ACO DRAIN

Commercial trench drainage
Technical handbook & product catalog

Design Services & Support Section

Note: This electronic file is part of a larger 160 page Technical Handbook. Please contact ACO at 1-800-543-4764 for a copy.
Design services & support

ACO has an established Technical Services Department with engineers and support staff offering many years experience advising on surface water management.

These free services are offered with no obligation and are supported with extensive, high quality information, literature and project specific technical documentation.

Technical support falls into four areas:

1. Application .................................................................................................................. 126
   - Installed location factors - loading, site & user requirements

2. Hydraulics ................................................................................................................... 142
   - Amount of liquid to collect and drain

3. Trench layout .............................................................................................................. 148
   - Where to position trench drain & outlets

4. Installation support .................................................................................................... 150
   - Correct installation for long service life
Complimentary services to aid selection, design and installation

1 Application

Trench drains are designed to collect and remove surface water. Failure is usually due to application issues. If the product ‘physically’ fails, replacement is essential. The priority is to address where and how the product will be used to ensure long service life.

1a) Loading

Loads influence pavement design and as the trench system is an integral part of the pavement, the correct installation detail is critical to product longevity.

A summary and comparison of commonly referenced Load Standards is provided on pages 128-129.

1b) Site requirements

There are a variety of materials used in trench drain systems. A summary of each is provided on pages 136-137.

Each material behaves differently in various environments and situations. ACO can provide advice on chemical and corrosion resistance for most common trench drain materials.

1c) User requirements

ACO provides specific product documentation indicating the standards each complies with.

Supporting documentation

SERVICE B/C - ACO can supply:
- Material data
- Material’s coupons (samples) for on site testing
- Material test reports

SERVICE D - ACO can supply:
- Industry standards/requirements and 3rd party test data, where relevant

Service documentation

SERVICE A - ACO can supply:
- Advice on application load class
- Load test certificates
- Installation section details

Material data

SERVICE B/C - ACO can supply:
- Industry standards/requirements and 3rd party test data, where relevant

2 Hydraulics

Hydraulics covers trench drain functionality and failure isn’t always apparent. Use of an undersized or oversized trench drain can have major cost and liability consequences, particularly in applications where flood damage to property or personal risk are of concern.

ACO offers several project specific hydraulic support services to accurately determine the most hydraulically efficient and cost effective trench drain size and layout.

Trench hydraulics - Hydro

SERVICE E - ACO can supply:
- Hydraulic liquid profiles for individual trench runs
- Liquid depth profiles at design conditions

Trench hydraulics - Ponding

SERVICE F - ACO can supply:
- Map of temporary ponding
- Approximate duration of any temporary ponding

Grate hydraulics - GIC

SERVICE G - ACO can supply:
- Grate performance dependent on location with crossfalls

3 Trench layout

Modular trench runs can be complex and ensuring the correct materials can be time consuming, particularly where multiple trench runs are involved. In addition, once materials arrive on site, determining what pieces go where can be a challenge. ACO offers several services to ensure this part of the process runs as smoothly and efficiently as possible.

Trench layout documents

SERVICE H - ACO can supply:
- Plan layouts of trench runs (CAD)
- Section layouts of trench runs showing modular sequence of channel units
- Bill of Materials (BOM) - Fully itemizing parts and pieces

Installation support

Even the right product can fail if incorrectly installed. Therefore, to ensure your trench drain investment performs as expected, getting the installation right is important. ACO has an in house team of engineers qualified to offer advice on most installation issues, such as size of concrete surround, haunch details, installation method options, etc.

Installation guidance

SERVICE A - ACO can supply:
- Installation section details by product type, pavement type and loading type

www.ACODrain.us
Current US load standards

A number of US standards make reference to grate loading. There is no current standard that specifically deals with trench drains of different widths.

Where possible, to enable comparison between the loading specified within each standard, equivalent stresses (psis) are calculated from the specified test load and test block size of each standard.

To assist in applying these standards to ACO products, a guide is provided below equating stresses (psis) to the Load Class A - F categories from EN 1433 : 2002 Drainage channels for vehicular and pedestrian areas. It is also broken down by internal channel widths.

Load class certification for each product is available upon request.

Common standards in North America:

ASME: A112.6.3 - 2001

- Plumbing standard relating to internal floor drains.
- Light Duty (Live Load < 2,000lb)
- Medium Duty (2,000lb < Live Load < 4,999lb)
- Heavy Duty (5,000lb < Live Load < 7,499lb)
- Extra Heavy Duty (7,500lb < Live Load < 10,000lb)
- Special Duty (Live Load > 10,000lb)

AASHTO Standard Specification for Highway Bridges

- Standard relating to design for bridges. Loadings are dealt with by wheel 'footprints' and axle ratings. No specification is given for measurement of the performance of trench drains.
- General specifications relate to vehicle loading up to HS20/HS25. Maximum truck weight 90,000lbs - 3 axles.
- HS20 Load - minimum 494 psi
- HS25 Load - minimum 617 psi

AASHTO: M306 - 10 Drainage Structure Castings

- Standard relating to castings in roadways
- See HS20 / HS25
- Light Duty = 0 - 416 psi
- Medium Duty = 416 - 1,039 psi
- Heavy Duty = 1,039 - 1,559 psi
- Extra-Heavy Duty = 1,559 - 2,079 psi
- Special Duty = over 2,079 psi

Plane standard comparison chart

### 4 in. - 8 in. internal width channels

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<tr>
<th>PSI</th>
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<td>Class A</td>
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### 8 in. - 12 in. internal width channels

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### over 12 in. internal width channels

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* Although the chart indicates that the minimum psi for HS20 falls into the top of Load Class B range, ACO strongly recommends using Load Class C or higher due to the volume and dynamic nature (speed, turning & braking) of traffic in typical HS20 applications.
1.a Application - Loading

**Load Class A** - 3,372 lbs - 15kN (44-70 psi)
Residential and light pedestrian traffic

**Load Class B** - 28,100 lbs - 125kN (369-580 psi)
Sidewalks and small private parking lots

**Load Class C** - 56,200 lbs - 250kN (739-1,160 psi)
Parking lots and general commercial areas

**Load Class D** - 89,920 lbs - 400kN (1,182-1,856 psi)
 Trafficked sections of roads and highways

**Load Class E** - 134,800 lbs - 600kN (1,773-2,785 psi)
Aircraft hangars, industrial areas, gas stations and light commercial forklifts

**Load Class F** - 202,320 lbs - 900kN (2,659-4,177 psi)
Aircraft runways, military establishments, docks, heavy industrial, heavy fork trucks and very heavy wheel loads
Load testing

EN 1433
The only standard written specifically for trench drains, and internationally recognized, is EN 1433: 2002 Drainage channels for vehicular and pedestrian areas.

EN 1433 accounts for different widths of grates. For trench drains less than 200mm wide, test block for load testing is 10” long by 3” wide. For trench drains 200mm to 300mm wide, test block is 10” long by 6” wide; for trench drains over 300mm, the test block is 10” diameter. This ensures that the full force of the test load is directed onto the grate.

EN 1433 also prescribes testing methods for system testing (the complete trench drain and grate). It accounts for both proof loading and catastrophic failure.

EN 1433 also outlines system testing for monolithic trench drains (grate and body manufactured as a single unit). See ACO Infrastructure for monolithic trench drains.

EN 1433 load test - with width specific test block
Diagrams show test load applied to typical grates through an EN 1433 prescribed width specific test block. Test blocks are sized to ensure the entire test load is applied to grate NOT grate supports - this ensures relevant results for all trench drain widths.

ASME: A112.6.3 load test - 3.5 in. dia. test block
This load standard is designed for small internal floor drains and prescribes a smaller (3.5” dia.) test block therefore exerting entire test load into the grate, providing relevant results for all trench drain widths.

AASHTO load test - 9 in. x 9 in. test block
Diagrams show test load applied to grates through a 9” x 9” (225 x 225mm) test block. At 4” and 8” widths, grate is NOT tested - the load is taken by supports rather than grate - results from these tests are questionable. Only at 12” and wider is grate being tested and relevant results will be provided.

1.a Application - Loading

Grate for 4 in. internal width trench drain
Diagram shows test block positioned centrally on grate - full test load is being applied to grate giving a meaningful result.

Grate for 8 in. - 12 in. internal width trench drain
Diagram shows test block positioned centrally on grate - full test load is being applied to grate giving a meaningful result.

Grate for over 12 in. internal width trench drain
Diagram shows test block positioned centrally on grate - full test load is being applied to grate giving a meaningful result.
Factors affecting loading

Contact area

Contact area between load and trench drain grate affects pressure (psf) exerted by load. Typically relates to tire type, but can include anything that may rest permanently or periodically on trench drain.

Wheel loads

Combined with contact area to calculate loading.
- Weight of vehicle/cart and its typical load, eg. forklift & weight of typical loaded pallet
- Number of wheels and axles that load is distributed over, affects individual wheel load
- Unusual traffic, eg. doles/dumpsters going over trench

Load frequency

It is also important to consider how often load is applied. Frequent or continuous loads will require heavier duty trench drain and/or larger concrete encasement detail than occasional loads of same weight.

Dynamic vs static loads

Static loads are a load/weight applied vertically onto the trench - no other movement. Not typically found in real life scenarios, but are used for load testing a grate or trench drain. They provide an objective measuring scale to rate loadings of grate/trench drain.

Dynamic loads - forces rise rapidly as traffic speed increases. Factors that intensify dynamic loading include:
- Vehicles traveling across or along trench
- Traffic braking, accelerating or turning on trench
- Speed of traffic
- Trench located at top or bottom of a ramp

Forces created by dynamic loads tend to twist trench drain and grate out of position. The more movement (turning and/or braking) and/or faster traffic, the greater the dynamic load. Trench body, grate type, installation detail, and locking mechanisms, are all important factors to consider when addressing dynamic loads.
1.b Application - Site requirements

Trench materials

Modular trench drain systems are generally manufactured from polymer concrete, fiberglass or HDPE (High Density Polyethylene).

ACO Drain commercial trench systems are manufactured from either polymer concrete or fiberglass. Other materials do not meet the compressive strength and thermal expansion properties required in commercial and industrial projects. ACO uses plastics primarily as a grate and trench material for residential applications (ACO SofT).

Polymer concrete

Polymer concrete is a composite material produced by mixing mineral aggregates with a resin binding agent. The finished material has excellent mechanical and thermal properties and offers good corrosion resistance to many chemicals. A maximum working temperature of 180°F (82°C) is recommended.

Due to their structural rigidity, polymer concrete trench drains can be used in a variety of pavement types such as concrete, asphalt and brick pavers.

Fiberglass

Fiberglass uses similar resin binding agents to those used for polymer concrete, but glass microfibers and fibers are used instead of mineral aggregates to provide a robust flexible material.

Fiberglass trench drains are designed to be fully encased in concrete.

Cement concrete

Concrete is Portland cement mixed with mineral aggregates. Generally used for large- scale cast-in-place slab applications, where mass is required for structural rigidity.

Expanded polystyrene farmers have disposal concerns, and are often released using gasoline. Local EPA regulations should be complied with.

Plastics

The most common plastic used in a trench drain is polyethylene - usually HDPE (High density PE) or MDPE (Medium density PE). Both HDPE & MDPE are readily available, economical materials that are easy to mold.

Plastic trench drains are designed to be fully encased in concrete, however, HDPE/MDPE have thermal properties that require the addition of concrete keying features to securely anchor the product within the concrete slab. Without adequate concrete keying features the trench may lose bond pull away from the concrete encasement and buckle, ultimately leading to product failure. This is of particular concern in applications where short term wide temperature ranges are expected, and/ or long trench runs are involved.

Metals

Trench drains can also be fabricated from mild or stainless steel. ACO recommends stainless steel trench drains for hygienic applications. See ACO Building Drainage products for details.

Grate materials

Grates are manufactured from a variety of materials. The most common are ductile iron, mild steel, stainless steel and plastic.

Grates need higher bending strength properties than the trench body to withstand flexural loads. Unlike the trench drain body, grates can be replaced and replaced after installation.

In commercial applications, all grates should be locked in place to ensure user safety and channel longevity.

Edge protection

The exposed edge of the trench helps pavement to maintain a visual straight line and helps hold the grate in position. The exposed edge is subjected to the same loads as the grate. In addition to effect of climate and traffic, the edge is exposed to impact from items being dropped or pulled across it (e.g. snow plows). Once the edge fails, the grate will move and cause catastrophic failure.

Metal edges are most commonly used as a wearing rail to withstand rigorous and repetitive traffic. Edge protection rails should be integrally cast-in or mechanically connected to the trench body. Edge rails that sit over existing standard edges are often ill-fitting and susceptible to failure.

Non-metallic option

Polymer concrete is an ideal material for non-metallic requirements. It offers excellent resistance properties - electrical resistivity rating of 1x10^13 ohm-cm.

H100 is a 100% polymer concrete channel that can be used with non-metallic grates (Types 4940/4950 - See ACO Sport range) to provide a 100% non-metallic trench drain system.

ACO’s Technical Services Department for additional suggestions if this is not a suitable solution.

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Mechanical properties

Trench material may be subject to compressive loads in use and needs to withstand the specified load.

Flexural strength

Inflates site handling and when trench body is in areas where encasement and soils are suspect.

Bending strength

Not generally required in trench bodies, but relevant to grates. Used as material measurement.

Thermal properties

Water absorption

The trench is designed to carry and channel long trench runs are involved.

Freeze-Thaw

Inability to withstand freeze thaw cycles causes surface spalling and leads ultimately to trench failure.

Water vapor transmission

WVT is measurement of water vapor flow through a material. Passage of water vapor may be critical.

Coefficient of expansion/contraction

Excessive movement between trench and trench surround creates debonding, causing unwanted stresses and possible failure.

Coefficient of water vapor diffusion

This coefficient quantifies the extent to which water vapor will pass through the material. This coefficient also influences inward diffusion of water vapor.

Water vapor transmission

WVT is measurement of water vapor flow through a material. Passage of water vapor may be critical.

Suitability

Different materials offer different surface and physical performance properties which may affect their suitability of use in various applications. These charts provide a side by side comparison.

Surface properties

Surface burning

Trench systems are often used around gas stations, chemical processing and interior applications and may be subject to fire; they should be noncombustible and not give off fumes or smoke.

Weathering

The majority of trench drains are used in exterior applications. Ability to withstand adverse weather will ensure long service life (erosion, UV degradation etc).
Sustainable drainage

In an environmentally perfect world permeable landscapes would be everywhere, allowing nature to work as intended. However, in reality, this is not possible and hard landscapes are common.

Sustainable drainage is the collection of rainwater and its treatment, and ultimately, its reuse.

The process involves collecting water runoff (that may or may not contain pollutants) and allowing it to be drained into sensitive areas or软 soil. Alternatively, it can be treated, stored for future use, or discharged to receiving waterways, ideally at low cost, and with minimal impact to the environment.

Surface drainage can be used to assist the ‘collect’ part of this process. Trench drains are ideal as they provide maximum collection and can form a barrier to prevent runoff flowing onto sensitive areas or soft landscaping. This is particularly important if the toxicity risk of pollutants is high, such as highway and gas station applications.

EPA requirements

Stormwater runoff is generated from rain and snowmelt events flowing over land or impervious surfaces, and not percolating into the ground. As the runoff flows over the land or impervious surfaces (paved streets, parking lots, and building rooftops), it accumulates debris, chemicals, sediment or other pollutants that could adversely affect water quality if the runoff is discharged untreated.

The primary method to control stormwater discharges is the use of Best Management Practices (BMPs). In addition, most stormwater discharges are considered point sources and require coverage under an NPDES permit.

LEED

Leadership in Energy and Environmental Design provides a green building rating system. Principles have been applied to commercial and institutional projects, schools, multiunit residential buildings, manufacturing plants, laboratories and other building types.

Areas where the use of trench drainage may assist in assignment of credits include:

- SUSTAINABLE SITES
  - Protect or Restore Habitat
  Compared to catch basins, trench drains require minimal excavation; reducing site restoration requirements.

- Rainwater Management
  Trench drains offer maximum capture of runoff, allowing for onsite nonpotable uses such as irrigation. Run-off can also be quality assessed and treated as required.

WATER EFFICIENCY

- Water Use Reduction
  Reclaimed water/Alternative water source - use of trench drains to capture rainwater for future irrigation in a controlled manner - i.e. treated, stored and snowmelt events flowing over land or

MATERIALS & RESOURCES

- Construction & Demolition Waste Management
  To reduce construction and demolition waste disposed of in landfills and incineration facilities by recovering, reusing, and recycling materials.

- Water Efficiency
  Trench drains require minimal excavation; reducing site waste/debris.

Go to www.usgbc.org for full details.

Hydrocarbons

Stormwater run-off frequently carries the risk of containing hydrocarbons. Trench drains in high risk areas, such as gas stations and airports almost always drain into oil-water separators. Refer to ACO Environment for details.

ACO now offers solutions for hydrocarbons to be removed at the outlet - these solutions are ideal for applications where the risk is lower, and/or where space does not allow for the use of an independent oil-water separator. Call ACO for details.

Chemical resistance

ACO Drain channel bodies are highly resistant to chemical attack and, with the appropriate grate, can be used in most environments where everyday acids and dilute alkalis are encountered.

Important considerations for chemical environments

When reviewing potential applications of trench drains in chemical environments, the following issues should be considered:

1. Type(s) & mixture of chemicals.
2. Concentration percentages.
3. Contact time with trench system.
4. Temperatures of chemicals flowing into the trench drain. 180°F (82°C) max.
5. flush system employed to clear chemicals from the system.
6. Cleaning agents should be checked for compatibility with trench materials.
7. ACO test coupons can be used for final determination of chemical resistance.
8. Grate, locking mechanism, edge rail, outlet and trash bucket materials should be checked for chemical resistance.
9. Check sealant for compatibility, if applicable.

Chemical resistance chart

These recommendations are for guidance only. They are based upon information compiled from resin and plastic manufacturers. Customers are advised to test a coupon of polymer concrete to ensure suitability. Test coupons are available free of charge from ACO.

If ACO Drain standard products are unable to provide adequate chemical resistance, contact ACO (800) 543-4764 for a suitable product solution.

ACO (800) 543-4764 for a suitable product solution.

WWW.ACODrain.us

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ASTM - B117 Salt Spray Test
ACO polymer concrete has passed independent tests and is unaffected by road de-icing salts. This test is an accelerated corrosion test that produces a corrosive attack to predict a material’s suitability in use. The ACO test sample showed no sign of degradation after 1,000 hours of salt spray exposure.
1.c Application - User requirements

Once trench drain choice has been narrowed by determining loading and durability requirements, options relative to project specific end user needs, or legislative obligations, need to be considered.

ACO can provide product guidance based on current industry standards and requirements. When third party testing has been carried out copies of test certificates are also available.

1. Legislative compliance

Trench drains are commonly used in public areas where accessibility is a concern and ADA legislation must be met. A number of grates are available that provide ADA compliance without compromising aesthetics or performance.

ADA REQUIREMENTS are set out in The Americans with Disabilities Act of 1990; Section 4.5.4.

Where grates are used within walking surfaces, the open slots should be no greater than 0.5 inches (12.7mm) wide in one direction. Where the length of the slot is greater than 0.5 inches, the opening should run perpendicular to the main direction of traffic.

The diagram shows the slots perpendicular to the flow of traffic; this helps prevent wheelchair wheels and walking aids becoming trapped or slipping on the grate surface.

2. User safety

ACO has categorized grate safety into 3 main types:
- Heel resistant - complies with ASME: A112.6.3
- Heel safe - Narrow slots for stiletto heel safety
- Bicycle safe - complies with AS 3996

HEEL RESISTANT - ASME: A112.6.3:
- Section 7.12 Heel Resistant Strainers & Grates

A grate designed to resist entry of heeled shoes, in which the maximum grate hole size in least dimension shall be 0.31" (8mm).

HEEL SAFE

For applications where high stiletto heels are commonplace, ACO recommends grates with openings of 0.25" (6.5mm) or less to prevent heels from becoming trapped, causing injury or falls.

3. Grate security

ACO recommends that grates be secured to prevent movement by traffic, which can cause damage to the trench and/or grate.

BOLTLESS LOCKING - mechanisms that hold grates captive without use of bolts. They are quick to install and remove, making installation and maintenance easier.

BOLT LOCKING - uses bolts to hold grates in place. Bolts fasten into either the frame or kicking bar that straddles the trench.

GRATE MATERIALS - stainless steel, ductile iron and plastic can all offer excellent aesthetics. Monolithic trench drains are manufactured using the same material for the grate and trench drain body.

4. Aesthetics

The top of the trench, usually the grate is the most visible part of the trench drain and aesthetically the most important.

Grates can be selected to blend into the pavement, or used as a feature or border.

Aesthetic options are typically based on:
- GRATE MATERIALS - stainless steel, ductile iron and plastic can all offer excellent aesthetics. Monolithic trench drains are manufactured using the same material for the grate and trench drain body.
- GRATE SLOT PATTERNS - perforated, slotted, mesh and decorative patterns are available.

5. Slip resistance

Slip resistance is critical for user safety. Ideally the slip resistance of the grate should be similar to the surrounding pavement to avoid both slip and/or trip hazards.

ACO has tested grate patterns using the widely accepted pendulum test.

PENDULUM TEST - A pendulum is swung over a wet pavement and measures surface frictional properties. Test results are given a BPN value - typically values in excess of 24 would be used (24 and under is regarded as high slip and skid potential).

ACO recommends selecting a grate with the similar BPN values as the surrounding pavement finish. Pavement slope, presence of surface contaminants, etc. can also negatively affect slip and skid resistance.

Other tests exist, such as the Variable-angle ramp test and horizontal pull test and can be carried out as necessary if required for specific projects.

Selection guidance and test data

BICYCLE SAFE - AS 3996 - 2006 Clause 3.3.6

No US Standard exists detailing slot sizes to avoid bicycle tires from becoming trapped. ACO rates grates based on Australian Standard AS 3996 - 2006 Clause 3.3.6 which specifies maximum slot length dependent on slot width for grates that are deemed Bicycle Tire Penetration Resistant.

To help determine the right aesthetics for a project, ACO offers an online grate Visualizer that allows pavement and grate choice combinations to be viewed.

3.3.6

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ACO can provide product guidance based on current industry standards and requirements. When third party testing has been carried out copies of test certificates are also available.
2. Hydraulics

Catchment hydraulics - calculating run-off

To calculate correct size of trench drain, catchment run-off must be calculated.

- Catchment area = pavement length x width (ft)
- Rainfall intensity in inches per hour

Once catchment run-off is calculated, other inflows, e.g. down spouts, can be added. Other factors that affect trench drain hydraulics:

- Ground fall percentage
- Pavement material - some materials absorb liquids, e.g. brick pavers
- Position and size of outlet pipe
- Surface roughness of trench material. Manning’s coefficient of roughness figures. See page 157
- Angle of approach to trench - this can affect grate hydraulics (steep slopes may cause bypass)

Non-uniform flow (Spatially Varied Flow)

Nonuniform flow accounts for liquid being carried in a trench plus the constant addition of liquid collected through the grates along the trench run - lateral intake. Run lengths, therefore, also influence a trench drain’s capacity.

A characteristic of nonuniform flow is liquid velocity and height change at successive cross sections along the trench.

To correctly model this situation, differential calculus is required; usually computer modeling is needed.

Hydro software - modeling trench hydraulics

Hydro is a purpose written, hydraulic design program modeled on differential calculus for nonuniform flow in open channels. See page 142. The program has been calibrated by empirical data following a series of experiments modeling lateral intake into trenches. Analysis of the effect of slope, run length, and trench cross sectional profiles are incorporated into the program.

Complex scenarios such as the effects of water inflow from down spouts or inlets along the length of the trench can also be modeled by the Hydro program. ACO can use Hydro to recommend optimum outlet positions along trench runs.

Electronic request form can be found at www.ACODrain.us.
2. Hydraulics

Effect of slope on trench hydraulic performance

Slope increases the hydraulic performance of the trench system because flow velocity is increased. The drawings below highlight the water profile in the trench - all parameters are the same on both examples except lower image has a 1% slope added.

This increase in capacity may result in larger areas being drained, outlets spaced further apart, or a narrower or shallower trench system being specified which will result in product and/or installation savings.

Position of outlet

A trench drain is ultimately connected to an underground pipe system. Outlet position can dramatically affect size and length of trench drain required.

End outlet - Water builds up along trench and may flood before reaching outlet. A larger/more costly trench drain and/or more outlets may be required.

Central outlet - If zero ground slope, run lengths to outlet are shorter and less likely to exceed capacity and flood. Allows smaller, more economic trench drain and/or fewer outlets with associated pipework.

Double end outlet - Where zero ground slope, allows run lengths to outlet to be shorter and less likely to exceed capacity and flood. Offers smaller, more economic trench drain but more outlets and associated pipework.

Size and type of outlet

In modeling hydraulic performance of trench drains, the assumption is that the outlet is not a restricting factor. Designers should ensure outlet, and subsequent pipe infrastructure, is not undersized and restricts outflow of the trench drain.
2. Hydraulics

Grate hydraulics

Usually the trench drain reaches hydraulic capacity before the grate. However, where there are concentrated flows running down steep slopes, the grate may not be capable of capturing all flow - even if the underlying trench is correctly sized.

Properly located trench runs put grates in the direct path of surface water runoff, exposing them to the following conditions:

- Flow rate of liquid from catchment area or point source(s). See page 142.
- Velocity and approach head (depth) of load determined by catchment roughness and slope.

A grate has a finite capacity to capture flow (surface water runoff) originating from the grate’s hydraulic capacity is exceeded.

A grate’s hydraulic performance is influenced by:

1. Grate characteristics
   - Intake area
   - Width of grate
   - Design features e.g. direction of bars/slots, slip resistant features

2. Catchment characteristics
   - Approach catchment slope (determines water velocity)
   - Catchment roughness (determines flow direction, water velocity and head)
   - One direction (barrier drain) or two or more directions (sag/valley drain)
   - Type of liquid
   - Debris

Designers should be aware of the trade-off between small inlets for heel safety and large inlets for optimum grate hydraulics.

The science of grate hydraulics is difficult to model in fluid mechanics. A grate’s hydraulic performance can be greatly influenced by sudden changes to grate, and/or catchment characteristics described left.

When liquid moves over a grate, either/or a combination of two scenarios can occur:

- Weir scenario: relevant where water depths are minimal and approach with speed.
- Drowned orifice: relevant where there is an accumulation of water above grate.

Drains positioned in sag/valley locations give rise to higher flow rates due to pressure of substantial static head (liquid depth) being pushed through grate openings.

Longitudinal opening grate at capacity

When comparing grates of equal intake area and width, longitudinal opening grates offer maximum potential for flow evacuation leading to high water intake. For example:

- 4 bars to interrupt and slow down flow before weir is produced.
- Slots 1, 2, 3 are treated as drowned orifices.
- Slot 4 acts as a weir.

Transverse opening grate at capacity

When comparing grates of equal intake area and width, transverse grates offer moderate water intake. Bars bridge across both sides of trench giving little flow interruption, but some drowned orifice effect.

Slot opening grate at capacity

There is very little flow interruption before the weir is produced leading to low water intake. The minimal depth above the slot will have negligible drowned orifice effect.

Leaves and other debris can impact hydraulic performance and can be incorporated into ACO’s software.

ACO has independently measured, by experimentation, the hydraulic intake capacities of ACO grates. Tests were carried out under varying flow rates and catchment approach slopes. To determine the hydraulic utilization, each grate was tested until bypass occurred (point at which liquids would pass across grate).

ACO’s Grating Intake Calculator (GIC) provides information on intake efficiency of chosen grate. If liquid intake is greater than grate’s capacity, extent of bypass (or failure) will be calculated.

To generate results from the GIC program the following information is required:

- Length of trench run (feet or meters)
- Length and width of catchment area (feet or meters). See page 142.
- Position of trench in catchment area
- Surrounding pavement/surface type, e.g., concrete, asphalt, etc.
- Rainfall intensity (in/hr or mm/hr)
- Perpendicular approach slopes to trench (%)
- Preferred grate type

Results are provided either electronically and/or in printout format.
Run layout service and part scheduling

ACO Scheduler
ACO has written a proprietary software program, Scheduler, that shows trench drain runs in profile and plan views. The program automatically prints out each run showing positions of accessories, outlets, junctions, etc. It automatically calculates a Bill of Materials for each run and totals multiple runs to ensure the correct amount of parts and pieces are ordered. Scheduler printouts are particularly useful for installers.

Results provided are:
- Sectioned profile of trench runs
- Plan view of trench runs
- Parts schedule fully itemizing parts and pieces

Scheduler printouts provide:
1. Profile and plan view of each trench run
2. Trench run direction change - e.g., 90° corner or junction
3. Positions and type of outlets
4. Detailed Bill of Materials to ensure all parts are correctly ordered

CAD design services
For more complex projects ACO can provide a custom trench drain layout using Auto-CAD to illustrate required positions and layouts of trench runs.

In order to produce a plan layout, the following information is required:
- Plan of site showing elevations
- Existence of any depth restrictions
- Position and type of any plumbing fixtures/outlets
- Position of any permanent structures
- Liquid flow pattern and type of traffic (including traffic flow)

Results provided are:
- Plan layouts (CAD) showing the trench drain positions relative to site structures

CAD printout provides:
1. Plan view of trench run layout with invert
2. Liquid flow directions
3. Position and type of outlet
4. Trench and grate type
ACO has a qualified site support technician available for installation training and assistance.

A fabrication service can assist with creating difficult corners, tees, shortened channels, etc. to make installation quicker and easier.

A Site Installation Guide is available, in addition to installation section drawings.

1 Installation .......................................................... 152
   - Overview of key steps required

2 Site work ............................................................ 154
   - Specific areas to consider

3 Layout options .................................................... 155
   - Connection options for complex layouts

4 Installation sections ............................................ 156
   - Overview of different pavements and loadings

Installation guidelines
**Installation**

Channel units are installed in a continuous trench, and are encased with concrete.

Full installation instructions are available in the Site Installation Manual. Contact ACO or visit www.ACODrain.us or view ACO Installation videos on www.youtube.com/user/acoamerica

1. **Excavation**

   Excavate trench to accommodate trench drain system. Excavation should be around center line of trench.

   Excavation must be sufficient enough to accommodate each of the following:
   - Channel/catch basin width and depth dimensions.
   - Concrete surround dimensions - 4” - 12”.
   - Specific loading and ground conditions will increase the excavation size.
   - See page 156 for further guidelines.

   For sloped systems, excavate base to roughly follow fall of trench drain run.

2. **Outlet installation**

   All installations should start from outlet point.

   - Determine type of outlet and position
   - Install outlet channel/catch basin and set haunch
   - Install channels starting at, and working away from, outlet - from deepest (highest channel number) to shallowest

3. **Trench drain installation**

   Channel units need to be supported at correct height and held securely in place to avoid movement during concrete pour. There are a number of options available:

   - **Patty supports**
     - Care should be taken that concrete is not trapped in joint between channels.

   - **Concrete key**
     - Avoid concrete/dirt at joint

   **Concrete key**

   **Avoid concrete/dirt at joint**

4. **Channel bracing**

   To prevent channel walls and joints being distorted by pressure of concrete, grates (or plywood cut to a snug fit) should be installed in channel prior to concrete pour.

   Shims or washers placed along each side allow easy removal of the grates.

   - **Adjustable clamp fits into recesses on side of channels**
   - No. 4 or 5 rebar allows easy height adjustments

5. **Concrete pour**

   Concrete should have compressive strength of minimum 4,000 psi.

   Grates should be suitably wrapped to protect from concrete splash.

   Concrete should be poured evenly (both sides of channels) and carefully to avoid dislodging channels. A wand-type vibrator should be used to ensure concrete distributes evenly underneath and around channels.

6. **Pavement finishing**

   Top of adjacent pavement must be above grate level by approximately 1/8” (3mm).

   Brick pavers should be set approx. 1/8” (3mm) above trench edge. First brick course should be set on mortar/concrete.

   Shaped, or curved, brick should be used to ensure smooth transition from channel to pavement.

   - **Concrete surround dimensions - 4” - 12”**
   - **Care should be taken with asphalt rolling**
   - **Concrete should have compressive strength of minimum 4,000 psi**

7. **Completing installation**

   - **Remove debris from trench drain and connections, if necessary.**
   - **Re-install trash bucket ensuring they are securely locked down.**
   - **Renew joint seals as required**
   - **Re-install grates, ensuring they are locked back in place**
   - **Renew joint seals as required**

   The trench drain is now ready for use.

**Maintenance**

Regular inspections of the trench drain are recommended. Frequency will depend on local conditions and environment, but should be done at least annually.

Inspections should cover:
- Grates and locking devices
- Catch basins and trash buckets
- Concrete surround and adjacent paving
- All items should be inspected for damage, blockage or movement. Compare with site drawings if necessary.

**Maintenance guidelines:**

1. **Remove grates**
2. **Remove debris from channel**
3. **Flush channels with water or high pressure washer (do not use boiling water or aggressive cleaning agents)**
4. **Repair damaged surfaces where necessary with an appropriate ACO repair kit.** See page 154.
5. **Renew joint seals as required**
6. **Empty trash buckets and clean out pipe connections**
7. **Re-install trash bucket**
8. **Re-install grates, ensuring they are locked back in place**

**ACO DRAIN**

www.ACODrain.us
4. Installation support

Site work
ACO provides separate installation details for each product with comprehensive on-site advice, when appropriate.

Ground conditions
Specific ground conditions or contaminated ground may call for a deeper/wider concrete surround or larger haunch than minimum recommendations. If in doubt, seek engineering advice.

Thermal movement
Longitudinal expansion joints, which for some slabs may be dowelled horizontally and de-bonded, will isolate the trench and concrete haunch from thermal movement of large concrete slabs.

Transverse joints in the concrete slab should be positioned to coincide with channel-to-channel joints. Alternatively the channel may be cut to align with the slab joint and resealed with a suitable flexible sealant.

Engineering advice should be sought for specifying expansion joints.

Temporary installation
During site work, and after trench run is laid, the trench top can be vulnerable to damage. Site traffic should be routed away from the trench. If temporary crossings are required, a base course of minimum width 3 feet should be installed either side of the trench for protection. Loose boards or plates are inadequate.

Site work accessories

<table>
<thead>
<tr>
<th>Seal and patch materials</th>
<th>Part No.</th>
<th>Weight lbs</th>
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<tbody>
<tr>
<td>ACO Seal flexible joint sealant - 10oz</td>
<td>91120</td>
<td>1.0</td>
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<tr>
<td>ACO Bond - polymer concrete repair kit - 1 gallon</td>
<td>06519</td>
<td>11.0</td>
</tr>
<tr>
<td>ACO Bond - polymer concrete repair kit - 5 gallons</td>
<td>06516</td>
<td>55.0</td>
</tr>
<tr>
<td>ACO Fiberglass repair kit - 1 gallon</td>
<td>08203</td>
<td>11.0</td>
</tr>
</tbody>
</table>

Joint sealing
All channel-to-channel and channel-to-fitting joints should be sealed with appropriate sealant. ACO channels are supplied with an 'SF Sealant Groove' as standard. This provides a groove that can be filled with an appropriate flexible sealant to create a watertight joint. This is particularly important with elevated slabs and where liquids may contain chemicals or oils.

Sealant should be resistant to the same chemicals as the trench material and be flexible to allow for any slab movement from temperature changes. Surfaces should be correctly prepared prior to applying sealant to ensure good adhesion.

Contact ACO Technical Department, or go to www.ACODrain.us for Technical Bulletin.

Connection options

Male-female connection
Interconnecting end details allow easy and effective joining of channels. It also helps with height and sideways alignment between channels. An SF groove provides positive placement for appropriate sealant.

Female-female connection
Creation of a direction change and high point, requires an outlet at start and end of run. To create, remove female end details and butt channels together, hold in place with ACO Bond.

Male-male connection
Creation of a low point, usually with bottom outlet where a catch basin is not required. To create, butt male ends together and fill gaps with ACO Bond.

Arrows depict direction of slope and flow

Traffic flow

3 ft

Blanking end plates
For 100mm in-line basins a blanking end plate is supplied to prevent concrete ingress during concrete pour. It also provides an aesthetic end finish.

Blanking end plates
For 200 and 300mm catch basins, a kit is available to close one end and fill gaps between channel and catch basin.

Sealant applied with caulk gun

Sealant applied with caulk gun

Sealant applied with caulk gun

Sealant applied with caulk gun

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Sealant applied with caulk gun

Sealant applied with caulk gun

Sealant applied with caulk gun

Sealant applied with caulk gun

Contact ACO Technical Department, or go to www.ACODrain.us for Technical Bulletin.
4. Installation support

Installation sections

An installed ACO Drain System should incorporate the following:

- Correct grate type
- Correct channel type and size
- Minimum grade 4,000 psi compressive strength cement concrete surround

It is recommended that the cement concrete surround be durable and conform to minimum strength requirements, as shown in the illustrations. Poor site conditions and low load bearing pavements will require an increase in these dimensions to meet both vertical and lateral loads.

These illustrations are a guide for average ground conditions only. Electronic installation drawings are available at www.ACODrain.us.

It is the customer’s responsibility to ensure that encasement size and detail is suitable for the specific application.

These illustrations are typical only. If in doubt, seek engineering advice.

Note:
1. Grate should be 1/8" (3mm) below pavement surface.
2. Installation brackets on FG200 require a minimum 10" (250mm) surround.

Care should be taken with asphalt rolling machines to avoid damage to channel edge and/or grate.

Note:
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2. Installation brackets on FG200 require a minimum 10" (250mm) surround.

4 in. (100mm) Channels
BLOCK PAVERS - EN 1433 Class B

4 in. (100mm) Channels
CONCRETE - EN 1433 Class E/F

8 in. (200mm) Channels
BLOCK PAVERS - EN 1433 Class B

8 in. (200mm) Channels
ASPHALT - EN 1433 Class C

8 in. (200mm) Channels
CONCRETE - EN 1433 Class E/F
4. Installation support

**Installation sections**

**12 in. (300mm) Channels**
- **BLOCK PAVERS** - EN 1433 Class B
- **ASPHALT** - EN 1433 Class C
- **CONCRETE** - EN 1433 Class E
- **CONCRETE** - EN 1433 Class F

**Note:**
1. Grate should be 1/8” (3mm) below pavement surface.

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**Glossary**

- **ASHHTO** - American Association of State Highway & Transportation Officials.
- **ADA** - Americans with Disability Act. See page 140.
- **CFS** - cubic foot per second - measure of flow.
- **FRP** - fibre reinforced plastic.
- **GIC** - ACO’s proprietary software program to calculate grate intake hydraulics. See page 147.
- **GPM** - Gallons per Minute - measure of flow.
- **Grade** - angle of pavement slope. See page 146.
- **Grate** - metal edge rail to prevent impact and reuse of rainwater.
- **Hydrological cycle** - cycle of water from oceans to rainfall and back to the ocean.
- **In-line catch basin** - with inlet catch basin to connect which acts as an exit to underground pipe work.
- **Invert depth** - depth from top of grate to base of channel. See page 9.
- **Kn** - kilometer - measurement of force, 1kN = 224.8lbs (102kg) of force.
- **Kohlrausch equation** - allows plotting details to interconnect with a pipe support or general damage to trench body. See page 136.
- **Manning’s equation** - (already uniform flow) equation for calculating flow in pipes or culverts. Does not allow for lateral intake of liquids.
- **Manning’s roughness coefficient** - measure of roughness of a materials surface. See page 137.
- **Non-uniform flow** - irregular flow velocity in trench due to change in lateral intake. See page 142.
- **Open grates** - cast in-place in paved area with little depth and no grate.
- **Overall depth** - depth from top of grate to underside of channel.
- **Pavement** - paved area surrounding trench.
- **Plain end** - section of pipe, will require coupling connection.
- **Polymer concrete** - mineral aggregates mixed with a resin binding agent. See page 138.
- **Ponding analysis** - calculated temporary flooding deemed acceptable for certain projects. See page 140.
- **PowerLock™** - ACO’s patented boltless locking system consisting of a sliding clip that locks onto the edge rail. See page 64.
- **psi** - pounds per square inch.
- **QuickLink™** - ACO’s patented boltless locking system consisting of shaped steel and spring clip. See page 18.
- **Scheduler** - ACO’s proprietary software program to illustrate/profile trench layouts. See page 148.
- **SF** - square feet at channel point to allow application of a sealant. See page 97.
- **Slip resistance** - measure of coefficient of friction of grate surface. See page 140.
- **Socket** - recess to accept a pipe size inside - similar to a coupler, see also ‘Bell end’.
- **Stainless steel** - mild steel with a minimum of 11% chromium added to provide enhanced corrosion resistance. There are a wide number of stainless steels available, each with differing properties. ACO grates are Grade 304 austenitic stainless steel.
- **Steep uniform flow** - constant flow velocity in trench/pipes. See Manning’s Equation.
- **Sustainable drainage (SUDS/WSUDS)** - low impact design (LID) leads to collection, treatment and reuse of rainwater. See page 138.
- **Trench** - complete drain system in paved area.
- **Visualizer** - online grate selection aid. See page 18/141.

**ACO DRAIN**

**ASME** - American Society of Mechanical Engineers.
**AS correlate** - American Association of State Highway and Transportation Officials.
**AASHTO** - American Association of State Highway and Transportation Officials - measures of flow.
**Sustainable drainage (SUDS/WSUDS)** - low impact design (LID) leads to collection, treatment and reuse of rainwater. See page 138.
Other ACO products

**Surface water drainage**

**ACO Sport**
Surface drainage and building accessories for track & field.

**ACO Infrastructure**
Surface drainage products engineered for highways, urban roads and bridges.

**Aquaduct**
Custom design and manufacture of fiberglass trench drain systems.

**ACO Duct**
Linear ducting system with removable solid covers.

**ACO Environment**
Oil water separators and spill containment systems.

**ACO Wildlife**
Tunnel and fence system to guide amphibians and other small creatures safely across roads.

**ACO StormBrixx**
A unique and patented plastic geocellular storm water management system.

**ACO Self**
Simple drainage and building components for use around the home, garden and office.

**Building drainage**

**ACO QuARTz**
Bathroom drainage.

**ACO BuildLine**
Drainage products for thresholds, balconies, green roofs and building façades.

**ACO Stainless**
Stainless steel trench drains.

**ACO Floor Drain**
Stainless steel floor drains.

**ACO Pipe**
Stainless steel push-fit pipe system.

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All reasonable care has been taken in compiling the information in this document. All recommendations and suggestions on the use of ACO products are made without guarantee since the conditions of use are beyond the control of the Company. It is the customer’s responsibility to ensure that each product is fit for its intended purpose and that the actual conditions of use are suitable. ACO Polymer Products, Inc. reserves the right to change products and specifications without notice.

Re-order Part # DL099