

# Catch Drains Part 1: General Information

## DRAINAGE CONTROL TECHNIQUE

Low Gradient	✓	Velocity Control		Short Term	✓
Steep Gradient		Channel Lining		Medium-Long Term	✓
Outlet Control		Soil Treatment		Permanent	[1]

[1] The design of permanent catch drains requires consideration of issues not discussed within this fact sheet, such as maintenance requirements. This fact sheet should not be used for the design of permanent drains.

Symbol → CD →



Photo 1 – Unlined catch drain



Photo 2 – Large rural catch drain (channel-bank)

### Key Principles

1. Catch drains typically have standardised cross-sectional dimensions. Rather than uniquely sizing each catch drain to a given catchment, standard-sized drains are used based on a maximum allowable catchment area for a given rainfall intensity.
2. The **maximum** recommended spacing of catch drains down a slope (Table 3) is based on the aim of avoiding rill erosion within the up-slope drainage slope. It should be noted that the **actual** spacing of catch drains down a given slope may need to be less than the specified maximum spacing if the soils are highly erosive soils, or if rilling begins to occur between two existing drains.
3. The critical design parameters are the spacing of the drains down a slope, the maximum allowable catchment area, the choice of lining material (e.g. earth, turf, rock or erosion control mats), and the required channel gradient.

### Design Information

Catch drains are drainage structures, as such, their design (i.e. maximum catchment area and horizontal spacing) must be based on local hydrologic and soil conditions.

Catch drains must have sufficient cross-sectional dimensions to fully contain the design flow with a minimum freeboard of 0.15m. This fact sheet provides design information on three standard parabolic-profile catch drains referred to as Type-A, Type-B and Type-C, and three triangular-profile V-drains; Type-AV, Type-BV and Type-CV.

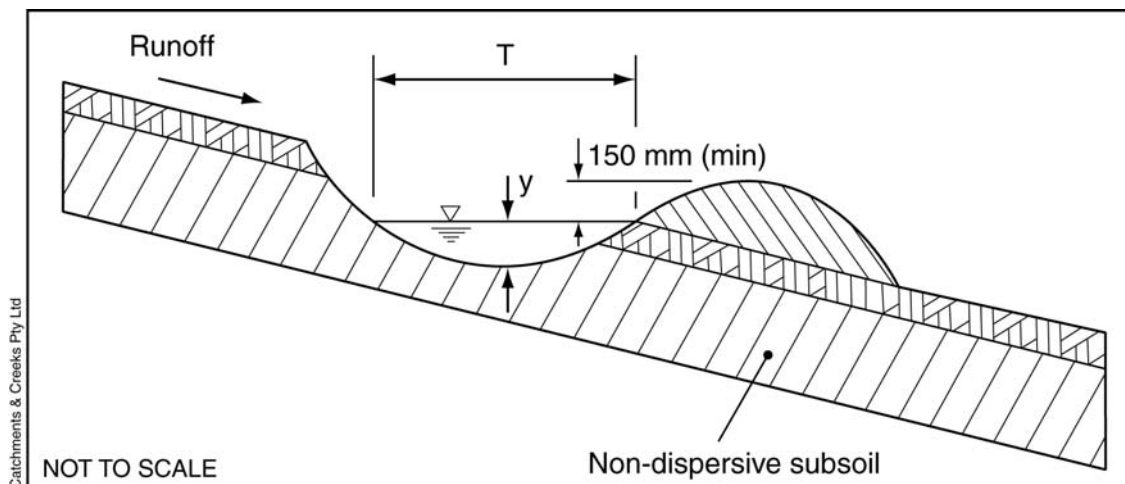
The minimum dimensions of these catch drains are provided in Tables 1 and 2.

The cross-sectional profile can be parabolic (U-shape), trapezoidal, or triangular (V-drain). Cut slopes (channel banks) should be no steeper than 1.5:1(H:V) and fill slopes (typically associated with a down-slope embankment) no steeper than 2:1 (H:V).

**Table 1 – Dimensions of standard parabolic catch drains (Figures 1 & 3)**

Catch drain type	Max top width of flow (T)	Maximum flow depth (y)	Top width of formed drain <sup>[1]</sup>	Depth of formed drain	Hyd. rad. (R) at max flow depth	Area (A) at max flow depth
<b>Type-A</b>	1.0m	0.15m	1.6m	0.30m	0.094m	0.100m <sup>2</sup>
<b>Type-B</b>	1.8m	0.30m	2.4m	0.45m	0.186m	0.360m <sup>2</sup>
<b>Type-C</b>	3.0m	0.50m	3.6m	0.65m	0.310m	1.000m <sup>2</sup>

[1] Top width of the formed drain assumes the upper bank slope is limited to a maximum of 2:1.



**Figure 1 – Parabolic catch drain with bank**

**Table 2 – Dimensions of standard triangular V-drains (Figure 2)**

Catch drain type	Max top width of flow (T)	Maximum flow depth (y)	Top width of formed drain	Depth of formed drain	Hyd. rad. (R) at max flow depth	Area (A) at max flow depth
<b>Type-AV</b>	1.0m	0.15m	2.0m	0.30m	0.072m	0.075m <sup>2</sup>
<b>Type-BV</b>	1.8m	0.30m	2.7m	0.45m	0.142m	0.270m <sup>2</sup>
<b>Type-CV</b>	3.0m	0.50m	3.9m	0.65m	0.237m	0.750m <sup>2</sup>

**Maximum spacing of catch drains:**

Maximum recommended spacing of catch drains down slopes is presented in Table 3. The actual spacing specified for a given site may need to be less than that presented in Table 3 if the soils are highly susceptible to erosion, or if intense storm events are expected (i.e. northern parts of Australia during the wet season).

**Table 3 – Maximum recommended spacing of catch drains down slopes**

Open Earth Slopes						Vegetated Slopes		
Slope	Horiz.	Vert.	Slope	Horiz.	Vert.	Slope	Horiz.	Vert.
1%	80m	0.9m	15%	19m	2.9m	< 10%	No maximum	
2%	60m	1.2m	20%	16m	3.2m	12%	100m	12m
4%	40m	1.6m	25%	14m	3.5m	15%	80m	12m
6%	32m	1.9m	30%	12m	3.5m	20%	55m	11m
8%	28m	2.2m	35%	10m	3.5m	25%	40m	10m
10%	25m	2.5m	40%	9m	3.5m	30%	30m	9m
12%	22m	2.6m	50%	6m	3.0m	> 36%	Case specific	

**Table 4 – Drain profile parameters for catch drains**

Parabolic: $y = C_1.T^2$	$C_1$	V-drain: $y = C_2.T$	$C_2$
Type-A	0.1500	Type-AV	0.1500
Type-B	0.0926	Type-BV	0.1667
Type-C	0.0556	Type-CV	0.1667

**Channel lining:**

If high flow velocities are expected, then the drain must be appropriately stabilised with geotextile fabric, *Erosion Control Mats/Mesh*, grass or rock. Alternatively, *Check Dams* can be placed at appropriate intervals to control the flow velocity; however, the impact of these *Check Dams* on the hydraulic capacity of the drain **must** be considered.



**Photo 3 – Rock lined catch drain**



**Photo 4 – Permanent catch drain**

**Gradient:**

The longitudinal gradient of catch drains primarily depends on the allowable flow velocity and Manning's roughness of the drainage channel. Excess channel gradient can initiate undesirable erosion (Photos 5 & 6).



**Photo 5 – Upper limit of erosion within a catch drain**

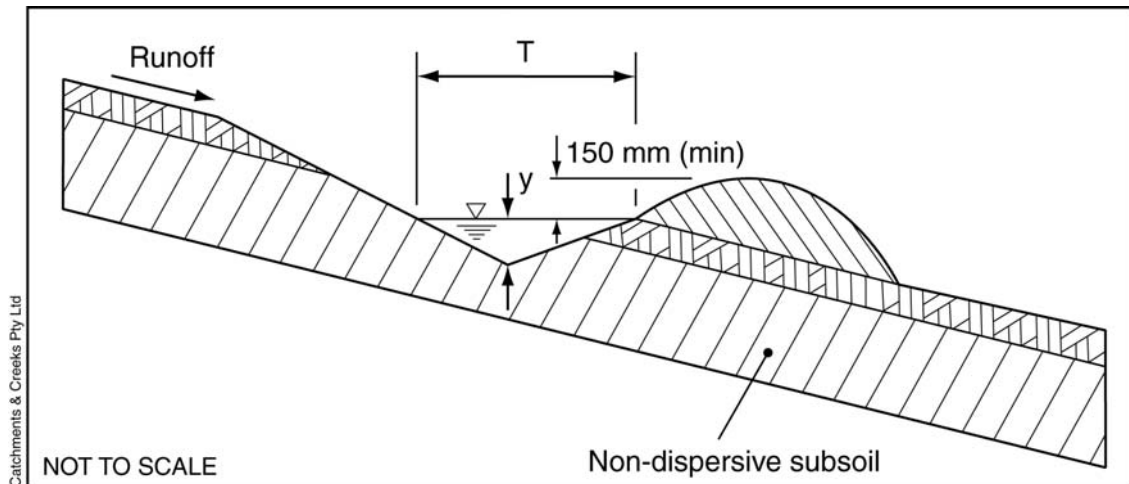


**Photo 6 – Velocity-induced bed scour within a catch drain**

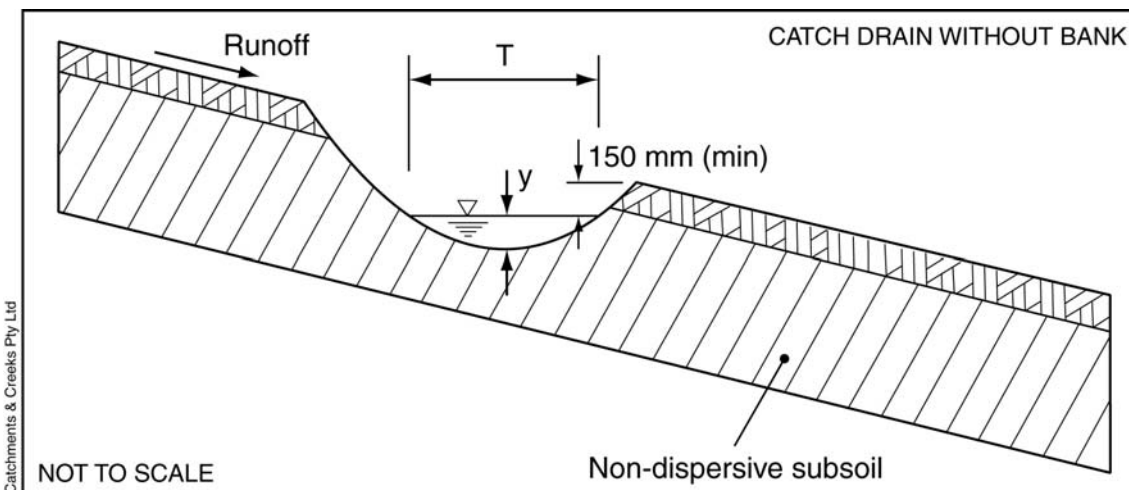
**Outlet Structures:**

Catch drains must discharge to a stabilised outlet, such as a road, permanent drainage channel, *Chute*, *Slope Drain*, or *Level Spreader*. *Level Spreaders* are used when the flow is to be released as 'sheet' flow.

At the immediate outlet of the catch drain it may be necessary to construct an energy dissipater or rock pad to control soil scour (refer to the Fact Sheet on *Outlet Structures*).



**Figure 2 – Triangular V-drain with down-slope bank**



**Figure 3 – Parabolic catch drain without bank**

**Types of drains:**

The following provides a brief description of some of the drains used within rural and construction land management.

- Berm drain: A drain formed by a berm located between the top and bottom of a batter.
- Catch drain: A drain adjacent to a batter or embankment.  
Also, the generic term used for all temporary drains on construction sites.
- Contour drain: A drain formed along the contour (zero fall). Such drains act as infiltration trenches, similar (but not the same) as contour furrowing or deep ripping.
- Cross drain: A drain directing surface runoff across a road or track.
- Diversion drain: A drain used to collect and divert water from an adjacent catchment.
- Mitre drain: A drain used to direct road runoff away from the road alignment.
- Spoon drain: A minor drain of semi-circular cross-section and no associated embankment.
- Table drain: A drain that has one bank consisting of the shoulder of a roadway.
- Windrow drain: A drain formed by an earth windrow located along the edge of a road or trail.
- Rubble drain: A sub-surface drain formed by a gravel-filled trench.

## Description

Catch drains are small open channels formed at regular intervals down a slope, or immediately up-slope or down-slope of a soil disturbance. They are usually excavated with a grader blade, or U-shaped cutting/excavation tools.

Catch drains can be formed with or without an associated down-slope bank. The inclusion of a down-slope bank significantly increases the hydraulic capacity of the drain; however, these banks are susceptible to damage by vehicles resulting in hydraulic failure of the drain.

Channel-banks (push-down) catch drains are formed by pushing the excavated material down-slope of the drain. These drains should only be used in areas that have good, erosion-resistant subsoils.

'Back-Push' banks are formed by pushing the excavated material up-slope to form a *Flow Diversion Bank*. In such cases the diverted water flows up-slope of the embankment instead of within the excavated trench (refer to the fact sheet on *Flow Diversion Banks*).

Back-push banks are used in preference to catch drains in areas that have highly erosive or dispersible subsoils.

Catch drains are usually significantly smaller than formally designed *Diversion Channels*.

The term 'catch drain' is also used in the stormwater industry to refer to permanent drainage channels placed above cut batters to prevent uncontrolled discharge down the batter.

## Purpose

Catch drains can be used to:

- direct stormwater runoff around a soil disturbance, or an unstable slope;
- collect sheet-flow runoff from an unstable slope before it is allowed to concentrate and cause rill erosion;
- collect sediment laden runoff down-slope of a disturbance and direct it to a sediment trap;
- collect and divert up-slope water around stockpiles and excavations.

## Limitations

Catch drains are only suitable for relatively small flow rates. For the management of high flow rates a formally designed *Diversion Channel* may be required.

The maximum catchment area depends on the type of drain (i.e. Type A/AV, B/BV or C/CV), and the local hydrologic conditions.

## Advantages

Quick and inexpensive to establish, or re-establish if disturbed.

Usually do not require complex formal design if based on standard design tables.

If constructed at appropriate gradients, flow velocities are usually small enough to avoid the need for special channel linings.

## Disadvantages

Can cause significant erosion problems and flow concentration if overtopped during heavy storms.

Can restrict the movement of earthmoving equipment around the site, including access to stockpiles. Thus, catch drains may have limited use within active construction areas until earthworks are completed.

## Common Problems

Installed at incorrect gradient. If the gradient is too shallow, it causes a reduction in the hydraulic capacity, if too steep it causes an increase in flow velocity.

Damage to associated flow diversion bank (rutting) caused by vehicles.

Catch drains that do not discharge to a stable outlet, causing downstream erosion, or initiating scour within the drain (Photo 5).

## Special Requirements

The erosion-resistance of the local subsoils should be investigated before planning or designing any excavated drains.

Straw bales or other sediment traps should **not** be placed within these drains due to the risk of causing surcharging of the drain.

Catch drains need to be appropriately stabilised (e.g. compacted and/or lined with a suitable channel lining) within a specified period from the time of construction.

Catch drain should drain to a suitable sediment trap if the diverted water is expected to contain sediment. 'Clean' water should divert around sediment traps.

The drain must have positive gradient along its full length to allow free drainage.

Sufficient space must be provided to allow maintenance access.

## Location

Typically used up-slope of cut batters, intermittently down long, exposed slopes, and up-slope of those stockpiles located within overland flow paths.

Catch drains are generally required up-slope of all cut and fill batters with a height greater than 2 metres and where run-on water is expected.

## Site Inspection

Check that the drain has a stable, positive grade along its length.

Check for a stable drain outlet.

Check if the associated embankment is free of damage (e.g. damage caused by construction traffic).

Check that the drain has adequate hydraulic capacity given the catchment area (general observations based on past experience).

Check if rill erosion is occurring within the catchment area up-slope of the drain. If rilling is occurring, then the lateral spacing of the drains will need to be reduced. However, some degree of rill erosion should be expected if recent storms exceeded the intensity of the nominated design storm.

Inspect for evidence of water spilling out (overtopping) of the drain, or erosion down-slope of the drain.

Inspect for erosion along the bed (invert) of the drain. Investigate the reasons for any erosion before recommending solutions. Bed erosion can result from either excessive channel velocities, or an unstable outlet, which causes bed erosion (head-cut) to migrate up the channel.

Possible solutions to channel erosion include:

- reduce effective catchment area;
- increase channel width;
- increase channel roughness;
- stabilise bed with mats or mesh;
- stabilise bed with turf or rock;
- stabilise the outlet.

Check the channel lining (if any) for damage or displacement. If *Erosion Control Mats* have been used, check that they are correctly overlapped in direction of flow.

If the drain is lined with rock, check that the rock is not reducing the drain's required hydraulic capacity.