Chapter ten

Design of tide gate for stream simulation

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Flap Gates , Tide Gates and or Storm Gates

Objectives and Purpose

The objective of this chapter is to provide an overview of the various types of tide gate found on public and private lands n Southwestern Oregon with observations on their use. A list of suppliers is included. Using that list a reader can request site specific information and current catalogs.

The purpose of a Tide Gate

A tide gate (also called a flap or storm gate) is a device for controlling the flow of tidal waters. They permit water to flow out of a developed area but prevent the back flow of water into those areas. Depending on their design the gates can prevent all or only a portion of the flow from back watering.

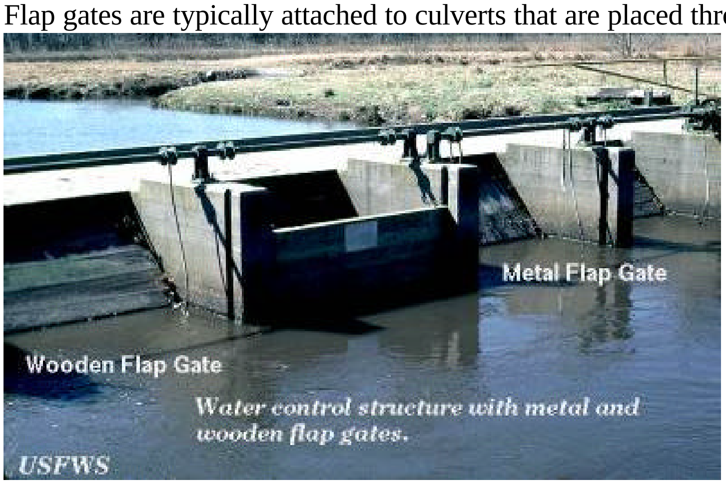
A Tide gate is a flow control device that, in principle, functions as a check valve, allowing water to flow through it in only one direction. The flap gate usually consists of a flat plate that is hinged at the top of a culvert outfall. The plate falls into a near vertical position over the face of the culvert opening to close it. A positive head differential against the downstream face (water elevation higher on the downstream side) will force the flap against the face of the culvert to seal it. A positive head against the upstream face (water elevation higher on the upstream side) of the gate will force it to open to release water.

For levees, tide gates or storm gates permit water to drain through the levee away from the protected development, while maintaining the integrity of the levee during high water events.

They are used extensively by farmers and ranchers along the coast to prevent salt water intrusion to their lands and flooding of fields.

Flap gates are typically constructed of cast iron, Plastic, fiberglass, and aluminum gates are also available. Larger gates are constructed of wood and are often hinged at the sides rater than the top.

Flap gates are typically attached to culverts that are placed through tidal dikes or river flood dikes.



Hydraulic Concerns

1. Gates are open when the water on the inlet side of the gate is higher then on the outlet side. The size of the gates must be sized to allow sufficient water to flow through the gates when their open to prevent flooding the inlet side when closed.
2. A pond, lake or channel is often constructed on the inlet side as a retention basin for high flows. The tide gate and basin must be sized together for a worst case condition.
3. Urban drainages are often designed for a 10 year peak flow event. Tide gate drainages have the potential to flood significantly areas if undersized. Ideally the flood basins analysis will include backwater affects for 10, 25, 50 and 100 year events.
4. In rural areas flooding of pastures during winter high tide events is anticipated. This same flooding during summer months would cause loses to both crops and livestock.
5. The inlet channels act not only as a conduit for flow but for retention. Changes in these channels that restrict the outflow of water during low tides will increase the risk of flooding when the gates are closed.

Connectivity and Fish Passage Concerns

Flap gates are obviously a barrier to all fish migration when they are closed. Unless designed otherwise a typical tide gate is closed during the majority of the incoming tide cycle. Fish that would move into an estuary during the incoming tide will not find an available opening.

An understanding of fish behavior at the tidegate culvert outlet is important. While adults will be attracted to a out going flow during migration period the opposite may be the case for juveniles or adult fish looking for habitat or protection in the estuaries. Ideally the fish and wildlife agencies can provide that site specific guidance. If we know when fish are moving relative to the tide cycle, we can design a tide gate entrance which is open at those stages.

In addition to creating migration barriers, a tide gate has other significant impacts. The following types of barriers are created by

Tide Gates are a barrier to Migration- physical barrier conditions.

1. - Tide gate closed condition- A tide gate acts a physical barrier to fish movement when the incoming tide elevation is higher then the outgoing flow.

2. - Tide gate open condition- When flow is allowed through the gates and the culvert is not back watered, The culvert may be a full or partial barrier for depth of flow and velocity of flow.

3. Tide gate open condition- as the tide recedes the depth of flow in the drainage below the tidegate also diminishes. The downstream channel may limit upstream movement and create a barrier.

4. Tidegate open condition- A heavy tidegate will provide only a minimal opening for flow when open. The constricted opening will have higher flow velocities which potential could be a physical barrier to fish passage.

5. Tidegate open conditions- If the tidegate is perched above the lowest level of the outgoing stream the culvert may have a hydraulic drop barrier to fish.

A tide gates may block Salinity

Since tide gate block inflow, in estuaries they block the movement of salt water upstream. a natural estuary with a salinity gradient is then converted to a freshwater pond with an instantaneous change to high salinity at the tidegate outfall.

A tide gate may block temperature mixing

The same action of blocking inflow also prevents temperature mixing in the estuary. IF the stream is any different temperature than the receiving water, the entire change becomes concentrated at the tidegate outlet instead of dispersed through the estuary.

A tidegate controls the fluctuations of water in the estuary or stream behind it

Tide gate also minimize the upstream water level fluctuation, Instead of several feet of fluctuations occurring every tide cycle the water level will fluctuate a fraction of that amount.

A tidegate may cause upstream channel filling

The upstream channel is altered by the change in hydraulic conditions caused by the tidegate impoundment. A natural estuary is characterized by tidal surge channels created by the rush of tidewater in and out. A tidegate eliminates the tidal flow and the channels fill with sediment.

Cumulative Impacts

By these actions , the basic chemistry, tidal characteristics and ecology of the upstream area is drastically altered. These changes likely work cumulatively with the migration barrier impact to further affect fish production. The salinity and temperature impacts are concentrated at the tidegate itself. If fish can not move upstream through the tidegate they can not willfully select their preferred temperature and salinity conditions. When they pass through the tidegate, they are instantly dropped in a radically new water quality environment. with no opportunity to move out of it.

Structural Concerns

Gated culverts have additional forces on them that are significantly higher then on culverts without gates. Those forces include the following:

1. Buoyancy affects tending to lift pipe .
2. Wave action on the gate from both sides of the culvert.
3. Air hammer affects with culvert
4. Biological presence of mussels that accumulate on opening preventing complete closure of gate
5. Electrolysis: gates are often at transition between saltwater and freshwater. Culvert materials will need treatment for placement in saltwater. Particular care must be taken if dissimilar metals are used in tidegate and culvert to deal with electrolysis. In addition culverts will need special handling to prevent damage to their protective surfacing.
6. Impact forces from tides and debris striking the gates.

Biological Concerns

The following commentary was prepared by Jay Charland for the Tillamook National Estuary Project.

"Fish which are resident in or migrating through the lower rives and sloughs of an estuary like Tillamook Bay would typically make use of the upland streams and channels on which tide gates are installed. The upland slack water areas are critical habitat for rearing salmonids, and the streams often lead to high quality spawning areas for adults. Rearing and resident fish would move into these off-channel areas when the tide rises to fill the channels and flood the tidal wetlands. Tide gate because they remain closed, particularly during flood tides or generate strong currents through their openings when draining, create an almost impassable barrier to juvenile salmonids and other fish. Thus the upland slack water areas and streams are lost to the fish, reducing their habitat quality and quantity.

A further complication occurs when the tidally influenced water outside the tide gate is saline. It has been suggested that resident fish time their movement into and out of side channels and sloughs by the salinity in the water. Rising Salinity at a point signal incoming tide and hence higher water, so fish will move into the side channel areas when salinity increases. Similarly, dropping salinity signals a drop in water level, so the fish move back toward the main channel. Tide gates which allow significant leakage have an unusual salinity pattern where salinity near a tidegate rises and falls twice during a single rise and fall of the tide in the main channel. The mid cycle fall in salinity can signal to fish in the slough that it is time to return to the main channel. The tidegate remains closed at that time and the fish are trapped at the upland end of the culvert. These fish are often easy prey for predatory birds.."

Determining the reserve volume of water at the tide gate inlet.

The following process is recommended for calculating the reserve volume of water. .

1. Determine the design flows for the culvert conventionally.

2. Determine the volume of the holding area behind the culvert. During winter months these areas are significantly larger then in the summer. In many areas full flooding of the backwater area is acceptable and dikes are expected to overtop during peak events.

Volume of reserve during summer flows
Volume of reserve during fall flows
Volume of reserve during normal winter flows
Volume of reserve during flood events

3. Using local tide data create a graph of the tide flows for the selected seasons noted above. On that graph set the maximum and minimum elevation of the reserve for that season. The minimum level should be the height of the highest low tide. The maximum will be set by local flooding conditions and land management goals.

4. Calculate the difference in volume between the two levels for each season. This difference is the reserve volume of water that must exit through the tidegate when the gate opens.

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5. Using a design program such as Culvert Master make a rating curve for the culvert. The curve should compare the flow in cubic feet per second that can exit through the culvert at different inlet and outlet flow elevations.

6. Using a trial and error method incrementally calculate the volume of flow that the proposed culvert can pass during a tidal cycle. The total volume of flow should equal the reserve volume plus the calculated peak flows for that particular season. The closer the increments the better the approximation.

Check Culvert for fish passage

Using FishXing determine when the culvert is a barrier to both juvenile and adult fish. The program will provide both a graphical and a tabular assessment for the various flow conditions. Note in your final report when the proposed design will be a barrier. Of particular importance is knowing at what tidal stages fish are expected to be moving through the pipe. We would ideally design the gates to provide acceptable passage during those periods.

Designing for backwater flow into the reserve area.

When back watering behind a culvert into it's reserve area, we need a target level of the maximum back watering height or volume allowed within the drainage. That elevation will normally be set by the landowner. Consider the following:.

1. Maximum level of saline water to prevent fields from being converted to saltwater estuaries.

2. Location of irrigation ponds.

3. Protection of buildings and infrastructure. The county may require a flood certificate verifying that buildings will not be affected.

4. Obtain permission from all land owners influenced by a change in backwater heights. Public agencies should prepare an Environmental Assessment. \

Most likely the land owners will only be concerned about backwater during the low flow periods of the year this is a local issue and needs a very clear understanding between all parties.

The following procedure is proposed for calculating the allowable backwater flow after a tidegate is normally closed. .

1. In our earlier calculations we estimated the volume of water that must exit from the culvert for each season based on maximum levels of the reserve area and tide cycle.

2. Using rainfall data determine the amount of runoff anticipated from storm events into the reserve area . This figure is the required reserve volume needed . The difference between the required reserve and the available reserve is the volume of water that can be backwatered into the area .

3. Adjust the floats on the tidegate to not exceed the flow limitations calculated above. This calculation can be developed from data from the manufacturer, calculated using orifice equations, or field developed rating curves.

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4. Seasonally, adjust the tidegate controls either increasing or decreasing the backwater flows. Review these adjustment with local landowners to build confidence in the procedure. Monitor the actual heights against the anticipated heights. Develop a real time curve for the tidegate which can be used to adjust floats or other backflow devices.

Solutions to Fish Barriers through Tide gate.

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Side Mounted Tide Gates

A method used in Canada and most recently in the United States is to modify the gate mounting hardware so the gate is rotated about 90 degrees and is hinged on the side. The hardware has to be modified to structurally support the gate, to keep it from opening too far, and to provide a thrust bearing for the weight of the gate. The gate should be mounted at an angle less than 90 degrees. If the gate is rotated a full 90 degrees, the weight of the gate will not help close it.

Light Weight Tide Gates

A second method is to use a lightweight gate such as plastic or aluminum. These lighter weight materials are formed into a thin dome - shaped gate. These considerably lighter gates open much wider with less water surface elevation difference.

The advantage of the lighter gates is they open wider then do the cast iron gates under the same flows. The wider flows reduce the velocity of and increase the depth of flows .

When a number of flap gates are placed on parallel culverts, often no more then one should be equipped with a light weight gate. If all gates in a group are light weight they will compete for flows and may still not open sufficiently for fish passage. A second option is to set the lighter tidegate lower then the heavier gates.

Gate Operators or Latches

A third solution to tidegate passage is the use of gate operators or latches. Operators prevent the tidegate from closing until the water rises to a critical elevation. Many of these designs use floats though one author noted that an electronic version was available that operated in response to the water surface.

Reversed Fish Ladder

A forth solution is to construct a reverse fishway using the methodology presented in chapter five. The fishway opening would be set to allow allow passage during periods of high tides. The opening could be controlled by an orifice or flash boards for flow control adjustments. Fish passage is provided during the high portion of the incoming tide and the beginning of the outgoing tide.

Secondary Door Opening

A secondary or “pet door” can be constructed into a conventional tidegate lid . The smaller door open wide when water is flowing out providing a relatively large opening for fish and aquatic wildlife to swim through. Because the small lid has negative buoyancy it will close when the tide reverses and water tries to flow back through the culvert. that will open wide

An adaptation of this idea is to have these secondary doors float controlled.. The floats hold the door open for a portion of the incoming tide. These float mounted openings have been developed in top and bottom hinged models. Several variations on that concept are commercially available.

Tidegate Alternatives

The following design guidance table was developed by Jay Charland of the Tillamock Bay National Estuary Project. The table is presented for a reference and can be used to help understand the various options available.

	Tidal Flushing	Fish Passage	Improve Drainage	Durability	Installation Ease
Pet Door top	None	High	yes	Good-Fair	Good
Pet door Bottom	Moderate	Moderate	No change	Fair	Fair
Side Hinge Large	None	High	yes	Good	Poor
Side Hinge Small	None	High	yes	Good	Fair
Radial (gator)	None	Low-Moderate	yes	Poor	Good
Nekton Design	Very High	Very High	Yes	Fair	Fair
Aluminum	None	Low	yes	Fair	Fair
Sluice/Flap Gate	Very High	Very High	yes	Fair	Fair
Conventional Cast Iron	none	Low-None	N/A	Good	Fair
Conventional Wood	None	Low-None	N/A	Good	Fair

Sequence of Events In Locating Tidegate Modification Sites

1. Tide Gate is large Enough
2. Land Owner is willing
3. Tide Gate upland drainage is or could be good fish habitat
4. Select an appropriate alternate tide gate design base on land characteristics, use fish behavior and hydrology.

Criteria for Selection of Tidegate

The following criteria are proposed for selection of an appropriate gate.

1. Cost effective: The value of the stream for fish and wildlife enhancement compared to others sites that need improvements.
2. Local Fabrication: Most agencies attempt to order materials that can be fabricated and consequently maintained locally.
3. Compliments the Land objectives: The tidegate must satisfy the passage criterion and local land owners goals.   A program of monitoring for compliance and maintenance needs to be incorporated into the project.
4. Allows for fish passage when fish are moving.   Local Fish and Wildlife agency input is desired to quantify the biological needs of the drainage.   See commentary earlier on fish movements during tide cycles.
5. If a tidegate is selected with an opening that allows fish to move into the system during the incoming tides, determine the opening size based on the maximum volume of backwater allowed into the reserve area..

Selection of Construction Materials for pipes and tide gate.

The choice of materials is a function of salinity.   In developing this chapter, various culvert manufacturers were contacted.. The following recommendations were proposed.

Oregon Culvert- Phil Perry

“Aluminum does well in salt war when the PH is very mild 7 to 8. Ocean water and brackish water normally has a pH of about 7.4. Wisconsin has some soils wih pH’s less then 6 and in some cases less than 5. These low Ph’s combined with the low Resistivity due to road salts will cause damage to aluminum.

Bob Patenaude, retired goophysical engineer, WDOT has written a couple of reports on pipe performance in Wisconsin including aluminum pipe. These studies have shown that polymer coated CSP did very well. Based on these studies and aluminum pipe performance with a plastic wrap around th band that I have personally seen in Wisconsin, I would recommend all aluminum structural plat structures and 42" diameter and larger CAP be draped and wrapped in a 10-20 mil plastic on the outside.

Contech Construction Products Inc

The following quote is taken from a brochure “ Corlix Helical Corrugated Aluminum Pipe”

“ Service -life expectancy studies on installed aluminum drainage products have been conducted since the early 1960's by state and federal agencies and many are on going. Most agencies are now predicting a minimum of 50 years service-life for 0.060 (16 gage) aluminum drainage products in soil/water environments with a pH of 4.0 to 9.0 and a resistivity of 500 Ohm-cm or greater. In addition, good performance may be expected in seawater environments of 35 ohm-cm when the pipe is backfilled with a clean granular material

As a matter of good design, there should be no dissimilar metals in contact with or bonded to the pipe. Experience has shown that galvanized steel fasteners are compatible with aluminum. Other metal to metal systems must be insulated with non-conducting coatings or materials. “

National Corrugated Steel Pipe Association

The NCSPA provided a chart that compares the various pipe materials for their ability to withstand abrasion and Environmental factors such as PH.,Resistivity and Abrasion. This chart provides an extensive comparison of the various metal and polymer coated pipes.
The very best treatment and best projected life were with polymer precoat . Aluminized Type II coatings also compared very well.

Procedure for selection culvert types.

1. Estimate Resistivity and Ph of soil and water in the area of the proposed tidegate structure.

2. Using NCSPA chart select a treatment method, Polymer or Aluminized steel type II. Using guide from Contech determine applicability of aluminum culvert

3. Based on costs and availability for the proposed size select a culvert material.

Tide Gates manufactured by Coquille Sheet Metal

Coquille Sheet Metal has manufactured at least two tide gate recently for the Coquille Watershed Association. The first was mounted on a 48 inch culvert and the second on an 84 inch culvert. Both tide gate were manufactured with aluminum plates to sketches provided by the Watershed Association. The gates have the following features.

1. Gates were mounted on plates welded to the ends of the culverts. No support wall was needed.

2. Approximate cost of a tide gate for 48 inch culvert delivered to site was $3800 each. The cost of the tide gate for the 74 inch culvert was estimated at $6450 each. The estimated cost for a tidegate fo r a 5 foot diameter culvert is $5000 each.

3. Tide gate included a “pet door” which float operated allowed fish passage out of the culvert during the incoming tide. At a certain elevation the door would close and remain closed until the flow exiting the culvert was higher then the inlet flow. See calculations of two potential size openings for comparison.

4. The tide gates as constructed appear to be slightly under designed. In my opinion the gates and hinges will need to be redesigned and reinforced to better handle the flows and forces associated with their locations.

5. The tide Gate met the design objectives except for the ability to fully open. The gates were constructed of aluminum which will create a much larger opening then the previous wood or metal version. Of course a side mounted design would have been optimal. Coquille Sheet metal said they would construct the side mounted version if plans were available. .

6. The tide Gate was easily installed and can be readily adjusted. I would propose that the floats be set seasonally and the size of the doors openings adjusted until the optimum flows are achieved. Ideally we could select an opening for the doors that could remain open for all but the highest of tides at which time the floats would shut the door.

Tide Gate Manufactured By Waterman

Waterman makes a tide Gate model SRT that meets the majority of the issues. It has a light weight aluminum door and a float mounted gate that can be preset to remain open for any specified tide depth. Waterman advertizes that the tide Gate use for tidal wetlands preservation and restoration.

The SRT tidegate requires a support wall. It can be connected to several culverts in series or a single pipe. The photo and writeup below explain the gates capabilities and uses. The cost of the assemble is relatively high. This is a good option and should be considered where valuable estuaries are being enhanced.

Waterman also manufactures a tidegate Model C10 or F10 that mounds directly in front of the culvert and tightly closes except when flow is exiting the culvert. The size of opening for movement of fish will be a function of the flow through the culvert.

Tide Gate Manufactured by Armtec.

Armtec, a Canadian firm , manufactures a side mounted, spring adjusted tidegate. The gates is either fully open or fully closed. The gate does require a support wall. This gate was recently installed locally at Larson Slough bridge site in Coos Bay. Like other square tide gate a slotted weir or secondary door can be added to the gate door to provide partial flow into the channel during the incoming tide. This modification will make this gate a very versatile choice for most sites.

The full opening features has many advantages:

1. Flow is not restricted .
2. Large opening for fish movement
3. Low velocity flow with the larger opening
4. The culvert is fully lighted potentially improving passage conditions.
5. Woody debris can float through the opening without being hung up on the door.
6. The company representative is Brian Christiansen @403-320-2888
7. Cost for side mounted tidegate:
   a. 48" diam CMP (1219mm) = $1800.00
   b. 60" diam cMP (1524mm)= $3450.00- 10 weeks delivery time
8. Need to confirm Maximum Head over pipe. If the head is over 10 feet then the model changes from a lightweight 10 C to a heavier weight 20 C.

Tidegate Manufactured by Nehalem Marine

Nehalem Marine has been manufacturing and installing the NTG series tide gate for several years. They are manufactured to maritime standards out of marine grade aluminum with UHMW nylon bearings and stainless steel pins. The gate is supplied with or without the mitigator fish passage device

The mitigator allows a controlled in flush to the waterway inside the tidegate during every tide cycle. This greatly increases fish passage, fish usage and water quality. NTG tide gate are available in any size although the 5 foot diameter is the most popular The NTG series with the Mitigator attachment has proven very compatible with farming and is being used extensively in Tillamock County ,Oregon. diked farmlands. The mitigator allows juvenile fish usage and increased water quality in many areas for the first time in many decades.

Leo Kuntz-president of Nehalem Marine gave us a tour of several sites in Tillamock where the mitigator was installed. We discussed the projects with Oregon Dept of Fish and Wildlife . In general they were very pleased with the results. Mr. Kuntz has taken the time to make his design work well. The gates are extremely durable and function well for juvenile passage .

The mitigator is a float activated cam that holds the door open about 3 to 4 inches after the gate has closed. When the float on the door reaches a set level the float unlocks the cam and the gate fully closes. The size of the cam determines the opening . The setting on the float determines how long the door is open. Mr. Kuntz appears to have optimized this design for providing juvenile passage at tidegate sites.

Flow Modeling through a pet door opening in a tide gate.

Using the " pet door'' a tide gate can be constructed that allows partial flow back into a drainage in it's normally closed condition . There are two conditions for flow through the tide Gate door. The first condition is when the water on the outlet side is below the top of the door. Flow at that time is considered as flow through a broad crested weir. The general equation for a rectangular , horizontal weir is

$$Q= C_d L H^{\wedge 3/2}$$

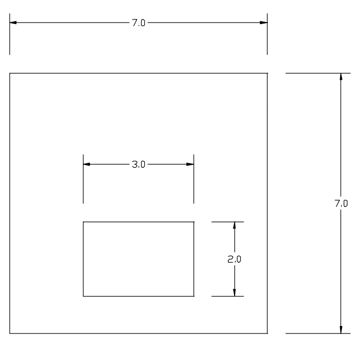
Cd= 3.09
L = Length in feet
H = Difference in head between the two water surfaces

The second condition is when the water level on the outside of the opening is over the top of the door. Under that condition flow is calculated as orifice flow. The discharge of an orifice is generally expressed as

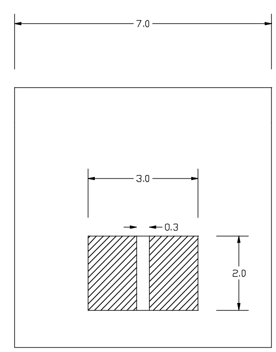
Q= CdA(2gH)^.5
Cd= 0.61
A= area in sq feet of opening
H= Difference in head

Opening Options :

Two conditions were compared the first with a 2' x 3 foot door in the tide Gate. The second was with a 3 inch wide by 2' high opening in the door of the tide Gate. The flows at various height through that door were then calculated.



Condition A
Maximum size opening
3' x 2' door on tidegate



Condition B
Minimum size opening
3 inch x 2' slotted opening
inside of door on tidegate

A rating curve is developed for the opening sizes.

Orifice Coefficent	0.61		0.61	
Width of opening	0.25		3	
Height of opening	2		2	
Difference In Head	varies			
Difference in elevation	cfs	Velocity in ft/sec	cfs	Velocity
0.5	1.7	3.5	20.8	3.5
1.0	2.4	4.9	29.4	4.9
1.5	3.0	6.0	36.0	6.0
2.0	3.5	6.9	41.5	6.9
2.5	3.9	7.7	46.4	7.7
3.0	4.2	8.5	50.9	8.5
3.5	4.6	9.2	54.9	9.2
4.0	4.9	9.8	58.7	9.8
4.5	5.2	10.4	62.3	10.4
5.0	5.5	10.9	65.7	10.9
5.5	5.7	11.5	68.9	11.5
6.0	6.0	12.0	71.9	12.0
6.5	6.2	12.5	74.9	12.5
7.0	6.5	13.0	77.7	13.0
7.5	6.7	13.4	80.4	13.4
8.0	6.9	13.8	83.1	13.8
8.5	7.1	14.3	85.6	14.3
9.0	7.3	14.7	88.1	14.7
9.5	7.5	15.1	90.5	15.1
10.0	7.7	15.5	92.9	15.5
10.5	7.9	15.9	95.2	15.9
11.0	8.1	16.2	97.4	16.2
11.5	8.3	16.6	99.6	16.6
12.0	8.5	17.0	101.7	17.0

Using the rates above, I made a gross comparison of the flows and velocities through the openings. Velocities through the openings are related to the difference in elevation. We know that most adult fish can swim for short burst up to 10 ft per second juveniles however will have a difficult time passing 4 ft per second. The most pertinent question is will the orifices allow to much flow to pass unreasonably raising the water level of the channel.

I next compared the worst case condition of quantity of flow that would occur for each of the flows above for an increment of time.

The affects of back watering an existing channel.

Given: Tide range in spring 6.5 feet

Length of tidal cycle approximately 5 hours

	3" wide opening	2 foot wide opening
Minutes	Cubic ft of water passed	
30	3115.3029	37383.635
30	4406	52868
30	5396	64750
30	6231	74767
30	6966	83592
30	7631	91571
30	8242	98908
30	8811	105737
30	9346	112151
30	9851	118217
30	10332	123987
30	10792	129501
Subtotal	91120	1093434

The larger opening potentially will allow at least ten times the water back into the channel as the smaller opening. Of course the question is what amount of flow would make a difference.

If we make the general assumptions on the channel size we can get a sense of the affects.

Length of Channel= 1000 feet
Width of Channel =20 feet

Estimated backwater from 3" wide opening

The calculation below demonstrate how th height of flow can be calculated for the channel behind the tidegate from the given flows in the table above.

Height of rise in channel's water elevation = 91120/ (1000*20)= 4.55 ft

This worst case scenario assumes that the gate was left open for the full tidal cycle.

Setting the Floats and Orifice Size by Trial and Error

In lieu of calculations, a trial and error procedure will also work.. The openings are controlled by floats. Begin by setting the floats at the maximum allowable backwater depth into the channel then monitor how long the gate was open and the actual depth of back watering that occurred. Adjust the floats upwards recording the values. Plot the values on a chart for a rating curve. Using this result we can predict the height of rise in the channel for various float settings.

An additional adjustment would be to change the size of the opening in the gate can be modified by merely bolting a plate with a smaller opening onto the gate.