Water System Design Parameters

The following are a list of design parameters that are important in the design of gravity-flow water systems :

1. **Maximum Pressure Limits** : The taps and valves closed state, should be the maximum pressure condition for the system. Maximum head limits for the pipe work will be used to carry out the calculations. This scenario is used at the start of the design to be able to place any break-pressure tanks that may be required.

2. **Safe Yield** : The safe yield is the minimum flow from the water source. It is important to not draw more than this supply from the system at any point. If this happens then spring boxes and/or break pressure tanks will run dry and air will enter the system.

3. **Negative or Low Pressure Head** : If the pressure head (P in the Bernoulli Equation) becomes negative at any point in the system then two things may happen. Firstly a siphon effect is occurring which is trying to suck water into the system. This is undesirable as polluted groundwater may be introduced into the system. Secondly, large negative pressures can cause air to come out of solution in the water and cause air-blocks. **Jordan [P.52]** suggests that the pressure head should, if possible, not fall below 10m (98100 Pa pressure) anywhere in the system and never go negative.

4. **Velocity Limits** : The flow velocity in the pipelines should not be to great as particles suspended in the water will cause excessive erosion. Also if the velocity is too low then these particles will settle out of the flow and may clog the pipes at low points. This then requires washouts at low points in the system. **Jordan [P.53]** suggests that the minimum velocity should be 0.7m/s and the maximum 3.0m/s.

5. **Natural Flow** : Natural flow may be allowed to occur in the system at some sections of pipe. Natural flow can be problematic in that the water velocity may exceed the limits set in parameter 4 above and/or increase the flow rate above the safe yield parameter 2. Close attention should be made to these situations.

6. **Residual Head** : The residual head at a tap stand or valve is important. If it's too high it will cause erosion of the valve and if it is too low then the flow will be minimal. **Jordan [P.141]** suggests the following limits :

Absolute minimum :	7m
Low end of desired range :	10m
Most desirable :	15m
High end of desired range :	30m
Absolute maximum :	56m

7. **Air-blocks** : These occur when there are topographic features between the source and the collecting tank that are lower than the collecting tank. Energy is lost from the system as these air-blocks are compressed and can result in no flow. **Jordan [P.55]** gives the following design practices to avoid air-blocks :

   - Arrange pipe sizes to minimise the frictional head loss between the source and the first air-block.
   - Use larger-sized pipe at the top and smaller sized pipe at the bottom of the critical sections where air is going to be trapped.
   - The higher air blocks are the more critical ones and should be eliminated or minimised first.
   - Air valves can be designed into the system to allow trapped air to escape.

8. **Cost** : Wherever possible smaller pipe diameters should be used, as they are cheaper. Combinations of pipes can often produce cheaper solutions than using just one pipe size. However pipe lengths should be rounded to the nearest 100m length. Also the number of concrete structures such as break-pressure tanks should be minimised.

Large systems (say, 100 taps or more) are difficult to analyse mathematically and meeting some of the above parameters in a case where all of the taps open may lead to an over design of the system. In such cases an acceptable rule of thumb is to allow a flow rate of 0.02 litres per second when all of the taps are open.