



GREEN INFRASTRUCTURE TOOLKIT

GUIDANCE DOCUMENT, 2024



**Resilience +
Sustainability**

CITY OF NEW ORLEANS

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SECTION 1: INTRODUCTION

PURPOSE OF THE TOOLKIT

The City of New Orleans (CNO) and the Sewerage and Water Board of New Orleans (SWBNO) are developing a city-wide integrated and comprehensive stormwater management strategy through a collaborative approach exhibited by CNO and SWBNO initiatives. These include the CNO's Resilience Strategy, the Hazard Mitigation Grant Programs Grey/Green Infrastructure Upgrades, the MS4 Partnership, and road reconstruction programs which include coordination with the Louisiana Department of Transportation and Development (DOTD).

This strategy generally seeks to reduce peak runoff from major storm events to reduce localized flooding, recharge groundwater, reduce subsidence, and filter pollutants from runoff water. In order to implement the strategy, the CNO and SWBNO intended to design and construct green infrastructure (GI) in targeted locations through the city, as well as enforce CNO's Building Code regulations on private development sites. GI projects use vegetation, soils, and natural processes to manage stormwater and create healthier urban environments. The above bodies seek to have a common set of standard design details for frequently used GI facilities in order to guide public and private implementation of stormwater management. Accompanying the design details are the supplemental specifications and this guidance document, which includes descriptions of the green infrastructure types, design considerations, maintenance needs, and sample life cycle costs.

TERMINOLOGY

The terminology used to describe green infrastructure has evolved over time and can vary from one location to another. The terminology used within the Toolkit is defined below along with other similar or related names for these concepts.

- **Bioretention Cell:** Defined land area planted with water tolerant plants. A bioretention cell is designed to detain stormwater and allow for both infiltration and filtration.
 - » Similar terminology: rain garden
- **Bioswale:** Shallow channel with side slopes that use plants to slow stormwater and filter pollutants. A bioswale differs from a bioretention cell in that a bioswale also conveys stormwater.
 - » Similar terminology: urban bioswale
- **Detention Basin:** Used to detain large volumes of stormwater during rain events. The basin collects runoff and then slowly discharges the stormwater into the municipal drainage system to reduce peak flow and allow time for sediments, suspended solids, and other pollutants to settle.
 - » Similar terminology: Dry detention basins, dry ponds
- **Green Infrastructure:** Stormwater management facilities that mimic the natural water cycle. The term encompasses a wide array of stormwater management practices.
 - » Similar terminology: Low impact development (LID), best management practices (BMPs), green stormwater infrastructure (GSI)
- **Filtration:** The process whereby pollutants carried in stormwater runoff are removed by plants and soil microbes before stormwater enters the municipal drainage system.
 - » Similar terminology: decontamination, cleansing
- **Infiltration:** The process whereby stormwater seeps into the ground to recharge groundwater and reduce soil subsidence.
 - » Similar terminology: groundwater recharge, percolation

- **Infiltration Trench:** An aggregate filled trench that stores and conveys stormwater.
 - » Similar terminology: French drain
- **Pervious Pavement:** A form of paving that allows stormwater runoff to vertically move through the pavement, its base, and subbase materials, storing stormwater to facilitate infiltration and slowed discharge.
 - » Similar terminology: porous pavement, permeable paving
- **Retention Basin:** An excavated area that maintains a permanent pool of water while accommodating temporary stormwater storage above the permanent water level.
 - » Similar terminology: wet detention basin, wet pond
- **Stormwater Planter:** A bioretention cell that is contained by hard edges and is typically above ground or partially above ground.
- **Suspended Pavement Systems:** A structure which supports the weight of pavement while preventing the compaction of soils beneath the pavement. The soil contains void space for tree roots and stormwater runoff storage.
- **Tree Cell:** A structure that uses a modular suspended pavement system that provides subsurface space for uncompacted soil, water, and air. Use of tree cells results in healthier trees.

USING THE TOOLKIT

The Toolkit is a guidance document that provides minimum standards and consistency across GI designs within the City of New Orleans. The Toolkit is not intended to provide a final design as each installation has unique site considerations requiring the Design Professionals to modify the Toolkit details accordingly. The Toolkit is intended to broaden the application of GI by providing an agency approved starting point.

Components of the Toolkit include:

- **Guidance Document**
 - » The guidance document provides a brief overview of green infrastructure and contains more detailed information for eight different GI types.
- **Typical Details**
 - » Typical details are provided for the eight green infrastructure types and their associated components.
- **Supplemental Specifications**
 - » Supplemental text to incorporate into technical specifications.
- **Planting List**
 - » A list of acceptable plants. GI plant material selection is not restricted exclusively to this list. Plants must be selected based on specific site conditions, plants' role in the function of GI, planting design intent, capacity of owner's maintenance staff, and owner preferences. Native plants are preferred in GI facilities as they are better adapted to local conditions.
- **Stormwater Calculator**
 - » An Excel based tool to calculate storage volume requirements, estimate water pollutant removal performance by GI, and to facilitate review by City staff.

SECTION 2: GREEN INFRASTRUCTURE OVERVIEW

Integrating GI into a highly developed area such as the city of New Orleans requires both creativity and a strategic approach to planning and design. This section provides an overview of items to be considered when designing any type of GI facility within the CNO.

SITE INFORMATION

The following site information should be collected prior to designing GI facilities:

Utility Locations

All existing utilities near the proposed GI must be located and identified prior to the design of GI facilities. Interference with existing utilities should be avoided whenever possible. When utilities cannot be avoided or relocated, a utility sleeve, anti-seep collar, or impermeable barrier may be utilized to protect the utility when extending through or near a GI installation. When proposing GI features near utility poles, access to the pole by utility workers must be maintained. When utilities are to be disturbed and/or interfered with, coordination must occur with appropriate agencies.

Specific considerations include:

- **Drainage systems:** the GI will become part of the overall stormwater drainage infrastructure. The method by which it connects to piping, swales, gutters, catch basins, inlets, manholes, and outlets is critical in the design.
- **Traffic control:** Avoid locating GI near traffic control features.
 - » Permanent signage such as stop signs, parking signs, etc. may be allowed within a GI feature so long as the location of the post does not conflict with the performance of the GI.
 - » The design of permanent traffic control signs within a GI Facility will need to be reviewed by the Traffic Division of DPW.
 - » When proposing GI in close proximity to traffic signals or stop signs, maintain sight distance to the traffic control.
- **Lighting:** When proposing GI near street wooden light poles, maintain offset from the base of the pole whenever possible to avoid the potential for the pole to rot.
 - » GI facilities shall not be installed in an area with electrical control panels, meter settings, or electrical conduit pull boxes.
- **Electrical:** GI shall not be installed within 10 feet of any underground electrical feature which carries current, such as electrical conduit. Below ground electrical crossings are not permitted in GI areas and it is recommended that the utilities be relocated outside of the GI.
- **Communications:** when proposing GI facilities near buried communication lines, the use of a utility sleeve or impermeable barrier may be required.

Utility Coordination

Designers shall coordinate with City agencies and utility companies when designing GI facilities. For any green infrastructure work within the public right-of-way, coordinate with agencies such as DPW, SWBNO, Parks and Parkways, and the Department of Safety and Permit. Designer may also need to coordinate with utility agencies such as AT&T, Cox Communications, and/or Entergy.

Existing Vegetation

When implementing GI near existing trees or other vegetation, measures to preserve and protect the existing vegetation during construction shall be employed. Existing trees that are to remain on site should be protected by identifying their critical root zones. A licensed arborist or landscape architect should evaluate the trees and recommend whether the tree is healthy, non-invasive, and of an appropriate species, as well as what measures shall be taken to preserve and protect them.

DESIGN CONSIDERATIONS

The following are general design considerations for all green infrastructure facilities:

- **Size:** The stormwater calculator provides the required volume of storage for sites where a stormwater management plan is required.
- **Location:** The location of a GI facility must consider the existing and proposed stormwater runoff and drainage patterns of the site. Siting of GI facilities shall maximize the captured flow and minimize the volume of stormwater runoff which bypasses the GI facility.
- **Components:** Common design components for GI facilities include, stormwater inlets, energy dissipation mechanisms, stormwater outlets and overflows, planting, soils, mulch, pervious paving, storage media, piping.

All pedestrian facilities shall comply with all applicable Americans with Disabilities Act standards and guidance.

SECTION 3: BIORETENTION CELLS

Bioretention cells are used to collect and detain stormwater runoff and allow for both infiltration and filtration. Bioretention cells provide both surface and subsurface storage. The name “bioretention” refers to the biological processes that plants use to uptake and retain pollutants in their vascular system, as well as soil microbes that capture and break down pollutants.

WHERE TO USE

Bioretention cells can be used in parking lot islands, street basins (also known as curb extensions or bulb outs), plazas, and other open spaces. Bioretention cells can be designed in any size and any shape, so they can be located almost anywhere.

DESIGN CONSIDERATIONS

- Bioretention cell size is determined by the catchment area and the volume of water it must manage.
- Length and width can vary substantially and are determined by the site limitations and the design intent.
- Depth of the subsurface materials can vary based on the volume of water, above ground storage depth, and subsurface conditions.
- Stormwater runoff can flow into a bioretention cell by the way of sheet flow, gaps in hardscape (curbs, etc.), bioswales, trench drains, and pipes that connect to other GI facilities or the storm drainage system.
- Bioretention cells shall have overflow structures and underdrain(s) to avoid relying solely on infiltration into subsurface soils and water uptake by plants.
- Step out zones are required where street parking is provided. Installation may include pavers, concrete, turf, gravel, pervious pavement, or other material based on the surrounding site conditions.
- Step out zones are not required where there is no on street parking required.
- Refer to the GI Toolkit typical details for design considerations and layout.



*Bioretention cell in a parking lot island; New Orleans, LA
Photo courtesy of Dana Brown & Associates*



*Bioretention cell in a park; Metairie, LA
Photo courtesy of Dana Brown & Associates*



*Bioretention cell in a street basin; Gretna, LA
Photo courtesy of Dana Brown & Associates*

BIORETENTION CELL MAINTENANCE REQUIREMENTS

During the establishment period of bioretention cell plantings, enough water must be provided to the plants so that they do not suffer from transplant shock. As the bioretention cell plants become established, watering can be discontinued and general maintenance reduced. The establishment period is defined as 12 months of growing season after the plants are installed.

Bioretention cells require regular removal of invasive species, weeds, and debris, as well as regular mulching. During regularly scheduled maintenance, inlets and outlets must be visually inspected for blockages and when standing water is present for more than 48 hours after a rainstorm has ended.

Operations and Maintenance Activities for Bioretention Cells

Activity	Schedule
<ul style="list-style-type: none">• Debris removal• Watering & weeding during establishment• Visual inspection of inlets & outlets	Weekly
<ul style="list-style-type: none">• Weeding• Removal of silt build up at inlets	Monthly
<ul style="list-style-type: none">• Mulching	Twice Annually
<ul style="list-style-type: none">• Regrading of eroded areas• Pipe and outlet inspection and clean out• Replacing plants as needed	Annually

BIORETENTION CELL COST

The construction cost for a typical installation of a bioretention cell is detailed below. The cost includes design, construction, and permitting. Costs are based on the value of the dollar (USD) in 2024 and are based on bioretention cells constructed in the New Orleans area.

Description of Typical Installation

For the purpose of comparing costs, the following assumptions are for a 360 square foot bioretention cell that is fully planted. This size is representative of a bioretention cell located in a T-end cap in a parking lot (9' W x 40' L).

Construction assumptions include:

- Cutting gaps into existing curbs
- Tying into an existing catch basin
- 3" of freeboard
- 8" of soil depth
- 3" of filter aggregate
- 12" of storage aggregate

The stormwater storage capacity for this typical bioretention cell installation is 363 cubic feet.

The total cost per cubic foot of storage is roughly \$80.

BIORETENTION CELL				
Example Construction Cost for a Bioretention Cell				
Item	Qty.	Unit	Unit Cost	Total Cost
Site Preparation				
Curb cuts	2	LF	\$ 8	\$ 16
Soil excavation & haul	29	CY	\$ 45	\$ 1,305
Site grading	40	SY	\$ 5	\$ 200
GI Components				
Filter Aggregate	4	CY	\$ 190	\$ 760
Storage Aggregate	14	CY	\$ 140	\$ 1,960
Geotextile Fabric	70	SY	\$ 5	\$ 350
Splash Block	2	EA	\$ 200	\$ 400
Energy Dissipation Material	1	CY	\$ 160	\$ 160
Catch Basin Tie In	1	EA	\$ 560	\$ 560
Pervious Pipe (6")	40	LF	\$ 40	\$ 1,600
Stand Pipe	1	EA	\$ 600	\$ 600
Planting Materials				
Soil	9	CY	\$ 175	\$ 1,575
Trees (2" cal.)	2	EA	\$ 800	\$ 1,600
Mulch (3" depth)	40	SY	\$ 10	\$ 400
Shrubs (3 gal.)	110	EA	\$ 45	\$ 4,950
Subtotal				\$ 16,500
Contingency			30%	\$ 5,000
Contractor Overhead & Profit			15%	\$ 3,300
Design			15%	\$ 3,800
Permitting			2%	\$ 500
Total*				\$ 29,100

*rounded up to the nearest \$100

These prices may vary at the time of purchase/construction.

SECTION 4: BIOSWALES

Bioswales are used to collect, slow, and convey stormwater runoff while allowing for infiltration and filtration. Bioswales provide both surface and subsurface storage and are used to convey stormwater runoff from one area toward an outlet.

WHERE TO USE

Bioswales are linear features to convey water to an outlet from one GI facility to another, thus creating a stormwater treatment system. Bioswales can be used across a broad range of project types, from green spaces (parks, ball fields, and rights-of-way) to paved areas (plazas, parking lots, and roadways). Bioswales can also be used along streets where linear spaces are available and conveyance of stormwater is needed.

DESIGN CONSIDERATIONS

- The width of the bioswale is limited by the space available and the design intent.
- Edges of bioswales may be defined by turf grass, concrete, modular pavers, or other hard materials.
- Curbs can define the edges of bioswales along streets. Small gaps in the curb that occur at regular intervals allow runoff from the impervious pavement to enter along the length of the bioswale.
- Refer to the GI Toolkit typical details for design considerations and layout.



*Bioswale along a building & sidewalk; New Orleans, LA
Photo courtesy of Dana Brown & Associates*



*Bioswale in a parking lot; New Orleans, LA
Photo courtesy of Dana Brown & Associates*



*Bioswale in a parking lot; Baton Rouge, LA
Photo courtesy of Dana Brown & Associates*

BIOSWALE MAINTENANCE REQUIREMENTS

During the establishment period, plants in a bioswale must be provided with enough water to minimize transplant shock. As the plants in the bioswale become established, watering can be discontinued and the general maintenance will be reduced. The establishment period is defined as 12 months of growing season after the plants are installed.

Bioswales require regular removal of invasive species, weeds, and debris as well as regular mulching and watering during periods of drought. During regularly scheduled maintenance, inlets and outlets must be visually inspected for blockages and when standing water is present for more than 48 hours after a rainstorm has ended.

Turf swales are different from bioswales as they provide minimal filtration of pollutants from stormwater runoff. Infiltration of the runoff into the subsurface soils is also limited because of the shallow root depth of the turf grass. If using a turf swale, then mowing will be a recurring maintenance line item. Turf grass will require watering until the seeds or sprigs are established and during periods of drought.

Operations and Maintenance Activities for Bioswales

Activity	Schedule
<ul style="list-style-type: none">• Debris removal• Watering & weeding during establishment• Mowing turf grass (if applicable)• Visual inspection of inlets & outlets	Weekly
<ul style="list-style-type: none">• Weeding• Removal of silt build up at inlets	Monthly
<ul style="list-style-type: none">• Mulching (if applicable)	Twice Annually
<ul style="list-style-type: none">• Regrading of eroded areas• Pipe and outlet inspection and clean out• Replacing plants as needed (if applicable)• Reseeding turf grass (if applicable)	Annually

BIOSWALE COST

The construction cost for a typical installation of a bioswale is detailed below. The cost includes design, construction, and permitting. Costs are based on the value of the dollar (USD) in 2024 and are based on bioswales constructed in the New Orleans area.

Description of Typical Installation

For the purpose of comparing costs, the following assumptions are for a 400 square foot bioswale that is fully planted. This size is representative of a bioswale located in the buffer yard of a parking lot that has 10 spaces (4' W x 100' L).

Construction assumptions include:

- Cutting gaps into existing curbs
- Tying into an existing catch basin
- 3" of freeboard with sloped edges
- 8" of soil depth
- 3" of filter course depth
- 12" of aggregate course depth

The stormwater storage capacity for this typical bioswale installation is 353 cubic feet.

The total cost per cubic foot of storage is roughly \$93.

BIOSWALE				
Example Construction Cost for a planted Bioswale				
Item	Qty.	Unit	Unit Cost	Total Cost
Site Preparation				
Curb cuts	2	LF	\$ 8	\$ 16
Soil excavation & haul	33	CY	\$ 45	\$ 1,485
Site grading	45	SY	\$ 5	\$ 225
GI Components				
Filter Aggregate	4	CY	\$ 190	\$ 760
Storage Aggregate	15	CY	\$ 140	\$ 2,100
Geotextile Fabric	30	SY	\$ 5	\$ 150
Splash Block	1	EA	\$ 300	\$ 300
Energy Dissipation Material	1	CY	\$ 160	\$ 160
Catch Basin Tie In	1	EA	\$ 560	\$ 560
Pervious Pipe (6")	100	LF	\$ 40	\$ 4,000
Stand Pipe	1	EA	\$ 600	\$ 600
Planting Materials				
Soil	10	CY	\$ 175	\$ 1,750
Trees (2" cal.)	1	EA	\$ 800	\$ 800
Mulch (3" depth)	45	SY	\$ 10	\$ 450
Shrubs (3 gal.)	120	EA	\$ 45	\$ 5,400
Subtotal				\$ 18,800
Contingency			30%	\$ 5,700
Contractor Overhead & Profit			15%	\$ 3,700
Design			15%	\$ 4,300
Permitting			2%	\$ 600
Total*				\$ 33,100

*rounded up to the nearest \$100

These prices may vary at the time of purchase/construction.

SECTION 5: STORMWATER PLANTERS

Stormwater planters are used to collect and detain stormwater runoff, usually from roofs or canopy structures through downspouts, rain chains, or sheet flow. Stormwater planters provide both surface and subsurface storage. Their function is similar to bioretention cells, but they are characterized by hard edges and sides that are either completely or partially above ground.

WHERE TO USE

Stormwater planters are typically located adjacent to structures such as buildings or canopies and intercept roof runoff prior to entering the drainage system.

DESIGN CONSIDERATIONS

- Stormwater planters must be sized based on the catchment area of the roof or other surface that is draining to them.
- The bottom of the stormwater planter can be closed or open. The planter should always have an underdrain and outlet pipe that connects to the storm drainage system or another GI facility.
- Materials for the planter walls can be concrete, brick, stone, or metal.
- The sides of the planter can also be designed to serve as seat walls.
- Soil excavation and haul costs need not apply if the planter is fully above ground.
- Impermeable lining/waterproofing is only needed against sides abutting a structure.
- Refer to the GI Toolkit typical details for design considerations and layout.



Stormwater planter; New Orleans, LA
Photo courtesy of Dana Brown & Associates



Stormwater planter; Portland, OR
Photo courtesy of Andrew Doyle



Stormwater planter; Portland, OR
Photo courtesy of Portland.gov

STORMWATER PLANTER MAINTENANCE REQUIREMENTS

During the establishment period, plants in a stormwater planter must be provided with enough water to minimize transplant shock. As the plants in the stormwater planter become established, watering can be discontinued and the general maintenance will be reduced.

Stormwater planters will require regular removal of invasive species, weeds, and debris. During regularly scheduled maintenance, inlets and outlets must be visually inspected for blockages and when standing water is present for more than 48 hours after a rainstorm has ended.

Operations and Maintenance Activities for Stormwater Planters

Activity	Schedule
<ul style="list-style-type: none">• Debris removal• Watering & weeding during establishment• Visual inspection of inlets & outlets	Weekly
<ul style="list-style-type: none">• Weeding• Removal of silt build up at inlets	Monthly
<ul style="list-style-type: none">• Mulching	Twice Annually
<ul style="list-style-type: none">• Regrading of eroded areas• Pipe and outlet inspection and clean out• Replacing plants as needed	Annually

STORMWATER PLANTER COST

The construction cost for a typical installation of a stormwater planter is detailed below. The cost includes design, construction, and permitting. Costs are based on the value of the dollar (USD) in 2024 and are based on stormwater planters constructed in the New Orleans area.

Description of Typical Installation

For the purpose of comparing costs, the following assumptions are for a one-hundred square foot stormwater planter that has an open bottom and that is fully planted.

Construction assumptions include:

- Retrofitting an open space adjacent to existing building
- Tying into an existing catch basin
- Concrete retaining wall on 3 sides (no wall adjacent to building)
- 6" of freeboard
- 8" of soil
- 3" of filter aggregate
- 12" of storage aggregate

The stormwater storage capacity for this typical stormwater planter installation is 117 cubic feet.

The total cost per cubic foot of storage is roughly \$183.

STORMWATER PLANTER				
Example Construction Cost for a Stormwater Planter w/ an Open Bottom				
Item	Qty.	Unit	Unit Cost	Total Cost
Site Preparation				
Soil excavation & haul	9	CY	\$ 45	\$ 405
GI Components				
Concrete Retaining Wall	33	LF	\$ 200	\$ 6,600
Filter Aggregate	1	CY	\$ 190	\$ 190
Storage Aggregate	4	CY	\$ 140	\$ 560
Impermeable Membrane	10	SY	\$ 10	\$ 100
Energy Dissipation Material	1	CY	\$ 160	\$ 160
Catch Basin Tie In	1	EA	\$ 560	\$ 560
Pervious Pipe (6")	25	LF	\$ 40	\$ 1,000
Stand Pipe	1	EA	\$ 600	\$ 600
Planting Materials				
Soil	3	CY	\$ 175	\$ 525
Mulch (3" depth)	12	SY	\$ 10	\$ 120
Shrubs (3 gal.)	30	EA	\$ 45	\$ 1,350
Subtotal				\$ 12,200
Contingency			30%	\$ 3,700
Contractor Overhead & Profit			15%	\$ 2,400
Design			15%	\$ 2,800
Permitting			2%	\$ 400
Total*				\$ 21,500

*rounded up to the nearest \$100

These prices may vary at the time of purchase/construction.

SECTION 6: INFILTRATION TRENCH

An infiltration trench, also known as a French drain, is used primarily in linear spaces to store, convey, and facilitate infiltration of stormwater runoff. Infiltration trenches consist of an aggregate filled channel with underdrains.

WHERE TO USE

Infiltration trenches can be located in parking lots, rights-of-way, and narrow spaces that are unsuitable for plants. Infiltration trenches are effective conveyance systems when above grade systems could pose risk to public safety or when maintenance access is limited or unsafe due to site conditions or adjacent land uses (e.g. heavy traffic).

DESIGN CONSIDERATIONS

- When designing an infiltration trench near utility poles and/or street poles, maintain separation from the poles whenever possible. Avoid locating infiltration trenches in an area with electrical control panels, meter settings, or electrical conduit pull boxes.
- Avoid locating infiltration trenches above underground public and/or private utilities where possible. If unavoidable, utility sleeves and impermeable barriers may be required.
- A decorative rock layer can be considered on top of the main storage aggregate layer.
- Infiltration trenches allow suspended sediment particles to settle, but do not substantially improve stormwater runoff quality.
- Refer to the GI Toolkit typical details for design considerations and layout.



*Infiltration trench; New Orleans, LA
Photo courtesy of Dana Brown & Associates*



*Infiltration trench; New Orleans, LA
Photo courtesy of Dana Brown & Associates*



*Infiltration Trench along a roadway
Photo courtesy of sustainablestormwater.org*

INFILTRATION TRENCH MAINTENANCE REQUIREMENTS

Initial establishment of infiltration trenches involves monitoring to verify the facility is operating properly. Long term maintenance may require removal and washing of the top layer of aggregate if clogging occurs.

Operations and Maintenance Activities for Infiltration Trenches

Activity	Schedule
<ul style="list-style-type: none">• Debris removal• Watering & weeding during establishment• Visual inspection of inlets & outlets	Weekly
<ul style="list-style-type: none">• Weeding• Removal of silt build up at inlets	Monthly
<ul style="list-style-type: none">• Regrading of eroded areas• Pipe and outlet inspection and clean out	Annually
<ul style="list-style-type: none">• Removal and replacement of the top layer of aggregate	As needed

INFILTRATION TRENCH COST

The construction cost for a typical installation of an infiltration trench is detailed below. The cost includes design, construction, and permitting. Costs are based on the value of the dollar (USD) in 2024 and are based on infiltration trenches constructed in the New Orleans area.

Description of Typical Installation

For the purpose of comparing costs, the following assumptions are for a 200 square foot infiltration trench.

Construction assumptions include:

- Retrofitting an existing open space
- Cutting gaps into existing curbs
- Tying into an existing catch basin
- 3" of filter aggregate
- 24" of storage aggregate

The stormwater storage capacity for this typical infiltration trench installation is 158 cubic feet.

The total cost per cubic foot of storage is roughly \$104.

INFILTRATION TRENCH				
Example Construction Cost for an Infiltration Trench				
Item	Qty.	Unit	Unit Cost	Total Cost
Site Preparation				
Curb cuts	2	LF	\$ 8	\$ 16
Soil excavation & haul	17	CY	\$ 45	\$ 765
Site grading	23	SY	\$ 5	\$ 115
GI Components				
Filter Aggregate	2	CY	\$ 190	\$ 380
Storage Aggregate	15	CY	\$ 140	\$ 2,100
Geotextile Fabric	80	SY	\$ 5	\$ 400
Splash Block	1	EA	\$ 300	\$ 300
Catch Basin Tie In	1	EA	\$ 560	\$ 560
Pervious Pipe (6")	100	LF	\$ 40	\$ 4,000
Stand Pipe	1	EA	\$ 600	\$ 600
Subtotal				\$ 9,300
Contingency			30%	\$ 2,800
Contractor Overhead & Profit			15%	\$ 1,900
Design			15%	\$ 2,100
Permitting			2%	\$ 300
Total*				\$ 16,400

*rounded up to the nearest \$100

These prices may vary at the time of purchase/construction.

SECTION 7: PERVIOUS PAVEMENT

Pervious pavement allows stormwater runoff to infiltrate through the pavement surface, either through joints or through voids in the pavement itself. There is storage below the pavement section in the form of aggregate that supports the pervious pavement. Sediments in the runoff are filtered as it flows through the pavement and aggregate sections. To comply with the City of New Orleans Stormwater building code, pervious paving must be either precast pervious concrete panels or pervious pavers.

WHERE TO USE

Pervious pavement can be used in all areas where concrete or asphalt pavement is typically used, such as sidewalks, bike lanes, and plazas, as well as in some vehicular use areas such as parking lots and roadside parking. Pervious paving can also be used in low volume and low speed vehicular use areas such as alleyways and driveways.

DESIGN CONSIDERATIONS

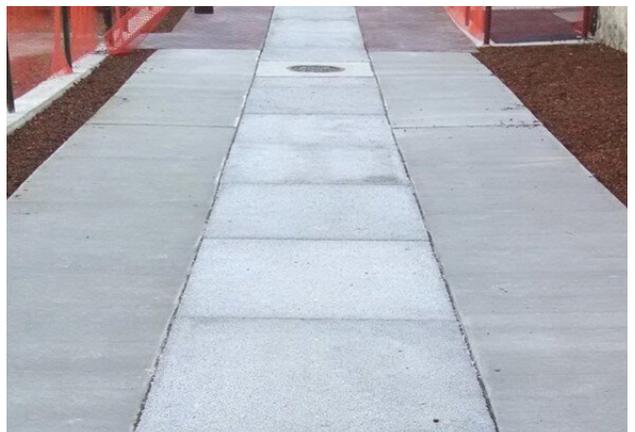
- Pervious paving shall have edge restraints such as a concrete band. Existing curbs (that are in good condition) and new curbs may also be used as edge restraints.
- If pervious paving is used in areas with potential for organic matter such as grass and leaves to accumulate, more frequent maintenance may be necessary.
- Underdrains and cleanouts shall be installed with all pervious paving systems.
- Permeable pavers use aggregate in the joints. The size of the aggregate and its base course are dependent on the application of use as determined by the designer.
 - » Open joint permeable pavers may also be used as determined by the designer.
- The designer can increase storage capacity under pervious pavement by increasing the depth of the aggregate or using subsurface storage tanks.
- Refer to the GI Toolkit typical details for design considerations and layout.



*Open joint pervious pavers; New Orleans, LA
Photo courtesy of Dana Brown & Associates*



*Pervious pavers with aggregate filled joints; Gretna, LA
Photo courtesy of Dana Brown & Associates*



*Precast pervious concrete panels; Lowell, MA
Photo courtesy of Porous Technologies LLC*

PERVIOUS PAVEMENT MAINTENANCE REQUIREMENTS

Pervious paving systems require regular removal of trash and other debris which may create clogs. The paving, contributing drainage areas, and the underdrains require regular inspections. Pervious paving systems require vacuuming with task-specific equipment. The type of equipment may vary depending on the paving system being designed.

Operations and Maintenance Activities for Pervious Paving

Activity	Schedule
<ul style="list-style-type: none">• Debris removal• Visual inspection of inlets & outlets	Weekly
<ul style="list-style-type: none">• Vacuuming• Replacing joint material (if applicable)	Twice Annually
<ul style="list-style-type: none">• Pipe and outlet inspection and clean out	Annually

PERVIOUS PAVEMENT COST

The construction cost for a typical installation of a pervious paving system is detailed below. The cost includes design, construction, and permitting. Costs are based on the value of the dollar (USD) in 2024 and are based on pervious pavement systems constructed in the New Orleans area.

Description of Typical Installation

For the purpose of comparing costs, the following assumptions are for a new 2,000 square foot pervious paver system. This size is representative of 10 parking spaces (20' W x 100' L).

Construction assumptions include:

- Traffic rated pervious pavers, 3" depth
- 2" bedding course aggregate
- 4" filter course aggregate
- 24" storage aggregate
- Tie into existing catch basin
- Concrete edge restraint on 3 sides, 1 side with new curb

The stormwater storage capacity for this typical infiltration trench installation is 1748 cubic feet.

The total cost per cubic foot of storage is roughly \$79.

PERVIOUS PAVING				
Example Construction Cost for a Pervious Paver System				
Item	Qty.	Unit	Unit Cost	Total Cost
Site Preparation				
Soil excavation & haul	204	CY	\$ 45	\$ 9,180
Site grading	223	SY	\$ 5	\$ 1,115
GI Components				
Bedding Aggregate	13	CY	\$ 190	\$ 2,470
Filter Aggregate	25	CY	\$ 190	\$ 4,750
Storage Aggregate	149	CY	\$ 140	\$ 20,860
Geotextile Fabric	299	SY	\$ 5	\$ 1,495
Pervious Pavers	2000	SF	\$ 10	\$ 20,000
Concrete Edging Restraint	140	LF	\$ 45	\$ 6,300
Concrete Curb	100	LF	\$ 75	\$ 7,500
Catch Basin Tie In	1	EA	\$ 560	\$ 560
Pervious Pipe (6")	100	LF	\$ 40	\$ 4,000
Cleanout	1	EA	\$ 600	\$ 600
Subtotal				\$ 78,900
Contingency			30%	\$ 23,700
Contractor Overhead & Profit			15%	\$ 15,400
Design			15%	\$ 17,700
Permitting			2%	\$ 2,400
Total*				\$ 138,100

*rounded up to the nearest \$100

These prices may vary at the time of purchase/construction.

SECTION 8: TREE CELLS

Tree cells are modular suspended pavement systems that provide substantial subsurface space for uncompacted soil, water, and air, which provide ideal growing conditions for tree roots, while also structurally supporting paving above. Tree cells provide subsurface detention and filtration by soils and the trees planted in them.

WHERE TO USE

Tree cells are designed for use in constrained and densely developed areas, along streets, in plazas and in parking lots to support the health and vigor of urban trees. Tree cells can be retrofitted in existing streets, plazas, parking lots, or designs as a component of a new streetscape.

DESIGN CONSIDERATIONS

- Using pervious paving above tree cells substantially increases the amount of water that can be captured and managed.
- The landscape architect should utilize alternative pervious paving materials in lieu of tree grates, which often cause trees to be girdled because of inadequate maintenance. The pervious material will serve to maintain a consistent grade between the walking surface and the finished grade of the soil in the tree cell. Products may include:
 - » Porous flexible paving
 - » Pervious paving
 - » Stabilized mulch
- In retrofit projects, the location of underground utilities is a major concern when installing trees. The system provides openings for underground pipes to pass through the cells, thus removing the need to relocate utility lines.
- Tree cells can be designed to manage water from the downspouts of a building by leading the downspout into the subsurface system. The designer will need to consider the volume of runoff from the spout and size the subsurface detention area accordingly.
- Tree cells can be designed to manage water from catch basins that are filling to capacity during heavy storm events. Catch basins can be retrofitted with an overflow pipe that is above the outflow pipe invert. This will allow water from the catch basin to flow into the subsurface storage area of the tree cell.
- Appropriate tree species should be considered with the anticipated volume of water that the tree cell will be receiving.



*Tree cell installation process; Baton Rouge, LA
Photo courtesy of Twin Shores Landscape*



*Tree cell installation process; Baton Rouge, LA
Photo courtesy of Twin Shores Landscape*



*Tree cell with pervious pavers; Baton Rouge, LA
Photo courtesy of Anthony Kendrick*

TREE CELL MAINTENANCE REQUIREMENTS

Tree cell maintenance is focused on the trees, which must be properly pruned every five years, or as needed after severe weather events. When using pervious paving in conjunction with tree cells, maintenance will be required for that specific pervious material.

Operations and Maintenance Activities for Tree Cells

Activity	Schedule
<ul style="list-style-type: none">• Watering & weeding during establishment• Visual inspection of inlets & outlets	Weekly
<ul style="list-style-type: none">• Weeding• Removal of silt build up at inlets	Monthly
<ul style="list-style-type: none">• Pipe and outlet inspection and clean out• Replacing plants as needed	Annually
<ul style="list-style-type: none">• Tree pruning	Every 5 years

TREE CELL COST

The construction cost for a typical installation of a tree cell system is detailed below. The cost includes design, construction, and permitting. Costs are based on the value of the dollar (USD) in 2024 and are based on tree cell systems constructed in the New Orleans area.

Description of Typical Installation

For the purpose of comparing costs, the following assumptions are for a 300 square foot tree cell.

Construction assumptions include:

- Retrofitting an existing sidewalk
- Tying into an existing catch basin
- Pervious pavers with a 6" aggregate base
- 36" of soil in a modular suspended pavement system
- 6" of aggregate base

The stormwater storage capacity for this typical tree cell system installation is 420 cubic feet.

The total cost per cubic foot of storage is roughly \$191.

TREE CELL				
Example Construction Cost for a Tree Cell System				
Item	Qty.	Unit	Unit Cost	Total Cost
Site Preparation				
Saw cutting of existing sidewalk	130	LF	\$ 6	\$ 780
Concrete sidewalk removal	34	SY	\$ 20	\$ 680
Curb cuts	6	LF	\$ 8	\$ 48
Soil excavation & haul	45	CY	\$ 45	\$ 2,025
GI Components				
Modular Suspended Pavement System	300	SF	\$ 75	\$ 22,500
Pervious Paving	252	SF	\$ 12	\$ 3,024
Aggregate	12	CY	\$ 140	\$ 1,680
Geotextile Fabric	92	SY	\$ 5	\$ 460
Splash Block	3	EA	\$ 300	\$ 900
Energy Dissipation Material	1	CY	\$ 160	\$ 160
Catch Basin Tie In	1	EA	\$ 560	\$ 560
Pervious Pipe (6")	60	LF	\$ 40	\$ 2,400
Cleanout	1	EA	\$ 600	\$ 600
Planting Materials				
Soil	34	CY	\$ 175	\$ 5,950
Trees (2" cal.)	3	EA	\$ 800	\$ 2,400
Mulch (3" depth)	3	SY	\$ 10	\$ 30
Tree grate	3	EA	\$ 500	\$ 1,500
Subtotal				\$ 45,700
Contingency			30%	\$ 13,800
Contractor Overhead & Profit			15%	\$ 9,000
Design			15%	\$ 10,300
Permitting			2%	\$ 1,400
Total*				\$ 80,200

*rounded up to the nearest \$100

These prices may vary at the time of purchase/construction.

SECTION 9: RETENTION BASINS

Retention basins, or wet ponds, are excavated ponding areas. Retention basins maintain a permanent ponding depth and allow for storage of specific design storms depending on the height of the freeboard and configuration of the outlet structure. They can be linear in shape to encourage settling of sediments prior to discharge, or they can have a smaller sediment basin at the inflow point. Generally, retention basins are planted with water-tolerant plants surrounding the permanent water level.

WHERE TO USE

Retention basins are primarily used when a lake or pond amenity can bring value to a project. On sites with contaminated soils, migration of the pollutants into the ground water through infiltration may be undesirable, which would necessitate a liner in the pond. Retention is generally employed where space for development is not a commodity.

DESIGN CONSIDERATIONS

- Retention basins require forebays to concentrate sedimentation near the inlet structure prior to entering the basin. Additional flow diversions can aid in increasing the distance stormwater travels within the basin and to slow velocities prior to discharge.
- Due to a preferred minimum side slope of 4:1, retention basins have a significant footprint which should be considered against other green infrastructure approaches.
- The integration of water-tolerant trees and shrubs surrounding and within retention basins will help mitigate water temperature increase during hot or sunny weather. Plants used along the riparian edge of the retention basin also provide habitat for wildlife and filter pollutants.
- Depending on the infiltration capacity of the soils, an impermeable liner may be required to maintain a permanent pool of water.
- Refer to the GI Toolkit typical details for design considerations and layout.



Retention basin; Baton Rouge, LA
Photo courtesy of Dana Brown & Associates



Retention basin; Duval County, FL



Retention basin; Cypress, TX
Photo courtesy of Clark Condon Associates

RETENTION BASIN MAINTENANCE REQUIREMENTS

Maintenance of retention basins includes, weeding and removal of trash and other debris. Retention basin forebays require as-needed cleaning, dredging, or other sediment removal practices.

A number of often overlooked maintenance needs of retention basins can significantly affect the ability of a retention basin to perform as designed. Semi-annual inspection and as-needed repair of the inlet and outlet structures will ensure the basin maintains its intended storage depth and will drain properly during and after storm events. Maintenance of the permanent pool, including temperature management (to prevent algae growth), wildlife and vector management, and the possible need for perimeter barriers, are important factors.

Owners may take a less traditional maintenance approach such as establishing no-mow areas to encourage wildlife habitat growth, reduce erosion, and remove additional pollutants.

Operations and Maintenance Activities for Retention Basins

Activity	Schedule
<ul style="list-style-type: none">• Debris removal• Watering & weeding during establishment (if applicable)• Mowing turf grass• Visual inspection of inlets & outlets	Weekly
<ul style="list-style-type: none">• Weeding• Removal of silt build up at inlets	Monthly
<ul style="list-style-type: none">• Mulching (if applicable)	Twice annually
<ul style="list-style-type: none">• Regrading eroded areas• Reseeding turf grass• Pipe and outlet inspection and clean out• Replacing plants as needed (if applicable)• Checking forebay for sedimentation & dredging if needed	Annually
<ul style="list-style-type: none">• Forebay dredging	Every 5 years

RETENTION BASIN COST

The construction cost for a typical installation of a retention is detailed below. The cost includes design, construction, and permitting. Costs are based on the value of the dollar (USD) in 2024 and are based on retention basins constructed in the New Orleans area.

Description of Typical Installation

For the purpose of comparing costs, the following assumptions are for a 3,000 square foot retention basin.

Construction assumptions include:

- Retrofitting an open space
- Tying into an existing catch basin
- 4' of standing water
- 2' of freeboard
- Trees around the perimeter

The stormwater storage capacity for this retention basin installation is 4,410 cubic feet.

The total cost per cubic foot of storage is roughly \$19.

RETENTION BASIN				
Example Construction Cost for a Retention Basin				
Item	Qty.	Unit	Unit Cost	Total Cost
Site Preparation				
Curb cuts	2	LF	\$ 8	\$ 16
Soil excavation & haul	260	CY	\$ 45	\$ 11,700
Site grading	340	SY	\$ 5	\$ 1,700
GI Components				
Inlet runnel	1	EA	\$ 6,500	\$ 6,500
Energy Dissipation Material	1	CY	\$ 160	\$ 160
Catch basin tie in	1	EA	\$ 560	\$ 560
10" PVC pipe	50	LF	\$ 115	\$ 5,750
Outlet structure	1	EA	\$ 7,000	\$ 7,000
Impermeable membrane	340	SY	\$ 10	\$ 3,400
Planting Materials				
Trees (2" cal.)	11	EA	\$ 800	\$ 8,800
Mulch (3" depth)	11	SY	\$ 10	\$ 110
Hydroseeding	3000	SF	\$ 0.50	\$ 1,500
Subtotal				\$ 47,200
Contingency			30%	\$ 14,200
Contractor Overhead & Profit			15%	\$ 9,300
Design			15%	\$ 10,700
Permitting			2%	\$ 1,500
Total*				\$ 82,900

*rounded up to the nearest \$100

These prices may vary at the time of purchase/construction.

SECTION 10: DETENTION BASINS

Detention basins, or dry ponds, are used to detain large volumes of stormwater. The basin collects and discharges stormwater runoff slowly, allowing time for suspended solids and other pollutants to be filtered by plants and soils. Stormwater runoff also has time to infiltrate into the ground. Detention basins are designed to fully drain all surface water. Vegetation that can tolerate temporary inundation is planted in detention basins.

WHERE TO USE

Detention basins require large areas of land to store large amounts of water. Typically the majority of the stormwater from an area is directed to one large detention basin. Detention basins mainly provide surface storage, but in some cases they can be used in combination with subsurface storage.

DESIGN CONSIDERATIONS

- Detention basins can and should be designed as site amenities rather than unusable land that is fenced off or otherwise inaccessible.
- Gentle side slopes, planting, and walkways around the basins can make it an amenity for the site.
- Side slopes must be at a minimum 4:1 ratio to create stable slopes and avoid erosion and maintenance problems. Additional erosion control measures must be used on steeper side slopes.
- Detention basins shall be designed with an outlet. The outlet can be a concrete outlet box or outflow structure with a drain inlet.
 - » The designer may incorporate a flow regulation device into the outlet structure to increase time of concentration.
 - » The outlet structure shall be accessible for maintenance purposes.
- Refer to the GI Toolkit typical details for design considerations and layout.



Detention basin with inlet runnel; New Orleans, LA
Photo courtesy of Dana Brown & Associates



Detention basin; New Orleans, LA
Photo courtesy of Dana Brown & Associates



Detention basin with inlet runnel; New Orleans, LA
Photo courtesy of Dana Brown & Associates

DETENTION BASIN MAINTENANCE REQUIREMENTS

Maintenance of detention basins will vary based on their plantings. If the detention basin has turf grass, shrubs, and trees, watering during the establishment period is required to minimize transplant shock. As the detention basin planting becomes established, watering can be discontinued and the general maintenance will be reduced. If the detention pond is planted with turf grass, then regular mowing will be required.

Detention basins will also require regular removal of invasive species, weeds, and debris. Visual inspection of inlets and outlets must also be completed during regularly scheduled maintenance visits. Drain inlets, and outlets should be inspected for blockages annually, or when standing water is present for more than 48 hours after a rainstorm has ended.

Operations and Maintenance Activities for Detention Basins

Activity	Schedule
<ul style="list-style-type: none">• Debris removal• Watering & weeding during establishment• Mowing turf grass• Visual inspection of inlets & outlets	Weekly
<ul style="list-style-type: none">• Weeding• Removal of silt build up at inlets	Monthly
<ul style="list-style-type: none">• Mulching	Twice annually
<ul style="list-style-type: none">• Regrading eroded areas• Reseeding turf grass• Pipe and outlet inspection and clean out• Replacing plants as needed	Annually

DETENTION BASIN COST

The construction cost for a typical installation of a detention basin is detailed below. The cost includes design, construction, and permitting. Costs are based on the value of the dollar (USD) in 2024 and are based on detention basins constructed in the New Orleans area.

Description of Typical Installation

For the purpose of comparing costs, the following assumptions are for a 1,000 square foot detention basin.

Construction assumptions include:

- Retrofitting an open space
- Cutting gaps into an existing curb
- Tying into an existing catch basin
- 3' of excavation

The stormwater storage capacity for this detention basin installation is 1,188 cubic feet.

The total cost per cubic foot of storage is roughly \$39.

DETENTION BASIN				
Example Construction Cost for a Detention Basin				
Item	Qty.	Unit	Unit Cost	Total Cost
Site Preparation				
Curb cuts	2	LF	\$ 8	\$ 16
Soil excavation & haul	50	CY	\$ 45	\$ 2,250
Site grading	112	SY	\$ 5	\$ 560
GI Components				
Inlet runnel	1	EA	\$ 6,500	\$ 6,500
Energy Dissipation Material	1	CY	\$ 160	\$ 160
Catch basin tie in	1	EA	\$ 560	\$ 560
10" PVC pipe	25	LF	\$ 115	\$ 2,875
Outlet structure	1	EA	\$ 7,000	\$ 7,000
Planting Materials				
Hydroseeding	750	SF	\$ 0.50	\$ 375
Trees (2" cal.)	3	EA	\$ 800	\$ 2,400
Mulch (3" depth)	28	SY	\$ 10	\$ 280
Shrubs (3 gal.)	73	EA	\$ 45	\$ 3,285
Subtotal				\$ 26,300
Contingency			30%	\$ 7,900
Contractor Overhead & Profit			15%	\$ 5,200
Design			15%	\$ 6,000
Permitting			2%	\$ 800
Total*				\$ 46,200

*rounded up to the nearest \$100

These prices may vary at the time of purchase/construction.