**Supplementary material for mobile sensors for hydraulic calibration of pipe network models**

**Alemtsehay G. Seyoum, Simon Tait, Alma N.A. Schellart, Will Shepherd, Joby Boxall**
*School of Mechanical, Aerospace and Civil Engineering, The University of Sheffield, United Kingdom*
*Corresponding author: a.g.seyoum@sheffield.ac.uk*

**List of Tables:**



**List of Figures:**

**Table S1**. Candidate pipe roughness values used in the optimisation

| No. | Water supply network roughness height (Ks) (mm) | Sewer network (Manning's $n$) (dimensionless) |
|---|---|---|
| 1 | 0.045 | 0.0060 |
| 2 | 0.104 | 0.0087 |
| 3 | 0.155 | 0.0095 |
| 4 | 0.184 | 0.0101 |
| 5 | 0.212 | 0.0108 |
| 6 | 0.239 | 0.0115 |
| 7 | 0.277 | 0.0121 |
| 8 | 0.316 | 0.0128 |
| 9 | 0.320 | 0.0132 |
| 10 | 0.331 | 0.0138 |
| 11 | 0.435 | 0.0147 |
| 12 | 0.659 | 0.0157 |
| 13 | 1.121 | 0.0165 |
| 14 | 2.074 | 0.0182 |
| 15 | 3.164 | 0.0202 |
| 16 | 6.769 | 0.0260 |

**Table S2**. Summary of key simulation and optimisation parameters used in the study

| Category | Parameter name | Value | Sensing type | Applicable scenario | Rational for selection |
|---|---|---|---|---|---|
| **Simulation parameters** | Demand profile resolution | 15 minutes | Both | Water supply | Defined in the water supply case study network. |
| | Rainfall data resolution | 1 minute | Both | Sewer | Defined in the sewer case study network. |
| | Sampling interval | 3 minutes | Both | Water supply | For mobile sensing, ensuring the possibility of collecting at least one measurement per pipe. Static sensing uses the same rate for consistency. |
| | | 10 seconds | Both | Sewer | |
| | Sensor speed | 0.25 m/s | Mobile | Both | For the mobile sensor to traverse the entire network twice in the 24 hours. |
| | Data collection duration | 24 hours | Both | Both | Matches 24-hour extended-period simulation for full daily demand cycle coverage. |
| | Number of sensor paths | 4 | Mobile | Both | To evaluate calibration robustness under different spatial sampling patterns. |
| **Optimisation parameters (NSGA II)** | Population size | 400<br>200 | Both<br>Both | Water supply<br>Sewer | To maintain population diversity for complex optimisation. |
| | Number of generations | 5,000 | Both | Both | To ensure convergence of both objective functions. |
| | Function evaluations | 2,000,000<br>1,000,000 | Both<br>Both | Water supply<br>Sewer | |
| | Crossover probability | 1 | Both | Both | For exploitation of good solutions for faster convergence |
| | Mutation probability | 0.005 | Both | Both | To maintain population diversity and avoid premature convergence. |
| | Number of optimisations runs | 5<br>5 per path (20 total) | Static<br>Mobile | Both<br>Both | To account for NSGA-II randomness and to verify consistency of the results. |
| | Convergence generation criterion | $10^{-4}$ | Both | Both | Defined as the earliest generation at which the absolute change in objective values remains below $10^{-4}$ over a 50-generation window. |

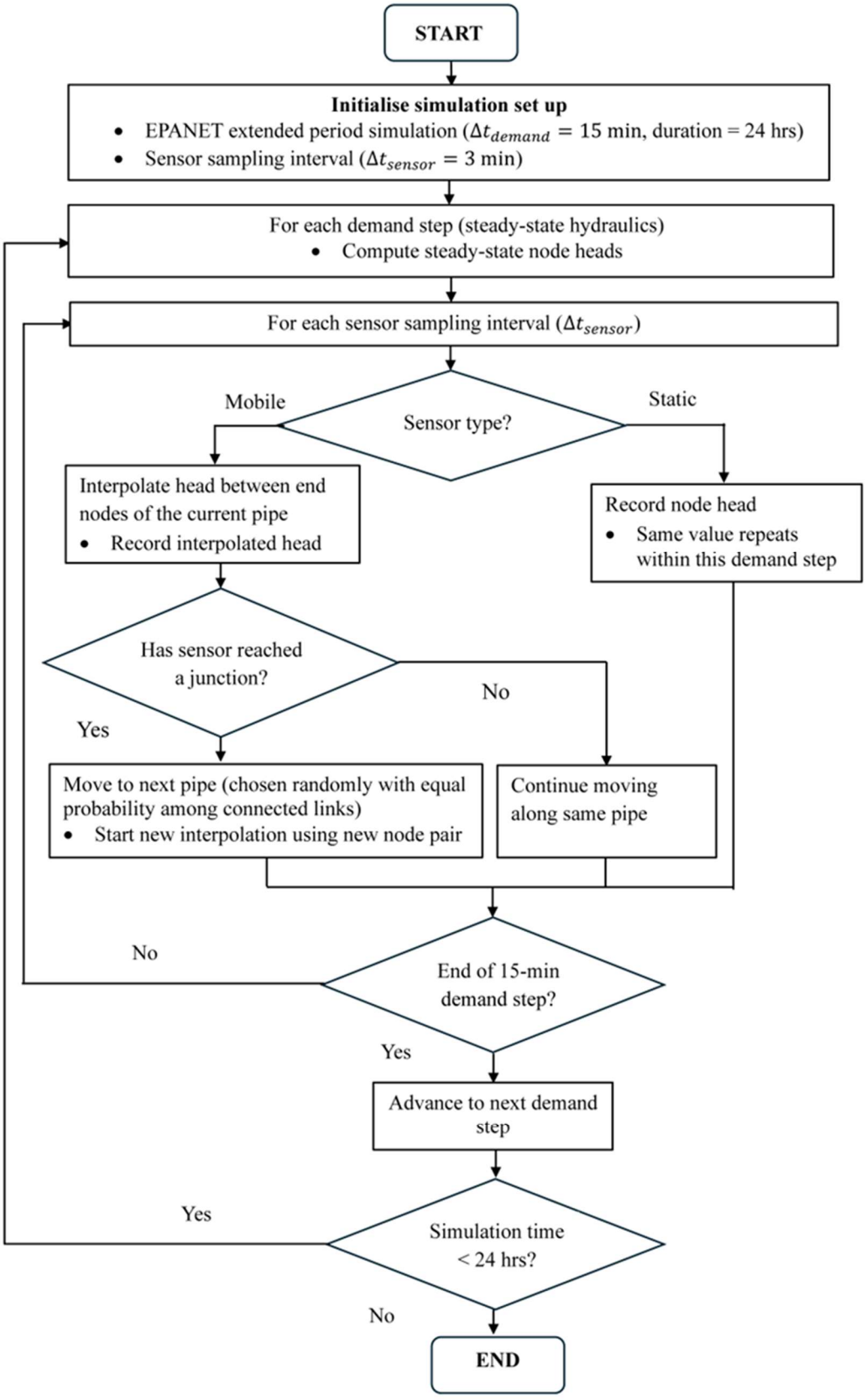


**Figure S1**. Flowchart illustrating how static and mobile sensors record data within EPANET's extended-period simulation.