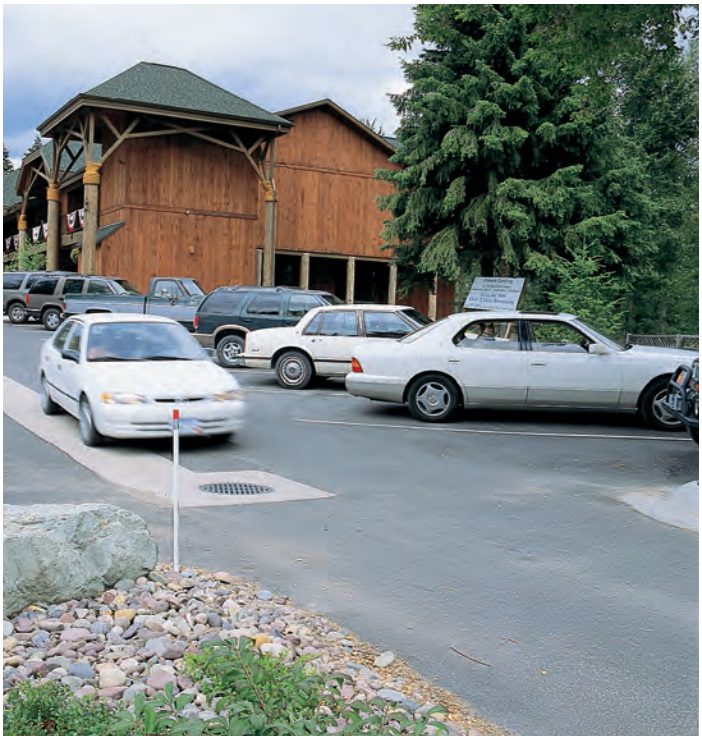
RAINSTORE^3

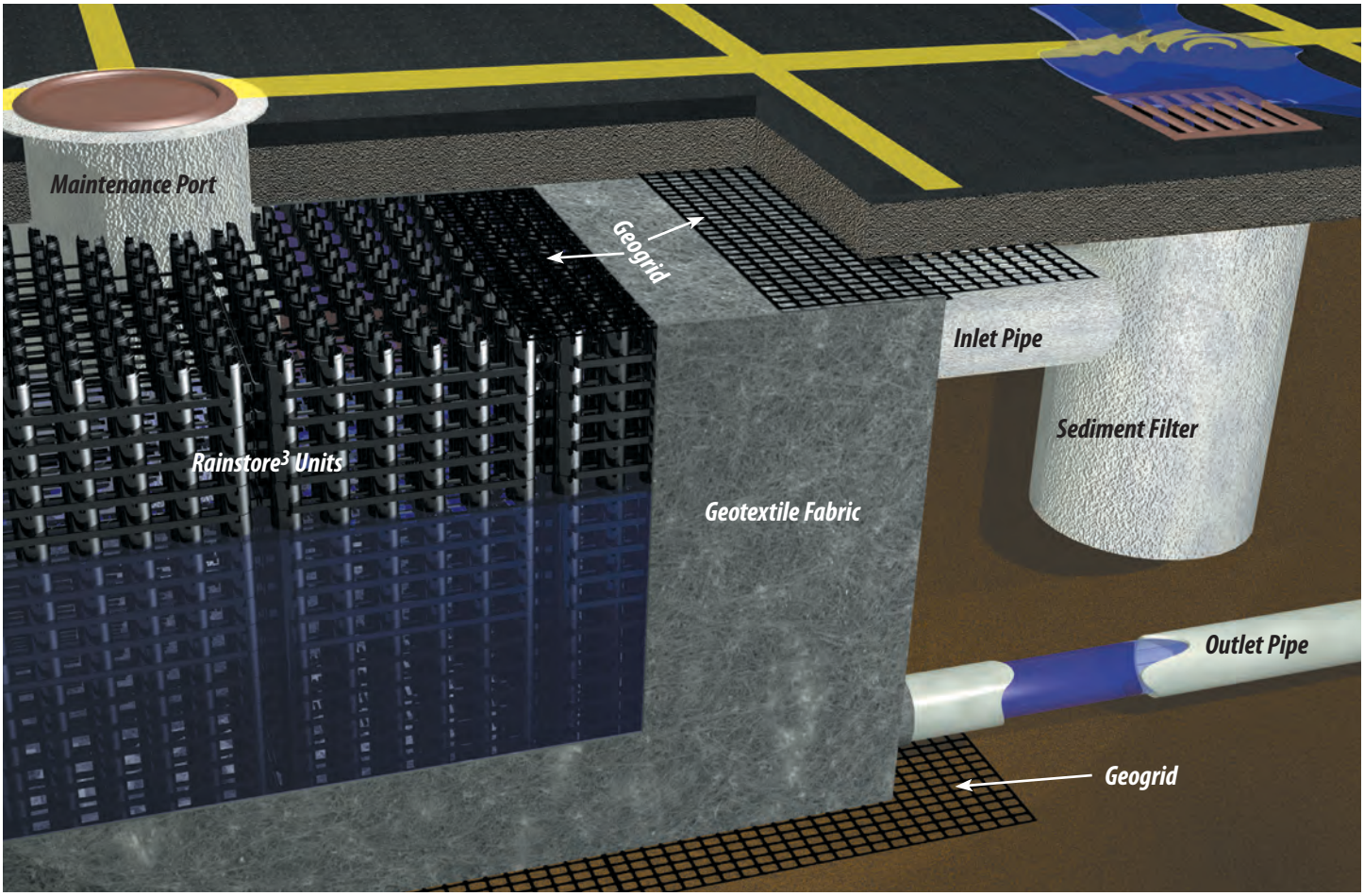
BY INVISIBLE STRUCTURES™

On the cover: Rainstore³ chamber under parking lot, Broomfield, CO. Without Rainstore³'s high water storage capacity at shallow depths, the flexibility in design, and the convenience of exfiltration, the owners of this site would have been unable to develop this site and would have been forced to find a different location for their new construction.



Above: Two views of a completed RS³ install under a parking lot in Big Fork, MT. Parking lot and off-street bays for approximately 48 cars, drains into a 26,250-gallon Rainstore³ stormwater detention structure. Diagonal parking is graded toward the center concrete strip, which drains toward the catch basin.

Below: Graphic representation of asphalt parking lot with Rainstore³ detention showing individual components. Drawing not to scale.



NOW IT IS POSSIBLE!

Invisible Structures, Inc., (ISI) has created a new class of subsurface water storage system, Rainstore^3 (RS^3). It is not pipe or arched chamber, but a structure with strength throughout its shape. The unique design places the plastic entirely in compression rather than bending or tension, resulting in an excess of H-20 loading, and high void storage volume of 94%! Minimum cover is only 0.3 meter (12″).

The structure can be as shallow as 0.1 meter (4″) or as deep as 2.4 meters (94″), and with any length and width in 1 m (40″) increments. Rainstore^3 eliminates site restrictions by conforming to custom project requirements.

RS^3 does not require any stone backfill between structures. Calculating the void (storage) volume is as simple as dividing storage demand by 94%. This means significant savings in amount of excavation, soil transport, imported stone, installation time, and labor.

Rainstore^3 can be utilized for long-term water storage for irrigation, fire protection, toilet flushing, and potable by encasing the structures in an impervious liner.

Porous lining materials around RS^3 offer 100% surface area coverage for water infiltration/exfiltration.

Above: Workers cover Rainstore^3 units with geogrid and geotextile fabric at Adams Street Station in Jacksonville, FL. Two separate Rainstore^3 detention chambers were designed at only 2 units high (20 cm) to account for the high water table.

Below: Portland State University designed a comprehensive stormwater harvesting system to be used for irrigation and toilet flushing. A Rainstore^3 harvesting system is used to hold and deliver stormwater to the plaza garden and treated and used for residence hall toilet flushing.

STORMWATER QUALITY IS OLD BUSINESS

Company Background and Product Line

Invisible Structures, Inc., has been in the stormwater management business since 1982 with our porous paving systems Grasspave^2 and Gravelpave^2, ring and grid structures for grass and gravel drivable surfaces. Large rolls sizes cover areas quickly while either protecting grass roots from compaction or containing small gravel to eliminate gravel migration. These products have extensive design brochures that cover all aspects from project photographs to latest technology and specifications. Check our web site www.invisiblestructures.com for a full display of information and downloadable details.

Draincore^2 (DC^2) collects excess irrigation and rainfall from recreational grass surfaces such as lawns, sports fields, and bio-swales, and transports filtered water to RS^3. This water may be recycled for irrigation or other uses. Draincore^2 conveys water in a shallow horizontal plane, eliminating trenching and backfill requirements of pipe.

Slopetame^2 (ST^2) is a three dimensional soil, vegetation, pre-vegetation containment mat used to reduce soil loss due to water erosion on slopes, river banks, channels, and bio-swales. Crossbars between rings serve to prevent rill erosion. ST^2 provides support for grasses and a variety of plant material whose roots furnish natural fibrous anchorage. ST^2 bio-swales will help clean debris and pollutants from stormwater prior to entering Rainstore^3.

RS^3 evolved from the ring and grid concept by allowing stackability to greater depths, and increased lateral compressive strength to resist deep soil pressures. The 94% void capacity was attained for RS^3 while satisfying structural criteria.

Water Quality Background

Water quality is critical and must be considered when dealing with stormwater management. In the past, point-source pollution (contaminates from a concentrated source) was of primary concern. Today, non-point source pollution (contaminates from a large area such as a parking lot) is important due to the magnitude of its effect and its prevalence.

The EPA has regulated point source pollution for years and is now implementing strict regulations to control non-point source pollution, which is cumulative and presents long term negative impacts upon our water resources.

Stormwater traveling across hard surfaces will collect contaminates from hydrocarbons to solid waste. The most effective pollution control incorporates treatment at the point of origin before reaching community waterways or water tables.

In nature, stormwater percolates into vegetated and non-vegetated areas where suspended solids are filtered and many chemicals neutralized. Research has shown that hydrocarbons are consumed by bio-organisms found in the root zone without killing the vegetation.

Invisible Structures' porous pavement and bio-swale products provide one of the most effective means of removing pollutants at the source. Refer to Porous Paving Inflow Method Detail for ways to reduce or eliminate catch basins and elaborate cleaning systems. Rainstore^3 in combination with ISI's other outstanding products provide a complete stormwater management package.

PRODUCT DESCRIPTION

Basic Structure

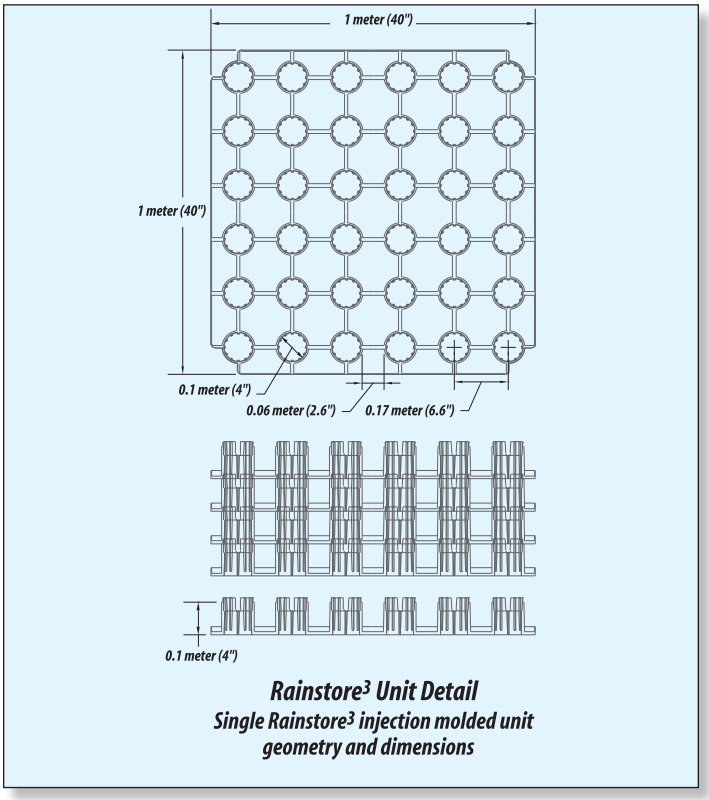
Rainstore^3 is a structure of thin-walled cylindrical columns injection molded of recycled resin of polypropylene (PP) plastic for strength, durability, and green industry benefit. Cylinders are 10 cm (4″) diameter, 5mm (0.2″) average wall thickness, 10 cm (4″) tall, and spaced 16.7 cm (4.6″) apart. T-shaped beams connect the cylinders and resist external lateral soil/water pressure. Compression fittings between layers create a rigid structure for ease of transport and installation.

Four archway openings in the top of each cylinder allow water to move freely throughout assembled columns. A single Rainstore^3 injection molded unit weighs 15 pounds and is comprised of 36 cylindrical columns that occupy one square meter (40″ × 40″ × 4″). A stack of 10 units will comprise one cubic meter (35.31 cubic feet), with approximately 248 gallons of net water storage.

RS^3 allows for water containment depths from 10 cm to 2.4 meters (4" to 7.9'). The following standard depths are stocked: *in meters* (0.2, 0.3, 0.4, 0.6, 0.8, 1.2, and 2.4) *in feet* (0.7, 1.0, 1.3, 2.0, 2.6, 4.0, and 7.9). Custom depths are also available.

Side bumpers provide foolproof, accurate spacing. Structures may be moved by hand. A layer of geogrid, below the cells and above the existing subsoil, provides a stable surface and will insure proper alignment.

RS3 withstands repeated freeze-thaw cycles, will not rust, break down, crack, is not affected by chemicals, extremes of pH, oils, salts, or fertilizers. Polypropylene plastics have a projected service life in excess of 100 years provided they are not exposed to UV light.



Rainstore³ Unit Detail
Single Rainstore³ injection molded unit geometry and dimensions

Overall System

RS3, wrapped with a geotextile filter fabric or geomembrane, and placed side by side in an excavated void create a variety of water storage structures. Inflow, outflow, visual inspection pipes, catch basins, pumps and water filters are installed as needed. Backfilling and compacting the sides, geogrid, base course, and surfacing complete the system.

STORMWATER MANAGEMENT APPLICATIONS

Land development significantly affects the natural course of stormwater. Prior to development, land is semi-porous enabling rainfall to directly infiltrate, which filters pollutants, recharges subsurface water tables, and reduces flooding. Sealing the earth's surface with parking lots, roads, walks, and roofs, results in rapid runoff to storm sewers and rivers, causing flooding and unacceptable pollution of valuable water resources.

To combat these serious problems, national (EPA) and regional regulatory agencies require all or a portion of stormwater to be managed on site.

Surface detention basins and ponds are common, but often occupy valuable real estate and create safety hazards, insects, weeds, and odor problems. Increasingly, the most economical and convenient solution is an "underground pond," where the water may be stored temporarily before it is released to a storm sewer (detention), stored until it exfiltrates (retention), or stored for reuse (harvesting).

Porous Paving

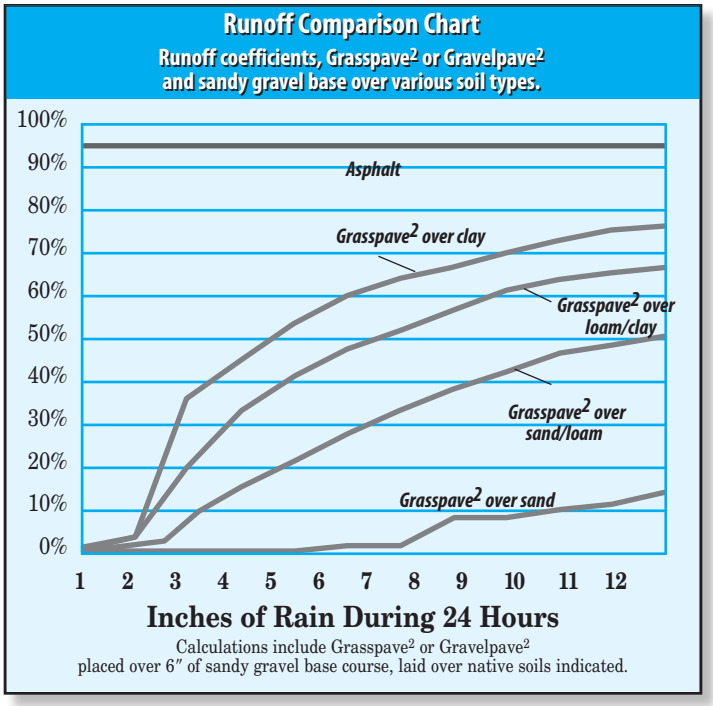
The most direct stormwater management technique is to allow the rain to penetrate the surface where it falls. This can be done with Grasspave2 or Gravelpave2 porous paving. The base course below these plastic reinforcement structures will typically store at least 2.5″ of rain, or more, if subsoils are porous. Firelanes and overflow parking areas are frequently used as infiltration basins.

Rainstore³ Detention

Short term storage and releasing stormwater at a predetermined rate through the use of small outlet pipes or pumps is detention. Downstream stormwater facilities may exist but have a limited flow rate capacity. While the water is held awaiting gradual release, it may or may not be allowed to exfiltrate into the site soils. A porous non-woven geotextile is used to encase RS3. Geomembranes are used when exfiltration must be avoided.

Rainstore³ Retention

When downstream stormwater facilities do not exist or the amount of water released from a site is limited for some other reason, stormwater retention is utilized. Typically, there are no outflow pipes. RS3 is encased in non-woven geotextile and placed above porous soil. Replenishing existing aquifers is a benefit.



Unique shapes and cutouts can easily be designed into Rainstore3 systems. This Rainstore³ detention system at a supermarket parking lot in Mt Pleasant, SC, has cutouts for tree islands and to fit the limited space on site. Over 23,000 pieces of Rainstore³ were used in three separate chambers to store 75,000 cubic feet of water.

Water Harvesting

As population centers expand in arid climates, traditional water sources such as rivers and aquifers have been significantly depleted. With increased water prices, it becomes more economical to harvest rainfall with Rainstore³. Also, demands upon ground resources are reduced, making some water critical projects possible. The choice for long term storage with Rainstore³ is influenced by site opportunities and constraints, access to community infrastructure (water, sewer, fire protection), government regulations, and owner principles and guidelines.

Stormwater falling on a site is collected from roofs, bio-swales, and parking areas. A strong impermeable liner surrounding the

Product Performance Analysis

Performance Criteria	Rainstore³ 2.4 meter (7.9') heigh	Arched Chambers (34″ × 75″ × 16″)	Corrugated Plastic Pipe (60″ dia.)	Corrugated Metal Pipe (72″ dia.)	Concrete Pipe (72″ dia.) Non-perforated
% of excavated volume available for water storage	~75%*	~40%*	~60%*	~53%*	~38%*
% of storage volume occupied by stone	0%	~59%	~60%	~70%	0%
Maximum water storage volume/ surface area	7.9 ft³ water storage/ft² surface area	~1.4 ft³ water storage/ft² surface area	3.8 ft³ water storage/ft² surface area	4.7 ft³ water storage/ft² surface area	3.2 ft³ water storage/ft² surface area
Chamber depth design flexibility	4″ min., 94″ max., in 4″ increments	12″ min., 30.5″ max.	12″ dia. min., 60″ dia. max., 6″ increments	12″ dia. min., 240″ dia. max., 6″ increments	12″ dia. min., 240″ dia. max., 6″ increments
Cover depth required	12″	18″	12″ – 30″ based on diameter	12″ – 24″ based on diameter	6″
On-site handling and manual installation	Easy	Easy	Difficult	Difficult	Difficult
Maintenance, inspection, clean-out	Moderate	Moderate	Easy	Easy	Easy
% of chamber surface area available for infiltration	100%	~75%, including side cuts	~15%, based on perforation area to pipe surface area	~15%, based on perforation area to pipe surface area	0%

*Calculations based on an average sized (10 meter × 10 meter) footprint installed per manufacturer's specifications.

chamber prevents evaporation and contamination. The water may be used for landscape irrigation, fire protection, potable applications, and industrial processes, such as water for heating and cooling with geothermal energy transfer. For long term storage, water may require chemical treatment or oxygenation to preserve water quality.

PRODUCT PERFORMANCE COMPARISON

Crushed rock wrapped in geotextile, concrete, corrugated metal or plastic pipe, and plastic arch chambers have been historical subsurface water storage options available to designers. Invisible Structures closely studied the performance of these systems and obtained feedback from engineers and contractors as to what they liked and disliked about available solutions.

With this information, ISI designers developed Rainstore^3 which boasts a highly efficient excavated volume, economical installation, reduced stone requirements, improved design flexibility, safety, strength, and exceptional longevity.

DESIGNING WITH RAINSTORE^3

Design Steps

1. *Choose system application:* Determine whether porous paving, detention, retention, and/or water harvesting methods will be used. Function will determine whether outflow pipes will be needed, and choice of liner to encase the structures.

2. *Determine the location and quantity of storage systems:* Pick the most appropriate site location to minimize excavation, grading, and piping — usually downhill from runoff sources. Use soil boring information to determine subsoil conditions and water table depth. Exfiltration requires porosity. Rainstore^3 can be located below most landscaped or paved surfaces. It may be desirable to use more than one location for storage.

3. *Choose surfacing to be placed above storage structure:* RS^3 allows for many different surfacing options — parking, green space, recreation, landscaping, and light weight buildings. Landscaping directly above a storage structure should be restricted to shallow rooted materials such as grasses, groundcovers, and low growing shrubs. Long term chemical root barrier materials are available if RS^3 must be kept root free.

If parking is the surface use, then choose between porous paving and hard surface options. Grasspave^2 and Gravelpave^2 filter stormwater directly by allowing percolation through the parking surface and base course into RS^3 without the use of pipe.

4. *Determine required capacity:* Local regulating agencies establish rainfall storage requirements. Calculate by multiplying the hard surface area (roads, parking lots, walks, roofs, etc.) by the "design rainfall" required, then by the runoff coefficient (refer to Runoff Comparison Chart on page 3). Determine supplemental storage requirements for irrigation, process, fire safety, or potable uses, and add to regulated storage demand.

5. *Determine quantity of Rainstore^3:* Convert the storage requirement to cubic meters, divide by 0.94 to determine volume of Rainstore^3 in cubic meters. Gallon storage reference is 1 m^3 of water = 264 gallons × .94 = 248 gallons/m^3 RS^3.

6. *Depth of Rainstore^3:* Factors such as depth of water table, bedrock and available excavation area affect the optimal depth of retention/ detention capability. Choose a RS^3 bottom elevation that is higher than the water table maximum level. In cases where surface area is very limited and storage volume is great, deeper structures are usually more cost effective. Include 12″ of gravel fill and surfacing cover in the decision. The Rainstore^3 cells are assembled to the desired depth prior to shipment. The following depths are available to avoid additional shipping costs: *in meters* (0.2, 0.3, 0.4, 0.6, 0.8, 1.2, and 2.4), *in feet* (0.7, 1.0, 1.3, 2.0, 2.6, 4.0, and 7.9).

Provide an appropriate safety factor when depth of structure is near the maximum water table level because water rising into RS^3 reduces storage volume. Please refer to the Product Description section for standard and custom depths.

7. *Choose the length and width of Rainstore^3:* Having already chosen RS^3 depth, pick the length and width that occupies the required volume of RS^3 (L × W = V/height). Adjust length or width as necessary to meet site criteria. The length and width must be in full meter increments.

8. *Determine catch basin and inflow locations:* **All water entering the Rainstore^3 structure must be reasonably silt and debris free to minimize maintenance and extend the system's useful life.**

Typical Soil Permeabilities

Soil Group	Typical Coefficient	Inches /Day	Description	Suitable for Exfiltration
GW	2.5 EE-2	850.4	well graded, clean gravels, gravel-sand mixtures	Yes
GP	5 EE-2	170.1	poorly graded clean gravels, gravel-sand mixtures	Yes
SW	>5 EE-4	17.0	well-graded clean sands, gravelly sands	Yes
SP	>5 EE-4	17.0	poorly graded clean sands, sand-gravel mix	Yes

Note: The following soil groups are not suitable for exfiltration (silty, clayey soils): GM, GC, SM, SM-SC, SC, ML, ML-CL, CL, OL, MH, CH, OH.

The preferred filtration method is a sand or bio-filter constructed with Gravelpave2 or Grasspave2 (refer to Porous Paving Inflow Method Detail). A catch basin or other structural means may also be used. Choose an inflow location that best suits site conditions and minimizes waterborne debris. Standard pipe made of PVC, HDPE, steel, concrete, tile, copper, or any other material may be used to convey water to or away from Rainstore3.

9. *Determine outflow locations (if necessary):* For gravity fed outflow, ensure that site topography allows the outflow pipe to travel to a lower elevation stormwater facility. Size the pipe to limit outflow to the desired rate. If gravity outflow is not possible, pumps may be used (refer to Water Harvest or Maintenance Port Details). **A fail safe power supply is essential if outflow pumps are used.**

10. *Select Rainstore3 liner:* First, choose between permeable and impermeable. Non-woven filter fabrics are typically used except when water harvesting or stormwater exfiltration is prohibited by regulation.

Acceptable impermeable liners are at least 40 mil PVC or equal. Permeable liners must be at least 8 ounce non-woven. Properly match fabric pore sizes to surrounding soils to prevent clogging and blinding. **Fabric seams must have a 24″ minimum overlap unless sewn.**

To make pipe connections to geotextile fabric, cut an "X" in the fabric, insert the pipe, gather fabric, and fasten tightly with a pipe clamp. If using a geomembrane, construct a "boot" of material and bond it to the circular opening. Insert the pipe through the boot and fasten with two pipe clamps (refer to the Water Harvest Detail).

11. *Determine quantity of geogrid:* **Three layers of geogrid Tensar BX1200 or TriAx160, Tenax MS330, Huesker Fornit 30 or equivalent) must be placed. One layer on the soil below the RS3 (see step 12), one layer directly on top of the RS3 cells — to stabilize with adjacent cells and to provide a walking surface — and the final layer placed on fabric-encased chamber and extended 0.5 meter (20″) beyond the sides of the structure.**

12. *Compute length, width, and depth of excavation:* **Excavation must extend at least 0.5 meter (20") beyond all sides of RS3 structures to allow for ease of product installation and backfill compaction with powered compactor. Soil below RS3 must be leveled with minimal compaction. A layer of geogrid (Tensar BX1200 or TriAx160, Huesker Fornit 30 or equivalent) must be placed on the subsoil and extended 0.5 meter (20″) beyond the sides of the structure.** Large and deep storage volumes may demand a drivable access route for excavation, leveling, compaction and placing Rainstore3 structures. **0.3 meters (12″) minimum, 0.9 meters (36″) maximum, structural base course (no greater than 1″ particle size) must cover the geogrid and extend past all RS3 sides by 0.5 meter (20″). Compact this layer to a minimum of 95% modified Proctor density.**

Native excavated soil or imported backfill may be used as long as it is considered structural and a 95% Proctor density is achieved. Compact in lifts as needed to attain proper compaction. Water saturated backfill should not be used as it is difficult to compact and creates excessive hydrostatic pressure on bottom sides of RS3.

Warning: Take extreme care when driving and/or compacting over the chamber and do not drive over exposed Rainstore3 units — wait until ALL the units are installed, the side backfill is complete, fabric and geogrid layers are completed, and an adequate amount of cover material is placed. Mark area to identify chamber location.

13. *Choose maintenance port locations:* Check local regulations proper size and placement of maintenance ports. An inside corner section of Rainstore3 may be removed to create a suitable opening for inspection and inserting cleanout pumps. (Refer to the Maintenance Port Detail.)

MAINTENANCE OF A RAINSTORE3 STORMWATER STORAGE CHAMBER

Invisible Structures, Inc. recommends that stormwater be pretreated prior to discharging into the chambers to avoid foreign matter accumulation inside the chamber. This can be accomplished by a variety of techniques or products. Some examples are:

Short Term Storage (Detention Basin)

"Zero" Maintenance — the Preferred Method

Use a natural, or "Bio-Filter," inlet device — essentially a porous pavement or swale, to pre-filter trash and sediment laden runoff before capture and conveyance into a Rainstore3 chamber. Use of a simple 10-12″ deep sand, or sand/gravel, filter pavement or swale will provide adequate vertical flow capacity (20 to 35+ inches per hour) and residence time to capture coarse debris and trash at the surface, with sediment and hydrocarbons (and even most traffic generated metals) kept in voids of the section for treatment action by bacteria and oxidation.

Water passing through the filter section can pass directly into the top of a Rainstore3 chamber, or be collected and transported over larger distances via Draincore2.

Only super fine sediments will pass through this section and be conveyed into the chamber. With relatively short storage times (24 to 48 hours) most of these sediments shall remain suspended,

or be easily re-suspended by the next rain event for removal. Long-term accumulations to a depth affecting exfiltration rates can be measured in decades, not years.

Trash pickup from the surface requires that Zero be in quotes. Also be aware that grass surface porous pavements (Grasspave^2) offer greater biological activity, but at a higher surface maintenance cost — mowing, fertilization and irrigation. Gravel surface porous pavements (Gravelpave^2) still provide biological activity at a level lower than with grass, but with lower maintenance required.

Short Term Storage (Detention Basin)

Low, but Periodic, Maintenance

Use a structural form of catch basin with a deep sump prior to use of a hooded elbow inlet into the chamber. Whether standard catch basins or sophisticated cyclonic flow devices are used, the objective is to remove any coarse debris and sediment (sand and larger) from entering the Rainstore^3 chamber. Periodic maintenance will be required to remove trash and sediment that accumulates in the device. Frequency shall depend upon the physical nature of sediments carried and allowed into the "screening" device.

Fine sediments may still be transported into the chamber via the inlet pipe and will likely be dispersed rather evenly over the entire chamber bottom surface area, where they will then settle to the bottom — depending upon the duration of time water is left in the chamber and the size of the particle. Particles smaller than the AOS of the porous fabric liner will pass through the liner and continue migration until stopped by underlying soils. Particles larger than the AOS shall remain inside the chamber, and can be periodically re-suspended by injecting high-pressure water into a Maintenance Port, with removal of the sediment laden water via sump pump from the same, or other, port.

Eventually, especially if maintenance is too infrequent, the bottom of the chamber may develop a thick sediment layer sufficient to obstruct exfiltration through the bottom of the chamber. The sides of the chamber shall continue to function, but time for total water evacuation will increase.

This approach is most closely related to more traditional design responses, but is not the best solution long term for the client. Standard catch basins are lowest initial cost, but much higher in maintenance cost. Commercial cyclonic devices may have lower maintenance cost, but offer higher levels of cleaning efficiency at much higher initial investment cost.

Long Term Storage (Water Harvest Basin)

"Zero" Maintenance — the Preferred Method

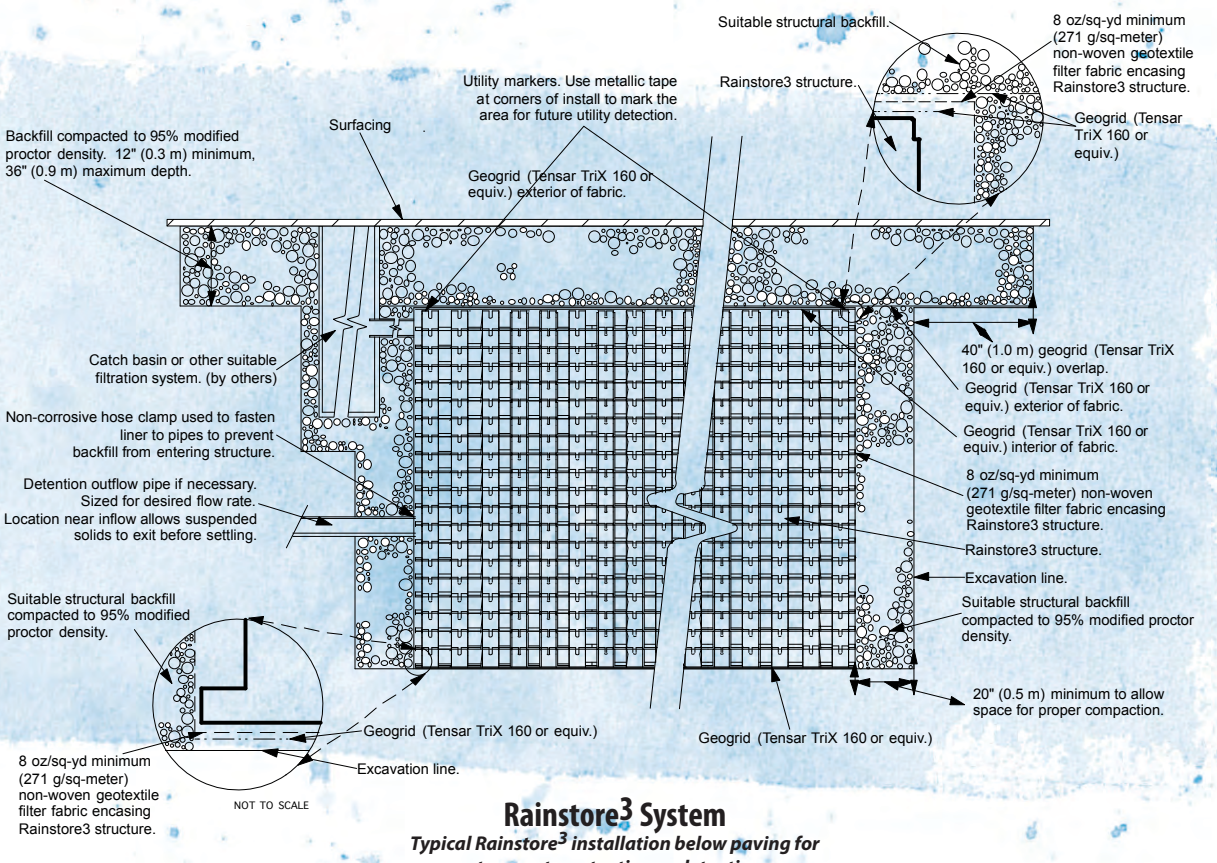
Again, use a natural, or "Bio-Filter", inlet device—essentially a porous pavement or swale, to pre-filter trash and sediment laden runoff before capture and conveyance into a Rainstore^3 chamber. Use of a simple 10-12″ deep sand, or sand/gravel, filter pavement or swale will provide adequate vertical flow capacity (20 to 35+ inches per hour) and residence time to capture coarse debris and trash at the surface, with sediment and hydrocarbons (and even most traffic generated metals) kept in voids of the section for treatment action by bacteria and oxidation.

Water passing through the filter section can pass directly into the top of a Rainstore^3 chamber, or be collected and transported over larger distances via Draincore^2.

Only super fine sediments will pass through this section and be conveyed into the chamber. With relatively short storage times (24 to 48 hours) most of these sediments shall be easily re-suspended by the next rain event for removal. This level of sediment can be safely captured and transported via pumps for water reuse in irrigation or gray water applications, or further filtered by an automatic sand filter device with "back-flush" capabilities.

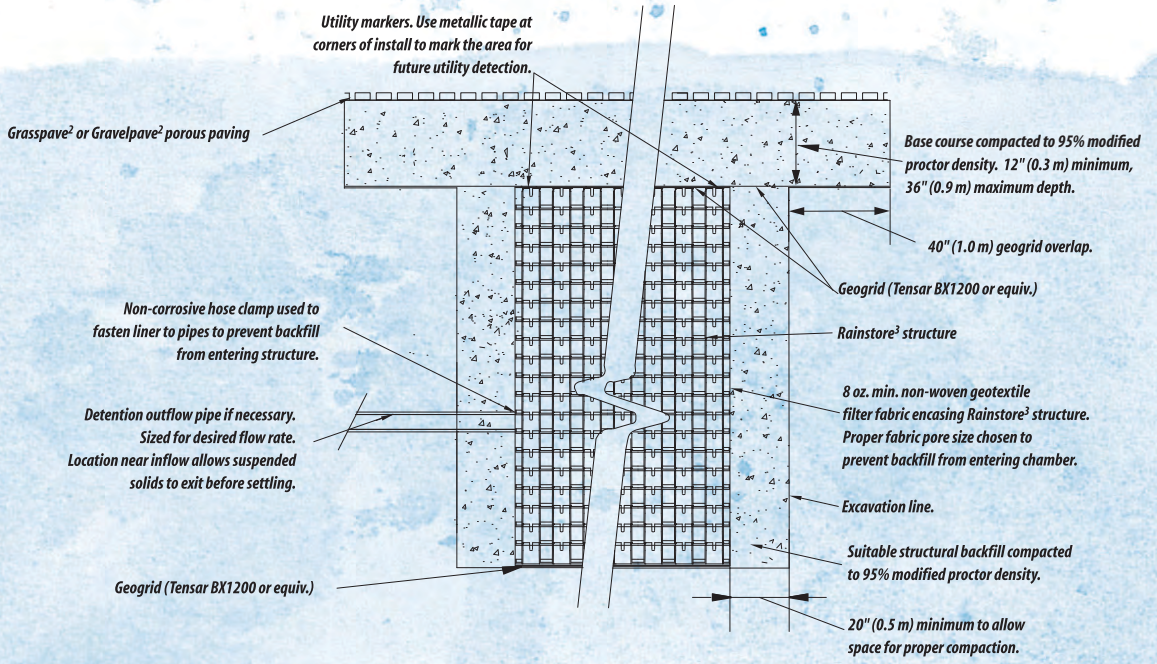
Above: Taller can be better for your design with 7.9 feet or 2.4 meters high versatility. H-20 loading capability allows use underneath all parking lots and a variety of structures.

DESIGN DETAILS



Rainstore³ System

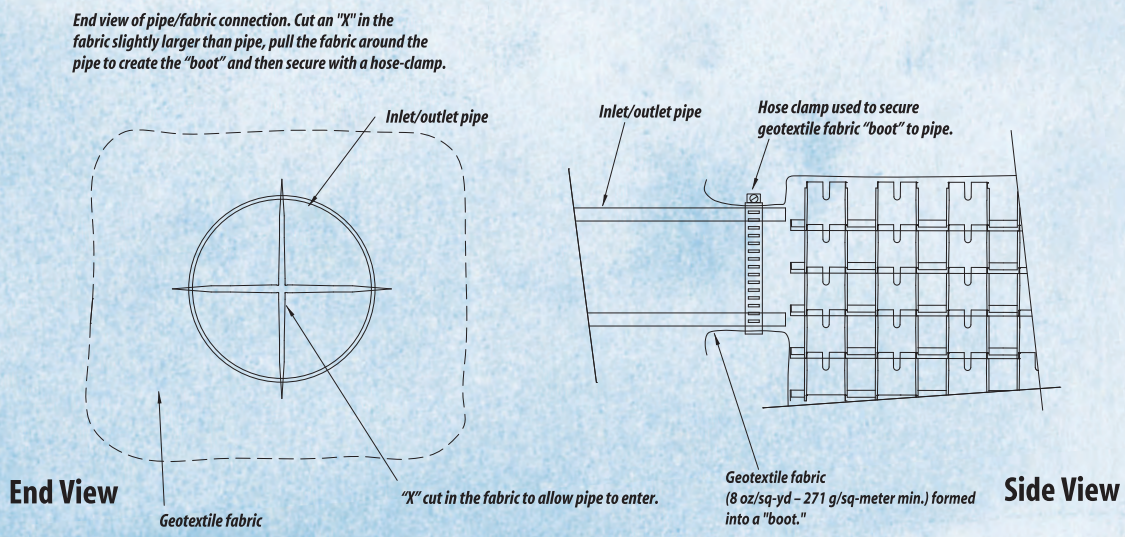
Typical Rainstore³ installation below paving for stormwater retention or detention



Porous Paving Inflow Method

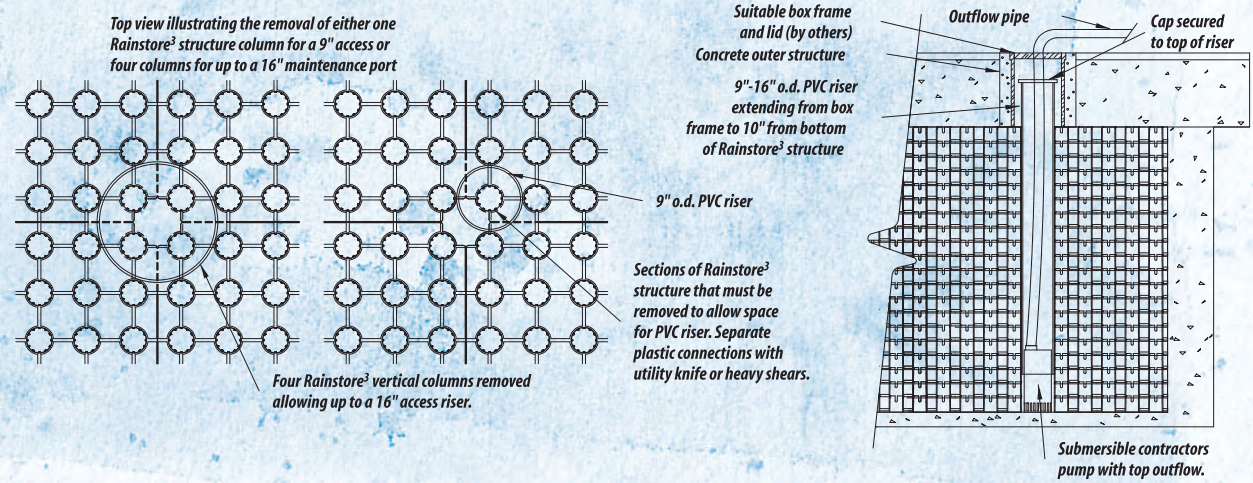
Eliminates structural inlets and provides thorough filtration

DESIGN DETAILS



Rainstore³ Inlets/Outlets With Fabric

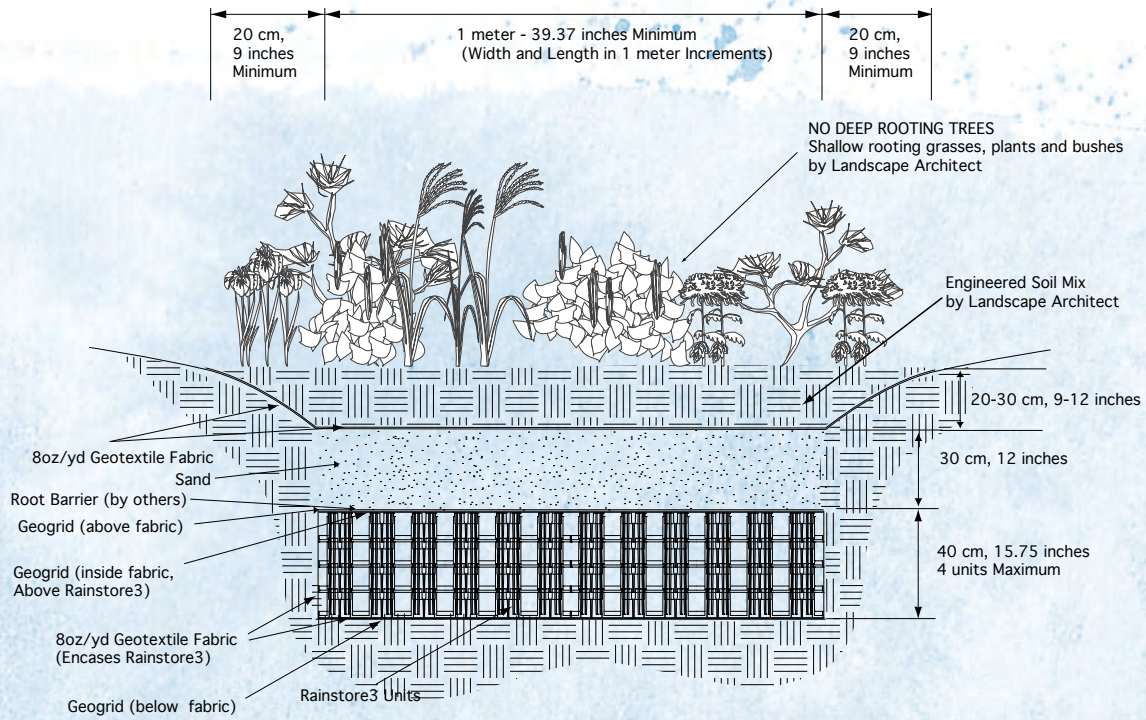
Connecting pipe to the Rainstore³ structure



Rainstore³ Maintenance Port

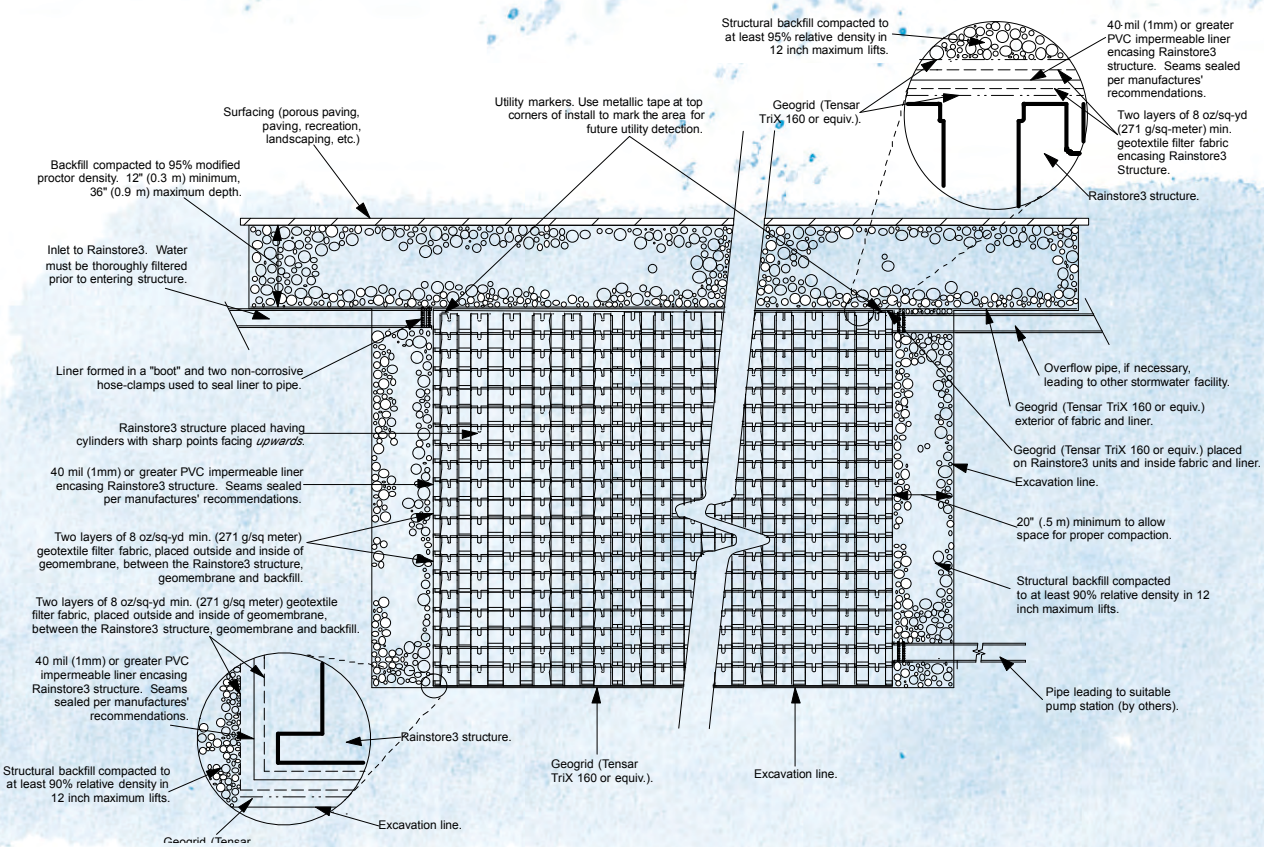
Method for providing inspection and cleanout access

DESIGN DETAILS



Rainstore³ Bio-Retention Rain Garden System

Rain Garden Design for Water Quality Improvement through Infiltration and Bioremediation



Rainstore³ Water Harvest

Long term water storage for irrigation, fire-protection, toilet flushing and others

Rainstore³ Materials and Budgeting Worksheet

Online version of the materials estimator available at: http://www.invisiblestructures.com/RS3/estimator.htm

Item	Description	Formula	Quantity	Unit	$/Unit	Budget Total $	Notes
1	Required Water Volume (V_w)	–		m^3	N/A	N/A	Minimum agency requirements+client/site requirements
2	RS³ Storage Volume (V_r)	$V_r = V_w/.94$		m^3			RS³ is 94% void
3	Depth RS³ (D)	see note		m	N/A	N/A	in meters (0.2, 0.3, 0.4, 0.6, 0.8, 1.2, and 2.4) in feet (0.7, 1.0, 1.3, 2.0, 2.6, 4.0, and 7.9)
4	Length RS³ (L)	$L=V_r/H \times W$		m	N/A	N/A	Site dimensions, round up to nearest meter
5	Width RS³ (W)	$W=V_r/H \times L$		m	N/A	N/A	Site dimensions, round up to nearest meter
6	Geotextile Fabric Area (A_f) for detention†	$A_f=2.1 \times ((L \times W)+(L \times D+W \times D))$		m^2			Top+bottom+sides+5%, 8 oz. min., includes labor
7	Geogrid Area (A_g)	$A_g=((L+1\ m) \times (W+1\ m)/0.95) \times 3)$		m^2			RS³ area+1 meter on each side+5%, includes labor
8	**Total Materials**	Add items 1-8	N/A	$	N/A		
9	Excavation Volume (V_e)	$V_e=(D+0.4\ m) \times (L+1\ m) \times (W+1\ m)$		m^3			Equipment, labor and hauling included
10	RS³ installation labor (L_r)	$L_r=V_r/15$		man-hours			Estimation assuming installation of $15 m^3$/man-hour
11	**Total***	Add items 9-11	N/A	$	N/A		

† For harvesting applications, budget for twice the fabric area (A_f) and include cost for 40 mil PVC liner = A_f
*Overhead and contingency expenses not included

USEFUL CONVERSIONS

1 gallon = .1337 ft^3	1 ft^2 = .0929 m^2	1 m^3 = 264.15 gallons
1 gallon = .003785 m^3	1 m^2 = 10.76 ft^2	1 m^3 = 35.314 ft^3
1 gallon = 3.7854 liters	1 m^2 = 1.196 yd^2	1 m^3 = 1.308 yd^3
1 inch = 2.54 cm	1 acre = 43,560 ft^2	1 yd^3 = .8361 m^3
1 cm = .3937 inches	1 acre = 4,047 m^2	1 ton @ 125/ft^3 = 16 ft^3
1 foot = .3048 m	1 acre foot = 1,233.5 m^3	1 ton @ 125/ft^3 = .593 yd^3
1 meter = 3.28 ft	1 ft^3 = .0283 m^3	1 ton @ 125/ft^3 = .453 m^3
	1 ft^3 = 7.48 gallons	

DESIGN AND TECHNICAL SUPPORT

Invisible Structures welcomes the opportunity to review project designs and answer technical questions. AutoCAD design details may be downloaded from our website. ISI staff is available for on-site construction guidance.

See a comprehensive list of project profiles with photos, project sizes, descriptions, locations, and designs on the web at www. invisiblestructures.com.

Rainstore³ Patent No. 6,095,718. International Patents Apply

INVISIBLE STRUCTURES™

Pioneering Stormwater Solutions

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