



Community Resilience Scenario Planning Model

Technical User Guide



American Planning Association

Making Great Communities Happen

This Technical User Guide was developed by Focused Planning Solutions, Inc., in collaboration with Hey and Associates, Inc., and the American Planning Association, with support from the University of California San Diego and the National Charrette Institute. This guide is the product of a FEMA-sponsored project to identify the best ways to use cutting-edge technological tools and participatory processes to engage citizens in the hazards planning process. The Community Resilience Scenario Planning Model (CRSPM) described in this guide can be used in the context of an overall plan update, as part of special purpose plans, or in developing a stand-alone community resilience plan and implementation strategy. This guide can also help communities integrate hazard mitigation into their local planning activities and increase implementation of risk reduction activities.



Focused Planning Solutions LLC

Hey and Associates, Inc.



National Charrette Institute
MICHIGAN STATE UNIVERSITY

American Planning Association, which has offices at 205 N. Michigan Ave., Suite 1200, Chicago, IL 60601-5927, and 1030 15th St., NW, Suite 750 West, Washington, DC 20005-1503; planning.org.

Community Resilience Scenario Planning Model

Technical User Guide

The Community Resilience Scenario Planning Model (CRSPM) consists of technology and tools designed for this project. It utilizes ArcGIS® desktop software coupled with the extensions Arc Hydro and CommunityViz®. Arc Hydro is a model and toolkit designed to delineate overland stormwater flows based on topographic data. CommunityViz is a scenario planning decision support tool. The dynamic analysis engine allows for open formulaic programming, making the software customizable for purposes such as the CRSPM. This combination of tools provides an effective platform for visualizing stormwater accumulation and impacts, exploring contributing factors and testing potential solutions to problems.

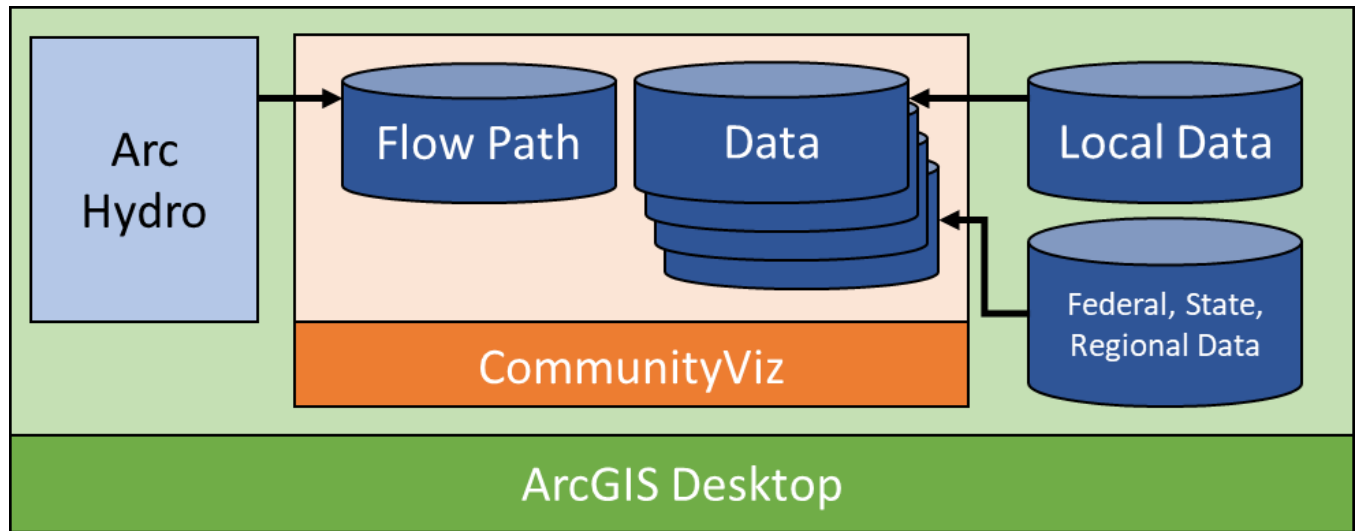


Figure 1: CRSPM Tool Diagram

Arc Hydro Flow Path Model

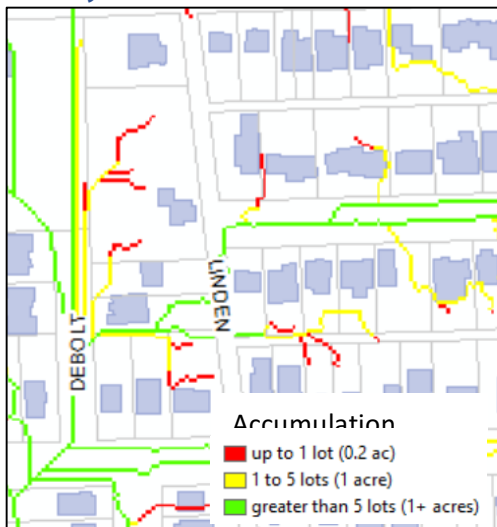


Figure 2: Flow Path Map

The flow path model provides a way for users of the CRSPM to visualize water movement and accumulation at a local level. The primary inputs required to prepare a flow path model are terrain data, most commonly Lidar, and rainfall amount. The flow path can be refined in a number of additional ways. For example, structures can be incorporated as impediments to flow, allowing the water to wrap around structures not otherwise represented in the terrain model. While flow path modeling is strictly a representation of overland flow and sewer systems are not explicitly accounted for in the flow path model, it can incorporate inlets to systems as volume capture points. This allows the model to better depict typical storm behavior when sewer systems are able to accommodate some amount of rainfall.

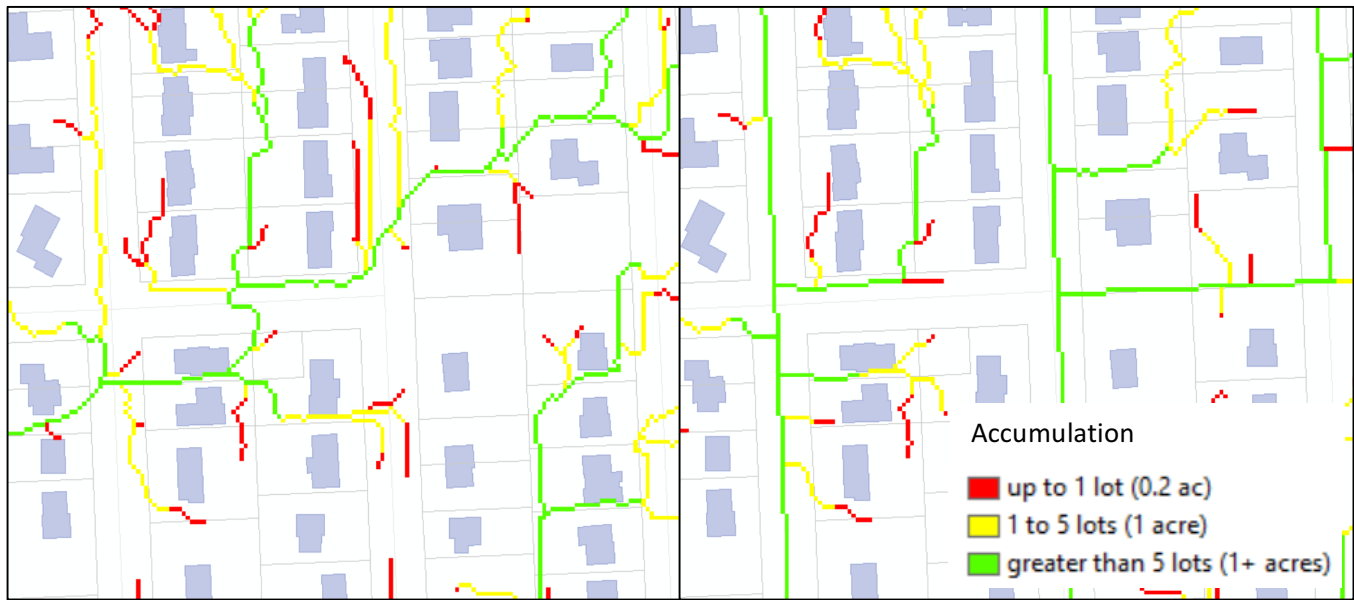


Figure 3: Flow path map without sewer inlets (left), including existing and, where available, proposed sewer inlets (right).

For this project, Hey and Associates, Inc. prepared the Arc Hydro flow path model for the neighborhoods in the Village of Downers Grove, Illinois, under study. In the three neighborhoods studied, two model runs were prepared. The first includes just terrain data and structure footprints. The second adds sewer system inlets, including some future infrastructure improvements where proposed and defined.

This CRSPM table of contents includes the flow path data layers (Arc Hydro outputs) and layers used as Arc Hydro model inputs.

TABLE 1: ARC HYDRO MODEL DATA

Source	Layer Name	Geometry
Local Input	Building	Polygon
Local Input	DEM	Raster
Local Input	Topography	Polyline
ARC Hydro Output	Flow Path No Sewer	Raster
ARC Hydro Output	Flow Path Sewer	Raster

Other Geographic Information System Data Inputs

In addition to the flow path data, the CRSPM table of contents includes several datasets. Locally provided data includes infrastructure (streets, railroads, detention basins, water and sewer pipes and points), building footprints, water data (FEMA Flood Insurance Rate Maps, floodways, Localized Poor Drainage Areas¹, watersheds with sub basins), impervious surfaces, parks, parcels, zoning and future land use. Most of this data is included for reference only although some local data sets are used in the dynamic analysis components.

Localized Poor Drainage Area (LDPA):

The village identified these locations as prone to flooding due to topography. Stormwater runoff tends to accumulate in these areas creating risk of flooding

¹ <http://www.downers.us/res/stormwater-management/lpda-amp-flood-plain>
[Planning.org/nationalcenters/hazards](http://planning.org/nationalcenters/hazards)

Reference data layers are for the user to be able to view and symbolize information which might aid in orienting the user or provide pertinent content for decision making. They do not directly interact with the dynamic model analysis components.

Table 2: Reference Data Layers		
Source	Layer Name	Geometry
Local	Active_LPDAs	Polygon
Local	Detention_Basin_Boundary	Polygon
Local	Detention_Basins	Point
Local	FloodWay	Polygon
Local	FP_100Year	Polygon
Local	FP_500Year	Polygon
Local	Future_Land_Use	Polygon
Local	Municipal Boundary	Polygon
Local	Non_Village_Storm_Pipes	Polyline
Local	Non_Village_Storm_Structures	Point
Local	Storm_Channel	Polyline
Local	Storm_Pipes	Polyline
Local	Storm_Pipes_ND	Polyline
Local	Storm_Points	Point
Local	Streets	Polyline
Local	Unincorporated_LDPAs	Polygon
Local	WaterSheds with SubBasins	Polygon
Local	Zoning	Polygon
Pre-processed	Clip_Study_Area	Polygon
Pre-processed	Study_Area_Boundary	Polygon
Pre-processed	Study_Area_Mask	Polygon

There are some data layers included for reference that include dynamic calculations. These layers can be used to provide visualization of some model information, such as impervious ratio or building coverage percent. They do not affect the core model formulas for impervious runoff.

Table 1: Dynamic Reference Layers		
Source	Layer Name	Geometry
Local	Impervious_Surface_Polygons	Polygon
Local	Parcels	Polygon
Pre-processed	Grid_10x10	Polygon

Finally, the CRSPM includes the layers used for dynamic analysis. Data about impervious surface and stormwater runoff are calculating directly from this data. The CRSPM manages these layers directly.

Table 2: Dynamic Analysis Layers

Source	Layer Name	Geometry
Analysis Auto-generated	Summary_Selection	Polygon
Preprocessed	Landcover_Paint	Polygon
User Defined	Location Selection	Polygon

Preprocessing Data for Analysis

Prior to building a CRSPM project, the data should be prepared for use in the model. Reference data, including dynamic reference layers, can be considered optional for use in a project. If the user wants to include the data listed in the current table of contents, input data should match the geometry type specified and data should be clipped to a defined clip area. The clip area should be larger than the study area to provide context, but not so large as to hinder model rendering and other performance considerations. All data should be projected to a common geographic projection.

A 10' by 10' vector grid was built for the project study area. The user can choose to build a similar grid for their own study area in GIS using the Fishnet² ArcToolbox tool or similar vector grid setup tool.

The primary preprocessed dataset for this project is the Landcover_Paint layer. This dataset is a polygon layer that provides full coverage landcover information for the study area. For the Village of Downers Grove, the data was derived from local data on impervious surfaces. Existing landcover types were established for each impervious type and remaining land was assigned "turf" for ease of classification. This worked well in the urban residential context, but could be refined for projects needing greater landcover diversity. The landcover data was also unioned with the 10' by 10' grid layer to provide smaller units of measure for future landcover "paints." Where impervious polygons split grids, partial grids were created. This allowed for accurate land area for existing and proposed change options.

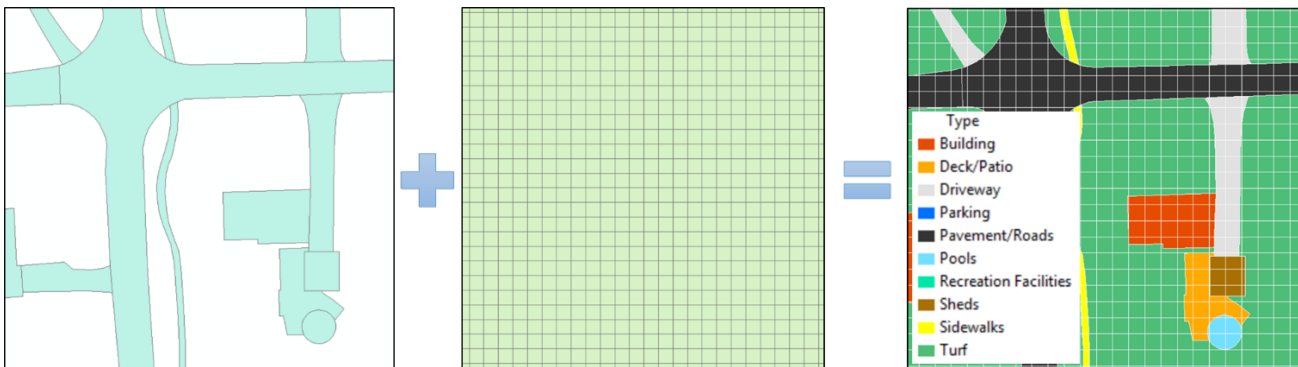


Figure 4: Landcover data setup process.

Building a CSRPM Project

Each neighborhood studied in the Village of Downers Grove pilot is setup as a unique CommunityViz project. The CRSPM can be templated to new locations within the village, in other parts of DuPage County, Illinois, or beyond. The following explains the steps to apply the CRSPM Super Template.

² <http://pro.arcgis.com/en/pro-app/tool-reference/data-management/create-fishnet.htm>
Planning.org/nationalcenters/hazards

Step 1: Obtain and prepare desired data for use in the CRSPM analysis per the previous documentation.

Step 2: Create a new empty CommunityViz analysis.³

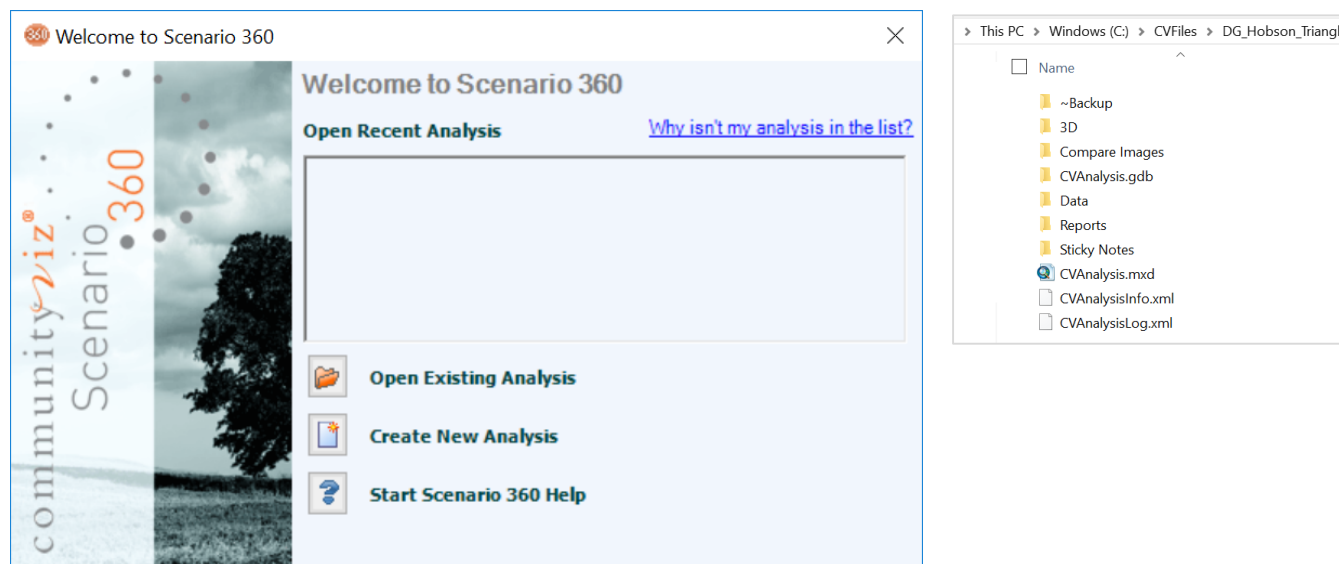


Figure 5 and 6: CommunityViz welcome screen (left); Example CommunityViz project folder structure.

This will create a project folder in the specified file location, the default being C:\CVFiles. The name of your analysis will be the name of the folder stored in this location. Inside every CommunityViz project folder, there will be a CVAnalysis.mxd, a CVAnalysis.gdb and a CVAnalysisInfo.xml. These files are automatically created by CommunityViz and are necessary to the structure of the analysis. CommunityViz also creates several folders which may initially be empty for potential future use in storing components of a CommunityViz project.

Step 3: Load Super Template "CRSPM_Template". This option can be found on the Scenario 360 drop-down > Analysis > Load Template. ... Once in the load browser window, navigate to the location where the

CRSPM_Template.cvtem file is stored. The default recommended storage location is C:\CVFiles\Templates. Make sure the file type drop-down is set to Super Templates (*.cvtem). Select "CRSPM_Template.cvtem" and click Open.

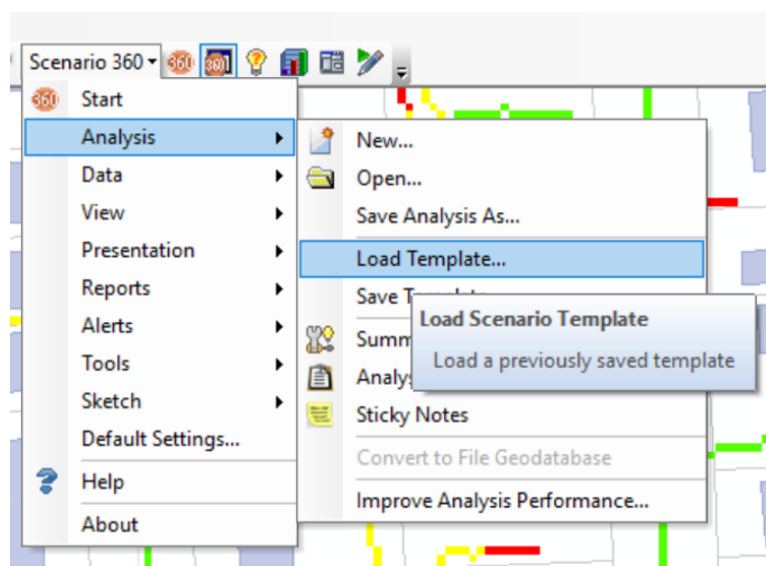


Figure 6: Scenario 360 drop-down menu > Analysis > Load Template...

³ The user must install ArcGIS 10.3 or newer and CommunityViz 5.1 or newer software.

Step 4: In Windows Explorer, copy the editing toolbox “DG_Toolbox” into the analysis data folder.

Step 5: With the project open in CommunityViz, load data for your study area.

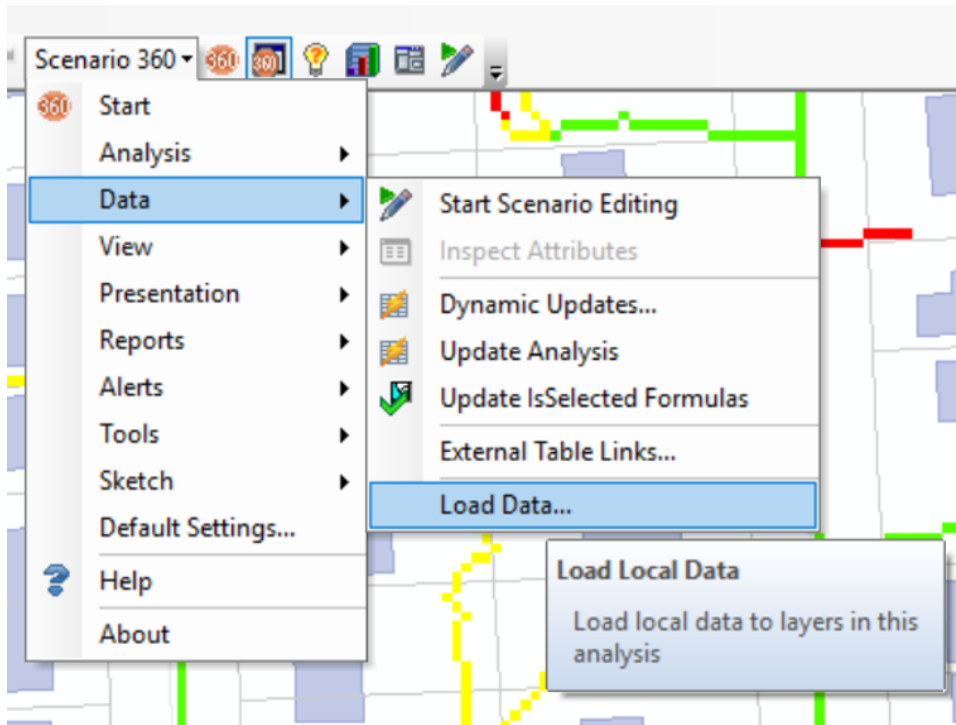



Figure 7: Scenario 360 drop-down > Data > Load Data...

Reference Data: The user can choose to bring in data for any of the reference layers in the table of contents using the CommunityViz Load Data . . . feature. This pulls data into the preexisting layers for your local study area seamlessly. Data which is not currently included in the CRSPM table of contents can also be added, just as with any ArcMap map document, using the ArcMap add data  button.

Dynamic Reference Data: Dynamic Reference Layers should be populated using the CommunityViz Load Data . . . option. If the user chooses not to use these reference layers, they should remain in the project file as empty data layers.

Dynamic Analysis Data: The only dynamic layer that needs to be populated is the Landcover_Paint layer. This layer should be prepared in a similar manner to the described preprocessing steps. Any polygon layer with a field “Type” will be accepted as a load data option, but user paint unit, such as the 10’ x 10’ grid, should be a consideration. In other words, large landcover polygons should be broken out into smaller more manageable polygons.


Using the CRSPM

The CRSPM is designed to be a ready-to-use scenario testing tool. Existing CRSPM projects, such as the neighborhoods built for the pilot, can be used directly by planners, practitioners, local officials, and residents alike. It is best for someone skilled in basic GIS to operate the model as it sits directly in ArcMap desktop, but the user need not be an expert in GIS.

To run a CRSPM project, use the following steps.

Step 1: Open the CRSPM project file. The default project storage for CommunityViz projects is C:\CVFiles.

Step 2: Review data in the study area and explore the flow path information. Determine which properties the user would like to explore with “what-if” scenarios for changing runoff potential. Zoom and pan as needed to provide a good view of the property(ies) of interest.

Step 3: Start Editing . The Location Selection and Summary_Selection layers should be turned on in the Table of Contents by default, but confirm that they are accessible in the Create Features window layer list.

Step 4: In the Create Features window, click on the Runoff Summary option under “Location Selection.” This will automatically bring up the Polygon Construction Tool. On the map, draw a polygon for the area of interest. Any portion of the Landcover_Paint layer data is available to select using this Runoff Summary boundary.

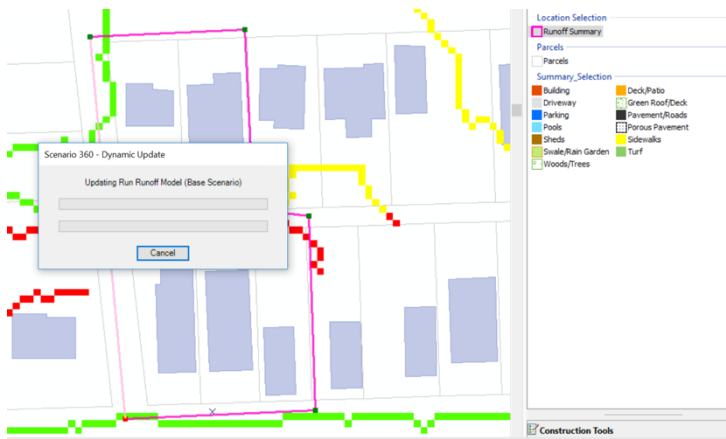


Figure 8: Sketch boundary for the runoff summary location selection.

Step 5: In the Create Features Window, choose a Summary_Selection landcover type you want to paint over an existing landcover type within the area of interest. For example, click on Porous Pavement in the list and then on the map click on a driveway feature. If you drag the paint cursor over multiple features while holding the left mouse button down, you can paint over a larger area.

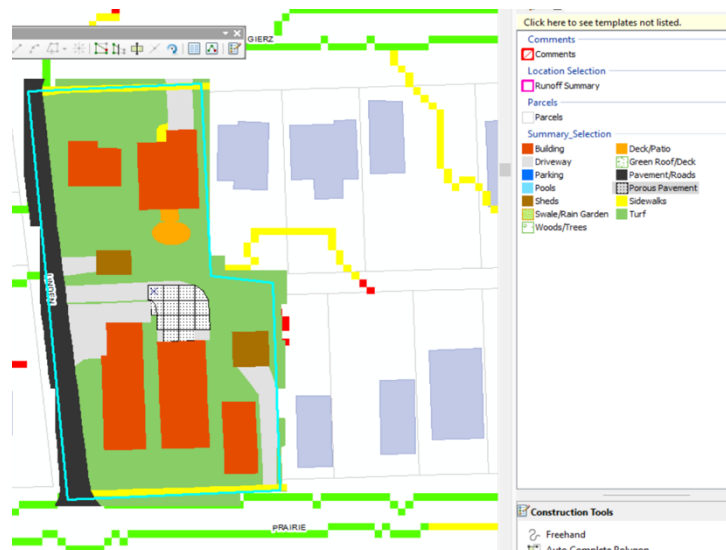


Figure 10: Paint future landcover options.

Step 6: Review the results in the charts. There are four main charts provided in the CRSPM. You can review estimated stormwater runoff for the existing landcover and the user proposed changes. There is also a net change to quickly see the positive or negative change from existing to future. The user can see runoff by landcover type to explore which landcover types provide the largest contributions to runoff. The existing landcover percent shows the impervious:pervious surface ratio for the selection area.

Step 7: Review and change input assumptions as desired. The CRSPM includes multiple assumptions behind the runoff calculations. The main assumption is the amount of rainfall. You can quickly change the default rain event from one inch to a larger or smaller rainfall amount.

The model also includes more expert driven assumptions for the runoff calculations. These include landcover-based coefficients for runoff absorption. These assumptions can be viewed by the user, but are locked to their assigned value. Any changes to these assumptions would need to be done in the assumption setup by an expert.

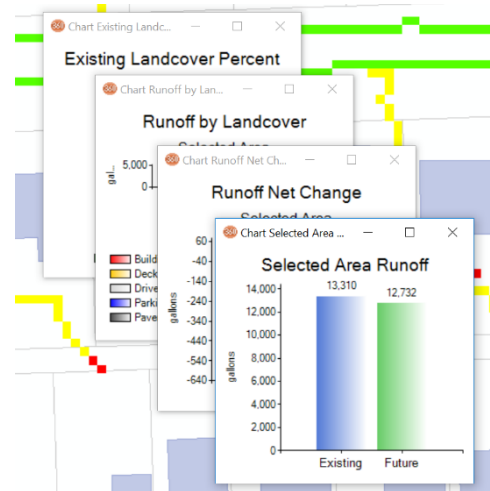


Figure 9: Charts in the CRSPM.

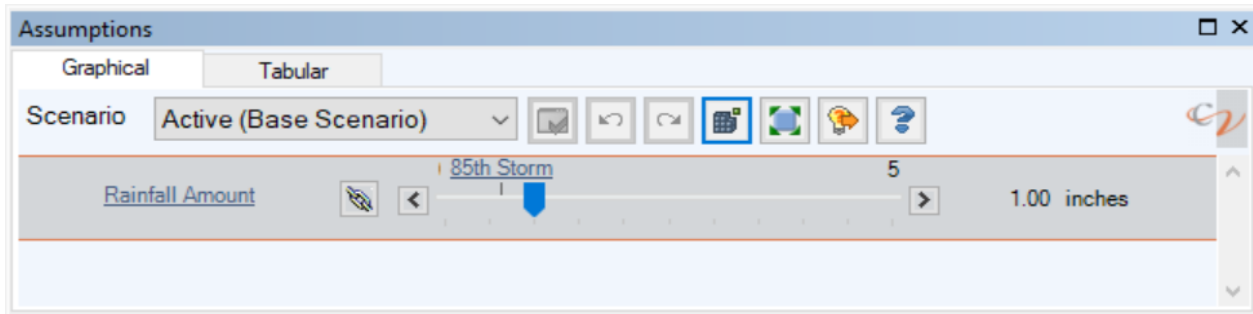



Figure 10: Rainfall amount assumption slider bar.

Assumptions			
Graphical		Tabular	
Name	Units	Base Scenario	
Impervious Standard		98	
Turf CN		74	
Woods CN		74	
Green Roof CN		75	
Porous Pavement CN		40	
Swale or Rain Garde...		63	

Figure 113: Runoff coefficient assumptions.

Step 8: Save changes as desired. Click  to Stop Editing. You can choose to save edits if you want to keep your work for future reference. If you discard edits, you can return to this project as a blank canvas and work on other locations or different iterations. If you save your work, you can always delete the area of interest by selecting the runoff summary feature (pink boundary) and deleting that. This will delete the landcover data in the Summary_Selection. You can then draw a new area of interest following the instructions in step 4.

Links to Training Resources

CommunityViz, ArcGIS and Arc Hydro are all software tools with a broad spectrum of training materials. This document does not attempt to provide technical or training documentation on the core software used. Here are a few resources for users interested in exploring or training more on the suite of tools used in the CRSPM.

For more information on CommunityViz software, explore the CommunityViz homepage: <http://communityviz.city-explained.com/index.html>.

Training resources for CommunityViz can be obtained from the CommunityViz Resources section under tutorials. The second link will take you directly to video tutorials.

<http://communityviz.city-explained.com/communityviz/resources.html>

<http://communityviz.city-explained.com/communityviz/videotutorials.html>

For more information on ArcGIS software and training go to the ESRI website:

<https://www.esri.com/en-us/home>

For information on Arc Hydro, you can search online as this may change over time. The current help topic on this is found at the following link.

<http://resources.arcgis.com/en/communities/hydro/01vn0000000s000000.htm>

Conclusion

The CRSPM toolkit combines a clear way to visualize overland flow at a local property level with interactive design components to test potential landcover changes. This toolkit can be templated to a user chosen location and the analysis replicated for immediate use. The data, impacts, and sketch tools are designed to be applicable for workshops with a public audience, working with stakeholder groups, and planning staff initial review and testing of design alternatives.