Rapid Pumping Main Sizing and Assessment Chart

Size your pumping mains to have a **1-5 m/km unit headloss**. Use the following chart for quick reference:

PUMPING MAIN SIZING CHART

l/s	⌀63	⌀75	⌀90	⌀110	⌀125	⌀140	⌀160	⌀180	⌀200	l/s
0.5	**1.2**	0.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.5
1	**4.3**	**1.8**	0.7	0.3	0.1	0.1	0.0	0.0	0.0	1
1.5	9.1	**3.7**	**1.6**	0.6	0.3	0.2	0.1	0.1	0.0	1.5
2	15.5	6.4	**2.7**	**1.0**	0.5	0.3	**0.2**	**0.1**	**0.1**	2
2.5	23.4	9.6	**4.0**	**1.5**	0.8	0.5	0.2	0.1	0.1	2.5
3		13.5	5.6	**2.1**	**1.1**	0.7	0.3	0.2	0.1	3
4		23.0	9.6	**3.5**	**1.9**	**1.1**	0.6	0.3	0.2	4
5			14.5	5.3	**2.9**	**1.7**	0.9	0.5	0.3	5
6			20.3	7.5	**4.0**	**2.3**	**1.2**	0.7	0.4	6
7			27.0	9.9	5.4	**3.1**	**1.6**	0.9	0.5	7
8				12.7	6.9	**4.0**	**2.1**	**1.2**	0.7	8
9				15.8	8.6	**5.0**	**2.6**	**1.5**	0.9	9
10				19.2	10.4	6.0	**3.1**	**1.8**	**1.1**	10
11				22.9	12.4	7.2	**3.7**	**2.1**	**1.3**	11
12				27.0	14.6	8.5	**4.4**	**2.5**	**1.5**	12
13					16.9	9.8	**5.1**	**2.9**	**1.7**	13
14					19.4	11.3	5.8	**3.3**	**2.0**	14
15					22.1	12.8	6.6	**3.8**	**2.2**	15
16					24.9	14.4	7.4	**4.3**	**2.5**	16
17					27.8	16.2	8.3	**4.8**	**2.8**	17
18						18.0	9.2	5.3	**3.1**	18
19						19.9	10.2	5.9	**3.5**	19
20						21.8	11.2	6.5	**3.8**	20
21						23.9	12.3	7.1	**4.2**	21
22						26.1	13.4	7.7	**4.6**	22
23						28.3	14.5	8.4	**4.9**	23
24							15.7	9.0	5.3	24
25							17.0	9.8	5.8	25

USAGE: Select a pipe diameter in the row for the planned flow to achieve a unit headloss between 1 and 5 m/km (green cells). I.e., for 10 l/s, select either ⌀160 or ⌀180 mm pipe (Source: S. Arnalich).

How to use the chart:

1. Go to the row with the closest figure to the planned flow.
2. Find the cells with unit headlosses between 1 and 5 m/km. They are shaded in green with bold font.
3. Move up in their rows to find the pipe diameters.
4. Don't be tempted by smaller, cheaper pipes – they'll cost you much more in the long run!

Example of use:

Size an HDPE main connecting a borehole with a safe yield of 6 l/s.

PUMPING MAIN SIZING CHART

l/s	ø63	ø75	ø90	ø110	ø125	ø140	ø160	ø180	ø200	l/s
0.5	1.2	0.5	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.5
1	4.3	1.8	0.7	0.3	0.1	0.1	0.0	0.0	0.0	1
1.5	9.1	3.7	1.6	0.6	0.3	0.2	0.1	0.1	0.0	1.5
2	15.5	6.4	2.7	1.0	0.5	0.3	0.2	0.1	0.1	2
2.5	23.4	9.6	4.0	1.5	0.8	0.5	0.2	0.1	0.1	2.5
3		13.5	5.6	2.1	1.1	0.7	0.3	0.2	0.1	3
4		23.0	9.6	3.5	1.9	1.1	0.6	0.3	0.2	4
5			14.5	5.3	2.9	1.7	0.9	0.5	0.3	5
6			20.3	7.5	4.0	2.3	1.2	0.7	0.4	6
7			27.0	9.9	5.4	3.1	1.6	0.9	0.5	7

Following the 6 l/s row, the first cell in green we find corresponds to **a ⌀125 mm pipe**. The other options are ⌀140 mm (2.3 m/km) and ⌀160 mm (1.2 m/km). The final choice will depend on the length of the pipe, as very long pumping mains may cause affordability issues. Additionally, investment funds are often easier to obtain initially than operational funds later on.

Operational impact

Together with human resources, pumping constitutes **the most expensive item** and the **main source of greenhouse gases** in the operation of a pumped water supply system. While some technologies, like solar pumping, decrease that burden significantly, it is still **vital to size pumping** mains correctly due to the **many advantages of investing in pipes**.

For example, buried pipes don't break unless damaged on purpose, are protected from extreme weather events (heat waves or storms), are rarely stolen, work in any weather condition and at night, and have no moving parts or electronics and don't require frequent cleaning. Additionally, pumping through undersized pipes requires oversizing more sensitive and expensive equipment.

Notes on the methodology

The chart optimizes for a combined OPEX and CAPEX over a period of ten years. No adjustment for the time value of money were made to keep it simple and because humanitarian funding focuses on life-saving, it expected to be used in a budget cycle and does not usually contemplate alternative uses of money, such as investing for a perpetuity.

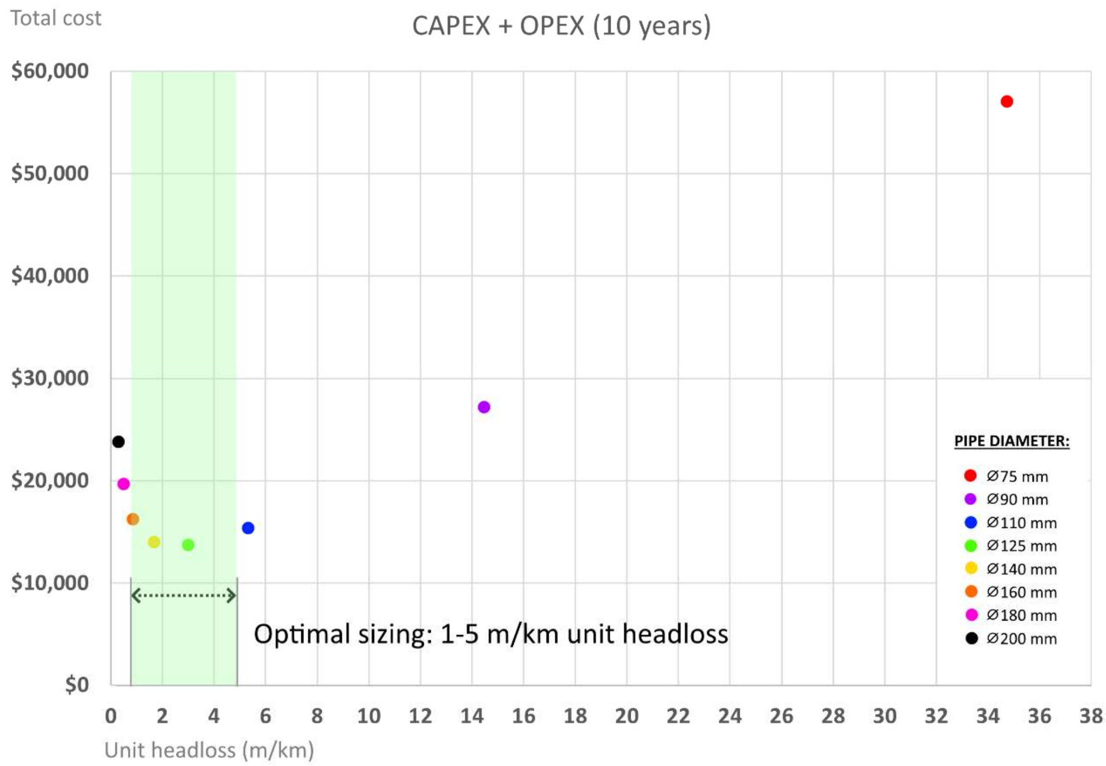

Figure 1. The total investment and operational cost for eight different pipe sizes are compared against unit friction losses. While a ⌀75 mm pipe costs $3,300, it ends up being four times more expensive than a ⌀125 mm pipe when considering long-term costs. The initial pipe purchase is the lesser cost.

On calculations: Hydraulic calculations were performed using the Hazen-Williams equation. Generator fuel efficiency was taken as 0.42 l/kWh, a common figure in refugee camps.

On prices: Kenyan prices for diesel and HDPE pipe PN10 PE100 were used, including all costs (transportation, handling, installation, etc.), taken as a percentage of the pipe's unit cost.

Sensitivity analysis: Since HDPE pipes are made from oil, the prices of diesel, transportation, and pipe tend to fluctuate together. The effect of increasing pipe prices relative to fuel prices is the widening of the sizing bracket towards higher unit headloss values. For example, a fourfold increase in pipe prices without a similar increase in diesel costs will increase the bracket to 3–14 m/km. However, these changes are considered very unlikely. It is thought that prices across countries and regions will change in absolute terms but not significantly in relative terms. This hypothesis was verified using ChatGPT-4o's Deep Research feature with the following prompt: "*Check the hypothesis that HDPE and diesel relative prices evolve similarly across countries and regions hosting refugee camps*."

Simplifications: Different pipes and flows will have slightly different sizing brackets. For example, it can be easily argued that, in the image above, a ⌀110 mm pipe with 6 m/km should also be included, as its overall cost is lower than a ⌀160 mm pipe that has been included. In the interest of simplicity, a standardized, easy-to-remember sizing bracket has been chosen.