Permeable Pavements

Design Report and Plan Development

Webinar – Advanced Permeable Pavement for Storm Water Management

February 17, 2015

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Permeable Pavement (1008)

- VII. Plans and Specifications
  - Design Report
  - Plans
  - Specifications

Design Report

- Per criteria in Standard
- Describes the intended use and objectives of the pavement system
- Presents hydrologic and hydraulic computations used for design
- Presents pollutant removal calculations

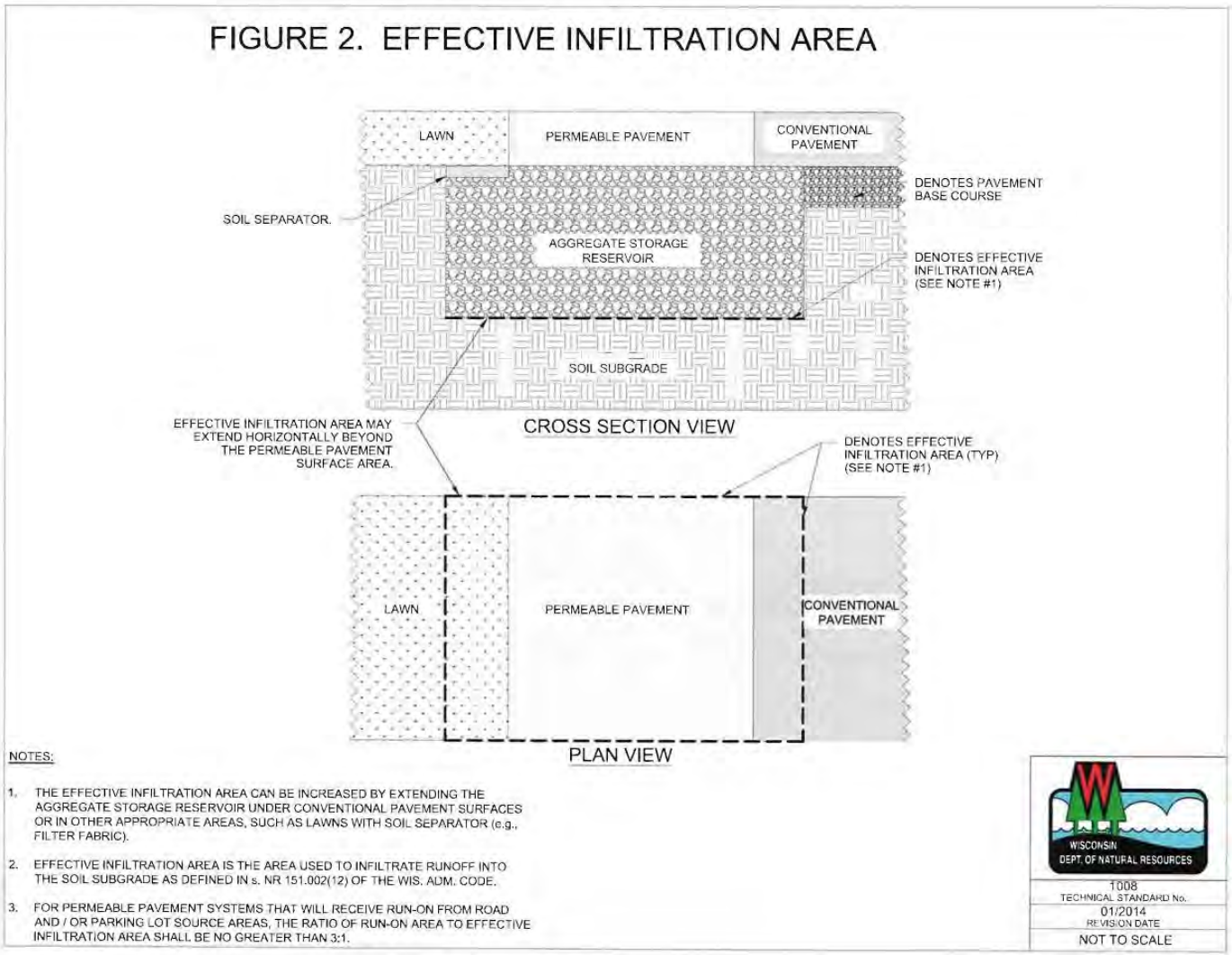
Permeable Pavement Test Plot

Design Report

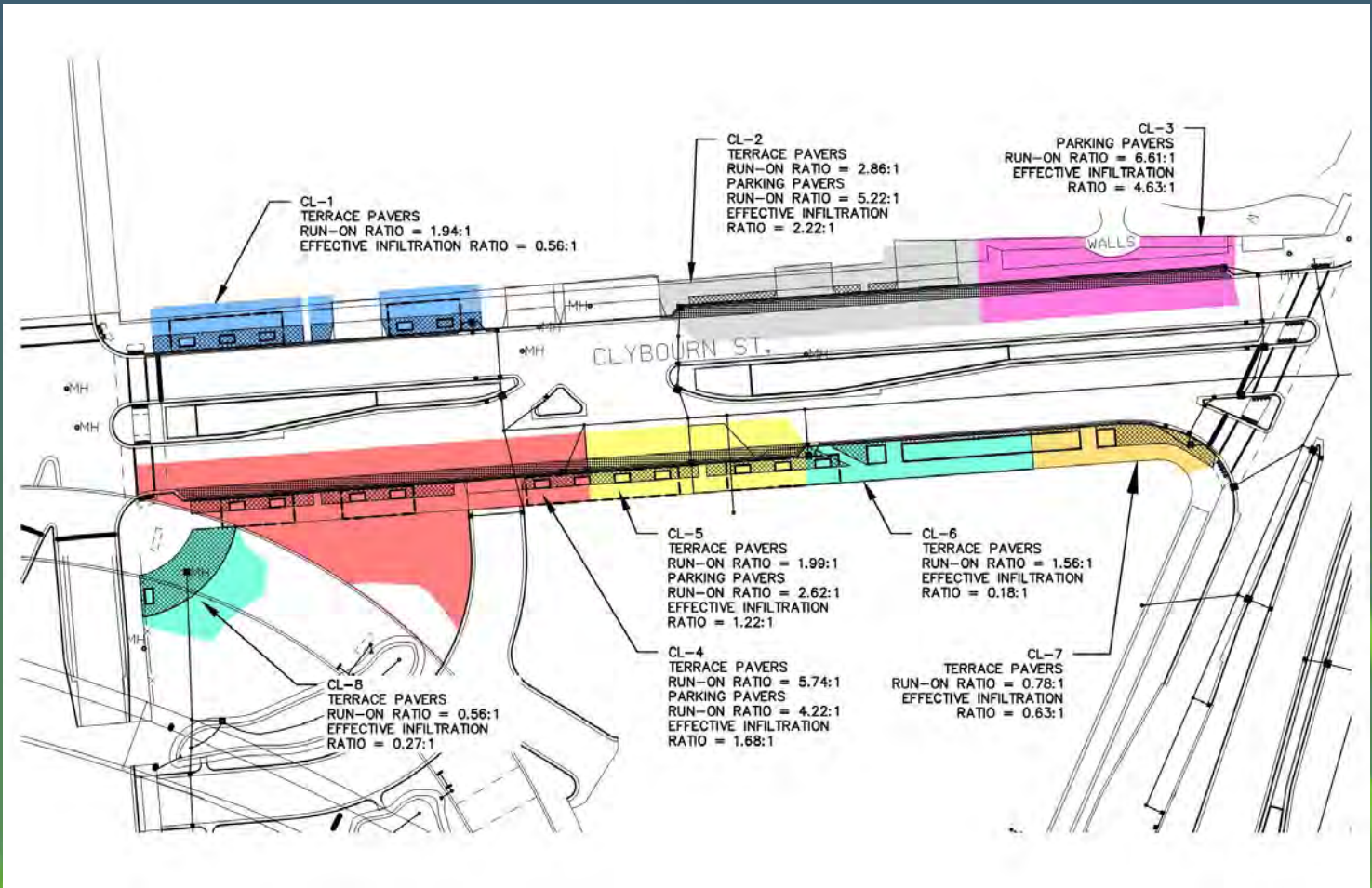
- Includes plan view exhibits
  - Tributary area
  - Flow paths
  - Run-on ratios

Hausmann Nature Center – Lapham Peak

Effective Infiltration Area



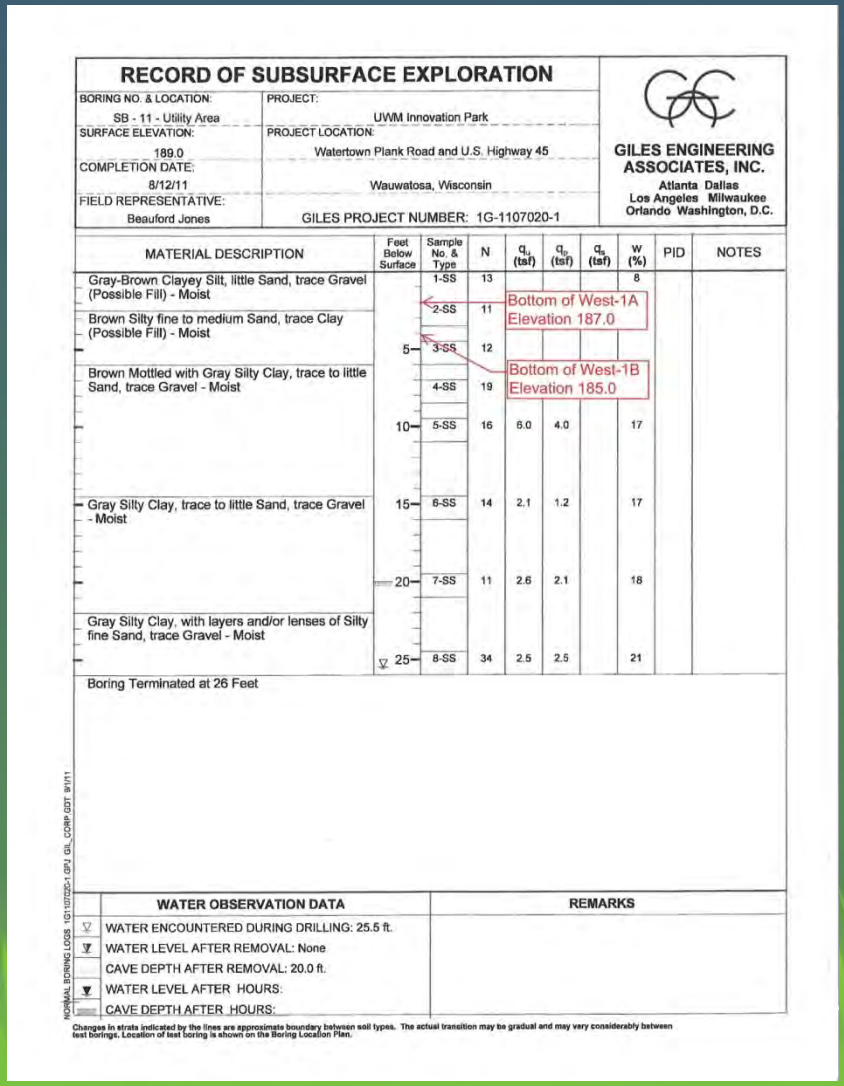
Run-on and Effective Infiltration Area Ratios



Design Report

- Includes documents or reports that support infiltration design parameters
  - Infiltration rate field test results
  - Soil boring logs
  - Depth to seasonal high groundwater

Typical Soil Boring Log



RECORD OF SUBSURFACE EXPLORATION

BORING NO. & LOCATION: SB - 11 - Utility Area	PROJECT: UWM Innovation Park
SURFACE ELEVATION: 189.0	PROJECT LOCATION: Watertown Plank Road and U.S. Highway 45
COMPLETION DATE: 8/12/11	Wauwatosa, Wisconsin
FIELD REPRESENTATIVE: Beauford Jones	GILES PROJECT NUMBER: 1G-1107020-1

GILES ENGINEERING ASSOCIATES, INC.
Atlanta Dallas
Los Angeles Milwaukee
Orlando Washington, D.C.

MATERIAL DESCRIPTION	Feet Below Surface	Sample No. & Type	N	q_u (tsf)	q_p (tsf)	q_s (tsf)	W (%)	PID	NOTES
Gray-Brown Clayey Silt, little Sand, trace Gravel (Possible Fill) - Moist		1-SS	13				8		
		2-SS	11						Bottom of West-1A Elevation 187.0
Brown Silty fine to medium Sand, trace Clay (Possible Fill) - Moist	5	3-SS	12						
Brown Mottled with Gray Silty Clay, trace to little Sand, trace Gravel - Moist		4-SS	19						Bottom of West-1B Elevation 185.0
	10	5-SS	16	6.0	4.0		17		
Gray Silty Clay, trace to little Sand, trace Gravel - Moist	15	6-SS	14	2.1	1.2		17		
	20	7-SS	11	2.6	2.1		18		
Gray Silty Clay, with layers and/or lenses of Silty fine Sand, trace Gravel - Moist	▽ 25	8-SS	34	2.5	2.5		21		
Boring Terminated at 26 Feet									

WATER OBSERVATION DATA	REMARKS
▽ WATER ENCOUNTERED DURING DRILLING: 25.5 ft.	
▼ WATER LEVEL AFTER REMOVAL: None	
CAVE DEPTH AFTER REMOVAL: 20.0 ft.	
▼ WATER LEVEL AFTER HOURS:	
CAVE DEPTH AFTER HOURS:	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

NORMAL BORING LOGS 1G1107020-1.GPJ GIL_CORP.GDT 9/1/11

Infiltration Rates per DNR Standards

PERMEABLE PAVEMENT -- INFILTRATION RATES

Permeable Pavement System	Infiltration Rate (in/hr)	Infiltration Rate (ft/sec)	Perm Pvmnt Area (sqft)	Constant Infiltration (cfs)
CL-1	0.13	3.00926E-06	847	0.003
CL-2	0.13	3.00926E-06	2080	0.006
CL-3	0.03	6.94444E-07	1859	0.001
CL-4	0.03	6.94444E-07	2375	0.002
CL-5	0.03	6.94444E-07	3640	0.003
CL-6	0.03	6.94444E-07	4689	0.003

Pavement Selection Parameters

- Permeability
- Anticipated use for the pavement – pedestrian, passenger vehicles, or heavy trucks
- Amount and type of traffic
- Degree of wheel turning movements that will occur on the pavement
- Compressive and flexural strength of the pavement

Grass-Pave with Accessible Path

Pavement Selection Parameters

- Cost -- installation and maintenance
- For permeable pavers/blocks: degree of interlock of the pavers -- impacts performance when there are a variety of travel directions
- Ability to meet ADA requirements
- Ability to be machine installed - saves time and money

City of Milwaukee - Freshwater Way

Pavement Selection Parameters

- Color and texture of the surface
- Aesthetic considerations
- Durability
- Maintenance requirements
- Ease of making repairs

Harris Bank – West Bend

Plans and Specifications

- Should allow for the determination, upon completion, of compliance of the permeable pavement system with the design and the Standard

Plans and Specifications

- Identify materials, construction processes and sequence, location, size, and elevations of permeable pavement system components

Missouri Botanical Gardens

Plans

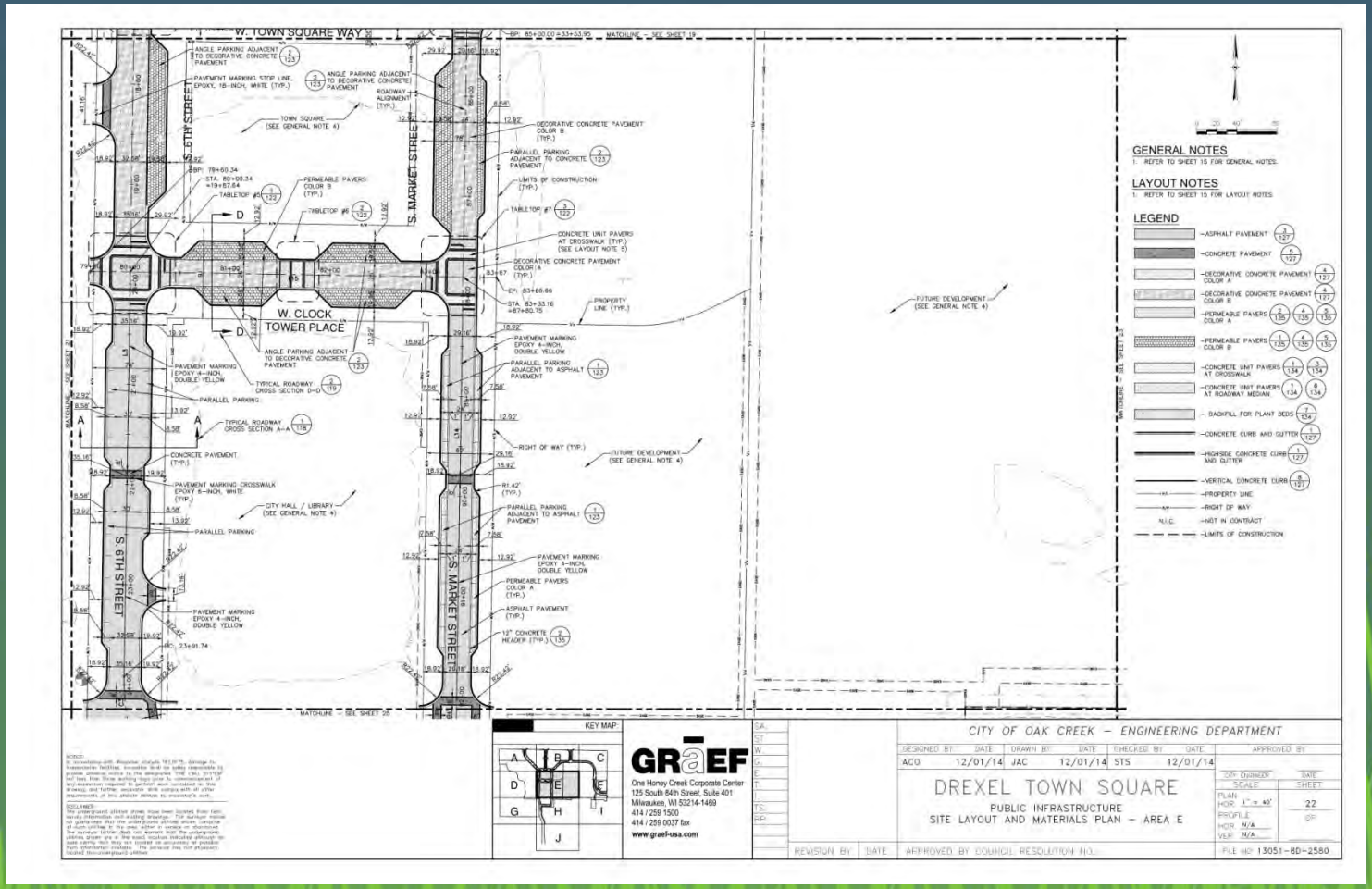
- Erosion and Sedimentation Control
  - Including measures to prevent clogging of any portion of the permeable pavement installation

Plans

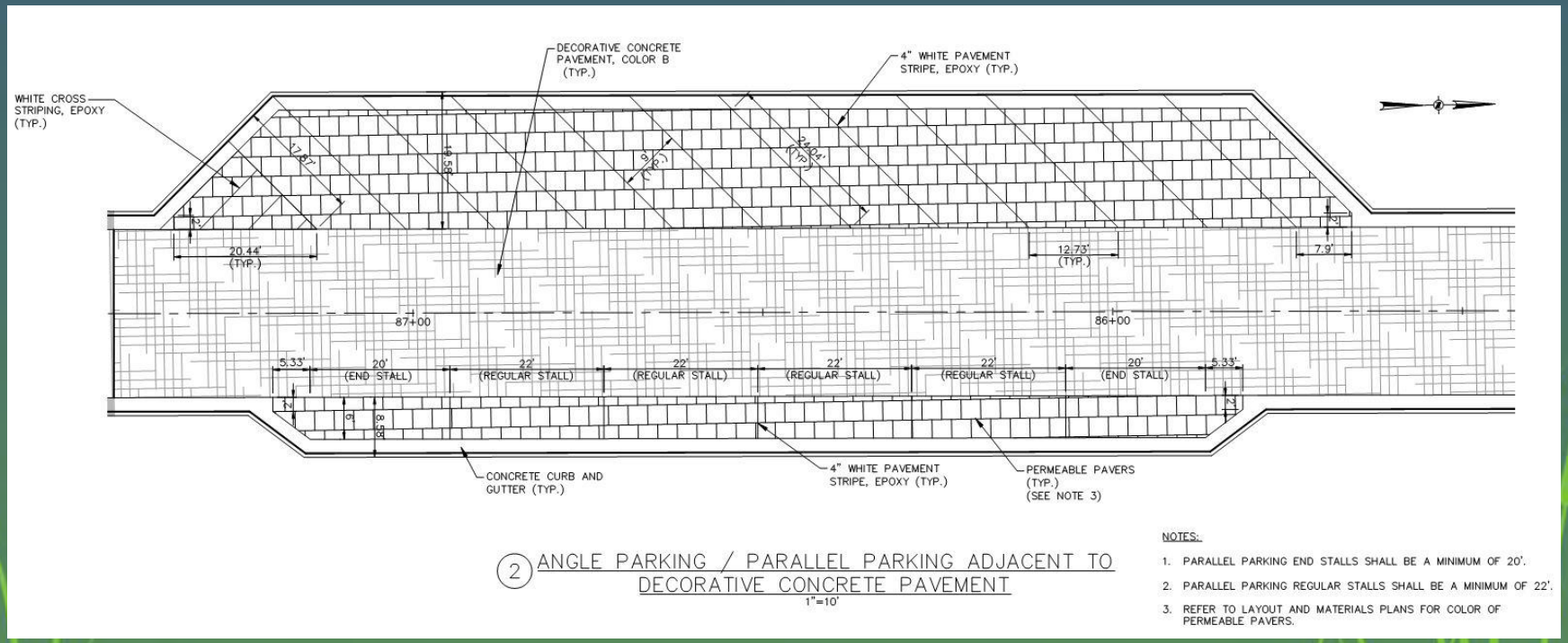
- Plan Views, showing:
  - Shape
  - Dimensions
  - Grades
  - Underdrain locations and elevations
  - Observation wells
  - Control structures

Drexel Town Square – Oak Creek

Drexel Town Square – Paving Plan



Drexel Town Square – Pavers in the Parking Lanes



(2) ANGLE PARKING / PARALLEL PARKING ADJACENT TO DECORATIVE CONCRETE PAVEMENT
1"=10'

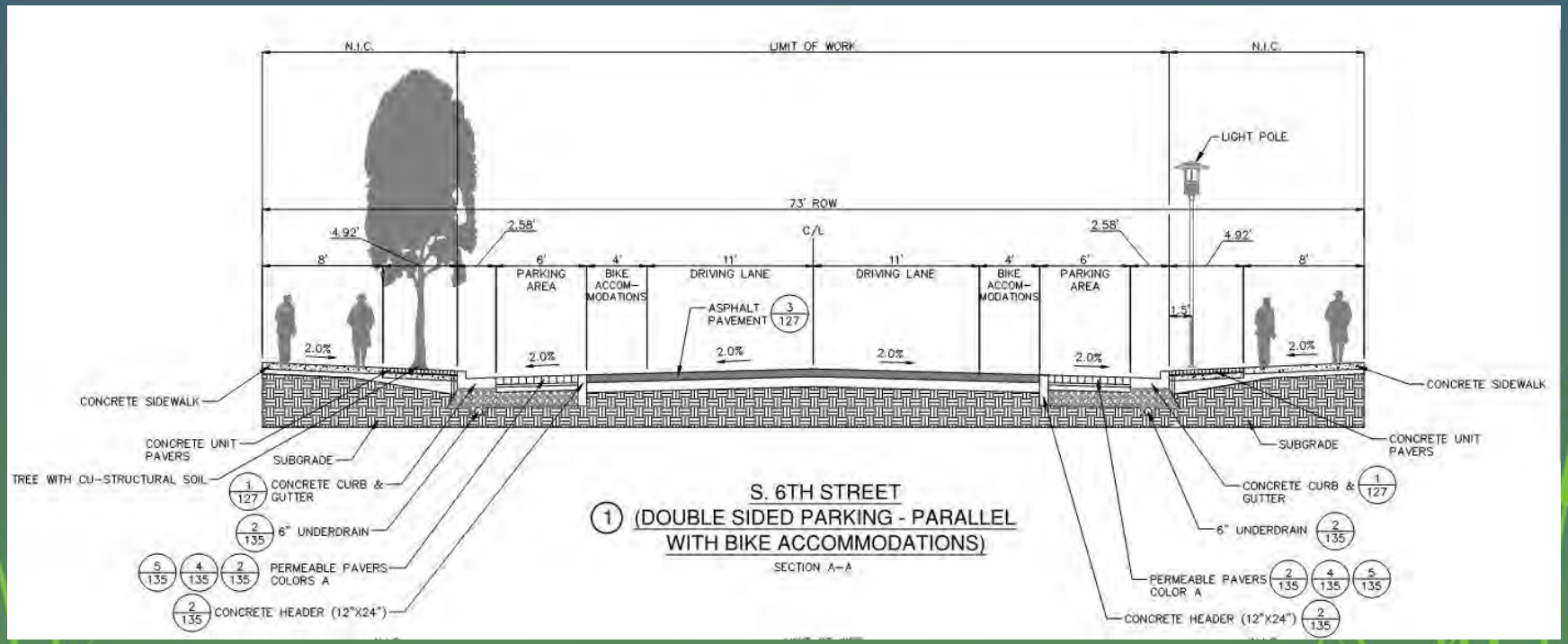
NOTES:

1. PARALLEL PARKING END STALLS SHALL BE A MINIMUM OF 20'.
2. PARALLEL PARKING REGULAR STALLS SHALL BE A MINIMUM OF 22'.
3. REFER TO LAYOUT AND MATERIALS PLANS FOR COLOR OF PERMEABLE PAVERS.

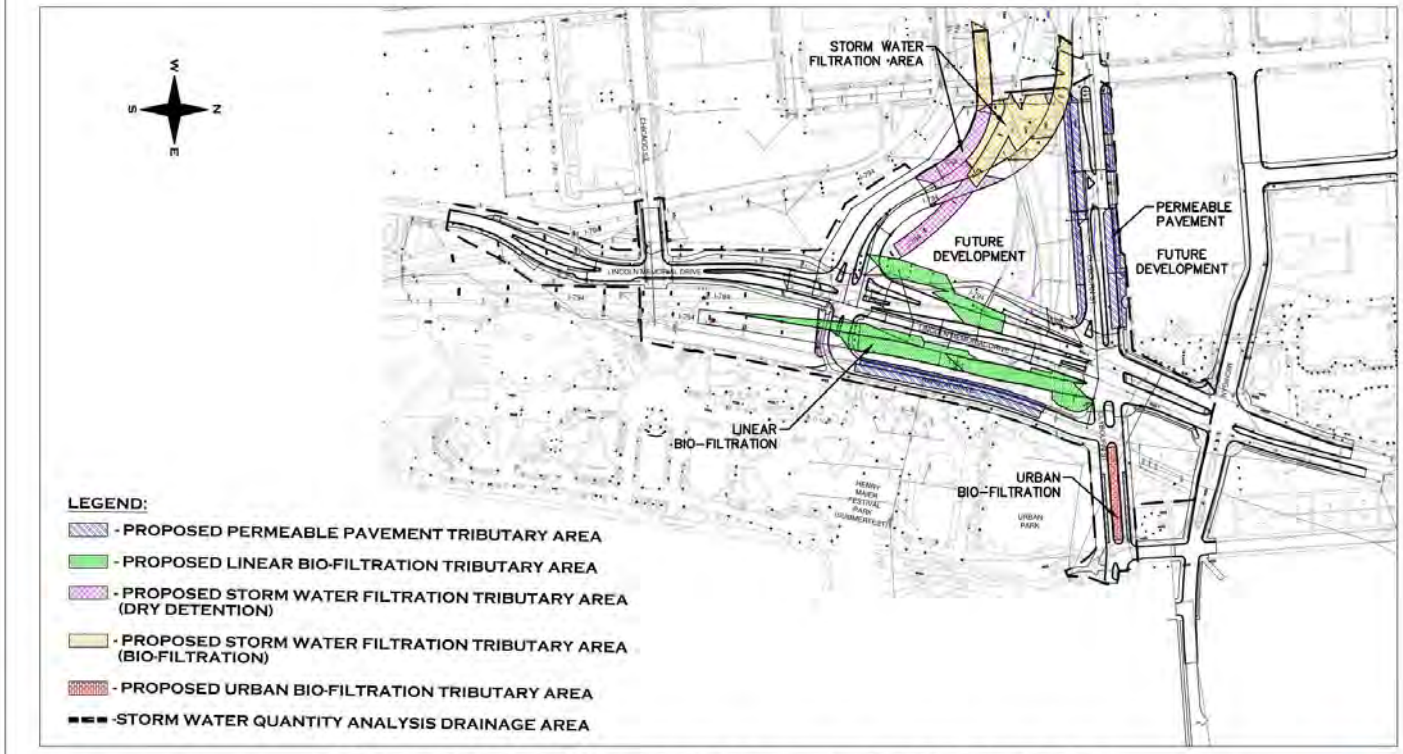
Plans

- Cross-sectional views, showing the location and depths of system components

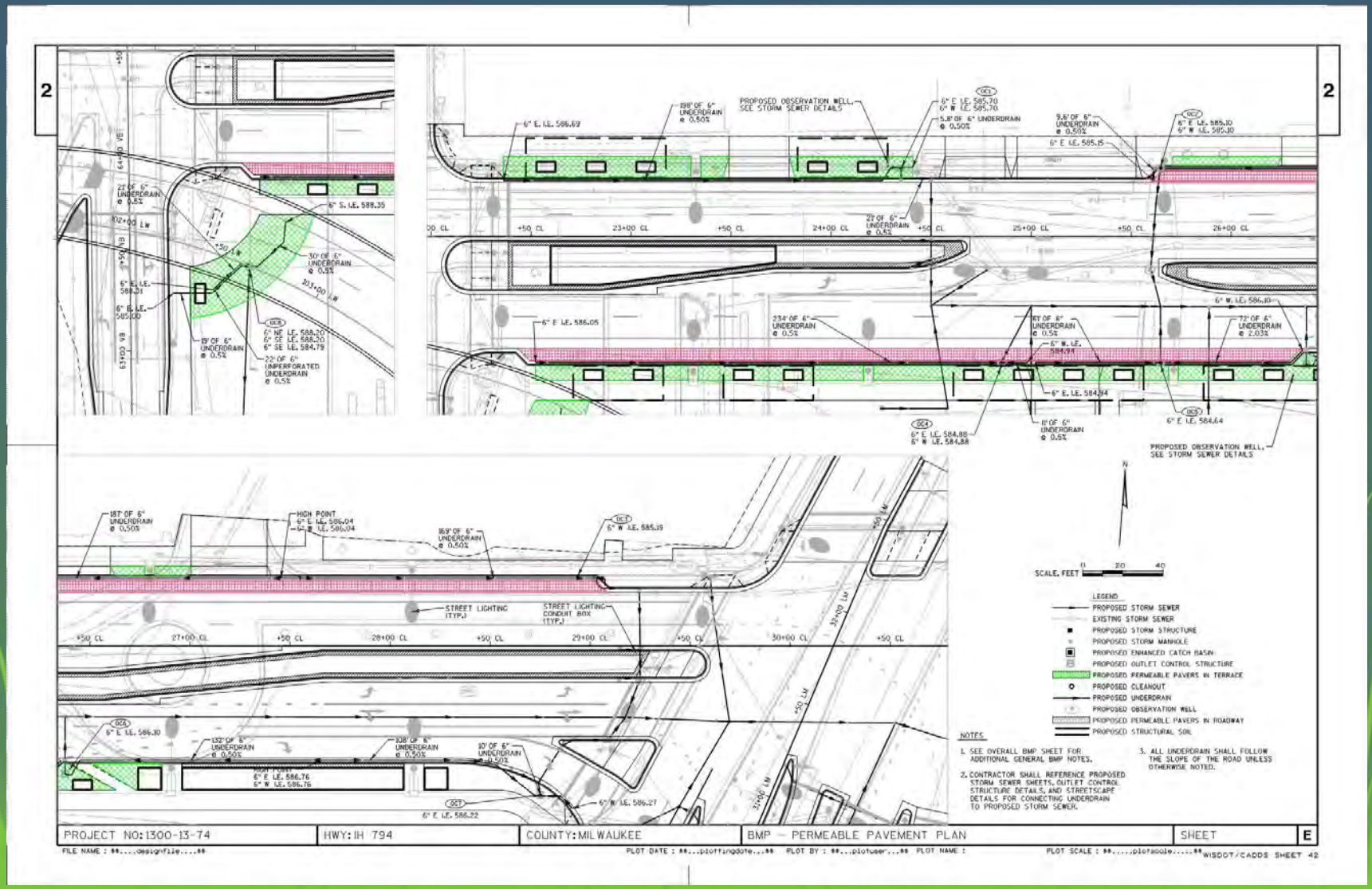
Drexel Town Square
Typical Road Cross-Section



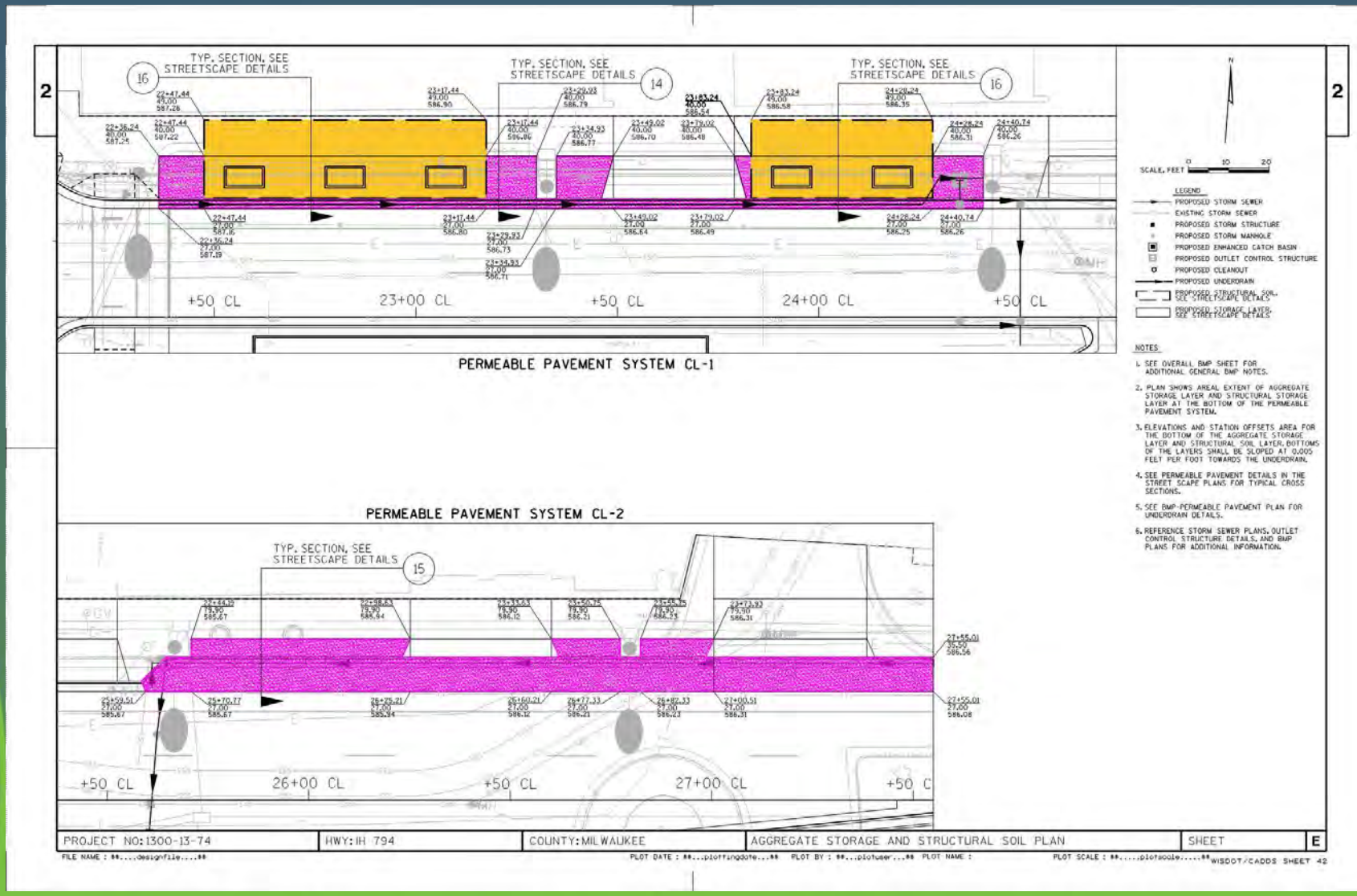
Lakefront Gateway - Milwaukee



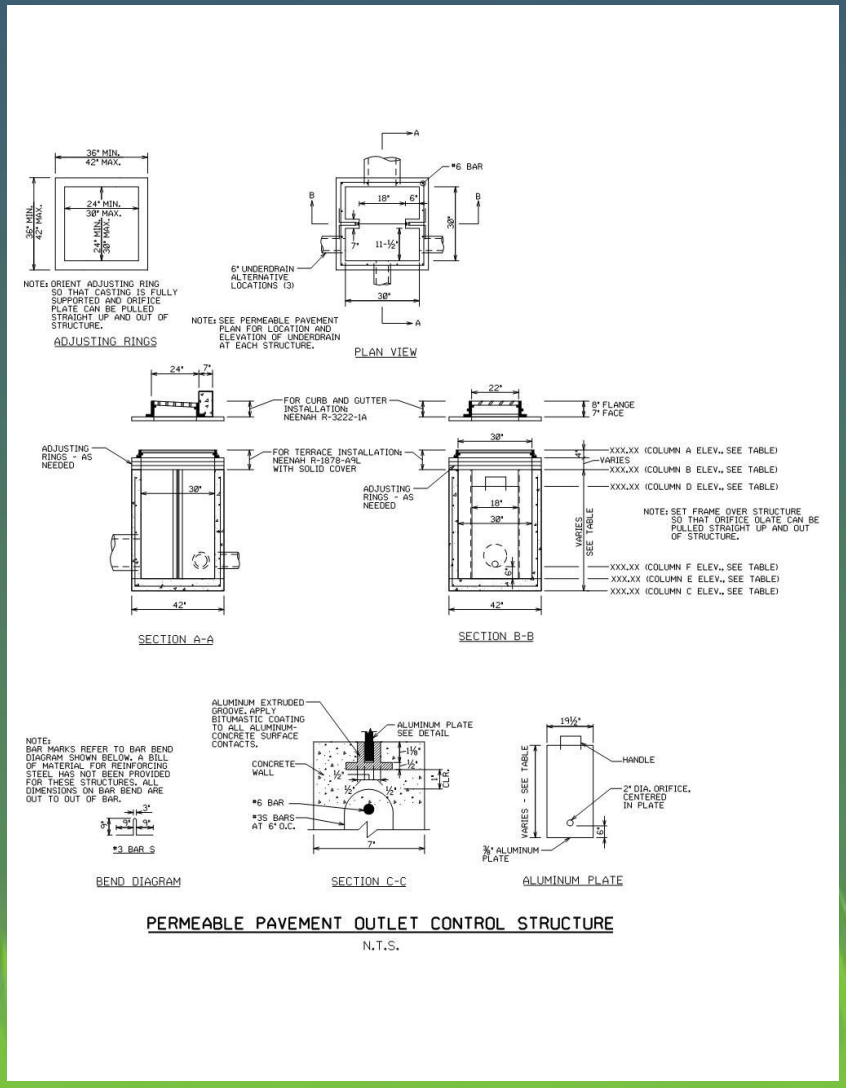
Permeable Pavement – Clybourn St.



Aggregate Storage Areas –Clybourn St.



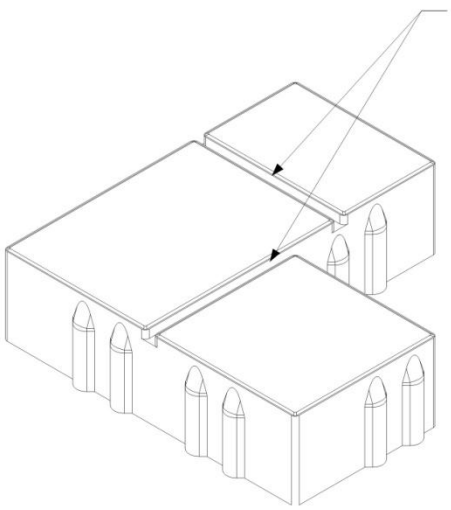
Permeable Pavement Outlet Control Structures



Permeable Pavement Outlet Control Structures

PERMEABLE PAVEMENT OUTLET CONTROL STRUCTURES TABLE OF STRUCTURE ELEVATIONS AND DIMENSIONS											
OUTLET CONTROL STRUCTURE	TYPE	CASTING	RIM ELEVATION	TOP OF PRECAST ELEV.	BOTTOM OF PRECAST ELEV.	HEIGHT OF PRECAST STRUCTURE	TOP OF ORIFICE PLATE ELEV.	BOTTOM OF ORIFICE PLACE ELEV.	HEIGHT OF ORIFICE PLATE	DIAMETER OF ORIFICE	ORIFICE INVERT ELEVATION
			A	B	C		D	E			F
OC - 1	TERRACE	R-1878-A9L	588.67	588.17	584.70	3.97	586.93	585.20	1.73	2 INCHES	585.70
OC - 2	GUTTER	R-3222-1A	588.43	587.43	584.10	4.33	586.93	584.60	2.33	2 INCHES	585.10
OC - 3	GUTTER	R-3222-1A	588.55	587.55	584.19	4.36	587.05	584.69	2.36	2 INCHES	585.19
OC - 4	GUTTER	R-3222-1A	588.15	587.15	583.88	4.27	587.60	584.38	3.22	2 INCHES	584.88
OC - 5	GUTTER	R-3222-1A	588.62	587.62	584.10	4.52	587.12	584.60	2.52	2 INCHES	585.10
OC - 6	TERRACE	R-1878-A9L	589.79	589.29	585.10	4.69	587.79	585.60	2.19	2 INCHES	586.10
OC - 7	TERRACE	R-1878-A9L	591.06	590.56	585.18	5.88	589.56	585.68	3.88	2 INCHES	586.18
OC - 8	TERRACE (PLAZA)	R-1878-A9L	590.90	590.40	583.79	7.11	588.72	584.29	4.43	2 INCHES	584.79

Detail of Permeable Pavement Block



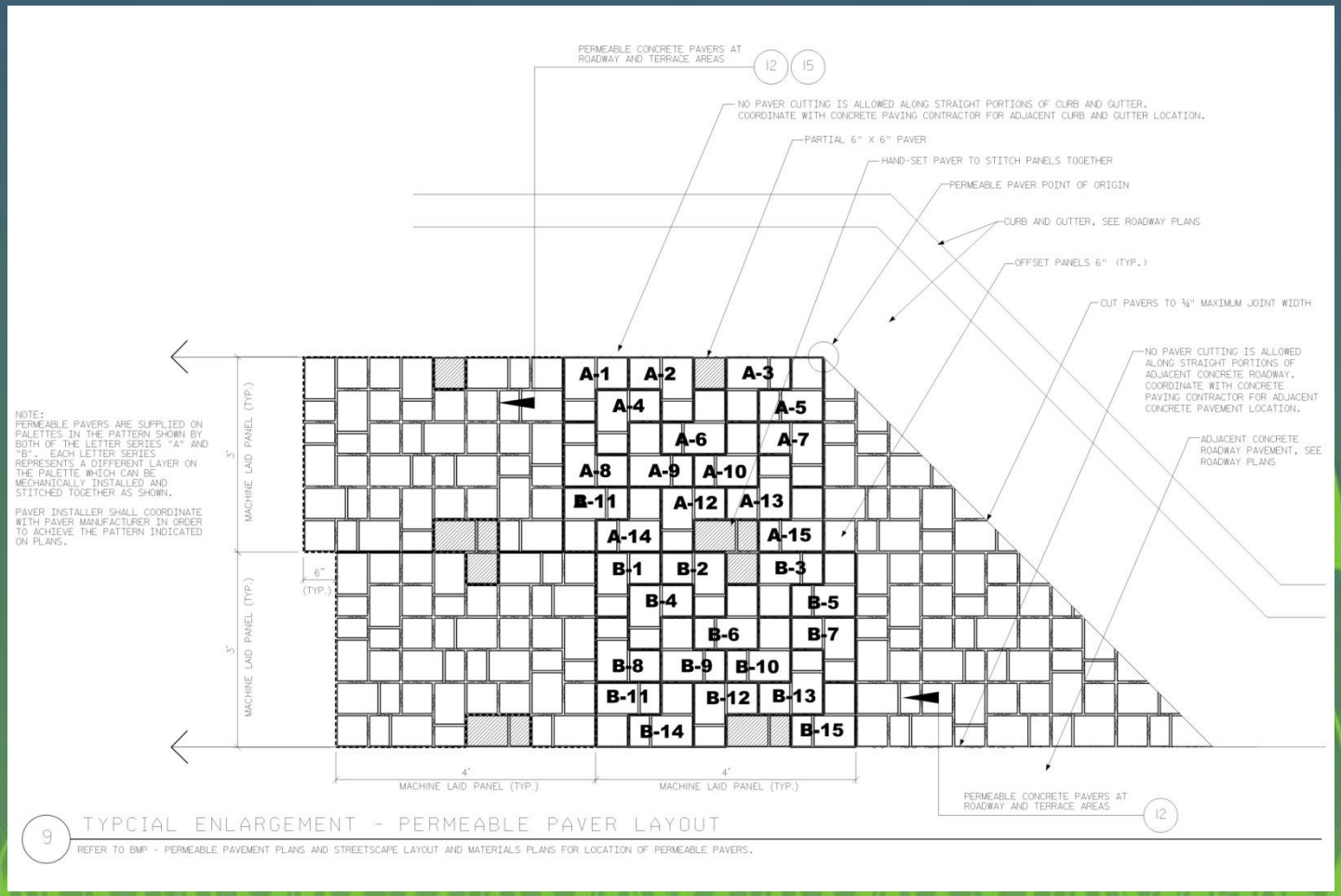
BELGARD AQUALINE SERIES PAVERS

- MULTI-COBBLE PERMEABLE PAVER SIZES:
  - 12" X 12" X 80MM
  - 12" X 12" X 100MM
- THE TWO PAVERS SIZES ARE TO BE USED IN THREE DIFFERENT AREAS:
  1. SAND-SET CONCRETE PAVER PAVING OVER CONCRETE BASE - 80MM, ITEM SPV.0165.1001; USED IN ROADWAY MEDIAN AREAS.
  2. PERMEABLE CONCRETE PAVERS - 80MM, ITEM SPV.0165.1002; USED IN SIDEWALK TERRACE AREAS.
  3. PERMEABLE CONCRETE PAVERS - 100MM, ITEM SPV.0165.1003; USED IN ON-STREET ROADWAY AREAS.
- SEE SPV'S FOR SPECIFIC PAVER INFORMATION AND COLORS

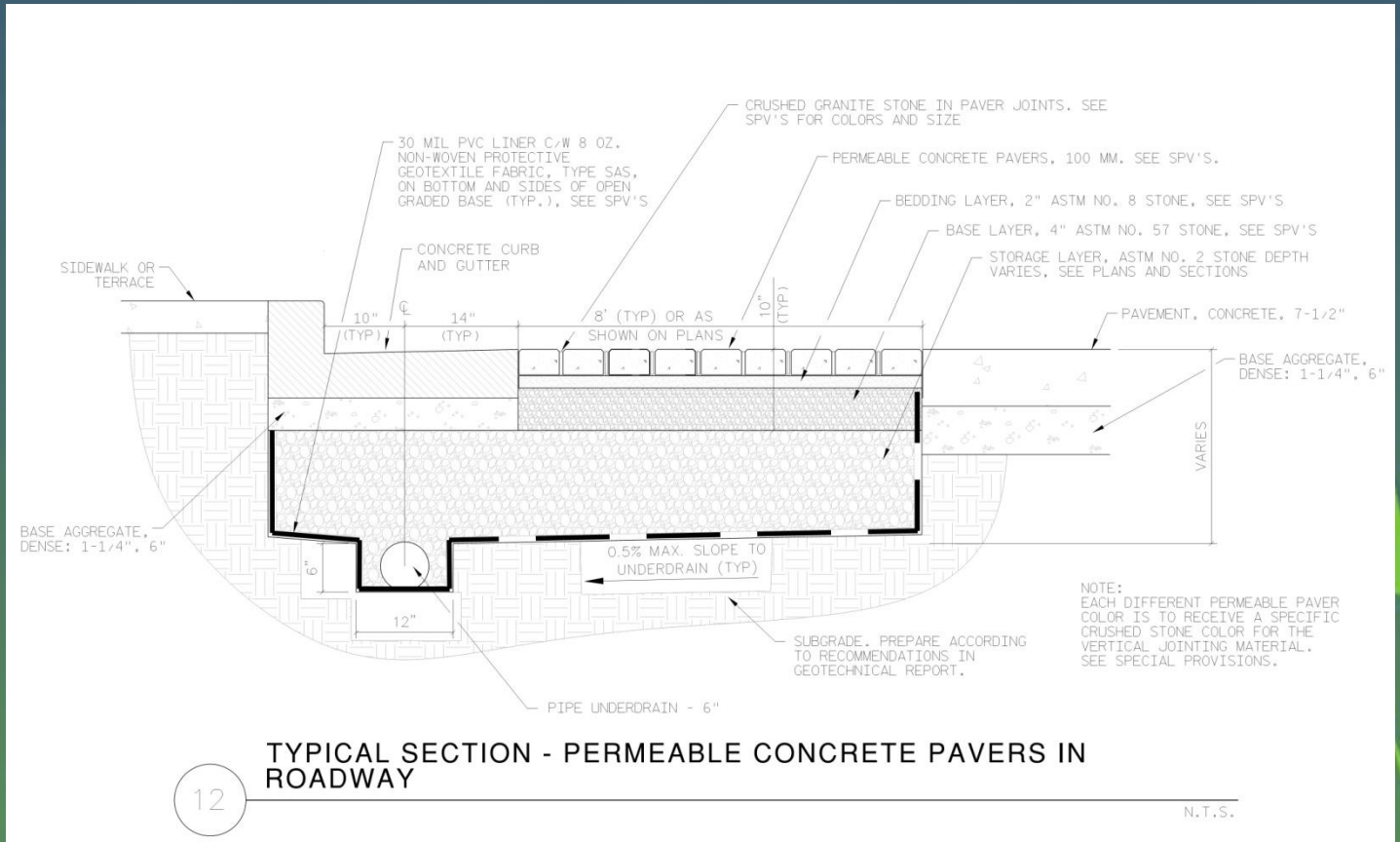
8 PERMEABLE CONCRETE PAVER

REFER TO BMP - PERMEABLE PAVEMENT PLANS AND STREETSCAPE LAYOUT AND MATERIALS PLANS FOR LOCATION OF PAVERS.

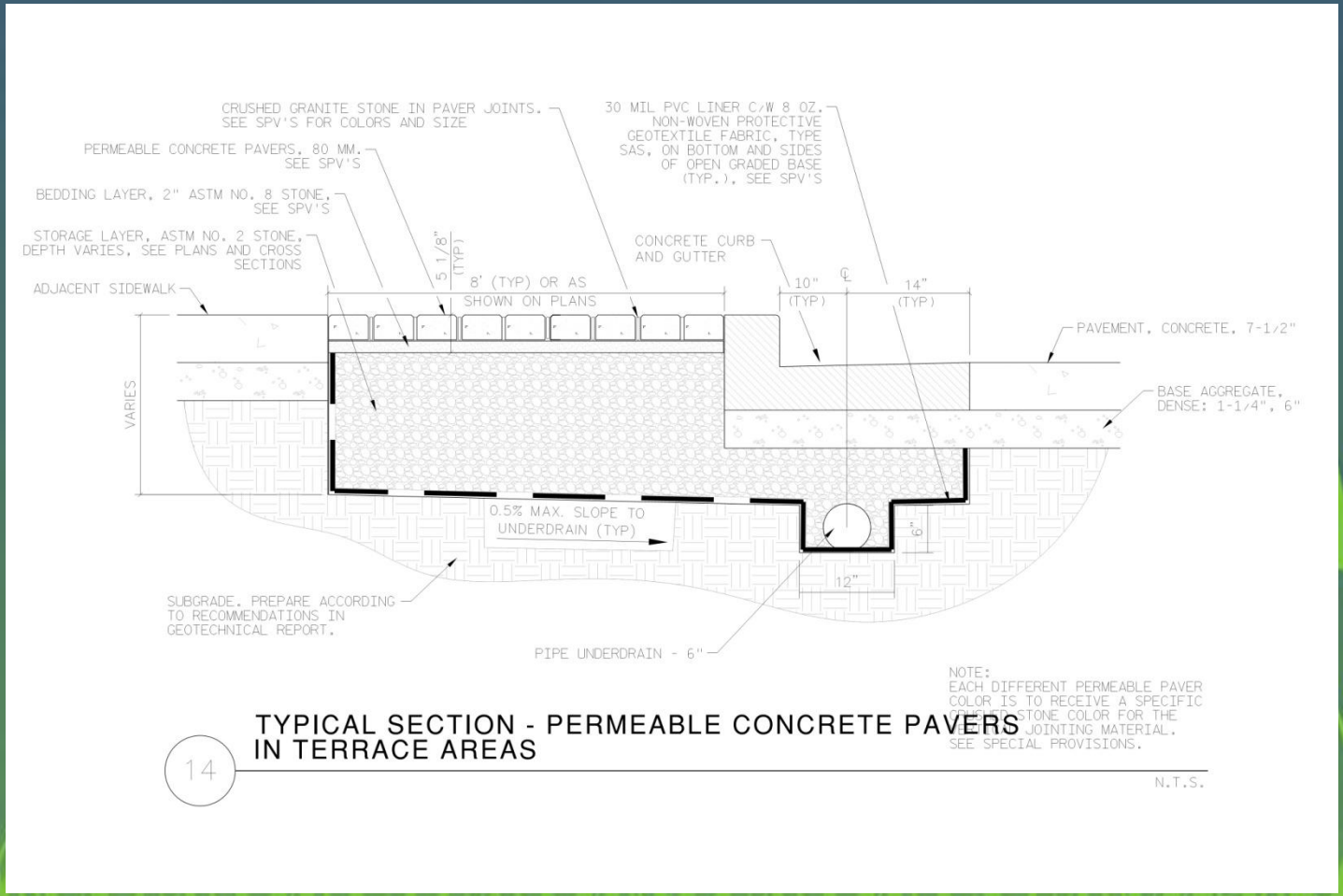
Layout Pattern for Permeable Pavement Blocks



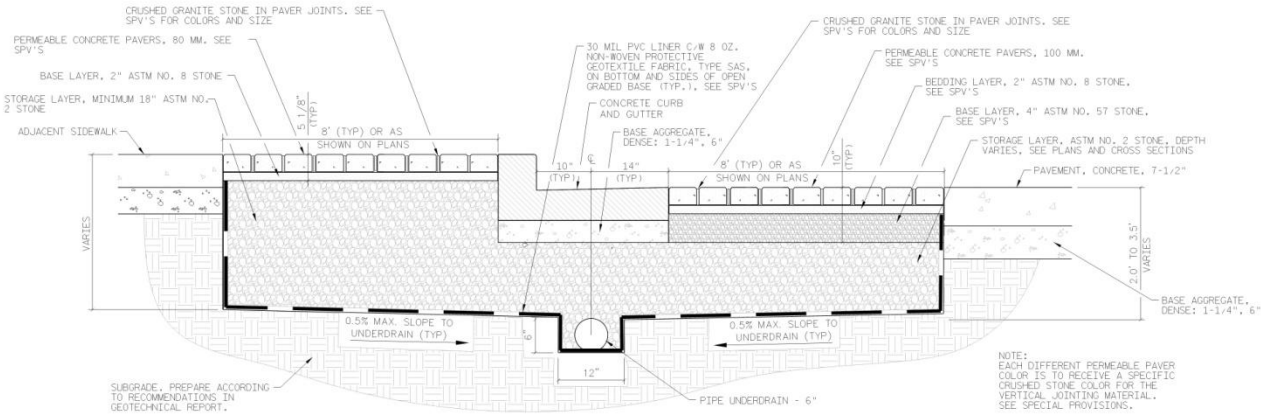
Cross-Section – Parking Lane



Cross-section - Terrace



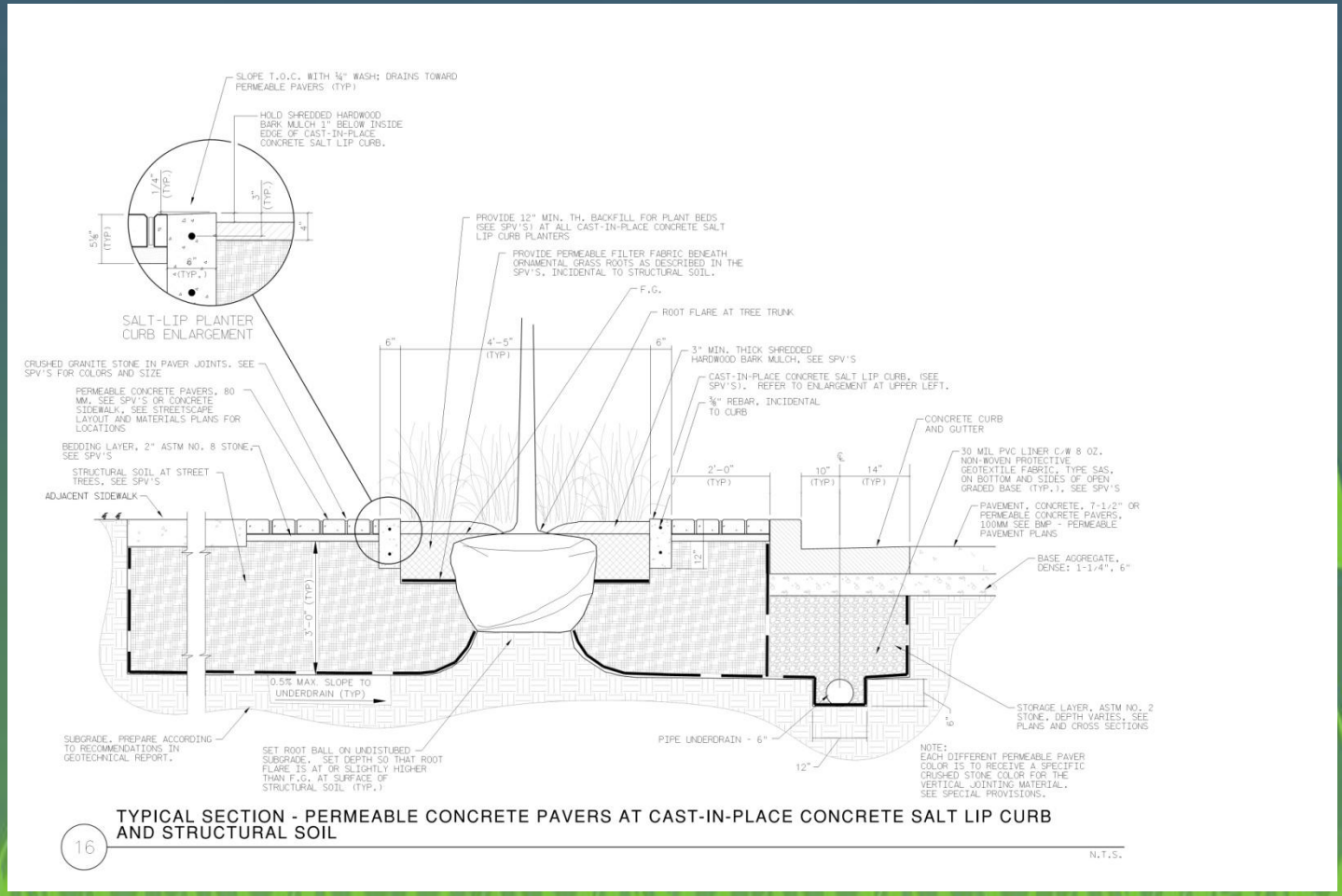
Cross-section – Parking Lane and Terrace



15 TYPICAL SECTION - PERMEABLE CONCRETE PAVERS IN ROADWAY AND ADJACENT TERRACE AREAS

N.T.S.

Cross-Section – Through Planter



Permeable Pavers Installation – Harris Bank, West Bend

ABB Parking lot at UWM Innovation Campus

ABB Parking lot at UWM Innovation Campus

Pervious Concrete – Urban Ecology Center

Missouri Botanical Gardens

Specifications

- Provide a description of Contractor's responsibilities
- Identify requirements for test reports and other evidence that materials meet the specifications

CSI Master Spec Format

SECTION 32 12 33

POROUS ASPHALT PAVING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Subgrade preparation.
2. Installation of underlying materials.
3. Porous asphalt mix design.
4. Porous asphalt production.
5. Porous asphalt installation.

B. Related Sections
1. Applicable provisions of [Division 01 – General Requirements] [Section 31 02 00 – General Requirements for Sitework] shall govern Work under this Section.
2. Section 31 05 13 – Soils for Earthwork.
3. Section 31 05 16 – Aggregates for Earthwork.
4. Section 32 11 23 – Aggregate Base Course.
5. Section 32 12 16 – Asphalt Paving.
6. Section 32 13 13 – Concrete Paving.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials: (AASHTO)
1. AASHTO T30 – Mechanical Analysis of Extracted Aggregate.
2. AASHTO T96 – Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
3. AASHTO T103 – Soundness of Aggregates by Freezing and Thawing.
4. AASHTO T104 – Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
5. AASHTO T164 - Quantitative Extraction Asphalt Binder from Hot Mix Asphalt (HMA).

B. ASTM International: (ASTM)

CSI Master Spec Format

1.3 SUBMITTALS

A. [Section 01 33 00 - Submittal Procedures] [Division 01 – General Requirements] [Section 31 02 00 – General Requirements for Sitework]: Requirements for submittals.

B. Product Data: Submit product information and mix design.

C. Certification: Provide Manufacturer's Certification Report that indicates Products and Materials meet or exceed all specified requirements.

D. Submit a list of materials proposed for work under this Section including name and address of materials producers and locations from which materials are to be obtained.

E. Submit certificates, signed by materials producers and relevant subcontractors, stating that materials meet or exceed specified requirements.

F. Submit samples of materials for review and approval by [Engineer] [Engineer/Architect] [Geotechnical Engineer] [Owner's Representative].

CSI Master Spec Format

PART 2 - PRODUCTS

2.1 POROUS ASPHALT MIX

A. Mix Properties:

	12.5 mm Mix	9.5 mm Mix
Percent Binder Content[1]	5.5 minimum	5.5 minimum
Binder Grade[2]	PG 64-22	PG 64-22
Percent Air Voids (Va @ 50 gyrations)	18 – 20	18 – 20
Percent Tensile Strength Ratio (TSR @ 5 cycles freeze/thaw) per ASTM D4867[3]	80 minimum	80 minimum
Percent Draindown at Production Temperature[4]	0.3 maximum	0.3 maximum

[1] - 5.75 - 6.0 percent recommended.

[2] - Minimum high temperature of 64 degrees C recommended.

[3] - Cantabro Abrasion test is not included in mix design guidelines.

[4] - Effective measures to reduce draindown include use of washed manufactured sand in lieu of crusher screenings and fibers. A slight reduction in production temperature may also be considered.

CSI Master Spec Format

3.2 POROUS ASPHALT PAVEMENT INSTALLATION

A. Mixing plant, hauling and placing equipment, and construction methods shall conform to [Wisconsin Department of Transportation] [Illinois Department of Transportation] [Florida Department of Transportation] Standard Specifications.

B. Use of surge bins shall not be permitted.

C. Hauling Equipment:
   1. Trucks used for hauling asphalt mixture shall have tight, clean, smooth metal bodies.
   2. Contractor shall apply a thin coat of a non-petroleum based or soap solution to prevent mixture from adhering to truck bodies.
   3. Each truck shall have a cover of canvas or other suitable material of such size sufficient to protect mixture from weather.
   4. When necessary to ensure delivery of material at specified temperature, insulate truck bodies and securely fasten covers.

D. Placing Equipment:
   1. Paver shall be a self-propelled unit with an activated screed or strike-off assembly, capable of being heated, if necessary, and capable of spreading and finishing mixture without segregation for widths and thicknesses required.
   2. Screed shall be adjustable to provide desired cross-sectional shape.
   3. Finished surface shall be of uniform texture and evenness and shall not show any indication of tearing, shoving, or pulling of mixture.
   4. Machine shall be in good mechanical condition and operated by competent personnel.

Specifications

- Require the Contractor to provide documentation of training in the installation of permeable pavement systems, or acceptable experiences or references

Specifications

- Example Training and Certifications:
  - Pavement Technician, by the National Ready Mix Concrete Association
  - Certificate for a Permeable interlocking Concrete Technician, from the Interlocking Concrete Pavement Institute

WisDOT – Special Provision

1. Permeable Concrete Pavers – 80mm, Item SPV.0165.XXXX; Permeable Concrete Pavers – 100mm, Item SPV.1065.XXXX;

A Description

This special provision describes furnishing and installing permeable concrete pavers in the roadway, terrace, and plaza areas, as shown on the Drawings. It includes cutting of the concrete pavers to fit and setting the concrete pavers as shown on the plans; as directed by the Engineer, and as hereinafter provided.

Construction work includes the placement and setting of pavers and the addition of joint material between the pavers, and cleaning and protection of finished concrete unit paver joints and surfaces.

B Materials

Concrete Pavers:

Pavers shall conform to the following requirements set forth in ASTM C936:

1. Measured length or width of test specimens shall not differ by more than +/- 0.063 in, while measured thickness shall not differ by more than +/- 0.125 in.
2. Average compressive strength of 8,000 psi with no individual unit under 7,200 psi when tested in accordance with ASTM C140.
3. Average absorption of five (5) percent with no unit greater than seven (7) percent when tested in accordance with ASTM C140.
4. For freeze-thaw testing, the average mass loss of all specimens tested shall not be greater than (A) 225 g/m2 when subject to 28 freeze thaw cycles, or (b) 500 g/m2 when subject to 49 freeze thaw cycles. Testing shall be conducted using a three (3) percent saline solution in according to ASTM C1645.

WisDOT – Special Provision

C Construction
Install the 6-inch concrete header, and base and aggregate for plaza area as described in Wisconsin standard specification section 602 Concrete Sidewalks.

Concrete Paver System:
Verify that concrete pavers are free from dust, dirt, and stains. Do not use soiled, cracked, or broken paver units. Place and compact base layers evenly over prepared substrate surface to a maximum thickness as indicated on the Drawings. Dampen and roller compact to level and even surface. Place paver units in pattern as indicated on Drawings from straight referenced edge and maintain a joint width of 5/16-inch at all vertical edges of each paver and at abutting vertical surfaces and protrusions. Maintain straight pattern lines evenly spaced, joint lines and coursing as indicated on the Drawings. Cut pavers to fit edges with a power saw. No cut paver shall be smaller than 1/3 of a whole unit if exposed to vehicular traffic.

WisDOT – Special Provision

D Measurement
The department will measure Permeable Concrete Pavers in area by the square foot acceptably completed.

E Payment
The department will pay for measured quantities at the contract unit price under the following bid items:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0165.XXXX	Permeable Concrete Pavers – 80mm	SF
SPV.0165.XXXX	Permeable Concrete Pavers – 100mm	SF

Specifications

- Descriptions of applicable standards, material requirements, and installation procedures.
- Requirements for system acceptance at the conclusion of construction.

Questions?