Contents

1 Introduction

This manual describes how to use the Tacoma Watershed Insights web application. This application lets users track stormwater infrastructure, assess performance, and make informed decisions regarding stormwater and water quality in Tacoma.

1.1 Purpose

The purpose of this manual is to provide a guide for users who want to learn how to navigate and use the Tacoma Watershed Insights web application. The manual covers the following topics:

- How to access and log in to the application
- How to view and explore the map and data layers
- How to use the tools and features of the application
- How to export and share data and reports

This manual is focused on the usability of the web application. It does not provide technical details about the methodology behind calculations or modeling assumptions. For information regarding these aspects, please refer to the Technical Methodology Report [1].

The manual assumes that users have a basic familiarity with web browsers and GIS concepts. The manual also provides links to external resources for further information and learning.

1.2 Key Concepts

Before using the Tacoma Watershed Insights web application, it is helpful to understand some key concepts that are used in the tool. These concepts are also referred to throughout this manual.

[1] *Technical Methods and Approach Document - City of Tacoma Watershed Planning Project.* Geosyntec Consultants, June 2023.

1.2.1 Climate Epochs

Stormwater facility results are calculated based on continuous rainfall-runoff simulation using a regional precipitation data set.[2]

Four scenarios or *climate epochs* have been developed as shown in Table 1.1.

Table 1.1: Climate Epochs

Scenario	Begin	End
1980s (Historic)	January 1, 1970	December 31, 1999
2030s	January 1, 2000	December 31, 2039
2050s	January 1, 2040	December 31, 2069
2080s	January 1, 2070	December 31, 2099

1.2.2 Facility Types

Water quality and hydrology calculations are specific to each facility type. *Facility Type* refers to stormwater facility names used by the City of Tacoma.

Table 1.2: Facility Types contained in the Tacoma Watershed Insights application

Facility Type	Description
Filterra/Vegetated box	Manufactured devices with high-rate filtration media that support plants.
Media Filter	Manufactured devices with high-rate filtration media consisting of a variety of inert and sorptive media types and configurations (e.g., cartridge filters, upflow filters, membrane filters, vertical bed filters).

[2] Salathé, E.P., Hamlet, A.F., Mass, C.F., Lee, S-Y., Stumbaugh, M., Steed, R. 2014. Estimates of Twenty-first Century flood risk in the Pacific Northwest based on regional scale climate model simulations. J. Hydrometeorology 15(5): 1881-1899, https://doi.org/10.1175/JHM-D-13-0137.1

Facility Type	Description
Oil-water Separator	Manufactured devices including oil/water separators and baffle chambers designed for removing floatables and coarse solids.
Pervious Pavement	Full-depth pervious concrete, porous asphalt, paving stones or bricks, reinforced turf rings, and other permeable surface designed to replace traditional pavement.
Pond/wet vault	Surface wet pond with a permanent pool of water, may include underground wet vaults.
Bioretention	Shallow, vegetated basins with a variety of planting/filtration media and often including underdrains.
Sand Filter	Filter bed with granular media, typically sand.
Swale	Shallow, vegetated channel, also called bioswale or vegetated swale.
Swirl Separator	Manufactured devices providing gravitational settling using swirl concentrators, screens, and baffles. Also referred to as hydrodynamic separators (HDS).
Dry Extended Detention Basin/Tank	Dry extended detention including grass-lined and concrete lined basins that are designed to empty after a storm.
Trench	Filter bed with granular media, typically sand. Full infiltration
Vault	Concrete-lined basins that drain after a storm.

1.2.3 Simple vs. Detailed Facilities

In the context of the Tacoma Watershed Insights application, facilities can be modeled as one of two types: Simple and Detailed.

The Tacoma Watershed Insights application models stormwater infrastructure as either Simple or Detailed facilities based on the availability of data and the complexity of the facility's design and opera-

tion.

1.2.3.1 Simple Facilities

By default, facilities are initially modeled as Simple Facilities unless detailed information has been entered. The Simple Facility model is used when detailed data about a facility is not available, such as the specific design parameters of the facility or the infiltration area. Simple facilities are assumed to treat or retain 91% of runoff from the effective drainage area.

1.2.3.2 Detailed Facilities

If more detailed data about a facility are available, the application can model the facility as a Detailed Facility. When the Simple Facility switch is turned off, parameters specific to the facility type become editable. Detailed Facilities provide a more accurate and comprehensive model of a facility's performance.

1.2.4 Pollutants

The Tacoma Watershed Insights application models 8 different stormwater pollutants. These are shown below.

Table 1.3: Stormwater Pollutants

Parameter	Group	EIM Parameter CAS
Bis(2-ethylhexyl) phthalate	Phthalate	117-81-7
Copper	Metal	7440-50-8
Phenanthrene	LPAH	85-01-8
Pyrene	HPAH	129-00-0
Total Nitrogen	Nutrient	None
Total Phosphorus	Nutrient	7723-14-0
Total Suspended Solids	Conventional	None
Zinc	Metal	7440-66-6

1.2.5 Subbasins

A Subbasin is a geographical area that drains into a particular receiving water or collection system node. In addition to reporting facility performance, the tool reports metrics on a subbasin level.

The subbasins used in this tool have been developed by the City of Tacoma. They are summarized in Table 1.4. Subbasins are referenced by a unique subbasin code using the subbasin code prefix shown in Table 1.4. For example, the first subbasin that is part of the Flett Creek Basin would be `FL_01`.

Table 1.4: City of Tacoma Subbasins

Basin	Number of Subbasins	Subbasin Code prefix
Flett Creek	10	`FL_`
Foss Waterway	15	`FS_`
Joes Creek	3	`JC_`
Leach Creek	6	`LC_`
Lower Puyallup	6	`LP_`
North Tacoma	11	`NT_`
Northeast Tacoma	6	`NE_`
Tideflats	6	`TF_`
Western Slopes	4	`WS_`

2 System Administration

2.1 Sign Up as a New User

You must register and be approved as a new user before using the site. To sign up, click **Login** in the upper right hand corner of the site. At the login page, click **Register** to be taken to the registration page. After entering the required details, click **Submit** to create your account. An email will be sent to your provided email address for verification.

Before you can access the site, your account must be approved by a User Admin. See the Modifying User Roles section for information on approving new users.

2.2 User Roles

Users can have one of the following roles associated with their account.

Only a User Admin or System Admin may edit user roles.

Table 2.1: Roles and Permissions

Role	Permissions
Public	None
Read-only	Read access to data via site and via token
User/Editor	All of the above, plus • access to scenarios and editing data
User Admin	All of the above, plus • access to user manager • access to application settings
System Admin	All of the above, plus • direct api access

2.3 Managing Users

Only a User Admin or System Admin may edit user roles. To approve new users and to update user roles, follow these steps.

1. Click on your profile avatar in the upper left-hand corner of the screen.
2. Select **Manage Users** from the menu.

You will be taken to the Manage Users page, where you can edit and save user role information.

3 Viewing Results with the Map Explorer

The map explorer module is the main access point for all the spatial resources that can be used to view existing infrastructure and water quality conditions.

3.1 Viewing Layers

By default, the following layers are enabled:

- Stormwater facilities
- Stormwater facility delineations
- Stormwater subbasins

To view other layers select the layer icon on the left-hand menu. A new panel will display with available layers.

Other layers that can be viewed are shown below.

Table 3.1: Map Data Layers

Category	Layer Name
Conveyances	Catchbasin Leads Regional Facility Model: Manholes Surfacewater Inlet Surfacewater Main Surfacewater Trunk
Landcover & Landuse	Land Cover Category Imperviousness Contours Runoff Terrain

Category	Layer Name
Pollutants	Total Copper Concentration
	Total Nitrogen Concentration
	Total Suspended Solids Concentration
	Total Zinc Concentration

3.2 Viewing Facility Overview Information

You can view summary information for a particular BMP by clicking on it from the Map Explorer. The map will zoom to the selected facility and a panel will be displayed showing information on a facility.

3.3 Viewing Facility Details

Click on **View Facility Details** from the Facility Overview Panel to see and edit particular facility attributes. In addition to the overview information displayed on the Map Explorer, you can view water quality parameters, cost analysis parameters, and detailed performance data.

3.4 Exporting Facility Details

To export detailed facility data, click on **Export Results** from the Facility Detail Page. This will export a `.csv` file with all facility attributes and performance results.

3.5 Searching for a Facility

To search for a particular facility, select the search icon on the left-hand toolbar. A panel will appear with search options. You may search by the following categories:

- **altid/node_id** - Refers to the facility id.
- **Facility Type** - Refers to the City designated facility type
- **Facility Type (WQ Modeling)** - Refers to the facility type designation used for water quality modeling

4 Results Viewer

4.1 Using the BMP Facility Results View

The BMP Facility Results View can be used to view a summary of the performance of existing BMP's. To access the viewer, select **WQ Results Viewer** from the dropdown menu at the top menu bar, or from the homepage.

You can view individual BMP results by selecting the **BMP Facility Results View** card or by selecting the icon on the left-hand menu bar. Results are summarized by climate epoch.

4.2 Using the Subbasins Results View

The water quality results viewer can be used to view the conditions of each stormwater subbasin. To access the viewer, select it from the dropdown menu at the top menu bar, or the homepage.

You can view aggregated results by subbasin by selecting the **Subbasin Results View** card or by selecting the icon on the left-hand menu bar. To view a chloropleth map of results, select the parameter to visualize from the menu next to the map.

4.3 Exporting Results

To export results from the Subbasin Results View, click the **Export** button on the table below the map. This will download a CSV file of all results. To export a selection of data, select the rows you want to export on the table, then click **Export**.

5 Editing Facility Data

5.1 Editing Water Quality Parameters

You can edit the parameters used to model facilities in the **Facility Details** view. There are several ways to navigate to this view:

- From the Map Explorer map, click on a facility to open the Facility Overview panel. Then, click on **View Facility Details** to be taken to the detail page.
- From the **Water Quality Results Viewer,** click on a BMP name in the table.

5.2 Updating from Simple to Detailed Facility

By default, most facilities are modeled as simple facilities, meaning only two parameters are used: Captured Percentage, and Retained Percentage. The Simple Facility type should be used when detailed data about a facility are not available (e.g. the facility's infiltration area).

If more detailed data are available, turn off the Simple Facility switch, and parameters specific to the facility type will be editable.

5.3 Editing Facility Type

If a Facility Type needs to be updated, select the Facility Type dropdown menu, and choose the appropriate facility type. Click **Save** to save your edits.

Warning Saving your edits does not recalculate results. To recalculate, click the **Refresh Results** button on the Facility Details Page.

5.4 Editing Life Cost Analysis Parameters

By default, facilities will not have cost parameters unless users provide cost analysis parameters. Facilities without cost data will show the following message under the Lifecycle Cost Analysis Heading:

> *Lifecycle costs are unavailable for this facility. This usually means that the "Cost Analysis Parameters" are incomplete.*

To edit lifecycle cost parameters, select the dropdown menu titled **Cost Analysis Parameters.** There, you can enter the cost analysis parameters directly for a facility. See the Cost Analysis Parameters section for descriptions of parameters.

5.4.1 Cost Estimator Tool

To assist with selection of cost analysis parameters, a cost estimator tool is available; it uses cost curves and methodology developed by King County to provide high-level cost estimates for various facilities. To use this tool, select a BMP to view the BMP facility details page. Next, click on the cost analysis parameters drop down and then click on the **King County Cost Estimator Tool.** This will open a dialog box to select and apply data from King County cost curves.

First, select the appropriate facility type under the **BMP Type** dropdown menu. This will preselect an appropriate BMP Cost Curve used by King County (**KC BMP Variation** in the tool). You can refine or change the selected cost curve under the **KC BMP Variation** menu. Cost curves that match the selected **BMP Type** will be shown in **bold**.

In order to calculate the cost parameters, you must enter a sizing parameter in the next dialog box. Depending on the cost curve selected, the dialog box will display either *area (sqft)* or *each (count).* Here, *area* refers to the footprint area of a facility (e.g. the total area of pervious pavement), or the number of facilities to be installed (e.g. number of UIC wells).

After entering the number denoting the area or number of facilities, the Capital Cost and O&M Costs will be calculated. Click *Apply to BMP Form* to apply the calculated costs to the facility. To calculate the final lifecycle cost, you will need to enter data for the following:

Install Year - The year of installation, denoting what year to apply the capital costs.

Replacement Cost - The cost to replace a facility. This cost is intended to reflect costs related to major replacement of facility components, such as replacement of soil after multiple years of use.

Lifespan Yrs - How long the facility would be operated before replacement would be necessary.

5.4.2 Global Cost Settings

In order to calculate lifecycle costs the same way for every facility, the tool uses four global cost parameters (*discount rate*, *inflation rate*, *planning horizon*, and *cost basis year*). These parameters apply to all facilities analyzed, instead of a particular facility.

To edit these global parameters, select *Settings* under your user profile in the top left portion of the screen. Individual cost parameters can be edited by clicking the edit tool to the left of each parameter name.

6 Using the Prioritization Module

The watershed prioritization module allows users to identify and prioritize areas for actions to meet watershed planning goals related to water quality, habitat, and social equity.

6.1 Selecting Project Type

The *Project Type* dialog denotes what type of project is being considered. The two choices are:

- **Retrofit** - Projects that are intended to improve water quality or hydrology. This choice gives a higher priority to subbasins that have a higher pollutant load, or do not have adequate stormwater infrastructure.
- **Preservation** - Projects that are intended to preserve an area in a subbasin with better water quality or already have adequate stormwater infrastructure.

6.2 Setting Priority Weights

The prioritization tool allows users to weight watershed management goals based on their relative importance. Weights are positive numbers

Weights can be zero or any positive number, and reflect a decision maker or stakeholders preferences. The higher the weight, the more important the criterion. Numerically, this represents a factor of preference. For example if Goal A has a weight of 1 and Goal B has a weight of 2, Goal B will be treated as twice as important as Goal A.

No constraints have been set on the scale of weights, however, it is common practice to set a total number of weighting points (e.g. 10 points) and assign weights so that the sum of weights is equal to this predetermined total.

Priority weights are assigned for each major watershed goal. Goals are comprised of subgoals and numeric metrics as described in Table 6.1:

Table 6.1: Watershed Planning Goals used in the Prioritization Module.

Goals	Sub-goals	Criteria
Goal 1: Improve Water Quality Outcomes (Clean Water Goal)	1.1 Prioritize areas based on pollutant concentrations	Total Nitrogen Concentration, TSS Concentration, Annual Runoff, Imperviousness
	1.2 Improve infrastructure in areas with inadequate stormwater management	Percent of Area Treated, Age of Development
Goal 2: Increase Resilience to Climate Change Impacts (Resilient Community Goal)	2.1 Target areas most vulnerable to and at risk for climate change impacts	Urban Heat Island, Capacity Issues Layer
Goal 3: Preserve and Restore Critical and Sensitive Habitat (Healthy Ecosystems)	3.1 Preserve and Improve Natural Spaces	ES Open Space/Natural Resource Areas, Biodiversity Corridors
Goal 4: Implement Equity and Social Justice (Healthy Neighborhoods; Equity)	4.1 Prioritize areas of overlapping equity needs as identified by other Tacoma programs	Equity Index Score, Livability Index
	4.2 Improve access to safe, high-quality roadway infrastructure (green infrastructure recommendation)	Pavement Condition Index

6.3 Viewing Prioritization Results

After selecting and submitting priority weights, results will be shown on the chloropleth map and in the *Subbasin Prioritization Results* table.

Subbasins with higher priority scores reflect a higher preference for new projects based on user weighting. Clicking on a row will highlight the selected subbasin on the map.

6.4 Downloading Prioritization Results

To understand the breakdown of attributes and weights from the prioritization module, download the results by clicking on the *Export* button. This will download a .CSV file listing subgoals, criteria, weights, direction of criteria (whether a criterion should be minimized or maximized), as well as the criterion-specific results.

7 Using the Scenario Designer

The Scenario Designer is used to create and evaluate potential new facilities or groups of facilities. It can be used to assess the potential performance of a new action, or compare various alternative actions.

7.1 Creating a New Scenario

To create a new scenario, click **Create New Scenario** in the Scenario Designer page. A new window will open with a multi-step form where you can enter information about your scenario. The first step asks for basic information about your scenario. Enter this information, then click **Next.**

7.1.1 Creating a New Delineation.

The next step is to create a new delineation. The new delineation represents the area that drains to a new facility. Enter a name for this new delineation and then click the **edit icon** on the map window.

Use the stormwater upstream trace tool in Tacoma's GIS system (AccessES) to identify the approximate upstream drainage area to the node where you plan to install the new facility. Draw the new delineation on the map. Double-click to complete the delineation. To delete a delineation after it has been completed, click the **delete icon** on the map window.

Once you have finished creating the delineation, click **Next.**

7.1.2 Creating a new facility

The final step is to create a new BMP facility. Under the **Create a BMP** section, add water quality parameters and cost analysis parameters. See the section on Editing Facility Data for instructions.

Use the map to indicate the location for the new facility. Click the **Edit Icon** in the map window and then click on your desired location on the map. Save your location by clicking on the **Accept Edits** icon. Then click **Next** under the **Create a BMP** form.

The new scenario will be summarized on the next screen. If everything looks good, click **Create Scenario** to save your scenario. On the next screen, be sure to click **Calculate Scenario WQ Results** to generate results.

Caution You must click **Calculate Scenario WQ Results** to generate performance results for your scenario.

8 Data Integrations

Facility data, subbasin data, and results can be easily integrated into other tools and applications through the **Data Integration Module.** Navigate to the module by clicking on **Profile** under the user menu in the top left corner of the application. The **Data Integration** panel is displayed below your profile information.

Data integration is performed through a REST API, which uses HTTP methods to read data from the tool.

8.1 Obtaining a read-only token

Each user is assigned a unique read-only token. This token allows the API server to identify and authorize your requests. Your read-only token will be displayed beneath your user profile.

8.2 Token Rotation

It is good practice to change your token at regular intervals, or in the event of your token being compromised. To rotate your token, click the **Rotate Token** button next to your token.

8.3 Making API Calls

All API calls are GET requests and are made in the following format:

```
https://www.tacomawatersheds.com/api/rest/{resource}/ {resource_id}/token/{toke
```

In the above URL structure, `{resource}` is the data type you are requesting, `{resource_id}` is the specific ID of the resource (optional and depends on the endpoint), and `{token}` is your unique read-only token.

8.3.1 API Endpoints

This API is organized around several endpoints representing different types of resources: `tmnt_facility`, `tmnt_delineation`, `subbasin`, and `results`. All responses are provided in JSON format unless otherwise specified.

Common Parameters:

- `f`: (optional, default=json, [json, geojson]) Format of response data
- `limit`: (optional, default=1e6) Number of records to return
- `offset`: (optional, default=0) Start from index
- `epoch`: (optional, default=1980s, [all, 1980s, 2030s, 2050s, 2080s]) Climate epoch filter

Get attributes for all treatment facilities:

```
/api/rest/tmnt_facility/token/{token}?f={f}&limit={limit}    &off-
set={offset}
```

Get attributes for a specific treatment facility:

```
/api/rest/tmnt_facility/{altid}/token/{token}
```

Replace `{altid}` with the specific facility id.

Get attributes for all delineations:

```
/api/rest/tmnt_delineation/token/{token}?f={f}&limit= {limit}&offset={offset}
```

Get attributes for a specific delineation:

```
/api/rest/tmnt_delineation/ {altid}/token/{token}?f={f}
```

Replace `{altid}` with the specific delineation id.

Get attributes for all subbasins:

```
/api/rest/subbasin/token/{token}?f={f}&limit={limit}& offset={offset}
```

Get attributes for a specific subbasin:

```
/api/rest/subbasin/{subbasin_id}/token/{token}
```

Replace `{subbasin_id}` with the specific subbasin id.

Get water quality results for a specific subbasin:

```
/api/rest/subbasin/wq/{subbasin_id}/token/{token}?epoch={epoch}
```

Replace `{subbasin_id}` with the specific subbasin id.

Get water quality results for all subbasins:

```
/api/rest/subbasin/wq/token/{token}?f={f}&limit={limit}&offset=
{offset}&epoch={epoch}
```

Get results:

```
/api/rest/results/token/{token}?ntype={ntype}&limit= {limit}&offset={offset}epo
```

The `ntype` parameter is optional and filters the data by node type (land_surface, tmnt_facility).

8.4 How to connect Excel with Tacoma Watersheds Results

Power Query is a powerful tool within Microsoft Excel that allows you to import data from various external data sources, including RESTful APIs. This tutorial will guide you on how to connect Excel Power Query with the Tacoma Watersheds `results` API.

Before starting, make sure you have your unique read-only token from the Tacoma Watersheds API.

8.4.1 Step 1: Open Power Query

1. Open Excel, and go to the **Data** tab in the Ribbon.
2. Click on **Get Data** in the left corner of the Ribbon.
3. In the dropdown menu, select **From Other Sources**, then **From Web**.

8.4.2 Step 2: Connect to the API

1. A pop-up window will appear prompting you to enter a URL.
2. In this field, enter the following API endpoint URL:

```
https://www.tacomawatersheds.com/api/rest/results/token/{token}?
ntype={ntype}limit={limit}& offset={offset}&epoch={epoch}
```

Replace `{token}` with your unique read-only token and fill in the `{ntype}`, `{limit}`, `{offset}`, and `{epoch}` as per your requirements. For example, if you want to get all results for `land_surface` node type and for the `1980s` climate epoch, your URL would be:

> `https://www.tacomawatersheds.com/api/rest/results/token/ your_token?ntype=land_`
>
> Click **OK**

8.4.3 Step 3: Parse the Response

1. A new window named **Power Query Editor** will open, and Excel will show you a preview of the data.
2. If the data appears as a single column of records, click on **List** to convert it to a table. Then click on the button with two arrows on the right side of the header of the column to expand the data into a tabular format.
3. If the data is in nested JSON format, you may need to click on the double-arrow button again to fully expand the data.

8.4.4 Step 4: Load the Data

1. Once you are satisfied with the preview of the data, click on **Close & Load** in the **Home** tab.
2. Excel will create a new worksheet and load the data into a table.

9 Source Code and Deployment

9.1 Source Code Information

Source code is available for the public at the project github repository: github.com/Geosyntec/StormPiper.

The source code is licensed under the Mozilla Public License 2.0 (MPL 2.0).

9.1.1 About the MPL 2.0

The MPL 2.0 is a free and open-source software license that allows the software to be freely used, modified, and shared under specific terms. Key highlights of the MPL 2.0 include:

- **Copyleft:** Modified files must be released under the same license, but linking is allowed without affecting the rest of the project.
- **Distribution:** You can distribute the code in both source and compiled form, provided you include the license file.
- **Attribution:** The original copyright notices must be retained in redistributed code.
- **Warranty Disclaimers and Liability Limitations:** The license includes standard provisions to protect contributors from legal claims.

You can view the full text of the MPL 2.0 license and specific details regarding the StormPiper project in the GitHub repository at:

https://github.com/Geosyntec/StormPiper/blob/main/LICENSE

Please refer to the `LICENSE` file within the repository for the complete terms and conditions governing the use of the StormPiper source code.

9.2 Local Development

9.2.1 Pre-requisites

Ensure you have Git, Python, Conda, and Docker installed on your system.

9.2.2 Getting Started

Follow the steps below to get the app up and running on your system:

9.2.2.1 Clone the Repository

First, clone the StormPiper repository:

```
git clone git@github.com:Geosyntec/StormPiper.git
```

9.2.2.2 Build and Activate a Virtual Environment

Next, create a virtual environment using Conda and activate it:

```
conda create -n stormpiper python=3.11
conda activate stormpiper
```

9.2.2.3 Install the Required Dependencies

Navigate to the StormPiper directory and install the necessary dependencies:

```
cd StormPiper
pip install -r stormpiper/requirements.txt
pip install -r stormpiper/requirements_test.txt
```

9.2.3 Running the Development Server

Run the development server with the following command:

```
uvicorn stormpiper.main:app --reload --port 8000
```

You can access the documentation at `localhost:8000/docs`.

9.2.4 Making Changes and Maintenance

9.2.4.1 Running Tests

Run the tests using:

```
pytest
```

To check test coverage:

```
coverage run --branch -m pytest
coverage report -m
```

9.2.4.2 Code Formatting and Type Checks

Use the provided script to check code formatting and type declarations:

```
bash scripts/lint.sh
```

9.2.5 Docker Deployment

9.2.5.1 Building the Container

Use the following command to build the container. It runs `make clean`, `make stack`, and then `make build`:

```
make develop
```

9.2.5.2 Running the Container

Start the container with:

```
make up
```

You can access the development server at `localhost:8080`.

To silence the logs, run the container in `daemon` mode:

```
make up-d
```

9.2.5.3 Stopping the Container

Stop the container by using:

```
make down
```

9.3 Deployment

Deploying the applicaiton on your own server requires knowledge of Kubernetes. Kubernetes is an open-source container orchestration platform that automates the deployment, scaling, and management of containerized applications. It provides mechanisms for deploying and managing applications across multiple servers, ensuring high availability and scalability.

See the Kubernetes documentation on Google Cloud Plaform for more information.

9.4 Deployment configuration

See the deployment scripts on the github repo for examples on how this applicaiton was deployed: https://github.com/Geosyntec/StormPiper/tree/main/.github/workflows

10 Parameter Definitions

10.1 Facility Parameters

Table 10.1: Facility Input Data

Parameter	Description
area_sqft	The footprint area of the facility in square feet.
captured_pct	The average annual percent of stormwater captured by the facility.
depth_ft	The depth of ponding for the facility in feet.
hsg	Hydrologic Soil Group classification for native infiltration. Valid Options: A B C D
inf_rate_inhr	The infiltration rate at the facility location in inches per hour.
media_filtration_rate_inhr	The media filtration rate at the facility in inches per hour.
retained_pct	The percent of stormwater retained or infiltrated by the facility.
retention_volume_cuft	The design retention volume of the facility in cubic feet.
treatment_rate_cfs	The treatment rate of the facility in cubic feet per second.

Table 10.2: Facility Water Quality Result Parameters

Parameter	Description
DEHP_conc_mg/l_effluent	Mean annual concentration of Bis(2-ethylhexyl) phthalate (DEHP) discharged from a facility (mg/l)
DEHP_conc_mg/l_influent	Mean annual concentration of Bis(2-ethylhexyl) phthalate (DEHP) flowing to a facility (mg/l)
DEHP_load_lbs_inflow	Mean annual load of Bis(2-ethylhexyl) phthalate (DEHP) entering a facility (lbs)
DEHP_load_lbs_removed	Mean annual load of Bis(2-ethylhexyl) phthalate (DEHP) removed by a facility (lbs)
DEHP_load_lbs_total_discharged	Mean annual load of Bis(2-ethylhexyl) phthalate (DEHP) exiting a facility (lbs)
PHE_conc_mg/l_effluent	Mean annual concentration of Phenanthrene discharged from a facility (mg/l)
PHE_conc_mg/l_influent	Mean annual concentration of Phenanthrene flowing to a facility (mg/l)
PHE_load_lbs_inflow	Mean annual load of Phenanthrene entering a facility (lbs)
PHE_load_lbs_removed	Mean annual load of Phenanthrene removed by a facility (lbs)
PHE_load_lbs_total_discharged	Mean annual load of Phenanthrene exiting a facility (lbs)
PYR_conc_mg/l_effluent	Mean annual concentration of Pyrene discharged from a facility (mg/l)
PYR_conc_mg/l_influent	Mean annual concentration of Pyrene flowing to a facility (mg/l)

Parameter	Description
PYR_load_lbs_inflow	Mean annual load of Pyrene entering a facility (lbs)
PYR_load_lbs_removed	Mean annual load of Pyrene removed by a facility (lbs)
PYR_load_lbs_total_discharged	Mean annual load of Pyrene exiting a facility (lbs)
TCu_conc_ug/l_effluent	Mean annual concentration of Total Copper discharged from a facility (ug/l)
TCu_conc_ug/l_influent	Mean annual concentration of Total Copper flowing to a facility (ug/l)
TCu_load_lbs_inflow	Mean annual load of Total Copper entering a facility (lbs)
TCu_load_lbs_removed	Mean annual load of Total Copper removed by a facility (lbs)
TCu_load_lbs_total_discharged	Mean annual load of Total Copper exiting a facility (lbs)
TN_conc_mg/l_effluent	Mean annual concentration of Total Nitrogen discharged from a facility (mg/l)
TN_conc_mg/l_influent	Mean annual concentration of Total Nitrogen flowing to a facility (mg/l)
TN_load_lbs_inflow	Mean annual load of Total Nitrogen entering a facility (lbs)
TN_load_lbs_removed	Mean annual load of Total Nitrogen removed by a facility (lbs)
TN_load_lbs_total_discharged	Mean annual load of Total Nitrogen exiting a facility (lbs)
TP_conc_mg/l_effluent	Mean annual concentration of Total Phosphorus discharged from a facility (mg/l)
TP_conc_mg/l_influent	Mean annual concentration of Total Phosphorus flowing to a facility (mg/l)
TP_load_lbs_inflow	Mean annual load of Total Phosphorus entering a facility (lbs)

Parameter	Description
TP_load_lbs_removed	Mean annual load of Total Phosphorus removed by a facility (lbs)
TP_load_lbs_total_discharged	Mean annual load of Total Phosphorus exiting a facility (lbs)
TSS_conc_mg/l_effluent	Mean annual concentration of Total Suspended Solids discharged from a facility (mg/l)
TSS_conc_mg/l_influent	Mean annual concentration of Total Suspended Solids flowing to a facility (mg/l)
TSS_load_lbs_inflow	Mean annual load of Total Suspended Solids entering a facility (lbs)
TSS_load_lbs_removed	Mean annual load of Total Suspended Solids removed by a facility (lbs)
TSS_load_lbs_total_discharged	Mean annual load of Total Suspended Solids exiting a facility (lbs)
TZn_conc_ug/l_effluent	Mean annual concentration of Total Zinc discharged from a facility (ug/l)
TZn_conc_ug/l_influent	Mean annual concentration of Total Zinc flowing to a facility (ug/l)
TZn_load_lbs_inflow	Mean annual load of Total Zinc entering a facility (lbs)
TZn_load_lbs_removed	Mean annual load of Total Zinc removed by a facility (lbs)
TZn_load_lbs_total_discharged	Mean annual load of Total Zinc exiting a facility (lbs)

Table 10.3: Facility Hydrology Result Parameters

Parameter	Description
bypassed_pct	Percent of mean annual runoff bypassed by a facility

Parameter	Description
design_intensity_inhr	Design storm intensity for a flow-based facility (in/hour)
design_volume_cuft_cumul	design volume for a volume-based facility (cubic feet)
ro_coeff	Design runoff coefficient for a facility
runoff_volume_cuft_bypassed	Mean annual runoff volume bypassed by a facility (cubic feet)
runoff_volume_cuft_captured	Mean annual runoff volume captured by a facility (cubic feet)
runoff_volume_cuft_inflow	Mean annual runoff volume entering a facility (cubic feet)
runoff_volume_cuft_retained	Mean annual runoff volume retained by a facility (cubic feet)
runoff_volume_cuft_total_discharged	Mean annual runoff volume exiting a facility (cubic feet)
runoff_volume_cuft_treated	Mean annual runoff volume treated by a facility (cubic feet)

10.2 Cost Data Parameters

Table 10.4: Global Cost Parameters

Parameter	Description
cost_basis_year	The base year for the cost calculation.
discount_rate	The rate used for discounting future cash flows.
inflation_rate	The rate of inflation considered in the cost calculation.
planning_horizon_yrs	The planning horizon in years for cost calculation.

Table 10.5: Facility Cost Parameters

Parameter	Description
capital_cost	The total capital cost for the facility.
capital_cost_basis_year	The base year for the calculation of the capital cost of the facility.
install_year	The year when a facility was or will be installed.
lifespan_yrs	The expected lifespan of a facility in years.
om_cost_basis_year	The base year for the calculation of the operation and maintenance cost of the facility.
om_cost_per_yr	The operation and maintenance cost of a facility per year.
present_value_capital_cost	The present value of the capital cost of the facility.
present_value_chart_table	The present value chart table related to the facility.
present_value_cost_table	The present value cost table related to the facility.
present_value_om_cost	The present value of the operation and maintenance cost of the facility.
present_value_total_cost	The total present value cost of the facility.
replacement_cost	The cost to replace or perform major upgrade to the facility.

10.3 Subbasin Parameters

Table 10.6: Landcover parameters

Parameter	Description
lc_pasture_pct	Landcover Pasture (pct)

Parameter	Description
lc_grass_pct	Landcover Grass (pct)
lc_water_pct	Landcover Water (pct)
lc_imp_roof_pct	Landcover Impervious-roof (pct)
lc_imp_nonroof_pct	Landcover Impervious-nonRoof (pct)
lc_imp_total_pct	Landcover Impervious-total (pct)

Table 10.7: Land Use parameters

Parameter	Description
lu_resair_pct	Landuse Airport Compatibility Residential (pct)
lu_commcmu_pct	Landuse Crossroads Mixed-Use Center (pct)
lu_rgcd_pct	Landuse Downtown Regional Growth Center (pct)
lu_com_pct	Landuse General Commercial (pct)
lu_indh_pct	Landuse Heavy Industrial (pct)
lu_indl_pct	Landuse Light Industrial (pct)
lu_resl_pct	Landuse Low-Scale Residential (pct)
lu_ins_pct	Landuse Major Institutional Campus (pct)
lu_resm_pct	Landuse Mid-Scale Residential (pct)
lu_resmfhd_pct	Landuse Multi-Family (High Density) (pct)
lu_comn_pct	Landuse Neighborhood Commercial (pct)
lu_comnmu_pct	Landuse Neighborhood Mixed-Use Center (pct)
lu_os_pct	Landuse Parks and Open Space (pct)
lu_shore_pct	Landuse Shoreline (pct)
lu_rgctm_pct	Landuse Tacoma Mall Regional Growth Center (pct)

Table 10.8: Subbasin Parameters

Parameter	Description
area_acres	The total subbasin area in acres.
basicwq_area_acres	The area in acres allocated for basic water quality.
basicwq_area_pct	The percentage of total area allocated for basic water quality.
eff_area_acres	The effective impervious area within a subbasin in acres.
eff_area_pct	The percentage of total area that is effective impervious area.
enhwq_area_acres	The area in acres treated by enhanced water quality facilities.
enhwq_area_pct	The percentage of total subbasin area treated by enhanced water quality facilities.
fc_area_acres	The area in a subbasin in acres treated by flow control facilities.
fc_area_pct	The percentage of total subbasin area treated by flow control facilities.
runoff_depth_inches	Depth of runoff in inches.
runoff_volume_cuft	Volume of runoff in cubic feet.
runoff_volume_cuft_generated	Volume of runoff generated in cubic feet.
runoff_volume_cuft_reduced	Volume of runoff reduced in cubic feet.
runoff_volume_pct_reduced	The percentage of runoff volume reduced.
tmnt_facility_count	Total number of treatment facilities within a subbasin
treated_area_acres	The area in acres that has been treated by stormwater facilities
treated_area_pct	The percentage of total area that has been treated by stormwater facilities

11 Appendix A - Technical Methodology

12 Appendix B - King County Unit Cost Basis

13 Appendix C - Workshop Slides