





BELGARD®

Commercial Site Solutions Guide



BRINGING PEOPLE AND PLACES TOGETHER

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Interlocking CONCRETE PAVEMENTS (ICP)

Belgard Canada is a leader in the concrete paver industry. We continually develop unique and innovative pavement solutions that meet or exceed CSA and ASTM standards and are available in an array of colours, finishes, shapes, and sizes to meet the design needs of any commercial, municipal or institutional project.



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Designing the Pavement System

SCIENCE BEHIND THE STRUCTURAL DESIGN

Interlocking concrete pavement systems have been proven to be durable and effective in a variety of pedestrian and vehicular applications, but like any pavement system, proper design, construction, and maintenance procedures are required. ASCE 58-16 is the latest edition of the published guidelines for structural design of interlocking concrete pavement created by the ASCE/T&DI Structural Design of Interlocking Concrete Pavement Standards Committee, and provides technical guidance on developing interlocking concrete pavement structures for various traffic loading and 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 a given traffic load for the given lifespan based on the native soil's bearing capacity. Calculating a pavement design, ESAL (Equivalent Single Axle Load) value can 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 and other commercial vehicles range from 0.21 to 6.87. In terms of selecting an acceptable paver for the given traffic load, both the paver thickness and paver aspect ratio have to be considered. The heavier the expected traffic, the thicker the paver needs to be



To obtain a copy of ASCE 58-16, please contact your Belgard Sales Representative.

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.

IS THE CONCRETE SEGMENTAL PRODUCT A PAVER, SLAB OR PLANK?

Paver shape and thickness must be selected based on the application. Most long planks and large slabs are not suitable for vehicular applications. Concrete segmental units should be evaluated based on a variety of site-specific conditions. The project pavement engineer should confirm that the product can meet expected performance for vehicular loading conditions.

PRODUCT	AREA (SQ. IN.)	MINIMUM THICKNESS (IN)	MAXIMUM LENGTH OR WIDTH (IN)	ASPECT RATIO	PLAN RATIO	CSA STANDARD	ASTM STANDARD	TYPICAL APPLICATION
Paver	≤101	2.4"	NA	≤4:1	NA	231.1	C936	PEDESTRIAN OR VEHICULAR
Slab	>101	1.2"	48	>4:1	NA	231.1	C1782	PEDESTRIAN
Plank	≤288	2.4"	48	≥4:1	≥4:1	231.1	NA	PEDESTRIAN

NOTE: There is currently no industry recognized definition of a plank (linear) segmental product. Reference the Canadian Standards Association A231.1 and A231.2 for unit concrete definitions applicable in Canada.

SAMPLE ASPECT & PLAN RATIOS

	WIDTH	LENGTH	THICKNESS	ASPECT RATIO	PLAN RATIO	
		12" 300mm	60mm (2-3/8")	5.1:1		
	6" 150mm		12" 300mm 80mm (3-1/8")* 3.8:1		3.8:1	2:1
	roomin	COOMIN	101.6 mm (4")	3:1		
÷	<i></i>		60mm (2-3/8")	2.5:1		
	6" 150mm	6" 150mm	80mm (3-1/8")	1.9:1	1:1	
· · · ·			101.6 mm (4")	1.5:1		
	6"	9"	60mm (2-3/8")	3.8:1	1 5.1	
	150mm	230mm	80mm (3-1/8")	2.9:1	1.5.1	
	4" 100mm	24" 600mm	80mm (3-1/8")	7.7:1	6:1	



THE DESIGN STANDARD

The following are the recommended minimum paver thickness and aspect ratio based on a Traffic Load Index which is an Oldcastledeveloped guideline for designing flexible segmental paving structures based on paver thickness, peripheral friction based on unit shape, and expected load conditions as a selection criteria for vehicular applications. These guidelines are based on sand bedding set over dense graded aggregate. The icons are used on the website and in the product information section in company catalogues.



Commercial Pedestrian

There are no restrictions for use in pedestrian only areas. However, in areas that will be subject to maintenance or emergency vehicles, a 2³/₆" (60mm) thick unit should have an aspect ratio less than or equal to 4:1, and a 3¹/₆" (80mm) thick unit less than or equal to 5:1. Planks and slabs can be used if properly designed by a pavement engineer.



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 31%" (80mm), and the units should have an aspect ratio less than or equal to 4:1. Planks and slabs should not be used in parking applications unless properly designed and engineered.



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 3¹/₈" (80mm), and the units should have an aspect ratio less than or equal to 3:1. Planks and slabs should not be used for roadway applications. A 45 or 90-degree herringbone paver pattern or L-shaped product is recommended for all vehicular roadway pavements.



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" (101.6mm), and the units should have an aspect ratio less than or equal to 3:1. Planks and slabs should not be used in heavy vehicular roadway applications. A 45 or 90-degree herringbone paver pattern or L-shaped product should be used for all vehicular roadway pavements. With exception to the VS-5 paver system engineered and tested for superior interlock and suited to design in runner or herring bone patterns.

Pattern Versatility

TRADITIONAL AND MULTI-PIECE PATTERNS

Belgard's patterns were developed to create the ultimate in pattern versatility allowing for many series pieces to fit together as intended. Add to this the various aesthetic elements (including colours 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. For a complete pattern library go to BelgardCommercial.com or Expocrete.com NOTE: What makes a pattern acceptable for vehicular applications is a combination of the pattern has a high degree of interlock, and the sizes involved match the available vehicular products.

VS 5 SERIES





ROMAN EURO



HOLLAND STONE





AQUA ROC™





Permeable Paver

MODULINE SERIES®

ECO-DUBLIN™





Permeable Paver

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 vehicular 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 the size of the area - larger patterns can be used in larger areas, and the application.



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.





2-6 x 12 (28%), 2-12 x 12 (58%)

Step 4

Adding colours, textures, and borders are where the true versatility of Belgard pavers are realized.



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

Typical Installations

Aggregate Base

Aggregate base materials should conform to that used under asphalt. If no local, state, or provincial standards exist, then the requirements for aggregate base in ASTM D2940 are recommended.

Minimum lift thickness are typically between 6 to 12 inches dependent on soil conditions and project type.



Rigid Base (Concrete/Asphalt)

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 pedestrian applications, although it can be applied in vehicular applications as long as suitable curb & durable bedding sand is used.



Bituminous Tack Coat Over Rigid Base

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 (pedestrian or vehicular applications) or asphalt (pedestrian 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.



2" (50MM) DIA. DRAIN HOLES
LOCATE AT LOWEST ELEVATIONS
FILL WITH ANGULAR DRAINAGE AGGREGATE

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 ESAL, which represent the estimated number of vehicles that pass over the surface during the design life.

- See "Designing the Pavement System" on page 8 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.



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

Typical Belgard Paver DCOF wet values ~ 0.75

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 on the website and in the product information pages in company catalogues to identify



Section 302.3 - 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.

Tactile paver 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.



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 colours 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, 3 mm chamfer widths 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 creates a 3 mm chamfer width for that reason.





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

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 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 CSA 231.1 "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.



The following icon is used on the website and in the product information pages in company catalogues to identify





Paver laying machine installing VS 5 Series at a project in British Columbia

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	ACTIVITY	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



Permeable Interlocking CONCRETE PAVEMENTS (PICP)



Use of PICP on various pedestrian and vehicular 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.



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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 sources 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, which maintain the base flow conditions between rainfall events in lakes and rivers, are reduced.



TYP. ASTM NO. 8, 89, OR 9 AGGREGATE IN OPENINGS CONCRETE PAVERS MIN. 3 1/8 IN. (80 MM) THICK FOR VEHICULAR TRAFFIC CURB/EDGE RESTRAINT WITH CUT-OUTS FOR OVERFLOW DRAINAGE (CURB SHOWN)

BEDDING COURSE 1 1/2 TO 2 IN. (40 TO 50 MM) THICK (TYP ASTM NO. 8 AGGREGATE) 4 IN. (100 MM) THICK ASTM NO. 57 STONE OPEN-GRADED BASE GEOTEXTILE ON TOP AND SIDES OF SUBBASE UNDER/BEYOND CURB MIN. 6 IN. (150 MM) THICK ASTM NO. 2 STONE SUBBASE OPTIONAL GEOTEXTILE ON SUBGRADE PER DESIGN ENGINEER SOIL SUBGRADE

Permeable Interlocking Concrete Pavements (PICP)

Permeable Interlocking Concrete Pavements (PICP) are fundamentally large scale infiltration reservoirs 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 INFILTRATION** 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 INFILTRATION** 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 95th 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	А
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

The goal of PICP is to mimic, if not improve upon a site's predevelopment hydrology by detaining as much stormwater as possible in the base/subbase, so that it can infiltrate back into the ground. PICP is considered a Low Impact Development (LID) Best Management Practice (BMP) for stormwater management. As a distributive infiltration practice, PICP conserves space by providing a functional pavement and Stormwater Control Measure in one system. Various methods are used to model the site hydrology and calculate runoff flow rates and volumes. Depending on the hydrology model used, a curve number or a runoff coefficient is needed to represent the PICP site condition. Belgard permeable pavers have a variety of shapes and surface openings. Based on the type of aggregate used in the surface openings (No. 8 or No. 9 stone), new installations can expect minimum infiltration rates of between 500 to 750 inches/hours when tested in accordance with ASTM C1781.

COVER DESCRIPTION	CURVE NUMBER for hydrologic soil group							
Condition	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	89	92	94	95				
Industrial	81	88	91	93				
Roads, Parking Lots & Roofs	98	98	98	98				

Source: USDA Technical Release 55

CURVE NUMBER FOR PICP SYSTEM

The Natural Resources Conservation Service (NRCS) method characterizes site runoff based on hydrologic soil type, land cover and amount of rainfall using a parameter known as a curve number (CN). Curve Numbers predict direct runoff from rainfall excess, and can range between 30 to 100, with lower numbers indicating lower runoff potential. Caution should be applied when using CNs for permeable pavement. Results can underestimate runoff in small watersheds (under 5 acres) for small storm events (below the 2-year storm), so for these cases, calculations should be verified by another method. Sample CNs per USDA Technical Release-55 are listed on this page. However, traditional hydrologic modelling requires CN modifications to properly model permeable pavement to account for reservoir storage. CNs for PICP systems can range anywhere between 45 for A soils to between 70-80 for D soils.

SURFACE RUNOFF COEFFICIENT FOR PICP SYSTEMS

A common question that is asked is "What is the runoff coefficient (C) of the PICP system? C represent the percentage of rainfall that becomes runoff based on the surface type and is used in the Rational Method to determine peak flow rates. It is overly simplistic and does not account for rainfall intensity, duration, or reservoir drainage. A C value of between 0.25 and 0.40 depending on subgrade permeability is appropriate for PICP systems when using the Rational Method.

CREDIT FOR PERVIOUS SURFACE

Correctly designed, installed, and maintained, PICP systems have surface infiltration rates higher than that of almost any natural soil, and several times greater than the maximum possible rainfall intensity. This is why a PICP surface should be given complete credit for "100% perviousness," as would a meadow or forest.

WATER VOLUME CONTROL

PICPs can detain or retain water quality volume through storage in the aggregate base and subbase. Most design storm requirements are easily controlled in the underground reservoir created until the subgrade soils infiltrate the water or until underdrains release the volume at a controlled rate.

Controlling Peak Discharge Rates

STORMWATER INFILTRATION

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 INFILTRATION 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 INFILTRATION system is used. What is unique to a NO INFILTRATION 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.



Preventing Downstream Impacts

EROSION CONTROL

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.

Wardynski, B.J., R.J. Winston, W.F. Hunt. 2012. "Thermal Mitigation Potential of Permeable Pavements", LID Research Summit.

Stormwater Quality

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.

PICP reduces pollutant concentrations through several processes including adsorption, microbial action, volatilization and filtration. Contaminants within the subgrade infiltrate will undergo further bacterial and chemical reactions with the native soils prior to reaching the groundwater table or receiving waters.

Filtration is not only effective at removing large particulate and suspended solids, but potentially also metals, Total Phosphorous (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 in addition to adsorption, is taking place with some pollutants.

Recommended Maintenance

Studies have found a relationship between joint infill material and long term infiltration rates. ASTM No. 8, 89, or 9 stone in properly sized joint openings provide the best performance. 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 semiannual 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.

Handling Roof Water

In some locations, roof water can be managed by the PICP system as long as the hydrologic design and base storage capacity 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 aggregate reservoir, a cleanout on the upstream and flow dissipater at the end of the outlet pipe is recommended as shown in the illustration below.



Site Stormwater Management



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 INFILTRATON** system (complete with liner) can be used as the long term storage reservoir, with the water being used for irrigation, washing, or other nonpotable applications. An integrated control system, which include water harvesting information (www.stormcapture.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.





PERMECAPTURETM

In certain applications, combining the benefits of PICP with the high volume detention/retention capabilities of StormCapture® vaults provides solutions for challenging site conditions. Examples of potential applications for PermeCapture include: coastal areas or sites with high water tables; poor or limited aggregate availability; poor soils, shallow rock, or excavation challenges; sites requiring access for inspection & maintenance of retention/detention water, or sites where aggregate water storage is not recognized or credited. The need to maintain an aesthetic surface is another reason to utilize this type of system. PermeCapture vaults are H-20 rated, and include HydraPorts to allow water from the PICP system to drain into the storage chambers. When used as a retention system, treatment and harvesting technology can be incorporated into the PermeCapture system.



Urban Environment

REDUCING DEICING SALT USE

PICP perform very well in cold weather conditions. Studies have found that freezing temperatures do not result in surface heaving and temperatures in the base and subbase remain above freezing even when surface air temperatures are well below freezing.

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.



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 colours. Belgard has tested a number of their lighter colour pavers to verify they achieve the desired solar reflectance or SRI values 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.



URBAN COOLING

Although using lighter coloured 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).



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 runon 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.

2. Using Permeable Pavement as a BMP



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.





NOTE: Image courtesy of North Carolina Department of Environment and Natural Resources.

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	D DESIGN	OPTI	ON 2 - P	ERMEA	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
Stormwa	ater Collection									
4 A	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
Stormwa	ater 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
Roadwa	y 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
Roadwa	y 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/w jointing 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)

Backed by years of experience and a national network of partners, Belgard Canada offers technical expertise and SRW products to meet the site challenges of projects that range from light commercial to the most challenging of site conditions.



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Types of Retaining Wall Construction

GRAVITY RETAINING WALL

A gravity retaining wall relies on the weight and batter of the SRW units to resist the soil forces exerted on the wall. Geogrid soil reinforcement is not used with gravity walls. The allowable heights of gravity retaining walls are typically limited to 2 to 3 times the front-to-back depth of the SRW facing unit.



GEOSYNTHETIC-REINFORCED RETAINING WALL

Geosynthetic reinforced walls use soil reinforcement layers, typically geogrids, to stabilize the soil behind the SRW facing, creating a coherent mass large enough to resist the soil forces acting on the wall system. The SRW facing unit, the geosynthetic reinforcement and the reinforced together then form the retaining wall system.

To resist more load, the reinforcement layers are lengthened and/or strengthened to provide the required resistance. Thus, reinforced wall systems can be designed for much taller earth retention heights and loading conditions than conventional gravity walls. Reinforced retaining walls should be designed by a qualified engineer and constructed by experienced contractors.


NO-FINES CONCRETE BACKFILL

In many retaining wall applications, sufficient space does not exist behind the face units to allow excavation or placement of geosynthetic reinforcement. For these instances, a wall system can be designed that is reliable, aesthetically pleasing and cost-effective. Using a noo-fines concrete backfill, the depth and mass of the wall can be effectively extended. Since the no-fines concrete backfill also serves as the required drainage zone. With the proper product selection, a retaining wall system can be designed that completely eliminates the need for the construction of a mechanically stabilized earth zone behind the wall facing and requires substantially less excavation than is usually necessary in grid-reinforced wall construction. Retaining walls using no-fines concrete backfill should be designed by a qualified engineer and constructed by experienced contractors. Structural backfill is also referred to as "no fines concrete", "stabilized aggregate".



GEOSYNTHETIC REINFORCED SOIL – INTEGRATED BRIDGE SYSTEM (GRS-IBS)

GRS-IBS technology is an innovative and cost-effective bridge system that is an alternate option to conventional bridge construction. The system uses closely spaced geosynthetic reinforcement layers and compacted aggregate to directly support bridge superstructure.

Due to the simplicity of design, construction speed, use of readily available materials and the elimination of deep foundations, the GRS-IBS method can reduce costs by 25-60% compared to conventional methods. GRS-IBS should be designed by a qualified engineer and constructed by experienced contractors.



Segmental Retaining Wall Best Practices Guide

The National Concrete Masonry Association (NCMA), the trade organization representing masonry and segmental retaining wall (SRW) producers and affiliates, has recently completed its SRW Best Practices Guide.

The Guide provides educational materials in support of NCMA's Zero Wall Failures Initiative. This initiative is "an industry-wide program to educate owners, designers, site civil engineers, geotechnical engineers, and installers of SRW systems on the industry's recommended best practices and to promote a philosophy that strives for ensuring successful wall performance." Using the Guide will help reduce poor retaining wall performance in addition to reducing liability of the involved design professionals by presenting information and guidelines regarding standards of practice. Some key suggestions from the Guide include:

- Follow provided guidelines for optimum project organization that define roles and responsibilities for the various parties involved in retaining wall design and construction.
- Retaining wall design should be done during the design phase of the project by a design professional working directly for the project owner or owner's representative and not be procured by the retaining wall contractor during the construction phase.
- Global and Compound Stability must be evaluated.
- The SRW components, Face unit, soil reinforcement and soil, must meet basic industry standards.
- Taller walls require special considerations including tighter standards for the reinforced soil.

PLANNING CONSIDERATIONS

The SRW design should be performed during the design phase of the project with the SRW designer as part of the design team. At the onset of the project, the SRW design engineer and site civil engineer should meet with the property owner to understand how the site will be used, project timeline and aesthetic objectives. Everyone on the team should also have an understanding of any special considerations, including local codes or ordinances, unusual site conditions and project relation to existing structures or utilities. Other issues that will impact design include existing site drainage and topography, surface water, soil characteristics, property lines, and proposed locations of structures, roads and utilities. The owner or site civil engineer should contract with a geotechnical engineer to obtain a report on soil characteristics, groundwater conditions, applicable seismic coefficients and applicable foundation remediation needs. Site access constraints may also exist that will impact construction or staging and should be discussed in the planning phase.





CHOOSING SRW UNITS

Segmental retaining wall units are available in a myriad of sizes, shapes, textures and colours. The minimum requirements for SRW units are covered in ASTM C1372, Standard Specification for Dry-Cast Segmental Retaining Wall Units. As with any product standard, these minimum requirements are appropriate for many, but not all, SRW applications. In areas that require extreme freeze/thaw durability, higher performance products may be required.

BUILDING TALL WALLS

Walls in excess of 10 feet require better soils, more rigorous attention to quality control, closer scrutiny to potential settlement, greater attention to compaction efforts during construction and careful attention to detailing. Project designer professionals must pay careful attention to site conditions well beyond the location of the SRW system. In addition, layout considerations, such as the wall batter and geosynthetic reinforcement lengths, become more significant. Other considerations include site geometry, existing or new structures above or below the wall, property boundaries and the extent of required excavation.

CHOOSING GEOSYNTHETIC REINFORCEMENT

The full evaluation of geosynthetic reinforcement materials is very important, yet very complex. Fortunately, a thirdparty review system is already in place to verify the strength properties and QC standards of reinforcement materials through the National Transportation Product Evaluation Program (NTPEP). Therefore, a best practice is to only use geosynthetic reinforcements with a current NTPEP report.

REINFORCED FILL GRADATION FOR TALL WALLS

	PERCENT PASSING						
SIEVE SIZE	WALLS BETWEEN 10-20'	WALLS > 20'					
1 in. (24 mm)	100	100					
No. 4	20-100	20-100					
No. 40	0-60	0-60					
No. 200	0-35, Pl < 6	0-15, Pl < 6					

How Segmental Retaining Walls Help In Land Development

Proper site planning can save significant time and money. Segmental retaining walls can convert a slope that uses horizontal space to a vertical grade change creating more usable and valuable land space. Segmental retaining walls should be considered for:

- Cost effectiveness
- Performance
- Aesthetics
- Versatility
- Speed of Construction
- Durability
- Environmentally Friendly



Examples of Site Utilization Include:

SLOPE STABILIZATION AND EROSION CONTROL

Soil stabilization is key to maintaining the integrity of the project site. By increasing the stability of the soil, you can increase your usable space on any project site and help prevent unnecessary erosion.



WATER MANAGEMENT

The most significant slopes at most typical land development projects are around the project perimeter, along interior water courses, around stormwater management ponds and wetland boundaries and between buildings. Segmental retaining walls help minimize the loss of valuable real estate at these locations by minimizing developmental impacts of stormwater ponds footprint and encroachments into wetland.



TERRACED WALLS

Terracing walls creates horizontal spaces that may improve landscape maintenance by eliminating steeper slopes that are hard to vegetate and maintain. Terraces can also provide valuable space for utilization of parking, patios and landscape.

- Create more usable 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





AB FenceTM system

AB Fence is a mortarless concrete fence system that uses maintenance free interlocking blocks to create an attractive and effective solution for sound abatement, security and privacy issues. Unlike precast wall systems that are limited in esthetic and installation options, AB Fence balances both design and practical needs of all stakeholders from developers and landowners to municipalities and homeowners.



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Components	45

Noise Abatement / Privacy Wall Solution

The AB Fence System not only adds curb appeal but offers a practical and pragmatic security and sound solutions for developers and municipalities. Incorporate gates, railings and even lighting into sweeping walls, curves and corners.

This concrete fence uses posts and panels like many typical fence systems to construct beautiful and durable concrete structures that will stand the test of time. The AB Fence Blocks have a split-faced look on one side and striated look on the other side. This gives the AB Fence System the ability to offer many different looks and styles without having to order any special blocks. Incorporating different color blocks to form patterns or banding within the panels and posts allows for even more options.

The AB Fence Blocks lock together to create posts and panel sections that are versatile and stack up quickly for easy installation. It can incorporate curves and corners with ease and use different colored/textured or multiple shaped blocks to create beautiful patterned fences.

- can be built up to 15' (4.57 m) and higher with engineering
- use it on its own or incorporate into existing fencing solutions
- · desirable design and aesthetic components to match geographical terrain
- dedicated technical support engineering, design and construction
- split-faced look on one side and striated look on the other side resulting in virtually limitless face profiles without the need of
 ordering special blocks
- · incorporate different color blocks to form patterns or banding within the panels and even posts
- easily build curves and corners
- approved for use on highway projects in British Columbia by the British Columbia Ministry of Transportation



AB Fence Post



OVERVIEW

The AB Fence System not only adds curb appeal but offers a practical and pragmatic security and sound solutions for developers and municipalities. Incorporate gates, railings and even lighting into sweeping walls, curves and corners.

AB Fence has 2 main components - posts and panels

- Posts are constructed on concrete piles, reinforced with steel and concrete grout.
- Fence Panels are dry stacked on a compacted base with 2 course bond beam assemblies to increase rigidity.

AB FENCE BASIC COMPONENTS



AB Fence Panel Block R

AB Fence Post Block



AB Fence Cap

APPROVED BY BCMOT

British Columbia's population growth coupled with increasing traffic density has resulted in the need of formal noise abatement standards to improve liveability along heavily trafficked roadways and highways.

AB Fence[™] System is now approved for use on highway projects in British Columbia as per the Ministry of Transportation Recognized Products List.



Column & Step

INTEGRATED SOLUTIONS

Leverage the Belgard product offering through custom and ready made column and step solutions for any application setting.

Belgard offers solutions that offer aestheic consistency and integration with hardscap components throughout a project while at the same time offer installation efficiencies throughout the scope of the project.



Column & Pillar Solutions	¥8
Step Solutions5	51

AB Courtyard®



OVERVIEW

- 4 corner units per column row
- Column width: 17"
- Centre opening: 2"



FlagStack[®] Pillar Kit



OVERVIEW

- Pillar Height / Pallet: 37.6" | 3.13'
- Pillar Height / Layer: 9.40" | .78'
- Centre opening: 210 x 240mm



FlagStack Pillar Unit



FlagStack Pillar Cap









StackStone®



OVERVIEW

- 4 corner units per column row
- 6 standard units per column row
- Column width: 17"
- Centre opening: 2"





Also able to construct large pillars

Tandem Column



OVERVIEW

 Building Tandem columns using the Tandem Modular block and select from Madria veneer or Ashlar veneer.

Weston Stone Universal





OVERVIEW

- 4 stones per column row
- Reverse laying pattern every course for stack bond joint
- Column width: 20"



ZenWall



OVERVIEW

- 4 corners per column row
- Reverse laying pattern every course
- Column width: 21.5"
- Centre opening: 5"
- Maximum column height: 36" / 3'





Landings[™] Step Unit



OVERVIEW

- Each Landings[™] Step Unit is manufactured with 2 unique face patterns
- The step units are palletized and packaged for easy skidsteer loader removal.
- Care needs to be taken in handling these units. If a blemish occurs on one side of unit, rotate 180° before setting unit into place.





SienaStone[®] Coping Unit





OVERVIEW

- 4 corners per column row
- Reverse laying pattern every course
- Column width: 21.5"
- Centre opening: 5"









System Solutions for site development

We see Belgard pavers, slab and walls being part of a greater system, used in concert with site solution components such as jointing sand, pedestal, post solutions, etc.

We are commited to partnering with the design community by helping you find complete system solutions to meet or even exceed your client's needs and expectations through comprehensive products are work in conjunction with our hardscape products.



Rise-It Paver System	. 54
Screwjack Pedestal System	. 54
Fechniseal HP NextGel Joining Sand	. 55
Sleeve-It® SD-1 Fence Post Anchor System	. 55
CornerStone Post-IN System	. 55

Site Solution System Accessories

DYNAMEX™ RISE-IT PAVER SYSTEM

The Dynamex[™] Rise-It Paver Pedestal System is designed to fully support the load of installed pavers and foot traffic.

- Improve drainage and protection of critical roofing membranes and moisture barrier systems
- Withstand over 6,500 lbs of load
- Apply over broken sidewalks or uneven concrete areas
- Manufactured and durably made from 100% recycled materials
- Maximize recreational and living space by expanding rooftop and terrace spaces





BLACK JACK & ONE STEP PEDESTALS

Design and build level decks on rooftops or any structural surface

- **OneStep** pedestals are designed for slab support engineered to reduce material, construction and life-cycle costs. They have a height range of between .95" and 1.77" (24mm and 44mm). The height may be increased to 4.1" (104mm) by using BJ 20E and/or BJ 40E extenders.
- **HalfStep** pedestals have a height range of .47" and .94" (12mm-24mm)
- **OneStep** and **HalfStep** pedestals have individual chocks that can be adjusted independently in 1mm increments to compensate for uneven installation surfaces. Both pedestals can be separated into halves or quarters enabling flush placement along wall edges as well as inside and outside corners.
- Supports Green Building LEED points available







SYSTEM SOLUTIONS FOR COMPLETE SITE DEVELOPMENT

TECHNISEAL® HP NEXTGEL JOINTING SAND

- Eliminate dust and haze
- Water resistant after 60 minutes
- Ideal for oncrete pavers, wet-cast pavers, natural stone, textured or clay pavers and porcelain tiles
- Applications include heavy-sloped and high-traffic areas
- False and wide joints from 1.5mm to 10cm (1/16" to 4")
- Ideal for commercial, residential and municipal proects







Granite

sranite

Tan

Techniseal NextGel





Urban Grey

Pacific Grey

SLEEVE-IT® SD-1 FENCE POST ANCHOR SYSTEM

- Integrates stable fence footings into the support structure of retaining walls
- Maximizes usable real estate at the top of a retaining wall
- Shortens construction time for retaining walls with summit fencing
- Provides an engineered load value for the prevention of fence post overturning



CORNERSTONE POST-IN SYSTEM

- Ideal for 457x457 and 600x600 slab sizes
- Allows for placement of fencing units on top of retaining walls
- Utilizes the large hollow cores of wall blocks for steel and wood fencing to strengthen and anchor your load bearing posts
- Provides an engineered load value for the prevention of fence post overturningturning of a fence post











Click. Drag. Design SOFTWARE SOLUTIONS

Whether it's part of initial feasability studies and project preparation to complete design specifications, you have accesses to comprehensive software solutions that bring designs from conception to completion.



RisiStone Wall Estimator	58
Allan Block Wall 15 Software	59

RisiStone Wall Estimator



RISISTONE WALL ESTIMATOR - WWW.RISISTONE.COM/ESTIMATOR/

- Provides complete Preliminary Estimation Results for Walls up to 4.0m (13ft) in height.
- Easily draw the Plan View of your Wall on any PC, tablet or mobile device, add grades and loading conditions
- A Preliminary Estimate of your Wall quantities is automatically generated, including Block, Geogrid, Backfill, Drainage Stone, Gravel Base, etc.
- Generate a complete, comprehensive Estimation Report to Print, including a Plan View of the Wall, Elevation View, and all Cross Sections for every Wall Height.
- Ideal for Feasibility or Preliminary Estimation of Geogrid, Gravity, or Multi-Depth Gravity Risi Stone Retaining Walls.
- Online tutorial https://youtu.be/166QA3rqFvQ



						T
The second second second second second			and the second second			
in Stations Red Salting to Sol Links Restaurant						
Jantibes						
dij/Coping Length			86.14 H			
tal Wall Area (including coping/consent)		20	4.65 eq.ft			
Area of Units (excluding coping/content)		18	4.39 sq ft			
Number of Corter Units						
inforcement Area		59	00 eo y0			
it Soil Volume (Reinforced Zone)		21	00 eu 96			
inage Appregate (Gravity Sections)		1	.00-cu yd			
se Gravel Volume		3	00 eu yt			
E Land E Deving Desinage Annumption				•		
Anton Top • (1) Rectified 10:19 as growt • (2) (2) Year	Guck Deals	• el before	Exercical Data	addities in	and Printing	
This Estivution	Tool is for philming	ry costing and ha	sibility refs.			
This Estimation If its part to be used for hiddens or ones	Tool is for phillminol truction. Always retain	ry coeffing and has sin a Protensional	Engineer to pro	which Firmal De	angia.	

Allan Block Design Software



AB WALL 15 SOFTWARE - WWW.ALLANBLOCK.COM

- AB Walls is a comprehensive design tool which outputs professional quality construction drawings with technical support data.
- Allows designers to transfer a conceptual layout from a site plan to a complete wall solution and export it to various CAD software programs as well as SketchUp.
- Generate elevations, plans, and multiple cross sectional views of retaining wall projects.
- Capabilities include static and seismic calculations for internal, external and internal compound stability.
- Take a designed wall project and print a complete package in one step making it an easy submittal
- Inspired by the work on the Best Practices for SRW Design document to help drive the industry towards zero wall failures





Paver Colours & Finishes

Available Colours



Grey

Desert Buff



Tofino Grey (FM)



Charcoal

Toscana



Rio

Autumn Blend



Victorian



Northern Blend



SATURA - Fogo Grey



SATURA - Levanna Blue



SATURA - Cerus Grey



SATURA - Nucari Brown

Face-Mix Colour Blend

SATURA - Valcour

Brown

- Greater concentration of colour and patented blending
- Greater cement content vs through mix
- Premium materials ensure a bold surface and superior surface wear

Finishes

Red

Manufacturing processes generate various finishes that are distinctive and can create the exact look you desire for your project.



Standard (Smooth)

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.

Textured (Slate, Diamond, Dimpled)

Unit surfaces offer a textured profile which creates units with authentic and various textures.



Roman (Tumbled, Antiqued)

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



Units can be manufactured with custom colour blends to meet any architectural design requirements.



PAVERS **APPLICATIONS** * THICKNESS SIZE UNITS (MM) (MM) \checkmark **Classic Standard** 60 mm 600 x 300 150 x 300 \checkmark \checkmark **Classic Standard 3:1** 230 x 300 60 mm 300 x 300 \checkmark \checkmark **Classic Half Standard** 60 mm 150 x 230 \checkmark \checkmark **Classic Double Standard** 60 mm 150 x 150 \checkmark **Classic California** 60 mm 150 x 230 \checkmark \checkmark \checkmark 230 x 300 **Classic Nevada** 60 mm 150 x 300 **Classic Standard 80mm** 60 mm 230 x 300 \checkmark \checkmark 300 x 300 \checkmark **Classic Double Standard 80** 60 mm 150 x 230 \checkmark \checkmark \checkmark Cobble 4.5 x 4.5 60 mm 115 x 115 \checkmark \checkmark Cobble 4.5 x 7 60 mm 115 x 172 \checkmark Dimensions6 60 mm 72.5 x 193 \checkmark Dimensions12 60 mm 140 x 193 \checkmark \checkmark Dimensions18 \checkmark \checkmark 60 mm 193 x 216











Pedestrian Traffic

in Vehicular Traffic Roadways

Accessability Compliant

sability Mechanical pliant Install Pedestal Application

ADA	MECHANICAL INSTALL		FINISHES		CHAMEED	SQ. FT. PER PALLET	
F		Smooth	Textured	Tumbled	WIDTH		
\checkmark		\checkmark			3 mm	116.2	
\checkmark			\checkmark		N/A	120	
\checkmark			\checkmark		N/A	112	
√ *		\checkmark			Rounded	120	
√ *		\checkmark			Rounded	112	
√ *		\checkmark			Rounded	120	
\checkmark		\checkmark			5 mm	120	
\checkmark		\checkmark			N/A	112	
√ *		\checkmark			Rounded	119.1	
√ *		\checkmark			Rounded	119.1	
√ *		\checkmark		\checkmark	N/A	95.3	
√ *		\checkmark		\checkmark	N/A	97.9	
√ *		\checkmark		\checkmark	N/A	97.2	

• Interlocking pavers can be used for a variety of different vehicular applications. Appropriate shape and thickness is based on project-specific conditions including type of loading, base design, and subgrade conditions. It is recommended that you consult a Belgard representative in your area before specifying products for vehicular applications.

* 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.

PAVERS

		THICKNESS	CIZE	APPLICA	ADA	
UNITS		(MM)	(MM)	(X)		E
	Dimension 3x9	60 mm	50 x 200	\checkmark	\checkmark	\checkmark
	Dimensions 6x12	60 mm	100 x 100	\checkmark	\checkmark	\checkmark
	Dimensions 12x24	60 mm	100 x 200	\checkmark		\checkmark
	Estate Stone	60 mm	100 x 100	\checkmark	\checkmark	\checkmark
	FlagStone					
	Grass Grid					
	Holland Stone 4 x 8	80 mm	100 x 200	\checkmark	\checkmark	\checkmark
	Holland Stone 2 x 8	60 mm	50 x 200	\checkmark	\checkmark	\checkmark
	Holland Stone 4 x 4	60 mm	100 x 100	\checkmark	\checkmark	\checkmark
	Holland Stone 4 x 8	60 mm	100 x 200	\checkmark		\checkmark
	Holland Stone 4 x 8	80 mm	100 x 200	\checkmark	\checkmark	\checkmark
	Holland Stone 8 x 8	60 mm	200 x 200	\checkmark	\checkmark	\checkmark
	Holland Stone 12 x 12	60 mm	300 x 300	\checkmark	\checkmark	\checkmark
	Mega-Arbel®	80 mm	390 x 532	\checkmark	\checkmark	
	Mega-Libre® Slab (2-Piece Modular)	60 mm	393 x 756 390 x 563	\checkmark		
	Moduline Series® 4 x 18	100 mm	102 x 457	\checkmark		\checkmark
64	Moduline Series® 4 x 24	100 mm	102 x 600	\checkmark		\checkmark
*	Moduline Series®	100 mm	300 x 600	\checkmark		\checkmark

MECHANICAL INSTALL		FINISHES		CHAMFER	SQ. FT. PER
	Smooth	Textured	Tumbled	WIDTH	PALLET
	\checkmark			7 mm	42.7
	\checkmark			7 mm	48
	\checkmark			7 mm	120
	\checkmark			7 mm	48
\checkmark	\checkmark			7 mm	96
	\checkmark			7 mm	42.7
	\checkmark			7 mm	48
	\checkmark			7 mm	120
\checkmark	\checkmark			7 mm	96
	\checkmark			7 mm	129
	\checkmark			7 mm	116
		\checkmark		N/A	60.9
		\checkmark		N/A	83
	\checkmark			2 mm	54
	\checkmark			2 mm	72
	\checkmark			6 mm	69.8

PAVERS

		THICKNESS	CIZE	APPLICATIONS *			ADA
UNITS		(MM)	(MM)	(F
	Old Country Stone Type 1	60 mm	190 x 380 x 60 380 x 380 x 60 380 x 570 x 60	\checkmark			
	Old Country Stone Type 2						
***	Old Country Stone Type 3						
-	Origins						
	Pacific Slate Standard						
0	Pacific Slate Double Standard						
	Pacific Standard Double Standard						
	River Rock (3-Piece Modular)	80 mm	290 x 145 290 x 290 290 x 435	\checkmark	\checkmark		
	River Rock Grana (3-Piece Modular)	80 mm	290 x 145 290 x 290 290 x 435	\checkmark	\checkmark		\checkmark
	River Rock Grana Border						
	Roman Euro 6 x 6	60 mm	150 x 150	\checkmark	\checkmark		
	Roman Euro 6 x 7	60 mm	150 x 175	\checkmark	\checkmark		
	Roman Euro 6 x 9	60 mm	150 x 225	\checkmark	\checkmark		
	Roman Euro 4x8	60 mm	225 x 225	\checkmark	\checkmark		
	Trapeza Paver	100 mm	380 x 253.3/126.7	\checkmark	\checkmark		\checkmark
	Turfstone	60 mm	100 x 200 200 x 200 200 x 300		\checkmark		\checkmark
	VS-5 75 x 300	108 mm	75×300 Pedestrian	(ehicular Road	ways Accessab	ility Mechanica	Pedestal
66	VS-5 150 x 300	108 mm	150 x 300	V	∠ Complia	ant instatl	

MECHANICAL INSTALL		FINISHES	-	CHAMEER	SO ET PER
	Smooth	Textured	Tumbled	WIDTH	PALLET
		\checkmark			139.9
\checkmark		\checkmark			89
\checkmark	\checkmark				89
			\checkmark	N/A	116
			\checkmark	N/A	119
			\checkmark	N/A	109
			\checkmark	N/A	109
	\checkmark				55.98
 Interlocking pa 	vers can be used for a var	iety of different vehicular a	applications. Appropriate s	varies between 4 - 10 mm hape and thickness is	120
based on project- that you consult a	specific conditions includir Belgard representative in	g type of loading, base de: your area before specifyin	sign, and subgrade conditi g products for vehicular a	ons. It is recommended oplications.	58
* When the produ broken off of an ir	ct is TUMBLED/ANTIQUED dividual unit that take it ou	there is a chance that pie It of compliance.	tes may be		70

It is the responsibility of the contractor to remove pieces with corner chips greater than 1/2" as to maintain ADA compliance.













PERMEABLE PAVERS

					ADA		
UNITS		THICKNESS	SIZE	()			F
	Aqua Roc™	80 mm	114 x 230	\checkmark	\checkmark	\checkmark	\checkmark
	Eco Dublin® (3-Piece Modular)	80 mm	88 x 175 175 x 175 x 261	\checkmark	\checkmark		\checkmark
	SF Rima™	80 mm	240 x 240	\checkmark	\checkmark		\checkmark

CONCRETE GRID PERMEABLE PAVERS

UNITS		THICKNESS	SIZE	APPLICATIONS			ADA
				(F
333	Turfstone™	80 mm	600 x 400	\checkmark	\checkmark		**



** Joint opening exceeds 1/2"

MECHANICAL INSTALL	FINISHES				MANUF.	%	CHAMEED	SQ. FT.
	Smooth	Textured	Face Mix	Antiqued	JOINT WIDTH	SURFACE OPENING	WIDTH	PER PALLET
	\checkmark				7.5	9%	3 mm	90
	\checkmark				12 mm	7%	N/A	80.2
	\checkmark							99

MECHANICAL INSTALL		FINISHES				SO ET	
	Smooth	Textured	Face Mix	Antiqued	% SORFACE OPENING	PER PALLET	
	\checkmark				40%	103.3	

• Interlocking pavers can be used for a variety of different vehicular applications. Appropriate shape and thickness is based on project-specific conditions including type of loading, base design, and subgrade conditions. It is recommended that you consult a Belgard representative in your area before specifying products for vehicular applications.

* 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.












ARCHITECTURAL SLABS												
		THICKNESS	CIZE	APPLIC	ADA							
UNITS		(MM)	(MM)	(Å		F						
	Slate Slabs	45 mm	450 x 450	\checkmark	\checkmark	\checkmark						
	Smooth Slabs	45 mm	450 x 450	\checkmark	\checkmark	\checkmark						
	Slate Slabs	45 mm	600 x 600	\checkmark	\checkmark	\checkmark						
	Smooth Slabs	45 mm	600 x 600	\checkmark	\checkmark	\checkmark						
	Smooth Slabs	45 mm	300 x 600	\checkmark	\checkmark	\checkmark						
	Galiano Slab	50 mm	600 x 600	\checkmark	\checkmark	\checkmark						
	Smooth Slabs	50 mm	300 x 600	\checkmark	\checkmark	\checkmark						
	Vancouver Bay Slab 16 x 16	45 mm	406 x 406	\checkmark	\checkmark	\checkmark						
	Vancouver Bay Slab 18 x 18	45 mm	454 x 454	\checkmark	\checkmark	\checkmark						
	Vancouver Bay Slab 12 x 24	45 mm	304 x 608	\checkmark	\checkmark	\checkmark						
	Vancouver Bay Slab 24 x 24	45 mm	608 x 608	\checkmark	\checkmark	\checkmark						













Pedestrian Traffic Vehicular Roadways Traffic

Accessability Compliant

sability Mechanical pliant Install

Pedestal Application

MECHANICAL INSTALL		FINIS	CHANGER				
	Smooth	Textured	Face Mix	Antiqued	WIDTH	PALLET	
		\checkmark				105	
	\checkmark					105	
		\checkmark				96	
	\checkmark					96	
	\checkmark					120	
	\checkmark		\checkmark			96	
	\checkmark					120	
		√ Shot Blast				149.5	
		√ Shot Blast				126	
		√ Shot Blast				112	
		√ Shot Blast				96	













MIRAGE® PORCELAIN PAVERS UNITS APPEARANCE THICKNESS SIZE Ardesie Stone 2 cm 60 x 60 Na.Me Stone 2 cm 60 x 60 Wood 120 x 20 Noon 2 cm Stones 2.0 60 x 60 Stone 2 cm Unico 33 x 60 Stone (Bullnose) 2 cm





	APPLIC	ATIONS	ADA	PEDESTAL APPLICATION	
(Ł		PALLET
\checkmark			\checkmark	\checkmark	232.5
\checkmark			\checkmark	\checkmark	232.5
\checkmark			\checkmark		155
\checkmark			\checkmark	\checkmark	232.5
\checkmark			\checkmark		254.8







Wall Colours & Finishes

Available Colours



Grey

Rustic



Charcoal



Manitoba Stone



Silverado



Sandstone



Victorian



Desert Buff



Rocky Mountain Blend



Earthtone



Coastal



SATURA - Cerus Grey



SATURA - Nucari Brown

Finishes

Manufacturing processes generate various finishes that are distinctive and can create the exact look you desire for your project. All processes are not available in all locations. Check with your local Belgard Sales Representative for more information.



Standard (Splitface)

Unit surfaces with a classic splitface textured profile.



Tumbled

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



Textured

Unit surfaces offer a textured profile which creates units with authentic slate textures.



Smooth

Units are smooth profile for modern designs.

SEGMENTAL RETAINING WALLS (SRW)										
		UNIT SIZE			CONNECTION TYPE		ADDITIONAL APPLICATIONS			
UNITS		Height (mm)	Width (mm)	Depth (mm)	Block	Other	Column	Steps		
FREESTAND	ING WALLS		·							
	Ashlar Tandem™ Wall (3 Piece Modular)	178	347, 198, 457	76	\checkmark		\checkmark			
	Melville Tandem™ Wall	180	603	67	\checkmark		\checkmark	\checkmark		
Contraction of the second	SienaEdge	180	1000	290				\checkmark		
	Weston Stone™ Universal	100	300	200			\checkmark	\checkmark		
	Zen Wall	75	325	225			\checkmark	\checkmark		
SRW (SEGM	ENTAL RETAINING WA	LLS)								
	AB [®] Aztec Classic	200	460	300	\checkmark			\checkmark		
	AB [®] 3 Degree	200	460	300	\checkmark			\checkmark		
	AB® Classic	200	460	300	\checkmark			\checkmark		
	AB® Collection Lite	100	460	300	\checkmark					
	AB® Jumbo	200	230	240	\checkmark			\checkmark		
1	AB [⊗] Stone	200	460	300	\checkmark			\checkmark		
1	AB [®] Vertical	200	460	300	\checkmark			\checkmark		
	AB® Collection Classic, AB Vertical	200	460	300	\checkmark		\checkmark			

	TEXTURE			FACE S	STYLES	RATTED/	SQFT &
Sculpted	Split	Tumbled	Smooth	Straight	Virtual Joint	SETBACK	UNITS PER PALLET
\checkmark					\checkmark	0/4°	70.1
			\checkmark	\checkmark		0/4°	46.7
			\checkmark	\checkmark		3°	12 units
		\checkmark		\checkmark		Vertical	100 units
			\checkmark	\checkmark		Vertical	29.2
\checkmark				\checkmark		6°	40 SqFt 40 Units
	\checkmark					3°	40 SqFt 40 Units
	\checkmark					6°	40 SqFt 40 Units
	\checkmark					6°	36 SqFt 72 Units
	\checkmark					6°	50 SqFt 100 Units
	\checkmark					12°	40 SqFt 40 Units
\checkmark	\checkmark					1°	40 SqFt 40 Units
	\checkmark					3°	40

SEGMENTAL RETAINING WALLS (SRW)											
		UNIT SIZE			CONNECTION TYPE		ACCESSORIES* (SOLD SEPARATELY)				
UNITS		Height (mm)	Width (mm)	Depth (mm)	Block	Other	Column/ Corner Unit	Step Unit			
SRW (SEGMI	ENTAL RETAINING WA	LLS)									
	AB Europa® Dover	200	460	265	\checkmark		\checkmark				
	AB Europa® Barcelona	100	460	265	\checkmark		\checkmark				
Ŵ	AB Europa® Palermo	200	230	240	\checkmark		\checkmark				
	Garden Wall	100	230	240	\checkmark		\checkmark				
1	CornerStone®	203	457	305	\checkmark		\checkmark				
TRACT	Pisa2®	150	200	300	\checkmark		\checkmark				
	P{isa Llte										
	SienaStone® 333	185	1000	333	\checkmark		\checkmark	\checkmark			
N	SienaStone® 500	185	1000	500	\checkmark		\checkmark	\checkmark			
	SienaStone® 925	185	1000	925	\checkmark		\checkmark	\checkmark			
	Versa-Lok®	153	406 (F), 355 (B)	300	\checkmark						

FENCING SYSTEM

		UNIT SIZE			CONNECT	ION TYPE	ACCESSORIES* (SOLD SEPARATELY)	
UNITS		Height (mm)	Width (mm)	Depth (mm)	Block	Block Other		Step Unit
5	AB Fence Panel	150	460	200	\checkmark		\checkmark	
E.	AB Fence Half Panel	200	230	150	\checkmark		\checkmark	
C	AB Fence Lite Panel	100	460	150	\checkmark		\checkmark	
-	AB Fence Half Lite Panel	100	150	150	\checkmark		\checkmark	

TEXTURE			FACE S	STYLES	PATTED/	SQ. FT.	
Sculpted	Split	Tumbled	Smooth	Straight	Virtual Joint	SETBACK	PER PALLET
	\checkmark	\checkmark				6°	40
	\checkmark	\checkmark				6°	36
	\checkmark	\checkmark				6°	50
	\checkmark	\checkmark				6°	20
	\checkmark			\checkmark		4°	40
						7°	24
	\checkmark					7°	18
	\checkmark					7°	12
	\checkmark					7°	6
	\checkmark					7.1°/ ¾"	24

TEXTURE				FACE S	TYLES	BATTER/	SQ. FT.
Sculpted	Split	Tumbled	Smooth	Straight	Virtual Joint	SETBACK	PER PALLET
\checkmark	\checkmark			\checkmark		Vertical	48
\checkmark	\checkmark			\checkmark		Vertical	64
\checkmark	\checkmark			\checkmark		Vertical	64
\checkmark	\checkmark			\checkmark		Vertical	40













Masony & Veneer Products

Expocrete's presence across western Canada allows for superior product consistency and operational efficiencies that directly benefit our customers.

In addition to our Belgard brand of hardscape products and solutions, Expocrete manufacturers and distributes complete masonry, veneer and concrete brick solutions that can be used as stand-a-lone implementations or add value to a site development through our Echelon Masonry brand.





by **Oldcastle**

Masonry



Specialty Masonry



ExpoBrick & Euro Brick



Beonstone Siding Panels





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 usable space for development.

ENGINEERING SERVICES

Our team of design consultants can help address both aesthetic and engineering design concerns, material quantity estimates and permit ready plans.



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.



LUNCH AND LEARNS

Informative, educational sessions brought to your office along with a healthy and delcious lunch.



BELGARDCOMMERCIAL.CA

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