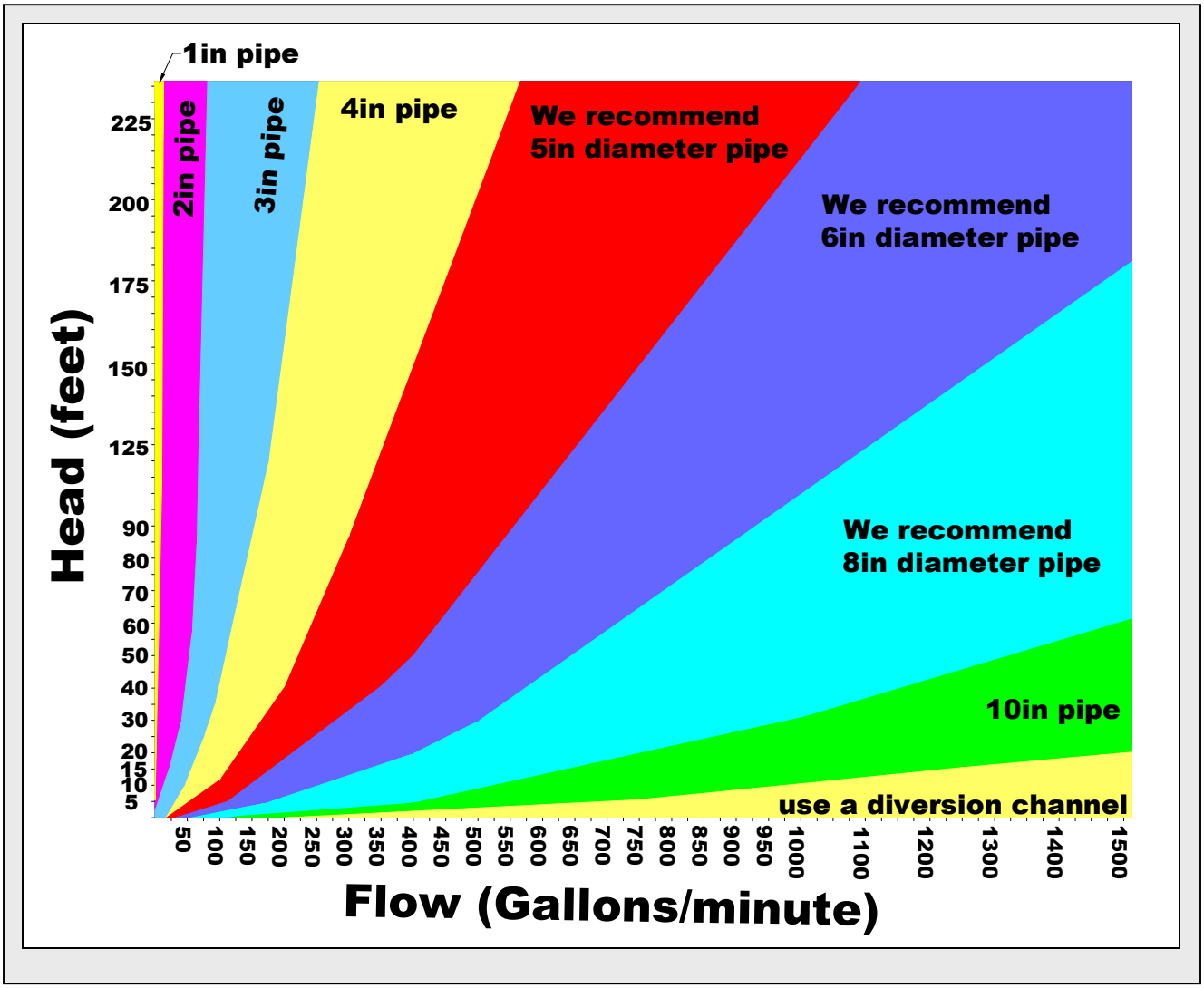
Appendix 7: *Choosing Pipe in a Closed Diversion System*

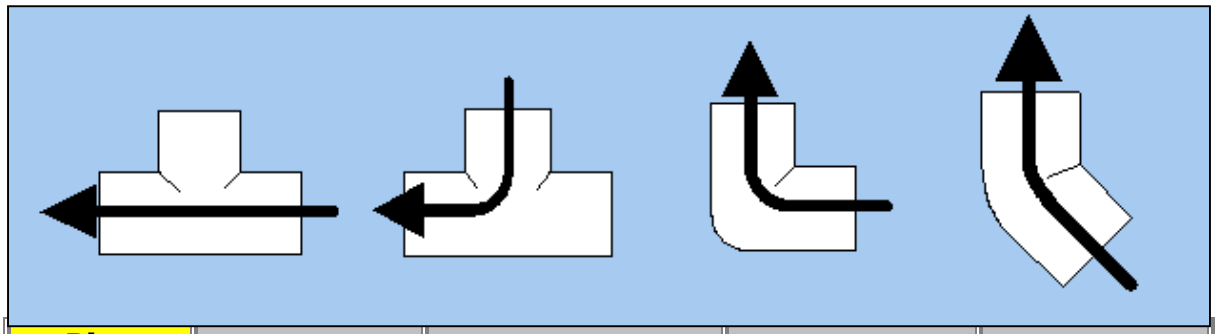
Once you have determined the water source inlet and measured the static head (vertical change in elevation) from the water source inlet to the turbine, measure the lineal distance for the path that the pipe for the diversion system will follow. You now want to select the optimal pipe diameter for your diversion system. The larger the pipe diameter, the less the friction loss will be. However, larger diameter pipes also cost more. You need to meet the hydro turbine's dynamic pressure and flow volume requirements. Beyond that, the optimal pipe diameter is the one that gives you the best cost-benefit ratio – the least cost per PSI of dynamic pressure. In the graph below we have provided a simple means of determining which pipe diameter to use, based on static head and flow information.

This graph is based on the assumption that your pipeline will have no turns or fittings with a radius greater than 22 degrees, and that it's overall length is under 500ft. If you do have additional friction losses from these elements, you will need to size your pipeline larger than what we have recommended here. In this case, we strongly recommend you contact our engineering staff to help you in designing and planning your system. Keep in mind that your flow must be adequate to keep the pipeline full even at low water levels to maintain a closed system and prevent cavitation and turbulence caused by air drawn into the system intake.



Appendix 8: *Other Pipeline Friction Losses*

Another major cause of head loss is in any fittings you might use. Avoid sharp corners in planning your pipeline, because sharp corners will cause turbulence and hence increase friction. The table below lists friction losses associated with various common plumbing fittings. It shows how many feet of pipeline length the fitting is equivalent to, in terms of friction loss. For example: A 'T' in a 4-inch pipeline represents 22ft of head lost – OUCH! Your goal in planning your pipeline is to keep it as straight as possible. Bends and curves should be less than 22 degrees. This is best accomplished with smooth, flexible hose sections making gradual curves where necessary, or by carefully heating and bending straight pipe sections to your needs.



Pipe Diameter	Tee-Run	Tee-Branch	90° Ell	45° Ell
½	1.0 feet	4.0 feet	1.5 feet	0.8 feet
¾	1.4 feet	5.0 feet	2.0 feet	1.0 feet
1	1.7 feet	6.0 feet	2.3 feet	1.4 feet
1¼	2.3 feet	7.0 feet	4.0 feet	1.8 feet
1½	2.7 feet	8.0 feet	4.0 feet	2.0 feet
2	4.3 feet	12.0 feet	6.0 feet	2.5 feet
2½	5.1 feet	15.0 feet	8.0 feet	3.0 feet
3	6.3 feet	16.0 feet	8.0 feet	4.0 feet
3½	7.3 feet	19.0 feet	10.0 feet	4.5 feet
4	8.3 feet	22.0 feet	12.0 feet	5.0 feet

Some other sources of potential head loss to be aware of:

- **Trash-rack/screen – clogged or poorly designed**
- **Pipe inlet – clogged inlet or inlet not properly submerged**
- **Valves – use gate, butterfly, or ball valves only in hydro systems as they allow unobstructed flow when open**
- **Size transitions in pipeline diameter, both increase or decrease**
- **Poorly sealed joints which allow air to be sucked into the pipeline**