



**NDS PRO**<sup>TM</sup>  
THE CHOICE OF PROFESSIONALS

# Principles of Exterior Drainage



**Quick Review**

# A. Background Information

## Company Information

NDS leads the exterior drainage industry with superior quality, design and service. NDS offers a full range of products, including catch basins, grates, channel drains, sewer fittings, flexible couplings, and other related products.

## Sources of Water

Surface water comes from rainfall or irrigation event that does not infiltrate the soil.

## The Basic Problems

Subsurface water and surface water run-off may constitute excess water that is detrimental to turf and other plant life. This excess water retards plant growth. Surface run-off causes erosion and is retained in surface depressions. Excessive surface and subsurface water will create structural damage to foundations, concrete slabs, and other building structures.

## Indicators of Drainage Problems

### PROBLEM



Excess water around the home cracks and damages the foundation and basement walls.

### SOLUTION



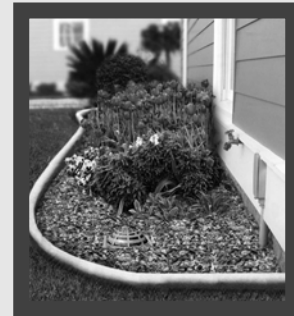
Catch basins and grates remove water from downspouts to protect your home's foundation and basement walls.

### PROBLEM



Excess water can drown evergreens, flowers, and other sensitive plants, destroying your landscape investment.

### SOLUTION



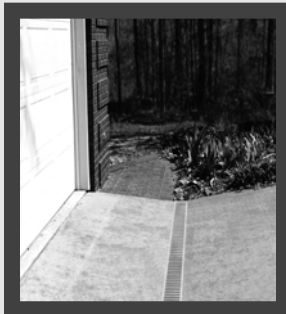
Catch basins and atrium grates remove excess water to protect plant root systems from overwater and rot.

### PROBLEM



- Water from the driveway enters into your garage.
- Water creates a slippery walkway area.

### SOLUTION



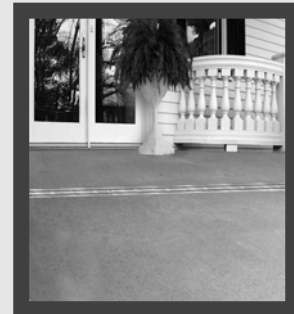
- Channel drains and grates
- Remove sheets of water moving across driveways and sidewalks.
- Prevent water from entering the garage or foundation areas.

### PROBLEM



- Channel drains and grates
- Remove sheets of water on driveways and sidewalks.
- Prevent water from entering the garage or foundation.

### SOLUTION



- Channel drains and grates
- Remove sheets of water on patios and backyards.
- Prevent water from entering your home.

**Soil Function**

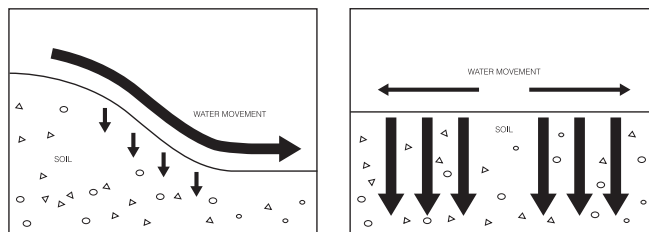
Soil acts as a pervious medium that provides passageways for water to move into the subsurface. The passage of water depends greatly upon the size of the voids in the soil structure. Granular soils with higher void sizes like sand, allow better water movement than compact soils with smaller void sizes like clay.

Compaction, from pedestrian and vehicular traffic, can reduce the void size in any soil. The best way to determine drainage needs in the soil is to probe with a soil auger 3' to 6' deep. Soil should be evaluated to at least 6" below the foundation depth for any building.

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**Topography**

Slopes have an influence on surface run-off and subsurface ground water. The greater the slope, the more surface run-off and less soil absorption. Conversely, the lesser the slope, the more soil absorption and less surface run-off are experienced.



**Influence of slope**

More surface water runoff, less soil penetration (center)

Less surface water runoff, more soil penetration (right)

**Grades and Pipe Slope**

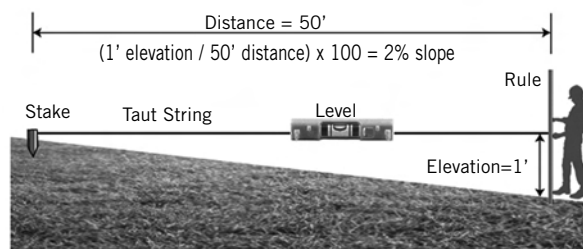
The slope or the grade of the surface can be identified by a line level for distances up to 50 feet where precision is not critical. Slope can be calculated using the following formula:

**(Rise / Run) x 100 = Slope.**

Example: (1' elevation change / 50' distance) x 100= 2% Slope  
**(1 / 50) x 100 = 2%**

**Line Level**

A line level is a small level bubble enclosed in a metal case, which can be hooked over a taut string. With the string tied to a stake or held to the ground at one point and adjusted until it is level, the difference in elevation between the string and the ground can be measured with a rule.



**Measuring**

Elevation difference can be measured with a line level

# B. Design

## Basic Drainage Design

The three basic functions of any storm drainage system are to:

1. **Collect** water
2. **Conduct** or move water through pipes
3. **Discharge** of water.

## Checklist for Drainage Design

- Analyze the topography of the land
  - Examine the slope of the grade
  - Find where water is coming from
  - Find where water is going
  - Identify and mark the low spots
- Look for downspouts
- Look for structures that inhibit water flow
  - Retaining walls, edging, walkways, etc
- Identify a safe discharge point
- Select type and size of drainage products to use
- Begin your design from the discharge point or retention basin

## Best Practices for Drainage Design

- Always begin by checking local code requirements
- Work from discharge point toward the high spots
- Discharged water should not cross any hardscapes
- Discharged water must never be directed onto another property
  - Smooth interior pipe – 1% (1.25" per 10 ft.)
  - Corrugated pipe – 2% (2.5" per 10 ft.)
- Design a safety outlet in case drain is blocked
- Keep it simple!

## Surface Drain Design

### Catch Basin vs. Channel Drains

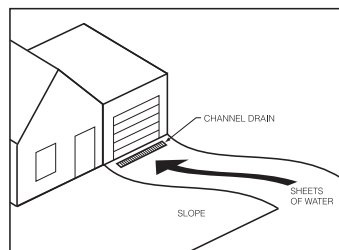
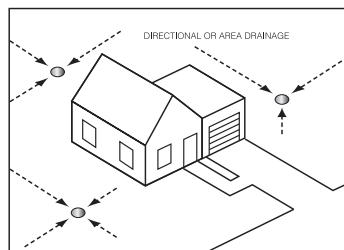
Catch basins and inlets are classified as area drains and are ideal for landscaping applications. Water is directed to the drain by the contours of the landscape. The Basin or inlet is connected to pipe that conducts the water to the discharge point.

Channel drains are ideal for hardscapes or concrete, brick, and paver flatwork applications. They operate on the same principle as a roof gutter. The channel drain acts as a perimeter drain at the edge of the slope. Sheets of water are intercepted by these linear drains and conducted to the discharge point through pipes.

#### Design options:

Directional Drainage (left)

Channel Drainage (right)



# C. Drainage Materials and Installation

## Pipes

### Drain Pipe – materials

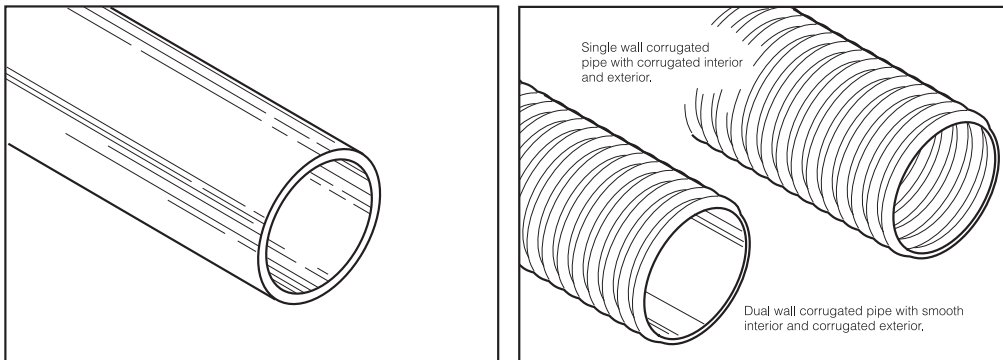
The two most common types of drain pipes for drainage applications are Corrugated and Sewer/Drain (smooth wall) pipe.

**Single wall corrugated pipe** is low in cost, flexible, and easy to install, but lacks a smooth interior wall that would allow the use of a drain snake should it become clogged. The **dual wall corrugated pipe** is more expensive and less flexible but has a smooth interior wall. Since all corrugated pipes are made of High Density Polyethylene, pipe connections have to be snapped together rather than glued together.

**Sewer and Drain pipe** is more rigid than any corrugated pipe making it easier to maintain a continuous slope in critical areas. Its smooth interior gives it ideal flow characteristics and allows the use of a drain snake when it becomes clogged. Sewer and Drain pipes are made from Poly Vinyl Chloride, Acrylonitrile Butadiene Styrene, Styrene, and polyethylene. Hence, pipe connections can be glued using PVC or ABS cement.

**DWV or Schedule 40 pipe** (SCH 40) systems are seldom used to collect water for drainage projects because of their higher cost. A variety of adapters are available to connect DWV or Schedule 40 pipe systems to Sewer and Drain and or Corrugated pipe systems.

**Perforated pipe** (holes or slits in the pipe) is used for subsurface drainage and **solid pipe** is used to conduct water from surface and/or subsurface drainage systems to a discharge point.



### Types of drain pipes

Smooth wall sewer & drain pipe (left)

HDPE corrugated pipe (right)

### Drain Pipe – installation

Gravity is the primary vehicle for conducting the drained water. There must be a continuous 1/8" per foot or 1% minimum slope for smooth interior pipe. 25% more slope may be required for corrugated pipe to compensate for the corrugated interior. Consult an engineer or architect for minimum slope in critical applications.

## Catch Basins

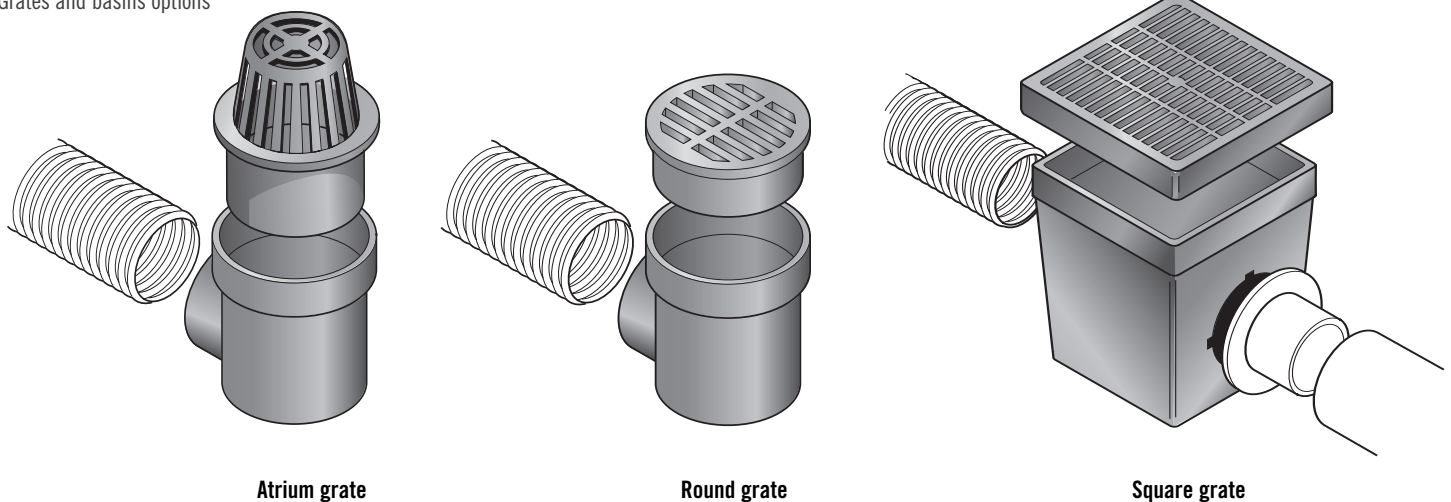
### Catch Basins and Inlets – materials

**Catch basins** are used to collect debris from run-off water that may clog drain lines. The debris is collected in the sump area of a catch basin and should be cleaned out periodically. A catch basin should be used in areas where debris like mulch, leaves, sand, silt, or grass clippings are prevalent. NDS basins are flexible by design and easy to install. Basins range in size from 6” round Spee-D basin and 9”x9” to 24”x24” square basins.

Atrium grates are used in landscape areas, planter beds, window wells, or where debris like mulch and leaves might clog a flat grate. They also have larger open surface areas to handle more run-off. Round grates are used often in landscape while square grates are easier to form around in concrete, pavers and other pavement applications.

#### Surface drain

Grates and basins options



All **NDS grates** fit directly into corrugated pipe, sewer/drain fittings, or NDS catch basins, adapters and risers. All NDS catch basin outlets fit directly into Corrugated or Sewer and Drain pipe and may be adapted to SCH 40 or DWV pipe.

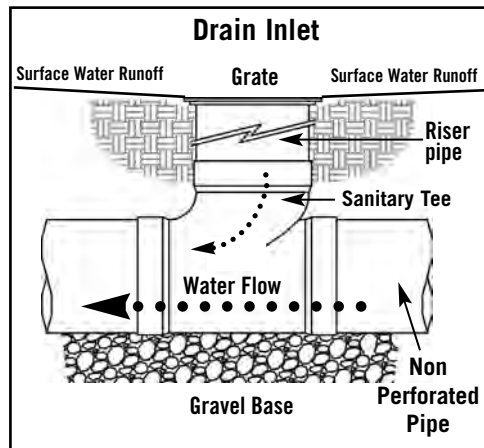
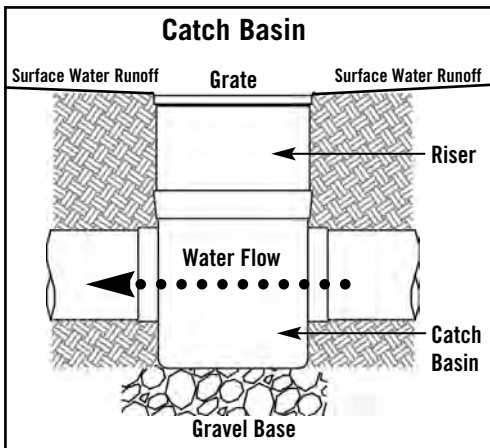
**NDS universal outlets** allow the installer to customize basins with 3”, 4”, 6”, 8”, 10”, or 12” connections in 1, 2, 3 and 4 outlet configurations.

**Riser extensions** allow the installer to vary the depth of the basin outlets to maintain the proper slope of the drain line. Additional sump area may be created by using risers with universal outlets.

**Low profile** adapters simplify installation in difficult soil conditions, or in areas where a sump area is not required.

**Basin and Grate – installation**

1. Choose the grate size according to amount of rainfall, surface area, and type. It may be necessary to install more than one grate or basin to accommodate excessive run-off or a combination of low spots. Use catch basins in applications where it is necessary to collect debris from run-off water in a sump pump. This helps minimize clogging of drainage pipes.
2. Locate low spot or any areas where excess water will accumulate.
3. Dig hole deep enough for overall height of basin and grate. Install basin in hole on top of a firm base. Work from the discharge point back to the grate. Excavate the base of the trench with a minimum 1% slope to ensure drain pipe slopes to the discharge point.
4. Connect pipe to the basin and backfill the trench and area around basin.
5. Finish of landscaping surrounding project area.



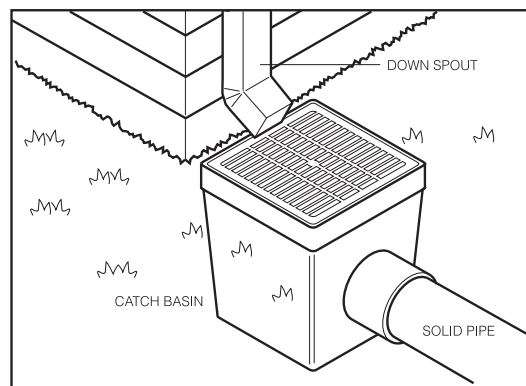
**Surface drains**

Catch basin (left)

Drain inlet (right)

**Down Spouts**

Down spouts remove a tremendous volume of water from roofs. The down spout can be directly connected to the drain pipe utilizing a down spout adapter. However, it is highly recommended that the down spout be placed over a drain basin to prevent debris from entering and clogging the drain pipe.



**Down Spout**

With catch basin

## Channel Drains

Channel drains are linear surface drains, connected together to a length appropriate for the specific installation. Run-off water collected in the drain is discharged to bottom or end outlets.

### Recommended Applications

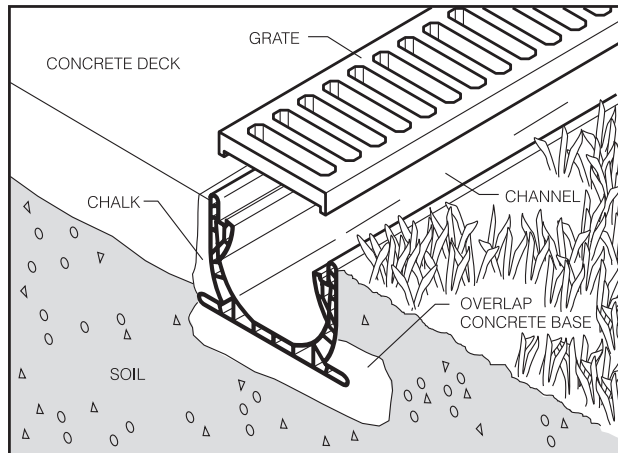
- Driveways
- Patios
- Swimming pools and spas
- Washdown areas
- Sidewalks



NDS offers non-sloped channel systems with many advantages over sloped channel systems.

- The NDS non-sloped system is less expensive and simplifies inventory by eliminating the need to stock various sloping channel sections.
- Multiple outlets provide safety through redundancy, should any individual outlet become clogged.
- The channel may be installed level.
- Proper flow is assured by use of sloped drain pipe.





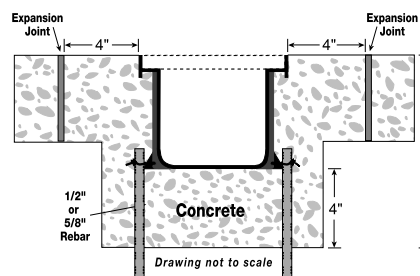
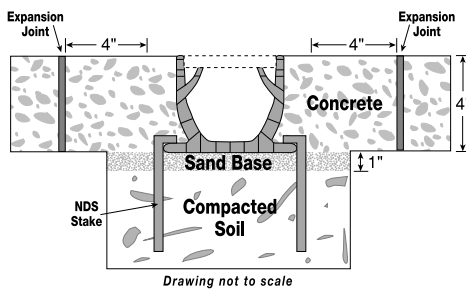
**Channel drain install**

Use an overlapping concrete base for installation next to a concrete deck. This installation will pin the channel against the deck

**Installation**

**A. Standard Installation**

- 1 Excavate a wide and deep trench to accommodate the channel and bedding concrete.
- 2 Erect a string line at each end of the drain run, as a guide for laying the channels to the required level.
- 3 Begin channel installation at the evacuation or discharge end of the run where the outlet or outlets are located.
- 4 Install channel end-to-end PVC cementing sections together.
- 5 Design bottom or end outlets into the channel run in the appropriate location and glue to the drain pipe or fittings.
- 6 PVC cement end caps where appropriate.
- 7 Using either NDS stakes, 1/2" or 5/8" rebar, or wood stakes, anchor channel to the trench bed every 24" on each side of channel.
- 8 Backfill with either concrete, sand, or soil, depending on the application.
- 9 Pour slab to grade and finish concrete.



**Channel drains**

Non-vehicular traffic installation (left)

Vehicular traffic standard installation (right)

### B. Suspended Installation

- 1 Suspended installation is ideal for retrofit installations with an existing concrete slab or new construction where forms can be used to suspend the channels.
- 2 Prepare the trench excavation.
- 3 Using 2" x 4" boards, span the width of the trench and bolt the channel grates to the boards.
- 4 Pour and compact concrete under and around the channels.
- 5 Finish to the proper grade.

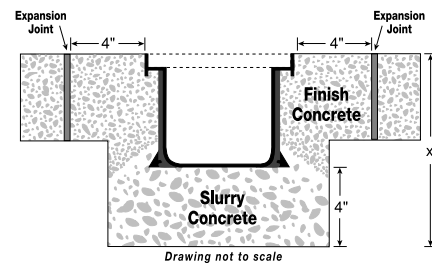
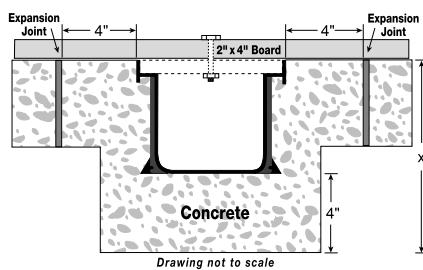
### C. Slurry Installation

- 1 This installation may be used in lieu of the standard installation.
- 2 Prepare the trench excavation and pull a string line to the proper elevation.
- 3 Pour a slurry of concrete in the trench to a depth that will insure at least 4" of concrete underneath the channels.
- 4 Lay the channels in the bedding slurry.
- 5 Check channel alignment and grade again.
- 6 After the slurry sets, concrete can be poured around the channel and finished to the proper grade.

#### Channel drains

Suspended installation (left)

Slurry installation (right)

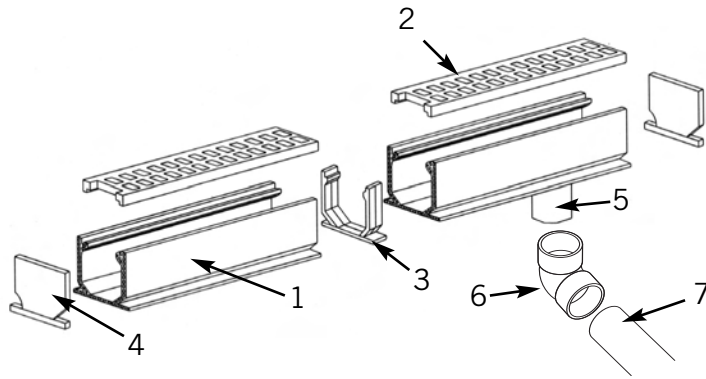


### NOTES

1. Grate must be installed prior to pouring concrete or backfill.
2. Grate should be recessed 1/8" below finish grade in non-traffic applications. Grate should be recessed 1/4" in traffic applications.
3. In asphalt or hot mastic applications, the channel must be encased in concrete for strength and to prevent distortion of the channel.
4. Grates should be taped prior to pouring concrete to prevent debris from entering channel during installation.
5. Refer to load classification chart for proper application.
6. Expansion joints must be provided parallel, but not immediately adjacent to each side of the drain and crack control joints utilized at right angles to the channel for installation in concrete.
7. PVC primer and medium body fast set PVC solvent cement must be used to cement all components.
8. Grate must be installed on channel at all times, except for cleaning.

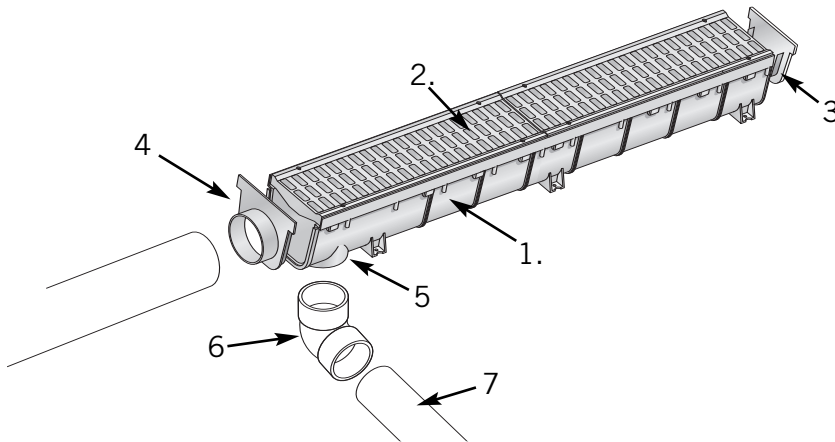
NDS offers grates, basins, and channel drains in plastic, cast iron, steel, and brass which are available in the following load classifications. Refer to the NDS Drainage Product Catalog for individual grate load recommendations.

**NOTE:** Loads are based on encasing product in concrete.



**Profile Channel Drain**

1. Channel
2. Grate
3. Coupling
4. End Cap or End Outlet
5. Bottom Outlet
6. Drain Fitting
7. Drain Pipe



**Modular Channel Drain**

1. Channel
2. Grate
3. End Cap (or End Outlet)
4. End Outlet (or End Cap)
5. Bottom Outlet
6. Drain Fitting
7. Drain Pipe

**Load Class table**



**Class A**

- Loads of 1-60 psi. Recommended for pedestrians, bicycles and wheel chair traffic.



**Class C**

- Loads of 176-325 psi. Recommended for heavy-duty pneumatic tire forklifts and tractor trailers at speeds less than 20 m.p.h., H-20 rated



**Class B**

- Loads of 61-175 psi. Recommended for medium-duty pneumatic tire traffic, autos and light trucks at speeds less than 20 m.p.h.



**Class D**

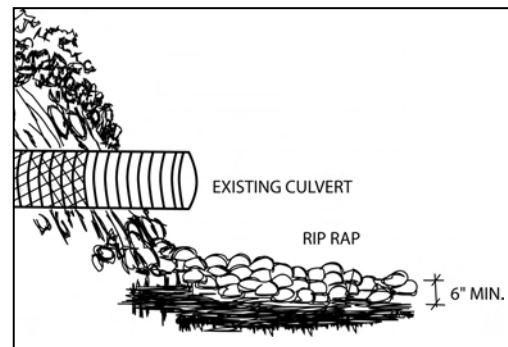
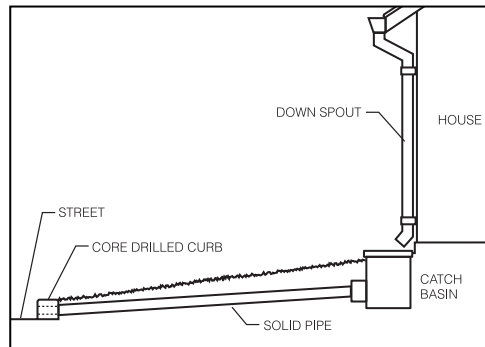
- Loads of 326-575 psi. Recommended for heavy-duty hard tire forklifts at speeds less than 20 m.p.h., H-20 rated.

## Outlets

Once the storm water is collected and conveyed in the drain pipe, it must be discharged to a safe location. Several options are available to discharge water. You can discharge on-site, into a pond for example; or discharge off site, into the street gutter or directly into the storm sewer.

### Core drilled curb discharge

Water can be discharged directly into the street by piping through the curb. Check local codes for approval (left)



### Culvert discharge

Water can be discharged into the existing culvert (right)

## Pop-Up Drainage Emitter

The pop-up emitter is opened by the hydrostatic pressure of water flowing through the drain pipe. As flow diminishes, the emitter closes again. The top of the emitter should be installed at a lower elevation than the invert of the pipe inlet (downspout connection, connection to a basin, etc.) to ensure proper flow. A 10' length of perforated pipe installed between the drain pipe and emitter will allow excess water in the drain pipe to leach into the soil.

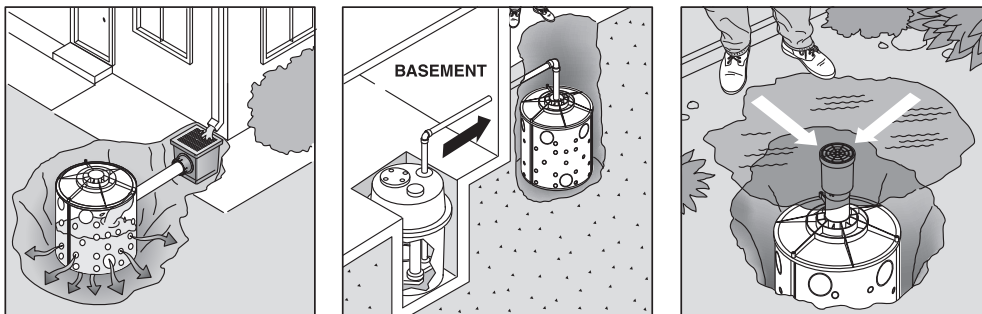
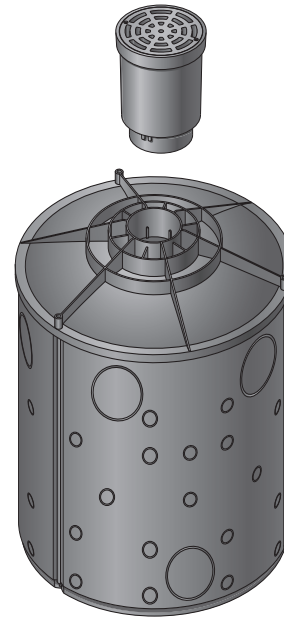
### Pop-up Emitter

Stormwater is discharged near the curb or to another safe area



### Flo-Well® Leaching System

The Flo-Well® allows water to be discharged directly into subsoil. This eliminates the need to install long runs of pipe to conduct the water to a far-off discharge point. The Flo-Well® disperses the water safely back into the subsoil within a safe area.

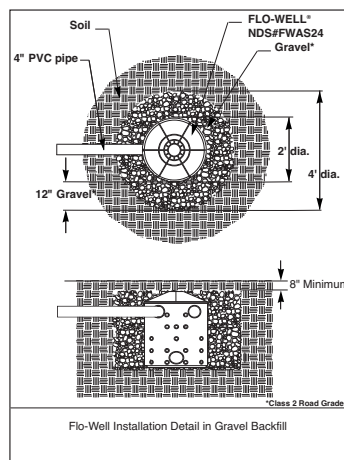
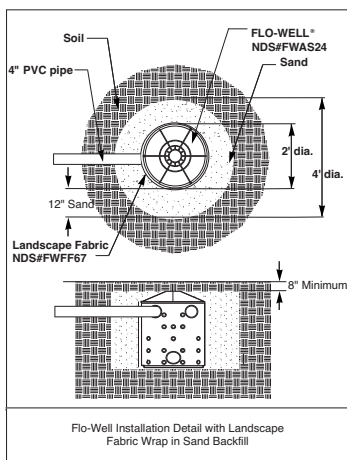


#### Flo-Well®

For gutters and downspouts (far left)

Install with sump pump (center)

Eliminates puddles (right)



#### Flo-Well® Installation

Location and number of ports removed will determine the rate and direction of leaching. Add gravel around outside of Flo-Well® unit to increase leaching capacity





Fax completed quiz to 1-559-562-9488  
Attention Literature Dept.

## Principles of Exterior Drainage — Quick Review Quiz

Please complete the following exam and return to NDS. A certificate of completion and an NDS hat will be sent to you for a 75% or higher score. Good Luck!

Name: \_\_\_\_\_

Company: \_\_\_\_\_ Date: \_\_\_\_\_

Company Address: \_\_\_\_\_

City: \_\_\_\_\_ State: \_\_\_\_\_ Zip: \_\_\_\_\_

Phone: \_\_\_\_\_ Email: \_\_\_\_\_

### Matching

- |                           |  |
|---------------------------|--|
| 1. _____ Catch Basin      | A. These are strainer covers that are installed on the top of a catch basin or drainage pipe   |
| 2. _____ Channel Drains   | B. Trench filled with coarse aggregate, and most commonly a perforated pipe, for intercepting and conveying ground water.  |
| 3. _____ French Drains    | C. This is the attachment that run vertically down the building in which the rain water is routed from the roof-mounted gutters to grade level                   |
| 4. _____ Grates           | D. Structure with a grate on top used to collect and divert surface water to an underground drain pipe system.   |
| 5. _____ Gutter Downspout | E. Ideal grate configuration for preventing clogged inlets due to leaves, mulch or debris in planters.   |
| 6. _____ Atrium grate     | F. Linear perimeter drain with a grate on top used to collect surface along flatwork or hardscapes, such as driveways, patios, parking lots, simming pools, etc. |

### Multiple Choice

7. When do you need a drainage system?

- A. When your in-laws are coming to town
- B. Everybody needs a drainage system
- C. For excess ground water or surface runoff
- D. Never

8. Which type of surface drainage system is ideal for hardscapes such as driveways, patios and swimming pools?

- A. French drains
- B. Channel drains
- C. Catch basins & grates
- D. Pump & hoses



**Catalogs available from NDS:**

- Drainage • Sloped Channel • Drip & Micro Irrigation • Landscape Fittings • Check Valves, Transition, Compression and Repair Couplings • Equipment Pad • Meter Box • Valve Box • Landscape

Oct2007



- **Catch Basins & Grates**
- **Channel Drains**
- **Flo-Well® Stormwater Leaching Systems**
- **Sewer & Drain Fittings**
- **Backwater & Diverter Valves**

- **Flexible Couplings**
- **Flexible Saddles**
- **Agrifim Drip Irrigation**
- **Grass Pavers**
- **Root Barriers**
- **Valve & Meter Boxes**

- **Equipment Pads**
- **Flo Control Transition Fittings**
- **Flo Control Check Valves**
- **Flo Control Ball Valves**
- **Flo Control Repair Couplings**
- **Flo Control Saddles**

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