# *Appendix B: Green Infrastructure Typical Details and Specifications*

*These typical details and specifications were developed to be manipulated and customized for each individual project by design professionals.*

The SFPUC's Urban Watershed Management Program (UWMP) is proud to introduce the *San Francisco Green Infrastructure Typical Details and Specifications*. These details incorporate the latest best practices in green infrastructure (GI) design nation-wide and, at the same time, reflect the unique challenges and specific needs for designing and building GI in the City and County of San Francisco. The details were vetted through an extensive city-family review process and reflect the expertise of many members of the City Family, including Public Works, the Department of Building Inspection, the Municipal Transportation Agency, and the Planning Department.

This Appendix provides general guidance for using the details and specifications effectively during the design and construction document development process.

*Bioretention in a plaza manages stormwater from the roof of a residential building in San Francisco.* *Photo: Krystal Zamora*

## Typical Details for Site-Specific Design

These details show **typical** configurations, rather than required **standard** configurations. This distinction is deliberate on the part of the project team, as we recognize that to create GI projects that are beautiful, functional, and contextual, designers must use their own creative thinking and professional judgement and, above all, be responsive to each site.

To ensure that the details are broadly applicable and can be adapted to many sites, wherever possible the details provide **guidelines** and **ranges of acceptability** instead of precise numeric requirements. Both the Designer Notes for each detail and the details themselves emphasize areas where the designer must exercise professional judgement to respond to the site.

For example, the Designer Notes for the bioretention planter section indicate that planter area, ponding depth, bioretention soil depth, and gravel reservoir course depth must be sized to meet project hydrologic performance goals. On the corresponding drawing, bioretention soil depth is shown with a minimum depth of 18 inches. Ponding depth should be between 2 and 6 inches. In these cases the details are indicating acceptable minimums and maximums but the designer must choose the bioretention soil depth and ponding depth that is appropriate for a given site. Bioretention facilities on a site with A soils may perform very well using the minimum soil depth, while facilities sited on C soils will benefit from a deeper soil profile.

Items that are **required** for system function can be found in the Construction Notes, the General Utility Notes, the Layout Requirements, and the Designer Checklists. For example, the Construction Notes for the bioretention planter section include the following:

1. Avoid compaction of existing subgrade below planter during construction.

2. Scarify subgrade to a depth of 6 inches (min) immediately prior to placement of gravel storage and bioretention soil.

3. Maximum drop from top of curb to top of bioretention soil shall include considerations for bioretention soil settlement.

### *Usage on Construction Documents*

ACAD drawings of typical details are available for download at www.sfwater.org/smr. Design professionals must modify facility plan and section configurations, materials, and construction notes to address the project's site conditions and meet project performance goals. To ensure that your use of the details is site-specific, please:

- Adjust plans, sections, and construction notes for site-specific design
- Remove the SFPUC GI Title Block from the details used in your set and replace it with a title that aligns with your projects' construction document nomenclature
- Incorporate all detail call-outs and references into the construction documents so that the contractor will have all the information required to build the project

*Permeable pavement along Octavia Blvd in San Francisco.*
*Photo: Krystal Zamora*

*Drought tolerant plantings can also be appropriate for vegetated roofs.* Photo: Ken Kortkamp

### *Typical Detail Content*

The details are organized to guide the licensed professional to the proper selection, layout, and design of GI technologies (such as permeable pavement and bioretention) and components (such as inlets, outlets, and edge treatments). The components allow the typical details to be modified to reflect specific design approaches and site conditions. The typical details include the following sections:

- Purpose
- Designer Guidelines
- Layout Requirements
- Designer Checklists
- Key Maps
- Facility Plans
- Facility Sections and Profiles
- General Notes
- General Utility Notes
- Construction Notes
- Component Details

**SAN FRANCISCO PUBLIC UTILITIES COMMISSION**

**STORMWATER MANAGEMENT REQUIREMENTS AND DESIGN GUIDELINES**

APPENDIX B:

# GREEN INFRASTRUCTURE TYPICAL DETAILS

(SEPTEMBER 2016, VERSION 2.0)

San Francisco Water Power Sewer

Services of the San Francisco Public Utilities Commission

**THIS INDEX HAS BEEN ACTIVATED FOR EASY ELECTRONIC NAVIGATION. CLICK ON THE DESIRED SHEET TITLE FOR DIRECT ACCESS.**

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE: SEPTEMBER 2016

VERSION: 2.0

REVISED:

## SHEET INDEX

DWG NO.

# USER GUIDE: HOW TO USE THESE GI TYPICAL DETAILS

THESE TYPICAL DETAILS AND SPECIFICATIONS WERE DEVELOPED TO BE REVISED AND CUSTOMIZED FOR EACH INDIVIDUAL PROJECT BY DESIGN PROFESSIONALS.

THEY SHOW **TYPICAL** CONFIGURATIONS, RATHER THAN A REQUIRED CITY **STANDARD** CONFIGURATION. THIS DISTINCTION IS DELIBERATE. WE RECOGNIZE THAT TO CREATE GI PROJECTS THAT ARE FUNCTIONAL, CONTEXTUAL, AND AESTHETIC, DESIGN PROFESSIONALS MUST USE THEIR PROFESSIONAL JUDGMENT AND CREATIVE THINKING TO BE RESPONSIVE TO EACH SITE-SPECIFIC CONDITION.

**ACAD DRAWINGS OF THESE TYPICAL DETAILS ARE PROVIDED SUCH THAT THE DESIGN PROFESSIONALS MUST MODIFY THE PLAN, SECTIONS, CALL-OUTS, AND/OR CONSTRUCTION NOTES TO ADDRESS THE PROJECTS SITE-SPECIFIC CONDITIONS.**

## CONTENT

THESE TYPICAL DETAILS ARE FORMATTED, ORGANIZED, AND DEVELOPED WITH THE NECESSARY INFORMATIONAL TOOLS TO GUIDE THE DESIGN PROFESSIONAL THROUGH THE PROPER SELECTION, LAYOUT, AND DESIGN OF **GI BEST MANAGEMENT PRACTICES (BMPS)** AND THE SELECTION OF APPROPRIATE SITE-SPECIFIC BMP **COMPONENT DETAILS** (I.E. INLETS, OUTLETS, AND EDGE TREATMENTS, ETC.). THESE TYPICAL DETAILS PROVIDE THE FOLLOWING ORGANIZATION:

**PURPOSE:** SUMMARY OF EACH FACILITY'S INTENDED PERFORMANCE AND FUNCTION.

**DESIGNER NOTES & GUIDELINES:** TECHNICAL DESIGN REQUIREMENTS AND/OR SIZING CRITERIA GUIDELINES ARE PROVIDED SUCH THAT EACH FACILITY IS DESIGNED AND APPROPRIATELY CUSTOMIZED BY THE DESIGN PROFESSIONAL.

**LAYOUT REQUIREMENTS:** TECHNICAL INFORMATION, DESIGN REQUIREMENTS, AND REFERENCE TO RELATED CITY REQUIREMENTS.

**DESIGNER CHECKLIST:** TECHNICAL DESIGN INFORMATION THAT **MUST** BE DETERMINED AND SHOWN IN THE CONSTRUCTION DOCUMENTS TO ENSURE PROPER DESIGN AND CONSTRUCTABILITY.

**BMP PLANS:** TYPICAL PLAN VIEW WITH GENERAL CONFIGURATION FOR PROPER FUNCTION. DIMENSIONAL LAYOUT AND EDGING MATERIALS SHOULD BE ADJUSTED BASED ON PROPOSED SITE DESIGN AND PROGRAMING. **[ADJUST ACAD DETAIL CALL-OUTS AND REFERENCES FOR USE IN CDs]**

**BMP SECTIONS AND PROFILES:** A TYPICAL SECTION AND/OR PROFILE WITH GENERAL CONFIGURATION FOR PROPER FUNCTION. DIMENSIONAL LAYOUT AND EDGING MATERIALS SHOULD BE ADJUSTED BASED ON PROPOSED SITE DESIGN AND PROGRAMING. **[ADJUST ACAD DETAILS CALL-OUTS AND REFERENCES FOR USE IN CDs]**

**CONSTRUCTION NOTES:** CONSTRUCTION RELATED NOTES FOR USE BY THE CONTRACTOR. **[ADJUST ACAD NOTES FOR USE IN CDs]**

## NAVIGATION

THE TYPICAL DETAILS HAVE BEEN DEVELOPED WITH A NAVIGATION SYSTEM AND KEY BAR TO ASSIST THE DESIGN PROFESSIONALS WITH LINKING THE SPECIFIC BMP TO RELEVANT DESIGN NOTES AND POSSIBLE DETAIL COMPONENTS. EXAMPLE KEY BAR:

| EDGE TREATMENTS | | | | | | SUBSURFACE CHECK DAMS | | SUBSURFACE OUTLETS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | KEY MAP | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | | |
| PC 1.1 | PC 1.2 | PC 1.3 | PC 1.4 | PC 1.5 | PC 1.6 | PC 2.1 | PC 2.2 | PC 3.1 | PC 3.2 | PC 3.3 | PC 3.4 |

## USE ON CONSTRUCTION DOCUMENTS

DESIGN PROFESSIONALS USING THE AUTOCAD DRAWINGS **MUST REVIEW AND ADJUST THE DETAILS AND CONSTRUCTION NOTES TO ADDRESS THEIR SITE-SPECIFIC CONDITIONS** . TO ALLOW FOR SITE-SPECIFIC DESIGN ADJUSTMENTS THE TYPICAL DETAILS ARE DEVELOPED AS **"NOT FOR CONSTUCTION"** DRAWINGS. TITLE BLOCKS ARE PROVIDED FOR DOCUMENT ORGANIZATION AND REFERENCE ONLY.

- **DO NOT** INCLUDE THE NON-ADJUSTED DETAIL WITH TITLE BLOCK WITHIN THE CONSTRUCTION DOCUMENTS.
- **DO NOT** INCLUDE NON-ADJUSTED DETAIL PLANS, SECTIONS, OR CONSTRUCTION NOTES WITHIN THE CONSTRUCTION DOCUMENTS.
- **DO NOT** REFERENCE THE GI TYPICAL DETAIL SHEET NAME AND/OR NUMBER (I.E. **BP 2.1**) AS A STANDARD DETAIL CALL-OUT WITHIN THE CDs.
- **DO NOT** EXPECT CONTRACTORS TO CONDUCT CALCULATIONS OR BE RESPONSIBLE FOR MISSING DESIGN INFORMATION.

## PURPOSE:

PERMEABLE PAVEMENT (PAVEMENT) CONTROLS PEAK FLOWS AND VOLUMES OF STORMWATER RUNOFF VIA INFILTRATION THROUGH THE PAVEMENT SURFACE, STORAGE IN THE PAVEMENT SECTION, INFILTRATION INTO NATIVE SOIL, AND OVERFLOW THROUGH OPTIONAL SUBSURFACE OUTLETS. RUNOFF IS TREATED AS IT FILTERS THROUGH THE PAVEMENT SECTION, AND INFILTRATES INTO UNDERLYING NATIVE SOIL.

## DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT PLAN, SECTION DRAWINGS, AND CALCULATE DEPTH TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. ALL PAVEMENT SYSTEMS MUST BE DESIGNED BY A LICENSED ENGINEER IN ACCORDANCE WITH THE AASHTO GUIDE FOR DESIGN OF PAVEMENT STRUCTURES BASED ON SITE-SPECIFIC CONDITIONS INCLUDING TRAFFIC LOADS AND SUBGRADE CONDITIONS. PAVEMENT SECTIONS SET FORTH IN THESE TYPICAL DETAILS ARE PROVIDED TO REPRESENT THE ANTICIPATED RANGE OF DESIGN REQUIREMENTS, BASED ON "GOOD" AND "POOR" SOIL CHARACTERIZATIONS NORMALLY ENCOUNTERED IN SAN FRANCISCO. **ACTUAL SECTION DEPTHS MUST BE DETERMINED AS DESCRIBED IN GUIDELINE #3, BELOW** . SEE TABLES BELOW FOR TRAFFIC LOADING AND EFFECTIVE ROADBED SOIL RESILIENT MODULUS ASSUMPTIONS USED IN DEVELOPING THESE TYPICAL SECTIONS.
3. TRAFFIC LOADING ASSUMPTIONS:

| DESIGN ASSUMPTION | MODERATE VEHICULAR | LIGHT VEHICULAR | PEDESTRIAN |
|---|---|---|---|
| EQUIVALENT SINGLE AXLE LOADS* | 2,000,000 | 40,000 | 800 |
| TRAFFIC INDEX (TI)** | 10 | 6.5 | 4 |
| * SEE AASHTO GUIDE FOR DESIGN OF PAVEMENT STRUCTURES FOR DEFINITIONS | | | |
| ** SEE CALTRANS HIGHWAY DESIGN MANUAL FOR DEFINITIONS | | | |

SUBGRADE ASSUMPTIONS:

| DESIGN ASSUMPTION | GOOD SOILS | POOR SOILS |
|---|---|---|
| EFFECTIVE ROADBED SOIL RESILIENT MODULUS, $M_R$(PSI)* | 6,800 | 3,700 |
| CALIFORNIA R-VALUE ** | 33.3 | 15.6 |
| DRAINAGE COEFFICIENT, m * | 1.15 | 0.75 |
| LAYER COEFFICIENT, a * FOR OPEN GRADED AGGREGATE BASE | 0.08 | |
| * SEE AASHTO GUIDE FOR DESIGN OF PAVEMENT STRUCTURES FOR DEFINITIONS | | |
| ** SEE CALTRANS HIGHWAY DESIGN MANUAL FOR DEFINITIONS | | |

4. GEOTECHNICAL EVALUATION OF SUBGRADE SOILS TO VERIFY THEIR STRUCTURAL SUITABILITY FOR PERMEABLE PAVEMENT INSTALLATIONS IS REQUIRED. INFILTRATION TESTING REQUIREMENTS ARE SUBJECT TO DIFFERENT THRESHOLDS. REFER TO SAN FRANCISCO STORMWATER MANAGEMENT REQUIREMENTS FOR GUIDANCE.
5. THE PERMEABLE PAVEMENT FACILITY MUST BE DESIGNED TO PROVIDE SUFFICIENT SUBSURFACE STORAGE IN THE PAVEMENT SECTION TO MEET PROJECT HYDROLOGIC PERFORMANCE GOALS. THE SECTION THICKNESS WILL BE A FUNCTION OF THE SUBGRADE INFILTRATION RATE (DRAINAGE COEFFICIENT), SUBGRADE SLOPE, AND THE HEIGHT AND SPACING OF SUBSURFACE CHECK DAMS. SEE **PC 2.1** AND **PC 2.2**.
6. ENTIRE PAVEMENT BASE SECTION MAY BE USED TO MEET SUBSURFACE STORAGE REQUIREMENTS.
7. SUBSURFACE STORAGE DRAWDOWN TIME (I.E. TIME FOR MAXIMUM SUBSURFACE STORAGE VOLUME TO INFILTRATE INTO SUBGRADE AFTER THE END OF A STORM) SHOULD NOT EXCEED 48 HOURS. DRAWDOWN TIME IS CALCULATED AS THE MAXIMUM SUBSURFACE PONDING DEPTH DIVIDED BY THE NATIVE SOIL INFILRATION RATE.
8. THE DESIGNER MUST ENSURE THAT THE PAVEMENT EDGES ARE RESTRAINED AND THAT WATER IS CONTAINED IN THE PAVEMENT SECTION AS NEEDED TO PROTECT ADJACENT PAVEMENT SECTIONS OR STRUCTURES. SEE EDGE TREATMENTS ( **PC 1.1** THROUGH **PC 1.6**) FOR GUIDANCE ON DESIGN OF THESE COMPONENTS.
9. THE DESIGNER MUST EVALUATE UTILITY SURVEYS FOR POTENTIAL UTILITY CROSSINGS OR CONFLICTS. REFER TO **GC 2.1** - **GC 2.12** FOR UTILITY CROSSING DETAILS AND **GC 1.4** - **GC 4.4** FOR UTILITY CROSSING CONFLICT DETAILS.

### RELATED COMPONENTS

| | | |
|---|---|---|
| EDGE TREATMENTS: | PC 1.1 | PC 1.6 |
| CHECK DAMS: | PC 2.1 | PC 2.2 |
| OVERFLOWS: | PC 3.1 | PC 3.3 |
| LINERS: | GC 1.1 | GC 1.2 |
| UTILITY CROSSINGS: | GC 2.1 | GC 2.12 |
| OBSERVATION PORTS: | GC 3.1 | GC 3.3 |
| UTILITY CONFLICTS: | GC 4.1 | GC 4.4 |
| CLEANOUTS: | GC 5.2 | |

### RELATED SPECIFICATIONS

| RELATED SPECIFICATIONS | CSI NO. |
|---|---|
| **PERMEABLE/POROUS UNIT PAVERS:**<br>- PERMEABLE /POROUS UNIT PAVERS<br>- JOINT FILLER AGGREGATE<br>- PAVEMENT BASE<br>- EDGE RESTRAINTS<br>- GEOTEXTILE FOR SOIL SEPARATION | 32 14 43 |
| **PERVIOUS CONCRETE PAVEMENT:**<br>- PERVIOUS CONCRETE<br>- PAVEMENT BASE<br>- GEOTEXTILE FOR SOIL SEPARATION | 32 13 43 |
| **POROUS ASPHALT PAVEMENT:**<br>- POROUS ASPHALT<br>- PAVEMENT BASE<br>- GEOTEXTILE FOR SOIL SEPARATION | 32 12 43 |

NOTES: PP 1.1, PP 1.2 | KEY MAP: PP 1.3 | SECTIONS: PP 2.1, PP 3.1, PP 4.1

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

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# PERMEABLE PAVEMENT

## DESIGNER NOTES (1 OF 2)

DWG NO. PP 1.1

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

## LAYOUT REQUIREMENTS:

1. ALL PERMEABLE PAVEMENT APPLICATIONS SHALL CONFORM TO THE CURRENT CITY OF SAN FRANCISCO PUBLIC WORKS PERMEABLE PAVEMENT DIRECTORS ORDER [PENDING COMPLETION]. THE DESIGN MUST COMPLY WITH SAN FRANCISCO PUBLIC WORKS STANDARD ACCESSIBILITY REQUIREMENTS.
2. THE PREFERRED AND ALLOWED CATCHMENT AREA CONTRIBUTING RUN-ON TO A PERMEABLE PAVEMENT FACILITY IS PROVIDED IN THE FOLLOWING TABLE:

| WEARING COURSE | PREFERRED RUN-ON RATIO | MAXIMUM RUN-ON RATIO** (AREA CONTRIBUTING RUN-ON: PERMEABLE PAVEMENT AREA) |
|---|---|---|
| PERVIOUS CONCRETE AND POROUS ASPHALT | MINIMAL | 3:1 |
| PERMEABLE UNIT PAVERS (≥ 1/2" GAPS) [PARCEL ONLY] * | 0:1 | 3:1 |
| PERMEABLE UNIT PAVERS (≥ 3/8" GAPS) * | 0:1 | 2:1 |
| PERMEABLE UNIT PAVERS (≥ 1/4" GAPS) | 0:1 | 1:1 |
| POROUS PAVERS | 0:1 | 0:1 (NO RUN-ON) |

*PAVERS WITH 3/8 INCH OR 1/2 INCH GAPS SHALL BE PERMEABLE INTERLOCKING CONCRETE PAVERS WITH INTEGRATED PRECAST INTERLOCKING SPACER.

**THE DESIGNER AND OWNER SHOULD CONSIDER THE INCREASED MAINTENANCE REQUIREMENTS ASSOCIATED WITH HIGHER RUN-ON RATIOS WHEN DESIGNING THE FACILITY.

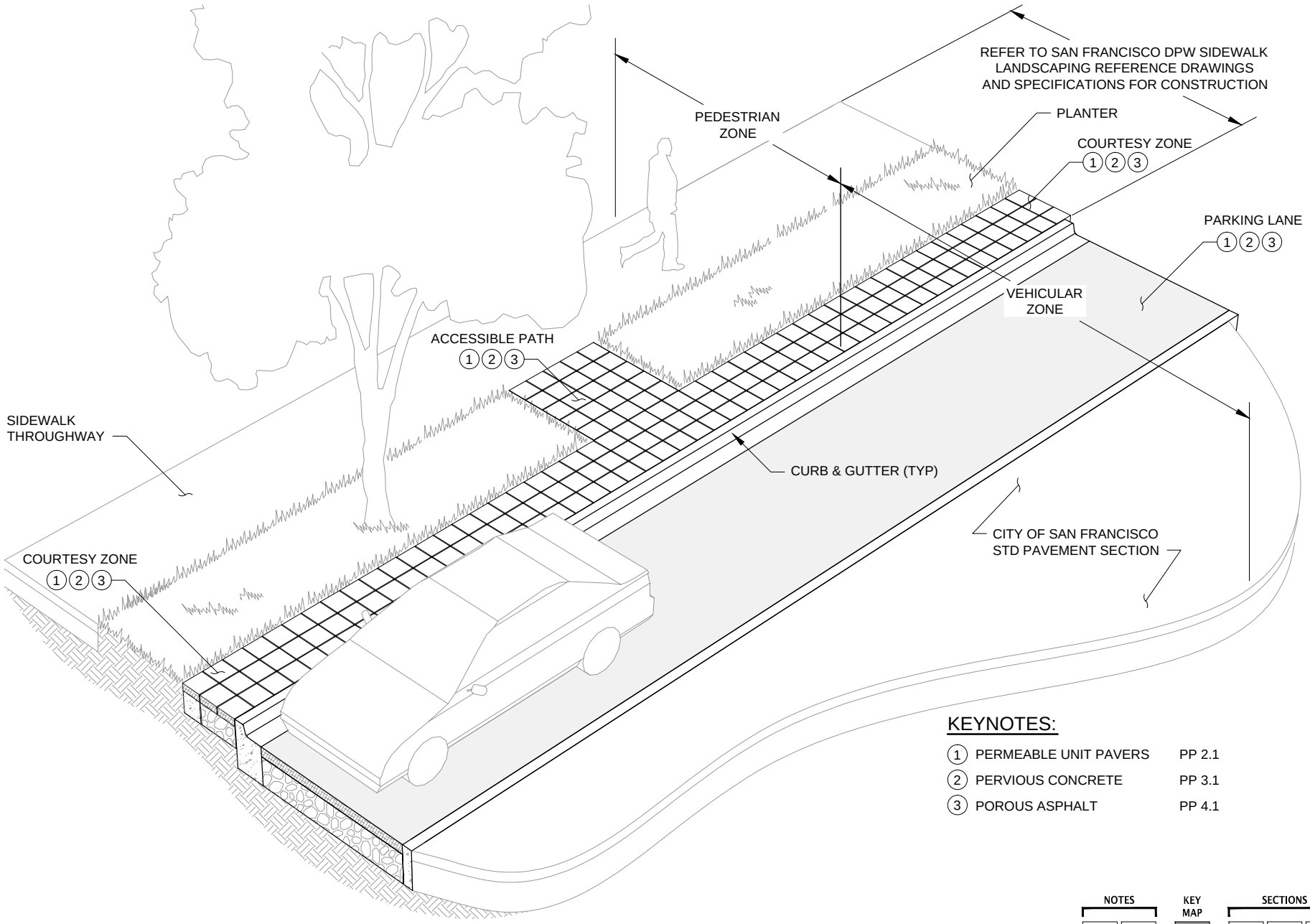
3. WHEN DESIGNED TO ACCEPT RUN-ON FROM OTHER CATCHMENT AREAS, PERMEABLE PAVEMENT AREAS MUST BE PROTECTED FROM SEDIMENTATION WHICH CAN CAUSE CLOGGING AND DIMINISHED FACILITY PERFORMANCE. THE FOLLOWING REQUIREMENTS APPLY FOR RUN-ON CONTRIBUTIONS:
   - RUN-ON FROM LAWN, LANDSCAPE OR OTHER ERODIBLE SURFACES IS DISCOURAGED. IF MINOR RUN-ON FROM LAWN OR LANDSCAPE AREAS IS UNAVOIDABLE, THOSE ERODIBLE AREAS MUST BE FULLY STABILIZED.
   - CONCENTRATED RUN-ON (E.G., DIRECT DISCHARGE FROM A DOWNSPOUT) SHOULD BE DISPERSED PRIOR TO DISCHARGE TO A PERMEABLE PAVEMENT FACILITY. ACCEPTABLE METHODS INCLUDE SHEET FLOW OR SUBSURFACE DELIVERY TO THE STORAGE RESERVOIR. IF SUBSURFACE DELIVERY IS USED, PRIMARY SETTLING IS REQUIRED (E.G., VIA SAND TRAP) FOLLOWED BY DISTRIBUTION TO STORAGE RESERVOIR (E.G., VIA PERFORATED PIPE).
4. WEARING COURSE SHALL BE SET FLUSH (± 3/16 INCH) WITH ADJACENT WALKING SURFACES.
5. WEARING COURSE SHALL HAVE A MINIMUM SURFACE SLOPE OF 0.5% TO ALLOW FOR SURFACE OVERFLOW AND A MAXIMUM SURFACE SLOPE AS LISTED BELOW:
   a. POROUS ASPHALT SURFACE: = 5 PERCENT SLOPE
   b. PERVIOUS CONCRETE SURFACE: = 10 PERCENT SLOPE
   c. PERMEABLE UNIT PAVERS: = 12 PERCENT SLOPE (PER MANUFACTURER'S RECOMMENDATION)
6. WHILE THERE IS NO MAXIMUM SLOPE FOR THE SUBGRADE UNDER THE PERMEABLE PAVEMENT COURSES, THERE MAY BE ENGINEERING CHALLENGES ASSOCIATED WITH SUBSURFACE CHECK DAM REQUIREMENTS ON SUBGRADE SLOPES EXCEEDING 5%. SEE SUBSURFACE CHECK DAMS (**PC 2.1** AND **PC 2.2**).

## DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ PERMEABLE PAVEMENT SPECIFICATIONS AND/OR PAVER TYPE AND GAP WIDTH
- ☐ PERMEABLE PAVEMENT WIDTH AND LENGTH
- ☐ ELEVATIONS AND CONTROL POINTS AT EVERY CORNER OR POINT OF TANGENCY
- ☐ THICKNESS OF EACH LAYER IN THE PAVEMENT SECTION
- ☐ JOINT SPACING AND TYPE
- ☐ SUBGRADE SLOPE
- ☐ SUBSURFACE CHECK DAM SPACING, HEIGHT, AND TYPE
- ☐ ELEVATIONS OF EACH PIPE INLET AND OUTLET INVERT
- ☐ TYPE AND DESIGN OF PERMEABLE PAVEMENT COMPONENTS (E.G., EDGE TREATMENTS, OUTLETS, UNDERDRAINS, etc.)

NOT FOR CONSTRUCTION - REFER TO USER GUIDE


| NOTES | | KEY MAP | SECTIONS | | |
|---|---|---|---|---|---|
| PP 1.1 | PP 1.2 | PP 1.3 | PP 2.1 | PP 3.1 | PP 4.1 |




## KEYNOTES:

| | | |
|---|---|---|
| 1 | PERMEABLE UNIT PAVERS | PP 2.1 |
| 2 | PERVIOUS CONCRETE | PP 3.1 |
| 3 | POROUS ASPHALT | PP 4.1 |

| NOTES | | KEY MAP | SECTIONS | | |
|---|---|---|---|---|---|
| PP 1.1 | PP 1.2 | PP 1.3 | PP 2.1 | PP 3.1 | PP 4.1 |

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San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

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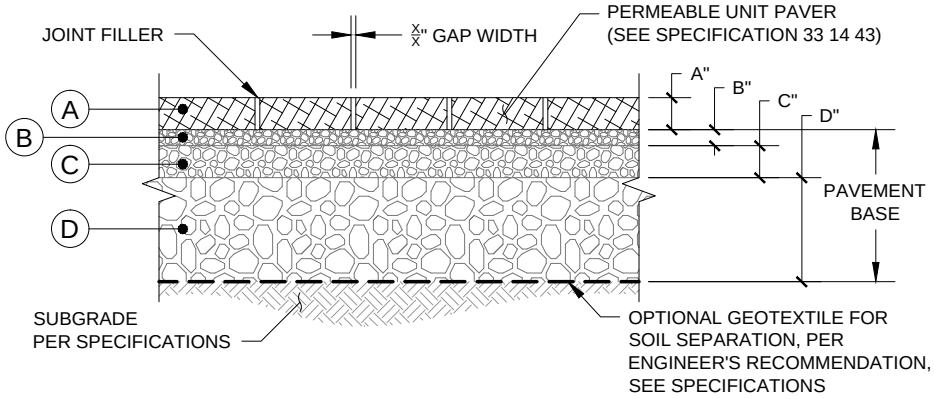
# PERMEABLE PAVEMENT

## KEY MAP

DWG NO. PP 1.3




PERMEABLE UNIT PAVERS 1

## MINIMUM MATERIAL THICKNESS (IN):

| LAYER | MATERIAL TYPE* | MODERATE VEHICULAR | | LIGHT VEHICULAR | | PEDESTRIAN | |
|---|---|---|---|---|---|---|---|
| | | GOOD SOILS** | POOR SOILS** | GOOD SOILS** | POOR SOILS** | GOOD SOILS** | POOR SOILS** |
| A | PERMEABLE UNIT PAVERS | 3 1/8 | 3 1/8 | 3 1/8 | 3 1/8 | 3 1/8 | 3 1/8 |
| B | LEVELING COURSE ASTM NO. 8 | 2 | 2 | 2 | 2 | 2 | 2 |
| C | BASE COURSE ASTM NO. 57 | 6 | 6 | 6 | 4 | 4 | 4 |
| D | RESERVOIR COURSE ASTM NO. 2, 3, OR 57 | 22 | 28 | - | 10 | - | - |

* MATERIAL FINER THAN NO. 100 SIEVE SHALL NOT EXCEED 2 PERCENT FOR ANY AGGREGATE LAYER (LICENSED PROFESSIONAL TO SELECT AGGREGATE).

** "GOOD" AND "POOR" SOIL CLASSIFICATIONS BASED ON AASHTO GUIDE FOR DESIGN OF PAVEMENT STRUCTURES. SEE DESIGNER NOTES FOR SUBGRADE ASSUMPTIONS. (LICENSED PROFESSIONAL MUST CALCULATE REQUIRED DEPTH BASED ON SITE CONDITIONS).

## TYPICAL JOINT FILLER AGGREGATE SIZE:

| GAP WIDTH (IN) | JOINT FILLER AGGREGATE * |
|---|---|
| 3/8 OR 1/2 | ASTM NO. 8 |
| 1/4 | ASTM NO. 9 OR 89 |
| 1/8 | ASTM NO. 10 ** |

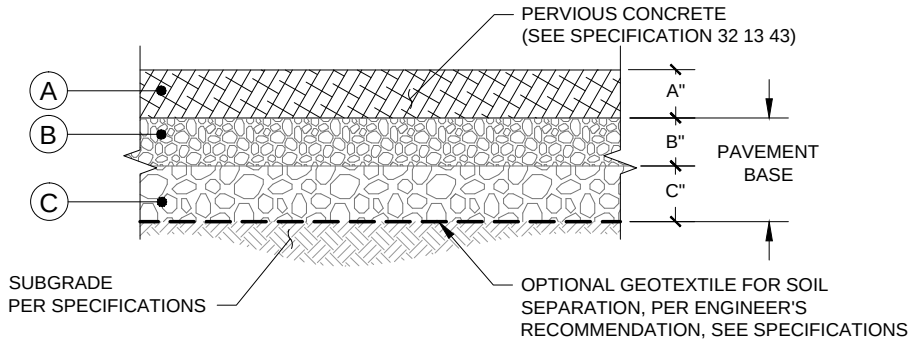
* PROVIDED FOR REFERENCE ONLY, FOLLOW MANUFACTURER'S RECOMMENDATIONS

** FOR POROUS PAVERS ONLY, ASTM NO. 20 SAND NOT ALLOWED PER MANUFACTURERS RECOMMENDATIONS.

## CONSTRUCTION NOTES:

1. SEE PERMEABLE/POROUS UNIT PAVER SPECIFICATIONS FOR WEARING COURSE, PAVEMENT BASE, SUBGRADE, AND OTHER REQUIREMENTS FOR PERMEABLE/POROUS UNIT PAVER FACILITIES.
2. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT SFPUC ASSET PROTECTION STANDARDS AND OTHER UTILITY PROVIDER REQUIREMENTS. COORDINATE WITH ENGINEER IN THE EVENT OF UTILITY CROSSINGS AND UTILITY CONFLICTS.


NOTES: PP 1.1, PP 1.2 | KEY MAP: PP 1.3 | SECTIONS: PP 2.1, PP 3.1, PP 4.1




PERVIOUS CONCRETE 1

## MINIMUM MATERIAL THICKNESS (IN):

| LAYER | MATERIAL TYPE* | MODERATE VEHICULAR | | LIGHT VEHICULAR | | PEDESTRIAN | |
|---|---|---|---|---|---|---|---|
| | | GOOD SOILS** | POOR SOILS** | GOOD SOILS** | POOR SOILS** | GOOD SOILS** | POOR SOILS** |
| A | PERVIOUS CONCRETE | 9 | 9.5 | 6.5 | 7 | 4.5 | 5 |
| B | BASE COURSE ASTM NO. 3 OR 57 | 6 | 6 | 6 | 6 | 6 | 6 |
| C | OPTIONAL RESERVOIR COURSE ASTM NO. 2, 3, OR 57 | - | - | - | - | - | - |

* MATERIAL FINER THAN NO. 100 SIEVE SHALL NOT EXCEED 2 PERCENT FOR ANY AGGREGATE LAYER (LICENSED PROFESSIONAL TO SELECT AGGREGATE).

** "GOOD" AND "POOR" SOIL CLASSIFICATIONS BASED ON AASHTO GUIDE FOR DESIGN OF PAVEMENT STRUCTURES. SEE DESIGNER NOTES FOR SUBGRADE ASSUMPTIONS. (LICENSED PROFESSIONAL MUST CALCULATE REQUIRED DEPTH BASED ON SITE CONDITIONS).

## CONSTRUCTION NOTES:

1. SEE PERVIOUS CONCRETE SPECIFICATIONS FOR WEARING COURSE, PAVEMENT BASE, SUBGRADE, AND OTHER REQUIREMENTS FOR PERVIOUS CONCRETE FACILITIES.
2. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT SFPUC ASSET PROTECTION STANDARDS AND OTHER UTILITY PROVIDER REQUIREMENTS. COORDINATE WITH ENGINEER IN THE EVENT OF UTILITY CROSSINGS AND UTILITY CONFLICTS.

NOT FOR CONSTRUCTION - REFER TO USER GUIDE


| NOTES | | KEY MAP | SECTIONS | | |
|---|---|---|---|---|---|
| PP 1.1 | PP 1.2 | PP 1.3 | PP 2.1 | PP 3.1 | PP 4.1 |


San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE SEPTEMBER 2016
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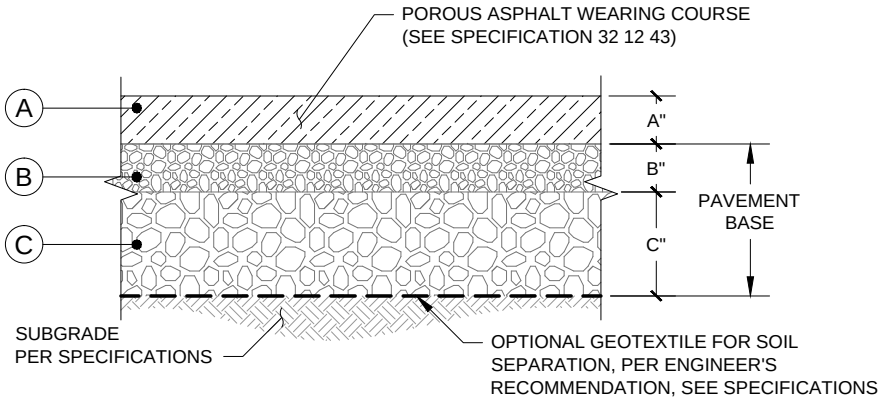
# PERMEABLE PAVEMENT

## MATERIAL SECTIONS
## PERVIOUS CONCRETE

DWG NO. PP 3.1




POROUS ASPHALT (1)

## MINIMUM MATERIAL THICKNESS (IN):

| LAYER | MATERIAL TYPE* | MODERATE VEHICULAR | | LIGHT VEHICULAR | | PEDESTRIAN | |
|---|---|---|---|---|---|---|---|
| | | GOOD SOILS** | POOR SOILS** | GOOD SOILS** | POOR SOILS** | GOOD SOILS** | POOR SOILS** |
| A | POROUS ASPHALT | 6 | 8 | 4 | 4 | 3 | 4 |
| B | BASE COURSE ASTM NO. 57 | 6 | 6 | 5 | 4 | 6 | 4 |
| C | RESERVOIR COURSE ASTM NO. 2, 3, OR 57 | 10 | 19 | - | 11 | - | 8 |

* MATERIAL FINER THAN NO. 100 SIEVE SHALL NOT EXCEED 2 PERCENT FOR ANY AGGREGATE LAYER (LICENSED PROFESSIONAL TO SELECT AGGREGATE).

** "GOOD" AND "POOR" SOIL CLASSIFICATIONS BASED ON AASHTO GUIDE FOR DESIGN OF PAVEMENT STRUCTURES. SEE DESIGNER NOTES FOR SUBGRADE ASSUMPTIONS. (LICENSED PROFESSIONAL MUST CALCULATE REQUIRED DEPTH BASED ON SITE CONDITIONS).

## CONSTRUCTION NOTES:

1. SEE POROUS ASPHALT SPECIFICATIONS FOR WEARING COURSE, PAVEMENT BASE, SUBGRADE, AND OTHER REQUIREMENTS FOR POROUS ASPHALT FACILITIES.
2. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT SFPUC ASSET PROTECTION STANDARDS AND OTHER UTILITY PROVIDER REQUIREMENTS. COORDINATE WITH ENGINEER IN THE EVENT OF UTILITY CROSSINGS AND UTILITY CONFLICTS.




| NOTES | | KEY MAP | SECTIONS | | |
|---|---|---|---|---|---|
| PP 1.1 | PP 1.2 | PP 1.3 | PP 2.1 | PP 3.1 | PP 4.1 |


San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE SEPTEMBER 2016
VERSION 2.0
REVISED

# PERMEABLE PAVEMENT

## MATERIAL SECTIONS
## POROUS ASPHALT

DWG NO. PP 4.1

## PURPOSE:

EDGE TREATMENTS ARE USED TO STABILIZE THE EDGE OF THE PERMEABLE PAVEMENT AND CONTAIN WATER WITHIN THE PERMEABLE PAVEMENT SECTION.

## DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT PLAN AND SECTION DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. ALL EDGE TREATMENT SYSTEMS MUST BE DESIGNED BY A LICENSED ENGINEER BASED ON SITE SPECIFIC CONDITIONS.
3. MINIMUM EDGE TREATMENT EMBEDMENT KEY DEPTHS ARE SPECIFIED TO PREVENT LATERAL SEEPAGE UNDER THE EDGE TREATMENT AND INTO ADJACENT PAVEMENT SECTIONS. DEEPER EMBEDMENT MAY BE REQUIRED UNDER SOME CONDITIONS.
4. FOR DEEP PAVEMENT SECTIONS, EDGE TREATMENT NOT REQUIRED TO EXTEND MORE THAN 12 INCHES BELOW WEARING COURSE PROVIDED REQUIREMENTS AT INTERFACE WITH IMPERMEABLE PAVEMENTS ARE SATISFIED.
5. USE THE EDGE TREATMENT KEY MAP ON **PC 1.2** AND CURRENT CITY OF SAN FRANCISCO PUBLIC WORKS PERMEABLE PAVEMENT DIRECTORS ORDER [PENDING COMPLETION] TO IDENTIFY WHERE EACH TYPE OF EDGE TREATMENT IS REQUIRED OR ALLOWED.

## DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ EDGE TREATMENT TYPE AND MATERIAL
- ☐ EDGE TREATMENT WIDTH AND HEIGHT
- ☐ EMBEDMENT KEY DEPTH IF DIFFERENT THAN THE PROVIDED MINIMUMS


| EDGE TREATMENTS | | | | | | SUBSURFACE CHECK DAMS | | SUBSURFACE OUTLETS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | KEY MAP | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | | |
| PC 1.1 | PC 1.2 | PC 1.3 | PC 1.4 | PC 1.5 | PC 1.6 | PC 2.1 | PC 2.2 | PC 3.1 | PC 3.2 | PC 3.3 | PC 3.4 |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# GREEN INFRASTRUCTURE TYPICAL DETAILS

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DATE: SEPTEMBER 2016

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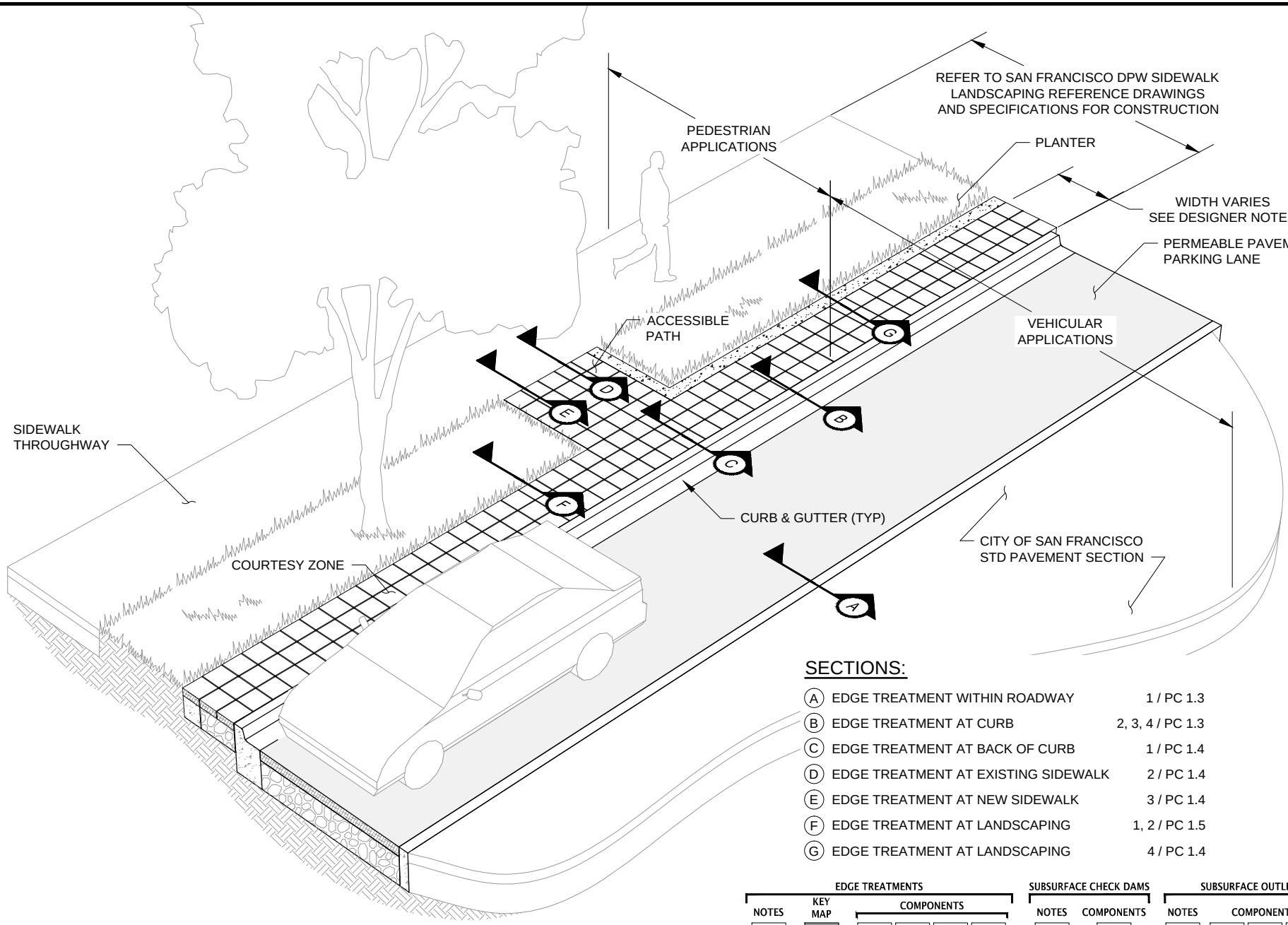
# PAVEMENT COMPONENTS

## EDGE TREATMENT DESIGNER NOTES

DWG NO. PC 1.1




## SECTIONS:

| | | |
|---|---|---|
| (A) | EDGE TREATMENT WITHIN ROADWAY | 1 / PC 1.3 |
| (B) | EDGE TREATMENT AT CURB | 2, 3, 4 / PC 1.3 |
| (C) | EDGE TREATMENT AT BACK OF CURB | 1 / PC 1.4 |
| (D) | EDGE TREATMENT AT EXISTING SIDEWALK | 2 / PC 1.4 |
| (E) | EDGE TREATMENT AT NEW SIDEWALK | 3 / PC 1.4 |
| (F) | EDGE TREATMENT AT LANDSCAPING | 1, 2 / PC 1.5 |
| (G) | EDGE TREATMENT AT LANDSCAPING | 4 / PC 1.4 |

| EDGE TREATMENTS | | | | | | SUBSURFACE CHECK DAMS | | SUBSURFACE OUTLETS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | KEY MAP | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | | |
| PC 1.1 | PC 1.2 | PC 1.3 | PC 1.4 | PC 1.5 | PC 1.6 | PC 2.1 | PC 2.2 | PC 3.1 | PC 3.2 | PC 3.3 | PC 3.4 |

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

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# GREEN INFRASTRUCTURE TYPICAL DETAILS

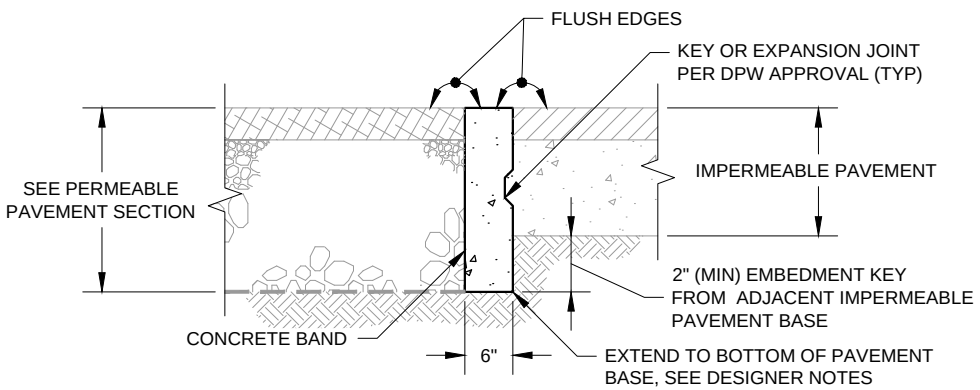
SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE: SEPTEMBER 2016
VERSION: 2.0
REVISED:

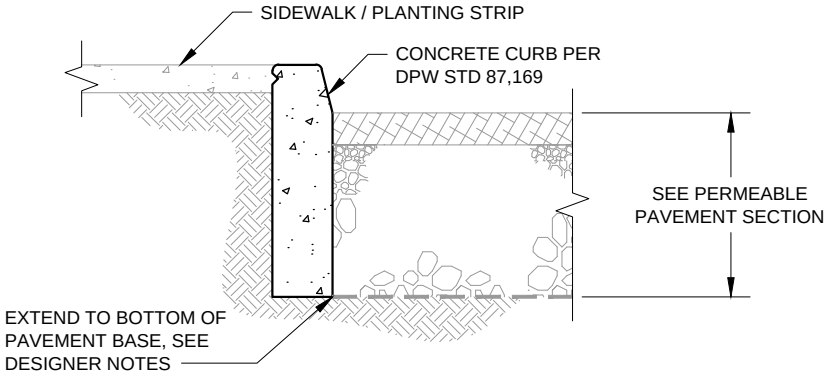
# PAVEMENT COMPONENTS

## EDGE TREATMENT KEY MAP

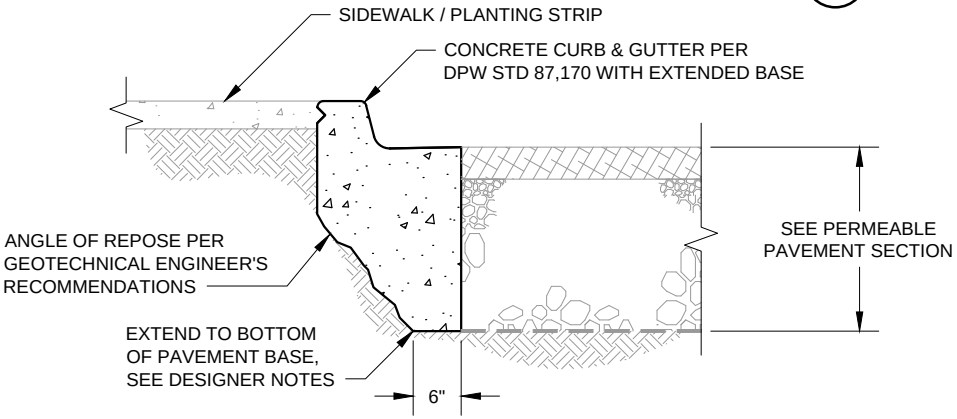
DWG NO. PC 1.2



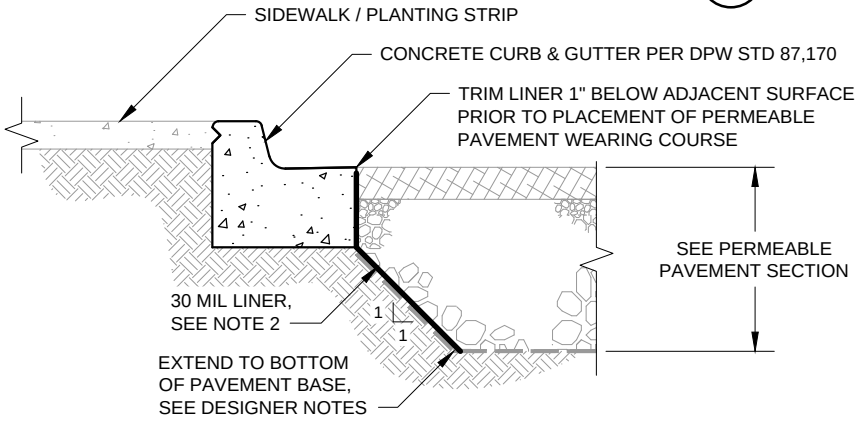

CONCRETE BAND WITHIN PAVED AREA 1



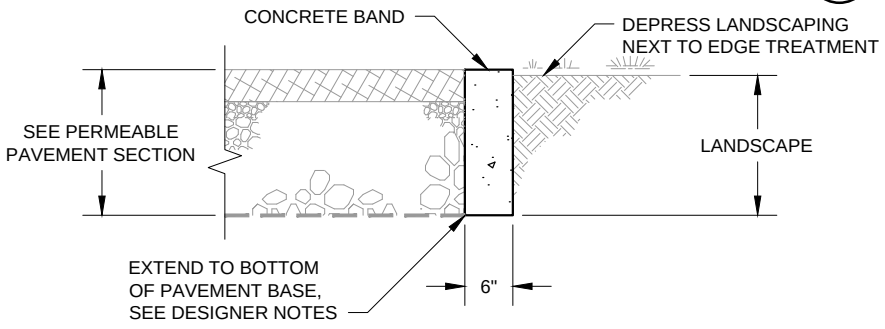

DEEPENED STANDARD CURB 2




DEEPENED STANDARD CURB AND GUTTER 3




IMPERMEABLE LINER AT STANDARD CURB AND GUTTER 4




CONCRETE BAND AT LANDSCAPE 5

## CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR EDGE TREATMENTS SHALL CONFORM TO SAN FRANCISCO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. LINER SHALL BE HDPE CONFORMING TO GEOSYNTHETIC RESEARCH INSTITUTE (GRI) GM13 OR LLDPE CONFORMING TO GRI GM 17.

| EDGE TREATMENTS | | | | | | SUBSURFACE CHECK DAMS | | SUBSURFACE OUTLETS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | KEY MAP | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | | |
| PC 1.1 | PC 1.2 | PC 1.3 | PC 1.4 | PC 1.5 | PC 1.6 | PC 2.1 | PC 2.2 | PC 3.1 | PC 3.2 | PC 3.3 | PC 3.4 |

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# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE SEPTEMBER 2016
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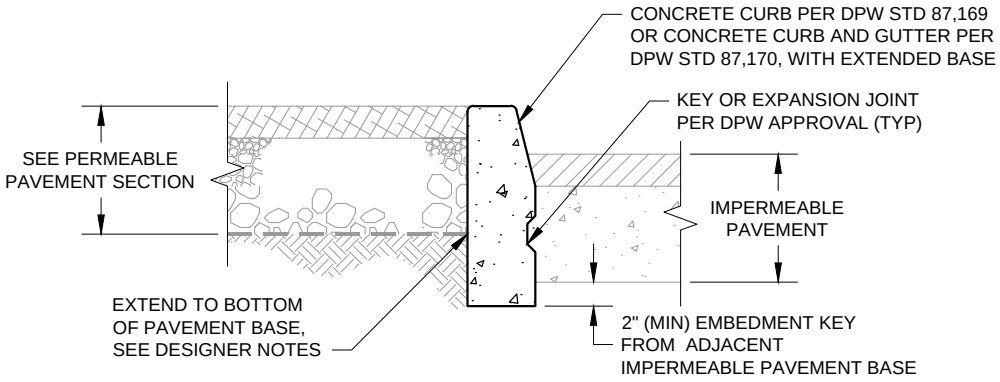
REVISED

# PAVEMENT COMPONENTS

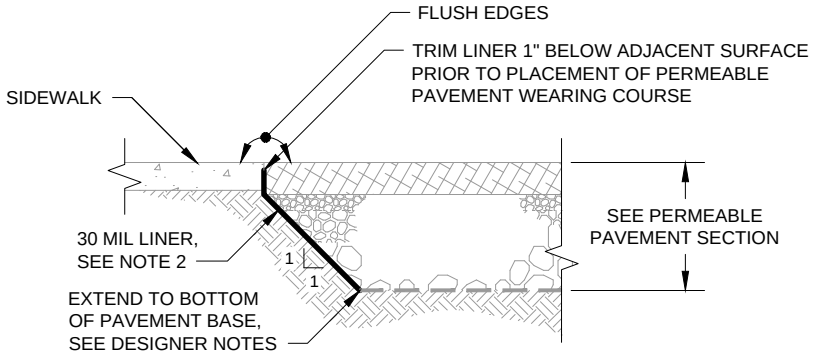
## EDGE TREATMENTS
## VEHICULAR APPLICATIONS

DWG NO. PC 1.3

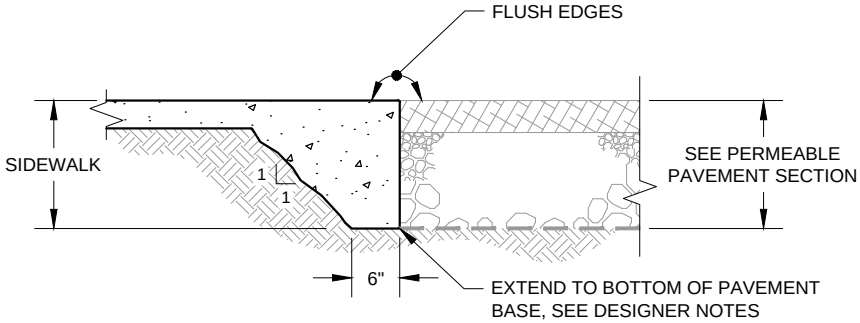
NOT FOR CONSTRUCTION - REFER TO USER GUIDE



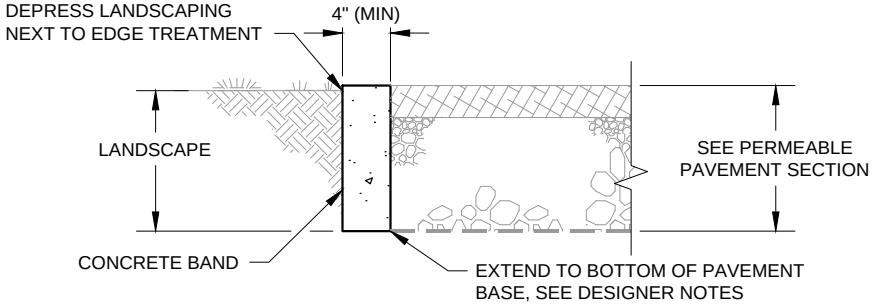

DEEPENED STANDARD CURB / CURB AND GUTTER 1




IMPERMEABLE LINER AT EXISTING SIDEWALK 2




THICKENED EDGE AT NEW SIDEWALK 3




CONCRETE BAND AT LANDSCAPE 4

## CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR EDGE TREATMENTS SHALL CONFORM TO SAN FRANCISCO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. LINER SHALL BE HDPE CONFORMING TO GEOSYNTHETIC RESEARCH INSTITUTE (GRI) GM13 OR LLDPE CONFORMING TO GRI GM 17.

| EDGE TREATMENTS | | | | | | SUBSURFACE CHECK DAMS | | SUBSURFACE OUTLETS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | KEY MAP | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | | |
| PC 1.1 | PC 1.2 | PC 1.3 | PC 1.4 | PC 1.5 | PC 1.6 | PC 2.1 | PC 2.2 | PC 3.1 | PC 3.2 | PC 3.3 | PC 3.4 |

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# GREEN INFRASTRUCTURE TYPICAL DETAILS

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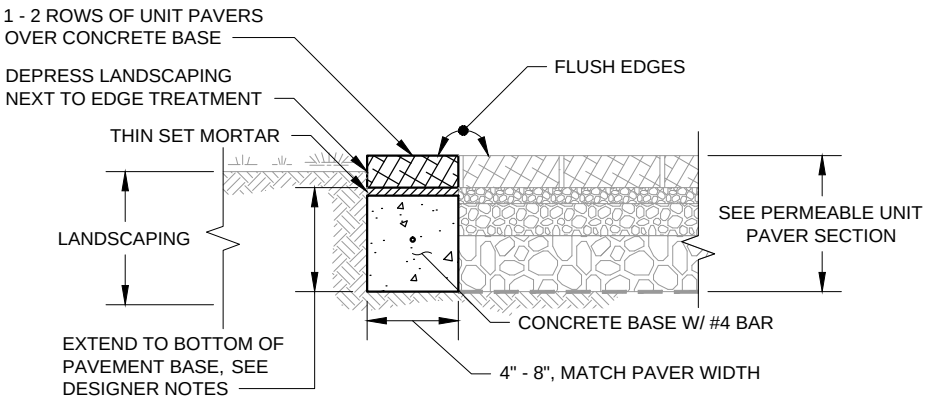
# PAVEMENT COMPONENTS

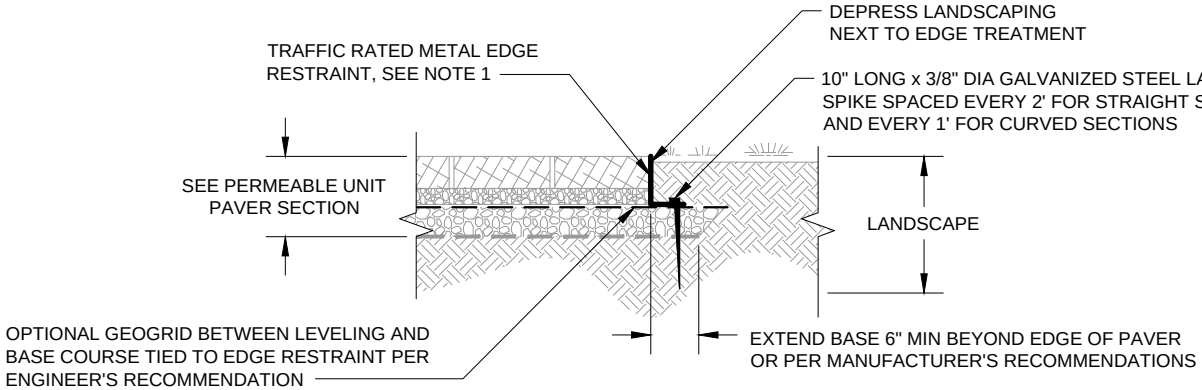
## EDGE TREATMENTS
## PEDESTRIAN APPLICATIONS (1 OF 2)

DWG NO. PC 1.4

NOT FOR CONSTRUCTION - REFER TO USER GUIDE




MORTARED PAVER AT LANDSCAPING 1




METAL PAVER EDGE AT LANDSCAPING 2

## CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR EDGE TREATMENTS SHALL CONFORM TO SAN FRANCISCO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. COORDINATE WITH SAN FRANCISCO PUBLIC WORKS IF STEEL IS REQUIRED IN RIGHT OF WAY.

| EDGE TREATMENTS | | | | | | SUBSURFACE CHECK DAMS | | SUBSURFACE OUTLETS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | KEY MAP | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | | |
| PC 1.1 | PC 1.2 | PC 1.3 | PC 1.4 | PC 1.5 | PC 1.6 | PC 2.1 | PC 2.2 | PC 3.1 | PC 3.2 | PC 3.3 | PC 3.4 |

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# GREEN INFRASTRUCTURE TYPICAL DETAILS

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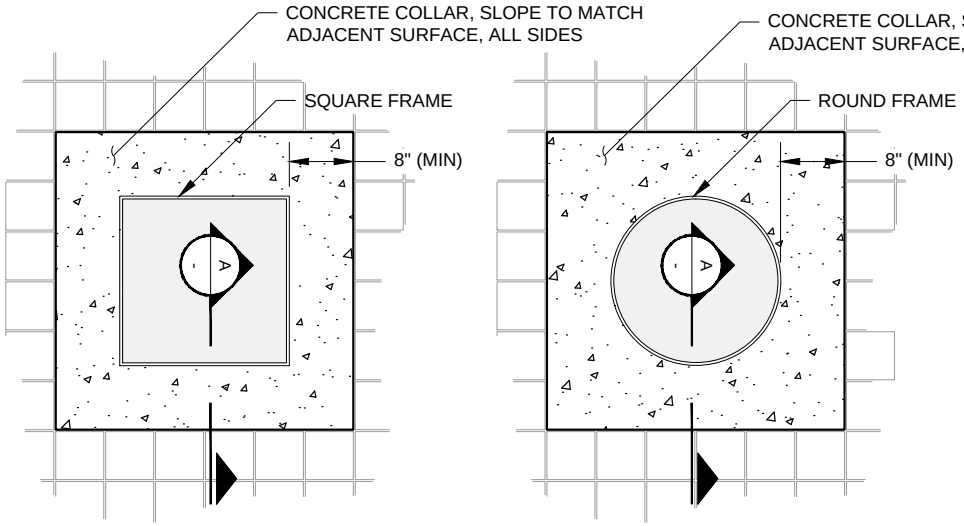
# PAVEMENT COMPONENTS

## EDGE TREATMENTS

## PEDESTRIAN APPLICATIONS (2 OF 2)

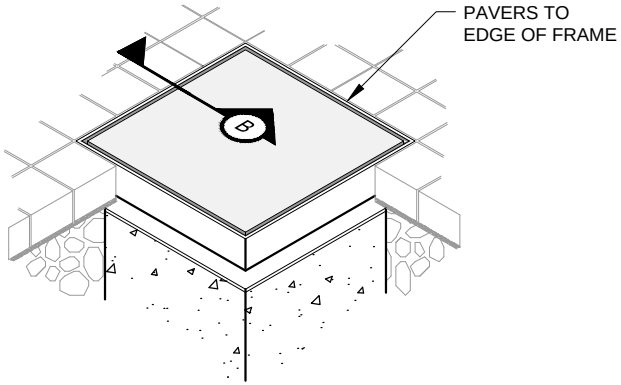
DWG NO. PC 1.5

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

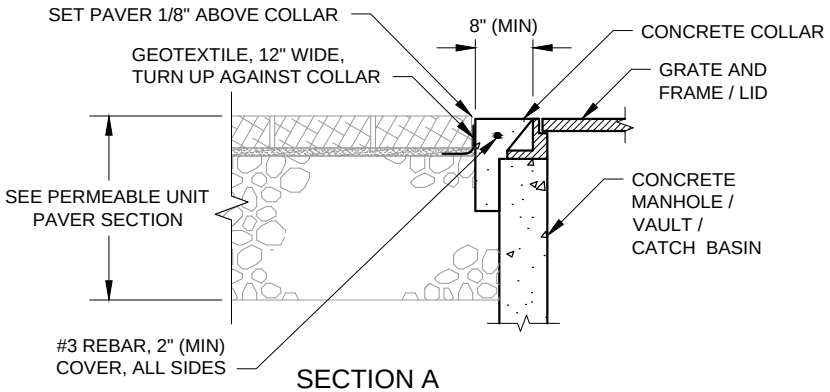



PLAN - SQUARE FRAME

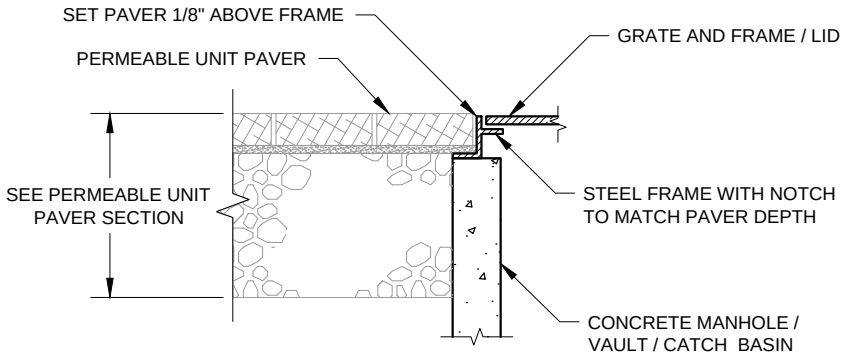
PLAN - ROUND FRAME




ISOMETRIC - SQUARE FRAME




SECTION A




SECTION B

PERMEABLE UNIT PAVER EDGE AT STRUCTURE - VEHICULAR APPLICATIONS (1)

PERMEABLE UNIT PAVER EDGE AT STRUCTURE - PEDESTRIAN APPLICATIONS (2)

## CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR EDGE TREATMENTS SHALL CONFORM TO SAN FRANCISCO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.

| EDGE TREATMENTS | | | | | | SUBSURFACE CHECK DAMS | | SUBSURFACE OUTLETS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | KEY MAP | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | | |
| PC 1.1 | PC 1.2 | PC 1.3 | PC 1.4 | PC 1.5 | PC 1.6 | PC 2.1 | PC 2.2 | PC 3.1 | PC 3.2 | PC 3.3 | PC 3.4 |

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# GREEN INFRASTRUCTURE TYPICAL DETAILS

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# PAVEMENT COMPONENTS

## EDGE TREATMENTS
## PAVER AT STRUCTURES

DWG NO. PC 1.6

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

## PURPOSE:

PERMEABLE PAVEMENT FACILITIES MUST BE DESIGNED TO PROVIDE SUBSURFACE STORAGE OF STORMWATER TO ALLOW TIME FOR THE WATER TO INFILTRATE INTO THE UNDERLYING SOIL. SLOPED FACILITIES ON POOR SOILS HAVE AN INCREASED POTENTIAL FOR LATERAL FLOWS THROUGH THE STORAGE RESERVOIR COURSE ALONG THE TOP OF THE RELATIVELY IMPERMEABLE SUBGRADE SOIL. THIS REDUCES THE STORAGE AND INFILTRATION CAPACITY OF THE PAVEMENT SYSTEM. SUBSURFACE DETENTION STRUCTURES, OR CHECK DAMS, CAN BE INCORPORATED INTO THE SUBGRADE AND ALIGNED PERPENDICULAR TO THE LONGITUDINAL SUBGRADE SLOPE TO CREATE PONDING IN THE AGGREGATE STORAGE RESERVOIR COURSE TO DETAIN SUBSURFACE FLOW, INCREASE INFILTRATION, AND REDUCE STRUCTURAL PROBLEMS ASSOCIATED WITH SUBGRADE EROSION ON SLOPES.

## DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT SECTION DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. WHILE THE DESIGNER MUST DETERMINE IF CHECK DAMS ARE NECESSARY BASED ON SITE-SPECIFIC CONDITIONS, SOME GENERAL GUIDELINES ARE PROVIDED BELOW:

| SUBGRADE SOILS | SUBGRADE SLOPE | RUNON FROM OTHER AREAS | CHECK DAM REQUIRED |
|---|---|---|---|
| TYPE A/B | ANY | ALLOWED | NO |
| TYPE C/D | ≤ 2% | NOT ALLOWED | NO |
| | ≤ 2% | ALLOWED | NO* |
| | > 2% | ALLOWED | YES |

* RECOMMENDED FOR SUBSURFACE FLOW PATHS OVER 50 FEET

3. THE DESIGNER MUST ESTABLISH THE HEIGHT AND SPACING OF THE CHECK DAMS BASED ON THE SUBGRADE SLOPE AND THE STORAGE DEPTH REQUIRED TO MEET PROJECT HYDROLOGIC PERFORMANCE GOALS. THE AVERAGE DEPTH OF SUBSURFACE STORAGE ACROSS THE FACILITY AREA MUST MEET THE REQUIRED STORAGE DEPTH. REFER TO CHECK DAM SPACING GUIDANCE ON THIS DRAWING FOR CHECK DAM SPACING CALCULATIONS.
4. MAXIMUM CHECK DAM HEIGHT IS GOVERNED BY 48 HOUR DRAWDOWN REQUIREMENT AND NATIVE SOIL INFILTRATION RATE. SEE **PP 1.1** FOR ADDITIONAL GUIDANCE.
5. THE AREA OF SUBBASE COVERED BY IMPERMEABLE CHECK DAM MATERIAL SHOULD BE EXCLUDED FROM HYDROLOGIC PERFORMANCE CALCULATIONS WHEN THE AREA IS SIGNIFICANT (GREATER THAN 10 PERCENT) RELATIVE TO THE PAVEMENT AREA.
6. THE DESIGNER MUST ENSURE THAT THE RESERVOIR COURSE DEPTH IS SUFFICIENT TO ACCOMMODATE THE HEIGHT OF THE CHECK DAMS WITH THE REQUIRED MINIMUM CLEARANCE.
7. CONVEYANCE CALCULATIONS ARE REQUIRED TO EVALUATE THE NEED FOR SUBSURFACE OUTLETS (E.G., PERFORATED OVERFLOW PIPES SET AT THE DESIGN SUBSURFACE PONDING DEPTH) AND DOWNSLOPE OVERFLOW SYSTEM. REFER TO **PC 3.1**.
8. LOCATE CHECK DAMS TO MINIMIZE IMPACT TO UTILITY ACCESS.
9. LOCATE PERVIOUS CONCRETE CONTROL JOINTS AT CHECK DAM LOCATIONS WHEN CHECK DAM EXTENDS INTO THE STRUCTURAL PAVEMENT SECTION.

## DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ CHECK DAM TYPE AND MATERIAL
- ☐ CHECK DAM ELEVATION, HEIGHT, AND WIDTH
- ☐ CHECK DAM SPACING
- ☐ CHECK DAM CLEARANCE (MEASURED FROM BOTTOM OF WEARING COURSE)

## CHECK DAM SPACING GUIDANCE:

TYPICAL MAXIMUM SPACING, $L_{SPACING,\ MAX}$ (FEET) :

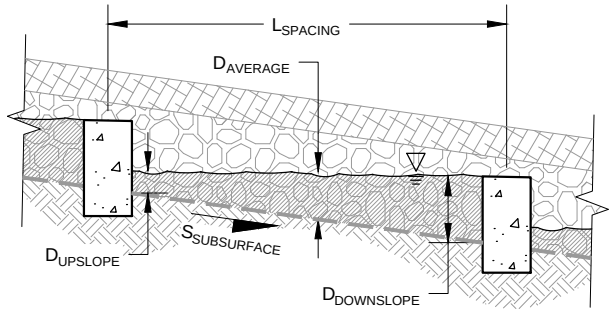
$$L_{SPACING,\ MAX} = D_{DOWNSLOPE} \div S_{SUBSURFACE}$$

$D_{DOWNSLOPE}$ = DOWNSLOPE STORAGE DEPTH (I.E. CHECK DAM HEIGHT) (FEET)
$S_{SUBSURFACE}$ = SUBSURFACE SLOPE (FT/FT)

SPACING, $L_{SPACING}$ (WHEN $L_{SPACING} \le L_{SPACING,\ MAX}$) :

$$L_{SPACING} = \frac{2\,(D_{AVERAGE} - D_{DOWNSLOPE})}{-\,S_{SUBSURFACE}}$$

$D_{AVERAGE}$ = AVERAGE STORAGE DEPTH (FEET)




| EDGE TREATMENTS | | | | | | | SUBSURFACE CHECK DAMS | | SUBSURFACE OUTLETS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | KEY MAP | COMPONENTS | | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | | |
| PC 1.1 | PC 1.2 | PC 1.3 | PC 1.4 | PC 1.5 | PC 1.6 | | PC 2.1 | PC 2.2 | PC 3.1 | PC 3.2 | PC 3.3 | PC 3.4 |

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

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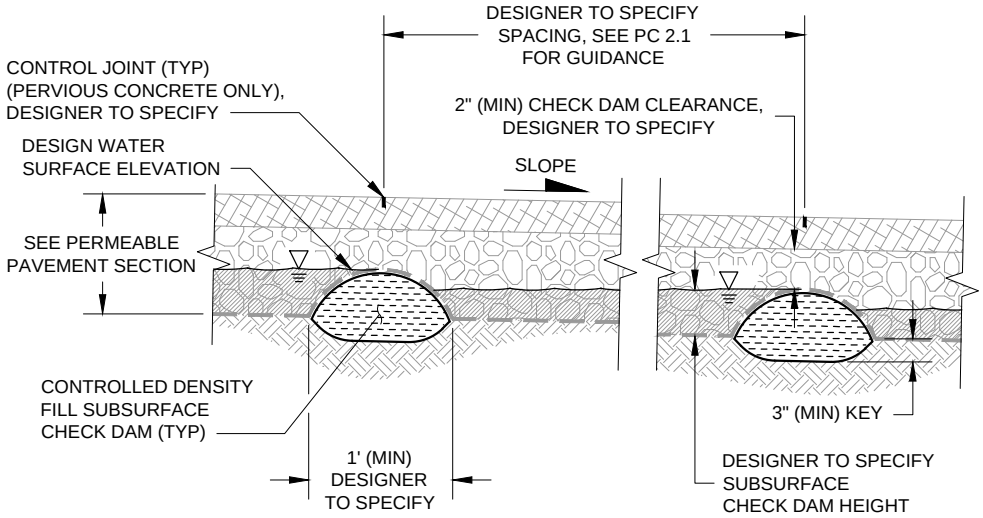
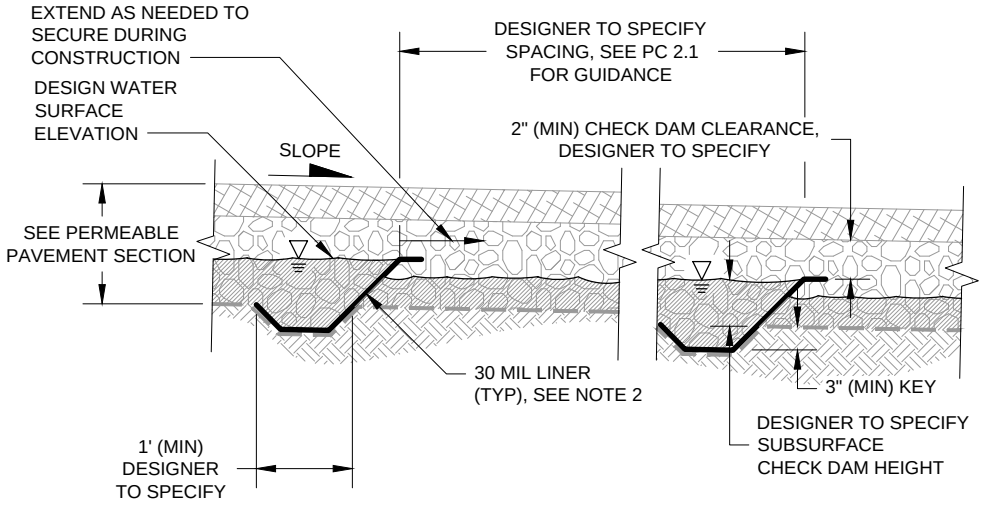
# PAVEMENT COMPONENTS

## SUBSURFACE CHECK DAMS DESIGNER NOTES

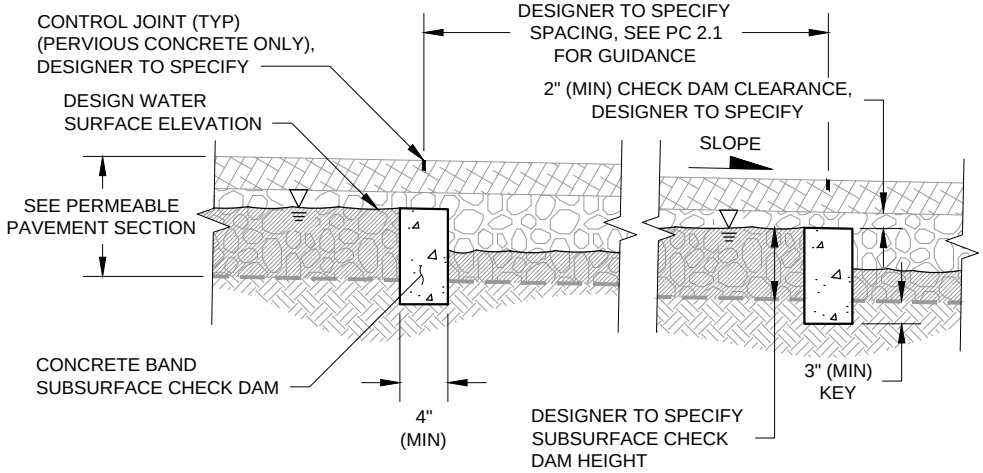
DWG NO. PC 2.1




CONTROLLED DENSITY FILL SUBSURFACE CHECK DAM 1




IMPERMEABLE LINER SUBSURFACE CHECK DAM 2




CONCRETE BAND SUBSURFACE CHECK DAM 3

## CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR CHECK DAMS SHALL CONFORM TO SAN FRANCISCO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. LINER SHALL BE HDPE CONFORMING TO GEOSYNTHETIC RESEARCH INSTITUTE (GRI) GM13 OR LLDPE CONFORMING TO GRI GM 17.

| EDGE TREATMENTS | | | | | | SUBSURFACE CHECK DAMS | | SUBSURFACE OUTLETS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | KEY MAP | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | | |
| PC 1.1 | PC 1.2 | PC 1.3 | PC 1.4 | PC 1.5 | PC 1.6 | PC 2.1 | PC 2.2 | PC 3.1 | PC 3.2 | PC 3.3 | PC 3.4 |

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# GREEN INFRASTRUCTURE TYPICAL DETAILS

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# PAVEMENT COMPONENTS
## SUBSURFACE CHECK DAMS

DWG NO. PC 2.2

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

## PURPOSE:

PERMEABLE PAVEMENT SUBSURFACE OVERFLOWS AND/OR UNDERDRAINS ARE DESIGNED TO CONVEY EXCESS FLOW TO AN APPROVED DISCHARGE POINT. FOR **SUBSURFACE OVERFLOW** CONFIGURATIONS, THE OVERFLOW RISER ELEVATION IS SET AT THE MAXIMUM DESIGN PONDING DEPTH IN THE PAVEMENT BASE. FOR **SUBSURFACE UNDERDRAIN** CONFIGURATIONS, THE CHECK DAM IS SET AT THE MAXIMUM DESIGN PONDING DEPTH IN THE PAVEMENT BASE, AND THE UNDERDRAIN IS LOCATED IN AN UNDERDRAIN TRENCH. WATER BELOW THE OVERFLOW RISER OR CHECK DAM ELEVATION IS TEMPORARILY STORED AND INFILTRATED INTO THE UNDERLYING SUBGRADE. UNDERDRAINS ARE ONLY RECOMMENDED WHEN AN AVAILABLE DAYLIGHT CONDITION EXISTS.

## DESIGNER NOTES & GUIDELINES:

1. DESIGNERS MUST ADAPT DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. OVERFLOW / UNDERDRAIN PIPES MUST BE LOCATED AT AN ELEVATION HIGHER THAN THE SEWER HYDRAULIC GRADE LINE TO PREVENT BACK FLOW INTO THE PAVEMENT SECTION.
3. OVERFLOW IS TYPICALLY PROVIDED BY A SUBSURFACE SLOTTED OVERFLOW PIPE(S) WITH DOWNSTREAM OUTLET CONTROL OR UPSTREAM CHECK DAMS SET AT THE DESIGN PONDING ELEVATION.
4. EMERGENCY OVERFLOW FOR LARGE STORM EVENTS CAN BE PROVIDED BY SURFACE SHEET FLOW UPON INUNDATION OF THE PAVEMENT SECTION (REQUIRES SURFACE CONVEYANCE SYSTEM OR OTHER RUNOFF COLLECTION METHOD).
5. THE DESIGNER MUST CONSIDER THE FLOW PATH OF WATER WHEN THE PERMEABLE PAVEMENT SECTION IS FULLY SATURATED TO THE MAXIMUM DESIGN DEPTH TO CONFIRM THERE ARE NO UNANTICIPATED DISCHARGE LOCATIONS (E.G., INTERSECTING UTILITY TRENCHES) AND TO ENSURE THE DESIGN PROVIDES EMERGENCY OVERFLOW CONVEYANCE TO AN APPROVED DISCHARGE POINT.
6. CONVEYANCE CALCULATIONS ARE REQUIRED TO DESIGN THE OVERFLOW / UNDERDRAIN PIPE DIAMETER AND PIPE SPACING TO SATISFY SAN FRANCISCO DPW HYDRAULIC REQUIREMENTS.
7. IF SITE CONSTRAINTS NECESSITATE USE OF OVERFLOW PIPE IN AN AREA SUBJECT TO VEHICULAR TRAFFIC OR OTHER LOADING, APPROPRIATE COVER DEPTH AND PIPE MATERIAL MUST BE DESIGNED.
8. WEARING COURSE MAY BE USED TO FULFILL MINIMUM COVER REQUIREMENTS PROVIDED WEARING COURSE IS RIGID PAVEMENT.
9. OPTIONAL OBSERVATION PORTS CAN BE USED TO DETERMINE WHETHER AN OVERFLOW / UNDERDRAIN IS DEWATERING PROPERLY. REFER TO **GC 3.1- GC 3.3**.
10. OVERFLOW / UNDERDRAIN PIPES MUST BE EQUIPPED WITH CLEANOUTS. REFER TO **GC 5.2**.
11. INSTALL OVERFLOW PIPES AT DOWNGRADIENT END OF PAVEMENT. OVERFLOWS NOT REQUIRED AT EACH CHECK DAM LOCATIONS.
12. PIPE MATERIAL SHALL BE DESIGNED PER SAN FRANCISCO ENVIRONMENTAL CODE (CHAPTER 5, SECTION 509 AND CHAPTER 7, SECTION 706).
13. AN OUTLET ORIFICE CONTROL DEVISE MAY BE INSTALLED TO FURTHER DETAIN OUTFLOW AND MAXIMIZE INFILTRATION. ENGINEER SHALL DESIGN, DETAIL, SPECIFY, AND CONDUCT SUPPLEMENTAL PERFORMANCE CALCULATIONS AS NEEDED.

## DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ OVERFLOW / UNDERDRAIN PIPE MATERIAL, DIAMETER, AND COVER DEPTH
- ☐ OVERFLOW / UNDERDRAIN PIPE INVERT ELEVATION AND SLOPE
- ☐ OVERFLOW / UNDERDRAIN PIPE ALIGNMENT AND DISCHARGE LOCATION

| EDGE TREATMENTS | | | | | | SUBSURFACE CHECK DAMS | | SUBSURFACE OUTLETS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | KEY MAP | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | | |
| PC 1.1 | PC 1.2 | PC 1.3 | PC 1.4 | PC 1.5 | PC 1.6 | PC 2.1 | PC 2.2 | PC 3.1 | PC 3.2 | PC 3.3 | PC 3.4 |

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

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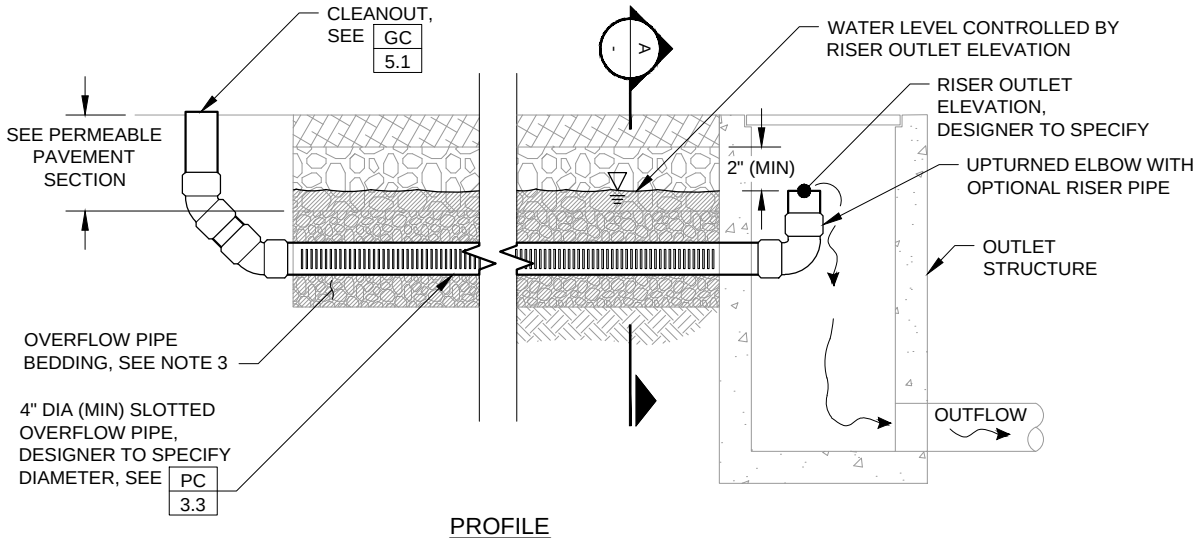
REVISED:

# PAVEMENT COMPONENTS

## SUBSURFACE OVERFLOWS DESIGNER NOTES

DWG NO. PC 3.1

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

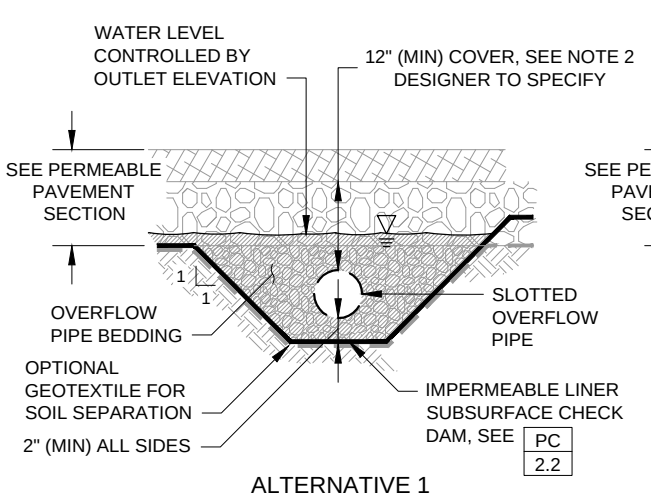



PROFILE

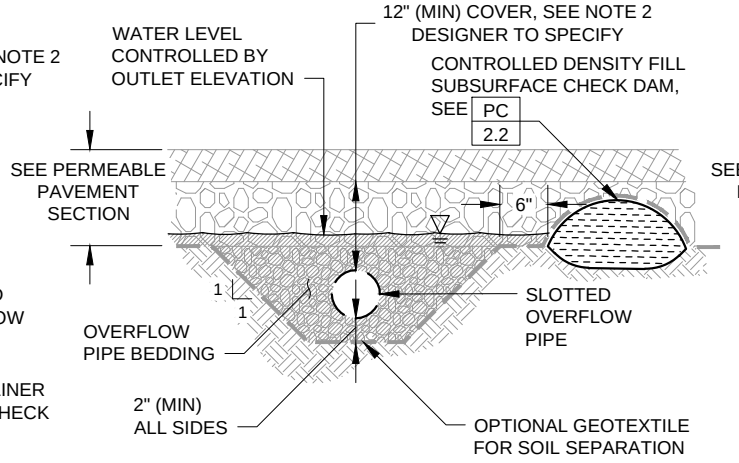
## OVERFLOW CONTROL STRUCTURE WITH RISER (1)

## CONSTRUCTION NOTES:

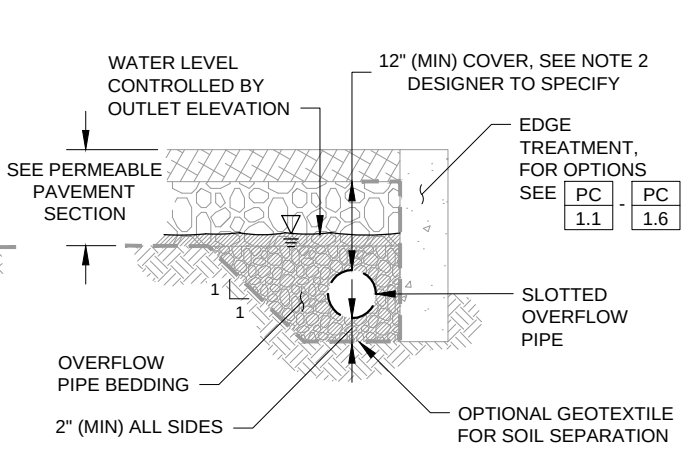
1. ALL MATERIAL AND WORKMANSHIP FOR OVERFLOW STRUCTURES SHALL CONFORM TO SAN FRANCISCO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. LOCATE OVERFLOW PIPE BELOW STRUCTURAL PAVEMENT BASE DEPTH.
3. OVERFLOW PIPE BEDDING SHALL BE ASTM NO. 57 CONFORMING TO THE REQUIREMENTS OF GRAVEL BASE MATERIAL FOR PAVEMENTS, UNLESS OTHERWISE SPECIFIED.




ALTERNATIVE 1




ALTERNATIVE 2




ALTERNATIVE 3

## OVERFLOW PIPE TRENCH SECTION (A)

| EDGE TREATMENTS | | | | | | SUBSURFACE CHECK DAMS | | SUBSURFACE OUTLETS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | KEY MAP | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | | |
| PC 1.1 | PC 1.2 | PC 1.3 | PC 1.4 | PC 1.5 | PC 1.6 | PC 2.1 | PC 2.2 | PC 3.1 | PC 3.2 | PC 3.3 | PC 3.4 |

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# GREEN INFRASTRUCTURE TYPICAL DETAILS

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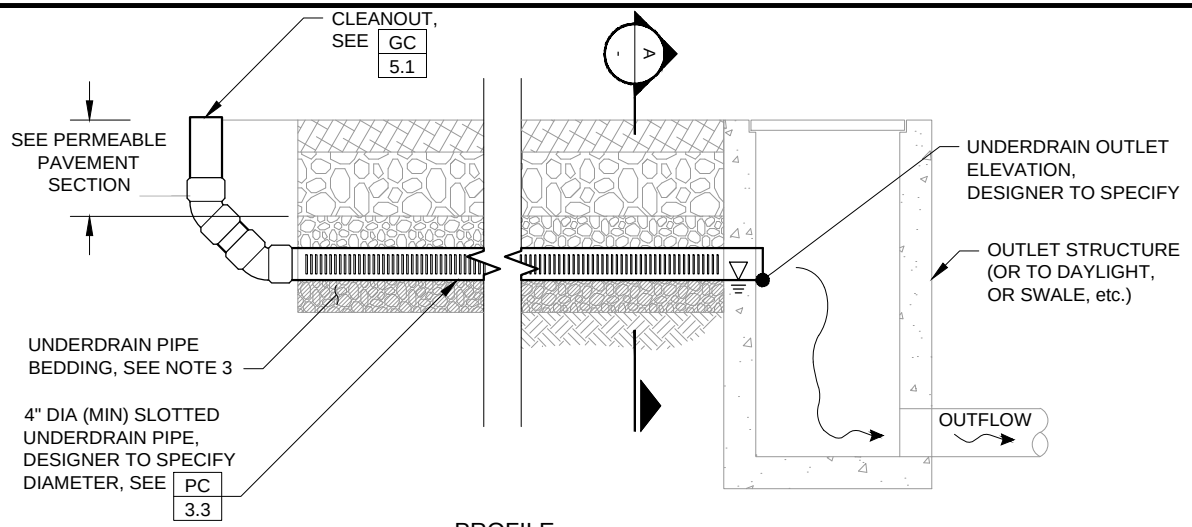
# PAVEMENT COMPONENTS

## SUBSURFACE OVERFLOW

DWG NO. PC 3.2

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

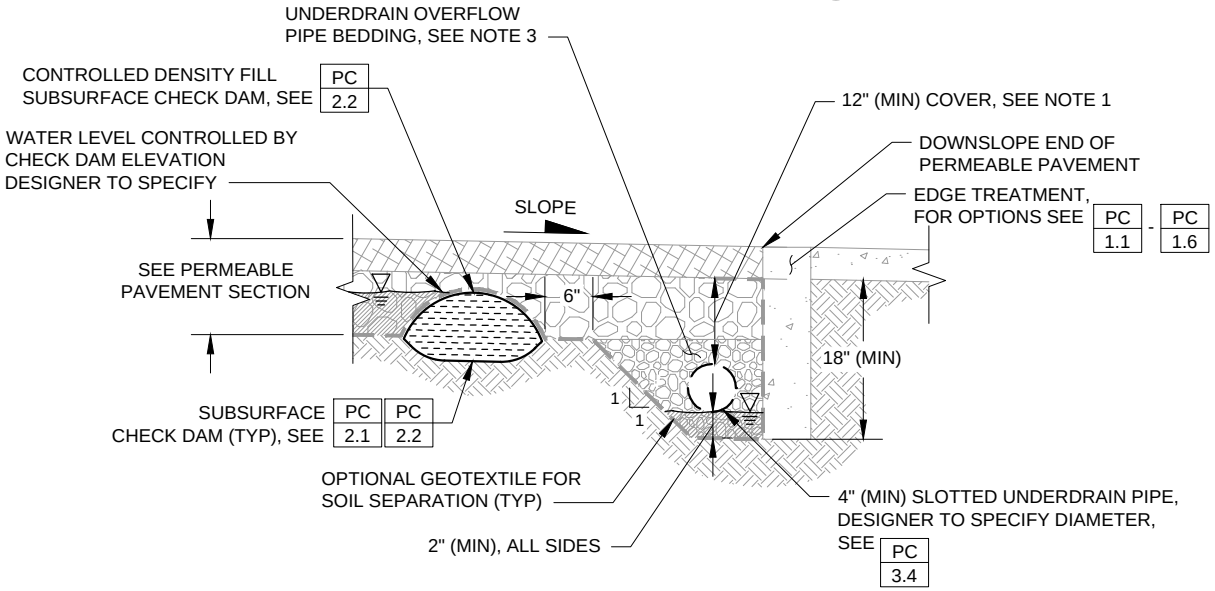



PROFILE

UNDERDRAIN TO DAYLIGHT 1

## CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR OVERFLOW STRUCTURES SHALL CONFORM TO SAN FRANCISCO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. LOCATE UNDERDRAIN PIPE BELOW STRUCTURAL PAVEMENT BASE DEPTH.
3. UNDERDRAIN PIPE BEDDING SHALL BE ASTM NO. 57 CONFORMING TO THE REQUIREMENTS OF GRAVEL BASE MATERIAL FOR PAVEMENTS, UNLESS OTHERWISE SPECIFIED.




CHECK DAM-CONTROLLED WITH UNDERDRAIN A

| EDGE TREATMENTS | | | | | | | SUBSURFACE CHECK DAMS | | SUBSURFACE OUTLETS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | KEY MAP | COMPONENTS | | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | | |
| PC 1.1 | PC 1.2 | PC 1.3 | PC 1.4 | PC 1.5 | PC 1.6 | | PC 2.1 | PC 2.2 | PC 3.1 | PC 3.2 | PC 3.3 | PC 3.4 |

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# GREEN INFRASTRUCTURE TYPICAL DETAILS

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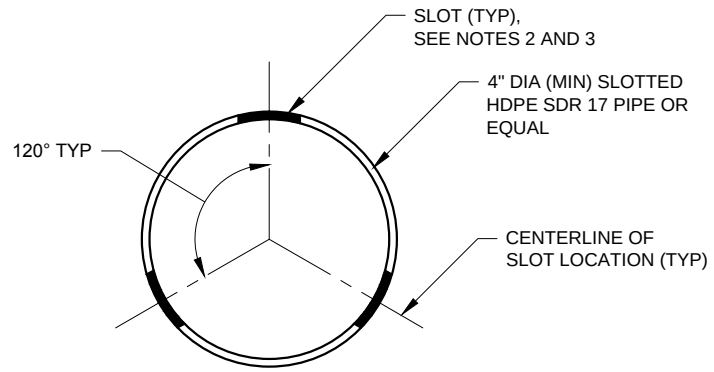
# PAVEMENT COMPONENTS

## SUBSURFACE UNDERDRAIN

DWG NO. PC 3.3

NOT FOR CONSTRUCTION - REFER TO USER GUIDE




SLOTTED UNDERDRAIN PIPE 2

## CONSTRUCTION NOTES:

1. UNDERDRAIN PIPE SHALL BE SLOTTED HDPE SDR 17 OR ACCEPTABLE SUBSTITUTE MATERIAL PER ENGINEERS SPECIFICATION. SINGLE WALL AND DUAL WALL CORRUGATED HDPE PIPE (AASHTO M252 AND M294 TYPES C, S, AND D) ARE NOT ACCEPTABLE.
2. ALL PERFORATIONS SHALL BE SLOTTED TYPE, MEASURING 0.032 INCH WIDE (MAX), SPACED AT 0.25 INCH (MIN), AND PROVIDING A MINIMUM INLET AREA OF 5.0 SQUARE INCH PER LINEAR FOOT OF PIPE.
3. PERFORATIONS SHALL BE ORIENTED PERPENDICULAR TO LONG AXIS OF PIPE, AND EVENLY SPACED AROUND CIRCUMFERENCE AND LENGTH OF PIPE.

| EDGE TREATMENTS | | | | | | SUBSURFACE CHECK DAMS | | SUBSURFACE OUTLETS | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | KEY MAP | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | | |
| PC 1.1 | PC 1.2 | PC 1.3 | PC 1.4 | PC 1.5 | PC 1.6 | PC 2.1 | PC 2.2 | PC 3.1 | PC 3.2 | PC 3.3 | PC 3.4 |

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# GREEN INFRASTRUCTURE TYPICAL DETAILS

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# PAVEMENT COMPONENTS

## UNDERDRAIN PIPE

DWG NO. PC 3.4

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

## PURPOSE:

BIORETENTION PLANTERS CONTROL PEAK FLOWS AND VOLUMES OF STORMWATER RUNOFF BY PROVIDING SURFACE, SUBSURFACE STORAGE AND INFILTRATION INTO NATIVE SOIL. WATER IS ALSO TREATED AS IT FILTERS THROUGH THE BIORETENTION SOIL.

## DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT PLAN AND SECTION DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. PLANTER AREA, PONDING DEPTH, BIORETENTION SOIL DEPTH, AND AGGREGATE STORAGE DEPTH MUST BE SIZED TO MEET PROJECT HYDROLOGIC PERFORMANCE GOALS.
3. PONDING AND BIORETENTION SOIL DRAWDOWN TIME (I.E., TIME FOR MAXIMUM SURFACE PONDING TO DRAIN THROUGH THE BIORETENTION SOIL AFTER THE END OF A STORM) RECOMMENDATIONS:
   - 3 - 12 HOUR PONDING AND BIORETENTION SOIL DRAWDOWN (TYPICAL)
   - 24 HOUR MAXIMUM PONDING AND BIORETENTION SOIL DRAWDOWN
4. FACILITY DRAWDOWN TIME (i.e., TIME FOR SURFACE PONDING TO DRAIN THROUGH THE ENTIRE SECTION INCLUDING AGGREGATE STORAGE AFTER THE END OF A STORM) REQUIREMENTS:
   - 48 HOUR MAXIMUM FACILITY DRAWDOWN (i.e. ORIFICE CONTROLLED SYSTEM OR EXTENDED STORAGE DEPTH WITHIN INFILTRATION SYSTEM)
5. AN AGGREGATE COURSE IS REQUIRED UNDER THE BIORETENTION SOIL FOR BIORETENTION IN SEPARATE SEWER SYSTEM AREAS TO PROVIDE ADDITIONAL TREATMENT. THIS AGGREGATE COURSE IS OPTIONAL FOR FACILITIES IN COMBINED SEWER SYSTEM AREAS. SEE GUIDANCE ON **BC 4.1**.
6. THE PLANTER WALL SLOPE IS TYPICALLY DESIGNED TO MATCH THE LONGITUDINAL SLOPE OF THE ADJACENT ROADWAY/SIDEWALK. THE FACILITY SUBGRADE, HOWEVER, SHOULD BE FLAT. CHECK DAMS MAY BE USED TO TERRACE FACILITIES TO PROVIDE SUFFICIENT PONDING FOR HIGHER-SLOPED INSTALLATIONS. DESIGNER MUST SPECIFY CHECK DAM HEIGHT AND SPACING. REFER TO **BC 6.1** AND **BC 6.2** FOR GUIDANCE ON CHECK DAM DESIGN.
7. DEPENDING ON THE HEIGHT OF THE PROPOSED PLANTER WALL, ADDITIONAL STRUCTURAL CONSIDERATIONS MAY BE REQUIRED TO ADDRESS WALL LOADING. REFER TO **BC 1.1** THROUGH **BC 1.7** FOR GUIDANCE ON EDGE TREATMENTS.
8. WHEN FACILITY CONSTRUCTION IMPACTS EXISTING SIDEWALK, ALL SAW CUTS MUST ADHERE TO SFPUC REQUIREMENTS. SAW CUTS SHOULD BE ALONG SCORE LINES AND ANY DISTURBED SIDEWALK FLAGS SHOULD BE REPLACED IN THEIR ENTIRETY.
9. PLANTERS IN PUBLIC RIGHT OF WAY SHALL BE DESIGNED WITH EMERGENCY OVERFLOW TO THE STREET IN THE EVENT THE PLANTER OUTLET IS OBSTRUCTED OR CLOGGED.
10. UP TO TWO PLANTERS MAY BE CONNECTED IN SERIES, IN LIEU OF MULTIPLE INLETS, PROVIDED THE CONNECTION IS A TRENCH DRAIN OR EQUAL SURFACE CONVEYANCE AND IS ADEQUATELY SIZED TO CONVEY FLOWS.
11. PLANTER VEGETATION MUST BE SPECIFIED BY DESIGN PROFESSIONAL PER SFPUC VEGETATION PALLET
12. THE DESIGNER MUST EVALUATE UTILITY SURVEYS FOR POTENTIAL UTILITY CROSSINGS OR CONFLICTS. REFER TO **GC 2.1** - **GC 2.12** FOR UTILITY CROSSING DETAILS AND **GC 1.4** - **GC 4.4** FOR UTILITY CROSSING CONFLICT DETAILS.
13. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT SFPUC ASSET PROTECTION STANDARDS AND OTHER UTILITY PROVIDER REQUIREMENTS.

| RELATED COMPONENTS | |
|---|---|
| EDGE TREATMENTS: | BC 1.1 - BC 1.7 |
| INLETS: | BC 2.1 - BC 2.4 |
| OUTLETS: | BC 3.1 - BC 3.4 |
| AGGREGATE STORAGE: | BC 4.1 |
| UNDERDRAINS: | BC 5.1 - BC 5.2 |
| CHECK DAMS: | BC 6.1 - BC 6.2 |
| LINERS: | GC 1.1 - GC 1.2 |
| UTILITY CROSSINGS: | GC 2.1 - GC 2.12 |
| OBSERVATION PORTS: | GC 3.1 - GC 3.3 |
| UTILITY CONFLICTS: | GC 4.1 - GC 4.4 |
| CLEANOUTS: | GC 5.2 |

| RELATED SPECIFICATIONS | CSI NO. |
|---|---|
| **BIORETENTION:**<br>- BIORETENTION SOIL MIX<br>- AGGREGATE STORAGE<br>- MULCH<br>- STREAMBED COBBLES | 33 47 27 |

| NOTES | | W/PARKING | | W/O PARKING | | BULBOUT | | | | | | PARCEL APPLICATIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PLAN | SECTIONS | PLAN | SECTIONS | ALT 1 | ALT 2 | ALT 3 | ALT 4 | ALT 5 | ALT 6 | NOTES | | PLAN | SECTIONS | | |
| BP 1.1 | BP 1.2 | BP 2.1 | BP 2.2 | BP 3.1 | BP 3.2 | BP 4.1 | BP 4.2 | BP 4.3 | BP 4.4 | BP 4.5 | BP 4.6 | BP 5.1 | BP 5.2 | BP 5.3 | BP 5.4 | BP 5.5 | BP 5.6 |

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# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE: SEPTEMBER 2016
VERSION: 2.0
REVISED:

# BIORETENTION PLANTER

## DESIGNER NOTES (1 OF 2)

DWG NO. BP 1.1

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

## LAYOUT REQUIREMENTS:

1. REFER TO THE SAN FRANCISCO STANDARD ACCESSIBILITY REQUIREMENTS IN THE SAN FRANCISCO PUBLIC WORKS SIDEWALK LANDSCAPING REFERENCE DRAWINGS AND SPECIFICATIONS FOR COURTESY STRIP, THROUGHWAY, PARKING SPACE AND ACCESSIBLE PATH REQUIREMENTS.
2. LOCATE CURB CUTS AND GUTTER MODIFICATIONS TO AVOID CONFLICTS WITH ACCESSIBILITY REQUIREMENTS (E.G., LOCATE OUTSIDE OF CROSSWALKS).

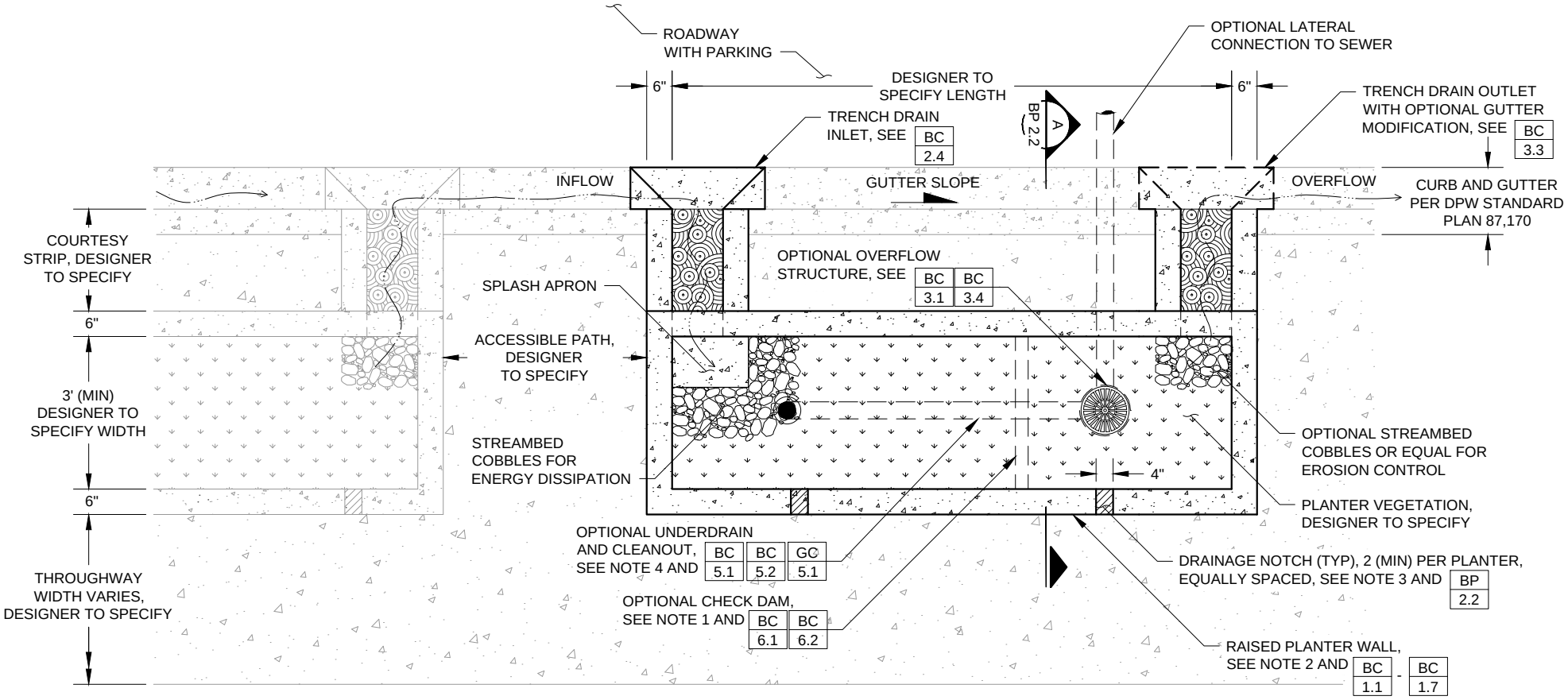
## DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ PLANTER WIDTH AND LENGTH
- ☐ DEPTH OF PONDING
- ☐ DEPTH OF FREEBOARD
- ☐ DEPTH OF BIORETENTION SOIL
- ☐ DEPTH AND TYPE OF AGGREGATE STORAGE, IF ANY
- ☐ PLANTER SURFACE ELEVATION (TOP OF BIORETENTION SOIL) AT UPSLOPE AND DOWNSLOPE ENDS OF FACILITY
- ☐ CONTROL POINTS AT EVERY PLANTER WALL CORNER AND POINT OF TANGENCY
- ☐ DIMENSIONS AND DISTANCE TO EVERY INLET, OUTLET, CHECK DAM, SIDEWALK NOTCH, ETC.
- ☐ ELEVATIONS OF EVERY INLET, OUTLET, STRUCTURE RIM AND INVERT, CHECK DAM, PLANTER WALL CORNER, AND SIDEWALK NOTCH
- ☐ TYPE AND DESIGN OF PLANTER COMPONENTS (E.G., EDGE TREATMENTS, INLETS/GUTTER MODIFICATIONS, UTILITY CROSSINGS, LINER, AND PLANTING DETAILS)

## SOIL TYPE GUIDANCE:

| HYDROLOGIC SOIL GROUP | SOIL TYPE | CORRESPONDING UNIFIED SOIL CLASSIFICATION | DESCRIPTION |
|---|---|---|---|
| A | SAND, LOAMY SAND, OR SANDY LOAM | GW - WELL-GRADED GRAVELS, SANDY GRAVELS<br>GP - GAP-GRADED OR UNIFORM GRAVELS, SANDY GRAVELS<br>GM - SILTY GRAVELS, SILTY SANDY GRAVELS<br>SW - WELL-GRADED, GRAVELLY SANDS<br>SP - GAP-GRADED OR UNIFORM SANDS, GRAVELLY SANDS | LOW RUNOFF POTENTIAL. SOILS HAVING HIGH INFILTRATION RATES EVEN WHEN THOROUGHLY WETTED AND CONSISTING CHIEFLY OF DEEP, WELL TO EXCESSIVELY DRAINED SANDS OR GRAVELS. |
| B | SILT LOAM OR LOAM | SM - SILTY SANDS, SILTY GRAVELLY SANDS<br>MH - MICACEOUS SILTS, DIATOMACEOUS SILTS, VOLCANIC ASH | SOILS HAVING MODERATE INFILTRATION RATES WHEN THOROUGHLY WETTED AND CONSISTING CHIEFLY OF MODERATELY DEEP TO DEEP, MODERATELY WELL TO WELL-DRAINED SOILS WITH MODERATELY FINE TO MODERATELY COARSE TEXTURES. |
| C | SANDY CLAY LOAM | ML - SILTS, VERY FINE SANDS, SILTY AND CLAYEY FINE SANDS | SOILS HAVING SLOW INFILTRATION RATES WHEN THOROUGHLY WETTED AND CONSISTING CHIEFLY OF SOILS WITH A LAYER THAT IMPEDES DOWNWARD MOVEMENT OF WATER, OR SOILS WITH MODERATELY FINE TO FINE TEXTURES. |
| D | CLAY LOAM, SANDY CLAY, SILTY CLAY, OR CLAY | GC - CLAYEY GRAVELS, CLAYEY SANDY GRAVELS<br>SC - CLAYEY SANDS, CLAYEY GRAVELLY SANDS<br>CL - LOW PLASTICITY CLAYS, SANDY OR SILTY CLAYS<br>OL - ORGANIC SILTS AND CLAYS OF LOW PLASTICITY<br>CH - HIGHLY PLASTIC LAYS AND SANDY CLAYS<br>OH - ORGANIC SILTS AND CLAYS OF HIGH PLASTICITY | HIGH RUNOFF POTENTIAL. SOILS HAVING VERY SLOW INFILTRATION RATES WHEN THOROUGHLY WETTED AND CONSISTING CHIEFLY OF CLAY SOILS WITH A HIGH SWELLING POTENTIAL, SOILS WITH A PERMANENT HIGH WATER TABLE, AND SHALLOW SOILS OVER NEARLY IMPERVIOUS MATERIAL. |


| NOTES | | W/PARKING | | W/O PARKING | | BULBOUT | | | | | | PARCEL APPLICATIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PLAN SECTIONS | | PLAN SECTIONS | | ALT 1 | ALT 2 | ALT 3 | ALT 4 | ALT 5 | ALT 6 | NOTES | | PLAN | SECTIONS | | |
| BP 1.1 | BP 1.2 | BP 2.1 | BP 2.2 | BP 3.1 | BP 3.2 | BP 4.1 | BP 4.2 | BP 4.3 | BP 4.4 | BP 4.5 | BP 4.6 | BP 5.1 | BP 5.2 | BP 5.3 | BP 5.4 | BP 5.5 | BP 5.6 |




## CONSTRUCTION NOTES:

1. CHECK DAMS SHALL BE SPACED TO PROVIDE PONDING PER SITE SPECIFIC DESIGN.
2. SLOPE TOP OF PLANTER WALL TO MATCH LONGITUDINAL SLOPE OF ADJACENT SURFACE.
3. LAY OUT DRAINAGE NOTCHES TO PREVENT PONDING BEHIND PLANTER WALL WITH 5' MAXIMUM SPACING BETWEEN NOTCHES.
4. PROVIDE ONE CLEANOUT PER PLANTER (MIN) FOR FACILITIES WITH UNDERDRAINS.
5. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT SFPUC ASSET PROTECTION STANDARDS. COORDINATE WITH ENGINEER IN THE EVENT OF UTILITY CROSSING AND UTILITY CONFLICTS.

| NOTES | | W/PARKING | | W/O PARKING | | BULBOUT | | | | | | PARCEL APPLICATIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PLAN SECTIONS | | PLAN SECTIONS | | ALT 1 | ALT 2 | ALT 3 | ALT 4 | ALT 5 | ALT 6 | NOTES | | PLAN | SECTIONS | | |
| BP 1.1 | BP 1.2 | BP 2.1 | BP 2.2 | BP 3.1 | BP 3.2 | BP 4.1 | BP 4.2 | BP 4.3 | BP 4.4 | BP 4.5 | BP 4.6 | BP 5.1 | BP 5.2 | BP 5.3 | BP 5.4 | BP 5.5 | BP 5.6 |

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE SEPTEMBER 2016

VERSION 2.0

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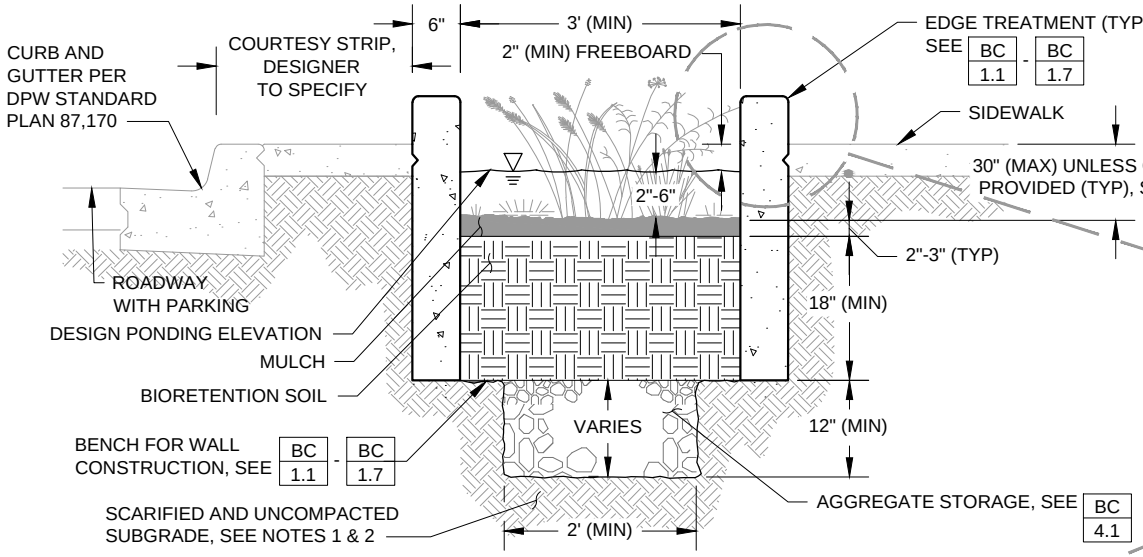
# BIORETENTION PLANTER

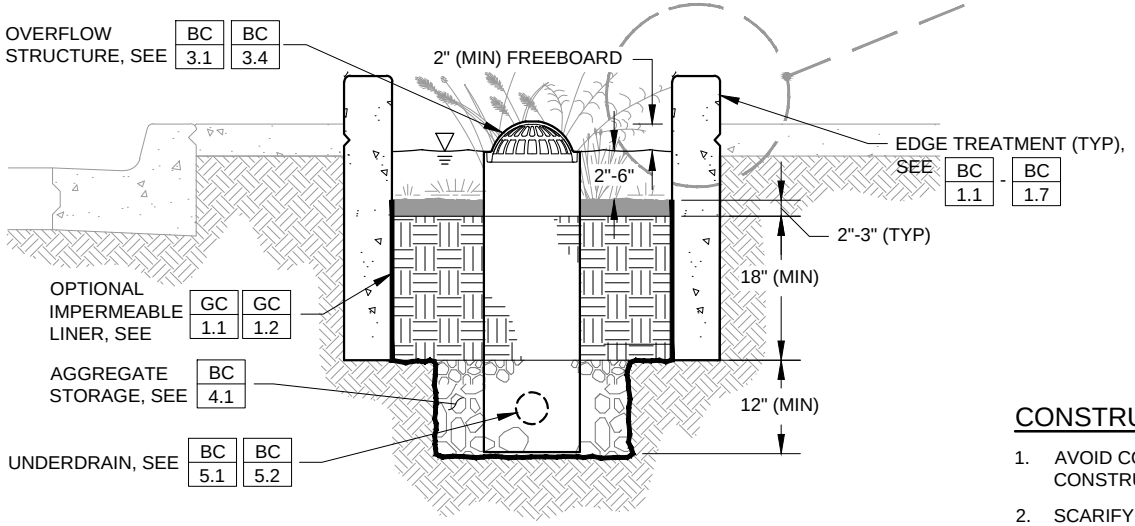
## ROADSIDE PLANTER WITH PARKING PLAN

DWG NO. BP 2.1

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

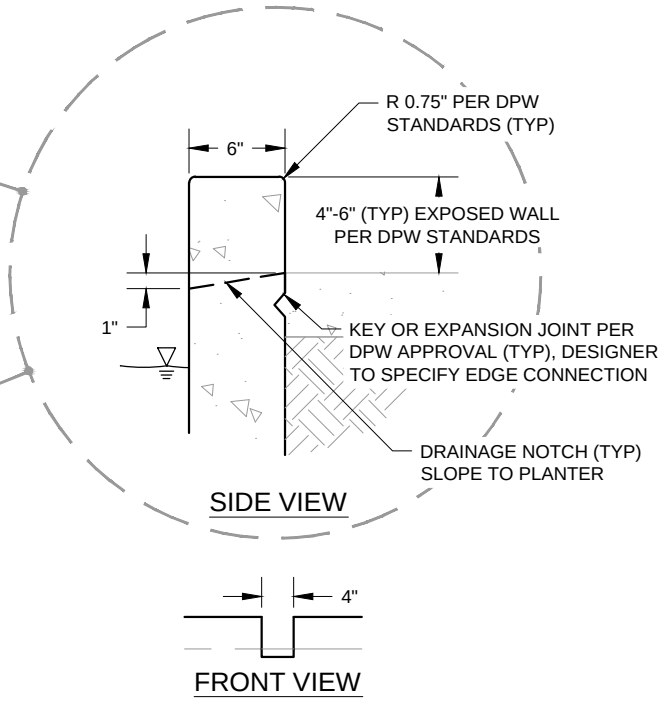



NO UNDERDRAIN - ALTERNATIVE 1




WITH UNDERDRAIN - ALTERNATIVE 2

BIORETENTION PLANTER WITH PARKING (A)




TYPICAL DRAINAGE NOTCH DETAIL

## CONSTRUCTION NOTES:

1. AVOID COMPACTION OF EXISTING SUBGRADE BELOW PLANTER DURING CONSTRUCTION.
2. SCARIFY SUBGRADE TO A DEPTH OF 3 INCHES (MIN) IMMEDIATELY PRIOR TO PLACEMENT OF AGGREGATE STORAGE AND BIORETENTION SOIL MATERIAL.
3. MAXIMUM DROP FROM TOP OF CURB TO TOP OF BIORETENTION SOIL SHALL INCLUDE CONSIDERATIONS FOR BIORETENTION SOIL SETTLEMENT.

| NOTES | | W/PARKING | | W/O PARKING | | BULBOUT | | | | | | PARCEL APPLICATIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PLAN SECTIONS | | PLAN SECTIONS | | ALT 1 | ALT 2 | ALT 3 | ALT 4 | ALT 5 | ALT 6 | NOTES | | PLAN | SECTIONS | | |
| BP 1.1 | BP 1.2 | BP 2.1 | BP 2.2 | BP 3.1 | BP 3.2 | BP 4.1 | BP 4.2 | BP 4.3 | BP 4.4 | BP 4.5 | BP 4.6 | BP 5.1 | BP 5.2 | BP 5.3 | BP 5.4 | BP 5.5 | BP 5.6 |

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

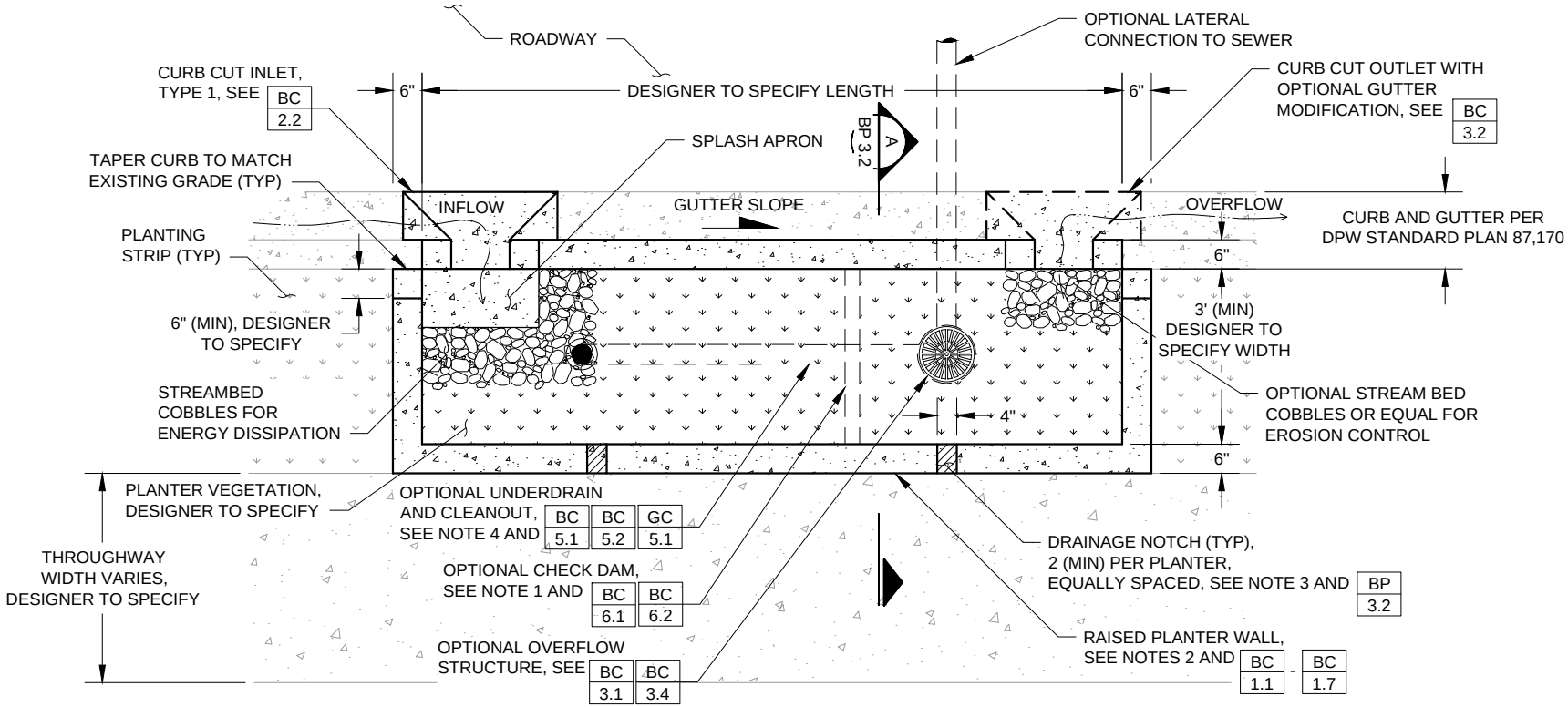
SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE: SEPTEMBER 2016
VERSION: 2.0
REVISED:

# BIORETENTION PLANTER

## ROADSIDE PLANTER WITH PARKING SECTIONS

DWG NO. BP 2.2




## CONSTRUCTION NOTES:

1. CHECK DAMS SHALL BE SPACED TO PROVIDE PONDING PER SITE SPECIFIC DESIGN.
2. SLOPE TOP OF PLANTER WALL TO MATCH LONGITUDINAL SLOPE OF ADJACENT SURFACE.
3. LAY OUT DRAINAGE NOTCHES TO PREVENT PONDING BEHIND PLANTER WALL WITH 5' MAXIMUM SPACING BETWEEN NOTCHES.
4. PROVIDE ONE CLEANOUT PER PLANTER (MIN) FOR FACILITIES WITH UNDERDRAINS.
5. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT SFPUC ASSET PROTECTION STANDARDS. COORDINATE WITH ENGINEER IN THE EVENT OF UTILITY CROSSING AND UTILITY CONFLICTS.

| NOTES | | W/PARKING | | W/O PARKING | | BULBOUT | | | | | | PARCEL APPLICATIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PLAN | SECTIONS | PLAN | SECTIONS | ALT 1 | ALT 2 | ALT 3 | ALT 4 | ALT 5 | ALT 6 | NOTES | | PLAN | SECTIONS | | |
| BP 1.1 | BP 1.2 | BP 2.1 | BP 2.2 | BP 3.1 | BP 3.2 | BP 4.1 | BP 4.2 | BP 4.3 | BP 4.4 | BP 4.5 | BP 4.6 | BP 5.1 | BP 5.2 | BP 5.3 | BP 5.4 | BP 5.5 | BP 5.6 |

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE SEPTEMBER 2016

VERSION 2.0

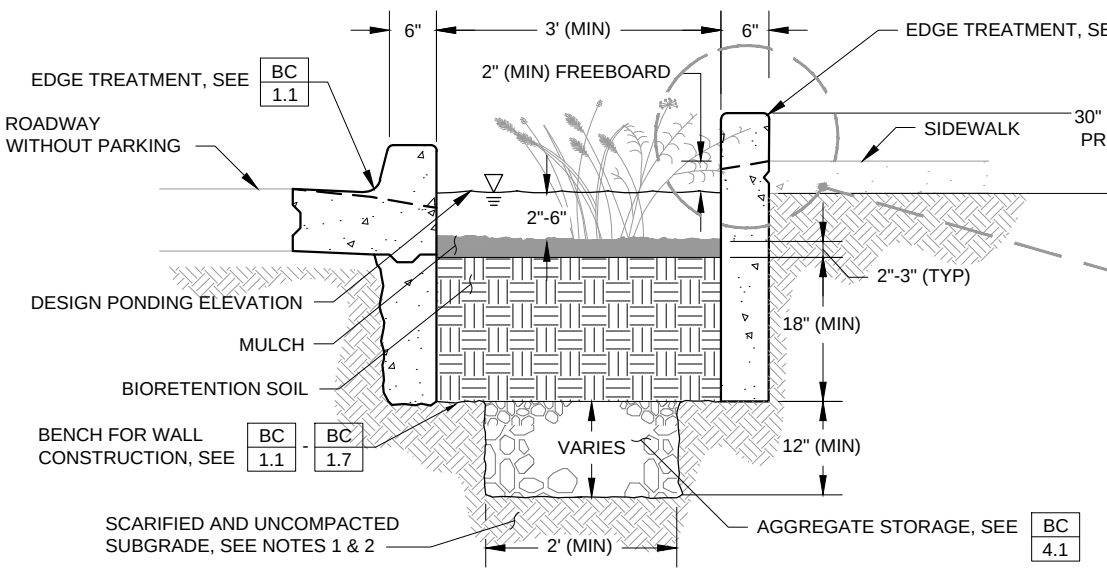
REVISED

# BIORETENTION PLANTER

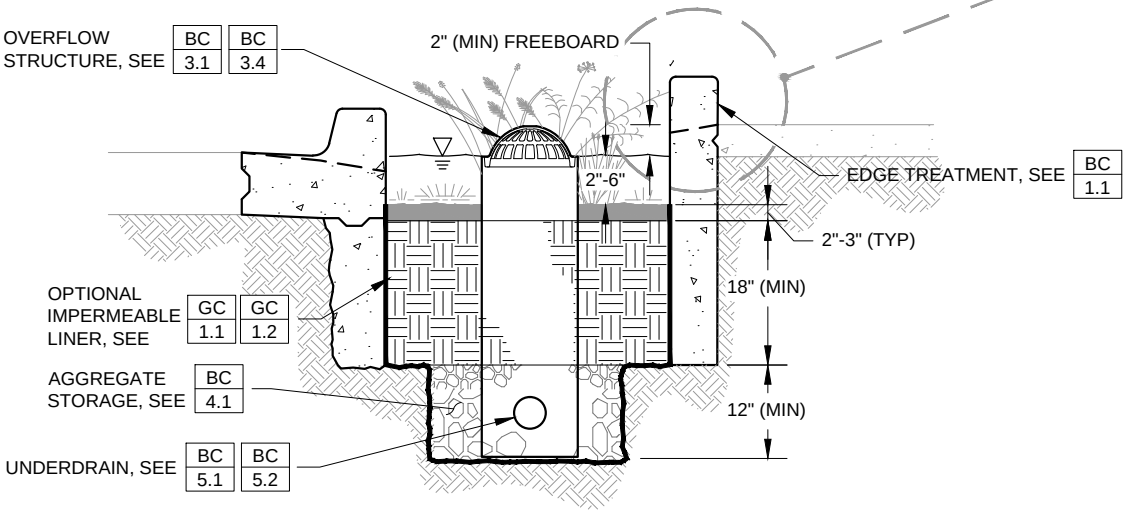
## ROADSIDE PLANTER WITHOUT PARKING PLAN

DWG NO. BP 3.1

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

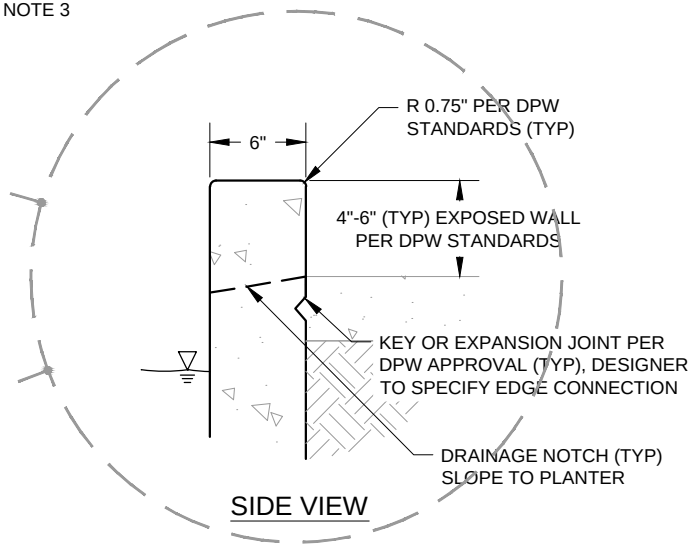



NO UNDERDRAIN - ALTERNATIVE 1




WITH UNDERDRAIN - ALTERNATIVE 2

BIORETENTION PLANTER WITHOUT PARKING (A)




TYPICAL DRAINAGE NOTCH DETAIL

## CONSTRUCTION NOTES:

1. AVOID COMPACTION OF EXISTING SUBGRADE BELOW PLANTER DURING CONSTRUCTION.
2. SCARIFY SUBGRADE TO A DEPTH OF 3 INCHES (MIN) IMMEDIATELY PRIOR TO PLACEMENT OF AGGREGATE STORAGE AND BIORETENTION SOIL MATERIAL.
3. MAXIMUM DROP FROM TOP OF CURB TO TOP OF BIORETENTION SOIL SHALL INCLUDE CONSIDERATIONS FOR BIORETENTION SOIL SETTLEMENT.

| NOTES | | W/PARKING | | W/O PARKING | | BULBOUT | | | | | | PARCEL APPLICATIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PLAN | SECTIONS | PLAN | SECTIONS | ALT 1 | ALT 2 | ALT 3 | ALT 4 | ALT 5 | ALT 6 | NOTES | | PLAN | SECTIONS | | |
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NOT FOR CONSTRUCTION - REFER TO USER GUIDE

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

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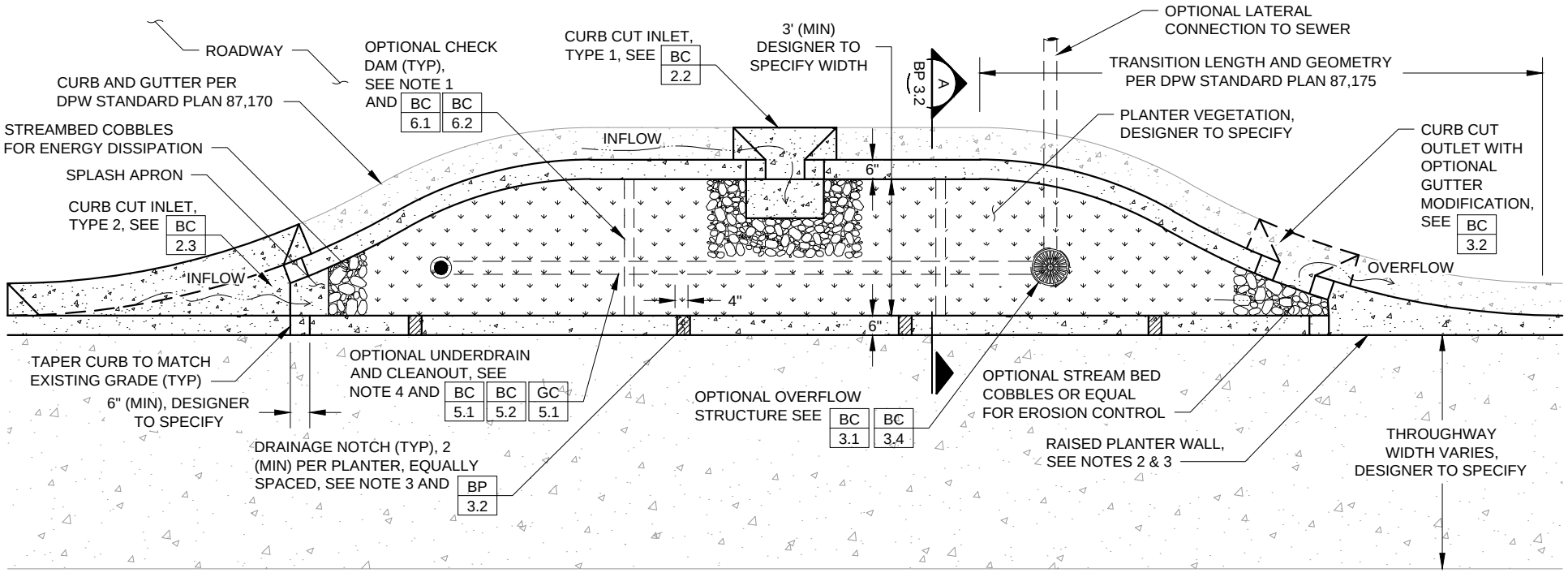
# BIORETENTION PLANTER

## ROADSIDE PLANTER WITHOUT PARKING SECTIONS

DWG NO. BP 3.2




## CONSTRUCTION NOTES:

1. CHECK DAMS SHALL BE SPACED TO PROVIDE PONDING PER SITE SPECIFIC DESIGN.
2. SLOPE TOP OF PLANTER WALL TO MATCH LONGITUDINAL SLOPE OF ADJACENT SURFACE.
3. LAY OUT DRAINAGE NOTCHES TO PREVENT PONDING BEHIND PLANTER WALL WITH 5' MAXIMUM SPACING BETWEEN NOTCHES.
4. PROVIDE ONE CLEANOUT PER PLANTER (MIN) FOR FACILITIES WITH UNDERDRAINS.
5. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT SFPUC ASSET PROTECTION STANDARDS. COORDINATE WITH ENGINEER IN THE EVENT OF UTILITY CROSSING AND UTILITY CONFLICTS.

| NOTES | | W/PARKING | | W/O PARKING | | BULBOUT | | | | | | PARCEL APPLICATIONS | | | | | |
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| | | PLAN SECTIONS | | PLAN SECTIONS | | ALT 1 | ALT 2 | ALT 3 | ALT 4 | ALT 5 | ALT 6 | NOTES | | PLAN | SECTIONS | | |
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San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

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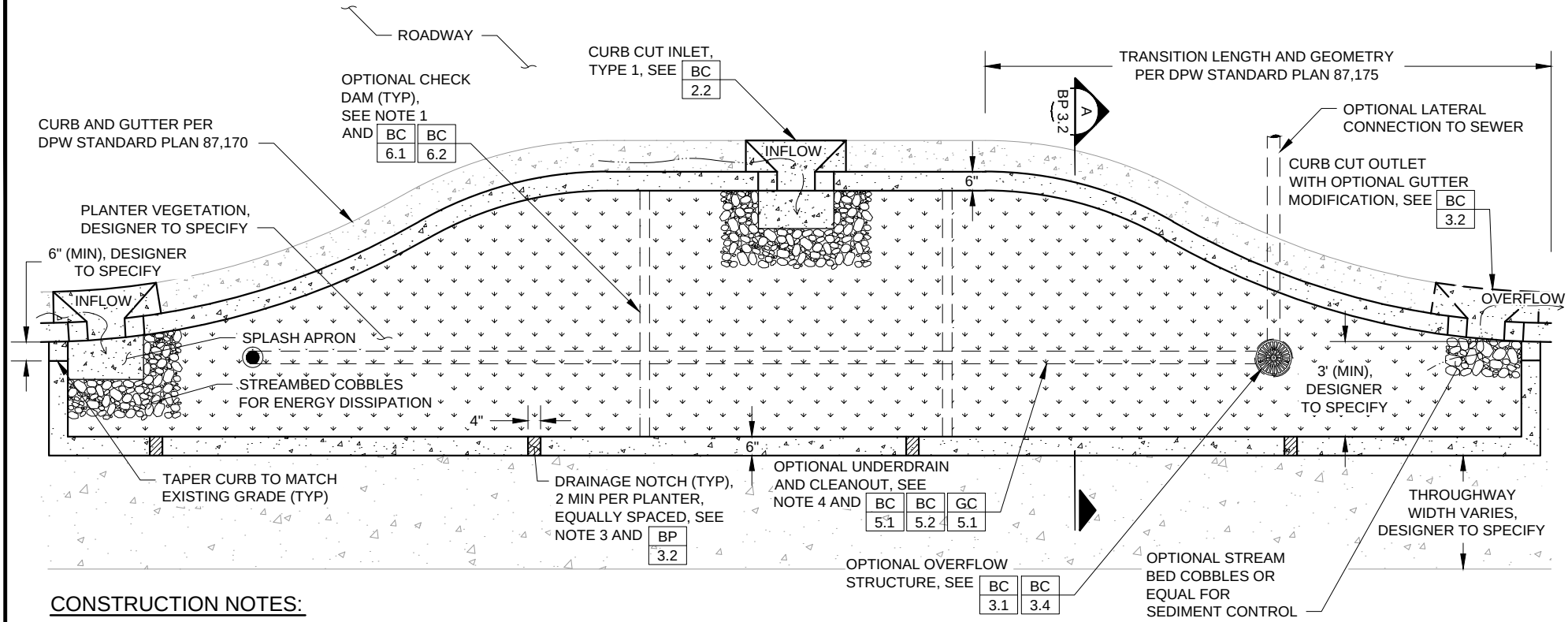
# BIORETENTION PLANTER

## ROADSIDE BULBOUT PLANTER ALTERNATIVE 1

DWG NO. BP 4.1

NOT FOR CONSTRUCTION - REFER TO USER GUIDE




## CONSTRUCTION NOTES:

1. CHECK DAMS SHALL BE SPACED TO PROVIDE PONDING PER SITE SPECIFIC DESIGN.
2. SLOPE TOP OF PLANTER WALL TO MATCH LONGITUDINAL SLOPE OF ADJACENT SURFACE.
3. LAY OUT DRAINAGE NOTCHES TO PREVENT PONDING BEHIND PLANTER WALL WITH 5' MAXIMUM SPACING BETWEEN NOTCHES.
4. PROVIDE ONE CLEANOUT PER PLANTER (MIN) FOR FACILITIES WITH UNDERDRAINS.
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| NOTES | | W/PARKING | | W/O PARKING | | BULBOUT | | | | | | PARCEL APPLICATIONS | | | | | |
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| | | PLAN | SECTIONS | PLAN | SECTIONS | ALT 1 | ALT 2 | ALT 3 | ALT 4 | ALT 5 | ALT 6 | NOTES | | PLAN | SECTIONS | | |
| BP 1.1 | BP 1.2 | BP 2.1 | BP 2.2 | BP 3.1 | BP 3.2 | BP 4.1 | BP 4.2 | BP 4.3 | BP 4.4 | BP 4.5 | BP 4.6 | BP 5.1 | BP 5.2 | BP 5.3 | BP 5.4 | BP 5.5 | BP 5.6 |

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# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

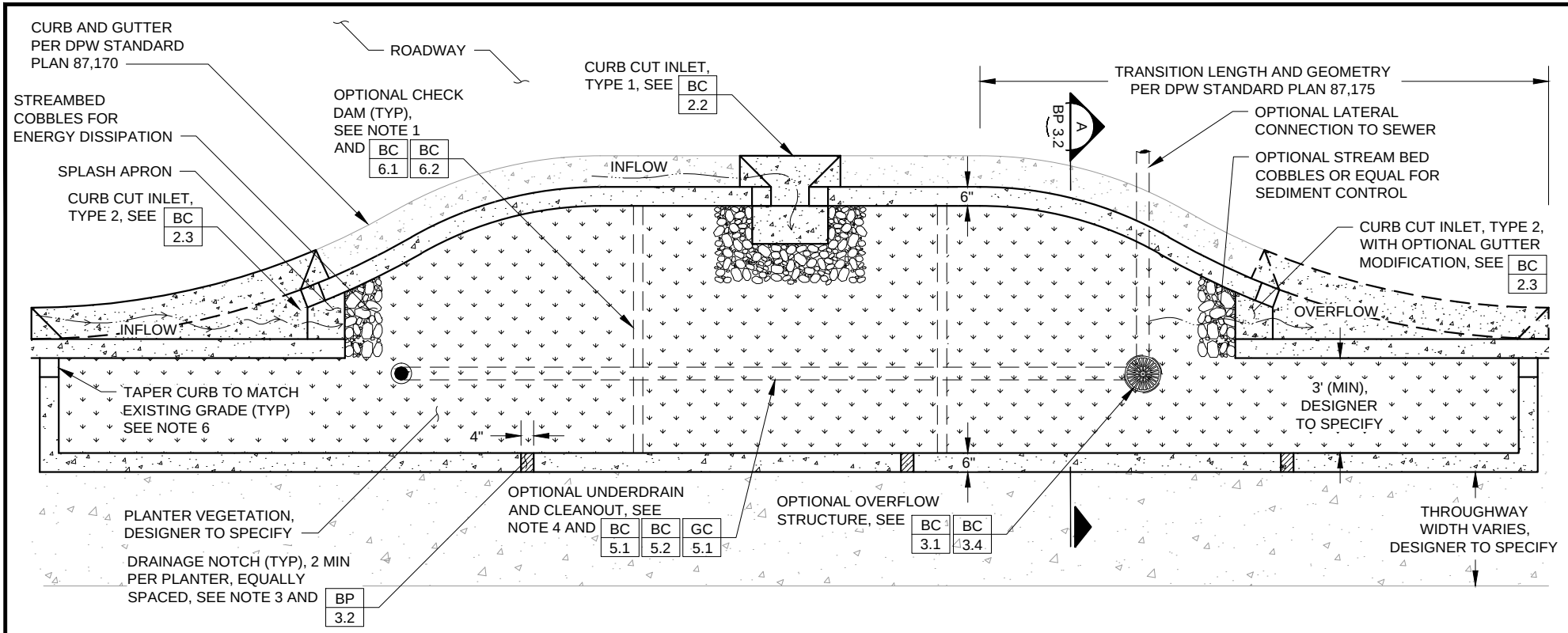
DATE: SEPTEMBER 2016
VERSION: 2.0
REVISED:

# BIORETENTION PLANTER

## ROADSIDE BULBOUT PLANTER ALTERNATIVE 2

DWG NO.
**BP 4.2**

NOT FOR CONSTRUCTION - REFER TO USER GUIDE




## CONSTRUCTION NOTES:

1. CHECK DAMS SHALL BE SPACED TO PROVIDE PONDING PER SITE SPECIFIC DESIGN.
2. SLOPE TOP OF PLANTER WALL TO MATCH LONGITUDINAL SLOPE OF ADJACENT SURFACE.
3. LAY OUT DRAINAGE NOTCHES TO PREVENT PONDING BEHIND PLANTER WALL WITH 5' MAXIMUM SPACING BETWEEN NOTCHES.
4. PROVIDE ONE CLEANOUT PER PLANTER (MIN) FOR FACILITIES WITH UNDERDRAINS.
5. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT SFPUC ASSET PROTECTION STANDARDS. COORDINATE WITH ENGINEER IN THE EVENT OF UTILITY CROSSING AND UTILITY CONFLICTS.
6. IF STREET PARKING IS ALLOWED IMMEDIATELY ADJACENT TO THE CURB CUT INLET/OUTLET, THE PLANTER WALL TAPER SHOULD BE LOCATED 18" BEHIND THE FACE OF CURB. COORDINATE WITH SAN FRANCISCO PUBLIC WORKS

| NOTES | | W/PARKING | | W/O PARKING | | BULBOUT | | | | | | PARCEL APPLICATIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PLAN | SECTIONS | PLAN | SECTIONS | ALT 1 | ALT 2 | ALT 3 | ALT 4 | ALT 5 | ALT 6 | NOTES | | PLAN | SECTIONS | | |
| BP 1.1 | BP 1.2 | BP 2.1 | BP 2.2 | BP 3.1 | BP 3.2 | BP 4.1 | BP 4.2 | BP 4.3 | BP 4.4 | BP 4.5 | BP 4.6 | BP 5.1 | BP 5.2 | BP 5.3 | BP 5.4 | BP 5.5 | BP 5.6 |

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

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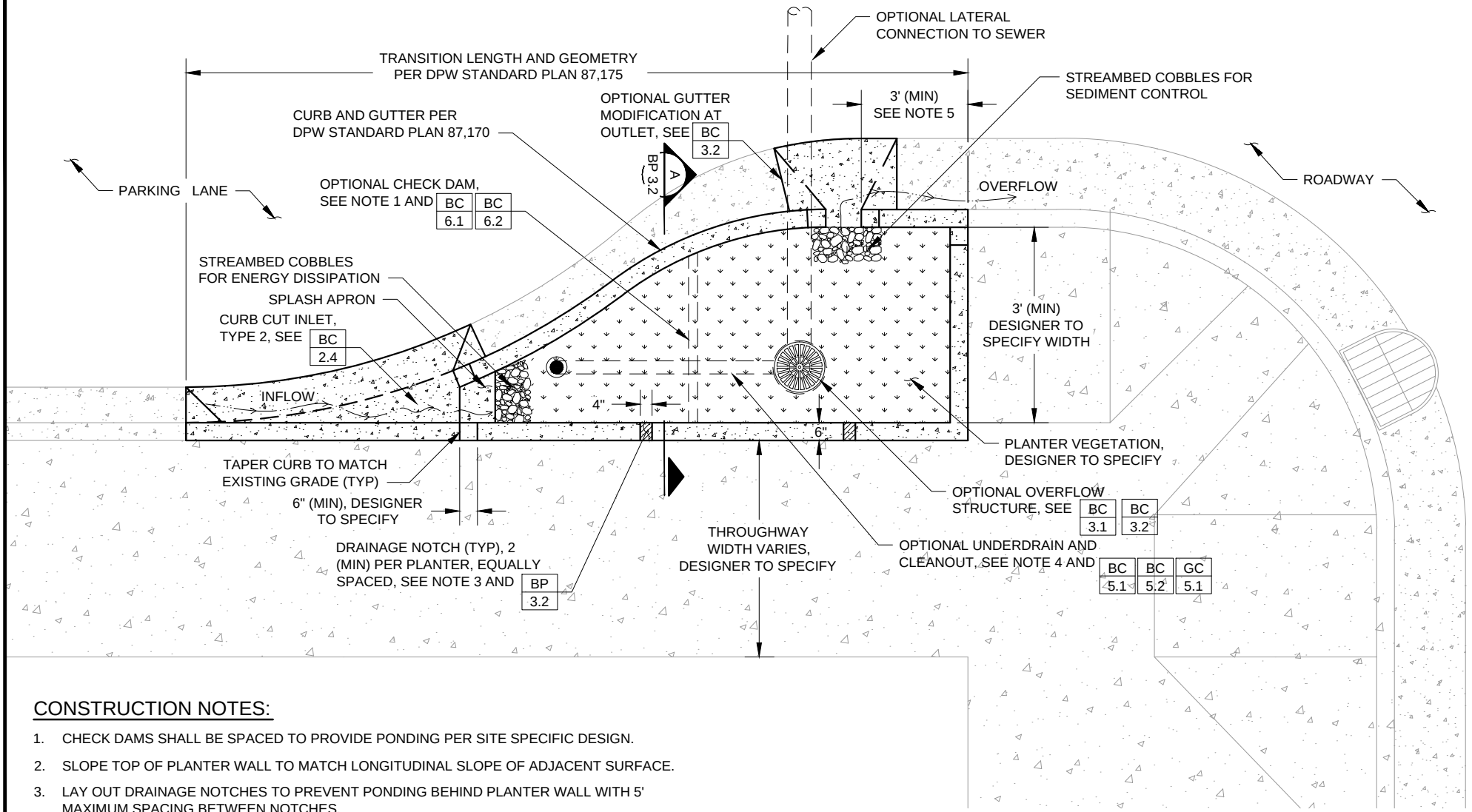
REVISED

# BIORETENTION PLANTER

## ROADSIDE BULBOUT PLANTER ALTERNATIVE 3

DWG NO. BP 4.3

NOT FOR CONSTRUCTION - REFER TO USER GUIDE




## CONSTRUCTION NOTES:

1. CHECK DAMS SHALL BE SPACED TO PROVIDE PONDING PER SITE SPECIFIC DESIGN.
2. SLOPE TOP OF PLANTER WALL TO MATCH LONGITUDINAL SLOPE OF ADJACENT SURFACE.
3. LAY OUT DRAINAGE NOTCHES TO PREVENT PONDING BEHIND PLANTER WALL WITH 5' MAXIMUM SPACING BETWEEN NOTCHES.
4. PROVIDE ONE CLEANOUT PER PLANTER (MIN) FOR FACILITIES WITH UNDERDRAINS.
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| NOTES | | W/PARKING | | W/O PARKING | | BULBOUT | | | | | | PARCEL APPLICATIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PLAN SECTIONS | | PLAN SECTIONS | | ALT 1 | ALT 2 | ALT 3 | ALT 4 | ALT 5 | ALT 6 | NOTES | | PLAN | SECTIONS | | |
| BP 1.1 | BP 1.2 | BP 2.1 | BP 2.2 | BP 3.1 | BP 3.2 | BP 4.1 | BP 4.2 | BP 4.3 | BP 4.4 | BP 4.5 | BP 4.6 | BP 5.1 | BP 5.2 | BP 5.3 | BP 5.4 | BP 5.5 | BP 5.6 |

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

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DATE SEPTEMBER 2016

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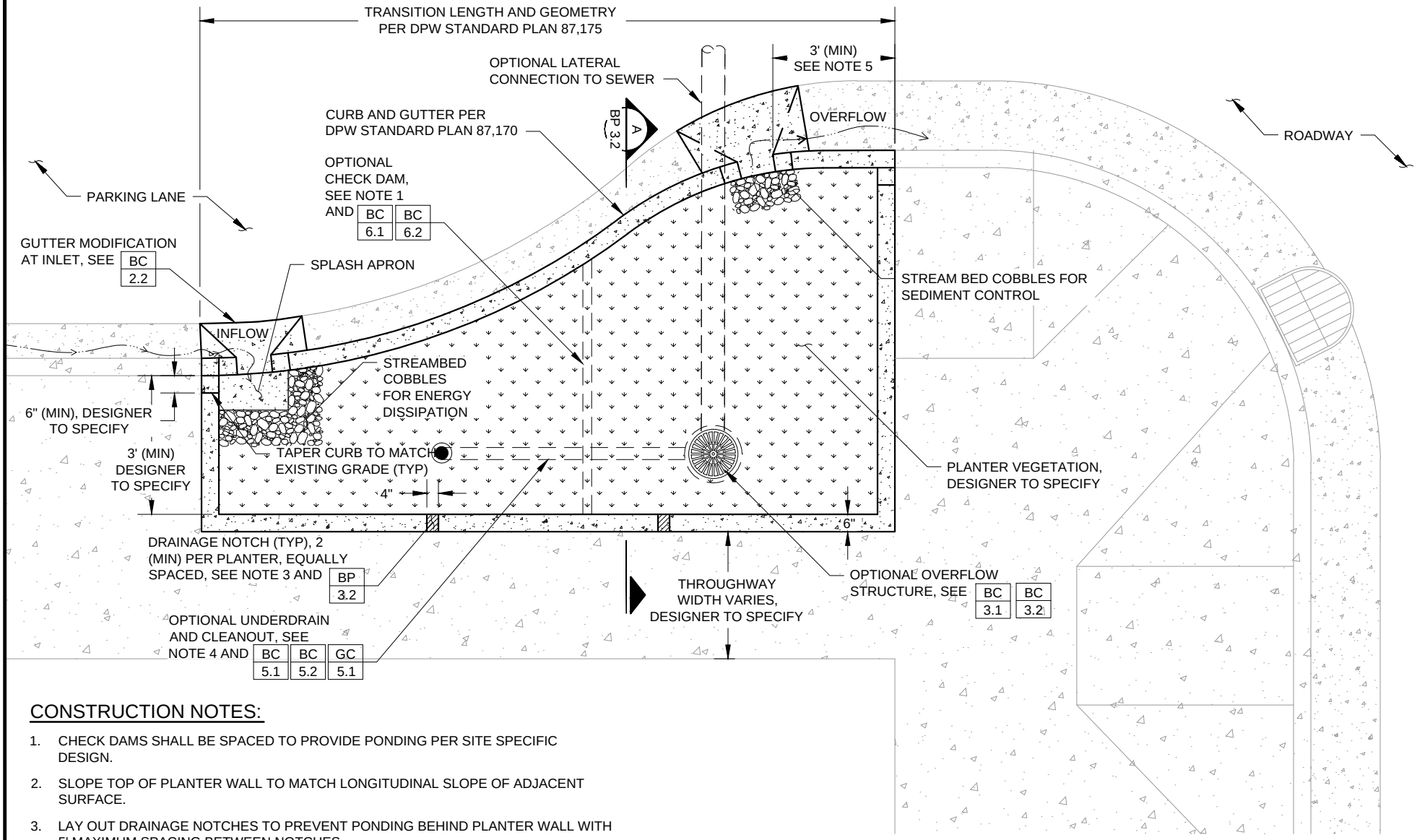
REVISED

# BIORETENTION PLANTER

## ROADSIDE BULBOUT PLANTER ALTERNATIVE 4

DWG NO. **BP 4.4**

NOT FOR CONSTRUCTION - REFER TO USER GUIDE




## CONSTRUCTION NOTES:

1. CHECK DAMS SHALL BE SPACED TO PROVIDE PONDING PER SITE SPECIFIC DESIGN.
2. SLOPE TOP OF PLANTER WALL TO MATCH LONGITUDINAL SLOPE OF ADJACENT SURFACE.
3. LAY OUT DRAINAGE NOTCHES TO PREVENT PONDING BEHIND PLANTER WALL WITH 5' MAXIMUM SPACING BETWEEN NOTCHES.
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| NOTES | | W/PARKING | | W/O PARKING | | BULBOUT | | | | | | PARCEL APPLICATIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PLAN SECTIONS | | PLAN SECTIONS | | ALT 1 | ALT 2 | ALT 3 | ALT 4 | ALT 5 | ALT 6 | NOTES | | PLAN | SECTIONS | | |
| BP 1.1 | BP 1.2 | BP 2.1 | BP 2.2 | BP 3.1 | BP 3.2 | BP 4.1 | BP 4.2 | BP 4.3 | BP 4.4 | BP 4.5 | BP 4.6 | BP 5.1 | BP 5.2 | BP 5.3 | BP 5.4 | BP 5.5 | BP 5.6 |

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# GREEN INFRASTRUCTURE TYPICAL DETAILS

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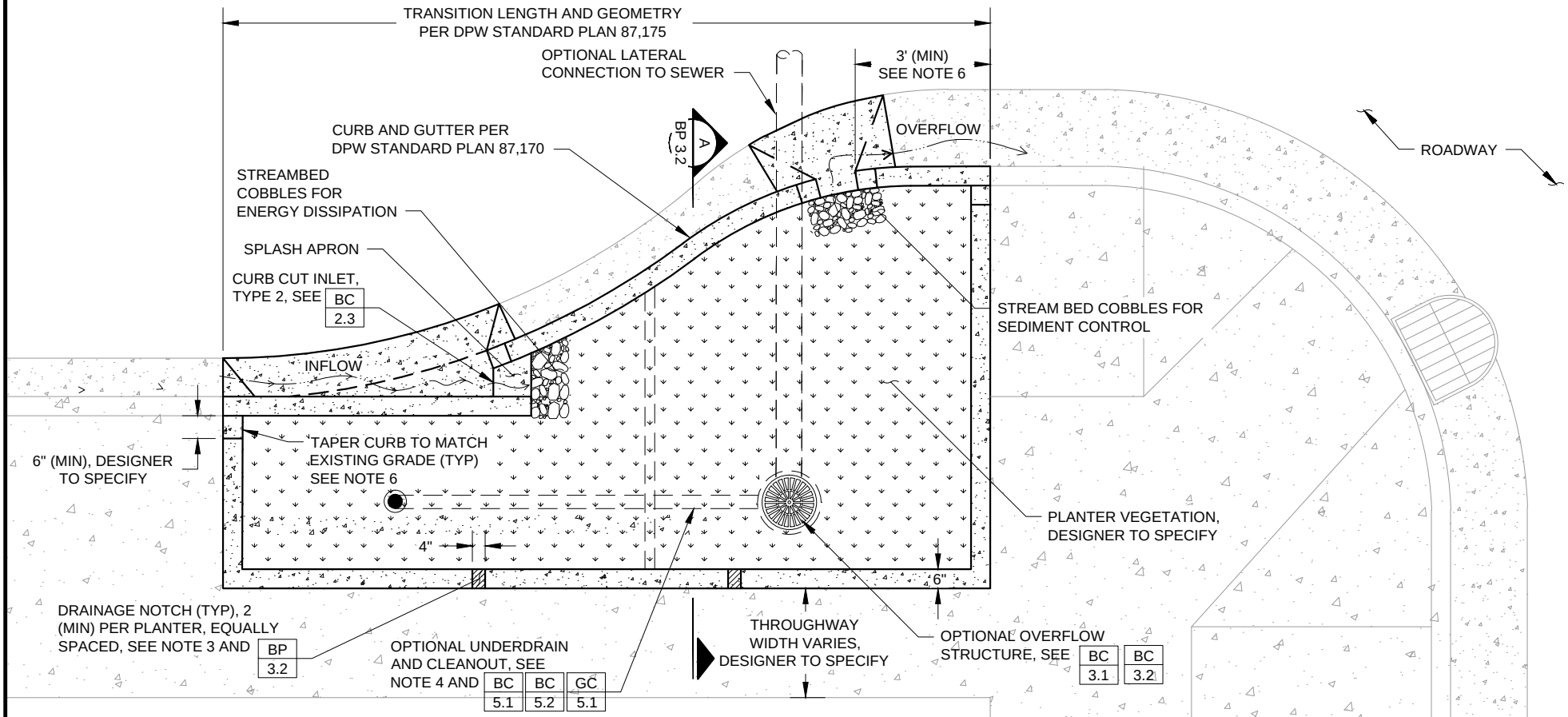
# BIORETENTION PLANTER

## ROADSIDE BULBOUT PLANTER ALTERNATIVE 5

DWG NO. BP 4.5

NOT FOR CONSTRUCTION - REFER TO USER GUIDE




## CONSTRUCTION NOTES:

1. CHECK DAMS SHALL BE SPACED TO PROVIDE PONDING PER SITE SPECIFIC DESIGN.
2. SLOPE TOP OF PLANTER WALL TO MATCH LONGITUDINAL SLOPE OF ADJACENT SURFACE.
3. LAY OUT DRAINAGE NOTCHES TO PREVENT PONDING BEHIND PLANTER WALL WITH 5' MAXIMUM SPACING BETWEEN NOTCHES.
4. PROVIDE ONE CLEANOUT PER PLANTER (MIN) FOR FACILITIES WITH UNDERDRAINS.
5. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT SFPUC ASSET PROTECTION STANDARDS. COORDINATE WITH ENGINEER IN THE EVENT OF UTILITY CROSSING AND UTILITY CONFLICTS.
6. IF STREET PARKING IS ALLOWED IMMEDIATELY ADJACENT TO THE CURB CUT INLET/OUTLET, THE PLANTER WALL TAPER SHOULD BE LOCATED 18" BEHIND THE FACE OF CURB. COORDINATE WITH SAN FRANCISCO PUBLIC WORKS.

| NOTES | | W/PARKING | | W/O PARKING | | BULBOUT | | | | | | PARCEL APPLICATIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PLAN | SECTIONS | PLAN | SECTIONS | ALT 1 | ALT 2 | ALT 3 | ALT 4 | ALT 5 | ALT 6 | NOTES | | PLAN | SECTIONS | | |
| BP 1.1 | BP 1.2 | BP 2.1 | BP 2.2 | BP 3.1 | BP 3.2 | BP 4.1 | BP 4.2 | BP 4.3 | BP 4.4 | BP 4.5 | BP 4.6 | BP 5.1 | BP 5.2 | BP 5.3 | BP 5.4 | BP 5.5 | BP 5.6 |

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

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# BIORETENTION PLANTER

## ROADSIDE BULBOUT PLANTER ALTERNATIVE 6

DWG NO. BP 4.6

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

## PURPOSE:

PARCEL BIORETENTION PLANTERS CONTROL PEAK FLOWS AND VOLUMES OF STORMWATER RUNOFF BY PROVIDING SURFACE, SUBSURFACE STORAGE AND INFILTRATION INTO NATIVE SOIL. WATER IS TREATED AS IT FILTERS THROUGH THE BIORETENTION SOIL.

## DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT PLAN AND SECTION DRAWINGS TO ADDRESS BUILDING- AND SITE-SPECIFIC CONDITIONS.
2. THE DESIGNER MUST COMPLY WITH ALL APPLICABLE SITE AND BUILDING CODE REQUIREMENTS FOR ON-SITE ACCESSIBILITY AND SAFETY INCLUDING, BUT NOT LIMITED TO, CURBS, PEDESTRIAN SURFACING, AND GUARDRAILS/FALL HEIGHTS.
3. PLANTER AREA, PONDING DEPTH, BIORETENTION SOIL DEPTH, AND AGGREGATE STORAGE DEPTH MUST BE SIZED TO MEET PROJECT-SPECIFIC PERFORMANCE GOALS.
4. PONDING AND BIORETENTIONSOIL DRAWDOWN TIME (I.E., TIME FOR MAXIMUM SURFACE PONDING TO DRAIN THROUGH THE BIORETENTION SOIL AFTER THE END OF A STORM) RECOMMENDATIONS:
   - 3 - 12 HOUR PONDING AND BIORETENTION SOIL DRAWDOWN (TYPICAL)
   - 24 HOUR MAXIMUM PONDING AND BIORETENTION SOIL DRAWDOWN
5. FACILITY DRAWDOWN TIME (I.E., TIME FOR SURFACE PONDING TO DRAIN THROUGH THE ENTIRE SECTION INCLUDING AGGREGATE STORAGE AFTER THE END OF A STORM) REQUIREMENTS:
   - 48 HOUR MAXIMUM FACILITY DRAWDOWN (i.e.ORFICE CONTROLLED SYSTEM OR EXTENDED STORAGE DEPTH WITHIN INFILTRATION SYSTEM)
6. AN AGGREGATE COURSE IS REQUIRED UNDER THE BIORETENTION SOIL FOR BIORETENTION IN SEPERATE SEWER SYSTEM AREAS TO PROVIDE ADDITIONAL TREATMENT. THIS AGGREGATE COURSE OPTIONAL FOR FACILITIES IN COMBINED SEWER SYSTEM AREAS. SEE GUIDANCE ON **BC 4**.1.
7. CHECK DAMS MAY BE USED TO TERRACE FACILITIES TO PROVIDE SUFFICIENT PONDING FOR HIGHER-SLOPED INSTALLATIONS. DESIGNER MUST SPECIFY CHECK DAM HEIGHT AND SPACING. REFER TO **BC 6.1** AND **BC 6.2** FOR GUIDANCE ON CHECK DAM DESIGN.
8. PLANTER OVERFLOW STRUCTURES SHALL BE DESIGNED TO CONVEY THE ANTICIPATED DESIGN FLOWS PER SAN FRANCISCO DBI REQUIREMENTS.
9. PLANTERS SHALL BE DESIGNED TO OVERFLOW TO THE STREET IN THE EVENT THE PLANTER OUTLET IS OBSTRUCTED OR CLOGGED.
10. MATERIALS FOR PLANTERS MAY VARY TO WORK WITH SITE AND ARCHITECTURAL PALETTE.
11. FACILITIES ADJACENT TO A BUILDING (WITHIN 10 FEET) SHOULD BE LINED TO AVOID NEGATIVE IMPACTS OF WATER AT FOUNDATION. LINER CAN BE OMITTED WITH LETTER FROM LICENSED DESIGN PROFESSIONAL(S) STATING THAT BUILDING WATERPROOFING, STRUCTURAL INTEGRITY, AND STORMWATER FUNCTION IS NOT IMPACTED.
12. FACILITIES MAY BE EXTENDED ABOVE GRADE FOR SEATWALL OR RAISED PLANTER CONFIGURATIONS, IF APPROPRIATE CONVEYANCE MEASURES ARE PROVIDED TO MEET DESIGN REQUIREMENTS.
13. CONVEYANCE CONNECTIONS MAY BE CONFIGURED TO ACCEPT RUNOFF VIA OVERHEAD CONVEYANCE (DOWNSPOUTS, OVERHEAD RUNNELS), SURFACE FLOW (CHANNELS), OR SUBSURFACE CONVEYANCE (PIPES, TRENCH DRAINS). REFER TO APPLICABLE SAN FRANCISCO DBI CODES FOR CONVEYANCE CONNECTION REQUIREMENTS.
14. CONVEYANCE CONNECTIONS (E.G. SCUPPER, CHANNEL, PIPE) SHALL BE SIZED TO ACCOMMODATE DRAINAGE FROM ROOF AREA WITH ADEQUATE FREEBOARD TO AVOID OVERFLOWING. REFER TO APPLICABLE SAN FRANCISCO DBI CODES FOR CONVEYANCE CONNECTION REQUIREMENTS.
15. UNDERDRAINS REQUIRED ON STRUCTURE TO DRAIN PLANTER AND AVOID ACCUMULATION OF WATER ON STRUCTURE WATERPROOFING SYSTEM
16. OVERFLOW STRUCTURE (MATERIAL AND WORKMANSHIP) SHALL CONFORM TO APPLICABLE SAN FRANCISCO DBI AND PUBLIC WORKS CODES AND REQUIREMENTS. SIZE AND MODEL OF ATRIUM GRATE AT OVERFLOW TO BE DETERMINED BY ENGINEER TO ENSURE CONVEYANCE OF PEAK FLOW.
17. THE DESIGNER MUST EVALUATE UTILITY SURVEYS FOR POTENTIAL UTILITY CROSSINGS OR CONFLICTS. REFER TO **GC 2.1** - **GC 2.12** FOR UTILITY CROSSING DETAILS AND **GC 1.4** - **GC 4.4** FOR UTILITY CROSSING CONFLICT DETAILS.
18. REFER TO SAN FRANCISCO DBI CODES FOR CURB AND/OR RAILING REQUIREMENTS.

| NOTES | | W/ PARKING | | W/O PARKING | | BULBOUT | | | | | | PARCEL APPLICATIONS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PLAN | SECTIONS | PLAN | SECTIONS | ALT 1 | ALT 2 | ALT 3 | ALT 4 | ALT 5 | ALT 6 | NOTES | | PLAN | | SECTIONS | | |
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San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE: SEPTEMBER 2016
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# BIORETENTION PLANTER

## PARCEL PLANTER DESIGNER NOTES (1 OF 2)

DWG NO. BP 5.1

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

## LAYOUT REQUIREMENTS:

THE DESIGNER MUST COMPLY WITH ALL STORMWATER, LAND USE, AND BUILDING CODE REQUIREMENTS:

1. ADHERE TO ALL CODES FOR ACCESSIBILITY REQUIRED FOR PARCEL LEVEL DEVELOPMENT
2. PARCEL PLANTERS SHOULD NOT INTERFERE WITH OTHER LAND USE REQUIREMENTS SUCH AS BUFFERING AND SCREENING, SETBACKS, SIGHT DISTANCE, AND MINIMUM SITE COVERAGE.
3. DESIGNER MUST COMPLY WITH ALL CURRENT LOCAL CODES, INCLUDING BUT NOT LIMITED TO:
   - SAN FRANCISCO STORMWATER MANAGEMENT ORDINANCE
   - SAN FRANCISCO PLANNING CODE
   - CALIFORNIA BUILDING CODE
   - SAN FRANCISCO BUILDING CODE AMENDMENTS
   - ADA STANDARDS FOR ACCESSIBLE DESIGN

## DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ PLANTER WIDTH AND LENGTH
- ☐ DEPTH OF PONDING
- ☐ DEPTH OF FREEBOARD
- ☐ DEPTH OF BIORETENTION SOIL
- ☐ DEPTH AND TYPE OF GRAVEL STORAGE, IF ANY
- ☐ PLANTER SURFACE ELEVATION (TOP OF BIORETENTION SOIL) AT UPSLOPE AND DOWNSLOPE ENDS OF FACILITY
- ☐ CONTROL POINTS AT EVERY PLANTER WALL CORNER OR POINT OF TANGENCY
- ☐ DIMENSIONS AND DISTANCE TO EVERY INLET, OUTLET, CHECK DAM, SIDEWALK NOTCH, ETC.
- ☐ ELEVATIONS OF EVERY INLET, OUTLET, STRUCTURE RIM AND INVERT, CLEAN OUT, PLANTER WALL CORNER, AND SIDEWALK NOTCH
- ☐ TYPE AND DESIGN OF PLANTER COMPONENTS (E.G., EDGE TREATMENTS, INLETS/GUTTER MODIFICATIONS, UTILITY CROSSINGS, LINER, AND PLANTING DETAILS).
- ☐ OVERFLOW STRUCTURE AND ATRIUM GRATE SIZE AND MODEL NUMBER

| RELATED COMPONENTS | |
|---|---|
| EDGE TREATMENTS: | BC 1.1 - BC 1.7 |
| INLETS: | BC 2.1 - BC 2.4 |
| OUTLETS: | BC 3.1 - BC 3.4 |
| AGGREGATE STORAGE: | BC 4.2 |
| UNDERDRAINS: | BC 5.1 - BC 5.2 |
| CHECK DAMS: | BC 6.1 - BC 6.2 |
| LINERS: | GC 1.1 - GC 1.2 |
| UTILITY CROSSINGS: | GC 2.1 - GC 2.12 |
| OBSERVATION PORTS: | GC 3.1 - GC 3.3 |
| UTILITY CONFLICTS: | GC 4.1 - GC 4.4 |
| CLEANOUTS: | GC 5.2 |

| RELATED SPECIFICATIONS | CSI NO. |
|---|---|
| **BIORETENTION:**<br>- BIORETENTION SOIL MIX<br>- AGGREGATE STORAGE<br>- MULCH<br>- STREAMBED COBBLES | 33 47 27 |

| NOTES | | W/PARKING | | W/O PARKING | | BULBOUT | | | | | | PARCEL APPLICATIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PLAN | SECTIONS | PLAN | SECTIONS | ALT 1 | ALT 2 | ALT 3 | ALT 4 | ALT 5 | ALT 6 | NOTES | | PLAN | SECTIONS | | |
| BP 1.1 | BP 1.2 | BP 2.1 | BP 2.2 | BP 3.1 | BP 3.2 | BP 4.1 | BP 4.2 | BP 4.3 | BP 4.4 | BP 4.5 | BP 4.6 | BP 5.1 | BP 5.2 | BP 5.3 | BP 5.4 | BP 5.5 | BP 5.6 |

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

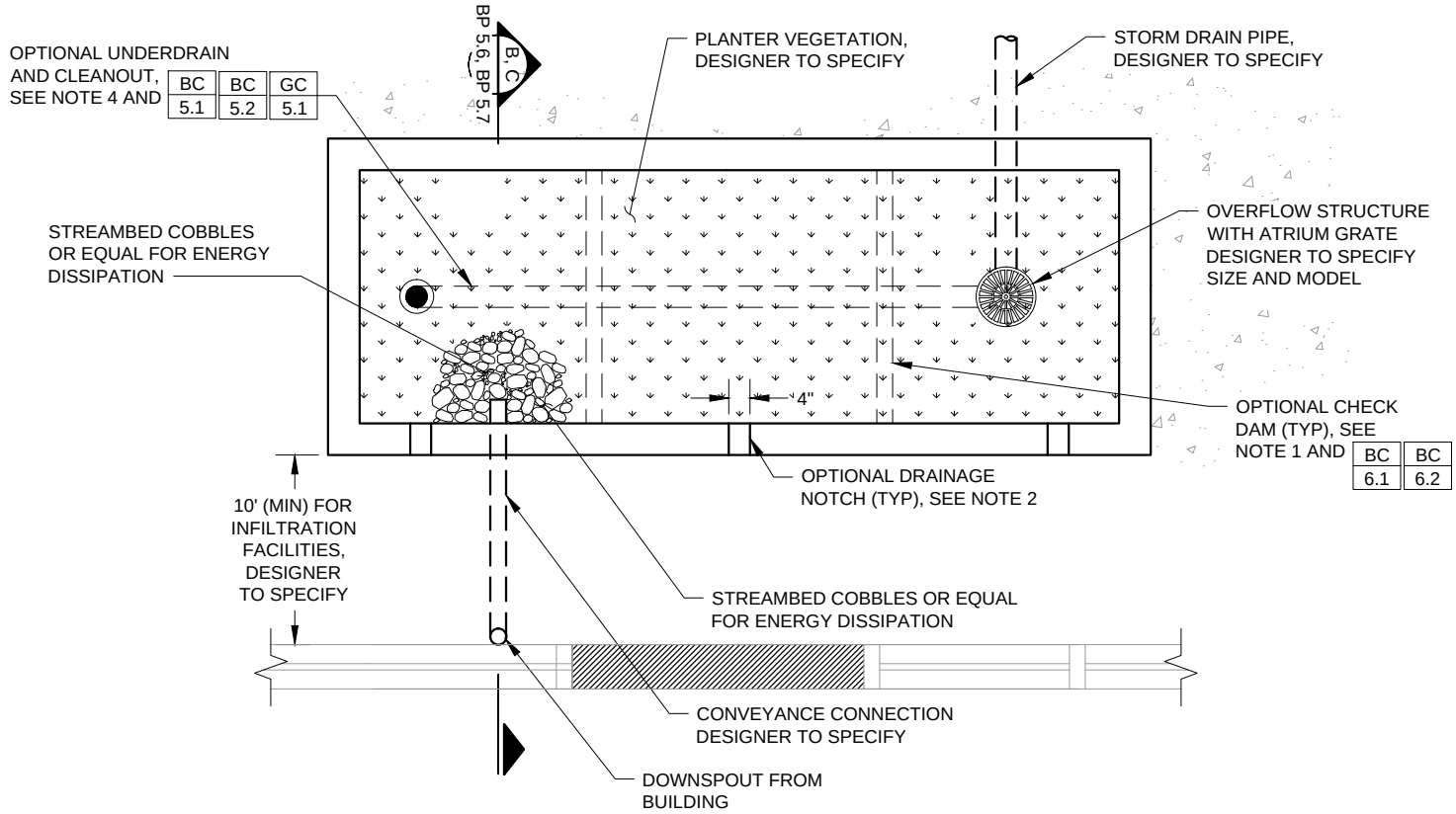
DATE: SEPTEMBER 2016
VERSION: 2.0
REVISED:

# BIORETENTION PLANTER

## PARCEL PLANTER DESIGNER NOTES (2 OF 2)

DWG NO. BP 5.2

NOT FOR CONSTRUCTION - REFER TO USER GUIDE




PLAN - ALTERNATIVE 1 (1)

## CONSTRUCTION NOTES:

1. CHECK DAMS SHALL BE SPACED TO PROVIDE PONDING PER SITE SPECIFIC DESIGN.
2. LAY OUT DRAINAGE NOTCHES TO PREVENT PONDING BEHIND PLANTER WALL WITH 5' MAXIMUM SPACING BETWEEN NOTCHES .
3. COORDINATE WATERPROOFING AT BUILDINGS WITH ARCHITECT AND ENGINEER.
4. PROVIDE ONE CLEANOUT PER PLANTER (MIN) FOR FACILITIES WITH UNDERDRAINS.
5. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT SFPUC ASSET PROTECTION STANDARDS. COORDINATE WITH ENGINEER IN THE EVENT OF UTILITY CROSSING AND UTILITY CONFLICTS.

| NOTES | | W/PARKING | | W/O PARKING | | BULBOUT | | | | | | PARCEL APPLICATIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PLAN | SECTIONS | PLAN | SECTIONS | ALT 1 | ALT 2 | ALT 3 | ALT 4 | ALT 5 | ALT 6 | NOTES | | PLAN | | SECTIONS | | |
| BP 1.1 | BP 1.2 | BP 2.1 | BP 2.2 | BP 3.1 | BP 3.2 | BP 4.1 | BP 4.2 | BP 4.3 | BP 4.4 | BP 4.5 | BP 4.6 | BP 5.1 | BP 5.2 | BP 5.3 | BP 5.4 | BP 5.5 | BP 5.6 | BP 5.7 |

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# GREEN INFRASTRUCTURE TYPICAL DETAILS

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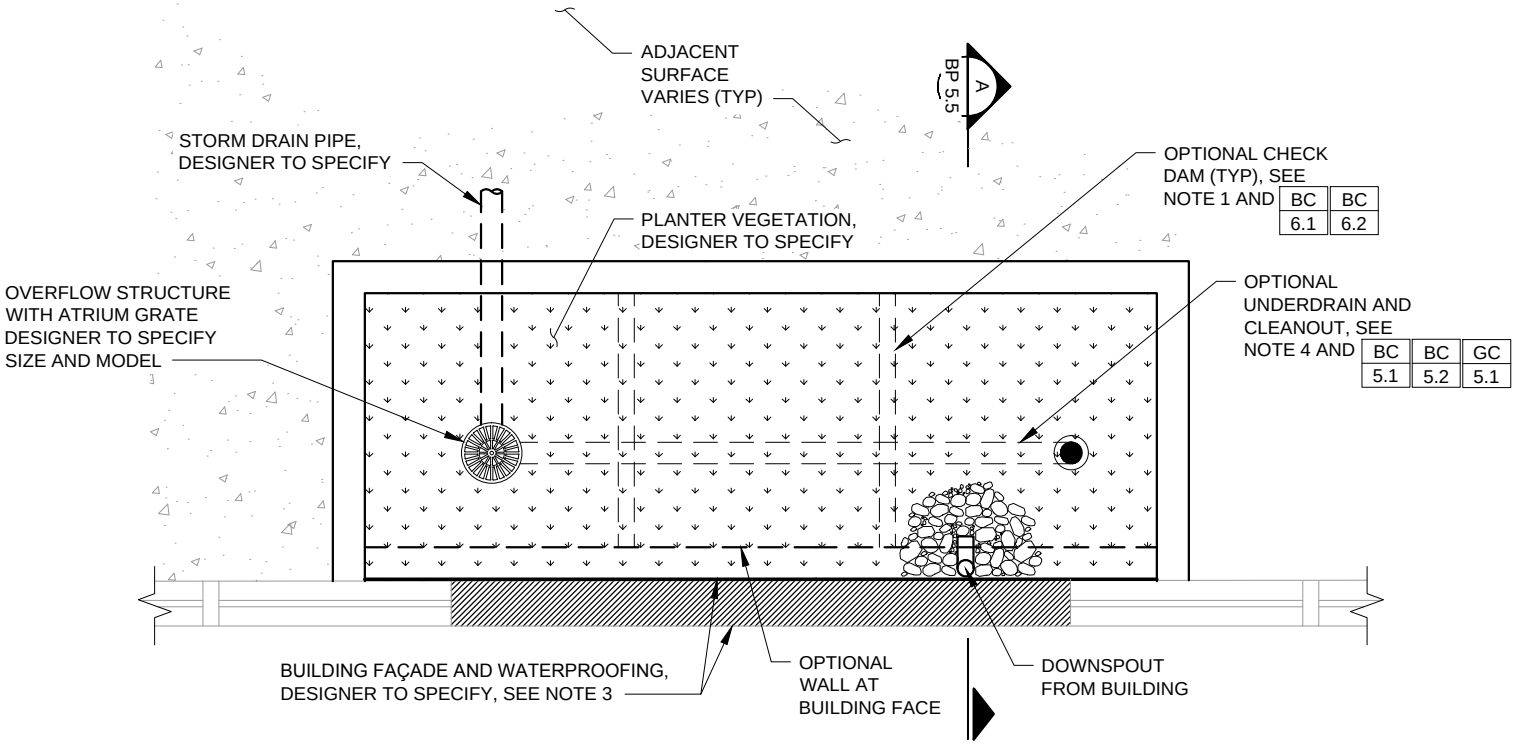
# BIORETENTION PLANTER

## PARCEL PLANTER PLAN ALTERNATIVE 1

DWG NO. BP 5.3

NOT FOR CONSTRUCTION - REFER TO USER GUIDE




PLAN - ALTERNATIVE 2 (1)

## CONSTRUCTION NOTES:

1. CHECK DAMS SHALL BE SPACED TO PROVIDE PONDING PER SITE SPECIFIC DESIGN.
2. LAY OUT DRAINAGE NOTCHES TO PREVENT PONDING BEHIND PLANTER WALL WITH 5' MAXIMUM SPACING BETWEEN NOTCHES .
3. COORDINATE WATERPROOFING AT BUILDINGS WITH ARCHITECT AND ENGINEER.
4. PROVIDE ONE CLEANOUT PER PLANTER (MIN) FOR FACILITIES WITH UNDERDRAINS.
5. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT SFPUC ASSET PROTECTION STANDARDS. COORDINATE WITH ENGINEER IN THE EVENT OF UTILITY CROSSING AND UTILITY CONFLICTS.

| NOTES | | W/PARKING | | W/O PARKING | | BULBOUT | | | | | | PARCEL APPLICATIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PLAN | SECTIONS | PLAN | SECTIONS | ALT 1 | ALT 2 | ALT 3 | ALT 4 | ALT 5 | ALT 6 | NOTES | | PLAN | | SECTIONS | |
| BP 1.1 | BP 1.2 | BP 2.1 | BP 2.2 | BP 3.1 | BP 3.2 | BP 4.1 | BP 4.2 | BP 4.3 | BP 4.4 | BP 4.5 | BP 4.6 | BP 5.1 | BP 5.2 | BP 5.3 | **BP 5.4** | BP 5.5 | BP 5.6 | BP 5.7 |

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

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REVISED:

# BIORETENTION PLANTER

## PARCEL PLANTER PLAN ALTERNATIVE 2

DWG NO. **BP 5.4**

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

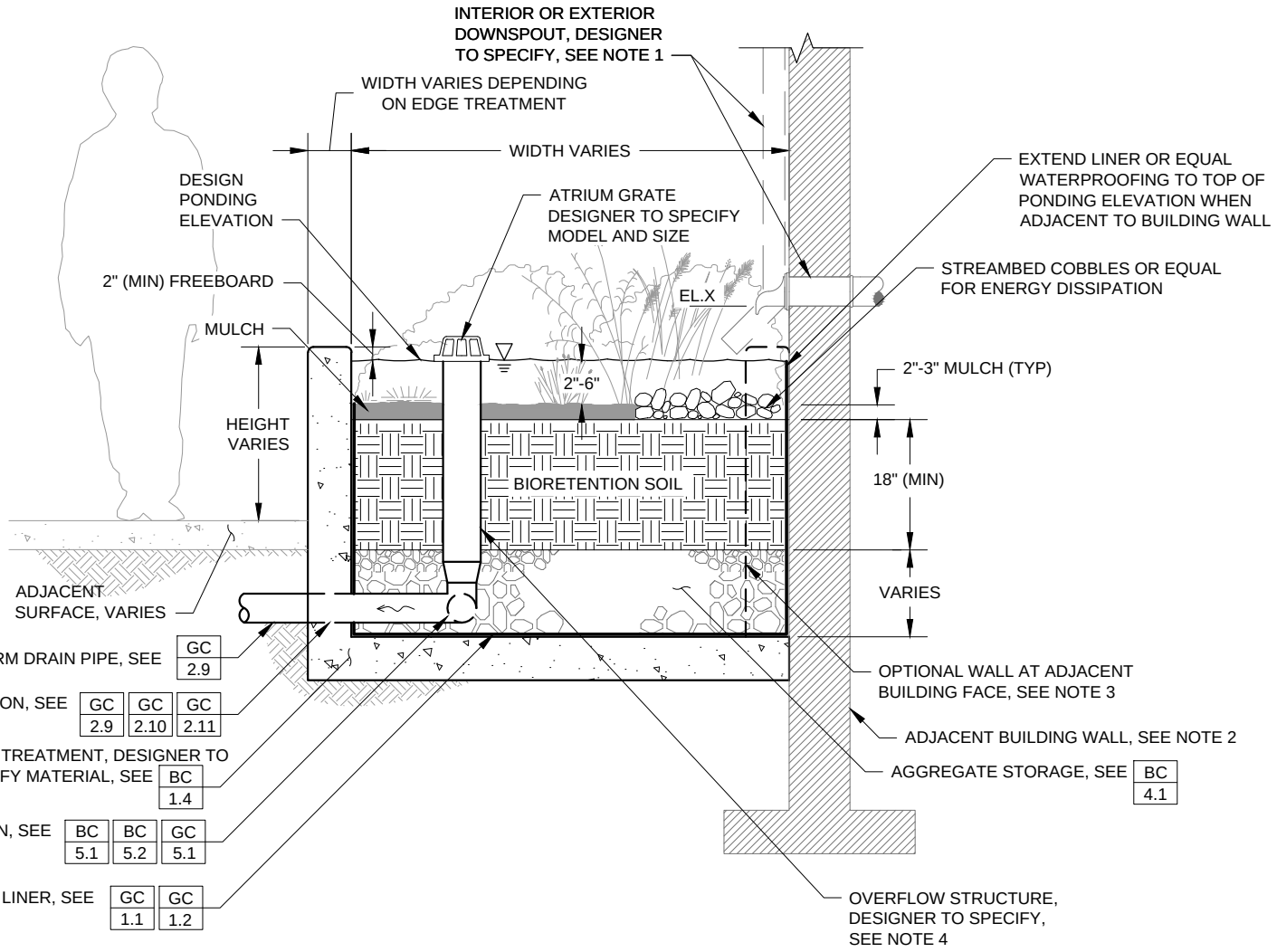
## CONSTRUCTION NOTES:

1. INSTALL DOWNSPOUTS OR OTHER CONVEYANCE CONNECTIONS (E.G. SCUPPER, CHANNEL, OVERHEAD RUNNEL) FROM BUILDING TO DRAIN ABOVE DESIGN PONDING ELEVATION. REFER TO APPLICABLE SAN FRANCISCO DBI CODES FOR CONVEYANCE CONNECTION REQUIREMENTS.

2. BUILDING WATERPROOFING BY ARCHITECT; COORDINATE PLANTER CONSTRUCTION WITH BUILDING FAÇADE / WATERPROOFING.

3. PROVIDE WALL AT BUILDING FACE IN CASES WHERE GAP IS REQUIRED BETWEEN WALL AND PLANTER OR WHERE BUILDING FAÇADE IS INCOMPATIBLE WITH PLANTER CONFIGURATION.

4. OVERFLOW STRUCTURE (MATERIAL AND WORKMANSHIP) SHALL CONFORM TO APPLICABLE SAN FRANCISCO DBI AND PUBLIC WORKS CODES AND REQUIREMENTS.




SECTION - RAISED BIORETENTION PLANTER (A)

| NOTES | | W/PARKING PLAN SECTIONS | | W/O PARKING PLAN SECTIONS | | BULBOUT ALT 1 | ALT 2 | ALT 3 | ALT 4 | ALT 5 | ALT 6 | PARCEL APPLICATIONS NOTES | | PLAN | | SECTIONS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BP 1.1 | BP 1.2 | BP 2.1 | BP 2.2 | BP 3.1 | BP 3.2 | BP 4.1 | BP 4.2 | BP 4.3 | BP 4.4 | BP 4.5 | BP 4.6 | BP 5.1 | BP 5.2 | BP 5.3 | BP 5.4 | BP 5.5 | BP 5.6 | BP 5.7 |

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# GREEN INFRASTRUCTURE TYPICAL DETAILS

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REVISED

# BIORETENTION PLANTER

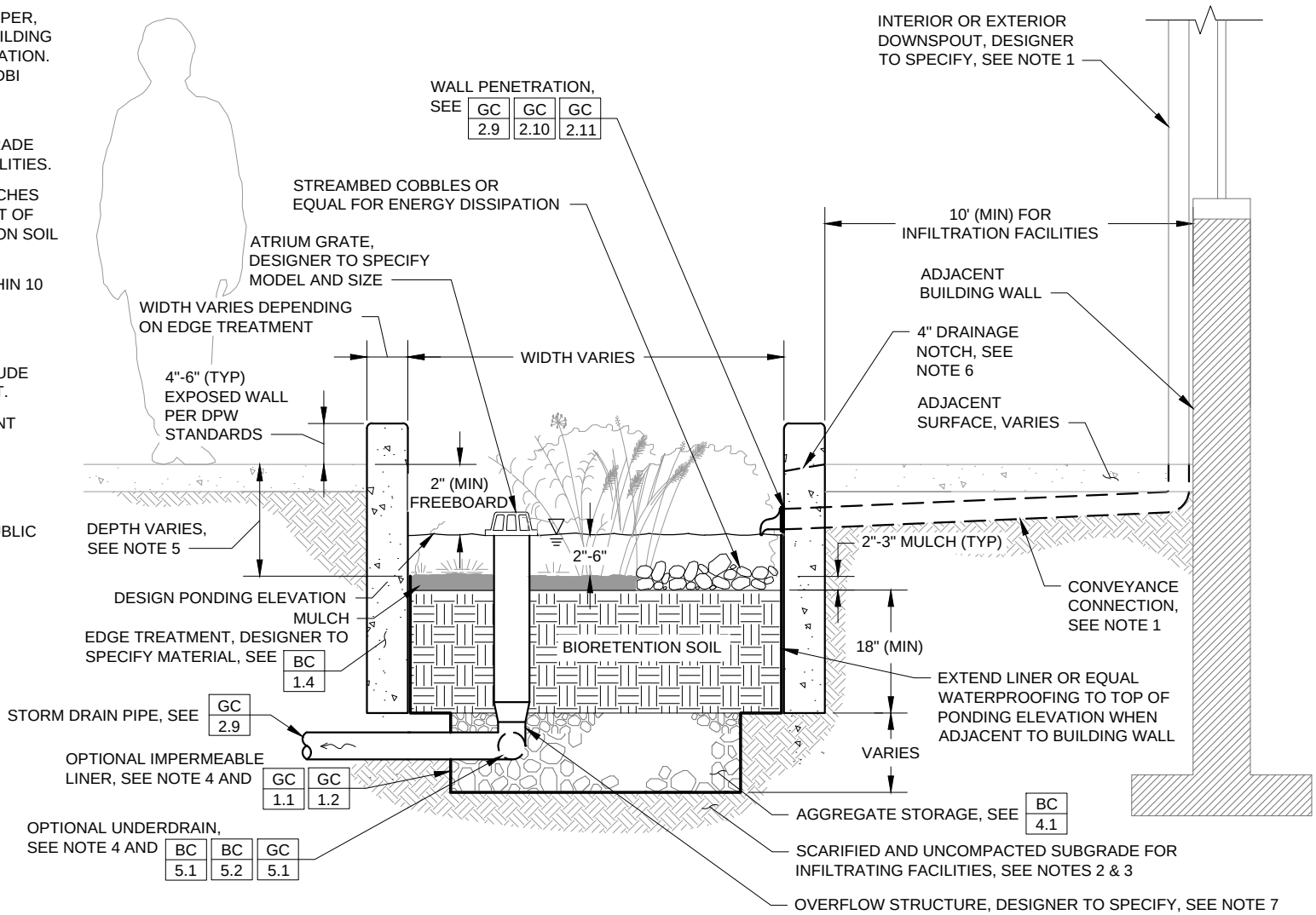
## PARCEL PLANTER
## RAISED PLANTER SECTION

DWG NO. BP 5.5

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

## CONSTRUCTION NOTES:

1. INSTALL DOWNSPOUTS AND OTHER CONVEYANCE CONNECTIONS (E.G. SCUPPER, CHANNEL, OVERHEAD RUNNEL) FROM BUILDING TO DRAIN ABOVE DESIGN PONDING ELEVATION. REFER TO APPLICABLE SAN FRANCISCO DBI CODES FOR CONVEYANCE CONNECTION REQUIREMENTS.
2. AVOID COMPACTION OF EXISTING SUBGRADE BELOW PLANTER FOR INFILTRATION FACILITIES.
3. SCARIFY SUBGRADE TO A DEPTH OF 3 INCHES (MIN) IMMEDIATELY PRIOR TO PLACEMENT OF AGGREGATE STORAGE AND BIORETENTION SOIL MATERIALS.
4. UNDERDRAIN AND LINER REQUIRED WITHIN 10 FEET OF BUILDING ENVELOPE UNLESS APPROVED PER DESIGNER.
5. MAXIMUM DROP FROM TOP OF WALKING SURFACE TO TOP OF MULCH SHALL INCLUDE CONSIDERATIONS FOR SOIL SETTLEMENT.
6. LAY OUT DRAINAGE NOTCHES TO PREVENT PONDING BEHIND PLANTER WALL. SLOPE NOTCHES TO DRAIN TO PLANTER.
7. OVERFLOW STRUCTURE (MATERIAL AND WORKMANSHIP) SHALL CONFORM TO APPLICABLE SAN FRANCISCO DBI AND PUBLIC WORKS CODES AND REQUIREMENTS.




SECTION - SURFACE BIORETENTION PLANTER (B)

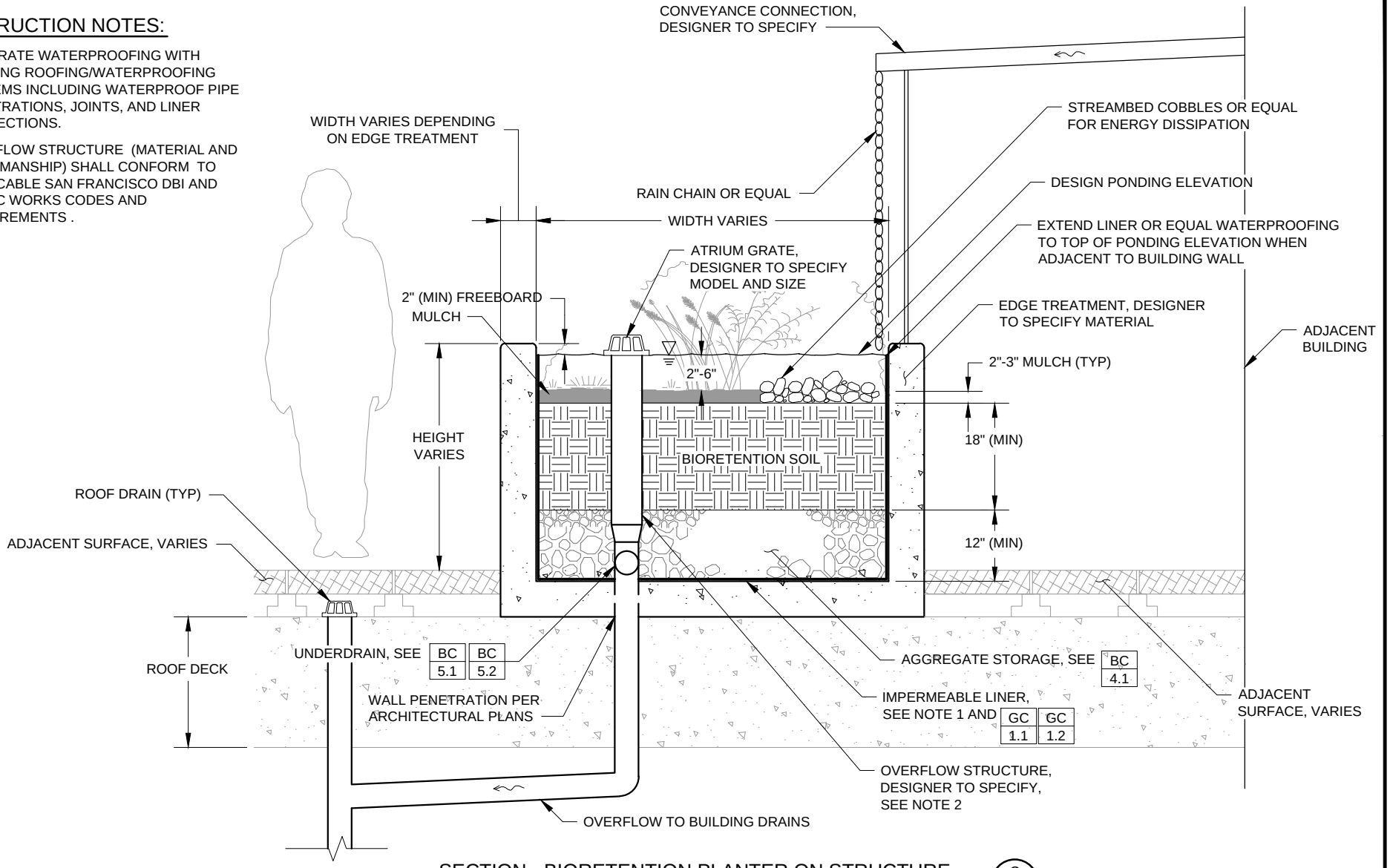
| NOTES | | W/PARKING PLAN SECTIONS | | W/O PARKING PLAN SECTIONS | | BULBOUT ALT 1 | ALT 2 | ALT 3 | ALT 4 | ALT 5 | ALT 6 | PARCEL APPLICATIONS NOTES | | PLAN | | SECTIONS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BP 1.1 | BP 1.2 | BP 2.1 | BP 2.2 | BP 3.1 | BP 3.2 | BP 4.1 | BP 4.2 | BP 4.3 | BP 4.4 | BP 4.5 | BP 4.6 | BP 5.1 | BP 5.2 | BP 5.3 | BP 5.4 | BP 5.5 | BP 5.6 | BP 5.7 |

| | | | | |
|---|---|---|---|---|
| San Francisco Water Power Sewer | GREEN INFRASTRUCTURE TYPICAL DETAILS<br>SAN FRANCISCO PUBLIC UTILITIES COMMISSION | DATE SEPTEMBER 2016<br>VERSION 2.0<br>REVISED | BIORETENTION PLANTER<br>PARCEL PLANTER<br>AT-GRADE PLANTER SECTION | DWG NO. BP 5.6 |

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

## CONSTRUCTION NOTES:

1. INTEGRATE WATERPROOFING WITH BUILDING ROOFING/WATERPROOFING SYSTEMS INCLUDING WATERPROOF PIPE PENETRATIONS, JOINTS, AND LINER CONNECTIONS.
2. OVERFLOW STRUCTURE (MATERIAL AND WORKMANSHIP) SHALL CONFORM TO APPLICABLE SAN FRANCISCO DBI AND PUBLIC WORKS CODES AND REQUIREMENTS .




## SECTION - BIORETENTION PLANTER ON STRUCTURE (C)

| NOTES | | W/PARKING | | W/O PARKING | | BULBOUT | | | | | | PARCEL APPLICATIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PLAN SECTIONS | | PLAN SECTIONS | | ALT 1 | ALT 2 | ALT 3 | ALT 4 | ALT 5 | ALT 6 | NOTES | | PLAN | | SECTIONS | |
| BP 1.1 | BP 1.2 | BP 2.1 | BP 2.2 | BP 3.1 | BP 3.2 | BP 4.1 | BP 4.2 | BP 4.3 | BP 4.4 | BP 4.5 | BP 4.6 | BP 5.1 | BP 5.2 | BP 5.3 | BP 5.4 | BP 5.5 | BP 5.6 | BP 5.7 |

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

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# BIORETENTION PLANTER

## PARCEL PLANTER
## PLANTER ON STRUCTURE SECTION

DWG NO. BP 5.7

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

## PURPOSE:

BIORETENTION BASINS CONTROL PEAK FLOWS AND VOLUMES OF STORMWATER RUNOFF BY PROVIDING SURFACE, SUBSURFACE STORAGE AND INFILTRATION INTO NATIVE SOIL. WATER IS ALSO TREATED AS IT FILTERS THROUGH THE BIORETENTION SOIL.

## DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT PLAN AND SECTION DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. FACILITY AREA, PONDING DEPTH, BIORETENTION SOIL DEPTH, AND AGGREGATE STORAGE DEPTH MUST BE SIZED TO MEET PROJECT HYDROLOGIC PERFORMANCE GOALS.
3. PONDING AND BIORETENTIONSOIL DRAWDOWN TIME (I.E., TIME FOR MAXIMUM SURFACE PONDING TO DRAIN THROUGH THE BIORETENTION SOIL AFTER THE END OF A STORM) RECOMMENDATIONS:
   - 3 - 12 HOUR PONDING AND BIORETENTION SOIL DRAWDOWN (TYPICAL)
   - 24 HOUR MAXIMUM PONDING AND BIORETENTION SOIL DRAWDOWN
4. FACILITY DRAWDOWN TIME (I.E., TIME FOR SURFACE PONDING TO DRAIN THROUGH THE ENTIRE SECTION INCLUDING AGGREGATE STORAGE AFTER THE END OF A STORM) REQUIREMENTS:
   - 48 HOUR MAXIMUM FACILITY DRAWDOWN (i.e.ORFICE CONTROLLED SYSTEM OR EXTENDED STORAGE DEPTH WITHIN INFILTRATION SYSTEM).
5. AN AGGREGATE COURSE IS REQUIRED UNDER THE BIORETENTION SOIL FOR BIORETENTION IN SEPARATE SEWER SYSTEM AREAS TO PROVIDE ADDITIONAL TREATMENT. THIS AGGREGATE COURSE IS OPTIONAL FOR FACILITIES IN COMBINED SEWER SYSTEM AREAS. SEE GUIDANCE ON **BC 4.1**.
6. CHECK DAMS MAY BE USED TO TERRACE FACILITIES TO PROVIDE SUFFICIENT PONDING FOR HIGHER-SLOPED INSTALLATIONS. DESIGNER MUST SPECIFY CHECK DAM HEIGHT AND SPACING. REFER TO **BC 6.1** AND **BC 6.2** FOR GUIDANCE ON CHECK DAM DESIGN.
7. THE FOLLOWING GUIDELINES APPLY TO RIGHT-OF-WAY APPLICATIONS:
   - BULBOUT CURB TRANSITIONS SHALL CONFORM TO DPW STANDARD PLAN 87,175.
   - WHEN FACILITY CONSTRUCTION IMPACTS EXISTING SIDEWALK, ALL SAW CUTS MUST ADHERE TO SFPUC REQUIREMENTS. SAW CUTS SHOULD BE ALONG SCORE LINES AND ANY DISTURBED SIDEWALK FLAGS SHOULD BE REPLACED IN THEIR ENTIRETY.
   - DESIGNER TO SPECIFY TRANSITION OF PLANTER TO TOP OF CURB ELEVATION BETWEEN CURB CUTS OR CONTINUOUS 6 INCH REVEAL AT CURB EDGE.
8. UP TO TWO PLANTERS MAY BE CONNECTED IN SERIES, IN LIEU OF MULTIPLE INLETS, PROVIDED THE CONNECTION IS A TRENCH DRAIN OR EQUAL SURFACE CONVEYANCE AND IS ADEQUATELY SIZED TO CONVEY FLOWS.
9. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT SFPUC ASSET PROTECTION STANDARDS AND OTHER UTILITY PROVIDERS REQUIREMENTS. SEE UTILITY CROSSINGS (**GC 2.1 - GC 2.12**) AND UTILITY CONFLICTS (**GC 4.1 - GC 4.4**).

| RELATED SPECIFICATIONS | CSI NO. |
|---|---|
| **BIORETENTION:**<br>- BIORETENTION SOIL MIX<br>- AGGREGATE STORAGE<br>- MULCH<br>- STREAMBED COBBLES | 33 47 27 |

## DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ FACILITY WIDTH, LENGTH, SLOPES (INCLUDING SIDE, CROSS, AND LONGITUDINAL), AND SHAPE
- ☐ DEPTH OF BIORETENTION SOIL
- ☐ DEPTH AND TYPE OF GRAVEL STORAGE, IF ANY
- ☐ PLANTER SURFACE ELEVATION (TOP OF BIORETENTION SOIL) AT UPSLOPE AND DOWNSLOPE ENDS OF FACILITY
- ☐ CONTROL POINTS AT EVERY CORNER OF FACILITY AND POINT OF TANGENCY
- ☐ DIMENSIONS AND DISTANCE TO EVERY INLET, OUTLET, CHECK DAM, SIDEWALK NOTCH, ETC.
- ☐ ELEVATIONS OF EVERY INLET, OUTLET, STRUCTURE RIM AND INVERT, CHECK DAM, AND SIDEWALK NOTCH
- ☐ TYPE AND DESIGN OF FACILITY COMPONENTS (E.G., EDGE TREATMENTS, INLETS/GUTTER MODIFICATIONS, UTILITY CROSSINGS, LINER, AND PLANTING DETAILS)

| RELATED COMPONENTS | |
|---|---|
| EDGE TREATMENTS: | BC 1.1 - BC 1.7 |
| INLETS: | BC 2.1 - BC 2.4 |
| OUTLETS: | BC 3.1 - BC 3.4 |
| AGGREGATE STORAGE: | BC 4.1 |
| UNDERDRAINS: | BC 5.1 - BC 5.2 |
| CHECK DAMS: | BC 6.1 - BC 6.2 |
| LINERS: | GC 1.1 - GC 1.2 |
| UTILITY CROSSINGS: | GC 2.1 - GC 2.12 |
| OBSERVATION PORTS: | GC 3.1 - GC 3.3 |
| UTILITY CONFLICTS: | GC 4.1 - GC 4.4 |
| CLEANOUTS: | GC 5.2 |

## LAYOUT REQUIREMENTS:

1. FOR RIGHT-OF-WAY APPLICATIONS, REFER TO THE SAN FRANCISCO STANDARD ACCESSIBILITY REQUIREMENTS IN THE SAN FRANCISCO DPW SIDEWALK LANDSCAPING REFERENCE DRAWINGS AND SPECIFICATIONS FOR CONSTRUCTION FOR COURTESY STRIP, THROUGHWAY, PARKING SPACE AND ACCESSIBLE PATH REQUIREMENTS.
2. LOCATE CURB CUTS AND GUTTER MODIFICATIONS TO AVOID CONFLICTS WITH ACCESSIBILITY REQUIREMENTS (E.G., LOCATE OUTSIDE OF CROSSWALKS).

NOTES: BB 1.1 | SECTIONS: BB 2.1, BB 2.2

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE: SEPTEMBER 2016
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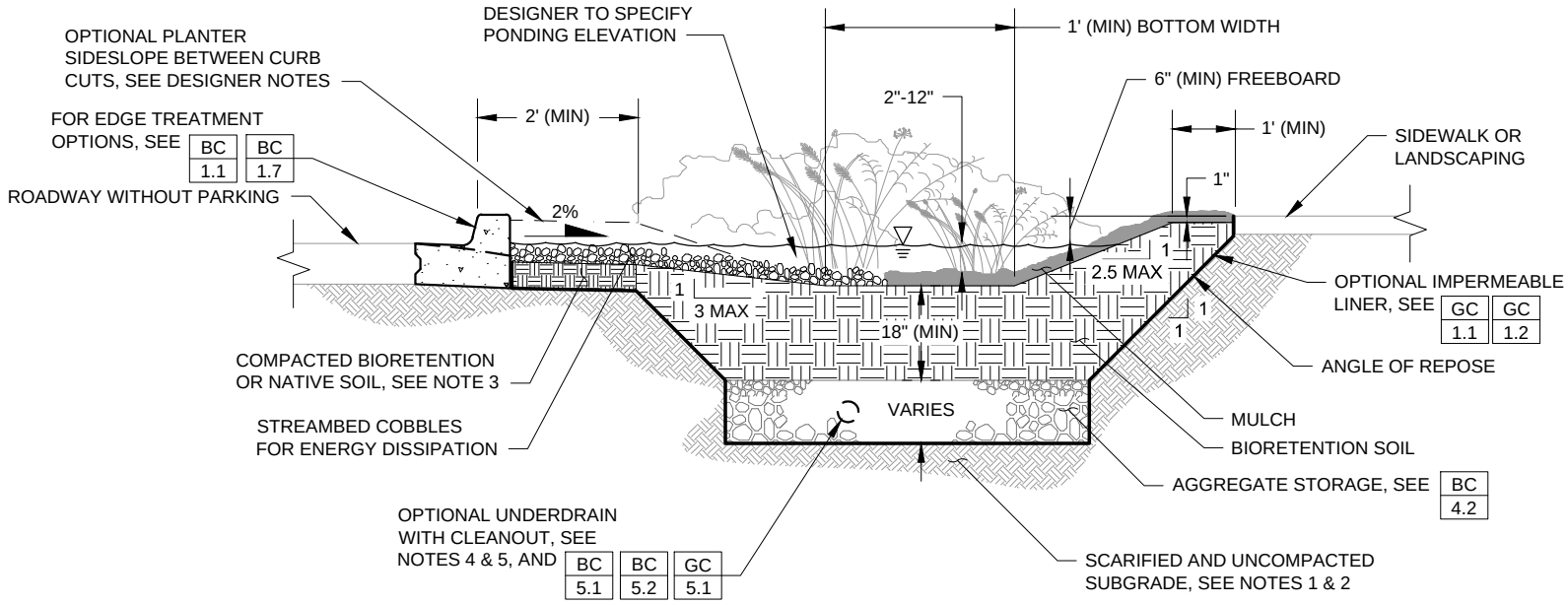
REVISED:

# BIORETENTION BASIN
## DESIGNER NOTES

DWG NO. BB 1.1




## CONSTRUCTION NOTES:

1. AVOID COMPACTION OF EXISTING SUBGRADE BELOW BASIN.
2. SCARIFY SUBGRADE TO A DEPTH OF 3 INCHES (MIN) IMMEDIATELY PRIOR TO PLACEMENT OF AGGREGATE STORAGE AND BIORETENTION SOIL MATERIALS.
3. COMPACT BIORETENTION SOIL IMMEDIATELY BEHIND CURB TO 90% OF MAXIMUM DENSITY PER STANDARD PROCTOR TEST (ASTM D698).
4. UNDERDRAIN REQUIRED FOR ALL FACILITIES WITH IMPERMEABLE LINER.
5. PROVIDE ONE CLEANOUT PER PLANTER (MIN) FOR FACILITIES WITH UNDERDRAINS.
6. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT SFPUC ASSET PROTECTION STANDARDS. COORDINATE WITH ENGINEER IN THE EVENT OF UTILITY CROSSING AND UTILITY CONFLICTS.



NOTES: BB 1.1
SECTIONS: BB 2.1 | BB 2.2

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

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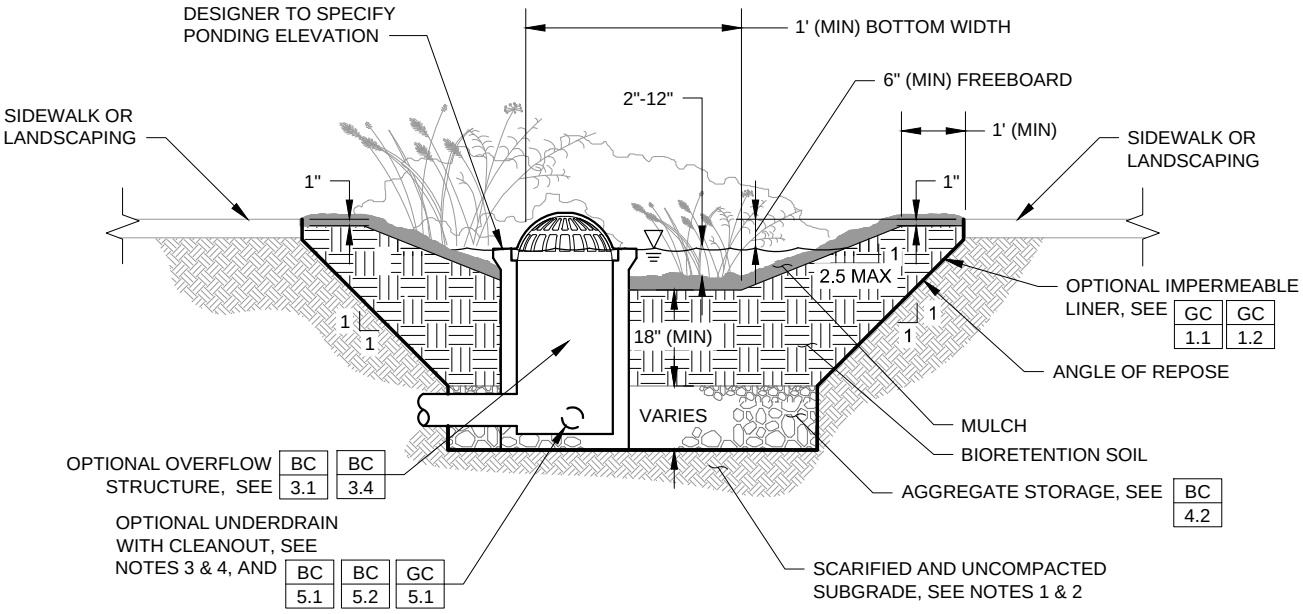
# BIORETENTION BASIN

## ROADSIDE SECTION

DWG NO. BB 2.1




## CONSTRUCTION NOTES:

1. AVOID COMPACTION OF EXISTING SUBGRADE BELOW BASIN.
2. SCARIFY SUBGRADE TO A DEPTH OF 3 INCHES (MIN) IMMEDIATELY PRIOR TO PLACEMENT OF AGGREGATE STORAGE AND BIORETENTION SOIL MATERIALS.
3. UNDERDRAIN REQUIRED FOR ALL FACILITIES WITH IMPERMEABLE LINER.
4. PROVIDE ONE CLEANOUT PER PLANTER (MIN) FOR FACILITIES WITH UNDERDRAINS.
5. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT SFPUC ASSET PROTECTION STANDARDS. COORDINATE WITH ENGINEER IN THE EVENT OF UTILITY CROSSING AND UTILITY CONFLICTS.

| NOTES | SECTIONS | |
|---|---|---|
| BB 1.1 | BB 2.1 | BB 2.2 |



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# GREEN INFRASTRUCTURE TYPICAL DETAILS

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# BIORETENTION BASIN

## PARCEL SECTION

DWG NO. BB 2.2

## PURPOSE:

EDGE TREATMENTS ARE USED TO DEFINE THE BOUNDARIES OF A BIORETENTION FACILITY AND ARE INTENDED PRIMARILY TO STABILIZE THE EDGE OF ADJACENT PAVEMENT AND MINIMIZE LATERAL MOVEMENT OF WATER, AS APPLICABLE. IN CASES WHERE ADEQUATE SPACE IS AVAILABLE, THE FACILITY SIDESLOPE CAN BE LAID BACK SUCH THAT THE SURROUNDING NATIVE SOIL IS STABLE AND CAN FUNCTION AS THE FACILITY EDGE TREATMENT. HOWEVER, WHEN SPACE IS LIMITED, EDGE TREATMENTS SUCH AS VERTICAL WALLS MAY BE USED TO MAINTAIN THE STRUCTURAL INTEGRITY OF THE SURROUNDING SURFACES. THESE EDGE TREATMENTS RETAIN STORMWATER WITHIN THE FACILITY (AND OUT OF THE SURROUNDING PAVEMENT SECTIONS, AS APPLICABLE) UNTIL WATER INFILTRATES, IS COLLECTED BY THE UNDERDRAIN, OR OVERFLOWS VIA THE DESIGNATED OUTLETS.

## DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. MINIMUM EDGE TREATMENT EMBEDMENT DEPTHS ARE SPECIFIED TO PREVENT LATERAL SEEPAGE UNDER THE EDGE TREATMENT AND INTO ADJACENT PAVEMENT SECTIONS, AS APPLICABLE.
3. DESIGNER MAY ELIMINATE CONSTRUCTION BENCH TO INCREASE EFFECTIVE FACILITY AREA (I.E. INFILTRATION AND STORAGE FOOTPRINT) PROVIDED PLANTER WALL EXTENDS TO BOTTOM OF AGGREGATE STORAGE.
4. DESIGNER MAY SPECIFY ALTERNATIVE MATERIAL TYPE FOR EDGE TREATMENTS PROVIDED MATERIAL MEETS STRUCTURAL REQUIREMENTS FOR LOADING CONDITIONS, SERVES AS A WATER BARRIER BETWEEN THE FACILITY AND ADJACENT PAVEMENT SECTIONS (AS APPLICABLE), AND COMPLIES WITH SAN FRANCISCO DPW STANDARD ACCESSIBILITY REQUIREMENTS.
5. FOOTING OR LATERAL BRACING SHALL BE PROVIDED FOR ALL PLANTER WALLS UNLESS THE DESIGNER DEMONSTRATES THAT THE PROPOSED WALL DESIGN MEETS LOADING REQUIREMENTS.
6. FOOTINGS AND LATERAL BRACING SHALL BE DESIGNED TO WITHSTAND ANTICIPATED LOADING ASSUMING NO REACTIVE FORCES FROM THE UNCOMPACTED BIORETENTION SOIL WITHIN THE FACILITY.
7. LATERAL BRACING SHALL MEET HYDROLOGIC AND HYDRAULIC DESIGN REQUIREMENTS FOR CHECK DAMS WHEN USED AS CHECK DAMS. SEE **BC 6.1**.
8. PLANTER WALLS EXTENDING MORE THAN 36 INCHES BELOW ADJACENT LOAD-BEARING SURFACE, OR WHEN LOCATED ADJACENT TO PAVERS, MUST HAVE FOOTING OR LATERAL BRACING. SEE **BC 1.5**

## DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ EDGE TREATMENT TYPE AND MATERIAL
- ☐ EDGE TREATMENT WIDTH AND HEIGHT
- ☐ EMBEDMENT DEPTH INTO SUBGRADE SOILS
- ☐ LATERAL BRACING/FOOTING REQUIREMENTS
- ☐ PIPE MATERIAL AND DIAMETER FOR ALL WALL PENETRATIONS
- ☐ WATER TIGHT CONNECTOR TYPE FOR ALL WALL PENETRATIONS (E.G., GROUTED, COMPRESSION, BOOT) SEE **GC 2.9** AND **GC 2.10**.
- ☐ ELEVATIONS - INLET, OUTLET, OVERFLOW STRUCTURE (RIM & INVERT), CLEANOUT (RIM & INVERT)
- ☐ ELEVATIONS - TOP OF SLOPE AND TOE OF SLOPE

| EDGE TREATMENTS | | | | | | | | INLETS | | | | OUTLETS | | | | AGGREGATE STORAGE COMPONENTS | UNDERDRAINS | | CHECK DAM | | MONITORING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | COMPONENTS | | | | | | | NOTES | COMPONENTS | | | NOTES | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | |
| BC 1.1 | BC 1.2 | BC 1.3 | BC 1.4 | BC 1.5 | BC 1.6 | BC 1.7 | | BC 2.1 | BC 2.2 | BC 2.3 | BC 2.4 | BC 3.1 | BC 3.2 | BC 3.3 | BC 3.4 | BC 4.1 | BC 5.1 | BC 5.2 | BC 6.1 | BC 6.2 | BC 7.1 | BC 7.2 | BC 7.3 |



San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

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DATE: SEPTEMBER 2016

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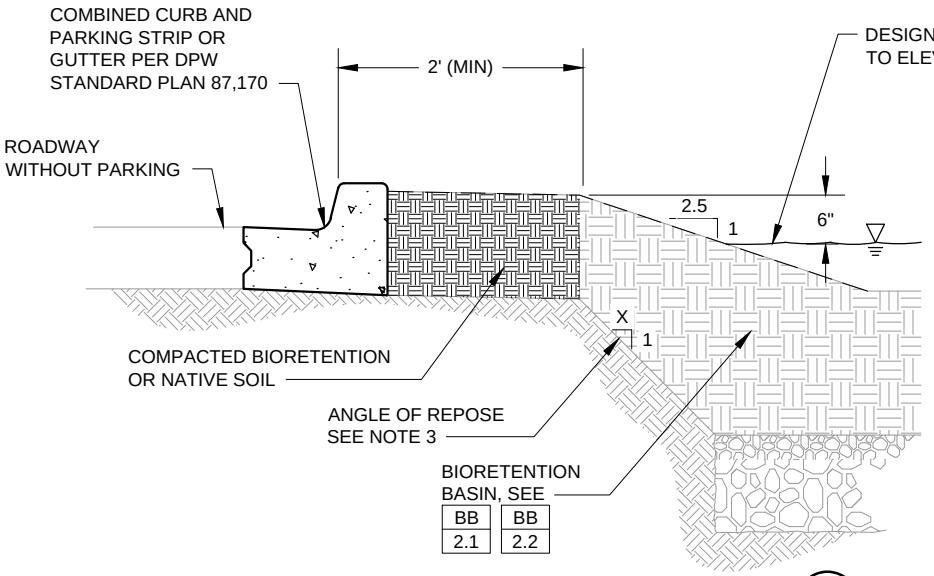
# BIORETENTION COMPONENTS

## EDGE TREATMENTS DESIGNER NOTES

DWG NO. BC 1.1




STANDARD CURB EDGE AT BIORETENTION BASIN 1

## CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR EDGE TREATMENTS SHALL CONFORM TO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. COMPACT BIORETENTION OR NATIVE SOIL TO 90% OF MAXIMUM DENSITY PER STANDARD PROCTOR TEST (ASTM D698).
3. ANGLE OF REPOSE VARIES PER GEOTECHNICAL ENGINEERS RECOMMENDATIONS.

| EDGE TREATMENTS | | | | | | | | INLETS | | | | OUTLETS | | | | AGGREGATE STORAGE COMPONENTS | UNDERDRAINS | | CHECK DAM | | MONITORING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | COMPONENTS | | | | | | | NOTES | COMPONENTS | | | NOTES | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | |
| BC 1.1 | BC 1.2 | BC 1.3 | BC 1.4 | BC 1.5 | BC 1.6 | BC 1.7 | | BC 2.1 | BC 2.2 | BC 2.3 | BC 2.4 | BC 3.1 | BC 3.2 | BC 3.3 | BC 3.4 | BC 4.1 | BC 5.1 | BC 5.2 | BC 6.1 | BC 6.2 | BC 7.1 | BC 7.2 | BC 7.3 |

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

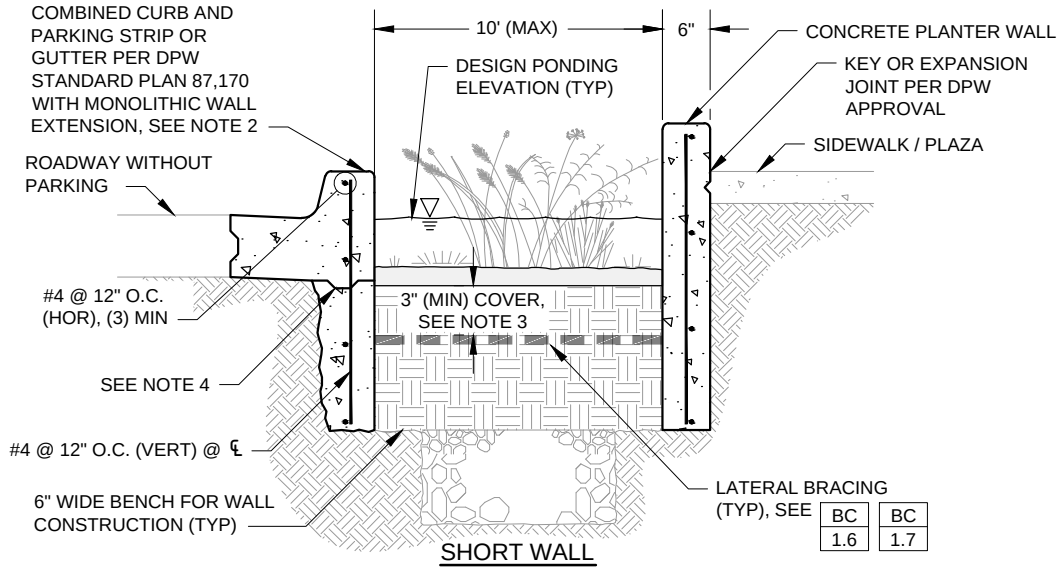
DATE: SEPTEMBER 2016
VERSION: 2.0
REVISED:

# BIORETENTION COMPONENTS

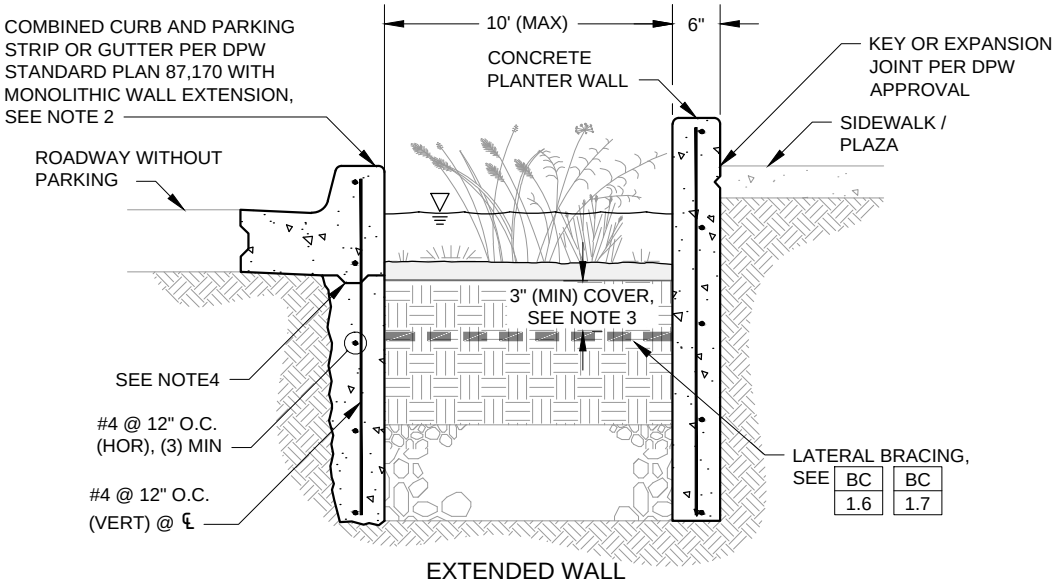
## EDGE TREATMENTS
## VEHICULAR APPLICATIONS (1 OF 2)

DWG NO. BC 1.2

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

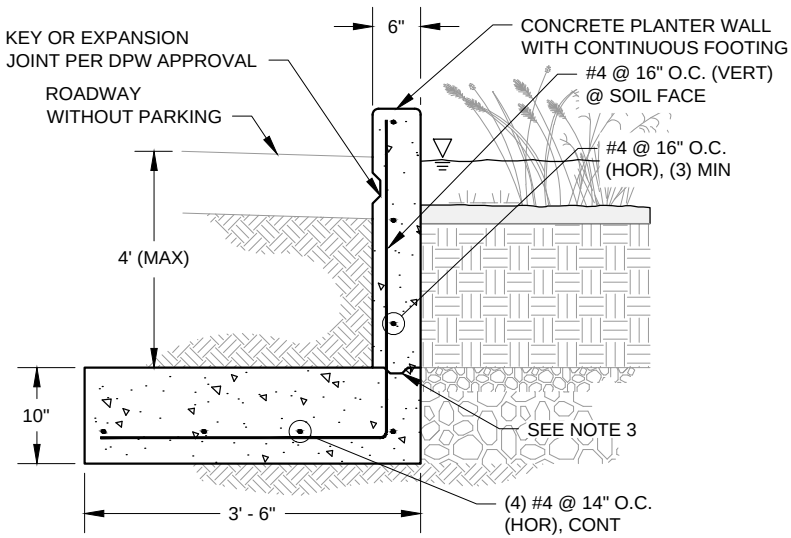



SHORT WALL




EXTENDED WALL

PLANTER WALL WITH LATERAL BRACING 1




PLANTER WALL WITH CONTINUOUS FOOTING 2

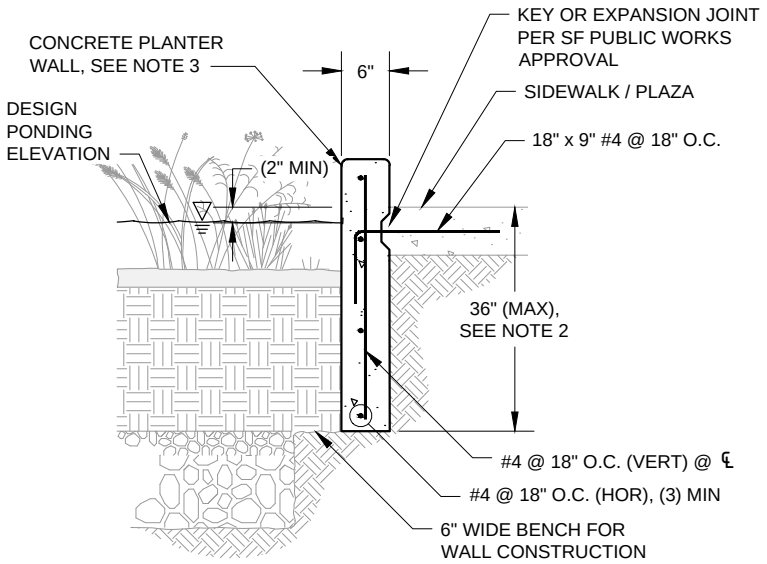
## CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR EDGE TREATMENTS SHALL CONFORM TO SAN FRANCISCO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. ALL PLANTER WALLS SHALL EXTEND TO BOTTOM OF BIORETENTION SOIL OR DEEPER.
3. CONTRACTOR TO PROVIDE 3 INCH MINIMUM COVER OVER ALL LATERAL BRACING FOR PLANT ESTABLISHMENT.
4. ALL CONSTRUCTION COLD JOINTS SHALL INCORPORATE EPOXY, DOWEL/TIE BAR, KEYWAY, OR WATER STOP.

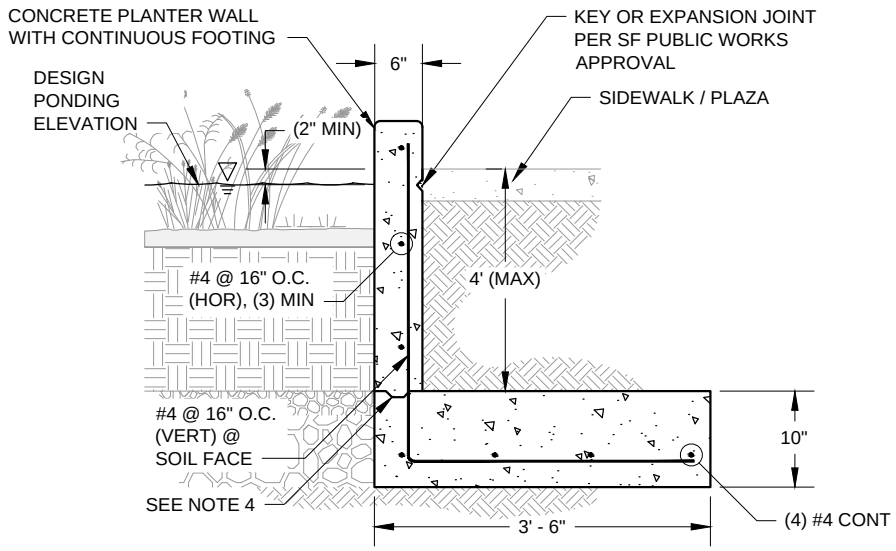
| EDGE TREATMENTS | | | | | | | | INLETS | | | | OUTLETS | | | | AGGREGATE STORAGE | UNDERDRAINS | | CHECK DAM | | MONITORING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | COMPONENTS | | | | | | | NOTES | COMPONENTS | | | NOTES | COMPONENTS | | | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | |
| BC 1.1 | BC 1.2 | BC 1.3 | BC 1.4 | BC 1.5 | BC 1.6 | BC 1.7 | | BC 2.1 | BC 2.2 | BC 2.3 | BC 2.4 | BC 3.1 | BC 3.2 | BC 3.3 | BC 3.4 | BC 4.1 | BC 5.1 | BC 5.2 | BC 6.1 | BC 6.2 | BC 7.1 | BC 7.2 | BC 7.3 |

| | | | |
|---|---|---|---|
| San Francisco Water Power Sewer | GREEN INFRASTRUCTURE TYPICAL DETAILS<br>SAN FRANCISCO PUBLIC UTILITIES COMMISSION | DATE SEPTEMBER 2016<br>VERSION 2.0<br>REVISED | BIORETENTION COMPONENTS<br>EDGE TREATMENTS<br>VEHICULAR APPLICATIONS (2 OF 2) |
| | | | DWG NO. BC 1.3 |

NOT FOR CONSTRUCTION - REFER TO USER GUIDE




PLANTER WALL - PARCEL ONLY 1




PLANTER WALL WITH CONTINUOUS FOOTING 2

## CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR EDGE TREATMENTS SHALL CONFORM TO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. PLANTER WALLS EXTENDING MORE THAN 36 INCHES BELOW ADJACENT LOAD-BEARING SURFACE, OR WHEN LOCATED ADJACENT TO PAVERS, MUST HAVE FOOTING OR LATERAL BRACING. COORDINATE WITH ENGINEER.
3. ALL PLANTER WALLS SHALL EXTEND TO BOTTOM OF BIORETENTION SOIL OR DEEPER.
4. ALL CONSTRUCTION COLD JOINTS SHALL INCORPORATE EPOXY, DOWEL/TIE BAR, KEYWAY, OR WATER STOP.

| EDGE TREATMENTS | | | | | | | INLETS | | | | OUTLETS | | | | AGGREGATE STORAGE | UNDERDRAINS | | CHECK DAM | | MONITORING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | COMPONENTS | | | | | | NOTES | COMPONENTS | | | NOTES | COMPONENTS | | | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | |
| BC 1.1 | BC 1.2 | BC 1.3 | BC 1.4 | BC 1.5 | BC 1.6 | BC 1.7 | BC 2.1 | BC 2.2 | BC 2.3 | BC 2.4 | BC 3.1 | BC 3.2 | BC 3.3 | BC 3.4 | BC 4.1 | BC 5.1 | BC 5.2 | BC 6.1 | BC 6.2 | BC 7.1 | BC 7.2 | BC 7.3 |

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

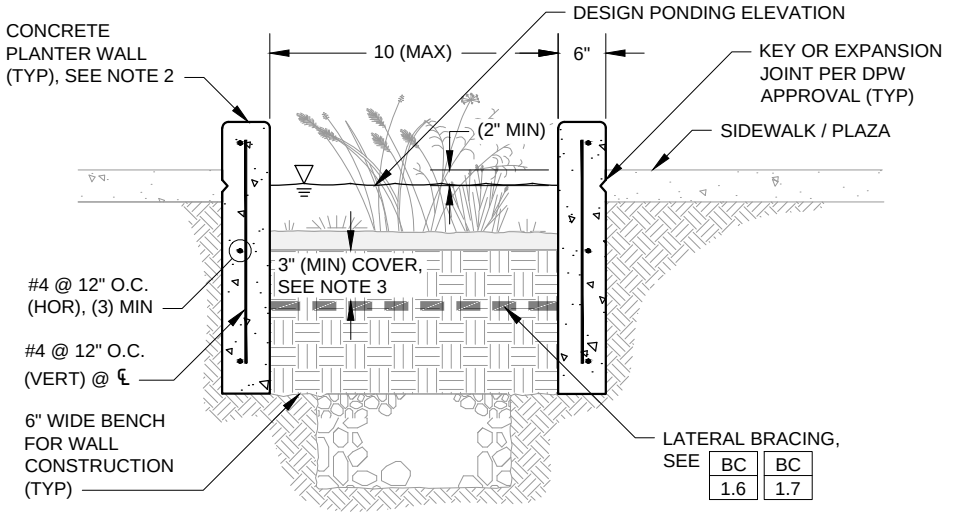
DATE SEPTEMBER 2016
VERSION 2.0
REVISED

# BIORETENTION COMPONENTS

## EDGE TREATMENTS
## PEDESTRIAN APPLICATIONS (1 OF 2)

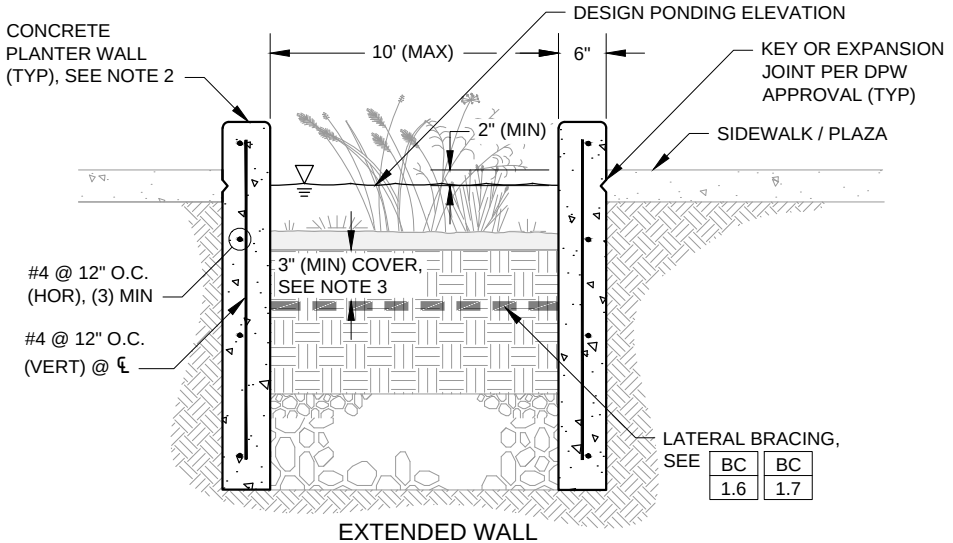
DWG NO. BC 1.4

NOT FOR CONSTRUCTION - REFER TO USER GUIDE




SHORT WALL

PLANTER WALL WITH LATERAL BRACING -SHORT 1




EXTENDED WALL

PLANTER WALL WITH LATERAL BRACING - EXTENDED 2

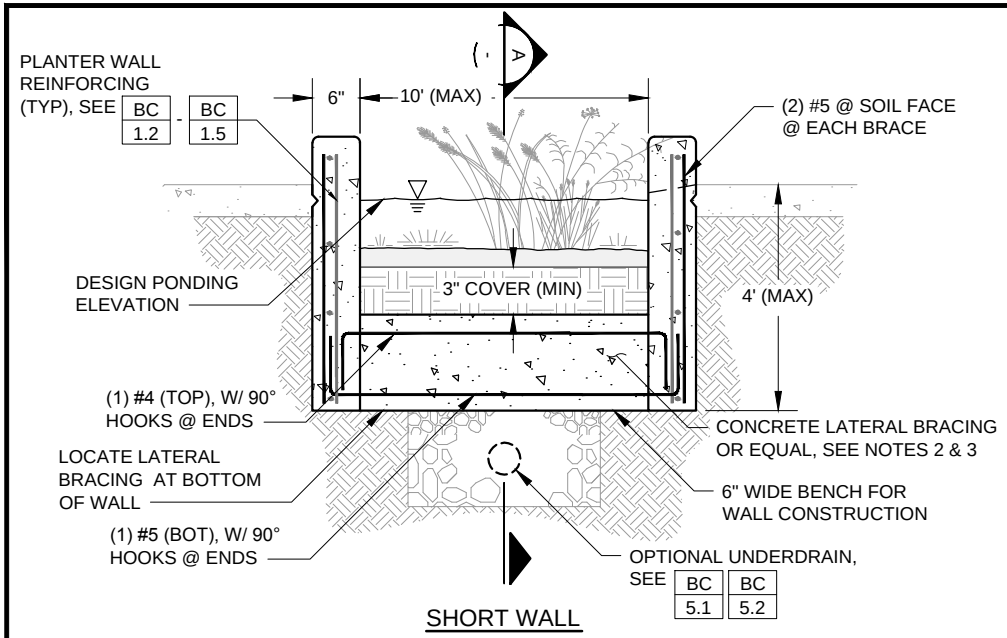
## CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR EDGE TREATMENTS SHALL CONFORM TO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. ALL PLANTER WALLS SHALL EXTEND TO BOTTOM OF BIORETENTION SOIL OR DEEPER.
3. CONTRACTOR TO PROVIDE 3 INCH MINIMUM COVER OVER ALL LATERAL BRACING FOR PLANT ESTABLISHMENT.
4. ALL CONSTRUCTION COLD JOINTS SHALL INCORPORATE EPOXY, DOWEL/TIE BAR, KEYWAY, AND WATER STOP.

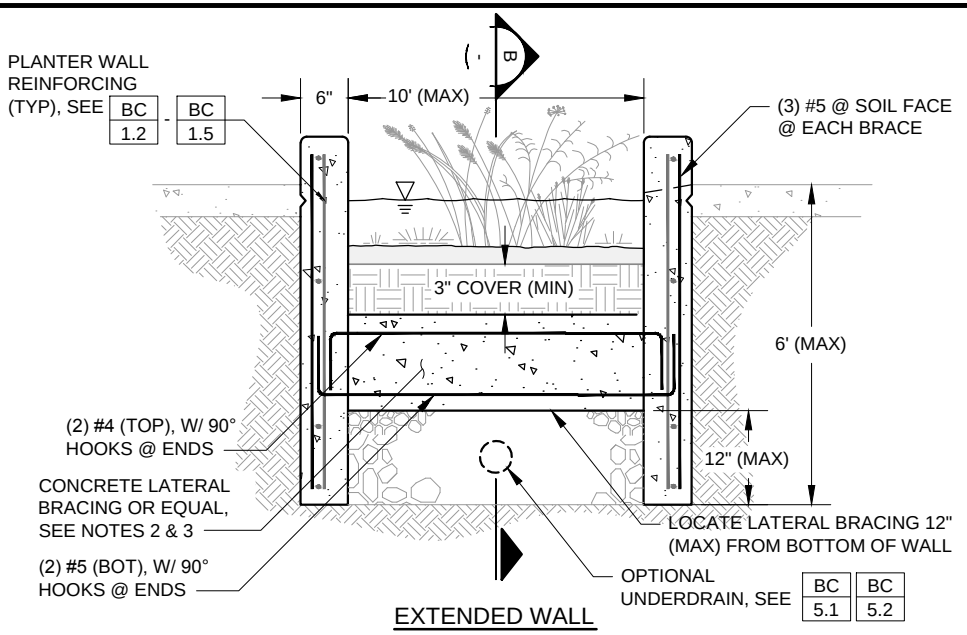
| EDGE TREATMENTS | | | | | | | INLETS | | | | OUTLETS | | | | AGGREGATE STORAGE COMPONENTS | UNDERDRAINS | | CHECK DAM | | MONITORING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | COMPONENTS | | | | | | NOTES | COMPONENTS | | | NOTES | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | |
| BC 1.1 | BC 1.2 | BC 1.3 | BC 1.4 | BC 1.5 | BC 1.6 | BC 1.7 | BC 2.1 | BC 2.2 | BC 2.3 | BC 2.4 | BC 3.1 | BC 3.2 | BC 3.3 | BC 3.4 | BC 4.1 | BC 5.1 | BC 5.2 | BC 6.1 | BC 6.2 | BC 7.1 | BC 7.2 | BC 7.3 |

| | | | |
|---|---|---|---|
| San Francisco Water Power Sewer | GREEN INFRASTRUCTURE TYPICAL DETAILS<br>SAN FRANCISCO PUBLIC UTILITIES COMMISSION | DATE SEPTEMBER 2016<br>VERSION 2.0<br>REVISED | BIORETENTION COMPONENTS<br>EDGE TREATMENTS<br>PEDESTRIAN APPLICATIONS (2 OF 2) | DWG NO. BC 1.5 |

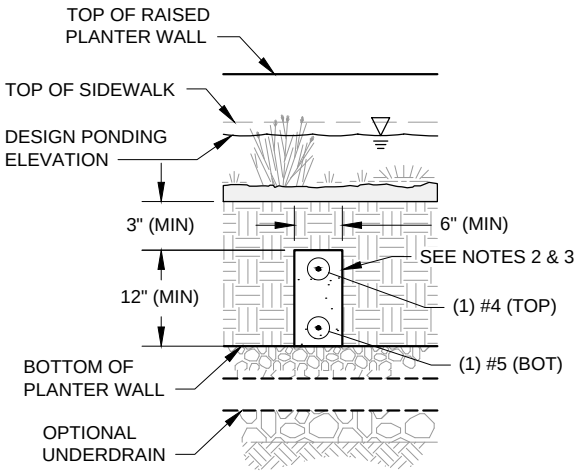
NOT FOR CONSTRUCTION - REFER TO USER GUIDE




SHORT WALL



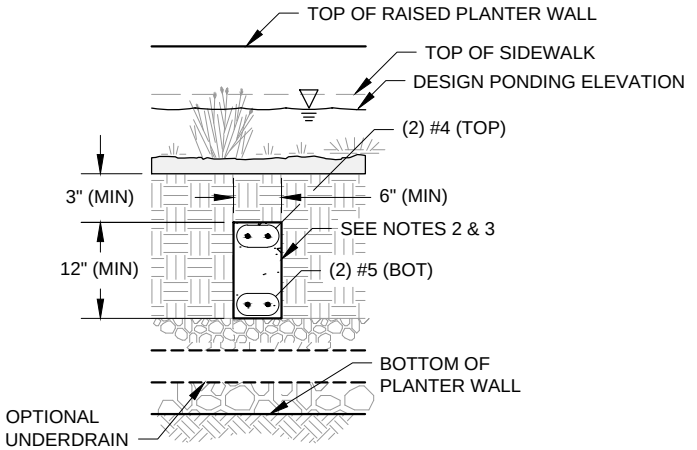

EXTENDED WALL




SECTION A

## CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR LATERAL BRACING SHALL CONFORM TO SAN FRANCISCO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. CONCRETE LATERAL BRACING SHALL BE CONTINUOUS (NO JOINTS).
3. LATERAL BRACING SHALL BE PROVIDED EVERY 6 FEET (MAX) FOR WALLS UP TO 4 FEET IN HEIGHT AND EVERY 4 FEET (MAX) FOR WALLS BETWEEN 4 AND 6 FEET IN HEIGHT.




SECTION B

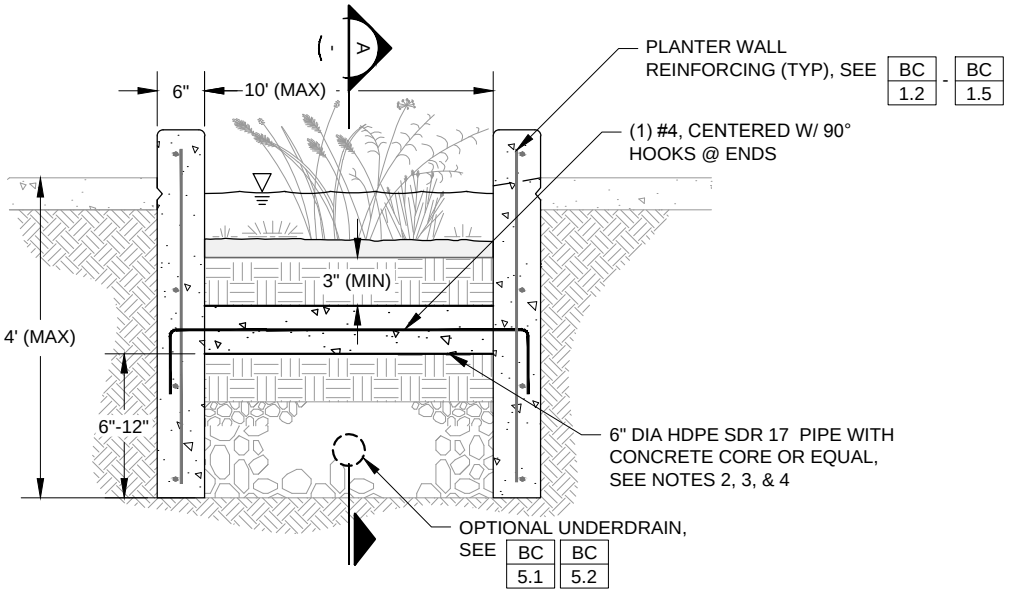
CONCRETE BRACING WALL - SHORT 1

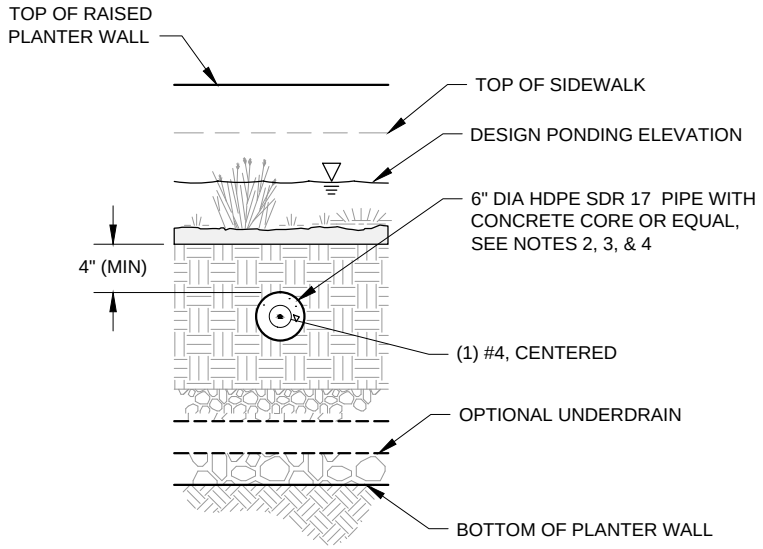
CONCRETE BRACING WALL - EXTENDED 2

| EDGE TREATMENTS | | | | | | | INLETS | | | | OUTLETS | | | | AGGREGATE STORAGE COMPONENTS | UNDERDRAINS | | CHECK DAM | | MONITORING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | COMPONENTS | | | | | | NOTES | COMPONENTS | | | NOTES | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | |
| BC 1.1 | BC 1.2 | BC 1.3 | BC 1.4 | BC 1.5 | BC 1.6 | BC 1.7 | BC 2.1 | BC 2.2 | BC 2.3 | BC 2.4 | BC 3.1 | BC 3.2 | BC 3.3 | BC 3.4 | BC 4.1 | BC 5.1 | BC 5.2 | BC 6.1 | BC 6.2 | BC 7.1 | BC 7.2 | BC 7.3 |

| | | | |
|---|---|---|---|
| San Francisco Water Power Sewer | GREEN INFRASTRUCTURE TYPICAL DETAILS<br>SAN FRANCISCO PUBLIC UTILITIES COMMISSION | DATE SEPTEMBER 2016<br>VERSION 2.0<br>REVISED | BIORETENTION COMPONENTS<br>EDGE TREATMENTS<br>LATERAL BRACING (1 OF 2) | DWG NO. BC 1.6 |

NOT FOR CONSTRUCTION - REFER TO USER GUIDE




SECTION A

## CONCRETE STRUT

1

## CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR LATERAL BRACING STRUCTURES SHALL CONFORM TO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. LATERAL BRACING SHALL BE PROVIDED EVERY 6 FEET (MAX) FOR WALLS UP TO 4 FEET IN HEIGHT.
3. OTHER MATERIALS MAY BE USED IN LIEU OF HDPE PROVIDED MATERIAL IS NON CORROSIVE, NON-LEACHING, AND SCHEDULE 40.
4. PROVIDE 3 INCH CONTINUOUS SLOT ACROSS TOP OF PIPE TO PLACE REINFORCEMENT AND ENSURE STRUT IS FREE OF VOIDS.

| EDGE TREATMENTS | | | | | | | INLETS | | | | OUTLETS | | | | AGGREGATE STORAGE COMPONENTS | UNDERDRAINS | | CHECK DAM | | MONITORING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | COMPONENTS | | | | | | NOTES | COMPONENTS | | | NOTES | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | |
| BC 1.1 | BC 1.2 | BC 1.3 | BC 1.4 | BC 1.5 | BC 1.6 | BC 1.7 | BC 2.1 | BC 2.2 | BC 2.3 | BC 2.4 | BC 3.1 | BC 3.2 | BC 3.3 | BC 3.4 | BC 4.1 | BC 5.1 | BC 5.2 | BC 6.1 | BC 6.2 | BC 7.1 | BC 7.2 | BC 7.3 |

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE: SEPTEMBER 2016
VERSION: 2.0
REVISED:

# BIORETENTION COMPONENTS

## EDGE TREATMENTS
## LATERAL BRACING (2 OF 2)

DWG NO. BC 1.7

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

## PURPOSE:

CURB CUTS AND TRENCH DRAINS SERVE AS INLETS TO CONVEY STORMWATER RUNOFF TO A BIORETENTION FACILITY. CURB CUTS ARE TYPICALLY USED IN PLANTER APPLICATIONS WHEN THE FACILITY IS IMMEDIATELY ADJACENT TO THE ROADWAY (I.E. NO COURTESY STRIP), PROVIDING AN OPENING TO INTERCEPT AND CONVEY STORMWATER FROM THE GUTTER TO THE PLANTER. TRENCH DRAIN SYSTEMS ARE MOST COMMONLY USED TO CONVEY STORMWATER FROM A GUTTER THROUGH THE COURTESY STRIP TO A BIORETENTION PLANTER; PROVIDING A CONTINUOUS SURFACE FOR PEDESTRIAN ACCESS WHILE MINIMIZING ELEVATION LOSSES AT THE FACILITY INFLOW LOCATIONS. CURB CUT AND TRENCH DRAIN INLETS INCLUDE MODIFICATIONS TO THE GUTTER TO HELP DIRECT FLOW INTO THE FACILITY.

## DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. THE DESIGNER MUST ENSURE THAT CURB CUTS AND TRENCH DRAIN INLETS ARE ADEQUATELY SIZED, SPACED, AND SLOPED TO SATISFY SAN FRANCISCO DPW HYDRAULIC REQUIREMENTS. THE CURB CUT OPENING WIDTH MUST BE SIZED BASED ON THE CATCHMENT AREA, LONGITUDINAL SLOPE ALONG THE CURB, AND THE CROSS SLOPE OF THE GUTTER OR ADJACENT PAVEMENT AT THE INLET. SEE SIZING EQUATIONS AND NOMOGRAPHS FOR CURB OPENING INLETS IN THE U.S. DEPARTMENT OF TRANSPORTATION HYDRAULIC ENGINEERING CIRCULAR NO. 27.
3. TRENCH DRAIN GRATES AND ASSEMBLIES MUST COMPLY WITH SAN FRANCISCO DPW STANDARD

## DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ CURB CUT DIMENSIONS
- ☐ FRAME AND GRATE TYPE/MATERIAL AND DIMENSIONS
- ☐ CHANNEL DIMENSIONS
- ☐ CONTROL ELEVATIONS FOR OPENINGS AT GUTTER AND PLANTER WALL

| EDGE TREATMENTS | | | | | | | INLETS | | | | OUTLETS | | | | AGGREGATE STORAGE COMPONENTS | UNDERDRAINS | | CHECK DAM | | MONITORING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | COMPONENTS | | | | | | NOTES | COMPONENTS | | | NOTES | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | |
| BC 1.1 | BC 1.2 | BC 1.3 | BC 1.4 | BC 1.5 | BC 1.6 | BC 1.7 | BC 2.1 | BC 2.2 | BC 2.3 | BC 2.4 | BC 3.1 | BC 3.2 | BC 3.3 | BC 3.4 | BC 4.1 | BC 5.1 | BC 5.2 | BC 6.1 | BC 6.2 | BC 7.1 | BC 7.2 | BC 7.3 |

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE: SEPTEMBER 2016

VERSION: 2.0

REVISED:

# BIORETENTION COMPONENTS

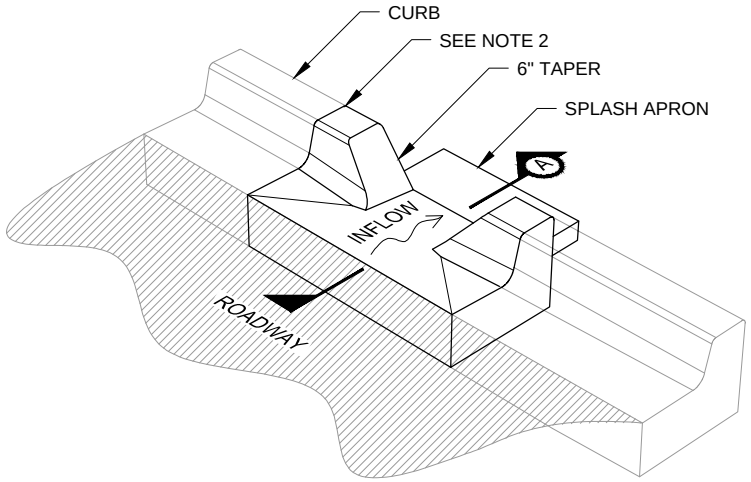
## INLETS

## DESIGNER NOTES

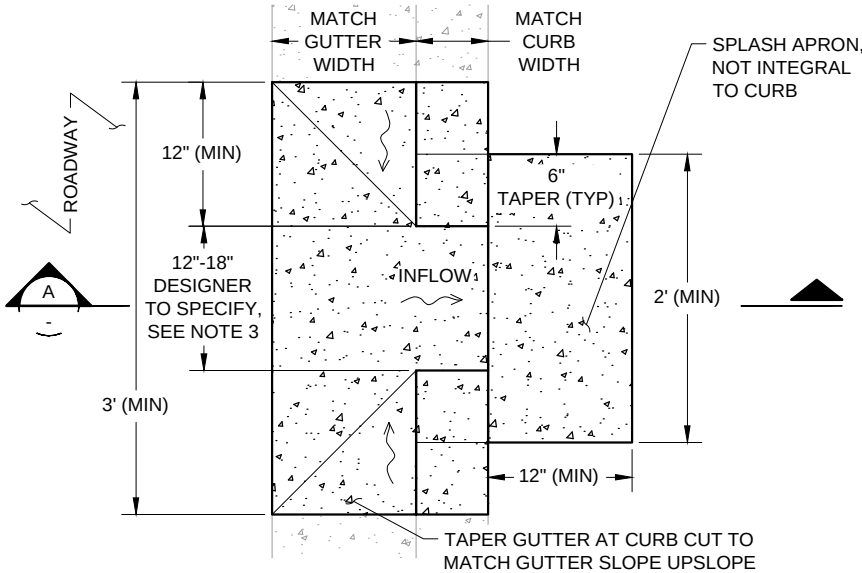
DWG NO.

BC 2.1

NOT FOR CONSTRUCTION - REFER TO USER GUIDE



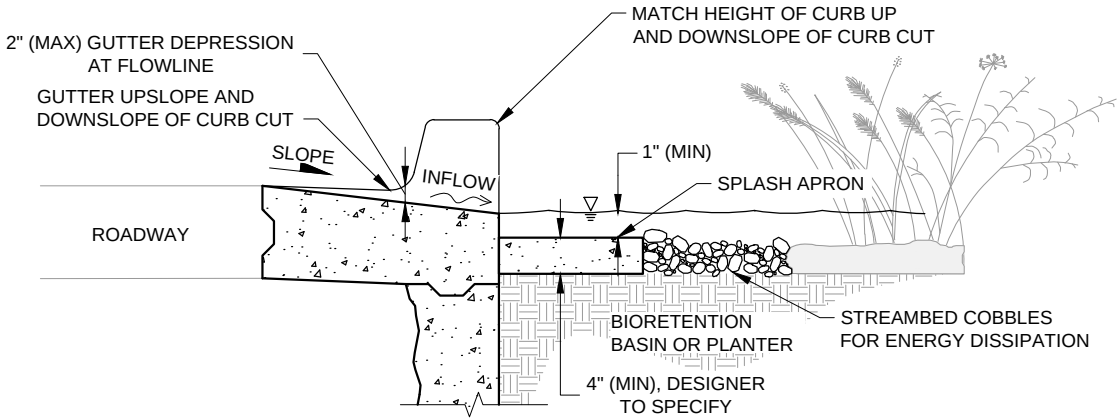

ISOMETRIC




PLAN

## CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR CURB CUTS SHALL CONFORM TO SAN FRANCISCO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. BOND NEW CURB AND GUTTER TO EXISTING CURB AND GUTTER WITH EPOXY AND DOWEL CONNECTION.
3. INLET CURB CUT WIDTH SHALL BE 18" ON GUTTER SLOPES ≥ 5%




SECTION A

INLET - CURB CUT TYPE 1 (1)

| EDGE TREATMENTS | | | | | | | | INLETS | | | | OUTLETS | | | | AGGREGATE STORAGE | UNDERDRAINS | | CHECK DAM | | MONITORING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | COMPONENTS | | | | | | | NOTES | COMPONENTS | | | NOTES | COMPONENTS | | | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | |
| BC 1.1 | BC 1.2 | BC 1.3 | BC 1.4 | BC 1.5 | BC 1.6 | BC 1.7 | | BC 2.1 | BC 2.2 | BC 2.3 | BC 2.4 | BC 3.1 | BC 3.2 | BC 3.3 | BC 3.4 | BC 4.1 | BC 5.1 | BC 5.2 | BC 6.1 | BC 6.2 | BC 7.1 | BC 7.2 | BC 7.3 |

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE: SEPTEMBER 2016
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REVISED:

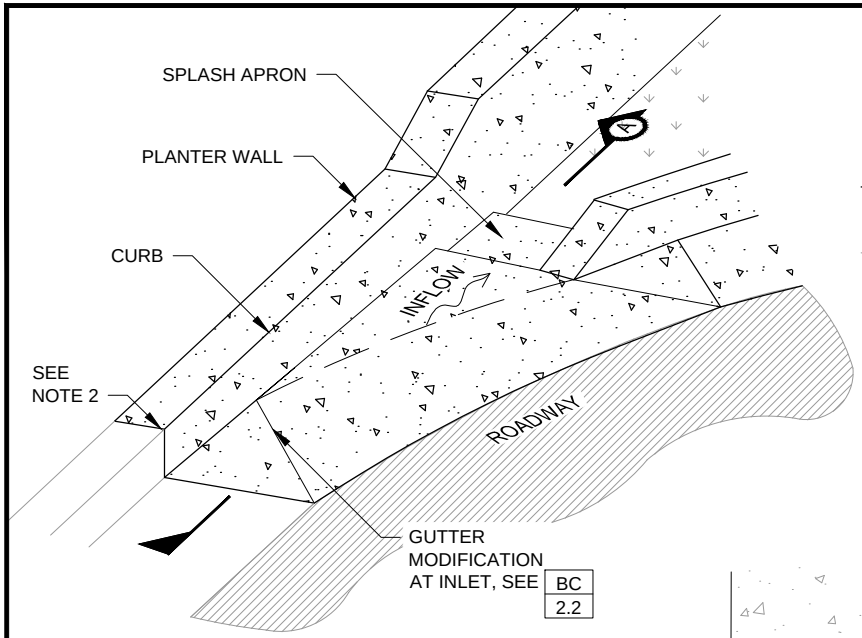
# BIORETENTION COMPONENTS

## INLETS

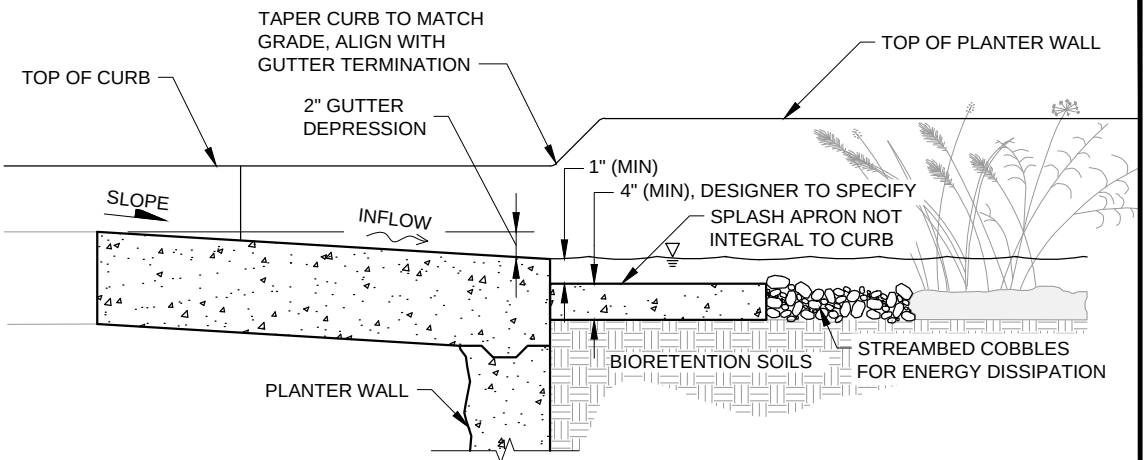
## CURB CUT WITH GUTTER MODIFICATION

DWG NO. BC 2.2

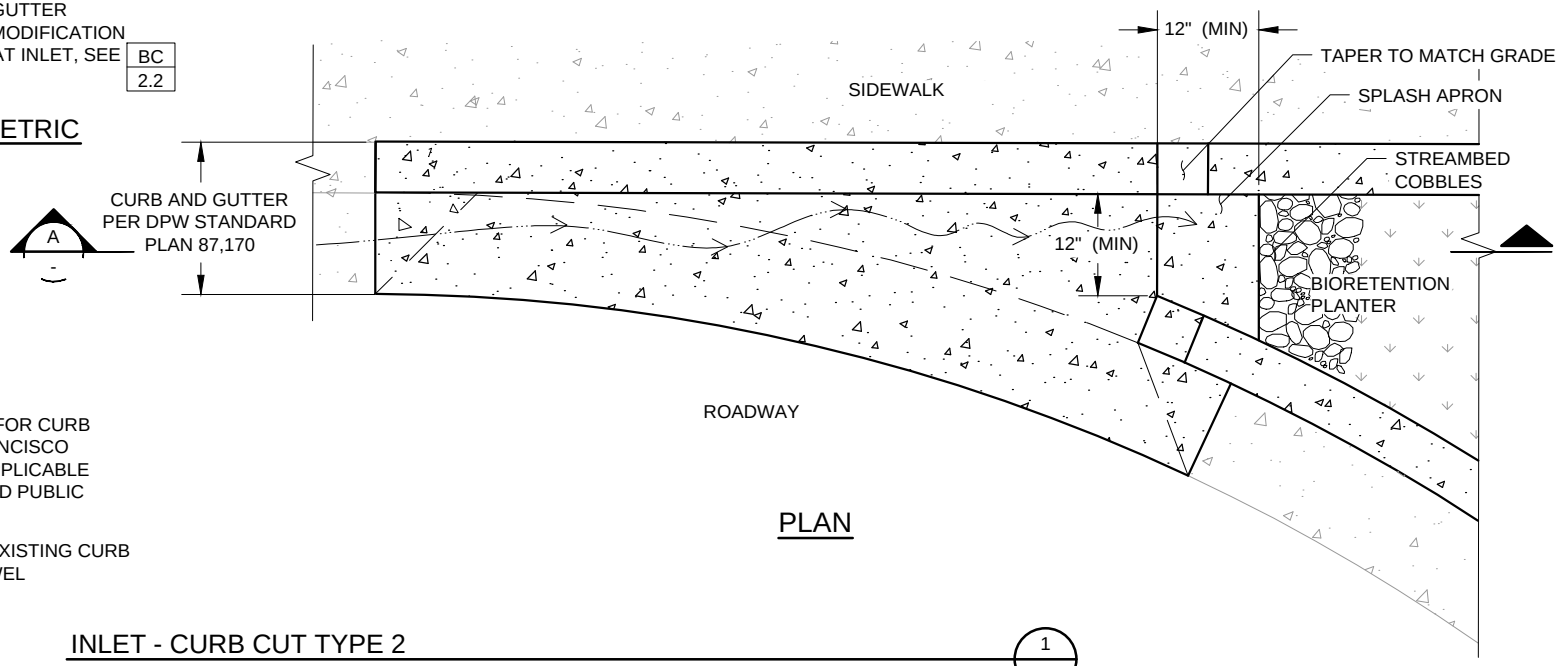
NOT FOR CONSTRUCTION - REFER TO USER GUIDE




ISOMETRIC




SECTION A




PLAN

## CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR CURB CUTS SHALL CONFORM TO SAN FRANCISCO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. BOND NEW CURB AND GUTTER TO EXISTING CURB AND GUTTER WITH EPOXY AND DOWEL CONNECTION.

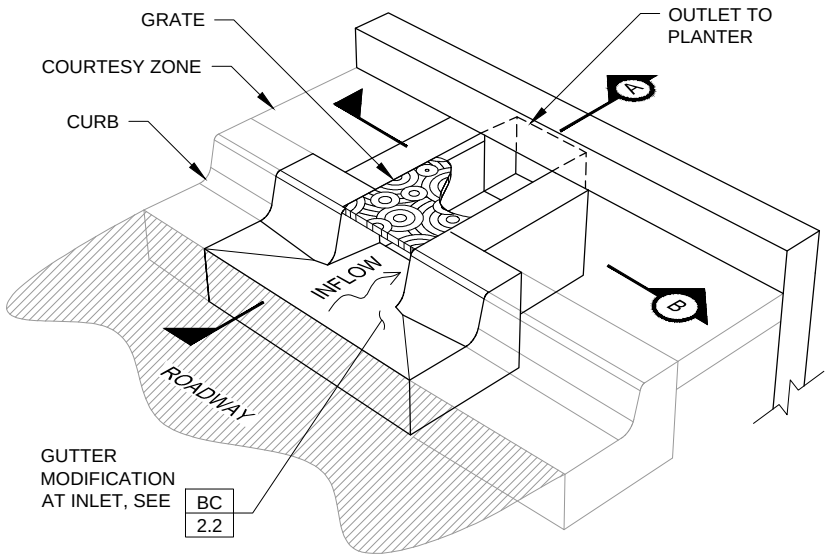
INLET - CURB CUT TYPE 2 (1)

| EDGE TREATMENTS | | | | | | | | INLETS | | | | OUTLETS | | | | AGGREGATE STORAGE | UNDERDRAINS | | CHECK DAM | | MONITORING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | COMPONENTS | | | | | | | NOTES | COMPONENTS | | | NOTES | COMPONENTS | | | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | |
| BC 1.1 | BC 1.2 | BC 1.3 | BC 1.4 | BC 1.5 | BC 1.6 | BC 1.7 | | BC 2.1 | BC 2.2 | **BC 2.3** | BC 2.4 | BC 3.1 | BC 3.2 | BC 3.3 | BC 3.4 | BC 4.1 | BC 5.1 | BC 5.2 | BC 6.1 | BC 6.2 | BC 7.1 | BC 7.2 | BC 7.3 |

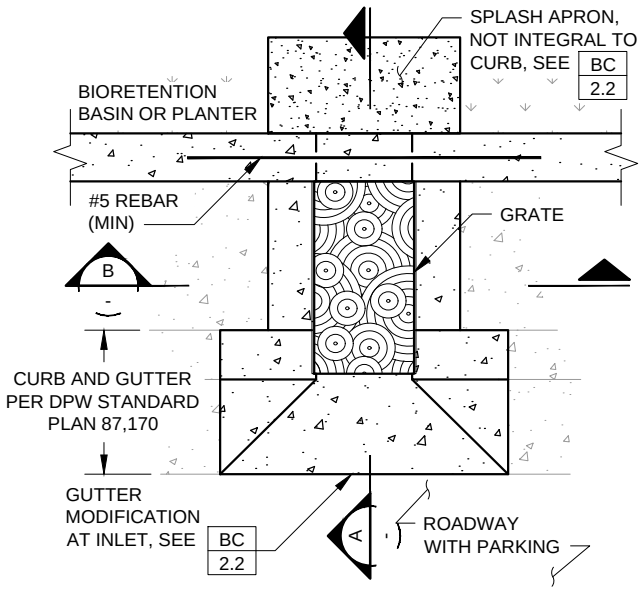
| | | | |
|---|---|---|---|
| San Francisco Water Power Sewer | **GREEN INFRASTRUCTURE TYPICAL DETAILS**<br>SAN FRANCISCO PUBLIC UTILITIES COMMISSION | DATE SEPTEMBER 2016<br>VERSION 2.0<br>REVISED | **BIORETENTION COMPONENTS**<br>**INLETS**<br>**CURB CUT AT BULB OUT** |

DWG NO. **BC 2.3**

NOT FOR CONSTRUCTION - REFER TO USER GUIDE



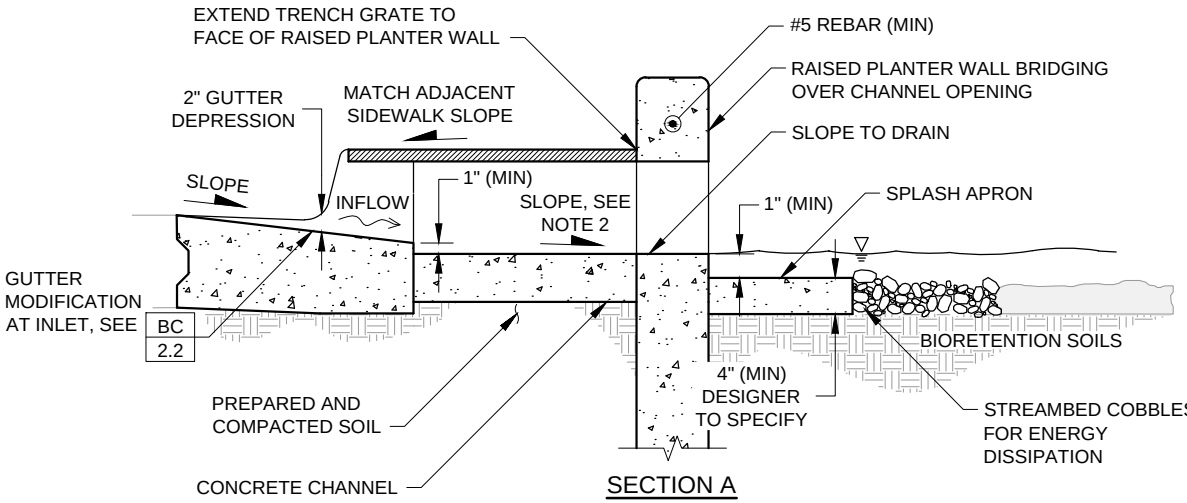

ISOMETRIC



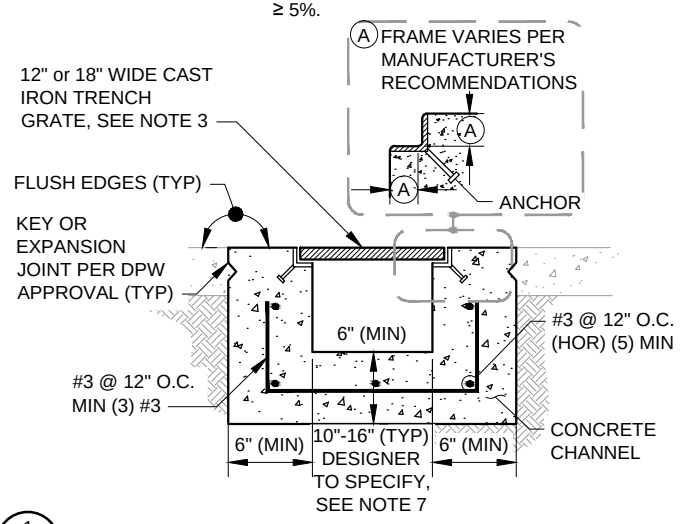

PLAN

## CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR TRENCH DRAIN ASSEMBLY SHALL CONFORM TO SAN FRANCISCO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. SLOPE TO PROVIDE AT LEAST 1 INCH DROP OVER LENGTH OF CHANNEL OR A MINIMUM OF 2 PERCENT, WHICHEVER IS LARGER.
3. ALL TRENCH GRATES SHALL BE REMOVABLE, RATED PER THE ANTICIPATED LOADING, AND BOLTED IN PLACE OR OUTFITTED WITH APPROVED TAMPER-RESISTANT LOCKING MECHANISM, FLUSH OR RECESSED IN GRATE.
4. BOND NEW CURB AND GUTTER TO EXISTING CURB AND GUTTER WITH EPOXY AND DOWEL CONNECTION.
5. HORIZONTAL CONTROL JOINTS SHALL BE PROVIDED EVERY 10 LINEAR FEET, OR PER MANUFACTURER'S RECOMMENDATIONS.
6. APPLY EPOXY BONDING AGENT AT ALL TRENCH DRAIN CONSTRUCTION COLD JOINTS.
7. INLET CURB CUT AND CONCRETE CHANNEL WIDTH SHALL BE 16" (MIN) ON GUTTER SLOPES ≥ 5%.




SECTION A




SECTION B

INLET - TRENCH DRAIN 1

| EDGE TREATMENTS | | | | | | | | INLETS | | | | OUTLETS | | | | AGGREGATE STORAGE | UNDERDRAINS | | CHECK DAM | | MONITORING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | COMPONENTS | | | | | | | NOTES | COMPONENTS | | | NOTES | COMPONENTS | | | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | |
| BC 1.1 | BC 1.2 | BC 1.3 | BC 1.4 | BC 1.5 | BC 1.6 | BC 1.7 | | BC 2.1 | BC 2.2 | BC 2.3 | BC 2.4 | BC 3.1 | BC 3.2 | BC 3.3 | BC 3.4 | BC 4.1 | BC 5.1 | BC 5.2 | BC 6.1 | BC 6.2 | BC 7.1 | BC 7.2 | BC 7.3 |

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE SEPTEMBER 2016
VERSION 2.0
REVISED

# BIORETENTION COMPONENTS

## INLETS

## CURB CUT WITH TRENCH DRAINS

DWG NO. BC 2.4

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

PURPOSE:

BIORETENTION OUTLET STRUCTURES CONVEY SURFACE AND/OR SUBSURFACE OUTFLOWS FROM A BIORETENTION FACILITY TO AN APPROVED DISCHARGE LOCATION.

DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. THE DESIGNER MUST SIZE CURB CUT, GRATE, AND OTHER OVERFLOW STRUCTURE FEATURES TO SATISFY SAN FRANCISCO DPW HYDRAULIC REQUIREMENTS.
3. AN OUTLET STRUCTURE OR CLEANOUT(S) THAT ALLOWS MAINTENANCE ACCESS TO ALL PIPES IS REQUIRED FOR FACILITIES WITH UNDERDRAINS.
4. IF SITE CONSTRAINTS NECESSITATE STORM DRAIN PIPE IN AN AREA SUBJECT TO VEHICULAR TRAFFIC OR OTHER LOADING, APPROPRIATE COVER DEPTH AND PIPE MATERIAL MUST BE SPECIFIED.
5. OUTLET PIPES MUST BE EQUIPPED WITH CLEANOUTS, SEE CLEANOUT DETAILS ( **GC 5.2**).
6. DESIGNER SHALL EVALUATE BUOYANCY OF STRUCTURES FOR SITE SPECIFIC APPLICATION AND SPECIFY THICKENED OR EXTENDED BASE / ANTI-FLOTATION COLLAR, AS NECESSARY.
7. SAND TRAP REQUIREMENTS (12 INCH SUMP AND CAST IRON HOOD/TRAP) MAY BE ELIMINATED WHEN OVERFLOW DIRECTLY DISCHARGES TO DOWNSTREAM (SAN FRANCISCO PUBLIC WORKS) SAND TRAP.
8. LOCATE ALL OVERFLOW PIPES AT AN ELEVATION HIGHER THAN THE SEWER HYDRAULIC GRADE LINE TO PREVENT BACKFLOW INTO THE BIORETENTION FACILITY.

DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ OUTLET STRUCTURE TYPE/MATERIAL, DIAMETER, AND DEPTH
- ☐ ATRIUM GRATE MANUFATURER, MODEL NO., AND SIZE
- ☐ SAND TRAP COMPONENTS AND DIMENSIONS
- ☐ FRAME AND GRATE TYPE, MODEL NO., AND SIZE
- ☐ CONTROL ELEVATIONS FOR OUTLET STRUCTURE RIMS
- ☐ MATERIAL AND DIAMETER FOR ALL PIPES
- ☐ WATER TIGHT CONNECTOR TYPE FOR ALL WALL PENETRATIONS (E.G., GROUTED, COMPRESSION, BOOT), SEE GC 2.9 AND GC 2.10

| EDGE TREATMENTS | | | | | | | INLETS | | | | OUTLETS | | | | AGGREGATE STORAGE COMPONENTS | UNDERDRAINS | | CHECK DAM | | MONITORING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | COMPONENTS | | | | | | NOTES | COMPONENTS | | | NOTES | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | |
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San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE: SEPTEMBER 2016

VERSION: 2.0

REVISED:

# BIORETENTION COMPONENTS

## OUTLETS

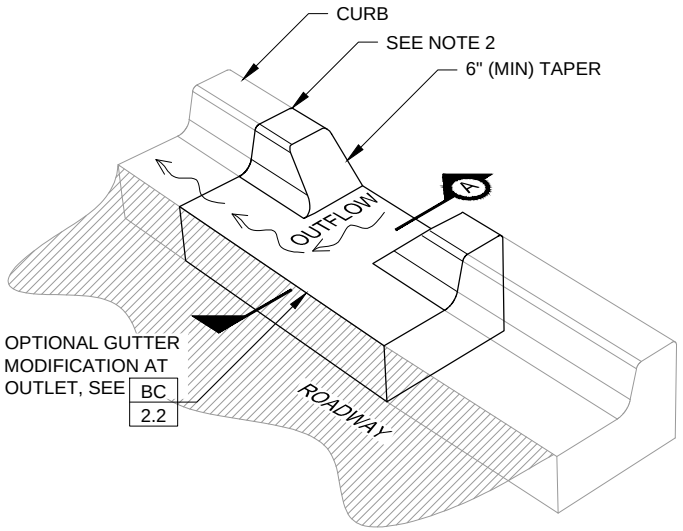
## DESIGNER NOTES

DWG NO.

**BC**

**3.1**

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

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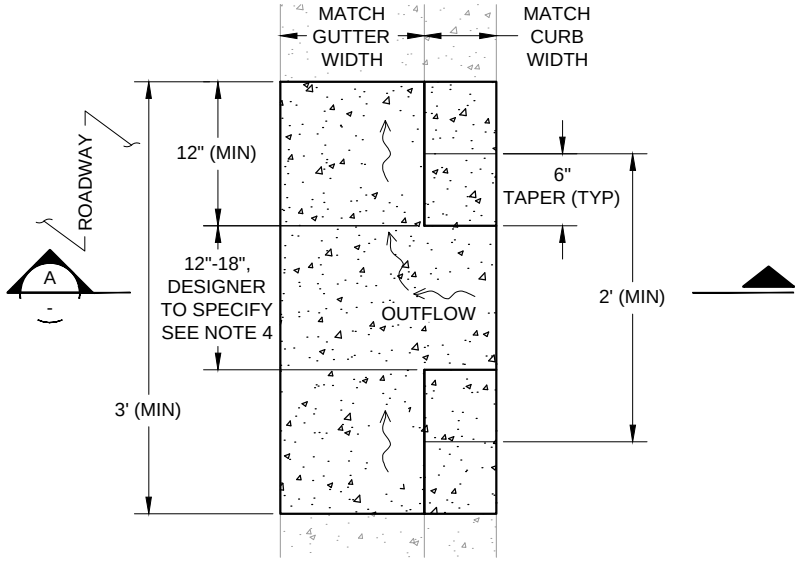
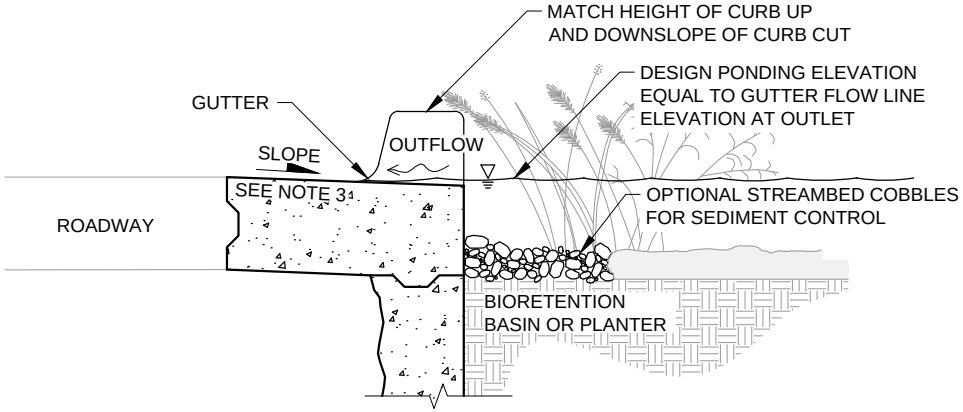



PLAN

## CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR CURB CUTS SHALL CONFORM TO SAN FRANCISCO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. BOND NEW CURB AND GUTTER TO EXISTING CURB AND GUTTER WITH EPOXY AND DOWEL CONNECTION.
3. MATCH GUTTER SLOPE UP AND DOWNSLOPE OF CURB CUT SLOPE SIMILAR TO INLET DETAIL UNLESS MODIFYING GUTTER
4. OUTLET CURB CUT WIDTH SHALL BE18" ON GUTTER SLOPES ≥ 5%




SECTION A

OUTLET - CURB CUT 1

| EDGE TREATMENTS | | | | | | | | INLETS | | | | OUTLETS | | | | AGGREGATE STORAGE | UNDERDRAINS | | CHECK DAM | | MONITORING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | COMPONENTS | | | | | | | NOTES | COMPONENTS | | | NOTES | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | |
| BC 1.1 | BC 1.2 | BC 1.3 | BC 1.4 | BC 1.5 | BC 1.6 | BC 1.7 | | BC 2.1 | BC 2.2 | BC 2.3 | BC 2.4 | BC 3.1 | BC 3.2 | BC 3.3 | BC 3.4 | BC 4.1 | BC 5.1 | BC 5.2 | BC 6.1 | BC 6.2 | BC 7.1 | BC 7.2 | BC 7.3 |

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

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VERSION 2.0

REVISED

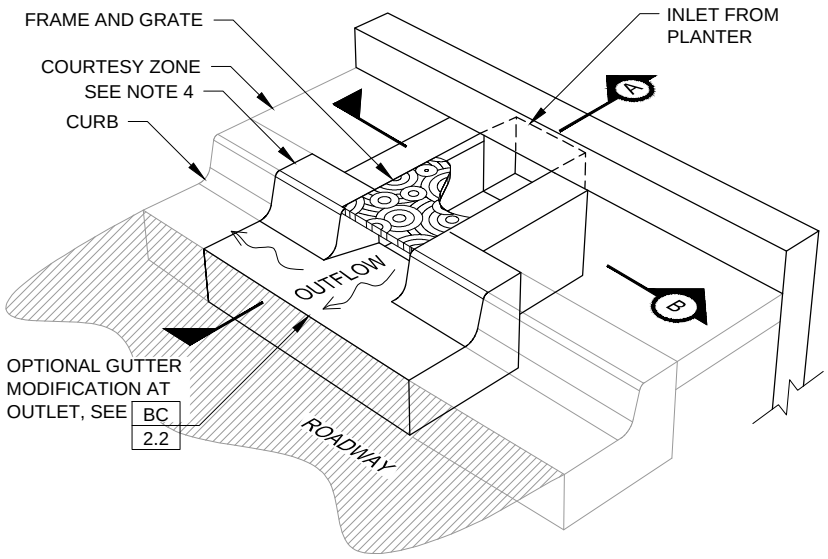
# BIORETENTION COMPONENTS

## OUTLETS

## CURB CUT

DWG NO. BC 3.2

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

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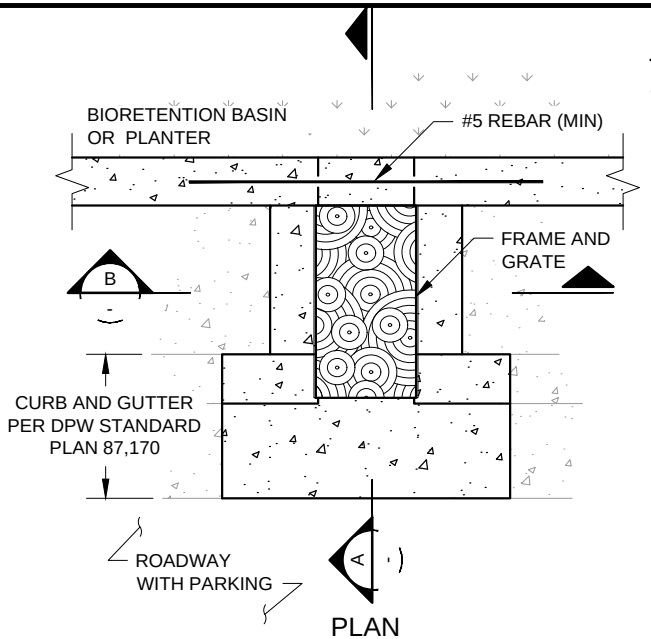
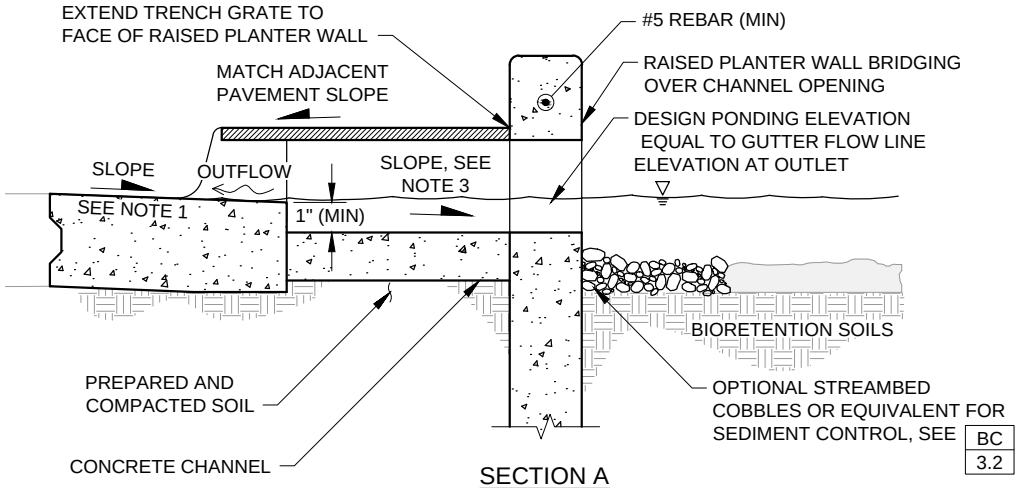


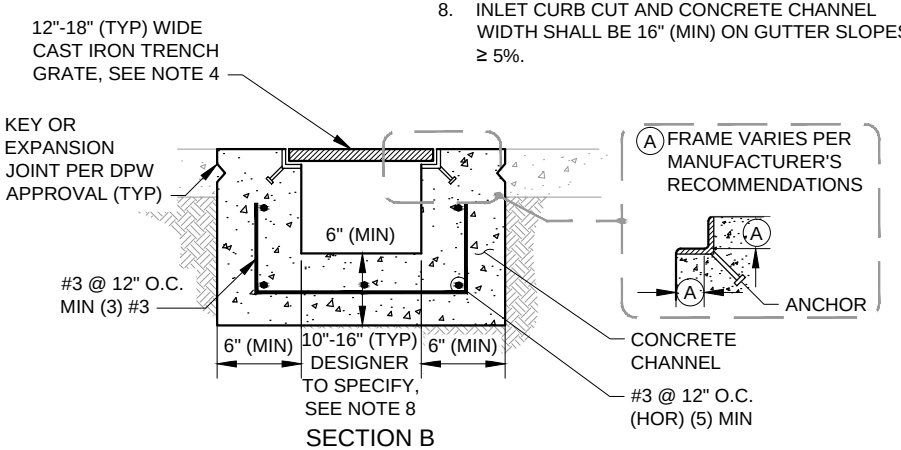

PLAN

## CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR TRENCH DRAIN ASSEMBLY SHALL CONFORM TO SAN FRANCISCO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. MATCH GUTTER SLOPE UP AND DOWNSLOPE (UNLESS MODIFYING GUTTER SLOPE INLET DETAIL).
3. SLOPE TO PROVIDE AT LEAST 1 INCH DROP OVER LENGTH OF CHANNEL OR A MINIMUM OF 2 PERCENT, WHICHEVER IS LARGER.
4. ALL TRENCH GRATES SHALL BE REMOVABLE, RATED PER THE ANTICIPATED LOADING, AND BOLTED IN PLACE OR OUTFITTED WITH APPROVED TAMPER-RESISTANT LOCKING MECHANISM, FLUSH OR RECESSED IN GRATE.
5. HORIZONTAL CONTROL JOINTS SHALL BE PROVIDED EVERY 10 LINEAR FEET, OR PER MANUFACTURER'S RECOMMENDATIONS.
6. BOND NEW CURB AND GUTTER TO EXISTING CURB AND GUTTER WITH EPOXY AND DOWEL CONNECTION.
7. APPLY EPOXY BONDING AGENT AT ALL TRENCH DRAIN CONSTRUCTION COLD JOINTS.
8. INLET CURB CUT AND CONCRETE CHANNEL WIDTH SHALL BE 16" (MIN) ON GUTTER SLOPES ≥ 5%.




SECTION A




SECTION B

## OUTLET - TRENCH DRAIN 1

| EDGE TREATMENTS | | | | | | | INLETS | | | | OUTLETS | | | | AGGREGATE STORAGE | UNDERDRAINS | | CHECK DAM | | MONITORING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | COMPONENTS | | | | | | NOTES | COMPONENTS | | | NOTES | COMPONENTS | | | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | |
| BC 1.1 | BC 1.2 | BC 1.3 | BC 1.4 | BC 1.5 | BC 1.6 | BC 1.7 | BC 2.1 | BC 2.2 | BC 2.3 | BC 2.4 | BC 3.1 | BC 3.2 | **BC 3.3** | BC 3.4 | BC 4.1 | BC 5.1 | BC 5.2 | BC 6.1 | BC 6.2 | BC 7.1 | BC 7.2 | BC 7.3 |

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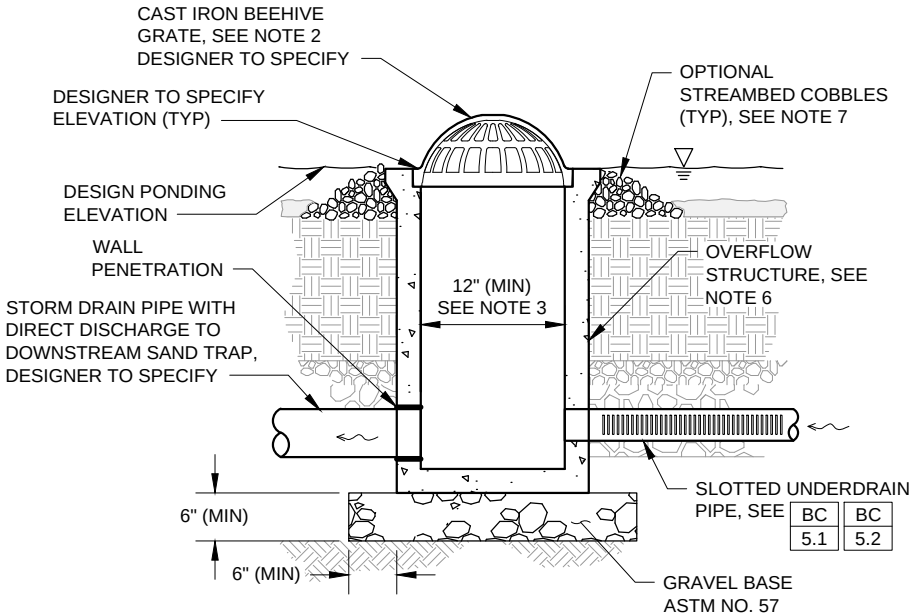
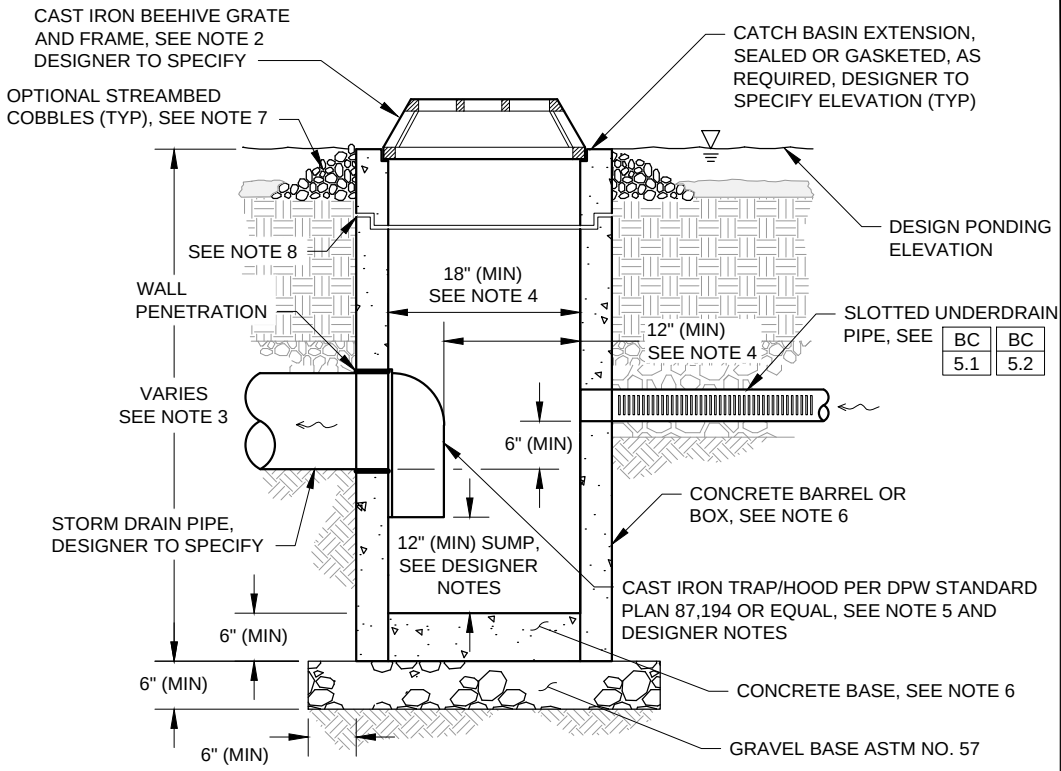
| San Francisco Water Power Sewer | **GREEN INFRASTRUCTURE TYPICAL DETAILS**<br>SAN FRANCISCO PUBLIC UTILITIES COMMISSION | DATE SEPTEMBER 2016<br>VERSION 2.0<br>REVISED | **BIORETENTION COMPONENTS**<br>**OUTLETS**<br>**CURB CUT WITH TRENCH DRAIN** |

DWG NO. **BC 3.3**

NOT FOR CONSTRUCTION - REFER TO USER GUIDE




OVERFLOW STRUCTURE AREA DRAIN 1




OVERFLOW STUCTURE WITH INTERGAL SAND TRAP 2

## CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR OVERFLOW STRUCTURES SHALL CONFORM TO SAN FRANCISCO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. SIZE OF ATRIUM GRATE SHALL MATCH SIZE OF RISER SPECIFIED IN PLANS, SHALL BE REMOVABLE TO PROVIDE MAINTENANCE ACCESS, AND SHALL BE BOLTED IN PLACE OR OUTFITTED WITH APPROVED TAMPER-RESISTANT LOCKING MECHANISM. MAXIMUM GRATE OPENING SHALL BE 4 INCHES.
3. IF INTERIOR DEPTH OF OVERFLOW STRUCTURE EXCEEDS 5 FEET, A PERMANENT BOLTED LADDER AND MINIMUM CLEAR SPACE OF 30 INCH BY 30 INCH IN SHALL BE PROVIDED FOR MAINTENANCE ACCESS.
4. 12 INCH (MIN) CLEARANCE WITHIN OVERFLOW STRUCTURE SHALL BE PROVIDED FOR MAINTENANCE ACCESS.
5. INSTALL CAST IRON TRAP/HOOD PER MANUFACTURER'S RECOMMENDATIONS.
6. BARREL/BOX AND BASE OF CATCH BASIN MAY BE PRE-CAST WITH REINFORCING STEEL PER MANUFACTURER'S RECOMMENDATIONS, POURED IN PLACE CONCRETE WITHOUT STEEL PER SAN FRANCISCO STANDARD PLANS AND SPECIFICATIONS, OR NYLOPLAST DRAIN BASIN (2812AG OR EQUAL). ENGINEER TO SPECIFY.
7. MINIMUM STREAMBED COBBLE DIAMETER SHALL BE LARGER THAN MAXIMUM GRATE OPENING.
8. GROUT ALL PENETRATIONS, CRACKS, SEAMS, AND JOINTS WITH CLASS "C" MORTAR.

| EDGE TREATMENTS | | | | | | | | INLETS | | | | OUTLETS | | | | AGGREGATE STORAGE | UNDERDRAINS | | CHECK DAM | | MONITORING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | COMPONENTS | | | | | | | NOTES | COMPONENTS | | | NOTES | COMPONENTS | | | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | |
| BC 1.1 | BC 1.2 | BC 1.3 | BC 1.4 | BC 1.5 | BC 1.6 | BC 1.7 | | BC 2.1 | BC 2.2 | BC 2.3 | BC 2.4 | BC 3.1 | BC 3.2 | BC 3.3 | BC 3.4 | BC 4.1 | BC 5.1 | BC 5.2 | BC 6.1 | BC 6.2 | BC 7.1 | BC 7.2 | BC 7.3 |

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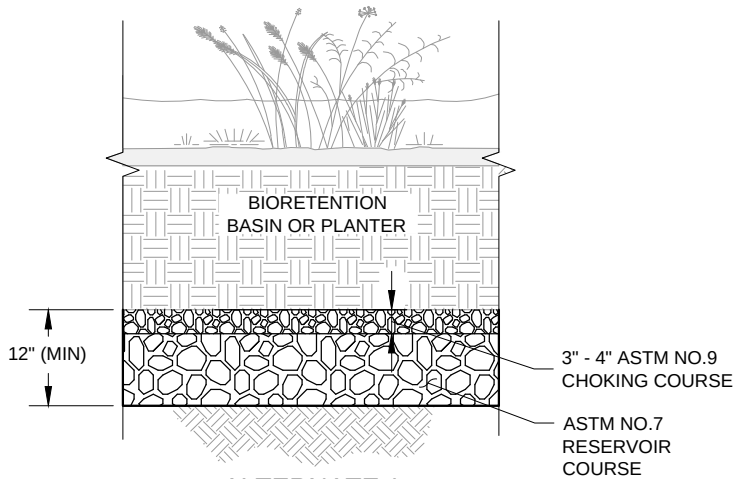
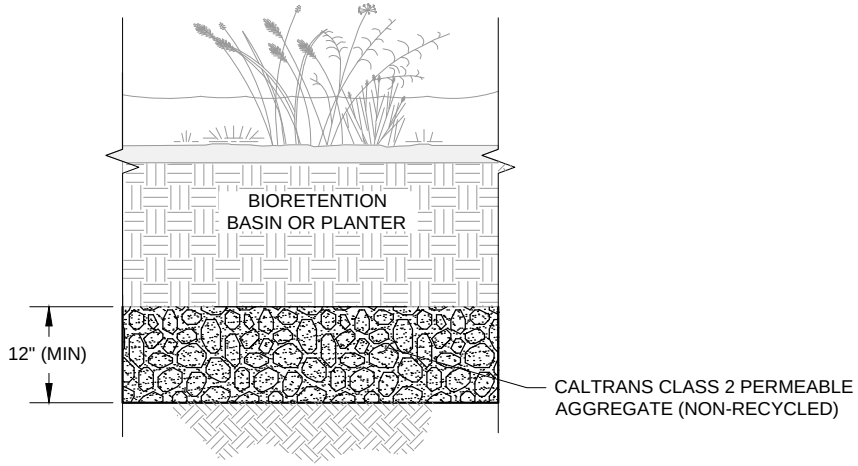
| San Francisco Water Power Sewer | GREEN INFRASTRUCTURE TYPICAL DETAILS<br>SAN FRANCISCO PUBLIC UTILITIES COMMISSION | DATE SEPTEMBER 2016<br>VERSION 2.0<br>REVISED | BIORETENTION COMPONENTS<br>OUTLETS<br>OVERFLOW STRUCTURES |
| | | | DWG NO. BC 3.4 |

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

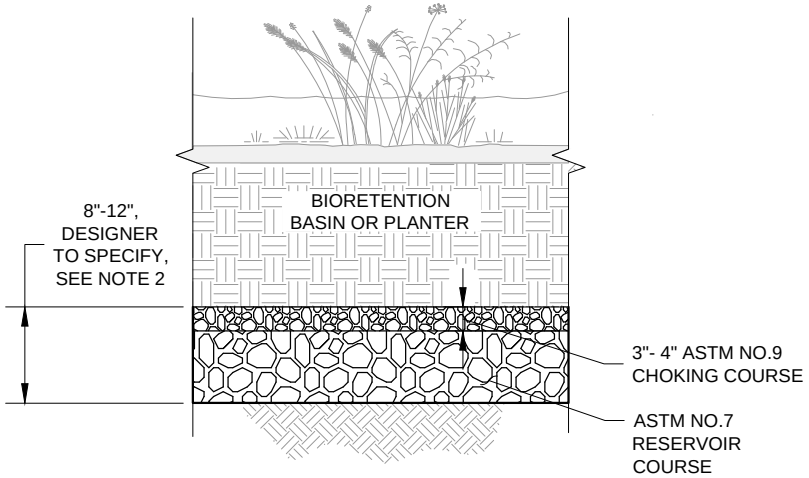



ALTERNATE 1




ALTERNATE 2

FOR USE IN SEPARATE SEWER SYSTEM AREAS




FOR USE IN COMBINED SEWER SYSTEM AREAS

## DESIGNER NOTES & GUIDELINES:

1. DESIGNER SHALL INCORPORATE APPROPRIATE AGGREGATE STORAGE LAYER SECTION INTO BIORETENTION PLANTER OR BIORETENTION BASIN DETAIL.
2. TOTAL AGGREGATE STORAGE DEPTH IN COMBINED SEWER SYSTEM (INCLUDING CHOKING COURSE) SHALL BE 8 TO 12 INCHES FOR FACILITIES WITH UNDERDRAINS. DEPTH MAY BE INCREASED TO MEET PROJECT HYDROLOGIC PERFORMANCE GOALS.
3. AGGREGATE STORAGE IS OPTIONAL FOR FACILITIES NOT REQUIRING UNDERDRAINS IN COMBINED SEWER SYSTEM AREAS.

| EDGE TREATMENTS | | | | | | | | INLETS | | | | OUTLETS | | | | AGGREGATE STORAGE COMPONENTS | UNDERDRAINS | | CHECK DAM | | MONITORING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | COMPONENTS | | | | | | | NOTES | COMPONENTS | | | NOTES | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | |
| BC 1.1 | BC 1.2 | BC 1.3 | BC 1.4 | BC 1.5 | BC 1.6 | BC 1.7 | | BC 2.1 | BC 2.2 | BC 2.3 | BC 2.4 | BC 3.1 | BC 3.2 | BC 3.3 | BC 3.4 | BC 4.1 | BC 5.1 | BC 5.2 | BC 6.1 | BC 6.2 | BC 7.1 | BC 7.2 | BC 7.3 |

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE: SEPTEMBER 2016
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# BIORETENTION COMPONENTS
## AGGREGATE STORAGE LAYERS

DWG NO.
**BC 4.1**

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

## PURPOSE:

UNDERDRAINS ARE USED TO COLLECT STORMWATER THAT HAS BEEN FILTERED THROUGH BIORETENTION SOIL AND CONVEY THAT TREATED STORMWATER TO A DESIGNATED OUTLET (E.G., PLANTER OVERFLOW STRUCTURE).

## DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER SHOULD INCLUDE UNDERDRAINS IN FACILITY DESIGN IN THE FOLLOWING SCENARIOS:
   - INFILTRATION IS PROHIBITED OR IMPRUDENT (E.G., FACILITY NEAR SENSITIVE INFRASTRUCTURE OR STEEP SLOPES, RISK OF CONTAMINATION IS HIGH OR SITE GROUNDWATER/SOILS ARE CONTAMINATED, THERE IS POOR INFILTRATION CAPACITY DUE TO SOILS OR HIGH GROUNDWATER).
   - SUBGRADE MEASURED (I.E., UNCORRECTED) INFILTRATION RATE IS LESS THAN 0.5 INCHES PER HOUR.
   - MAXIMUM SURFACE POOL DRAWDOWN PERIOD CANNOT BE ACHIEVED (SEE **BB 1.1**, **BP 1.1**, AND **BP 5.1**).
3. AN OUTLET STRUCTURE AND/OR CLEANOUT(S) TO ALLOW MAINTENANCE ACCESS TO ALL PIPES IS REQUIRED FOR FACILITIES WITH UNDERDRAINS.
4. UNDERDRAIN PIPE SHALL HAVE A SMOOTH INTERIOR WALL TO FACILITATE MAINTENANCE WITH PRESSURIZED WATER OR ROOT CUTTING EQUIPMENT.
5. DESIGNER SHOULD CONSIDER THE INSTALLED ELEVATION OF THE UNDERDRAIN PIPE WITHIN THE BIORETENTION FACILITIES AGGREGATE STORAGE LAYER TO PROMOTE INFILTRATION, BELOW THE UNDERDRAIN, WHEN FEASIBLE. DESIGNER SHOULD ALSO CONSIDER THE USE OF ORIFICES OR OTHER CONTROL STRUCTURES TO PROVIDE ADDITIONAL INFILTRATION AND FLOW CONTROL BENEFITS WHERE APPLICABLE.
6. PIPE MATERIAL SHALL BE DESIGNED PER SAN FRANCISCO ENVIRONMENTAL CODE (CHAPTER 5, SECTION 509 AND CHAPTER 7, SECTION 706).

## DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ UNDERDRAIN MATERIAL TYPE AND SIZE
- ☐ UNDERDRAIN ELEVATION, SLOPE, AND LOCATION WITHIN BASIN OR PLANTER
- ☐ PIPE BEDDING MATERIAL SPECIFICATION (i.e. AGGREGATE STORAGE LAYER)
- ☐ DISCHARGE LOCATION TO OVERFLOW STRUCTURE
- ☐ CLEANOUT LOCATIONS AND MAINTENANCE ACCESS
- ☐ ORIFICE FLOW CONTROL STRUCTURE(S), AS APPLICABLE

| EDGE TREATMENTS | | | | | | | INLETS | | | | OUTLETS | | | | AGGREGATE STORAGE COMPONENTS | UNDERDRAINS | | CHECK DAM | | MONITORING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | COMPONENTS | | | | | | NOTES | COMPONENTS | | | NOTES | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | |
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San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE: SEPTEMBER 2016

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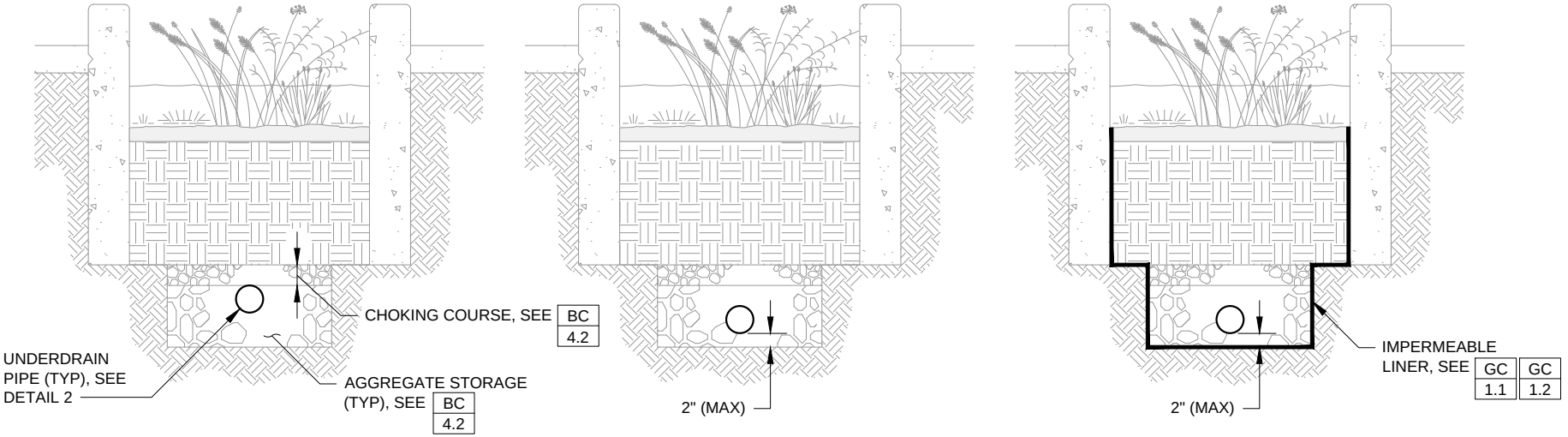
REVISED:

# BIORETENTION COMPONENTS

## UNDERDRAINS DESIGNER NOTES

DWG NO.: BC 5.1

NOT FOR CONSTRUCTION - REFER TO USER GUIDE




ELEVATED UNDERDRAIN
TYPE B/C SOILS (WHEN REQUIRED)

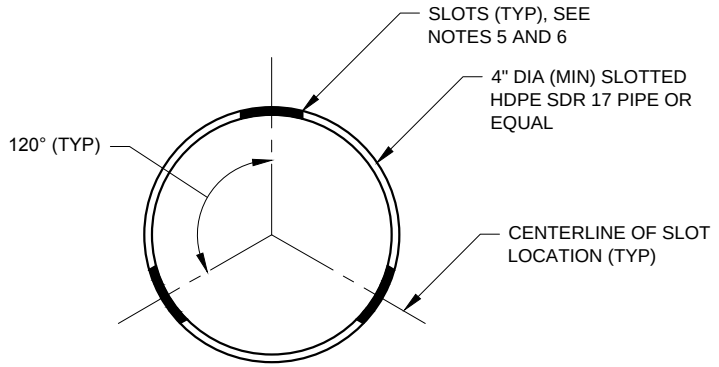
BOTTOM UNDERDRAIN
TYPE D SOILS

UNDERDRAIN WITH LINER
WHERE INFILTRATION PROHIBITED

## UNDERDRAIN PLACEMENT ALTERNATIVES

## CONSTRUCTION NOTES:

1. UNDERDRAIN PIPE SHALL BE SLOTTED HDPE SDR 17 OR ACCEPTABLE SUBSTITUTE MATERIAL PER ENGINEERS SPECIFICATION.
2. ALL MATERIAL AND WORKMANSHIP FOR UNDERDRAINS SHALL CONFORM TO SAN FRANCISCO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
3. SET CROWN OF UNDERDRAIN PIPE AT OR BELOW BOTTOM OF CHOKING COURSE. SEE DESIGNER NOTES FOR ADDITIONAL GUIDANCE ON LOCATING UNDERDRAIN PIPE IN GRAVEL STORAGE.
4. LONGITUDINAL SLOPE OF UNDERDRAIN PIPE SHALL BE 0.5% MINIMUM.
5. UNDERDRAIN PIPE SHALL BE SLOTTED HDPE SDR 17 OR ACCEPTABLE SUBSTITUTE MATERIAL PER ENGINEERS SPECIFICATION. SINGLE WALL AND DUAL WALL CORRUGATED HDPE PIPE (AASHTO M252 AND M294 TYPES C, S, AND D) ARE NOT ACCEPTABLE.
6. UNDERDRAIN PIPE SHALL BE SLOTTED TYPE, MEASURING 0.032 INCH WIDE (MAX), SPACED AT 0.25 INCH (MIN), AND PROVIDING A MINIMUM INLET AREA OF 5.0 SQUARE INCH PER LINEAR FOOT OF PIPE.
7. SLOTS SHALL BE ORIENTED PERPENDICULAR TO LONG AXIS OF PIPE, AND EVENLY SPACED AROUND CIRCUMFERENCE AND LENGTH OF PIPE.




SLOTTED UNDERDRAIN PIPE 2

| EDGE TREATMENTS | | | | | | | | INLETS | | | | OUTLETS | | | | AGGREGATE STORAGE | UNDERDRAINS | | CHECK DAM | | MONITORING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | COMPONENTS | | | | | | | NOTES | COMPONENTS | | | NOTES | COMPONENTS | | | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | |
| BC 1.1 | BC 1.2 | BC 1.3 | BC 1.4 | BC 1.5 | BC 1.6 | BC 1.7 | | BC 2.1 | BC 2.2 | BC 2.3 | BC 2.4 | BC 3.1 | BC 3.2 | BC 3.3 | BC 3.4 | BC 4.1 | BC 5.1 | BC 5.2 | BC 6.1 | BC 6.2 | BC 7.1 | BC 7.2 | BC 7.3 |

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE SEPTEMBER 2016
VERSION 2.0
REVISED

# BIORETENTION COMPONENTS
## UNDERDRAINS

DWG NO. BC 5.2

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

## PURPOSE:

CHECK DAMS ARE OFTEN USED IN BIORETENTION FACILITIES AT SLOPED LOCATIONS (ALIGNED PERPENDICULAR TO THE LONGITUDINAL SLOPE OF THE FACILITY) TO REDUCE FLOW VELOCITIES (AND EROSION) THROUGH THE FACILITY AND TO PROMOTE SURFACE PONDING, SUBSURFACE STORAGE, AND INFILTRATION OF STORMWATER. CHECK DAMS CAN BE CONSTRUCTED OF A VARIETY OF MATERIALS INCLUDING CONCRETE, WOOD, METAL, ROCK, OR COMPACTED SOIL.

## DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT SECTION DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. THE DESIGNER MUST ESTABLISH THE HEIGHT AND SPACING OF CHECK DAMS BASED ON THE PONDING DEPTH REQUIRED TO MEET PROJECT HYDROLOGIC PERFORMANCE GOALS AND THE MAXIMUM DESIRED DROP FROM THE SURROUNDING GRADE TO THE FACILITY BOTTOM. REFER TO CHECK DAM SPACING GUIDANCE PROVIDED ON THIS DRAWING FOR FURTHER GUIDANCE.
3. FOR BIORETENTION SWALES (SLOPED BOTTOM), THE AVERAGE DEPTH OF PONDING ACROSS THE FACILITY AREA MUST MEET THE REQUIRED STORAGE DEPTH.
4. CONCRETE CHECK DAM SHALL MEET STRUCTURAL REQUIREMENTS FOR LATERAL BRACING WHEN USED AS LATERAL BRACING. SEE **BC 1.6** AND **BC 1.7**.

## THE DESIGNER SHALL SPECIFY THE FOLLOWING, AS APPLICABLE:

- ☐ CHECK DAM TYPE AND MATERIAL
- ☐ CHECK DAM HEIGHT, WIDTH, AND ELEVATION
- ☐ CHECK DAM SPACING

| EDGE TREATMENTS | | | | | | | | INLETS | | | | OUTLETS | | | | AGGREGATE STORAGE COMPONENTS | UNDERDRAINS | | CHECK DAM | | MONITORING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | COMPONENTS | | | | | | | NOTES | COMPONENTS | | | NOTES | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | |
| BC 1.1 | BC 1.2 | BC 1.3 | BC 1.4 | BC 1.5 | BC 1.6 | BC 1.7 | | BC 2.1 | BC 2.2 | BC 2.3 | BC 2.4 | BC 3.1 | BC 3.2 | BC 3.3 | BC 3.4 | BC 4.1 | BC 5.1 | BC 5.2 | BC 6.1 | BC 6.2 | BC 7.1 | BC 7.2 | BC 7.3 |

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE: SEPTEMBER 2016

VERSION: 2.0

REVISED:

# BIORETENTION COMPONENTS

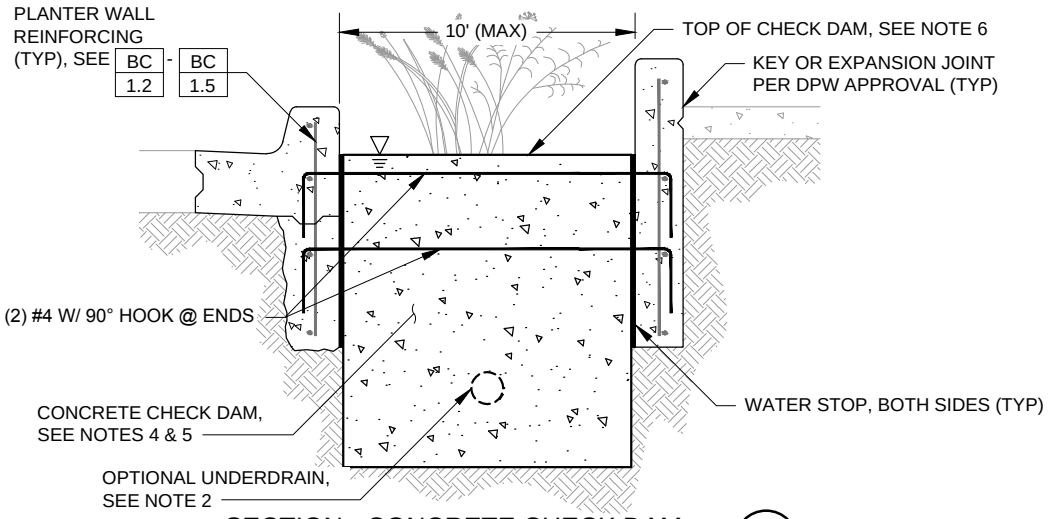
## CHECK DAMS
## DESIGNER NOTES

DWG NO.

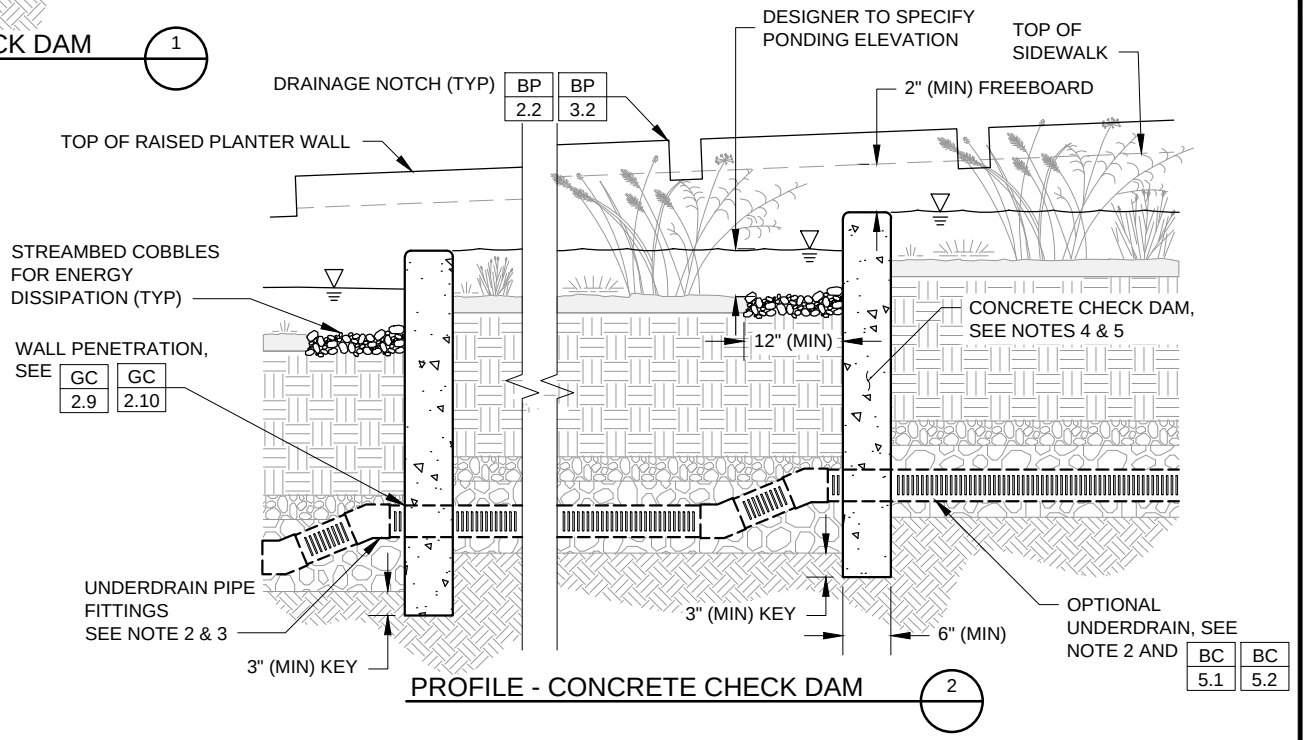
**BC**

**6.1**

NOT FOR CONSTRUCTION - REFER TO USER GUIDE




SECTION - CONCRETE CHECK DAM 1




PROFILE - CONCRETE CHECK DAM 2

## CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR CHECK DAM ASSEMBLY SHALL CONFORM TO SAN FRANCISCO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. UNDERDRAIN TO PASS THROUGH CHECK DAM IN NON-PERFORATED HDPE SDR 17 PIPE.
3. PIPE FITTINGS SHALL BE USED TO ACCOMMODATE CHANGES IN GRADE, AS NEEDED.
4. CONCRETE CHECK DAM SHALL BE CONTINUOUS (NO JOINTS) AND REINFORCED WITH #4 BAR, PLACED AT 18 INCHES ON CENTER, EACH WAY.
5. CONCRETE CHECK DAM SHALL MEET STRUCTURAL REQUIREMENTS FOR LATERAL BRACING WHEN USED AS LATERAL BRACING. COORDINATE WITH ENGINEER.
6. TOP OF CHECK DAM TO BE LEVEL WITH CREST ELEVATION MATCHING PONDING ELEVATION UNLESS NOTCH SIZED TO CONVEY DESIGN FLOWS PROVIDED.

| EDGE TREATMENTS | | | | | | | | INLETS | | | | OUTLETS | | | | AGGREGATE STORAGE COMPONENTS | UNDERDRAINS | | CHECK DAM | | MONITORING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | COMPONENTS | | | | | | | NOTES | COMPONENTS | | | NOTES | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | |
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San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE SEPTEMBER 2016

VERSION 2.0

REVISED

# BIORETENTION COMPONENTS

## CHECK DAMS

DWG NO. BC 6.2

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

## PURPOSE:

BIORETENTION OUTLET MONITORING SYSTEMS ARE DESIGNED TO MONITOR FLOWS IN THE UNDERDRAIN, OVERFLOW, AND OTHER OUTLET PIPES. THESE FLOWS ARE TYPICALLY VERY SMALL, REQUIRING THE USE OF SENSITIVE EQUIPMENT (WEIRS, STILLING WELLS, AND HIGHLY SENSITIVE PRESSURE TRANSDUCERS) TO PRODUCE ACCURATE FLOW ESTIMATES. THESE GUIDELINES WILL HELP THE DESIGNER TO DESIGN A SYSTEM WHICH WILL BE CONDUCIVE TO FLOW MEASUREMENT USING THIS EQUIPMENT.

## DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT THE SECTION DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. THE DESIGNER MUST CONSULT WITH EQUIPMENT MANUFACTURER'S REPRESENTATIVE AND MONITORING PROFESSIONAL OR TECHNICIAN PRIOR TO COMPLETION OF DESIGN.
3. UNDERDRAIN AND BYPASS FLOW SHOULD BE MEASURED WITH THE USE OF VOLUMETRIC PIPE WEIRS, STILLING WELLS, AND PRESSURE TRANSDUCERS.
4. **THE OUTLET AND UNDERDRAIN PIPES SHALL BE AT LEAST 6 INCHES IN DIAMETER AT BIORETENTION MONITORING WEIR LOCATIONS.** A REDUCER COUPLING MAY BE USED TO TRANSITION FROM PIPE DIAMETERS LESS THAN 6 INCHES TO 6 INCHES MINIMUM DIAMETER PROVIDED TRANSITION OCCURS A MINIMUM OF 3 FEET UPSTREAM OF WEIR. THE DESIGNER MUST EVALUATE AND MITIGATE THE IMPACT OF THE PIPE WEIRS ON PIPE CONVEYANCE CAPACITY AND PIPE INVERT ELEVATION.
5. PRESSURE TRANSDUCERS MAY BE VENTED OR UNVENTED. IF UNVENTED, A NEARBY BAROMETRIC TRANSDUCER OF THE SAME MAKE SHOULD BE INSTALLED FOR ATMOSPHERIC PRESSURE CORRECTION.
6. WHEN MEASURING FLOW ENTERING THE MONITORING STRUCTURE:
   - PVC STILLING WELLS MUST BE VENTED ABOVE THE HIGH WATER LINE AND WATER TIGHT BELOW THE HIGH WATER LINE (OR WATER TIGHT WITHIN THE SUMP, IF PERFORATED).
   - INSTALL FLEXIBLE TUBING THROUGH FACE OF PIPE WEIR AND STILLING WELL WALL WITH WATERTIGHT FITTINGS. TUBE SHALL PASS THROUGH WEIR AND EXTEND 2 INCHES BEYOND WEIR FACE TO AVOID MEASURING WATER DEPTH NEAR NAPPE OF WEIR. TUBE SHALL PASS THROUGH THE FACE OF THE WEIR AS FAR FROM WEIR CREST AS PRACTICABLE TO AVOID IMPACTS ON FLOW DYNAMICS.
7. WHEN MEASURING FLOW EXITING THE MONITORING STRUCTURE:
   - PVC STILLING WELLS MUST BE PERFORATED BELOW THE INVERT OF THE OUTLET PIPE. PERFORATIONS SHOULD ALWAYS BE ABOVE THE TOP OF THE PRESSURE TRANSDUCER HOUSING TO PROVIDE A PERMANENT WET POOL FOR THE TRANSDUCER.
   - THE STRUCTURE SHALL BE WATER TIGHT. CALIBRATION OF THE WEIR IN THE OUTLET PIPE WILL BE DIFFICULT IF LARGE VOLUMES OF WATER ARE NEEDED TO INCREASE THE WATER LEVEL IN THE STRUCTURE TO THE INVERT OF THE PIPE WEIR.
8. THE MONITORING STRUCTURE SHOULD BE LARGE ENOUGH TO PROVIDE ACCESS FOR INSTALLATION, MAINTENANCE, AND REMOVAL OF MONITORING EQUIPMENT.
9. THE DESIGNER MUST ENSURE THAT BACKWATER CONDITIONS DO NOT OCCUR IN THE MONITORING STRUCTURE. IF THE VOLUMETRIC WEIRS ARE SUBMERGED DUE TO BACKWATER THEY WILL NOT FUNCTION PROPERLY.

## DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ MONITORING STRUCTURE TYPE/MATERIAL, DIAMETER, AND DEPTH
- ☐ PRESSURE TRANSDUCER TYPE AND SPECIFICATIONS
- ☐ WEIR TYPE, SIZE, AND RATING CURVES
- ☐ CONTROL ELEVATIONS FOR WEIRS, STILLING WELLS, AND PRESSURE TRANSDUCERS
- ☐ MATERIAL TYPE AND SIZE FOR ALL PIPES AND TUBING
- ☐ DIAGRAM WITH ALL OUTLET MONITORING ASSEMBLY COMPONENTS IDENTIFIED OR REQUEST FOR CONTRACTOR SUBMITTAL OF MONITORING ASSEMBLY

| EDGE TREATMENTS | | | | | | | | INLETS | | | | OUTLETS | | | | AGGREGATE STORAGE COMPONENTS | UNDERDRAINS | | CHECK DAM | | MONITORING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | COMPONENTS | | | | | | | NOTES | COMPONENTS | | | NOTES | COMPONENTS | | | | NOTES | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | |
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San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE: SEPTEMBER 2016

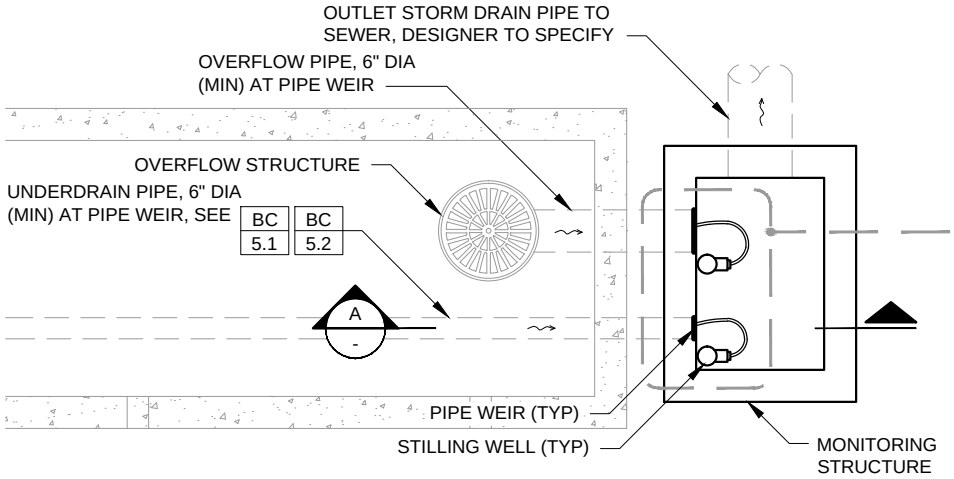
VERSION: 2.0

REVISED:

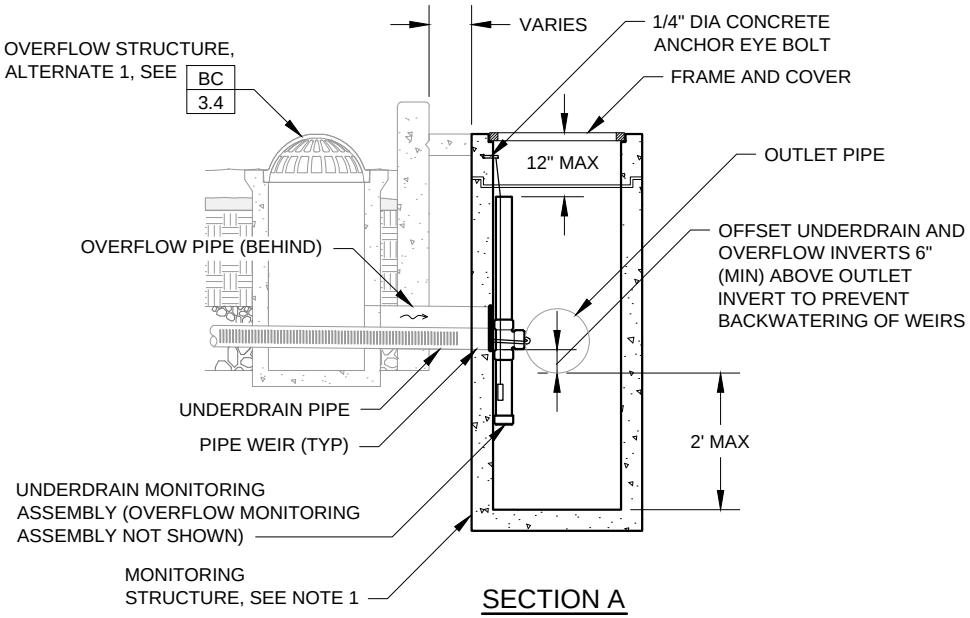
# BIORETENTION COMPONENTS

## OUTLET MONITORING DESIGNER NOTES

DWG NO. BC 7.1



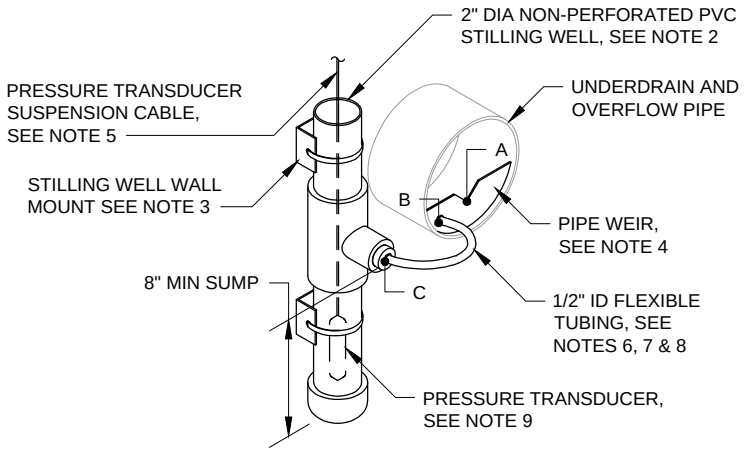

PLAN




SECTION A

## UNDERDRAIN AND OVERFLOW PIPE MONITORING ASSEMBLY DETAIL

(APPLIES TO BOTH ASSEMBLIES)




## CONSTRUCTION NOTES:

1. MONITORING STRUCTURES WITH AN INTERIOR DEPTH GREATER THAN 5 FEET SHALL HAVE A MINIMUM CLEAR SPACE OF 30 INCH BY 30 INCH ACCESSIBLE BY A PERMANENT BOLTED LADDER.
2. STILLING WELL SHALL BE MOUNTED VERTICALLY AND ALL FITTINGS SHALL BE WATERTIGHT.
3. ATTACH STILLING WELL WITH PREFABRICATED METAL STRUT CHANNEL AND PIPE CLAMPS (2 MINIMUM) PER MANUFACTURERS RECOMMENDATION.
4. PIPE WEIR SHALL BE INSTALLED LEVEL AND WITHIN 1 INCH OF END OF PIPE.
5. PRESSURE TRANSDUCER SUSPENSION CABLE SHALL BE 1/16 INCH COATED STAINLESS STEEL CABLE WITH FERRULED CABLE LOOP AND COMPATIBLE OVAL CARABINER FOR CONNECTION TO CONCRETE ANCHOR EYE BOLT.
6. INSTALL FLEXIBLE TUBING THROUGH FACE OF PIPE WEIR AND STILLING WELL WALL WITH WATERTIGHT FITTINGS. TUBE SHALL PASS THROUGH WEIR AND EXTEND 2 INCHES BEYOND WEIR FACE .TUBE SHALL BE INSTALLED AS FAR FROM WEIR CREST AS PRACTICABLE, SEE DESIGNER NOTES.
7. ATTACH TUBE BELOW WEIR NOTCH (POINT B SHALL BE BELOW POINT A).
8. PROVIDE NEGATIVE SLOPE IN TUBE (POINT C SHALL BE BELOW POINT B).
9. PRESSURE TRANSDUCER SHALL BE RATED FOR ZERO TO 21 PSI OF PRESSURE AND AN ACCURACY OF ±0.1 PERCENT FULL SCALE RANGE OR BETTER AT 25°C.

| EDGE TREATMENTS | | | | | | | | INLETS | | | | OUTLETS | | | | AGGREGATE STORAGE | UNDERDRAINS | | CHECK DAM | | MONITORING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | COMPONENTS | | | | | | | NOTES | COMPONENTS | | | NOTES | COMPONENTS | | | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | |
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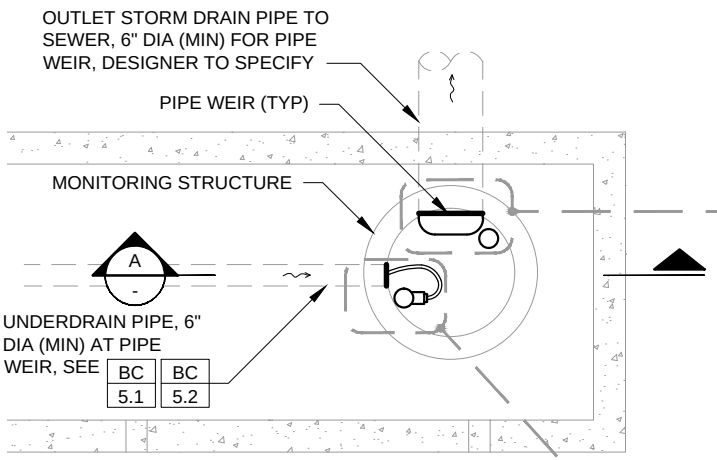
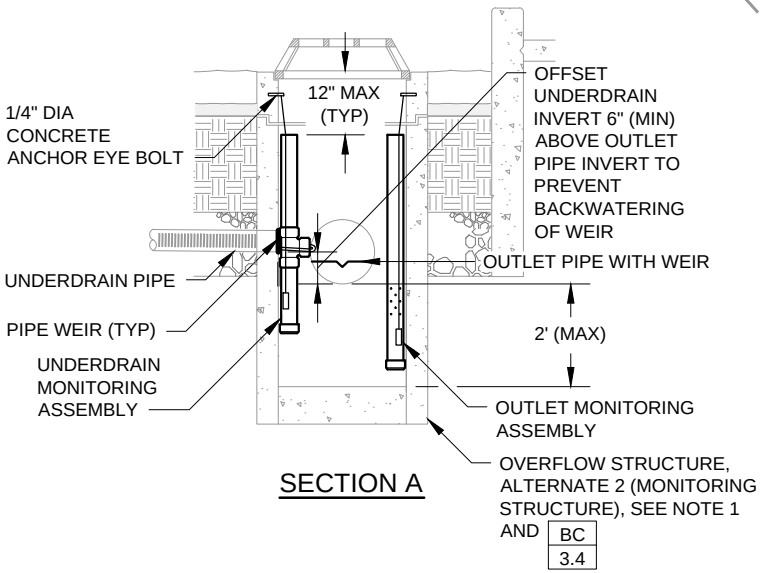
|---|---|---|---|
| San Francisco Water Power Sewer | GREEN INFRASTRUCTURE TYPICAL DETAILS<br>SAN FRANCISCO PUBLIC UTILITIES COMMISSION | DATE SEPTEMBER 2016<br>VERSION 2.0<br>REVISED | BIORETENTION COMPONENTS<br>OUTLET MONITORING<br>EXTERNAL ACCESS STRUCTURE |
| | | | DWG NO. BC 7.2 |

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

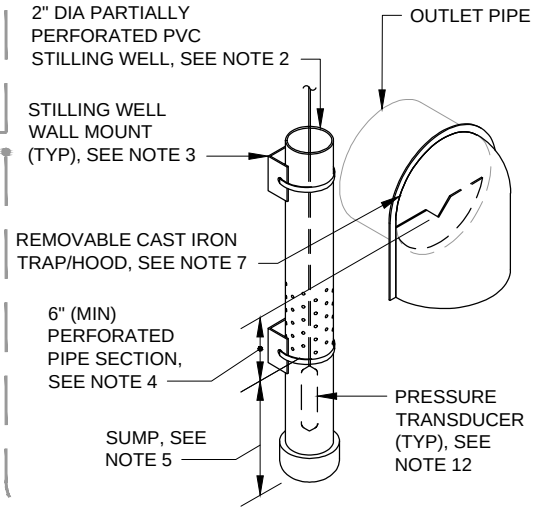



PLAN

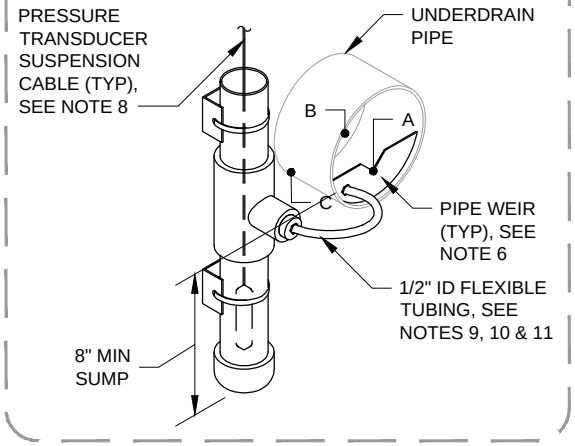



SECTION A

## OUTLET PIPE MONITORING ASSEMBLY DETAIL




## UNDERDRAIN MONITORING ASSEMBLY DETAIL




## CONSTRUCTION NOTES:

1. MONITORING STRUCTURES WITH AN INTERIOR DEPTH GREATER THAN 5 FEET SHALL HAVE A MINIMUM CLEAR SPACE OF 30 INCH BY 30 INCH ACCESSIBLE BY A PERMANENT BOLTED LADDER.
2. STILLING WELL SHALL BE MOUNTED VERTICALLY AND ALL FITTINGS SHALL BE WATERTIGHT.
3. ATTACH STILLING WELL WITH PREFABRICATED METAL STRUT CHANNEL AND PIPE CLAMPS (2 MINIMUM) PER MANUFACTURERS RECOMMENDATION.
4. PROVIDE PERFORATIONS ALONG CIRCUMFERENCE OF STILLING WELL BETWEEN OUTLET PIPE INVERT AND PRESSURE TRANSDUCER SUMP. PERFORATIONS SHALL MEASURE 1/4 INCH DIAMETER (MINIMUM) AT 1 INCH (MAXIMUM) ON-CENTER SPACING, ALL DIRECTIONS.
5. STILLING WELL SUMP SHALL BE NON-PERFORATED AND EXTEND 4 INCHES (MINIMUM) BELOW AND 2 INCHES (MINIMUM) ABOVE PRESSURE TRANSDUCER HOUSING TO ALLOW FOR SEDIMENT ACCUMULATION IN THE BOTTOM OF THE WELL AND PROVIDE A PERMANENT WET POOL FOR THE TRANSDUCER.
6. PIPE WEIR SHALL BE INSTALLED LEVEL AND WITHIN 1 INCH OF END OF PIPE.
7. REMOVABLE CAST IRON TRAP/HOOD SHALL BE NEENAH R-3701 SERIES, NEENAH R-3711 SERIES OR EQUAL. INSTALL TRAP/HOOD PER MANUFACTURERS RECOMMENDATION.
8. PRESSURE TRANSDUCER SUSPENSION CABLE SHALL BE 1/16 INCH COATED STAINLESS STEEL CABLE WITH FERRULED CABLE LOOP AND COMPATIBLE OVAL CARABINER FOR CONNECTION TO CONCRETE ANCHOR EYE BOLT.
9. INSTALL FLEXIBLE TUBING THROUGH FACE OF PIPE WEIR AND STILLING WELL WALL WITH WATERTIGHT FITTINGS. TUBE SHALL PASS THROUGH WEIR AND EXTEND 2 INCHES BEYOND WEIR FACE. TUBE SHALL BE INSTALLED AS FAR FROM WEIR CREST AS PRACTICABLE, SEE DESIGNER NOTES.
10. ATTACH TUBE BELOW WEIR NOTCH (POINT B SHALL BE BELOW POINT A).
11. PROVIDE NEGATIVE SLOPE IN TUBE (POINT C SHALL BE BELOW POINT B).
12. PRESSURE TRANSDUCER SHALL BE RATED FOR ZERO TO 21 PSI OF PRESSURE AND AN ACCURACY OF ±0.1 PERCENT FULL SCALE RANGE OR BETTER AT 25°C.

| EDGE TREATMENTS | | | | | | | | INLETS | | | | OUTLETS | | | | AGGREGATE STORAGE | UNDERDRAINS | | CHECK DAM | | MONITORING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOTES | COMPONENTS | | | | | | | NOTES | COMPONENTS | | | NOTES | COMPONENTS | | | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | NOTES | COMPONENTS | |
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San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE AUGUST 2016

VERSION 2.0

REVISED

# BIORETENTION COMPONENTS

## OUTLET MONITORING
## INTERNAL CATCH BASIN MONITORING

DWG NO. BC 7.3

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

## PURPOSE:

SUBSURFACE INFILTRATION SYSTEMS, ALSO KNOWN AS DRY WELLS, STORMWATER DRAINAGE WELLS, INFILTRATION GALLERIES, AND SEEPAGE PITS, CONTROL PEAK FLOWS AND VOLUMES OF STORMWATER RUNOFF THROUGH SUBSURFACE STORAGE AND INFILTRATION INTO NATIVE SOIL. WATER IS ALSO TREATED AS IT FILTERS THROUGH THE GRAVEL, SAND (IF PROVIDED), AND NATIVE SOIL.

## DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT PLAN AND SECTION DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. SUBSURFACE INFILTRATION SYSTEMS ARE CONSIDERED CLASS V INJECTION WELLS AND SUBJECT TO THE U.S. EPA UNDERGROUND INJECTION CONTROL (UIC) PROGRAM. SUBSURFACE INFILTRATION SYSTEMS MUST BE REGISTERED WITH EPA REGION IX PRIOR TO COMING ONLINE.
3. FIELD-TESTED INFILTRATION RATES OF NATIVE SOILS MUST BE BETWEEN 0.5 (INCHES PER HOUR) AND 5 (INCHES PER HOUR). FOR SITES WITH INFILTRATION RATES GREATER THAN 5 IN/HR, SUBSURFACE INFILTRATION SYSTEMS MAY STILL BE ALLOWED PROVIDED THAT THE RUNOFF IS FULLY TREATED USING UPSTREAM BMPS OR BY INSTALLING A MINIMUM OF 18 INCHES OF ASTM C33 SAND WITH AN INFILTRATION RATE LESS THAN 5 INCHES PER HOUR AT THE BASE OF THE FACILITY.
4. SUBSURFACE STORAGE DRAWDOWN TIME (I.E. TIME FOR MAXIMUM SUBSURFACE STORAGE VOLUME TO INFILTRATE INTO SUBGRADE AFTER THE END OF A STORM) SHOULD NOT EXCEED 48 HOURS. DRAWDOWN TIME IS CALCULATED AS THE MAXIMUM SUBSURFACE STORAGE DEPTH DIVIDED BY THE NATIVE SOIL INFILTRATION RATE.
5. SUBSURFACE INFILTRATION SYSTEM SUBGRADES SHOULD BE LEVEL, REGARDLESS OF ANY LONGITUDINAL SLOPE OF THE SITE, TO PROMOTE EQUAL SUBSURFACE DISTRIBUTION OF RUNOFF.
6. DEPENDING ON THE HEIGHT AND AREA OF THE PROPOSED SUBSURFACE INFILTRATION SYSTEM, ADDITIONAL STRUCTURAL CONSIDERATIONS MAY BE REQUIRED TO ADDRESS EARTH PRESSURE AND/OR SURFACE LOADING.
7. SUBSURFACE INFILTRATION SYSTEMS ARE MOST COMMONLY USED TO MANAGE STORMWATER RUNOFF FROM ROOFS AND PARKING LOTS, BUT CAN BE USED IN OTHER APPLICATIONS. IN AREAS WITH HIGH SEDIMENT LOADS, RUNOFF SHOULD PASS THROUGH STORMWATER PRE-TREATMENT MEASURES TO REMOVE COARSE SEDIMENT THAT CAN CLOG PORE SPACES. REFER TO THE STORMWATER MANAGEMENT REQUIREMENTS APPENDIX A: BMP FACT SHEETS FOR ADDITIONAL REQUIREMENTS.
8. SUBSURFACE INFILTRATION SYSTEMS ARE NOT APPROVED AS TREATMENT MEASURES FOR RUNOFF FROM INDUSTRIAL AREAS, AREAS SUBJECT TO HIGH (GREATER THAN 15,000 VEHICLES PER DAY) TRAFFIC LOADING, AUTOMOTIVE REPAIR SHOPS, CAR WASHES, FLEET STORAGE AREAS, NURSERIES, SITES THAT STORE CHEMICALS OR HAZARDOUS MATERIALS, OR OTHER LAND USES THAT POSE A HIGH THREAT TO WATER QUALITY.
9. SUBSURFACE INFILTRATION SYSTEMS SHOULD NOT BE USED IN AREAS OF KNOWN OR PRESUMED CONTAMINATED SOIL OR GROUNDWATER, AREAS WITH CURRENT OR HISTORICAL INDUSTRIAL USE, AREAS WITHIN 100 FEET OF CURRENT OR HISTORICAL UNDERGROUND STORAGE TANKS, FILLED FORMER BAY, MARSH OR CREEK AREAS, OR AREAS WITHIN 150 FEET OF A CURRENT OR HISTORICAL HIGHWAY. SEE SETBACK REQUIREMENTS TABLE ON **SI 1.2**.
10. SMALL SYSTEMS (TYPICALLY A FEW FEET IN WIDTH) ARE KNOWN AS DRY WELLS AND ARE RECOMMENDED FOR SMALL DRAINAGE AREAS WITH LOW POLLUTANT LOADINGS, SUCH AS ROOFTOPS LESS THAN 0.25 ACRES IN SIZE. LARGER SYSTEMS (TYPICALLY 10 TO 100 FEET IN WIDTH) ARE KNOWN AS INFILTRATION GALLERIES AND CAN BE USED TO RECEIVE RUNOFF FROM DRAINAGE AREAS TYPICALLY UP TO 5 ACRES IN SIZE.
11. THE DRAWINGS PROVIDED DO NOT COVER DESIGNS THAT UTILIZE PROPRIETARY STORAGE, DISTRIBUTION, AND/OR STRUCTURAL SYSTEMS OTHER THAN PREFABRICATED DRY WELL STRUCTURES, WHICH HAVE BEEN SHOWN IN A GENERIC WAY. REFER TO THE MANUFACTURER'S RECOMMENDATIONS FOR ALL PROPRIETARY SYSTEMS.

## GENERAL UTILITY NOTES:

1. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT SFPUC ASSET PROTECTION STANDARDS, OTHER GOVERNING UTILITY STANDARD, AND OTHER UTILITY PROVIDER REQUIREMENTS. SEE UTILITY CROSSING DESIGNER NOTES ON **GC 2.1**.
2. PROVIDE UTILITY TRENCH DAM, ANTI-SEEP COLLAR, OR EQUIVALENT TO PREVENT PREFERENTIAL FLOW OF WATER FROM INFILTRATIVE FACILITY INTO UTILITY TRENCH FROM CAUSING DAMAGE DOWNSTREAM. ENGINEER TO EVALUATE SITE CONDITIONS AND NEED FOR TRENCH DAM. REFER TO **GC2.12** FOR GUIDANCE ON UTILITY TRENCH DAM DESIGN.
3. PROPOSED UTILITY LINES TO BE LOCATED OUTSIDE OF FACILITY.

| RELATED COMPONENTS | | |
|---|---|---|
| UTILITY CROSSINGS: | GC 2.1 | GC 2.12 |
| OBSERVATION PORTS: | GC 3.1 | GC 3.3 |
| UTILITY CONFLICTS: | GC 4.1 | GC 4.4 |
| CLEANOUTS: | | GC 5.2 |

| NOTES | | LARGE SYSTEMS | | SMALL SYSTEMS | |
|---|---|---|---|---|---|
| | | PLAN SECTIONS | | PLAN SECTIONS | |
| SI 1.1 | SI 1.2 | SI 2.1 | SI 2.2 | SI 3.1 | SI 3.2 |

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE: SEPTEMBER 2016
VERSION: 2.0
REVISED:

# SUBSURFACE INFILTRATION SYSTEMS

## DESIGNER NOTES (1 OF 2)

DWG NO. SI 1.1

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

## LAYOUT REQUIREMENTS:

**REFER TO STORMWATER MANAGMENT REQUIRMENTS APPENDIX C: CRITERIA FOR INFILTRATION - BASED BMPS FOR MORE DETAILED INFORMATION ON SITING AND DESIGN REQUIREMENTS FOR INFILTRATION BASED BMPS.**

1. STANDARD SETBACK REQUIREMENTS PER THE STORMWATER MANAGEMENT REQUIREMENTS:

| SETBACK DISTANCE (FEET) | SETBACK FROM: |
|---|---|
| 5 | PROPERTY LINE |
| 10 | DOWNGRADIENT FROM ADJACENT FOUNDATIONS |
| 100 | UPGRADIENT FROM ADJACENT FOUNDATIONS |
| 100 | UPGRADIENT FROM GROUND SLOPES >15% |
| 150 | DRINKING WATER WELL |

2. REFER TO APPENDIX C OF THE STORMWATER MANAGEMENT REQUIREMENTS FOR CONDITIONAL SETBACK REQUIREMENTS AND THE SFPUC ASSET PROTECTION STANDARDS FOR ADDITIONAL SETBACK REQUIREMENTS REGARDING WATER AND SEWER INFRASTRUCTURE.

3. MINIMUM 4-FOOT VERTICAL SEPARATION FROM BASE OF SUBSURFACE INFILTRATION SYSTEM TO BEDROCK IS REQUIRED.

4. VERTICAL SEPARATION TO GROUND WATER:
   - **BAYSIDE**: MINIMUM 4-FOOT VERTICAL SEPARATION FROM BASE OF SUBSURFACE INFILTRATION SYSTEM TO SEASONAL HIGH GROUNDWATER TABLE IS REQUIRED FOR ALL BAYSIDE GROUNDWATER BASINS.
   - **LOBOS & WESTSIDE BASINS**: MINIMUM 4-FOOT TO 10-FOOT VERTICAL SEPARATION FROM BASE OF SUBSURFACE INFILTRATION SYSTEM TO SEASONAL HIGH GROUNDWATER TABLE IS REQUIRED IN THE LOBOS AND WESTSIDE GROUNDWATER BASINS, DEPENDENT UPON SITE CHARACTERISTICS AND SFPUC APPROVAL.

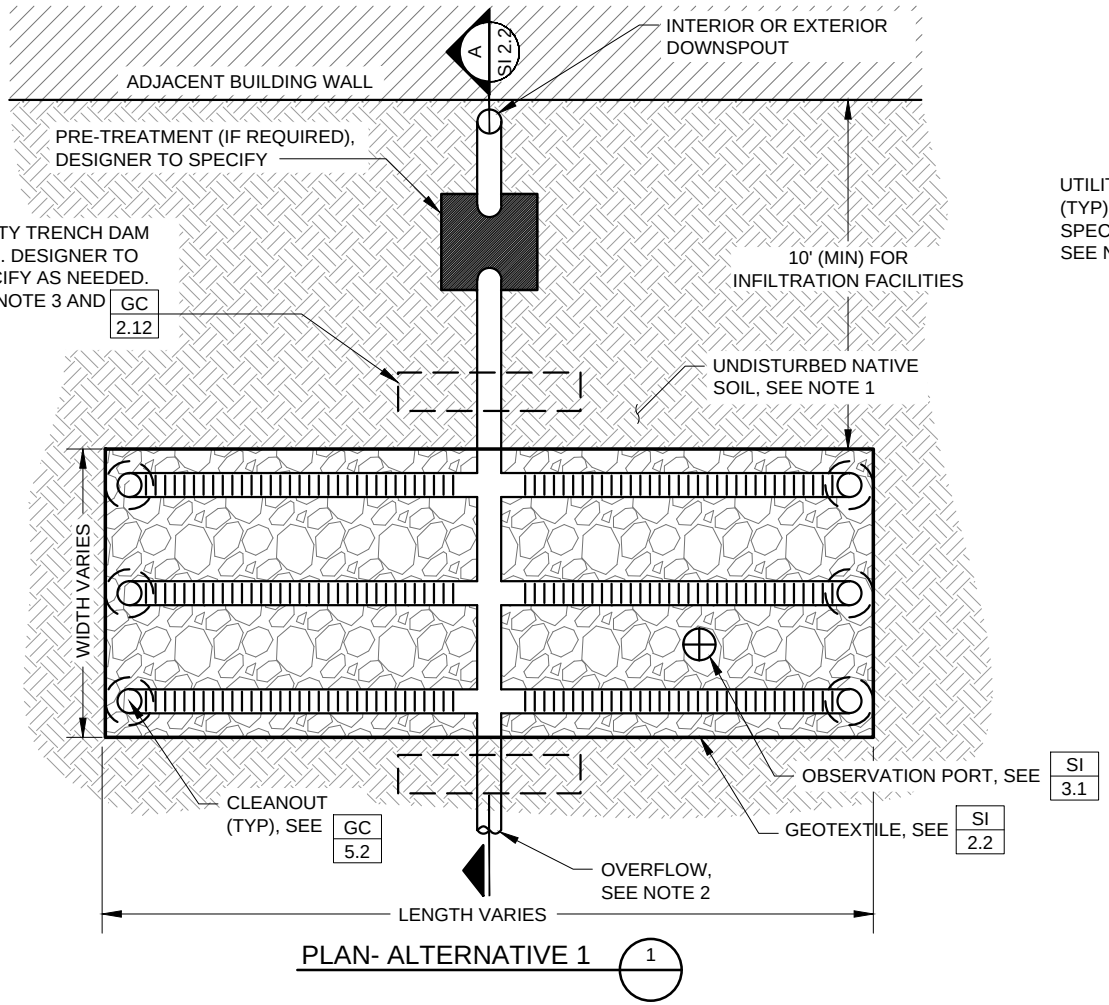
## DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ SUBSURFACE INFILTRATION SYSTEM WIDTH AND LENGTH
- ☐ DEPTH AND TYPE OF AGGREGATE STORAGE LAYER
- ☐ DEPTH AND TYPE OF FILTER SAND, IF REQUIRED
- ☐ ELEVATIONS AND CONTROL POINTS AT EVERY CORNER
- ☐ AGGREGATE STORAGE SPECIFICATIONS AND/OR DRY WELL TYPE AND DIMENSIONS
- ☐ ELEVATIONS OF EACH PIPE INLET AND OVERFLOW INVERT
- ☐ TYPE AND DESIGN OF SUBSURFACE INFILTRATION COMPONENTS (E.G. INLETS, OVERFLOWS, OBSERVATION WELLS)
- ☐ SETBACK DIMENSIONS TO BEDROCK, HIGH GROUNDWATER TABLE, PROPERTY LINES, FOUNDATIONS, WATER SUPPLY WELLS, SEWER MAINS, AND GROUND SLOPES OF 15% OR GREATER, AS APPLICABLE. SEE SFPUC ASSET PROTECTION STANDARDS.
- ☐ TYPE AND SIZE OF PRETREATMENT MEASURE, AS NESSESARY

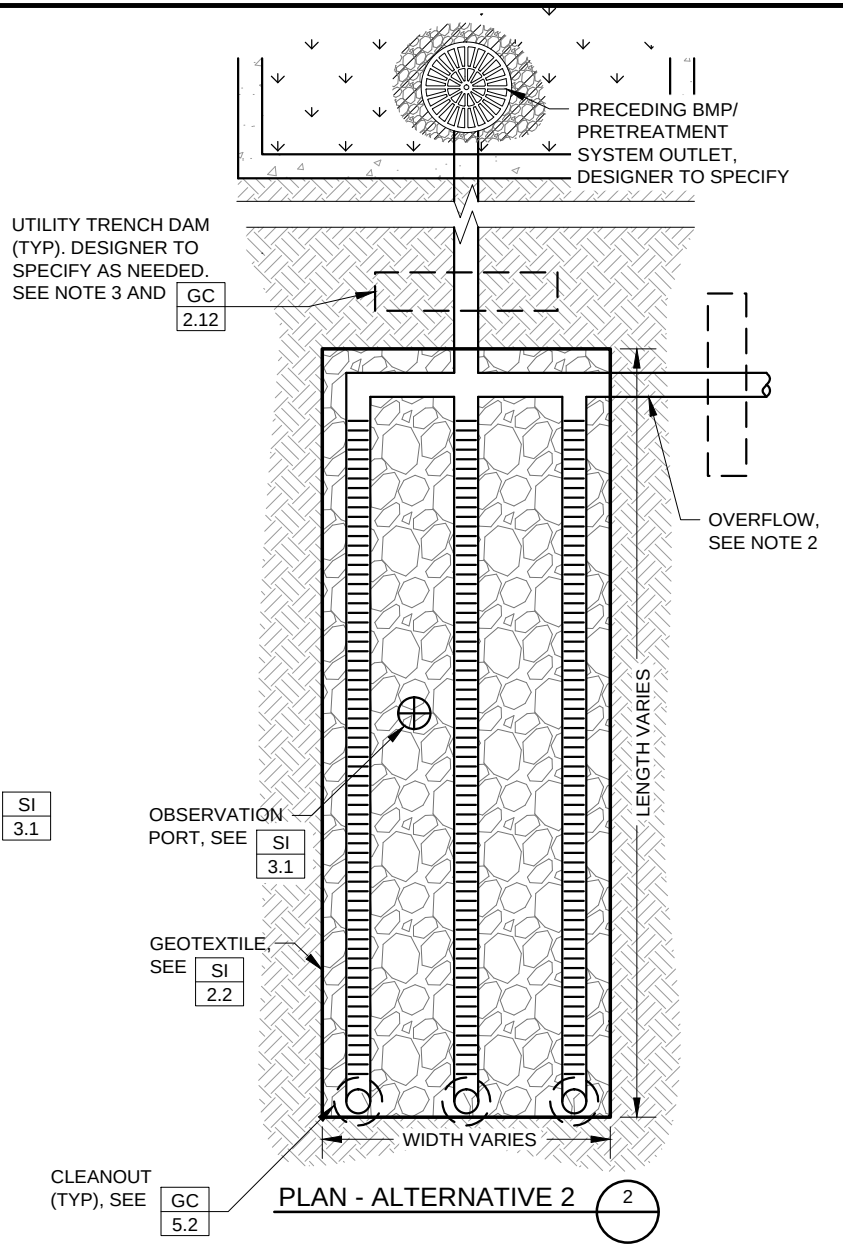
## SOIL TYPE GUIDANCE:

| HYDROLOGIC SOIL GROUP | SOIL TYPE | CORRESPONDING UNIFIED SOIL CLASSIFICATION | DESCRIPTION |
|---|---|---|---|
| A | SAND, LOAMY SAND, OR SANDY LOAM | GW - WELL-GRADED GRAVELS, SANDY GRAVELS<br>GP - GAP-GRADED OR UNIFORM GRAVELS, SANDY GRAVELS<br>GM - SILTY GRAVELS, SILTY SANDY GRAVELS<br>SW - WELL-GRADED, GRAVELLY SANDS<br>SP - GAP-GRADED OR UNIFORM SANDS, GRAVELLY SANDS | LOW RUNOFF POTENTIAL. SOILS HAVING HIGH INFILTRATION RATES EVEN WHEN THOROUGHLY WETTED AND CONSISTING CHIEFLY OF DEEP, WELL TO EXCESSIVELY DRAINED SANDS OR GRAVELS. |
| B | SILT LOAM OR LOAM | SM - SILTY SANDS, SILTY GRAVELLY SANDS<br>MH - MICACEOUS SILTS, DIATOMACEOUS SILTS, VOLCANIC ASH | SOILS HAVING MODERATE INFILTRATION RATES WHEN THOROUGHLY WETTED AND CONSISTING CHIEFLY OF MODERATELY DEEP TO DEEP, MODERATELY WELL TO WELL-DRAINED SOILS WITH MODERATELY FINE TO MODERATELY COARSE TEXTURES. |
| C | SANDY CLAY LOAM | ML - SILTS, VERY FINE SANDS, SILTY AND CLAYEY FINE SANDS | SOILS HAVING SLOW INFILTRATION RATES WHEN THOROUGHLY WETTED AND CONSISTING CHIEFLY OF SOILS WITH A LAYER THAT IMPEDES DOWNWARD MOVEMENT OF WATER, OR SOILS WITH MODERATELY FINE TO FINE TEXTURES. |
| D | CLAY LOAM, SANDY CLAY, SILTY CLAY, OR CLAY | GC - CLAYEY GRAVELS, CLAYEY SANDY GRAVELS<br>SC - CLAYEY SANDS, CLAYEY GRAVELLY SANDS<br>CL - LOW PLASTICITY CLAYS, SANDY OR SILTY CLAYS<br>OL - ORGANIC SILTS AND CLAYS OF LOW PLASTICITY<br>CH - HIGHLY PLASTIC LAYS AND SANDY CLAYS<br>OH - ORGANIC SILTS AND CLAYS OF HIGH PLASTICITY | HIGH RUNOFF POTENTIAL. SOILS HAVING VERY SLOW INFILTRATION RATES WHEN THOROUGHLY WETTED AND CONSISTING CHIEFLY OF CLAY SOILS WITH A HIGH SWELLING POTENTIAL, SOILS WITH A PERMANENT HIGH WATER TABLE, AND SHALLOW SOILS OVER NEARLY IMPERVIOUS MATERIAL. |


NOTES: SI 1.1 | SI 1.2
LARGE SYSTEMS PLAN SECTIONS: SI 2.1 | SI 2.2
SMALL SYSTEMS PLAN SECTIONS: SI 3.1 | SI 3.2




PLAN- ALTERNATIVE 1 (1)




PLAN - ALTERNATIVE 2 (2)

## CONSTRUCTION NOTES:

1. AVOID COMPACTION AND DISTURBANCE OF EXISTING SOIL WITHIN 5 FEET ADJACENT TO AND BELOW INFILTRATION FACILITIES DURING CONSTRUCTION.
2. ROUTE OVERFLOW PIPE TO THE STORM SEWER OR TO ANOTHER BMP FOR FURTHER TREATMENT AS SHOWN ON THE DESIGN PLANS.
3. PROVIDE UTILITY TRENCH DAM OR EQUIVALENT MEASURE OUTSIDE OF THE INFILTRATION FACILITY AT PIPE PENETRATIONS TO PREVENT PREFERENTIAL FLOW FROM INFILTRATION GALLERY INTO UTILITY TRENCHES. COORDINATE WITH ENGINEER.

| NOTES | | LARGE SYSTEMS | | SMALL SYSTEMS | |
|---|---|---|---|---|---|
| | | PLAN SECTIONS | | PLAN SECTIONS | |
| SI 1.1 | SI 1.2 | SI 2.1 | SI 2.2 | SI 3.1 | SI 3.2 |

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San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE: SEPTEMBER 2016
VERSION: 2.0
REVISED:

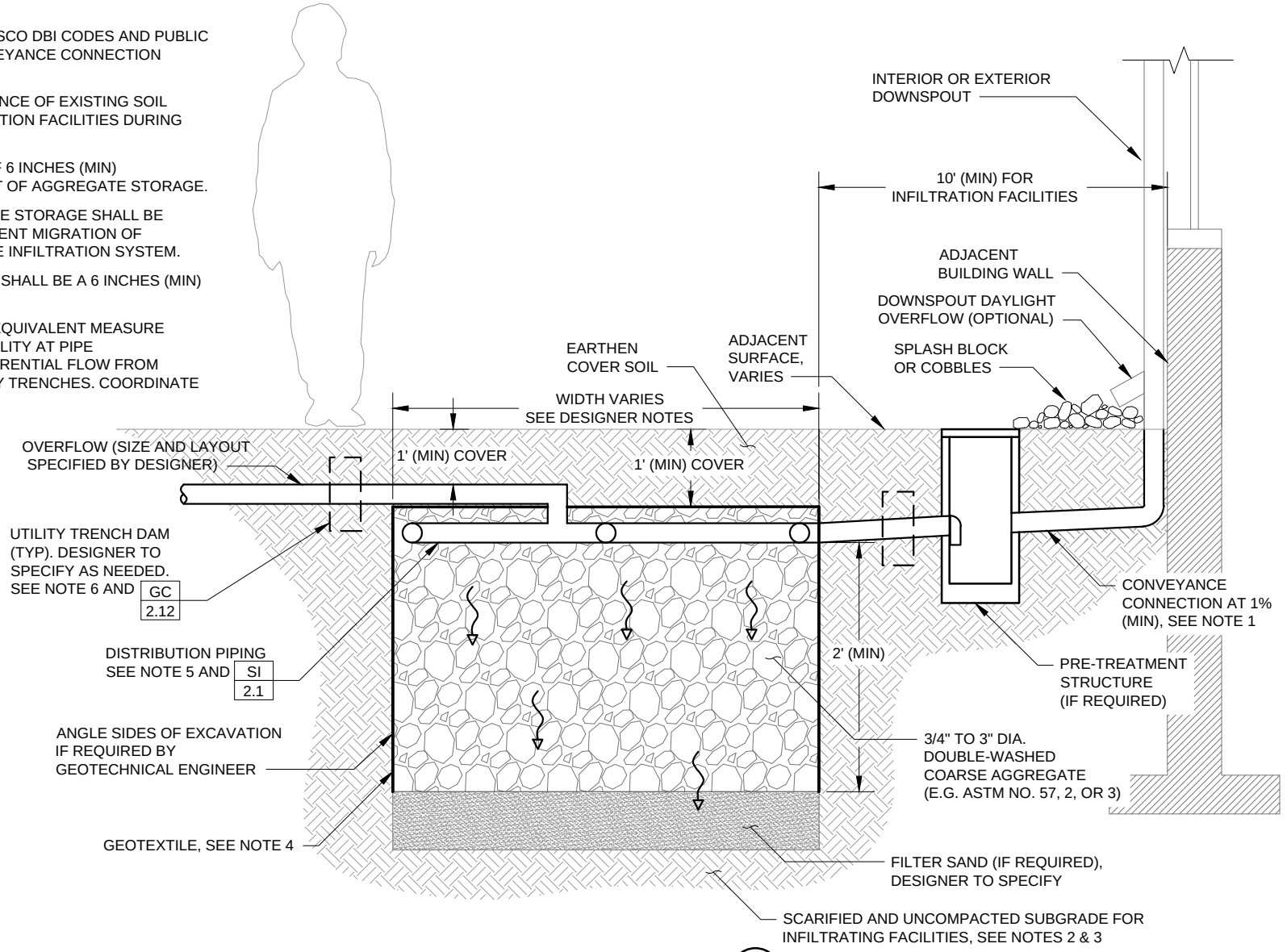
# SUBSURFACE INFILTRATION SYSTEM

## INFILTRATION GALLERY
## LARGE SYSTEM - PLAN

DWG NO. SI 2.1

## CONSTRUCTION NOTES:

1. REFER TO APPLICABLE SAN FRANCISCO DBI CODES AND PUBLIC WORKS REQUIREMENTS FOR CONVEYANCE CONNECTION REQUIREMENTS.
2. AVOID COMPACTION AND DISTURBANCE OF EXISTING SOIL ADJACENT TO AND BELOW INFILTRATION FACILITIES DURING CONSTRUCTION.
3. SCARIFY SUBGRADE TO A DEPTH OF 6 INCHES (MIN) IMMEDIATELY PRIOR TO PLACEMENT OF AGGREGATE STORAGE.
4. SIDEWALLS AND TOP OF AGGREGATE STORAGE SHALL BE LINED WITH A GEOTEXTILE TO PREVENT MIGRATION OF ADJACENT SOILS INTO SUBSURFACE INFILTRATION SYSTEM.
5. SUBSURFACE DISTRIBUTION PIPING SHALL BE A 6 INCHES (MIN) IN DIAMETER.
6. PROVIDE UTILITY TRENCH DAM OR EQUIVALENT MEASURE OUTSIDE OF THE INFILTRATION FACILITY AT PIPE PENETRATIONS TO PREVENT PREFERENTIAL FLOW FROM INFILTRATION GALLERY INTO UTILITY TRENCHES. COORDINATE WITH ENGINEER.




SECTION - ALTERNATIVE 1 (A)

| NOTES | | LARGE SYSTEMS | | SMALL SYSTEMS | |
|---|---|---|---|---|---|
| | | PLAN SECTIONS | | PLAN SECTIONS | |
| SI 1.1 | SI 1.2 | SI 2.1 | SI 2.2 | SI 3.1 | SI 3.2 |

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San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

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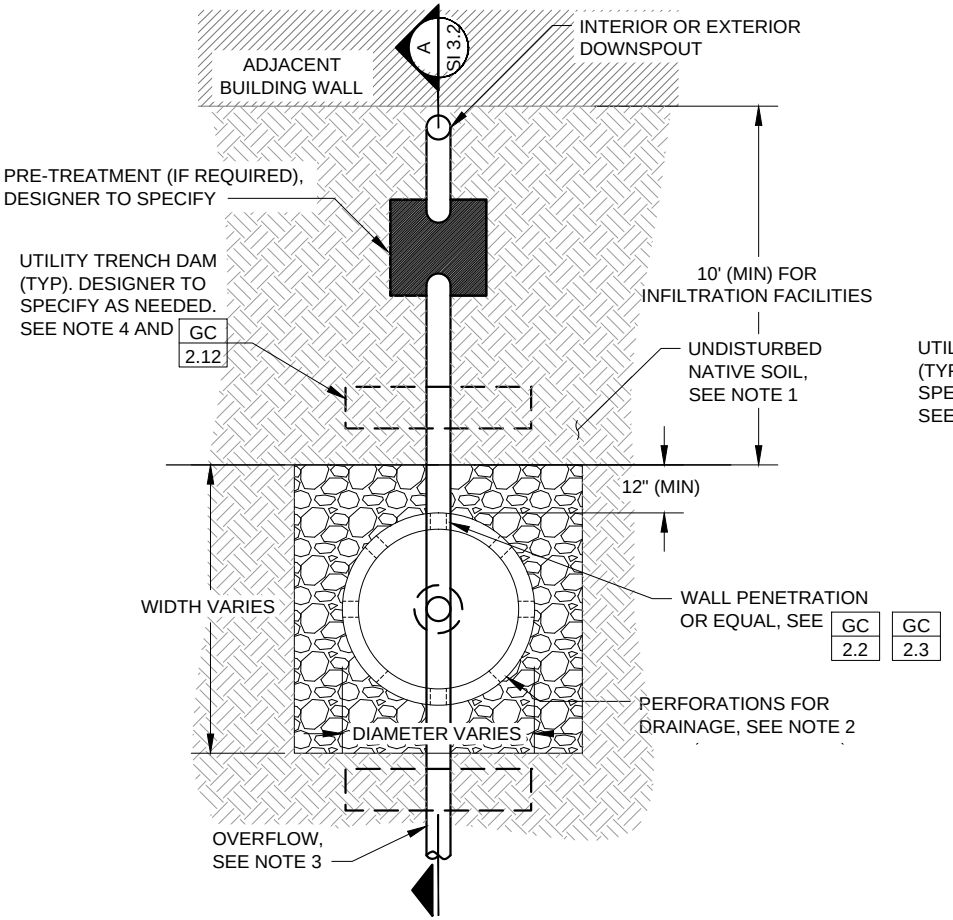
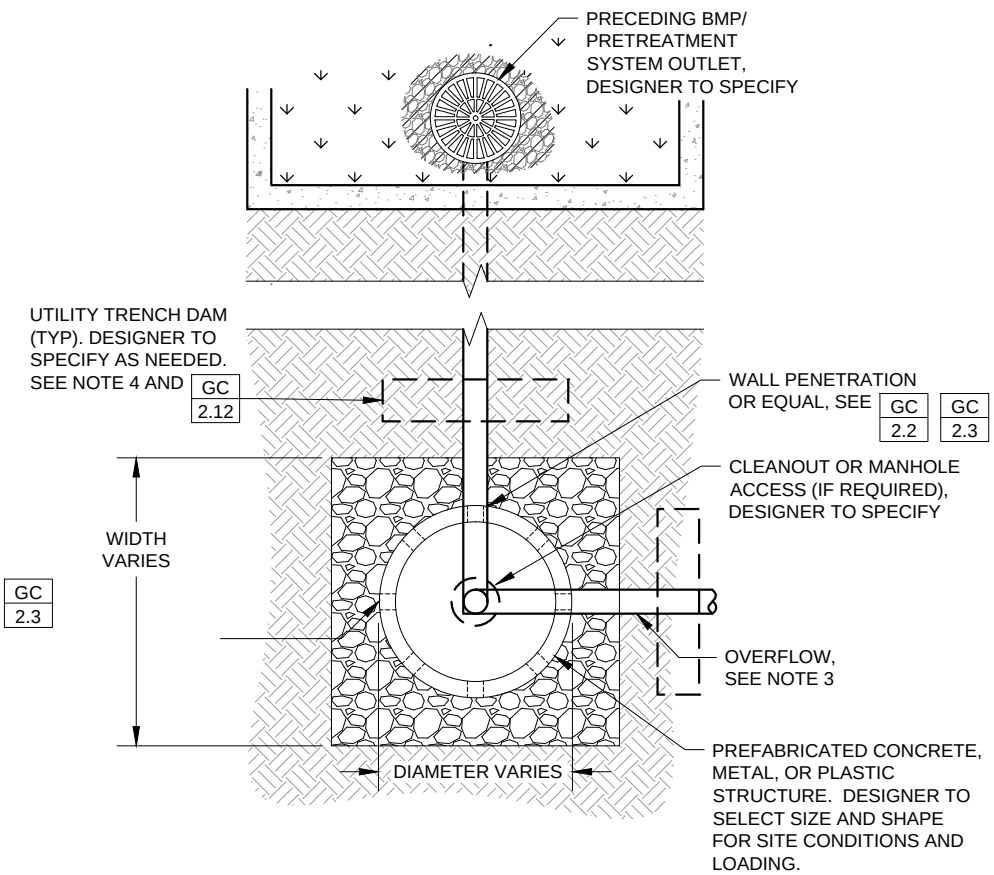
# SUBSURFACE INFILTRATION SYSTEM

## INFILTRATION GALLERY LARGE SYSTEM - SECTION

DWG NO. SI 2.2




PLAN- ALTERNATIVE 1 (1)




PLAN - ALTERNATIVE 2 (2)

## CONSTRUCTION NOTES:

1. AVOID COMPACTION AND DISTURBANCE OF EXISTING SOIL WITHIN 5 FEET ADJACENT TO AND BELOW INFILTRATION FACILITIES DURING CONSTRUCTION.
2. PREFABRICATED DRY WELLS SHALL HAVE SMALL DIAMETER PERFORATIONS TO PREVENT LATERAL MOVEMENT OF AGGREGATE INTO WELL AND SHALL BE SUFFICIENT IN NUMBER TO ALLOW FOR THE DRAINAGE OF THE STRUCTURE WITHIN 48 HOURS.
3. ROUTE OVERFLOW PIPE TO THE STORM SEWER OR TO ANOTHER BMP FOR FURTHER TREATMENT AS SHOWN ON THE DESIGN PLANS.
4. PROVIDE UTILITY TRENCH DAM OR EQUIVALENT MEASURE OUTSIDE OF THE INFILTRATION FACILITY AT PIPE PENETRATIONS TO PREVENT PREFERENTIAL FLOW FROM INFILTRATION GALLERY INTO UTILITY TRENCHES. COORDINATE WITH ENGINEER.

| NOTES | | LARGE SYSTEMS | | SMALL SYSTEMS | |
|---|---|---|---|---|---|
| | | PLAN SECTIONS | | PLAN SECTIONS | |
| SI 1.1 | SI 1.2 | SI 2.1 | SI 2.2 | SI 3.1 | SI 3.2 |

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

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# SUBSURFACE INFILTRATION SYSTEM

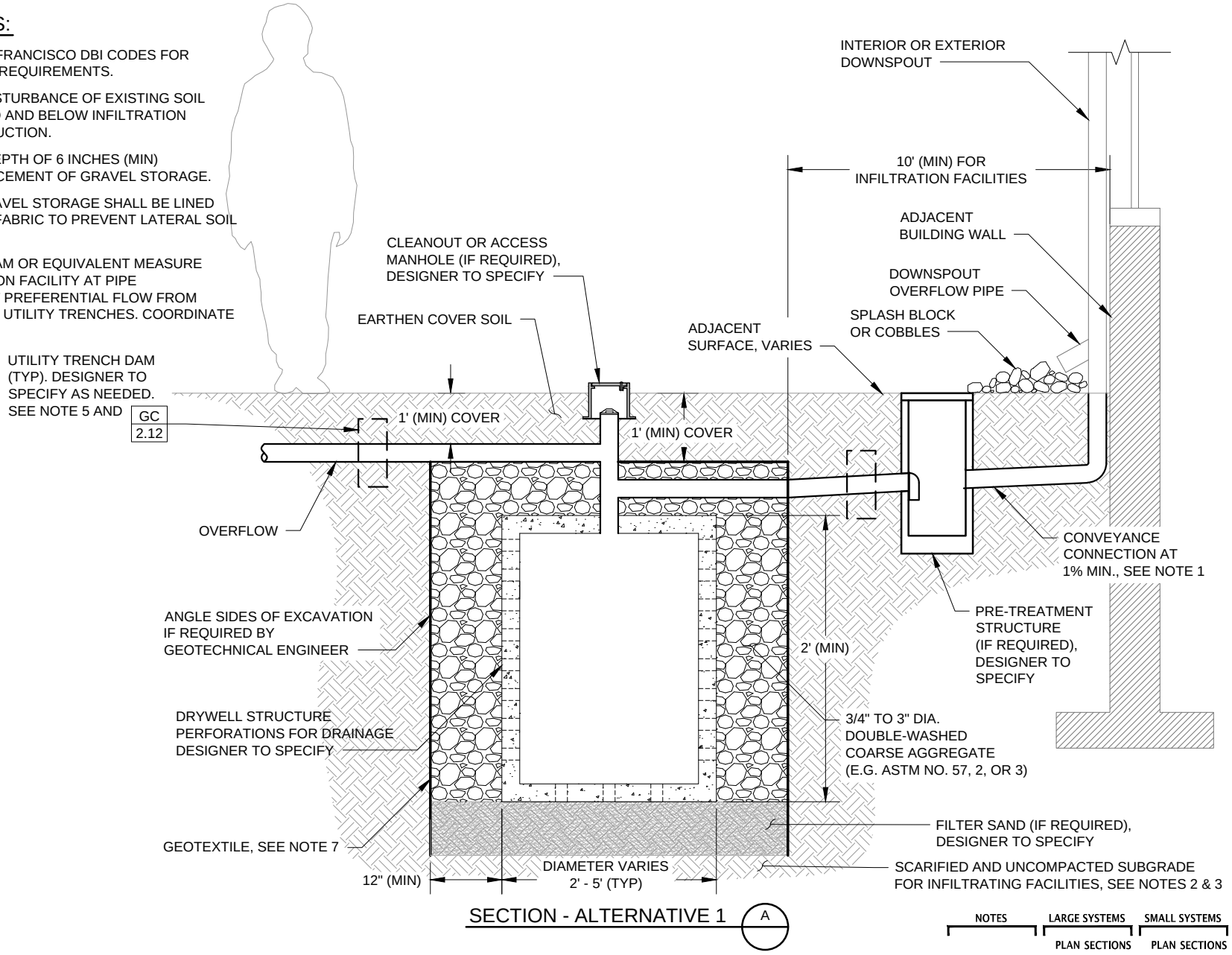
## DRY WELL
## SMALL SYSTEM - PLAN

DWG NO. SI 3.1

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

## CONSTRUCTION NOTES:

1. REFER TO APPLICABLE SAN FRANCISCO DBI CODES FOR CONVEYANCE CONNECTION REQUIREMENTS.
2. AVOID COMPACTION AND DISTURBANCE OF EXISTING SOIL WITHIN 5 FEET ADJACENT TO AND BELOW INFILTRATION FACILITIES DURING CONSTRUCTION.
3. SCARIFY SUBGRADE TO A DEPTH OF 6 INCHES (MIN) IMMEDIATELY PRIOR TO PLACEMENT OF GRAVEL STORAGE.
4. SIDEWALLS AND TOP OF GRAVEL STORAGE SHALL BE LINED WITH A PERMEABLE FILTER FABRIC TO PREVENT LATERAL SOIL MOVEMENT.
5. PROVIDE UTILITY TRENCH DAM OR EQUIVALENT MEASURE OUTSIDE OF THE INFILTRATION FACILITY AT PIPE PENETRATIONS TO PREVENT PREFERENTIAL FLOW FROM INFILTRATION GALLERY INTO UTILITY TRENCHES. COORDINATE WITH ENGINEER.




SECTION - ALTERNATIVE 1 (A)

| NOTES | | LARGE SYSTEMS | | SMALL SYSTEMS | |
|---|---|---|---|---|---|
| | | PLAN SECTIONS | | PLAN SECTIONS | |
| SI 1.1 | SI 1.2 | SI 2.1 | SI 2.2 | SI 3.1 | SI 3.2 |

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San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE: SEPTEMBER 2016
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# SUBSURFACE INFILTRATION SYSTEMS

## DRY WELL
## SMALL SYSTEM - SECTION

DWG NO. SI 3.2

## PURPOSE:

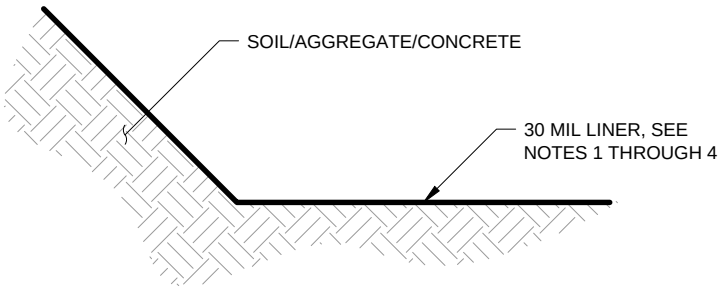
IMPERMEABLE LINERS IN GREEN INFRASTRUCTURE CAN BE USED TO RESTRICT MOVEMENT OF WATER INTO UNDERLYING AND/OR ADJACENT SOILS AND/OR AGGREGATES TO PROTECT SENSITIVE INFRASTRUCTURE (E.G., IMPERMEABLE ROADWAY BASE, FOUNDATIONS, UTILITIES), MITIGATE RISK OF GEOLOGIC HAZARDS (E.G., STEEP SLOPES, CONTAMINATED SOILS), OR OTHER SITE-SPECIFIC CONDITIONS)

## DESIGNER NOTES & GUIDELINES:

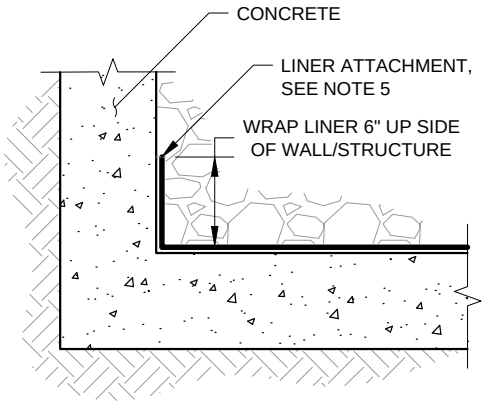
1. THE DESIGNER MUST ADAPT DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. THE DESIGNER AND/OR GEOTECHNICAL ENGINEER SHOULD ASSESS THE RISK OF WATER LEAKAGE FROM THE PLANTER AND DETERMINE THE LINER EXTENTS AND LINER CONNECTION REQUIREMENTS (E.G., WATER TIGHT, SOIL TIGHT), DEPENDING ON DEGREE OF PROTECTION NECESSARY TO PROTECT ADJACENT INFRASTRUCTURE.
6. CONSIDER PLACING GEOTEXTILE ON PREPARED SUBGRADE PRIOR TO PLACEMENT OF LINER TO PROTECT LINER FROM DAMAGE DURING INSTALLATION.
7. DEPENDING ON ANTICIPATED FACILITY MAINTENANCE, IT MAY BE PRUDENT TO INCLUDE A GEOTEXTILE OVER THE LINER TO PROVIDE AN ADDITIONAL BARRIER BETWEEN LINER AND MAINTENANCE EQUIPMENT OR TO PROTECT AGAINST AGGRESSIVE PUNCTURES DURING PLACEMENT AND COMPACTION.

## DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ LINER TYPE AND EXTENTS (E.G., FULL LINER, PARTIAL LINER)
- ☐ LINER ANCHOR TYPE (E.G., WATER TIGHT, SOIL TIGHT)
- ☐ LINER JOINT WELDING/SEALING REQUIREMENTS
- ☐ OTHER CRITICAL PROJECT-SPECIFIC PLACEMENT REQUIREMENTS



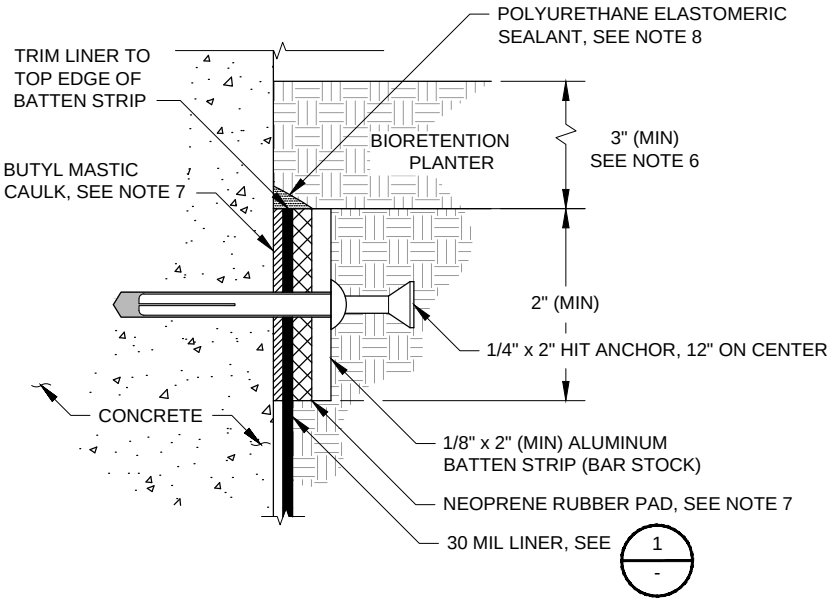

IMPERMEABLE LINER 1




SOIL TIGHT LINER ATTACHMENT AT WALL/STRUCTURE 2

## CONSTRUCTION NOTES:

1. LINER SHALL BE HDPE CONFORMING TO GEOSYNTHETIC RESEARCH INSTITUTE (GRI) GM13 OR LLDPE CONFORMING TO GRI GM17.
2. LINER SHALL LAY FLUSH WITH GROUND WITH NO AIR VOIDS BELOW THE LINER PRIOR TO BACKFILLING MATERIAL ABOVE THE LINER. CONTOUR THE SUBGRADE AS NEEDED TO ENSURE LINER LAYS FLUSH WITH GROUND.
3. OVERLAP LINER PER MANUFACTURER'S RECOMMENDATIONS.
4. ALL SEAMS SHALL BE WELDED PER MANUFACTURER'S RECOMMENDATIONS UNLESS OTHERWISE SPECIFIED.
5. SECURE LINER CONTINUOUSLY WITH DOUBLE-SIDED TAPE ALONG LINER EDGE AND SINGLE SIDED TAPE ALONG THE TOP EDGE OF LINER TO HOLD LINER IN PLACE DURING BACKFILLING.
6. TOP OF LINER TO BE AT LEAST 3" BELOW FINISH GRADE OF BIORETENTION SOIL EXCEPT WHEN ADJACENT TO BUILDING WALL. WHEN ADJACENT TO BUILDING WALL, LINER OR EQUAL WATERPROOFING SHALL EXTEND TO TOP OF FREEBOARD ELEVATION.
7. APPLY BUTYL MASTIC CAULK, BATTEN STRIP, AND NEOPRENE RUBBER PAD CONTINUOUSLY ALONG TOP EDGE OF LINER.
8. APPLY BEAD OF POLYURETHANE ELASTOMERIC SEALANT CONTINUOUSLY ALONG TOP EDGE OF BATTEN STRIP ASSEMBLY.




WATER TIGHT LINER ATTACHMENT AT WALL/STRUCTURE 3

NOTES COMPONENTS

| GC 1.1 | GC 1.2 |
|---|---|

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE SEPTEMBER 2016
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# GENERAL COMPONENTS

## LINERS

## LINERS AND ATTACHMENTS

DWG NO. GC 1.2

## PURPOSE:

WHEN SITING GREEN INFRASTRUCTURE (GI) FACILITIES, THE DESIGNER SHOULD LOCATE AND ASSESS ALL KNOWN UTILITY CROSSINGS AND CONFLICTS AND ADJUST THE DESIGN TO AVOID AS MANY EXISTING UTILITIES AS POSSIBLE. THE CRITICALITY OF UTILITY CONFLICTS IN TERMS OF THEIR POTENTIAL IMPACT TO THE PROJECT'S DESIGN PERFORMANCE, COST, AND SCHEDULE SHOULD BE CAREFULLY EVALUATED DURING THE PLANNING PHASE.

THE PURPOSE OF THE FOLLOWING TYPICAL UTILITY CROSSING DETAILS IS TO ALERT THE DESIGNERS TO COMMON UTILITY CROSSINGS THAT OCCUR ON GI PROJECTS WITHIN THE PUBLIC RIGHT-OF-WAY AND PROVIDE GENERAL GUIDANCE ON THE PROTECTION OF THESE UTILITIES. THEY ARE PROVIDED AS TYPICAL APPLICATIONS AND DO NOT REPRESENT APPROVED CITY UTILITY STANDARDS AND SPECIFICATIONS. IN ADDITION TO THESE TYPICAL DETAILS, DESIGNERS MUST FOLLOW ALL APPLICABLE LOCAL AND FEDERAL REGULATIONS ASSOCIATED WITH THEIR PROJECT.

## DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS AND UTILITY REQUIREMENTS AND OBTAIN APPROVAL FROM ALL RELEVANT UTILITY PROVIDERS PRIOR TO CONSTRUCTION. COORDINATION AND APPROVAL FROM THE FOLLOWING UTILITY PROVIDERS MAY BE NECESSARY, BUT NOT EXCLUSIVELY:
   - SFPUC CITY DISTRIBUTION DIVISION (CDD) FOR DOMESTIC/RECYCLED/FIRE WATER
   - SFPUC WASTEWATER ENTERPRISE (WWE) FOR SANITARY/STORM/SEWER
   - PACIFIC GAS ELECTRIC (PGE) FOR ELECTRIC/GAS/UTILITY POLES
   - SFMTA FOR TRAFFIC SIGNAL/STREET SIGNS/PARKING METERS/BUS STOPS AND CATENARY POLES.
2. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT SFPUC ASSET PROTECTION STANDARDS. NOTE WHICH UTILITY APPURTENANCES (I.E. CLEANOUT VENTS, WATER METER BOXES, HYDRANTS, VALVES, ETC.) ARE NOT ALLOWED WITHIN BIORETENTION PLANTERS. REFER TO THE SFPUC SEWER LATERAL DETAILS FOR THE PLACEMENT OF CLEANOUT VENTS WITHIN BIORETENTION PLANTERS. PER CURRENT STANDARDS, POTABLE WATER DISTRIBUTION MAINS ARE NOT PERMITTED TO RUN UNDER OR THROUGH BIORETENTION PLANTERS.
3. UTILITY CONFLICTS SHALL BE MITIGATED PER SFPUC SURFACE IMPROVEMENT STANDARDS AND OTHER UTILITY PROVIDER REQUIREMENTS. ENGINEER TO EVALUATE CONDITIONS AND NEED TO INCLUDE MEASURES TO ENSURE WATER TIGHT UTILITY PENETRATIONS THROUGH PLANTER WALL, AS NEEDED AND TO PREVENT PREFERENTIAL FLOW INTO UTILITY TRENCHES (E.G., WATER STOP, TRENCH BLOCK, OR TRENCH COLLAR). (REFER TO **GC 2.9** - **2.12**)
4. THE DESIGNER MUST DETERMINE THE TYPE OF PROTECTION MEASURE(S) REQUIRED BASED ON THE SITE-SPECIFIC CONDITIONS, UTILITY REQUIREMENTS, AND THE FUNCTION THE PROTECTION MEASURE MUST PERFORM. THE FOLLOWING ARE BRIEF DESCRIPTIONS OF THE PROTECTION MEASURES INCLUDED IN THESE DETAILS:
   a. SOIL OR ENGINEERED FILL WITH OVERLYING IMPERMEABLE LINER: PROTECTS UTILITY FROM DAMAGE DURING FUTURE TRENCHING, EXCAVATION, AND LANDSCAPE ACTIVITIES. THE LINER PREVENTS PREFERENTIAL FLOW OF WATER INTO THE UTILITY TRENCH. THESE METHODS ARE GENERALLY ONLY ACCEPTABLE WHEN THE FACILITY DOES NOT INCLUDE AN UNDERDRAIN OR WHEN THE LINER CAN BE LOCATED BELOW THE INVERT OF THE UNDERDRAIN.
   b. SLEEVE/CASING: BY HOUSING THE UTILITY PIPE WITHIN A LARGER CARRIER PIPE OR APPROVED SPLIT SLEEVE PRODUCT, THE UTILITY PIPE CAN BE REPLACED IF NEEDED IN THE FUTURE WITHOUT SIGNIFICANT IMPACT TO THE OVERLYING INFRASTRUCTURE. THE SLEEVE ALSO PROTECTS THE PIPE FROM IMPACT DURING CONSTRUCTION AND FUTURE TRENCHING, EXCAVATION, AND LANDSCAPE ACTIVITIES. ADDITIONALLY, SLEEVES CAN BE USED TO SEAL THE UTILITY FROM THE INFILTRATED STORMWATER AND/OR PROTECT THE INFILTRATION FACILITY FROM SEWER LATERAL LEAKAGES. SEE THE UTILITY SLEEVE GUIDANCE.
   c. UTILITY TRENCH DAM: WHERE UTILITY TRENCHES CROSS UNDER INFILTRATIVE FACILITIES, SUBSURFACE WATER MAY PREFERENTIALLY FLOW THROUGH THE TRENCH AND CAUSE DAMAGE TO DOWNSTREAM INFRASTRUCTURE. RISKS INCLUDE BACKFILL EROSION, CREATION OF VOIDS, THE DEGRADATION OF OVERLYING FILL/PAVEMENT, AND SUBSURFACE WATER BEING DIRECTED TO BUILDING FOUNDATIONS OR BASEMENTS. UTILITY TRENCH DAMS PLACED OUTSIDE OF THE INFILTRATION FACILITY FOOTPRINT PREVENT WATER FROM TRAVELING FURTHER ALONG THE UTILITY TRENCH.
   d. INSULATING WRAP: PROVIDES IMPACT AND WATER PROTECTION FOR EXISTING SHALLOW UTILITY SERVICE LINES THAT ARE REMAINING IN PLACE WITHIN INFILTRATION FACILITIES.
6. FOR PERMEABLE PAVEMENT FACILITIES, UTILITY CROSSINGS SHOULD BE BELOW THE BOTTOM OF THE STRUCTURAL PAVEMENT SECTION, WHENEVER POSSIBLE. IF UTILITIES ENCROACH INTO THIS SECTION, THE ENGINEER SHALL CONFIRM THAT THE STRUCTURAL INTEGRITY OF THE PAVEMENT CAN BE MAINTAINED OVER THE UTILITY.
7. THE AREA OF SUBBASE COVERED BY SUBSURFACE CHECK DAMS, IMPERMEABLE LINERS, COMPACTED ENGINEERED FILL, CONCRETE PADS AND OTHER UTILITY INFRASTRUCTURE SHOULD BE EXCLUDED FROM HYDROLOGIC PERFORMANCE CALCULATIONS WHEN THE AREA IS SIGNIFICANT (GREATER THAN 10 PERCENT) RELATIVE TO THE INFILTRATIVE AREA.


| NOTES | | BIORETENTION | | | PERMEABLE PAVEMENT | | | WALL PENETRATIONS | | | TRENCH DAM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GC 2.1 | GC 2.2 | GC 2.3 | GC 2.4 | GC 2.5 | GC 2.6 | GC 2.7 | GC 2.8 | GC 2.9 | GC 2.10 | GC 2.11 | GC 2.12 |

## UTILITY SLEEVE NOTES AND GUIDANCE:

THE DESIGNER MUST SPECIFY THE TYPE OF SLEEVE METHOD AND MATERIALS THAT SHALL BE USED FOR ALL APPLICABLE NEW AND EXISTING UTILITIES TO REMAIN IN PLACE WITHIN THE FOOTPRINT OF INFILTRATION FACILITIES. DEPENDING ON THE SPECIFIC SITE CONDITIONS AND GOVERNING UTILITY STANDARDS, EXISTING UTILITIES TO REMAIN IN PLACE SHALL BE SLEEVED THE ENTIRE LENGTH WITHIN THE INFILTRATION FACILITY USING ONE OF THE FOLLOWING METHODS OR AN APPROVED EQUAL:

a. PLASTIC PIPE, 1 - 2 SIZES LARGER THAN UTILITY PIPE, CUT IN HALF, PLACED AROUND UTILITY PIPE, SEALED ALONG JOINTS WITH ADHESIVE, AND CLAMPED TOGETHER WITH STAINLESS STEEL BANDS/HOSE CLAMPS. PIPE SUPPORTS (E.G. CLOSED CELL FOAM BLOCKING) WITHIN THE SLEEVE PER UTILITY PROVIDER'S REQUIREMENTS.

b. GEORGE FISCHER "CONTAIN-IT" PIPE CONTAINMENT SYSTEM PRODUCT, PART NO. 8326-040AA OR 8326-060AA OR EQUAL, INSTALLED PER MANUFACTURER'S RECOMMENDATIONS.

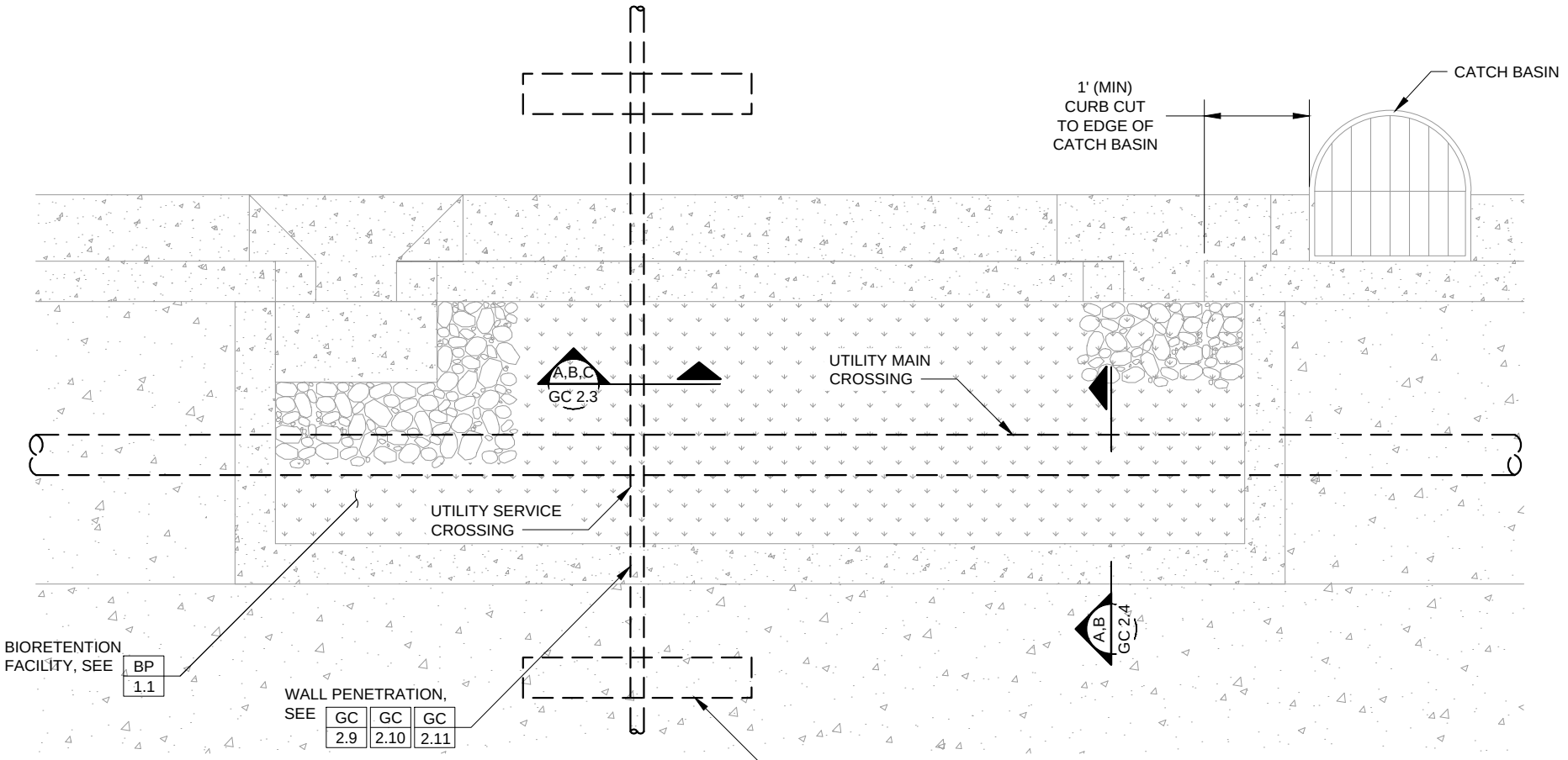
c. STAINLESS STEEL SPLIT SLEEVE PRODUCT INSTALLED AROUND THE EXISTING PIPE AND POSITIONED IN THE FORM TO CENTER THE UTILITY PIPE. AFTER INSTALLATION, THE MANUFACTURER'S RECOMMENDED MATERIAL IS USED TO SEAL THE ANNULAR SPACE BETWEEN THE SPLIT SLEEVE AND PIPE. USE PIPE SEAL AND INSULATOR INC., WS SPLIT SEALWALL SLEEVE, OR EQUAL.

## EXISTING UTILITY COORDINATION NOTES:

1. THE DESIGNER SHALL LOCATE ALL EXISTING UTILITIES WITHIN THE PROJECT AREA TO THE MOST PRACTICAL EXTENT POSSIBLE UTILIZING SITE SURVEYS, AS-BUILT PLANS, SITE INVESTIGATIONS, POTHOLING, UTILITY AGENCY DATA, ETC. AND PRESENT THIS INFORMATION AND SOURCE (I.E. AS-BUILT VS. ASSUMED LOCATION) CLEARLY ON THE DESIGN DRAWINGS. THE ASSUMED LOCATION OF EXISTING UTILITIES SHALL BE PROVIDED IN THE SAME COORDINATE SYSTEM AS THE REST OF THE DESIGN DRAWINGS. DESIGN DRAWINGS SHALL ALSO INCLUDE CONTACT INFORMATION FOR ANY UTILITIES AFFECTED BY THE PROJECT.
2. IF AN EXISTING UTILITY HAS THE POTENTIAL TO IMPACT THE PROJECT DESIGN AND/OR THE PERFORMANCE OF THE GI FACILITY, THE EXACT LOCATION, DEPTH, AND CONDITION OF THIS UTILITY SHOULD BE FIELD VERIFIED DURING THE DESIGN PHASE (VIA POTHOLING OR OTHER APPROVED METHOD) TO PREVENT COSTLY REDESIGNS AND/OR PROJECT DELAYS DURING CONSTRUCTION.
3. THE CONTRACTOR SHALL VERIFY THE LOCATIONS AND DEPTH OF EXISTING UTILITIES AT THE START OF CONSTRUCTION PER THE PROJECT SPECIFICATIONS. ANY DISCREPANCIES BETWEEN THE EXISTING UTILITIES SHOWN IN THE DESIGN DRAWINGS AND THE ACTUAL FIELD CONDITIONS SHOULD BE COMMUNICATED TO THE ENGINEER IMMEDIATELY.
4. THE CHECK DAM SPACING AND HEIGHT SPECIFIED ON THE DESIGN PLANS MUST BE MAINTAINED. IF THE CHECK DAM PROTECTING THE EXISTING UTILITY WILL IMPACT THE CHECK DAM SPACING SPECIFIED ON THE PLANS, THE ENGINEER MUST EVALUATE ITS IMPACT ON THE HYDROLOGIC PERFORMANCE AND APPROVE THE VARIANCE. SEE **PC 2.1** AND **PC 2.2** FOR FURTHER DETAILS.

## DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ LINER EMBEDMENT DEPTH INTO SUBGRADE SOILS
- ☐ PIPE AND SLEEVE MATERIALS AND DIAMETER FOR ALL WALL PENETRATIONS
- ☐ WALL PENETRATION TYPE (E.G., GROUTED, COMPRESSION, BOOT) SEE **GC 2.9 - 2.11**.
- ☐ GEOTEXTILE FABRICS AND/OR LINER MATERIALS
- ☐ ENGINEERED BACKFILL MATERIAL
- ☐ DIMENSIONS OF ALL PROTECTION MEASURES
- ☐ MINIMUM SETBACKS TO ADJACENT INFRASTRUCTURE, PAVEMENT BASES, SURFACES
- ☐ MINIMUM PIPE COVER AS REQUIRED BY UTILITY PROVIDER




## CONSTRUCTION NOTES:

1. ABANDONED UTILITIES WITHIN FOOTPRINT OF FACILITY AND OBSERVED DURING CONSTRUCTION MUST BE REMOVED. COORDINATE WITH MUNICIPAL OR PRIVATE OWNER AND ENGINEER.
2. PROVIDE UTILITY TRENCH DAM OR EQUIVALENT MEASURE OUTSIDE OF THE INFILTRATION FACILITY AT PIPE PENETRATIONS TO PREVENT PREFERENTIAL FLOW FROM INFILTRATION GALLERY INTO UTILITY TRENCHES. COORDINATE WITH ENGINEER.



San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

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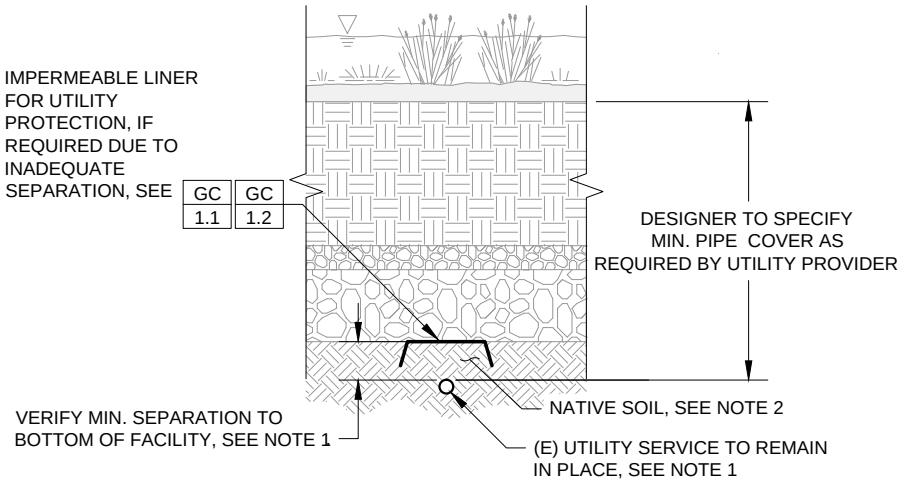
# GENERAL COMPONENTS

## UTILITY CROSSINGS

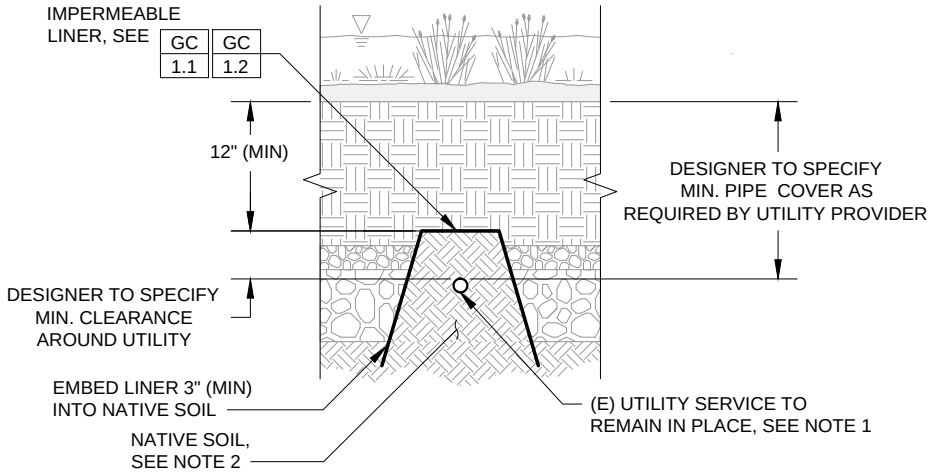
## BIORETENTION

DWG NO. GC 2.3

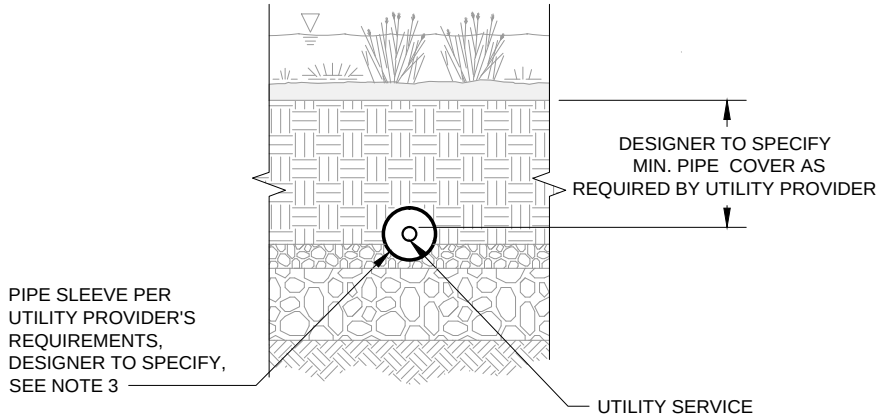
NOT FOR CONSTRUCTION - REFER TO USER GUIDE




SHALLOW UTILITY SERVICE UNDER BIORETENTION FACILITY — A




SHALLOW UTILITY SERVICE WITHIN BIORETENTION FACILITY — B




SLEEVED UTILITY SERVICE WITHIN BIORETENTION FACILITY — C

## CONSTRUCTION NOTES:

1. CONTRACTOR SHALL LOCATE AND DETERMINE DEPTH OF EXISTING UTILITY WITHIN THE FOOTPRINT OF THE BIORETENTION FACILITY WHILE LIMITING THE AMOUNT OF DISTURBANCE TO THE SOIL/BACKFILL MATERIAL OVER AND AROUND THE UTILITY PIPE. IF ELECTROMAGNETIC UTILITY LOCATING, POTHOLING, OR OTHER METHOD REVEALS THAT THE UTILITY PIPE DOES NOT MEET THE REQUIRED CLEARANCE FROM THE BOTTOM OF THE BIORETENTION FACILITY, THE UTILITY PROVIDER MAY REQUIRE THAT PROTECTION MEASURES, SUCH AS THOSE SHOWN ON THIS PLAN, BE IMPLEMENTED PER THEIR STANDARDS. ANY DISCREPANCIES BETWEEN THE EXISTING UTILITIES SHOWN IN THE DESIGN DRAWINGS AND THE ACTUAL FIELD CONDITIONS SHOULD BE COMMUNICATED TO THE ENGINEER IMMEDIATELY.
2. EXISTING UTILITIES AND NATIVE SOIL AROUND EXISTING UTILITIES SHOULD REMAIN IN PLACE WHERE POSSIBLE. IF A PORTION OR ALL OF THE UTILITY IS UNCOVERED DURING EXCAVATION OR EXISTING SOIL WITHIN 1 FOOT OF THE KNOWN EXISTING UTILITY IS SCARIFIED, NATIVE SOIL OR APPROVED ENGINEERED BACKFILL SHALL BE CAREFULLY PLACED AND COMPACTED AROUND THE UTILITY PER THE UTILITY PROVIDER'S REQUIREMENTS.
3. UTILITY PROVIDER MAY ALLOW UTILITY SERVICES TO BE LEFT IN PLACE AND WRAPPED WITH A WATERTIGHT WRAP OR TAPE IN LIEU OF A SLEEVE. THIS MUST BE APPROVED PRIOR TO THE START OF CONSTRUCTION.


| NOTES | | BIORETENTION | | | PERMEABLE PAVEMENT | | | WALL PENETRATIONS | | | TRENCH DAM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GC 2.1 | GC 2.2 | GC 2.3 | GC 2.4 | GC 2.5 | GC 2.6 | GC 2.7 | GC 2.8 | GC 2.9 | GC 2.10 | GC 2.11 | GC 2.12 |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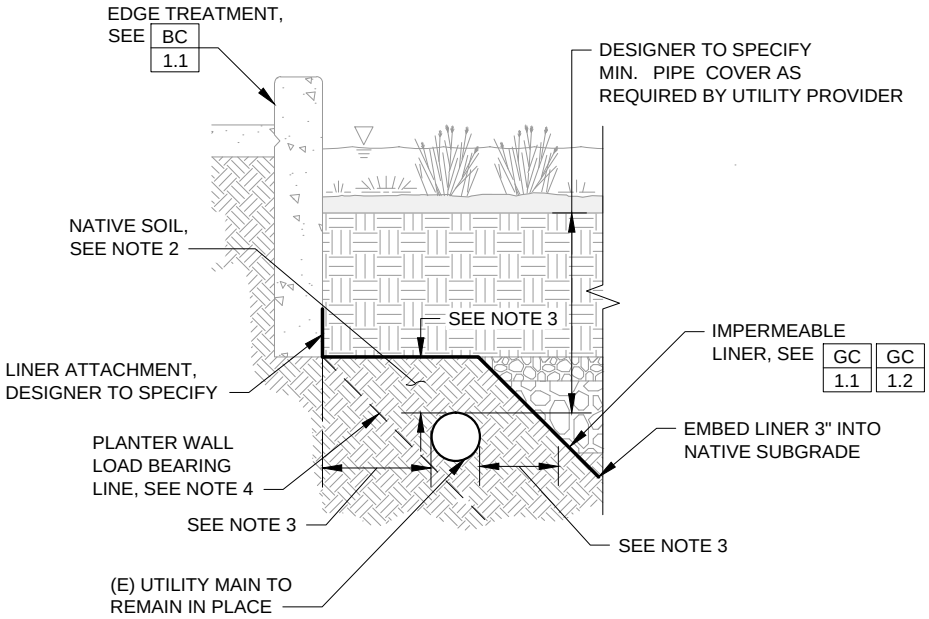
# GENERAL COMPONENTS

## UTILITY CROSSINGS

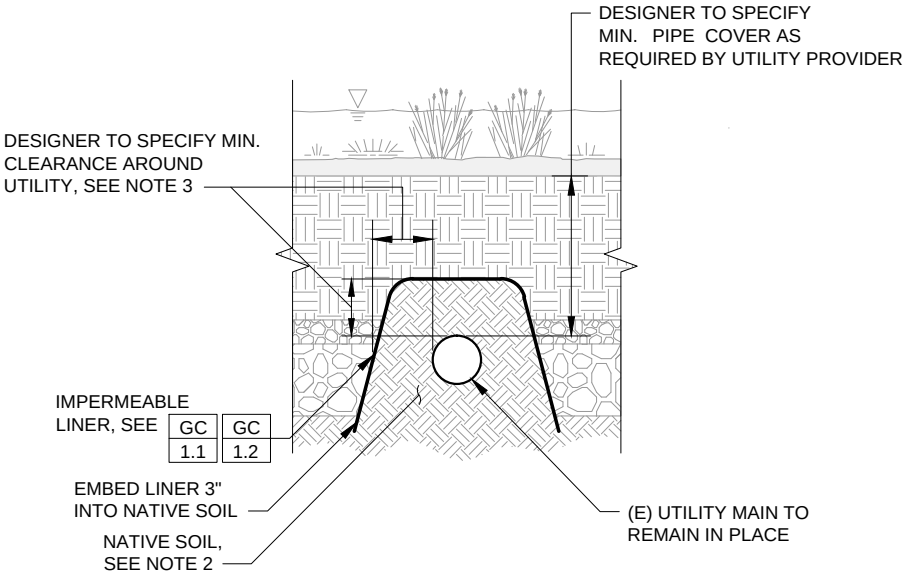
## BIORETENTION SECTIONS (1 OF 2)

DWG NO. GC 2.4

NOT FOR CONSTRUCTION - REFER TO USER GUIDE




UTILITY MAIN ADJACENT TO PLANTER WALL — A

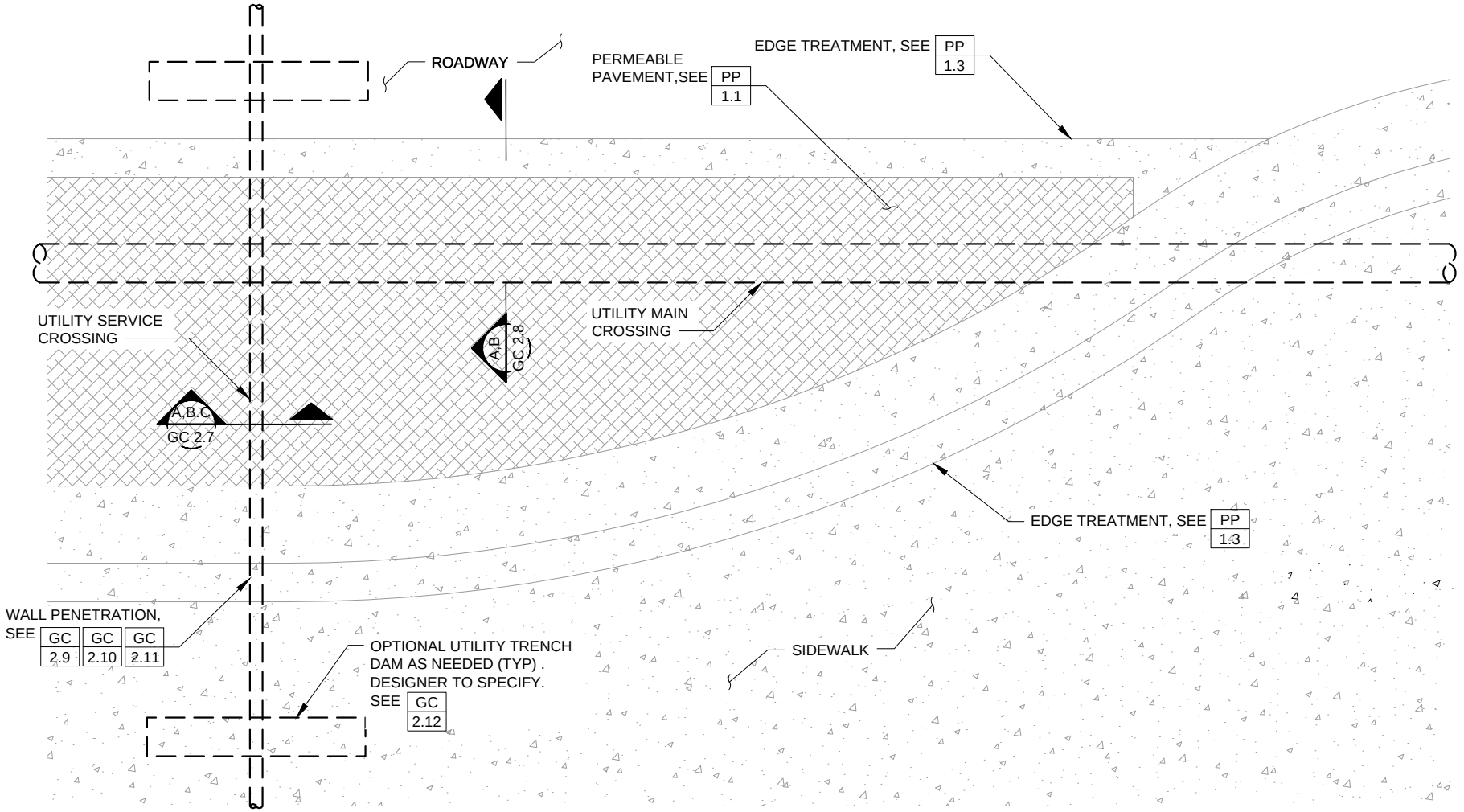



SHALLOW UTILITY MAIN WITHIN BIORETENTION FACILITY — B

## CONSTRUCTION NOTES:

1. ANY DISCREPANCIES BETWEEN THE EXISTING UTILITIES SHOWN IN THE DESIGN DRAWINGS AND THE ACTUAL FIELD CONDITIONS SHOULD BE COMMUNICATED TO THE ENGINEER IMMEDIATELY.
2. EXISTING UTILITIES AND NATIVE SOIL AROUND EXISTING UTILITIES SHOULD REMAIN IN PLACE WHERE POSSIBLE. IF A PORTION OR ALL OF THE UTILITY IS UNCOVERED DURING EXCAVATION OR EXISTING SOIL WITHIN 1 FOOT OF THE KNOWN EXISTING UTILITY IS SCARIFIED, NATIVE SOIL OR APPROVED ENGINEERED BACKFILL SHALL BE CAREFULLY PLACED AND COMPACTED AROUND THE UTILITY PER THE UTILITY PROVIDER'S REQUIREMENTS.
3. PROVIDE THE MINIMUM CLEARANCE AROUND THE UTILITY MAIN AND SETBACKS FROM STRUCTURAL ELEMENTS PER THE UTILITY PROVIDER'S REQUIREMENTS.
4. UTILITY MAINS SHALL NOT BE SUBJECT TO LOADING FROM NEW PLANTER WALLS. LOAD BEARING LINES TO BE DETERMINED BY THE GEOTECHNICAL ENGINEER.


| NOTES | | BIORETENTION | | | PERMEABLE PAVEMENT | | | WALL PENETRATIONS | | | TRENCH DAM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GC 2.1 | GC 2.2 | GC 2.3 | GC 2.4 | GC 2.5 | GC 2.6 | GC 2.7 | GC 2.8 | GC 2.9 | GC 2.10 | GC 2.11 | GC 2.12 |




## CONSTRUCTION NOTES:

1. ABANDONED UTILITIES WITHIN FOOTPRINT OF FACILITY AND OBSERVED DURING CONSTRUCTION MUST BE REMOVED. COORDINATE WITH MUNICIPAL OR PRIVATE OWNER AND ENGINEER.
2. PROVIDE UTILITY TRENCH DAM OR EQUIVALENT MEASURE OUTSIDE OF THE INFILTRATION FACILITY AT PIPE PENETRATIONS TO PREVENT PREFERENTIAL FLOW FROM INFILTRATION GALLERY INTO UTILITY TRENCHES. COORDINATE WITH ENGINEER.


| NOTES | | BIORETENTION | | | PERMEABLE PAVEMENT | | | WALL PENETRATIONS | | | TRENCH DAM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GC 2.1 | GC 2.2 | GC 2.3 | GC 2.4 | GC 2.5 | GC 2.6 | GC 2.7 | GC 2.8 | GC 2.9 | GC 2.10 | GC 2.11 | GC 2.12 |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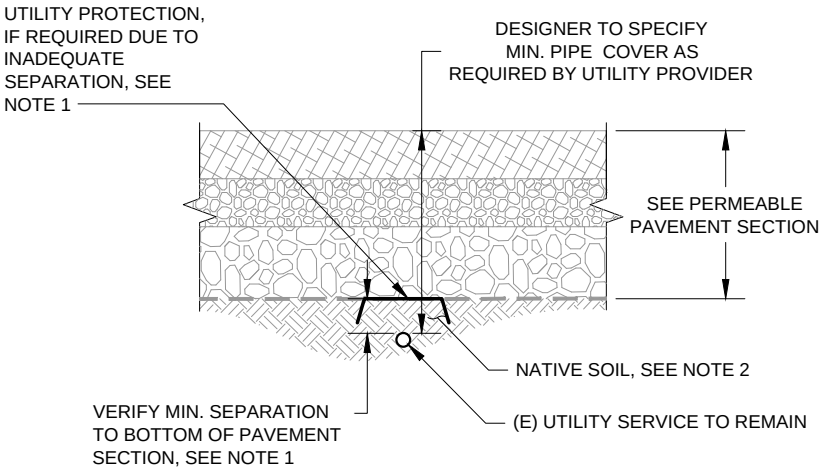
# GENERAL COMPONENTS

## UTILITY CROSSINGS

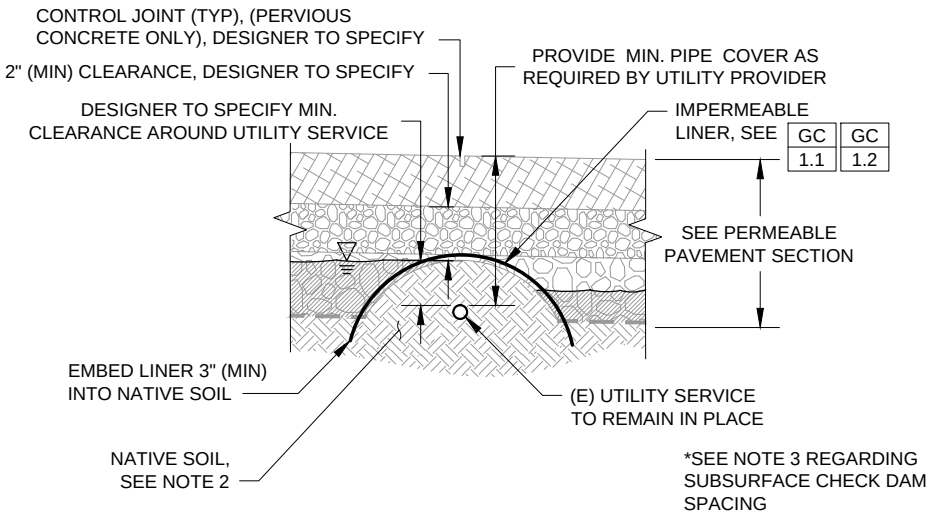
## PERMEABLE PAVEMENT

DWG NO. GC 2.6

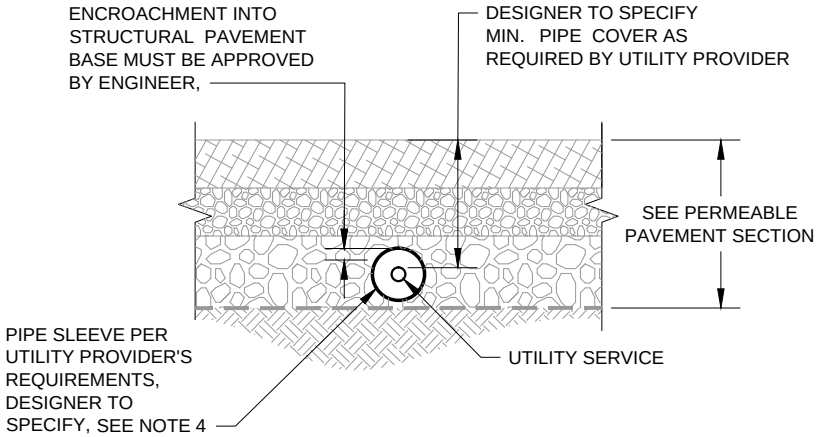
NOT FOR CONSTRUCTION - REFER TO USER GUIDE




SHALLOW UTILITY SERVICE UNDER PERMEABLE PAVEMENT — A




SHALLOW UTILITY SERVICE WITHIN SUBSURFACE CHECK DAM — B




SLEEVED UTILITY SERVICE WITHIN PERMEABLE PAVEMENT — C

## CONSTRUCTION NOTES:

1. CONTRACTOR SHALL LOCATE AND DETERMINE DEPTH OF EXISTING UTILITY WITHIN THE FOOTPRINT OF THE PERMEABLE PAVEMENT FACILITY WHILE LIMITING THE AMOUNT OF DISTURBANCE TO THE SOIL/BACKFILL MATERIAL OVER AND AROUND THE UTILITY PIPE. IF ELECTROMAGNETIC UTILITY LOCATING, POTHOLING, OR OTHER METHOD REVEALS THAT THE UTILITY PIPE DOES NOT MEET THE REQUIRED SETBACK FROM THE BOTTOM OF THE PERMEABLE PAVEMENT SECTION, THE UTILITY PROVIDER MAY REQUIRE THAT PROTECTION MEASURES, SUCH AS THOSE SHOWN ON THIS PLAN, BE IMPLEMENTED.
2. EXISTING UTILITIES AND NATIVE SOIL AROUND EXISTING UTILITIES SHOULD REMAIN IN PLACE WHERE POSSIBLE. IF A PORTION OR ALL OF THE UTILITY IS UNCOVERED DURING EXCAVATION OR EXISTING SOIL WITHIN 1 FOOT OF THE KNOWN EXISTING UTILITY IS SCARIFIED, NATIVE SOIL OR APPROVED ENGINEERED BACKFILL SHALL BE CAREFULLY PLACED AND COMPACTED AROUND THE UTILITY PER THE UTILITY PROVIDER'S REQUIREMENTS.
3. THE CHECK DAM SPACING AND HEIGHT SPECIFIED ON THE DESIGN PLANS MUST BE MAINTAINED. IF THE CHECK DAM PROTECTING THE EXISTING UTILITY WILL IMPACT THE CHECK DAM SPACING SPECIFIED ON THE PLANS, COORDINATE WITH ENGINEER.
4. UTILITY PROVIDER MAY ALLOW SHALLOW UTILITY SERVICES TO BE LEFT IN PLACE AND WRAPPED WITH A WATERTIGHT WRAP OR TAPE IN LIEU OF A SLEEVE. THIS SHOULD BE APPROVED PRIOR TO THE START OF CONSTRUCTION.

| NOTES | | BIORETENTION | | | PERMEABLE PAVEMENT | | | WALL PENETRATIONS | | | TRENCH DAM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GC 2.1 | GC 2.2 | GC 2.3 | GC 2.4 | GC 2.5 | GC 2.6 | GC 2.7 | GC 2.8 | GC 2.9 | GC 2.10 | GC 2.11 | GC 2.12 |

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

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# GREEN INFRASTRUCTURE TYPICAL DETAILS

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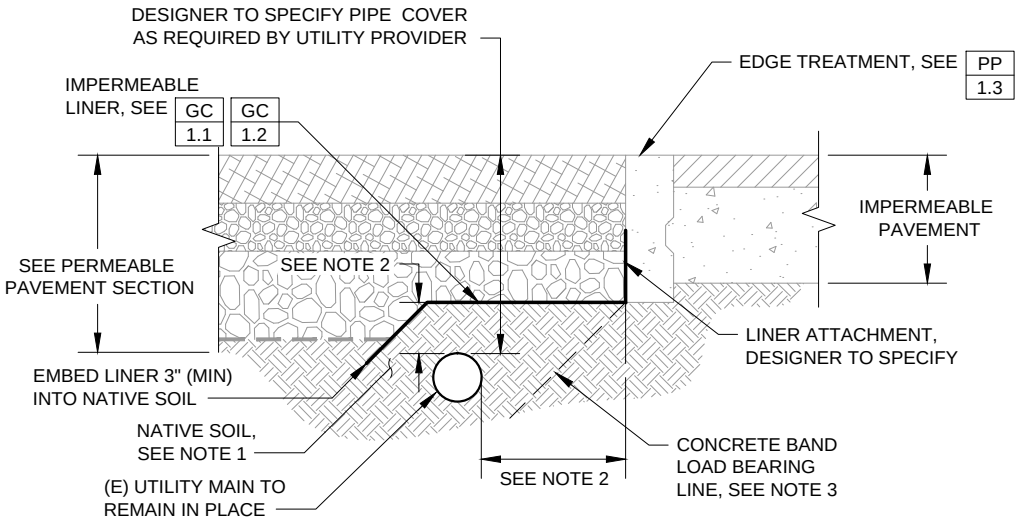
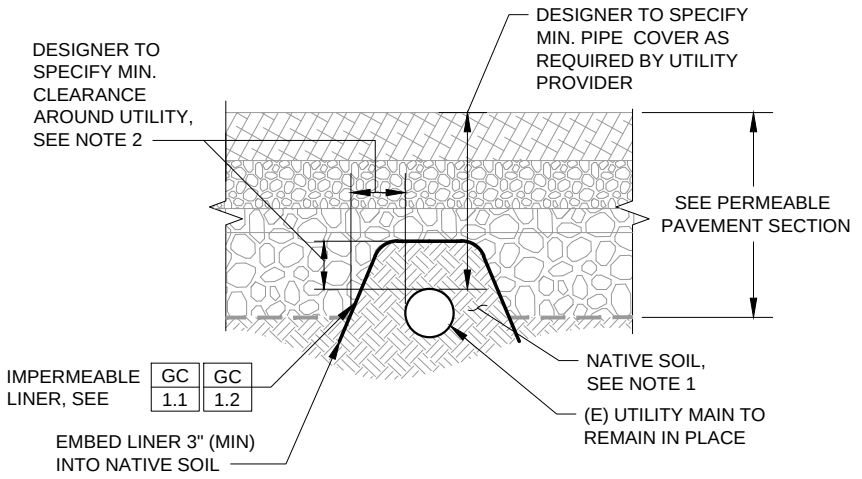
# GENERAL COMPONENTS

## UTILITY CROSSINGS PERMEABLE PAVEMENT SECTIONS (1 OF 2)

DWG NO. GC 2.7




UTILITY MAIN WITHIN PERMEABLE PAVEMENT AND ADJACENT TO EDGE RESTRAINT — A




UTILITY MAIN WITHIN PERMEABLE PAVEMENT — B

## CONSTRUCTION NOTES:

1. EXISTING UTILITIES AND NATIVE SOIL AROUND EXISTING UTILITIES SHOULD REMAIN IN PLACE WHERE POSSIBLE. IF A PORTION OR ALL OF THE UTILITY IS UNCOVERED DURING EXCAVATION OR EXISTING SOIL WITHIN 1 FOOT OF THE KNOWN EXISTING UTILITY IS SCARIFIED, NATIVE SOIL OR APPROVED ENGINEERED BACKFILL SHALL BE CAREFULLY PLACED AND COMPACTED AROUND THE UTILITY PER THE UTILITY PROVIDER'S REQUIREMENTS.
2. PROVIDE THE MINIMUM CLEARANCE AROUND THE UTILITY MAIN AND SETBACKS FROM STRUCTURAL ELEMENTS PER THE UTILITY PROVIDER'S REQUIREMENTS.
3. UTILITY MAINS SHALL NOT BE SUBJECT TO LOADING FROM NEW CURBS/WALLS. LOAD BEARING LINES TO BE DETERMINED BY THE GEOTECHNICAL ENGINEER.


| NOTES | | BIORETENTION | | | PERMEABLE PAVEMENT | | | WALL PENETRATIONS | | | TRENCH DAM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GC 2.1 | GC 2.2 | GC 2.3 | GC 2.4 | GC 2.5 | GC 2.6 | GC 2.7 | GC 2.8 | GC 2.9 | GC 2.10 | GC 2.11 | GC 2.12 |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# GREEN INFRASTRUCTURE TYPICAL DETAILS

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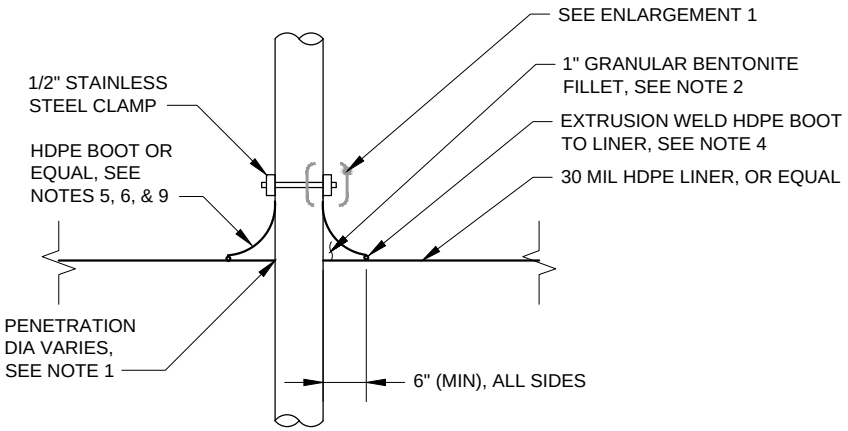
## GENERAL COMPONENTS

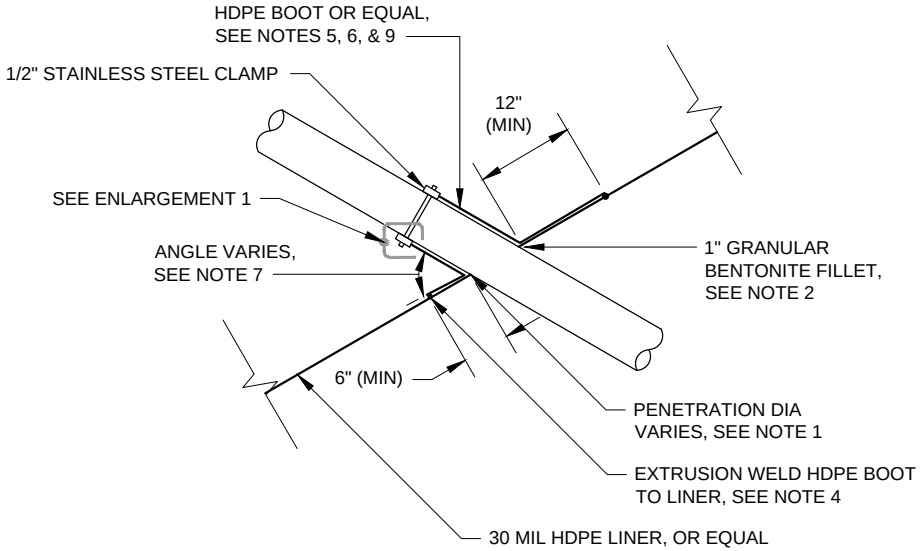
UTILITY CROSSINGS PERMEABLE PAVEMENT SECTIONS (2 OF 2)

DWG NO. GC 2.8

NOT FOR CONSTRUCTION - REFER TO USER GUIDE



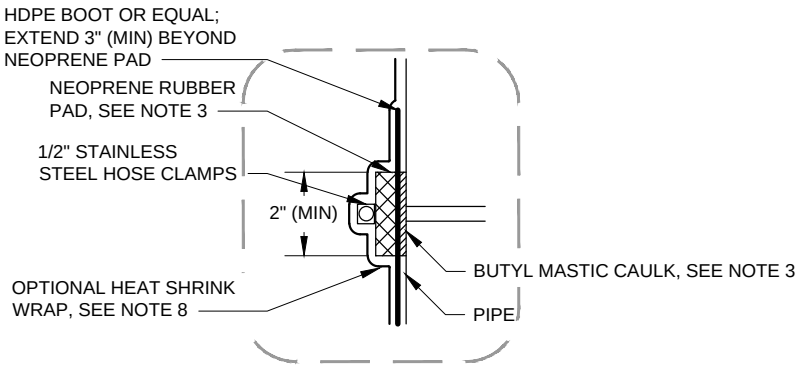

TYPICAL LINER PENETRATION - PERPENDICULAR 1




TYPICAL LINER PENETRATION - ANGLED 2

## CONSTRUCTION NOTES:

1. CUT OPENING IN LINER FOR PIPE TO WITHIN 1/2" OF PIPE OUTSIDE DIAMETER.
2. FILL ANNULAR SPACE WITH 1" MINIMUM GRANULAR BENTONITE FILLET AS SHOWN.
3. APPLY BUTYL MASTIC CAULK AND NEOPRENE RUBBER PAD CONTINUOUSLY AROUND PIPE.
4. PROVIDE CONTINUOUS EXTRUSION WELD AT PIPE BOOT/LINER INTERFACE.
5. FORM BOOT WITH SUFFICIENT MATERIAL TO PREVENT OVERSTRESSING DURING BACKFILLING, BUT WITHOUT FOLDS OR WRINKLES.
6. CONSTRUCT BOOT FROM SAME MATERIAL AS THE LINER.
7. ANGLE SHOULD NOT BE LESS THAN 30°. IF ANGLE IS LESS THAN 30° ADD SOIL AROUND THE PIPE TO INCREASE THE ANGLE AND PREVENT STRESSING AND CRACKING .
8. SEAL CLAMP AND END OF BOOT WITH HEAT SHRINK WRAP. EXTEND HEAT SHRINK WRAP ONE PIPE DIAMETER (MINIMUM) BEYOND CLAMP.
9. CONTRACTOR MAY USE PREFABRICATED PIPE BOOTS IN LIEU OF FIELD-FABRICATED BOOTS. CONNECT PREFABRICATED BOOT TO LINER AND PIPE PER MANUFACTURER'S RECOMMENDATIONS.




ENLARGEMENT 1

| NOTES | | BIORETENTION | | | PERMEABLE PAVEMENT | | | WALL PENETRATIONS | | | TRENCH DAM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GC 2.1 | GC 2.2 | GC 2.3 | GC 2.4 | GC 2.5 | GC 2.6 | GC 2.7 | GC 2.8 | GC 2.9 | GC 2.10 | GC 2.11 | GC 2.12 |

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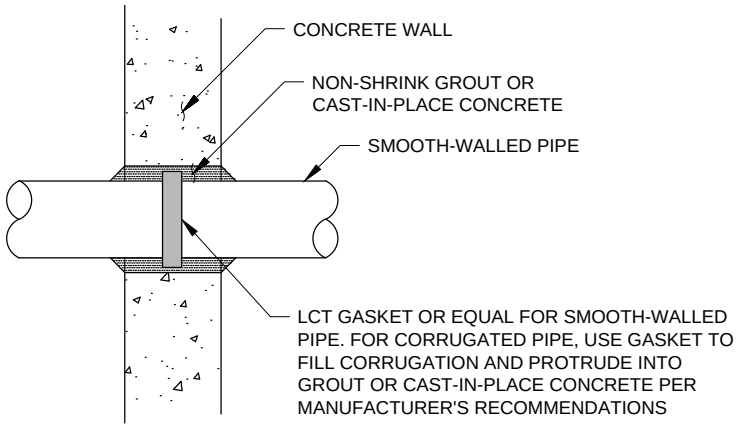
# GENERAL COMPONENTS

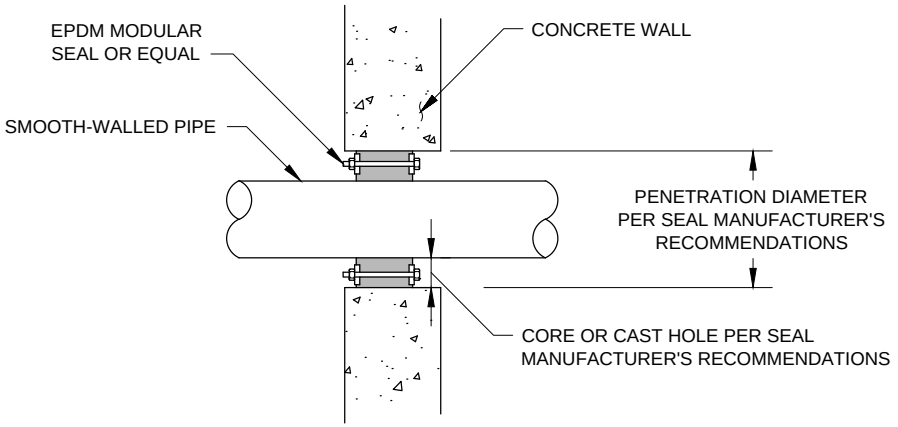
## UTILITY CROSSINGS
## LINER PENETRATIONS

DWG NO. GC 2.9

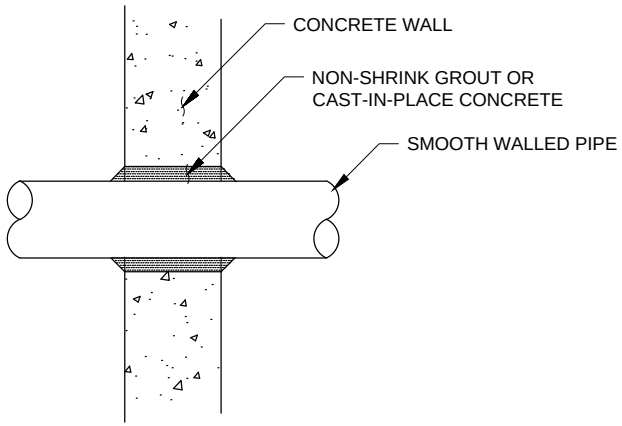
NOT FOR CONSTRUCTION - REFER TO USER GUIDE




TYPICAL WATERTIGHT WALL PENETRATION - ALTERNATE 1 (1)




TYPICAL WATERTIGHT WALL PENETRATION - ALTERNATE 2 (2)




TYPICAL SOIL TIGHT WALL PENETRATION (3)



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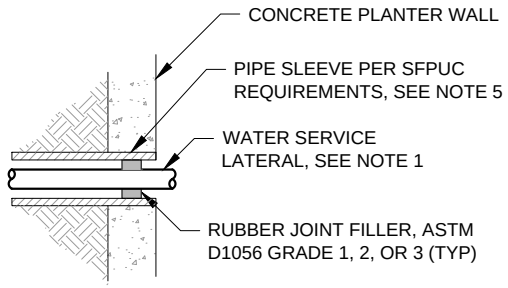
## GENERAL COMPONENTS

### UTILITY CROSSINGS

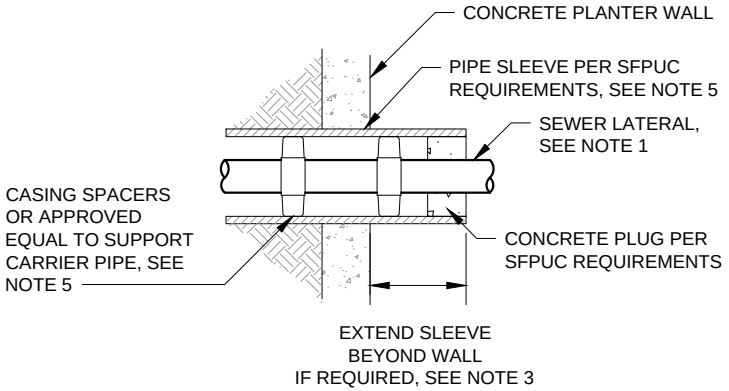
### WALL PENETRATIONS (1 OF 2)

DWG NO. GC 2.10

NOT FOR CONSTRUCTION - REFER TO USER GUIDE




WALL PENETRATION FOR WATER LATERALS 1




WALL PENETRATION FOR SEWER LATERALS 2

## CONSTRUCTION NOTES:

1. IN CASES WHERE SHALLOW EXISTING UTILITIES, SUCH AS STREET LIGHT CONDUIT, HAVE BEEN APPROVED TO REMAIN IN PLACE PER THE UTILITY PROVIDER, AND SLEEVING FROM ONE END IS NOT FEASIBLE, THE EXISTING UTILITIES SHALL BE CAREFULLY WRAPPED WITH AN INSULATION MATERIAL (MIN. 1" THICK) AND A WATERTIGHT TAPE UNTIL THE WALLS ARE FORMED AROUND THE PIPE CROSSINGS. ONCE THE WALLS ARE SET, THE INSULATION WRAP SHALL BE REMOVED AND THE WALL PENETRATIONS SEALED.
2. DETECTABLE UTILITY MARKING TAPE SHALL BE PLACED OVER ALL UTILITIES WITHIN THE FOOTPRINT OF BIORETENTION FACILITIES. REFER TO THE TAPE MANUFACTURER'S RECOMMENDATIONS FOR MAXIMUM TAPE BURIAL DEPTH.
3. IF SEWER LATERAL IS BELOW BOTTOM OF BIORETENTION FACILITY AND WALL PENETRATION IS NOT NECESSARY, THE CITY MAY REQUIRE THE SLEEVE AROUND NEW LATERAL PIPE TO BE EXTENDED BEYOND THE OUTSIDE OF THE PLANTER ON THE SIDEWALK SIDE. SEE DESIGN DRAWINGS FOR FURTHER DIRECTION.
4. ALL OTHER REPLACED OR NEW UTILITY SERVICES, SUCH AS GAS, TELECOM, ELECTRICAL, AND IRRIGATION RUNNING THROUGH A BIORETENTION FACILITY SHALL BE SLEEVED AND WALL PENETRATIONS SHALL BE DESIGNED TO MEET UTILITY PROVIDER'S REQUIREMENTS.
5. PIPE SLEEVE DESIGN AND MATERIALS, CONFORMING TO SFPUC STANDARDS, SHALL BE SPECIFIED ON THE DESIGN DRAWINGS.



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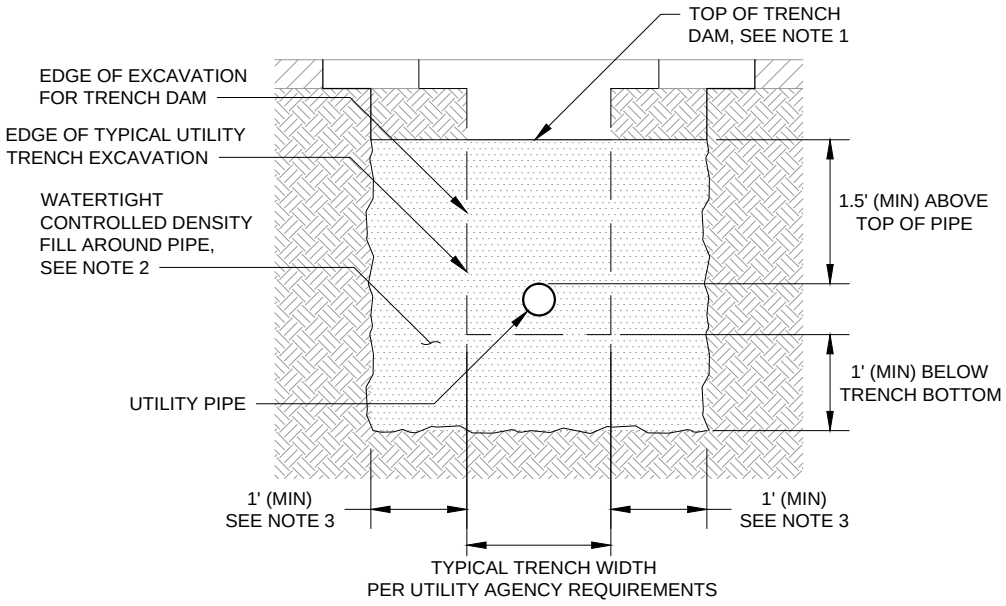
# GENERAL COMPONENTS

## UTILITY CROSSINGS

## WALL PENETRATIONS (2 OF 2)

DWG NO. GC 2.11




UTILITY TRENCH DAM 1

## CONSTRUCTION NOTES:

1. REFER TO DESIGN PLANS FOR TRENCH DAM LOCATIONS.
2. CONTROLLED DENSITY FILL SHALL BE 100 - 150 PSI STRENGTH WITH A WATER CONDUCTIVITY OF 1.0 X $10^{-6}$ CM/SEC (MAX).
3. TRENCH DAM SHALL EXTEND BEYOND THE EXISTING UTILITY TRENCH INTO THE NATIVE SOIL PER THE MINIMUM DIMENSIONS SHOWN. THE TRENCH DAM SHALL HAVE A MINIMUM THICKNESS OF 1' (MEASURED PARALLEL TO THE UTILITY PIPE LENGTH).


| NOTES | | BIORETENTION | | | PERMEABLE PAVEMENT | | | WALL PENETRATIONS | | | TRENCH DAM |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GC 2.1 | GC 2.2 | GC 2.3 | GC 2.4 | GC 2.5 | GC 2.6 | GC 2.7 | GC 2.8 | GC 2.9 | GC 2.10 | GC 2.11 | GC 2.12 |

## PURPOSE:

WHEN SITING GREEN INFRASTRUCTURE (GI) FACILITIES, THE DESIGNER SHOULD LOCATE AND ASSESS ALL KNOWN UTILITY CROSSINGS AND CONFLICTS AND ADJUST THE DESIGN TO AVOID AS MANY EXISTING UTILITIES, LIGHTS, POLES, SIGNS AND OTHER INFRASTRUCTURE AS POSSIBLE. THE CRITICALITY OF INFRASTRUCTURE CONFLICTS IN TERMS OF THEIR POTENTIAL IMPACT TO THE GI PROJECT'S DESIGN PERFORMANCE, COST, AND SCHEDULE SHOULD BE CAREFULLY EVALUATED DURING THE PLANNING PHASE.

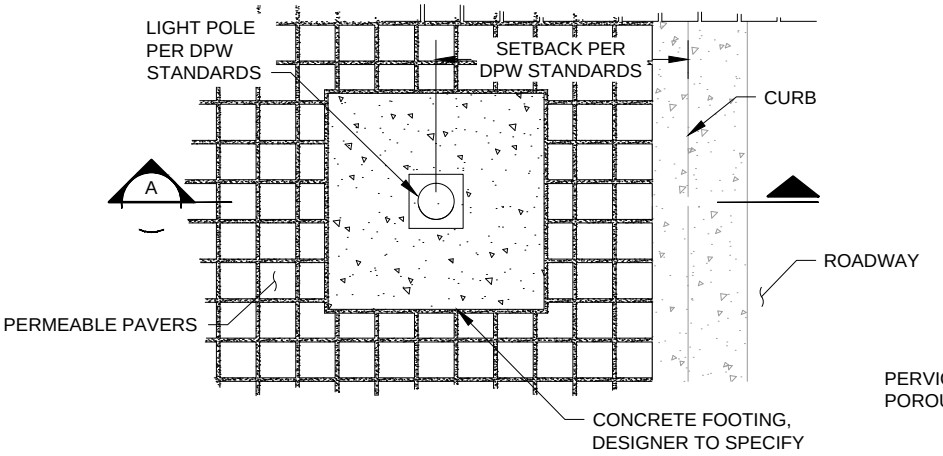
THE PURPOSE OF THE FOLLOWING TYPICAL UTILITY CONFLICT DETAILS IS TO ALERT THE DESIGNERS TO COMMON UTILITY CONFLICTS THAT OCCUR ON GI PROJECTS WITHIN THE PUBLIC RIGHT-OF-WAY AND PROVIDE GENERAL GUIDANCE ON THE PROTECTION AND/OR RELOCATION OF THESE UTILITIES IN RELATION TO THE GI FACILITY. THEY ARE PROVIDED AS TYPICAL APPLICATIONS AND DO NOT REPRESENT APPROVED CITY UTILITY STANDARDS AND SPECIFICATIONS.

## DESIGNER NOTES AND GUIDELINES:

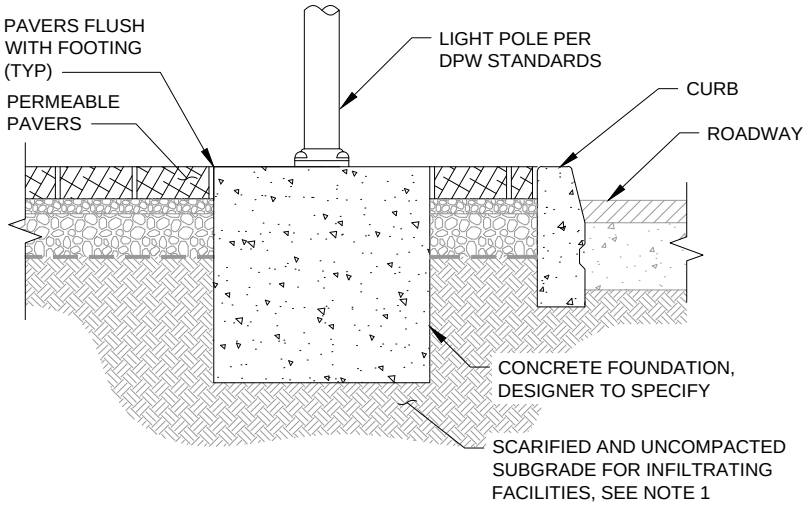
1. THE DESIGNER MUST ADAPT DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS AND UTILITY REQUIREMENTS AND OBTAIN APPROVAL FROM ALL RELEVANT UTILITY PROVIDERS PRIOR TO CONSTRUCTION. COORDINATION AND APPROVAL FROM THE FOLLOWING UTILITY PROVIDERS MAY BE NECESSARY, BUT NOT EXCLUSIVELY:
   - SFPUC CITY DISTRIBUTION DIVISION (CDD) FOR DOMESTIC/RECYCLED/FIRE WATER
   - SFPUC WASTEWATER ENTERPRISE (WWE) FOR SANITARY/STORM/SEWER
   - PACIFIC GAS ELECTRIC (PGE) FOR ELECTRIC/GAS/UTILITY POLES
   - SAN FRANCISCO PUBLIC WORKS FOR TRAFFIC SIGNAL/LIGHT POLE
   - SFMTA FOR STREET SIGNS/PARKING METERS/BUS STOP, CATENARY POLES
2. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT SFPUC ASSET PROTECTION STANDARDS.
3. THE AREA OF SUBBASE COVERED BY THE INFRASTRUCTURE FOOTINGS, COMPACTED ENGINEERED FILL, CONCRETE PADS AND OTHER UTILITY INFRASTRUCTURE SHOULD BE EXCLUDED FROM HYDROLOGIC PERFORMANCE CALCULATIONS WHEN THE AREA IS SIGNIFICANT (GREATER THAN 10 PERCENT) RELATIVE TO THE INFILTRATIVE AREA.
4. DESIGNER TO SPECIFY CONCRETE FOOTING DIMENSIONS AND REINFORCEMENT FOR ALL VERTICAL INFRASTRUCTURE.
5. SEE SAN FRANCISCO PUBLIC WORKS TRAFFIC LIGHT STANDARDS FOR REQUIRED SETBACKS FROM CURBS, GUARD POSTS REQUIREMENTS, AND FOOTING DESIGN STANDARDS.
6. ALL STREET SIGN PLACEMENTS SHALL BE APPROVED BY SFMTA PRIOR TO INSTALLATION.
7. ALL PARKING METER INSTALLATIONS OR RELOCATION DESIGNS SHALL CONFORM TO SFMTA STANDARDS.

## DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ STREET LIGHT, SIGN, AND UTILITY POLE FOUNDATION DIMENSIONS, REINFORCEMENT, AND SPECIFICATIONS
- ☐ GEOTEXTILE FABRICS AND/OR LINER MATERIALS
- ☐ ENGINEERED BACKFILL MATERIAL
- ☐ DIMENSIONS OF ALL PROTECTION MEASURES
- ☐ MINIMUM SETBACKS TO ADJACENT INFRASTRUCTURE, PAVEMENT BASES, SURFACES

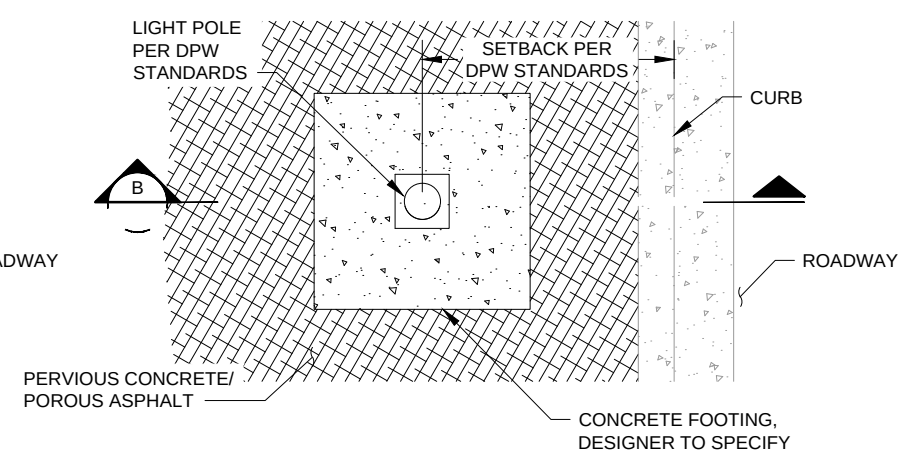



PLAN




SECTION A

UTILITY POLE AT PERMEABLE PAVEMENT 1

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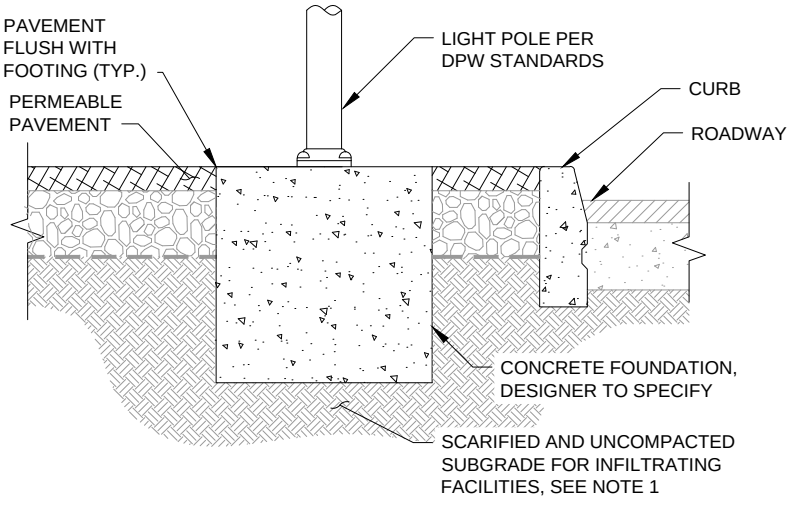


SECTION B

UTILITY POLE AT PERVIOUS CONCRETE/POROUS ASPHALT 2

## CONSTRUCTION NOTES:

1. AVOID COMPACTION OF EXISTING SUBGRADE BELOW PERMEABLE PAVEMENT DURING CONSTRUCTION.

| NOTES | COMPONENTS | | |
|---|---|---|---|
| GC 3.1 | GC 3.2 | GC 3.3 | GC 3.4 |

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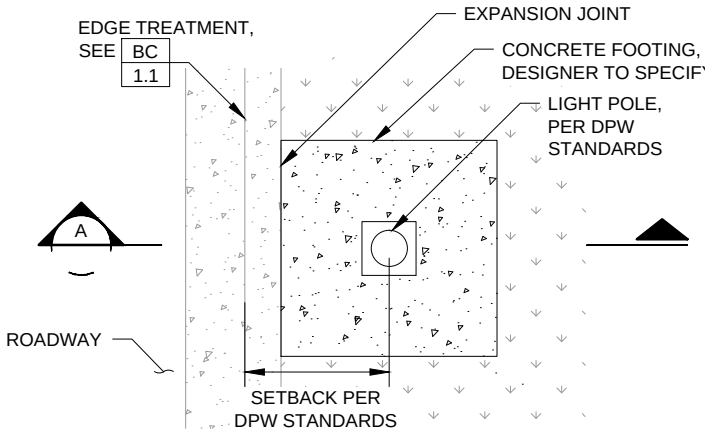
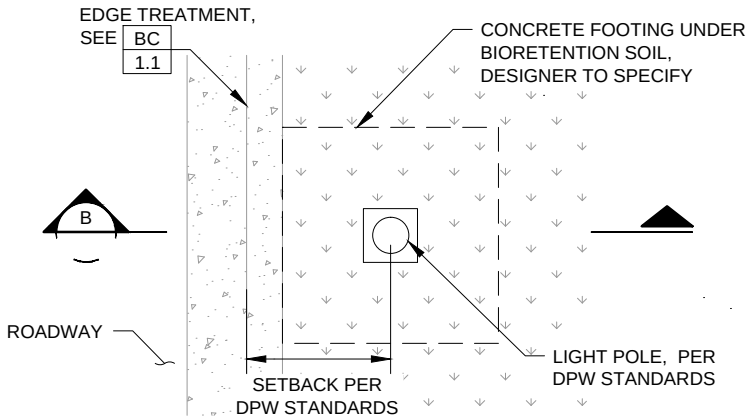
## GENERAL COMPONENTS
### UTILITY CONFLICTS
### STREET/TRAFFIC LIGHT POLES (1 OF 2)

DWG NO. GC 3.2

NOT FOR CONSTRUCTION - REFER TO USER GUIDE




PLAN

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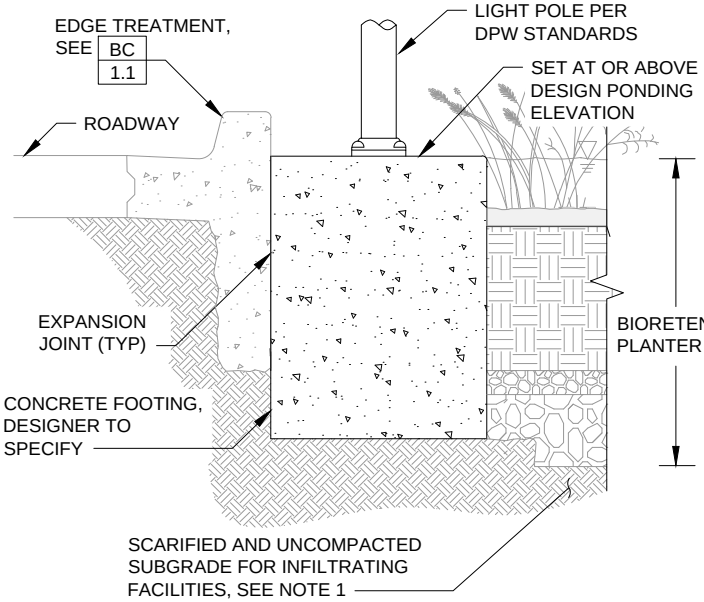
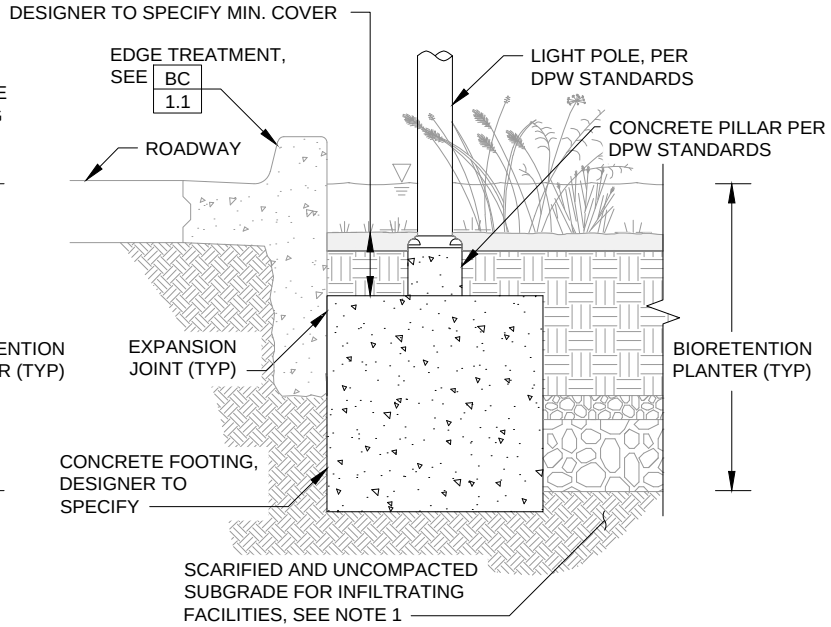



SECTION A

UTILITY POLE AT PLANTER 1




SECTION B

UTILITY POLE AT PLANTER 2

## CONSTRUCTION NOTES:

1. AVOID COMPACTION OF EXISTING SUBGRADE BELOW INFILTRATION FACILITIES DURING CONSTRUCTION.

| NOTES | COMPONENTS | | |
|---|---|---|---|
| GC 3.1 | GC 3.2 | GC 3.3 | GC 3.4 |

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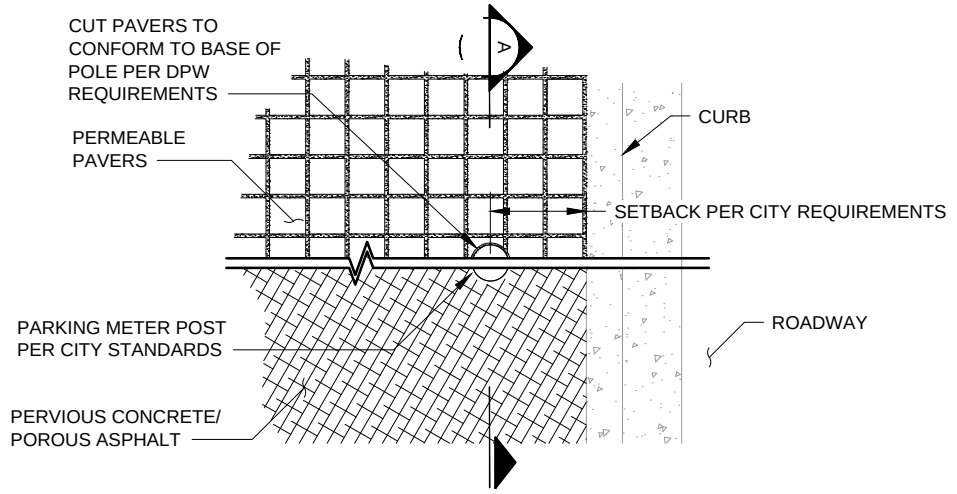
# GENERAL COMPONENTS

## UTILITY CONFLICTS

## STREET/TRAFFIC LIGHT POLES (2 OF 2)

DWG NO. GC 3.3

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

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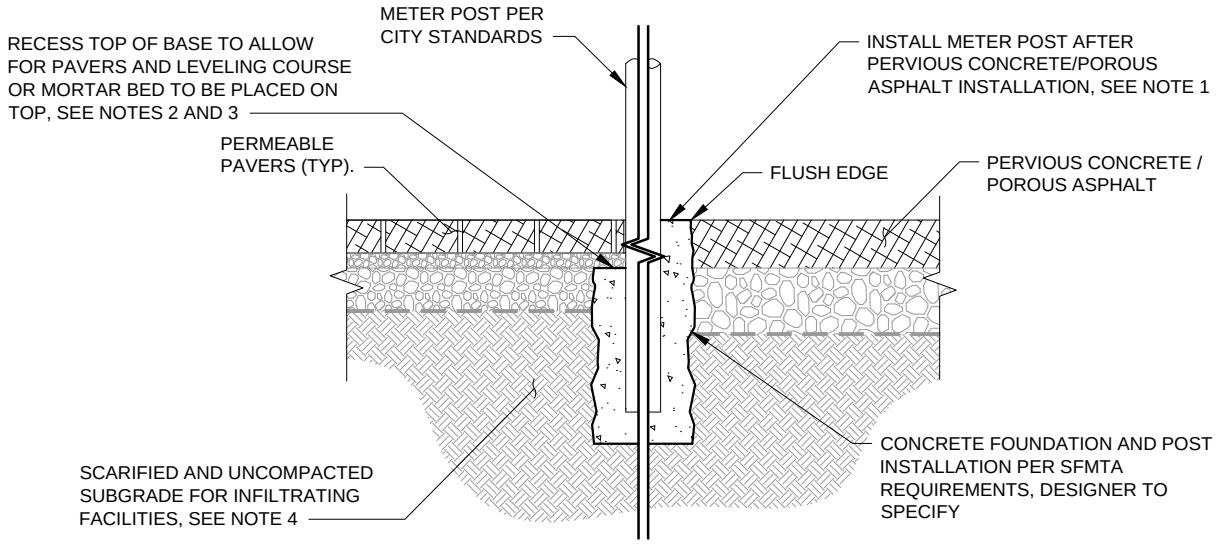


SECTION A

PARKING METER AT PERMEABLE PAVEMENT (1)

## CONSTRUCTION NOTES:

1. DUE TO THE ADDED COMPLEXITY OF INSTALLING PERVIOUS CONCRETE AND POROUS ASPHALT AROUND NUMEROUS POLES/POSTS, IT IS RECOMMENDED POST HOLES BE DRILLED OUT AFTER THE PERVIOUS CONCRETE/POROUS ASPHALT HAS CURED. IF POLES ARE INSTALLED PRIOR TO THE PLACEMENT OF PERVIOUS CONCRETE/POROUS ASPHALT, THE CONTRACTOR SHALL COORDINATE WITH THE DESIGNER ON HOW THE PERVIOUS CONCRETE/POROUS ASPHALT SHALL BE INSTALLED AROUND AND/OR OVER THE POLE BASES.
2. WHERE METER POLES ARE SHOWN WITHIN A PERMEABLE PAVER AREA, THE BASES OF THE POLES SHALL BE INSTALLED BEFORE THE PAVER INSTALLATION. THE DESIGNER MAY SPECIFY THAT THE TOP OF THE BASES BE SET (OR CUT DOWN) AT A DEPTH THAT ALLOWS THE PAVERS AND LEVELING COURSE TO COVER THE TOP OF THE BASE AND REMAIN FLUSH WITH THE SURROUNDING PAVEMENT.
3. INSTALL PERMEABLE PAVEMENT OVER TOP OF FOOTING PER PROJECT SPECIFICATIONS AND MANUFACTURER'S RECOMMENDATIONS.
4. AVOID OVER-COMPACTION OF EXISTING SUBGRADE BELOW PERMEABLE PAVEMENT DURING CONSTRUCTION.

| NOTES | COMPONENTS | | |
|---|---|---|---|
| GC 3.1 | GC 3.2 | GC 3.3 | GC 3.4 |



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# GENERAL COMPONENTS

## UTILITY CONFLICTS
## PARKING METERS

DWG NO. GC 3.4

## PURPOSE:

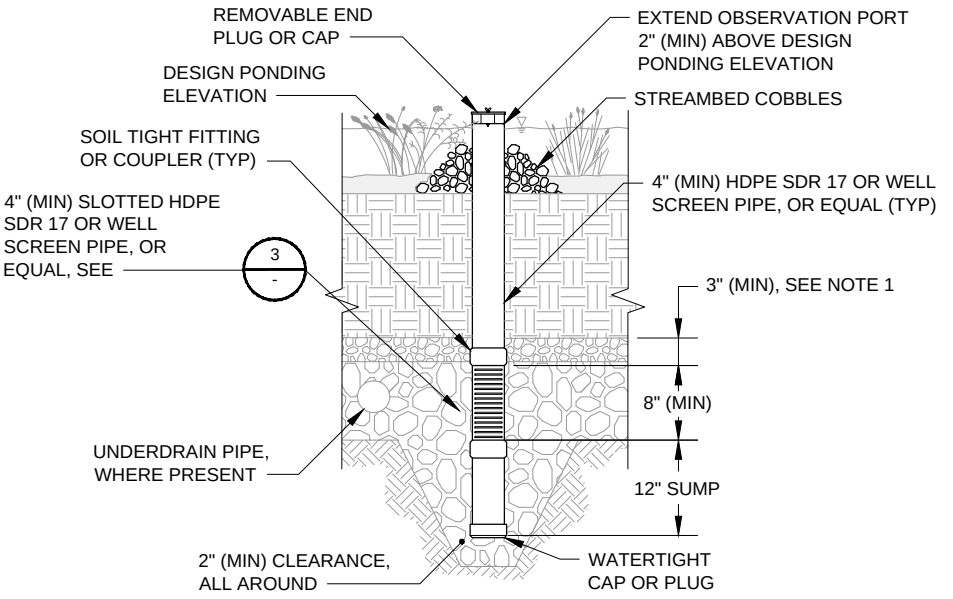
OBSERVATION PORTS ALLOW FOR MEASUREMENT OF DRAWDOWN THROUGH A FACILITY (WHEN WATER LEVEL MEASUREMENTS ARE NOT OBSERVABLE AT THE SURFACE). THESE PORTS CAN ALSO BE USED FOR LONG-TERM MONITORING WITH A PRESSURE TRANSDUCER. FOR SYSTEMS INCLUDING UNDERDRAINS, CLEANOUTS MAY SERVE AS THE FACILITY OBSERVATION PORT PROVIDED LONG-TERM MONITORING IS NOT REQUIRED FOR THE FACILITY.

## DESIGNER NOTES & GUIDELINES:

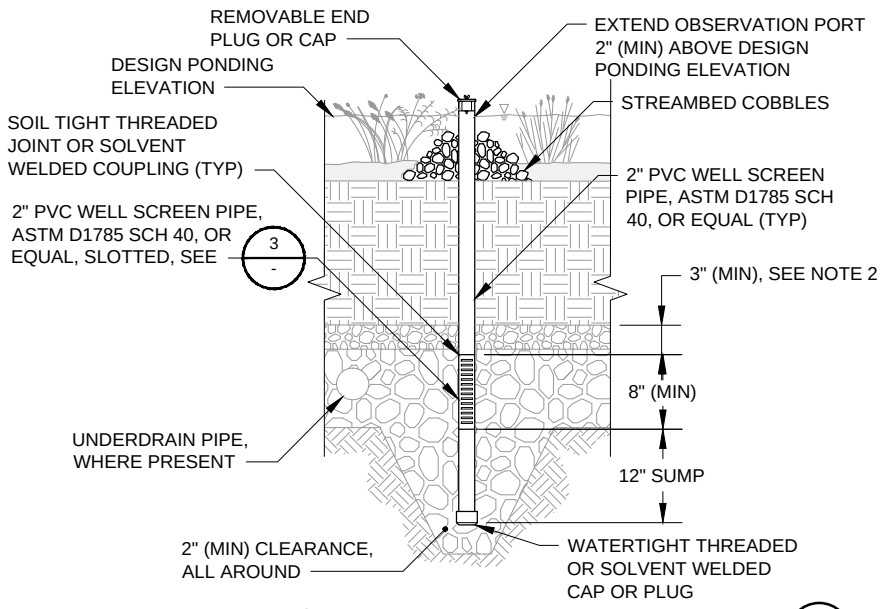
1. THE DESIGNER MUST ADAPT DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. OBSERVATION PORTS WITHIN A BIORETENTION FACILITY ARE NOT REQUIRED TO INCLUDE A SEPARATE LOCKING COVER ASSEMBLY. HOWEVER, DESIGNERS SHOULD CONSIDER REQUIRING A LOCKING OBSERVATION PORT CAP OR PLUG IF THE RISK OF TAMPERING IS CONSIDERED TO BE HIGH.
3. WHENEVER FEASIBLE, OBSERVATION PORTS SHOULD BE LOCATED OUTSIDE OF THE TRAVELED WAY. IF SITE CONSTRAINTS NECESSITATE INSTALLATION OF OBSERVATION PORTS IN AN AREA SUBJECT TO VEHICULAR TRAFFIC OR OTHER LOADING, OBSERVATION PORT COVER ASSEMBLIES AND MANHOLES MUST BE DESIGNED TO WITHSTAND ANTICIPATED LOADING (E.G., H-20).
4. OBSERVATION PORTS SHOULD INCLUDE A 12 INCH WATERTIGHT SUMP TO ACCOMMODATE CONTINUOUS WATER LEVEL MEASUREMENT WITH A PRESSURE TRANSDUCER.

## DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

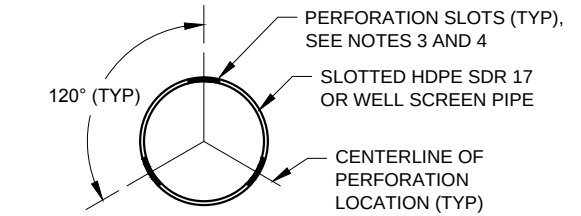
- ☐ OBSERVATION PORT MATERIAL, DIAMETER, AND DEPTH
- ☐ OBSERVATION PORT COVER ASSEMBLY/MANHOLE TYPE AND SIZE (IF APPLICABLE)
- ☐ CONTROL ELEVATIONS FOR OBSERVATION PORT RIMS
- ☐ TYPE OF MONITORING EQUIPMENT TO BE INSTALLED (IF APPLICABLE)




HDPE OBSERVATION PORT 1




PVC WELL CASING/SCREEN OBSERVATION PORT 2




PIPE SLOT DETAIL 3

## CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR OBSERVATION PORTS SHALL CONFORM TO SAN FRANCISCO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. PROVIDE 3 INCH MINIMUM COVER FROM BOTTOM OF BIORETENTION SOIL TO BEGINNING OF OBSERVATION PORT PERFORATIONS.
3. ALL PERFORATIONS SHALL BE SLOTTED TYPE, MEASURING 0.032 INCH WIDE (MAX), SPACED AT 0.25 INCH (MIN), AND PROVIDING A MINIMUM INLET AREA OF 5.0 SQUARE INCH PER LINEAR FOOT OF PIPE FOR PIPES 4 INCH IN DIAMETER AND LARGER AND 2.0 SQUARE INCHES PER LINEAR FOOT OF PIPE FOR PIPES SMALLER THAN 4 INCHES IN DIAMETER.
4. PERFORATIONS SHALL BE ORIENTED PERPENDICULAR TO LONG AXIS OF PIPE, AND EVENLY SPACED AROUND CIRCUMFERENCE AND LENGTH OF PIPE.
5. ALL FITTINGS SHALL BE SOIL TIGHT, UNLESS NOTED OTHERWISE.

| NOTES | COMPONENTS | |
|---|---|---|
| GC 4.1 | GC 4.2 | GC 4.3 |

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

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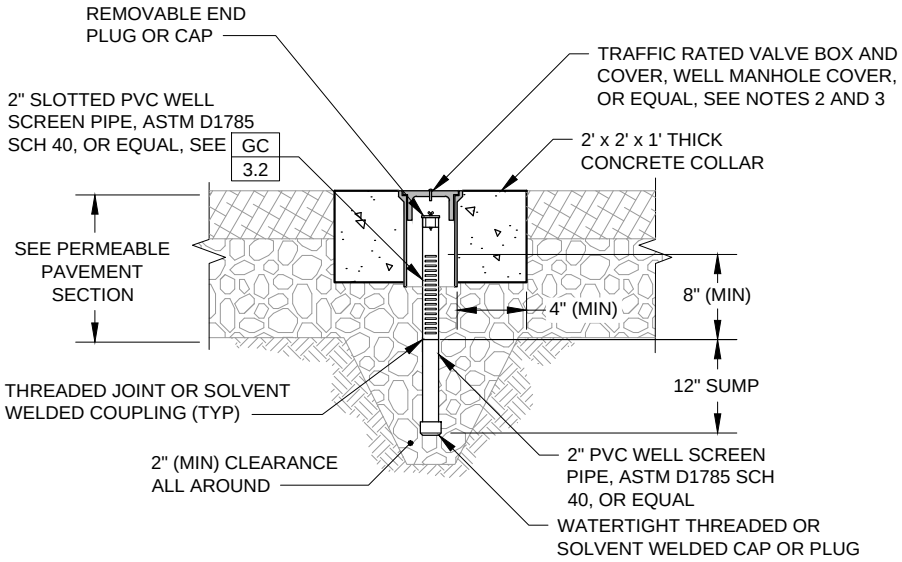
# GENERAL COMPONENTS

## OBSERVATION PORT BIORETENTION

DWG NO. GC 4.2



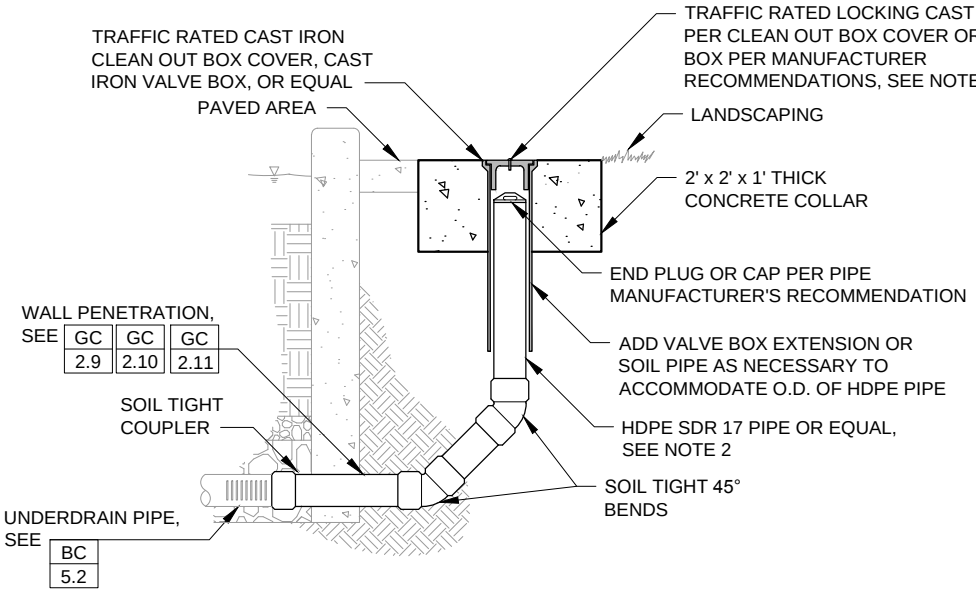

PVC WELL SCREEN OBSERVATION PORT (1)

## CONSTRUCTION NOTES:

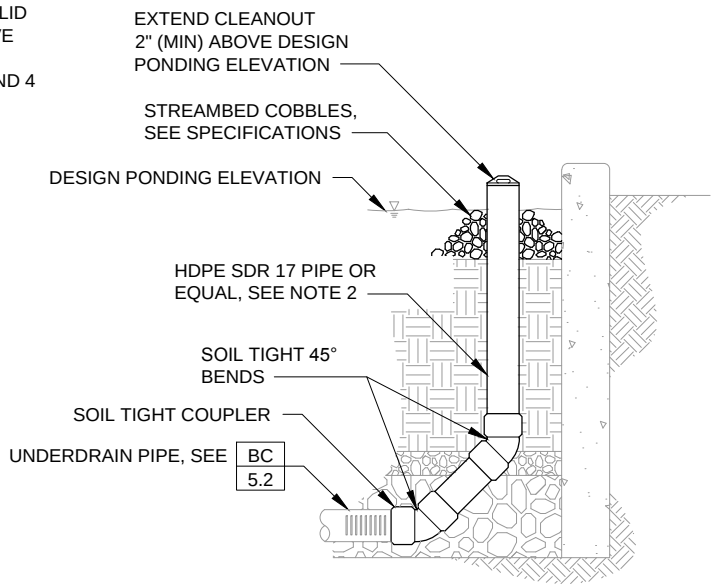
1. ALL MATERIAL AND WORKMANSHIP FOR OBSERVATION PORTS SHALL CONFORM TO SAN FRANCISCO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. COVER SHALL BE TRAFFIC RATED WITH TAMPER RESISTANT LOCKING MECHANISM. COVER SHALL INCLUDE CASTING OF STANDARD TRIANGLE SYMBOL, "TEST WELL", "MONITORING WELL", OR EQUAL.
3. OBSERVATION PORT COVERS AND LIDS MUST COMPLY WITH SAN FRANCISCO DPW STANDARD ACCESSIBILITY REQUIREMENTS.
4. WELL SCREEN SLOTS SHALL BE 0.032 INCHES WIDE (MAX), SPACED AT 0.25 INCH (MIN), AND PROVIDE A MINIMUM INLET AREA OF 2.0 SQUARE INCH PER LINEAR FOOT OF PIPE.
5. ALL FITTINGS SHALL BE SOIL TIGHT, UNLESS NOTED OTHERWISE.



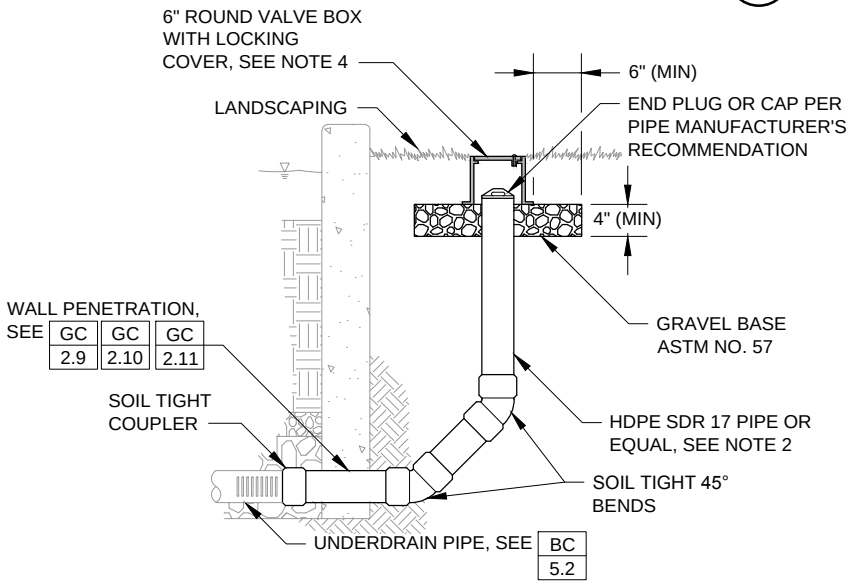
NOTES: GC 4.1
COMPONENTS: GC 4.2, GC 4.3




CLEANOUT - ALTERNATIVE 1 (1)




CLEANOUT - ALTERNATIVE 2 (2)




CLEANOUT - ALTERNATIVE 3 (PARCEL ONLY) (3)

## CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR CLEANOUTS SHALL CONFORM TO SAN FRANCISCO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. CLEANOUT PIPE AND FITTINGS SHALL BE SAME SIZE AND MATERIAL AS SLOTTED UNDERDRAIN PIPE.
3. COVER SHALL BE TRAFFIC RATED WITH TAMPER RESISTANT LOCKING MECHANISM. COVER SHALL INCLUDE CASTING OF "CO" OR EQUAL.
4. CLEANOUT COVERS AND LIDS MUST COMPLY WITH SAN FRANCISCO PUBLIC WORKS STANDARD ACCESSIBILITY REQUIREMENTS.
5. CLEANOUT SHALL BE INSTALLED TO ALLOW FOR MAINTENANCE ACCESS TO ALL PIPES.
6. ALL FITTINGS SHALL BE SOIL TIGHT.

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REVISED:

# GENERAL COMPONENTS

## CLEANOUTS

DWG NO. GC 5.1

## PURPOSE:

END-OF-BLOCK MONITORING SYSTEMS ARE DESIGNED TO MONITOR FLOWS EXITING AN END-OF-BLOCK CATCH BASIN. THESE FLOWS ARE TYPICALLY VERY SMALL, REQUIRING THE USE OF SENSITIVE EQUIPMENT (STILLING WELLS AND HIGHLY SENSITIVE PRESSURE TRANSDUCERS) TO PRODUCE ACCURATE FLOW ESTIMATES. THESE GUIDELINES WILL HELP THE DESIGNER TO DESIGN A SYSTEM WHICH WILL BE CONDUCIVE TO FLOW MEASUREMENT USING THIS EQUIPMENT.

## DESIGNER NOTES AND GUIDELINES:

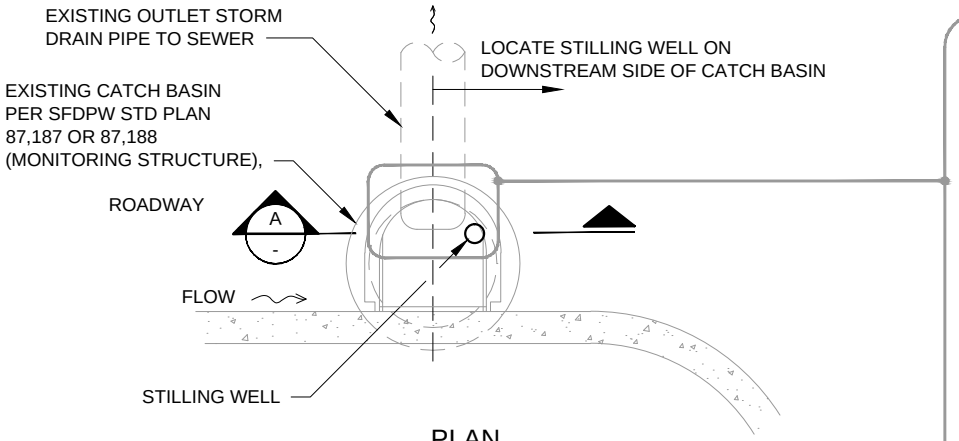
1. THE DESIGNER MUST ADAPT THE SECTION DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. THE DESIGNER MUST CONSULT WITH EQUIPMENT MANUFACTURER'S REPRESENTATIVE AND MONITORING PROFESSIONAL OR TECHNICIAN PRIOR TO COMPLETION OF DESIGN.
3. END-OF-BLOCK CATCH BASIN FLOWS SHOULD BE MEASURED WITH THE USE OF STILLING WELLS AND PRESSURE TRANSDUCERS.
4. PRESSURE TRANSDUCERS MAY BE VENTED OR UNVENTED. IF UNVENTED, A NEARBY BAROMETRIC TRANSDUCER OF THE SAME MAKE SHOULD BE INSTALLED FOR ATMOSPHERIC PRESSURE CORRECTION.
5. PVC STILLING WELLS MUST BE PERFORATED BELOW THE INVERT OF THE OUTLET PIPE. PERFORATIONS SHOULD ALWAYS BE ABOVE THE TOP OF THE PRESSURE TRANSDUCER HOUSING TO PROVIDE A PERMANENT WET POOL FOR THE TRANSDUCER.
6. THE STRUCTURE SHALL BE WATER TIGHT. CALIBRATION OF THE OUTLET PIPE WILL BE DIFFICULT IF LARGE VOLUMES OF WATER ARE NEEDED TO INCREASE THE WATER LEVEL IN THE STRUCTURE TO THE INVERT OF THE PIPE WEIR.
7. THE MONITORING STRUCTURE SHOULD BE LARGE ENOUGH TO PROVIDE ACCESS FOR INSTALLATION, MAINTENANCE, AND REMOVAL OF MONITORING EQUIPMENT.

## DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

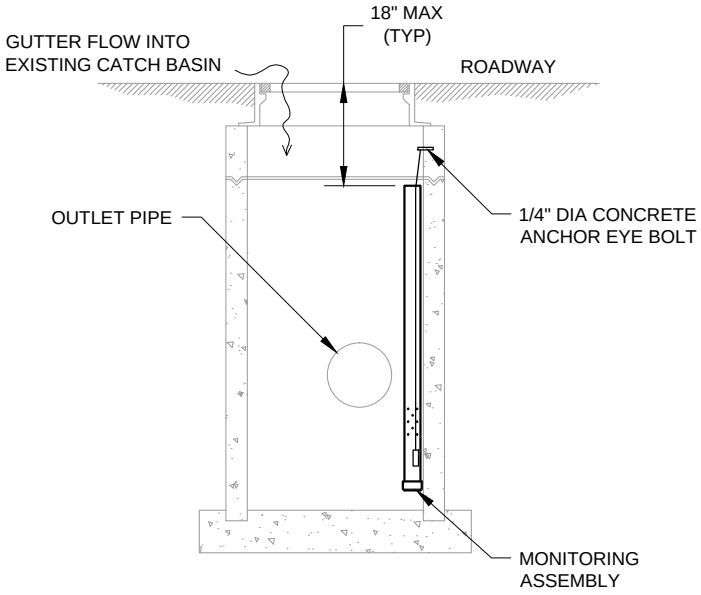
- ☐ CATCH BASIN TYPE/MATERIAL, DIAMETER, AND DEPTH
- ☐ PRESSURE TRANSDUCER TYPE AND SPECIFICATIONS
- ☐ CONTROL ELEVATIONS FOR STILLING WELLS AND PRESSURE TRANSDUCERS
- ☐ MATERIAL TYPE AND SIZE FOR ALL PIPES AND TUBING
- ☐ DIAGRAM WITH ALL OUTLET MONITORING ASSEMBLY COMPONENTS IDENTIFIED OR REQUEST FOR CONTRACTOR SUBMITTAL OF MONITORING ASSEMBLY



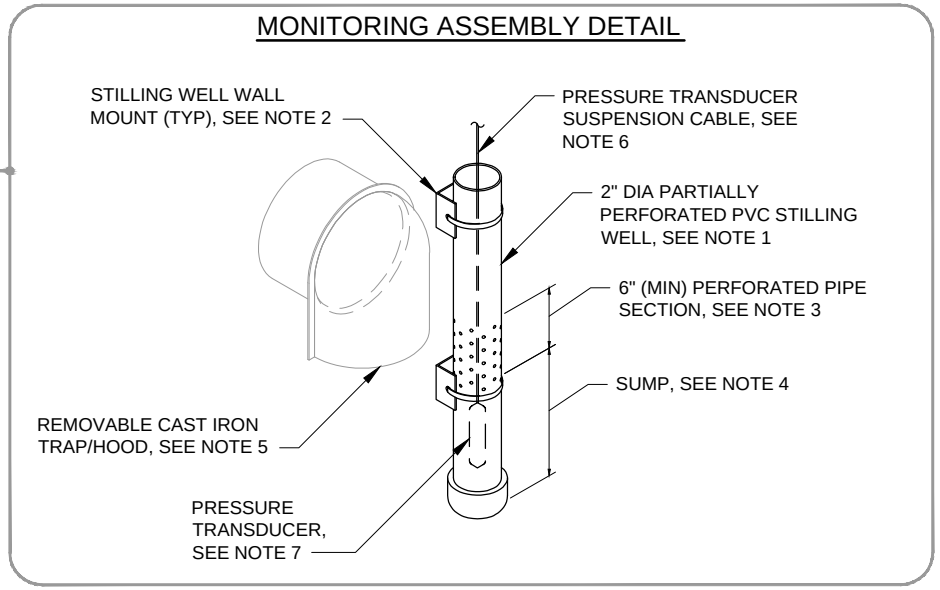
NOTES COMPONENTS
GC 6.1 | GC 6.2




PLAN




SECTION A




## CONSTRUCTION NOTES:

1. STILLING WELL SHALL BE MOUNTED VERTICALLY AND ALL FITTINGS SHALL BE WATERTIGHT.
2. ATTACH STILLING WELL WITH PREFABRICATED METAL STRUT CHANNEL AND PIPE CLAMPS (2 MINIMUM) PER MANUFACTURERS RECOMMENDATION.
3. PROVIDE PERFORATIONS ALONG CIRCUMFERENCE OF STILLING WELL BETWEEN OUTLET PIPE INVERT AND PRESSURE TRANSDUCER SUMP. PERFORATIONS SHALL MEASURE 1/4 INCH DIAMETER (MINIMUM) AT 1 INCH (MAXIMUM) ON-CENTER SPACING, ALL DIRECTIONS.
4. STILLING WELL SUMP SHALL BE NON-PERFORATED AND EXTEND 4 INCHES (MINIMUM) BELOW AND 2 INCHES (MINIMUM) ABOVE PRESSURE TRANSDUCER HOUSING TO ALLOW FOR SEDIMENT ACCUMULATION IN THE BOTTOM OF THE WELL AND PROVIDE A PERMANENT WET POOL FOR THE TRANSDUCER.
5. REMOVABLE CAST IRON TRAP/HOOD SHALL BE NEENAH R-3701 SERIES, NEENAH R-3711 SERIES OR EQUAL. INSTALL TRAP/HOOD PER MANUFACTURERS RECOMMENDATION.
6. PRESSURE TRANSDUCER SUSPENSION CABLE SHALL BE 1/16 INCH COATED STAINLESS STEEL CABLE WITH FERRULED CABLE LOOP AND COMPATIBLE OVAL CARABINER FOR CONNECTION TO CONCRETE ANCHOR EYE BOLT.
7. PRESSURE TRANSDUCER SHALL BE RATED FOR ZERO TO 21 PSI OF PRESSURE AND AN ACCURACY OF ±0.1 PERCENT FULL SCALE RANGE OR BETTER AT 25°C.

NOTES COMPONENTS

| GC | GC |
|---|---|
| 6.1 | 6.2 |

San Francisco Water Power Sewer

# GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE SEPTEMBER 2016

VERSION 2.0

REVISED

# GENERAL COMPONENTS

## END-OF-BLOCK MONITORING

DWG NO. GC 6.2

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

# Specifications and Design Guidelines

In addition to the Typical Details, several common Specifications and Design Guideline documents have been developed and available for download at www.sfwater.org/smr.

## *Specifications*

Specifications have been developed in Construction Specifications Insitute (CSI) master format for the most common permeable paving systems and for bioretention soils. Projects submitting an SCP that propose permeable paving and/or biorentention must include the corresponding Specifications within the Supporting Documentation section. Like the Typical Details, these Specifications have been developed to be adjusted where noted in the informational Designer Notes. Designer Notes must be reviewed by the design professional and removed from the final specification prior to submitting the SCP.

## *Design Guidelines*

Design Guideline materials have been developed for common design related topics. SFPUC staff involved in the review process will base SCP approval on these guidelines to ensure BMPs are functional and maintainable.

*Willie Brown Middle School in San Francisco utilized rainwater harvesting, bioretention, and permeable pavement to comply with the Stormwater Management Ordinance.* *Photo: Krystal Zamora*

**DIVISION 33 – UTILITIES**

**Section 33 47 27 – Bioretention**

DESIGNER NOTE: Green text corresponds to notes to the designer. Remove prior to use.

DESIGNER NOTE: Replace "Engineer/Landscape Architect" with person in responsible charge for the project (e.g., Owner, Engineer, Landscape Architect).

## PART 1 GENERAL

1.01 SUMMARY

A. This section includes:

**1.** Bioretention Soil Mix

**2.** Aggregate Storage

**3.** Mulch [To be completed by designer.]

**4.** Streambed Gravel [To be completed by designer.]

B. Related Sections:

**1.** Section 01 57 29 – Temporary Protection of Green Infrastructure Facilities

DESIGNER NOTE: The designer should list any additional specification sections which relate to the bioretention work (i.e., clean outs and underdrains, overflow structures, planting, temporary erosion control, utilities, irrigation, earthwork, other appurtenances, etc.).

1.02 STANDARDS AND CODES

A. Reference Standards: This section incorporates by reference the latest versions of the following documents. These references are a part of this section as specified and modified.

| Reference | Title |
|---|---|
| Caltrans | Standard Specifications |
| San Francisco DPW | Engineering Standard Specifications |
| ASTM | Annual Book of ASTM Standards, American Society for Testing and Materials, Philadelphia, PA, 1997 or latest edition. |

1.03 DEFINITIONS

A. Bioretention Soil Mix (BSM): A soil mix that has been specially blended and tested for use in bioretention facilities with the intent to meet the following objectives:

**1.** Infiltrate runoff at a minimum rate of 5 inches per hour throughout the life of the facility, and

**2.** By nature of its components be capable of the removal of certain suspended and dissolved stormwater pollutants, and

**3.** Have sufficient moisture retention and other agronomic properties to support healthy vegetation.

1.04 REFERENCES

DESIGNER NOTE: Designer to provide references to all project specific documents (e.g., geotechnical report).

1.05 SUBMITTALS

A. Pre-Installation Submittals: The Contractor shall submit to the Engineer/Landscape Architect the following a minimum of 20 calendar days (or as directed by the Engineer/Landscape Architect) prior to the construction of bioretention facilities:

**1.** BSM Submittals

a. Two one (1) gallon samples of the BSM.

b. Source certificates for all BSM materials.

c. Sieve analysis of BSM per ASTM D422 performed within two (2) months of product delivery to site

d. Certification from the soil supplier or an accredited testing agency that the BSM, including sand and compost components, conforms to all industry or technical society reference standards specified in Sections 2.01.A, 2.01.B, and 2.01C.

e. A description of the equipment and methods used to mix the sand and compost to produce BSM.

f. Organic content test results of the BSM, performed in accordance with Testing Methods for the Examination of Compost and Composting (TMECC) 05.07A, “Loss-On-Ignition Organic Matter Method.”

g. Permeability test results for BSM per ASTM D2434 (Modified). See SFPUC Modified ASTM D2434 Procedures for required modifications to test.

DESIGNER NOTE: On larger projects, it may be appropriate to require that the above testing be performed on samples taken at the supplier’s yard from the stockpile to be used for the project; see designer note in Section 1.06.C.2.

**2.** Sand Submittals

a. Sieve analysis of sand per ASTM D422 performed within two (2) months of product delivery to site.

DESIGNER NOTE: Consider revising acceptable age of sieve tests depending on scale of project. On a larger project it may be appropriate to require testing on samples taken at the supplier’s yard from the stockpile to be used for the project.

**3.** Compost Submittals

a. Quality analysis results for compost performed in accordance with Seal of Testing Assurance (STA) standards, as specified in Section 2.01.C, and performed within two (2) months of product delivery to site.

b. Sieve analysis of compost per TMECC 02.02-B performed within two (2) months of product delivery to site.

**4.** Other Submittals

a. Cut sheets of any media or soil admixes to enhance moisture retention properties, if used.

b. Testing agency qualifications as specified in Section 1.06.B.

DESIGNER NOTE: Designer should include relevant submittal requirements for mulch and streambed gravel (e.g., sieve analysis), to ensure quality of delivered products.

1.06 QUALITY CONTROL AND QUALITY ASSURANCE

A. General: Test and inspect bioretention materials and operations as Work progresses as described in this section. Failure to detect defective Work or materials at any time will not prevent rejection if a defect is discovered after installation, nor shall it constitute final acceptance.

B. Testing Agency Qualification:

**1.** General: Agencies that perform testing on bioretention materials, including permeability testing, shall be accredited by STA, ASTM, AASHTO, or other designated recognized standards organization. All certifications shall be current. Testing agency shall be capable of performing all tests to the designated and recognized standards specified and shall provide test results with an accompanying Manufacturer's Certificate of Compliance. The following information shall be provided for all testing laboratories used:

a. Name of lab(s) and contact person(s)

b. Address(es) and phone number(s)

c. Email address(es)

d. Qualifications of laboratory and personnel including the date of current certification by STA, ASTM, AASHTO, or approved equal.

**2.** Compost: Laboratory that performs testing shall be independent, enrolled in the US Composting Council's (USCC) Compost Analysis Proficiency (CAP) program, and perform testing in accordance with USCC Test Method for The Examination of Composting and Compost (TMECC). The sample collection protocol can be obtained from the U.S. Composting Council, 4250 Veterans Memorial Highway,

Suite 275, Holbrook, NY 11741, 631-737-4931, www.compostingcouncil.org.

C. Responsibilities of Contractor

**1.** Submittals: Some of the tests required for this specification are unique, and BSM shall be considered a long-lead-time item. Under no circumstance shall failure to comply with all specification requirements be an excuse for a delay or for expedient substitution of unacceptable material(s). The requirements of Division 0 apply in their entirety.

Pre-Placement Conference: A mandatory pre-placement conference will take place, including at a minimum the Engineer/Landscape Architect, the Resident Engineer, the Owner/Client Representative, Installer, and general Contractor, to review schedule, products, soil testing, permeability testing, and installation. The Contractor shall notify the Engineer/Landscape Architect a minimum of 2 working days prior to conference.

DESIGNER NOTE: Pre-placement conference is mandatory for all projects within the public right-of-way, or on other public property, and is strongly recommended for privately-owned parcel projects.

**2.** Testing: All testing specified herein is the responsibility of the Contractor and shall be conducted by an independent testing agency, retained by the Contractor. The Owner reserves the right to conduct additional testing on all materials submitted, delivered, or in-place to ensure compliance with Specifications.

DESIGNER NOTE: Batch-specific test results and certifications shall be required for projects installing more than 500 cubic yards of BSM.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect the BSM and mulch from contamination and all sources of additional moisture at supplier site, during transport, and at the project site, until incorporated into the Work.

B. The Contractor is required to coordinate delivery of BSM and aggregates with bioretention facility excavation and soil installation. A written schedule shall be submitted for review as part of the submittal package. BSM should not be stockpiled onsite for any length of time. In no case shall BSM be stockpiled onsite for more than 24 hours without prior written approval by the Engineer/Landscape Architect. If stockpiling onsite for any length of time, BSM stockpiles shall meet the following requirements:

**1.** Locate stockpiles away from drainage courses, inlets, sewer cleanout vents, and concentrated stormwater flows

**2.** Place stockpiles on geotextile fabric

**3.** Cover stockpiles with plastic or comparable material

**4.** Contain stockpiles (and prevent contamination from adjacent stockpiles) with temporary perimeter barrier (e.g., sand bags, wattles, silt fence)

## PART 2 PRODUCTS

2.01 BIORETENTION SOIL MIX (BSM)

A. General: BSM shall be a well-blended mixture of sand and compost, shall have sufficient moisture retention to support healthy plant growth, and shall meet the following criteria:

**1.** Mixture proportions: 30 to 40 percent Compost by volume and 60 to 70 percent Sand by volume

DESIGNER NOTE: Up to 15 percent of the sand fraction may be replaced with other media or soil admixtures (e.g., scoria, coconut coir, perlite, expanded shale, gypsum, vermiculite, pumice, biochar, etc.) to enhance moisture retention capacity of soil, provided admixtures are low in fines (less than 5 percent passing the 200 sieve) and do not break down under normal handling and use. No topsoil, peat, silts, or clays are permitted to be used as admixtures. Admixtures shall be free of sediments and other materials deleterious to plant growth.

**2.** Organic matter content: 4 to 8 percent as determined by TMECC 05.07-A, Loss on Ignition Method.

**3.** Extraneous materials: BSM shall be free of all roots, plants, weeds, sod, stones, clods, pockets of coarse sand, construction debris, or other extraneous materials harmful to plant growth.

**4.** Permeability/Saturated Hydraulic Conductivity: 10 inches per hour (minimum) tested in accordance with ASTM D2434 (Modified). See SFPUC Modified ASTM D2434 Procedures for required modifications to test.

DESIGNER NOTE: 10-inch-per-hour minimum rate assumes a design rate of 5 inches per hour and a correction factor of 2 to account for reduction in performance from initially measured rates.

**5.** Acceptance of BSM quality and performance may be based on samples taken from stockpiles at supplier's yard, submitted test results, and/or onsite and laboratory testing of installed material at the discretion of the Engineer/Landscape Architect. The point of acceptance will be determined in the field by the Engineer/Landscape Architect.

DESIGNER NOTE: Designer to consider non-compost based BSM specification if facility is serviced by an underdrain and if it is draining to phosphorus sensitive water body.

B. Sand: Sand in the BSM shall conform to the requirements for Sand, Type [specify type from table below] specified herein, unless otherwise approved by the Engineer/Landscape Architect.

DESIGNER NOTE: Designer to specify sand type based on project specific requirements. If bioretention facilities will be subjected to heavy sediment loads (e.g., arterial runoff), consider specifying Sand, Type B (low fines sand) in an effort to reduce clogging risk (pending local availability). Additionally, projects anticipating heavy sediment loads should incorporate pre-settling measures at the upstream end of the facility to allow for more efficient maintenance of facilities.

**1.** Sand shall be free of wood, waste, coating, or any other deleterious material.

**2.** Sand material shall meet the following specifications for gradation.

| Sieve Size[1] | Percent Passing by Weight | |
|---|---|---|
| | Type A[2] | Type B (low fines)[3] |
| **3/8 inch** | 100 | 100 |
| **No. 4** | 90 to 100 | 90 to 100 |
| **No. 8** | 70 to 100 | 70 to 100 |
| **No. 16** | 40 to 95 | 40 to 85 |
| **No. 30** | 15 to 70 | 15 to 60 |
| **No. 50** | 5 to 55 | 8 to 15 |
| **No. 100** | 0 to 15 | 0 to 4 |
| **No. 200** | 0 to 5 | 0 to 2 |

[1] Sieve provided in nominal size square openings or United States Standard Sieve Series sizes.

[2] Sand conforming to ASTM C33 for Fine Aggregate satisfies the requirements of this specification for Sand, Type A.

[3] Type B (low fines) sand gradation pending local availability.

**3.** Coefficient of Uniformity: $C_u = \frac{D_{60}}{D_{10}}$: 4 or less for Sand, Type B.

**4.** Effective Particle Size ($D_{10}$): 0.3 to 0.5 mm for Sand, Type B.

**5.** All aggregate passing the No. 200 sieve shall be non-plastic.

**6.** Acceptance of grading and quality of the sand may be based on samples taken from stockpiles at supplier's yard or a submitted gradation report at the discretion of the Engineer/Landscape Architect. The point of acceptance will be determined in the field by the Engineer/Landscape Architect.

C. Compost: Compost in the BSM shall be well decomposed, stable, weed free organic matter sourced from waste materials including yard debris, wood wastes or other organic materials, not including biosolids or manure feedstock. Compost shall conform to California Code of Regulations

Title 14, Division 7, Chapter 3.1 requirements, be certified through the USCC Seal of Testing Assurance (STA) Program, and meeting the criteria specified herein.

**1.** Feedstock: Feedstock materials shall be specified and include one or more of the following: landscape/yard trimmings, grass clippings, food scraps, and agricultural crop residues. Feedstock shall not include biosolids or manure.

**2.** Organic Matter Content: 35 to 75 percent by dry weight tested in accordance with TMECC 05.07-A (Loss on Ignition Organic Matter Method).

**3.** Carbon to Nitrogen Ratio: C:N between 15:1 and 25:1 when tested in accordance with TMECC 05.02-A.

**4.** Maturity/Stability: shall have a dark brown color and a soil-like odor. Compost exhibiting a sour or putrid smell, containing recognizable grass or leaves, or is hot (120°F) upon delivery or rewetting is not acceptable. In addition any one of the following is required to indicate stability:

a. Specific Oxygen Uptake Rate (SOUR): 1.5 milligrams $O_2$ per gram biodegradable volatile solids per hour (maximum) per TMECC 05.08-A.

b. Carbon Dioxide Evolution Rate: 8 milligrams $CO_2$ per gram volatile solids per day per TMECC 05.08-B.

c. Dewar Self Heating Test: 20°C temperature rise (maximum) per TMECC 05.08-D (Class IV or V).

d. Solvita®: Index value greater than 6 per TMECC 05.08-E.

**5.** Toxicity: Seed Germination: greater than 80 percent of control AND Vigor: greater than 80 percent of control per TMECC 05.05-A.

**6.** Nutrient Content: provide analysis detailing nutrient content including N-P-K, Ca, Na, Mg, S, and B.

a. Total Nitrogen: 0.9 percent (minimum).

b. Boron: Total shall be < 80 ppm

**7.** Salinity/Electrical Conductivity: less than 6.0 deciSiemen per meter (dS/m or mmhos/cm) per TMECC 04.10-A (1:5 Slurry Method, Mass Basis).

**8.** pH: 6.5 to 8 per TMECC 04.11-A (1:5 Slurry pH).

**9.** Gradation: Compost for BSM shall meet the following size gradation per TMECC 02.02-B (test shall be run on dry compost sample):

| Sieve Size | Percent Passing by Weight |
|---|---|

| | ***Min*** | ***Max*** |
|---|---|---|
| 1 inch | 99 | 100 |
| 1/2 inch | 90 | 100 |
| 1/4 inch | 40 | 90 |
| No. 200 | 1 | 10 |

**10.** Bulk density: 500 to 1,100 dry pounds per cubic yard.

**11.** Moisture content: 30 to 55 percent of dry solids.

**12.** Inerts: compost shall be relatively free of inert ingredients, including glass, plastic and paper, less than 1 percent by weight or volume per TMECC 03.08A.

**13.** Weed seed/pathogen destruction: provide proof of process to further reduce pathogens (PFRP). For example, turned windrows must reach minimum 55°C for 15 days with at least 5 turnings during that period.

**14.** Select Pathogens

a. Salmonella: less than 3 Most Probable Number per 4 grams of total solids, dry weight per TMECC 07.02.

b. Coliform Bacteria: fecal coliform less than 1,000 Most Probable Number per gram of total solids, dry weight per TMECC 07.01.

**15.** Trace Contaminants Metals (lead, mercury, etc.): Product must meet US EPA, 40 CFR 503 regulations.

D. Soil Admixtures: [Specify admixtures, if used]

2.02 AGGREGATE STORAGE

DESIGNER NOTE: Aggregate storage layer requirements are dependent on location of project (i.e., MS4 areas vs. combined sewer areas), site specific conditions (e.g., native soil infiltration rates, storage volume needs of project). The designer should update this specification based on the aggregate storage materials required for the project.

DESIGNER NOTE: Aggregate storage is optional in combined sewer areas for facilities without underdrains. BSM depth may also be increased for additional storage capacity (in lieu of an aggregate storage layer), provided the facility is within a combined sewer area and not serviced by an underdrain.

A. Aggregate Storage shall consist of hard, durable, and clean, sand, gravel, or mechanically crushed stone, substantially free from adherent coatings. Materials shall be washed thoroughly to remove fines, organic matter, extraneous debris, or objectionable materials. Recycled materials are not permitted. The material shall be obtained only from a source(s) approved by the Engineer/Landscape Architect. Written requests for source approval shall be submitted to the Engineer/Landscape Architect not less than ten (10) working days prior to the intended use of the Material. Should the proposed source be one that the Engineer/Landscape Architect has no

history of Material performance with, the Engineer/Landscape Architect reserves the right to take preliminary samples at the proposed source, and make preliminary tests, to first determine acceptability of the new source and then perform the applicable Material approval testing. Continued approval of a source is contingent upon the Materials from that source continuing to meet Contract requirements. Materials shall meet the Standard Specifications for grading and quality for use in the Work; however, allowable exceptions may be specified in the Contract.

B. Aggregate storage shall meet the following specifications for grading and quality.

**1.** Aggregate gradation testing in accordance with ASTM C136 at least once per 500 cubic yards.

| Sieve[1] | Percent Passing by Weight | | |
|---|---|---|---|
| | **Choking Course ASTM No. 9 (Modified)[3]** | **Reservoir Course ASTM No. 7 (Modified)[4]** | **Caltrans Class 2 Permeable Aggregate (MS4 Areas Only)** |
| 1 inch | – | – | 100 |
| 3/4 inch | – | 100 | 90 to 100 |
| 1/2 inch | 100 | 90 to 100 | – |
| 3/8 inch | 100 | 40 to 70 | 40 to 100 |
| No. 4 | 85 to 100 | 0 to 15 | 25 to 40 |
| No. 8 | 10 to 40 | 0 to 5 | 18 to 33 |
| No. 16 | 0 to 10 | – | – |
| No. 30 | – | – | 5 to 15 |
| No. 50 | – | – | 0 to 7 |
| No. 200[2] | 0 to 2 | 0 to 2 | 0 to 3 |

[1] Sieve provided in nominal size square openings or United States Standard Sieve Series sizes.

[2] Gradation modified from ASTM for portion passing the No. 200 sieve.

[3] Materials likely to meet this specification are available locally as Graniterock 1/4” premium screenings (Wilson 1/4" x #10 Premium Screenings).

[4] Materials likely to meet this specification are available locally as Graniterock 1/2” premium screenings (Wilson 1/2" x #4 Roofing Aggregate).

**2.** Crushed Particles: 90 percent (minimum) fractured faces tested in accordance with California Test 205. Do not use rounded river gravel.

**3.** L.A. Abrasion: 40 percent (maximum) tested in accordance with ASTM C 131.

DESIGNER NOTE: If the designer chooses to specify materials that differ from those provided herein, the designer should check their filter criteria to evaluate the likelihood of finer-graded material migration into underlying coarser graded materials or reduction in permeability relative to the underlying material. Refer to the SFPUC Aggregate Filter Criteria Guidance document for information on selecting appropriate alternate materials.

DESIGNER NOTE: Designer should verify that underdrain slot dimensions for project are compatible with aggregate gradation specified. Refer to the SFPUC Aggregate Filter Criteria Guidance document for information on selecting appropriate underdrain materials.

2.03 MULCH

DESIGNER NOTE: This section intentionally left blank. Designer to specify mulch requirements for bioretention facilities. Mulch may be wood, compost, or rock mulch. Mulch shall be free of dyes, recycled dimensional lumber, and bark. Materials selected shall be sufficiently permeable to allow water to pass through at a rate equal to or greater than the underlying BSM. Typical mulch recommended for this application includes tree trimming mulch per Caltrans Standard Specification Section 20-7.02D(6)(a) and (e), or other comparable material (e.g., arbor mulch).

2.04 STREAMBED GRAVEL

DESIGNER NOTE: This section intentionally left blank. Designer to specify gravel requirements, including gradation, for bioretention facilities. Streambed Gravel shall be sized to provide energy dissipation and to minimize erosion at facility inlets and outlets. The following text is a sample/template specification for cobbles within a bioretention facility:

Streambed Cobbles shall be clean, naturally occurring water rounded gravel material. Streambed Cobbles shall have a well-graded distribution of cobble sizes and conform to the following gradation [Designer to specify]:

| Streambed Cobbles | |
|---|---|
| **Approximate Size[1]** | **Percent Passing by Weight** |
| | |
| | |
| | |
| | |

[1] Approximate size can be determined by taking the average dimension of the three axes of the rock, Length, Width, and Thickness, by use of the following calculation: (Length + Width + Thickness )/3 = Approximate Size Length is the longest axis, width is the second longest axis, and thickness is the shortest axis.

The grading of the cobbles shall be determined by the Engineer/Landscape Architect by visual inspection of the load before it is dumped into place, or, if so ordered by the Engineer/Landscape Architect, by dumping individual loads on a flat surface and sorting and measuring the individual rocks contained in the load. Cobbles must be washed before placement.

## PART 3 EXECUTION

3.01 GENERAL

A. Prevent runoff from adjacent pervious and impervious surfaces from entering the bioretention facility (e.g., sand bag inlet curb cuts, stabilize adjacent areas, flow diversion) until authorization is given by the

Engineer/Landscape Architect. Refer to SFPUC Specification Section 01 57 29 Temporary Protection of Green Infrastructure Facilities.

B. Exclude equipment from bioretention facilities. No equipment shall operate within the facility once bioretention facility excavation has begun, including during and after excavation, backfilling, mulching, or planting.

C. Prevent foreign materials and substances, such as silt laden run-off, construction debris, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid from entering or being stored in the facility at any point during construction.

3.02 GRADING

A. The Contractor shall not start bioretention facility grading until all areas draining to the facility are stabilized and authorization has been given by the Engineer/Landscape Architect.

B. Construct bioretention facility subgrade to +/- 3/4 inch of the grades and slopes specified on the Plans.

C. Excavation within 6 inches of final native soil grade shall not be permitted if facility soils have standing water, or have been subjected to more than 1/2 inch of precipitation within the previous 48 hours.

3.03 SUBGRADE PREPARATION AND PROTECTION

A. Protect the bioretention excavation from over compaction and/or contamination.

**1.** Areas which have been over compacted by equipment or vehicle traffic or by other means and which need to be ripped, over excavated, receive additional scarification, or other restorative means shall be done at the Contractor's expense and at the direction of the Engineer/Landscape Architect.

**2.** Excavated areas contaminated by sediment laden runoff prior to placement of BSM or Aggregate Storage material shall be remediated at the Contractor's expense by removing the contaminated soil (top 3 inches minimum) and replacing with a suitable material, as determined by the Engineer/Landscape Architect.

B. Remove all trash, debris, construction waste, cement dust and/or slurry, or any other materials that may impede infiltration into prepared subgrade.

C. The subgrade shall be inspected and accepted by the Engineer/Landscape Architect prior to placement of any materials or final subgrade scarification.

D. Scarify the surface of the subgrade to a minimum depth of 3 inches immediately prior to placement of BSM or aggregate storage material. Acceptable methods of scarification include use of excavator bucket teeth or a rototiller to loosen the surface of the subgrade.

E. Place aggregate storage material, where shown on drawings with conveyor belt or with an excavator or loader from a height no higher than 6 feet unless otherwise approved by the Engineer/Landscape Architect (i.e., do not dump material directly from truck into cell).

F. Aggregate Storage areas contaminated by sediment-laden runoff prior to placement of BSM shall be remediated at the Contractor's expense by removing the contaminated aggregate storage material (top 3 inches minimum or as directed by the Engineer/Landscape Architect) and replacing with clean aggregate storage material per Section 2.03, to the lines and grades on the Plans.

G. Aggregate Storage material shall be inspected and accepted for placement and finish grade by the Engineer/Landscape Architect prior to the installation of BSM. Any material that does not conform to this Specification shall be removed and replaced with acceptable material or remediated to the satisfaction of the Engineer/Landscape Architect, at the Contractor's expense.

3.04 BIORETENTION SOIL MIX PLACEMENT

A. The Contractor shall not place BSM until the Engineer/Landscape Architect has reviewed and confirmed the following:

**1.** BSM delivery ticket(s): Delivery tickets shall show that the full delivered amount of BSM matches the product type, volume and manufacturer named in the submittals. Each delivered batch of BSM shall be accompanied by a certification letter from the supplier verifying that the material meets specifications and is supplied from the approved BSM stockpile.

**2.** Visual match with submitted samples: Delivered product will be compared to the submitted 1-gallon sample, to verify that it matches the submitted sample. The Engineer/Landscape Architect may inspect any loads of BSM on delivery and stop placement if the soil does not appear to match the submittals; and require sampling and testing of the delivered soil to determine if the soil meets the requirements of Section 2.01 before authorizing soil placement.

**3.** Inspection of the aggregate storage layer, underdrain, cleanout, and overflow structure installation, where included on the plans.

DESIGNER NOTE: On larger projects, it may be appropriate to require that the testing specified in Section 2.01 be performed on samples taken at the supplier's yard from the stockpile to be used for the project; see designer note in Section 1.06.C.2.

B. BSM placement, grading and consolidation shall not occur when the BSM is excessively wet, or has been subjected to more than 1/2 inch of precipitation within 48 hours prior to placement. Excessively wet is defined as being at or above 22 percent soil moisture by a General Tools &

Instruments DSMM500 Precision Digital Soil Moisture Meter with Probe (or equivalent). A minimum of three readings with the soil moisture probe will be used to determine the average percent soil moisture reading per each truck load. There should be no visible free water in the material.

C. The Contractor shall place BSM loosely with a conveyor belt or with an excavator or loader from a height no higher than 6 feet, unless otherwise approved by the Engineer/Landscape Architect (i.e., do not dump material directly from truck into cell). Soil shall be placed upon a prepared subgrade in accordance with these Specifications and in conformity with the lines, grades, depth, and typical cross-section shown in the Drawings or as established by the Engineer/Landscape Architect.

D. Excessively dry BSM may be lightly and uniformly moistened, as necessary, to facilitate placement and workability.

E. Compact BSM using non-mechanical compaction methods (e.g., boot packing, hand tamping, or water consolidation) to 83 percent (+/- 2 percent) of the maximum dry density per modified Proctor test (ASTM D1557), or as directed by the Geotechnical Engineer. Determination of in-place density shall be made using a nuclear gauge per ASTM D6938. Moisture content determination shall be conducted on a soil sample taken at the location of the nuclear gage reading per ASTM D2216.

DESIGNER NOTE: BSM compaction target density will be updated as more data from installed projects becomes available on the optimal compaction to minimize settlement while maintaining the infiltration capacity of the media. Designers are encouraged to report field density measurements, observed infiltration rates (if available), and anecdotal field observations (e.g., soil appears well draining, settlement observed minimal).

F. Grade BSM to a smooth, uniform surface plane with loose, uniformly fine texture. Rake, remove ridges, and fill depressions to meet finish grades.

G. Final soil depth shall be measured and verified only after the soil has been compacted. If after consolidation, the soil is not within +/- 3/4 inch of the grades and slopes specified on the Plans, add material to bring it up to final grade and raked.

H. The BSM shall be inspected and accepted for placement and finish grade by the Engineer/Landscape Architect prior to the installation of planting and mulch. Any BSM that does not conform to this Specification shall be remediated to the satisfaction of the Engineer/Landscape Architect, or removed and replaced with acceptable BSM, at the Contractor's expense.

3.05 PLANTING AND MULCHING

A. Bioretention facilities shall be planted and mulched as shown on the Plans.

B. Bioretention facilities shall not be planted or mulched when soils are excessively wet as defined in Section 3.04.

C. Bioretention facility areas contaminated by sediment laden runoff prior to planting or placement of mulch shall be remediated at the Contractor's expense by removing the contaminated BSM (top 3 inches minimum) and replacing with BSM per Section 2.01, to the lines and grades on the Plans.

D. All mulch shall be inspected and accepted by the Engineer/Landscape Architect to ensure appropriate depth and material prior to facility commissioning (e.g., unblocking of inlets).

DESIGNER NOTE: Planting and mulching requirements shall be determined by the designer and included or referenced herein.

3.06 FLOOD TESTING

A. Inlets shall be constructed per the Plans and free from all obstructions prior to commencing flow testing.

B. Testing shall be conducted at the conclusion of the 90-day plant grow-in period. Protection and flow diversion measures installed to comply with Section 01 57 29 Temp Protection of GI Facilities shall be removed in their entirety prior to commencing flow testing.

C. Underdrains shall be plugged at the outlet structure to minimize water consumption during testing.

D. Prior to testing, broom sweep gutter and other impervious surfaces within the test area to remove sediments and other objectionable materials.

E. The Engineer/Landscape Architect shall be present during the demonstration. The Contractor shall notify the Engineer/Landscape Architect a minimum of 2 working days prior to testing.

F. The Contractor shall water test each facility to demonstrate that all inlet curb openings are capturing and diverting all water in the gutter to the facility, outlet structures are engaging at the elevation specified, and the designed ponding depth is achieved. Testing shall include application of water from a hydrant or water truck per Section 00 73 73, Article 3.04 (Requirements for Using Water For Construction), at a minimum rate of 10 gallons per minute, into the gutter a minimum of 15 feet upstream of the inlet curb opening being tested. Each inlet shall be tested individually. If erosion occurs during testing, restore soils, plants, and other affected materials.

DESIGNER NOTE: Designer should update test flow rate for inlets to reflect project-specific design, as needed.

G. Engineer/Landscape Architect will identify deficiencies and required corrections, including but not limited to relocating misplaced plants, adjusting streambed gravel, adjusting mulch, adjusting inlets, splash aprons, and forebays, removing and replacing inlets, and removing debris.

H. Once adjustments are made, the Contractor shall re-test to confirm all test water flows into the facility from the gutter and correct any remaining deficiencies identified by Engineer/Landscape Architect.

I. Inlets, outlets, and other bioretention facility appurtenances shall not be accepted until testing and any required correction and retesting is complete and accepted by the Engineer/Landscape Architect.

DESIGNER NOTE: The Owner may, at any time, conduct additional testing on all materials submitted, delivered, or in-place, to ensure compliance with the Specifications. Testing may include permeability testing per ASTM D2434 (Modified), density testing per ASTM D6938, etc., if the Engineer/Landscape Architect suspects the facility does not conform to these specifications (e.g., as evidenced by lower than anticipated infiltration capacity).

DESIGNER NOTE: Designer should consider adding a similar requirement to the Concrete Paving and Sanitary Sewerage Utilities sections of the Specifications, as needed.

**END OF SECTION**

## DIVISION 32 – EXTERIOR IMPROVEMENTS

## Section 32 14 43 – Permeable/Porous Unit Pavers

DESIGNER NOTE: The specifications below are based on the best available information. Designer should modify the specifications to satisfy project-specific constraints. The City uses the term “Permeable Unit Pavers” when infiltration achieved via aggregate filled joints and “Porous Unit Pavers” when infiltration is achieved through the paver material itself.

DESIGNER NOTE: Green text corresponds to notes to the designer.

### PART 1 GENERAL

1.01 SUMMARY

A. This section Includes:

1. Permeable/Porous Unit Pavers
2. Joint Filter Aggregate
3. Pavement Base
4. Edge Restraints
5. Geotextile for Soil Separation

B. Related Sections

DESIGNER NOTE: The designer should list any additional specification sections which relate to the permeable/porous unit paver work (i.e., temporary erosion control, utilities, earthwork, etc.)

1.02 STANDARDS AND CODES

A. Reference Standards: This section incorporates by reference the latest version of the following documents. These references are a part of this section as specified and modified.

| Reference | Title |
|---|---|
| Caltrans | Standard Specifications |
| San Francisco DPW | Engineering Standard Specifications |
| ASTM C67 | Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units |
| ASTM C13 | Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine |
| ASTM C136 | Method for Sieve Analysis for Fine and Coarse Aggregate |
| ASTM C140 | Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units |
| ASTM D448 | Standard Classification for Sizes of Aggregate for Road and Bridge Construction |

| | |
|---|---|
| ASTM C936 | Standard Specification for Solid Interlocking Concrete Pavers |
| ASTM C979 | Specification for Pigments for Integrally Colored Concrete |
| ASTM C1781 | Standard Test Method for Surface Infiltration Rate of Permeable Unit Pavement Systems |
| ASTM E2835 | Standard Test Method for Measuring Deflections using a Portable Impulse Plate Load Test Device |

1.03 REFERENCES

DESIGNER NOTE: Designer to provide references to related industry manuals and guidance and all project specific documents (e.g., geotechnical report).

A. Interlocking Concrete Pavement Institute (ICPI)

1. Permeable Interlocking Concrete Pavement manual.

DESIGNER NOTE: The designer should consider the use of the ICPI Permeable Design Pro software for structural design and determination of adequate depth for the pavement section.

1.04 SUBMITTALS

A. Bid Submittals: The Contractor shall submit to the Owner the following as part of the bid proposal:

1. Paver Installation Subcontractor:

a. A copy of Subcontractor's current certificate from the Interlocking Concrete Pavement Institute's Concrete Paver Installer Certification program.

b. Job references from three (3) projects of a similar size and complexity. Provide Owner/Client/General Contractor names, postal address, phone number, and email address.

DESIGNER NOTE: The designer should incorporate by reference these requirements in Division 00 of the Specifications.

B. Pre-Installation Submittals: The Contractor shall submit to the Engineer the following a minimum of 20 calendar days prior to the construction of the permeable/porous unit pavers:

1. Paver manufacturer's/installation subcontractor's drawings and details indicating perimeter conditions, junctions with other materials, expansion and control joints, paver layout/patterns, joint spacing and/or tabs, color arrangement, and installation [and setting] procedures. Drawings and details shall also indicate layout, pattern and relationship of paving joints to fixtures and project formed details.

2. Source certificates, gradations, R-values, LA abrasion, and cleanness values of aggregates for base, reservoir course, and joint filler materials performed within one (1) month of product delivery to site.

   DESIGNER NOTE: Consider revising acceptable age of sieve test depending on scale of project. On a larger project it may be appropriate to require testing by an independent lab with samples taken at the supplier's yard from the stockpile to be used for the project.

3. Product data sheets for unit pavers and geotextiles.

4. Laboratory test reports certifying compliance of the concrete pavers with ASTM C936.

5. Manufacturer's certification of concrete pavers by ICPI as having met applicable ASTM standards.

DESIGNER NOTE: Especially when using colored pavers, consider requiring submittal of full-size samples of each paver type, thickness, color, and finish. Require submittal of samples indicating the range of color expected in the finished installation. Accepted samples would become the standard of acceptance for the work of this Section.

1.05 QUALITY CONTROL AND QUALITY ASSURANCE

A. General: Test and inspect permeable/porous unit paver materials and operations as Work progresses as described in this section. Failure to detect defective Work or materials at any time will not prevent rejection if a defect is discovered later, nor shall it constitute final acceptance.

1. Paver Installation Subcontractor Qualifications:

2. Installer shall provide documentation showing three (3) successful permeable/porous unit paver installations completed in the last three (3) years, collectively totaling more than 10,000 square feet. Documentation shall include name and address of project, and contact information for project owner.

3. Installer shall utilize job foremen holding a record of completion from the Interlocking Concrete Pavement Institute PICP Installer Technician Course.

DESIGNER NOTE: Consider changing these requirements to match scale and complexity of project including a minimum total amount of pavers placed.

B. Responsibilities of Contractor

1. Pre-Placement Conference: A mandatory pre-placement conference will take place, including at a minimum the Engineer, the Owner, general Contractor, and paver installer, to review the manufacturers'

quality control plan, personnel qualifications, and the paver installers' Method Statement and Quality Control Plan.

2. Reference Panel: Place reference panels on the project site, on a subgrade and base prepared as specified, using the material and construction requirements for pavement in this Specification. Each panel must have a surface area of at least 100 square feet (sf), and a width and thickness as specified for the pavement in the Contract Documents. The Engineer shall observe and accept each element of the paver construction prior to the placement of additional pavement. Failure to install acceptable reference panels of permeable/porous unit pavers will indicate an unqualified installer. Construction and evaluation of the reference panel(s) will occur as follows:

   a. Notify the Engineer at least ten (10) Working Days before installing paver reference panel.

   b. Coordinate the location of the reference panel with the Engineer.

   c. Notify the Engineer when each element of the reference panel is ready for inspection.

   d. Remove, replace, and dispose of any unsatisfactory portions of reference panel as determined by the Engineer and at no additional cost to the Owner.

   e. Retain and maintain approved reference panel during construction in an undisturbed condition as a standard for judging completed portions of the final installations.

   Approved reference panels may remain as final installations of the Work at the discretion of the Engineer. If not retained, the reference panel shall be removed and disposed at no additional cost to the Owner.

   DESIGNER NOTE: Mechanized installations may require a larger mock up area. Consult with the paver installation (Sub) Contractor on the size of the reference panel.

   DESIGNER NOTE: Use this panel to determine expected settlement (surcharge) of the leveling course, joint sizes, and lines, laying pattern, color and texture of the job.

   DESIGNER NOTE: The designer should consider requiring verification of subgrade infiltration rate and provision to increase reservoir course depth based on results.

3. Infiltration Testing: Perform surface infiltration tests per ASTM C1781 as described below.

   a. Three (3) test locations per 10,000 square feet of permeable/porous unit pavers, in place

b. One (1) additional test location per 5,000 square feet of permeable/porous unit pavers, or fraction thereof, in place

DESIGNER NOTE: Designer to specify the number and location(s) of required post construction infiltration tests.

C. Acceptance

1. The surface elevation of pavers shall be 1/8 to 1/4 inch (3 to 6 mm) above adjacent drainage inlets, concrete collars or channels.

2. Lippage: No greater than 1/8 inch (3 mm) difference in height between adjacent pavers.

3. Bond lines for paver courses shall be within ½ inch (± 15 mm) over a 50-foot (15 m) string line.

4. The final surface tolerance of compacted pavers shall not deviate more than ± 3/8 inch (10 mm) under a 10-foot (3 m) long straightedge.

5. Infiltration Rate: The average of all tests shall be greater than 50 inches per hour with no single test less than 25 inches per hour.

DESIGNER NOTE: The designer should adjust infiltration rates to reflect project specific conditions such as anticipated sediment loading based on pavement use (e.g., vehicular, pedestrian) and design run-on from adjacent surfaces. The recommended criteria are as follows:

- For permeable/porous unit pavers that will accept run-on from adjacent impervious and/or pervious surfaces OR pavement that will be subject to vehicular traffic:
  - The average of all surface infiltration tests shall be greater than 100 inches per hour with no single test less than 50 inches per hour
- For permeable pavement not subject to run-on OR vehicular traffic:
  - The average of all surface infiltration tests shall be greater than 50 inches per hour with no single test less than 25 inches per hour

DESIGNER NOTE: The surface of the pavers may be 1/8 to 1/4 inch (3 to 6 mm) above the final designed elevations after compaction. This helps compensate for possible minor settling normal to pavements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. General: Comply with Division 1 Product Requirement Section.

B. Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.

C. Delivery: Deliver materials in manufacturer's original, unopened, undamaged container packaging with identification tags intact on each paver bundle.

1. Coordinate delivery and paving schedule to minimize interference with normal use of buildings adjacent to paving.

2. Deliver concrete pavers to the site in steel banded, plastic banded, or plastic wrapped cubes capable of transfer by forklift or clamp lift.

D. Unload pavers at job site in such a manner that no damage occurs to the product or existing construction.

E. Storage and Protection: Store materials in a protected area such that they are kept free from mud, dirt, and other foreign materials.

1.07 MAINTENANCE

DESIGNER NOTE: Consider requiring the provision of additional pavers to be retained and stored by the Owner for future maintenance.

- Extra materials: Provide [Specify area] [Specify percentage] additional material for use by Owner for maintenance and repair.
- Extra pavers shall be from the same production run as installed materials.

## PART 2 PRODUCTS

DESIGNER NOTE: Some projects may include permeable/porous and solid unit pavers. Specify each product, as required.

2.01 PERMEABLE/POROUS UNIT PAVERS

A. Manufacturer: [Specify manufacturer name.].

1. Contact: [Specify ICPI member manufacturer contact information.].

B. Permeable/Porous Unit Paver Type: [Specify name of product group, family, series, etc.].

1. Material Standard: Comply with ASTM C 936.

2. Color [and finish]: [Specify color.] [Specify finish].

3. Color Pigment Material Standard: Comply with ASTM C979.

4. Size: [Specify.] inches [({Specify.}mm)] x [Specify.] inches [({Specify}mm)] x [Specify.] inches [({Specify.} mm)] thick.

5. Joint Gap Size: [Specify.] inches

6. Joint Gap Mechanism: [Specify if integral spacer, or other paver spacer.] type

7. Bevel Size: [Specify.] inches, [Specify.] type

DESIGNER NOTE: Concrete pavers with spacers integral to each unit are recommended for mechanically installed pavers and pavers subject to vehicular traffic. Verify with manufacturer that overall dimensions do not include spacers.

2.02 JOINT FILLER AGGREGATE

A. Crushed Particles: 90 percent (minimum) tested in accordance with California Test 205.

B. LA Abrasion: Less than 40 tested in accordance with ASTM C131.

C. Cleanness Value: 75 (minimum) tested in accordance with California Test 227 at least once per 500 cubic yards of base material.

D. Rounded river gravel may not be used.

E. Permeable Unit Paver: The following aggregate shall be used to fill joints unless manufacturer recommends otherwise. Aggregate gradations shall be per Section 2.03.C.1. If manufacturer recommendation is different from the gradations shown below the Contractor shall be notified at least 48 hours prior to placement of the joint filler.

| Gap Width | Aggregate Gradation |
|---|---|
| 3/8" or ½" | ASTM No. 8 (modified) |
| ¼" | ASTM No. 89 (modified) |
| 1/8" | ASTM No. 10 (modified) |

F. Porous Unit Pavers: Joint filler shall be per manufacturer's recommendation.

2.03 PAVEMENT BASE

A. Pavement Base Material shall be consist of clean, mechanically crushed stone, substantially free from adherent coatings. Materials shall be washed thoroughly to remove clay, organic matter, extraneous debris, or objectionable materials. Recycled materials or rounded river gravel are not permitted. Material shall be obtained only from a source(s) approved by the Engineer. Written requests for source approval shall be submitted to the Engineer not less than ten (10) Working Days prior to the intended use of the Material. Should the proposed source be one that the Engineer has no history of Material performance with, the Engineer reserves the right to take preliminary samples at the proposed source, and make preliminary tests, to first determine acceptability of the new source and then perform the applicable Material approval testing. Continued approval of a source is contingent upon the Materials from that source continuing to meet Contract requirements. Materials shall meet the Standard Specifications for grading and quality for use in the Work; however, allowable exceptions may be specified in the Contract. The Engineer shall reserve the right to sample and test Material at any time including at the source.

B. Pavement Base shall consist of up to three (3) layers as specified on the Plans and included herein:

1. "Leveling Course" shall be ASTM No. 8 (modified) stone per Section 2.03.C.

   DESIGNER NOTE: This layer of the pavement base is intended to provide a smooth, level surface for placement of pavers.

2. "Base Course" shall be ASTM No. 57 (modified) stone per Section 2.03.C.

   DESIGNER NOTE: This layer of the pavement base is intended to provide structural (load bearing) capacity to the pavement.

3. "Reservoir Course" shall be ASTM No. 2 (modified), ASTM No. 3 (modified), or ASTM No. 57 (modified) stone per Section 2.03.C.

   DESIGNER NOTE: This layer of the pavement base is intended to provide water storage and drainage of the pavement, structural support, and a capillary break. The materials specified should be crushed, clean, washed rock to provide the desired structural capacity, maintain good drainage, function as a capillary barrier, and minimize clogging of the subgrade due to export of fines.

   DESIGNER NOTE: ASTM No. 2 stone is preferred.

DESIGNER NOTE: If the designer chooses to specify materials that differ from those provided herein, the designer should check their filter criteria to evaluate the likelihood of finer-graded material migration into underlying courser graded materials or reduction in permeability relative to the underlying material. Refer to SFPUC aggregate filter criteria guidance document for information on selecting appropriate alternate materials.

C. Pavement Base Material shall meet the following specifications for grading and quality.

DESIGNER NOTE: If the designer chooses to specify materials per the procedure above, provide the required gradation the in the table below.

1. Aggregate Gradation tested in accordance with ASTM C136 at least once per 500 cubic yards of base material.

| Sieve[1] | Percent Passing by Weight | | | | | |
|---|---|---|---|---|---|---|
| | ASTM No. 10 (modified) | ASTM No. 89 (modified) | ASTM No. 8 (modified) | ASTM No. 57 (modified) | ASTM No. 3 (modified) | ASTM No. 2 (modified) |
| 3 inch | – | – | – | – | – | 100 |
| 2 1/2 inch | – | – | – | – | 100 | 90 to 100 |
| 2 inch | – | – | – | – | 90 to 100 | 35 to 70 |
| 1 1/2 inch | – | – | – | 100 | 35 to 70 | 0 to 15 |
| 1 inch | – | – | – | 95 to 100 | 0 to 15 | – |
| 3/4 inch | – | – | – | – | – | 0 to 5 |
| 1/2 inch | – | 100 | 100 | 25 to 60 | 0 to 5 | – |
| 3/8 inch | 100 | 90 to 100 | 85 to 100 | – | – | – |
| No. 4 | 85 to 100 | 20 to 55 | 10 to 30 | 0 to 10 | – | – |

| | | | | | | |
|---|---|---|---|---|---|---|
| No. 8 | – | 5 to 30 | 0 to 10 | 0 to 5 | – | – |
| No. 16 | – | 0 to 10 | 0 to 5 | – | – | – |
| No. 30 | – | – | – | – | – | – |
| No. 50 | – | 0 to 5 | – | – | – | – |
| No. 100[2] | 10 to 30 | – | 0 to 2 | 0 to 2 | 0 to 2 | 0 to 2 |
| No. 200[2] | 0 to 2 | 0 to 2 | – | – | – | – |

[1] Sieve provided in nominal size square openings or United States Standard Sieve Series sizes.

[2] Gradation modified from ASTM for portion passing the No. 100 and 200 sieve, as shown.

2. R-Value: 78 (minimum) tested in accordance with California Test 301.
3. L.A. Abrasion: 30 percent (maximum) tested in accordance with ASTM C131.
4. Cleanness Value: 75 (minimum) tested in accordance with California Test 227 at least once per 500 cubic yards of base material.
5. Crushed Particles: 90 percent (minimum) with two (2) or more fractured faces tested in accordance with California Test 205.
6. The combined portion of Material retained on the U.S. No. 4 sieve shall not contain more than 0.1 percent wood waste by weight. The portion of Material passing a U.S. No. 10 sieve shall not have wood waste that results in more than 250 parts per million of organic matter by calorimetric tests when tested. The color shall be measured after the sample has been in the test solution for 1 hour.

## 2.04 ACCESSORIES

A. Provide accessory materials as follows: Edge Restraints

1. Manufacturer: [Specify manufacturer.].
2. Material(s): [Pre-cast concrete] [Cut stone] [steel].
3. Material Standard: [Specify material standard.].
4. Configuration: [Specify geometry, manufacturer's model number, stakes or spikes, paver spacers, coatings, color, etc.]

DESIGNER NOTE: Curbs will typically be cast-in-place concrete or precast set in concrete haunches. Cast in place concrete curbs should be specified in another Section. Do not use plastic edging with steel spikes to restrain unit pavers for vehicular applications.

## 2.05 GEOTEXTILE FOR SOIL SEPARATION

DESIGNER NOTE: See ICPI publication, Permeable Interlocking Concrete Pavements for guidance on geotextile selection. Geotextile is not typically required under permeable pavement applications unless recommended by a geotechnical engineer. Geotextile can be placed vertically for material separation between side walls of reservoir course and native soil.

A. Geotextile shall be woven, consisting only of long chain polymeric fibers or yarns formed into a stable network such that the fibers or yarns retain their position relative to each other during handling, placement, and design service life. At least 95 percent by weight of the material shall be polyolefins or polyesters. The material shall be free from defects or tears. The geotextile shall also be free of any treatment or coating which might adversely alter its hydraulic or physical properties after installation. The geotextile shall conform to the properties specified herein:

| Geotextile Property | Test Method | Requirement |
|---|---|---|
| Grab Tensile Strength, minimum in weakest direction | ASTM D4632 | 200 lbs/in |
| Apparent Opening Size (AOS) | ASTM D4751 | 40 to 50 |
| Ultraviolet (UV) Radiation Stability, minimum strength retained after 500 hours in weatherometer | ASTM D4355 | 50% |
| Flow Rate, minimum | ASTM D4491 | 140 gal/min/ft$^2$ |

DESIGNER NOTE: The designer should consider including specifications for signage and pavement markings in this section.

## PART 3 EXECUTION

### 3.01 SUBGRADE PREPARATION AND PROTECTION

A. Construct subgrade to +/- ¾ inch of the grades and slopes specified on the Plans.

B. Grading of subgrade shall be with low ground pressure equipment when within six (6) inches of final subgrade elevation.

C. Compact subgrade to 90 percent (+/- 2 percent) of the maximum dry density per standard Proctor test (ASTM D698), or as directed by the Geotechnical Engineer. Determination of in-place density shall be made using a nuclear gauge per ASTM D6939.

DESIGNER NOTE: The designer should set compaction requirements based on consideration of site specific geotechnical properties of the native soil (e.g., permeability, stiffness) and performance requirements for the pavement section (e.g., traffic loading, infiltration, cost).

D. Areas of the subgrade which are over-compacted, as determined by the Geotechnical Engineer, shall be ripped/tilled to a depth of 12 inches (minimum) or as directed by the Geotechnical Engineer and shall be recompacted in accordance with Section 3.01.C. Contractor shall locate all utilities within pavement footprint prior to ripping and re-compacting subgrade.

E. Proof-roll prepared subgrade with loaded dump truck, remove soft spots, and replace with permeable structural fill as directed by the Engineer to achieve uniform subgrade.

DESIGNER NOTE: Other subgrade verification methods may be required if site conditions limit proof rolling. Consult with geotechnical engineer for acceptable methods.

F. After compaction and proof roll, scarify subgrade ¼- to ½-inch deep by hand rake. Once scarified, materials or equipment shall not be permitted within the prepared subgrade area so as to avoid recompaction or clogging of the scarified subgrade.

G. The subgrade shall be protected from over-compaction or contamination by silty run-off or other contaminants.

1. Provide physical barriers or direct traffic to eliminate unnecessary vehicular traffic on the subgrade during construction in accordance with SFMTA and SFDPW ordinances and specifications.

2. Provide flow diversion and erosion control measures to protect the permeable pavement area from sedimentation until the upstream catchment area is thoroughly stabilized.

H. Areas of subgrade over-compacted by construction traffic or other impacts by the Contractor or Subcontractors shall be ripped/tilled and re-compacted in accordance with Section 3.01.D. All work and materials required to correct the over-compacted subgrade, including utility locates within the pavement footprint, shall be at the Contractor's expense.

I. Areas of subgrade contaminated by the accumulation of silty material following rains or other debris or contamination shall be removed and disposed at the Contractor's expense.

J. The subgrade shall be inspected and accepted by the Engineer prior to placement of the geotextile or pavement base.

K. Place geotextile, if required, on scarified subgrade. Care shall be taken to provide full coverage and to prevent the geotextile from being torn. Damaged geotextile shall be repaired as indicated by the manufacturer and to the satisfaction of the Engineer, at no additional cost to the Owner. Overlaps of the geotextile shall be a minimum of 1 foot or to the manufacturer's recommendation, whichever is greater.

DESIGNER NOTE: The use of geotextile under permeable pavement systems should be avoided unless required by the project geotechnical engineer as it can be prone to subsurface clogging.

3.02 PAVEMENT BASE

A. Construct pavement base to the lines, grades, and thicknesses shown on the Plans.

B. Place the pavement base so as to prevent loaded dump trucks from driving directly on the prepared subgrade.

C. Compact pavement base, in six (6)-inch (maximum) lifts, by making a minimum of three passes over the pavement base material with a ten (10)-ton vibratory roller, or as directed by the Geotechnical Engineer. The first two (2) passes (minimum) shall be in vibratory mode. The final pass shall be in static mode. Acceptance of the pavement base will be based on Engineer's observation of aggregate movement during final compaction pass. Compaction equipment shall be accepted by the Engineer prior to use.

DESIGNER NOTE: For areas or sites that cannot accommodate a vibratory roller compactor, consider allowing compaction of pavement base with a 13,500 lbf (60 kN) minimum vibratory plate compactor with a compaction indicator. At least two passes should be made over each lift of the aggregates.

D. Pavement base shall be true to the designed grade and slope, +/- 0.05 feet, after compaction for each layer. In the event of low spots, additional material shall be added and recompacted. In the event of high spots, excess material shall be removed and the area recompacted.

E. Pavement base materials shall be protected from over-compaction or contamination by silty run-off or other contaminants.

1. Provide physical barriers or direct traffic to eliminate unnecessary vehicular traffic on the pavement base during construction in accordance with SFMTA and SFDPW ordinances and specifications.

2. Do not subject placed and compacted gravel leveling course to any pedestrian or vehicular traffic before unit paver installation begins.

3. Provide flow diversion and erosion control measures to protect the permeable pavement area from sedimentation until the upstream catchment area is thoroughly stabilized.

F. Any damage to the pavement base (including contamination by silty run-off) shall be repaired to the satisfaction of the Engineer at the Contractor's expense. Contaminated pavement base shall be removed and replaced to the limits as determined by the Engineer.

G. The pavement base shall be inspected and accepted by the Engineer prior to placing any pavers.

DESIGNER NOTE: Consider developing a testing plan for the required testing and inspection of the pavement base. Verification of the in place density/compaction of the open graded base materials is typically not possible with the use of a nuclear densometer due to nature of these materials. Therefore other means to verify these materials are firm and unyielding (such as observation of the compaction process by a geotechnical engineer) are necessary.

DESIGNER NOTE: Consider requiring the Contractor to compact aggregates without crushing them.

3.03 PAVERS AND JOINT/OPENING FILL MATERIAL

A. Lay the unit pavers in the pattern(s) and joint widths shown on the Plans. Maintain straight pattern lines.

B. Fill gaps at the edges of the paved area with cut units. Cut pavers subject to tire traffic shall be no smaller than 1/3 of a whole unit.

C. Cut pavers and place along the edges with a double-bladed splitter or masonry saw.

D. Fill all openings and joints with joint filler aggregate conforming to Section 2.02.

E. Remove excess aggregate on the surface by sweeping pavers clean.

F. Compact and seat the pavers into the bedding material using a low-amplitude, 75 to 90 Hz plate compactor capable of at least 5,000 lbf (22 kN). This will require at least two passes with the plate compactor.

G. Do not compact within 6 feet (2 m) of the unrestrained edges of unit pavers.

H. Apply additional joint filler aggregate to the openings and joints if needed, filling them completely. Remove excess aggregate by sweeping, then compact the pavers. This will require at least two passes with the plate compactor.

I. All pavers within 6 feet (2 m) of the laying face must be left fully compacted and joints must be filled at the completion of each working day.

J. Compacted unit pavers shall meet the acceptance criteria set forth in Section 1.05.C.

3.04 PROTECTION OF PAVEMENT

A. Pavement surface shall be kept clean and free of clogging debris and soils from the Contractor's operations and all upstream and adjacent debris. If debris or soils contaminate the pavers/joints, the pavement shall be cleaned at the Contractor's expense and to the satisfaction of the Engineer. If pavement cannot be unclogged, it shall be removed and replaced at the Contractor's expense and to the satisfaction of the Engineer.

B. Paver installation (Sub) Contractor shall return to the site after 6 months from the completion of the Work and provide the following as needed to fully meet the specifications described herein: fill paver joints with stones, replace broken or cracked pavers, and re-level settled pavers to initial elevations. **Any additional work shall be considered part of the original bid price and with no additional compensation.**

3.05 REJECTION

A. Pavers that do not meet the acceptance criteria set forth in Section 1.05.C will be rejected by the Engineer on a lot by lot basis. Permeable/porous unit pavers that have been rejected by the Engineer or the Contractor shall be removed and replaced at no additional cost to the Owner.

**END OF SECTION**

## DIVISION 32 – EXTERIOR IMPROVEMENTS

## Section 32 13 43 – Pervious Concrete

DESIGNER NOTE: The specifications below are based on the best available information. Designer should modify the specifications to satisfy project-specific constraints.

DESIGNER NOTE: Green text corresponds to notes to the designer. Blue text corresponds to requirements taken directly from ACI 522.1.

### PART 1 GENERAL

1.01 SUMMARY

A. This section includes:

1. Pervious Concrete
2. Pavement Base
3. Geotextile for Soil Separation

B. Related Sections:

DESIGNER NOTE: The designer should list any additional specification sections which relate to the pervious concrete work (i.e., temporary erosion control, utilities, earthwork, etc.)

1.02 STANDARDS AND CODES

A. Reference Standards This section incorporates by reference the latest versions of the following documents. These references are a part of this section as specified and modified.

| Reference | Title |
|---|---|
| Caltrans | Standard Specifications |
| San Francisco DPW | Engineering Standard Specifications |
| AASHTO | Standards of the American Association of State Highway and Transportation Officials, 1998 or latest edition |
| ACI 522.1 | Specifications for Pervious Concrete Pavement |
| ACI 301 | Specifications for Structural Concrete |
| ACI 305.1 | Standard Specifications for Hot Weather Concreting |
| ACI 306.1 | Standard Specifications for Cold Weather Concreting |
| ACI 308.1 | Standard Specifications for Curing Concrete |
| ASTM | Annual Book of ASTM Standards, American Society for Testing and Materials, Philadelphia, PA, 1997 or latest edition. |

1.03 REFERENCES

DESIGNER NOTE: Designer to provide references to related industry manuals and guidance and all project specific documents (e.g., geotechnical report).

1.04 SUBMITTALS

A. Bid Submittals: The Contractor shall submit to the Owner the following as part of the bid proposal:

1. National Ready Mix Concrete Association (NRMCA) Pervious Concrete Contractor Certifications and project experience as specified in Section 1.05.A for the crew assigned to this project.

DESIGNER NOTE: The designer should incorporate by reference these requirements in Division 00 of the Specifications.

B. Pre-Installation Submittals: The Contractor shall submit to the Engineer the following a minimum of 20 calendar days prior to the construction of the pervious cement concrete pavement:

1. NRMCA Certifications for the batch plant to be used in the production of pervious concrete for this project.

2. Proposed mix design including the following:

a. Batch weights of all constituents.

b. Portland cement type and brand.

c. Non-Portland cement pozzolan type and source.

d. Microfiber brand and type.

e. Admixture type and brand.

f. Aggregate source(s), gradation(s), LA abrasion, and cleanness value(s).

g. Fresh density of the pervious concrete per ASTM C1688.

No concrete shall be placed until the Engineer has provided written acceptance of the mix design per Section 1.05.B.

3. Source certificates, gradations, R-values, LA abrasion, and cleanness values of aggregates for base and reservoir course materials performed within one (1) month of product delivery to site.

DESIGNER NOTE: Consider revising acceptable age of sieve test depending on scale of project. On a larger project it may be appropriate to require testing by an independent lab with samples taken at the supplier's yard from the stockpile to be used for the project.

4. Product data sheets for all proposed admixtures and geotextiles.

5. A detailed plan of the proposed paving pattern showing the location and type (saw cut or rolled in plastic concrete) of all planned joints. No

deviation from the jointing pattern shown on the Plans will be allowed without written approval of the Engineer.

6. A detailed procedure for the production, transportation, placement, protection, curing, and temperature monitoring of concrete for hot and/or cold weather, unless written approval of the Engineer waiving the requirement is received.

7. Field technician qualifications as specified in Section 1.05.A.

8. Testing agency qualifications as specified in Section 1.05.A.

9. Density of fresh pervious concrete, length of cores, and density of cores for one (1) reference panel. Reference panel shall be placed, jointed, cured, and tested as specified in Section 1.05.D.1 and be within tolerance of the required thickness defined by the Contract Documents.

1.05 QUALITY CONTROL AND QUALITY ASSURANCE

A. General: Test and inspect concrete materials and operations as Work progresses as described in this section. Failure to detect defective Work or materials at any time will not prevent rejection if a defect is discovered later, nor shall it constitute final acceptance.

1. Contractor and Personnel Qualifications

a. Contractor qualification: Unless otherwise approved by Engineer, Contractor shall provide evidence of employment for one (1) NRMCA certified Pervious Concrete Installer and four (4) NRMCA certified Pervious Concrete Technicians who must be on site, working as members of each placement crew, during all concrete placement.

For all projects where the total pervious concrete pavement area exceeds 20,000 square feet (sf), the Contractor shall provide evidence of employment for at least one (1) NRMCA certified Pervious Concrete Craftsman who must be onsite, working as part of the placement crew, during all concrete placement. Additionally, for every 10,000 sf of pavement area over 20,000 sf, one (1) additional NRMCA certified Pervious Concrete Installer is required on site, working as part of the placement crew.

The Contractor shall provide documentation showing three (3) successful pervious concrete projects completed in the last three (3) years collectively totaling more than 20,000 square feet. Documentation shall include name and address of project, and contact information for project owner.

DESIGNER NOTE: The designer should adjust as required based on the availability of qualified bidders and the size of the project.

b. Field technician qualification: Field tests of concrete required in the responsibilities of the testing agency shall be performed by an individual certified as both an NRMCA Certified Pervious Concrete Technician, or equivalent, and an ACI Concrete Field Testing Technician – Grade I, or equivalent.

DESIGNER NOTE: The designer should adjust as required based on the availability of qualified personnel and the size of the project.

c. Testing agency qualification: Agencies that perform testing on concrete materials shall meet the requirements of ASTM C1077 and provide evidence of employment for at least one (1) NRMCA Certified Pervious Concrete Technician, responsible for testing, or providing direct oversight of testing, of all concrete materials. Agencies inspecting the Work shall meet the requirements of ASTM E329. Testing agencies performing the testing shall be accepted by the Engineer before performing any Work.

d. Batch plant qualification: Batch plant used for pervious concrete shall be a semi-automatic or automatic batching plant with a current NRMCA certification.

DESIGNER NOTE: Volumetric (truck mounted) Site Mixed Mobile Mixers may be used at the designers discretion. Mixing operations should be per manufactures directions. Designer should specify certification and calibration requirements for Volumetric Mobile Mixers including, but not limited to:

- Proof of Volumetric Mixer Manufacturer Bureau (VMMB) certification, compliance with VMMB 100-01 Volumetric Mixer Standards, and associated VMMB rating plate, or equal
- Provisions for calibration of Volumetric Mobile Mixers performed with aggregate manufactured for the project and recalibrated with each restocked stock pile

Additionally, the designer should specify required quality control measures to ensure aggregates, cementitious material, and admixtures are free from contamination from deleterious material or other stockpiles/storage containers, protected from damage by equipment, vehicles, or weather, and properly batched in lieu of batch ticket (e.g., labeling of aggregate bins to ensure correct aggregate is fed into appropriate mixer material compartment.

B. Approved Mix Design: Once accepted by the Engineer, the mix design meeting the criteria specified in Section 2.01.F shall become the Approved Mix Design and shall not be modified in any way. The Approved Mix Design shall be determined from information submitted under Section 1.04 and from results of reference panel testing as described in Section 1.05.D.1.

Modifications to the Approved Mix Design will not be allowed and any modified mix placed in the Work will be rejected. Proposed modifications to the Approved Mix Design shall be submitted as a new mix design and shall require a new reference panel to validate the proposed mix design and determine the new Approved Mix Design. If accepted by the Engineer, the new mix design shall become the Approved Mix Design. The requirement for a new reference panel may be waived at the discretion of the Engineer. Only one (1) Approved Mix Design shall be valid at any time. Admixture and water dosages may be modified as needed to maintain mix properties.

C. Responsibilities of Contractor

1. Pre-Placement Conference: A mandatory pre-placement conference will take place including at a minimum the Engineer, the Owner, general contractor, pervious concrete installer, concrete supplier, and field testing agency representative. The document Checklist for the Concrete Pre-Construction Conference (available from the National Ready Mix Concrete Association) will be used to review all materials, personnel qualifications, concrete production, delivery, maintaining moisture retention of fresh mixture, preparation, placing, curing (including timing, placement, and securing of curing cover), jointing, testing procedures, and responsibilities. Meeting emphasis will be on how pervious concrete differs from conventional concrete.

2. Reference Panel: Place reference panels on the project site, on a subgrade and base prepared as specified, using the material and construction requirements for pavement in this Specification. Each panel must have a surface area of at least 225 square feet, and a width and thickness as specified for the pavement in the Contract Documents. The Engineer shall observe and accept each element of the pervious concrete construction. Construction and evaluation of the reference panel(s) will occur as follows:

a. Notify the Engineer at least ten (10) Working Days before installing pervious concrete reference panel.

b. Coordinate the location of the reference panel with the Engineer.

c. Notify the Engineer when each element of the reference panel is ready for inspection.

d. Remove, replace, and dispose of any unsatisfactory portions of reference panel as determined by the Engineer and at no additional cost to the Owner.

e. Retain and maintain approved reference panels during construction in an undisturbed condition as a standard for judging completed portions of the final installations.

Approved reference panels may remain as final installations of the Work at the discretion of the Engineer. If not retained, the reference panel shall be removed and disposed of at no additional cost to the Owner.

3. Testing facilitation: Owner's use of testing services will not relieve Contractor of the responsibility to furnish materials and construction in full compliance with the Contract Documents. Unless otherwise specified in the Contract Documents, Contractor shall assume the following duties and responsibilities:

   a. Furnish the materials to be tested, including concrete cores.

   b. Furnish any necessary labor to assist Owner's testing agency in obtaining and handling samples, including concrete cores, at the project site or at the source of materials.

   c. Provide measures to collect slurry and debris during coring operation in order to avoid sealing adjacent pavement.

   d. Fill core holes in accordance with Section 1.05.D.2.

   e. Advise Owner's testing agency at least 24 hours in advance of operations to allow for completion of quality tests and for assignment of personnel.

4. Pressure wash testing: Before final acceptance by the Engineer, the Contractor shall pressure wash the pervious concrete. Pressure washing shall be provided and completed by using portable washer equipment working at a minimum of 3,000 psi at 2.0 to 2.5 gpm. The nozzle shall be a zero degree nozzle and be held a maximum of three (3) inches off the concrete surface. The Contractor shall pressure test three (3) locations per lot or as determined by the Engineer. Any sections of pervious concrete that breaks up, ravels, or does not infiltrate shall be removed and replaced with acceptable pervious concrete to the nearest joints. The Engineer will reject the concrete if the pressure washing dislodges aggregate particles from more than two (2) percent of the pervious concrete in a single panel (joint to joint) or dislodges aggregates from a contiguous area of the pavement surface exceeding five times the nominal maximum aggregate size in any direction.

   The Contractor shall decide, after placing the pervious concrete, when to perform the quality assurance pressure wash testing for the acceptance.

DESIGNER NOTE: The designer should consider requiring verification of subgrade infiltration rate and provision to increase reservoir course depth based on results.

D. Testing

1. Reference Panel: Testing for the reference panel shall adhere to the requirements for testing of Pavement per Section 1.05.D.2 for approval by the Engineer. Each test shall meet the acceptance criteria for Reference Panel as defined in Section 1.05.E.1.

   The Engineer shall inspect and approve the reference panel prior to the placement of additional pervious concrete.

   Failure to install acceptable reference panels of pervious concrete will indicate an unqualified installer.

   Production sections of this Work shall not be placed until achieving a complete reference panel that fully complies with the Plans and Specifications and has written acceptance issued by the Engineer.

   The completed and accepted reference panels shall be maintained and protected throughout the duration of the Work and may not be demolished and disposed of without written permission from the Engineer. If a reference panel is incorporated into the Work, it shall remain in place and be accepted as a single lot.

   Unless otherwise determined by the Engineer, density testing of fresh concrete and hardened cores will be used to validate the mix design per the design criteria set forth in Section 1.04.B and the acceptance criteria in Section 1.05.E.1.

   The average fresh density and average hardened density of the cores shall be the densities used for the Approved Mix Design.

2. Pavement: The following testing shall be conducted for approval by the Engineer for each reference panel and each lot of pervious concrete placed, where a lot is defined as the lesser of one (1) day's production or 5,000 square feet of pervious concrete, in place, unless otherwise specified below:

   a. Density testing of at least one (1) cubic foot of fresh concrete in accordance with ASTM C1688.

   b. Thickness testing of three (3), four- (4)-inch hardened concrete cores in accordance with ASTM C174 and adhering to the following requirements:

      1) Removed not less than seven (7) days after placement of pervious concrete.

      2) Location selected in accordance with ASTM D3665.

      3) Cut in accordance with ASTM C42.

c. Density and void content testing of the three (3) hardened concrete cores extracted for thickness testing and trimmed to produce flat core ends per ASTM C42 paragraph 7.4.1 and 7.4.2. Samples shall be tested in accordance with ASTM C1754.

d. Surface infiltration tests per ASTM C1701 and at the frequency described below.

1) Three (3) test locations per 10,000 square feet of pervious concrete, in place

2) One (1) additional test location per 5,000 square feet of pervious concrete, or fraction thereof, in place

DESIGNER NOTE: Designer to specify the number and location(s) of required post construction infiltration tests.

Core holes shall be filled with solid concrete, pre-blended grout, or pervious concrete and shall match adjacent pavement color, and grade. At the Engineer's discretion, a sacrificial panel for cores may be required or allowed.

Each test shall meet the acceptance criteria for Pavement as defined in Section 1.05.E.2.

E. Acceptance

1. Reference Panel: Acceptance of the reference panel will be based on the criteria for acceptance of Pavement per Section 1.05.E.2 with the following deviations:

a. Hardened Density: The density of each core shall be within five (5) pounds per cubic foot of the average hardened density of the three (3) cores.

b. Fresh Density: The fresh density shall be within or equal to five (5) pounds per cubic foot of the average fresh density of the three (3) samples.

2. Pavement: Acceptance of a lot of pervious concrete will be based on the following criteria:

a. Smoothness: Pervious concrete pavement smoothness shall be checked with a 10-foot straightedge. Vertical measurement should be taken between the pavement's determined plane and straight edge, discounting surface void and roughness irregularities, in a direction perpendicular and parallel to the centerline. The finished pavement shall be uniform to a degree such that no variations greater than 3/8-inch are present between the straight edge and pavement surface over a distance of at least 6 inches.

b. Grade: Pervious concrete shall be true to designed spot elevations plus or minus ½ inch and shall not deviate from designed slope more than ¼ inch in ten (10) feet. Where abutting existing facilities such as sidewalks, walkways, curbs, driveways or other pavements, the pervious concrete shall be flush.

c. Line: Pervious concrete margins shall be true to designed lines plus or minus ½ inch at any point.

d. Slope: Pervious concrete shall be sloped as shown on the Plans. Slope shall be consistent to within 1/4 inch in ten (10) feet.

e. Thickness: Each core sample shall be equal to the minimum section depth or more as specified on the Plans.

f. Hardened Density: The density of the core samples for each lot shall be within five (5) pounds per cubic foot of the density as accepted in the reference panel.

g. Void Content: The total void content of the core samples for each reference panel and lot shall be twenty (20) percent, plus or minus five (5) percent, in place, as constructed.

h. Infiltration Rate: The average of all surface infiltration tests shall be greater than 250 inches per hour with no single test less than 100 inches per hour.

DESIGNER NOTE: The designer should adjust infiltration rates to reflect project specific conditions such as anticipated sediment loading based on pavement use (e.g., vehicular, pedestrian) and design run-on from adjacent surfaces. The recommended criteria are as follows:

- For permeable pavement that will accept run-on from adjacent impervious and/or pervious surfaces OR pavement that will be subject to vehicular traffic:
  - The average of all surface infiltration tests shall be greater than 250 inches per hour with no single test less than 100 inches per hour
- For permeable pavement not subject to run-on OR vehicular traffic:
  - The average of all surface infiltration tests shall be greater than 100 inches per hour with no single test less than 75 inches per hour

i. Fresh Density: The fresh density shall be within or equal to five (5) pounds per cubic foot of the fresh density indicated by the Approved Mix Design.

j. Batch Ticket: Each load of pervious concrete transported to the location of placement shall have a Batch Ticket delivered with the load. Batch Tickets shall be provided upon request for each load and shall be in accordance with ASTM C94, with the following additions:

1) Batch weights of all constituents in the mix, including cement, aggregate, admixtures, water, and fibers

2) Signature of responsible representative of the concrete producer, affirming the accuracy of the information provided

k. Appearance: Each lot of finished pervious concrete will be inspected for appearance by the Engineer after completion of pressure wash testing per Section 1.05.C.4. The pervious concrete shall have a consistent surface texture, shall have no more than five (5) percent of the surface area within each panel (joint to joint) filled with paste, shall be free of ridges or other surface imperfections, shall have joints that are in the specified location and are constructed per specification, shall be free of cracks and shall not be raveled.

A panel will be considered raveled if aggregate is dislodged from a contiguous area of the pavement surface or longitudinally along a joint exceeding five times the nominal maximum aggregate size in any direction OR if aggregate particles are dislodged from more than two (2) percent of the pervious concrete within each panel (joint to joint).Raveling occurring during the first three (3) months after installation is subject to complete removal and replacement of affected panels with acceptable pervious concrete at the Owner's discretion and Contractor's expense. Requirement to replace affected panels shall continue until three (3) months after the date of replacement. Written notification of defects is the sole responsibility of the Owner.

DESIGNER NOTE: The designer should incorporate by reference these requirements in Division 00 of the Specifications.

l. Conformance to Approved Mix Design: The pervious concrete used shall conform to the Approved Mix Design within the limits set forth in ASTM C94.

3. Required Inspections: Notify the Engineer at least 48 hours prior to required inspections specified in Sections 3.01, 3.02, and 3.03.B.

## PART 2 PRODUCTS

DESIGNER NOTE: Designers should maximize the use of regionally available materials.

2.01 PERVIOUS CONCRETE

DESIGNER NOTE: No reinforcing bars or tie bars will be used in the installation of pervious concrete.

Pervious Concrete shall comply with ASTM C94, except sections 4.2, 6.1.2, 6.1.3, 6.1.4, 6.1.5, 7, 8, 16, 17, 18, 19, 20 and the requirements specified herein. The volume of fresh concrete in a given batch shall be determined from the total mass of the batch divided by the design density of the concrete. The total mass of the batch shall be determined as the net mass of the concrete in the batch as delivered, including the total mixing water as defined in ASTM C94 Paragraph 9.3.

A. Cement: Cement in the mix design shall conform to the requirements for Portland Cement or Blended Hydraulic Cement as specified herein:

1. Portland Cement: Portland Cement shall meet the requirements of ASTM C150 Type I, II, or V Portland cement.

2. Blended Hydraulic Cement: Blended Hydraulic Cement shall be Type IP or IS Cement conforming to ASTM C595. Type IP(X), Portland Pozzolan Cement, and IS(X) where (X) dictates pozzolan and slag percentage, respectively, shall be Portland Cement and Pozzolan. The pozzolan shall be limited to fly ash or ground granulated blast furnace slag.

   The fly ash or ground granulated blast furnace slag constituent content in the finished cement shall not vary more than plus or minus 5 percent by weight of the finished cement from the certified value.

3. Supplementary cementitious material shall be as specified herein:

   a. Fly Ash: Fly ash shall conform to the requirements of ASTM C618, Class F or C.

   b. Slag Cement: Slag cement shall meet the requirements of ASTM C989, Grade 100 or Grade 120.

   c. Silica Fume: Silica fume shall meet the requirements of ASTM C1240.

B. Aggregates: Aggregates shall conform to ASTM C33 except as specified herein, unless otherwise approved by the Engineer.

1. Aggregate Gradation tested in accordance with ASTM C136 at least once per 300 cubic yards of concrete.

| Sieve[1] | Percent Passing by Weight | | | | |
|---|---|---|---|---|---|
| | Coarse Aggregate | | | | Fine Aggregate |
| | ASTM No. 7 | ASTM No. 8 | ASTM No. 89 | ASTM No. 9 | |
| 2 inch | – | – | – | – | – |
| 1 1/2 inch | – | – | – | – | – |

| | | | | | |
|---|---|---|---|---|---|
| 1 inch | – | – | – | – | – |
| 3/4 inch | 100 | – | – | – | – |
| 1/2 inch | 90 to 100 | 100 | 100 | – | – |
| 3/8 inch | 40 to 70 | 85 to 100 | 90 to 100 | 100 | 100 |
| No. 4 | 0 to 15 | 10 to 30 | 22 to 55 | 85 to 100 | 95 to 100 |
| No. 8 | 0 to 5 | 0 to 10 | 5 to 30 | 10 to 40 | 80 to 100 |
| No. 16 | – | 0 to 5 | 0 to 10 | 0 to 10 | 50 to 85 |
| No. 30 | – | – | 0 to 5 | 0 to 5 | 25 to 60 |
| No. 50 | – | – | – | – | 5 to 30 |
| No. 100 | – | – | – | – | 0 to 10 |
| No. 200 | – | – | – | – | 0 to 3 |

[1] Sieve provided in nominal size square openings or United States Standard Sieve Series sizes.

In individual tests, a variation of 4 percent under the minimum percentages or over the maximum percentages will be allowed. The average of three successive tests shall be within the percentages stated above. Aggregate shall contain no pieces larger than two times the maximum sieve size for the specified grading measured along the line of greatest dimension.

2. Coarse Aggregate

   a. LA Abrasion: 35 percent (maximum) tested in accordance with ASTM C131 at least once per 300 cubic yards of concrete.

   b. Cleanness Value: 75 (minimum) tested in accordance with California Test 227 at least once per 300 cubic yard of concrete.

3. Acceptance of grading and quality of the aggregate may be based on samples taken from stockpiles at the concrete plant or a submitted gradation report at the discretion of the Engineer. The point of acceptance will be determined in the field by the Engineer.

C. Admixtures

1. Air Entraining Admixtures: Air entraining admixtures shall meet the requirements of ASTM C260.

2. Water Reducing Admixtures: Water reducing admixtures shall meet the requirements of ASTM C494, Type A.

3. Hydration Stabilizing Admixtures: Hydration stabilizing admixtures shall meet the requirements of ASTM C494, Type B or Type D.

4. Superplasticizers: Superplasticizers and retarders shall meet the requirements of ASTM C494, Type F or Type G and ASTM C1017, Type 1.

5. Viscosity Modifying Admixtures: Viscosity modifying admixtures may be used if approved by the Engineer.

6. Color Pigment: Color pigment shall meet the requirements of ASTM C979 for integrally colored concrete. Pigments shall be color stable, non-fading, and resistant to lime and other alkalis.

   DESIGNER NOTE: Designer to specify color, as indicated by manufacturer's designation, architect's sample, etc. with provision for approved equal color.

D. Water: Clean potable water or water conforming to ASTM C1602 shall be used in the mix design and on the jobsite. The use of hot water is not permitted.

E. Microfibers: Microfibers shall conform to the requirements of ASTM C1116, Type III and shall be monofilament and ½ inch in length.

F. Mix Design:

1. General: The Contractor shall propose a mix design for pervious concrete and shall submit the mix design to the Engineer for acceptance prior to constructing the reference panels. Pervious concrete shall not be placed in the reference panels without a mix design that has been reviewed and accepted by the Engineer.

2. Mix Design Criteria: The Contractor shall include the following elements and results of the described procedures in the proposed mix design:

   a. The cementitious content, including pozzolans if used, shall be a minimum of 480 and a maximum of 600 pounds per cubic yard.

   b. The mix may incorporate up to 5 percent fine aggregate, by weight.

   c. The mix shall incorporate a hydration stabilizing admixture.

   d. The mix may incorporate microfibers or fibers per Manufacturer's recommendations.

   e. The mix shall be designed to meet the acceptance criteria for Void Content per Section 1.05.F.2 as determined by the testing methods specified in Section 1.05.E.2.

   f. The water/cement ratio shall be between 0.27 and 0.35.

   g. Up to 50 percent of cementitious material in the mix, by weight, may be fly ash, slag cement, or a combination of silica fume and either or both of the above, with silica fume not exceeding 10 percent.

   Deviations from this mix design, such as the use of internal curing admixtures, cementitious content outside of the range specified, or finer aggregate gradations may be permitted at the sole discretion of the Engineer provided the Contractor can demonstrate the viability of the mix design through past successful installations or sound science.

2.02 PAVEMENT BASE

A. Pavement Base Material shall consist of clean, mechanically crushed stone, substantially free from adherent coatings. Materials shall be washed thoroughly to remove clay, organic matter, extraneous debris, or objectionable materials. Recycled materials or round river gravel are not permitted. Material shall be obtained only from a source(s) approved by the Engineer. Written requests for source approval shall be submitted to the Engineer not less than Working 10 days prior to the intended use of the Material. Should the proposed source be one that the Engineer has no history of Material performance with, the Engineer reserves the right to take preliminary samples at the proposed source, and make preliminary tests, to first determine acceptability of the new source and then perform the applicable Material approval testing. Continued approval of a source is contingent upon the Materials from that source continuing to meet Contract requirements. Materials shall meet the Standard Specifications for grading and quality for use in the Work; however, allowable exceptions may be specified in the Contract. The Engineer shall reserve the right to sample and test Material at any time including at the source.

B. Pavement Base shall consist of up to two (2) layers as specified on the Plans and included herein:

1. "Base Course" shall be ASTM No. 3 (modified) or ASTM No. 57 (modified) stone per Section 2.02.C.

   DESIGNER NOTE: This layer of the pavement base is intended to provide structural (load bearing) capacity to the pavement.

2. "Reservoir Course" shall be ASTM No. 2 (modified), ASTM No. 3 (modified), or ASTM No. 57 (modified) stone per Section 2.02.C.

   DESIGNER NOTE: This layer of the pavement base is intended to provide storage and drainage of the pavement, structural support, and a capillary break. The materials specified should be crushed, clean, washed rock to provide the desired structural capacity, maintain good drainage, function as a capillary barrier, and minimize clogging of the subgrade due to export of fines.

DESIGNER NOTE: If the designer chooses to specify materials that differ from those provided herein, the designer should check their filter criteria to evaluate the likelihood of finer-graded material migration into underlying courser graded materials or reduction in permeability relative to the underlying material. Refer to the SFPUC aggregate filter criteria guidance document for information on selecting appropriate alternate materials.

C. Pavement Base Material shall meet the following specifications for grading and quality.

1. Aggregate Gradation tested in accordance with ASTM C136 at least once per 500 cubic yards of base material.

| Sieve[1] | Percent Passing by Weight |
|---|---|

| | ASTM No. 2 (modified) | ASTM No. 3 (modified) | ASTM No. 8 (modified) | ASTM No. 57 (modified) |
|---|---|---|---|---|
| 3 inch | 100 | – | – | – |
| 2 1/2 inch | 90 to 100 | 100 | – | – |
| 2 inch | 35 to 70 | 90 to 100 | – | – |
| 1 1/2 inch | 0 to 15 | 35 to 70 | – | 100 |
| 1 inch | – | 0 to 15 | – | 95 to 100 |
| 3/4 inch | 0 to 5 | – | – | – |
| 1/2 inch | – | 0 to 5 | 100 | 25 to 60 |
| 3/8 inch | – | – | 85 to 100 | – |
| No. 4 | – | – | 10 to 30 | 0 to 10 |
| No. 8 | – | – | 0 to 10 | 0 to 5 |
| No. 16 | – | – | 0 to 5 | – |
| No. 100[2] | 0 to 2 | 0 to 2 | 0 to 2 | 0 to 2 |

[1] Sieve provided in nominal size square openings or United States Standard Sieve Series sizes.

[2] Gradation modified from ASTM for portion passing the No. 100 sieve.

2. R-Value: 78 (minimum) tested in accordance with California Test 301.

3. L.A. Abrasion: 30 percent (maximum) tested in accordance with ASTM C131.

4. Cleanness Value: 75 (minimum) tested in accordance with California Test 227 at least once per 500 cubic yards of base material.

5. Crushed Particles: 90 percent (minimum) with two (2) or more fractured faces tested in accordance with California Test 205.

6. The combined portion of Material retained on the U.S. No. 4 sieve shall not contain more than 0.1 percent wood waste by weight. The portion of Material passing a U.S. No. 10 sieve shall not have wood waste that results in more than 250 parts per million of organic matter by calorimetric tests when tested. The color shall be measured after the sample has been in the test solution for 1 hour.

## 2.03 GEOTEXTILE FOR SOIL SEPARATION

DESIGNER NOTE: Geotextile is not typically required under permeable pavement applications unless recommended by a geotechnical engineer. Geotextile can be placed vertically for material separation between side walls of reservoir course and native soil.

A. Geotextile shall be woven, consisting only of long chain polymeric fibers or yarns formed into a stable network such that the fibers or yarns retain their position relative to each other during handling, placement, and design service life. At least 95 percent by weight of the material shall be polyolefins or polyesters. The material shall be free from defects or tears. The geotextile shall also be free of any treatment or coating which might

adversely alter its hydraulic or physical properties after installation. The geotextile shall conform to the properties specified herein:

| Geotextile Property | Test Method | Requirement |
|---|---|---|
| Grab Tensile Strength, minimum in weakest direction | ASTM D4632 | 200 lbs/in |
| Apparent Opening Size (AOS) | ASTM D4751 | 40 to 50 |
| Ultraviolet (UV) Radiation Stability, minimum strength retained after 500 hours in weatherometer | ASTM D4355 | 50% |
| Flow Rate, minimum | ASTM D4491 | 140 gal/min/ft$^2$ |

DESIGNER NOTE: The designer should consider including specifications for signage and pavement markings in this section.

## PART 3 EXECUTION

### 3.01 SUBGRADE PREPARATION AND PROTECTION

A. Construct subgrade to +/- ¾ inch of the grades and slopes specified on the Plans.

B. Grading of subgrade shall be with low ground pressure equipment when within six (6) inches of final subgrade elevation.

C. Compact subgrade to 90 percent (+/- 2 percent) of the maximum dry density per standard Proctor test (ASTM D698), or as directed by the Geotechnical Engineer. Determination of in-place density shall be made using a nuclear gauge per ASTM D6939.

DESIGNER NOTE: The designer should set compaction requirements based on consideration of site specific geotechnical properties of the native soil (e.g., permeability, stiffness) and performance requirements for the pavement section (e.g., traffic loading, infiltration, cost).

D. Areas of the subgrade which are over-compacted, as determined by the Geotechnical Engineer, shall be ripped/tilled to a depth of 12 inches (minimum) or as directed by the Geotechnical Engineer and shall be recompacted in accordance with Section 3.01.C. Contractor shall locate all utilities within pavement footprint prior to ripping and re-compacting subgrade.

E. Proof-roll prepared subgrade with loaded dump truck, remove soft spots, and replace with permeable structural fill as directed by the Engineer to achieve uniform subgrade.

DESIGNER NOTE: Other subgrade verification methods may be required if site conditions limit proof rolling. Consult with geotechnical engineer for acceptable methods.

F. After compaction and proof roll, scarify subgrade ¼- to ½-inch deep by hand rake. Once scarified, materials or equipment shall not be permitted within the prepared subgrade area so as to avoid recompaction or clogging of the scarified subgrade.

G. The subgrade shall be protected from over-compaction or contamination by silty run-off or other contaminants.

1. Provide physical barriers or direct traffic to eliminate unnecessary vehicular traffic on the subgrade during construction in accordance with SFMTA and SFDPW ordinances and specifications.

2. Provide flow diversion and erosion control measures to protect the permeable pavement area from sedimentation until the upstream catchment area is thoroughly stabilized.

H. Areas of subgrade over-compacted by construction traffic or other impacts by the Contractor or Subcontractors shall be ripped/tilled and re-compacted in accordance with Section 3.01.D. All work and materials required to correct over-compacted subgrade, including utility locates within the pavement footprint, shall be at the Contractor's expense.

I. Areas of subgrade contaminated by the accumulation of silty material following rains or other debris or contamination shall be removed and disposed at the Contractor's expense.

J. The subgrade shall be inspected and accepted by the Engineer prior to placement of the geotextile or pavement base.

K. Place geotextile, if required, on scarified subgrade. Care shall be taken to provide full coverage and to prevent the geotextile from being torn. Damaged geotextile shall be repaired as indicated by the manufacturer and to the satisfaction of the Engineer at no additional cost to the Owner. Overlaps of the geotextile shall be a minimum of one (1) foot or to the manufacturer's recommendation, whichever is greater.

DESIGNER NOTE: The use of geotextile under permeable pavement systems should be avoided unless required by the project geotechnical engineer as it can be prone to subsurface clogging.

3.02 PAVEMENT BASE

A. Construct pavement base to the lines, grades, and thicknesses shown on the Plans.

B. Place the pavement base so as to prevent loaded dump trucks from driving directly on the prepared subgrade.

C. Compact pavement base, in six (6) inch (maximum) lifts, by making a minimum of three passes over the pavement base material with a ten (10) ton vibratory roller, or as directed by the Geotechnical Engineer. The first two (2) passes (minimum) shall be in vibratory mode. The final pass shall be in static mode. Acceptance of the pavement base will be based on Engineer's observation of aggregate movement during final compaction pass. Compaction equipment shall be accepted by the Engineer prior to use.

DESIGNER NOTE: For areas or sites that cannot accommodate a vibratory roller compactor, consider allowing compaction of pavement base with a 13,500 lbf (60 kN) minimum vibratory plate compactor with a compaction indicator. At least two passes should be made over each lift of the aggregates.

D. Pavement base shall be true to the designed grade and slope, +/- 0.05 feet, after compaction for each layer. In the event of low spots, additional material shall be added and recompacted. In the event of high spots, excess material shall be removed and the area recompacted.

E. The pavement base shall be protected from over-compaction or contamination by silty run-off or other contaminants.

1. Provide physical barriers or direct traffic to eliminate unnecessary vehicular traffic on the pavement base during construction in accordance with SFMTA and SFDPW ordinances and specifications.

2. Provide flow diversion and erosion control measures to protect the permeable pavement area from sedimentation until the upstream catchment area is thoroughly stabilized.

F. Any damage to the pavement base (including contamination by silty run-off) shall be repaired to the satisfaction of the Engineer at the Contractor's expense. Contaminated pavement base shall be removed and replaced to the limits as determined by the Engineer.

G. The pavement base shall be inspected and accepted by the Engineer prior to placing any pervious concrete.

DESIGNER NOTE: Consider developing a testing plan for the required testing and inspection of the pavement base. Verification of the in place density/compaction of the open graded base materials is typically not possible with the use of a nuclear densometer due to nature of these materials. Therefore other means to verify these materials are firm and unyielding (such as observation of the compaction process by a geotechnical engineer) are necessary.

DESIGNER NOTE: Consider requiring the Contractor to compact aggregates without crushing them.

3.03 MIXING, PLACEMENT & CURING OF PERVIOUS CONCRETE

A. Pervious concrete formwork

1. Forms shall be made of steel or wood and shall be in good condition, clean, and capable of being anchored in place so as to ensure pavement placement true to the grades, lines and slopes as specified on the Plans.

2. Forms that are bent, warped, unclean, or otherwise deemed inadequate by the Engineer shall not be used.

3. Existing curbs, structures, or the vertical face of previously placed pervious concrete may be used as a form.
4. Set, align, and brace forms to satisfy the lines, grades, and slopes on the Plans.
5. Apply form-release agent to the form face immediately before placing concrete.
6. No pervious concrete shall be placed until the forms are inspected and accepted by the Engineer.
7. Slip forming is an acceptable method for placement of pervious concrete.

B. Batching, mixing, and delivery

1. Pervious concrete shall be batched and centrally mixed at a batching plant meeting the requirements set forth in Section 1.06.A.4. Pervious concrete shall not be shrink mixed or transit mixed.
2. Begin mixing immediately after cement has been added to aggregates. Batch and mix concrete in compliance with ASTM C94, with the following exceptions:
   a. Placement of concrete shall occur no more than 60 minutes from the time water or aggregate is added to the cement.
   b. If a hydration-stabilizing admixture is used, up to 60 minutes may be added to the placement time, resulting in a maximum placement time of 120 minutes.

   Additional water may be added on site, but the fresh density must still meet the requirements of Section 2.01.F.2 after water addition.

C. Placing and consolidation

1. Pervious concrete shall not be placed on standing water or frozen pavement base.
2. Wet the pavement base with water before concrete placement such that the material is saturated but without any standing water on the prepared base immediately before concrete placement.
3. Place pervious concrete on the prepared pavement base as close to its final position as possible, either directly from the transporting equipment or by conveyor, unless otherwise specified. Spread the concrete using mechanized equipment or hand tools, without segregation.
4. Strike off concrete between forms using a form riding paving machine or roller screed at the appropriate height, as determined by the Contractor, to allow for compaction to finished grade. Equipment used for striking off the pervious concrete shall leave a smooth surface, free of ridges or other imperfections, without drawing excessive paste to

the surface. Vibratory screeds are not permitted. Other strike-off devices may be used when accepted by the Engineer.

5. Compact pervious concrete with a purpose built pervious concrete cross roller or alternate method approved by the Engineer. Rollers shall be of sufficient weight and width to compact the fresh pervious concrete to grade, leaving a smooth surface, free of ridges or other imperfections, without drawing excessive paste to the surface. Compacted pervious concrete shall meet the acceptance criteria for Smoothness set forth in Section 1.05.E.2.

6. Contractor's personnel shall take care to avoid foot traffic in the pervious concrete to prevent non-uniform compaction and to keep contaminated material from entering the pavement mix. Foot traffic on the fresh concrete shall not be allowed after it has been struck off.

7. Place pervious concrete continuously. Where placement has been halted for a period of 15 minutes, a header shall be placed between the forms and a construction joint formed. The construction joint shall be located at a contraction joint location, unless otherwise approved by the Engineer. The pervious concrete shall be compacted and finished to the header before placement may continue. Upon resuming placement, the header may be carefully removed and a construction joint formed at that location. Any sloughing or sagging of the previously placed pervious concrete at the header location shall be corrected prior to placing new pervious concrete against the joint.

D. Edging: Edging of the top surface shall be completed in plastic concrete to a radius of not less than 1/4 inch. Defects shall be repaired immediately.

E. Jointing: Joints shall be of three (3) types: construction, contraction, and isolation. Wherever possible, the angle between intersecting joints shall be between 80 and 100 degrees. Construct joints at the locations and to the horizontal dimensions indicated on the Plans.

1. Construction Joints: Construction joints shall be formed at the end of a day's work or when necessary to stop production for any reason.

   a. Construction joints shall be located as near as possible to the location of a planned contraction or isolation joint.

   b. Construction joints are to be formed by placing a header between the forms, at right angles, to the full depth of the finished pervious concrete, and set to the height of the forms. Pervious concrete shall be placed against the header and compacted and finished as normal, including edging.

   c. Upon resuming paving, the header shall be carefully removed and new pervious concrete placed directly against the existing pervious concrete. The new pervious concrete shall be

compacted and finished against the hardened pervious concrete as if it were a form.

d. If an isolation joint is planned at this location, then the premolded joint filler shall be placed against the existing pervious concrete and the new pervious concrete shall be placed against the premolded joint filler. The joint shall be tooled on both sides of the premolded joint filler.

2. Contraction Joints: Contraction joints shall be used to control random cracking.

   a. Contraction joints shall be placed every 15 feet unless otherwise shown on the Plans.

      DESIGNER NOTE: Designer should consider size and aspect ratio of panels when locating joints.

   b. Plastic Formed Joints: Contraction joints may be formed in the plastic concrete using a roller designed for this purpose or by other methods accepted by the Engineer.

      1) Rollers shall have sufficient weight to produce the joint and shall not otherwise damage or mar the surface.

      2) Plastic formed joints shall be a minimum depth of 1 and 3/4 inches and have a width of no more than 1/8 inch.

      3) Joints shall be tooled on both sides of the joint with a radius not less than 1/4 inch.

   c. Saw Cut Joints: At the option of the Contractor, contraction joints may be saw cut provided joints are early-entry dry-cut type.

      1) Joints shall be cut using purpose built early-entry saw cutting equipment.

      2) Saw cut joints shall be a minimum depth of 1/4 of the pervious concrete thickness, up to a maximum required depth of 1 and 1/4 inches, and have a joint width of no more than 1/8 inch.

      3) Saw cutting shall occur as soon as the concrete is sufficiently cured so that it may be cut without raveling or dislodging aggregate from the finished surface, no longer than four (4) hours after placement of pavement.

      4) Remove cuttings from surface immediately after saw cutting of joints.

      5) To minimize drying, curing materials shall be removed only as needed to make cuts and shall be replaced immediately after cutting. The exposed pervious concrete shall be kept moist for the entire duration of exposure.

3. Isolation Joints: Isolation joints shall be used where the pervious concrete abuts existing facilities or where shown on the Plans.
    a. Isolation joints shall continue through the depth of the pervious concrete using a 3/8 inch premolded joint filler.
    b. Isolation joints may be formed by inserting the premolded joint filler into the plastic concrete or by forming a construction joint and affixing the premolded joint filler against one side of the joint and placing fresh pervious concrete against it.
    c. Isolation joints and filler shall be flush with the surrounding pervious concrete and shall not deviate from the acceptance criteria for Grade as specified in Section 1.05.E.2.
    d. The edges of the pervious concrete on either side of the premolded joint filler shall be hand tooled to a radius not less than 1/4 inch.

F. Curing

1. Begin curing within 20 minutes of concrete discharge from the truck, unless otherwise specified or approved by the Engineer.
2. Completely cover the pavement surface and all exposed edges with a minimum six- (6)-mil-thick white polyethylene sheet, unless otherwise specified or approved by the Engineer. No wetted burlap or cloth shall be used.
3. Thoroughly secure a polyethylene sheet at all exterior edges and interior laps without using soil. The method of securing the cover material shall prevent wind from removing the sheet and from blowing under the sheet across the surface of the concrete.
4. Curing compound shall not be used on any pervious cement concrete surface.
5. Cure pavement for a minimum of 7 uninterrupted days, unless otherwise specified or approved by the Engineer.
6. With the exception of saw cutting equipment, all traffic shall be kept off of the pervious concrete during the curing period.
7. Any testing for acceptance shall not occur until the end of the curing period.

G. Cold-weather construction

1. Protect concrete from freezing and record concrete temperature no less than twice per 24-hour period in accordance with ACI 306.1.

## 3.04 OPENING TO TRAFFIC

A. No traffic shall be allowed on the pervious cement concrete pavement for 10 days.

3.05 PROTECTION OF PAVEMENT

A. Cured and exposed pervious cement concrete pavement surface shall be kept clean and free of clogging debris and soils from the Contractor's operations and all upstream and adjacent debris. If debris or soils contaminate the pervious pavement voids, the pavement shall be cleaned at the Contractor's expense and to the satisfaction of the Engineer. If pervious cement concrete pavement cannot be unclogged, it shall be removed and replaced at the Contractor's expense and to the satisfaction of the Engineer.

3.06 REJECTION

A. Pervious concrete that does not meet the acceptance criteria set forth in Section 1.05.E.2 will be rejected by the Engineer on a lot-by-lot basis. Pervious concrete that has been rejected by the Engineer or the Contractor shall be removed and replaced at no additional cost to the Owner.

**END OF SECTION**

## DIVISION 32 – EXTERIOR IMPROVEMENTS

## Section 32 12 43 – Porous Asphalt Concrete

DESIGNER NOTE: The specifications below are based on the best available information. Designer should modify the specifications to satisfy project-specific constraints.

DESIGNER NOTE: Green text corresponds to notes to the designer.

### PART 1 GENERAL

1.01 SUMMARY

A. This section includes:

**1.** Porous Asphalt Pavement

**2.** Pavement Base

**3.** Geotextile for Soil Separation

B. Related Sections:

DESIGNER NOTE: The designer should list any additional specification sections which relate to the porous asphalt work (i.e., traffic control, temporary erosion control, utilities, earthwork, etc.)

1.02 STANDARDS AND CODES

A. Reference Standards: This section incorporates by reference the latest revisions of the following documents. These references are a part of this section as specified and modified.

| Reference | Title |
|---|---|
| Caltrans | Standard Specifications (published by State of California Business, Transportation, and Housing Agency, Department of Transportation) |
| San Francisco DPW | Engineering Standard Specifications |
| AASHTO | Standards of the American Association of State Highway and Transportation Officials, 1998 or latest edition |
| ASTM | Annual Book of ASTM Standards, American Society for Testing and Materials, Philadelphia, PA, 1997 or latest edition. |
| NAPA IS 115 | Design, Construction, and Maintenance of Open-Graded Asphalt Friction Courses |
| NAPA IS 131 | Porous Asphalt Pavements for Stormwater Management, Design, Construction, and Maintenance. |

**1.** Caltrans Standard Specifications: Any references to Caltrans Standard Specifications invoke technical specifications in Section 39 for material, construction, and quality control and quality assurance

only. Caltrans contractual requirements, general specifications, and measurement and payment do not apply.

**2.** Caltrans Standard Specifications Term Equivalencies

| Terms Equivalencies | |
|---|---|
| **Term or Clause in Caltrans Standard Specifications** | **Term or Clause in These Specifications** |
| The Department | The Owner |
| OGFC | Porous Asphalt |

1.03 REFERENCES

DESIGNER NOTE: Designer to provide references to related industry manuals and guidance and all project specific documents (e.g., geotechnical report).

1.04 SUBMITTALS

A. Bid Submittals: The Contractor shall submit to the Owner the following as part of the bid proposal:

**1.** Project experience and personnel qualification examples as specified in Section 1.05.B for the contractor and personnel assigned to this project.

DESIGNER NOTE: The designer should incorporate by reference these requirements in Division 00 of the Specifications.

B. Pre-Installation Submittals: Submittals shall conform to the requirements of Caltrans Standard Specifications including:

**1.** Proposed job mix formula per Section 1.05.B of this Specification.

**2.** Proposed QC plan per Section 39-1.04A (General Requirements for Contractor Quality Control) and Section 39-2.02A (Quality control plan requirements for the “Standard Construction Process”). The QC Plan shall satisfactorily test the porous asphalt for compliance with Section 39-2.02B (Quality Control for Standard Construction Process) of the Caltrans Standard Specifications, with the following modifications and additions:

a. Aggregate durability index shall be tested in accordance with Caltrans Test Method 229 at least one time per each 750 tons of porous asphalt.

b. Aggregate cleanliness value shall be tested in accordance with Caltrans Test Method 227 at least one time per each 750 tons of porous asphalt.

c. Air voids shall be tested for by determining the bulk specific gravity in accordance with ASTM D6752 or AASHTO T275, the maximum theoretical specific gravity with AASHTO T209, and the voids by test ASTM D3203.

d. Draindown shall be tested in accordance with ASTM D6390.

e. Retained tensile strength shall be tested in accordance with AASHTO 283.

f. Three (3) surface infiltration tests per ASTM C1701 shall be conducted per 10,000 square feet of porous asphalt, in place and one (1) additional test per 5,000 square feet of porous asphalt, or fraction thereof, in place. Document and record the results of each field infiltration test with a designated test number. Include infiltration rate, date pavement was placed, date test was taken, and location on the site (via stationing or other means) where test was performed in each test record. If minimum required field infiltration rate is not achieved at any location as defined in this Section, re-test for field infiltration rate at a new location for each failed field infiltration test. Coordinate location with Owner's Representative.

The QC plan shall be consistent with the Caltrans Quality Control Quality Assurance Manual for Asphalt Concrete Production and Placement (latest version).

In addition to the Caltrans submittal requirements, the Contractor shall submit the following:

**3.** Source certificates, gradations, R-values, LA abrasion, and cleanness values of aggregates for base and reservoir course materials performed within one (1) month of product delivery to site.

**4.** Product data sheets for geotextiles.

**5.** Testing agency qualifications as specified in Section 1.05.A.

1.05 QUALITY CONTROL AND QUALITY ASSURANCE

A. General: Test and inspect asphalt materials and operations as Work progresses as described in this section. Failure to detect defective Work or materials at any time will not prevent rejection if a defect is discovered later, nor shall it constitute final acceptance.

DESIGNER NOTE: This specification does not include a test panel/mockup due to the difficulty of installation and because physical properties of the material are known from the plant test. Consider whether project design objectives warrant the cost of a test panel/mockup.

**1.** Contractor and Personnel Qualifications

DESIGNER NOTE: The designer should adjust the required qualifications for the contractor and personnel based on the availability of qualified bidders and project size, complexity, and risk.

a. Contractor qualification: The Contractor shall provide documentation showing one of the following for the general contractor or paving subcontractor:

1) One (1) example owner-accepted porous asphalt project, similar (or greater) in extent to the proposed project, completed in the last one (1) year with reference.

OR

2) Three (3) example owner-accepted open graded friction course projects completed in the last one (1) year with references.

Documentation shall include name and address of project, and contact information for project owner.

b. Personnel qualification: The Contractor or paving subcontractor shall provide a qualified foreman with experience installing porous asphalt and documentation showing with following:

1) One (1) example owner-accepted porous asphalt project, similar (or greater) in extent to the proposed project, completed in the last one (1) year with reference.

Documentation shall include name and address of project, and contact information for project owner.

The qualified foreman shall be onsite for the duration of asphalt work including preparation, placement, testing, and completion.

c. Testing agency qualification: Agencies that perform testing on porous asphalt materials shall meet the requirements of Caltrans Standard Specification Section 39-1.03A or be accredited by the AASHTO Accreditation Program (AAP) for the scope and standard being evaluated.

d. Plant qualification: Batch or continuous mixing plants used for porous asphalt shall meet the requirements of Caltrans Standard Specification Section 39-1.08A.

B. Authorized Job Mix Formula (JMF): The mix design process shall conform to Caltrans Specification Section 39-1.03 except as noted below.

**1.** The final paragraph under Section 39-1.03A is deleted and replaced with the following:

a. Submit a complete JMF submittal including identification of asphalt binder percentage in form CEM-3511 Contractor Job Mix Formula Proposal. Determine the optimum asphalt binder content using California Test 368 in a lab that meets the requirements of 1.05.A. of these specifications.

The products used in the JMF shall meet the requirements in Section 2.01 of this Specification.

The JMF shall meet the quality characteristics defined in Section 39-2.02B (Quality Control for Standard Construction Process) with the modified and additional quality characteristics listed in the table below.

| Quality Characteristics | Test Method | Requirement |
|---|---|---|
| Aggregate Durability Index | CT 229 | DI >= 35 |
| Aggregate Cleanness Value | CT 227 | CV >= 75 |
| Air Void Content by Corelok (%)[1] | ASTM D6752 (with AASHTO T209 and ASTM D3203) | 16–20% |
| Air Void Content by Paraffin Wax (%)[1] | AASHTO T275 (with AASHTO T209 and ASTM D3203) | 18–22% |
| Draindown (% of total weight) | ASTM D6390 | <= 3% |
| Retained Tensile Strength (%) | AASHTO 283 | >= 80% |
| Infiltration Rate (Average Inches per Hour) | ASTM C1701 | See Note 2. |

[1] Either method of determining air void content is acceptable.

[2] The finish surface shall yield an infiltration rate that is consistent with the following: The average infiltration rate from three (3) infiltration tests conducted per ASTM C1701 shall be greater than 100 inches per hour with no single test less than 50 inches per hour. Water shall infiltrate rapidly and uniformly through the surface without formation of large puddles when applied at a rate of 5 gallons per minute (gpm).

**2.** Once verified and accepted by the Engineer, the JMF meeting the criteria above shall become the Authorized JMF. Acceptance of the JMF shall be per Caltrans Standard Specification Section 39-1.03G, except that verification of the JMF by the City of San Francisco shall be considered equivalent to verification of the JMF by Caltrans. Any adjustments or renewals of the JMF shall be per Caltrans Standard Specifications Section 39-1.03 (Hot Mix Asphalt Mix Design Requirements). Submit a letter from the asphalt supplier with the recommended temperature ranges for mixing, laying, breakdown rolling, and finished rolling, as well as the recommended maximum temperature of the finished mat before placement of subsequent lifts.

C. Responsibilities of Contractor

**1.** General: Conform to the requirements set forth in Section 39-1.04 (Contractor Quality Control) and Section 39-2.02 (Standard Construction Process Contractor Quality Control) of the Caltrans Standard Specifications.

**2.** Pre-Placement Conference: A mandatory pre-placement conference will take place, including at a minimum the Engineer, the Owner, the general Contractor, and paving subcontractor, to review preparation, placement, testing procedures, and responsibilities.

**3.** Quality Control: Contractor quality control inspection and testing of porous asphalt shall be conducted in accordance with the approved QC plan.

**4.** Load Slip: Provide a load slip certified by a licensed weightmaster showing combined mixture weight for each load of porous asphalt transported to the location.

**5.** Infiltration Rate Testing: Perform surface infiltration tests per ASTM C1701 as described below.

a. Three (3) test locations per 10,000 square feet of porous asphalt in place.

b. One (1) additional test location per 5,000 square feet of porous asphalt, or fraction thereof, in place.

DESIGNER NOTE: Designer to specify the number and location(s) of required post-construction infiltration tests.

**6.** Required Inspections: Notify the Engineer at least 5 business days prior placement of porous asphalt.

**7.** Failed Tests: Each test shall meet the acceptance criteria as defined in this section. For any single quality characteristic except smoothness, if two consecutive quality control test results do not comply with the action limits or specifications:

a. Stop production.

b. Notify the Engineer.

c. Take corrective action.

d. Demonstrate compliance with the specifications before resuming production and placement.

DESIGNER NOTE: The following table is a Sample Contractor Quality Control Sampling and Testing Plan; it is provided to illustrate the type and frequency of testing that may be required The Contractor will need to develop a similar table as part of their QC plan. Frequency and standard for all tests should be project specific.

| Sample Contractor Quality Control Sampling and Testing Plan | | | | | | |
|---|---|---|---|---|---|---|
| **Quality Characteristic** | **Test Standard** | **Frequency** | **Sample Location** | **Contractor Responsibility** | **Attribute or Tolerance** | |
| **Plant Operations** | | | | | | |
| Aggregate Gradation | CT 202 | 1/750 tons | Plant | Plant Inspector | 1/2" | TV ± 6 |
| | | | | | 3/8" | TV ± 6 |
| | | | | | No. 4 | TV ± 7 |
| | | | | | No. 8 | TV ± 5 |
| | | | | | No. 30 | TV ± 4 |
| | | | | | No. 200 | TV ± 2 |
| Asphalt Binder Content | CT 382 | Daily | Plant | Plant Inspector | Design ± 0.5% | |
| Percent of crushed particles coarse aggregate (%, min)<br>One fractured face<br>Two fractured faces<br>Fine aggregate (%, min) (Passing no. 4 sieve and retained on no. 8 sieve.)<br>One fractured face | CT 205 | 1/project | Plant | Plant Inspector | <br>90<br>75<br><br>90 | |
| Los Angeles Rattler (%, max)<br>Loss at 100 rev.<br>Loss at 500 rev. | CT 211 | 1/project | Plant | Plant Inspector | <br>12<br>40 | |
| Aggregate Durability Index | CT 229 | 1/750 tons | Plant | Plant Inspector | DI > 35 | |
| Aggregate Cleanness Value | CT 227 | 1/750 tons | Plant | Plant Inspector | CV > 75 | |
| Asphalt Temp. | Recorded | Continuous | Plant | Plant Inspector | 120–190 | |
| Plant Mix Temperature | Recorded | Continuous | Plant | Plant Inspector | 165 Maximum | |
| Aggregate moisture content | CT 226 | 2/day | Plant | Plant Inspector | For adjusting the plant controller at the HMA plant | |
| Flat and elongated particles (%, max by weight @ 5:1) | CT 235 | 1/project | Plant | Plant Inspector | Report Only | |

| Sample Contractor Quality Control Sampling and Testing Plan | | | | | |
|---|---|---|---|---|---|
| **Quality Characteristic** | **Test Standard** | **Frequency** | **Sample Location** | **Contractor Responsibility** | **Attribute or Tolerance** |
| **Street Operations** | | | | | |
| Subgrade Preparation | Visual | Daily | Jobsite | Field Inspector | Smooth and Clean |
| Asphalt Paver & Hopper | Visual and Measure | Daily | Jobsite | Field Inspector | Manufacturer Standards |
| Compaction Equipment | Visual and Measure | Daily | Jobsite | Field Inspector | Manufacturer Standards |
| Compaction Process | Visual | Continuous | Jobsite | Field Inspector | Per Specifications |
| Pavement Temp. at Breakdown | Temperature Equipment | Hourly | Mat Behind Paver | Field Inspector | Per Specifications |
| Asphalt Binder Content | CT 382 | Daily | Mat Behind Paver | Field Inspector/Tester | Design ± 0.5% |
| HMA Moisture Content (%, max) | CT 226 | Daily | Mat Behind Paver | Field Inspector/Tester | 1.0 |
| Lift Thickness | Measured | Hourly | Mat Behind Paver | Field Inspector | Per Specifications |
| Pavement Temp. at Finish | Temperature Equipment | Daily | At Finish Roller | Field Inspector | Per Specifications |
| Air Void Content by Paraffin Wax (%) | AASHTO T275 (with AASHTO T209 and ASTM D3203) | Daily | Cores of Finished Surface | Field Inspector | 16–20% |
| Tensile Strength | AASHTO 283 | Daily | Cores of Finished Surface | Engineer | >= 80% |
| Long./Transverse Joints | Visual | Continuous | Pavement Joints | Field Inspector | Industry Standards |
| Smoothness | 10 ft straightedge | Hourly | Finished Surface | Field Inspector | Per Specifications |

| Sample Contractor Quality Control Sampling and Testing Plan | | | | | |
|---|---|---|---|---|---|
| **Quality Characteristic** | **Test Standard** | **Frequency** | **Sample Location** | **Contractor Responsibility** | **Attribute or Tolerance** |
| **Street Operations (continued)** | | | | | |
| Infiltration Rate<br>(average Inches per hour) | ASTM C1701 | Three (3) test locations per 10,000 square feet of pervious asphalt, in place<br>One (1) additional test location per 5,000 square feet of pervious asphalt, or fraction thereof, in place | Finished Surface | Field Inspector | Each Test: 50”/hr min<br>Daily Avg.: 100”/hr min |
| Pavement Transitions | Visual | Daily | AC Transitions | Field Inspector | Per Specifications |

D. Acceptance: Acceptance of porous asphalt shall be determined based on the criteria defined in Section 39-2.03A (Acceptance) of the Caltrans Standard Specifications, with the following modifications and additions:

**1.** Source aggregate will not be subject to acceptance testing once is has been approved as part of the JMF, unless samples are requested by the Engineer.

**2.** Air Voids: Air voids shall be tested for by determining the bulk specific gravity in accordance with ASTM D6752 or AASHTO T275, the maximum theoretical specific gravity with AASHTO T209, and the voids by test ASTM D3203.

**3.** Retained Tensile Strength: Retained tensile strength shall be tested in accordance with AASHTO 283.

Test results for air voids, draindown, and retained tensile strength shall be consistent with the characteristics of the approved JMF.

**4.** Infiltration Testing

a. Infiltration Rate Testing: The average of all surface infiltration tests shall be greater than 200 inches per hour with no single test less than 100 inches per hour.

DESIGNER NOTE: The designer should adjust infiltration rates to reflect project specific conditions such as anticipated sediment loading based on pavement use (e.g., vehicular, pedestrian) and design run-on from adjacent surfaces. The recommended criteria are as follows:

- For porous asphalt that will accept run-on from adjacent impervious and/or pervious surfaces OR pavement that will be subject to vehicular traffic:
  - The average of all surface infiltration tests shall be greater than 200 inches per hour with no single test less than 100 inches per hour
- For porous asphalt not subject to run-on OR vehicular traffic:
  - The average of all surface infiltration tests shall be greater than 100 inches per hour with no single test less than 50 inches per hour

b. Infiltration Visual Testing: Visual flood testing of the surface shall be conducted by application of clean water at the rate of at least 5 gpm over the surface, using a hose or other distribution devise. Water used for the test shall be clean, free of suspended solids and deleterious liquids and will be provided at no extra cost to the Owner. All applied water shall infiltrate directly without large puddle formation or surface runoff, and shall be observed by the

Engineer. The Engineer shall mark areas where large puddles form in the field. Areas with slow infiltration shall not exceed 10 percent of the total surface.

DESIGNER NOTE: Smoothness specification should be revised as needed to reflect project design objectives (e.g., smoothness specifications from Section 212 of the City Streets and Highways specifications).

**5.** Smoothness: Porous asphalt smoothness shall be checked with a 10-foot straightedge. Vertical measurement shall be taken between the pavement's determined plane and straight edge in a direction perpendicular and parallel to the centerline. The finished pavement shall be uniform to a degree such that no variations greater than 3/8-inch are present between the straightedge and pavement surface.

**6.** Grade: Porous asphalt shall be true to designed spot elevations plus or minus ½ inch and shall not deviate from designed slope more than ¼ inch in ten (10) feet. Where abutting existing facilities such as sidewalks, walkways, curbs, driveways or other pavements, the porous asphalt shall be flush.

**7.** Line: Porous asphalt margins shall be true to designed lines plus or minus ½ inch at any point.

**8.** Slope: Porous asphalt shall be sloped as shown on the Plans. Slope shall be consistent to within 1/4 inch in ten (10) feet.

**9.** Thickness: Each core sample shall be equal to the minimum section depth or more as specified on the Plans.

DESIGNER NOTE: Revise the load slip specification as needed to align with the measurement and payment specifications.

**10.** Load Slip: Each load of porous asphalt transported to the location of placement shall have a load slip delivered with the load that is certified by a licensed weightmaster and includes the combined mixture weight.

DESIGNER NOTE: Designer should specify consequences of any failed acceptance tests (e.g., reduced payment for lower infiltration rate and lower percent voids, reduced payment for failed smoothness tests) or if consequences are full replacement.

**11.** Reduced Payment Factors: The reduced payment factors in Caltrans Standard Specification 39-2.03A (Testing) do not apply.

DESIGNER NOTE: The following table is a Sample Owner Quality Assurance Sampling and Testing Plan is provided to illustrate the type and frequency of testing that may be required. Frequency and standard for all tests should be project specific.

| Sample Owner Quality Assurance Sampling and Testing Plan | | | | | |
|---|---|---|---|---|---|
| **Quality Characteristic** | **Test Standard** | **Frequency** | **Sample Location** | **Responsibility** | **Attribute or Tolerance** |
| **Plant Operations** | | | | | |
| **Street Operations** | | | | | |
| Asphalt Binder Content | CT 382 | Daily | Hopper | Engineer | Design ± 0.5% |
| HMA Moisture Content (%, max) | CT 226 | Daily | Hopper | Engineer | 1.0 |
| Lift Thickness | Measured | Hourly | Cores of Finished Surface | Engineer | Per Specifications |
| Air Void Content by Paraffin Wax (%) | AASHTO T275 (with AASHTO T209 and ASTM D3203) | Daily | Cores of Finished Surface | Engineer | 16–20% |
| Tensile Strength | AASHTO 283 | Daily | Cores of Finished Surface | Engineer | >= 80% |
| Long./Transverse Joints | Visual | Continuous | Pavement Joints | Engineer | Per Specifications |
| Smoothness | 10 ft straightedge | Hourly | Finished Surface | Engineer | Per Specifications |
| Infiltration Rate (average inches per hour) | ASTM C1701 | 3/day | Finished Surface | Engineer | Each Test: 50”/hr min Daily Avg.: 100”/hr min |
| Pavement Transitions | Visual | Daily | AC Transitions | Engineer | Per Specifications |

## PART 2 PRODUCTS

DESIGNER NOTE: If a product is not available, the designer needs to ensure that the desired voids and surface texture will meet the desired pavement characteristics for surface smoothness, voids, and bonding.

2.01 POROUS ASPHALT

Porous Asphalt mixture must comply with the approved Job Mix Formula (See Section 1.05 of this Specification). The components of the asphalt mixture must comply with the specifications below.

A. Asphalt Binder: Asphalt binder must comply with Caltrans Specification Section 92 except as noted below.

**1.** Performance Graded (PG) Asphalt Binder: PG asphalt binder must be PG 70-10 per Caltrans Specification Section 92-1.02B.

**2.** PG Polymer Modified Asphalt Binder:

PG polymer modified asphalt binder must be PG 76-22 PM per Caltrans Specification Section 92-1.02B for use in vehicular applications.

PG polymer modified asphalt binder must be either PG 64-28 PM or PG 76-22 PM per Caltrans Specification Section 92-1.02B for use in pedestrian applications.

B. Aggregates: Aggregates shall conform to Caltrans Specification Section 39-1.02E for Open Graded Friction Course (OGFC) with the following additions and modifications:

**1.** Durability Index: 35 (minimum) tested in accordance with California Test 229 at least once per 750 tons of porous asphalt.

**2.** Cleanness Value: 75 (minimum) tested in accordance with California Test 227 at least once per 750 tons of porous asphalt.

**3.** Aggregate for porous asphalt shall meet the following gradation:

| **Porous Asphalt Aggregate Gradation** | |
|---|---|
| **Sieve[1]** | **Percent Passing by Weight** |
| 3/4 inch | 100 |
| 1/2 inch | 85 to 100 |
| 3/8 inch | 55 to 75 |
| No. 4 | 10 to 25 |
| No. 8 | 5 to 12 |
| No. 30 | 0 to 10 |
| No. 200 | 0 to 3 |

[1] Sieve provided in nominal size square openings or United States Standard Sieve Series sizes.

C. Materials Not to Be Used: The following materials shall not be used unless approved in advance by the Engineer.

**1.** Geosynthetic pavement interlayer

**2.** Tack Coat (except on vertical faces of curbs, edges of PCC structures, or when paving over areas with impermeable bases).

**3.** Asphalt Rubber Binder.

**4.** Crumb Rubber Modifier.

**5.** Reclaimed Asphalt Pavement.

**6.** Paint Binder per Section 212.06 of the DPW Standard Specifications

D. Job Mix Formula (JMF): The JMF shall comply with the requirements of Section 1.05.C of this Specification.

2.02 PAVEMENT BASE

A. Pavement Base Material shall consist of clean, mechanically crushed stone, substantially free from adherent coatings. Materials shall be washed thoroughly to remove clay, organic matter, extraneous debris, or objectionable materials. Recycled materials are not permitted. The Material shall be obtained only from a source(s) approved by the Engineer. Written requests for source approval shall be submitted to the Engineer not less than 10 Working Days prior to the intended use of the Material. Should the proposed source be one that the Engineer has no history of Material performance with, the Engineer reserves the right to take preliminary samples at the proposed source, and make preliminary tests, to first determine acceptability of the new source and then perform the applicable Material approval testing. Continued approval of a source is contingent upon the Materials from that source continuing to meet Contract requirements. Materials shall meet the Standard Specifications for grading and quality for use in the Work; however, allowable exceptions may be specified in the Contract. The Engineer shall reserve the right to sample and test Material at any time including at the source.

B. Pavement Base shall consist of up to two (2) layers as specified on the Plans and included herein:

**1.** "Base Course" shall be ASTM No. 3 (modified) or ASTM No. 57 (modified) stone per Section 2.02.C.

DESIGNER NOTE: This layer of the pavement base is intended to provide structural (load bearing) capacity to the pavement.

**2.** "Reservoir Course" shall be ASTM No. 2 (modified), ASTM No. 3 (modified), or ASTM No. 57 (modified) stone per Section 2.02.C.

DESIGNER NOTE: This layer of the pavement base is intended to provide storage and drainage of the pavement, structural support, and a capillary break. The materials specified should be crushed, clean, washed gravel to provide the desired structural capacity, maintain good drainage, function as a capillary barrier, and minimize clogging of the subgrade due to export of fines.

DESIGNER NOTE: If the designer chooses to specify materials that differ from those provided herein, the designer should check their filter criteria to evaluate the likelihood of finer-graded material migration into underlying coarser graded materials or reduction in permeability relative to the underlying material. Refer to the SFPUC aggregate filter criteria guidance document for information on selecting appropriate alternate materials.

C. Pavement Base Material shall meet the following specifications for grading and quality.

**1.** Aggregate Gradation tested in accordance with ASTM C136 at least once per 500 cubic yards of base material.

| Sieve[1] | Percent Passing by Weight | | | |
|---|---|---|---|---|
| | ASTM No. 2 (modified) | ASTM No. 3 (modified) | ASTM No. 8 (modified) | ASTM No. 57 (modified) |
| 3 inch | 100 | – | – | – |
| 2 1/2 inch | 90 to 100 | 100 | – | – |
| 2 inch | 35 to 70 | 90 to 100 | – | – |
| 1 1/2 inch | 0 to 15 | 35 to 70 | – | 100 |
| 1 inch | – | 0 to 15 | – | 95 to 100 |
| 3/4 inch | 0 to 5 | – | – | – |
| 1/2 inch | – | 0 to 5 | 100 | 25 to 60 |
| 3/8 inch | – | – | 85 to 100 | – |
| No. 4 | – | – | 10 to 30 | 0 to 10 |
| No. 8 | – | – | 0 to 10 | 0 to 5 |
| No. 16 | – | – | 0 to 5 | – |
| No. 100[2] | 0 to 2 | 0 to 2 | 0 to 2 | 0 to 2 |

[1] Sieve provided in nominal size square openings or United States Standard Sieve Series sizes.

[2] Gradation modified from ASTM for portion passing the No. 100 sieve.

**2.** R-Value: 78 (minimum) tested in accordance with California Test 301.

**3.** L.A. Abrasion: 30 percent (maximum) tested in accordance with ASTM C 131.

**4.** Cleanness Value: 75 (minimum) tested in accordance with California Test 227 at least once per 500 cubic yards of base material.

**5.** Crushed Particles: 90 percent (minimum) with two (2) or more fractured faces tested in accordance with California Test 205.

**6.** The combined portion of Material retained on the U.S. No. 4 sieve shall not contain more than 0.1 percent wood waste by weight. The portion of Material passing a U.S. No. 10 sieve shall not have wood waste that results in more than 250 parts per million of organic matter by calorimetric tests when tested. The color shall be measured after the sample has been in the test solution for 1 hour.

## 2.03 GEOTEXTILE FOR SOIL SEPARATION

DESIGNER NOTE: Geotextile is not typically required under permeable pavement applications unless recommended by a geotechnical engineer. Geotextile can be placed vertically for material separation between side walls of reservoir course and native soil.

A. Geotextile shall be woven, consisting only of long chain polymeric fibers or yarns formed into a stable network such that the fibers or yarns retain their position relative to each other during handling, placement, and design service life. At least 95 percent by weight of the material shall be polyolefins or polyesters. The material shall be free from defects or tears. The geotextile shall also be free of any treatment or coating which might

adversely alter its hydraulic or physical properties after installation. The geotextile shall conform to the properties specified herein:

| Geotextile Property | Test Method | Requirement |
|---|---|---|
| Grab Tensile Strength, minimum in weakest direction | ASTM D4632 | 200 lbs/in |
| Apparent Opening Size (AOS) | ASTM D4751 | 40 to 50 |
| Ultraviolet (UV) Radiation Stability, minimum strength retained after 500 hours in weatherometer | ASTM D4355 | 50% |
| Flow Rate, minimum | ASTM D4491 | 140 gal/min/ft$^2$ |

DESIGNER NOTE: The designer should consider including specifications for signage and pavement markings in this section.

## PART 3 EXECUTION

### 3.01 SUBGRADE PREPARATION AND PROTECTION

A. Construct subgrade to +/- ¾ inch of the grades and slopes specified on the Plans.

B. Grading of subgrade shall be with low ground pressure equipment when within six (6) inches of final subgrade elevation.

C. Compact subgrade to 90 percent (+/- 2 percent) of the maximum dry density per standard Proctor test (ASTM D698), or as directed by the Geotechnical Engineer. Determination of in-place density shall be made using a nuclear gauge per ASTM D6939.

DESIGNER NOTE: The designer should set compaction requirements based on consideration of site specific geotechnical properties of the native soil (e.g., permeability, stiffness) and performance requirements for the pavement section (e.g., traffic loading, infiltration, cost).

D. Areas of the subgrade which are over-compacted, as determined by the Geotechnical Engineer, shall be ripped/tilled to a depth of 12 inches (minimum) or as directed by the Geotechnical Engineer, and shall be recompacted in accordance with 3.01.C. Contractor shall locate all utilities within pavement footprint prior to ripping and re-compacting subgrade

E. Proof-roll prepared subgrade with loaded dump truck, remove soft spots, and replace with permeable structural fill as directed by the Engineer to achieve uniform subgrade.

F. After compaction and proof roll, scarify subgrade ¼ to ½ inch deep by hand rake. Once scarified, materials or equipment shall not be permitted within the prepared subgrade area so as to avoid recompaction or clogging of the scarified subgrade.

G. The subgrade shall be protected from over-compaction or contamination by silty run-off or other contaminants.

1. Provide physical barriers or direct traffic to eliminate unnecessary vehicular traffic on the subgrade during construction in accordance with SFMTA and SFDPW ordinances and specifications.

2. Provide flow diversion and erosion control measures to protect the permeable pavement area from sedimentation until the upstream catchment area is thoroughly stabilized.

H. Areas of subgrade over-compacted by construction traffic or other impacts by the Contractor or Subcontractors shall be ripped/tilled and re-compacted in accordance with Section 3.01.D. All work and materials required to correct the over-compacted subgrade, including utility locates within the pavement footprint, shall be at the Contractor's expense.

I. Areas of subgrade contaminated by the accumulation of silty material following rains or other debris or contamination shall be removed and disposed at the Contractor's expense.

J. The subgrade shall be inspected and accepted by the Engineer prior to placement of the geotextile or pavement base.

K. Place geotextile, if required, on scarified subgrade. Care shall be taken to provide full coverage and to prevent the geotextile from being torn. Damaged geotextile shall be repaired as indicated by the manufacturer and to the satisfaction of the Engineer, at the Contractor's expense. Overlaps of the geotextile shall be a minimum of 1 foot or to the manufacturer's recommendation, whichever is greater.

DESIGNER NOTE: The use of geotextile under permeable pavement systems should be avoided unless required by the project geotechnical engineer as it can be prone to subsurface clogging.

3.02 PAVEMENT BASE

A. Construct pavement base to the lines, grades, and thicknesses shown on the Plans.

B. Place the pavement base so as to prevent loaded dump trucks from driving directly on the prepared subgrade.

C. Compact pavement base, in six (6)-inch (maximum) lifts, by making a minimum of three passes over the pavement base material with a ten (10)-ton vibratory roller, or as directed by the Geotechnical Engineer. The first two (2) passes (minimum) shall be in vibratory mode. The final pass shall be in static mode. Acceptance of the pavement base will be based on Engineer's observation of aggregate movement during final compaction pass. Compaction equipment shall be accepted by the Engineer prior to use.

DESIGNER NOTE: For areas or sites that cannot accommodate a vibratory roller compactor, consider allowing compaction of pavement base with a 13,500 lbf (60 kN) minimum vibratory plate compactor with a compaction

indicator. At least two passes should be made over each lift of the aggregates.

D. Pavement base shall be true to the designed grade and slope, +/- 0.05 feet, after compaction for each layer. In the event of low spots additional material shall be added and recompacted. In the event of high spots, excess material shall be removed and the area recompacted.

E. The pavement base shall be protected from over-compaction or contamination by silty run-off or other contaminants.

**1.** Provide physical barriers or direct traffic to eliminate unnecessary vehicular traffic on the pavement base during construction in accordance with SFMTA and SFDPW ordinances and specifications.

**2.** Provide flow diversion and erosion control measures to protect the permeable pavement area from sedimentation until the upstream catchment area is thoroughly stabilized.

F. Any damage to the pavement base (including contamination by silty run-off) shall be repaired to the satisfaction of the Engineer at the Contractor's expense. Contaminated pavement base shall be removed and replaced to the limits as determined by the Engineer.

G. The pavement base shall be inspected and accepted by the Engineer prior to placing any porous asphalt.

3.03 POROUS ASPHALT PREPARATION

DESIGNER NOTE: Designer should specify where a tack coat should be applied, if at all. See 3.03.A.2 for list of potential locations.

A. Preparation for placement of porous asphalt pavement shall comply with Section 39-1.09 of the Caltrans Standard Specifications, except as noted below.

**1.** Pavement Base: Confirm that the completed pavement base conforms to these specifications.

**2.** Tack Coat: Shall not be used except on vertical faces of curbs, edges of PCC structures, or when paving over areas with impermeable bases.

**3.** Geosynthetic Pavement Interlay: Shall not be used.

**4.** Environmental Conditions: Do not place porous asphalt when the ambient temperature is less than 60 degrees Fahrenheit, on any wet surface, or when the average ground surface temperature is less than 45 degrees Fahrenheit.

**5.** Qualified Personnel: The qualified foreman as defined in 1.05.B.2 shall be onsite for the duration of porous asphalt preparation.

3.04 POROUS ASPHALT PLACEMENT

DESIGNER NOTE: Designer should specify where a tack coat should be applied (e.g., face of curb, structures,) if at all.

A. Porous asphalt equipment, transportation, spreading, and compacting shall comply with the Caltrans Specification applicable to Open Graded Friction Course (OGFC), except as noted below or as specified in the approved mix design.

B. Qualified Personnel: The qualified foreman as defined in 1.05.B.2 shall be onsite for the duration of porous asphalt placement.

C. Spreading and Compacting Equipment: shall conform to Section 39-1.10 of the Caltrans Standard Specifications except that pneumatic tire rollers shall not be used.

DESIGNER NOTE: The compaction could be established by the contractor rather than prescribed below depending on whether the contracting agency prefers to take a prescriptive approach or performance based approach. Prescriptive is used here because full depth porous asphalt is an emerging technology and there are limited density specifications for open graded (porous) asphalt mixtures. But care must be taken to ensure this prescriptive specification is compatible with the acceptance criteria.

D. Spreading and Compacting:

The type of rollers to be used and their relative position in the compaction sequence shall be dictated by the contractor provided the requirements below are met and the completed porous asphalt meets the required quality characteristics specified in Section 1.05. Deviation from the requirements below must be approved in advance by the Engineer.

**1.** The porous asphalt shall be laid in lifts of up to 4 inches in thickness using approved equipment to achieve the total thickness indicated in the Plans.

DESIGNER NOTE: Designer should consider using thinner lifts to the extent practical to ensure better compaction.

**2.** The temperature of the Porous HMA mix during laying, breakdown rolling, and finished rolling, shall be within the supplier-recommended temperature range.

**3.** Breakdown rolling shall be performed with one or two passes of a 7.5- to 10-ton vibratory roller operated in low amplitude mode when the mix temperature is within the supplier-recommended temperature range.

**4.** Finished rolling shall be performed with a double-drum finish roller operated in static mode when the mix temperature is within the supplier-recommended temperature range.

**5.** Finished paving shall be even, without pockets, and graded to elevations shown on the Plans. Finished porous asphalt shall meet the acceptance criteria for Smoothness set forth in Section 1.05.D.

DESIGNER NOTE: Designer should specify details of the straightedge test and tolerance if different than specified in Section 1.05E.

**6.** The Contractor shall take care to insure that the porous asphalt lifts join completely to previous lifts. The Contractor shall keep the time between lift placements to a minimum, keeping the surface of the previous lift clear from dust and moisture between lifts, and restrict traffic from initial lifts until the full depth of asphalt pavement has been placed.

**7.** Sufficient time shall be allowed between lifts to allow the asphalt to set and cool to at or below the supplier recommended maximum temperature for placement of subsequent lifts.

3.05 OPENING TO TRAFFIC

A. After final rolling, no vehicular traffic of any kind shall be permitted on the pavement surface until cooling and hardening has taken place, and in no case within the first six (6) hours. Provide traffic control measures as necessary to prevent vehicular use and remove when no longer required.

3.06 PROTECTION OF PAVEMENT

A. Hardened porous asphalt pavement surface shall be kept clean and free of clogging debris and soils from the Contractor's operations and all upstream and adjacent debris. If debris or soils contaminate the porous pavement voids, the pavement shall be cleaned at the Contractor's expense and to the satisfaction of the Engineer. If porous asphalt pavement cannot be unclogged, it shall be removed and replaced at the Contractor's expense and to the satisfaction of the Engineer.

3.07 REJECTION

A. Porous asphalt that does not meet the acceptance criteria set forth in Section 1.05.E will be rejected by the Engineer. Porous asphalt that has been rejected by the Engineer shall be removed and replaced at the Contractor's expense.

**END OF SECTION**