Course 302. Planning and Urban Demand Management

Homework Assignment 1: “Audits” and “Leaks and Leak Detection”

Data for the example water system discussed in class is included in the Microsoft Excel file “System_Data_1.xls”. A schematic diagram of the water system is also attached. Using this data, do the following exercises:

1. Shown below is Figure 4.1 from the Thornton text, which presents in each column various system water balance expressions. Based on the given data, which “boxes” are known and which are unknown?

![Water Balance Diagram](image)

**Figure 4.1** An international standard water balance. (*Source: Ref. 4*)

2. At present, no data is known for this system about leaks or meter accuracy. Which boxes in the water balance figure would be affected by new data regarding leaks and meters?

3. Using the data provided at the bottom of the data spreadsheet, calculate unavoidable real losses (UARL) for this system. What percentage of the total system input appears to go towards UARL?

4. Assuming that all meters in the system are accurate, what is the magnitude of total losses for the system? What is the magnitude of real losses and apparent losses? How would these values change if the system’s meters were inaccurate?
5. Using the example audit on pp. 54-55 of the Thornton text as a guide, complete an audit of this system using the IWA methodology. Be sure to calculate:
   a. Infrastructure leakage index (ILI)
   b. Cost of real losses
   c. Cost of apparent losses
   d. Target real losses (assuming ILI of 3.5 is desirable)
   e. Value of current excess real losses

6. If a leak detection program costing $500,000 per year could reduce leakage to the target level, what would be the benefit-to-cost ratio of this program?

7. Using the map of the water distribution system, identify 4 zones that could be isolated with valve closures for zonal flow testing. In each case, indicate exactly where valves would be closed and opened and where meters would be located for each zone.

8. Zonal flow tests were conducted from this system for three zones:
   a. Zone A included nodes 33, 34, and 35 with water entering only through pipe 2, which connects node 6 to node 35 (flow was closed between nodes 33 and 7);
   b. Zone B included nodes 7, 8, 9, 10, 11, and 12 with water entering the zone only through pipe 62, which connects node 6 to node 7 (flow was closed between nodes 33 and 7); and
   c. Zone C included nodes 14, 26, 27, and 28 with water entering the zone only through pipe 79, which connects nodes 16 and 28 (flow was closed between nodes 15 and 14, nodes 16 and 26, and nodes 25 and 26).
   The 24 hour metering data are given on the second page of the data worksheet. Which of the 3 zones tested would be good candidates for comprehensive leak detection surveys?
Schematic diagram of example water distribution system
(selected pipe numbers are shown in red)