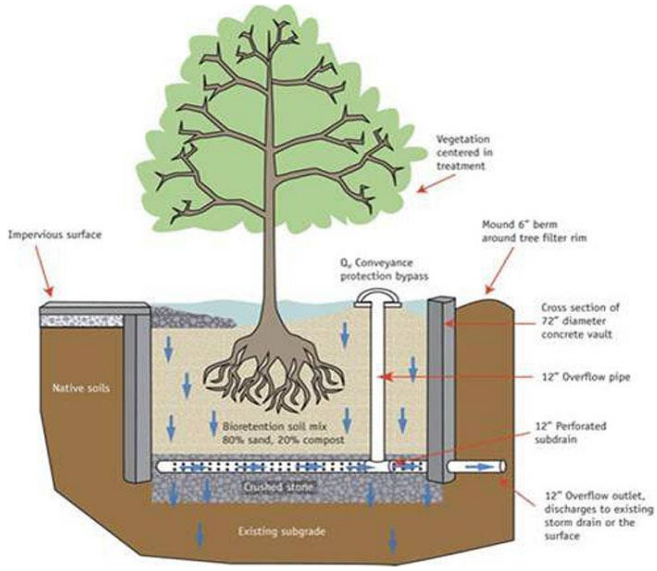
5.4 Tree Box



Tree boxes are similar to planter boxes but on a larger scale. Typically, the depth of a tree box will be substantially greater than a planter box. Trees use the water collected in the box as it passes through the soil. Excess water infiltrates into the ground below if it is an open bottom box. In extreme rain events, excess water can be conveyed through an underdrain to an additional box or different LID SWMF.

Advantages:

Tree boxes can easily enhance outdoor spaces, while providing extra storage for stormwater. They enhance water quality by filtering out impurities and reducing the total volume of stormwater runoff. Typically, they consist of impermeable sides such as concrete depending on the location, the underlying soil type, and depth of SHGW. They are a great approach to areas with a lot of impervious area such as along the perimeters of sidewalks, driveways, or along other impervious areas. This application is desirable in most areas with well-drained soils (HSG A and B), as well as, soils that tend to drain slowly (HSG C and D). In arear with HSG C and D soils, the native soil is removed and replaced with well-draining soil.

Limitations:

The limiting factor for using a tree box will typically be the depth to groundwater. Refer to Section 2 for guidance on how to determine the depth to groundwater at your location.

- This application is intended to rely on infiltration and water uptake by the tree; therefore, it is recommended for parcels with a greater separation between the SHGW and natural grade.
- A closed bottom box may be used in areas with high SHGW. These boxes will solely rely on the tree to utilize the collected stormwater; therefore, the tree must be carefully selected.
- High sediment loads tend to clog the voids in the soil and reduce the capacity of the system. Suspended sediment should be allowed to settle out of the water before it enters the tree box.

Design Considerations:

- Tree box design considerations are similar to the topics presented in **Section 5.3** *Planter Boxes*, but on a larger scale; topsoil, gravel, and sand are placed in the excavation replacing naturally impermeable soil.
- Soil types A and B are best suited for open bottom application. Closed bottom application is suitable for any soil types.
- If the tree box does not have a closed bottom, it will require a thicker layers of gravel and sand.
- The benefit to this application is that the area can be planted with vegetation that would not normally survive in the native impermeable soil. This allows a wider variety of vegetation options.
- Tree boxes can be directly connected to roof drains and gutters through a downspout.
- Several boxes around the property can be connected in series allowing for a greater capacity.
- A PVC riser can be installed which acts as an emergency drain, should the water rise beyond the desired depth. The riser will establish the maximum depth of water that will be contained in the tree box before it is conveyed to another tree box connected to the same pipe or a different LID SWMF application.
- The riser or underdrain drain should be installed to a design height which is determined by the design storage volume and the surface area allotted for the tree box. This safety measure will mitigate localized flooding and allow excess water to drain away from the area once the design capacity is exceeded.

- The following provides a brief description of the construction process:
    - A qualified contractor that is familiar with excavations and shoring should prepare the site.
    - Filter / geotextile fabric will need to be installed to separate the native soil from the sand filter.
    - Once the filter / geotextile fabric is installed, slotted underdrains should be placed at the predetermined design elevation. The underdrains allow water to infiltrate and rise in the outlet pipe.
    - The system piping should be fitted with cleanout capabilities for maintenance.
    - The underdrains should be surrounded by filter / geotextile fabric with at least 12 inches of gravel wrapped with another layer of filter / geotextile fabric separating it from the initial layer of sand. This will ensure that the sand does not wash out through the slots in the PVC.
    - Once the pipe is secure and protected with filter / geotextile fabric, a layer of sand is placed in the excavation.
    - Followed by another layer of geotextile fabric separating the sand from a layer of 3/8 inch to 5/8 inch diameter gravel;
    - The depth of each filter media (sand and gravel) will be dependent on the overall depth of the tree box.
    - A final layer of geotextile fabric should be placed to separate the gravel from nutrient rich topsoil. The topsoil will fill the remaining portion of the tree box.
    - Ensure that the layer of topsoil is deep enough for the newly planted tree(s) to establish a healthy root system.
- Layer depths associated with sand and gravel are dependent on the overall depth of the tree box. The sand and gravel filter the water, while the topsoil provides nutrients to the plants.

- Plants that are native to northwest Florida generally required little to no pesticides or maintenance. See approved plant list in **Appendix A**.
- **Do not** apply pesticides to the area due to the fact that the tree box is intended to purify water.

The shape of your tree box will be determined by the space available on your property. Tree boxes can be constructed in any shape, but the easiest shape to calculate volume capacity for is a cube. If complex shapes are desired, it is recommended to separate the area into several easily definable shapes such as circles, squares, and rectangles in order to determine an equivalent area. Once the equivalent area is determined, the required depth is calculated based on the required storage capacity.

Design Steps (open bottom application only):

5. First determine the storage treatment volume, soil conditions, depth to the SHGW, and the natural slope of the property at your location using the method described in **Section 2** and **Section 3**, this will assist in choosing the optimal location for the LID SWMF.

6. You will want to keep 2-foot minimum separation between the bottom of the tree box and the SHGW.

7. Next, identify the natural grade of your property to ensure that the tree box is in a location that will capture a majority of the stormwater travelling across your yard.

8. Calculate the area required for the tree box, while maintaining the required separation from the SHGW. We will use the same stormwater retention volume calculated in **Section 3** for this example. Porosity is the ratio of void volume to total volume, in other words it relates to the amount of water that can be stored between the sand and gravel. In order to get a representative volume for the capacity of the planter you will need to take into account the average porosity of the filter media (sand and gravel), for this we will use 0.4 (40%). This means that the filter media takes up approximately 60% (0.6) of the tree box.

Required Volume of Stormwater to Be Retained (ft^3)	*Space Allotted for Filter Media (%)*	*Required Volume of Stormwater to Be Retained (ft^3) / Porosity of Soil*	*Total Required Volume (ft^3)*
421 ft^3	*60 %*	$\frac{421\ ft^3}{0.4}$	*= 1,053 ft^3*

From this calculation, we can see that we need to increase the volume to accommodate the space that the sand, gravel, and soil occupy.

9. For this example, the SHGW is approximately 10 feet below ground surface, leaving 8 feet for the depth of the tree box. You will aslo want to determine the total required volume associated with the filter media.

Total Required Volume - Required Water Volume = Filter Media Volume (ft^3)	*Depth of Tree Box (ft)*
1,053 ft^3 - 421 ft^3= 632 ft^3	*8 ft*

Required Area of Tree Box (ft^2)
$\frac{1{,}053\ ft^3}{8\ ft} = 132\ ft^2$

10. Now we will determine the required length of the tree box if it is approximately 10 ft wide.

Required Area of Tree Box (ft^2)	Total Required Length of Planter (ft)	
$132\ ft^2$	$\frac{132\ ft^2}{10\ ft}$	$= 14\ ft$

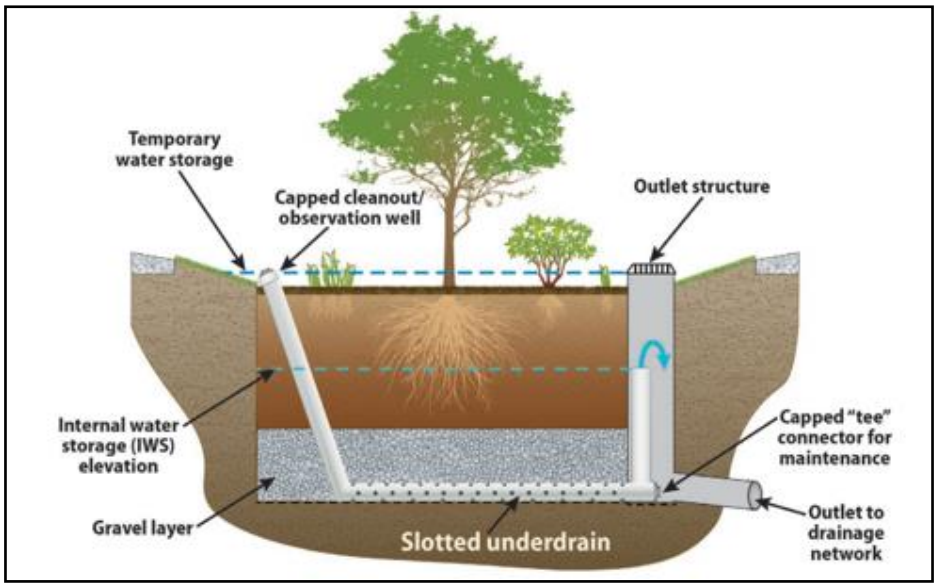
For this example a 14-foot long, 10 foot wide, 8-foot deep tree box would meet the minimum stormwater management criteria.

Refer to Calculation Sheet 5.4 included at the end of this section for assistance in designing a tree box.

Operation and Maintenance:

Operation and maintenance is similar to the planter box design but on a larger scale. The best time to inspect any type of stormwater management system is when it is raining or directly after a storm. Accumulated sediments will need to be removed periodically. Topsoil or mulch will need to be replenished and vegetation will need to be maintained on a seasonal basis.

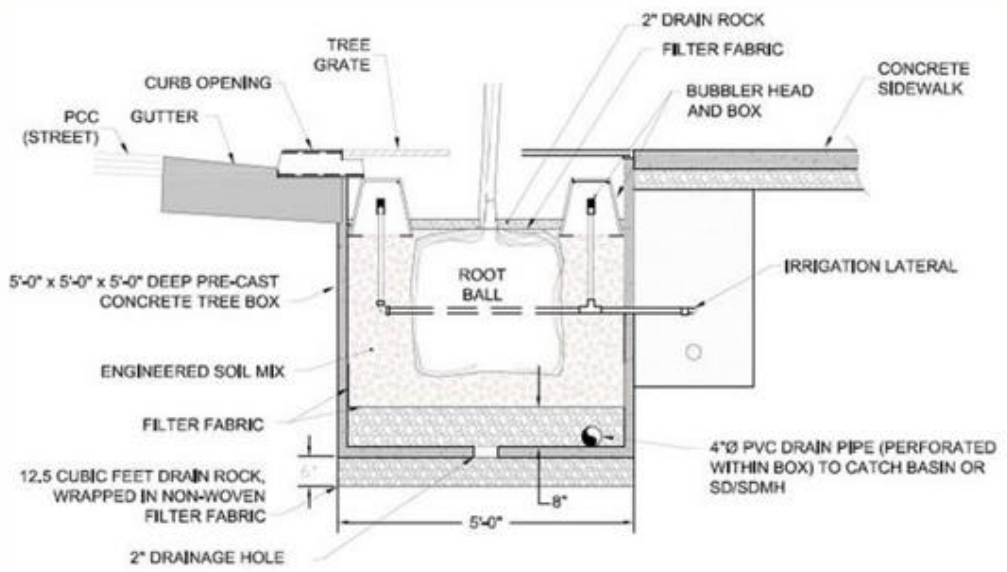
Tree Box Examples:



EPA Large Volume Storms and Low Impact Development, October 2017.

Maintenance Form 5.4 – Tree Box:

Tree Box LID SWMF		
Owner:		
Address:		
Phone:		
E-mail:		
Parcel Number:		
Date of Last Inspection:		
- Please attach pictures		
List any additional LID SWMF on site:		
List any previous concerns:		
Inspection List	Yes	No
Does water drain freely through the system?	☐	☐
Are there any areas with standing water?	☐	☐
Is the vegetation thriving?	☐	☐
Are there any areas with stressed or dying plants?	☐	☐
Is there an excess of plant debris in the tree box?	☐	☐
Is there a buildup of sediment in the tree box?	☐	☐
If the tree box drains to another area, are fittings tight?	☐	☐
Are pipes free from clogs?	☐	☐
Is the system over flowing?	☐	☐
Are sediment basins clean and clear from build up?	☐	☐
Is there any apparent erosion in the area?	☐	☐
Has the soil settled?	☐	☐
Has there been any soil compaction within or near the tree box?	☐	☐
Last time soil was replenished in the tree box footprint.		
Last time sediment was removed from the tree box.		
Maintenance Items To be Completed:		
By signing this form, I certify that I have inspected this system.	**Owners Signature**	**Date**



https://www.unce.unr.edu/programs/sites/nemo/lid/renotree/

Calculation Sheet 5.4 – Tree Box Design:

Only Enter Information In To The Green Boxes - All Other Boxes Are Automatically Calculated

Low Impact Development Calculation Sheet

Owner		Line 1
Address		Line 2
Phone		Line 3
E-mail		Line 4
Parcel Identification Number		Line 5
Total Proposed Disturbed Area	ac	Line 6

Proposed Impervious Area Totals

House		ft^2	Line 7
Detached Garage		ft^2	Line 8
Shed		ft^2	Line 9
Driveway		ft^2	Line 10
Patio / Porch / Deck		ft^2	Line 11
Pool		ft^2	Line 12
Misc Description:		ft^2	Line 13

Is Your Property In The Following Locations:

		Yes	No
ICPAL	If "yes" see section 3.4	☐	☐
Dune Lake	If "yes" see section 3.5	☐	☐
Near a Mosquito Control Ditch	If "yes" see section 3.6	☐	☐

Area Totals

Total Impervious Area		ft^2	Line 14
Total Impervious Area (acres)		ac	Line 15
Total Impervious Area (acres)	= Total Area (ft^2) * (1 acre/ 43,560 ft^2)		
Total Pervious Area		ac	Line 16
Total Pervious Area (ft^2)		ft^2	Line 17

Total Pervious Area (acres) = Total Area (acres) - Total Impervious Area (acres)

Next Determine the Volume Required Per the LDC Section 5.06.00

Total Property (square feet)		ft^2	Line 18

Soils Characteristics

Depth to Seasonal High Groundwater Table		ft below ground surface	Line 19

Predominant Soil Type

Predominant Soil Type				Value Taken From USGS Soils Survey	Line 20
Infiltration	Actual K_{sat}		in/hr	Provided in Table 3	Line 21
Design Infiltration	Design K_{sat}		in/hr		Line 22

Stormwater Volume Requirements

0.5 in Rainfall Over Disturbed Area		ft^3		Line 23
1 in Runoff Over Proposed Impervious Surface		ft^3		Line 24
Attenuation Volume		ft^3	Find Largest Value Between Line 23, 24, and 25 And Enter The Value On Line 26	Line 25
Required Retention Volume		ft^3		Line 26

*****Special Circumstances Only - Verify Your Location****

Section 3.4 Stormwater Volume Requirements for ICPAL

0.5 in Rainfall Over Disturbed Area		ft^3		Line 27
1 in Runoff Over Proposed Impervious Surface		ft^3		Line 28
Attenuation Volume		ft^3	Find Largest Value Between Line 27, 28, and 29 And Enter The Value On Line 30	Line 29
Required Retention Volume		ft^3		Line 30

Section 3.5 Stormwater Volume Requirements for Dune Lake

0.5 in Rainfall Over Disturbed Area		ft^3		Line 31
1 in Runoff Over Proposed Impervious Surface		ft^3		Line 32
Attenuation Volume		ft^3	Find Largest Value Between Line 31, 32, and 33 And Enter The Value On Line 34	Line 33
Required Retention Volume		ft^3		Line 34

Section 3.6 Stormwater Volume Requirements for Mosquito Control Ditch

0.5 in Rainfall Over Disturbed Area		ft^3		Line 35
1 in Runoff Over Proposed Impervious Surface		ft^3		Line 36
Attenuation Volume		ft^3	Find Largest Value Between Line 35, 36, and 37 And Enter The Value On Line 38	Line 37
Required Retention Volume		ft^3		Line 38

Table 3. NRCS Soil Data

Map Unit Symbol	Map Unit Name	HSG	SHGW Elevation (SHGW)	High Water Season	Permeability Rate (Ksat)
5	Chipley sand, 5 to 8 % slopes	A	-2 feet	Dec - Apr	6 in/hr
8	Dorovan-Pamlico association, frequently flooded	B/D	0 (at surface)	Jan – Dec	0.6 in/hr
12	Foxworth sand, 0 to 5 percent slopes	A	-3.5 feet	Jun – Oct	20 in/hr
16	Kureb sand, 0 to 8 percent slopes	A	-5 feet	----	6 in/hr
17	Lakeland sand, 0 to 5 percent slopes	A	-5 feet	----	6 in/hr
18	Lakeland sand, 5 to 12 percent slopes	A	-5 feet	----	6 in/hr
19	Lakeland sand, 12 to 30 percent slopes	A	-5 feet	----	6 in/hr
21	Leon sand, 0 to 2 percent slopes	A/D	0 (at surface)	Jun – Feb	0.6 in/hr
27	Rutlege fine sand, 0 to 2 percent slopes	A/D	0 (at surface)	Dec – May	6 in/hr
30	Tifton fine sandy loam, 5 to 8 percent slopes	B	-3.5 feet	Jan – Feb	0.6 in/hr
36	Pits	-	On-site test	On-site test	On-site test
45	Dirego muck, frequently flooded	A/D	0 (at surface)	Jan – Dec	6 in/hr
49	Eglin sand, 0 to 5 percent slopes	A	-5 feet	----	6 in/hr
50	Mandarin sand, 0 to 2 percent slopes	A	-1.5 feet	Jun – Dec	0.6 in/hr
51	Bigbee loamy sand, 0 to 5 percent slopes, occasionally flooded	A	-3.5 feet	Jan – Mar	6 in/hr
53	Arents, 2 to 8 percent slopes	A	-5 feet	----	20 in/hr
54	Newhan-Corolla sands, rolling	A	-5 feet	----	20 in/hr
55	Beaches	-	0 (at surface)	----	0 in/hr
56	Kureb sand, hilly	A	-5 feet	----	6 in/hr
57	Hurricane sand, 0 to 5 percent slopes	A/D	-2 feet	Nov – Apr	6 in/hr
58	Duckston muck, frequently flooded	A/D	0 (at surface)	Jan – Dec	6 in/hr
62	Resota sand, 0 to 5 percent slopes	A	-3.5 feet	Dec – Apr	20 in/hr
63	Pickney sand, depressional	A/D	0 (at surface)	Nov – Apr	6 in/hr
64	Pamlico muck	A/D	0 (at surface)	Dec – May	0.6 in/hr
69	Florala loamy fine sand, 2 to 5 percent slopes	C	-1.5 feet	Dec – Mar	0.06 in/hr
99	Water	-	-	-	-
100	Waters of Gulf of Mexico	-	-	-	-

Site Characteristics

Total Disturbed Area		ft^2	Line 1
Impervious Area		ft^2	Line 2
Impervious Surface Ratio (ISR)			Line 3

Soil Characteristics

Soil Type - Refer to Section 2.4			Line 4
Rainfall Intensity	0.43	in/hr	Line 5
Infiltration Rate - Refer to Table 3		in/hr	Line 6
Design Infiltration Rate (Divide By 2)		in/hr	Line 7
Rainfall Depth	8.73	in	Line 8
Reduced Rainfall Depth		in	Line 9

Attenuation Calculation

Design Factor - Choose One Based On The ISR Calculated In Line 3			Line 10
ISR Less Than 0.4	1		
ISR Between 0.4 and 0.7	1.2		
ISR Greater Than 0.7	1.4		
Design Rainfall Depth		in	Line 11
Design Rainfall Depth (Conversion)		ft	Line 12
Required Storage Volume		ft^3	Line 13

Site Characteristics

Total Disturbed Area		ft^2	Line 1
Impervious Area		ft^2	Line 2
Impervious Surface Ratio (ISR)			Line 3

Soil Characteristics

Soil Type - Refer to Section 2.4			Line 4
Rainfall Intensity	0.61	in/hr	Line 5
Infiltration Rate - Refer to Table 3		in/hr	Line 6
Design Infiltration Rate (Divide By 2)		in/hr	Line 7
Rainfall Depth	14.7	in	Line 8
Reduced Rainfall Depth		in	Line 9

Attenuation Calculation

Design Factor - Choose One Based On The ISR Calculated In Line 3			Line 10
ISR Less Than 0.4	1		
ISR Between 0.4 and 0.7	1.2		
ISR Greater Than 0.7	1.4		
Design Rainfall Depth		in	Line 11
Design Rainfall Depth (Conversion)		ft	Line 12
Required Storage Volume		ft^3	Line 13

Only Enter Information In To The Green Boxes - All Other Boxes Are Automatically Calculated

Site Characteristics

Total Disturbed Area		ft^2	Line 1
Depth To SHGW		ft	Line 2
Infiltration		in/hr	Line 3

Treatment Volumes

Design Volume (largest value from Site Characteristics sheet)		ft^3	Line 4

Tree Box Design - Single LID Application

Additional Volume Requirement		ft^3	Line 5
Total Required Volume of Tree Box		ft^3	Line 6
Depth of Tree Box		ft	Line 7
Required Area		ft^2	Line 8
Width of Planter		ft	Line 9
Design Length		ft	Line 10
Recovery Time		hr	Line 11

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