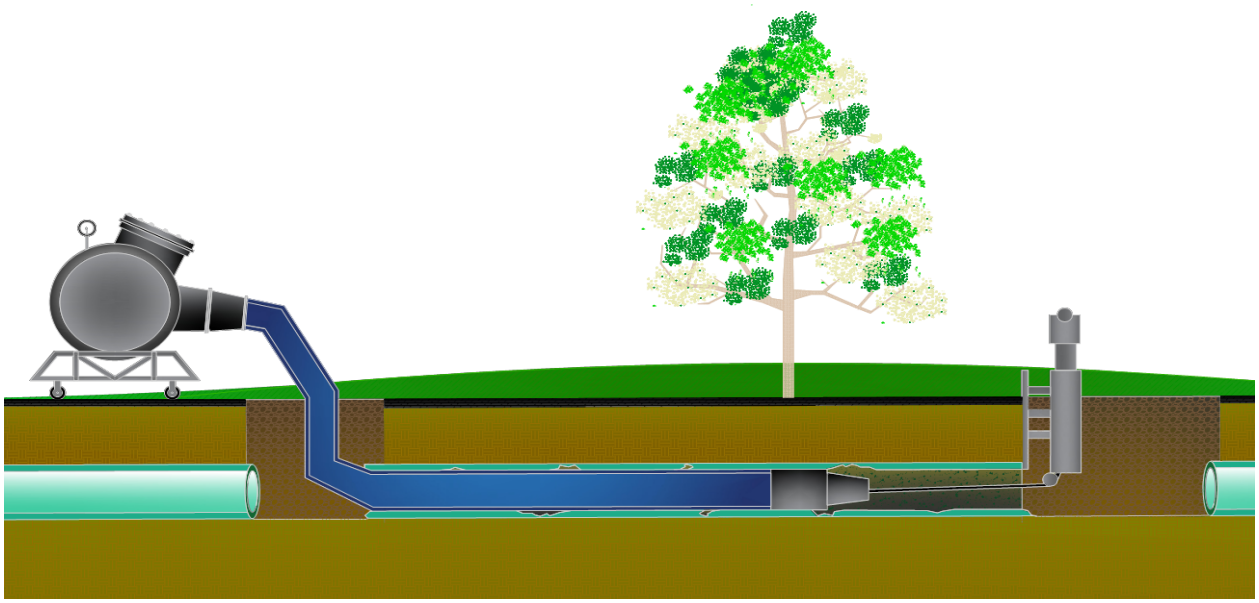
Item	Description	Unit	Quantity	Unit Cost	Total Cost
1	Excavation	CY	6,478	$5.00	$32,389
2	Removal/Disposal of Existing Pipe	LF	5,300	$2.00	$10,600
3	Disposal of Excavated Materials	LF	6,478	$3.00	$19,433
4	Bypass Pumping	LF	5,300	$5.00	$26,500
5	Dewatering	LF	5,300	$5.00	$26,500
6	Pipe Material (10" PVC Sewer)	LF	5,300	$7.00	$37,100
7	Pipe Installation	LF	5,300	$4.00	$21,200
8	Pipe Bedding Material (Placed)	CY	1,178	$7.00	$8,244
9	Trench Backfill Material (Placed)	CY	5,300	$9.00	$47,700
10	Lateral Connections	EA	53	$500.00	$26,500
11	Asphalt Patch	SF	15,900	$2.00	$31,800
12	Manholes (assume reuse existing)	EA	0	$8,000.00	$0
13					
	Subtotal				**$287,967**
14	Contingency			30%	$86,390
	Total Cost				**$374,357**
15				LF	$5,300
	Unit Cost				**$71**



ATTACHMENT B: SEWER PIPE RELINING

Opinion of Probable Costs
Statewide Sewer Cost Survey
Line Existing Pipe (10" at 10' Deep, 5300' Long Trench)

Item	Description	Unit	Quantity	Unit Cost	Total Cost
1	Excavation	CY	0	$5.00	$0
2	Removal/Disposal of Existing Pipe	LF	0	$2.00	$0
3	Disposal of Excavated Materials	LF	0	$3.00	$0
4	Bypass Pumping	LF	5,300	$2.00	$10,600
5	Dewatering	LF	0	$5.00	$0
6	Liner Materials and Installation	LF	5,300	$50.00	$265,000
7	Pipe Installation	LF	0	$4.00	$0
8	Pipe Bedding Material (Placed)	CY	0	$7.00	$0
9	Trench Backfill Material (Placed)	CY	0	$9.00	$0
10	Lateral Connections	EA	53	$500.00	$26,500
11	Asphalt Patch	SF	0	$2.00	$0
12					
	Subtotal				**$302,100**
13	Contingency			30%	$90,630
	Total Cost				**$392,730**
				LF	$5,300
				Unit Cost	**$74**



ATTACHMENT C: NEW SEWER INSTALLATION COST

Opinion of Probable Costs
Statewide Sewer Cost Survey
New Pipe (12" at 12' Deep, 5300' Long Trench)

Item	Description	Unit	Quantity	Unit Cost	Total Cost
1	Excavation	CY	7,656	$7.00	$53,589
2	Disposal of Excavated Materials	LF	7,656	$3.00	$22,967
3	Dewatering	LF	5,300	$6.00	$31,800
4	Pipe Material (12" PVC Sewer)	LF	5,300	$9.00	$47,700
5	Pipe Installation	LF	5,300	$5.00	$26,500
6	Pipe Bedding Material (Placed)	CY	1,178	$7.00	$8,244
7	Trench Backfill Material (Placed)	CY	6,478	$9.00	$58,300
8	Lateral Connections	EA	53	$500.00	$26,500
9	Asphalt	SF	15,900	$2.00	$31,800
10	Manholes (500 FT spacing)	EA	11	$8,000.00	$88,000
11					
	Subtotal				**$395,400**
12	Contingency			30%	$118,620
	Total Cost				**$514,020**
13				LF	$5,300
	Unit Cost				**$97**

ATTACHMENT D: SUMMARY OF SEWER SYSTEMS AND COST BY COUNTY

Opinion of Probable Costs

Statewide Sewer Cost Survey

County	2020 Population	2060 Population Projection[4]	Existing Sewer Pipe (miles)	Average Age of Existing Sewer Pipe[6]	Sewer Pipe to be Relined/Replaced (miles)[3]	New Sewer Pipe to be Installed by City (miles)[1,2,5]	Cost to Replace/Reline	Cost to Install New	Total Cost
Beaver	7,767	13,502	26	35	17	7	$ 6,507,600	$ 3,713,160	$ 10,220,760
Box Elder	54,571	77,029	183	35	111	22	$ 42,490,800	$ 11,395,560	$ 53,886,360
Cache	127,647	273,815	451	32	232	134	$ 88,809,600	$ 68,629,440	$ 157,439,040
Carbon	21,602	24,384	177	35	107	10	$ 40,959,600	$ 5,121,600	$ 46,081,200
Daggett	1,444	1,678	6	35	5	1	$ 1,914,000	$ 256,080	$ 2,170,080
Davis	355,137	503,985	1,893	33	986	122	$ 377,440,800	$ 62,611,560	$ 440,052,360
Duchesne	22,797	29,275	43	35	27	19	$ 10,335,600	$ 9,474,960	$ 19,810,560
Emery	11,230	12,141	40	35	30	4	$ 11,484,000	$ 2,176,680	$ 13,660,680
Garfield	6,063	8,963	15	35	11	5	$ 4,210,800	$ 2,304,720	$ 6,515,520
Grand	10,300	14,301	90	35	53	8	$ 20,288,400	$ 3,969,240	$ 24,257,640
Iron	57,055	127,795	283	35	167	69	$ 63,927,600	$ 35,467,080	$ 99,394,680
Juab	13,750	27,502	46	35	28	15	$ 10,718,400	$ 7,682,400	$ 18,400,800
Kane	8,357	18,583	22	35	14	10	$ 5,359,200	$ 5,121,600	$ 10,480,800
Millard	12,787	16,311	38	35	23	7	$ 8,804,400	$ 3,329,040	$ 12,133,440
Morgan	11,945	24,234	19	35	12	19	$ 4,593,600	$ 9,474,960	$ 14,068,560
Piute	1,635	2,436	0	35	0	0	$ -	$ -	$ -
Rich	2,532	3,909	3	35	2	1	$ 765,600	$ 256,080	$ 1,021,680
Salt Lake	1,128,570	1,778,666	3,771	38	2,382	525	$ 911,829,600	$ 268,755,960	$ 1,180,585,560
San Juan	17,768	19,418	40	40	25	14	$ 9,570,000	$ 6,914,160	$ 16,484,160
Sanpete	31,637	45,495	101	35	62	19	$ 23,733,600	$ 9,603,000	$ 33,336,600
Sevier	30,504	42,729	102	35	62	24	$ 23,733,600	$ 12,419,880	$ 36,153,480
Summit	75,491	156,150	185	34	83	104	$ 31,772,400	$ 53,136,600	$ 84,909,000
Tooele	83,677	203,377	236	35	140	134	$ 53,592,000	$ 68,373,360	$ 121,965,360
Uintah	38,983	50,174	303	35	179	35	$ 68,521,200	$ 17,797,560	$ 86,318,760
Utah	650,594	1,398,075	2,347	34	1,440	675	$ 551,232,000	$ 345,579,960	$ 896,811,960
Wasatch	32,741	96,696	92	35	55	69	$ 21,054,000	$ 35,339,040	$ 56,393,040
Washington	196,762	581,731	822	35	485	340	$ 185,658,000	$ 173,878,320	$ 359,536,320
Wayne	2,845	6,425	1	35	1	3	$ 382,800	$ 1,664,520	$ 2,047,320
Weber	255,152	449,055	867	32	581	176	$ 222,406,800	$ 90,140,160	$ 312,546,960
Total	**3,271,343**	**6,007,834**	**12,202**	**35**	**7,320**	**2,567**	**$2,802,096,000**	**$1,314,586,680**	**$4,116,682,680**
Rounded Cost[7]							**$2,900,000,000**	**$1,400,000,000**	**$4,300,000,000**

[1]Assumed municipalities pay for 25% and contractors pay for 75% of length of sewer pipe installation in new development.

[2]Assumed installation of lagoon and sewer if 2060 population for a municipality exceeds 2000.

[3]Assumed 50% lined and 50% replaced.

[4]Population estimates based on numbers collected from service districts or municipalities. When not available, population estimates based on "Municipal Population Projections: 2012 Baseline

[5]In urban communities, 17ft/capita (calculated using data collected from cities and improvement districts) for new sewer installation was used to estimate length of new pipe installation. In rural communities 20ft/capita accounts for larger distances between homes.

[6]Age of sewer pipe based on survey information. If community was not contacted, the assumed average system age is 35 years.

[7]Costs were rounded up to the nearest $100 million. The total cost is the sum of the rounded values.