Walkthroughs

This document intends to provide some hints for solving the course assignments, and along with *FAQ* aims at clarifying unfamiliar concepts.

Assignment 1

Sewer modeling

In this exercise the main idea is to learn how to visualize pipe profiles and learn about capacity, head and critical levels. Start by building a network including relevant information about the pipes and junctions from the tables. After filling in the network components' attributes and general model parameters (mentioned in the assignment file), run the simulation with conditions mentioned in the assignment. Pipe profiles can be visualized by first selecting the start node then pressing Ctrl+selecting the end node of the desired section and then right clicking and choosing either shortest or the best route. Critical levels are inserted either by assigning critical levels at junctions (not conduits!) or by assuming an imaginary critical level line based on its definition. Several physical properties of manholes/junctions (Figure 1) and pipes (Figure 2):

- *Rim elevation* = Node invert elevation + Maximum node depth (height between its invert and the ground surface).
- *Invert elevation*: Height of the manhole bottom.
- *Surcharge depth*: Represents the ability of a manhole to hold pressure, i.e. additional pressure head that can be accepted before flooding occurs. When surcharge depth is 0, it holds no pressure above its rim.
- *Outlet offset* = Pipe invert elevation – Node invert elevation.

When inserting invert elevation and manhole depth, software calculates automatically the rim elevation. So to avoid messing up the manhole physical attributes, the invert elevation must be specified and the ground elevation (rim) is then calculated from the depth.

Water supply modeling

The main purpose is to learn about the relationship between elevation, head and flow. Start by building a network including pipes' and junctions' attributes, and water consumption patterns (all included in the assignment file). Run the simulation and observe pressures, flows and velocities in the system and for individual pipes/junctions. Perform the required changes and observe what happens to flows, velocities and heads in the network and in individual pipes/junctions. Brief and concise reporting is recommended.

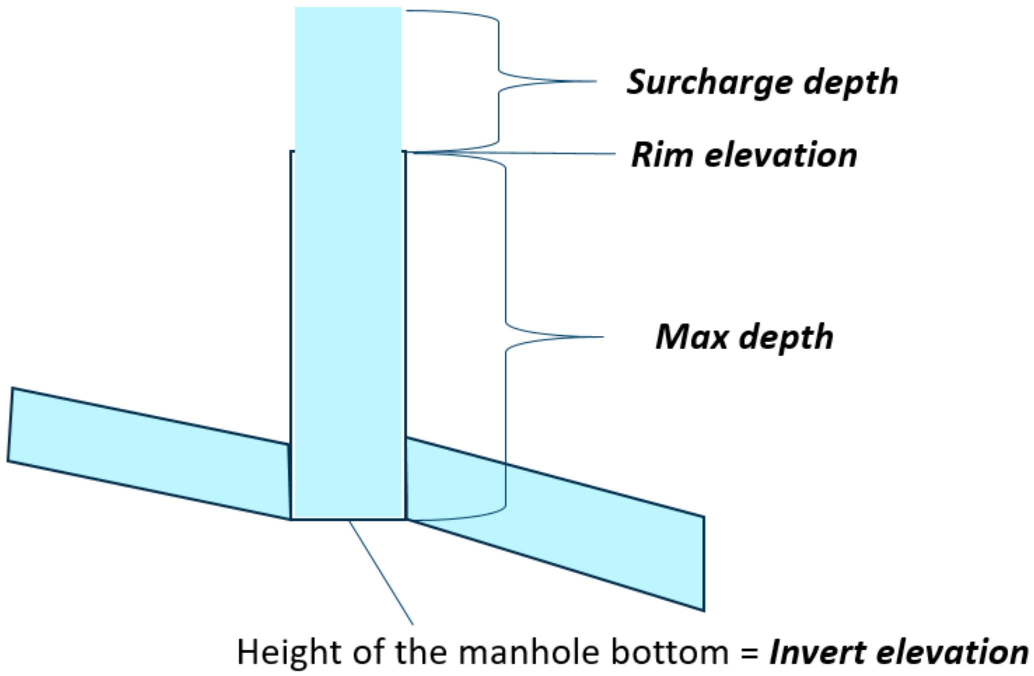

Figure 1: Junction (Manhole) physical attributes.

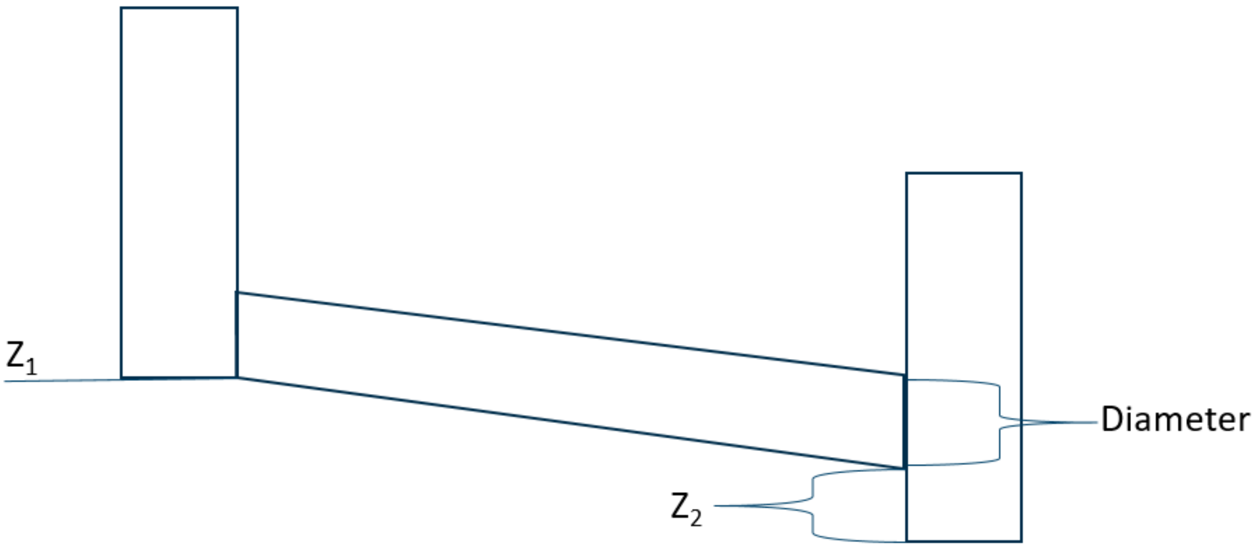

Figure 2: Pipe physical attributes (Z2 - pipe offset).

Assignment 2: Basic hydraulics

This assignment focuses on basic pipe hydraulics. Relevant equations and tables are included in the assignment file. Tasks 1-2 and 4 are pretty straightforward: use equations and lecture slides to derive and calculate; task 3 requires iteration in Excel. In task 3, start by deciding in which direction water flows in pipes and guess the discharges, then compute head loss h_f and iterate. In each node, the continuity equation must hold, i.e. $\sum Q = 0$. Iteration is done with Solver Add-In; activate it via:
File ⇒ Options ⇒ Add-Ins ⇒ [Manage: Excel Add-Ins] Go . . . ⇒ Solver Add-In ⇒ OK

Assignment 3: Modeling leakage

In this assignment, the main topic is leakage and its representation in the water supply model. Leakage can me modeled using two methods: using emitters or adding leakage to node consumption. Appropriate multiplier means that the nodal consumption must be multiplied with a value that increases the node consumption by an amount that is equal to the leakage when using emitters. After changing the leakage rate, compare the pressures to RIL guidelines and report at what conditions the system breaks (min pressure < 0). For the maximum level of leakage the system could handle consider the minimum pressure requirements. For the last task present a figure where pressure is plotted against leakage for different emitter exponents and emitter coefficients.

Assignment 4: Inflow and infiltration

This assignment aims at relating levels of inflow/infiltration to water consumption and rainfall. RDII is the component of a sewer flow above normal DWF pattern, and it represents the sewer flow response to rainfall or snowmelt in the system. Use Excel for producing graphs and tables. For Exercise 2: in task 2a consider a simplification that 100 % of rainfall turns to runoff. In 2b(ii) compare the difference between the minimum rainfall estimate to two remaining estimates.

Assignment 5: Reducing energy use and leakage in water supply system

This assignment aims at presenting pumps and pump curves in the water supply network, and their relationship with head and energy efficiency. There are three scenarios in the model: Base scenario, Water tower in use scenario and Pressure rezoning scenario. They represent different settings for reducing energy use and leakage in the water supply system and are analyzed in the assignment. While analyzing the system performance in three scenarios, pay attention to flows, pressures and velocities and compare them to RIL guidelines of good practices for water supply systems. Fill in the Excel table and find reasons for reduced energy efficiency and differences in the network behavior in different scenarios.

Assignment 6: Water quality in a water supply network

In this short assignment, additional level of optimization of a simplified water supply system is introduced. Start by running the model and checking whether residual chlorine concentration is sufficient at the *Hospital* node. The WHO Guidelines suggest chlorine levels for effective disinfection to be minimum at 0.2 mg/l; consider the minimum value throughout the system, and make the *Hospital* node to receive $0.3 - 0.5$ mg/l of chlorine. Bulk coefficient is changed via: *Model* ⇒ *Chemicals...* ⇒ *New* ⇒ *Global bulk coefficient*