

# Analysis of Connections

The following Connection Types are available in **xpdrainage**, each type is processed differently during the Analysis.

## Pipes and Channels

When a pipe or channel is analysed its capacity is taken into account based on the **Manning's formula** using the bottom slope and the full section. Water will flow into the connection via an **Outlet** as specified in the Junctions tab of the Stormwater Control, with any excess water held back. The type of outlet will affect how the connection impacts the flow.

### Free Discharge outlet

When the outlet is set to Free Discharge the flow leaving the Stormwater Control/Junction is based solely on the flow in the Pipe/Channel. This is calculated using the Manning formula, based on the actual head between the Stormwater Control/Junction and the controlling downstream level.

### Flow Control outlet

When the outlet is specified as a flow control (orifice, gate, pump, ...), the flow through the control and the attached connection are calculated separately and the lowest of the two values is used.

In all cases, if the water level in the downstream structure is higher than the water level in the upstream structure, then there is no flow through the connection.

### Hydrograph transformation

A Time of Travel is calculated for the pipe/channel using the **Muskingum-Cunge** approach. Note that only this parameter is calculated according to the Muskingum-Cunge method, the routing through the connection is done as a simple time delay (with no attenuation).

## Attenuated Flow

With the Attenuated Flow type, the routing through the connection is done according to the Muskingum method. This calculation is done using the Time of Travel and Retention Coefficient on the Connections Input spreadsheet. The time of travel through the pipe/channel. i.e. the time it takes water to pass through the pipe/channel, is calculated from the connection length and the flow velocity estimated by the user. The Retention Coefficient is also estimated by the user, the following guidance can be used to set a value. 0.5 is the maximum possible value and gives no dispersal of the hydrograph (translation only). Values between 0.2 and 0.4 are recommended for natural channels. 0.4 would be a reasonable default for swales and 0.2 for bioretention systems. A value of 0.1 is the minimum allowed, giving more spread. Note that the spread is symmetrical. If the water level in the downstream structure is higher than the water level in the upstream structure, then there is no flow through the connection.

## Lagged Flow

With the Lagged Flow type, the routing through the connection is done as a simple translation (with no attenuation). The time of travel through the pipe/channel. i.e. the time it takes water to pass through the pipe/channel, is calculated from the connection length and the flow velocity estimated by the user. The output hydrograph is equal to the input hydrograph with a delay equal to the time of travel. If the water level in the downstream structure is higher than the water level in the upstream structure, then there is no flow through the connection.

## No Delay

In the case of the No Delay connection, the output hydrograph is equal to the input hydrograph without any delay, i.e. the flow is transferred instantly from the upstream end to the downstream end. If the water level in the downstream structure is higher than the water level in the upstream structure, then there is no flow through the connection.



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### Workflow - What's next...?



**Connect Inflows** to your **Stormwater Control**, specify **Inlets** or **Outlets** or connect to another Stormwater Control or **Junction**.