Geo Water Collector Web Application

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Introduction

Our study focused on Domestic Rain Water Harvesting (DRWH) with an emphasis on the use of Geographic Information Science Techniques (GIST). Due to current drought conditions, we thought it would be helpful to create a web application that would aid consumers in the City of Lynwood, CA to recognize the potential of rain water harvesting through the use of water catchment techniques. The potential for rain water harvesting is measured by the runoff equation based on the rooftops catchment area in square feet. Average precipitation data was gathered in two datasets - 10 years average precipitation data and 30 years average precipitation data. According to a 2010 study by the City of Lynwood's Urban Management Plan report, city residents are relying on 50% of their water through pumping of underground water resources. For this reason, consumer awareness of the potential for Domestic Rainwater Harvesting (DRWH) through rooftops is one way to utilize GIS. The City of Lynwood CA served as the study area for this project (Figure 1)

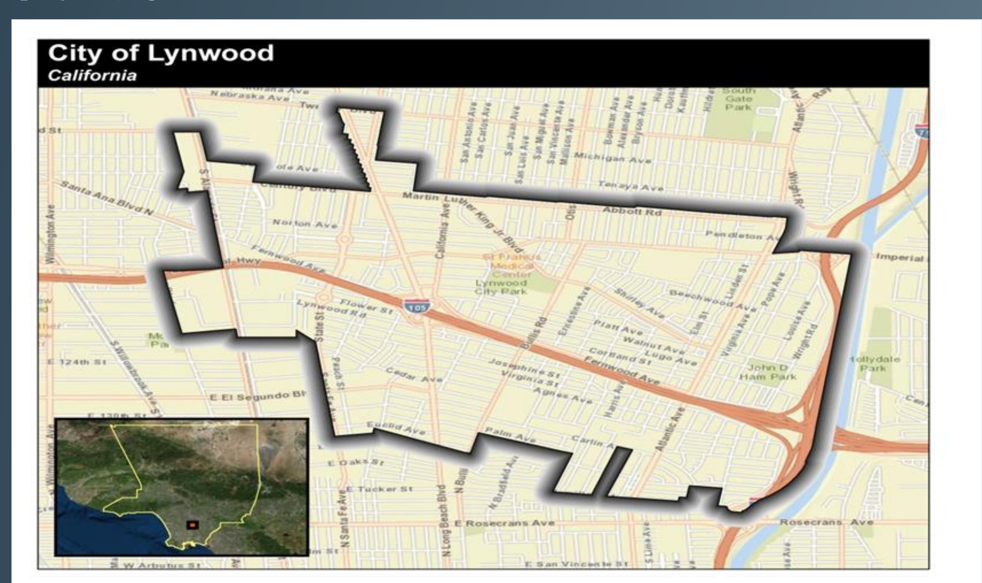


Figure 1. Study Area ***Lynwood, CA***

Data and Data Sources

Since the study is focused on the use of Geographic Information Science techniques to calculate the potential of single family residential homes' rooftops to collect water, it was necessary to select a product that could reach as many web application user's as possible. The use of a web application to display geographical data has increased. Therefore, the creation of a web application presented the best way to deliver the information. In order to develop a web application, it was necessary to research what software and web platforms were available and which would provide the best results. Table 1, shows the data and data sources used to create the analysis portion in ArcMap and the reference map in Figure 1.

Table 1. *List of data and data sources for the Geo Water Collector Web Application*

Dataset	Format	Feature Type	Projection	Convertion	Availability
Boundary	vector	Polygon	NAD 1983 StatePlane California V	none	yes
Zoning	vector	Polygon	NAD 1983 StatePlane California V	none	yes
Building foot print	vector	Polygon	NAD 1983 StatePlane California V	none	yes
Land Use	vector	Polygon	NAD 1983 StatePlane California V	none	yes
2005 -2013 yearly precipitation observ	vector	Point	NAD 1983 StatePlane California V	none	yes
Data Created from existing datasets					
Lynwwod 10 year Prep	vector	Polygon	NAD 1983 StatePlane California V	none	yes
Lynwwod 30 year Prep	vector	Polygon	NAD 1983 StatePlane California V	none	yes

Timeline

Project management skill sets are an integral part of the process for implementing an innovative approach such as that undertaken in this project. A project management outline was necessary to accomplish the initial project deliverables such as: project proposal, criteria, and scope and was used to set a framework to line up with our proposed project. Having a set schedule of deliverables and tasks was crucial to completing our project successfully. Figure 2 illustrates the project management process using Microsoft Project software.

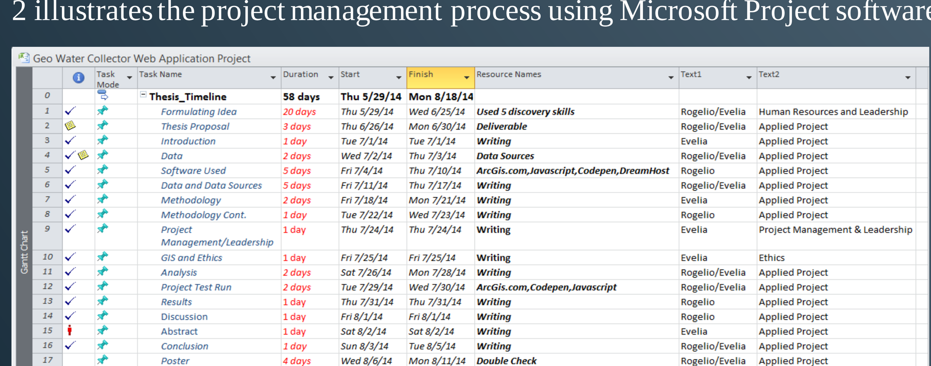


Figure 2. *Geo Water Collector Web Application Project Management Timeline.*

Methodology

The project was divided in two sections. The first section describes how ArcMap was used to analyze the runoff. The second part describes the process to create a customize web application; utilizing ArcGIS online alone with ESRI API for JavaScript, CodePen and DreamHost.

ArcMap: The Geo Water Collector (GWC) workflow was created based on GIS technology. The completion of the project requires a series of steps that must be completed using ArcMap.

Area Selection: The city of Lynwood California was selected as the study area for this project. The following steps were required to create the sample area:

Runoff Calculation: In order to use this equation in ArcMap it was necessary to add all of the elements in a shapefile that contains building footprints. This layer was created by selecting the buildings that were located in single family residential homes according to the zooning layer. Once selected areas were exported the following attribute fields were added to the shapefile:

1. Average Precipitation

2. Area in sq. ft.

.3.Coefficient (0.95)

4.Volume Cubic Feet

5. Gallon

6. Total gallons

7. Water Price

a. Water price is based on the City on Lynwood water prices. The city of Lynwood uses the following measurements and rates for water usage:

i. HCF = 100 ft^3 of water

1. 1 ft^3 = 7.5 gallons

2. Rate per HCF in the city of Lynwood, CA = $5.63

8. HFC (Hundred Cubic Feet)

9. Water Value

Web Application Methodology

The following software programs were used in the process:

1. **ArcGIS online**. ArcGIS online is a mapping platform use by many GIS professionals to create and share interactive maps. Since ArcGIS online is

A. API for JavaScript

2. **ArcMap 10.2**. ArcMap is the main component of ESRI's ArcGIS suite of geospatial processing programs, and is used primarily to view, edit, create, and analyze geospatial data.

3. **CodePen**. Codepen is a JavaScript, CSS, HTML web editor application.

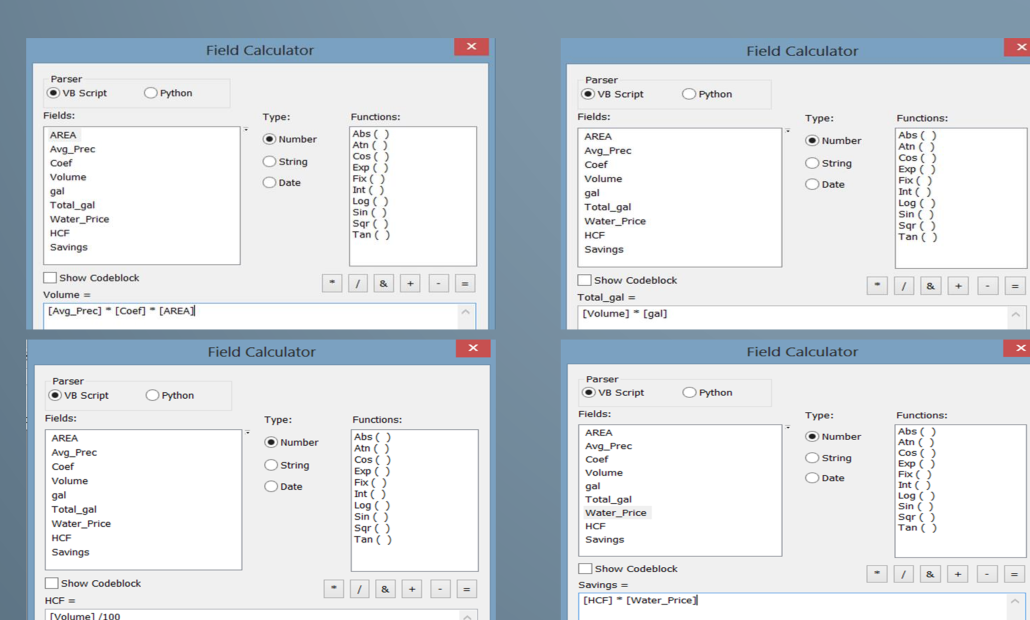


Figure 3. *Calculation order: From top-left to right-bottom.*

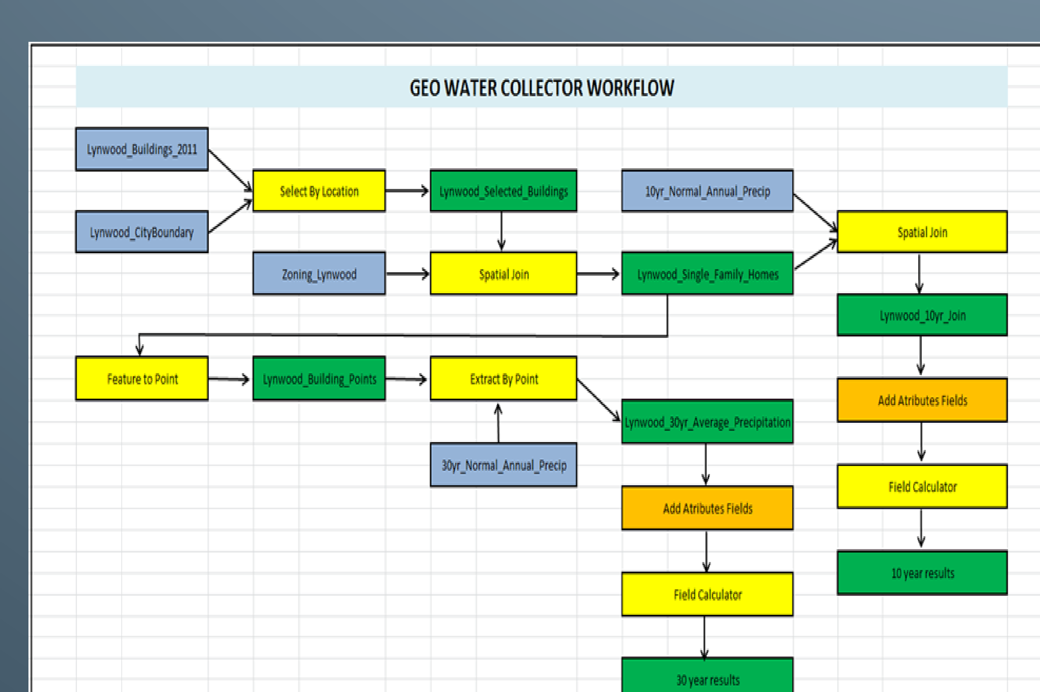
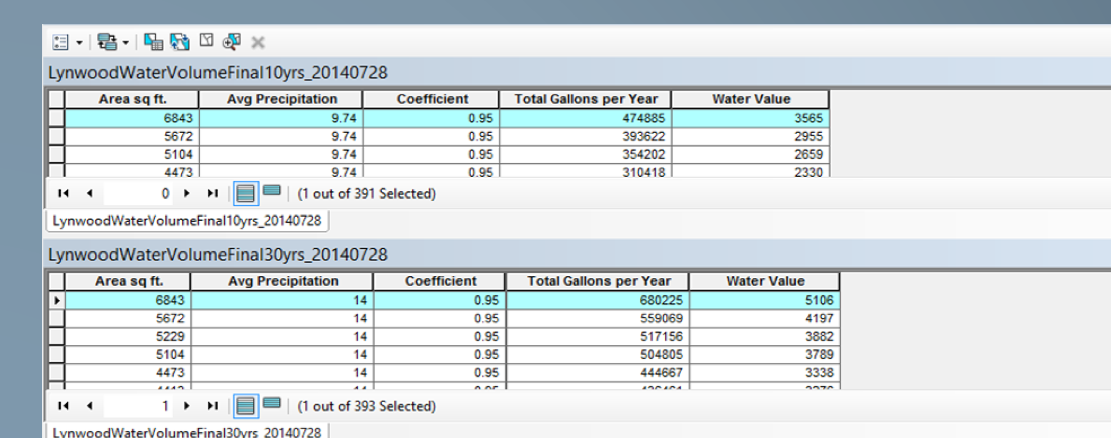


Figure 4. *Geo Water Collector Workflow.*

Results

Results one and two are based on the 10 and 30 year average precipitation data respectively. The third result is the display portion of this study which is provided through the Geo Water Collector web application. The result of the 10 year average precipitation indicates a dry decadal period. If our pilot study for the city of Lynwood CA were geared towards a climatological study, we would need to use the 30 year average precipitation data. For the purpose of our pilot study, we felt that the 10 year average precipitation of 9.74 inches illustrates the current weather conditions for the decadal period of 2004-2013. Our pilot study represents a feasibility study for implementing DRWH techniques to provide the web application users with a more accurate accounting for how many gallons they would save. Figure 5, Illustrates the difference that 10 and 30 years average precipitation makes in regards to the total gallons per year saved.



LynwoodWaterVolumeFinal10yrs_20140728

Area sq ft.	Avg Precipitation	Coefficient	Total Gallons per Year	Water Value
6843	9.74	0.95	474885	3565
5672	9.74	0.95	393622	2955
5104	9.74	0.95	354202	2659
4473	9.74	0.95	310418	2330

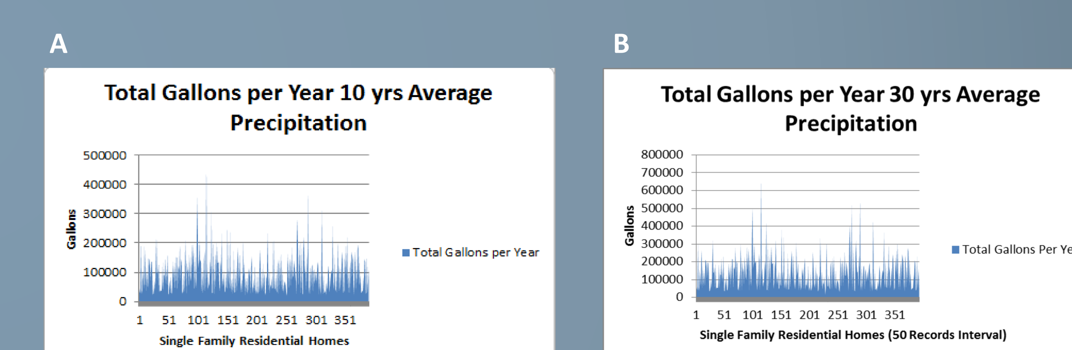
(1 out of 391 Selected)

LynwoodWaterVolumeFinal30yrs_20140728

Area sq ft.	Avg Precipitation	Coefficient	Total Gallons per Year	Water Value
6843	14	0.95	680225	5106
5672	14	0.95	559069	4197
5229	14	0.95	517156	3882
5104	14	0.95	504805	3789
4473	14	0.95	444667	3338

(1 out of 393 Selected)

Figure 5. *The attributes tables show a comparison of the Total gallons per year results.*



Figures 6A and 6B. *Show the comparison of average precipitation data for Total Gallons Per Year.*

In creating this web application, we inferred that the viewers would be able to understand the data in a visual and dynamic way. Figure 7 illustrates how within the Geo Water Collector web application, we created a pilot study of the City of Lynwood with the buildings, and joined the average precipitation data using the 10 year average precipitation for the City of Lynwood, CA. Figure 8 illustrates the steps needed to use the calculator where the user can input the average precipitation, the Area (square feet) of their rooftops, and the coefficient table. The coefficient table illustrates the type of materials most rooftops are made from. Also, we added a button (Average Precipitation) which takes the user to a link that looks up the most current average precipitation. The user can then input their local average precipitation into the calculator.

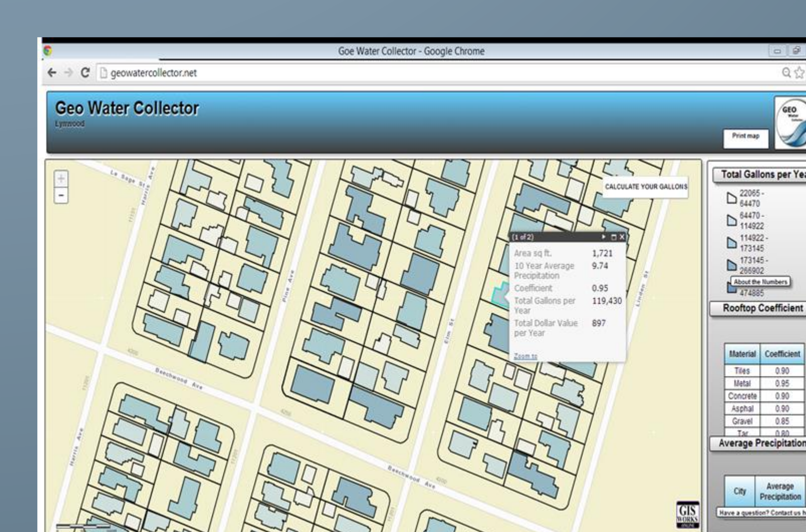


Figure 7. *Illustrates the Geo Water Collector Web Application.*

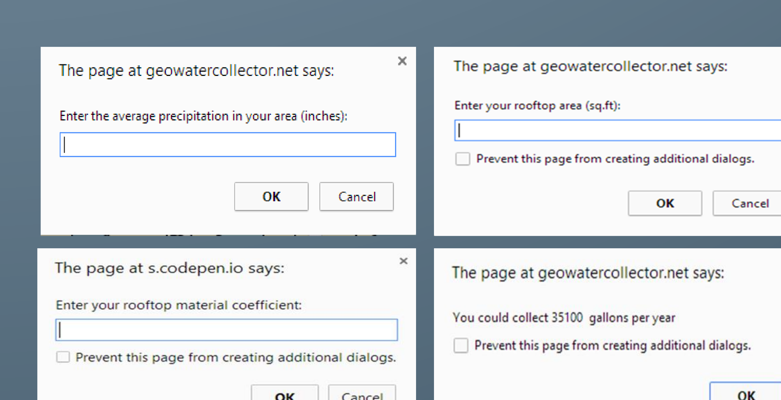


Figure 8. *Geo Water Collector Calculator workflow from top-left to bottom-right.*

Discussion

There are issues associated with the need to find alternatives to properly manage and conserve water resources. The daily use of water resources in a household is sometime improperly used due to water use habits. Therefore, we created a dynamic way to visualize the potential of domestic rainwater harvesting. In order to illustrate the findings in a dynamic way, we decided to use a web application to enhance the user's participation in understanding the calculation method with the 10 year average precipitation data. We also, created a calculator to give users the freedom to use their own measurements regardless of geographic coordinates. Figure 9 shows the link to current averages within any United States Cities to limit the uncertainty factors of climatological data. The user is free to look up the current averages for their geographic location and be provided up to date information. In Figure 10, we demonstrate another uncertainty which is provided to us by the City of San Diego. The equation used for the analysis portion of our study does not take into consideration the pitch of the rooftop. Therefore, the gallons saved are an estimated amount.

The limitations associated with our pilot study of Lynwood through the use of Geo Water Collector web application are; the single family residential homes buildings layer is limited to a section of the City of Lynwood. Also, Figures 11A and 11B illustrate that when you open geowatercollector.net on Firefox and internet explorer browsers there are coding limitations, for example the color scheme. Another uncertainty is the fact that we used vector data which is static and is recommended by (H. Weerasinghe, 2011) that raster data be used with current data updates.

In comparing 10 and 30 years of average precipitation data, we discovered that the 30 year average is commonly used through the scientific community. Consequently, we discovered that it was not sufficient for our study to only produce static reference maps because we wanted to limit the uncertainty factor.

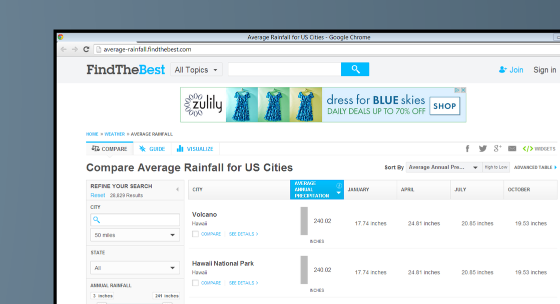


Figure 9. *Illustrates the Average Precipitation link, to look up current average precipitation in the cities within the United States.*

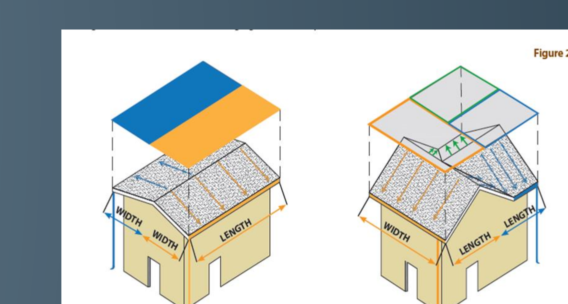


Figure 10. *Shows that the runoff equation does not take into consideration the pitch of the rooftop.*

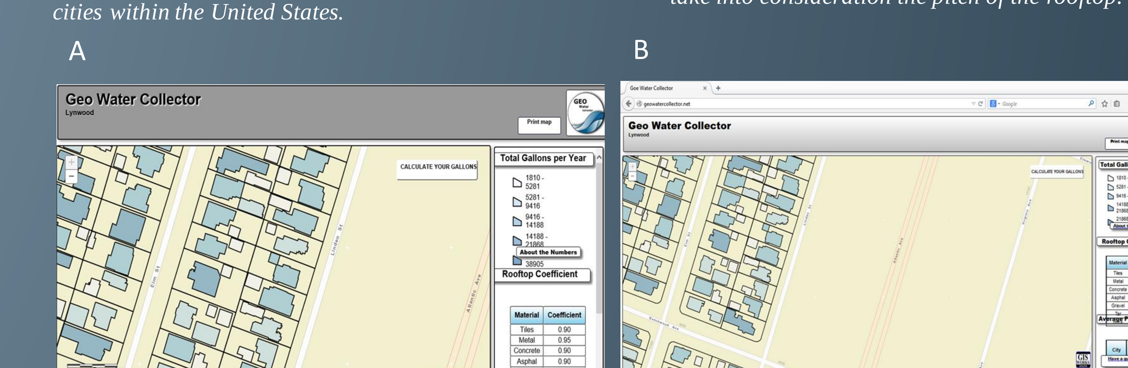


Figure 10A and 10B. *Browser compatibility limitations. Left (Internet Explorer. Right (FireFox).*

Conclusion

Our study is a sample study that can be implemented by the homeowner. We also hope to provide water service municipalities ideas for creating incentives for those homeowners that wish to implement water conservation techniques through the use of our Geo Water Collector web application that was created by using GIS Techniques. The purpose of the study is to demonstrate the use of GIS to visualize the potential of Domestic Rain Water Harvesting (DRWH) for single family residential homes, for the conservation of water. The Geo Water Collector web application can change the way we use water domestically through an alternative DRWH system. The DRWH system can help in enforcing the conservation of water needed for Southern Californian's but not limited to any particular geographic location. The calculator created within the Geo Water Collector web application is not formatted with the data used, it is independent of the layers. Therefore, in our "about the numbers" button the user can find what they need to calculate their own water savings in gallons. We found that this web application can be suited for water service municipalities in that it can be a quick tool for billing discrepancies or other applications. We hope that water service municipalities could implement the Geo Water Collector web application within their current frameworks without disturbing their current framework. Therefore, through the use of the Geo Water Collector web application, we feel that for an initial quick spatial analysis of the potential for DRWH of single family residential homes. The results and the significance of this pilot study is that we can give non GIS professionals and GIS professionals a tool to gather spatial information concerning their own rooftops. Consequently, the type of analysis and web application created to find the potential in DRWH is helpful in giving approximate gallons saved through the resources provided in the Geo Water Collector and the equation used.

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