Western University Faculty of Engineering
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Design Documentation: 14 Roof Garden

Design Description:

Automated irrigation system that uses a water timer, hose,

inverted watering spike, and zip ties!

1 Final Design Documentation

1.1 Description

Need Statement:

Youth Opportunities Unlimited staff and volunteers who manage the rooftop garden want to use a system that manages space, watering needs, and staff resources with the focus of autonomously providing their crops with water which will allow YOU to maximize crop yield, preserve soil nutrients, improve water efficiency and avoid problems of not having enough produced crop or spending too much time manually watering the plants instead of directly helping youth.

Our Solution:

The purpose of our design is fulfilling Youth Opportunity Unlimited's need of autonomously irrigating the plants on their rooftop garden!

Our design has 4 main sub-systems (detailed information provided later in document):

The 1st is the digital water timer:

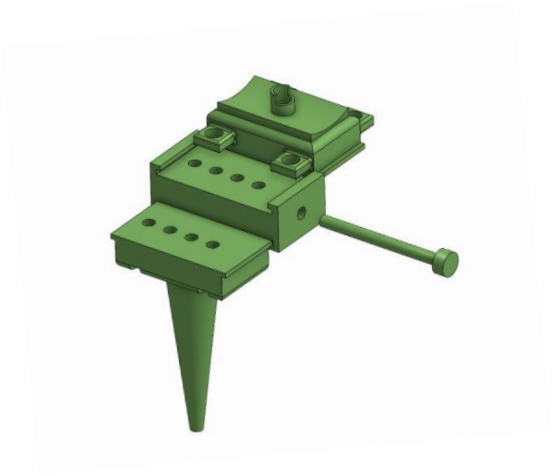
Watering Timer -3 Outlet

This system controls when water flows through the system and can be set based on the user's specific watering desires with the help of an included instruction manual.

The 2nd sub-system is a hose:

The hose allows water to flow all over the entirety of the expanse of the roof and to all the different plant beds.

3/8-inch holes are drilled into the bottom of the hose using a power drill into which the 3rd sub-system is the inserted – the Inverted Water Sprinkler:

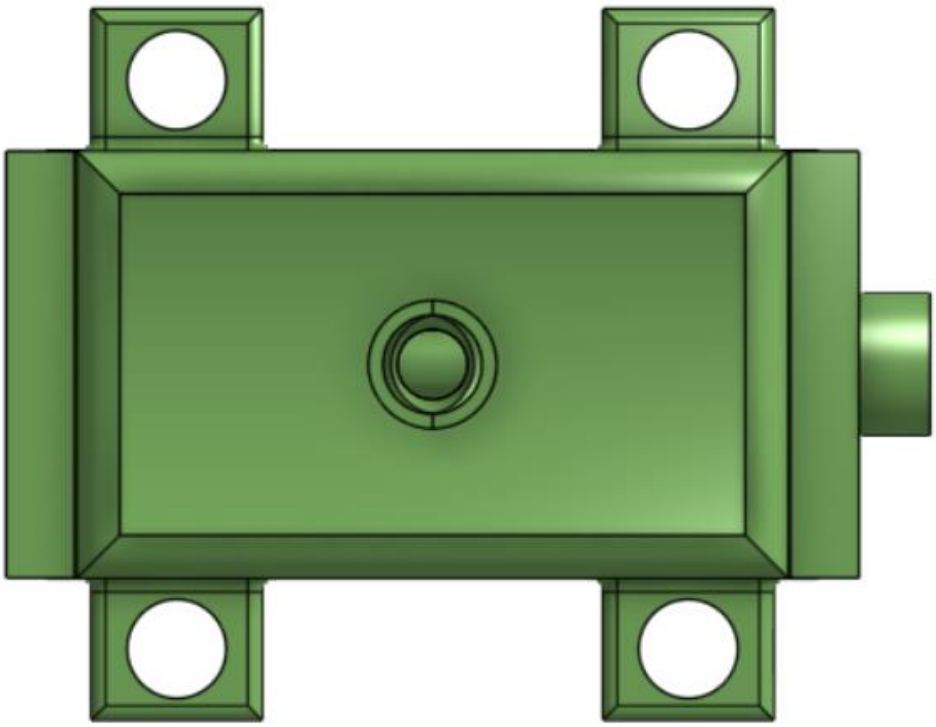


This component regulates how much water gets to each section of the design. For examples, one plant bed might get more water due to its higher watering intake needs, while another might get less. These preferences can be adjusted accordingly by the user using a simple sliding peg mechanism!

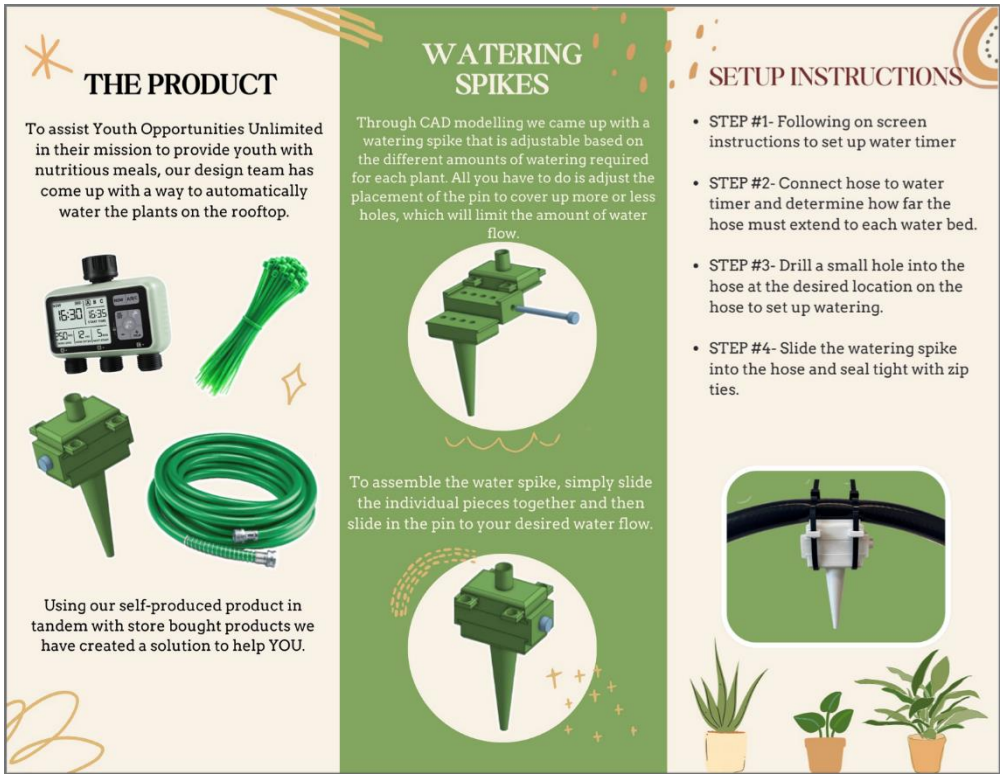
The further the peg is inserted into the design, the more holes are blocked off, and the less water will flow to the soil underneath! On the other hand, the less the peg is inserted results in less holes being cut off and more water flow!

Finally, the 4th component of our design are zip ties:

We recommend using a length of at least 10 inches for them – after all, the excess sections could simply be cut out after the zip tie is attached. In terms of attachment, they are inserted into the holes on the sides of the inverted sprinkler (shown below) and envelop its entire body as well as the hose – creating a secure connection between both parts (full image provided in instruction manual)!



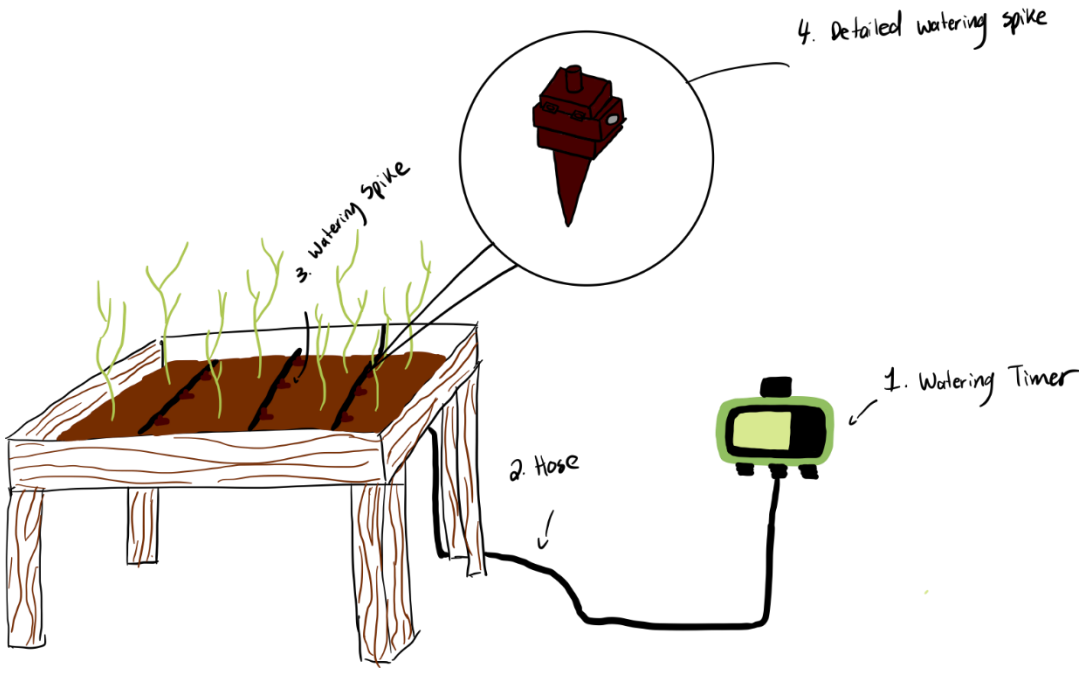
All this information, and more, is featured in the instruction manual we have created for our design!



1.2 Design Drawings

1.2.1 Overall schematic drawing

14roofgarden - Schematic Drawing



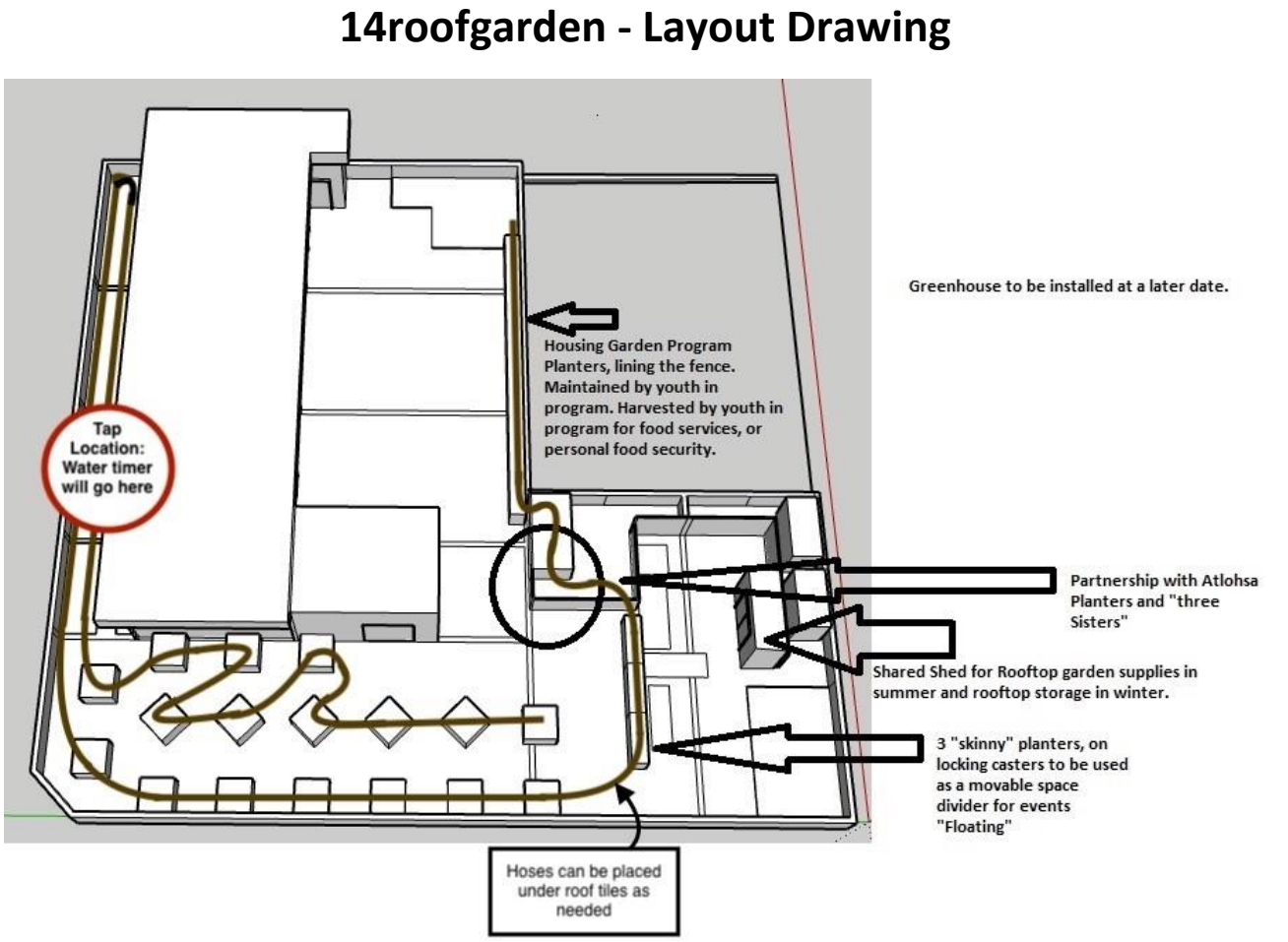
As can be seen from the schematic, the water timer **[1]** has 1 intake water port and 3 output water ports. The timer would be attached to the water source – spigot – on the rooftop while the hoses **[2]** could be attached to the output ports – evidently, a maximum of 3 can be connected to this design, however digital water timers with more output ports do exist on the market (i.e. 4,5,6)!

The hose(s) would flow underneath any pavement tiles and on top of the soil in the plant beds. The hose setup can either be constructed along the plant bed's width (as shown in the image above) or along its length. This choice depends several factors such as the exact water pressure on the rooftop, how much length of hose is available, and the exact aesthetic requirements the user has.

Along the hose, 3/8-inch holes would be drilled into its bottom using a drill, and into said holes the watering spikes (aka inverted sprinklers) would be inserted **[3]** the spike portion going into the dirt. We recommend using at least 2 watering spikes per plant bed (based on average plant bed size) and up to a maximum of 6 – this maximum is recommended as to not decrease the water pressure too much.

Finally, the zip ties would wrap around both the hose and watering spike **[4]** in order to secure these pieces together. While testing did show that the spike would remain lodged in the hose without zip ties – due to the tightness of the drilled hole – we still recommend using zip ties as an added security measure to increase the design's stability!

1.2.2 Overall layout drawing



The red circle represents where the digital timer would be installed – right onto the water spigot!

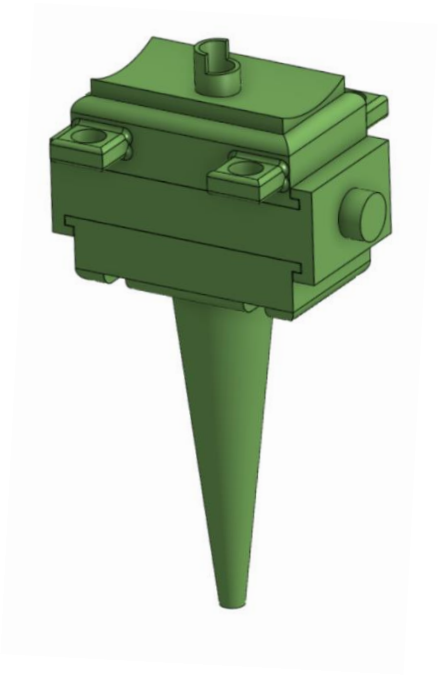
The brown lines represent the hose layout on the roof – the exact locations of these can be easily modified if the user's needs were to change (i.e. plant beds are moved). Additionally, as previously mentioned, we recommend these hoses are installed underneath pavement tiles and on top of the soil of plant beds in order to maximize their efficiently while also maximizing safety (no tripping hazards!).

The inverted sprinkler would be installed onto the sections of the hose that are in the plant beds and secured to the hose using zip ties. Furthermore, the locations of these could also be easily modified (i.e. plant beds are added/removed): The user would simply have to cut off the zip ties, remove the spike, and reseal the hole using tape. Our testing showed that tape easily managed to stop any leaking from the previously created hole!

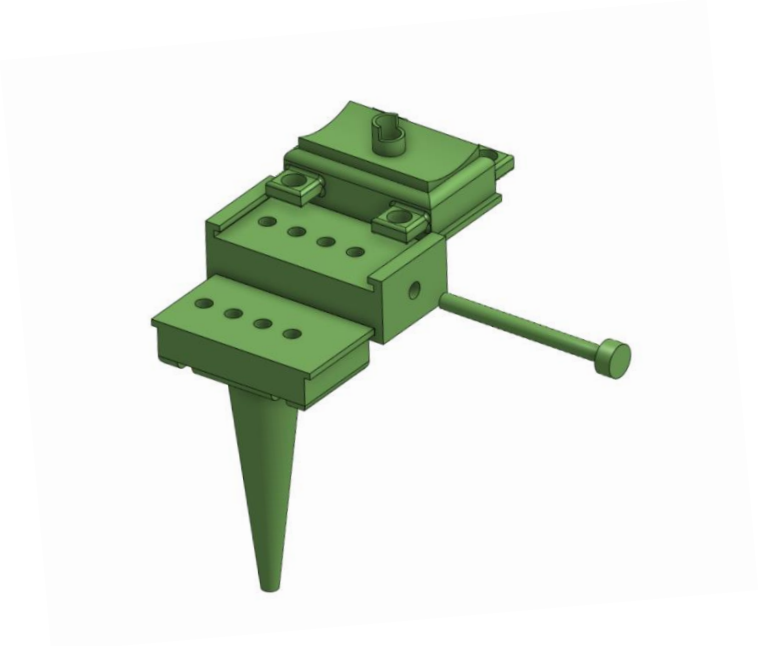
Finally, in sections where the hose was to ‘end’ (hose runs out of length), more hoses could be attached using a male-female connector (to extend the reach of the design), a hose dead end could be used (to stop water from coming out of the other side), or a simple water run-off section could be created there (i.e. into a patch of ground/a tub).

1.2.3 Detail drawings

Inverted Sprinkler – Assembly Assembled



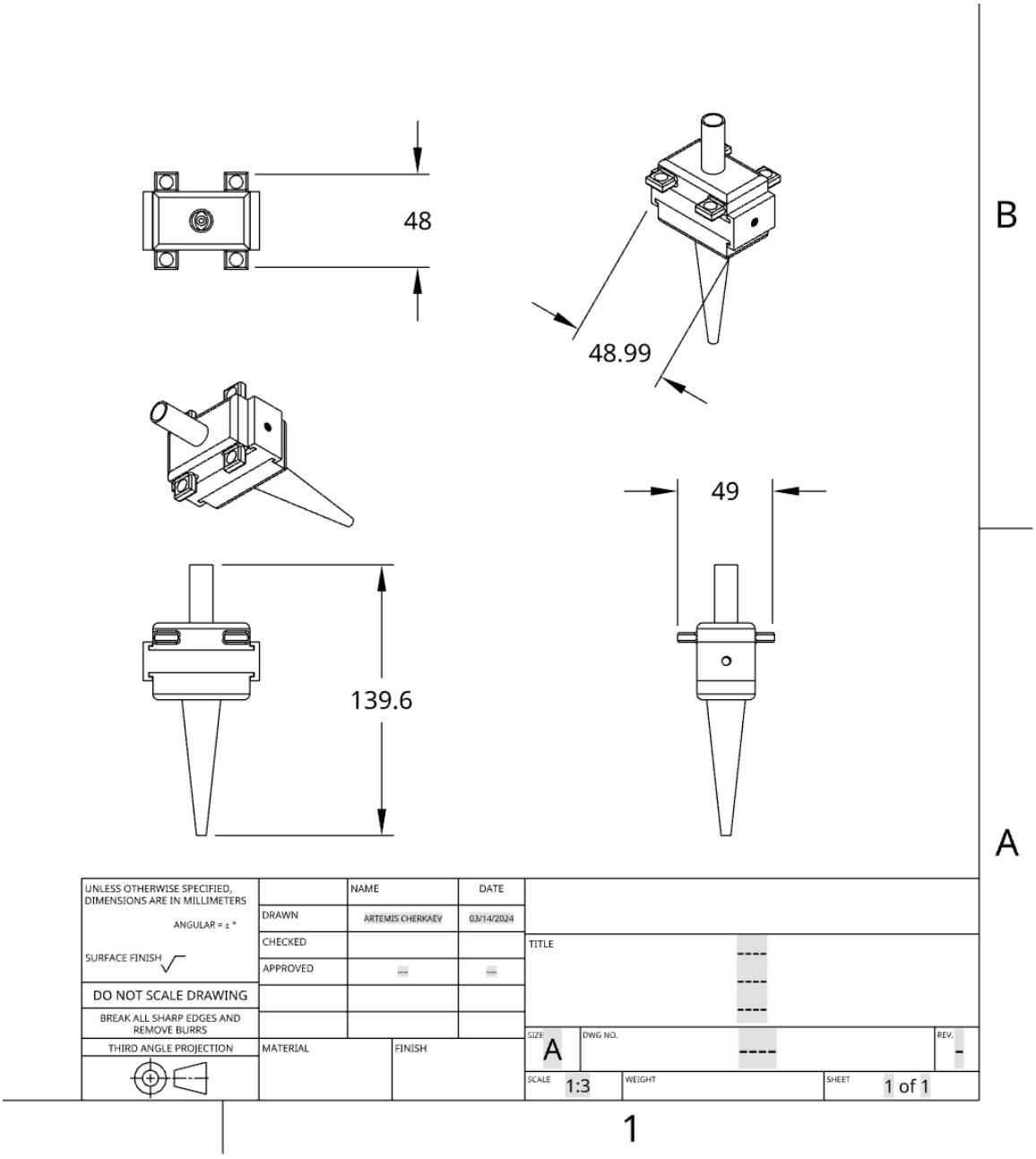
Inverted Sprinkler – Assembly Disassembled



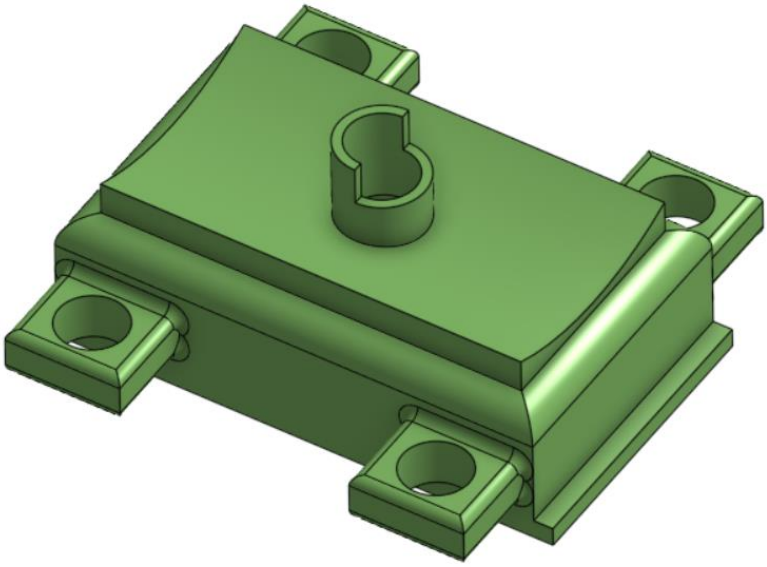
Inverted Sprinkler – Important Information

- Created using 3D printing
- PETG material with 15% carbon fiber filling
- Less than 50g in weight

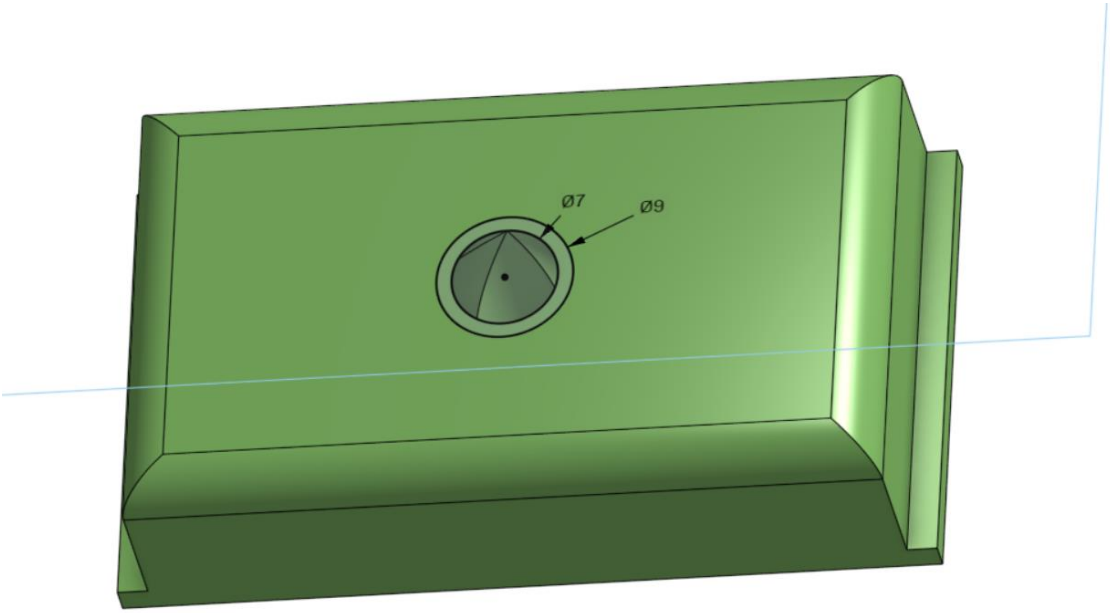
Inverted Sprinkler - Engineering Drawing



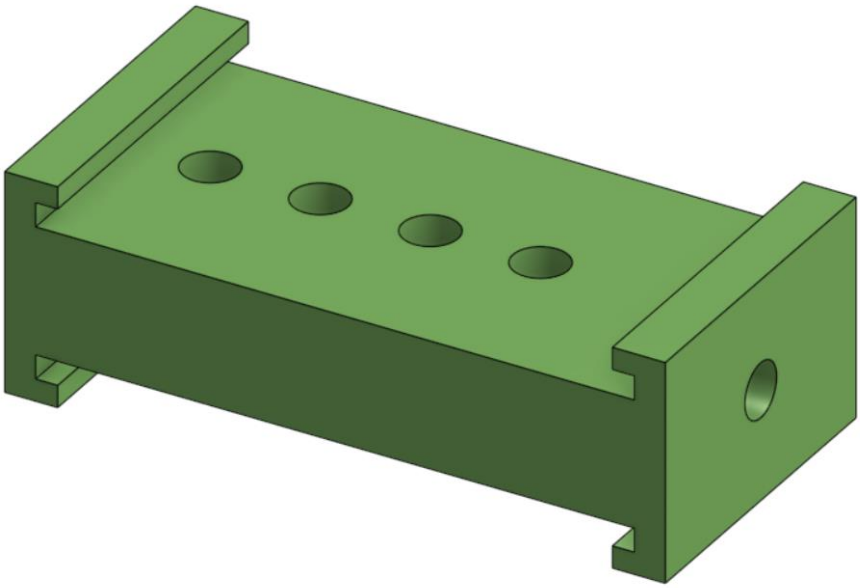
Inverted Sprinkler – Intake Piece



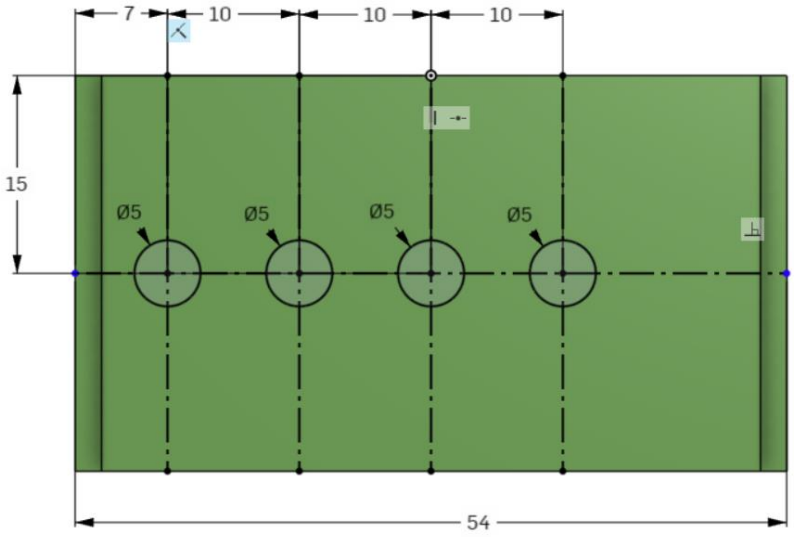
Inverted Sprinkler – Intake Piece - Dimensions



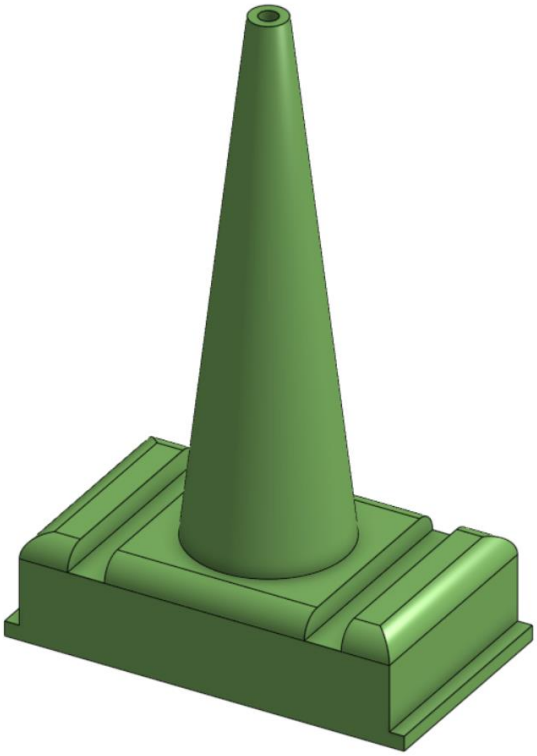
Inverted Sprinkler – Flow Control Block



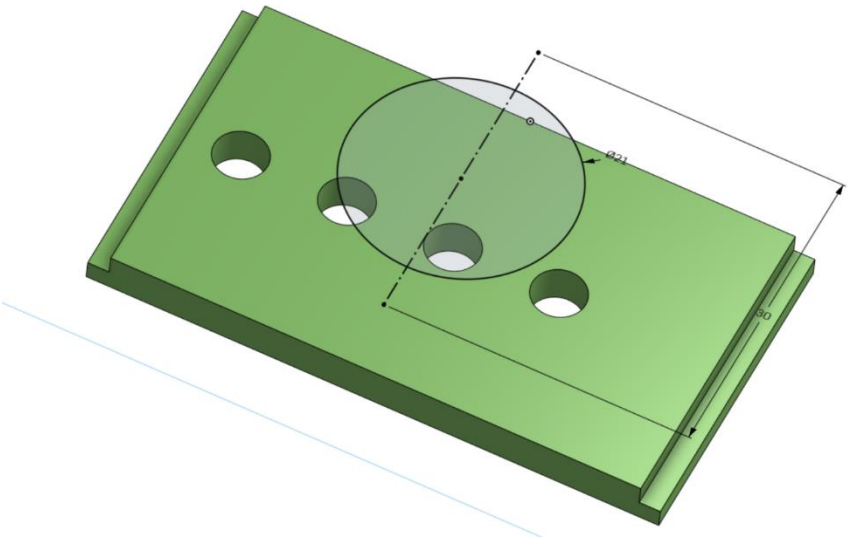
Inverted Sprinkler – Flow Control Block - Dimensions



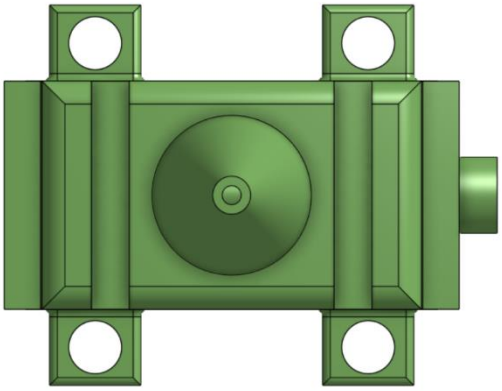
Inverted Sprinkler – Distribution Spike

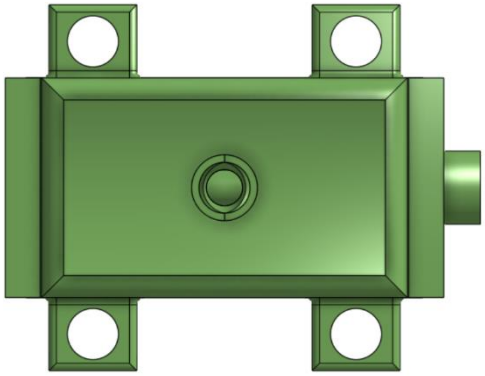


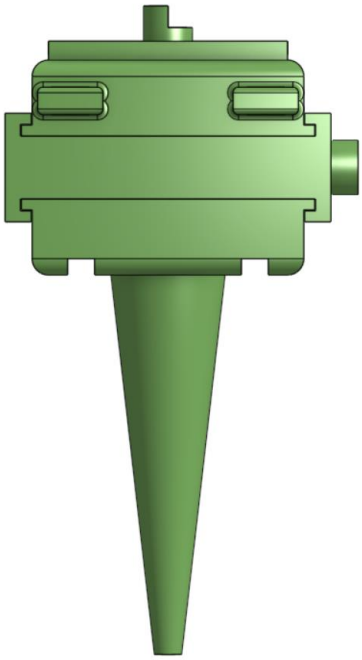
Inverted Sprinkler – Distribution Spike - Dimensions

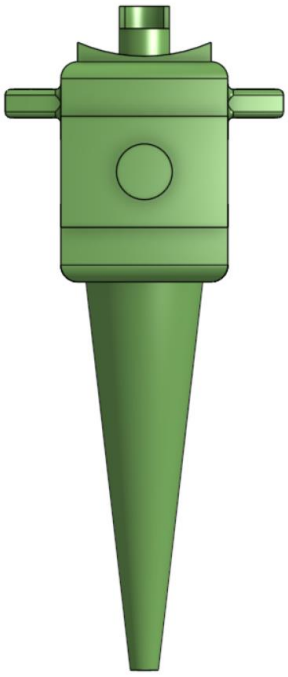


Inverted Sprinkler – Multi-Dimensional Views









Hose

Hose – Important Information

- PVC material
- GHT standard connector (adapt 3/4" tap faucet)
- Temperature range: -10°C to 40°C
- Water Pressure Max: 600 Kpa
- Abrasion resistant
- 10ft long

Digital Water Timer

Digital Water Timer – Important Information

- Manual Rain Delay Function (can set up the timer to adjust the timing to the rain levels)
- 15.5D x 6.5W x 16.5H cm
- Plastic, Acrylonitrile Butadiene Styrene
- IP65 waterproof
- 2 AA batteries (up to a year of battery life)

Zip Ties

Zip Ties – Important Information

- Nylon material
- temperature range of -40°C to 85°C
- 12 inches

2 Bill of Materials

Table 1: Bill of Materials

#	Item Description	Units	Quantity	Unit cost	Cost	Source
1	PETG Inverted Sprinkler Filament	1 kg	2	45.99	$91.98	Amazon
2	Hose	1	3	22.33	$66.99	Amazon
3	Zip ties	1 pack (100 zip ties)	1	8.69	$8.69	Amazon
4	Digital Water Timer	1	1	49.99	$49.99	Amazon
Total					$217.65	
Total with Tax					$245.94	