

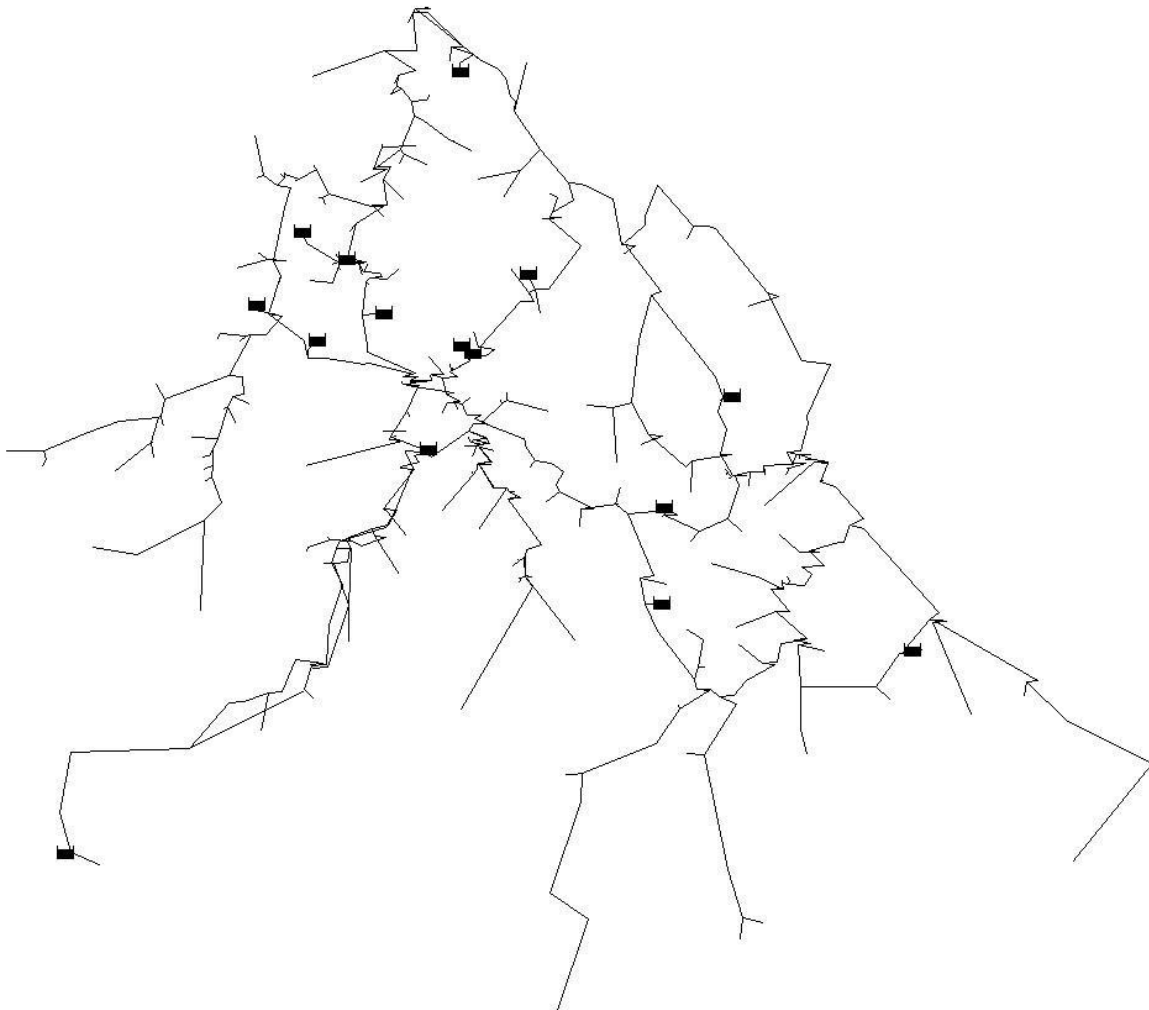
# **SYSTEM ID: KY V19**

---

## **NARRATIVE DESCRIPTION**

The KY V19 system is based on a real-world water distribution system in Kentucky. It serves 5,095 customers and sells water for \$12.55 per 1,000 gallons. The system has an average demand of 1.41 MGD. The network was used by Hernandez & Ormsbee (2021) as part of a classification study. A general schematic of the system is shown below. The system has fifteen reservoirs, eleven pumps, and 221 miles of pipe. Water loss within the system is estimated to be 75%.

## **NETWORK SCHEMATIC:**



## **HISTORY OF THE NETWORK FILE**

The KY V19 system was originally created by Erika Hernandez Hernandez in 2018 as part of an article "Segment-Based Assessment of Consequences of Failure on Water Distribution Systems" which was published in 2021 in the *Journal of Water Resources Planning & Management*.

### **ORIGINAL REFERENCE:**

Hernandez Hernandez, Erika, and Ormsbee, Lindell. "Segment-Based Assessment of Consequences of Failure on Water Distribution Systems." *Journal of Water Resources Planning and Management* 147.4 (2021): 04021009.

[10.1061/\(ASCE\)WR.1943-5452.0001340](https://doi.org/10.1061/(ASCE)WR.1943-5452.0001340)

**ABSTRACT:** This paper presents an assessment methodology that considers the impact of actual valve locations in a water distribution system in creating discrete isolated groups of pipes or segments when evaluating the performance of the network under a failure condition. The layout of the distribution network used as a case study and the location of the isolation valves are based on a survey of the real system instead of being artificially generated. In addition to evaluating the performance of the system under typical conditions with metrics based on loss of connectivity and the reduction in demand satisfaction, the assessment also includes a consideration for fire flow requirements that has not been widely used in combination with a segment-based reliability assessment.

### **ADDITIONAL CITATIONS:**

The original publication of Hernandez et. al. (2021) and by inference the KY V19 system have been cited by 2 additional authors. These may be accessed by moving your cursor over the following link while simultaneously depressing the CTRL key on your keyboard: [2 Citations](#)

## **AVAILABLE INFORMATION**

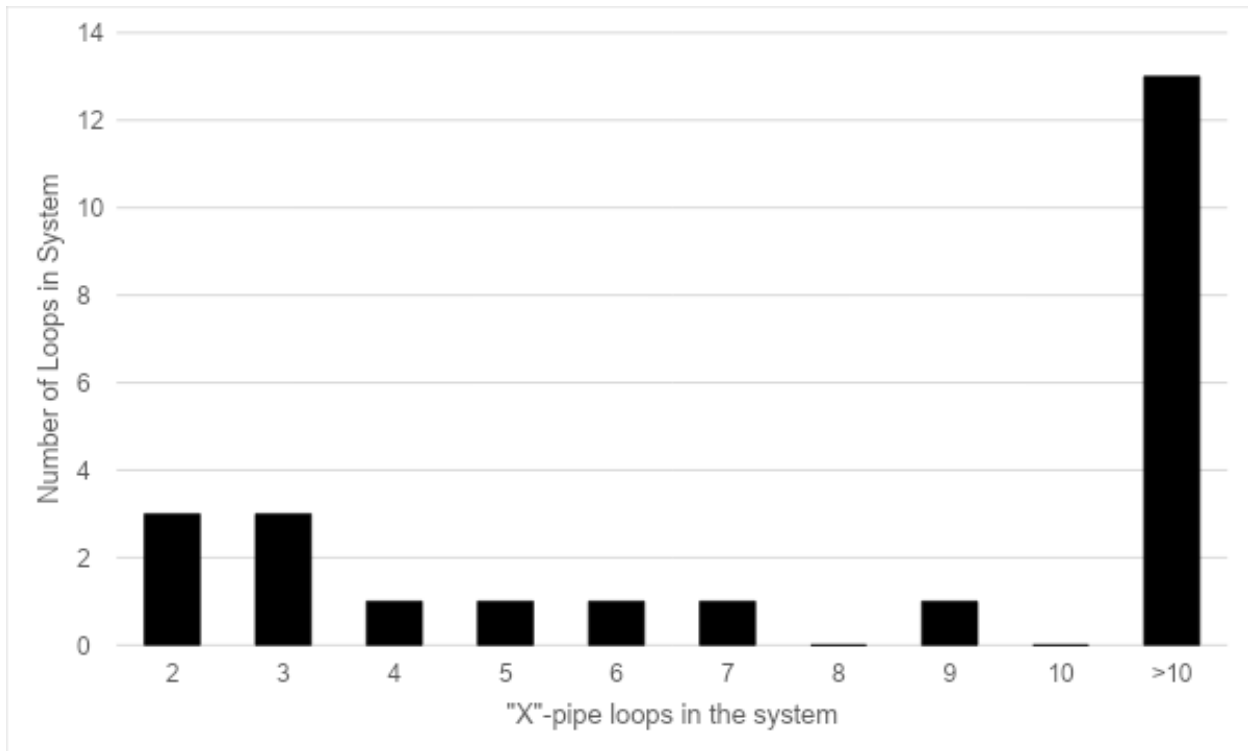
Physical attributes	Yes
Schematic diagram	Yes
Network geometry data	Yes
GIS data file	Yes
Background map	Yes
Elevation data	Yes
Pipe data	Yes
<i>Pipe material</i>	Yes
<i>Pipe age</i>	Yes
<i>Pipe pressure class</i>	No
<i>Nominal or actual diameters</i>	Nominal
Pump data	Yes
<i>Useful horsepower</i>	No
<i>Pump operating curves</i>	Yes
Tank data	NA
<i>Elevation data</i>	
<i>Stage storage curves</i>	
<i>Water quality information</i>	No
Valve data	Yes
<i>PRV/FCV data</i>	No
<i>Isolation valve data</i>	Yes
<i>Hydrant data</i>	No
Demand data	Yes
<i>Total system demand</i>	Yes
<i>Nodal demand data</i>	Yes
<i>Temporal data demands</i>	Yes
<i>System leakage</i>	Yes
Hydraulic data	No
<i>Hydraulically calibrated model</i>	
<i>Field hydraulic calibration data</i>	
Water quality data	No
<i>Disinfection method</i>	
<i>Chlorine residual data</i>	
<i>Booster station data</i>	
<i>Fluoride/Chloride field data</i>	
<i>Water quality calibrated model</i>	
Operational data	No
SCADA datasets	
<i>Operational rules</i>	

**SYSTEM CLASSIFICATION:**

**PIPE/LOOP HISTOGRAM:**

Hoagland et al. (2015) designed a network classification algorithm for use in classifying water distribution systems as either “branched,” “looped,” or “gridded” based on the observed frequency of network loops with different numbers of distinct pipe segments. The frequency distribution for the KY V19 system is provided below. Using this information, Hoagland et al., classified this system as being a LOOPED system.

# Total Pipes:	1012
# Branch Pipes:	493
Ratio (Branch Pipes / Total Pipes):	0.49



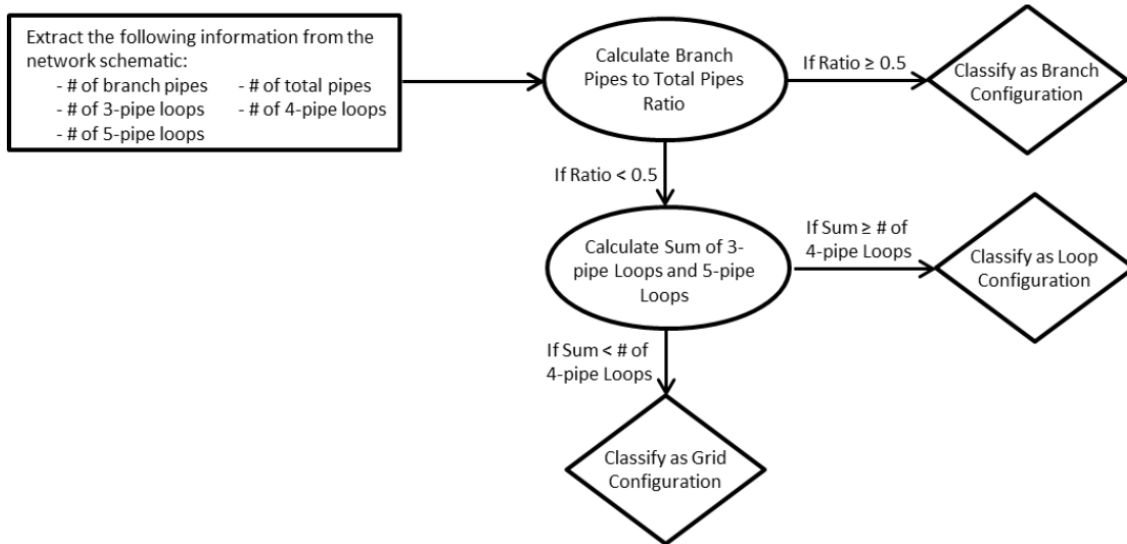


Figure 3.4. Classification Algorithm (Hoagland et al., 2015)

Hoagland, Steven & Schal, Stacey & Ormsbee, Lindell & Bryson, Lindsey. (2015). Classification of Water Distribution Systems for Research Applications. 696-702. 10.1061/9780784479162.064.

### NETWORK STRUCTURE METRICS:

Building on the work of Hoagland et al., (2015), Hwang & Lansey (2017) created an expanded classification system that allows for further classification of a system as being either a transmission or distribution branched, looped, gridded, or hybrid system. Their algorithm streamlines the classification system by removing unnecessary nodes that do not contribute to the structure of the system while still retaining their use as intermediate points for demand data entry. A full description of the algorithm can be found in the cited reference.

Application of the Hwang and Lansey classification algorithm to the system yields the following statics and associated classification:

Parameter	Value
Edges	834
Pipes	656
Nodes	811
Average Diameter	5.4
Reduced Nodes	146
Reduced Edges	169
Branched Edges	385
Branched Index	0.7
Meshed Connectedness	0
Reduced Meshed Connectedness	0.08
Loop Density	0
Average Node Degree	2.1
Hwang & Lansey Classification	Distribution Branch

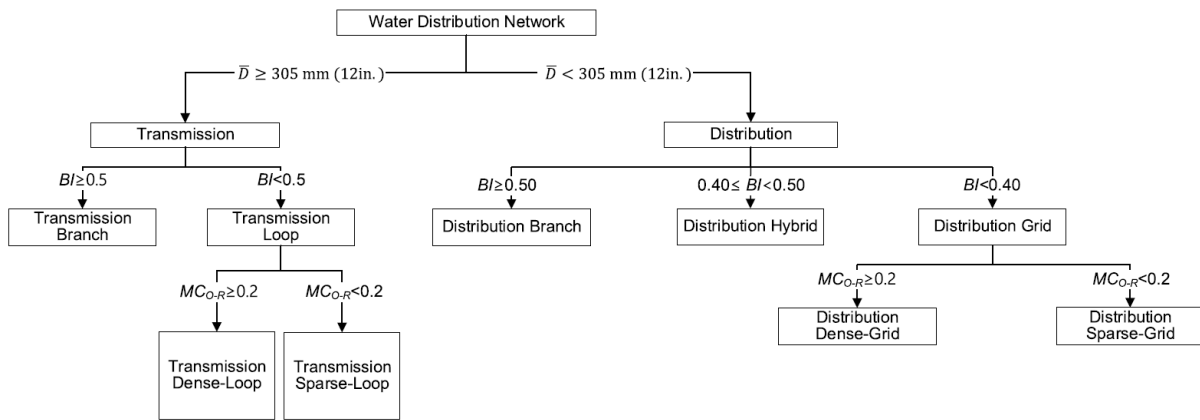


Figure 7. Water Distribution System Classification Flowchart (Hwang & Lansey, 2017)

Hwang H. & Lansey, K. (2015) "Water distribution system classification using system characteristics and graph theory metrics." *Journal of water resource planning and management* 143(12) [https://doi.org/10.1061/\(ASCE\)WR.1943-5452.0000850](https://doi.org/10.1061/(ASCE)WR.1943-5452.0000850)

## **DETAILED DATA SUMMARIES**

### **PHYSICAL ASSETS:**

<b>Asset Type:</b>	<b># of Assets</b>
Master Meters	-
Tanks	15
Pumps	11
Water Sources	1

### **NETWORK CHARACTERISTICS:**

# Total Pipes:	1012
# Junctions	796
# Reservoirs	15
# Tanks	0
# Regulating Valves	0
# Isolation Values	167
# Hydrants	Unknown
Elevation Data	YES

### **PIPE DATA:**

<b>Diameter (in)</b>	<b>Length (ft)</b>
2	80215
3	98467
4	358531
6	380362
8	196820
10	32641
15	22199
16	185
53.5	33

### **PUMP DATA:**

Pump Horsepower	NO
Pump Curves:	YES

**DEMAND STATISTICS:**

<b>Demographic Type</b>	<b>Population</b>	<b>Households</b>
Directly Serviceable:	12,175	5,095
Indirectly Serviceable:		
Total Serviceable:	12,175	5,095

<b>Production Statistics</b>	
Total Annual Volume Produced (MG):	695.581
Total Annual Volume Purchased (MG):	8.341
Total Annual Volume Provided (MG):	703.900
Estimated Annual Water Loss:	75%

<b>Water Costs</b>	
Customer Type	Cost per 1000 gallons
Customers within the municipality	
Customers outside the municipality	\$12.55

**CUSTOMERS AND USAGE:**

<b>Customer Type</b>	<b>Customer Count</b>	<b>Average Demand (MG)</b>
Wholesale:		
Residential:	3,250	142.253
Commercial:	275	25.000
Institutional:	1	2.000
Industrial:	2	6.117
Other:		
Total Customers:	3,528	
Flushing, Maintenance & Fire Protection:		
Total Water Usage:		175.370



**DATA FILE ATTRIBUTES:**

<b>ATTRIBUTE</b>		<b>UNITS</b>
Pipe Length & Diameter	X	Feet & inches
Pipe Age	X	Year Installed
Node Elevation	X	Feet
Node Demand	X	GPM
Valves		
Hydrants		
Tank Levels	X	Feet
Tank Volume	X	Cubic Feet
PRVs		
WTP		
WTP Capacity	X	GPD
Pump Data	X	HP