GREEN INFRASTRUCTURE GRANTS FOR HOMES

September 2023

RESIDENTIAL DESIGN GUIDANCE

Introduction

The following Residential Green Infrastructure Design Guidance are intended to support the San Francisco Public Utilities Commission (SFPUC) Pilot Residential Green Infrastructure Grant Program (Pilot Program). This guide is intended to be a resource for homeowners, designers, and contractors when developing project proposals on behalf of participating homeowners. Please refer to the Residential Green Infrastructure Grant Pilot Program Guidelines for more information on program eligibility and other requirements.

For typical residential green infrastructure design configurations, please refer to the Residential Green Infrastructure Typical Details available at sfpuc.org/programs/grants/green-infrastructure-grants-homes. Non-residential green infrastructure typical details can also be found in the Green Infrastructure Typical Details & Specifications of the San Francisco Stormwater Management Requirements and Design Guidelines.

Projects that infiltrate stormwater into the property's soils will require a Simple Infiltration Test to demonstrate infiltration feasibility and establish the design infiltration rate as outlined in the Geophysical Constraints section below. Infiltrative green infrastructure facilities are projects that collect stormwater runoff from a contributing area and infiltrate stormwater into the subgrade soils, including rain gardens, permeable surface with contributing area, and infiltration trenches.

For more information, please visit sfpuc.org/programs/grants/green-infrastructure-grants-homes where you will find the Program Guidelines and other program materials. If you have questions, please contact us at GIhomes@sfwater.org.

PERMEABLE DRIVEWAY EXAMPLE

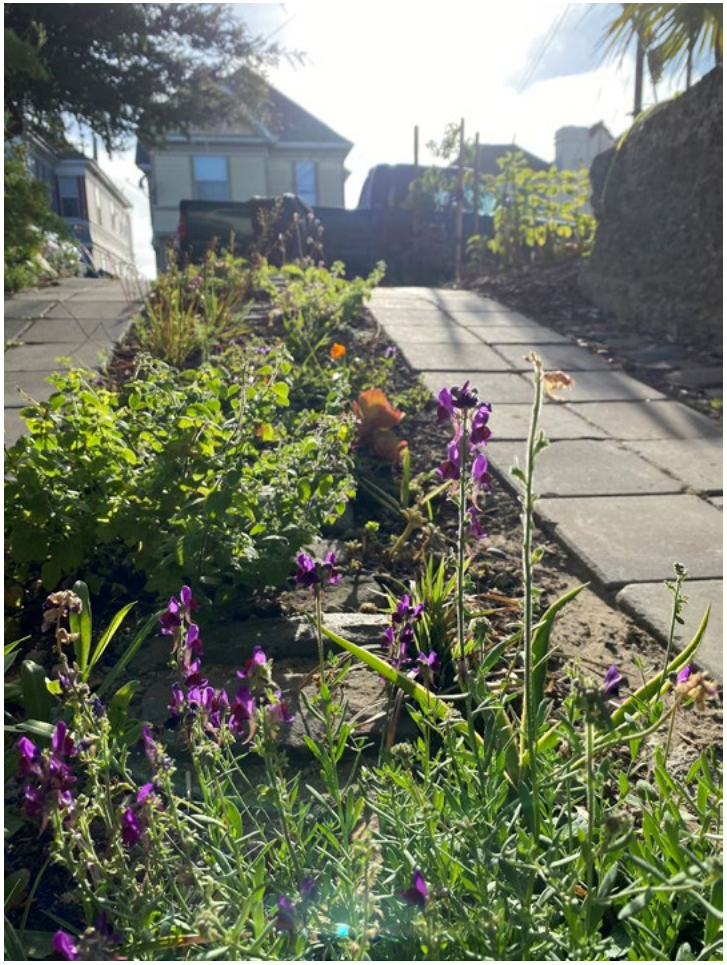


Photo: California Climate Action Now!

General Definitions

Facility - A stormwater managment facility, or “best management practice”, captures, slows down, or infiltrates stormwater runoff. Examples include rain gardens, permeable pavements, and rainwater harvesting cisterns.

DMA - A “drainage management area” is the impermeable area that drains to and is managed by a green infrastructure facility.

Impermeable Surface - A surface that water cannot pass through. Most impervious surfaces are made of hard artificial material such as pavement, concrete, brick, or rooftop.

Permeable Surface - A surface that water can seep through such as soil (unless it is highly compacted).

Aggregate - Coarse or medium grained particulate material like sand, gravel, crushed stone, or geosynthetic material. Small spaces between the material’s grains hold water and allow it to seep through.

Infiltrative Facily - A green infrastructure facility embedded in the ground that has a layer of aggregate below the surface that will capture stormwater so it can seep into the soil below. Three examples of infiltrative facilities are rain gardens, infiltration trenches, and porous pavers/permeable pavement.

Downspout - A pipe that carries stormwater from roof to ground level.

Lateral - A buried pipe that carries stormwater and or sewage to the sewer main below the street.

Swale - A small landscaped trench about 6” deep, in some cases filled with stones, that has a gentle gradient to route runoff into a BMP.

Low Flow Orifice - An opening at a rainwater cistern’s base that allows runoff to slowly drain. Low flow orifices are allowed to drain to another cistern, rain garden, landscaped area/pervious surface, or to a sewer lateral connection. A low-flow orifice may not exceed 0.5” in diameter.

Stormwater Performance Requirement

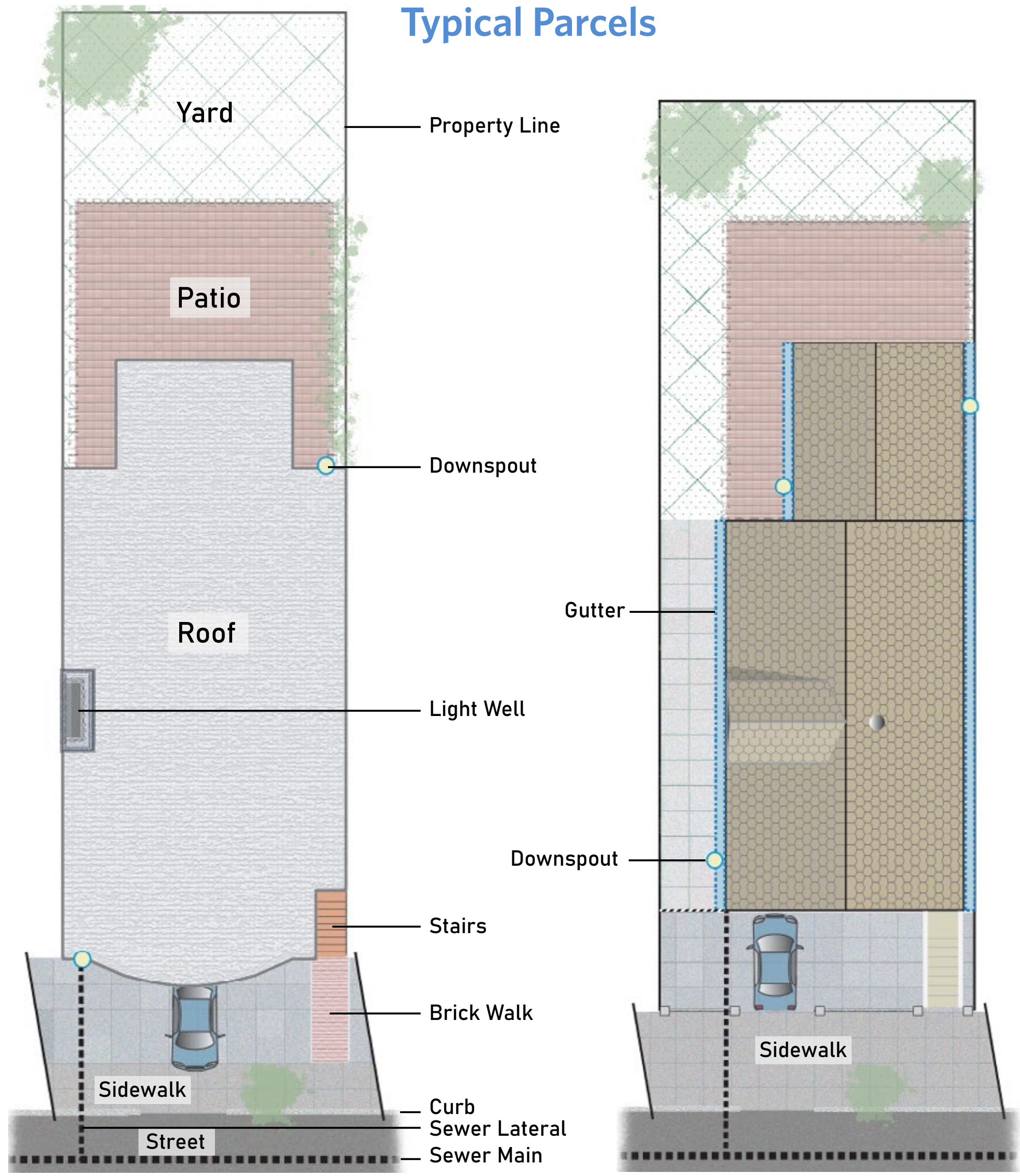
All green infrastructure facilities should strive to capture stormwater runoff from the 90th percentile storm (the design storm), equivalent to a 0.75-inch total depth over the Drainage Management Area (DMA). There is no minimum DMA that must be achieved per residential property, however the contractor selected by the property owner should make their best effort to maximize the DMA of each project and strive to capture a minimum DMA of 500 square feet of impervious surface (i.e., roof, pavement, or other hardscape).

The facility sizing requirement is consistent with the stormwater performance requirement of the SFPUC's large-parcel Green Infrastructure Grant Program (GIGP). The GIGP Performance Calculator can be used as a tool to establish the minimum sizing for various green infrastructure facility types per DMA and soil type. The GIGP Performance Calculator can be downloaded at the following link (http://sfpuc.org/gig-application).

Example Project Types

The following guidance provides examples of green infrastructure configurations for two typical residential parcel sizes in San Francisco. For example detailed construction drawings, please refer to the Residential Green Infrastructure Typical Details available at sfpuc.org/programs/grants/green-infrastructure-grants-homes.

Typical Parcels



RAIN GARDENS

Typical System Components

- Disconnection and rerouting of downspout(s) (See Downspout Disconnection and Overflow section for disconnection requirements).
- Subsurface drainage rock layer.
- Bioretention soil layer.
- Minimum 6-inch ponding depth.
- Planting.
- Impermeable Barrier between adjacent foundation if needed (see Geophysical Constraints section for minimum setback requirements).
- Overflow connection, if needed (See Downspout Disconnection and Overflow section for overflow requirements).
- Fully lined rain gardens are not eligible for SFPUC grant funding.
- Underdrains are required at locations with soil infiltration rates <0.5 inches/hour.

Facility Feasibility and Sizing

- Simple Infiltration Test is required to establish feasibility and design infiltration rate.
- Table 1 lists geophysical constraints that limit feasibility for this project type.
- Typical sizing to capture and infiltrate the 0.75-inch design storm:
    - Hydrologic Soil Group (HSG) A Soils: 4% of the contributing roof area.
    - HSG B Soils: 5% of the contributing roof area.

Rain Garden

Photo: Seattle Public Utilities, RainWise Program

Projects can build a rain garden: a vegetated basin that captures stormwater and utilizes plants to soak up and transpire runoff, remove pollutants, and infiltrate stormwater into the soil. Projects may direct roof runoff and/or impervious areas to a rain garden.

RAIN GARDENS

Plant Selection

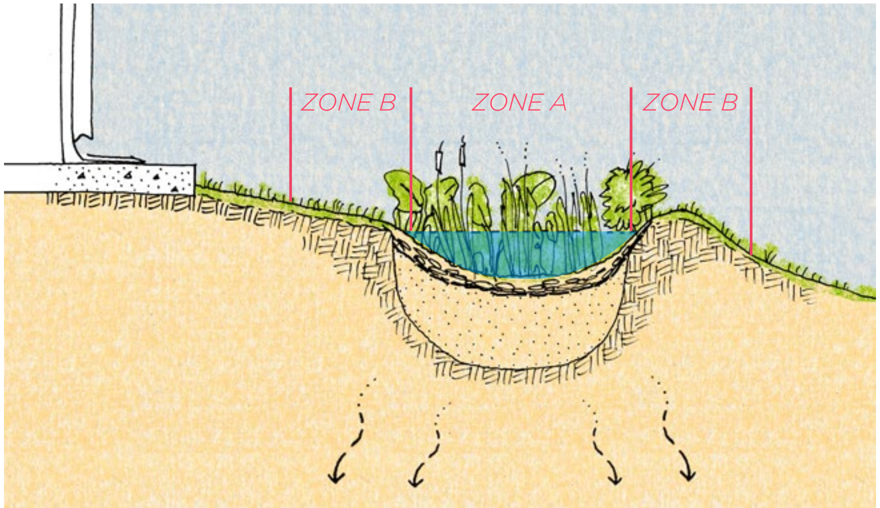
Where possible, native vegetation should be used to provide habitat for local insects, birds, and other species. SF Environment has a list of native plant nurseries in the Bay Area and the SF Planning Green Connections Ecology Guides have recommendations for plants that promote target species.

The plant palette for the lower planting area, or Zone A, should be selected for viability in well-drained soil, as well as periods of inundation during the rainy season. Vegetation for the slopes and edges of the rain garden where soil will remain relatively dry, or Zone B, should be drought-tolerant. All plantings might require irrigation during initial establishment and during the dry season, depending on the application and species used.

Trees can also be incorporated in rain gardens to further reduce stormwater runoff volume through interception and evapotranspiration. Trees also help regulate microclimates through evapotranspiration and by mitigating the effects of solar and heat radiation. In addition to hydrological and microclimatic benefits, trees provide habitat and cultural value.

For additional information about plant selection and water efficient landscapes, refer to San Francisco's Water Efficient Irrigation Requirements, the San Francisco Plant Water Use List, and the SFPUC Vegetation Pallette for Bioretention.

RAIN GARDEN WITH INUNDATION ZONES



ACHILLEA MILLEFOLIUM (YARROW)

Photo: Barbara Eisenstein

RAIN GARDENS

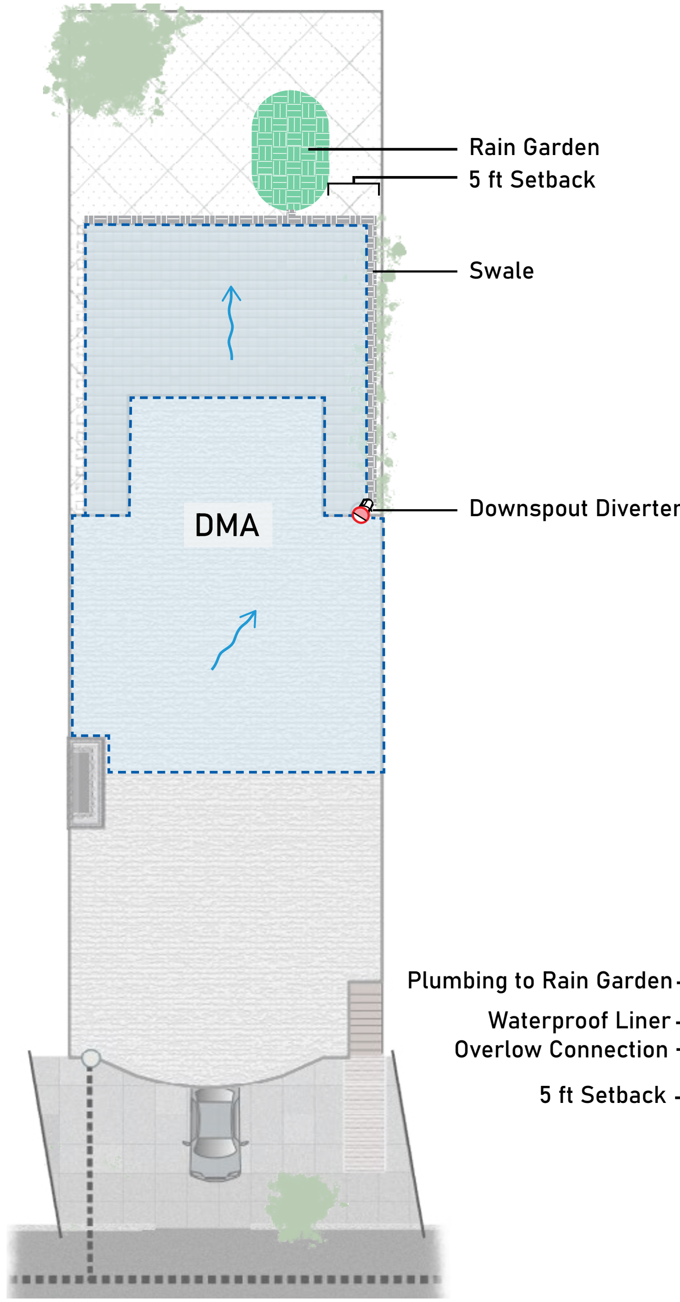
Example 1

The downspout at the back of the house is disconnected and routed into a swale that is dug around the patio to convey runoff from the rear half of the roof and the patio into the rain garden. The rain garden is setback five feet from the property line.

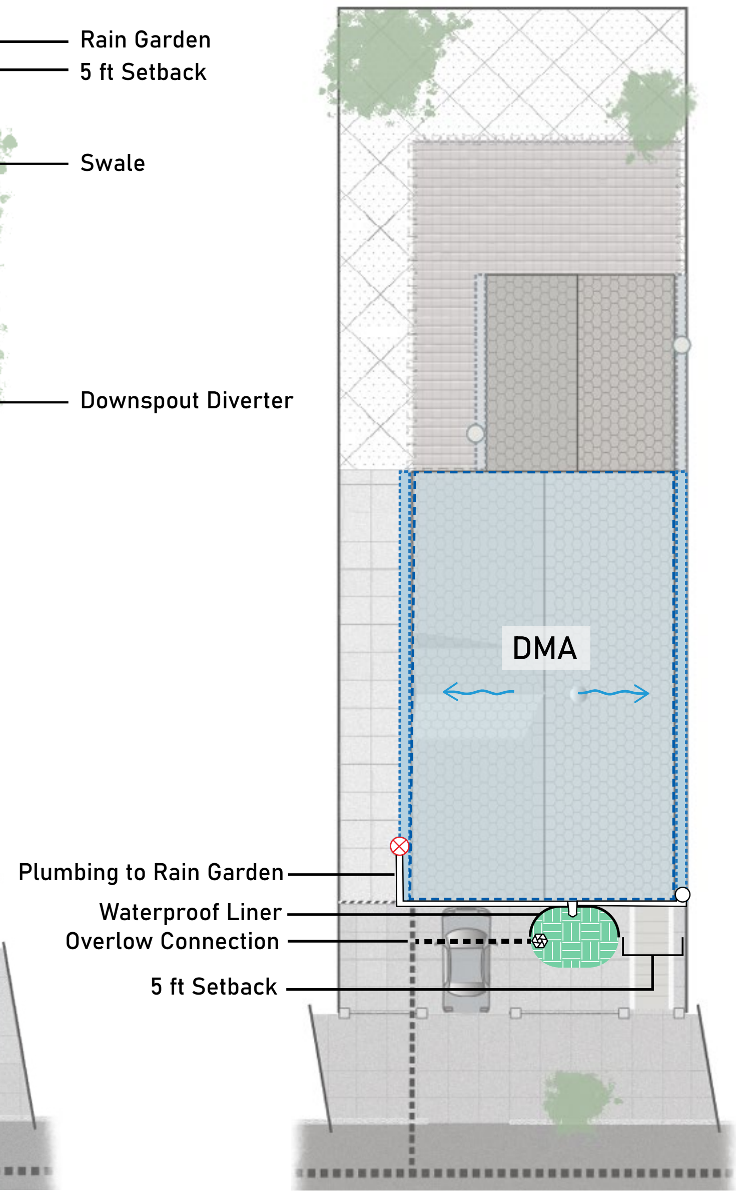
Example 2

The gutter's tilt along the right side of the roof is adjusted so that it drains to the front of the house, where it is piped into the rain garden along with the runoff from the disconnected downspout on the left side of the house. The side of the rain garden that's adjacent to the house has a waterproof liner. A pipe is buried across the driveway to connect the rain garden's overflow to the sewer lateral.

Example 1



Example 2



RAINWATER HARVESTING

Typical System Components

- Full disconnection and rerouting of downspout (See Downspout Disconnection and Overflow section for disconnection requirements).
- First flush diverter and debris screen.
- Cistern
- Low-flow orifice connection to discharge cistern to rain garden, landscape area, or existing downspout/lateral.
- At grade concrete pad or gravel base.
- Overflow connection into existing downspout/ sewer lateral.

Facility Feasibility and Sizing

- Cistern volume below the overflow must be a minimum 0.25 gallons per square foot of contributing roof area.
- Low-flow orifice may not exceed 0.5-inches diameter.
- Must be on a stable, flat area that does not block the path of travel for fire safety access.
- If possible, cisterns should be opaque and placed in cool, shaded area or underground to avoid algal growth.
- Refer to the San Francisco Rainwater Harvesting Manual for additional information.

Rainwater Harvesting System

Projects can install a tank or cistern that collects roof runoff and stores it for indoor or outdoor uses such as irrigation. Roof runoff can be directed to a cistern to capture and detain the design storm volume, and release runoff volume through a low-flow orifice.

RAINWATER HARVESTING

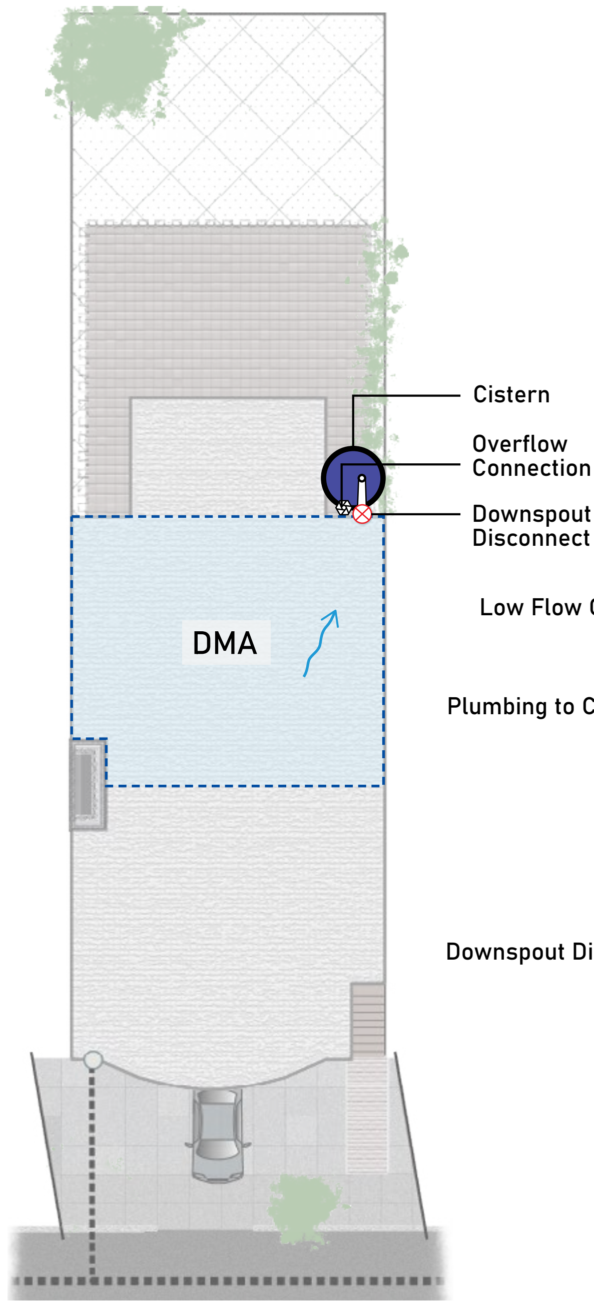
Example 1

Runoff from the back half of the roof area is routed into a rainwater cistern located beside the patio by disconnecting the downspout. The cistern has an overflow connection back to the existing downspout.

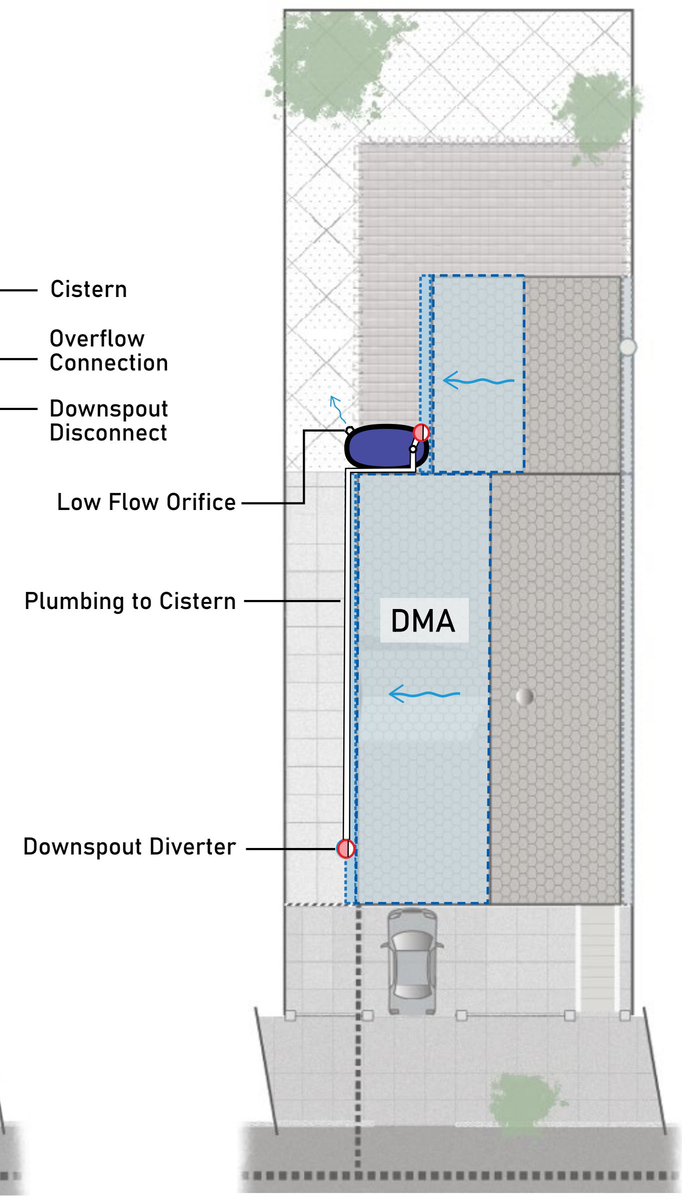
Example 2

Downspout diverters are installed on both downspouts on the left side of the house to divert low flows coming from the left side of the roof to the rainwater cistern located at the corner of the patio beside the beginning of the backyard. The cistern has a low flow orifice that drains onto the yard's grass.

Example 1



Example 2



PERMEABLE PAVEMENT

Typical System Components

- Removal of existing hardscape and subgrade.
- Scarification/decompaction and regrading of subgrade.
- Disconnection and rerouting of downspout(s) to subgrade (if applicable, see Downspout Disconnection and Overflow section for overflow requirements).
- Permeable Pavement/Concrete/ Pavers.
- Leveling course and base course.
- Drainage rock storage layer.
- Check dams (if applicable, see Geophysical Constraints section for additional information).

Facility Feasibility and Sizing

- Drainage rock storage layer must comply with minimum material thickness outlined in the SFPUC's GI Standard Details.
- If disconnecting and rerouting downspout:
  - Simple Infiltration Test is required to establish feasibility and design infiltration rate.
  - Drainage rock storage layer must be sized for the 0.75-inch design storm.
  - Refer to Table 1 for geophysical constraints that limit feasibility.

Permeable Pavers

Photo: Oakland Press, Porous paving options catch on, one driveway at a time

Projects can remove existing site hardscape and replace with permeable pavement (a porous load-bearing surface such as pavement, pavers, concrete) to capture, infiltrate, and remove pollutants from runoff. Roof runoff can be rerouted to the subsurface storage layer to collect runoff from roof area (contributing impervious area).

PERMEABLE PAVEMENT

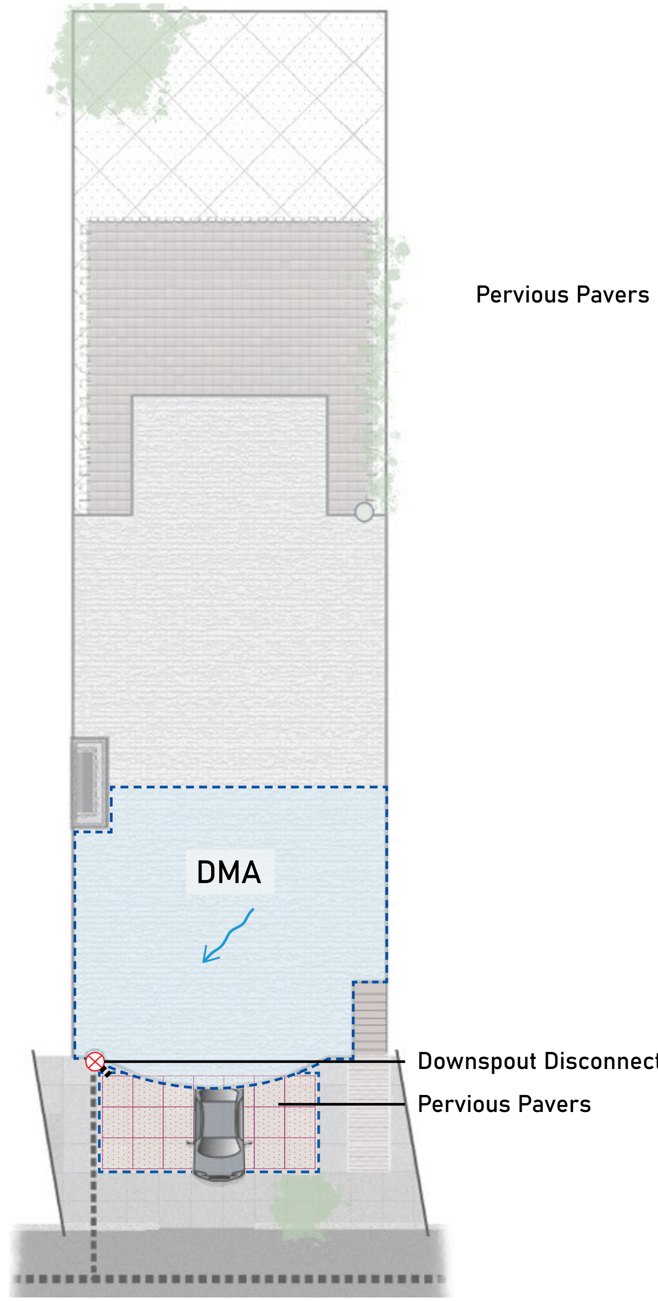
Example 1

The back section of the patio is replaced with pervious pavers to convert it to a pervious surface, and the surface of the driveway is replaced with porous load-bearing pavers. A layer of drainage rock is installed below the porous pavers so that it can manage a larger DMA including the front half of the roof while still effectively infiltrating runoff to the ground below. The downspout beside the garage is disconnected at grade and piped into the drain rock below the porous pavers.

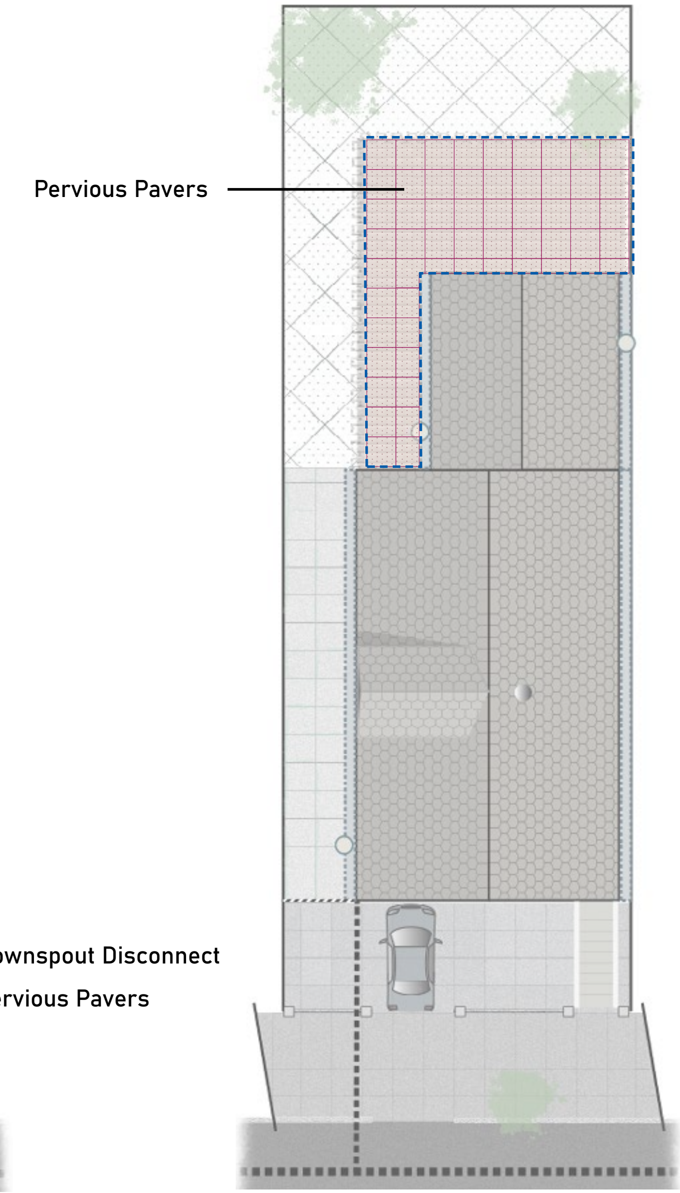
Example 2

The back section of the patio is replaced with pervious pavers to convert it to a pervious surface.

Example 1



Example 2



INFILTRATION TRENCHES

Typical System Components

- Disconnection and rerouting of downspout(s) (see Downspout Disconnection and Overflow section for disconnection requirements)
- Drainage rock storage layer
- Geotextile Fabric
- Topsoil
- Overflow connection, if needed (see Downspout Disconnection and Overflow section for disconnection requirements)

Facility Feasibility and Sizing

- Simple Infiltration Test is required to establish feasibility and design infiltration rate
- Refer to Table 1 for geophysical constraints that limit feasibility
- Typical sizing to capture and infiltrate the 0.75-inch design storm based on 24-inch drainage rock depth4:
    - HSG A Soils: 6% of the contributing impervious area
    - HSG B Soils: 6.5% of the contributing impervious area

Infiltration Trench

Photo: Flows to Bay, San Mateo Countywide Water Pollution Prevention Program

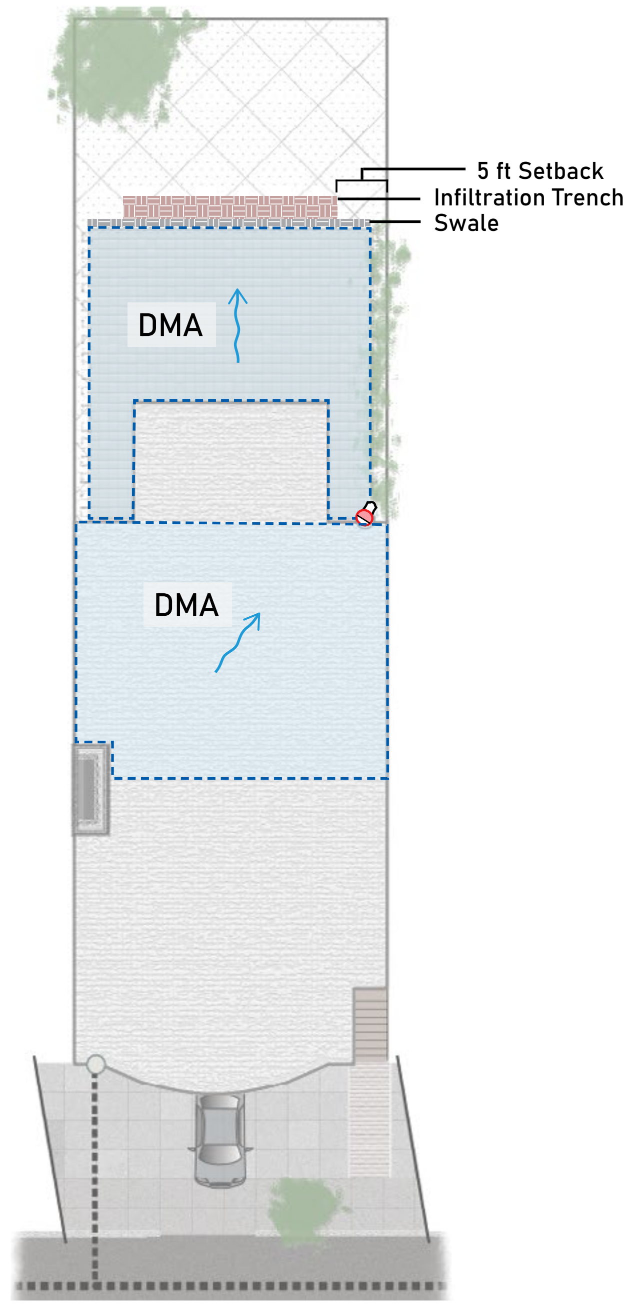
Projects can direct stormwater runoff from hardscape and/or roofs to an infiltration trench: a rock-filled trench that receives and infiltrates stormwater runoff to capture, infiltrate, and remove pollutants from runoff. Infiltration trenches may be an unvegetated trench on the surface or may be entirely buried.

INFILTRATION TRENCHES

Example 1:

A swale is dug along the back edge of the patio to collect the patio's runoff and direct it into the infiltration trench. The infiltration trench is istalled with a setback 5 ft from the property line, and is buried below the swale and the yard.

Example 1



FACILITY COMBINATIONS

Multiple green infrastructure facilities can be installed in sequence to manage runoff from the same DMA, which allows each BMP to be sized smaller than they would otherwise need to be if they were treating the same DMA individually.

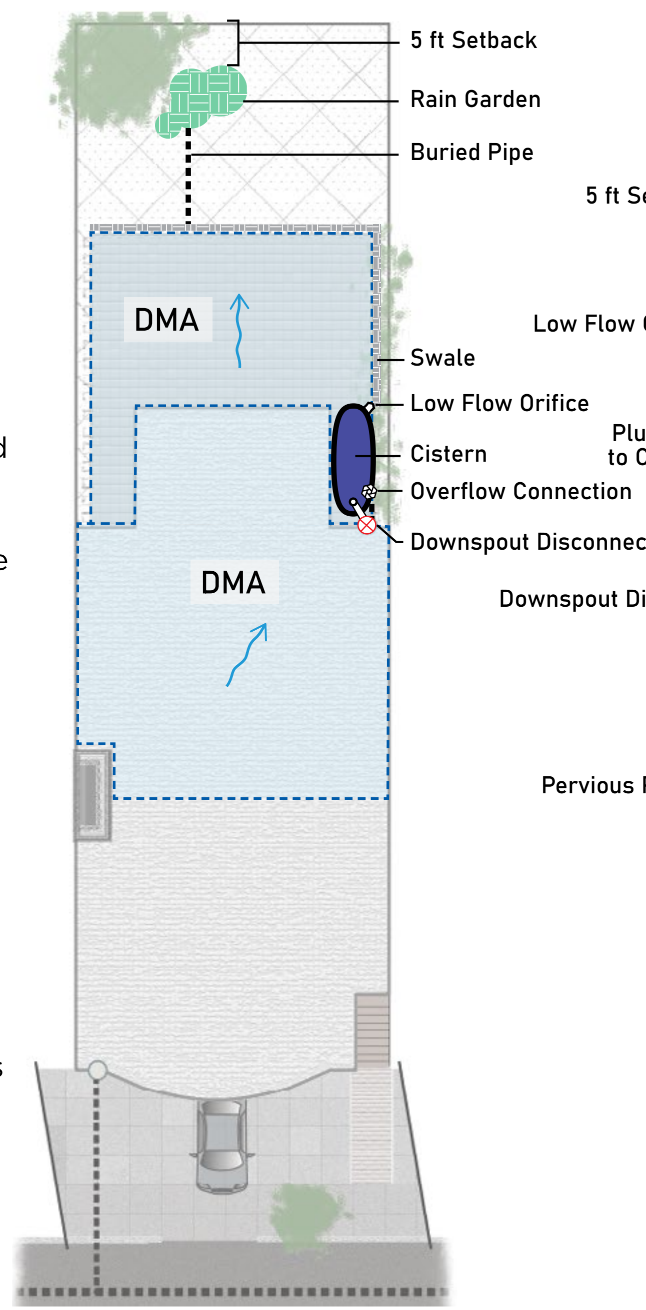
Example 1

The rear downspout is disconnected and routed into a rainwater cistern, which has an overflow connection back to the sewer lateral at the base of the disconnected downspout. The cistern's low flow orifice may discharge to a narrow swale filled with drain-rock which collects runoff from the patio and drains to a rain garden via pipe buried under the yard.

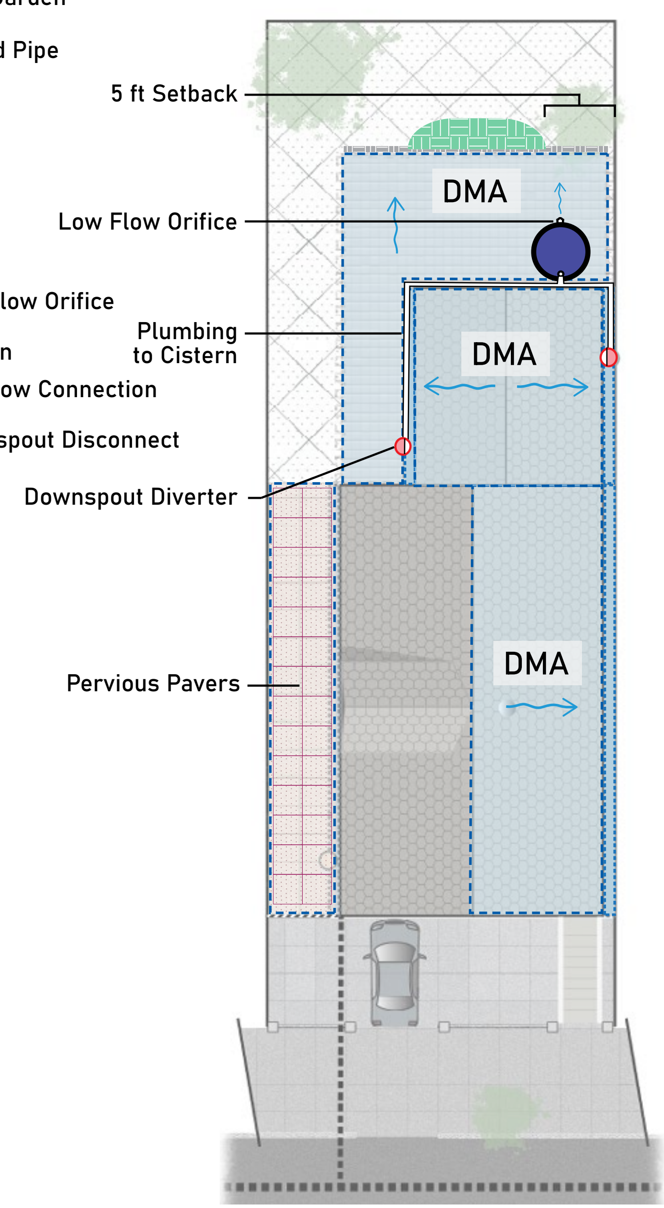
Example 2

The concrete walkway beside the house is replaced with pervious landscaping to reduce impervious area. Downspout diverters are installed at both downspouts on the home's rear addition to divert runoff from the entire right side of the roof and the left side of the rear addition's roof into a rainwater cistern. The cistern has a low flow orifice that can drain across the patio. A swale is installed along the back edge of the patio to direct all patio runoff into the rain garden. Because only low flows from the roof areas are directed into the cistern and rain garden, they do not need an overflow connection to the sewer lateral.

Example 1



Example 2



Geophysical Constraints

The feasibility of infiltrative green infrastructure facilities on residential parcels is based on the property's geophysical conditions. The SFPUC has assessed residential site conditions through a Desktop Analysis that uses available GIS data and other resources to determine depth to groundwater and bedrock, site slopes, seismic hazard areas, Maher areas (soil contamination), and distance to surrounding structures. In-situ geotechnical investigation, such as a Simple Infiltration Test, is required to determine site conditions and infiltrative facility feasibility, as the Desktop Analysis provides a high-level summary of expected conditions based on available data and actual site conditions may vary. A map of San Francisco's soil types and other factors is available at ArcGIS Web Application.

In general, facilities that infiltrate stormwater from a contributing impervious area (i.e., rain gardens, permeable pavement managing roof runoff, or infiltration trenches) have the following design constraints:

- Infiltrating facilities should not be installed on sloped areas exceeding 5%.
- Infiltrating facilities should not be installed in contaminated area (Maher Area) or seismic risk zones (Liquefaction Zones, Landslide Zones).
- Infiltrating facilities without an underdrain should not be installed in soils with low-infiltrative soils (less than 0.5 inches/hour, after the correction factor [CF]):
    - Perform a Simple Infiltration Test in or near the proposed BMP location, minimum of one per parcel. Refer to the SFPUC's Infiltration Testing Guidance for more information.
- Infiltrating facilities must provide a 4-foot minimum vertical separation from base of the facility to bedrock.
- Infiltrating facilities must provide a 4-foot minimum vertical separation from base of the facility to seasonal high groundwater in all Bayside groundwater basins; 10-foot minimum vertical separation from base of facilities to seasonal high groundwater in the Lobos and Westside groundwater basins, with the potential for reduction to 4-foot separation with SFPUC approval. A map of San Francisco's groundwater basins is available at ArcGIS Web Application.
- Infiltrating facilities must meet the setback requirements described in Appendix C of the SFPUC Stormwater Management Requirements and Design Guidelines including a 5-foot setback from property lines and a 10-foot setback from upgradient foundations.

See Table 1 for a summary of design guidelines for each facility type.

Table 1: Geophysical Constraints on Feasibility of Green Infrastructure Types

Green Infrastructure Facility Type	Groundwater or Bedrock Separation less than 4 feet	Slope greater than 5%	Maher Area	Liquefaction or Landslide Hazard Zone	Design Infiltration Rate less than 0.5 inches per hour	Setback to foundation or property line less than Required Setback
Rain Garden	Not Feasible	Not Feasible	Additional study required	Geotechnical engineer approval required	Underdrain required	Geotechnical engineer approval required
Rainwater Harvesting Cistern	Feasible	Feasible	Feasible	Feasible	Feasible	Feasible
Impervious Surface Removal and Replacement with Permeable Pavement	Feasible	Feasible up to 10% slope	Feasible	Feasible	Feasible	Feasible
Impervious Surface Removal and Replacement with Permeable Pavement (with Contributing Roof Area)	Not Feasible	Feasible up to 10% slope with check dams in drainage layer for subgrade slopes >2%	Additional study required	Geotechnical engineer approval required	Not Feasible	Geotechnical engineer approval required
Infiltration Trench	Not Feasible	Not Feasible	Additional study required	Geotechnical engineer approval required	Not Feasible	Geotechnical engineer approval required

Downspout Disconnection and Overflow

There are two approved methods to route roof runoff to green infrastructure facilities: the low-flow downspout diversion method or the downspout disconnection and overflow method. Each are described below. The method selected should be determined based on site conditions and constraints such as downspout location(s), downspout conditions, sewer lateral location and elevation, and facility location(s) and elevation(s).

Low-flow Downspout Diversion: The downspout diversion method diverts low flows (i.e the design storm flows) into the facility and bypasses larger flows through the existing downspout/sewer lateral. This configuration does not require an overflow connection from the facility back to the existing downspout/sewer lateral as there should be no overflow from the facility in larger storm events. There are two approved methods for providing downspout diversion:

- Prefabricated Downspout Diverter (e.g. EarthMinded FlexiFit Diverter): Install the diverter in an existing downspout, divert low flows to the green infrastructure facility.
- Rain Barrel to Facility: Connect downspout to a rain barrel with a low-flow orifice at the bottom of the barrel sized to divert the design storm to the green infrastructure facility. Connect overflow from the rain barrel back to existing downspout/sewer lateral.

Full Downspout Disconnection and Overflow: The downspout disconnect method disconnects the existing downspout from the existing sewer lateral and reroutes the downspout to the facility. The sewer lateral is plugged at grade where the downspout was disconnected. An overflow structure within the facility connects back into the existing sewer lateral or other site drainage infrastructure.

REROUTING RUNOFF FROM YOUR DOWNSPOUT TO A FACILITY

Locating Your Downspout

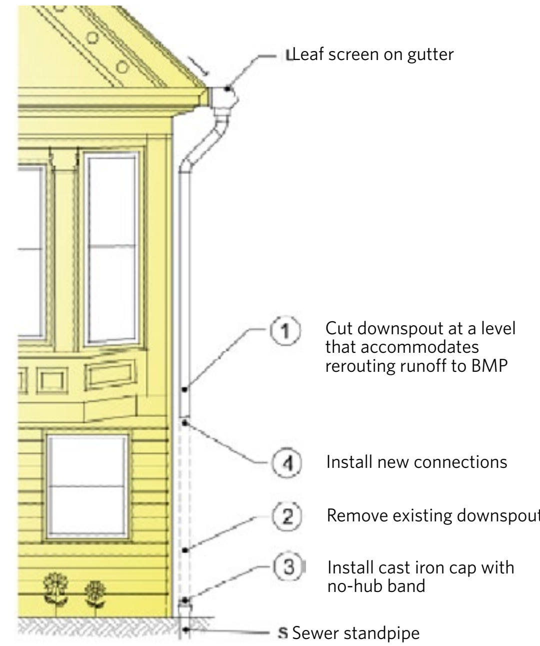
- The number of downspouts and their locations vary house-to-house.
- For houses with angled roofs, stormwater is usually collected by gutters. In these cases, downspouts connect to the gutter and are most often external to the home.
- For houses with flat roofs, stormwater is usually collected by an area drain at the rooftop's lowpoint. In these cases, downspouts are usually internal to the home beginning at the drain.
- Many downspouts are on the street-side of the building with no easy route to a backyard facility, and many are located inside a house's walls. These situations may require site-specific solutions and consultation with a plumbing professional.

Scenarios & Solutions

- Buildings with garages below street grade often have the downspout connecting to sewer laterals on the ceiling of the garage. Downspout(s) can be disconnected there and routed to the desired location.
- If a downspout is within a building's wall but near the location of the facility, the wall can be opened to access the pipe.
- If a downspout is located within a building's wall but at an inaccessible location, it might be possible to cap the top of the downspout at roof level and redirect rainwater to a new downspout.

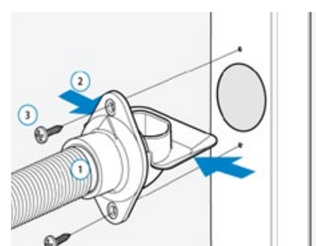
Option 1: Downspout Disconnect

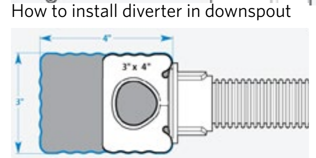
- The downspout is fully disconnected from the sewer lateral so that 100% of the runoff it collects is rerouted into a facility.
- The lower section of a disconnected downspout should be cut near the ground and sealed with a cast iron pipe cap with a no-hub band to prevent sewer gases from escaping or sewage backing up and overflowing through the cut pipe.
- The facility that the disconnected downspout runoff is directed into must have an overflow structure that connects back to the existing downspout or a sewer lateral.



Option 2: Downspout Diverter

- A simple device that is installed in the downspout to divert low flows into a facility, while larger flows from more intense storms bypass the diverter into the sewer lateral.
- The example pictured to the right is a FlexiFit diverter made by EarthMinded.


How to install diverter in downspout


Cross-sectional view of diverter in downspout


Downspout diverter routing runoff into a rainwater cistern