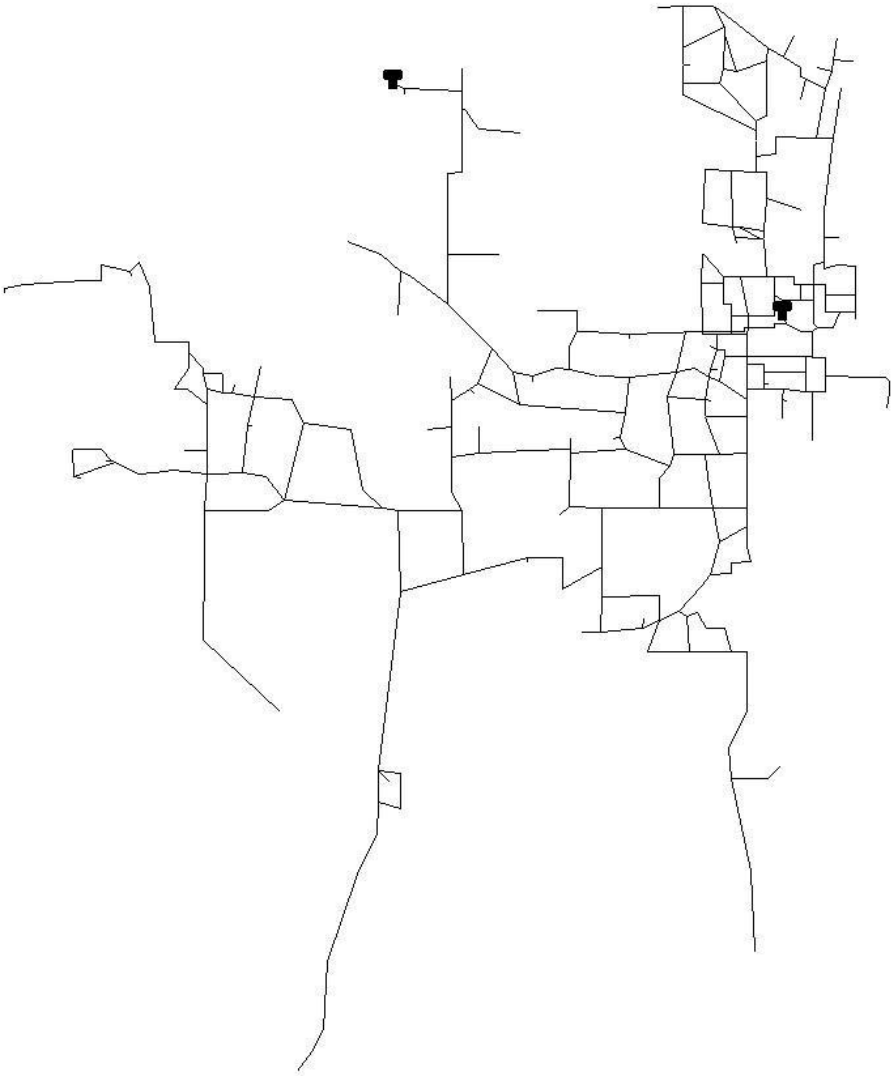
SYSTEM ID: PA1

NARRATIVE DESCRIPTION

The PA1 system is based on a portion of the North Penn Water Authority distribution system. The system has an average demand of 2.7 MGD. The network was developed as part of study by Clark (1994). A general schematic of the system is shown below. The system has two tanks and 99 miles of pipe.

NETWORK SCHEMATIC:



HISTORY OF THE NETWORK FILE

The PA1 system was originally developed by Clark (1994) as part of an article “Applying Water Quality Models” which was published in 1994 in *The Proceedings of the NATO Advanced Study Institute on Computer Modeling of Free-Surface and Pressurized Flows*. It reported the results of a study sampling water for chlorine and THM dynamics.

ORIGINAL REFERENCE:
Clark, R.M., 1994. Applying water quality models. In *Computer Modeling of Free-Surface and Pressurized Flows* (pp. 581-612). Springer, Dordrecht.

ABSTRACT: The Safe Drinking Water Act of 1974 and its Amendments of 1986 (SDWAA) requires that the U.S. Environmental Protection Agency (USEPA) establish maximum contaminant level goals (MCLGs) for each contaminant which may have an adverse effect on the health of persons. Each goal is required to be set at a level at which no known or anticipated adverse effects on health occur, allowing for an adequate margin of safety (Clark, et al., 1987). Maximum Contaminant Levels (MCLs) must be set as near to MCLGs as feasible.

ADDITIONAL REFERENCE:
Vasconcelos, J.J., Rossman, L.A., Grayman, W.M., Boulos, P.F. and Clark, R.M., 1997. Kinetics of chlorine decay. *Journal-American Water Works Association*, *89*(7), pp.54-65. https://doi.org/10.1002/j.1551-8833.1997.tb08259.x

ADDITIONAL CITATIONS:
The original publication of Clark (1994) and by inference the PA1 system has been cited by 11 additional authors. These may be accessed by moving your cursor over the following link while simultaneously depressing the CTRL key on your keyboard: 11 Citations.

AVAILABLE INFORMATION

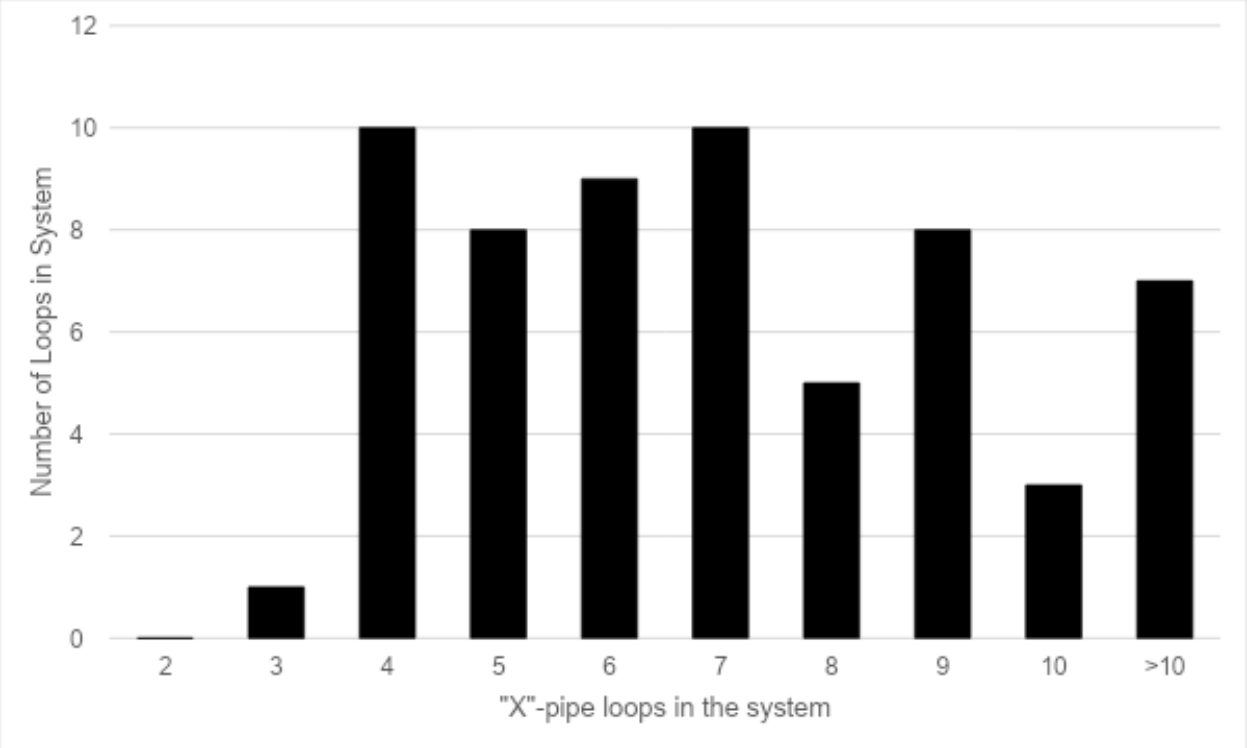
Physical attributes	Yes
Schematic diagram	Yes
Network geometry data	Yes
GIS data file	No
Background map	No
Elevation data	Yes
Pipe data	Yes
Pipe material	No
Pipe age	No
Pipe pressure class	No
Nominal or actual diameters	Nominal
Pump data	NA
Useful horsepower	
Pump operating curves	
Tank data	Yes
Elevation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

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 PA1 system is provided below. Using this information, Hoagland et al., classified this system as being a GRIDDED system.

# Total Pipes:	399
# Branch Pipes:	109
Ratio (Branch Pipes / Total Pipes):	0.273



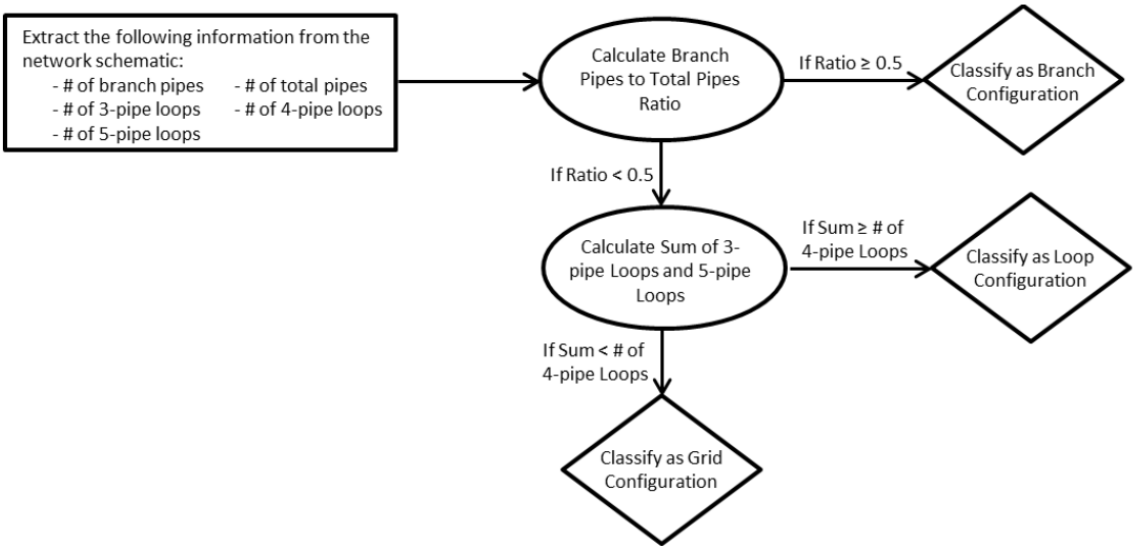


Figure 3.4. Classification Algorithm (Hoagland et al., 2015)

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	399
Pipes	399
Nodes	339
Average Diameter	11
Reduced Nodes	146
Reduced Edges	206
Branched Edges	103
Branched Index	0.3
Meshed Connectedness	0.1
Reduced Meshed Connectedness	0.21
Link Density	0
Average Node Degree	2.4
Hwang & Lansey Classification	Distribution Dense-Grid

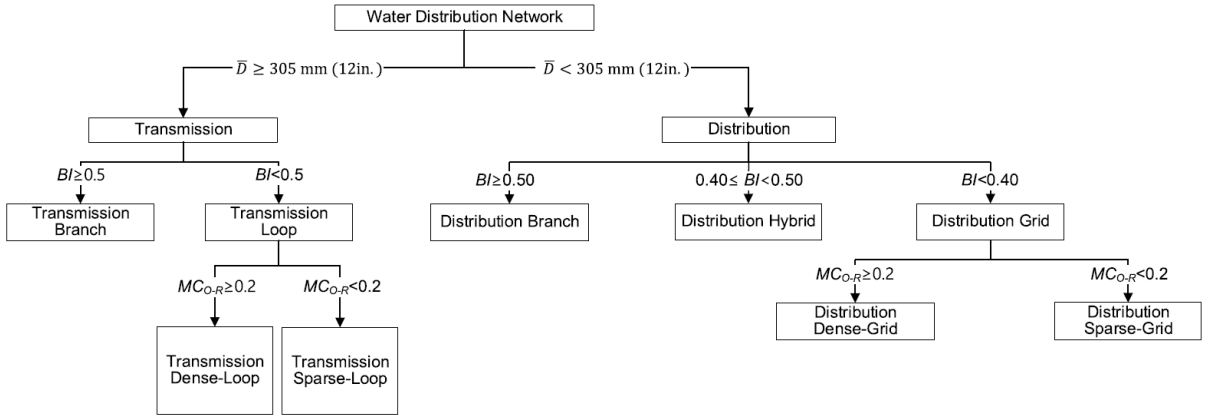


Figure 7. Water Distribution System Classification Flowchart (Hwang & Lansey, 2017)

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

DETAILED DATA SUMMARIES

PHYSICAL ASSETS:

Asset Type:	# of Assets
Master Meters	0
Tanks	2
Pumps	0
Water Sources	0

NETWORK CHARACTERISTICS:

# Total Pipes:	399
# Junctions	337
# Reservoirs	0
# Tanks	2
# Regulating Valves	0
# Isolation Values	Unknown
# Hydrants	Unknown
Elevation Data	YES

PIPE DATA:

Diameter (in)	Length (ft)
4	14,000
6	35,390
8	174,428
10	1,118
12	168,154
16	124,369
24	6,500

PUMP DATA:

Pump Horsepower	NO
Pump Curves:	NO

DATA FILE ATTRIBUTES:

ATTRIBUTE		UNITS
Pipe Length & Diameter	X	Feet & inches
Pipe Age		
Node Elevation	X	Feet
Node Demand	X	GPM
Valves		
Hydrants		
Tank Levels	X	Feet
Tank Volume		
PRVs		
WTP		
WTP Capacity		
Pump Data		