

3.0 GENERAL INSTALLATION PRACTICES

3.1 New Construction Installation Practices

A long service life and excellent performance characteristics of the SmartDitch system can only be achieved by proper handling and installation of the sections. It is important for the owner, engineer and/or contractor to understand that the HDPE SmartDitch system is designed to utilize the bedding and surrounding soil for support that will result from recommended installation procedures. Engineers have found through considerable experience that properly compacted granular materials are ideal for backfilling the sections. Together, the sections with anchors and surrounding soil form a high performance “anchoring system” that will provide years of stability.

The following is a partial review of installation procedures; it is not intended to replace the installation specifications provided by the engineer or owner. See Appendices for detailed cross sectional shop drawings.

3.1.1 Subgrade / Ditch Preparation

Excavate to the desired line and grade for ditch installation. Grade the subgrade so that the SmartDitch sections can be laid without sags or humps. Grade the ditch cross section to match the SmartDitch cross sectional shape. Excavate or fill as required along the ditch shoulders so that no more than 6 to 8 inches of backfill will be required along ditch side after the sections are placed (see *Figure 5* below).

Prepare the subgrade to be firm, smooth, and free of debris, rocks, and sharp objects. Trim and remove any tree roots. Remove unstable soils and replace with compacted soil fill.



Figure 5

3.1.2 Bedding & Backfill Materials

The ditch subgrade, of suitable material, should provide uniform and continuous support against the SmartDitch walls. Bedding backfill and general installation requirements shall be in accordance with project plans and specifications and manufacturer's recommendations.

Care must be taken to choose foundation, bedding, and haunching materials that are compatible to minimize migration or loss of bedding or haunching support into the surrounding soils

To ensure a satisfactory SmartDitch channel-soil system, correct backfill material must be used. Most coarse grained soils (as classified by the Unified Soils Classification System) are acceptable bedding backfill material.

3.1.3 Suitable Soil Types

The SmartDitch system is suitable for installation in soils that can be excavated and remain unsupported with a cross section that matches the SmartDitch cross sectional shape. Typical suitable soil types include the following:

SmartDitch Section Sidewall Slope	OSHA Soil Type	USCS Soil Group Symbol	AASHTO Classification
1H:1V (1 horizontal to 1 vertical)	Type A or B – stiff clays, silts, dense silty or clayey sands, angular gravels	Stiff CL or CH, ML, MH, SM, SC, SC-SM, GM, GC, GC-GM, angular, GP or GW	Angular A-1, A-2, stiff A-4, A-5, A-6 or A-7

Soils that will not remain unsupported at a sidewall slope of 1H: 1V may not be suitable for SmartDitch channel section installation. These soils may include very soft clays and very loose clean sands. Installation in these soils may be possible by over-excavating the unsuitable soil and replacing it with compacted soil fill meeting one of the typical suitable soil types listed in the table above. Alternately, it may be possible to stabilize localized areas of unsuitable soil by treating the soil with quicklime (calcium oxide, do not use pulverized limestone or “ag lime”) or fly ash prior to SmartDitch channel installation.

Where the specifications permit the use of native soil as backfill, care should be taken to ensure that the material does not include rocks, sharp objects, soil clumps, debris, frozen or organic material.

Backfill between the sections and the ditch using material free of debris, rocks and sharp objects. Bedding backfill and general installation requirements shall be in accordance with project plans and specifications and manufacturer's recommendations.

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3.1.4 Unstable Soil Conditions

Where the trench bottom has soft, loose or highly expansive soils, it is regarded as unstable. An unstable trench bottom must be stabilized before laying SmartDitch sections or a foundation must be constructed to minimize differential settlement or undermining of the trench bottom. A well-graded sandy gravel compacted to 90% density, or crushed stone is recommended for use in foundation layers.

The depth of the sandy gravel or crushed stone material used for foundation depends upon the severity of the trench bottom soil conditions. When crushed rock is used the use of filter cloth/geotextile material to completely surround the foundation material will prevent foundation and bedding materials from migrating into one another which could cause loss of bottom support. Filter cloth/geotextile material is not needed if the same material is used for foundation and bed, or if graded sandy gravel is used for the foundation.

Cement- or lime-stabilized backfill may also be used to achieve a high stiffness without the need for significant compaction.



Figure 6

3.1.5 SmartDitch Section Installation

SmartDitch sections are typically laid end-to-end along the bank. Ensure that the ditch bank is free of tripping hazards and is level for connecting the ditch sections. *NOTE: if assembling sections prior to installation, connect no more than 3 sections together prior to placement.* Sections are typically laid into the ditch flow lines by hand (see Figure 6).

Actual/lay lengths and weights for each channel can be found in **2.1.2 Physical Dimensions & Weights** table on page 7 of this document.

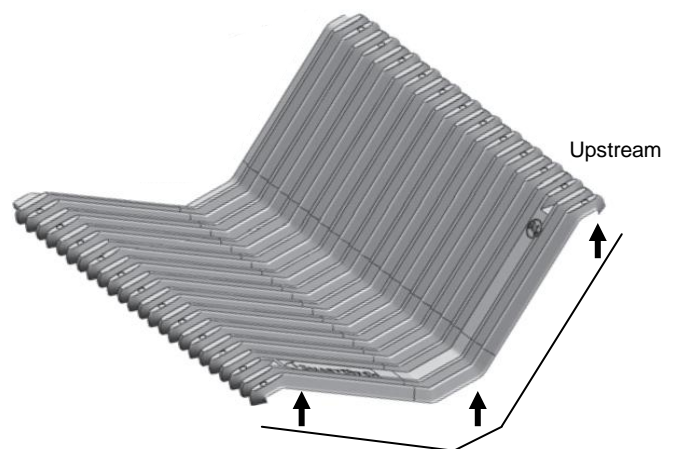


Figure 7

3.1.6 Joint Assembly

Each SmartDitch channel section is approximately 8'-10' in length, depending on the variety utilized on the project. The weights for each size can be found in **2.1.2 Physical Dimensions & Weights** table on page 7 of this manual.

Install seal underneath the round (female) channel groove corrugation on the downstream section of the channel. See Figure 7 for greater illustration.

When connecting individual sections together, upstream sections overlaps previous laid downstream sections. The tops of channel corrugations alternate flat to round.

Overlap with the flat corrugation of the upstream end over the rib following the rib with the gasket. Once parts are nested, clamp/vise grip each side of nested area to secure for installation of fasteners. See Figure 8 for greater illustration.

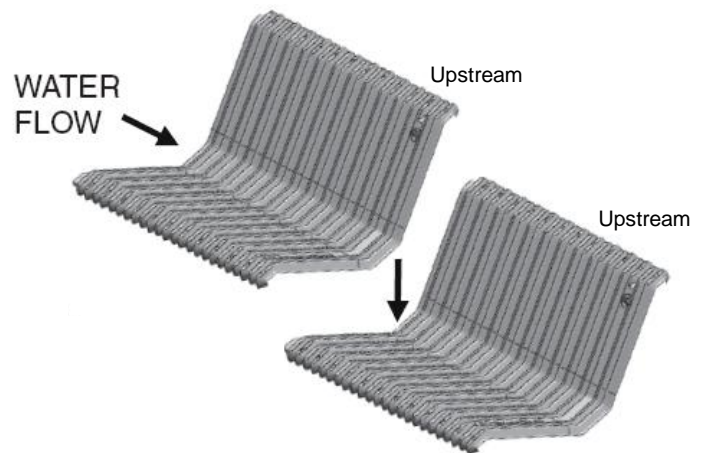


Figure 8

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3.1.6 Joint Assembly (cont.)

Install screws through the dimples visible on the top side of the male channel in the following manner:

- Trapezoidal channels: Drill coated self tapping screws through both nested liners
 - Five (5) dimples and screws for each 12" trapezoidal channel connection point
 - Nine (9) dimples and screws for each 24" trapezoidal channel connection point
- Semi-circular channels: Drill 1/4" holes through both nested channels at the dimples visible on the top side of the male channel and install screws:
 - Ten (10) dimples and screws for each 24" semi-circular channel connection point.

NOTE: Visually inspect backside of connected channels to ensure that screws have pushed through and secured overlapped channels.

The allowances for angular deflection per joint to form a curve can be found in **Angular Deflection at the SmartDitch Joint** table on page 9 of this document.



3.1.7 Backfill and Tamping

Trench bedding or bottom shall be of uniform thickness and density. Bedding material should be placed in the haunching zone areas as called for in the engineering specifications. Uniform stable support is provided by placing the specified material in small quantities to eliminate voids and make firm contact with the section.

Bedding shall be placed in 6" - 8" lifts and compacted so as not to disturb the grade or alignment. A tamping bar or shovel slicing can facilitate compaction in the lower quadrant of the channel (haunches). Mechanical tampers may be specified in some instances and care should be taken to avoid contact directly with the channel.

It is recommended that backfill material be compacted to a minimum of 85% of Standard Proctor Density. Prime embedment materials and select backfill are determined by the project specifications.

To assist in determining these backfill/tamping amounts, please review the channel measurements found in the **2.1.2 Physical Dimensions & Weights** table on page 7 of this manual.



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3.1.8 Anchoring

Drill 1/2" holes through both joined channels at the shoulder section of the sections. A recessed indentation is provided to pre-mark the location.

Drive cable anchor into ground at desired location close to the recessed pockets. Pull up on cable to engage anchor horizontally. After the sections have been placed in the ditch; anchor first section in place. Pull on unanchored end of last section to straighten connected sections tight. Anchor each section. See *Figure 9* for details.

Thread loose end of cable anchor up through 1/2" holes drilled in section shoulder. Slide the washer over the cable and into the recessed indentation. Take a cable lock and thread the cable up through the narrow end of the cable lock and slide the cable lock down snugly against the washer on the stake column. NOTE: Do not over extend cable anchors such that the section connection is bowed out (see *Figures 10 & 11* for details).

For a more detailed view of cable lock and washer connection, see *Figure 12* below.

Using pliers, grip the cable securely and tighten the cable lock until cable anchor is taut. Trim excess cable leaving 2" above the cable lock. Repeat process at all joints. Additional anchoring may be added as needed.

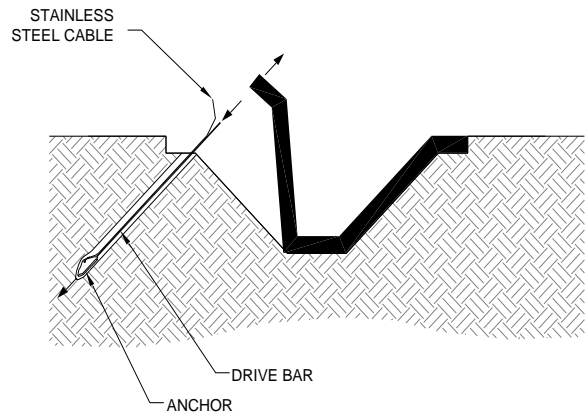


Figure 9

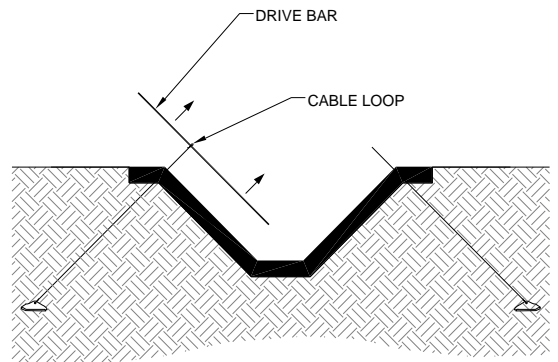


Figure 10

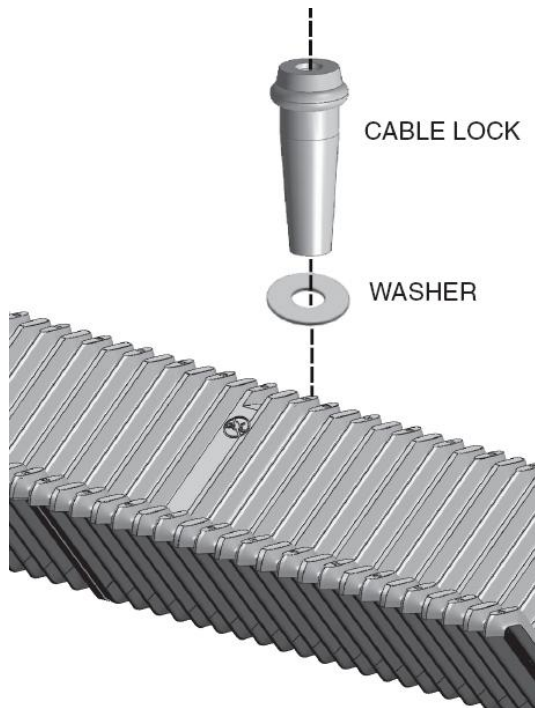


Figure 12

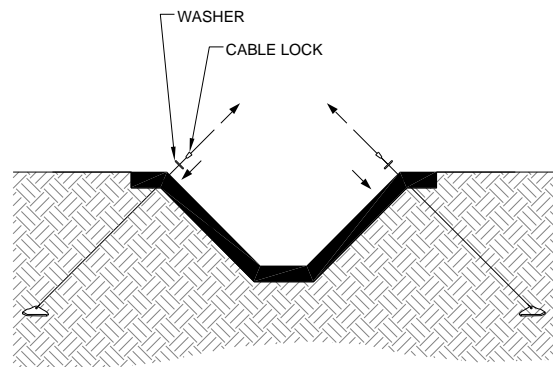


Figure 11

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3.1.8 Anchoring (cont.)

Note that the total number of anchors used per channel is based on the site conditions of the project. For standard projects (i.e. low slope/flow/velocity), standard anchor amounts can be used on channels.

Projects that involve greater slopes, flow levels and velocity may involve more direct assistance from your SmartDitch Engineer or Salesperson contact. See **Flow Calculations Chart** in the Appendix (page 32) for greater detail on slope, flow and velocity levels.

3.2 Anchor Capacity and Guidelines

The capacity of the anchors provided with SmartDitch are summarized in the following table.

Model #	Holding Capacity	Drive Rod Diameter	Standard Depth of Installation
400	300 lbs	¼"	20"
680	1,100 lbs	½"	30"
880	3,000 lbs	¾"	42"

The standard anchor provided with the SmartDitch system is model 680. Other anchors can be special ordered if needed.

The holding capacity for the anchor is for average soil conditions (Class 5 as listed in the table below). Site soils will need to be evaluated. Soils in a higher class will have a lower holding capacity. A torque probe can be used to determine soil class

3.3 Soil Classifications and Anchor Capacity

3.3.1 Classifications and Probe Values

The values listed in the table below are estimates based on typical conditions. We recommend you perform a pull test to ensure that the anchor will meet project needs under site conditions.

Class	Description	Probe Value
1	Solid bedrock	+600 in./lbs
2	Dense clay; compact gravel; dense fine sand; laminated rock; slate; schist; sand stone	500-600 in./lbs
3	Shale; broken bedrock; hardpan; compact gravel; clay mixtures	400-600 in./lbs
4	Gravel; compact gravel and sand; claypen	400-500 in./lbs
5	Medium-firm clay; loose standard gravel; compact coarse sand	300-400 in./lbs
6	Medium-firm clay; loose coarse sand; clayey silt; compact fine sand	200-300 in./lbs
7	Fill; loose fine sand; wet clays; silt	100-200 in./lbs
8	Swamp; marsh; saturated silt; humus	Under 100 in./lbs

3.3.2 Anchoring Stability – Steep Slopes

The primary force that will prevent the SmartDitch system from sliding on a slope is frictional resistance. The frictional force must exceed the shear stress created at the channel interface. The frictional resistance can be calculated using the following equation:

$$f = N \tan \Phi$$

Where:

- f = frictional force
- N = normal force acting on the channel
- Φ = friction angle of the channel-soil interface

The friction angle is dependent upon the soil that is in contact with the SmartDitch. A typical average friction angle between HDPE and sand is 18°. A typical average friction angle between clay and HDPE is 15°.

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3.3.2 Anchoring Stability – Steep Slopes (cont.)

The primary force acting on the channel-soil interface is shear stress. Shear stress can be calculated using the following equation.

$$\tau = \gamma d S$$

Where:

- τ = shear stress
- γ = unit weight of water
- d = depth of water in channel
- S = slope of channel

Good contact between the SmartDitch system and the surrounding soil is essential in developing the maximum frictional resistance. The anchors supplied with the SmartDitch system will also provide resistance to sliding and help maintain good contact between soil and channel.

Because of the multiple factors present in any given installation, there is no rule of thumb for how steep of slope to which the SmartDitch system can be installed. Each installation will need to be evaluated individually.

3.4 Lateral Flow Erosion and Undermining

Lateral flow from an adjacent parallel hillside may cause erosion of the soil along the SmartDitch sections or undermine them. Erosion control practices that may be implemented to prevent undermining include geotextile fabric, coconut mat and/or the placement of riprap along the sides of the SmartDitch section. Some conceptual methods are illustrated in *Figures 13 & 14*.

Note that Control of side erosion and undermining will need to be designed for site-specific conditions by an engineer.

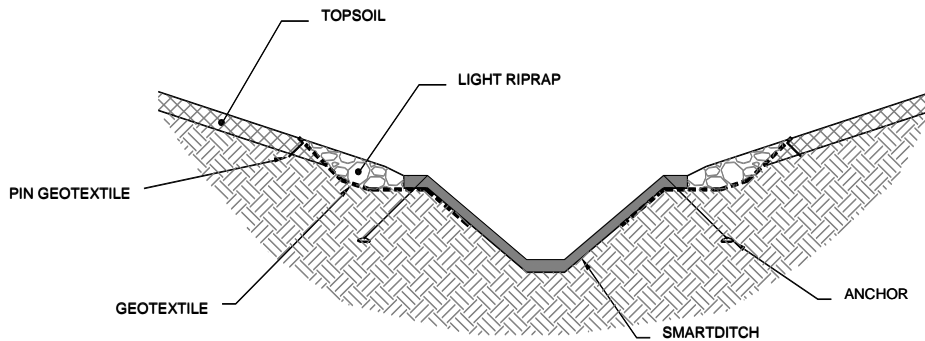


Figure 13

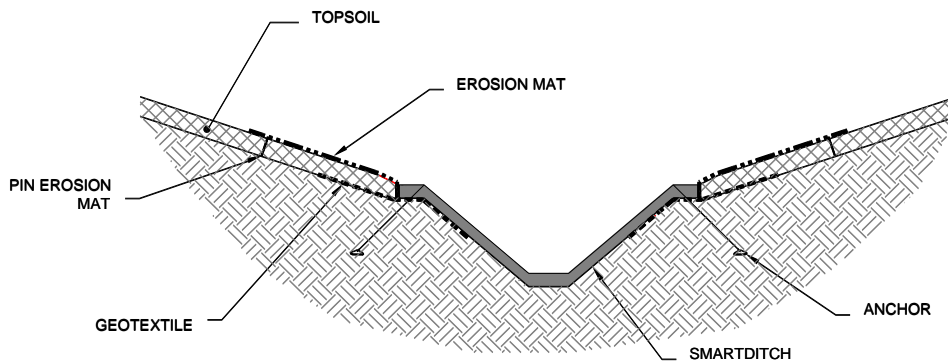


Figure 14

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3.5 Fittings

Penda has created a standardized line of SmartDitch fittings that are molded or fabricated using the same materials that are used to produce SmartDitch channel sections. One of the core attributes of Penda is the ability to fabricate a wide assortment of fittings, standard as well as non-standard. For a complete listing of our standard fittings with dimensions, please contact Penda Corporation. Refer to the **Fittings** section on page 8 for additional details.

3.6 Traffic Loading Conditions

SmartDitch sections are not designed to support vehicular traffic. Foot traffic on the sections by people or animals will not damage or affect the performance of the sections.

3.7 Relining Applications

SmartDitch can be used to rehabilitate existing concrete and earthen ditches. Installation procedures are similar to those used in new construction.

The existing ditch subgrade of the concrete or earthen ditch should provide uniform and continuous support against the SmartDitch walls. Prepare the subgrade to be firm, smooth, and free of debris, rocks, and sharp objects. Trim and remove any tree roots. Remove unstable sections of concrete and replace with compacted soil fill.

The soil adjacent to the sections should be graded flush with the top of the concrete ditch prior to installation of the SmartDitch Sections. SmartDitch sections are typically laid end-to-end along the bank. Ensure that the ditch bank is free of tripping hazards and is level for connecting the ditch sections. *(Connect no more than 3 sections together prior to placement into the ditch.)*

Three inches of sand bedding is recommended, but not required. Bedding backfill and general installation requirements shall be in accordance with project plans and specifications and manufacturer's recommendations. See *Figures 15 and 16* below for details.

Joint assembly and anchoring of SmartDitch sections for relining are similar to the new installation practices.

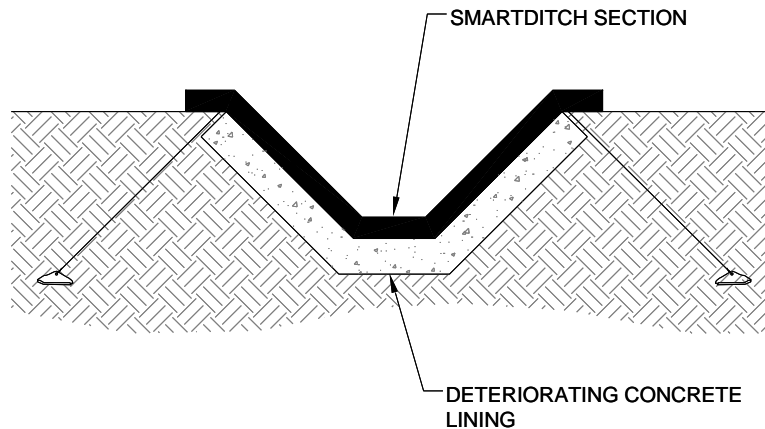


Figure 15

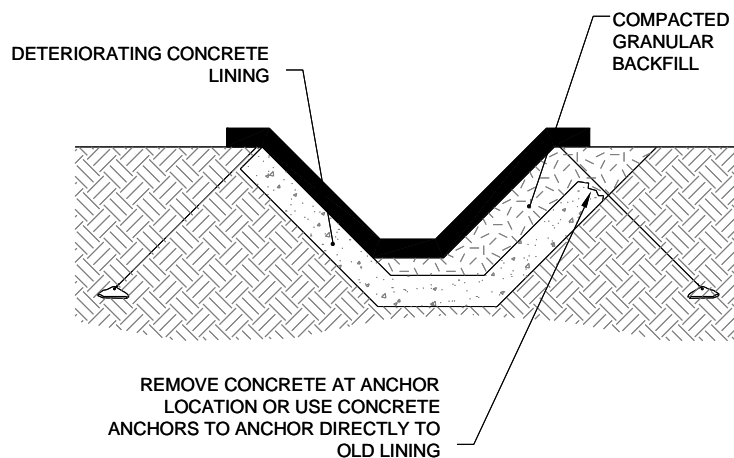


Figure 16

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3.8 Post Installation Inspection

Once the installation of SmartDitch channels is complete, a comprehensive review of all components and materials is recommended. Based on existing inspection cycles, review the following elements on visual and functional levels:

- Location review
 - Backfill bedding does not disturb grade or alignment and voids are not present (see the **New Construction Installation Practices – Tamping and Backfill** section for details).
- Straight/bulkhead channel review
 - Water moves freely at predetermined flow rates (see the **Flow Attributes**, **Flow Velocity** and **Flow Calculations** sections for details).
- Joint connection review
 - Screws are locked in place at drill dimple locations (see the **Joint Assembly** section for details).
 - Water is not leaking beyond expressed rates (see the **Leakage** section for details).
- Anchoring review
 - Anchor number per channel is appropriate for flow demands (see the **New Construction Installation Practices – Anchoring** section for details).
 - Anchor cables are taught and pull-tested to appropriate soil levels; loose cable is not visible (see the **New Construction Installation Practices – Anchoring** and **Soil Classifications and Anchor Capacity** sections for details).

3.9 Handling/Shipping/Storage Guidelines

Utilize the following guidelines when handling, shipping or storing SmartDitch channels and installation elements:

Follow all applicable safety guidelines.

- Do not drop the sections from delivery truck into an open trench or onto uneven surfaces.
- Inspect all sections prior to installation.
- Temperature extremes have minimal affect on the strength or handling characteristics of SmartDitch. SmartDitch remains highly impact resistant even in sub-zero conditions.
- Hot weather especially when coupled with direct sunlight, will raise the sections temperature, but will not significantly affect handling or installation behavior.
- Avoid driving over the sections.
- SmartDitch sections should be stored on a flat surface on the original shipping pallets.

- Carbon black is added to polyethylene to protect against UV degradation. Some discoloration may occur if stored uncovered over an extended time period.

3.10 Cleaning

Inspect SmartDitch lined ditches, laterals, or other components of the water distribution system regularly to ensure proper operation and delivery and or drainage of water. Remove any rocks, debris, or other obstructions from sections to ensure maximum flow and efficiency.

In low flow situations or during the dry season some sediment may accumulate in between the corrugations. To minimize potential problems, flow should be maintained at a minimum, or self-cleansing, velocity. When utilizing SmartDitch, a minimum slope of 0.005 (½%) is recommended to maintain the self-cleansing velocity. This minimizes the accumulation of sediments and the likely hood of vegetation starting to grow. If vegetation does grow is can be easily cleaned out with hand tools.

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