

COMMERCIAL SITE SOLUTIONS GUIDE



Understanding YOUR NEEDS

Belgard[®] Commercial is committed to partnering with the design community, by helping you find solutions to meet, or even exceed, your client's needs and expectations.

HERE'S HOW WE CAN HELP:



PLANNING

This **SITE SOLUTIONS GUIDE** is designed to help design professionals solve regulatory, budgetary, and site solution issues for commercial development. To assist you with identifying potential **SYSTEMS SOLUTIONS** for your site. We also offer a highly qualified team of experienced consultants.



DESIGN

We developed a series of product lines to specifically meet the expectations of the commercial construction industry. To meet your design needs, visit **belgardcommercial.com** for supporting documentation and resources, including research studies, specifications, laying patterns, and CAD drawings.



CONSTRUCTION

Often, the key to a successful installation is dependent on a qualified contractor. In 2014, Belgard Commercial will roll out our national **BELGARD COMMERCIAL AUTHORIZED CONTRACTOR** (BCAC) program. The purpose of this program is to grow the list of pre-qualified installers to be utilized for any commercial job.

COLOR LEGEND



BENEFITS PAGES

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Sustainable Site Solutions



Interlocking CONCRETE PAVEMENTS (ICP)

Belgard is the undisputed leader in the concrete paver industry. Through rigorous internal research and development, Belgard continually develops unique and innovative pavement solutions that exceed ASTM standards & are available in an array of colors, textures, shapes, and sizes to meet the design needs of any pedestrian (PLAZA) or vehicular (BOULEVARD) application. In addition, Belgard offers a variety of tools and services to ensure the success of every project, from downloadable CAD files to life cycle costing.

BELGARD COMMERCIAL: MODULINE SERIESTM 6 x 12

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Defining Public Places

MAXIMIZING YOUR OPTIONS WHEN DEFINING SPACES

Defining the identity of public spaces can be accomplished through the simple selection of a particular shape, pattern or texture of a paver that is complementary to the local culture or environment.

Designing the Pavement System

SCIENCE BEHIND THE STRUCTURAL DESIGN

Interlocking concrete pavement systems have been proven to be a durable and effective alternative even in vehicular (BOULEVARD) applications; but, as with any pavement, proper design, construction and maintenance procedures are required. ASCE 58-10 was created by the ASCE/T&DI Structural Design of Interlocking Concrete Pavement Standards Committee to provide guidelines for developing appropriate flexible pavement structures using aggregate base materials for various TRAFFIC LOAD INDEX & subgrade conditions.

This standard guideline was developed based on the 1993 AASHTO Guide for Design of Pavement Structures, which calculates the thickness of a road cross section required to withstand the TRAFFIC LOAD INDEX for the given lifespan based on the native soil's bearing capacity. ESALs (Equivalent Single Axle Loads) express the equivalent damage created by each type of vehicle as compared to an 18,000-pound axle load. For example, passenger cars have a Vehicle Load Factor (VLF) of 0.0004 (it would take 2,500 cars to create the same damage as one ESAL) while full fire trucks range from 0.21 to 6.87.

In terms of selecting an acceptable paver for the given TRAFFIC LOAD INDEX, both the paver thickness and aspect ratio have to be considered. The heavier the expected traffic, the thicker the paver needs to be to prevent it from flipping (rotating) out of place. Controlling the ASPECT RATIO, which is the longest length divided by the thickness, helps to prevent the flexural loads expected from the given traffic type from exceeding the limitations of the concrete.

To obtain a copy of ASCE 58-10, please contact your Belgard Sales Representative.

SAMPLE ASPECT RATIOS

	WIDTH	LENGTH	THICKNESS	ASPECT RATIO
			60mm (2-3/8")	5.1:1
	6"	12"	80mm (3-1/8")*	3.8:1
			101mm (4")	3:1
	6"	6"	60mm (2-3/8")	2.5:1
			80mm (3-1/8")	1.9:1
			101mm (4")	1.5:1
		0"	60mm (2-3/8")	3.8:1
	0	9	80mm (3-1/8")	2.9:1

* For design options using rigid base and bituminous setting beds, talk to your local Belgard Commercial representative.

THE DESIGN STANDARD

The following are the recommended minimum paver thickness and aspect ratio for each type of **TRAFFIC LOAD INDEX** based on an evaluation of **BOULEVARD** products to date. The icons are used on the **PRODUCT DETAILS** pages at the back of this guide to define what products are suitable for each.

Commercial Plaza

There are no restrictions for use in pedestrian only areas. However, in areas that will be subject to maintenance or emergency vehicles, a 2 3/8" (60mm) thick unit should have an aspect ratio less than or equal to 4:1, and a 3 1/8" (80mm) thick unit should have an aspect ratio less than or equal to 5:1.

Facility & Business Parking

Facility and business parking are primarily used by cars, but will be subject to occasional service or delivery truck traffic. In these areas, the minimum recommended thickness is 3 1/8" (80mm), and the units should have an aspect ratio less than or equal to 4:1.

Commercial & Residential Roads

Commercial and residential roads, like subdivision roads, are primarily used by cars, delivery trucks and occasional heavy transports. In these areas, the minimum recommended thickness is 3 1/8" (80mm), and the units should have an aspect ratio less than or equal to 3.5:1.

Minor Collector & Bus Parking

Minor collectors or bus parking lots have an increased number of heavy vehicles driving over the surface on any given day. In these areas, the minimum recommended thickness is 4" (100mm), and the units should have an aspect ratio less than or equal to 3:1.

Pattern Versatility

TRADITIONAL MODULINE & AQUALINE SERIES

Belgard's Moduline and Aqualine series were developed to create the ultimate in pattern versatility. All units are based on imperial 3-inch or 4-inch dimensional increments and have a raster / footprint that is exactly as specified, allowing all series pieces to fit together as intended. Add to this the various aesthetic elements (including colors and textures) that are available to create unique patterns, accents, highlights and borders and the possibilities are truly endless.

The following are examples of some popular paver patterns.

NOTE: What makes a pattern acceptable for vehicular applications is a combination of (A) the pattern has a high degree of interlock, and (B) the sizes involved match the available BOULEVARD products.

Patterns recommended for BOULEVARD USE are highlighted in orange.

STACK BOND 6 x 6, 12 x 12, 18 x 18 OR 24 x 24

STRETCHER BOND 6 x 6, 12 x 12, 18 x 18 OR 24 x 24

HERRINGBONE 6 x 12 OR 12 x 24

BOX PATTERN 1 1-6 x 6 (20%), 1-12 x 12 (80%) OR 1-12 x 12 (20%), 1-24 x 24 (80%)

BASKET WEAVE 6 x 12 OR 12 x 24

COURSED RUNNER BOND 2-6 x 12 (66%), 2-6 x 6 (34%) OR 2-12 x 24 (66%), 2-12 x 12 (34%)

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ENLARGED HERRINGBONE 2-6 x 6 (17%), 2-6 x 12 (33%), 1-12 x 18 (50%)

BOX PATTERN 2 1-6 x 6 (14%), 1-6 x 12 (29%), 1-12 x 12 (57%) OR 1-12 x 12 (14%), 1-12 x 24 (29%), 1-24 x 24 (57%)

CHECKER BOARD 8-6 x 6 (50%), 2-12 x 12 (50%) OR 8-12 x 12 (50%), 2-24 x 24 (50%)

8–12 x 12 (50%), 2–24 x 24 (50%)

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ASHLAR RUNNER BOND 1–6 x 6 (7%), 2–6 x 12 (27%) 1–12 x 12 (27%), 1–12 x 18 (39%)

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STAGGER 6-3 x 12 (10%), 2-6 x 6 (3.5%), 1-6 x 12 (3.5%) 1-12 x 12 (7%), 1-12 x 24 (14%) 1-24 x 24 (28%), 1-24 x 30 (34%)

BOX PATTERN 3 1-6 x 6 (14%), 1-6 x 12 (29%), 1-12 x 12 (57%) OR

1-12 x 12 (14%), 1-12 x 24 (29%), 1-24 x 24 (57%)

ASHLAR STACK 1-6 x 6 (4%), 4-6 x 12 (32%), 4-12 x 12 (64%) 1-12 x 12 (4%), 4-12 x 24 (32%), 4-24 x 24 (64%)

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SPANISH BOND 1–6 x 6 (11%), 4-6 x 12 (89%) OR 1–12 x 12 (11%), 4-12 x 24 (89%)

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K PATTERN 2–6 x 6 (25%), 4-6 x 9 (75%) OR

BOX PATTERN 4 1-6 x 6 (12.5%), 1-3 x 12 (12.5%) 1-6 x 12 (25%), 1-12 x 12 (50%)

Create Your Own Patterns

Step 1

Typically there is a look or feel that you want to express in an area, and there is nothing better to help with that than the laying pattern of the pavement surface. Stack or running bond patterns create a structural elegance, enlarged herringbone patterns can utilize a lot of different shapes, and block patterns mask the repeat layout creating a random appearance and provide increased interlock (necessary for BOULEVARD applications). Start off by selecting the general shape that best fits your intent, or create your own unique repeatable pattern, such as the one shown adjacent. Make sure the general shape is repeatable before proceeding.

Step 2

Now select the scale of the pattern, keeping in mind (A) the size of the area - larger patterns can be used in larger areas, and (B) the application – see the PRODUCT DETAILS pages to verify what Moduline or Aqualine sizes are available for each application type. For vehicular applications, it is also important to keep lines less than 4 feet in length to provide proper interlock.

Step 3

Once you have decided on the scale of the laying pattern, it is time to fill the shape. The following are examples of the previous pattern with different sized pieces – note that even slight changes in the pieces used can alter the appearance dramatically.

Step 4

Adding colors, textures, and borders are where the true versatility of the Moduline & Aqualine series are realized. The available options are only limited by your own imagination.

Belgard Commercial: Moduline Series™

2-6 x 12 (28%), 1-12 x 12 (28%), 1-12 x 18 (44%)

Concrete & Asphalt Overlay

When installing pavers over the top of an existing asphalt or concrete pad, there are three installation options listed below in order of preference.

Sand Set

In a sand set application, a 1" sand bedding layer is placed between the pavers and underlying asphalt or concrete (similar to a standard installation). Drain holes are required at low spots to allow water that seeps into the joints to escape.

This method is most common in PLAZA applications, although it can be applied in BOULEVARDS as long as suitable curb & durable bedding sand is used.

Bituminous Set

This is similar to sand set except a bituminous binder is added to the bedding sand which, in essence, adheres the pavers to the underlying concrete (PLAZA or BOULEVARD applications) or asphalt (PLAZA applications only).

This approach is also commonly used for high impact traffic areas such as cross walks, as the bituminous material helps prevent rotational failure of the pavers.

Mortar Set

Mortar set uses a latex modified mortar under and around the pavers (similar to what is done for ceramic tiles).

This approach is only recommended over concrete, as asphalt is too flexible and will crack the mortar. In northern climates, the mortared joints need to be regularly maintained to prevent moisture penetration, and the use of de-icing salts is discouraged.

Handles H-20/HS-20 Loading

AASHTO's H-20 and HS-20 are live load ratings applied to the design of bridges or other suspended items (*e.g. lids for concrete vaults*).

Because the pavers sit on a flat aggregate surface, they are not subject to the same bending moments and shear, and therefore will not collapse under the applied loads. Paver systems are actually designed for thousands, if not millions, of ESALs, which represent the estimated number of vehicles that pass over the surface during the design life.

- See "Designing the Pavement System" on page 10 for more details.

In terms of being able to withstand the surface pressure exerted by the truck tires, the heaviest gross axle weight (GAW) for a firetruck that is allowed is 24,000 pounds. Assuming standard tires are used (even though Super Single tires are required) the maximum weight on each of the wheels is 12,000 pounds (24,000 pounds/2 wheels). Using a conservative contact area on the bottom of the wheel of 8 inches square, the pressure exerted by each front wheel is 187.5 psi (12,000 pounds/64 square inches). Any concrete paver offered under the Belgard line is made in accordance with ASTM C936, which calls for an average compressive strength of 8,000 psi with no individual unit being less than 7,200 psi. Simply put, the pavers are on average 40 times stronger than required to withstand the surface pressure that would be exerted under the most extreme conditions.

BENEFITS | INTERLOCKING CONCRETE PAVEMENTS

Ensuring Compliance & Public Safety

STANDARDS FOR ACCESSIBLE DESIGN

The 2010 ADA Standards for Accessible Design (*Department of Justice*, 2010) contains scope and technical requirements for accessibility to sites, buildings and elements by individuals with disabilities. The following discusses how our commercial lines of pavers comply with the applicable sections.

Section 302.1 - Floor and ground surfaces shall be stable, firm, and slip resistant.

ANSI B101 testing was conducted by a third party firm on a selection of different finishes available for the Moduline series to determine the respective Dynamic Coefficient Of Friction (DCOF). The minimum requirements to achieve a high traction rating, meaning there is a low risk of slips and falls, are:

- DCOF > 0.43 for level floors
- DCOF > 0.46 for ramps up to 4.76 degrees

The results, which are summarized adjacent, show that most finishes, with the exception of a ground face sealed product tested wet, met the high traction rating. According to the National Floor Safety Institute, "this will be viewed positively by the insurance underwriters."

BOT-3000 Universal Walkway Tester Digital Tribometer

Standard paver wet = 0.75 Ground face wet = 0.48 Ground face sealed wet = 0.41

Section 302.3 - Openings in floor and ground surfaces shall not allow passage of a sphere more than ½ inch (13mm) diameter.

To verify the openings in a ground surface are compliant, a simple test is done to see if a ½ inch diameter sphere can pass through the opening. In the case of pavers, this test would be conducted on the joints in a relaxed state without jointing material in place.

The following icon is used in the PRODUCT DETAILS pages to identify those standard and permeable pavers that pass this test.

Section 303.2 - Changes in level of ¼ inch (6.4 mm) high maximum shall be permitted to be vertical.

Pavers, when installed correctly, are placed on a loose layer of bedding aggregate, then compacted down into it to set the pavers into place. One purpose of the bedding layer is to adjust for possible height variances in the paver thickness so that the final surface does not have any changes in elevation present.

Section 705 - Detectable warnings shall consist of truncated domes and shall comply with 705.

The Moduline truncated dome units are manufactured in accordance with the new dome size and spacing requirements outlined in Section 705. Plus the modular size makes it easy to match the specified marking dimensions for curb ramps in Section 406.

12" 12"

Section 705 - Detectable warning surfaces shall contrast visually with adjacent walking surfaces either light-on-dark or dark-on-light.

Light Reflectance Value (LRV) testing was done on all of the NATIONAL COLORS to determine which pairings provide the required visual contrast. The test results are summarized in the adjacent table.

Studies at the University of Pittsburgh showed that for manual and power wheelchairs, use of 2mm chamfers would be acceptable for any route traveled by individuals using wheelchairs. The exposure limit results are actually better than that of a standard poured concrete sidewalk surface. The Moduline series includes a 2mm chamfer for that reason.

Source: "Vibration Exposure of Individuals Using Wheelchairs over Concrete Paver Surfaces" University of Pittsburgh, 2004. LRV for National Colors

COLOR	LRV				
Almond	20.0				
Desert	27.9				
Foundry	20.5				
Graphite	9.8				
Linen	30.4				
Rust	12.8				
Suede	19.2				
Sunset	13.1				
Truffle	13.0				

2mm chamfers would be acceptable for any route traveled by individuals using wheelchairs.

Lower Capital & Maintenance Cost

MACHINE INSTALLATION

The standard pre-conception for pavers is that they are expensive. This, for a large part, is due to the need for labor to hand install individual units. Belgard[®] Commercial has various pavers that are manufactured in machine installation patterns, whereby specialized equipment can install upwards of 5,000 square feet in a single work day.

This automation of the installation process significantly reduces the capital costs. Entire parking lots, streets, ports & airport tarmacs have been economically constructed using this approach.

The fact that pavers are factory manufactured in accordance with ASTM C-936 "Standard Specifications for Solid Interlocking Concrete Paving Units" also benefits the bottom line. Test reports can accompany the product when it is shipped onsite, eliminating the potential risk of having to replace the product due to poor quality. Once the jointing material is installed, the surface is immediately ready for traffic — no curing delays are required.

Pavers laying machine.

ACCESS OF UNDERGROUND UTILITIES

The annual cost of utility cuts in the average city is in the millions of dollars. The existing surface material needs to be broken out and disposed of, the underground repairs made, and then new material used for the final patch. With each patch, the service life of the pavement is also reduced.

With interlocking concrete pavements, the short term costs and long term impacts are both reduced. Clusters of pavers can be removed by hand— saw-cutting equipment and pneumatic jack-hammers are not required. The same pavers can also be reinstated, reducing the waste disposal and replacement material costs. Short term patching products are eliminated, and there are no changes to the area's overall appearance. Being a flexible pavement system with built in control joints, the pavement also has an increased ability to deal with any subsequent fill settlement .

Pavers being removed to allow for an underground repair.

Improved Life Cycle

LONGER SERVICE LIFE, LESS MAINTENANCE, GREATER VALUE

An investment in roadway infrastructure does not stop after initial construction. Like any asset, it requires some investment to keep it in usable condition. For roadways, this includes ongoing surface maintenance, periodic restoration and eventual base rehabilitation.

Life cycle costing analysis is a technique that quantifies all of the costs associated with the construction and maintenance of a pavement over a set analysis period. According to the report "Life Cycle Cost Management of Interlocking Concrete Block Pavements – Methodology Report" from ARA/ICPI, a paver system is expected to last 30 or more years before it reaches the trigger pavement condition index where rehabilitation is required. During this time, the following level of maintenance is expected.

YEAR	ΑCΤΙVΙΤΥ	QUANTITY (%)
8	Replace Cracked Pavers	2
20	Replace Worn/Rutted Pavers (wheelpath)	5
28	Replace Cracked Pavers	2
35	Replace Worn/Rutted Pavers (wheelpath)	5

At years 8 and 28, it is expected that approximately 2% of the pavers over the entire surface will have become cracked or chipped and will need to be replaced. In years 20 and 35, a more significant maintenance is expected to take place— this includes removal of a larger area of pavers (most likely in the wheelpaths), leveling/replacement of the bedding sand underneath, then reinstatement of a majority of the original pavers.

Paver installations have demonstrated life spans that exceed 30 years, as compared to traditional pavement which typically lasts 12-15 years Source: US EPA

When compared to the equivalent life cycle costing of other traditional paving practices, the results for paver systems are often better because of the:

- 1. Higher performance life of pavers as compared to asphalt.
- 2. Lower capital cost of pavers compared to cast-in place concrete
- 3. Lower/easier maintenance requirements
- 4. Reduced vulnerability to utility cuts

Sample Range of Results for Life Cycle Analysis

Although we cannot guarantee the life cycle costing will be less in every circumstance, we are willing to assist with the analysis to determine if pavers are ultimately more economical. Contact your local Belgard Representative for details.

Permeable Interlocking CONCRETE PAVEMENTS (PICP)

Use of PICP on various PLAZA and BOULEVARD applications can add to the aesthetic look of a project, eliminate the need for traditional stormwater conveyance works, improve groundwater quality, and increase usable land space by decreasing or eliminating the need for a retention pond. Belgard experts can work closely with your design team to design and gain approval for the PICP system that best matches the onsite soil conditions, design storms, and local regulatory requirements.

DESIGN	Preserving our Drinking Water Supply Controlling Runoff Volume Controlling Peak Discharge Rates Preventing Downstream Impacts Stormwater Quality Site Stormwater Management Stormwater Harvesting	22 23 24 25 26 28 29
BENEFITS	Urban Environment Meeting Impervious Cover Requirements Optimizing Land Use Lowering Infrastructure Costs Grey Versus Green Infrastructure	30 32 33 34 35

Preserving Our Drinking Water Supply

STORMWATER FILTRATION

The US Geological Survey reports that half of the drinking water in America comes from groundwater reserves, while the other half comes from lakes and rivers. Both of these are adversely impacted when impervious surfaces like buildings, parking lots and roads prevent rain from infiltrating back into the ground. Groundwater reserves are not being recharged, and shallow groundwater flow systems are reduced, which maintain the base flow conditions between rainfall events in lakes and rivers.

Permeable Interlocking Concrete Pavements (PICP) are fundamentally large scale infiltration galleries with a drivable surface course over top. The open graded base and subbase aggregates have approximately 32% and 40% open space respectively, providing for temporary water storage. Being the same aggregates used for railway tracks, they are more than capable of supporting vehicular loads.

With **FULL EXFILTRATION** systems, which are used on soils with high infiltration rates (*Type A and B soils*), it is expected that any precipitation that falls will drain almost as quickly as it is introduced; any excess rain can accumulate in the subbase for the short term.

With **PARTIAL EXFILTRATION** systems, which are used on *Type C and some D soils*, the amount of excess rain that accumulates in the base/subbase is regulated by the elevation of the outlet control for the underdrain, which is set to only store as much water as can drain in 1 to 2 days post rainfall event.

It is a common misconception that a high soil infiltration rate is required for an infiltration system to work. The majority of 95^{th} percentile design storms in the US range from one to two inches total precipitation. Even at infiltration rates as low as $0.05^{"}$ /hour, it would only take 40 hours for full 2" of rain to drain out of the aggregate base/subbase storage zone.

TEXTURE CLASS	MINIMUM FILTRATION RATE (f) inch per hour	HYDROLOGIC SOIL GROUPING
Sand	8.27	А
Loamy Sand	2.41	A
Sandy Loam	1.02	В
Loam	0.52	В
Silt Loam	0.27	С
Sandy Clay Loam	0.17	С
Clay Loam	0.09	D
Silty Clay Loam	0.06	D
Sandy Clay	0.05	D
Silty Clay	0.04	D
Clay	0.02	D

Source: Virginia Stormwater Management Program Manual

Controlling Runoff Volumes

CURVE NUMBER FOR PICP SYSTEM

The goal of PICPs is to mimic, if not improve upon, a site's predevelopment hydrology by retaining as much stormwater as possible in the base/subbase, so that it can infiltrate back into the ground.

To calculate the projected runoff volume from a typical site, the Soil Conservation Service (SCS) model uses a **Curve Number "CN"** to provide an indication of the amount of runoff generated by a given storm. The CN is based on the infiltration characteristics of the drainage area related to soil type, soil moisture, antecedent rainfall, cover type, impervious surfaces and surface retention.

COVER DESCRIPTION	CURVE NUMBER for hydrologic soil group								
Condition	Percent Impervious	А	В	С	D				
Woods		30-35	55-66	70-77	77-83				
Pasture		39-68	61-79	74-86	80-89				
Row Crops		61-72	70-81	77-88	80-91				
Lawn, Parks		39-68	61-79	74-86	80-89				
Commercial & Business	85	89	92	94	95				
Industrial	72	81	88	91	93				
Paved Roads, Parking Lots		98	98	98	98				
Roofs		98	98	98	98				

Source: USDA Technical Release 55

Sample CNs per the USDA Technical Release — 55 are listed to the left. When developing a CN for a PICP system, one needs to account for both surface and base/subbase retention. Consider a site with a 24-hour 100-year design storm of 10 inches and Type C native soils. Infiltration testing determined the onsite rate to be 0.2"/hr, so 0.1"/hr is used for the design (recommended reduction of 50% applied). Over the 24-hour duration storm, subgrade infiltration is occurring throughout the rainfall period, which equates to 2.4" of water. Allowing for two more days of post storm event drainage, and an additional 4.8" of water can be retained; assuming a void ratio of 40% for the subgrade aggregates, the overflow for the underdrain would be set at 12" above the subgrade. It is not until the storage and infiltration capacities of the system are exceeded within the storm interval (greater than 7.2" in 24 hours) that discharge will occur equal to the surplus precipitation rate.

To determine the applicable CN, select the traditional curve that would be equivalent to the projected overflow of the PICP system at the design storm; in this case, for a design storm of 10", it would be a CN of 43. It should be noted that this CN, on a Type C soil, exceeds any predevelopment conditions per the above table.

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Controlling Peak Discharge Rates

STORMWATER EXFILTRATION

Traditional site design has focused on estimating the peak runoff rate from large, but less frequent, extreme storm events (or how much stormwater runoff is leaving the site under worst case conditions) to ascertain if the receiving body, be it a river or stormwater collection system, can handle the anticipated flow. Detention facilities are built to slow down the rate of runoff to levels the receiving body can handle, with the outflow from the pond being controlled by the diameter and number of outlet pipes; the discharge rate can be calculated using a standard orifice equation.

As shown previously, for **FULL** and **PARTIAL EXFILTRATION** systems, any outflow is eliminated from the PICP area until the system design is exceeded. However, where either the native soils do not drain, or infiltration is not desired (underlying swelling clays or contaminated soils), there can be no reliance on infiltration so a **NO EXFILTRATION** system is used. What is unique to a **NO EXFILTRATION** system is the inclusion of an impervious liner underneath the storage aggregates; this turns the PICP system into a large detention device, with the available storage volume being the void ratio of the aggregate base/subbase. As the native subgrade soils are not exposed to moisture, there are no structural limitations on how long the water can be stored.

On sloped sites, periodic benches are used to create a series of storage reservoirs that slow the water flow. This prevents all of the water from flowing down to the low end and overflowing out of the paver joints. The flow from each storage reservoir is controlled by the size and number of openings in the respective check dam.

In colder climates, where there may be a concern with shallow stationary water freezing within the subbase, a deeper trench can be excavated at the low end so water is stored below the frost line. The adjacent profile is an example of this approach from Elmhurst College in Chicago.

3" Rock Permeable Base Wrap in Filter Fabric

A common question that is asked is "What is the runoff coefficient (C) of the PICP pavement?". The runoff coefficient represents the percentage of rainfall that becomes runoff based on the surface type and is used in the Rational Method to determine peak flow rates. Due to its simplistic approach, one of the main limitations of the Rational Method is that it does not apply to areas that have significant storage areas (such as PICP). Rather than trying to determine a peak flow, it is recommended that the standard orifice equation be used to determine the maximum pipe diameter for the allowable site discharge.

Preventing Downstream Impacts

DOWNSTREAM HYDROLOGY

Improperly managed stormwater can result in downstream hydrologic impacts, such as erosion along existing drainage courses, flooding of adjacent low lying areas, and sedimentation/contamination of receiving waters (including ecological areas such as wetlands and estuaries, recreational areas such as lakes and rivers, and/or surface water supplies of drinking water).

These impacts can be minimized, if not effectively avoided, through better site design using PICPs. Studies have shown that "the slower and more controlled outflow (from PICP) closely mimics natural interflow and reduces the risk of flooding and erosion in downstream receiving waters".

Source: Drake, Jennifer and Tim Van Seters "Evaluation of Permeable Pavements in Cold Climates" Toronto and Region Conservation Authority (TRCA), December 2012.

REDUCED THERMAL IMPACTS ON RECEIVING WATERS

Under predevelopment conditions, stormwater that infiltrates into the ground stays at a relatively constant temperature; conversely, post development stormwater runoff from impervious areas can be very hot in the summer months and extremely cold in the winter months. These temperature extremes can have a devastating effect on aquatic organisms. Many fish species can be harmed by acute temperature changes of only a few degrees. That is why the Independence & Security Act (2007) requires that predevelopment temperatures be maintained from all Federal development or redevelopment.

With PICP systems, the water is stored below ground, so the thermal temperature impacts are minimal.

Studies conducted at North Carolina State University verified that both warm and cold thermal buffering were provided by shallow infiltration systems like PICP, therein reducing the frequency of harmful temperatures.

Source: Hunt Bill and Brad Wardynski "Thermal Mitigation Potential of Permeable Pavements" LID Research Summit, August 2012.

Stormwater Quality

	TOTAL SUSPENDED SOLIDS	TOTAL PHOSPHORUS	TOTAL NITROGEN
Georgia	80%	50%	50%
New Jersey	80%	-	-
New York	82 - 95%	65%	80 - 85%
North Carolina	70 - 85%	10 - 60%	10 - 30%
Pennsylvania	85%	85%	30%
Texas (TCEQ)	89%	-	-
Virginia	-	25%	25%

STORMWATER TREATMENT VIA PICP SYSTEM

Filtration primarily occurs at the joint/void aggregates, being the smallest gradation of material within the system. Studies conducted at Florida Gulf Coast University (FGCU) proved that the TSS removal efficiency of the jointing material was related to the gradation of the particulate in comparison with the gradation of the jointing aggregate. For example, the adjacent chart shows how an ASTM #10 aggregate is capable of removing all particulate greater than 50 microns. What does this ultimately mean? If all of the TSS is larger than 50 microns (say winter sand), then 100% removal efficiency can be expected. PICPs are recognized by several agencies, including the US EPA, as providing stormwater quality improvements. Reported removal efficiencies for Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN) from different states are listed on the adjacent table. What is not clear is the proportional benefits of each of the pollutant removal pathways involved, which are filtration, adsorption, microbial action, volatilization, and absorption (infiltration).

Source: Kim et al "Investigation of Hydraulic Capacity and Water Quality Modifications of Stormwater by Permeable Interlocking Concrete Pavement (PICP) System" Florida Gulf Coast University, 2013.

Filtration is not only effective at removing large particulate and suspended solids, but potentially also TP and hydrocarbons subject to the degree that each binds (adsorbs) to the filtered particulates.

Within the open graded base/subbase, it is expected that volatilization and microbial action is taking place with the hydrocarbons & TN, but as of yet the actual degree is unknown.

Infiltration accounts for the remainder of the quality improvements, with the minimum removal efficiency of the contaminants being proportional to the infiltration efficiency. In other words, if 50% of the stormwater infiltrates into the subgrade, it is expected that a minimum of 50% of the contaminant loading is prevented from discharging to the stormwater system. This generalization is the basis for the Florida **BMPTrains software** developed by the University of Central Florida, which calculates the required infiltration volume of the system based on a comparison of the pre and post development nutrient loadings. **Available at www.stormwater.ucf.edu**. The underlying expectation is that the contaminants within the subgrade infiltrate will undergo further bacterial and chemical reactions within the native soils prior to reaching the groundwater table or receiving waters.

TREATMENT TRAIN

Nitrate tends to occur in highly soluble forms, and as such is not effectively controlled by *No Exfiltration* systems. However, there are two options that can be pursued.

1. North Carolina State University is experimenting with the concept of creating a permanent water storage zone at the bottom of the system by putting an upward elbow on the underdrain. The intent is to create anoxic conditions (little to no dissolved oxygen present) such that denitrification will occur, wherein nitrates and nitrites are converted to atmospheric nitrogen.

2. Route the discharge towards other flow based practices such as modular wetlands (see adjacent photo) to provide secondary treatment. The PICP system would provide preliminary TSS removal and interim storage, with flow into the modular wetland being controlled by an internal orifice assembly. Within the wetland itself, a downstream horizontal flow biofilter is used to remove additional levels of TSS, nutrients, metals hydrocabons and bacteria.

RECOMMENDED MAINTENANCE

The joints of the PICP system, like any other filter, can become clogged. The FGCU study estimated it would take 7-20 years for a typical system to deteriorate to the point were it is no longer functional (infiltration rate less than 10 inches per hour), with the range being subject to the contaminant loading rate and the size of the jointing material used. Where contaminant loading is concentrated, such as around tree canopies, winter snow storage piles or stormwater run-on areas (water is running onto the PICP surface from adjacent areas), clogging can be accelerated.

The recommended regular maintenance includes semi-annual cleaning (spring and fall) using a mechanical or regenerative air sweeper to remove any surface debris, especially compostables like leaves and winter sand. Annual infiltration testing following ASTM C1781 should also be done on the PICP surface, especially at the previously listed spots. Where the infiltration rate is found to be approaching 10 inches per hour, or where there is any surface ponding noted, remedial maintenance using a vacuum truck should be conducted. Vacuum trucks are capable of extracting the accumulated debris and jointing material from between the pavers. New jointing material is then swept back in, and the system is almost as good as new. Please note that power washing is not recommended as this will only push debris deeper into the joints.

To allow for replacement of pavers that may become damaged, and to ensure an even match with existing, a rule of thumb is to store 2 to 5% of the total project as attic stock. Damaged pavers can be pulled up and the new ones reinstated with a few simple tools.

Regenerative Air Sweeper for Regular Maintenance.

Vacuum Truck for Remedial Maintenance.

Site Stormwater Management

HANDLING ROOF WATER

In several states, roof water can be managed by the PICP system as long as the hydrologic design can accommodate the additional water volume. When discharging the roof water onto the PICP surface, it receives the same filtration treatment as any direct rainfall, but the run-on area may be subject to accelerated clogging. Also, for large drain pipes, some form of flow dissipation should be used to prevent washout of the jointing aggregates. When the roof water is diverted into the subgrade, a cleanout sump on the upstream and flow dissipater at the end of the outlet pipe is recommended.

FLAT SITES

On sites with little topographic relief, or where there is extremely shallow bedrock, it is difficult and costly to construct the traditional underground stormwater management system. A cost-effective alternative at some sites has been to use the PICP streets and parking lots as the stormwater conveyance system. Keeping in mind that the hydraulic conductivity of the subbase aggregates is in excess of 56.000 inches per hour, each square foot of cross section of road subbase has more flow capacity than a 6" diameter pipe (*using Hazen-Williams formula at 1% slope*). Even for NO EXFILTRATION systems, as long as a nominal slope can be maintained, the design concept is feasible.

PICP providing all drainage at Gateway Village, Murfreesboro TN.

Stormwater Harvesting

USING PICP SYSTEM AS A STORAGE RESERVOIR

Water harvesting utilizes a free resource to reduce municipal water supply costs, while complying with regional stormwater management guidelines.

In southern climates, a **NO EXFILTRATON** system (complete with liner) can be used as the long term storage reservoir, with the water being used for irrigation, washing, or other non-potable applications. An integrated control system, such as provided by **Water Harvesting Solutions** (www.wahaso.com) is typically used to operate these harvesting systems. In addition, where the PICP is also serving a stormwater management function, it is recommended that an active control system be used to monitor weather forecast information and to automatically draw down the water volume to accommodate projected precipitation rates.

In northern climates, or where larger storage volumes are required, the **PermeCapture®** system can be used. PermeCapture[™] combines the pretreatment benefits of PICP with the increased storage volume (90%) of structural precast concrete. The **PermeCapture®** vaults are H-20 rated, and include proprietary ports in the lids to allow water from the PICP system to drain, precluding the need for separation geotextiles that may clog. Pump stations, polishing chambers, and treatment units (e.g. UV systems) can be added, as required, to provide improved water quality for use in toilets, cooling systems, etc

Urban Environment

REDUCING DEICING SALT USE

According to the TRCA (*see page 25 for reference*), PICPs "function well even during freezing temperatures. Elevation surveys indicated that freezing temperatures created no significant surface heaving or slumping, confirming that the pavements are unaffected by winter conditions".

Studies conducted at the University of New Hampshire have shown that "pervious pavements exhibit greater frictional resistance, and can become clear of snow and ice faster, than conventional pavements. Substantial reductions of up to 77% in annual salt loads for anti-icing/de-icing practices were demonstrated". The reduction in salt usage was primarily due to the ability of melt water to drain through the porous surface because of the insulating qualities of the PICP system; surficial re-freezing as black ice is therefore eliminated and the associated salt usage prevented.

Rather than use de-icing salts or sand, an alternative is to use the same ASTM #8 or #9 chip as used in the paver joints. Because permeable pavers are made with high quality concrete, snow can be plowed or shoveled without the need for special blades or equipment.

Belgard Commercial: Mega-Bergerac®

Source: Roseen, et al "Final Report on a Cold Climate Permeable Interlocking Concrete Pavement Test Facility at the University of New Hampshire Stormwater Center", May 2013).

MITIGATING URBAN HEAT ISLAND

The "heat island" effect impacts urban areas that have systematically used up existing natural ground cover by replacing them with buildings, parking lots and paved streets. The resulting lack of parkland and trees results in higher overall temperatures in these microclimates. In turn, these temperatures place a higher demand on energy, produce more pollution and greenhouse gas emissions, and clearly create quality of life issues for all those living in such environments.

The Solar Reflective Index (SRI) is a composite measure or indication of how well a surface emits absorbed heat. Since solar heat represents approximately 47% of the sun's energy at the earth's surface, it is an important consideration when selecting paver colors. Belgard has tested a number of their lighter color pavers to verify they achieve the desired SRI rating in accordance with the most recent LEED requirements — as the SRI results are subject to the specific mix designs of each manufacturer, contact the local sales representative for results. In an effort to address the remaining 53% (ultraviolet 3% and infrared radiation 50%), Belgard researchers are exploring the environmental benefits of photocatalytic cement. Innovative advances in this technology are expected soon.

URBAN COOLING

Although using lighter colored pavers does benefit Urban Heat Island, the increased pavement reflectance adversely affects human thermal comfort during hot periods due to an increase in the Mean Radiant Temperature contributed by the increased reflected radiation striking the human bodies. Using the PICP system as an evaporative system is a way of mitigating this impact. Water that is stored in the base is allowed to slowly evaporate through the pavers thereby cooling the paver surface. It is no different than how our bodies cool off by perspiring.

Studies at University of California-Davis found that keeping water near the surface of the pavement, through sprinkling water on the surface or injecting water into the pavement to keep the water level near the surface, will increase the evaporation rate and consequently produces a better evaporative cooling effect. Stored water in the base of pavement allows water to slowly evaporate through, thereby cooling the paver surface

Source: Li, Hui "Evaluation of Cool Pavement Strategies for Heat Island Mitigation" University of California-Davis, 2012.

PAVING AROUND TREES

The ability of air and water to be able to move through the PICP to new or existing vegetation is key to their survival and growth. By adding load bearing tree soils, which support the weight of pavement and vehicles but still provides space for tree roots to flourish, the pavement can extend right up to the border of the tree pit. This practice is not possible with conventional paving without the use of specialized structural supports (steel grates, concrete vaults).

Potential Root Growth Area

Meeting Impervious Cover Requirements

DECREASING IMPERVIOUS COVER

In certain jurisdictions, there are limits on the amount of impervious cover that can exist on a site in order to control either the amount of runoff that is generated and/or the water quality of the runoff.

Examples of impervious surfaces include buildings, pavement, and recreational facilities (patios, pool decks, tennis courts, etc). In North Carolina for example, there are Built Upon Area (BUA) restrictions on new developments, which is a percentage of impervious cover that is allowed on a given site and is based on a number of factors including allocated density, location in the watershed, etc. The use of PICP typically allow for credits against the impervious cover requirements because of their ability to control and treat the rain falling on them, as well as any run-on from other areas accounted for in the design. The following is an example of BUA credit calculations per the North Carolina Department of Environment and Natural Resources.

1. Conventional Pavement

By designing a PICP system that can handle all of the direct rainfall and run-on from the building, the required water quality and quantity requirements are met. As a low density development, there is a 24% BUA limit. Building and pavement consume all available impervious cover quantities.

NOTE: This slide is taken directly from a presentation prepared by the NC Department of Environment & Natural Resources.

Simply put, using PICP allows for the site design to accommodate a wider range of possibilities that would otherwise not have been possible, including a larger building footprint or a separate garage, addition of outdoor recreational facilities, and/or more parking. This not only meets the intended environmental requirements, but also increases the property value due to the increased flexibility of the lot.

Optimizing Land Use

INCREASED VALUE & SAFETY

In conventional stormwater drainage designs, detention or retention ponds can consume a large portion of the site. These ponds have limited alternative applications (assuming the pond dries out sufficiently for the intended alternative use) and reduce the income generating footprint of the site.

PICP combine the parking and drive lanes with the retention or detention footprint, therein allowing the lands that would otherwise be consumed by the pond to be transformed into continuous use green space, recreational areas, or even reclaimed for increased development.

Examples exist where the use of PICP allowed for the preservation of wooded/ecological areas that would have otherwise been cleared for, or impacted by, the stormwater detention or retention systems.

In other commercial developments or subdivisions, additional building lots were added, with the revenue of the additional building or house exceeding any increased capital cost of the PICP system. In high density developments, more parking spots were available using PICP, and therefore more units were added to the high rise building. One developer in a particularly tight ocean front development referred to the additional parking stalls achieved by PICP as "million dollar lots" as he was able to add a one million dollar condo for each additional parking spot.

With the water detention/retention facility located below ground, we also eliminate public safety concerns associated with the accidental drowning of children and do not provide breeding grounds for insects that transmit diseases like West Nile Virus.

Lowering Infrastructure Costs

PICP = ROAD + STORMWATER MANAGEMENT

Infrastructure refers to items that are essential to enable, sustain, or enhance societal living conditions in a new development. These include roads, water supply, stormwater management, sanitary sewers, electrical grids, telecommunications, and so forth.

Experience has shown that total infrastructure costs can be lower using PICP than with conventional roads and stormwater management systems. The cost savings are realized through the reduction or elimination of the stormwater works, including catchbasins, manholes, underground pipes, ponds, treatment systems, and associated appurtenances.

Source: US EPA "Case Studies Analyzing the Economic Benefits of Low Impact Development and Green Infrastructure Programs" August 2013.

The following is an example of an infrastructure analysis conducted for a subdivision development in cooperation with the design firm. The capital cost savings were \$566,612, or a net savings of 28.1% as compared to the original design approach. Although we cannot guarantee the infrastructure cost analysis will prove PICP to be less in every circumstance, we are willing to assist with the analysis to determine if a PICP system is ultimately more economical.

		OPTI	ON 1 - S	TANDARI	DESIGN	ΟΡΤΙ	ON 2 - F	PERMEA	BLE PAVEMENT	DIFFERENCE
Item No	Item	Quantity	Unit	Unit Price	Cost	Quantity	Unit	Unit Price	Cost	
Site Prep										
1	Clearing/Grubbing	1	Lump Sum		\$0.00	1	Lump Sum		\$0.00	\$0.00
2	Excavation	1100	C.Y.	\$30.00	\$33,000.00	300	C.Y.	\$30.00	\$9,000.00	\$24,000.00
3	Subgrade preparation (lime stabilization or equivalent)		SF		\$0.00		SF		\$0.00	\$0.00
Stormwat	er Collection									
4A	Area Drains (grassed areas)	11	EA	\$2,000.00	\$22,000.00	6	EA	\$2,000.00	\$12,000.00	\$10,000.00
4B	Catchbasins	7	EA	\$6,500.00	\$45,500.00		EA		\$0.00	\$45,500.00
5	Manholes	2	EA	\$5,000.00	\$10,000.00	1	EA		\$0.00	\$10,000.00
6	4" Rooftop drains		LF		\$0.00	2000	LF	\$25.00	\$50,000.00	-\$50,000.00
7	6 to 8" Drain lines	800	LF	\$40.00	\$32,000.00	800	LF	\$40.00	\$32,000.00	\$0.00
8	10" Drain Lines		LF		\$0.00		LF		\$0.00	\$0.00
9	12" Drain Lines	1000	LF	\$80.00	\$80,000.00		LF		\$0.00	\$80,000.00
10	18" Drain Lines	800	LF	\$124.00	\$99,200.00		LF		\$0.00	\$99,200.00
11	24" Drain Lines	500	LF	\$143.00	\$71,500.00		LF		\$0.00	\$71,500.00
12	36" Drain Lines	650	LF	\$189.00	\$122,850.00		LF		\$0.00	\$122,850.00
Stormwat	er Retention and Treatment									
13A	Retention Pond		Lump Sum		\$0.00		Lump Sum		\$0.00	\$0.00
13B	Value of land consumed by pond		Lump Sum		\$0.00		Lump Sum		\$0.00	\$0.00
14	Underground Storage/Detention System	50000	CF	\$7.00	\$350,000.00		CF		\$0.00	\$350,000.00
15	Water Quality Treatment Systems	1	EA	\$98,000.00	\$98,000.00		EA		\$0.00	\$98,000.00
16	Headwall/Discharge Structure	1	EA	\$7,000.00	\$7,000.00		EA		\$0.00	\$7,000.00
17	Miscellaneous Drainage or Pump Works	1	EA	\$45,000.00	\$45,000.00	1	EA	\$8,000.00	\$8,000.00	\$37,000.00
Roadway	Base									
18	Dense Graded Base		C.Y.	included below	\$0.00		C.Y.		\$0.00	\$0.00
19	Dense Graded Subbase		C.Y.	included below	\$0.00		C.Y.		\$0.00	\$0.00
20	Open Graded Base (ASTM #56 or #57 stone)		C.Y.		\$0.00		C.Y.	included below	\$0.00	\$0.00
21	Open Graded Subbase (ASTM #2, #3 or #4 stone)		C.Y.		\$0.00		C.Y.	included below	\$0.00	\$0.00
22	Subgrade drainage piping		LF		\$0.00		LF		\$0.00	\$0.00
23	Separation geotextile		SF		\$0.00		SF		\$0.00	\$0.00
24	Liner		SF		\$0.00		SF		\$0.00	\$0.00
Roadway	Wearing Surface									
25	Curb and Gutter	11065	LF	\$23.00	\$254,495.00		LF		\$0.00	\$254,495.00
26	Header Curb		LF		\$0.00	10232	LF	\$14.00	\$143,248.00	-\$143,248.00
27	Asphalt	203477	SF	\$3.65	\$742,691.05		SF		\$0.00	\$742,691.05
28	Concrete		SF		\$0.00		SF		\$0.00	\$0.00
29	Interlocking Concrete Pavers (c/w jointing sand, bedding)		SF		\$0.00		SF		\$0.00	\$0.00
30	Permeable Interlocking Paver (c/wjointing aggregate, bedding)		SF		\$0.00	203477	SF	\$5.86	\$1,192,375.22	-\$1,192,375.22
				TOTAL	\$2,013,236.05			TOTAL	\$1,446,623.22	\$566,612.83
									DIFFERENCE	28.1%

Consider the ever increasing cost of oil, the increased design life of pavers, the ease of maintenance, and the capital savings realized through mechanical installation, and the end result is a superior, more aesthetically pleasing surface at a lower cost.

Grey Versus Green Infrastructure

BEING GREEN DOESN'T COST MORE

In many older cities, stormwater and indoor sewage are combined into a single network of drain pipes referred to as Combined Sewer Overflow (CSO) systems. Although these systems are adequate during low rainfall events, the CSO systems are unable to adequately treat much of the wastewater during heavy rainstorms. As a result, large volumes of untreated wastewater enter local rivers and lakes. To reduce these issues, the cities are either required to update their entire grey infrastructure system or look at ways to reduce stormwater runoff across the city through the implementation of LID "green" practices like PICP.

In West Union, Iowa, they compared the life cycle cost of a permeable paver system in the downtown area with those of traditional pavement systems. Results showed that although permeable pavement will initially be more expensive, the lower maintenance and repair costs will result in cost savings in the long run. The city would begin to realize these cost savings by year 15 of the project. Estimated cumulative savings over a 57 year period were calculated to about \$2.5 million. Additional benefits beyond reduced flooding included (1) enhancement of the groundwater supplies; (2) improved water quality in an impaired lake downstream from the development; (3) enhanced recreational amenities at the lake; (4) improved pavement surface temperatures; and (5) improved street appearance.

Source: US EPA "Case Studies Analyzing the Economic Benefits of Low Impact Development and Green Infrastructure Programs" August 2013.

The Philadelphia Water Department performed a full Benefit Cost Analysis (BCA) comparison of green versus grey infrastructure to evaluate the best approach for investing the city's funds to solve the CSO problem in a dense urban environment. The analysis demonstrated that for equal investment amounts and similar overflow volume reductions, the use of LID/GI would provide 20 times the benefits of traditional stormwater infrastructure such as large tunnels and pumping stations.

Source: Greenworks Philadelphia "Philadelphia Combined Sewer Overflow Long Term Control Plan Update, Supplementary Documentation, Volume 2 – Triple Bottom Line Analysis" October 2009. The City of New York, for example, determined that the operation & maintenance of the Green Strategy was \$200,000 less annually than their Grey Strategy. Over a 20-year period, the Green Strategy will reduce CSO volumes by nearly 2 billion gallons more than was possible by the Grey Strategy. In total, the Green Strategy would cost \$5.3 billion, which is \$1.5 billion less than the \$6.8 billion for the Grey Strategy. Plus the Green Strategy provides additional valuable benefits not provided by the Grey Strategy, including (1) improved neighborhood aesthetics; (2) lower summer temperatures; (3) reduced energy use; (4) cleaner air and water; and (5) increased property values.

Source: US EPA "Maintenance of Low Impact Development: Communities are Easily Managing LID Practices" December 2012.

Segmental Retaining Walls (SRW)

With over 20 years' experience and a national network of manufacturing facilities, Belgard offers technical expertise and SRW products to meet the site challenges of projects that range from light commercial to heavy vehicular load applications. From decorative walls to geogrid reinforcement, Belgard offers a variety of SRW options—including our latest innovation, Mega-Tandem™ Mass Segmental Retaining Wall.


DESIGN	Defining Outdoor Space Increasing Usable Space	40 .41
BENEFITS	How SRWs Improve Land Development Product Innovation	42 44

SRW Solutions Provider

Belgard® Commercial offers a number of SRW products in a variety of specifications, colors, and textures to achieve your design goals—including our latest innovation, Mega-Tandem[™] Mass Segmental Retaining Wall[™] (MSRW)[™].













Belgard Commercial: Keystone Country Manor®

SA ST

Defining Outdoor Space

CREATE AN OUTDOOR ESCAPE

Create an outdoor getaway amidst a city backdrop with Belgard[®] Hardscapes. Segmental Retaining Walls are an easy way to define outdoor sanctuaries for a breath of fresh air and lunch time rejuvenation. Incorporating waterfalls, reflecting pools, and gardens can add a touch of relaxation even inside a corporate courtyard.

Courtyard Walls

Commercial courtyard walls, such as planter boxes, can be made using small-scale segmental units. Although these products have limited height capabilities, their small size makes them highly versatile.



Belgard Commercial: Cambridge Cobble®, Belair Wall®

Freestanding Walls

Freestanding walls, commonly used to create seating and low divider walls, are an easy and cost-effective alternative to veneered masonry walls. Their small size makes them highly versatile, while the double-sided texture allows for aesthetically appealing applications.



Belgard Commercial: Belair Wall®

Increasing Usable Space

ELEVATE YOUR PROPERTY WITH RETAINING WALLS

Segmental Retaining Walls can be designed to conform to any shape while maximizing the site's usable space, particularly on high sloped terrains.

Single-tiered walls create an impressive structure and convey grandeur, while multi-tiered walls can include landscaped terraces, adding a visually stunning element to a very functional architectural solution. Where high grade changes exist, the segmental retaining wall incorporates geogrid to utilize the weight of the reinforced soil as part of the overall structure.

TYPICAL MEGA-TANDEM[™] GRAVITY WALL SECTION



How SRWs Improve Land Development

SRW SLOPE STABILIZATION

Soil stabilization is key to maintaining the integrity of slope and the project site. By increasing the stability of the soil, you can increase your useable space on any project site, help prevent unnecessary erosion and runoff, make the site safer for the occupants, visitors and maintenance crews, and improve the aesthetics of the site.

- Increases useable land
- Prevents erosion
- Prevents runoff
- Makes the site safer
- Improves aesthetics



Belgard Commercial: Anchor Diamond® 9D

CONTROLLING EROSION

Erosion control is a primary concern for any site with a slope. Soil erosion and runoff must be managed both during and after construction of a project to make sites both useable and safe. Retaining walls control erosion by stabilizing slopes that could be washed away with heavy rain. Soil that is washed or blown away from a site is likely to make its way to nearby waterways and contribute to sedimentation. A carefully planned retaining wall can be a multi-faceted solution to erosion control and storm water management.

- Makes the site safer
- Prevents excessive runoff
- Helps with stormwater management



Belgard Commercial: Anchor Diamond Pro®

STORMWATER MANAGEMENT

Water absorbed by the soil is pulled down-slope by gravity. A certain amount of water will build up behind a retaining wall. Building proper drainage into a wall design can prevent damage to the wall and to the slope it is stabilizing.

Retaining walls are designed to handle some water buildup by considering the soil type and backfill necessary to improve drainage and relieve water pressure. For stormwater management, segmental walls can be designed with irrigation units that support plant root growth and stabilize the soil. Plants help to filter out pollutants from stormwater or runoff and help minimize potential damage from heavy rains. They also prevent excessive runoff into streets, parking lots, and nearby waterways. Incorporating plants onto supported terraces also allows the wall to withstand greater pressure, much like deep roots hold soil naturally.



Belgard Commercial: Anchor Diamond Pro Stone Cut®

SITE SAFETY & UTILITY

Two obvious, but perhaps overlooked, benefits of segmental retaining walls are that they make a site more useable and safer for occupants. This is especially true in residential applications where the site has a significant slope. Adding a retaining wall can provide multiple tiers to a yard, offering the homeowner more useable space where there had previously been little to none.

Site safety is important in all instances, and minimizing an unstable slope directly impacts the safety and utility of the land.

- Create more useable space by replacing an unusable slope with flat terrain
- Create a variety of levels on the site, such as terraced gardens and outdoor seating areas



Belgard Commercial: Celtik[®] Wall

Product Innovation

MEGA-TANDEM™ MASS SEGMENTAL RETAINING WALL (MSRW)™

Belgard[®] is committed to being the industry leader for hardscapes innovation. As part of our commitment, we have a North American Research and Development Center focused on developing products to enrich our commercial offering, such as the Mega-Tandem[™] Mass Segmental Retaining Wall (MSRW)[™].

Mega-Tandem (MSRW) system designed by Belgard provides the natural appearance of chiseled stone that will complement any hardscape. The innovative, versatile system can be used to create attractive curved or straight retaining and freestanding landscape walls. Great for use in a wide range of commercial hardscape projects.



Belgard Commercial: Mega-Tandem™



FEATURES & BENEFITS

Benefits of Belgard[®] Mega-Tandem[™] (MSRW)[™]:

- Meets ASTM standards (C-1372 and C-1262)
- Classic look of natural chiseled stone
- 12 different facial textures
- Build curved or straight walls
- Running bond configuration
- Three color blends
- Positive mechanical connection with reinforced polypropylene connecting members

Benefits by the numbers:

- Minimum outside radius of 16'
- Free standing walls up to 36"
- 8,500 PSI compressive strength concrete
- Panel size: 12" x 24" 65 lbs./panel
- Engineered 90° corners
- Gravity walls up to 10'
- Reinforced walls up to 15'

Belgard Commercial: Mega-Tandem™

DIMENSIONS

UNITS	TEXTURED VENEER MODULE
Approx. Dimensions	24"W x 12"D x 3"H
Approx. Weight*	65 lbs.
Coverage	2.0 sq. ft.

Gravity Walls to 6' = 27'' Connector

Gravity Walls to 10' = 46'' Connector

Reinforced Walls up to 15' with geogrid reinforcement

CONNECTING MEMBERS

Belgard's connector design creates structural integrity in curved or straight walls.





Technical Product Information



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Paver Processes



Colorgard

For color that lasts a lifetime—Belgard's Colorgard technology evenly disperses color throughout each and every product, creating a consistent and beautiful look to last the lifetime of your project. The Belgard Colorgard process is an integral part of the product mix design, using oxide pigmentation to disperse key colors homogeneously throughout each and every paver or wall product to create stable, lasting color that is not affected by UV rays or the elements of weather.



Newly installed Belgard Colorgard paver



Belgard Colorgard paver after 15 years of exposure

Texturgard*

Texturgard is a face-mix process fusing a combination of rich pigments and finely graded exotic aggregate materials into the matrix of the top wear course of the paving units.



Core Mix

Integral colors are blended within sturdy, mixed coarse aggregate base and throughout the entire block.

Face Mix

3/8" finely graded exotic colored aggregates combined with durable, long-lasting oxide pigments that stand up to the elements.



Paver Colors, Textures & Finishes

National Colors



Regional Colors

In addition to our national color offering, Belgard Commercial products come in a number of local colors. Check with your local Belgard Sales Representative for details.

Texture/Finishes

Belgard Commercial Hardscapes provides a number of textures and finishes to create the exact look you desire for your project.



Smooth (non-process)

Unit surfaces and micro-chamfers are carefully molded using a highquality precision machined steel shoe assembly which creates units with an extremely smooth surface and precision detailed chamfer.



Shot Blast (un-sealed)

Exposes the surface of the paving unit to reveal the natural beauty of the aggregates and pigmentation.







Ground Face (sealed)

The top of the paving units are ground smooth which exposes the aggregate colors and pigmented background.

Ground Face (un-sealed)

The top of the paving units are ground smooth which exposes the aggregate colors and pigmented background.

Shot Blast (sealed)

Exposes the surface of the paving unit to reveal the natural beauty of the aggregates and pigmentation.



Tumbled/Antiqued

Units are molded to form specific surface and side textures that are processed through tumbling equipment, imparting a distressed or aged appearance.

Product Details





BUSINESS PARKING

COMMERCIAL & RESIDENTIAL ROAD

MODULINE SERIES[™] PAVERS

					APPLIC	ATIONS	
PAVERS		Paver Thickness	Ŕ				Ł
	4" x 24"	80 mm	80 mm				\checkmark
	4" x 18"	80 mm	80 mm				\checkmark
	3" x 12"	60 mm 80 mm 101.6 mm	60 mm	80 mm	101.6 mm	101.6 mm	\checkmark
	6" x 6"	60 mm 80 mm 101.6 mm	60 mm	80 mm	80 mm	101.6 mm	√*
	6" Bishop Hat	60 mm 80 mm 101.6 mm	60 mm	80 mm	80 mm	101.6 mm	\checkmark
	6" x 9"	60 mm 80 mm	60 mm	80 mm	80 mm		√*
	6" x 12"	60 mm 80 mm 101.6 mm	60 mm	80 mm	101.6 mm	101.6 mm	\checkmark
	12" x 12"	60 mm 80 mm 101.6 mm	60 mm	80 mm	101.6 mm	101.6 mm	\checkmark
\diamond	12" x 12" ADA Truncated Dome	60 mm	60 mm				\checkmark
	12" x 18"	60 mm	60 mm				\checkmark
	12" x 24"	60 mm	60 mm				\checkmark
	18" x 18"	60 mm	60 mm				\checkmark
	18" x 24"	60 mm	60 mm				\checkmark
	24" x 24"	60 mm	60 mm				\checkmark
	24" x 30"	60 mm	60 mm				\checkmark

* When the product is TUMBLED/ANTIQUED, there is a chance that pieces may be broken off of an individual unit that take it out of compliance. It is the responsibility of the contractor to remove pieces with corner chips greater than 1/2" as to maintain ADA compliance.







PERMEABLE





COLORGARD PROCESS	TEXTURGARD PROCESS	FINISHES					
G	$\overbrace{\checkmark}$	Shot Blast	Shot Blast Sealed	Ground Face	Ground Face Sealed	Smooth	Tumbled/ Antiqued
\checkmark		\checkmark		\checkmark		\checkmark	
\checkmark		\checkmark		\checkmark		\checkmark	
\checkmark		\checkmark		\checkmark		\checkmark	
\checkmark		\checkmark		\checkmark		\checkmark	\checkmark
\checkmark		\checkmark		\checkmark		\checkmark	
\checkmark		\checkmark		\checkmark		\checkmark	\checkmark
\checkmark	IN SELECT REGIONS	\checkmark	IN SELECT REGIONS	\checkmark	IN SELECT REGIONS	\checkmark	
\checkmark	CHECK WITH	\checkmark	CHECK WITH	\checkmark	CHECK WITH	\checkmark	
\checkmark	BELGARD SALES REP.		BELGARD SALES REP.		BELGARD SALES REP.	\checkmark	
\checkmark		\checkmark		\checkmark		\checkmark	
\checkmark		\checkmark		\checkmark		\checkmark	
\checkmark		\checkmark		\checkmark		\checkmark	
\checkmark		\checkmark		\checkmark		\checkmark	
\checkmark		\checkmark		\checkmark		\checkmark	
\checkmark		\checkmark		\checkmark		\checkmark	

Product Details





BUSINESS PARKING



INTERLOCKING CONCRETE PAVERS (ICP)

				APPLIC	ATIONS
PAVERS	Paver Thickness	Ŕ			
Anchor Cobble [®] 8 5/8" x 6" *Only available in New Jersey.	60 mm	60 mm			
Country Marnor [®] (Square) 6" x 6" & (Rectangle) 6" x 9" *Only available in New Jersey.	60 mm	60 mm			
Dublin Cobble [®] (3 pc) 3" x 6", 6" x 6", 6" x 9"	60 mm	60 mm			
Dublin Cobble [®] (Small Square) 6" x 6" (Rectangle) 6" x 9" *Only available in Mid-Atlantic.	60 mm	60 mm			
Dublin Cobble [®] (Large Square) 9" x 9"	60 mm	60 mm			
Holland Stone 4" x 8"	60 mm 80 mm	60 mm	80 mm	80 mm	
Lafitt™ Grana Slab 14 7/8" x 7 3/8", 14 7/8" x 14 7/8", 14 7/8" x 22 5/16"	50 mm	50 mm			
Lafitt™ Rustic Slab 14 7/8" x 7 3/8", 14 7/8" x 14 7/8", 14 7/8" x 22 5/16"	50 mm	50 mm			
London Cobble™ (Square) 6" x 6"	60 mm	60 mm			
London Cobble™ (Rectangle) 6" x 9"	60 mm	60 mm			
Mega-Arbel [®] Patio Slab 15 3/8" x 21"	60 mm	60 mm			
Mega-Bergerac® (3 pc) 9 7/16" x 4 3/4", 9 7/16" x 9 7/16", 9 7/16" x 14 3/16"	80 mm	80 mm	80 mm (see Note 1)		
Mega-Bergerac® (Large Square) 14 3/16" x 14 3/16"	80 mm	80 mm	80 mm (see Note 1)		
Mega-Lafitt™ (3 pc) 10 1/2" x 5 1/4", 10 1/2" x 10 1/2", 10 1/2" x 15 3/4"	80 mm	80 mm	80 mm (see Note 1)		
Mega-Lafitt™ (Large Square) 15 3/4" x 15 3/4"	80 mm	80 mm	80 mm (see Note 1)		
Mega Old World Paver™ (3 pc) 7 11/16" x 10 1/16", 10 1/16" x 10 1/16", 10 1/16" x 12 13/16"	80 mm	80 mm	80 mm (see Note 1)		
Old World Paver™ (3 pc) 5 1/8" x 7 3/4", 5 1/8" x 10 1/4", 5 1/8" x 12 13/16"	80 mm	80 mm	80 mm (see Note 1)		
Urbana® Stone (3 pc) 4" x 8", 8" x 8", 8" x 12"	60 mm	60 mm			
Urbana [®] Stone (Large Square) 12" x 12"	60 mm	60 mm			

* When the product is TUMBLED/ANTIQUED, there is a chance that pieces may be broken off of an individual unit that take it out of compliance. It is the responsibility of the contractor to remove pieces with corner chips greater than 1/2" as to maintain ADA compliance.

** These products have a pronounced surface texture which may have vertical variations that approach or exceed the 1/4" maximum permitted













	COLORGARD PROCESS	TEXTURGARD PROCESS			FINISHES			
E	G	\bigotimes	Shot Blast	Ground Face	Smooth	Tumbled/ Antiqued	Pressed Face	
\checkmark	\checkmark				\checkmark			
*	\checkmark					\checkmark		
*	\checkmark					\checkmark		
*	\checkmark					\checkmark		
*	\checkmark					\checkmark		
\checkmark	\checkmark				\checkmark			
\checkmark	\checkmark				\checkmark			
\checkmark	\checkmark	IN SELECT					\checkmark	
\checkmark	\checkmark	REGIONS ONLY.			\checkmark			
\checkmark	\checkmark	CHECK WITH YOUR LOCAL BELGARD	CHECK WITH YOUR LOCAL BELGARD			\checkmark		
***	\checkmark							\checkmark
*	\checkmark	SALES REP.				\checkmark		
*	\checkmark					\checkmark		
**	\checkmark						\checkmark	
**	\checkmark						\checkmark	
**	\checkmark						\checkmark	
**	\checkmark						\checkmark	
\checkmark	\checkmark						\checkmark	
\checkmark	\checkmark						\checkmark	

*** These products have joint openings that exceed 1/2".

Note 1 - for vehicular applications, it is recommended that pavers be installed on a concrete slab as designed by a local P.E.

Product Details





COMMERCIAL & RESIDENTIAL ROAD

AQUALINE SERIES™ PERMEABLE PAVERS

				APPLIC	ATIONS	
PAVERS	Paver Thickness	Ŕ				Ł
3" x 12"	80 mm 101.6 mm	80 mm	80 mm	101.6 mm	101.6 mm	\checkmark
6" x 6"	80 mm 101.6 mm	80 mm	80 mm	80 mm	101.6 mm	\checkmark
6" x 12"	80 mm 101.6 mm	80 mm	80 mm	101.6 mm	101.6 mm	\checkmark
12" x 12"	80 mm 101.6 mm	80 mm	80 mm	101.6 mm	101.6 mm	\checkmark
9" x 9" L-Stone	80 mm	80 mm	80 mm	80 mm		\checkmark
12" x 12" L-Stone	80 mm 101.6 mm	80 mm	80 mm	101.6 mm	101.6 mm	\checkmark

PERMEABLE INTERLOCKING CONCRETE PAVERS (PICP)

				APPLIC	ATIONS	
PAVERS	Paver Thickness	(i)				F
Aqua Roc™ 4 1/2" x 9"	80 mm	80 mm	80 mm	80 mm		\checkmark
Aqua Roc™ II 3 15/16" x 7 7/8"	80 mm	80 mm	80 mm	80 mm		\checkmark
Drainstone [®] 4" x 8" *Only available in Mid-Atlantic	80 mm	80 mm	80 mm	80 mm		***
Eco Dublin [®] 3 7/16" x 6 7/8", 6 7/8" x 6 7/8", 6 7/8" x 10 1/4"	80 mm	80 mm	80 mm	80 mm		\checkmark
Subterra [®] Stone 7 5/8" x 11 3/8" *Only available in New England & Mid-Atlantic	80 mm	80 mm				***
Turfstone™ 15 3/4" x 23 5/8"	80 mm	80 mm	Limited Use			***

* When the product is TUMBLED/ANTIQUED, there is a chance that pieces may be broken off of an individual unit that take it out of compliance. It is the responsibility of the contractor to remove pieces with corner chips greater than 1/2" as to maintain ADA compliance.

*** These products have joint openings that exceed 1/2".













COLORGARD TEXTURGARD **FINISHES** PROCESS PROCESS Tumbled/ G Shot Blast Ground Face Smooth Pressed Face Antiqued \checkmark \checkmark \checkmark \checkmark \checkmark \checkmark IN SELECT \checkmark \checkmark \checkmark REGIONS ONLY. \checkmark \checkmark \checkmark \checkmark \checkmark CHECK WITH \checkmark \checkmark \checkmark \checkmark \checkmark YOUR LOCAL BELGARD \checkmark \checkmark \checkmark \checkmark \checkmark SALES REP. \checkmark \checkmark \checkmark \checkmark \checkmark

	COLORGARD PROCESS	TEXTURGARD PROCESS			FINISHES		
	G		Shot Blast	Ground Face	Smooth	Tumbled/ Antiqued	Pressed Face
\checkmark	\checkmark				\checkmark		
\checkmark	\checkmark	IN SELECT			\checkmark		
\checkmark	\checkmark	REGIONS ONLY.			\checkmark		
\checkmark	\checkmark	CHECK WITH			\checkmark		
\checkmark	\checkmark	BELGARD SALES REP.					\checkmark
\checkmark	\checkmark				\checkmark		

Product Details

SEGMENTAL RETAINING WALLS (SRW)

		SIZE OF UNIT	CONNECTION TYPE				
WALLS	Height	Width	Depth	Rear Lip	Fiberglass Pin	Surface Lug	Plastic Clips
Allan Block [®] Collection * * *Only available in New England	4"/8"	9"/18"	9 1⁄2"/12"	NO	NO	NO	NO
Allan Block Courtyard Collection [®] * * *Only available in New England	6"	9"/16 ½"	7"	NO	NO	NO	NO
Allan Block Europa Collection [®] * * *Only available in New England	4"/8"	9"/18"	9 1⁄2"/10 1⁄2"	NO	NO	NO	NO
Anchor® 9D	6"	17 ³ /4"	9"	YES	NO	NO	NO
Anchor Aspen Stone® *Only available in New Jersey	4"	11 5%"	7"	YES	NO	NO	NO
Anchor [®] Diamond 9D	6"	17"	9"	YES	NO	NO	NO
Anchor Diamond Pro®	8"	18"	12"	YES	NO	NO	NO
Anchor Diamond Pro Stone Cut® *Only available in New Jersey, New York & Mid-Atlantic	8"	18"/7"/11"	12"	YES	NO	NO	NO
Anchor Highland Stone [®] *Only available in New York	6"	6"/12"/18"	12"	YES	NO	NO	NO
Anchor Highland Stone [®] Freestanding *Only available in New York	6"	6"/12"/18"	12"	NO	NO	NO	NO
Anchor Vertica®	8"	18"	11"	NO	NO	YES	NO
Anchor Vertica Pro® *Only available in New York, New Jersey & Mid-Atlantic	8"	18"	20"	NO	NO	YES	NO
Antique Quarry™ Freestanding Wall	6"	8"; 16"	11"	YES	NO	NO	NO
Antique Quarry™ Retaining Wall	6"	8"; 16"	8"	YES	NO	NO	NO
Belair Wall [®] Freestanding Wall	3"/6"	6"/16"	11"	NO	NO	YES	NO
Belair Wall [®] Retaining Wall	3"/6"	6"/16"	8"	YES	NO	NO	NO
Castle Manor™	6"	6"; 8"; 10"; 12"; 16"	10"	NO	YES	NO	NO
Celtik [®] Wall 90mm	3 %16"	6 ⁷ / ₈ "; 10 ⁷ / ₁₆ "; 13 ⁹ / ₁₆ "; 17 ¹ / ₈ "	8 1/8"	NO	NO	NO	YES
Celtik [®] Wall 135mm	5 ⁵ ⁄16"	6 ⁷ / ₈ "; 10 ⁷ / ₁₆ "; 13 ⁹ / ₁₆ "; 17 ¹ / _{8"}	8 1/8"	NO	NO	NO	YES
2-Sided Celtik [®] Wall 90mm	3 %16"	11 ¹ /16 ["] x 9 ³ /16 ["] ; 9 ³ /16 ["] x 7 ⁵ /16 ["] ; 7 ⁵ /16 ["] x 5 ⁷ /16; 5 ⁷ /16 x 3 ⁹ /16 ["]	9"	NO	NO	NO	NO
2-Sided Celtik [®] Wall 135mm	5 ⁵ ⁄16"	11 ¹ / ₁₆ " x 9 ³ / ₁₆ "; 9 ³ / ₁₆ " x 7 ⁵ / ₁₆ "; 7 ⁵ / ₁₆ " x 5 ⁷ / ₁₆ "; 5 ⁷ / ₁₆ " x 3 ⁹ / ₁₆ "	9"	NO	NO	NO	NO
Keystone [®] Compac III *Only available in Mid-Atlantic, New Jersey & New York	8"	18"	12"	NO	YES	NO	NO
Keystone [®] Victorian Compac III *Only available in New Jersey	8"	18"	12"	NO	YES	NO	NO
Keystone Country Manor® *Only available in New Jersey & New York	3"	16/14"; 12/10"; 10/8"; 6/6"; 6/4"	10"	NO	NO	NO	NO
Keystone Country Manor® *Only available in New Jersey, New York & Mid-Atlantic	6"	16/14"; 12/12"; 12/10"; 10/8; 6/4	10"	NO	YES	NO	NO
Keystone Country Manor [®] Plus *Only available in New York	6"	16/14"; 12/10"; 6/4	10"	NO	YES	NO	NO
Keystone [®] Standard III *Only available in Mid-Atlantic, New Jersey & New York	8"	18"	18"	NO	YES	NO	NO
Marquise Pro™	8"	18"	12"	YES	NO	NO	NO
Mega-Tandem™	12"	24"	3"	NO	NO	NO	NO
Versa-Lok [®] Standard *Only available in Pennsylvania, Maryland & New England	6"	16/14"	12"	NO	NO	NO	NO
Versa-Lok [®] Weathered *Only available in Pennsylvania & Maryland	6"	16/14"	12"	NO	NO	NO	NO
Weston Stone [®] Universal	4"	12"	8"	NO	NO	NO	NO
Weston Stone® 3 Piece *Only available in New Jersey	4"	8"; 12"; 16"	8"	NO	NO	NO	NO

** Available in multiple pieces/sizes.

					WALL BATTER /		
Reinforced Polypropylene	MULTI-PIECE	Natural	Three Plane	Straight	Tumbled	Textured	SET BACK
NO	YES	NO	NO	NO	NO	Split Face	6, 12 Degree
NO	YES	NO	NO	NO	NO	Split Face	6 Degree
NO	YES	NO	NO	YES	NO	Split Face	6 Degree
NO	NO	NO	NO	YES	NO	Split Face	10.6 Degree; 1.125" Per Course
NO	NO	NO	NO	YES	NO	Crunch Face	10.6 Degree
NO	NO	NO	NO	YES	NO	Split Face	10.6 Degree
NO	NO	NO	NO	YES	NO	Split Face	7.1 Degree; 1" Per Course
NO	YES	NO	NO	YES	NO	Crunch Face	7.1 Degree; 1" Per Course
NO	YES	NO	YES	YES	NO	Straight Face	10.6 Degree
NO	YES	NO	YES	YES	NO	Straight Face	Vertical
NO	NO	NO	NO	YES	NO	Split Face	2, 4 Degree
NO	NO	NO	NO	YES	NO	Split Face	2, 4 Degree
NO	YES	YES	NO	YES	NO	Chiseled	Vertical
NO	YES	YES	NO	YES	NO	Chiseled	Vertical, 9.5 Degree/1"
NO	YES	YES	NO	YES	NO	Sculpted	Vertical
NO	YES	YES	NO	YES	NO	Sculpted	Vertical, 9.5 Degree
NO	YES	YES	NO	NO	YES	Split Face	Vertical, 9.5 Degree
NO	YES	NO	NO	YES	NO	Crunch Face	Vertical or 9 Degree
NO	YES	NO	NO	YES	NO	Crunch Face	Vertical or 9 Degree
NO	YES	NO	NO	YES	NO	Crunch	Vertical
NO	YES	NO	NO	YES	NO	Crunch	Vertical
NO	NO	NO	YES	YES	NO	Split Face	Near vertical, 8.8 Degree
NO	NO	NO	NO	YES	NO	Split Face	Near vertical, 8.8 Degree
NO	YES	NO	NO	YES	YES	Soft Split	Vertical or 9.5 Degree
NO	YES	NO	NO	YES	YES	Soft Split, Tumbled	Vertical or 9.5 Degree
NO	YES	NO	NO	YES	YES	Soft Split, Tumbled	Vertical or 9.5 Degree
NO	NO	NO	NO	YES	NO	Split Face	Near vertical, 8.8 Degree
NO	NO	NO	YES	YES	NO	Split Face	7.1 Degree or 1"
YES	NO	YES	NO	YES	NO	Natural	2.4 Degree Batter
NO	NO	NO	NO	YES	NO	Standard	Vertical
NO	NO	NO	NO	YES	NO	Weathered	Vertical
NO	NO	NO	NO	YES	YES	Tumbled	Vertical
NO	YES	NO	NO	YES	YES	Tumbled	Vertical

ANCHOR COBBLE Only available in New Jersey.

Traffic Load Index & Compliance



Processes 6

Paver Thickness





COUNTRY MANOR® SQUARE & RECTANGLE Only available in New Jersey.





G

Paver Thickness

60 мм



DUBLIN COBBLE® 3-PIECE

Traffic Load Index & Compliance (4) **()** 3-Piece Modular 3 x 6 x 2 3/8 6 x 6 x 2 3/8 6 x 9 x 2 3/8



Paver Thickness

60 мм



DUBLIN COBBLE® SMALL SQUARE & RECTANGLE

Only available in Mid Atlantic.

Paver Thickness

60 мм





DUBLIN COBBLE® LARGE SQUARE





Paver Thickness

60 мм



HOLLAND STONE

Traffic Load Index & Compliance





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60 мм / 80 мм



80 MM Thick machine installation pattern available.

(Note: half pieces are present in the pattern.)



LAFITT[™] GRANA SLAB





LAFITT™ RUSTIC SLAB



LONDON COBBLETM SQUARE

Traffic Load Index & Compliance





Paver Thickness

60 мм



LONDON COBBLETM RECTANGLE





Paver Thickness





MEGA-ARBEL® PATIO SLAB





Paver Thickness





MEGA-BERGERAC® 3-PIECE





MEGA-BERGERAC[®] LARGE SQUARE

Traffic Load Index & Compliance



For vehicular applications, it is recommended that pavers be installed on a concrete slab as designed by a local P.E.

Processes

G



MEGA-LAFITT[™] 3-PIECE





Paver Thickness

Paver Thickness

80 MM

80 mm

For vehicular applications, it is recommended that pavers be installed on a concrete slab as designed by a local P.E.



MEGA-LAFITT™ LARGE SQUARE

Traffic Load Index & Compliance





Paver Thickness

80 mm

For vehicular applications, it is recommended that pavers be installed on a concrete slab as designed by a local P.E.



MEGA OLD WORLD PAVER™



OLD WORLD PAVER™

Processes	Paver Thicknes
	80 mm
For vehicular applications, it i hat pavers be installed on a designed by a local P.E.	is recommended concrete slab as
	For vehicular applications, it that pavers be installed on a designed by a local P.E.



Paver Thickness

80 MM

For vehicular applications, it is recommended that pavers be installed on a concrete slab as designed by a local P.E.





Paver Thickness

or vehicular applications, it is recommended



URBANA® STONE 3-PIECE







Paver Thickness

60 мм



URBANA® STONE LARGE SQUARE



AQUA ROC™





.

AQUA ROC II™



80 MM Thick machine installation pattern available.





80 mm

80 MM Thick machine installation pattern available. (Note: half pieces are present in the pattern.)



DRAINSTONE[®] Only available in Mid Atlantic.





ECO DUBLIN®



SUBTERRA® STONE

Only available in New England & Mid Atlantic.





TURFSTONETM



Processes

Paver Thickness

80 мм



AB COLLECTION®

Only available in New England.

Applications

AB Stone-12º Se	tback	AB Lite Stone-6	Setback	AB Cap	
8 x 18 x 12 Available in Granite Grey only		4 x 18 x 12	Contraction of the second	4 x 17 1/2 x 12	and a second
AB Classic-6° Se	etback	AB Junior Lite-6	° Setback		•
8 x 18 x 12		4 x 9 x 12			
AB Jumbo Junior-	6° Setback	AB Corner			
8 x 9 x 9 1/2		8 x 16 x 8			



AB COURTYARD COLLECTION®

Only available in New England.

AB Dublin Blo	ck	Corner Block	Post Cap	
6 x 16 1/2 x 7		6 x 15 1/2 / 15 x 7	3 x 24 x 12	
AB York Block		Cap		
6 x 9/7 1/2 x 7	Ŵ	3 1/2 x 9 1/4 / 7 x 10		



AB EUROPA® COLLECTION

Only available in New England.

Applications





ANCHOR® 9D



ANCHOR ASPEN STONE®

Only available in New Jersey.







ANCHOR® DIAMOND 9D







ANCHOR DIAMOND PRO®



ANCHOR DIAMOND PRO STONE CUT®

Only available in New Jersey, New York & Mid-Atlantic.

Medium & Small Units	 Large Unit	,
8 x 11 x 12	8 x 18 x 12	
8 x 7 x 12	Cap	
	4 x 17 1/4 x 10 x 10	Control of



ANCHOR HIGHLAND STONE® RETAINING

Only available in New York.

Applications





ANCHOR HIGHLAND STONE[®] FREESTANDING

Only available in New York.

Applications





ANCHOR VERTICA®

Victorian Face	
8 x 18 x 11	To a
Сар	
4 x 17 1/14 x 10 3/8	



ANCHOR VERTICA PRO®

Only available in New York, New Jersey & Mid-Atlantic.

Applications





ANTIQUE QUARRYTM FREESTANDING

Applications





ANTIQUE QUARRYTM RETAINING





BELAIR WALL® FREESTANDING

Applications

6" Freestandin	ıg Wall	3" Freestandi	ng Wall
6 x 6 x 11	THE R.	3 x 6 x 11	And Make
6 x 16 x 11		3 x 16 x 11	
6 x 6 x 11 6 x 16 x 11		3 x 6 x 11 3 x 16 x 11	



BELAIR WALL® RETAINING





CASTLE MANOR™





CELTIK® WALL 90MM

Applications





CELTIK[®] WALL 135MM





CELTIK® WALL 90MM DOUBLE-SIDED

••			
90mm Celtik Wall Double Sided		Double Sided Capping Unit	
3 9/16 x 11 1/16 Front x 9 3/16 Back x 9	CUNIN	3 1/2 x 16 Front x 3 11/16 Back x 11	Congress of
1/16 x 9 3/16 Front x 5/16 Back x 9			
9/16 x 7 5/16 Front x 7/16 Back x 9			
9/16 x 5 7/16 Front x 9/16 Back x 9			


CELTIK® WALL 135MM DOUBLE-SIDED

Applications





KEYSTONE® COMPAC III

Only available in Mid-Atlantic, New Jersey & New York.

Applications





KEYSTONE® VICTORIAN COMPAC III

Only available in New Jersey.





Technical Information

KEYSTONE COUNTRY MANOR® 3"

Only available in New Jersey & New York.

Applications





KEYSTONE COUNTRY MANOR® 6"

Only available in New Jersey, New York & Mid-Atlantic.

Applications





KEYSTONE COUNTRY MANOR[®] PLUS Only

Only available in New York





KEYSTONE® STANDARD III

Only available in New Jersey, New York & Mid-Atlantic.

Applications







MARQUISE[™] PRO





MEGA-TANDEM™ (MSRW)™

Mega-Tandem	С
12 x 24 x 3	2' Si uț
	4'





Technical Information

VERSA-LOK® STANDARD

Only available in Pennsylvania, Maryland & New England.

Applications





VERSA-LOK[®] WEATHERED

Only available in Pennsylvania & Maryland.

Applications





WESTON STONE® UNIVERSAL





WESTON STONE® 3-PIECE

Only available in New Jersey.







Professional Support

ENVIRONMENTAL SOLUTIONS

Belgard consultants can work with your team to develop the best PICP system design or retaining wall configuration to control runoff volume and discharge rates, improve the quality of local groundwater, reduce or prevent downstream impacts, and minimize the land consumed for stormwater management.

SITE PLANNING

The experts at Belgard can help you optimize your site in a number of ways—whether you're looking for creative ways to define public spaces, manage or harvest stormwater, or increase the useable space for development.

DESIGN ASSISTANCE

Our team of design consultants can help address both aesthetic and engineering design concerns, including issues with local soil conditions, concrete or asphalt overlays, handling H-20/HS-20 loading, safety compliance, slope stabilization, and erosion control.

CAD FILES

For your convenience, Belgard offers a constantly expanding library of easy-to-download CAD files of our products and patterns.

CONTINUING EDUCATION

Belgard offers a variety of ongoing educational programs for our industry partners, including Lunch & Learns, online CEU courses, and our Belgard University training program.





46 Spring Street | Holbrook, MA 02343 ph: 781.767.2202 | Toll Free: 800.462.2225

331 Newman Springs Rd. | Suite 236 | Bldg. 2 | Third Floor Red Bank, NJ 07701 | ph: 800.682.5625

> 13555 Wellington Center Circle | Suite 101 Gainesville, VA 20155 | ph: 866.259.9473

> > 735 Wagnum Rd. | P.O. Box 472 Fishers, NY 14453 | ph: 800.444.2103



900 Ashwood Parkway | Suite 600 | Atlanta GA 30338 ph. 877.235.4273 | fx. 770.804.3369

belgardcommercial.com