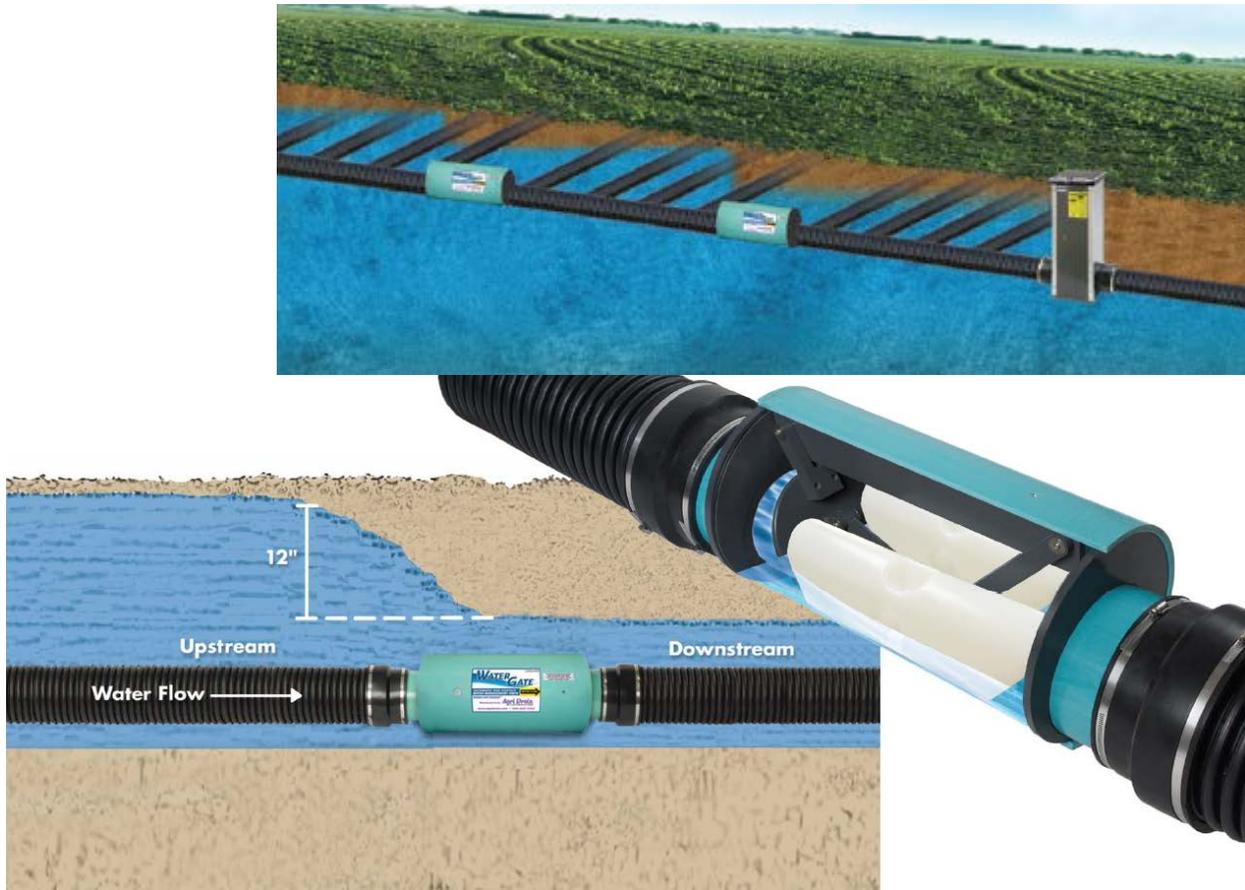


## Technical Guidance Water Gate Valves

January 2017 – Agri Drain Corporation and USDA-Natural Resources Conservation Service



### Function and Options

The Water Gate is a float-activated pressure-sustaining valve, typically used in managed subsurface drainage systems. The Water Gate is designed to be installed in-line, completely subsurface, with no interference to farming or other operations. Currently, there are two valve sizes available: the 8 inch and 10 inch, each with a nominal one-foot “lift”; an increase in water elevation between the downstream and upstream sides of the valve. Valves that generate a two-foot “lift” are planned for production. The published valve sizes are based on valve pipe diameter, and are not directly linked to the size of drainage tile that can be controlled.

The Water Gate operates in either free-flow or managed-flow mode.

- The managed-flow mode is activated by backing water up into the valve. This is accomplished by installing a traditional Water Level Control Structure (WLCS) in the drainage main or sub-main at the lowest point of the drainage system that you wish to manipulate or control. Locate the first Water Gate one foot in elevation upstream from

the WLCS. Water Gates can be used in series, locating additional units at elevation intervals equal to the lift that the Water Gate will provide.

- When the WLCS is not activated, the drainage tile flows freely. The Water Gate valve remains open and the valve operates in free-flow mode.

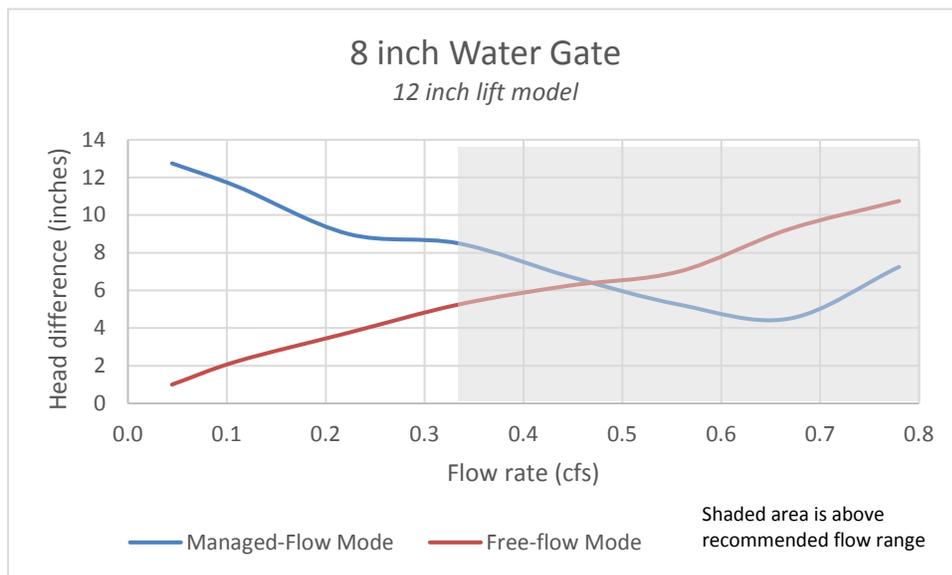
The managed-flow mode requires 12 inches of water (head) on the downstream side of the valve to activate the float. In addition, achieving the flow capacities described in this Technical Note requires at least 4 inches of head on the upstream side of the valve. There must be a water supply from above. The Water Gate does not pump water upstream. Rather, it is a passive device that regulates flow.

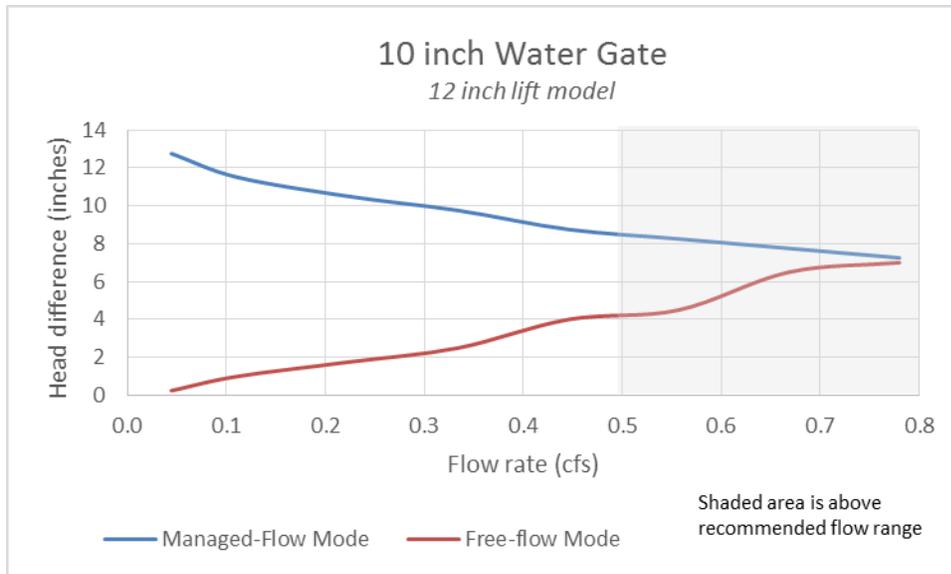
The recommended maximum number of Water Gates in series is three. This limitation is in place primarily to help minimize the potential for small variations in valve performance being magnified and significantly affecting the performance of the managed drainage system as a whole.

### Pressure-Flow Performance

When designing a managed drainage system using the Water Gate, it is important to be aware of the pressure-flow performance of the valve. The valve works by introducing a differential head through activation of the float. The differential head varies according to the amount of flow passing through the valve, and depends on the balance of forces acting on the float and gate valve.

Testing conducted at the University of Illinois, Department of Agricultural and Biological Engineering, determined the performance of each valve. In managed-flow mode, the goal is to achieve the nominal lift (12 inches) across a wide range of flows. In free-flow mode, the valve acts primarily as a simple orifice; the goal is to minimize the amount of pressure drop (head loss) across the valve to minimize any effects on the capacity of the drainage system.





To use the pressure-flow performance information, it is necessary to know the expected flow through the in-line valve. The flow capacity of the drainage tile is governed by the size and design of the tile and the grade at which it is installed.

For example, the maximum flow in an 8 inch corrugated plastic tile (CPT) at 0.2% grade is 0.44 cubic feet per second (cfs) or about 200 gallons per minute (gpm). In this example, an 8 inch Water Gate would provide about 7 inches of lift in managed-flow mode, and 6 inches of head loss in the free-flow mode. Switching to a 10" Water Gate at these same flows would yield about 11 inches of lift in managed-flow mode and 4 inches of head loss in the free-flow mode.

In general, the Water Gate performance at lower flow rates most closely matches the target 12 inch lift in managed-flow mode and minimal head loss in free-flow mode. Given the performance, the table below provides recommended flow ratings for the valves. The table lists the slope at which a certain size of CPT achieves this maximum recommended flow:

Water Gate Size	Maximum Flow Capacity		Tile Grade (%) at flow equal to the capacity of Water Gate				
	cfs	gpm	5" CPT	6" CPT	8" CPT	10" CPT	12" CPT
8"	0.33	150	1.25%	0.47%	0.12%	0.04%	
10"	0.50	225	2.80%	1.06%	0.26%	0.09%	0.03%

If a design flow other than the maximum CPT flow is warranted, use that flow for design, rather than the maximum pipe flow capacity shown above.

### Valve Performance for Subirrigation

The Water Gate can be used to manage subsurface water in a subirrigation system.

- When designing the system for passive subirrigation, the valve performance for drainage is applicable. This type of system manages outflow only, relying on drainage from the system for water supply.
- When designing the system for active subirrigation, where water is added to the upper portion of the system, use the pressure-flow performance of the valve to determine if the system will retain adequate water in the upper portion of the field for uniform distribution.