CHAPTER 4 - WSSC DATA ANALYSIS

4.1 Introduction

Washington Suburban Sanitary Commission (WSSC) is among the 10 largest water and wastewater utilities in the United States. WSSC serves 420,000 customer accounts and provides water sewer services to 1.6 million resident customers in D.C. and Maryland.

The pinhole leak (which is the same as copper pitting corrosion) problem has emerged as a significant problem in the source area of WSSC. Some of the complaints shown below from WSSC customers reflect the nature of the problem in terms of where the leaks occur and the extent of the damage (From WSSC website survey):

"We had so many pinhole leaks that we finally had a plumber come in and replace all of the cold-water pipes"

"There were multiple pinhole leaks which required the entire pipe between water main and house intake to be replaced."

"We had so many pinhole leaks that caused so much damage to drywall, possessions, and carpet last year we replaced all the copper at both the plumber's and WSSC's suggestion."

The average cost of repairing domestic copper pipe is around $500 ~ 1000, and the replacement of the system is approximately $ 4,000~ 6,000 (From national plumber survey). In this chapter, a statistical analysis is performed to obtain the failure rates. In addition, with the aid of GIS (Geographic Information System), spatial distribution of pinhole leaks are displayed and analyzed for selecting top 3 zip codes of detailed customer survey.

4.2 Data Analysis

WSSC provided basic data on pinhole leaks without revealing any consumer information. Figure 4.1 shows the frequency distribution of number of leaks reported vs. pipe installed year.

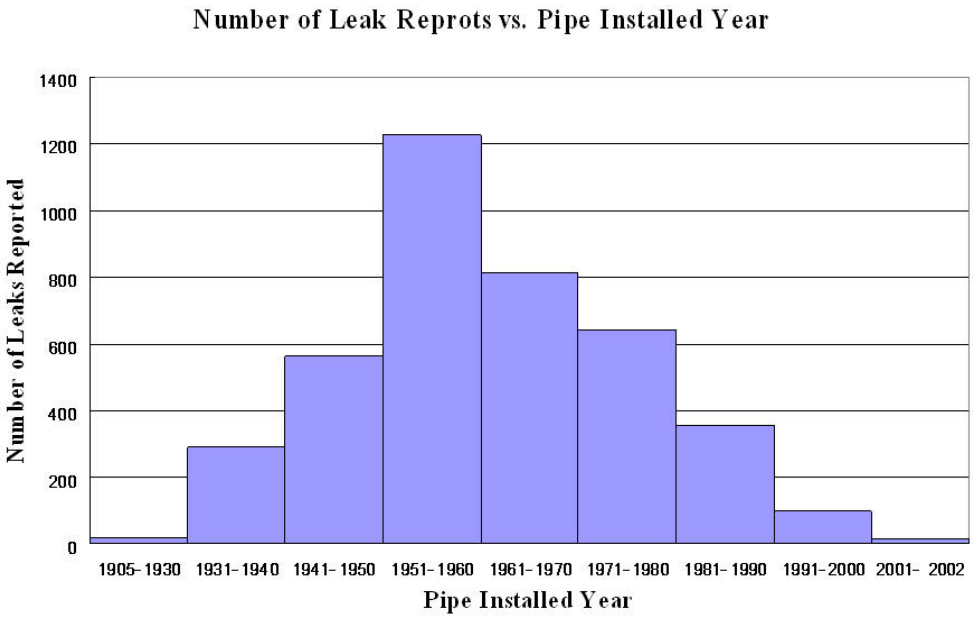

Figure 4.1 Number of Reports vs. Pipe Installed Year

Figure 4.2 shows the calculated leak rates. The leak rate is given by

$$\text{Leak rate} = \frac{\text{Total number of leaks in the reported period}}{\text{Number of years in the reported period}}$$

A box-whisker plot of the data is shown in Figure 4.3.

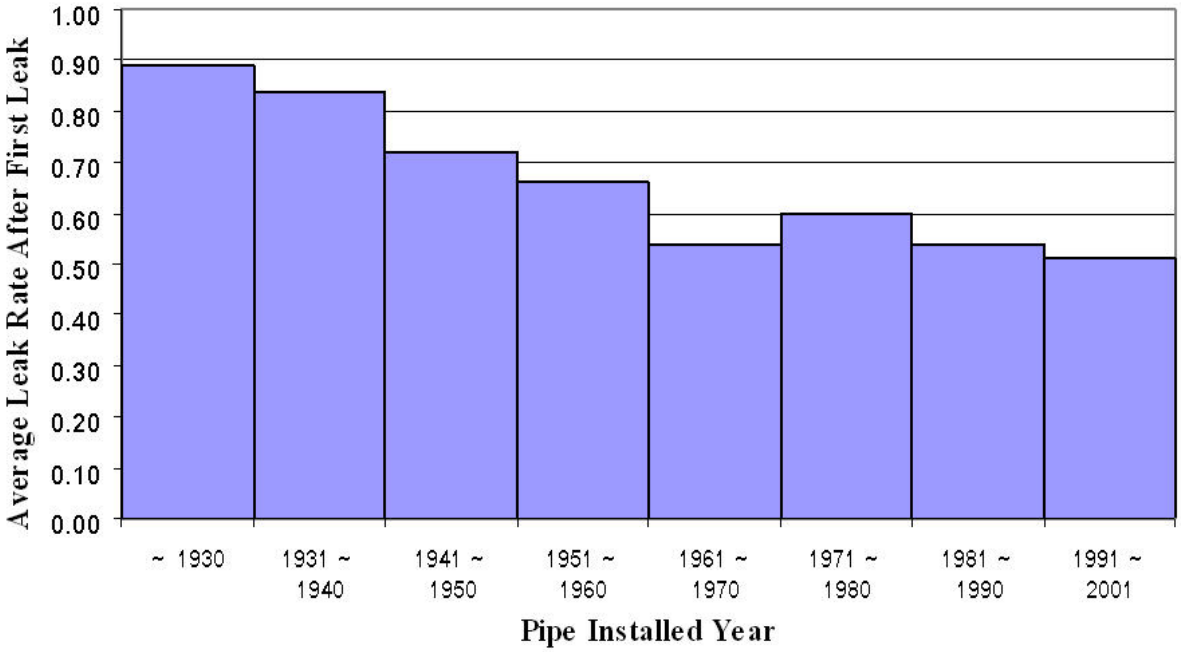

Figure 4.2 Leak Rate After First Leak vs. Pipe Installed Year

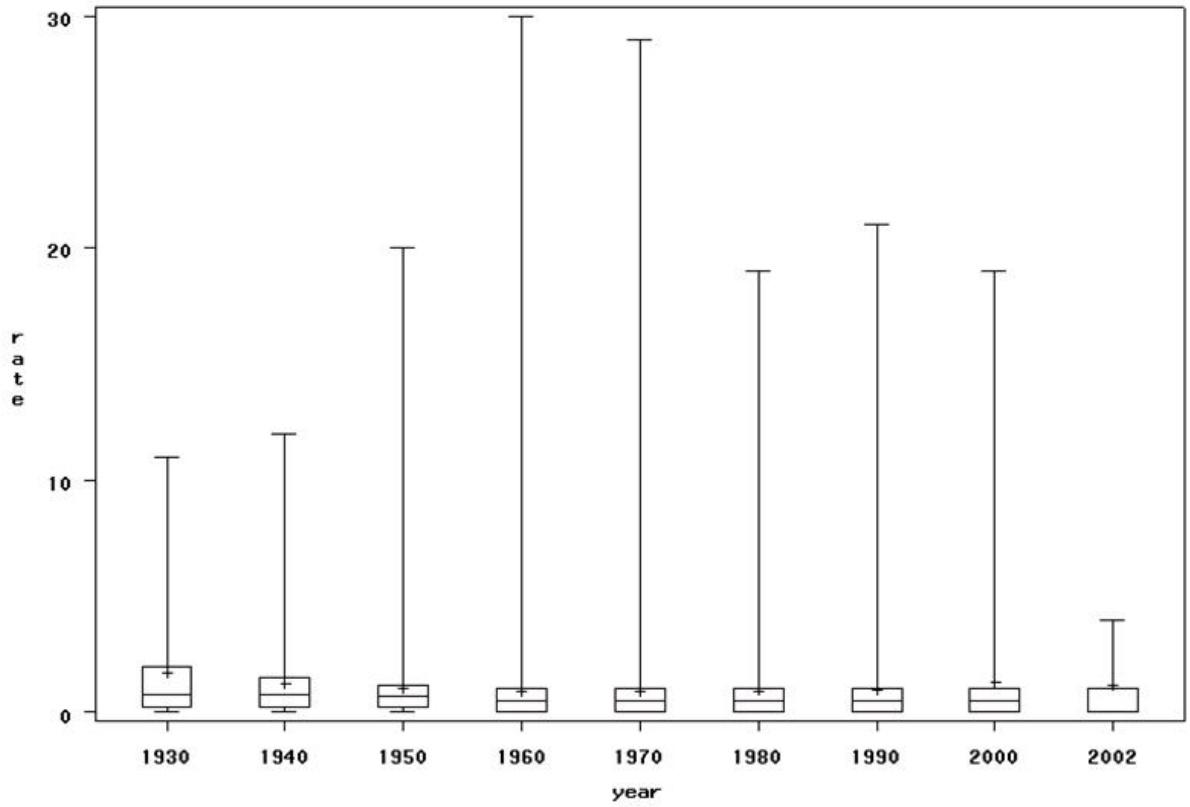

Figure 4.3- LRFF vs. Pipe Installed Decade

Figure 4.4 shows that most of the pinhole leaks are reported from Cold water pipes. The leak rate is higher in cold water pipes as shown in Table 4.1.

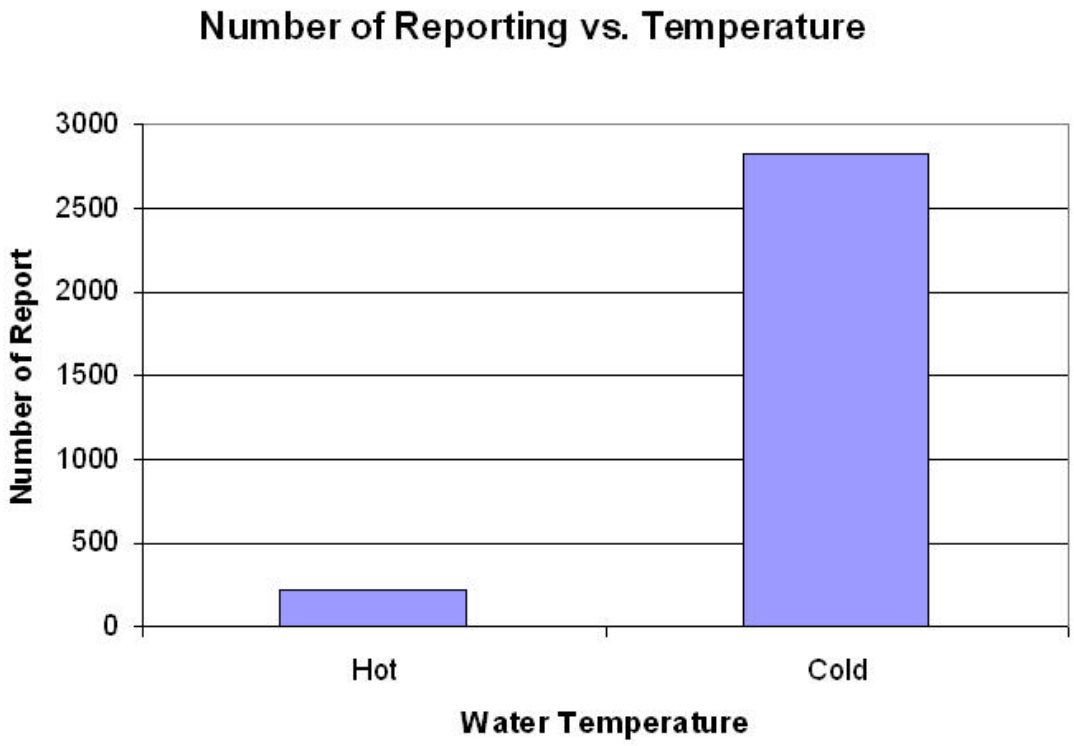

Figure 4.4 Number of reports vs. Temperature

Table 4.1 Leak Rate by Temperature

	Avg. Leak Rate
Hot	0.31
Cold	0.40

Figure 4.5 shows that most of the leaks are in horizontal pipes. However, the leak rate does not show any trend.

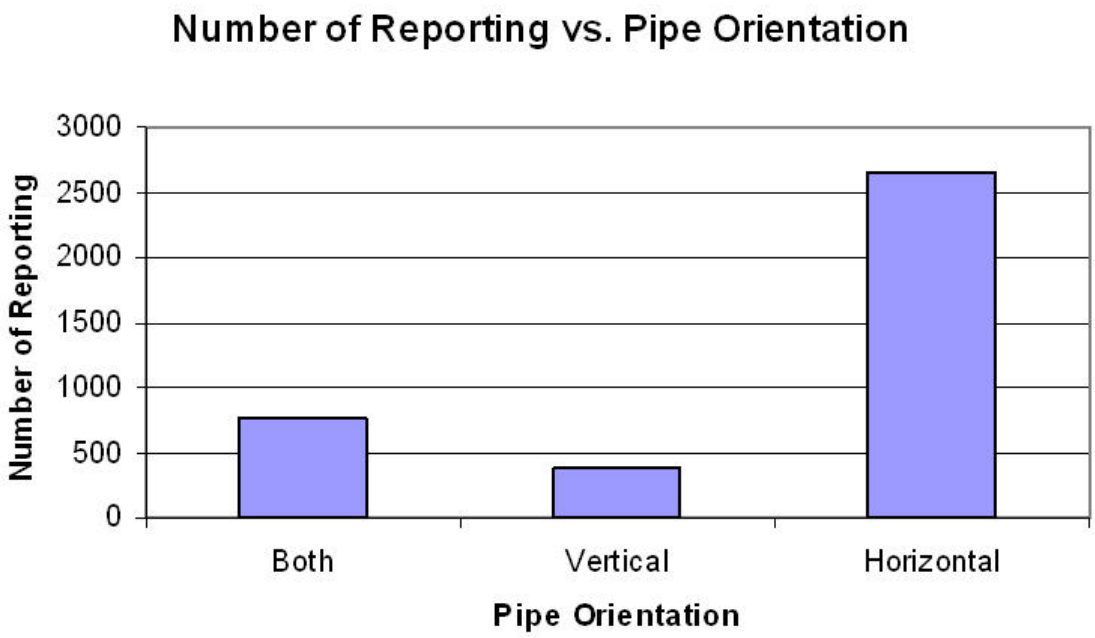

Figure 4.5 Number of Reporting vs. Pipe Orientation

Table 4.2 Leak Rate by Orientation

Orientation	Average of Leak Rate
Vertical	0.40
Horizontal	0.57
Both	1.21

Figure 4.6 shows that most leaks occur in thinner pipes. The leak rates however, show no appreciable trends as shown in Table 4.3.

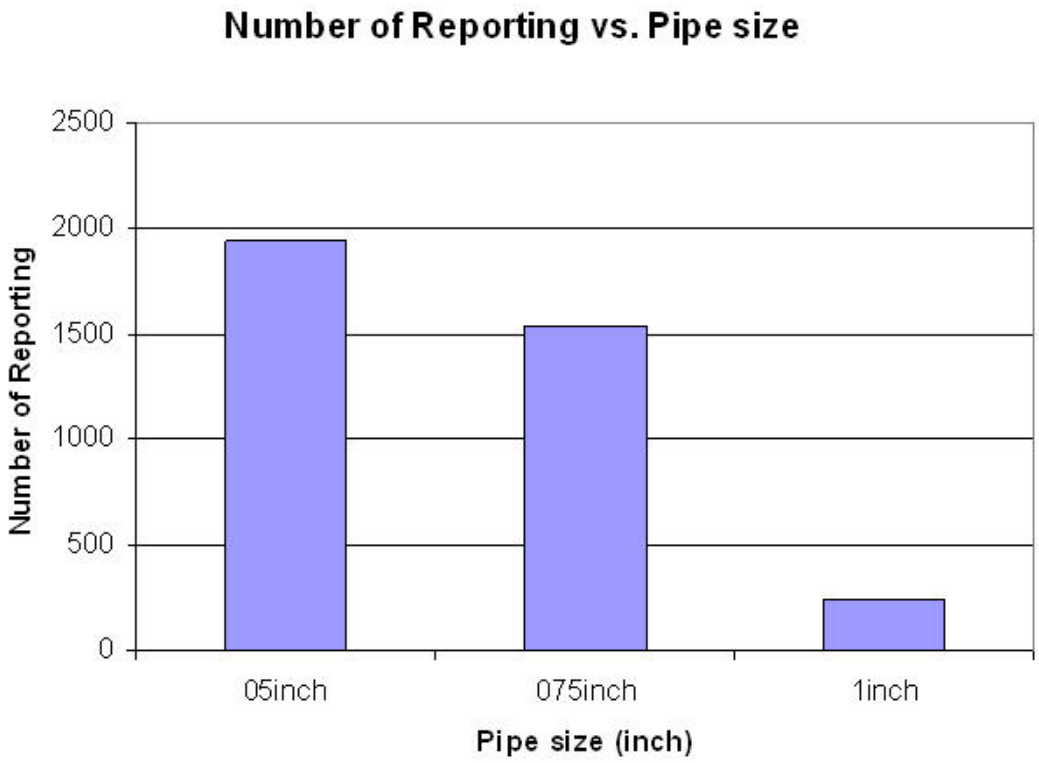

Figure 4.6 Number of Report by Pipe size

Table 4.3 Leak Rate by Pipe Size

	Avg. Leak Rate After First Failure
0.5inch	0.65
0.75inch	0.73
1inch	0.55

From figure 4.7, it is seen that M pipe has the maximum leak rate. As explained in Chapter 2, among K, L, M pipe, M pipe has the thinnest thickness.

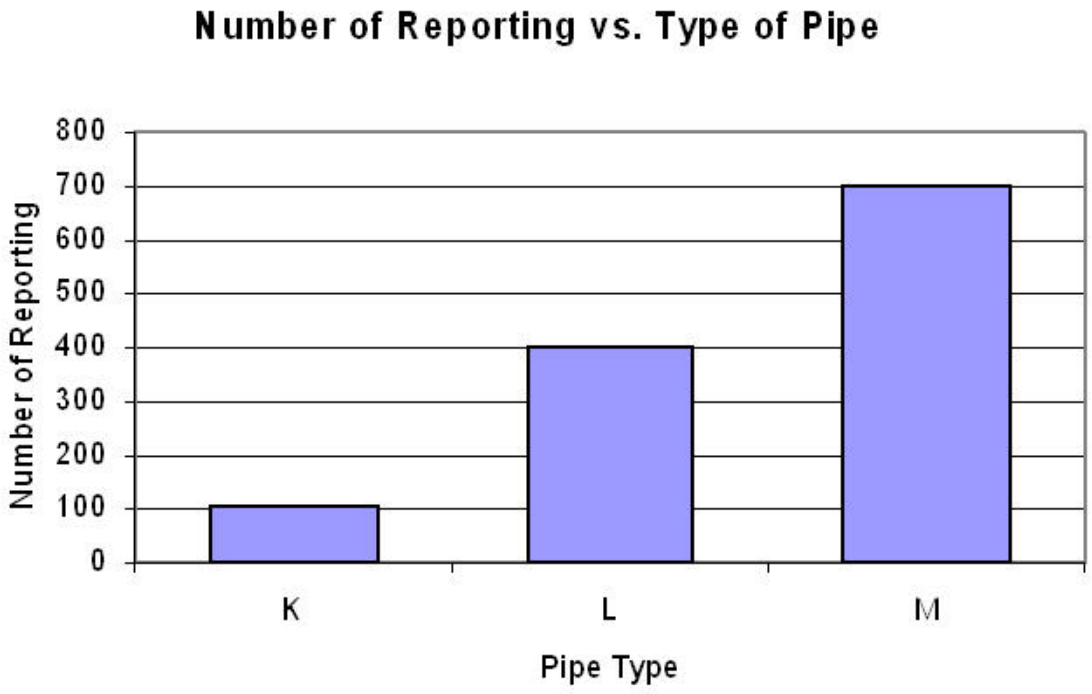

Figure 4.7 Number of Reports by Pipe Type

4.3 GIS Analysis of spatial distribution of pinhole leaks

There are 4 reservoirs, namely, Triadelphia, Rocky Gorge, Little Seneca and Jennings Randolph with total holding capacity of 14 billion gallons in Maryland. Both Little Seneca and Jennings Randolph are regionally shared. And there are 2 water treatment plants. The Patuxent (max 56 MGD) and the Potomac (max 285 MGD) plants produce an average of 167 million gallons per day (MGD) of safe drinking water. Figure 4.8 represents the area that's covered by the WSSC. The pinhole leak locations are shown by zip codes in Figure 4.9.

Table 4.4 contains zip codes corresponding to the ranked number of leaks per person and absolute number of leaks. Column (1) contains zip codes for the ranked number of leaks per person. Column (2) has the population, column (3) has the number of leaks, column (4) has the ranked number of leaks per person, column (5) has the ranks for the number of leaks per person, and column (6) has the ranks for the number of leaks.

From Table 4.4 data it is seen that the areas that have significant pinhole leak problems are located in close proximity with the water treatment plants. Based on this observation, zip codes 20817, 20707, and 20815 are selected as top three choices for detailed customer survey. The area corresponding to zip code 20817 has the maximum number of pin hole leaks and has the second rank in the number leaks per person. Column (4), number of pinhole leaks per person, is important as the population in each zip code area is different. The region is in close proximity to the Potomac water treatment plant. Zip code area of 20707 is selected as the third choice in the top 3 locations because of its close proximity to the Patuxent water treatment plant with rank 1 in the number of leaks and rank 2 for the number of leaks for that treatment plant. It has overall rank of 8 in both the categories when both the treatment plants are considered. It is also recommended zip code area 20815 as the third choice because it experiences significant number of pinhole leaks. When detailed data become available from this survey, more elaborate calculations are possible. The survey questionnaire (made by Dr. Bosch et al.) is shown in the Appendix A.

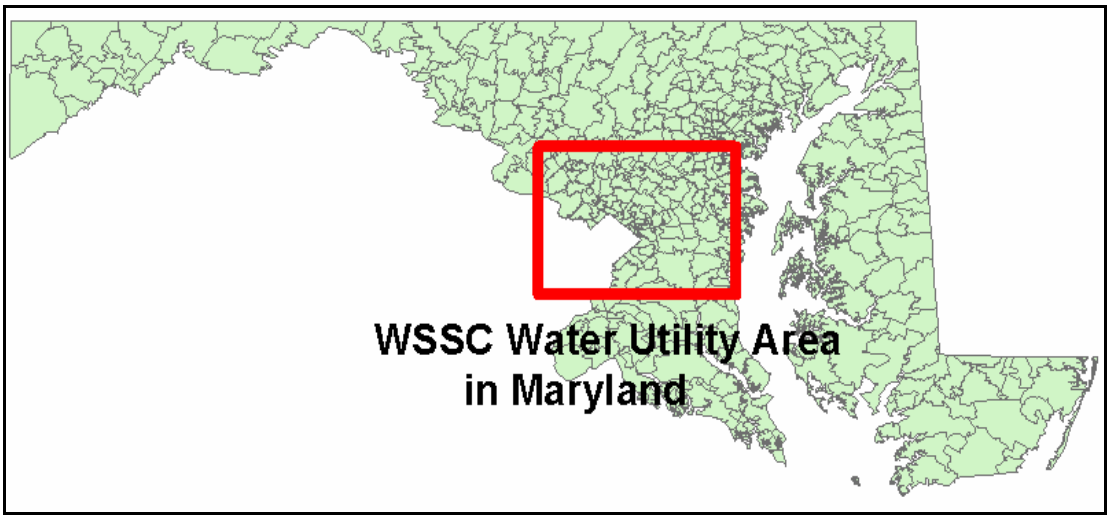

Figure 4.8 Area that's covered by WSSC

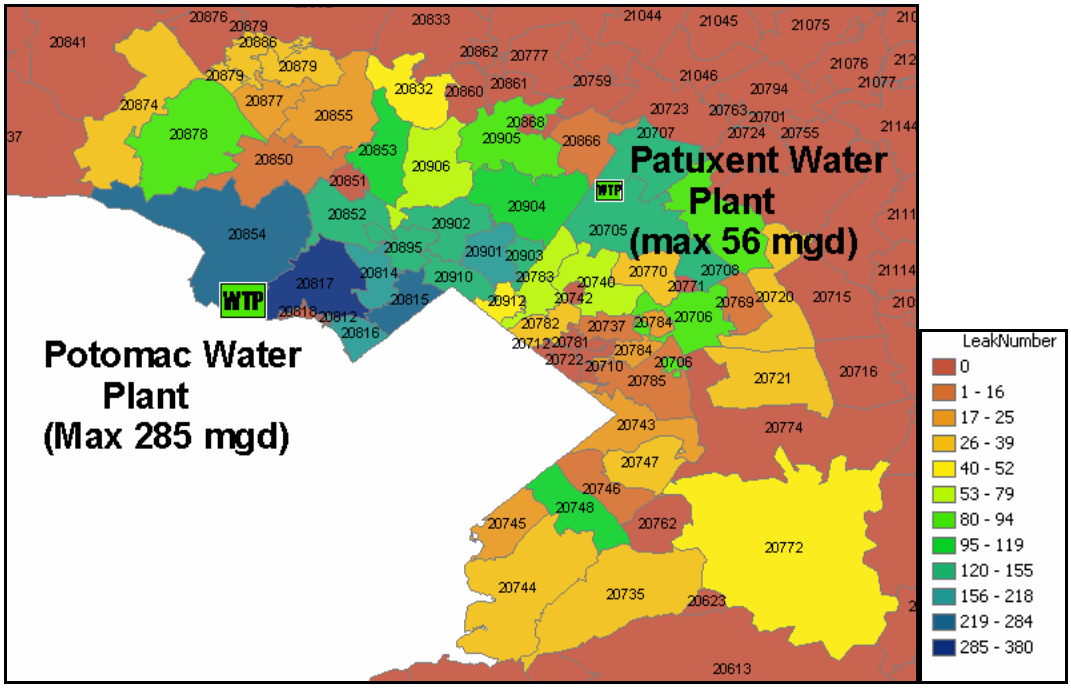

Figure 4.9 Leak Number on the basis of GIS Analysis

Table 4.4 pinhole leak analysis for the WSSC distribution area

Zip (1)	Population 2001 (2)	# of Leaks (3)	Pinhole/ person (4)	Rank by number of leaks per person (5)	Rank by number of leaks (6)
20816	15143	173	0.011424421	1	6
20817	33954	380	0.011191612	2	1
20815	28270	284	0.010045985	3	2
20814	25916	218	0.008411792	4	4
20903	18039	127	0.007040302	5	12
20895	19713	134	0.006797545	6	10
20705	20551	129	0.006277067	7	11
20707	25815	149	0.005771838	8	8
20901	36935	205	0.005550291	9	5
20854	48226	261	0.005412018	10	3
20905	17295	93	0.005377277	11	15
20853	26432	119	0.004502119	12	13
20910	37144	155	0.004172949	13	7
20740	21503	79	0.003673906	14	16
20708	25633	94	0.003667148	15	14
20852	40252	140	0.003478088	16	9