VILLAGE OF PENTWATER

PIER RAILING MOUNTED SAND CAPTURE FENCING

PRELIMINARY ENGINEERING REPORT

820890

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APPENDICES

INTRODUCTION

This report presents the results of the preliminary design evaluation for the installation of permanent railing mounted "sand capture" fence panels totaling approximately 576 feet on both the north and south piers of the Village's channel. This project also proposes an approximate 60', off pier extension of the north pier railing, adjacent to Mears State Park, to which permanent "sand capture" fencing will also be affixed.

Temporary bamboo fencing installed on the north pier in early 2013 and additional ice and water shield installed in early 2014 has proven to be effective in keeping windborne sand deposited along the leading and trailing edges of the temporary fence. The Village has provided periodic sand removal from this area which has kept the majority of this sand from blowing into and filling the harbor channel, the primary objective. Based on the success of the temporary measures the Village wishes to install a permanent, durable but cost effective feature that has aesthetic value and is considering a non-corrosive metal type fencing as the most practical solution.

Existing snow fencing marks the approximate location for a proposed railing extension. The railing extension will be of similar material to the existing pier railing and will be anchored by concrete foundations into the sand.

STAKEHOLDERS

The pier structures (north and south), a 3' buffer zone and revetments within 30' of the pier structures are owned by the US Army Corps of Engineers (Corp). F&V requested and received "as-built" construction drawings for the pier structures which were reconstructed approximately 15 years ago. Based upon our discussion with the Grand Haven Corp office it is our understanding that a parks/recreation lease agreement between the Village and Corp exists whereby the Village provides maintenance functions on the pier. During this discussion, the Corp indicated that they paint the pier railings every other year with an epoxy based paint. A copy of the existing parks/recreation lease agreement should be located and reviewed to determine pier maintenance responsibilities once these improvements are constructed.

In addition to the Village and Corp, stakeholders include the Michigan DNR/Mears State Park at the north pier and the South Beach Association for the south pier. The Corp has indicated that a construction permit will not be required for installation of the sand capture fencing on existing pier mounted railings. Plans, when finalized will need to be submitted to the Corp for structural and safety review.

PRELIMINARY DESIGN

In late November, a limited topographic field survey of the north pier area tied to USGS datum was performed, primarily for the design of the proposed railing extension.

Railing Extension

A 60 foot inner railing extension is proposed along the north pier from the east end (land side end) of the wave attenuator, see Appendix A. This railing extension will be constructed of tubular steel to match the existing pier mounted railing. It will be constructed off of the existing pier using concrete foundations. It is proposed that the easternmost 36' will be angled to the northeast instead of the 90 degree bend to the north as depicted on prior drawings provided by the Village. We believe this will help with the maintenance removal of deposited sand.

This railing will be free standing in that it will not be connected to the pier mounted railing. It should be noted that we propose the top of concrete foundations to be 1' below existing sand elevation. The railing extension

will be epoxy painted to match the existing pier mounted railings. See Appendix B for preliminary details of this railing.

The estimated construction cost for foundation installation, railing fabrication, painting and installation is $12,000.

Sand Capture Panel Location

The placement locations for the permanent sand capture fencing on the existing pier mounted railing was identified in the preliminary location drawings provided by the Village with the projects request for proposals. We have measured the existing railing to verify the length of railing where panel will be affixed. These locations are shown on the drawing in Appendix A and summarized below:

Location	Length
South Pier (on pier railing)	294 lineal feet
North Pier (on pier railing)	224 lineal feet
North Pier (new railing extension)	60 lineal feet
Total	578 lineal feet

Sand Capture Panel Material Alternatives

In addition to the material identified in the Village's initial research we have identified other alternative materials for consideration. The following provides a description of the principle alternatives, preliminary cost estimates as well as a list of pros/cons of each.

A. Corrugated Metal Wall Panels:

Initial research by Village representatives identified two possible supplier options for the sand fencing materials, including McElroy Metal Mega-Rib metal roof/wall panel and a similar product from Berridge called Deep Deck corrugated wall panel. Standard wall panels are 36" in height and can be affixed either directly to the railing with stainless steel bolts or with spacers to provide some separation between the railing and panels. While these panels can come with a manufacturers paint system, we are concerned with the durability of the paint in the proposed environment. For corrugated metal wall panels, we recommend the McElroy Galvalene Plus product, 22 gauge thickness (unpainted), which is the maximum thickness for this product. We do have concern that damage or vandalism could occur with the relatively "thin" thickness of this product. It should be noted that paint application can only be applied to 24 gauge and higher thicknesses. A contractor applied "rolled edge" or "J channel" should be applied on panel edges to provide a safe edge. An example of this material is provided in Appendix C.

Estimated material fabrication/delivery and installation cost for Corrugated Metal Wall panels is $9,000. The upcharge with manufacturer Kynar Paint System will be approximately $2,500.

B. Fabricated Stainless Steel Panels (solid or perforated):

The panels would be fabricated from stainless steel, which can either be solid or perforated, with a proposed 42" height to match railing height. Panel lengths can vary based on railing dimensions, but are anticipated to be 12' long. A manufacturer applied "hemmed" or "U-channel edge" is recommended on all four sides to provide a safe edge surface. We recommend 16 gauge thickness to maximize durability, and minimize potential damage due to vandalism. The panels can be affixed either directly to the railing with stainless steel bolts or with spacers to provide railing separation. Stainless steel panels can be solid or perforated to mimick the porosity of the existing temporary fencing. While these panels can also come with a manufacturers powder coat paint system, we are concerned with the durability of the paint in the proposed environment. With the thicker panel section, it is also possible to bend the top portion (6"+/-) at a 45 degree angle to provide further deflection of wind borne sand and still maintain the stability of the panel. We do not see this as an option for the Corrugated Metal Panels. See Appendix C for a representative example of this product. Stainless steel panels can be finished with a powder coating to match railing color or left unfinished.

Estimated material/installation cost for Fabricated Stainless Steel Panels:

1. 49 – 42"x12' -16 gauge stainless steel panels with hemmed or "U-channel" edge (perforated or non-perforated), estimated cost is $25,000-$28,000.
2. Upcharge for pre-bent top section. $2,000
3. Upcharge for powder coating to match pier rails. $3,000.

C. Decorative Chain Link Fencing with Vertical Vinyl Slats:

The material is zinc galvanized chain-link or vinyl coated fence with vertical galvanized stretcher bars inserted in the fabric and assembled in a galvanized framework that can be mounted to the existing railing. Chain link fencing sections could be affixed with bolts, with or without spacers, or stainless steel bands for easy removal for maintenance. Vertical vinyl slats would be installed to mimic the permeability of the existing temporary fencing along the pier railing. From a durability standpoint we would expect that the chain link fence would last 8-10 years with proper inspection/maintenance. It is estimated that the vinyl slats would need to be replaced every other year. A representative example of this product is included in Appendix C.

Estimated material/installation cost for Decorative Chain Link Fence with Vertical Vinyl Slats is $15,000

Material	Pro's	Con's
Corrugated Metal Wall Panels	▪ Inexpensive ▪ Can Come Prefinished (24 guage) ▪ Medium Durability	▪ Damage potential due to thin gauge ▪ Periodic refinishing (if painted) (appr. 2 yrs) ▪ Aesthetic Value
Fabricated Stainless Steel Panels	▪ High Durability ▪ Aesthetic Value	▪ High Cost ▪ Periodic refinishing (if painted) (appr. 2 yrs)
Chain Link Fence w/Vinyl Slats	▪ Relatively Inexpensive ▪ Low Cost	▪ Low Durability, damage potential due to vandalism ▪ Routine Maintenance of Chain Link ▪ Periodic Slat Replacement ▪ Aesthetic Value

SUMMARY

Preliminary project cost summary for the Sand Capture Fencing based on the above described alternatives are:

Description	Corrugated Metal Panel	Stainless Steel Panel	Chain Link Fencing
Pier Railing Extension Fabrication/Installation	$12,000	$12,000	$12,000
Sand Fence Panel Fabrication and Delivery	$9,000	$28,000	$15,000
Contractor Costs (Mob, Prep, Install and Clean-Up)	$7,500	$7,500	$7,500
Engineering/Contracting/Inspection	$6,500	$6,500	$6,500
Total Estimated Project Cost	**$35,000**	**$54,000**	**$41,000**

Appendix A

Field Survey with Railing Extension
Sand Capture Panel Layout

FLEIS&VANDENBRINK
DESIGN. BUILD. OPERATE.
2960 Lucerne Drive SE
Grand Rapids, MI 49546
P: 616.977.1000
F: 616.977.1005

REVISION:

VILLAGE OF PENTWATER
PENTWATER TOWNSHIP, OCEANA COUNTY, MICHIGAN
PIER RAILING

FIGURE 1

DESIGN TEAM: DW
CHECK BY:
DRAWING INFORMATION: Pier Figure 01615 karim

NOT FOR CONSTRUCTION

JANUARY 2015
F&V PROJECT NO. 820890

1

Appendix B

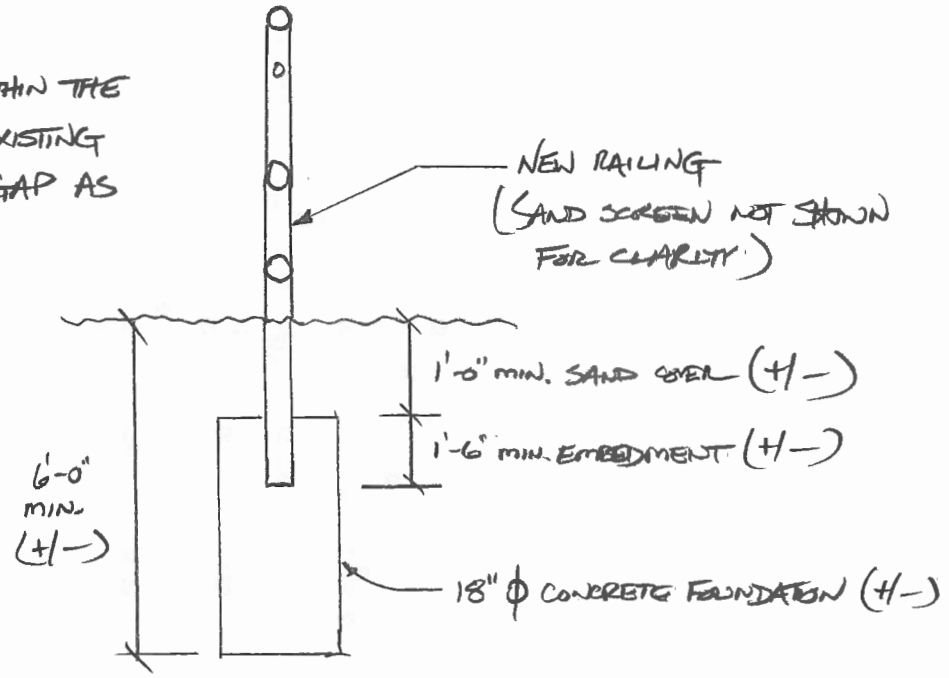
Pier Railing / Sand Capture Panel Details

FLEIS & VANDENBRINK
ENGINEERING, INC.
www.fveng.com

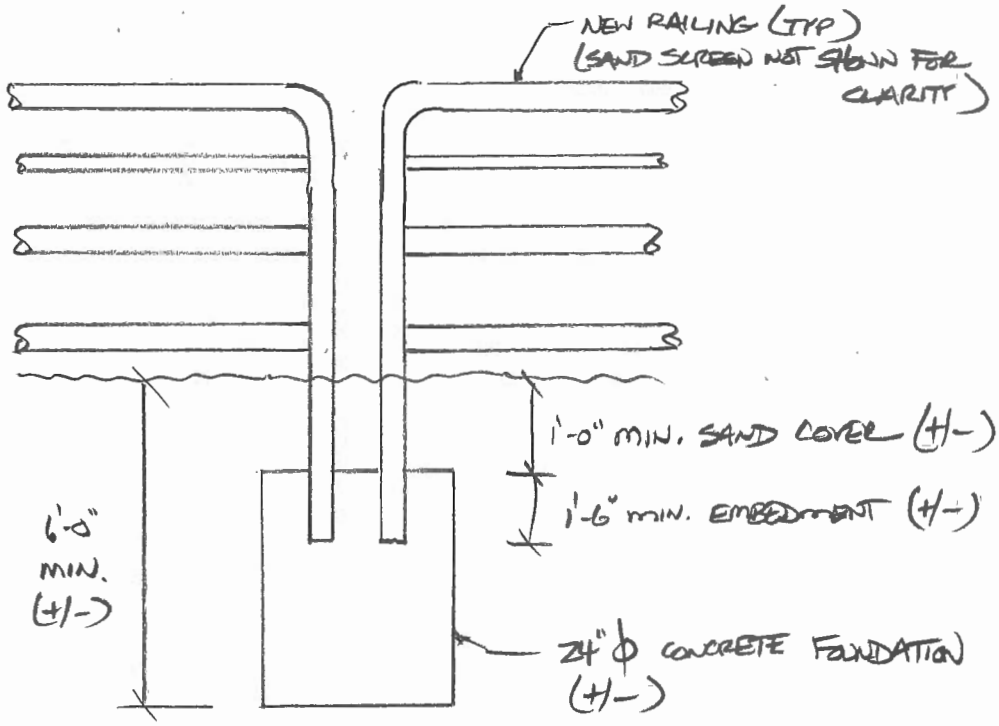
Calculation Sheet

Computed by MOXEY Subject SAND FENCE DETAILS Sheet 1 of 2
Checked by _____ Client PENTWATER Job No. 820890 Date 12/11/14

NOTE: OFFSET POST WITHIN THE FOOTING AT THE EXISTING PIER TO LIMIT GAP AS REQUIRED.



FOOTING DETAIL - SINGLE POST



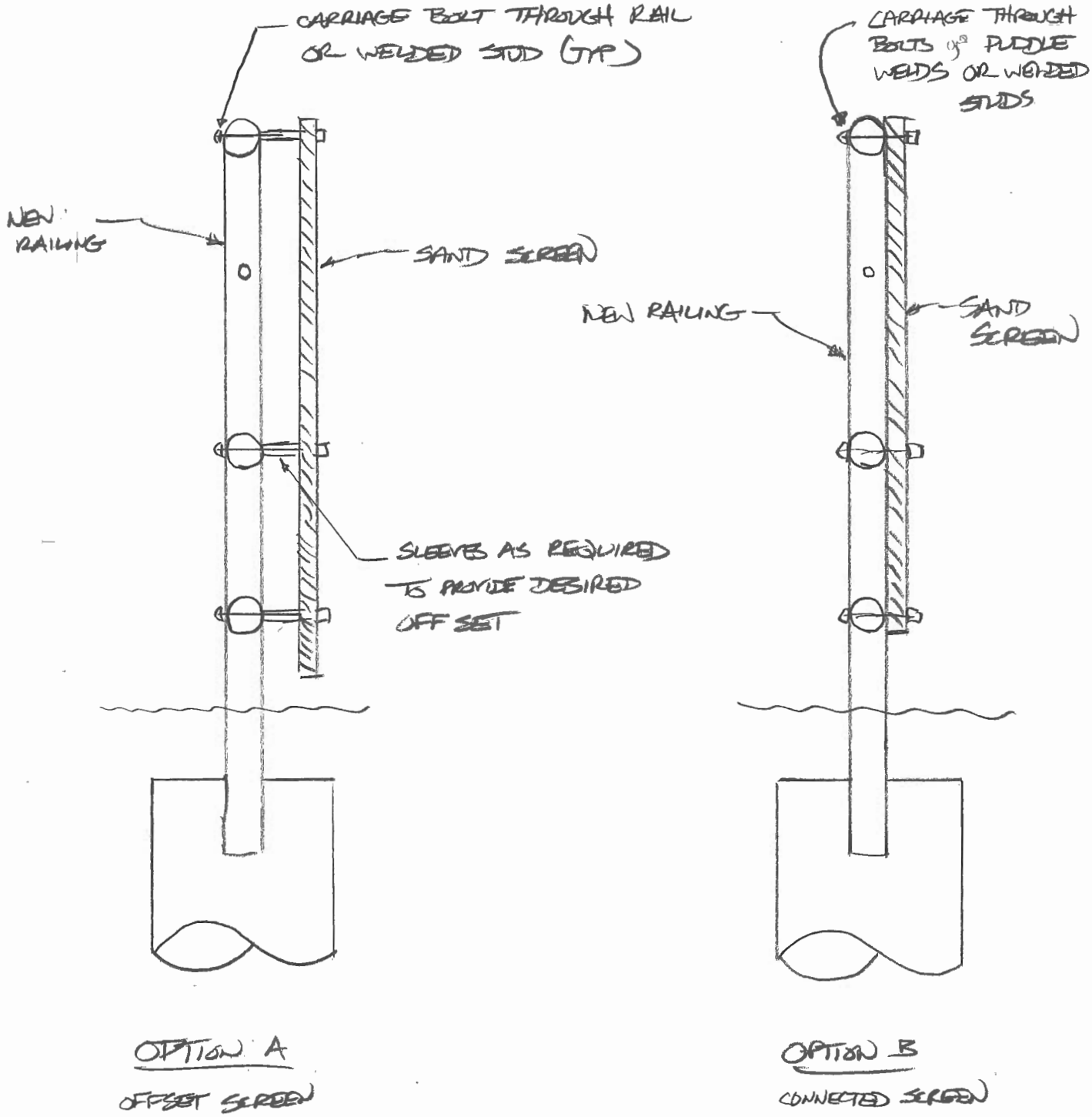
FOOTING DETAIL - DOUBLE POST

FLEIS & VANDENBRINK
ENGINEERING, INC.
www.fveng.com

Calculation Sheet

Computed by _____ Subject _____ Sheet 2 of 2

Checked by _____ Client _____ Job No. _____ Date _____



OPTION A
OFFSET SCREEN

OPTION B
CONNECTED SCREEN

SCREEN CONNECTION DETAILS

NOTE: SPECIFIC CONNECTORS DEPEND ON SELECTED SCREEN MATERIALS / CONFIGURATION

FLEIS & VANDENBRINK
ENGINEERING, INC.
www.fveng.com

Calculation Sheet

Computed by MOXEY Subject SAND FENCE Sheet 1 of 1
Checked by _____ Client PENTWATER Job No. 820890 Date 12/12/14

FOOTING VOLUME - SINGLE

$\frac{\pi}{4} \times \left(\frac{18"}{12}\right)^2 \times 5' = 8.8$ cft

DOUBLE

$\frac{\pi}{4}\left(\frac{24"}{12}\right)^2 \times 5' = 15.7$ cft

TOTAL VOLUME OF CONCRETE $\leq 10 * 8.8 + 3 \times 15.7 = 135$ cft $= 5$ cyd

CONCRETE COST = 5 cyd x $100/cyd = $500

SONOTUBES: 13 EA @ $10 = $130

LABOR REQD TO EXCAVATE, FORM, POUR & BACKFILL
- ASSUME 2 8-HR DAYS AT A CREW COST OF $250/HR = $4,000

MISC COSTS $370

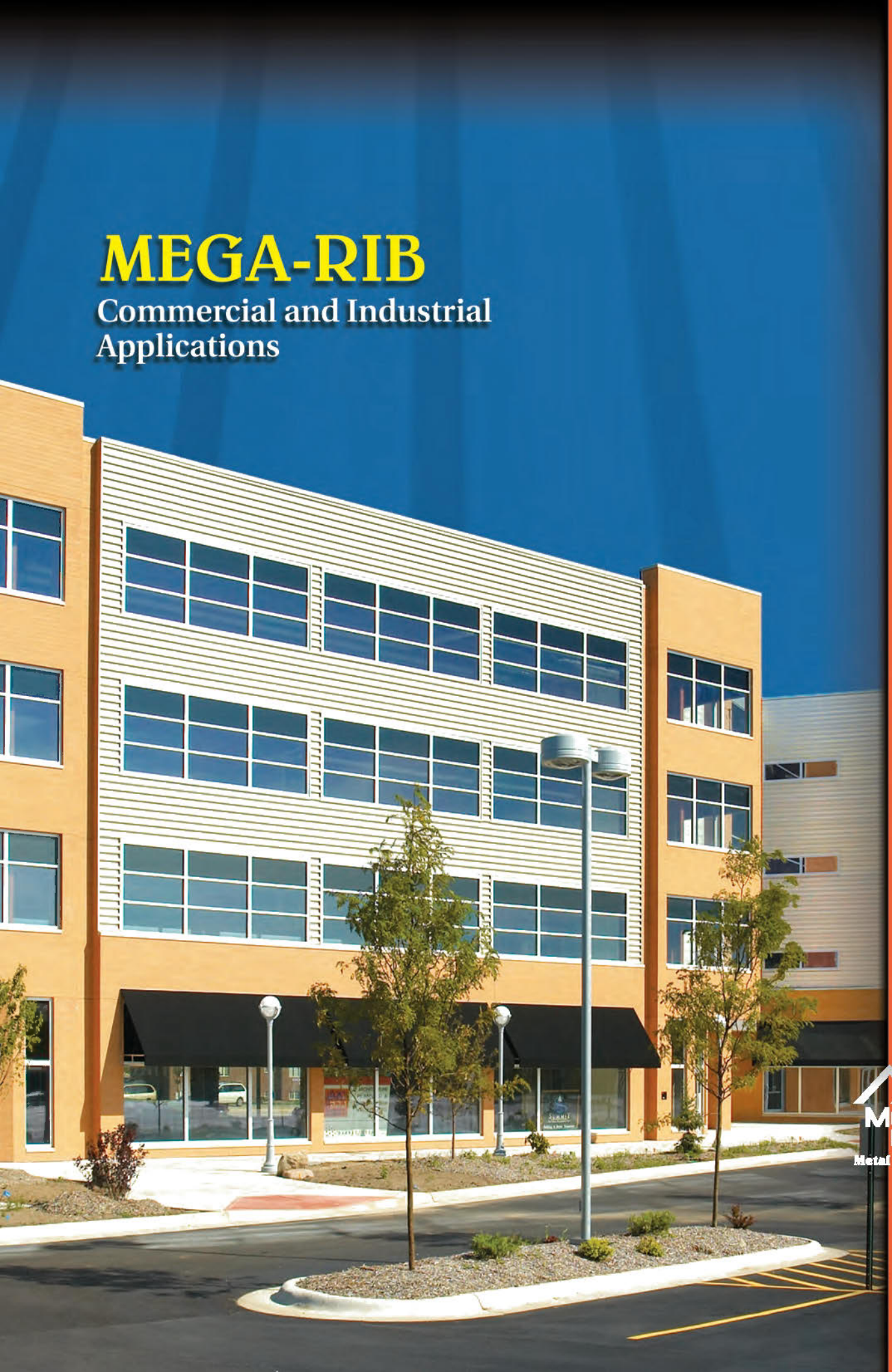
TOTAL ESTIMATED FOUNDATION COST $5,000

Appendix C

Examples of Sand Capture Panel Material Alternatives

MEGA-RIB

Commercial and Industrial Applications



MEGA-RIB

McELROY METAL

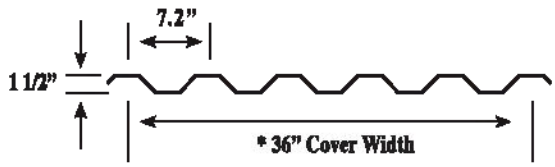
Metal Roof & Wall Panels

MEGA-RIB

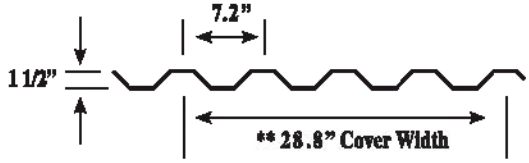
Mega-Rib is one of the most versatile metal wall and roof panels in the industry. While Mega-Rib was designed and engineered to meet the demands of the industrial environment, it also provides the aesthetics and design flexibility to be used in architectural applications.

Mega-Rib is an excellent cladding for industrial applications.

MEGA-RIB PANEL DIMENSIONS



* Standard for 24, 22, 20, and 18 gauge material. Also available in 26 ga. However, customer must specify if 26 ga is required.



** Standard for 26 ga material.

Testing Data:

UL580 Class 90 - Uplift Test: Const. #244
ICCES Evaluation for 24 Gauge: ER-5896
Florida State Approval: FL1652.8 & FL1747.5
Miami Dade County Approved: (NOA#09-0504.04)

McELROY METAL

CORPORATE OFFICE
P.O. BOX 1148 • SHREVEPORT, LOUISIANA 71163
800-562-3576 • FAX: 318-747-8029

For more information about our McElroy Metal products and services please visit:
www.mcelroymetal.com

Installed horizontally, Mega-Rib adds distinctive elegance.

Mega-Rib features a Galvalume® substrate and Kynar 500® coatings, which are proven to provide unsurpassed protection against panel chalk and fade.

With 7.2" rib spacing, Mega-Rib provides optimum strength and spanning capabilities.

MEGA-RIB SECTION PROPERTIES

SECTION PROPERTIES								
			TOP IN COMPRESSION			BOTTOM IN COMPRESSION		
Panel Gauge	FY KSI	Weight PSF	Ix IN.4	Se IN.3	Ma KIP IN.	Ix IN.4	Se IN.3	Ma KIP IN.
29	80	0.72	0.0500	0.0573	2.0900	0.0470	0.0483	1.7360
26	80	1.13	0.0860	0.1024	3.6800	0.0860	0.0864	3.4600
26	50	1.13	0.0880	0.1053	3.1520	0.0880	0.1021	3.0550
24	50	1.17	0.0970	0.1215	3.6370	0.0970	0.1126	3.3700

For Mega-Rib 22, 20, and 18 gauge material section properties and load tables, please visit www.mcelroymetal.com.

Notes:
1. Section properties are calculated in accordance with the 2007 AISI North American Specification for the Design of Cold-Formed Steel Structural Members.
2. Ix is for deflection determination.
3. Se is for bending.
4. Ma is the allowable bending moment.
5. All values are for one foot of panel width.

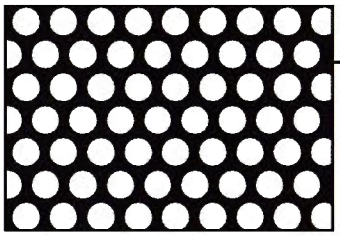
MEGA-RIB LOAD TABLE

ALLOWABLE LOADS (PSF)*																					
		NEGATIVE WIND LOAD						LIVE LOAD						DEFLECTION L/180					
Ga.	FY KSI	4'	5'	6'	7'	8'	9	4'	5'	6'	7'	8'	9	4'	5'	6'	7'	8'	9
29	80	78	55	40	31	24	19	71	48	35	27	21	16	124	63	37	23	15	10
26	80	166	111	78	59	46	36	158	105	75	56	43	34	221	113	65	41	27	18
26	50	147	97	69	51	39	31	143	95	67	50	38	30	226	116	67	42	28	19
24	50	177	116	81	60	46	36	165	108	78	58	43	34	249	127	74	46	31	21

Notes:
1. Loads are based upon 3 spans of equal lengths.
2. Allowable uniform loads are based upon equal span lengths.
3. Negative Wind is wind suction or uplift and is NOT increased by 33 1/3%.
4. Live is the allowable live or snow load.
5. Deflection (L/180) is the allowable load that limits the panel's deflection to L/180 while under positive or live load.
6. The weight of the panel has NOT been deducted from the allowable loads.
7. Positive Wind, Negative Wind, and Live Load values are limited to combined shear & bending using Eq C3.3.1-1 of the AISI Specification.
8. Positive Wind and Live Load values are limited by web-crippling using a bearing length of 3.125"
9. Web crippling values are determined using a ratio of the uniform load actually supported by the top flanges of the section.
10. Load Tables are limited to a maximum allowable load of 500 psf.
12. See website for more comprehensive load table.

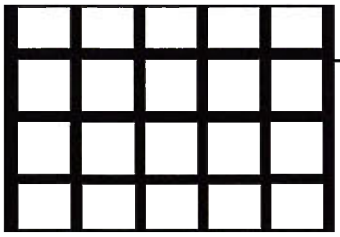
PERFORATED METAL

Perforated metal is extremely versatile and lightweight. The most common applications include: screens, diffusers, guards, filters, vents and more. We can perforate most any metal, plastic or rubber material with round, square, slotted, decorative or architectural holes.



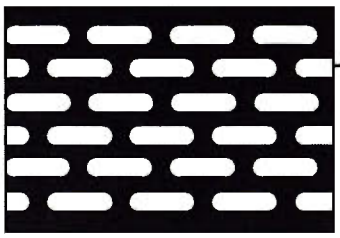
ROUND PERFORATION

One of the most popular perforation options available. Ventilation and decoration are some of its most common uses. You can choose from many sizes and patterns of holes.



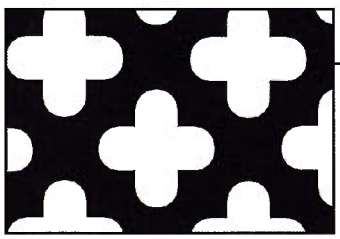
SQUARE PERFORATION

A good option when a greater open area is required in a project. This translates to greater ventilation and lighter weight. Many square sizes and pattern layouts are available.



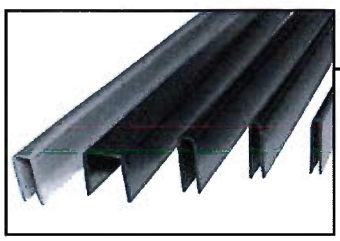
SLOTTED PERFORATION

Provides greater ventilation than round perforation and is better suited for decorative use than square perforation. Many slot sizes and pattern layouts are available by special order.



DECORATIVE/ARCHITECTURAL PERFORATION

Ideal for many architectural applications that require an aesthetic appeal. Many decorative styles, extremely versatile and lightweight. Some architectural applications include: sunscreens, ceiling panels, exterior cladding or anyapplication requiring a decorative look.

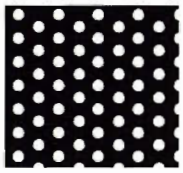


U-EDGING

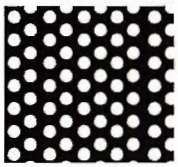
A perforated metal accessory that is a u-shaped strip attached to the edge of a perforated metal sheet to make the edges more attractive and safer. Available in carbon or stainless steel, aluminum and galvanized.

ROUND HOLES

A FEW OF OUR AVAILABLE PERFORATIONS - (holes at actual size)



1/16" @ 1/8"
STAGGERED
Open area . . . 22.5%



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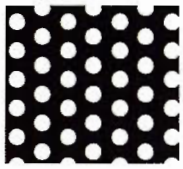
STAGGERED
Open area . . . 36%



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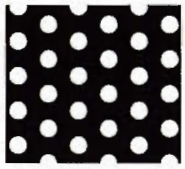
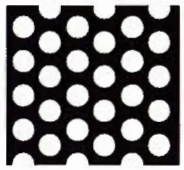
STAGGERED
Open area . . . 32%



3/32" @ 3/16"
STAGGERED
Open area . . . 23%



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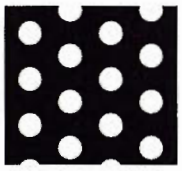
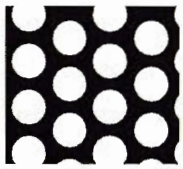
STAGGERED
Open area . . . 40%



1/8" @ 1/4"
STAGGERED
Open area . . . 23%

5/32" @ 7/32"
STAGGERED
Open area . . . 46%



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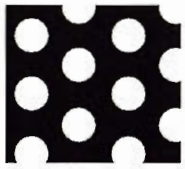
STAGGERED
Open area . . . 51%



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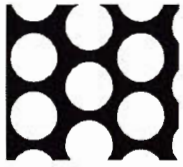
STAGGERED
Open area . . . 33%



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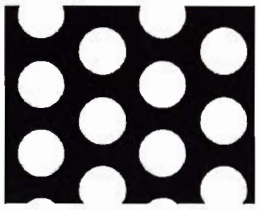
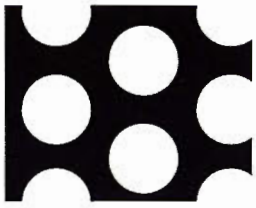
STAGGERED
Open area . . . 58%



1/4" @ 3/8"
STAGGERED
Open area . . . 40%



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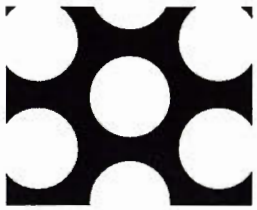
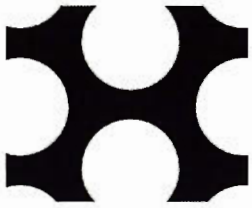
STAGGERED
Open area . . . 40%



7/16" @ 9/16"
STAGGERED
Open area . . . 51%



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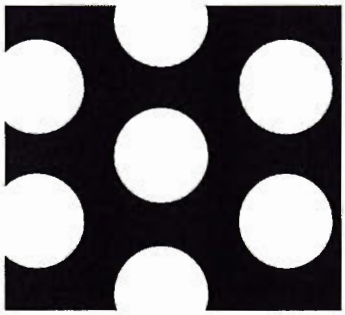
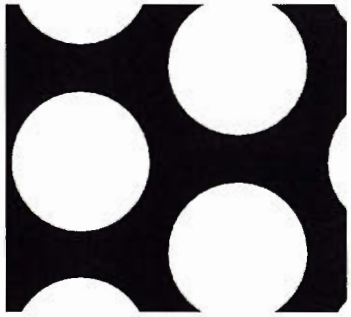
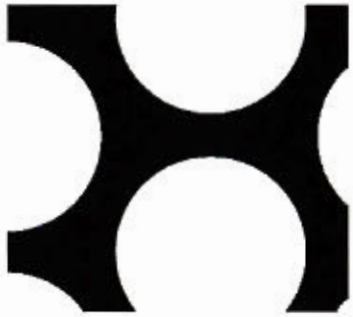
STAGGERED
Open area . . . 47%



1/2" @ 3/4"
STAGGERED
Open area . . . 40%



3/4" @ 1"
STAGGERED
Open area . . . 51%



1" @ 1-1/4"
STAGGERED
Open area . . . 58%

PERFORATED METAL

COMMON APPLICATIONS OF ROUND PERFORATED METAL

- Vents
- Diffusers
- Grills
- Screens
- Strainers
- Filters
- Guards
- Decorative

and many more

Building Exterior

FEATURES OF ROUND & SQUARE PERFORATED METAL

- Lightweight
- Extremely Versatile
- Large Open Area
- Customizable
- Economically Priced
- Decorative

Many More Patterns, Materials & Gauges

Sunshade Application

Formulas for Determining Percentage of Open Areas

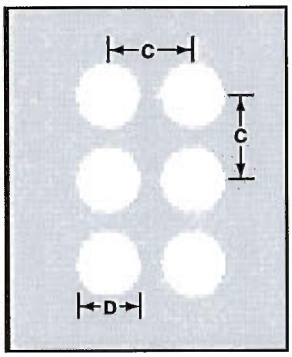
In each formula "D" = hole diameter and "C" = center spacing

60° Staggered Centers Pattern (Standard)

$$\frac{Dia^2}{Center^2} \times 90.5 = \text{Percentage of Open Area}$$

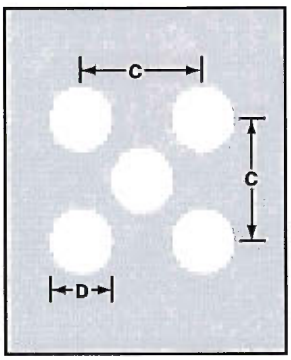
Straight Line Pattern

$$\frac{Dia^2}{Center^2} \times 78.54 = \text{Percentage of Open Area}$$



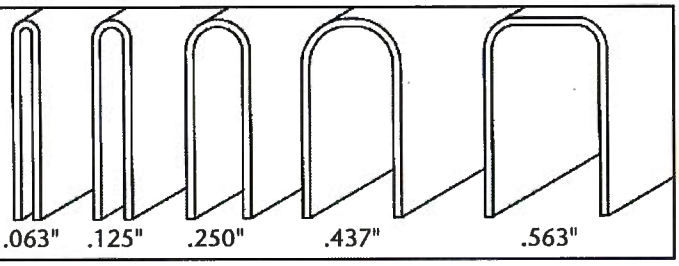
45° Staggered Centers Pattern

$$\frac{Dia^2}{Center^2} \times 157.08 = \text{Percentage of Open Area}$$



U-EDGING (OPENINGS)

Available in carbon steel, stainless steel, aluminum and galvanized

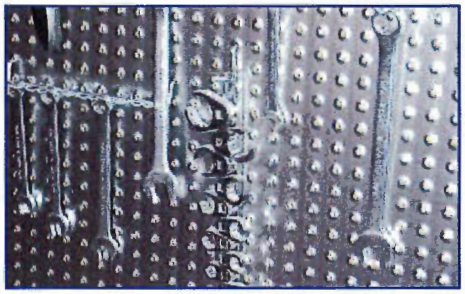


PERFORATED METAL

APPLICATIONS

Sunscreens

Airport Parking Deck

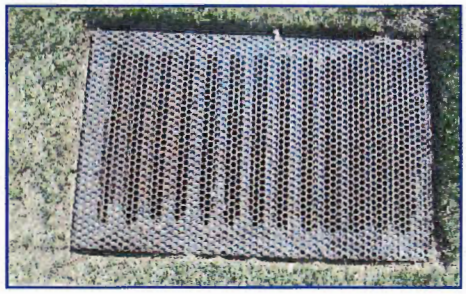


Pegboard

Ceiling

Infill Panels

Signage



Drain Covers

Patio Furniture

DECORATIVE CHAIN LINK FENCING WITH VERTICAL VINYL SLATS

Decorative Chain Link Fencing with Vertical Vinyl Slats