

our book's  
kTable B-5. Typical Coefficients of Pipe Friction for Design<sup>a</sup>

| Material   | Hazen-Williams C | Manning n <sup>b</sup> | Moody diagram $\epsilon^b$ |         |
|--|------------------|------------------------|----------------------------|---------|
|  |                  |                        | mm                         | in.     |
| <b>New pipe or lining</b>  |                  |                        |                            |         |
| Smooth glass or plastic <sup>c</sup>   | 150              | 0.009                  | 0.019                      | 0.00075 |
| Centrifugally spun cement-mortar lining <sup>d</sup>   | 145              | 0.009                  | 0.038                      | 0.0015  |
| Cement-mortar lining troweled in place   | 140              | 0.009                  | 0.076                      | 0.003   |
| Commercial steel or wrought iron   | 140              | 0.009                  | 0.076                      | 0.003   |
| Galvanized iron  | 135              | 0.010                  | 0.13                       | 0.005   |
| Ductile or cast iron, uncoated   | 130              | 0.010                  | 0.19                       | 0.0075  |
| Asbestos-cement, coated  | 145              | 0.009                  | 0.038                      | 0.0015  |
| Asbestos-cement, uncoated  | 140              | 0.009                  | 0.076                      | 0.003   |
| Centrifugally cast concrete pressure pipe  | 135              | 0.010                  | 0.13                       | 0.005   |
| <b>Ten-State Standards [1]</b>   |                  |                        |                            |         |
| Cement mortar or plastic lining  | 120              | 0.011                  | 0.41                       | 0.016   |
| Unlined steel or ductile iron  | 100              | 0.011                  | 1.5                        | 0.060   |
| <b>Old pipe or lining [in moderate service (20 yr or more), nonaggressive water]<sup>e</sup></b> |                  |                        |                            |         |
| Smooth glass or plastic  | 135              | 0.010                  | 0.13                       | 0.005   |
| Centrifugally spun cement-mortar lining <sup>f</sup>   | 130              | 0.010                  | 0.19                       | 0.0075  |
| Cement mortar troweled in place  | 125              | 0.010                  | 0.28                       | 0.011   |
| Asbestos cement, coated  | 130              | 0.010                  | 0.19                       | 0.0075  |
| Asbestos cement, uncoated  | 125              | 0.010                  | 0.28                       | 0.011   |
| Ductile iron or carbon steel, uncoated   | 100              | 0.013                  | 1.5                        | 0.060   |
| Centrifugally cast concrete pressure pipe  | 130              | 0.010                  | 0.19                       | 0.0075  |
| Wood stave   | 110              | 0.012                  | 0.89                       | 0.035   |
| Riveted steel  | 80               | 0.016                  | 5.6                        | 0.22    |
| Concrete, formed   | 80               | 0.016                  | 5.6                        | 0.22    |
| Clay (not pressurized)   | 100              | 0.013                  | 1.5                        | 0.060   |
| Wrought iron   | 100              | 0.013                  | 1.5                        | 0.060   |
| Galvanized iron  | 90               | 0.014                  | 0.30                       | 0.012   |

<sup>a</sup>For critical problems, consult the literature [4,5,6].<sup>b</sup>Values are calculated from C coefficients for 300-mm (12-in.) pipe, a velocity of 1.1–2.1 m/s (3.7–6.9 ft/s), and a temperature of 20°C (68°F).<sup>c</sup>PVC, polyethylene, polypropylene, polybutylene, reinforced thermosetting resin pipe, and polyvinyl chloride.<sup>d</sup>Average value for pipes 150 to 900 mm (6 to 36 in.) diameter [2].<sup>e</sup>For conservative design, reduce old pipe C values (and increase n values) by 0.02%/mm (0.5%/in.) for pipe less than 450 mm (18 in.). Note that the Hazen-Williams and Manning equations predict headloss on the unsafe side for small pipes and/or low velocities.<sup>f</sup>Conservative values for water pipe 150–500 mm (6–20 in.) [2].

ref: Sanks, Pumping Station Design