Arrow Platform

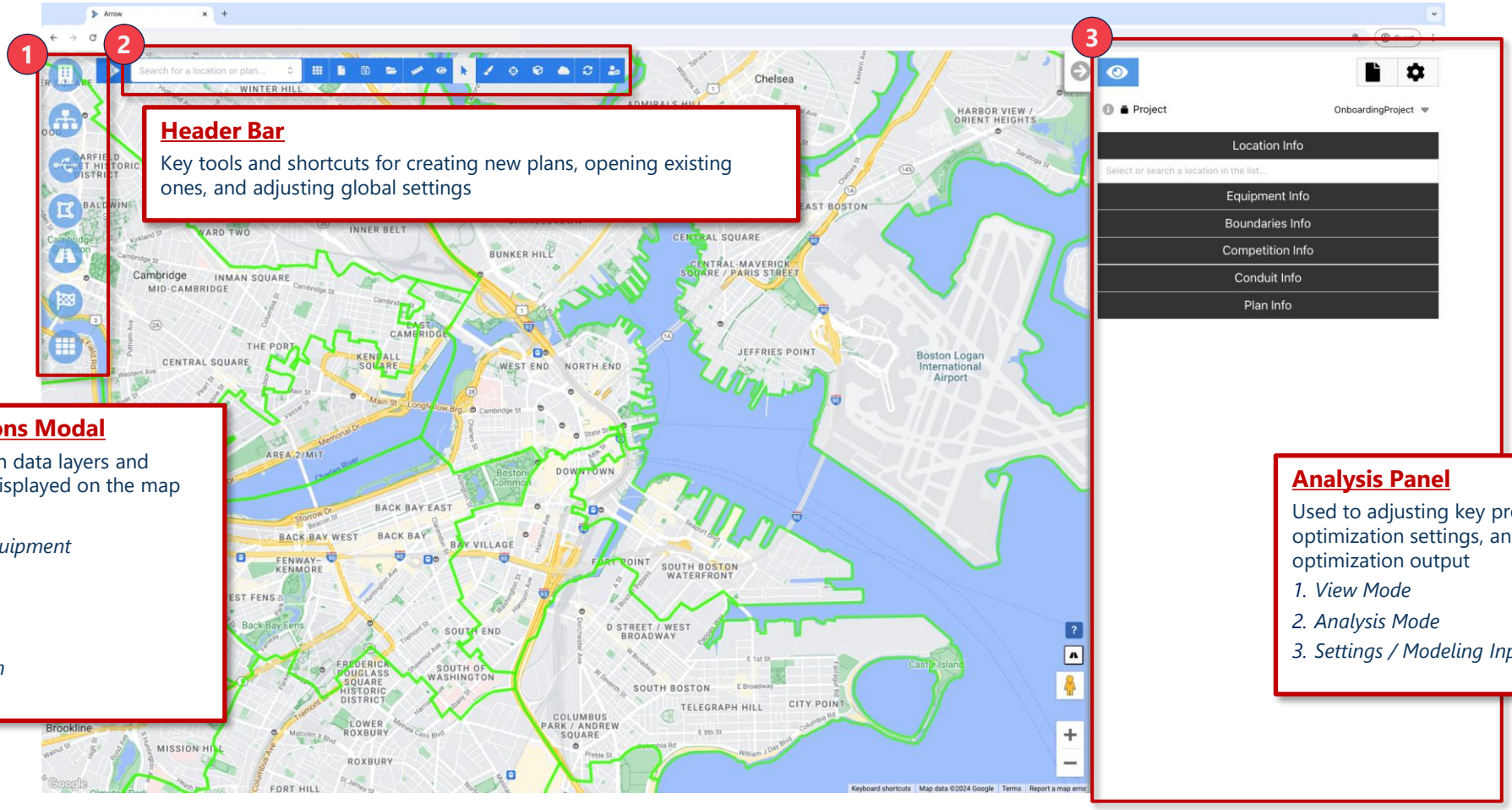
Quick Start Guide

ARROW
by altman solon

altman solon

Content

Users interact with Arrow through controls located in three key areas of the screen: Header Bar, Visualizations Modal and Analysis Panel



We recommend the following order of operations for running optimizations

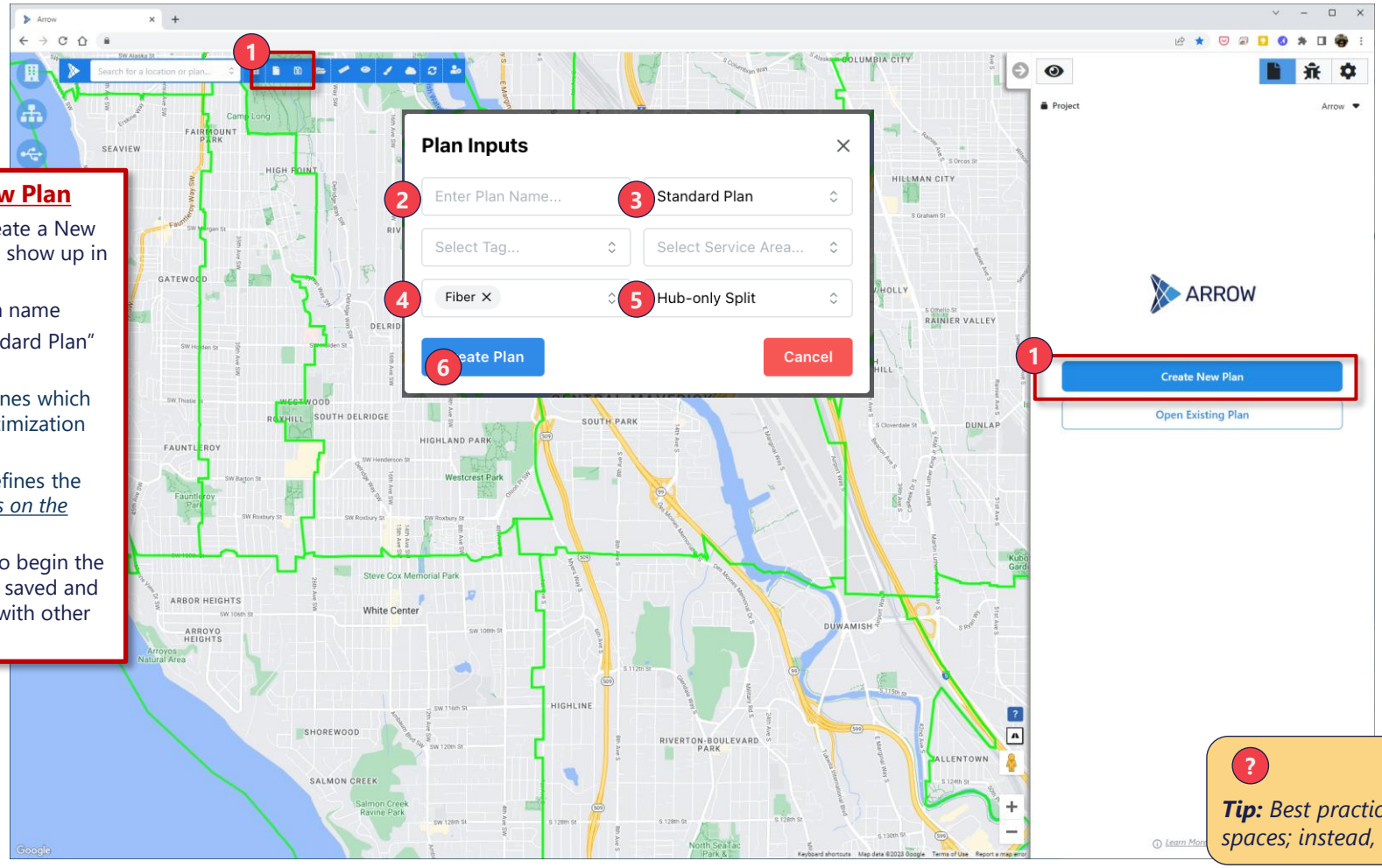
Order of Operations		Description
Set-Up	New Plan	**Create a New Plan** • Before adjusting any settings or running simulations, please create a plan to store results for later reference
	Settings	**Adjust Data Sources and Plan Settings** • To ensure plans run with correct / most recent data, circuit locations, fiber routes, analysis areas, and build costs should be adjusted here
	Locations	**Select Location Types to be Used in the Run** • Users can turn on location layers to be used in simulations and to view on the map • A plan will not run without a selection here
	Input	**Adjust Analysis Settings** • Configure build type and parameters, and financial assumption to best suit analysis goals
	Equipment	**Select Equipment to View on Map** • Users can turn on equipment layers to view on the map • If existing fiber is loaded into the application, this layer can be turned on for viewing; it does not need to be turned on in order to be used in optimizations
Results	Output	**View Build and Financial Results** • Build (fiber miles, CapEx, locations connected) and financial (NPV, IRR, revenue, cash flow) outputs are easily accessible once a run is complete

Notes: Before planning to use Arrow, make sure you have active log in credentials. If a setting is not mentioned, keep default.

Create a new plan and select ‘Standard Plan’ in plan type dropdown

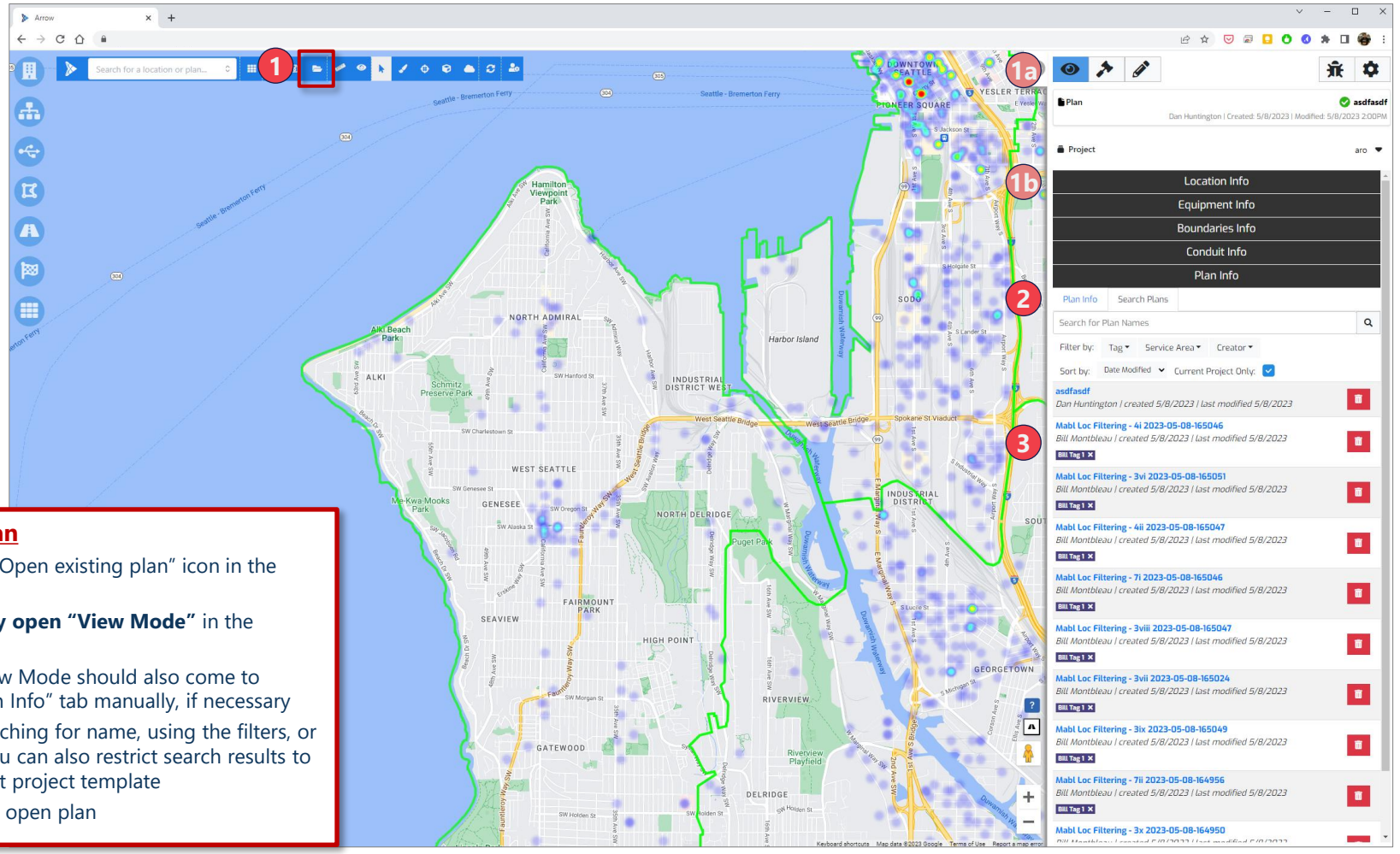
Creating and Saving a New Plan

1. **Create New Plan** – Click “Create a New Plan”. Plan Inputs prompt will show up in the center of the screen.
2. **Plan Name** – Give the plan a name
3. **Standard Plan** – Select “Standard Plan” from the dropdown
4. **Endpoint Technology** – Defines which technology to use for the optimization (e.g., Fiber, 5G)
5. **Network Construction** – Defines the network architecture – *Details on the following pages*
6. **Create** – Click “Create Plan” to begin the analysis. The plan is also now saved and can accessed later or shared with other users



Tip: *Best practice is to save names without spaces; instead, use underscores (“_”)*

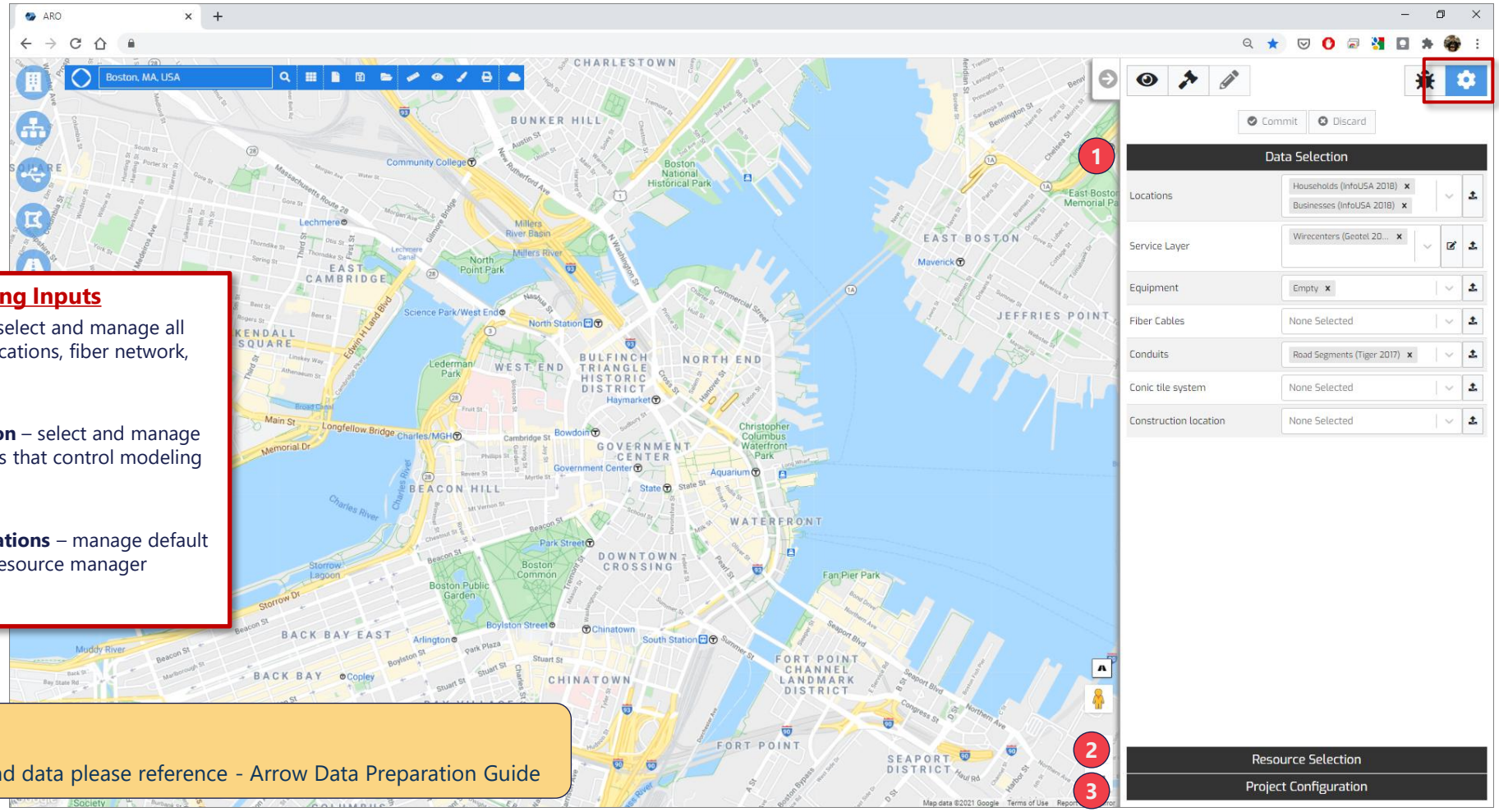
Saved plans can be accessed through Plan Info tab in the View Mode



Opening an Existing Plan

1. **Plan Open Mode** – Click "Open existing plan" icon in the header bar
2. **This should automatically open "View Mode"** in the Analysis Panel
3. **"Plan Info"** tab within View Mode should also come to forefront, navigate to "Plan Info" tab manually, if necessary
4. **Search** – Find plan by searching for name, using the filters, or clicking through pages. You can also restrict search results to plans created using current project template
5. **Open** - Click plan name to open plan

Data and Resources selected in Setting section of the Analysis Pane determine what is available for Arrow to use during optimization runs

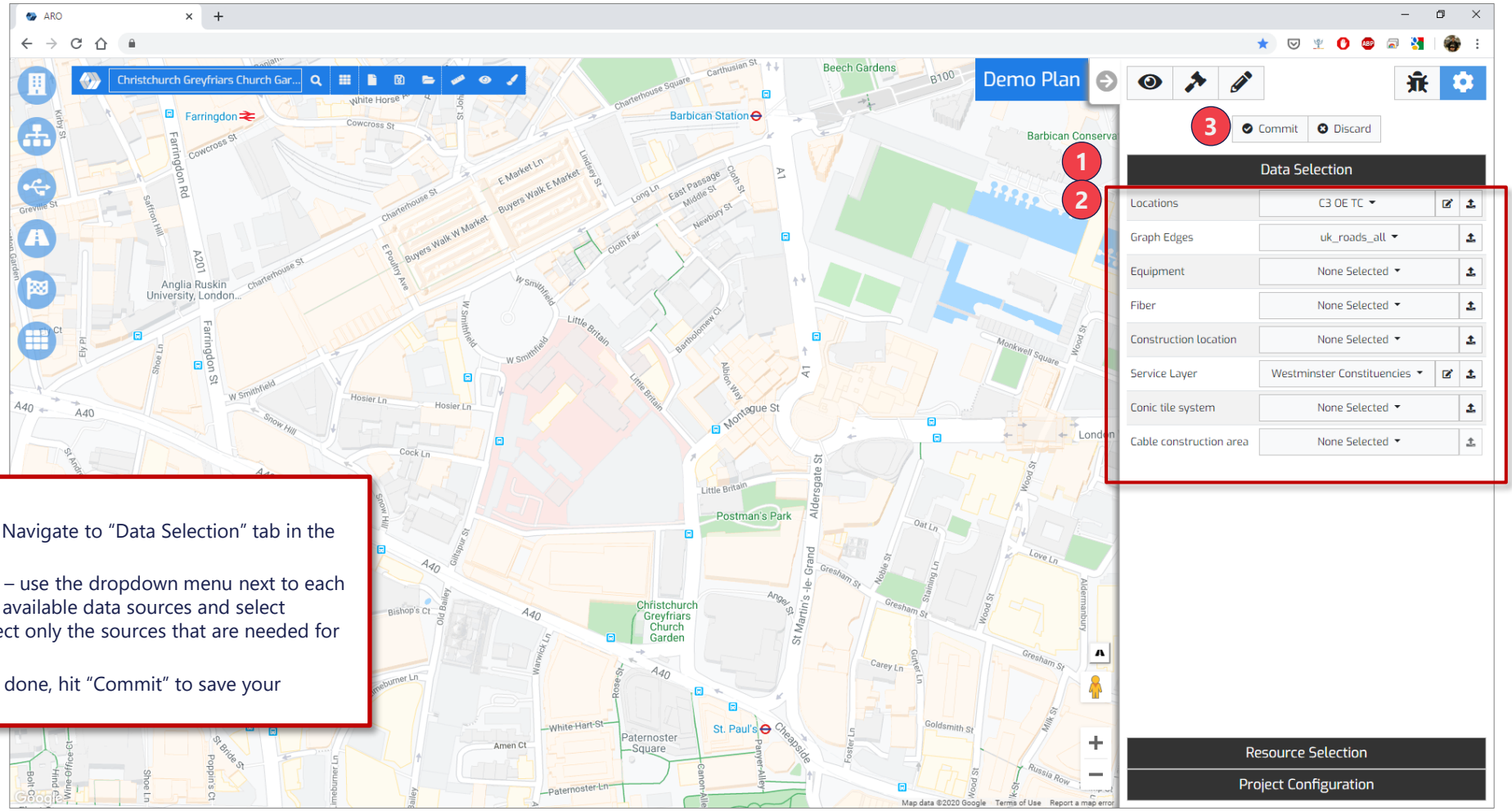


Data and Modeling Inputs

1. **Data Selection** – select and manage all data layers, e.g. locations, fiber network, service areas etc.
2. **Resource Selection** – select and manage resource managers that control modeling inputs
3. **Project Configurations** – manage default project data and resource manager selection

? To learn how to load data please reference - Arrow Data Preparation Guide

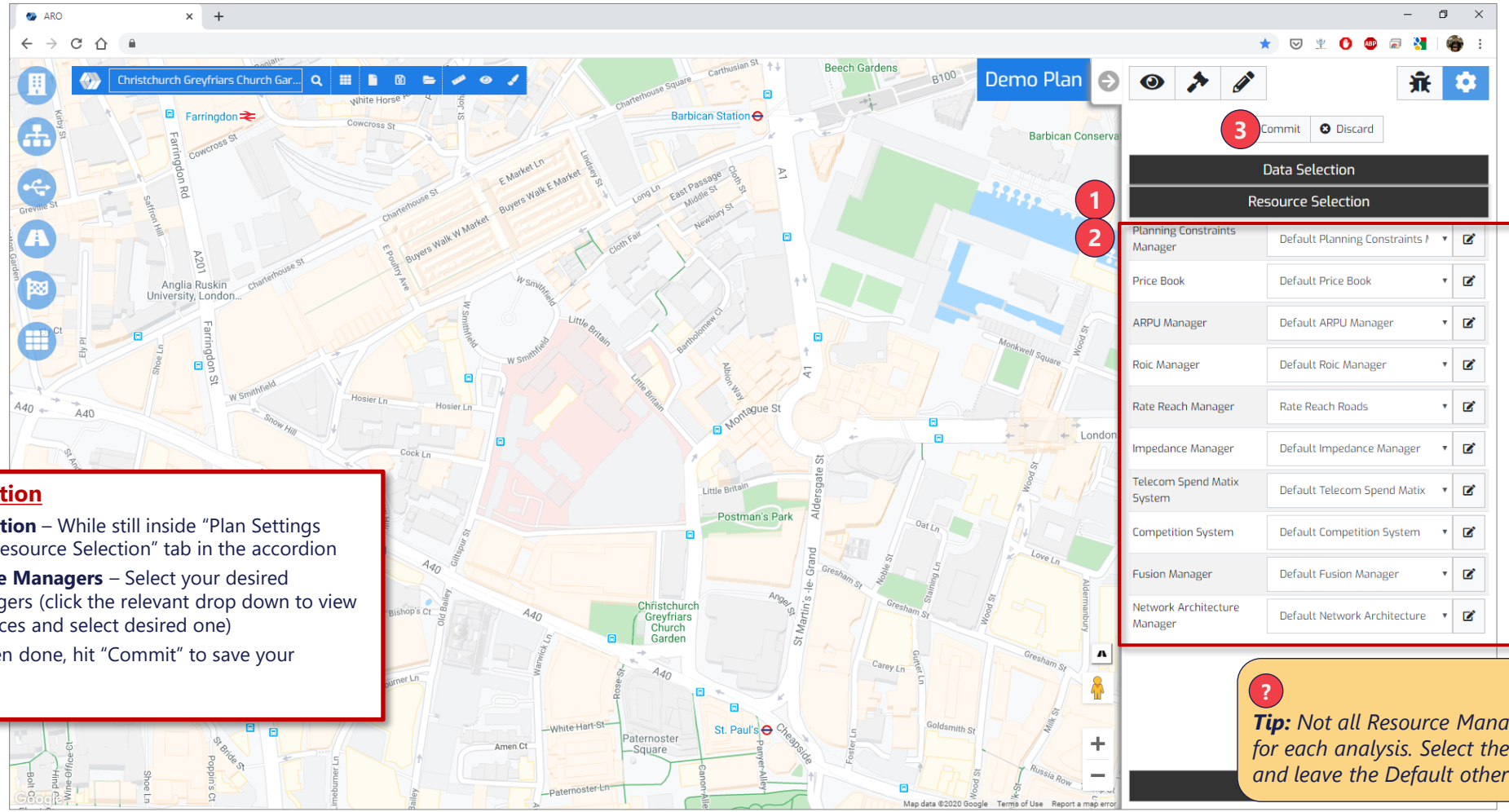
Select data layers to include in the analysis



Data Selection

1. **Data Selection** – Navigate to "Data Selection" tab in the accordion
2. **Pick Data Layers** – use the dropdown menu next to each data type to view available data sources and select desired ones. Select only the sources that are needed for the analysis
3. **Commit** – When done, hit "Commit" to save your selection

Select Resource Managers to use in the analysis

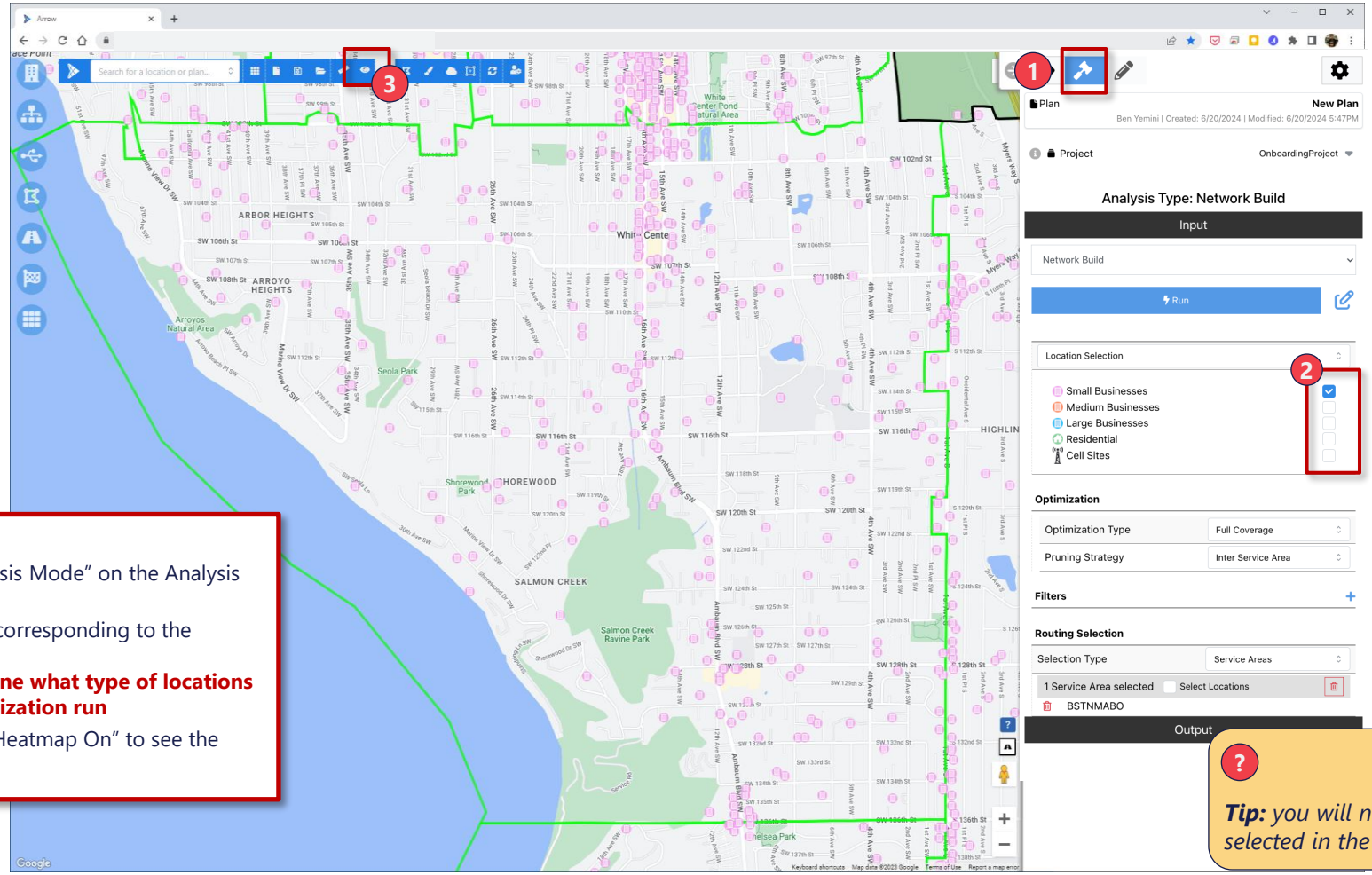


Resource Selection

1. **Resource Selection** – While still inside "Plan Settings Mode", open "Resource Selection" tab in the accordion
2. **Select Resource Managers** – Select your desired Resource Managers (click the relevant drop down to view available resources and select desired one)
3. **Commit** – When done, hit "Commit" to save your selection

Tip: *Not all Resource Managers are needed for each analysis. Select the ones you need, and leave the Default otherwise*

Turn on location layers to be used in simulations, and to view on the map



Locations

1. **Analysis Mode** – Go to "Analysis Mode" on the Analysis Panel
2. **Enable** – Select the checkbox corresponding to the desired location type(s)
   Your selections here determine what type of locations will be targeted in the optimization run
3. **Heatmap** – Toggle "Location Heatmap On" to see the individual locations

Tip: *you will not see locations unless they are selected in the data sources*

Adjust optimization settings, and run a plan

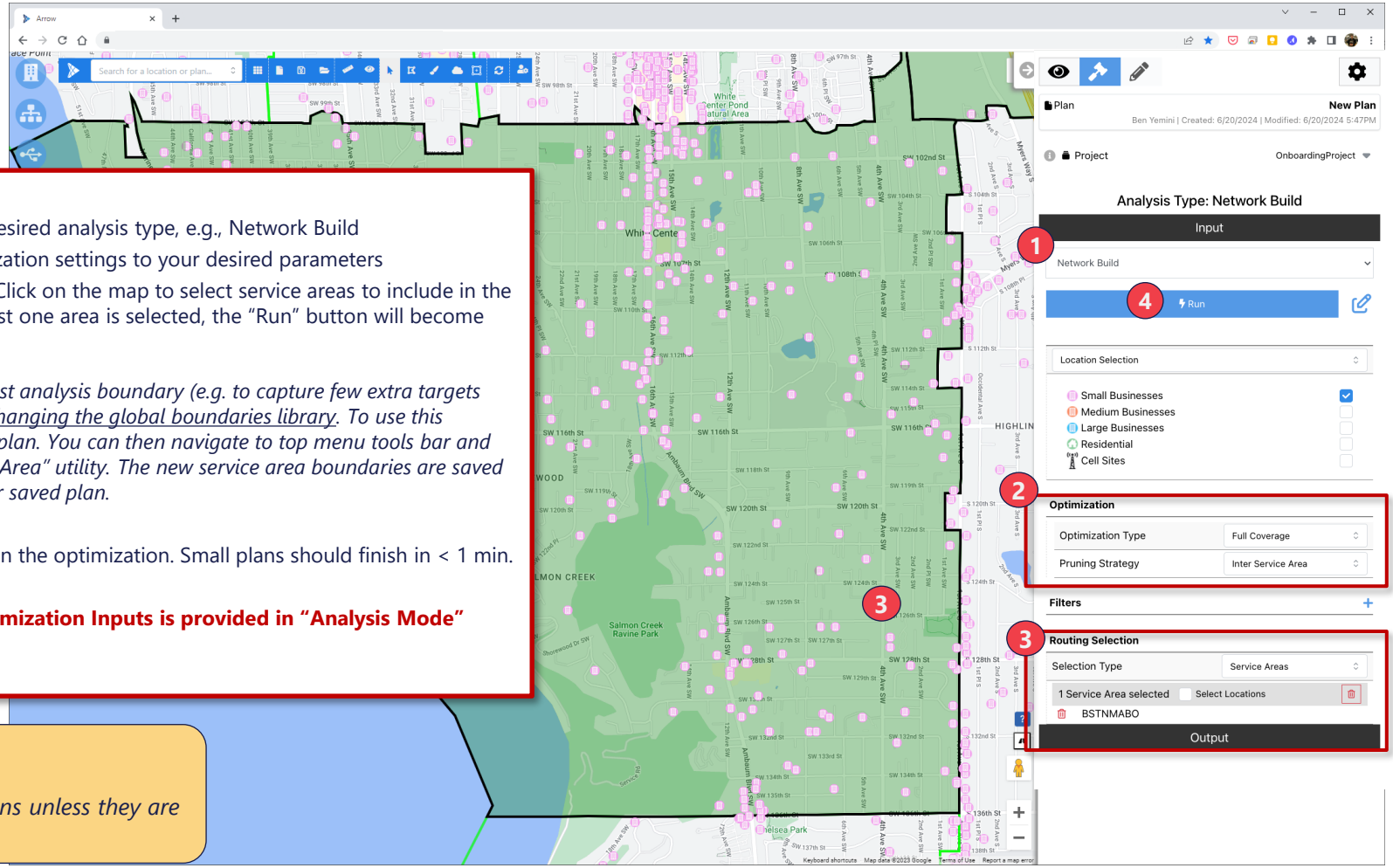
Optimization Inputs

1. **Analysis Type** – Select desired analysis type, e.g., Network Build
2. **Settings** – Adjust optimization settings to your desired parameters
3. **Geography Selection** – Click on the map to select service areas to include in the optimization. Once at least one area is selected, the "Run" button will become available

   Note, it is possible to adjust analysis boundary (e.g. to capture few extra targets near the edges) without changing the global boundaries library. To use this capability, first save your plan. You can then navigate to top menu tools bar and use the "Edit Plan Service Area" utility. The new service area boundaries are saved only in the context of your saved plan.

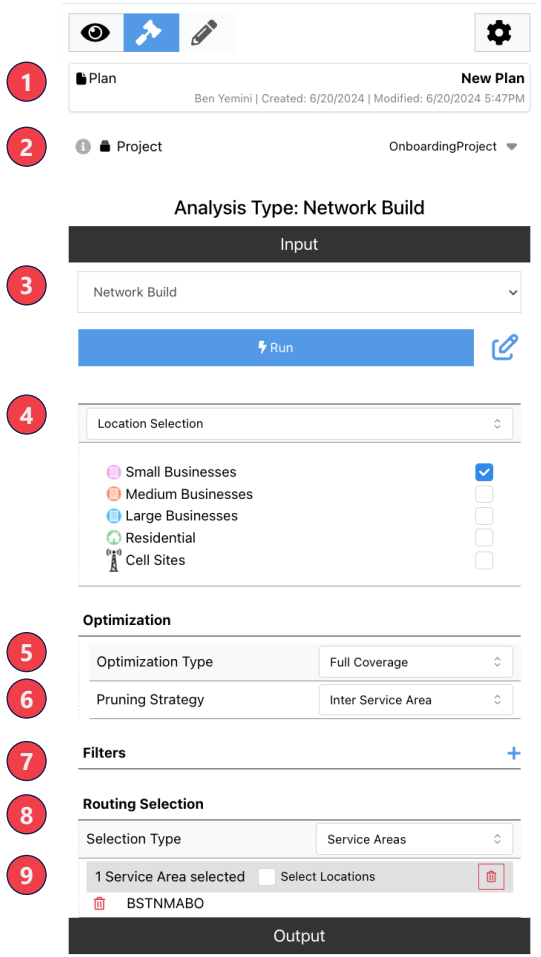
4. **Run** – Click "Run" to begin the optimization. Small plans should finish in < 1 min.

Detailed description of Optimization Inputs is provided in "Analysis Mode" section of this document



Tip: *you will not see locations unless they are selected in the data sources*

Analysis Settings define all the aspects of optimization plan to be run



1. **Plan Information**
2. **Project** – Defines which project template (defaults for data and resource selection) should be used as a starting point
3. **Analysis Type**
   - *Network Build*: runs an optimization and places equipment as part of plan
   - *Network Analysis*: runs the pruning analysis and shows high level financials for all levels of build
4. **Location Selection** Defines which endpoint types to target in the optimization
5. **Optimization type** – 5 target optimization types available, e.g. full build, coverage target - *Details on the following pages*
6. **Pruning Strategy** – Indicates where the budget constraint is to be applied: to all selected geographies (“Inter Service Area”) or to each (“Intra Service Area”)
7. **Filters –** Adds filters to the locations analyzed based on preconfigured attributes. Note, once a filter is added and service areas are selected the locations that match the filter can be previewed on the map.
8. **Selection Type** – Defines whether the selection mode will be service areas (selecting polygons) or location selection (individual locations)
9. **Selected Areas/Locations** – Lists areas/locations selected for the analysis

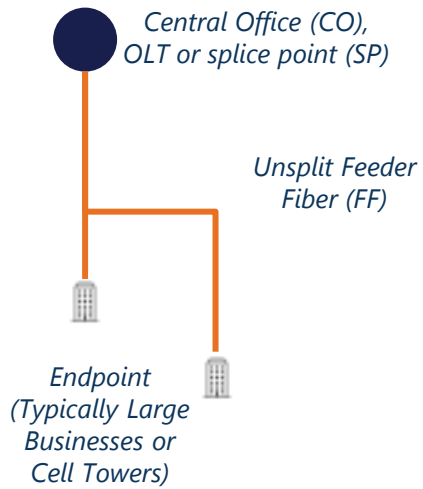
Tip: Please contact Arrow team member to configure filters for your environment

The four different hub and spoke network architectures can be illustrated by the following fiber architectures

Point-to-Point *(Individual)*

Direct Routing *(Optimized)*

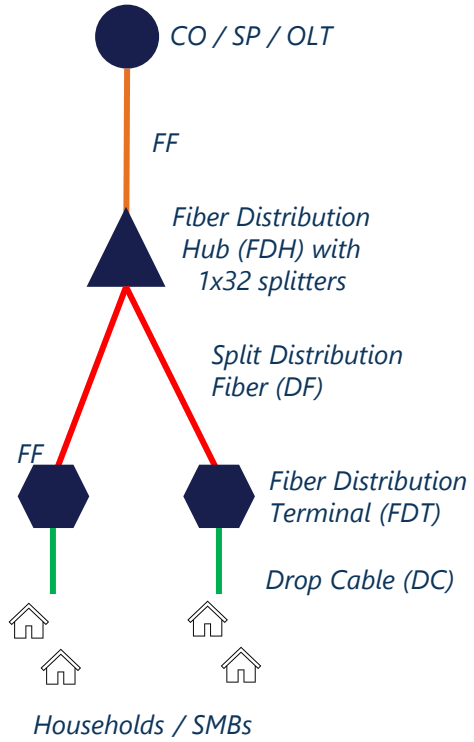
Single-level architecture with no passive optical equipment placed along route

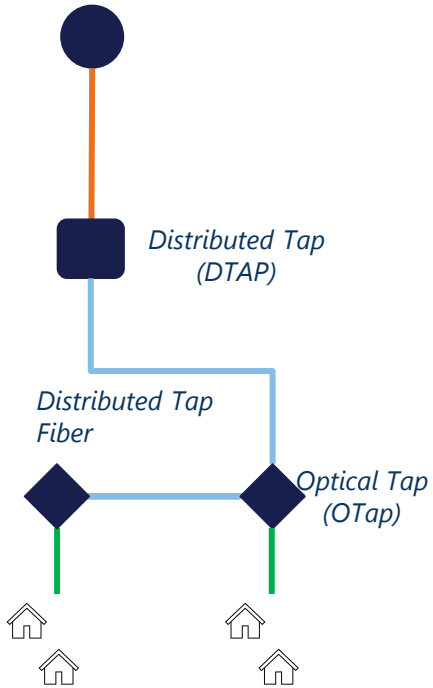


Hub-Only Split

Distributed Tap

Two-level architecture with with passive optical equipment placed along route

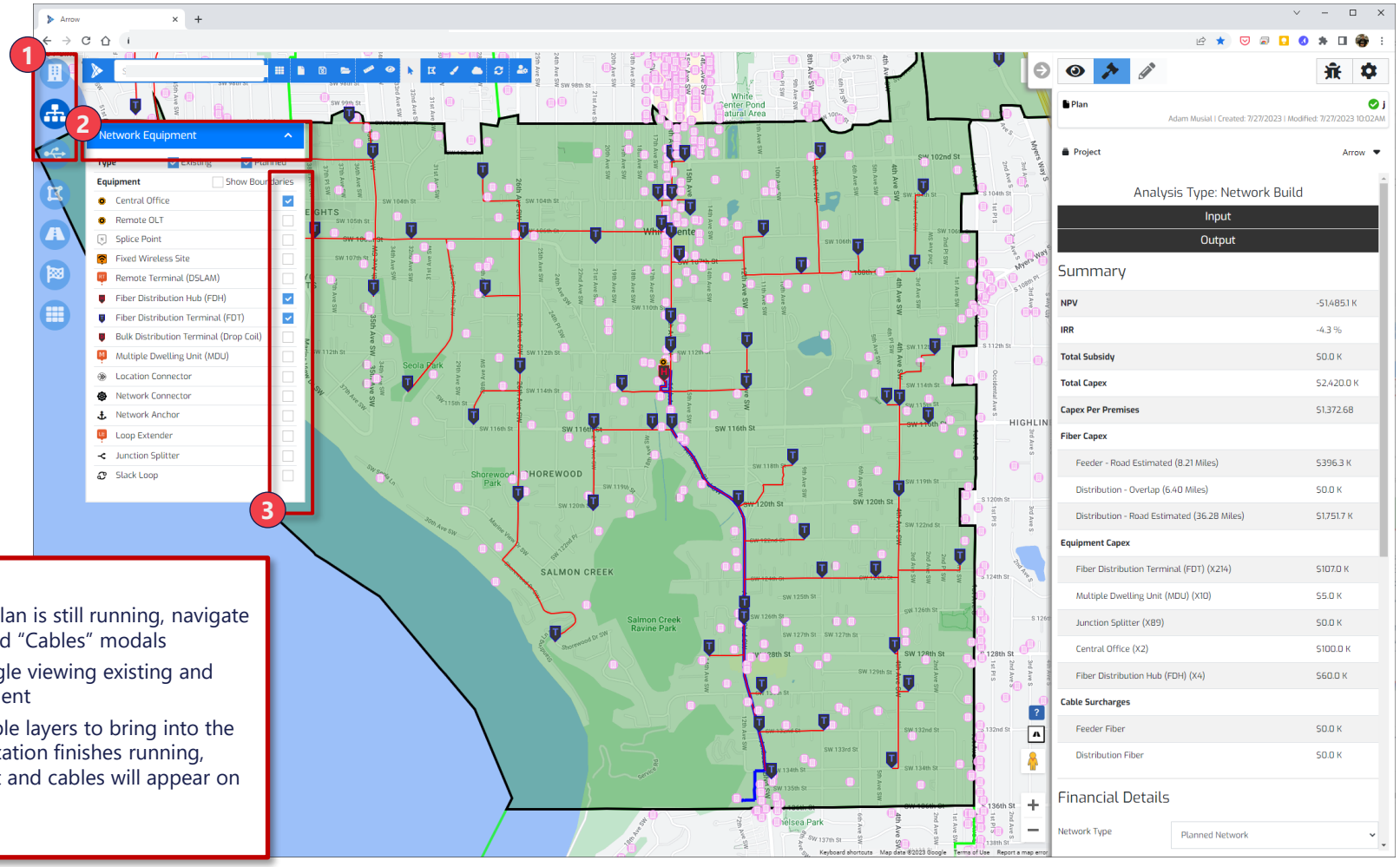




In Network Build, Arrow allows users to run five main types of optimizations

Full Coverage	***Design network that covers every location in target service area(s)*** **–** Coverage provided by fiber or fixed wireless technology, as specified by the user
Budget	***Build most financially attractive network for a fixed budget amount*** **–**Route to highest-opportunity locations first (IRR-based), until construction budget runs out
Coverage Target	***Design NPV-maximizing network that achieves desired coverage level*** **–** Route to most attractive locations first, until coverage target is reached
Plan IRR Floor	***Within a given budget, build until plan IRR is reached*** **–** Continue expanding until plan IRR falls to target IRR, or budget runs out, whichever comes first. Resulting plan IRR will be no less than target IRR
Segment IRR Floor	***Build to all locations that exceed target IRR*** **–** Every location above target IRR will be routed to. Resulting plan IRR will be above target IRR

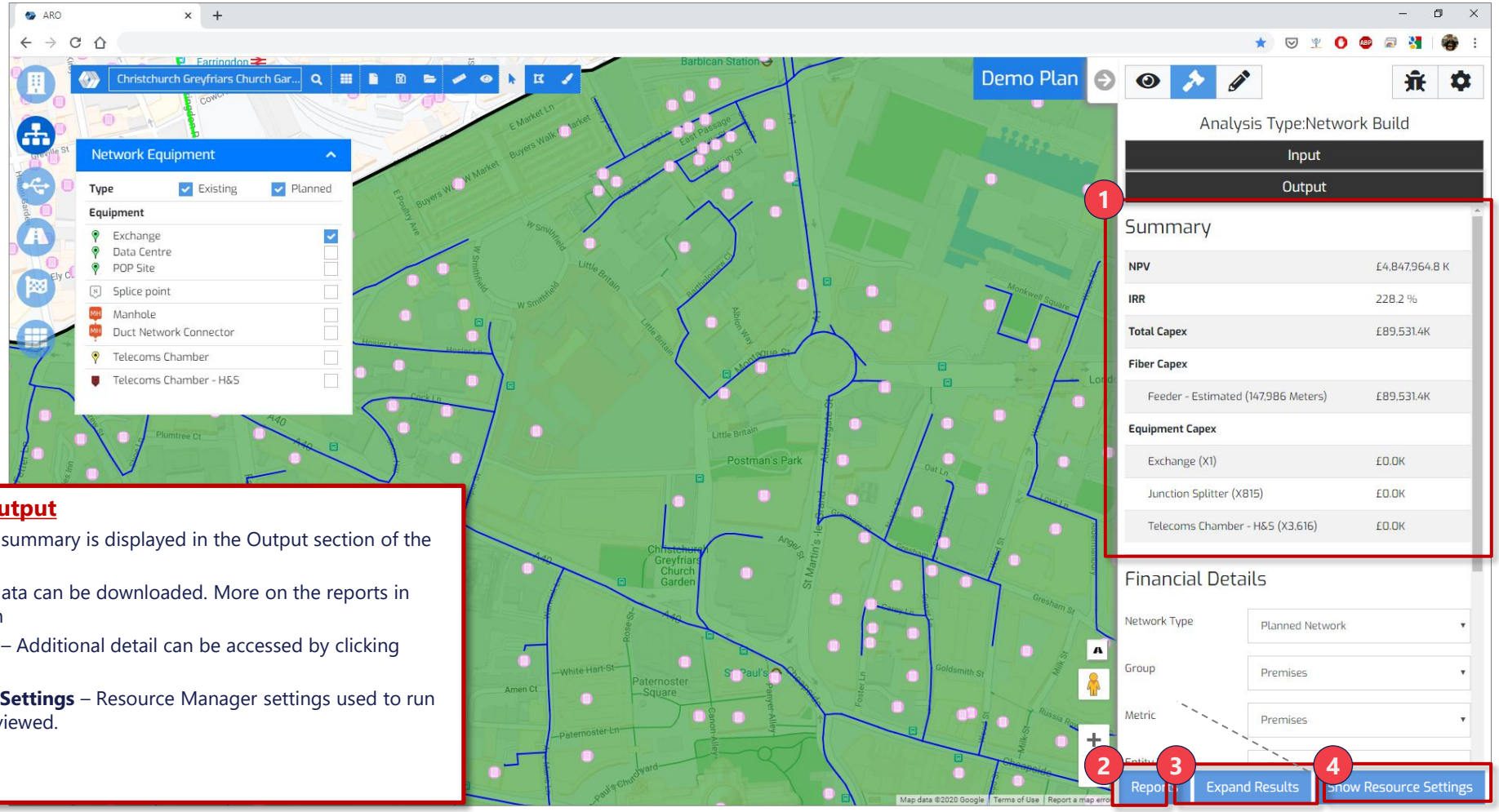
Turn on equipment and cable layers to view on the map



Equipment

1. **Open Modals** – While the plan is still running, navigate to "Network Equipment" and "Cables" modals
2. **Existing vs. Planned** – Toggle viewing existing and planned networking equipment
3. **Enable** – Toggle specific cable layers to bring into the view. As soon as the optimization finishes running, Planned network equipment and cables will appear on the map (if enabled)

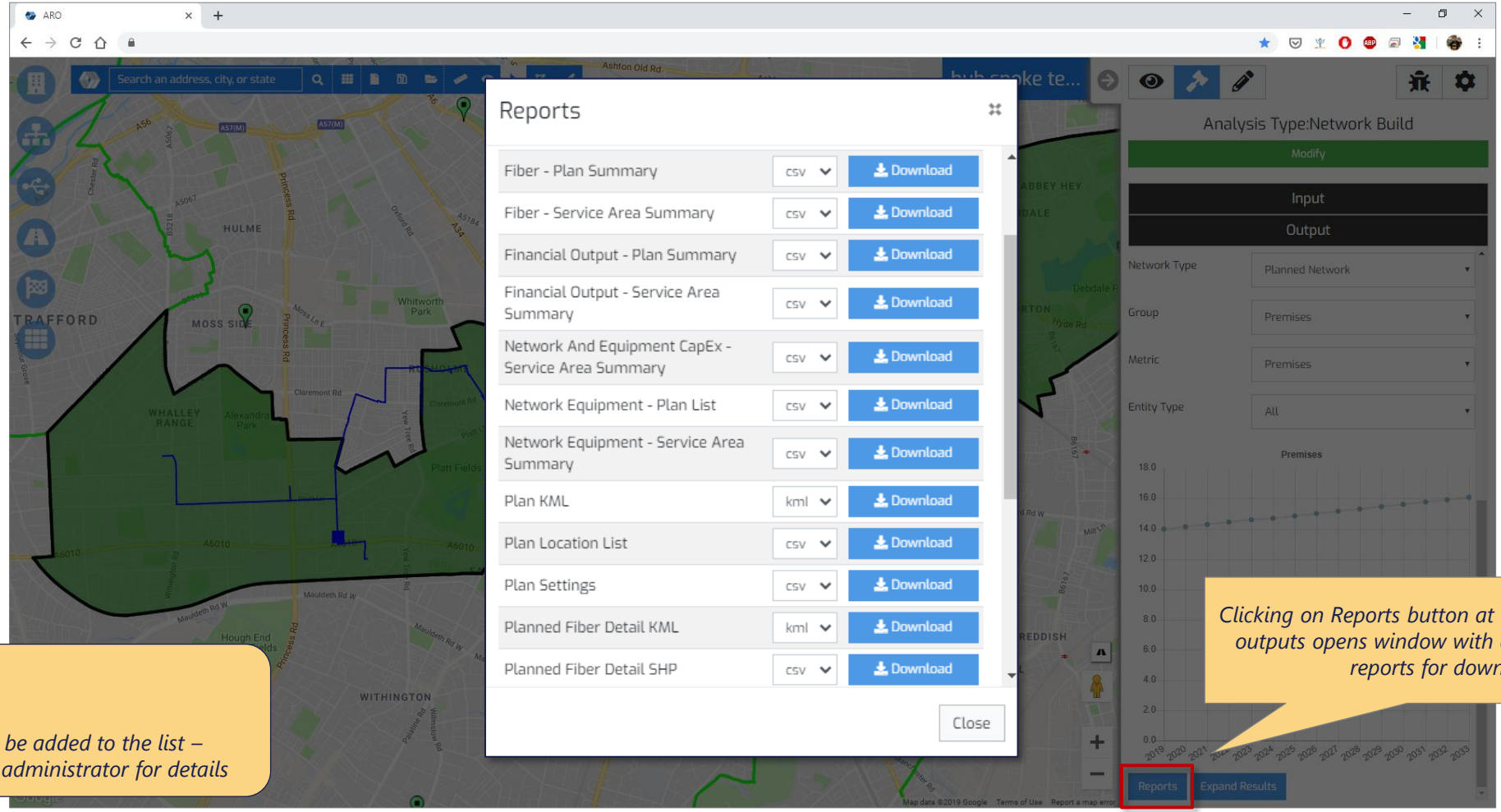
Plan results, including bill of materials and financial projections, can be accessed in Output panel



Optimization Output

1. **Summary** – Pan summary is displayed in the Output section of the Analysis panel
2. **Reports** – Plan data can be downloaded. More on the reports in their own section
3. **Financial Detail** – Additional detail can be accessed by clicking "Expand Results
4. **Show Resource Settings** – Resource Manager settings used to run the plan can be viewed.

After running a plan, number of reports can be extracted from Arrow, including financial projections and new fiber routes

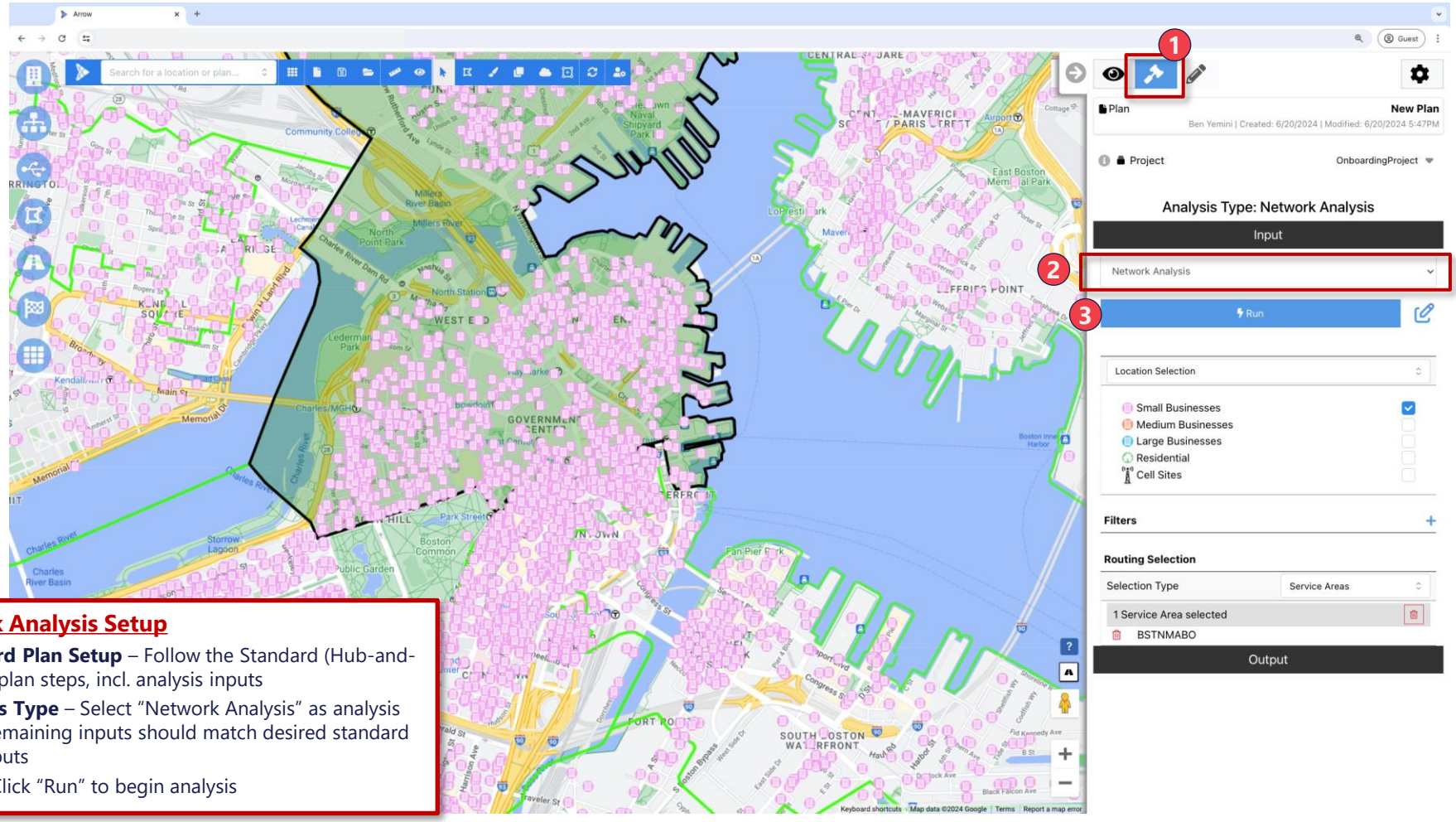


Tip:
Custom reports can be added to the list – contact your Arrow administrator for details

Most commonly-used reports include the following

Financial Output Plan Summary	Operating business model, including year over year subscriber, revenue and costs figures for the plan. *(Also available per service area as Financial Output - Service Area Summary)*
Planned Fiber Detail SHP	Contains the fiber geometries and fiber placement type by service area. *(Also available in KML format as Planned Fiber Detail KML)*
Routed Locations List	Itemized list of connected locations from the plan. Includes latitude and longitudes of each location, number of premises, as well as the equipment connected to and drop cable length
Network And Equipment Capex Service Area Summary	Breaks down the Capex for each equipment/fiber type, length of fiber built, as well as counts of the different equipment built

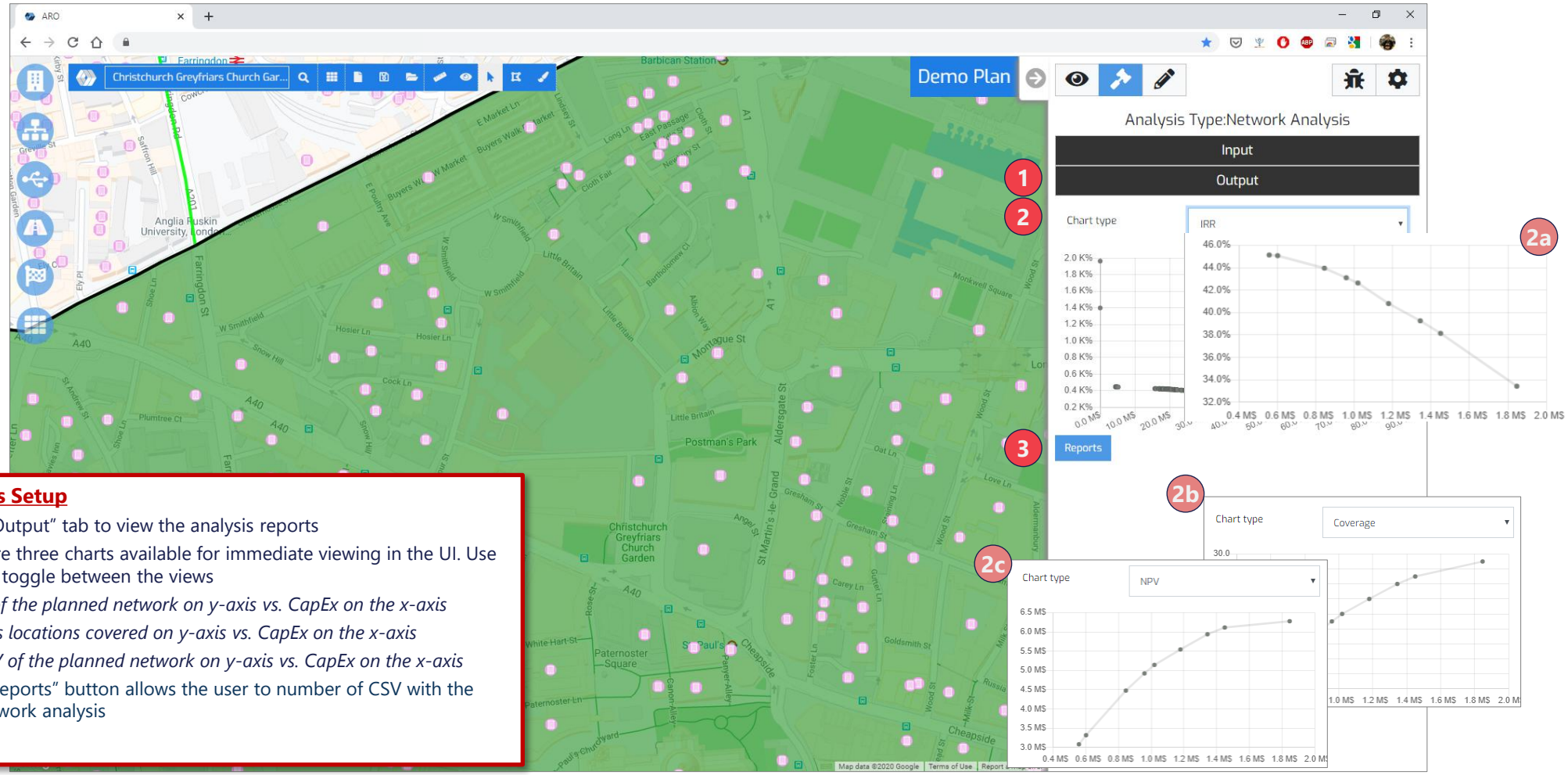
Network Analysis plan setup should mimic that of a standard plan, with analysis type set to Network Analysis



Network Analysis Setup

1. **Standard Plan Setup** – Follow the Standard (Hub-and-Spoke) plan steps, incl. analysis inputs
2. **Analysis Type** – Select "Network Analysis" as analysis type. Remaining inputs should match desired standard plan inputs
3. **Run** – Click "Run" to begin analysis

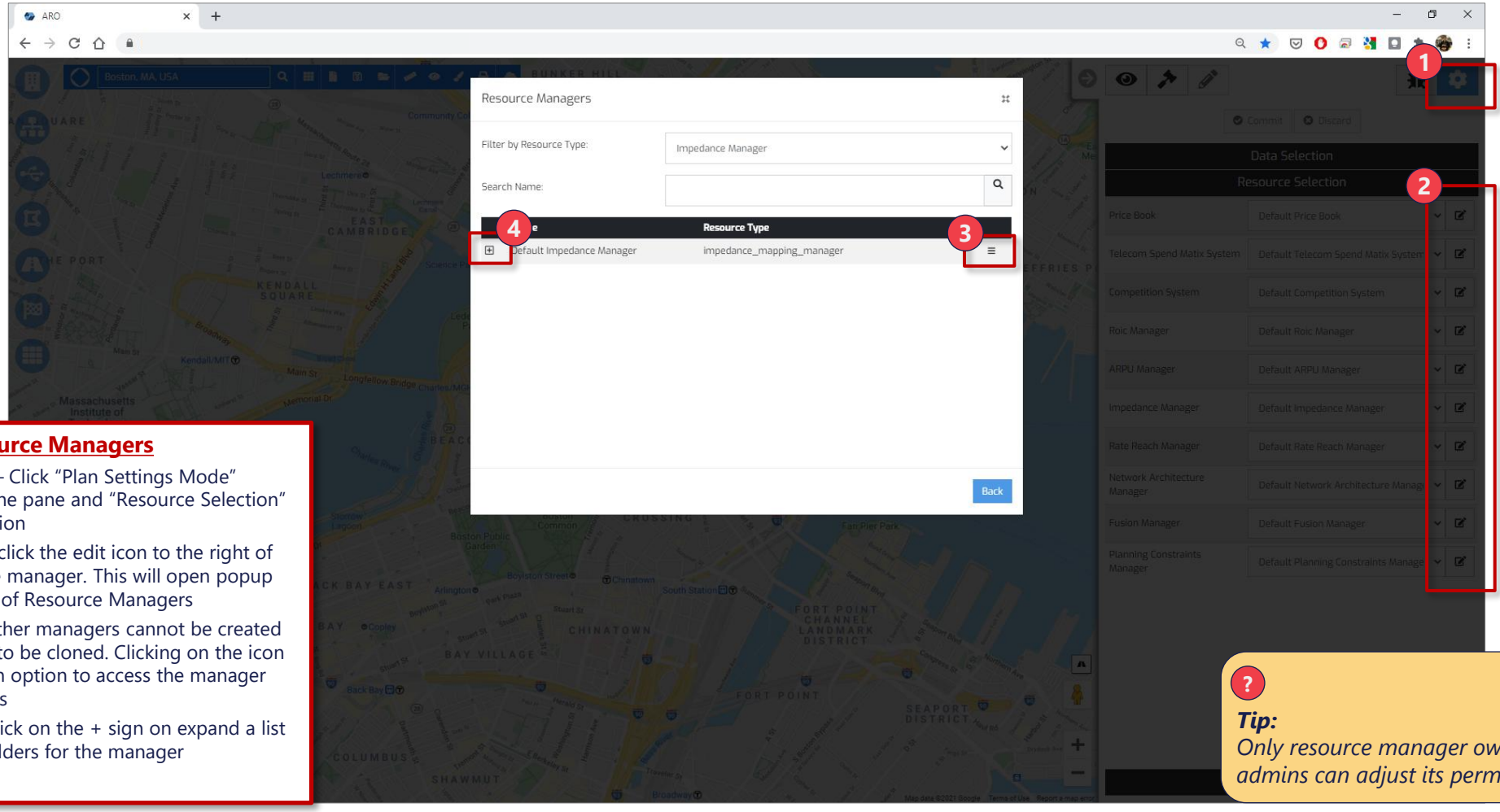
After running a network analysis, there are 3 views of the output in the UI



Network Analysis Setup

1. **Output** – Click "Output" tab to view the analysis reports
2. **Charts** – There are three charts available for immediate viewing in the UI. Use the dropdown to toggle between the views
   - *IRR – shows IRR of the planned network on y-axis vs. CapEx on the x-axis*
   - *Coverage – shows locations covered on y-axis vs. CapEx on the x-axis*
   - *NPR - shows NPV of the planned network on y-axis vs. CapEx on the x-axis*
1. **Reports** – The "Reports" button allows the user to number of CSV with the details of the network analysis

Resource Managers are configured via their respective management windows



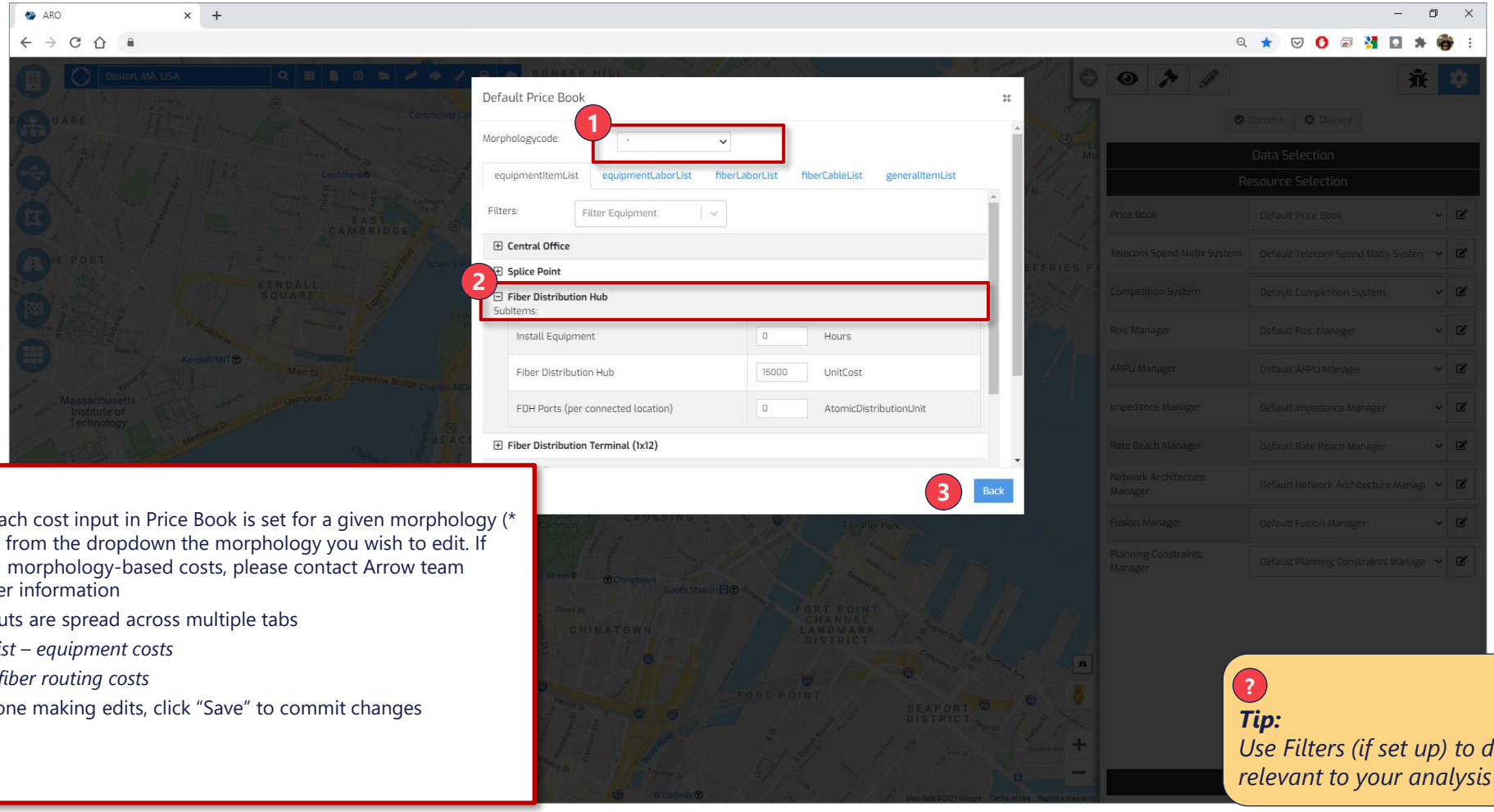
Managing Resource Managers

1. **Open Settings** – Click "Plan Settings Mode" button to open the pane and "Resource Selection" tab in the accordion
2. **Manager Edit** – click the edit icon to the right of relevant resource manager. This will open popup screen with a list of Resource Managers
3. **Clone / Edit** – Other managers cannot be created blank, and need to be cloned. Clicking on the icon also gives user an option to access the manager and edit its values
4. **Permissions** – Click on the + sign on expand a list of permission holders for the manager

Tip:
Only resource manager owners and Arrow admins can adjust its permissions

Tip: Only resource manager owners and Arrow admins can adjust its permissions

Price Book is used to specify various network build costs



Price Book

1. **Morphology** – Each cost input in Price Book is set for a given morphology (* by default). Select from the dropdown the morphology you wish to edit. If you plan on using morphology-based costs, please contact Arrow team member for further information
2. **Inputs** – Cost inputs are spread across multiple tabs
   - *Equipment Item List – equipment costs*
   - *Fiber Labor List – fiber routing costs*
3. **Save** – When done making edits, click "Save" to commit changes

Tip:
Use Filters (if set up) to display elements relevant to your analysis type

Tip: Use Filters (if set up) to display elements relevant to your analysis type

ARPU manager controls ARPU assumptions for target endpoints

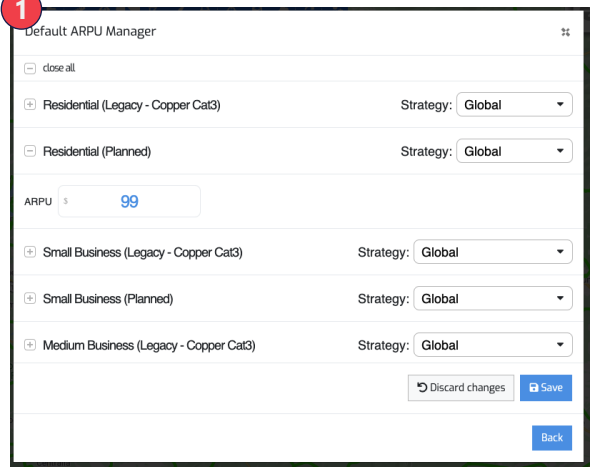
ARPU Manager

1. **Residential ARPU Strategy** – allows you to define the value Arrow uses for residential (household) endpoints by selecting Global, Segmentation or Location Layer.
- *Global uses the value specified in the UI.*
- *Location Layer uses the value specified for individual locations in the Locations data layer.*

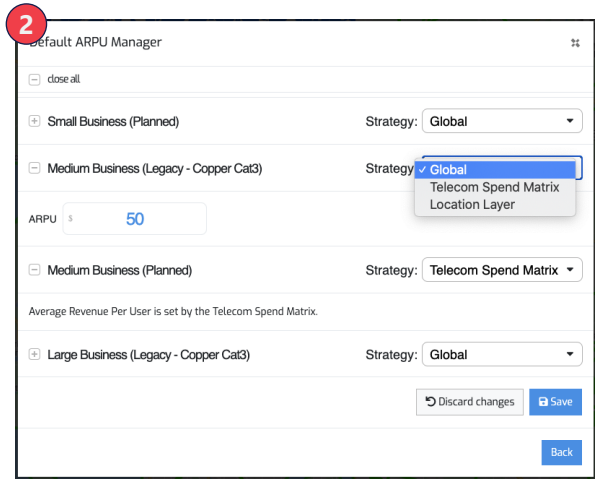
2. **Business or Cell Tower ARPU Strategy** – allows you to define the value Arrow uses for Business or Cell Tower endpoints by selecting Global, Telecom Spend Matrix or Location Layer.
- *Global uses the value specified in the UI.*
- *Telecom Spend Matrix uses the values derived from the Telecom Spend Matrix resource manager (e.g. industry and employee count).*
- *Location Layer use the value specified for individual locations in the Locations data layer.*

Separate tabs for each location type and Legacy (BAU) vs. Planned locations

1



2

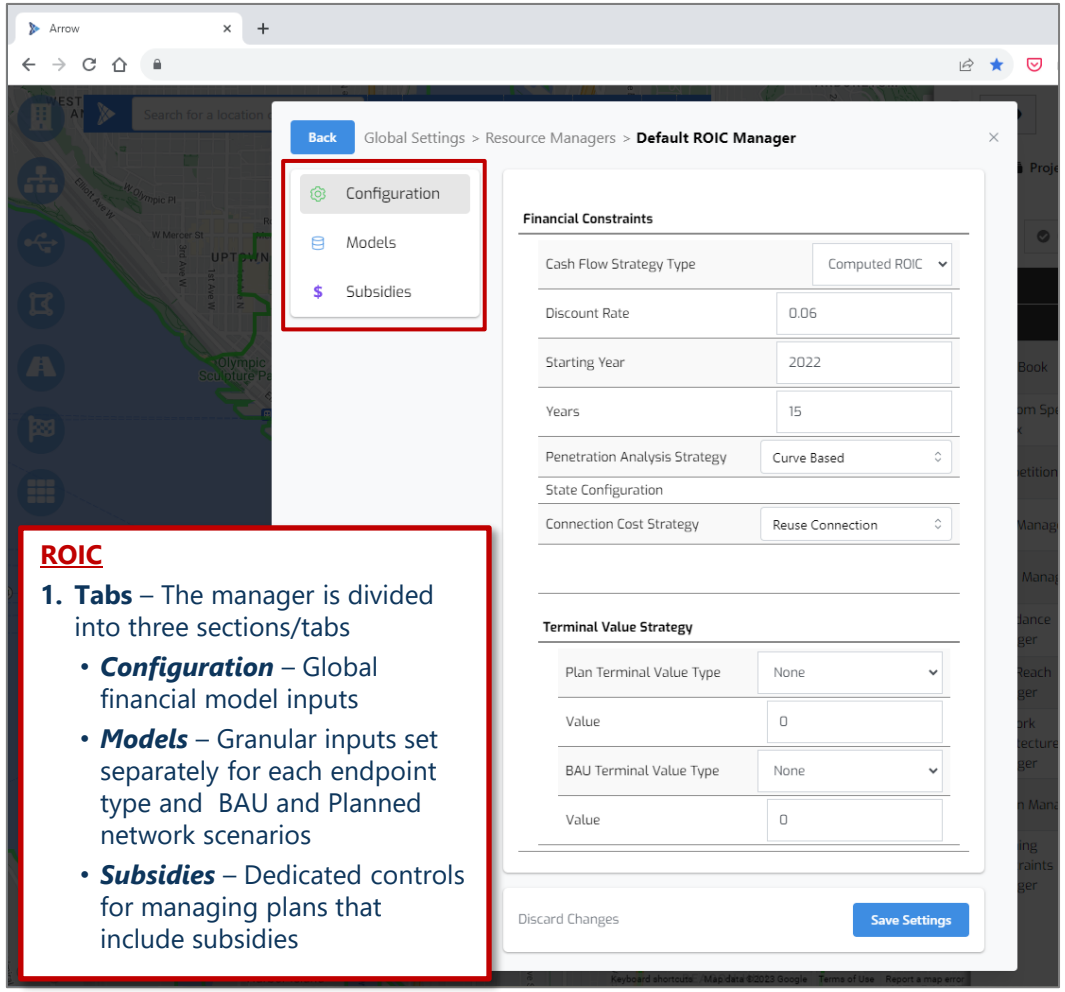


?

Tip: *Please contact Arrow team member to adjust ARPU strategy settings*

Tip: Please contact Arrow team member to adjust ARPU strategy settings

ROIC Manager defines the YoY financial profile of each plan analyzed in Arrow



Financial Constraints – Global business case inputs

Cash Flow Strategy Type – use Computed ROIC for all plans

Discount Rate – Cost of capital / WACC to use for NPV calculation

Starting Year – Which year the plan starts *(only relevant when TSM ARPU strategy is used)*

Years – How many years to project the cash flows for and use in NPV/IRR calculations

Penetration Analysis Strategy – Specifies the method to determine customer penetration over time

- **Curve Based** – Penetration follows a predefined adoption curve *(defined by the penetrationRate parameter on the Models tab)*
- **Flow Share** – Uses granular flow-share modeling to determine each period's subscribers *(using churn and locations growth settings from the Models tab)*

Connection Cost Strategy – Specifies how to handle individual location's re-connect costs

- **New Connection** – Charges full new connection cost every time location (re)subscribes *(cost set by ConnectCost field in the Models tab)*
- **Reuse Connection** – Probabilistically model for what fraction of new subscribers had connected in the prior periods and only charge for the net new locations, tracks unconnected customers as a percentage of total premises
- **Improved Reuse Connection** – similar to Ruese Connection, however, this approach tracks unconnected customers as a percentage of non-customers

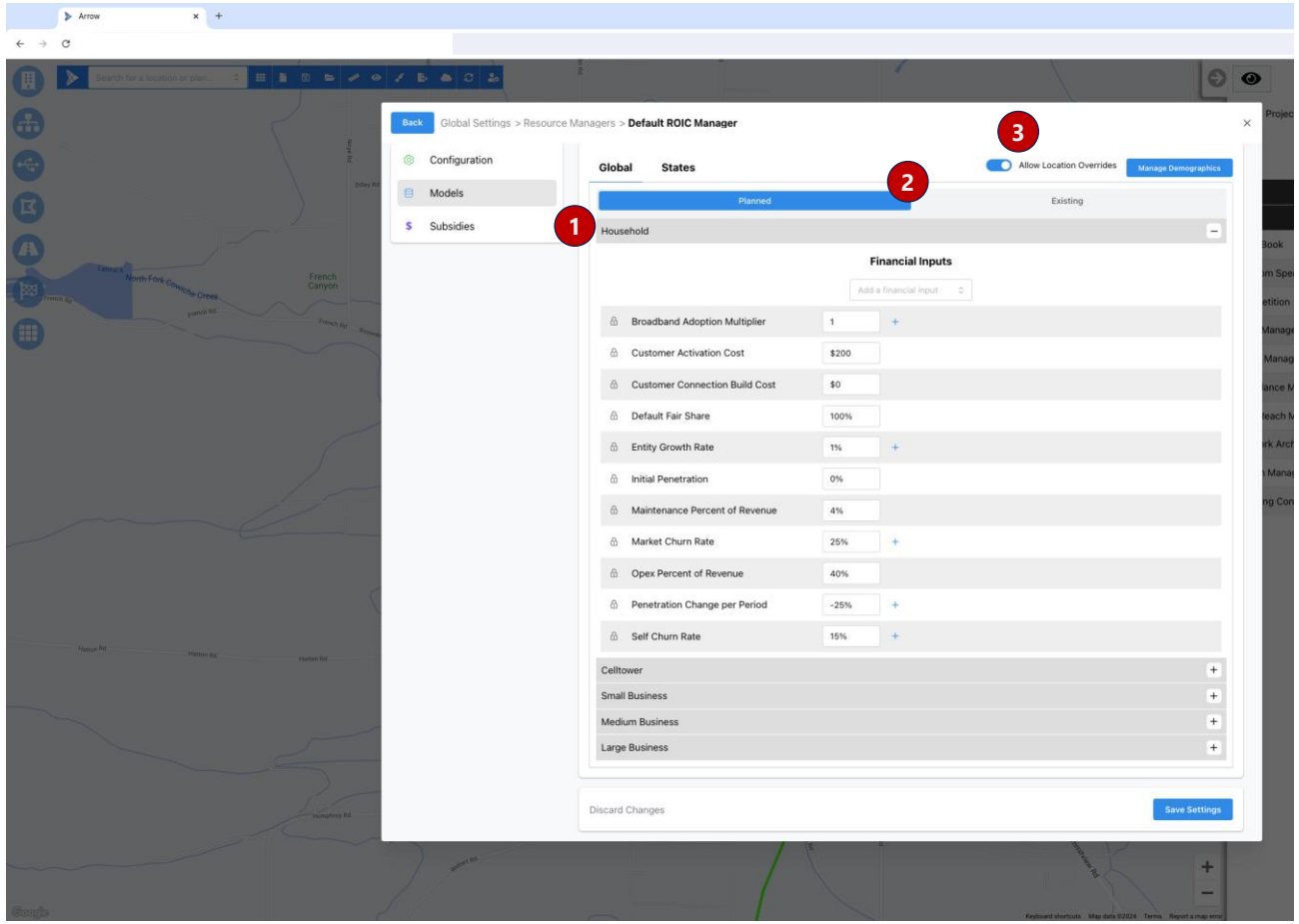
Terminal Value Strategy – Set separately for Planned and BAU scenarios

Terminal Value Type – Defines what method of TV calculation to use

- **None** – No terminal value applied
- **Net Cash Flow Multiple** – Last year's net cash flow multiplied by the value and added to the last period
- **EBITDA Multiple** – Similar to Net Cash Flow, but maintenance and new build costs are excluded
- **Perpetual Growth** – Assumes that a business will generate cash flows at a constant growth rate (from the last period) forever, must be a value between 0 and 1.

Value – Multiplier to use for the given strategy type (fraction for Perpetual Growth)

ROIC Manager defines the YoY financial inputs for each location analyzed in Arrow



1. **Inputs are set independently for each endpoint type** – Household (Residential), Celltowers and Small, Medium and Large Businesses

2. **For each endpoint type, users can set Planned and Existing location network inputs** – This allows Arrow to account for revenue cannibalization in network overbuild scenarios
   - **Planned** – Financial inputs for locations that will be connecting to the new planned network
   - **Existing** – Financial inputs for locations served by the legacy network / the network that the plan will overbuild. These values are only required if you run overbuild scenarios on your network footprint.

3. **Location Overrides** will leverage inputs defined at the location data library and use the ARPU defined by the ARPU resource manager instead of the inputs specified in the ROIC Models UI settings.

Tip: See the Arrow Platform user guide for the full list of available ROIC financial inputs.

Below are a list of commonly updated Resource Manager Settings:

Price Book Settings

- **Central Office Cost** – Cost for Arrow to create a new Central Office or use and existing Central Office
- **Fiber Distribution Hub**– Cost for Arrow to create Fiber Distribution Hub equipment
- **Fiber Distribution Terminal**– Cost for Arrow to create Fiber Distribution Terminal equipment
- **Install Fiber** – Cost for Arrow to install Feeder or Distribution fiber. (Cost per **meter/foot**).
- **Network Architecture Manager**
- **Hub Clustering Strategy**– Determines which algorithm is used when assigning locations to FDHs

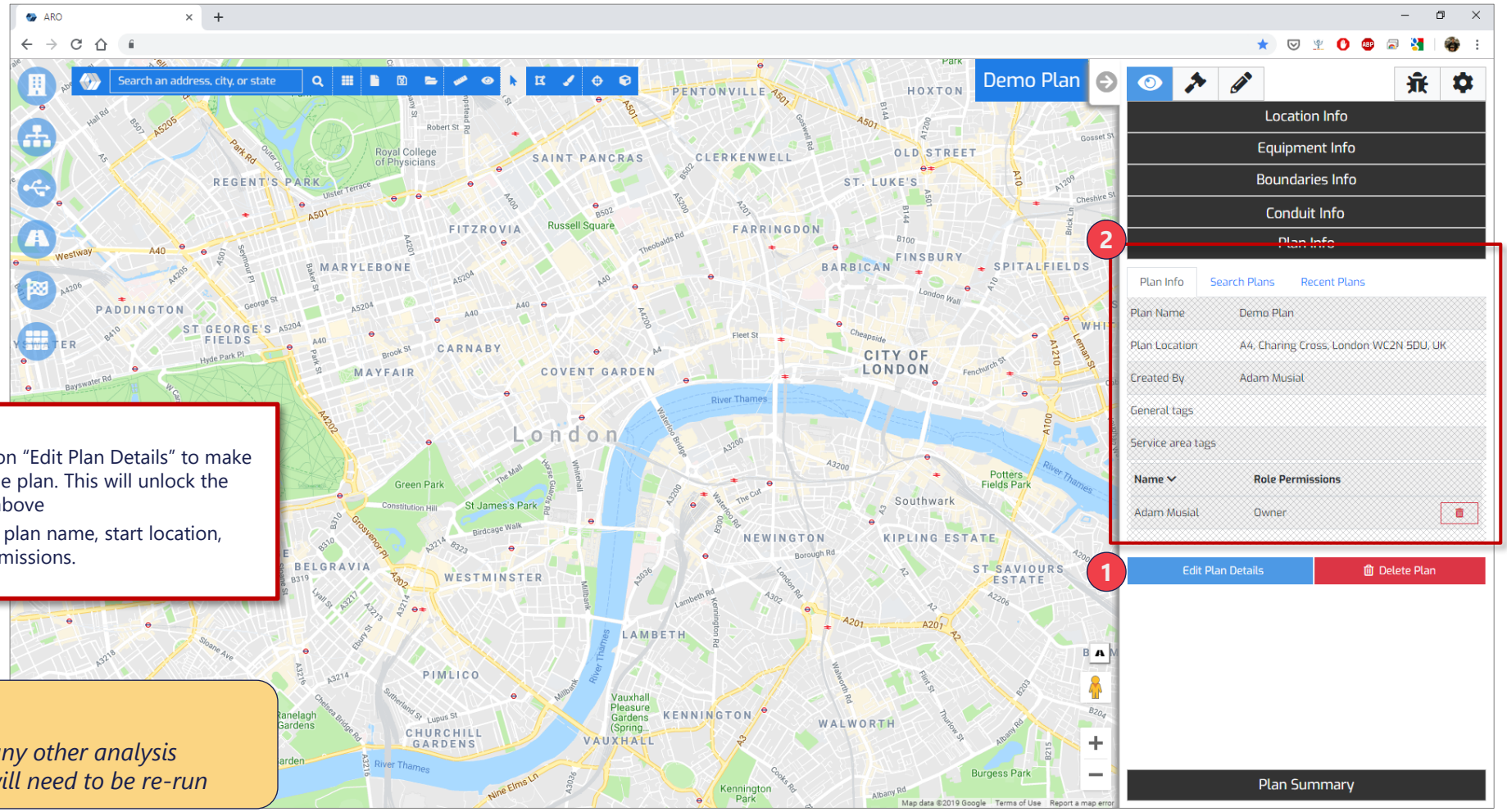
Network Architecture Manager

- **Hub Clustering Strategy**– Determines which algorithm is used when assigning locations to FDHs
- **Max Distance From Terminal** – This setting determines how close distribution fiber is build to the location. This location can be configured in the following path:
  - *Hub-only Split > Terminal Configuration > Max Distance From Terminal*
- **Multiple Dwelling Unit (MDU) Upgrade Threshold**– This threshold determines how many "single family" locations within the same latitude/longitude there are before they are considered multiple dwelling units (i.e. apartments). This setting can be configured in the following path:
  - *Hub-onlySplit > Fiber Capacity Configuration > Consolidation Rules > MDU Upgrade Threshold > threshold*

Planning Constraints Manager

- **Fiber Routing Mode** – Determines whether Arrow will route off existing fiber or build new fiber from scratch.
- **Edge Buffer Distance** – Determines whether Arrow can build fiber outside of a service area. This can be due to Arrow's optimization algorithms to build shorter fiber routes. **Note** this will **not** connect to locations outside of the service area boundary.

Plan Info tab allows users to search, open, delete, rename and update permissions to existing plans

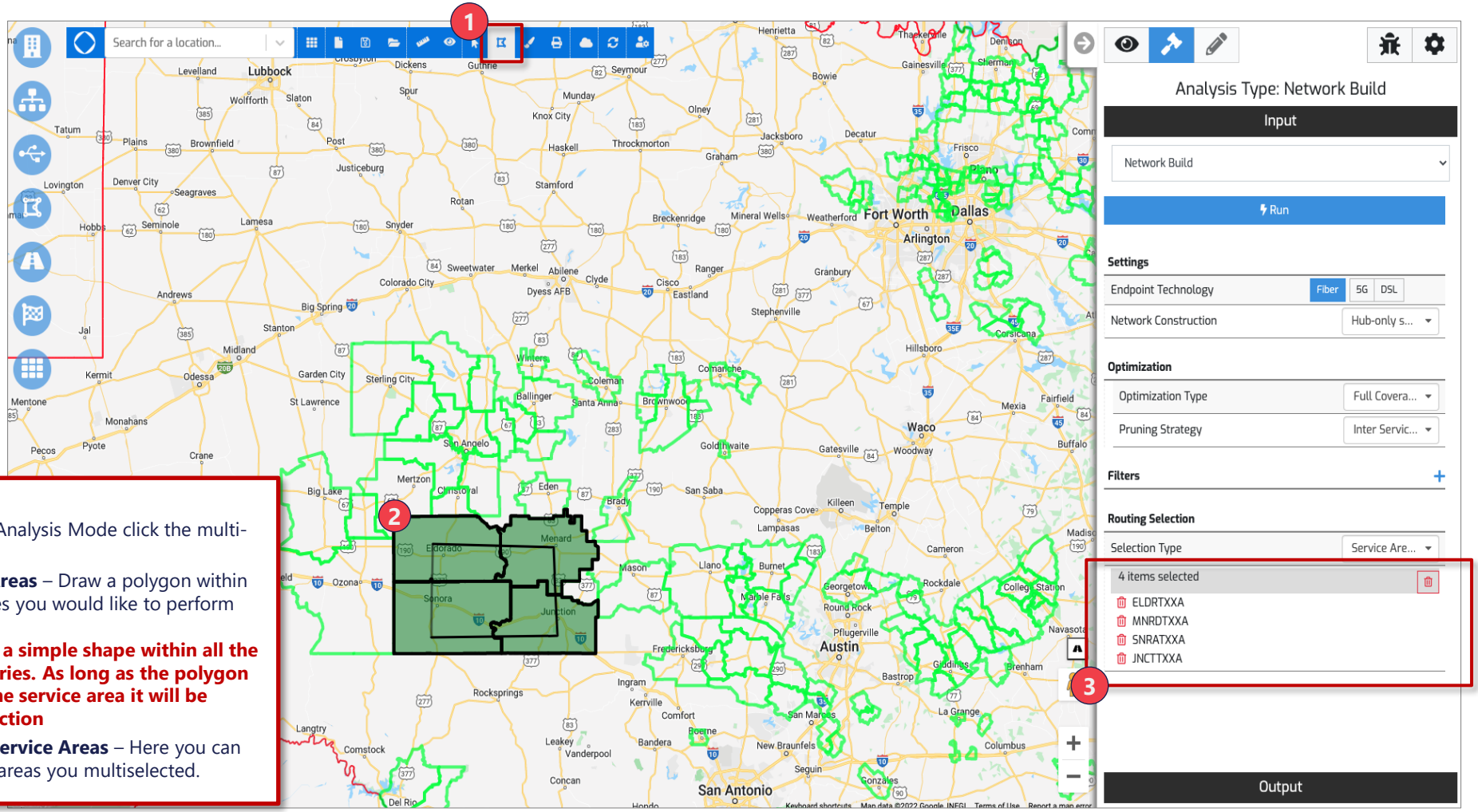


Location Info

1. **Edit Plan** – Click on "Edit Plan Details" to make any changes to the plan. This will unlock the greyed-out area above
2. **Update** – Update plan name, start location, tags and user permissions.

Tip: *For editing any other analysis settings, a plan will need to be re-run*

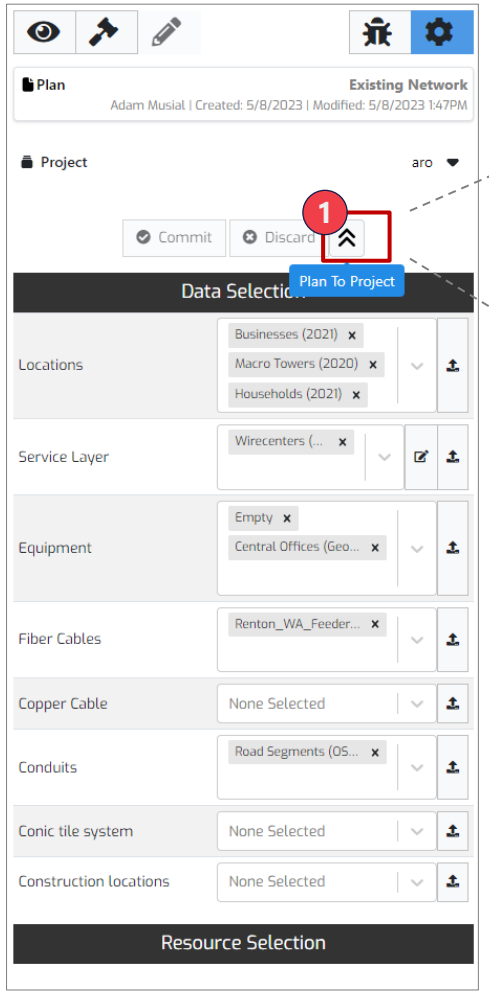
Multi-selecting Service Areas using the Lasso Tool

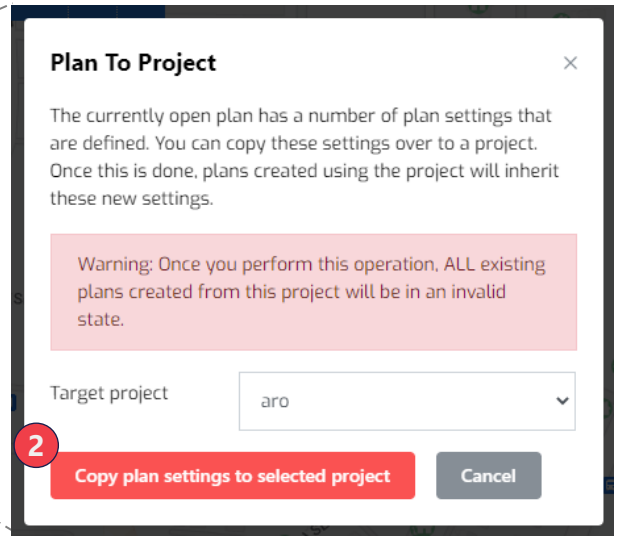


Locations

1. **Lasso Tool** – In Analysis Mode click the multi-select lasso tool.
2. **Select Service Areas** – Draw a polygon within all the boundaries you would like to perform analysis on.
   Polygon can be a simple shape within all the desired boundaries. As long as the polygon edge touches the service area it will be included in selection
3. **View Selected Service Areas** – Here you can view the service areas you multiselected.

Users can set their project defaults (data and resources that are enabled by default) and create new Projects directly above Data Selection panel





Setting Default Project Settings

When in a plan, user can copy that plan's settings (which Data layers and Resource Managers are selected) into project defaults. Going forward, every time a new plan is created, it will automatically select the default data and resource layers from that plan

1. **Plan to Project** – Click on "Plan to Project" to select which project you wish to update
2. **Copy plan settings** – Confirm your action by clicking on "Copy plan settings..." button

Tips:

- Users, and groups of users, can utilize multiple project templates. Go to User Settings to choose which one is in use by default
- If you don't see a specific data set or resource manager, make sure it has been added to the selected project

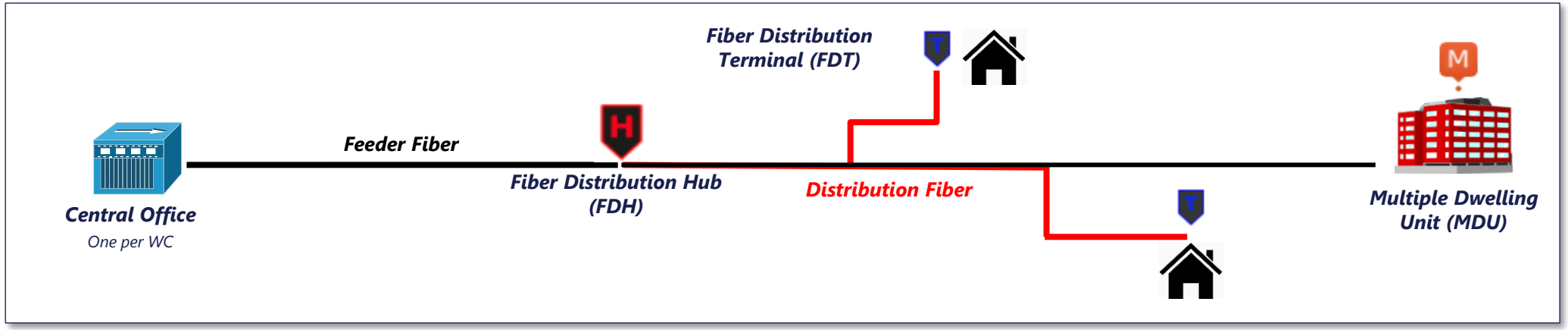
Tip: Users, and groups of users, can utilize multiple project templates. Go to User Settings to choose which one is in use by default

Arrow comes preloaded with variety of datasets, requiring only target locations to be supplied by end users

	Dataset	Description and Usage	Source
Boundaries	***Census Blocks***	*Used to map each location to competition data*	*Tiger*
	Wirecenters	*Default polygons defining individual areas being analyzed*	*Geotel*
	Zip Codes	*Alternative service area for analysis*	*Tiger*
	States, CBSAs, Counties, etc.	*Reference boundaries used to conveniently select broader areas for large optimization plans*	*varies*
Competition	***FCC Broadband Data Collection (BDC)***	*Census-block-level broadband availability data, used to calculate each expected fair share for resi and SMB locations*	*FCC*
	Provider Fiber Routes	*Publicly available provider fiber routes, used to calculate expected fair share for enterprise and tower locations*	*Geotel*
Business Spend	***Altman Solon Telecom Spend Matrix***	*Proprietary estimates of business spend on telecom services, organized by industry, business size and telecom product*	*Altman Solon*
Wireless Signal Impedance	***Clutter***	*Used in fixed wireless optimization, defines signal degradation characteristics of a given area (30mx30m grid)*	*NASA*
Conduits	***Road Segments***	*Proxy conduits used to define which ways new fiber can go*	*OpenStreetMap*
Target Endpoints	***Residential, Business, Towers***	*Latitude and longitude of target locations to use in planning*	*client*
Network Infrastructure	***Network and Equipment Assets***	*Existing fiber and copper network, and equipment infrastructure, as needed (if at all) for accurate modeling*	*client*

The Arrow platform uses the following network architecture for FTTP deployments

FTTP Network Architecture



Element	Central Office	Fiber	FDH	FDT	MDUs
Description	• Hub which a conglomerate signal is distributed to optical nodes in neighborhoods or prem locations • Carries voice, data, and/or video services to end users	• **Feeder Fiber**: Cable that connects the CO to the FTH splitter • **Distrib. Fiber**: Cable running from the FDH splitter to the customer premise	• Splits the feeder cable into distribution cables to go to customer premises • Includes FDH to hold splitter	• Interconnect between the fiber optic distribution network and drop cables connecting customer prems	• Provides connection from network to MDU • One required per building, generally placed in the basement • Additional equipment required for each prem
Cost Components	• Inter-office facilities • Fiber distribution frame • Power, space, frame • Ops support system	• Materials • Labor	• Splitter materials and labor • Fiber distribution hub materials and labor	• Materials	• Equipment • Installation

Sources: Altman Solon Research & Analysis

In planning routes to target locations, Arrow factors in a number of necessary network equipment elements and their costs

Typical Arrow Enterprise / Tower Build Plan Components

Illustrative