TRADE-OFF TOOL FOR SAMPLING (TOTS)

U.S. Environmental Protection Agency

User's Guide

Disclaimer

The U.S. Environmental Protection Agency, through its Office of Research and Development, funded and managed the research described here under Contract EP-C-16-015 to Eastern Research Group, Inc. It has been subjected to the Agency's review and has been approved for publication. Note that approval does not signify that the contents necessarily reflect the views of the Agency. Mention of trade names, products, or services does not convey official EPA approval, endorsement, or recommendation.

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Foreword

The U.S. Environmental Protection Agency (EPA) is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. To meet this mandate, EPA's research program is providing data and technical support for solving environmental problems today and building a science knowledge base necessary to manage our ecological resources wisely, understand how pollutants affect our health, and prevent or reduce environmental risks in the future.

The Center for Environmental Solutions and Emergency Response (CESER) within the Office of Research and Development (ORD) conducts applied, stakeholder-driven research and provides responsive technical support to help solve the Nation's environmental challenges. The Center's research focuses on innovative approaches to address environmental challenges associated with the built environment. We develop technologies and decision-support tools to help safeguard public water systems and groundwater, guide sustainable materials management, remediate sites from traditional contamination sources and emerging environmental stressors, and address potential threats from terrorism and natural disasters. CESER collaborates with both public and private sector partners to foster technologies that improve the effectiveness and reduce the cost of compliance, while anticipating emerging problems. We provide technical support to EPA regions and programs, states, tribal nations, and federal partners, and serve as the interagency liaison for EPA in homeland security research and technology. The Center is a leader in providing scientific solutions to protect human health and the environment.

This report provides a brief overview of the tools and frameworks available to support the remediation activities related to wide-area sampling planning and implementation during a biological incident; a workflow illustration that depicts the relationship and sequence of the tools and frameworks and how to utilize these resources to rapidly develop actionable plans; and brief recommendations on tool improvements and collaboration.

Gregory Sayles, Director
Center for Environmental Solutions and Emergency Response

U.S. ENVIRONMENTAL PROTECTION AGENCY

TRADE-OFF TOOL FOR SAMPLING (TOTS)

U.S. Environmental Protection Agency
Homeland Security Research Program
Research Triangle Park, NC 27711

Acronym/Abbreviation List

Acronym	Definition
AAS	Aggressive Air Sampling
AGO	ArcGIS Online
AOI	Area of Interest
API	Application Programming Interface
CESER	Center for Environmental Solutions and Emergency Response (EPA)
CFU	Colony-Forming Unit(s)
CSV	Comma Separated Values
CTR	Combined Targeted and Random
DHS	Department of Homeland Security
EPA	U.S. Environmental Protection Agency
GIS	Geospatial Information Science
GP	Geoprocessing Service
GPX	GPS Exchange Format
GUID	Global Unique Identifier
HSRP	Homeland Security Research Program (EPA)
JS	JavaScript
JSON	JavaScript Object Notation
KML	Keyhole Markup Language
OGC	Open Geospatial Consortium
PIV	Personal Identity Verification
REST	Representational State Transfer
RSS	Resource Description Framework (RDF) Site Summary
TOTS	Trade-off Tool for Sampling
URL	Uniform Resource Locator
VSP	Visual Sample Plan
WMS	Web Map Services
XLS	Microsoft Excel Spreadsheet

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Introduction

Learn about this web-based Geographical Information System (GIS) tool that allows users to create sampling designs and estimate the associated resource demand through interactive, point-and-click tools to visually develop sampling plans
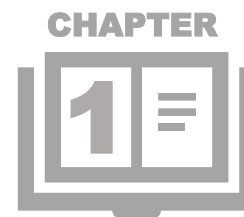
The U.S. Environmental Protection Agency's (EPA) Center for Environmental Solutions and Emergency Response (CESER) within the Office of Research and Development (ORD) conducts applied stakeholder-driven research and provides responsive technical support to help solve the Nation's environmental challenges. The Center's research focuses on innovative approaches to address environmental challenges associated with the built environment. CESER develops technologies and decision-support tools to help safeguard public water systems and groundwater, guide sustainable materials management, remediate sites from traditional contamination sources and emerging environmental stressors, and address potential threats from terrorism and natural disasters. To collect the data necessary to assess the efficacy of remediation efforts following a biological contamination incident, a well-defined and thorough sampling and analysis plan (SAP) needs to be developed and implemented. A large-scale release can result in contamination of a wide area and would require significant time and resources for recovery. As one of the components that go into SAP development, responders will need to select a sampling design that will address the site-specific objectives, meet the clearance goals, and not exceed the available resources (cost and time).

A probability-based sampling design can be used to create statistically defensible sampling plans. However, these plans might have sampling collection and/or processing demands that exceed allotted resources. Targeted sampling designs, also referred to as judgmental sampling, use professional judgment and interpretation and target sample locations with some attribute of interest such as a known area of contamination or areas near the suspected contaminant release point. A targeted-based sampling design might allow responders to quickly determine if an area is contaminated, reducing the overall response costs and recovery time. A combined targeted and random (CTR) sampling design might be used to obtain statistically-sound conclusions while including targeted sampling in areas that are most likely contaminated.

To support remediation activities implemented during the Consequence Management Phase of a biological response, EPA's Homeland Security Research Program (HSRP) developed the Trade-off Tool for Sampling (TOTS). The primary TOTS user community is composed of EPA, Regional, and Department of Homeland Security (DHS) response personnel, including sampling teams and planners, that are responsible for designing and implementing an appropriate sampling strategy. TOTS allows users to create sampling designs and estimate the associated resource demand through interactive point-and-click tools to visually develop sampling plans for biological contamination incidents and might cover other contaminant types in the future. Users can plot sample locations in conjunction with externally developed indoor or outdoor imagery that can be imported into the tool. Based on the plans designed, TOTS estimates the total time and cost necessary for implementation, which includes preparing the sampling kit, conducting the sampling campaign, and analyzing the samples in the laboratory. The resulting sample plan can be used to consider trade-offs in the sampling design (i.e., cost-benefit analysis), alternate sampling approaches (i.e., traditional versus innovative sampling methods), and sampling coverage.

How to Use This Guide

The purpose of this guide is to provide the necessary information to operate the tool. Described in this guide are the methods that provide the basis for the calculations used in the tool and information describing how to access and operate the tool. Appendix A provides a brief Quick Start Guide.

The "icon key" to the right contains symbols used throughout this guide to highlight important information and additional guidance.

ICON KEY
♀ Valuable Tip
⚠ Important Note

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Design and Methodology

Understand the tool's underlying methodology, overall workflow, and default data and assumptions that impact results
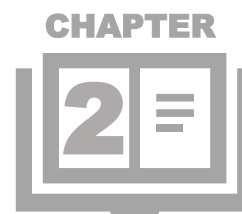
TOTS is a web-based application that requires only an Internet connection and web browser for access. Application design components and the methodology and parameters that are the basis for results within the tool are described in the sections that follow.

Design Components

React, Esri's ArcGIS JavaScript application programming interface (API), and Esri's ArcGIS REST API were used to develop the graphical user interface to support completing tasks required to estimate resource demands associated with developing sampling plans. TOTS also interfaces with a geoprocessing server to support background actions such as converting imported visual sample plan (VSP) files, generating random samples on the map, and comparing samples plotted against a contamination map. ArcGIS allows users to: (1) interact with geoprocessing tools, map layers, datasets, and other data types, and connect them to a process; (2) publish layers to a user's ArcGIS Online account; and (3) share the published layers with other Esri products such as Collector and Survey123. Results can also be downloaded into a Microsoft Excel™ spreadsheet that captures the sampling plan conditions, computational results, and a screenshot of the map. Figure 1 illustrates the overall tool design.
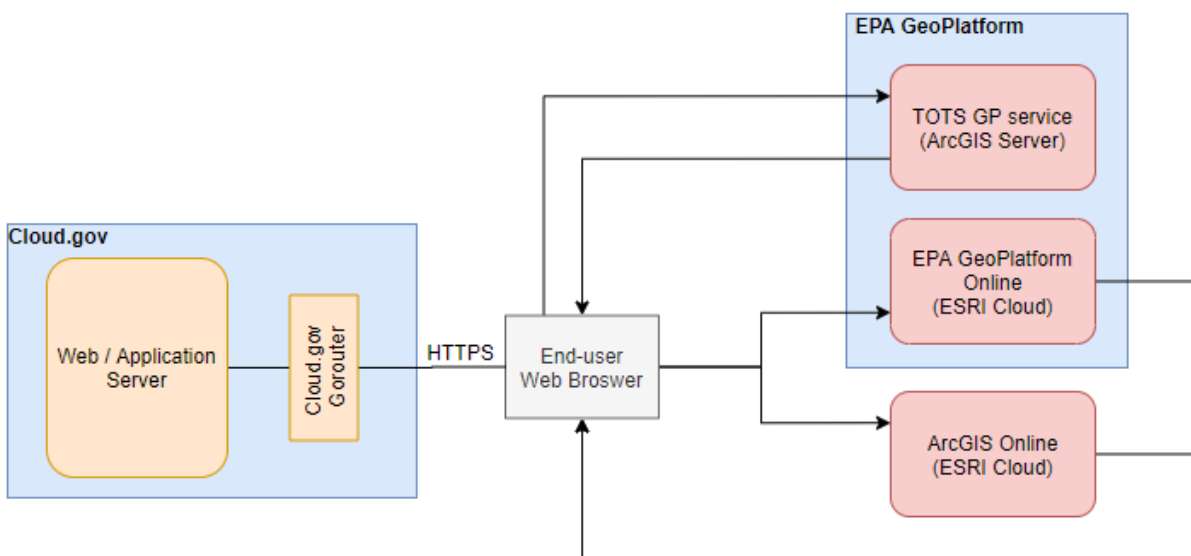
Figure 1. Trade-off Tool for Sampling Design Components

The tool is organized into a sequence of steps (described in Chapter 4 of this user's guide) that guides users through inputs and selections to calculate estimated resource demands for a sampling plan.

Methodology to Estimate Resource Demands

Research was conducted to support estimating cost and time calculations related to sampling biological contamination. Factors were developed for the following six sample method types:

Traditional Methods
1. Swab
2. Sponge Stick
3. 37-mm Microvacuum Filters

Innovative Methods

4. Wet Vacuum
5. Floor Cleaning Robot
6. Aggressive Air Sampling (AAS)

The parameters and calculations used to generate resource demand estimates within the tool are described below. Appendix B presents detailed values that correlate with parameters that are defined for each sample type. The Sample Type Parameters cannot be edited for the default sample method types provided. However, users can create a copy of any default method to create their own custom sample type and edit any of the parameters (see Chapter 4 for guidance on how to Create Custom Sample Types).

Sample Type Parameters

AA = Actual Area of Sample (in^2) as measured by ArcGIS JS API
SA = Reference Sample Surface Area (in^2)
$TTPK$ = Time to Prepare Kits (person hours per sample)
TTC = Time to Collect (person hours per sample)
TTA = Time to Analyze (person hours per sample)
ALC = Analysis Labor Cost
AMC = Analysis Material Cost
$MCPS$ = Material Cost per Sample ($)
$TCPS$ = Total Cost per Sample ($)
$WVPS$ = Waste Volume per Sample (L)
$WWPS$ = Waste Weight per Sample (lb)

Default values are provided for several parameters that characterize other conditions of an event. TOTS allows users to change these values to assess the impact on cost and time estimates (e.g., the impact of increasing the number of available sampling teams and/or laboratories available for processing samples).

User Inputs

ST = Number of Available Teams for Sampling (N)
SP = Personnel per Sampling Team (N)
SH = Sampling Team Hours per Shift (hours)
SS = Sampling Team Shifts per Day (N)
SLC = Sampling Team Labor Cost ($)
AL = Number of Available Laboratories for Analysis (N)

AH = Analysis Laboratory Hours per Day (hours)
AOISA = Area of Interest Surface Area (ft^2) (optional)[1]

The following calculations are used by the tool to generate resource demand estimates based on the parameters selected.

Resource Demand Calculations

Total Required Sampling Time (team hours)
> = Time to Prepare Kits (hours) + Time to Collect (hours)
> = *TTPK + TTC*

Sampling Hours per Day (hours) (*SHPD*)
> = Number of Available Teams for Sampling (N) * Sampling Team Hours per Shift (hours) * Sampling Team Shifts per Day (N)
> = *ST * SH * SS*

Sampling Personnel Hours per Day (hours)
> = Sampling Hours per Day (hours)/Personnel per Sampling Team (N)
> = *SHPD * SP*

Sampling Personnel Labor Cost ($) (*SPLC*)
> = Sampling Team Labor Cost ($)/Personnel per Sampling Team (N)
> = *SLC/SP*

Time to Complete Sampling (days) (*TTCS*)
> = (Time to Collect (hours) + Time to Prepare Kits (hours))/Sampling Hours per Day (hours)
> = *(TTC + TTPK)/SHPD*

Total Sampling Labor Cost ($) (*TSLC*)
> = Number of Available Teams for Sampling (N) * Personnel per Sampling Team (N) * Sampling Team Hours per Shift (hours) * Sampling Team Shifts per Day (N) * Sampling Personnel Labor Cost ($) * Time to Complete Sampling (days)
> = *ST * SP * SH * SS * SPLC * TTCS*

Time to Complete Analyses (days) (*TTCA*)
If the result of this calculation is less than 1 day, then the result is increased to 1 day to account for shipping time.
> = Time to Analyze (person hours per sample)/(Number of Available Laboratories for Analysis (N) * Analysis Laboratory Hours per Day (hours))
> = *TTA/(AL * AH)*

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[1] This value represents the size of the overall area where samples are collected. TOTS allows users to enter a value in the Calculate Resources panel. The value is used to compute percent of area sampled.

Sampling Cost ($) (SC)
        = Total Sampling Labor Cost ($) + Material Cost per Sample ($)
        = *TSLC + MCPS*

Analysis Cost ($) (AC)
        = Analysis Labor Cost ($) + Analysis Material Cost ($)
        = *ALC + AMC*

Total Cost ($)
        = Sampling Cost ($) + Analysis Cost ($)
        = *SC + AC*

Total Time (days)
        If Time to Complete Analyses (days) (*TTCA*) < Time to Complete Sampling (days) (*TTCS*)
                = Time to Complete Sampling (days) (TTCS)
        Else
                = Time to Complete Analyses (days) (*TTCA*)

Limiting Factor
        If Time to Complete Analyses (days) (*TTCA*) < Time to Complete Sampling (days) (*TTCS*)
                = Sampling
        Else
                = Analysis

Total Sampled Area (ft^2) (*TSA*)
        = Area of all samples in sampling plan as measured by ArcGIS JS API

Percent of Area Sampled
        = (Total Sampled Area (ft^2)/Area of Interest Surface Area (ft^2)) * 100
        = *(TSA/AOISA) * 100*

Total Number of User-Defined Samples (N)
        = Number of samples the user added to a sampling plan

Total Number of Samples
        Aggregated for each sample:
                = Actual Area of Sample (in^2) as measured by ArcGIS JS API/Reference Surface
                Area (in^2)
                = *AA/S*A

Total Waste Volume (L)
        Aggregated for each sample:
                = Waste Volume per Sample (L)
                = *WVPS*

Total Waste Weight (lb)
        Aggregated for each sample:
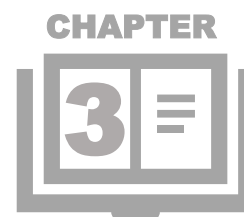   = Waste Weight per Sample (lb)

$= WWPS$

Layer Types and Sample Types

CHAPTER

3

Understand how to work with different layers and sample types

TOTS allows users to load various types of layers and create custom sample types to help explore options for designing sampling plans. The type and size of samples and team configuration will impact the sampling plan resource demands (cost and time). The tool is flexible and allows users to create their own sample types. The sections that follow describe the different layer types that can be imported, the default sample types that are included with the tool, and the procedure to create custom sample types.

Layer Types

Layers are used in TOTS to visually represent different views that aid a user in developing a sampling plan. Layers can be static or active when interactively drawing on the map. TOTS has five main layer types:

- Samples – Layers that contain sample locations are used to create a sampling plan. Sample layers should be a feature layer or a graphics layer. TOTS starts with an empty default sample layer, or sample layers can also be added via file import or from datasets that were published to ArcGIS Online through TOTS. Additional samples can be added to sample layers that were imported from a file.

- Visual Sample Plan (VSP) – VSP layers use the same schema as Samples layers, but the data come from an imported VSP file. When a VSP file is imported, TOTS automatically converts the samples to have geometry and a corresponding schema that can be processed by TOTS.

- Area of Interest – This layer contains features to help guide the user to the area where the samples should be located. This layer should be a feature layer or graphics layer. Only the geometry of features is necessary for the Area of Interest layers; therefore, there is no schema for this layer type. Area of Interest layers can only be added through file import.

- Reference – Reference layers are anything that can help the user in placing samples such as a street view map or base map. Reference layers can be any type of Esri layer. Reference layers are meant to be flexible and do not have a schema. Reference layers can be added via ArcGIS Online, URL, and/or file upload.

- Contamination Map – Contamination Map layers are a special type of layer that is available only when training mode[2] is enabled. Contamination Maps are used in conjunction with the TOTS training mode to test the effectiveness of a sampling plan in a classroom setting. Contamination Map layers are completely hidden from the user until the "View Contamination Hits" button is clicked, at which point the user can make the layer visible via the Legend Widget.

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[2] Training mode is used to illustrate and quickly check whether sample locations overlap with contamination. This feature requires a contamination map be loaded where the intersect of samples and contamination zones are identified.

Tables 1 and 2 present the schemas used by the Samples, VSP, and Contamination Map layer types.

> ♀ Schema field names are case-sensitive and should be in all caps.

Table 1. Samples and VSP Layer Schema

Field Name	Field Type	Description
OBJECTID	Long	Surrogate integer key controlled by Esri systems.
GLOBALID	GUID	Surrogate global unique identifier (GUID) key controlled by Esri systems.
PERMANENT_IDENTIFIER	GUID	40-byte global unique identifier (GUID) given to each sample. Controlled by TOTS.
TYPE* **	Text (255 Characters)	Sampling method type (Sponge, Microvac, Wet Vac, Robot, Aggressive Air, Swab, and any custom sample types).
TTPK **	Double	Time to Prepare Kits (person hours per sample)
TTC **	Double	Time to Collect (person hours per sample)
TTA **	Double	Time to Analyze (person hours per sample)
TTPS	Double	Total Time per Sample (person hours per sample)
LOD_P	Double	Limit of Detection for Porous Surfaces per Sample (CFU)
LOD_NON	Double	Limit of Detection for Nonporous Surfaces per Sample (CFU)
MCPS **	Double	Material Cost per Sample ($)
TCPS	Double	Total Cost per Sample ($)
WVPS	Double	Waste Volume per Sample (L)
WWPS	Double	Waste Weight per Sample (lb)
SA **	Double	Reference Surface Area (in²)
AA	Double	Actual Area of Sample (in²). Holds the area calculated by TOTS.
ALC **	Double	Analysis Labor Cost ($)
AMC **	Double	Analysis Material Cost ($)
NOTES	Text (2000 Characters)	Notes entered by the user.
CONTAMTYPE	Text (20 Characters)	Contamination Map Type. Assigned by TOTS when using the "View Contamination Hits" feature. Could be Biological, Chemical, or Radiological.
CONTAMVAL	Double	Contamination Map Value. Assigned by TOTS when using the "View Contamination Hits" feature.
CONTAMUNIT	Text (10 Characters)	Contamination Map Unit. Assigned by TOTS when using the "View Contamination Hits" feature.
CREATEDATE	Date	Datetime the sampling event was created.
UPDATEDDATE	Date	Datetime the sampling event was last updated.
DECISIONUNITUUID	GUID	40-byte global unique identifier (GUID) given to each sampling layer. Controlled by TOTS.
DECISIONUNIT	Text (255 Characters)	Group key indicative of sampling layer. This key could be elevation, building floor, or location.
DECISIONUNITSORT	Integer	Controls how decision units (sampling layers) are ordered in TOTS. The sorting feature is currently not available in TOTS but could be added in the future.

* Indicates required fields for file import

** Indicates required fields for custom sample types

Table 2. Contamination Map Layer Schema

Field Name	Field Type	Description
OBJECTID	Long	Surrogate integer key controlled by Esri systems.
GLOBALID	GUID	Surrogate global unique identifier (GUID) key controlled by Esri systems.
PERMANENT_IDENTIFIER	GUID	40-byte global unique identifier (GUID) given to each sample. Controlled by TOTS.
CONTAMTYPE*	Text (20 Characters)	Contamination Map Type. Assigned by TOTS when using the "View Contamination Hits" feature. Could be Biological, Chemical, or Radiological.
CONTAMVAL*	Double	Contamination Map Value. Assigned by TOTS when using the "View Contamination Hits" feature.
CONTAMUNIT*	Text (10 Characters)	Contamination Map Unit. Assigned by TOTS when using the "View Contamination Hits" feature.

* Indicates required fields for file import

Default Sample Types

Default sample types are provided with the tool. Table 3 provides a description of the sample types that are included with the tool. Appendix B presents detailed values that correlate with attributes that are defined for each sample type.

Table 3. Default Sample Types

Sample Type	User Interface Label	Description
Swab	Swab	Traditional sampling method. A 4-square-inch sample taken via a swab.
Sponge Stick	Sponge	Traditional sampling method. A 100-square-inch sample taken via sponge wipe.
37 mm Microvacuum Filters	Micro Vac	Traditional sampling method. A 144-square-inch sample taken via a 37-mm vacuum cassette.
Wet Vacuum	Wet Vac	Innovative sampling method taken via a wet vacuum.
Floor Cleaning Robot	Robot	Innovative sampling method taken via an automated floor cleaning robot.
Aggressive Air Sampling	Aggressive Air	Innovative sampling method adapted from asbestos mitigation sampling approaches, taken via suspending spores, with the use of a tool such as a leaf blower, where the samples can be collected.

Custom Sample Types

The tool allows users to create their own sample types. Custom sample types adhere to the same schema as shown in Table 1.

Run the Tool

Understand the steps that are required to run the tool and generate output
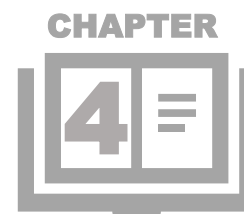
The targeted users for TOTS include response personnel from EPA, Regional, and DHS, including sampling teams and planners, that are responsible for designing and implementing an appropriate sampling strategy. TOTS users are assumed to have the requisite understanding of considerations related to designing sampling plans to address a contamination incident.

Minimum System and Software Requirements

Table 4 describes the minimum system requirements and required software for the tool.

Table 4. Minimum System and Software Requirements

Required Software	64-bit version of the latest modern standards-based browsers: Chrome Microsoft Edge
Processor	2.2 GHz minimum processor
RAM	For desktop browsers, it is recommended to have at least 8 GB system memory Mobile devices should have a minimum of 2 GB of RAM (4 GB recommended)
Optimal Screen Resolution	1024 x 768 pixels
Disk Space	1 gigabyte (GB) available

Access the Tool

To start the tool, open a web browser and enter https://tots-stage.app.cloud.gov/ into the address bar. Please use one of the following supported web browsers: Chrome or Edge.

> ⚠ Internet Explorer is not supported, because TOTS utilizes tools from the ArcGIS JS API that are not supported in Internet Explorer.

Figure 2 presents the main TOTS interface. Primary navigation steps are shown on the left and utility functions are located along the top right utility bar. These features are described in the sections that follow.
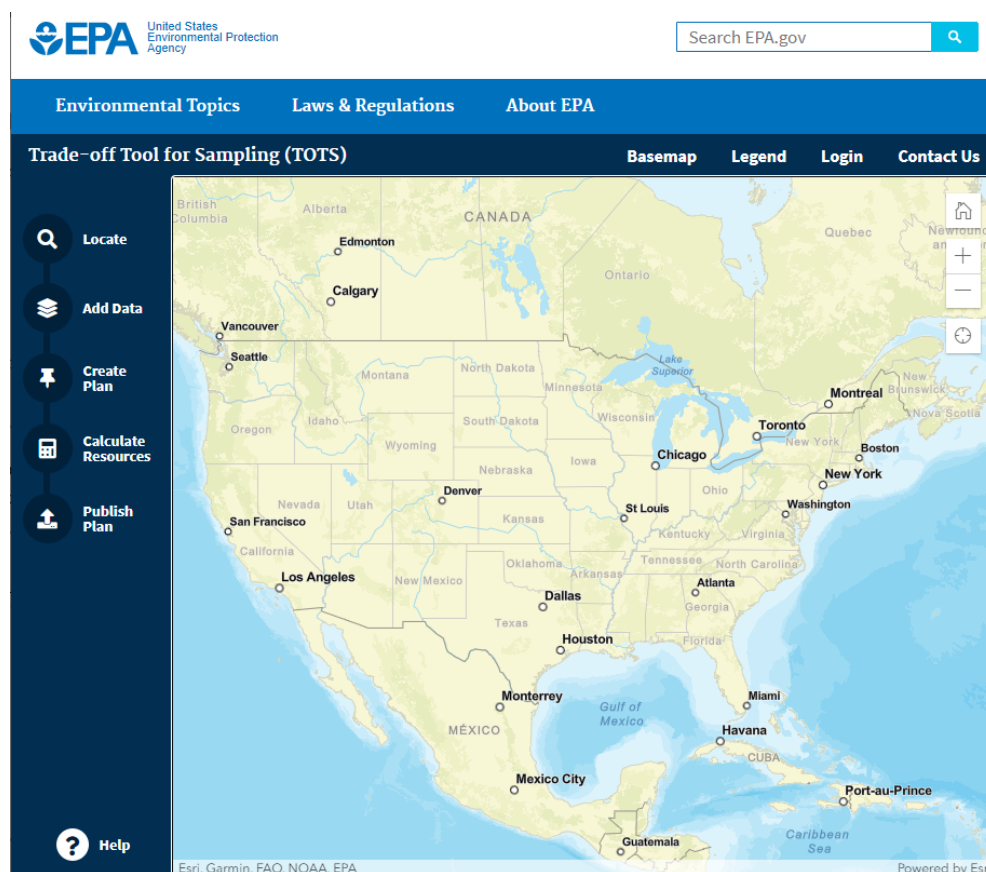
Figure 2. TOTS Home Screen

Utility Features

Basemap

The "Basemap" feature is accessible from the right side of the top toolbar as shown in Figure 2. Figure 3 provides an expanded view of the options under the "Basemap" feature. The "Basemap" feature is used to change the underlying reference map. Users can choose from numerous options including: Streets (default), Imagery, Topographic, Terrain with labels, and many more. Click "Basemap" again to close the "Basemap" feature.
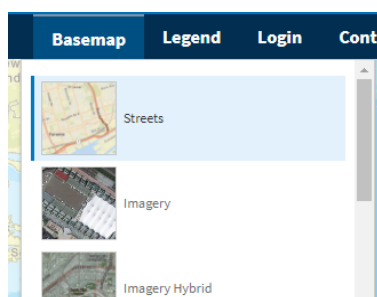

Figure 3. Basemap Feature

Legend

The "Legend" feature is accessible from the right side of the top toolbar as shown in Figure 2. Figure 4 shows an expanded view of the options under "Legend." Click "Legend" again to close the "Legend" feature. After a layer is imported or created within TOTS, the "Legend" displays and defines the symbology used for each layer to allow users to differentiate between the different layers and control layer visibility using the following features:

Figure 4. Legend Feature

- **Expand/Collapse** (▷ button/ ▽ button) – Expands/collapses the list of sub layers.

- **Visibility Toggle** (👁 button) – Toggles the visibility for the layer.

- **Opacity Slider Toggle** (☰ button) – Toggles the opacity slider.

- **Opacity Slider** – Controls the transparency of the layer. This control is available at the main layer and each sub layer.

- **Control Toggle (** ⋯ button) – Hides or shows the Zoom to Layer and Delete Layer buttons.

- **Zoom to Layer** – Zooms to the extent of the associated layer.

- **Delete Layer** – Removes the associated layer from the map. Published TOTS layers are NOT deleted from ArcGIS Online.
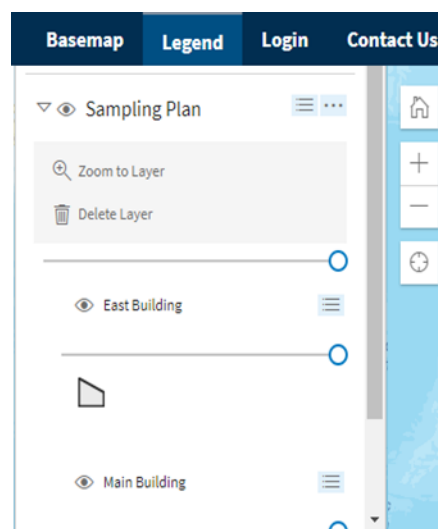
Login

A "Login" button is accessible on the right side of the top toolbar (as shown in Figure 2) to allow users to login to an existing ArcGIS Online (AGO) account. As shown in Figure 5, users should sign into their AGO account if they are planning to leverage AGO resources. EPA users can access their Esri Enterprise login credentials by using their portal ID or PIV card access credentials. NOTE: Users do not need to login to use TOTS.
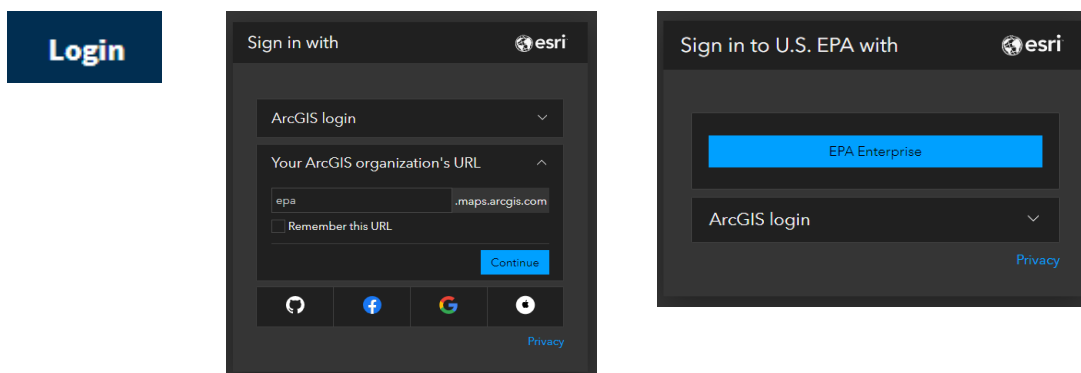
Figure 5. Authentication Examples

Contact Us

The "Contact Us" button available on the right side of the top toolbar (as shown in Figure 2) is used to submit comments, questions, feature requests, bugs to the Homeland Security Research Program.

Help

The "Help" button on the bottom of the left navigation menu (as shown in Figure 2) is used to display the Getting Started screen as shown in Figure 6. A quick overview of the key steps to get started using TOTS is displayed.
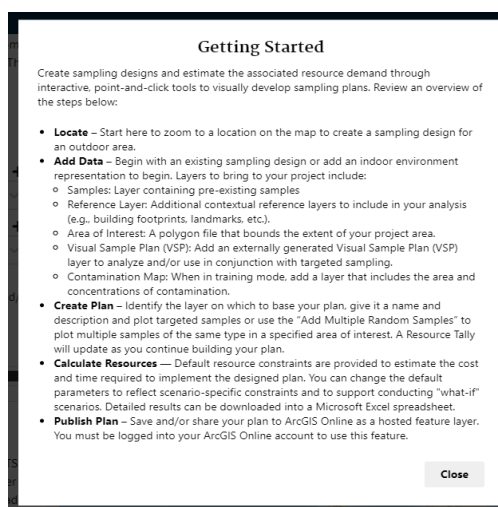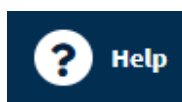

Figure 6. Help Widget

Navigation Features

Locate

The "Locate" tab on the left navigation menu is used to zoom to a location of interest on the map. As shown in Figure 7, an address or place can be entered and searched.

- "Find address or place" is used for finding a location on the map and zooming to that location

Alternatively, users can manually zoom to a location by hovering their mouse over the map and using the scroll wheel, by pressing the +/- buttons on the top right of the map, or by pressing the ⊕ button in the top right corner of the map.

This step is optional. If users intend to add external layers, they can skip this tab and go to "Add Data." TOTS will automatically zoom to the layers added through "Add Data." The "Add Data" or "Next" buttons are used to continue to the next step.
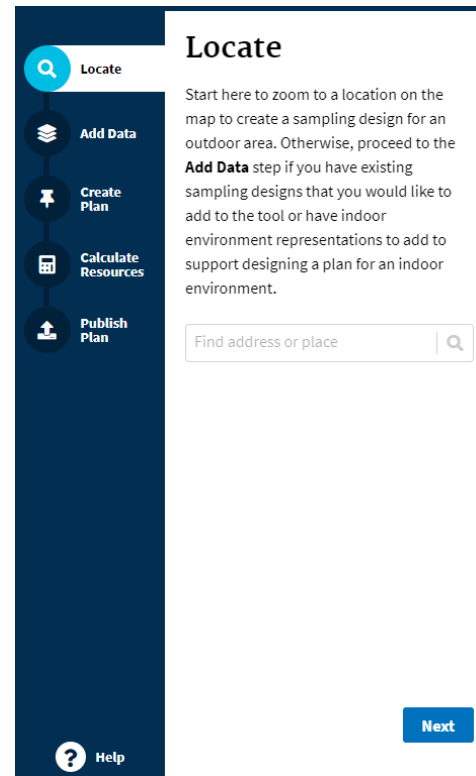

Figure 7. Locate Tab

Add Data

The "Add Data" tab on the left navigation menu is used to begin with an existing sampling design or to add an indoor environment representation. This step is optional. If users do not have any supporting data, they can continue to the "Create Plan" step.

External data can be added to TOTS in three forms: 1) from ArcGIS Online, 2) from a URL, or 3) from a file. As shown in Figure 8, users can use the first drop down to select how they are going to add external data. To add data from AGO, users must select "Search for Layers" in the "Add Data" drop down, find the layer using the search features, and then click the "Add" button for the desired layer.

- **Data Location** – Allows user to choose from one of four ways to further filter data: "ArcGIS Online" shows all publicly available layers in ArcGIS Online, "My Content" shows all layers available in the user's ArcGIS Online account, "My Organization" shows all layers available through the user's organization, and "My Groups" shows all layers available to all members associated with a defined Group..

⚠ Users must login to ArcGIS Online through TOTS to use the "My Content," "My Organization," and "My Groups" filter options.
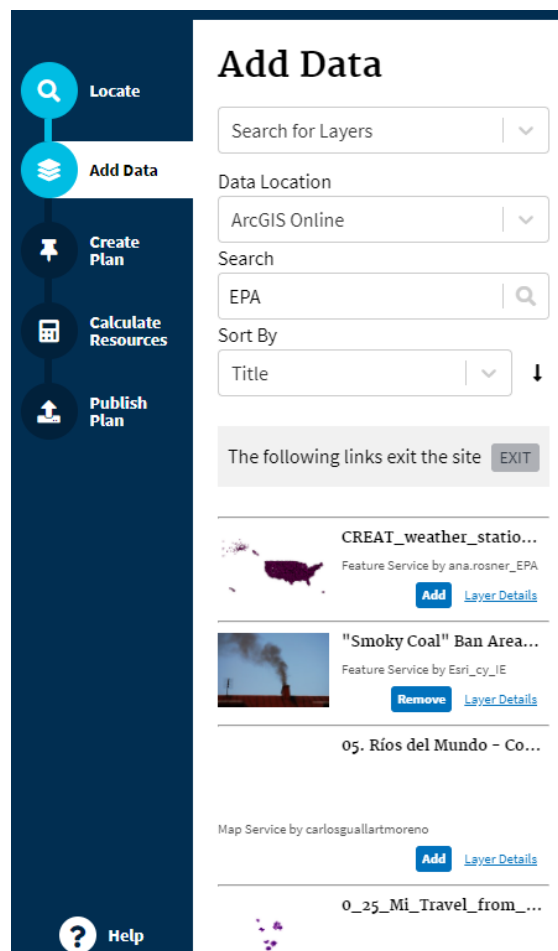

Figure 8. Add Data Tab (from ArcGIS Online)

- **Search** – Allows users to further filter results by searching for layer names or keywords.

- **Sort By** – Allows users to sort the results by relevance, title, owner, rating, views, or date. The user can also change whether the results are sorted in ascending or descending order by clicking the up/down arrow to the right of the "Sort By" drop down. The sort order buttons are not available if "Relevance" is selected in the "Sort By" drop down.

- **Add** – Adds the layer to the map. **If the layer was published by TOTS, then the layer will automatically be added as a Sample Layer type**. If the layer was not published by TOTS, then it is added as a Reference Layer type.

- **Remove** – Removes the layer from the map.

- **Layer Details** – Links to the layer in ArcGIS Online.

To add data from a URL, users must select the "Add Layer from Web" in the "Add Data" drop down, select the layer type using the "Type" drop down, enter the URL into the "URL" text box, and click the "Add" button. Figure 9 shows the "Add Layer from Web" screen. Layers added by URL are always added as reference layers.

- **Type** – Identifies the type of layer to which the URL refers. Users can choose from one of the following five types:
    - **ArcGIS Server web service** – Map, image or feature resource that is located on an ArcGIS Server site.
    - **WMS OGC web service** – Feature service that follows the OGC Web Feature Service specification.
    - **KML file** – File containing a set of geographic features.
    - **GeoRSS file** – Web feed that includes geographic features and locations.
    - **CSV file** – Web-based, comma-separated values text file that includes location information.
- **URL** – Lists the URL of the layer to be added.
- **Sample URL(s)** – Displays a list of sample URL layers. The list changes depending on the "Type" selection.
- **Add** – Adds the URL layer to the map.

Figure 9. Add Data Tab (Add Layer from Web)

To add data from a file, users must select the "Add Layer from File" option in the "Add Data" drop down, select a layer type using the "Layer Type" drop down, select a "Sample Type" (only for VSP layer types), and then browse to the file or drag and drop the file. Figure 10 shows the "Add Layer from File" screen. TOTS supports the following file types: Shape File, CSV, KML, GPX and Geo JSON.

⚠ Only files with layers having fewer than 4,000 features can imported. For **Reference Layer Types** with more than 4,000 features, users can store the reference layer on ArcGIS Online and add the layer via the "Search for Layers" option.

- **Layer Type** – Identifies the type of layer being added. User can choose from the following five types:

  o **Samples** – A layer containing features representing samples. This layer can be used to create a sampling plan.

  o Table **1** provides a list of required attributes for this layer type.

  o **Reference Layer** – A layer that can be used to help users plot samples. This layer type is only for reference on the map and cannot be used with any of the other TOTS features. This layer type does not have any required attributes.

  o **Area of Interest** – A layer that is used to give users an idea of where the samples should be plotted. This layer type does not have any required attributes.

  o **VSP** – A layer containing features (samples) representing the selected "Sample Type." This option has an additional "Sample Type" selection that is used to set the attributes of the features in the layer. This layer can be used to create a sampling plan.

  o Table **1** provides a list of required attributes for this layer type.

Figure 10. Add Data Tab (Add Layer from File)

  o **Contamination Map** –Available only in training mode. This layer type is used to determine whether any samples plotted in the active sampling layer intersect with a contaminated zone defined in the contamination map. This layer is hidden from the map and the "Legend" widget until users click the "View Contamination Hits" button on the "Calculate Resources" tab. After the "View Contamination Hits" button is clicked, the layer is visible in the "Legend" widget where users can choose to make the layer visible on the map.

- **Sample Type** – Determines what values are assigned to the attributes of the VSP samples. It is only available if the "VSP" layer type is selected. . Users can choose from one of six pre-defined sample types (Sponge, Micro Vac, Wet Vac, Robot, Aggressive Air, or Swab) or a custom sample type.
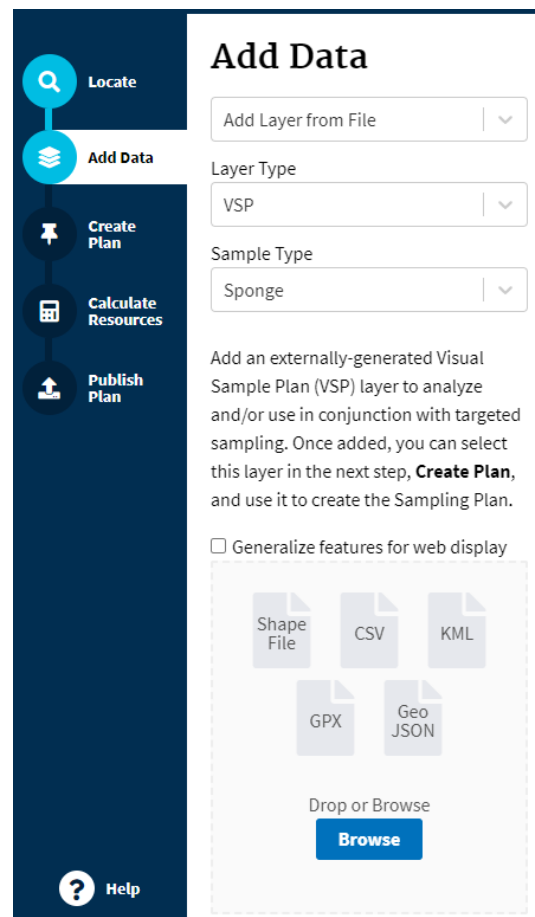
- **Generalize features for web display** – Simplifies the geometry for faster rendering. This option should only be used if users are encountering performance issues when working with large datasets. This setting can affect the accuracy of calculations since it can affect the area of the features.

When users are finished adding all supporting external data, they click the "Create Plan" tab or "Next" button to continue.

Create Plan

The "Create Plan" tab on the left navigation menu is used to create one or more sampling plans. As shown in Figure 11, the "Create Plan" panel can be used to manually place/draw samples on the map, generate random samples, create custom sample types, and enable training mode. Users must first provide a "Plan Name," optionally provide a "Plan Description," and click "Save." Features available in the "Create Plan" panel are described below.

- **Training Mode** – Enables/disables training mode. When Training Mode is enabled, the "Contamination Map" layer type option is enabled on the "Add Layer from File" of the "Add Data" tab and the "Include Contamination Map" option is enabled on the "Calculate Resources" tab. Training Mode is disabled by default.

- **Auto Zoom** – Enables/disables the auto zoom feature. When enabled, TOTS will automatically zoom to the extent of a sample each time a user plots a sample and when users select a different sampling plan. Auto Zoom is disabled by default.

- **Start Over** – Clears all progress in the current session and refreshes TOTS to start over from scratch. Users will remain logged into their AGO account.

- **Delete All Samples** – Deletes all samples on the "Active Sampling Layer."

- **Plan Name** – Lists the name of the plan. This field is limited to 255 characters.

- **Plan Description** – Provides an optional description of the plan. This field is limited to 2048 characters.

Figure 11. Create Plan Tab

- **Save** – Temporarily saves the "Plan Name" and "Plan Description" within the current session. If the user is logged into ArcGIS Online, this button also verifies the entered "Plan Name" is not already in use on their account and organization.

After the "Save" button is clicked, the plan controls and layer controls are enabled as shown in Figure 12, which allows users to create plans and associate layers.

- **Specify Plan –** Selects any plan a user has created.

> 💡 Changing the "Specify Plan" menu selection will automatically update the Resource Tally in the left navigation menu and update the "Active Sampling Layer" drop down. Users can use this menu selection to quickly toggle between plans to get a quick comparison between two plans. If user have the Auto Zoom feature turned on, changing this selection will also zoom to all of the samples that comprise the selected plan.
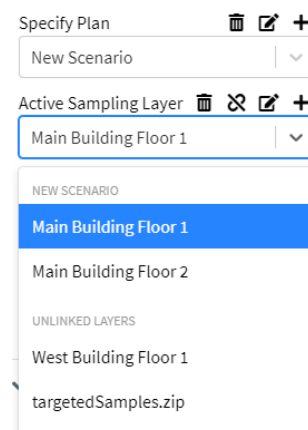
Figure 12. Layer Linkage Status

- **Delete Plan** (🗑 button) – Deletes the plan.

- **Edit Plan** (✏ button) – Edits the plan name and/or plan description.

- **Add Plan** (✚ button) – Adds a new plan.

- **Active Sampling Layer** – Selects a layer to edit. A layer must be selected in the "Active Sampling Layer" menu to plot samples on a layer, add notes to a sample, or change the layer to which a sample belongs.

- **Delete Layer** (🗑 button) – Deletes the layer.

- **Link/Unlink Layer** (🔗 button/✂ button) – Links/unlinks the layer to the selected plan. The link button can also be used to link "Samples" or "VSP" layers that were added from a file or ArcGIS Online during the "Add Data" step. The "Active Sampling Layer" drop down menu is organized to make it easy to see which layers are part of the selected plan and which layers are unlinked.

- **Edit Layer** (✏ button) – Edits the layer name.

- **Add Layer** (✚ button) – Adds a new layer to the selected plan. This button also displays a link to the "Add Data" tab where users can import a "Samples" layer from a file.

Users can create as many plans as they want for comparison purposes. Each plan can support multiple layers, which is helpful for organizing samples during plan creation. When a plan is published, the layers are combined into a single layer to facilitate importing the output into other field data acquisition tools such as Esri Collector and Survey123. Figure 13 shows the relationship hierarchy between plans, layers, and samples.
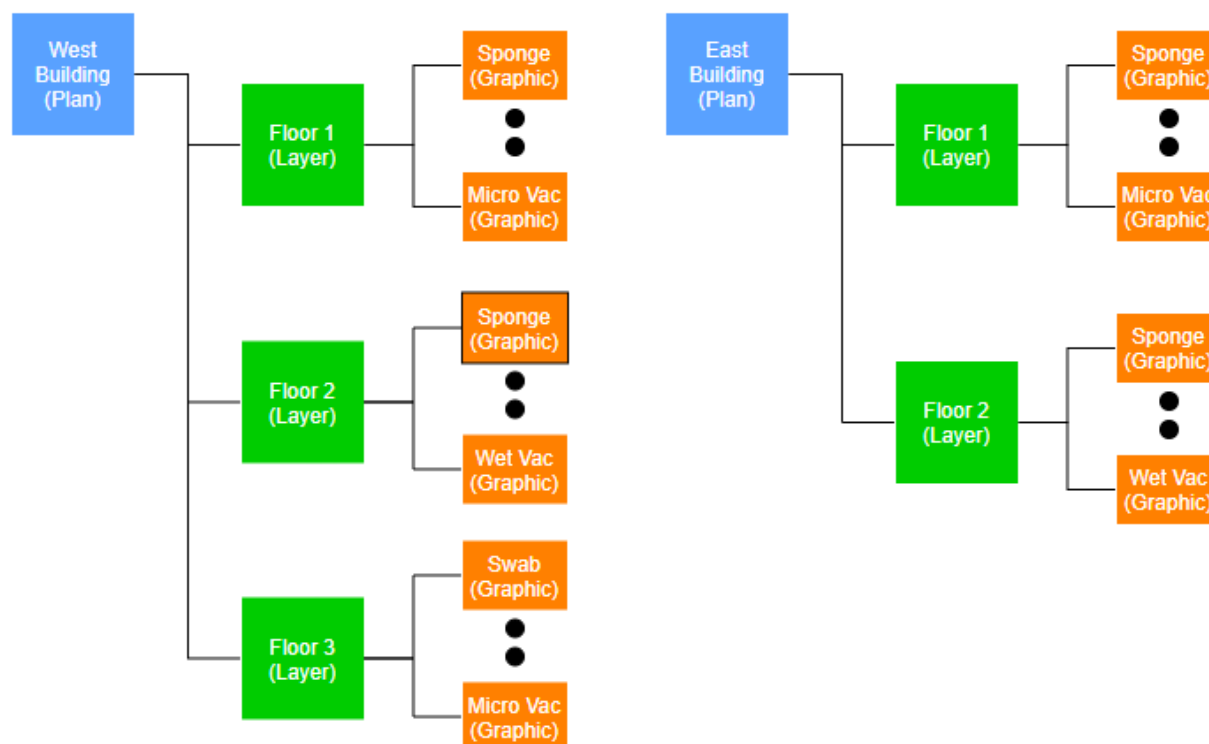
Figure 13. Plan/Layer Relationship Hierarchy

As shown in Figure 13, there is a one-to-many relationship between a plan and the associated layers. TOTS provides flexibility to users to define what is represented within a layer. For example, a layer could be a two-dimensional representation of a floor in a multistory building, a layer could be a specific decision unit, or a specific location of interest (e.g., stairwell #2). One or more sample types, of user-defined quantities, can be plotted on each layer. TOTS then aggregates the resource demand estimates for all layers that are actively "linked" to a sampling plan.

ADD TARGETED SAMPLES

Users can manually plot/draw samples using the "Add Targeted Samples" area in the "Create Plan" panel as shown in Figure 14. Buttons with the ✐ icon are point samples, which are simply placed on the map by clicking. Buttons with the ⌘ icon are polygon samples that need to be drawn on the map. Polygon samples are drawn by clicking on the map to place vertices and then double clicking on the last vertex to complete the drawing. As users add samples to the map, the counts on the buttons are updated to indicate how many samples of that type are on the map. These buttons are highlighted, when a user clicks on them, to indicate the drawing tool is active. When the sample button is active, users can add multiple samples of that type by clicking multiple times on the map.

Users can select from both established sample types, or from custom sample types that they have created (see Create Custom Sample Types).

- **Established Sample Types** – Shows sample types that are included with TOTS. The parameters for these sample types were developed through HSRP research.

- **Custom Sample Types** – Shows sample types that are created by a user. "Custom Sample Types" can be used to explore "what if" scenarios and or experimental sampling methods.

After samples are placed on the map, users can adjust the color and outline color of samples to their liking using the "Symbology Settings" as shown in Figure 15. This adjustment is useful when using a basemap that conflicts with the default color scheme. Changes in symbology settings will affect the colors of all "Samples," "VSP," "Area of Interest," and "Contamination Map" layers items.

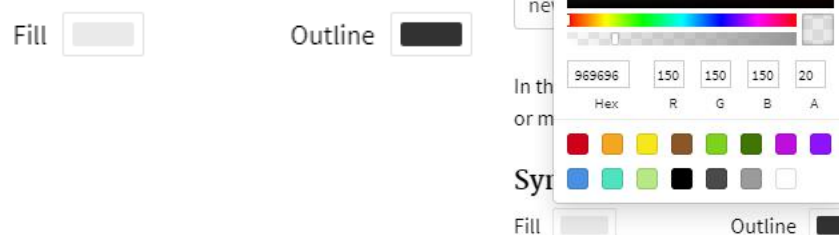**Figure 14. Add Targeted Samples**

Figure 15. Symbology Settings

When a user clicks on a sample on the map, a pop-up box is displayed over the map as shown in Figure 16. The box displays attributes about the sample and provides access to several quick features, including the ability to delete the sample, change the layer with which the sample is associated, or enter a note. If a user has the "Create Plan" tab open, the pop-up will automatically be docked. Features are described in more detail below:

- **Delete Sample** (🗑 button) – Deletes the sample.

- **View in Table** (⊞ button) – Views the sample in the attribute table. This button will open the attribute table and scroll to the sample.

- **Zoom to** (⊕ button) – Zooms to the sample.

- **Dock/Undock** (▢ button/⬓ button) – Docks the pop-up to the side/undocks the pop-up to make it float over the sample.

- **Close** (✕ button) – Closes the pop-up.

- **Attribute List** – Lists all the attribute values for the sample in a table. Initially only the first five attributes are visible. Users can click the "Show More" link to view all the attributes.

- **Show More/Less** – Shows all the sample attributes/reverts to only viewing the first five attributes.

- **Layer** – Displays the layer name to which the sample belongs. Users can change the layer association by selecting a different layer from the drop down. This feature is useful if a user accidentally plots/draws a sample on the wrong layer. The layer change takes affect after clicking the "Save" button.

- **Note** – Provides field for entering sample level notes. These notes are available in the download on the "Calculate Resources" tab, and the notes are available in ArcGIS Online after the sample plan is published.

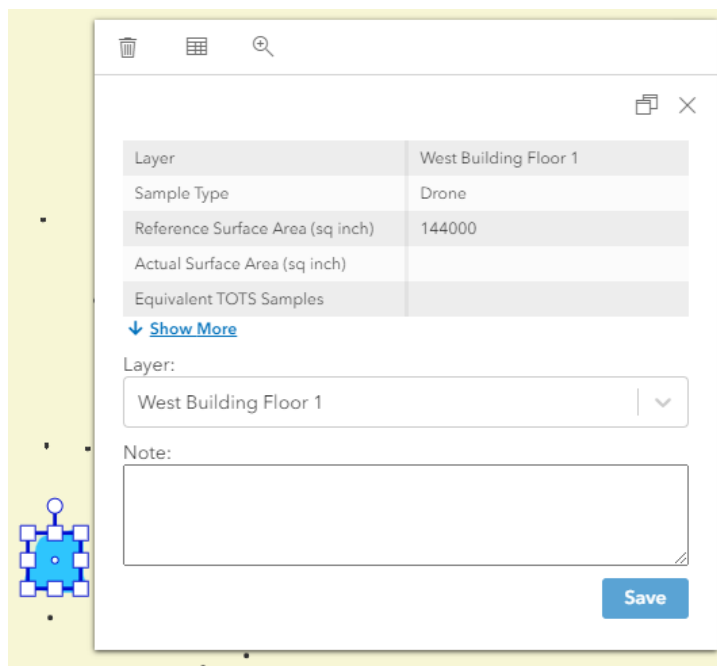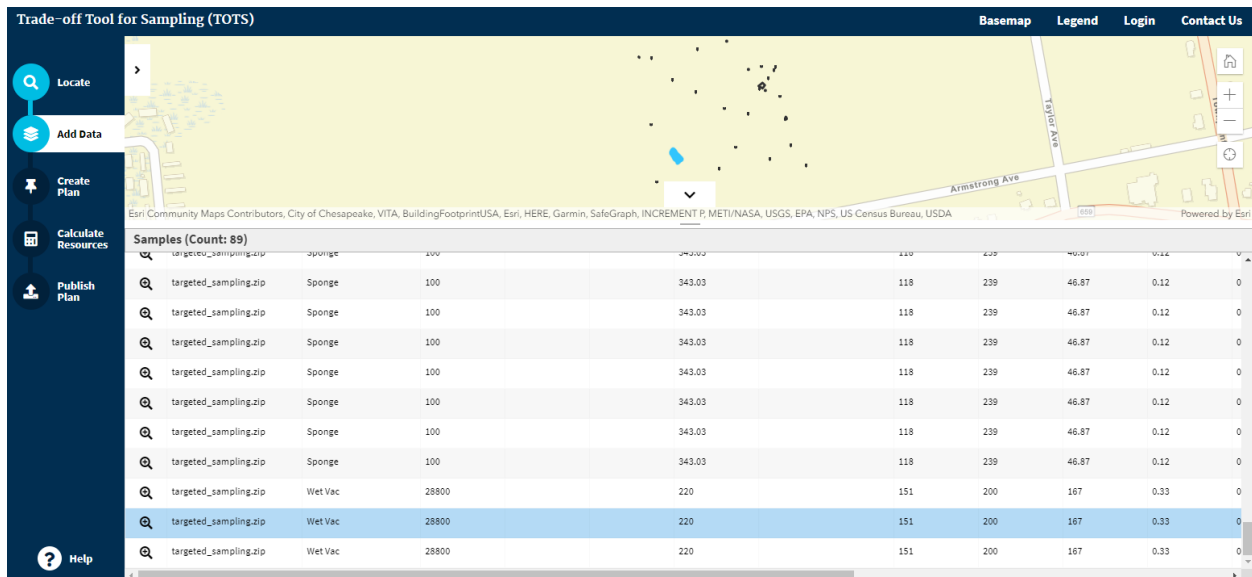- **Save** – Saves layer changes and any notes entered.

Figure 16. Edit Sample Pop-up

SAMPLE ATTRIBUTE TABLE

The sample attribute table is a feature that shows all the samples and their associated attributes in tabular form as shown in Figure 17. Once samples are added to the map, the sample attribute feature becomes available. Users can either open the sample attribute table by clicking the ⌃ button at the bottom of the map or by clicking a sample on the map and then click the "View in Table" button on the pop-up. Users can also hide the sample attribute table by clicking the ⌄ button.

If a user clicks a row in the sample attribute table, the associated sample is highlighted. If a user clicks a sample on the map, the associated row in the sample attribute table is highlighted. The ▬ handle can be used to adjust the height of the table. The 🔍 button can be used to zoom to that sample on the map.

Figure 17. Sample Attribute Table

💡 The attribute table can be helpful to confirm the inclusion of very small samples (e.g., 4" x 4" swab). Depending on the zoom level of the map, some samples might not be visible due to limitations of rendering very small points at a certain zoom scale. The attribute table (and counts shown on the sample type buttons) will reflect the number of samples that are associated with the plan.

ADD MULTIPLE RANDOM SAMPLES

Users can plot multiple samples at once using the "Add Multiple Random Samples" feature as shown in Figure 18. To use this tool, users must click the "Draw Sampling Mask" button, draw a bounding box on the map (where the samples will be plotted), select a "Sample Type," enter the "Number of Samples" to generate, and then click "Submit." Once the random samples are plotted on the map, the sampling mask(s) that was previously drawn on the map is discarded. Users can continue adding more batches of samples by repeating this process of drawing sampling masks and submitting samples to plot.

Alternatively, users can use an existing file to bound the samples. Users would choose to "Use Imported Area of Interest," select an "Area of Interest Mask," specify a "Sample Type," enter the "Number of Samples" to generate, and then click "Submit." When using the "Use Imported Area of Interest" option, the "Area of Interest Mask" is not removed from the map. Features in this panel are described in detail below.

Figure 18. Add Multiple Random Samples
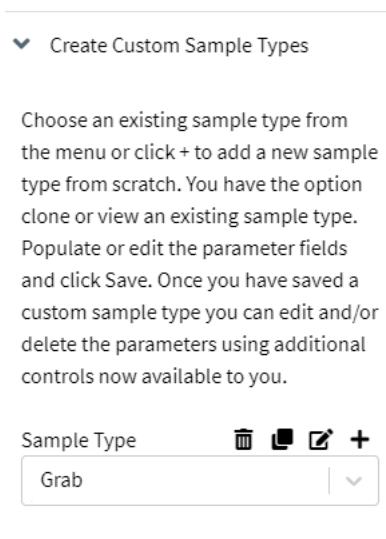
- **Draw Sampling Mask** – Selects the option to draw a sampling mask for use as the bounding box.

- **Use Imported Area of Interest** – Selects the option to use an imported area of interest as the bounding box.

- **Draw Sampling Mask** – Draws a sampling mask feature on the map. This sampling mask acts as a bounding box that will contain the randomly generated samples.

- **Area of Interest Mask** – Selects the area of interest layer. This area of interest layer acts as a bounding box that will contain the randomly generated samples.

- **Add** – Navigates to the "Add Data" tab to facilitate adding an Area of Interest layer.

- **Sample Type** – Selects the type of sample to be randomly generated and plotted on the map. All the default parameters associated with the selected sample type are applied to the samples that are generated. Users can select between the established sample types (Sponge, Microvac, Wet Vac, Robot, Aggressive Air, or Swab) or custom sample types.

- **Number of Samples** – Lists the number of samples to generate randomly. If a user draws or adds multiple sample masks, each area will get this many samples.

- **Submit** – Generates the random samples on the map and removes any sampling masks that were drawn on the map. If there are multiple sample masks, then each sample mask will get the number of samples entered in the "Number of Samples" input. The "Submit" button is not visible until a user adds a sampling mask to the map.

CREATE CUSTOM SAMPLE TYPES

Users can create custom sample types for testing "what if" scenarios and experimental scenarios as shown in Figure 19. The established sample types cannot be edited or deleted. Users can view the values of established sample types and clone (create a copy) of any of the established sample types, or previously created custom sample types, to use as a starting point for a new sample type. Custom sample types can be used with imported VSP files from the "Add Data" tab and with the "Add Multiple Random Samples" feature on the "Create Plan" tab. Custom Sample Type controls are described in detail below.

- **Sample Type** – Selects the sample type to manage and or view.

- **Delete Custom Sample Type** (🗑 button) – Deletes the custom sample type. This cannot be used with the established sample types: Swab, Sponge, Microvac, Wet Vac, Robot, and Aggressive Air.

- **Clone** (🗐 button) – Clones the sample type. The Clone can be used to create a new sample type that is based on an existing sample type. The new sample type must have a unique name.

- **Edit** (✏ button) – Edits the parameters of an existing custom sample type. This button is not available for established sample types.

- **Add** (+ button) – Creates a new custom sample type from scratch.

⌄ Create Custom Sample Types

Choose an existing sample type from the menu or click + to add a new sample type from scratch. You have the option clone or view an existing sample type. Populate or edit the parameter fields and click Save. Once you have saved a custom sample type you can edit and/or delete the parameters using additional controls now available to you.

Sample Type   🗑 🗐 ✏ +

Grab   ⌄

Figure 19. Custom Sample Type Controls

As shown in Figure 20, users are prompted to enter the following information when creating or editing a custom sample type:

- **Sample Type Name** – Provides the name of the sample type. This name should be unique.

- **Reference Surface Area** – Provides the anticipated surface area covered by the sample type. The actual geometry drawn on the map might not match this value, especially for hand drawn "Polygon" samples.

- **Shape Type** – Selects the type of shape: "Point" or "Polygon." If "Point" is selected, users will just click on the map and a box of fixed size is placed on the map. If "Polygon" is used, users will need to draw the sample on the map.

- **Time to Prepare Kits** – Provides the number of hours it takes to prepare kits for a single sample.

- **Time to Collect** – Provides the number of hours to collect a single sample.

- **Time to Analyze** – Provides the number of hours to analyze a single sample.

- **Total Time per Sample** – Provides the total time per sample required to prepare kits, collect the sample, and analyze the sample. This value should be the sum of the time required to prepare, collect, and analyze samples.

- **Limit of Detection for Porous Surfaces per Sample (CFU)** – Provides the smallest concentration that can be reliably measured from a porous surface. It is used as a reference only and is not used in any calculations. This value is visible in sample pop-ups.

- **Limit of Detection for Nonporous Surfaces per Sample (CFU)** – Provides the smallest concentration that can be reliably measured from a nonporous surface. It is used as a reference only and is not used in any calculations. This value is visible in sample pop-ups.

- **Material Cost** – Provides the cost, in dollars, for the materials required to take a single sample.

- **Total Cost per Sample** – Provides the cost, in dollars, for the labor, materials, and waste required to take one sample.

Figure 20. Custom Sample Type Inputs

- **Waste Volume** – Provides the approximate waste volume, in liters per sample, that can occur for a single sample.

- **Waste Weight** – Provides the approximate waste weight, in pounds per sample, that can occur for a single sample.

- **Analysis Labor Cost** – Provides the labor cost, in dollars, to analyze a single sample.

- **Analysis Material Cost** – Provides the material cost, in dollars, to analyze a single sample.

- **Cancel** – Cancels create a new sample type or changes to an existing sample type.

- **Save** – Saves a new sample type or changes to an existing sample type.

> ⚠ Currently, TOTS does not allow users to save custom sample types for use beyond their current session. Users should preserve the attributes and parameters for any custom sample types outside of TOTS to reference in the future. Saving custom sample types is on a future enhancements list.

RESOURCE TALLY

TOTS provides a quick view of the current resource tally with high-level metrics of the selected sampling plan. As shown in Figure 21, the Resource Tally is displayed in the center of the left navigation menu and dynamically changes as changes to the sampling plan are made. Resource tally metrics presented include:

Figure 21. Resource Tally

- **Total Cost** – Aggregates sampling cost and analysis cost for the sampling plan. This value includes the cost of all layers associated with the sampling plan.

  - 👥 **Sampling Cost** – Lists the subset of Total Cost associated with sampling activities (sampling labor cost + sampling material cost) of the sampling plan. This value includes the cost of all layers associated with the sampling plan.

  - ⚗ **Analysis Cost** – Lists the subset of Total Cost associated with analysis costs (analysis labor cost + analysis material cost) of the sampling plan. This value includes the cost of all layers associated with the sampling plan.

- **Max Time day(s)** – Lists the maximum time necessary to execute the sampling plan. This value is either the total time to complete sampling or the total time to complete the analysis, whichever is greater.

o 👥 **Sampling Time** – Lists the total time to complete sampling.

o ⚗ **Analysis Time** – Lists the total time to complete the analysis. If the limiting factor is "Analysis," then an additional day will be added to this value to account for shipping time.

- **Limiting Factor** – Lists either "Sampling" or "Analysis," depending on which item requires more time to complete.

> 💡 The Resource Tally widget is only visible once the user has selected a sampling plan with at least one sample. Users should be sure that their sampling layer is linked to their sampling plan.

Once users are satisfied with the sampling plan they have created, they can click "Calculate Resources" or "Next" to view a more detailed breakdown of resource demand calculations.

Calculate Resources

Clicking on the "Calculate Resources" tab on the left navigation menu allows users to view estimates of the cost and time that is required to implement the designed plan. Estimates are based on default parameters and reflect scenario-specific constraints. Note: the "Create Plan" step must be completed prior to using this tab. As shown in Figure 22, the "Calculated Resources" tab is used to perform calculations on the active sampling plan and displays a detailed summary of estimates.

Figure 22. Calculate Resources Tab

Users can tweak resource constraints, as shown in Figure 23, to see how these values will impact resource demand estimates for the sampling plan. Users can also download results to an Excel spreadsheet (includes a detailed summary and a screenshot of the map) and "View Contamination Hits" when in training mode. Refer to Chapter 2 for information on the methodology behind the calculations.

- **Plan Name** – Lists the name of the plan that was selected in the "Specify Plan" drop down of the "Create Plan" tab.

- **Plan Description** – Provides a description of the currently selected plan.

- **Number of Available Teams for Sampling** – Lists the number of teams that will be used for sampling purposes. The default value is 1.

- **Personnel per Sampling Team** – Lists the number of personnel on each sampling team. The default value is 3.

- **Sampling Team Hours per Shift** – Lists the number of hours per shift. The default value is 5.

- **Sampling Team Shifts per Day** – Lists the number of shifts per day. The default value is 1.

- **Sampling Team Labor Cost ($)** – Lists the labor cost, in dollars, per person per hour. The default value is $420.

- **Number of Available Laboratories for Analysis** – Lists the number of laboratories that will be used to analyze the samples collected. The default value is 1.

- **Analysis Laboratory Hours per Day** – Lists the number of hours the laboratory can dedicate to analyzing samples per day. The default value is 24.

- **Surface Area** – Estimates the surface area being sampled. If this value is greater than 0, additional outputs are displayed in the output of "View Detailed Results."

- **View Detailed Results** – Runs the calculations and displays a detailed summary report of the sampling plan. The summary report includes a "Download" button, where a user can download a Microsoft Excel version of the summary report that includes a screenshot of the map.

Plan Name: New Scenario

Plan Description: This scenario is for demonstration purposes. <u>Show less</u>

Number of Available Teams for Sampling

| 1 |

Personnel per Sampling Team

| 3 |

Sampling Team Hours per Shift

| 5 |

Sampling Team Shifts per Day

| 1 |

Sampling Team Labor Cost ($)

| 420 |

Number of Available Labs for Analysis

| 1 |

Analysis Lab Hours per Day

| 24 |

Surface Area (ft^2) (optional)

| 7400 |

View Detailed Results

Figure 23. Calculate Resources Inputs

If "Training Mode" was enabled on the "Create Plan" tab, the "Include Contamination Map" section is available as shown in Figure 24. This feature compares the selected sampling plan to a "Contamination Map" and highlights any samples that intersect with a feature in the "Contamination Map" layer. This feature is useful for testing the effectiveness of a sampling plan in a classroom setting.

Figure 24. View Contamination Hits Options

- **Contamination Map** – Provides the Contamination Map layer to compare against the sampling plan.

- **Add** – Navigates to the "Add Data" tab, so users can add a Contamination Map layer.

- **View Contamination Hits** – Compares the sampling plan against the selected Contamination Map and highlights samples that would have detected a contaminant. The Contamination Map is available in the "Legend" widget once "View Contamination Hits" is clicked where a user can make the Contamination Map visible on the map. Figure 25 illustrates an example of the results of "View Contamination Hits" feature.

Figure 25. View Contamination Hits Results

When users have finished creating the sampling plan, they can click "Download" or publish their plan in an AGO account by clicking "Publish" or "Next" to continue.

> If a user has generated multiple plans or instances of a plan that might vary by layer association, they can toggle between the "Create Plan" and "Calculate Resources" tabs to change the "active plan" and recalculate results. Users can download each instance of the calculations to preserve any work from their session.

Publish

This step allows users to publish sampling plans to their ArcGIS Online account. Users can click the "Publish Plan" tab on the left navigation menu. As shown in Figure 26, users will be prompted to login to their AGO account if they are not already. Users can either login by using the "Login" button in the top toolbar or by clicking "Publish."
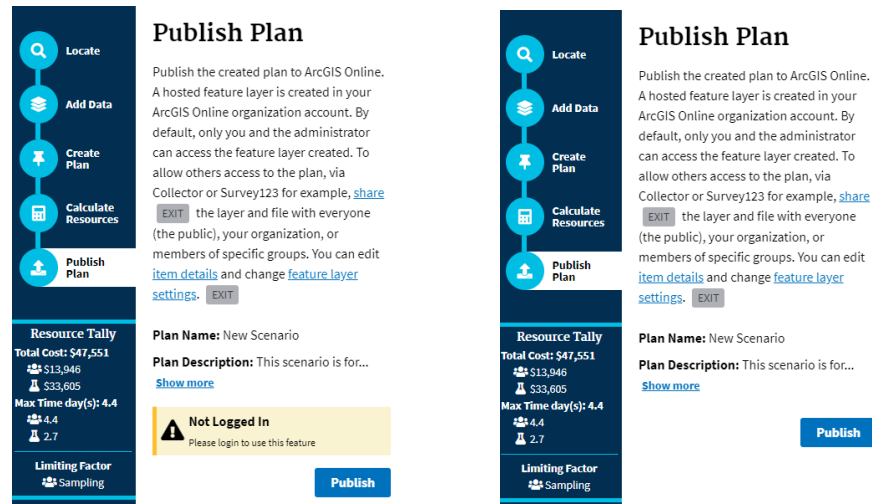
Figure 26. Publish Plan

If the plan name is already in use, users are prompted to change the plan name as shown in Figure 27.

Figure 27. Plan Name Not Available Warning

By default, the plan/layer is accessible only to the user who published the layer and the administrator of the organization. To allow others access to the plan, via Collector or Survey123, for example, user can share the layer and file with everyone (the public), their organization, or members of specific groups. Users can also edit item details and change feature layer settings.

Retrieve a Published Plan

Published plans are saved in a user' ArcGIS Online (AGO) account as content. TOTS users can retrieve sampling plans saved to their ArcGIS Online account for use in a future TOTS session. Published plans have a layer type of "Sample Layer" and can be retrieved by following the "Add Data" steps that are described above. User can follow the steps below to link a published sampling plan to a new TOTS scenario.

1. Start a new TOTS session.

2. Log into an AGO account to access "My Content."

3. Click on "Add Data" and select "My Content" from the "Data Location" drop-down.

4. Locate and select the previously published layer (i.e., sampling plan).

5. If the layer was created by TOTS, TOTS will automatically recognize the "layer type" as "Sample Layer" type.

6. Click the "Create Plan" tab on the left navigation menu. Enter a Name and Description and click "Save."

7. Using the Active Sampling Layer controls shown in Figure 12, click the 🔗 button to link the layer to the selected plan. The previously published layer will be available for selection in the "Active Sampling Layer" drop-down to "link to" the current plan. Any features associated with the layer will be loaded into the active sampling layer.

Troubleshooting

Read about issues and resolutions to common problems

This chapter provides solutions to commonly found problems that users might encounter when using TOTS.
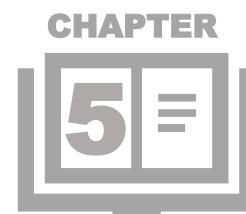
Table 5. Troubleshooting Guide

Problem	Cause	Remedy
Unsupported Browser	TOTS uses features from the ArcGIS JS API that are not supported by Internet Explorer.	Open TOTS using one of the preferred browsers, Chrome or Edge.
Web Service Error	Possible issue with the network connection, TOTS GP Service outage, or other web service outages.	Retry the operation. If the issue persists, press F12, copy any errors in the Console, and submit a bug report to HSRP.
No Data	The file being imported does not contain any data.	Ensure the file has features and re-import.
Missing Required Attributes	The layer being imported is missing required attributes in one or more of the features. The incorrect layer type could have been selected (e.g., attempting to import a sample layer as a contamination map).	Verify that the correct layer type was selected and try again. If the issue persists, verify that ALL the features in the file being imported have ALL required attributes.
Unknown Sample Type	The sample file uploaded does not contain the "TYPE" attribute.	Ensure that every feature in the file being uploaded has the TYPE attribute.
Exceeded Transfer Limit	The request is too large for the GP Service to handle.	If this occurs while using the "Add Multiple Random Samples" tool, decrease the number of samples to 1000 or less. If this occurs while importing a VSP file, split up the VSP file into multiple files, where each file has 1000 features or less, and import them separately.
No Samples	Either no plan was selected, or the selected plan has no samples added to it prior to clicking the "View Contamination Hits" button.	Go to the "Create Plan" tab and verify that a plan is selected in the "Specify Plan" drop down. Verify the selected plan has samples on it.
No Contamination Map	No contamination map was selected when using the "View Contamination Hits" button.	Ensure that a Contamination Map was selected. If there are no Contamination Maps in the drop down, then click the "Add" button and import a Contamination Map.
No Features in Contamination Map	The Contamination Map file that was imported does not contain any features.	Ensure the Contamination Map file has features and re-import.

This concludes the User's Guide. If users have any questions, please email the point of contact listed in Chapter 1.

Appendix A – Quick Start Guide

Learn about how to quickly access and use the tool

To access the tool, open a web browser and type https://tots-stage.app.cloud.gov/ into the address bar. Please use one of the following supported web browsers: Chrome or Edge. TOTS uses tools from the ArcGIS API that are not supported by Internet Explorer.

TOTS is used to create sampling designs and estimate the associated resource demand through interactive point-and-click tools to visually develop sampling plans. The left navigation menu is used to move through the various steps within TOTS as shown in Figure A-1. Review an overview of the steps below:

- **Locate** – Start here to zoom to a location on the map to create a sampling design for an outdoor area.
- **Add Data** – Begin with an existing sampling design or add an indoor environment representation to begin. Layers to bring to the project include:
    o Samples: Layer containing pre-existing samples.
    o Reference Layer: Additional contextual reference layers to include in your analysis (e.g., building footprints, landmarks).
    o Area of Interest: A polygon file that bounds the extent of the project area.
    o Visual Sample Plan (VSP): An externally generated Visual Sample Plan (VSP) layer to analyze and/or use in conjunction with targeted sampling.
    o Contamination Map: When in training mode, adds a layer that includes the area and concentrations of contamination.
- **Create Plan** – Select the layer on which to base the plan, give it a name and description and add targeted samples or use the "Add Multiple Random Samples" to draw multiple samples of the same type in a specified area of interest. A Resource Tally will update as the plan is built. A companion summary table is also available detailing the attributes of any samples that are added to the plan. Create custom sample types or clone existing sample types to support conducting "what-if" scenarios.
- **Calculate Resources** – Review the default resource constraints that are provided to estimate the cost and time required to implement the designed plan. Change the default parameters to reflect scenario-specific constraints and to support conducting "what-if" scenarios. Detailed results can be downloaded into a Microsoft Excel spreadsheet.
- **Publish Plan** – Save and/or share the plan to ArcGIS Online as a hosted feature layer. Log into the ArcGIS Online account to use this feature.
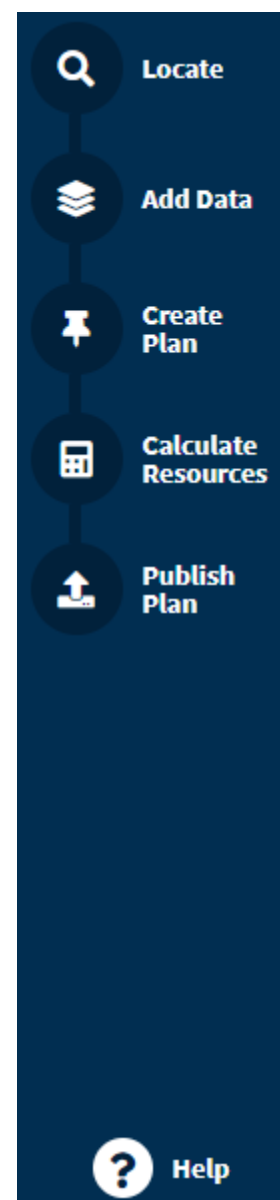- **Help** – Use at any time to view the help widget.

Figure A-1. Navigation

Appendix B – Sample Attributes

Use to reference the attribute values for each of the provided sample types

This appendix details the attribute values for each of the established sample types provided by TOTS.

Table B-1. Sponge Attributes

Attribute Name	Abbreviation	Value
Sample Type	TYPE	Sponge
Shape Type	ShapeType	Point
Reference Surface Area (in²)	SA	100
Total Cost Per Sample (Labor + Material + Waste)	TCPS	343.03
Analysis Labor Cost	ALC	118
Analysis Material Cost	AMC	239
Sampling Material Cost ($/sample)	MCPS	46.87
Time to Prepare Kits (person h/sample)	TTPK	0.12
Time to Collect (person h/sample)	TTC	0.09
Time to Analyze (person h/sample)	TTA	0.7
Total Time per Sample (person h/sample)	TTPS	0.99
Limit of Detection for Porous Surfaces per Sample (CFU)	LOD_P	14
Limit of Detection for Nonporous Surfaces per Sample (CFU)	LOD_NON	0
Waste Volume (L/sample)	WVPS	0.1
Waste Weight (lb/sample)	WWPS	4.3

Table B-2. Microvac Attributes

Attribute Name	Abbreviation	Value
Sample Type	TYPE	Micro Vac
Shape Type	ShapeType	Point
Reference Surface Area (in²)	SA	144
Total Cost Per Sample (Labor + Material + Waste)	TCPS	395.84
Analysis Labor Cost	ALC	151
Analysis Material Cost	AMC	288
Sampling Material Cost ($/sample)	MCPS	34.28
Time to Prepare Kits (person h/sample)	TTPK	0.18
Time to Collect (person h/sample)	TTC	0.15
Time to Analyze (person h/sample)	TTA	0.8
Total Time per Sample (person h/sample)	TTPS	1.21
Limit of Detection for Porous Surfaces per Sample (CFU)	LOD_P	105
Limit of Detection for Nonporous Surfaces per Sample (CFU)	LOD_NON	0
Waste Volume (L/sample)	WVPS	0.02
Waste Weight (lb/sample)	WWPS	4.3

Table B-3. Wet Vac Attributes

Attribute Name	Abbreviation	Value
Sample Type	TYPE	Wet Vac
Shape Type	ShapeType	Polygon
Reference Surface Area (in²)	SA	28800
Total Cost Per Sample (Labor + Material + Waste)	TCPS	220
Analysis Labor Cost	ALC	151
Analysis Material Cost	AMC	200
Sampling Material Cost ($/sample)	MCPS	167
Time to Prepare Kits (person h/sample)	TTPK	0.33
Time to Collect (person h/sample)	TTC	0.46
Time to Analyze (person h/sample)	TTA	0.8
Total Time per Sample (person h/sample)	TTPS	1.07
Limit of Detection for Porous Surfaces per Sample (CFU)	LOD_P	105
Limit of Detection for Nonporous Surfaces per Sample (CFU)	LOD_NON	40
Waste Volume (L/sample)	WVPS	5
Waste Weight (lb/sample)	WWPS	28.5

Table B-4. Robot Attributes

Attribute Name	Abbreviation	Value
Sample Type	TYPE	Robot
Shape Type	ShapeType	Polygon
Reference Surface Area (in²)	SA	144000
Total Cost Per Sample (Labor + Material + Waste)	TCPS	267
Analysis Labor Cost	ALC	200
Analysis Material Cost	AMC	288
Sampling Material Cost ($/sample)	MCPS	400
Time to Prepare Kits (person h/sample)	TTPK	0.33
Time to Collect (person h/sample)	TTC	0.3
Time to Analyze (person h/sample)	TTA	0.7
Total Time per Sample (person h/sample)	TTPS	1.12
Limit of Detection for Porous Surfaces per Sample (CFU)	LOD_P	105
Limit of Detection for Nonporous Surfaces per Sample (CFU)	LOD_NON	140
Waste Volume (L/sample)	WVPS	0.5
Waste Weight (lb/sample)	WWPS	10.5

Table B-5. Aggressive Air Attributes

Attribute Name	Abbreviation	Value
Sample Type	TYPE	Aggressive Air
Shape Type	ShapeType	Polygon
Reference Surface Area (in²)	SA	144000
Total Cost Per Sample (Labor + Material + Waste)	TCPS	267
Analysis Labor Cost	ALC	118
Analysis Material Cost	AMC	200
Sampling Material Cost ($/sample)	MCPS	207
Time to Prepare Kits (person h/sample)	TTPK	0.33
Time to Collect (person h/sample)	TTC	0.5
Time to Analyze (person h/sample)	TTA	0.5
Total Time per Sample (person h/sample)	TTPS	1.12
Limit of Detection for Porous Surfaces per Sample (CFU)	LOD_P	0
Limit of Detection for Nonporous Surfaces per Sample (CFU)	LOD_NON	0
Waste Volume (L/sample)	WVPS	0.1
Waste Weight (lb/sample)	WWPS	5

Table B-6. Swab Attributes

Attribute Name	Abbreviation	Value
Sample Type	TYPE	Swab
Shape Type	ShapeType	Point
Reference Surface Area (in²)	SA	4
Total Cost Per Sample (Labor + Material + Waste)	TCPS	219
Analysis Labor Cost	ALC	118
Analysis Material Cost	AMC	239
Sampling Material Cost ($/sample)	MCPS	21
Time to Prepare Kits (person h/sample)	TTPK	0.12
Time to Collect (person h/sample)	TTC	0.07
Time to Analyze (person h/sample)	TTA	0.7
Total Time per Sample (person h/sample)	TTPS	0.89
Limit of Detection for Porous Surfaces per Sample (CFU)	LOD_P	25
Limit of Detection for Nonporous Surfaces per Sample (CFU)	LOD_NON	0
Waste Volume (L/sample)	WVPS	0.01
Waste Weight (lb/sample)	WWPS	2

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Homeland Security Research Program
Research Triangle Park, NC 27711