

Infiltration and Inflow Revisited

January 30, 2024

Infiltration and inflow have long been a problem waste water collection systems. This case study revisits this issue, taking into account storm water around manhole covers as well as through pick and vent holes.

Definitions for Infiltration and Inflow

Infiltration is usually defined as the introduction of ground water leaking or seeping into a gravity sewer line as a result of various types of cracks and other defects generally occurring below the ground surface.

1. Cracked or broken joints
2. Separated joints
3. Crushed pipe
4. Holes in pipe

Inflow is usually defined as the introduction of storm water rapidly into a gravity sewer line by activities or events acceptable at the time.

1. Flow through manhole covers
2. Flow through vent holes in manhole covers
3. Flow into broken and open cleanouts
4. Roof drains tied into sewer service
5. Very shallow, damaged pipe

In this paper, we examine the effect of reducing inflow through manhole covers, listed Inflow 1 & 2 only, and how this affects pump run time in selected pump stations. The study area is in Ouachita Sewer District #5 shown in Figure 1, below. All pump stations in the study area tributary to the Kiroli Pump Station which pumps to the Ouachita Parish treatment plant.

Leakage Through/Around Manhole Covers

While leakage through pick holes in manhole covers has been recognized as a significant source of inflow, leakage between the cover and the supporting surface has not. A report by Meyer and Warren entitled "A Report on Inflow of Surface Water through Manhole Covers" examined the quantity of leakage through vent holes, open pick holes, and the space between the cover and the bearing surface concluding that significant leakage occurs depending on the head on the manhole cover, the area of flow provided by pick and vent holes, and the seal between the cover and bearing surface.

Study Location

In an attempt to quantify the volume of inflow through manhole covers, a yearlong study was conducted in Ouachita Sewer District #5, located in Ouachita Parish, Louisiana in northeast Louisiana. These stations are shown in Figure 2, below. They are Hart, Canyon, Nichols, Nichols Lane, T. Johns, and Restful Homes.

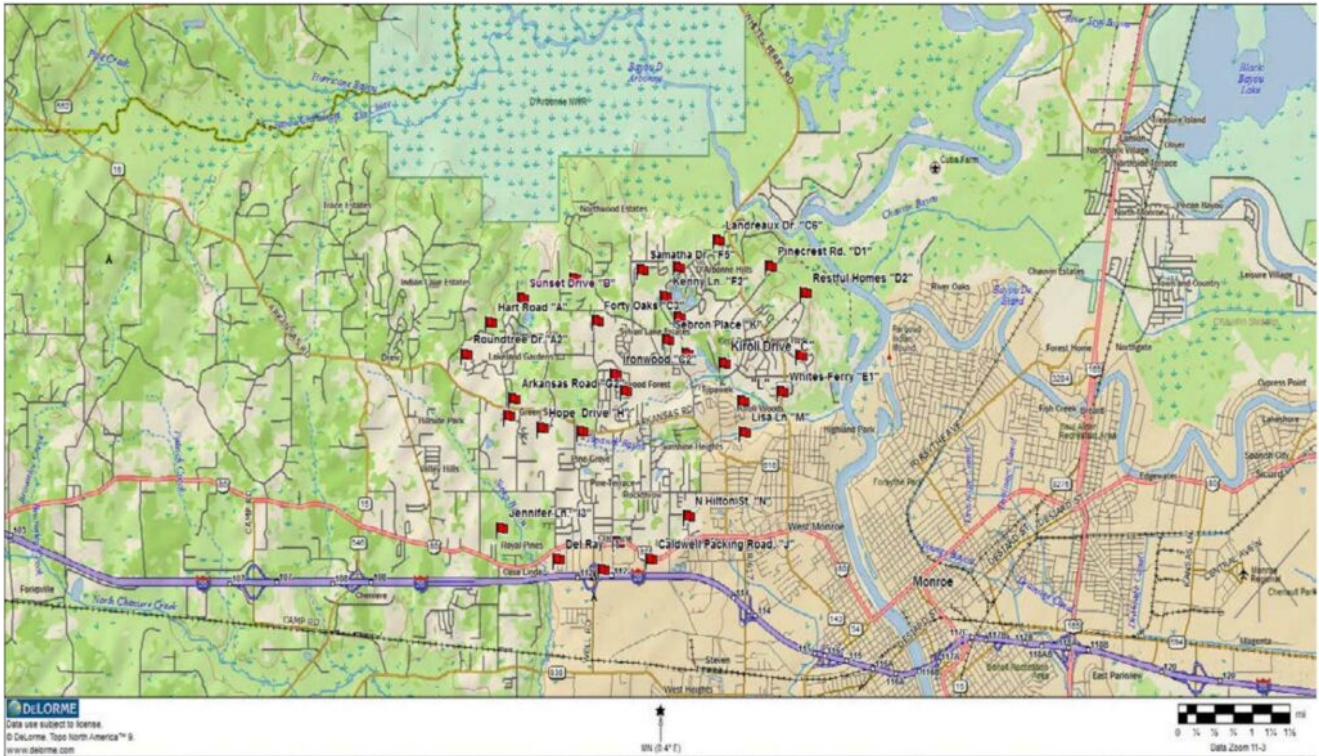


Figure 1: Ouachita Sewer District #5

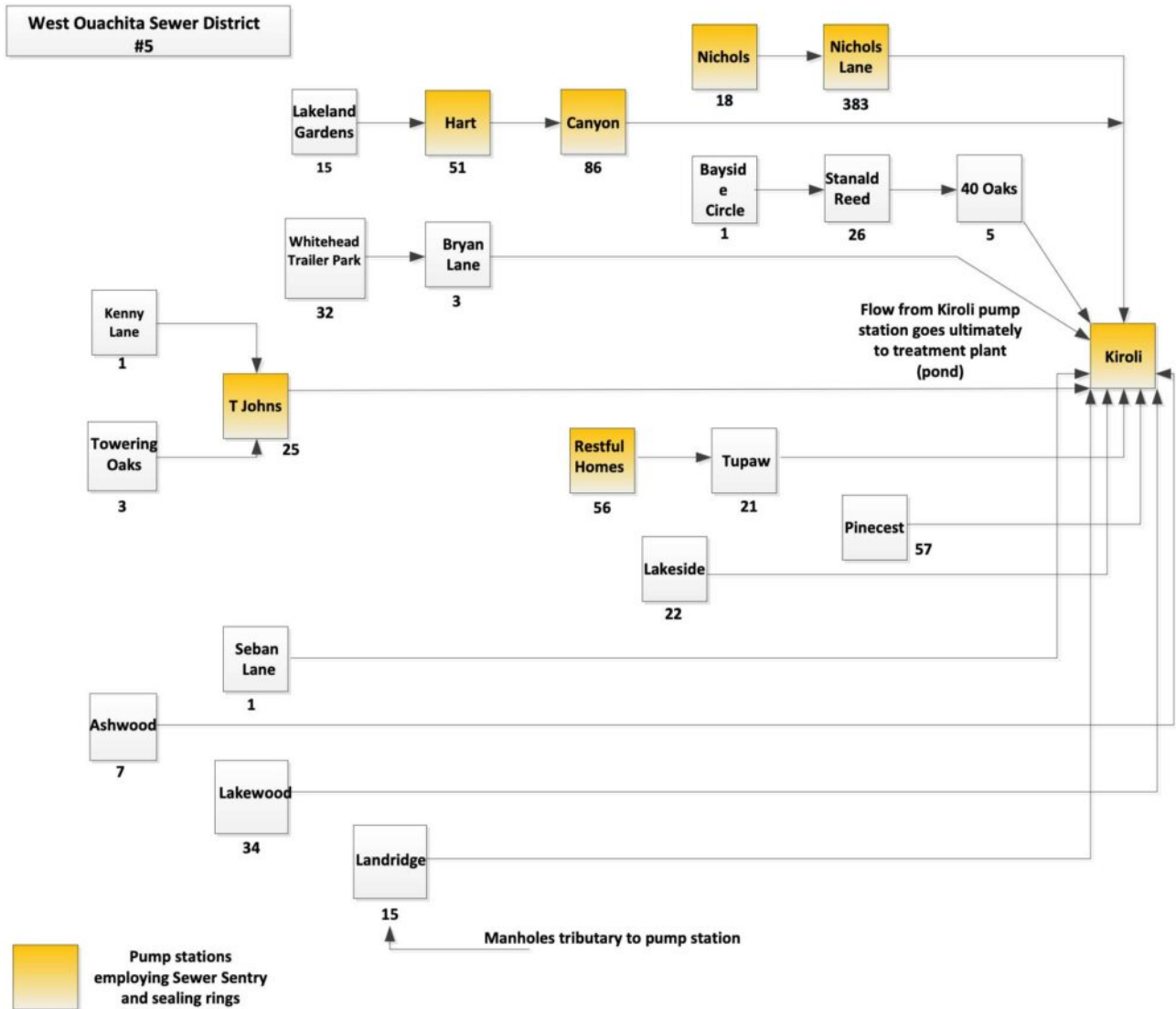


Figure 2: Pump Stations Where Tributary Manholes Have Been Sealed

Manholes tributary to six other pump stations in the area were not sealed. These are shown below in Figure 3. The pump stations in both groups were equipped to measure the run time of the pump(s). Pump run times for each group of pump stations were recorded in 2013, prior to sealing manholes and in 2015 after sealing the manholes in the “Kiroli” group of pump stations.

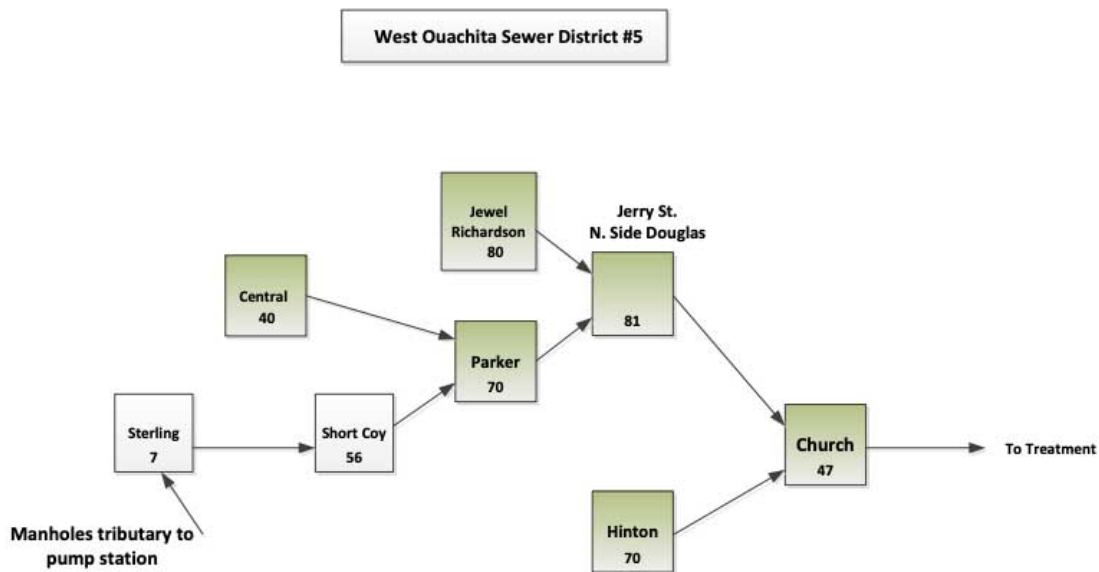


Figure 3: Pump Stations with Manholes Not Yet Sealed

Sealing Manhole Covers

New manhole covers were obtained for all manholes tributary to pump stations where the pump run times were being monitored. The new covers had no pick or vent holes. Each cover was outfitted with a proprietary device called a “” developed by David Putnam, owner of Jabar Corporation, an Underground Utilities Contractor specializing in sewer repair and rehabilitation, located in Calhoun, Louisiana. The device is shown below in Figure 4 and installed in Figure 5. It is constructed of Dupont Zytel, which is a nylon resin that is:

1. Impact resistant
2. Chemical resistant
3. UV light resistant
4. Heat resistant
5. Cold resistant

In addition, all manholes were fitted with a 1” wide, 1/8” rubber seal to minimize leakage between the cover and bearing surface. The Sewer Sentry was installed through a hole drilled in the cover using the rubber gasket to minimize leakage. The Sewer Sentry protrudes approximately 5/8 of an inch above the surface of the manhole cover thus allowing some sheet flow over the cover without leakage but not so high as to damage bicycles, vehicles etc. The hole allows for the escape of gases which would otherwise build up in the sewer system creating an explosive hazard.

Precipitation

Annual precipitation values were obtained as the average of 3 NWS weather stations and the web site, “Weather Collector” (<http://www.theweathercollector.com/>) and shown below in Table 1.

Table “1” Rainfall Amounts (inches)

USC00169631 West Monroe		USC00166314 Monroe Delta Community College		US1LAOC0001 Swartz 2.0 SSW		MLU WeatherCollector	
2013	2015	2013	2015	2013	2015	2013	2015
52.6	56.9	49	55.9	55.6	58.0	50.3	53.6
8.2% increase		14.1% increase		4.4% increase		6.4% increase	

The average increase in precipitation for the 4 stations was 8.3 % between 2013 and 2015.

Pump Run Times

Table 2 below shows the effect of sealing manhole covers on pump run times. Both sets of manhole covers (hereafter referred to as the Church group and the Kiroli group) were unsealed in 2013 while the 7 stations terminating with the Kiroli pump station were sealed in 2015. It appears that sealing the manhole covers made a substantial difference in run times between the two groups. The run times in the Church group **increased** an average of 19.2% per month with a range of between 5.5% and 42.3%. All six stations in the group showed an increase. Given that precipitation increased by 8.3% between 2013 and 2015 this is not unexpected. However, all 7 stations in the Kiroli group registered a **decrease** in run times between 2013 and 2015. The average run time dropped 26.7% with a range between 3.5% and 54.3%.

Table "2" Summary of Sewer Sentry Operational Data

Manholes sealed in 2015?	Station Name	Tributary Manholes	2013 average monthly power usage	2015 average monthly power usage	Percent change
no	Central	40	163	187	12.8
no	Richardson-Jewel	80	939	994	5.5
no	Hinton	70	620	782	26.1
no	Parker	70	646	1119	73.2
no	Jerry Street North Side Douglas	81	2754	3188	13.6
no	Church	47	4192	5235	19.9
					Average 19.2
yes	Nichols	18	207	95	-54.3
yes	Hart	51	1421	1094	-22.9
yes	Restful Homes	56	1202	1056	-12.2
yes	T. Johns	25	1601	916	-42.8
yes	Canyon	86	5955	3642	-38.8
yes	Nichols Lane	383	7919	6958	-12.1
					Average -30.5

In an attempt to quantify the effect of sealing manhole covers it might be useful to examine a simplified cost model. Since we have the monthly Kw-hr usage, we can compute the cost to run each station assuming a cost per Kw-hr of \$0.099, obtained from documents published by Entergy. The results are shown in Table 3 below. The cost to operate the Church group of pump stations **increased** from \$11,045.20 in 2013 to \$13,667.90 in 2015, an increase of 23.7%. The cost to operate the Kiroli group of pump stations **decreased** from \$21,745 in 2013 to \$16,348 in 2015, a drop of nearly 25% even though the annual precipitation increased by 8.3%.

Table "3" Summary of Cost Data

Manholes sealed in 2015?	Station Name	2013 average yearly power usage (Kw-hr/yr)	2013 Annual Cost (\$.099/Kw-hr)	2015 average yearly power usage	2015 Annual Cost (\$.099/Kw-hr)	Percent change
no	Central	163*12 = 1956	\$193.6	187*12 = 2244	\$222.20	12.8
no	Richardson-Jewel	939*12 = 11268	\$1115.5	994*12 = 11928	\$1180.90	5.5
no	Hinton	620*12 = 7440	\$736.5	782*12 = 9384	\$929.20	26.1
no	Parker	646*12 = 7752	\$767.4	1119*12 = 13428	\$1329.40	73.2
no	Jerry Street North Side Douglas	2754*12 = 33048	\$3271	3188*12 = 38256	\$3787.40	13.6
no	Church	4192*12 = 50304	\$4980.1	5235*12 = 62820	\$6219.20	19.9
		Total = 111568	\$11045.2	Total = 138060	\$13667.9	23.7
yes	Nichols	207*12 = 2484	\$245.9	95*12 = 1140	\$112.9	-54.3
yes	Hart	1421*12 = 17052	\$1688.1	1094*12 = 13128	\$1299.70	-22.9
yes	Restful Homes	1202*12 = 14424	\$1428	1056*12 = 12672	\$1254.50	-12.2
yes	T. Johns	1601*12 = 19212	\$1902	916*12 = 10992	\$1088.20	-42.8
yes	Canyon	5955*12 = 71460	\$7074.5	3642*12 = 43704	\$4326.70	-38.8
yes	Nichols Lane	7919*12 = 95028	\$9407.8	6958*12 = 83496	\$8266.10	-12.1
		Total = 219660	\$21745.3	Total = 165132	\$16348.1	-24.8

Summary

This study suggests that removal of pick and vent holes, sealing the region between the cover and the bearing surface and installation of the Sewer Sentry incorporating a raised vent hole to allow for minimal inflow and manhole ventilation can result in substantial reduction in pump run times and a corresponding drop in power costs. The Church group of pump stations saw an average increase in cost of 23% between 2013 and 2015. The increase in precipitation between 2013 and 2015 was 8.3%. All six (6) pump stations in the group saw an increase in cost ranging from 13 to 76%. In contrast, the Kiroli group of pump stations saw an average drop in power cost of 24.8% between 2013 and 2015 with all six (6) stations seeing a drop ranging from 12 to 54%.

Conclusions

1. Use of the Sewer Sentry as well as eliminating pick holes and sealing the bearing surface appears to dramatically reduce infiltration and inflow as evidenced by pump run times and the associated cost.
2. Use of the Sewer Sentry allows sewer gases to be vented to the atmosphere while minimizing inflow, thus avoiding potentially explosive conditions in gravity sewer systems.

References

1. Memo dated January 13, 2011 from Entergy Corporation entitled: "Continued Low Entergy Prices for Entergy Louisiana; Customers Still Encouraged to Conserve"
2. <https://sewersentry.com/>

About the Authors

David Putnam, owner JABAR Corporation, Utility Contractor, Calhoun, LA

Terry Cox, Ouachita Parish Sewer District #5, Ouachita Parish, Louisiana

D.M. Griffin Jr., PhD, P.E. – retired Professor of Civil Engineering, Louisiana Tech University, Ruston, LA