2 Hydraulics

Catchment hydraulics

Calculating run-off

The catchment run-off must be accurately calculated to determine the correct size of the trench drain.

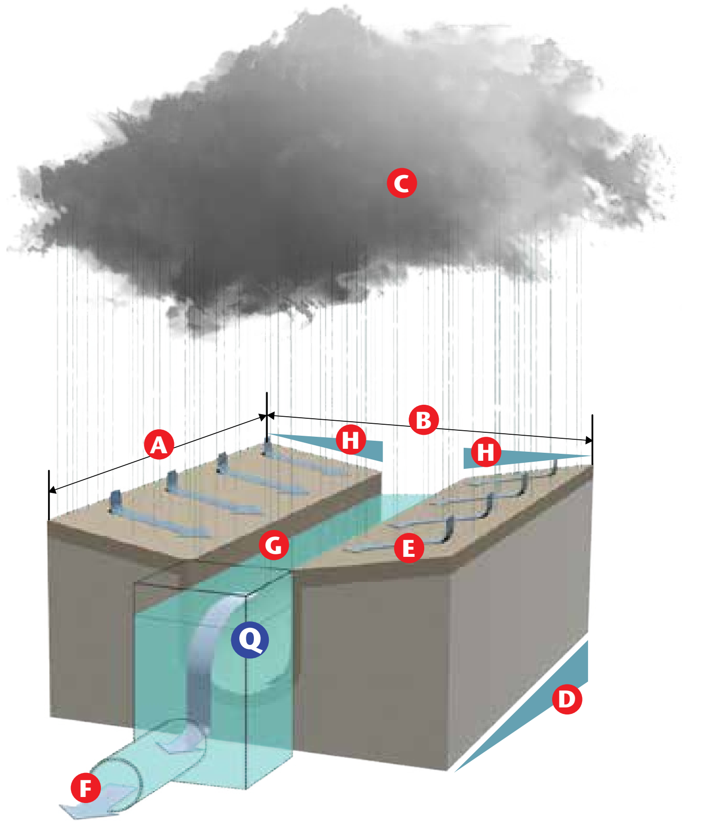
- Pavement length **(A)** x width **(B)** = Catchment area (m²)
- Rainfall intensity **(C)** (mm/hr)

Once catchment run-off **(Q)** is calculated, other inflows can be added.

Factors that affect trench drain hydraulics:

- Ground fall **(D)**
- Pavement material as some materials absorb liquids such as brick pavers **(E)**
- Position and size of outlet pipe **(F)**
- The roughness of the surface of the trench material. For Manning's roughness coefficient, see page 111 **(G)**
- Crossfall to the trench drain can affect grate hydraulics. For example steep slopes may cause bypass in ramp applications **(H)**

$$Q\ (L/s) = \frac{\text{Area }(AxB) \times \text{Rainfall intensity }(C)}{60\ (\text{minutes}) \times 60\ (\text{seconds})}$$



Non-uniform flow

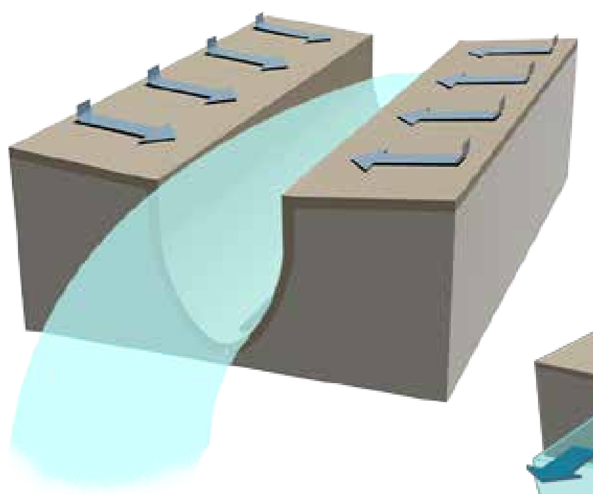
Non-uniform flow accounts for liquid being carried in a trench plus the constant addition of liquid collected through the grates (lateral intake) along the trench run. This resulting buildup of liquid means that a trench's run length will influence its hydraulic capacity.

A characteristic of non-uniform flow is the change of liquid velocity and height at successive cross-sections along the trench. Differential calculus and computer modelling is required to simulate this. **'Hydro'** is a purpose written hydraulic design program modelled on differential calculus for non-uniform flow in open channels.

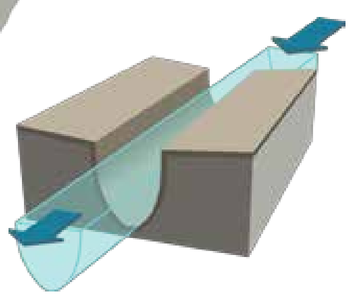
The program has been calibrated by empirical data from a series of experiments, modelling lateral intake into trenches. Analysis on the effect of slope, run length and trench cross section profiles are included in the program. It can also model complex scenarios and optimum outlet positions along trench runs.

For more information, see page 117.

$$\frac{dy}{dx} = \frac{S_0 - S_f - 2\alpha Qq / gA^2}{1 - \alpha Q / gA^2 D}$$



Non-uniform flow



Steady uniform flow

ACO Technical Services – Modelling channel hydraulics

To generate results from the **'Hydro'** program, the following information is required:

- Length of trench run (metres).
- Length and width of catchment area (metres).
- Surrounding pavement material, for example concrete, asphalt or pavers.
- Rainfall intensity (mm/hr).
- Ground fall along the trench run (%).
- Crossfall perpendicular to the trench run (%).
- Preferred position of outlets along trench drain and any outlet size restrictions.
- Any slab depth restrictions.

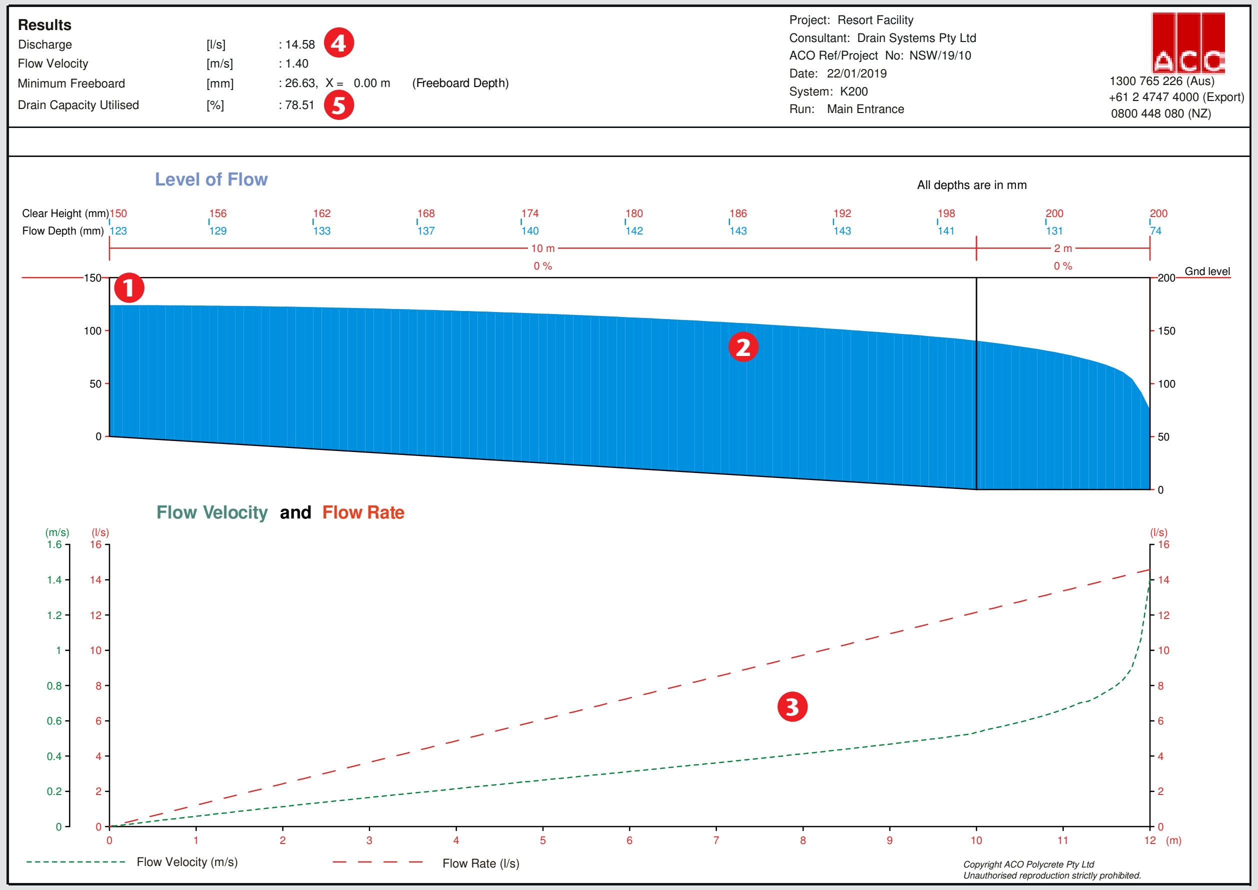
The electronic request form can be found at **www.acodrain.com.au/technical-support.htm**
Results are provided either electronically or as a printout.

Hydraulic results

The **'Hydro'** program calculates the following information:

Key

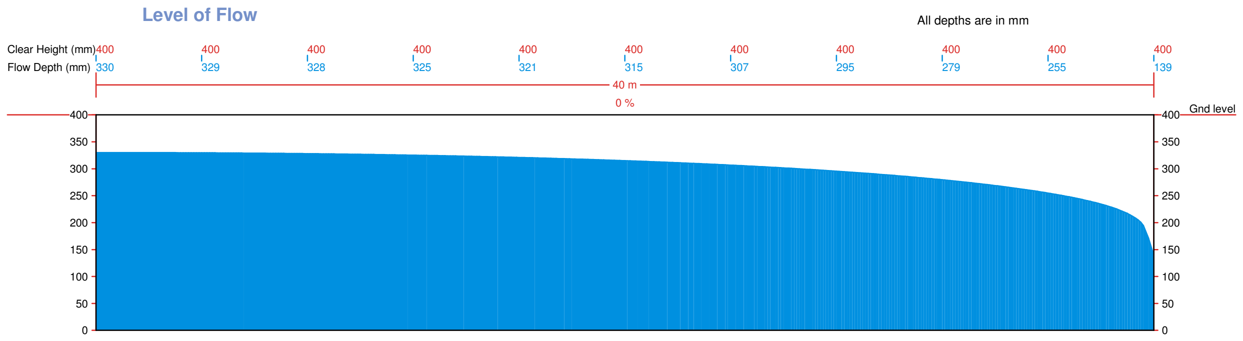
1. Position and size of minimum freeboard (gap between underside of grate and top of liquid in trench).
2. Hydraulic profile of liquid.
3. Flow velocity and flow rate at all points along the trench.
4. Maximum discharge capacity of trench run.
5. The percentage (%) of the hydraulic utilisation of the trench drain. If the hydraulic utilisation is over 100%, ponding occurs. The example below shows a hydraulic utilisation of 78.51%.

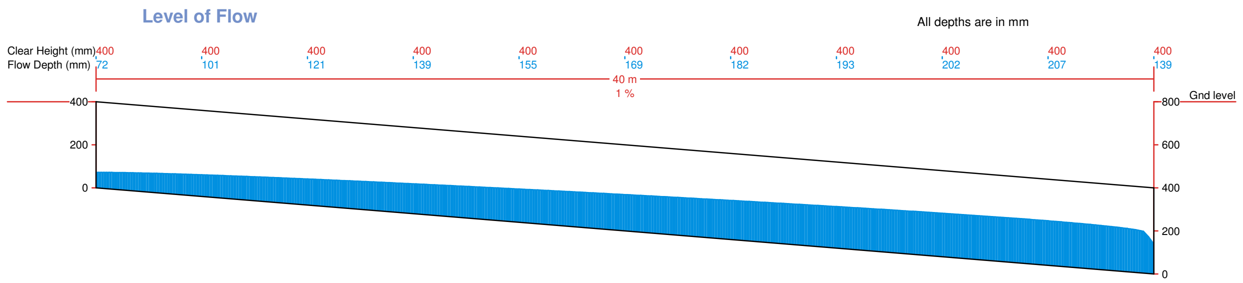


Effect of slope on trench drain hydraulics

Hydraulic capacity

Slope increases the hydraulic capacity of the trench drain because flow velocity is increased. This increase in capacity may result in larger areas being drained, outlets spaced further apart or a narrower and/or shallower trench system being specified that will result in product and installation cost savings.The drawings below highlight the water profile in the trench. The channel and flows are the same in both examples except the lower image has a 1% slope added. Note the difference in flow depth.





Position of outlet

Trench drains connect to underground pipes and the outlet position can dramatically affect the size and length of the trench drain required.

End outlet

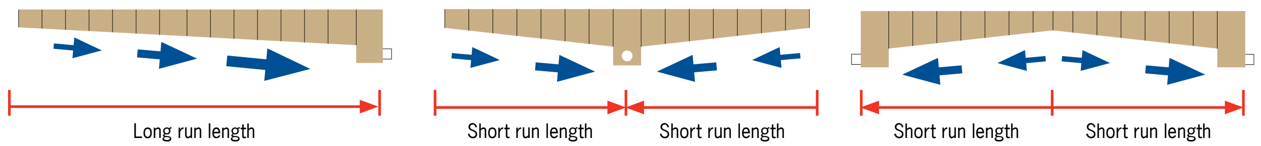
With a single end outlet, water may build up along the trench and cause ponding before reaching the outlet.

Central outlet – two directions

A central outlet enables a smaller trench drain as the central outlet reduces the build up of water, reducing the risk of ponding.

Double end outlet – two directions

An outlet at either end of the trench run enables a smaller trench drain but requires more outlets and additional pipework.



Size and type of outlet

Designers need to ensure the outlet and pipe infrastructure is not undersized restricting the outflow of the trench drain.

Horizontal end outlet

A pipe is connected horizontally at the end of the trench. This minimises excavation but offers the lowest outlet capacity.

Vertical end outlet

A pipe is connected vertically at the bottom of the trench. This option improves the outlet capacity due to gravity.

In-line pit

The pit is the same width as the trench, but deeper. It offers superior outlet capacity as large pipes can be connected and the increased depth gives increased head of water pressure.


Good


Better


Best

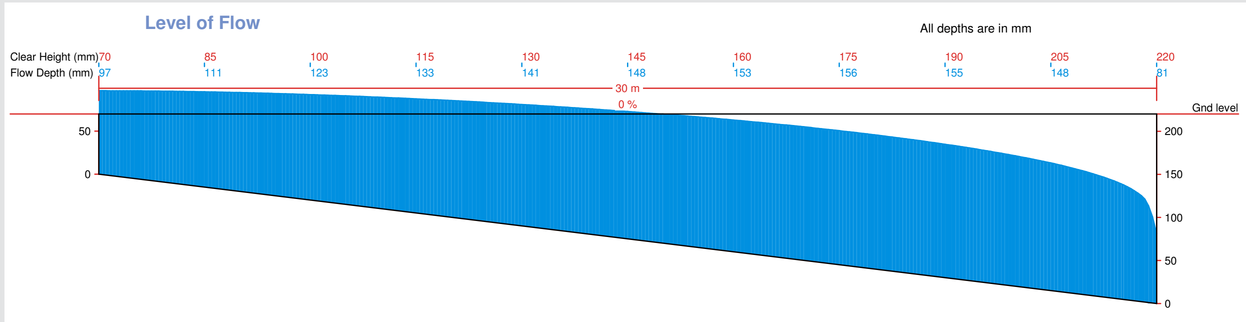
ACO Technical Services – Modelling catchment hydraulics

Temporary ponding refers to a brief flood situation that is acceptable with an undersized trench drain to enable a more cost effective drainage solution. The drain is designed to work effectively under average weather conditions, but will be slightly undersized during heavy storms.

Temporary ponding should only be considered where buildings and property are not in close proximity to the drainage system to minimise risk of damage. It is an ideal option for outer areas such as large car parks and distribution yards. A risk analysis should be carried out when temporary ponding is considered.

In order to produce a ponding analysis map, the following information is required:

- The same information required for the **'Hydro'** program, see page 117.
- Plan of site showing elevations.
- Location of buildings near the drain.



The **'Hydro'** result above indicates that flooding and ponding will occur and the situation requires a re-evaluation of the drainage size (width, depth, run length) or if temporary ponding can be tolerated, a ponding analysis, see below.

Ponding analysis results

The ponding analysis map shows the size and location of the ponding.

Key

1. Run-off scenario.
2. Catchment geometry showing width and depth of temporary ponding.
3. Visual map of worst ponding scenario.
4. Trench drain length an length of temporary ponding.
5. Project notes.