# User Guide

## Contents



## Overview

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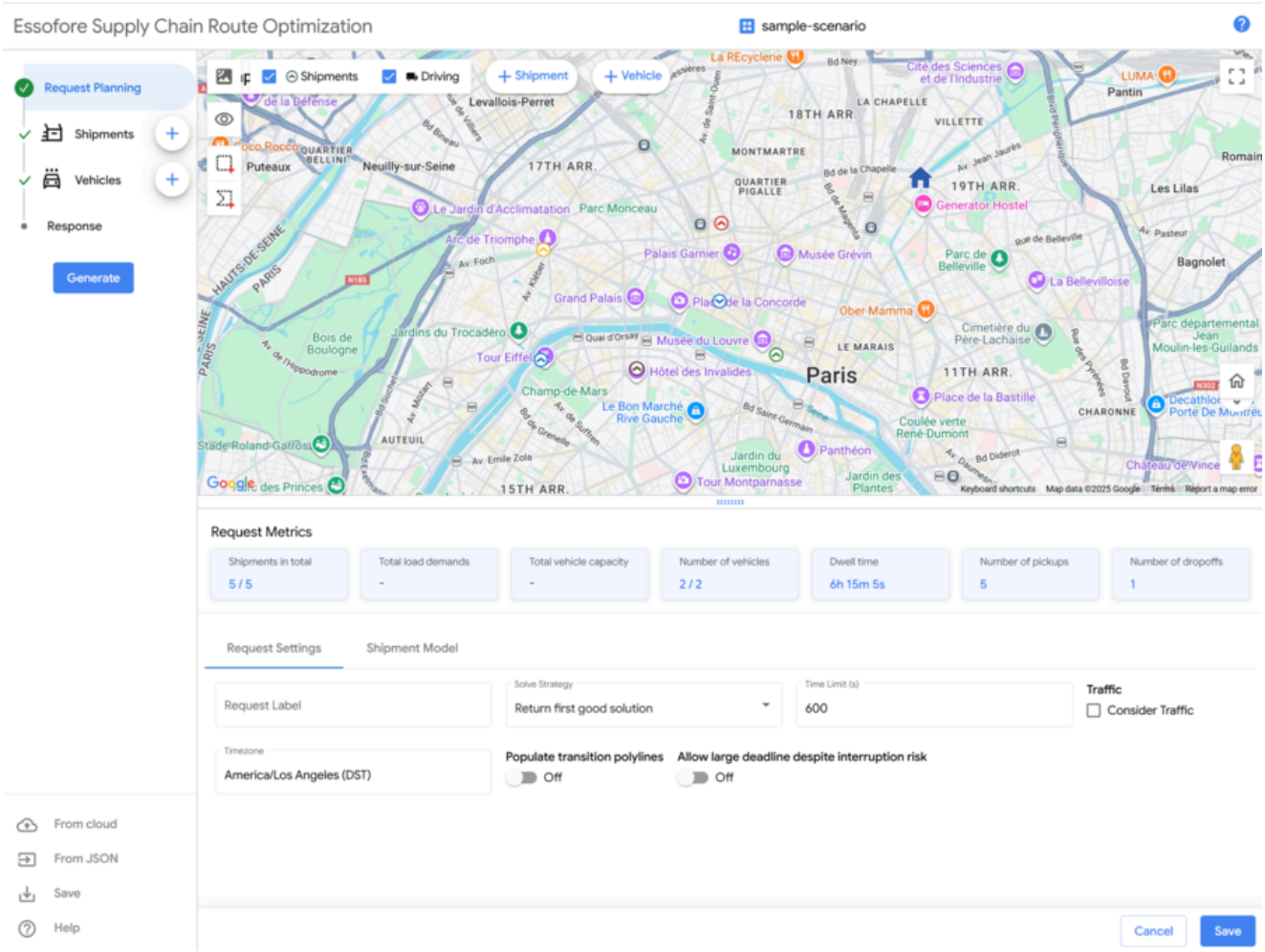
Essofore Supply Chain Route Optimization (aka Fleet Routing App) is a web application that planners on transportation or logistics teams can use to plan pickups and deliveries to locations using a fleet of vehicles.



application overview

Fleet Routing App lets users:

- Plan fleeting routing scenarios from a fresh start.
- Load pre-defined fleet routing scenarios from a local file or from a corporate transportation management system.
- Generate a plan or solution to a scenario.
- Make manual adjustments to the scenario or the solution, such as moving a shipment from one vehicle to another, or changing the time window of a pick-up.
- Save the resulting plan (solution) to the TMS so that vehicles can be dispatched.

## Quick tour

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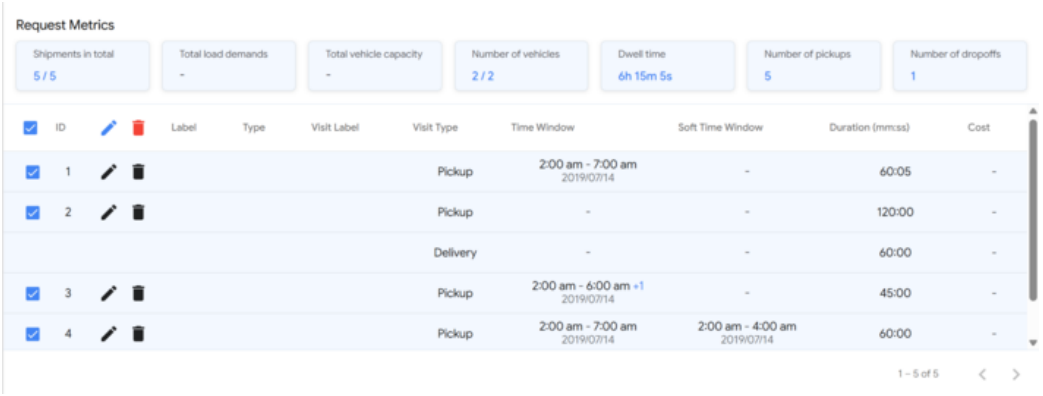
Learn the basics of using Fleet Routing App by getting a solution to a vehicle routing problem.

**Get an initial solution**

1. Download the sample scenario. If your browser opens this in a new tab, do *Save As* to save to your computer in a location you will remember.
2. Click *Essofore Supply Chain Route Optimization* in the top-left corner of the web page to get to the starting page.
3. Select *Load*, *Choose a file*, and browse to where you saved the `sample-scenario.json` file from Step 1. Upon selection, the file will be load and you will be taken into the application automatically.
4. Let's find a solution for all of the Shipments and allow the solver to consider all Vehicles.
    1. Select the *Request Settings* > *Shipments* item on the left hand side of the page.
    2. In the Shipment Click the checkbox in the top row of the Shipments table to include all shipments.



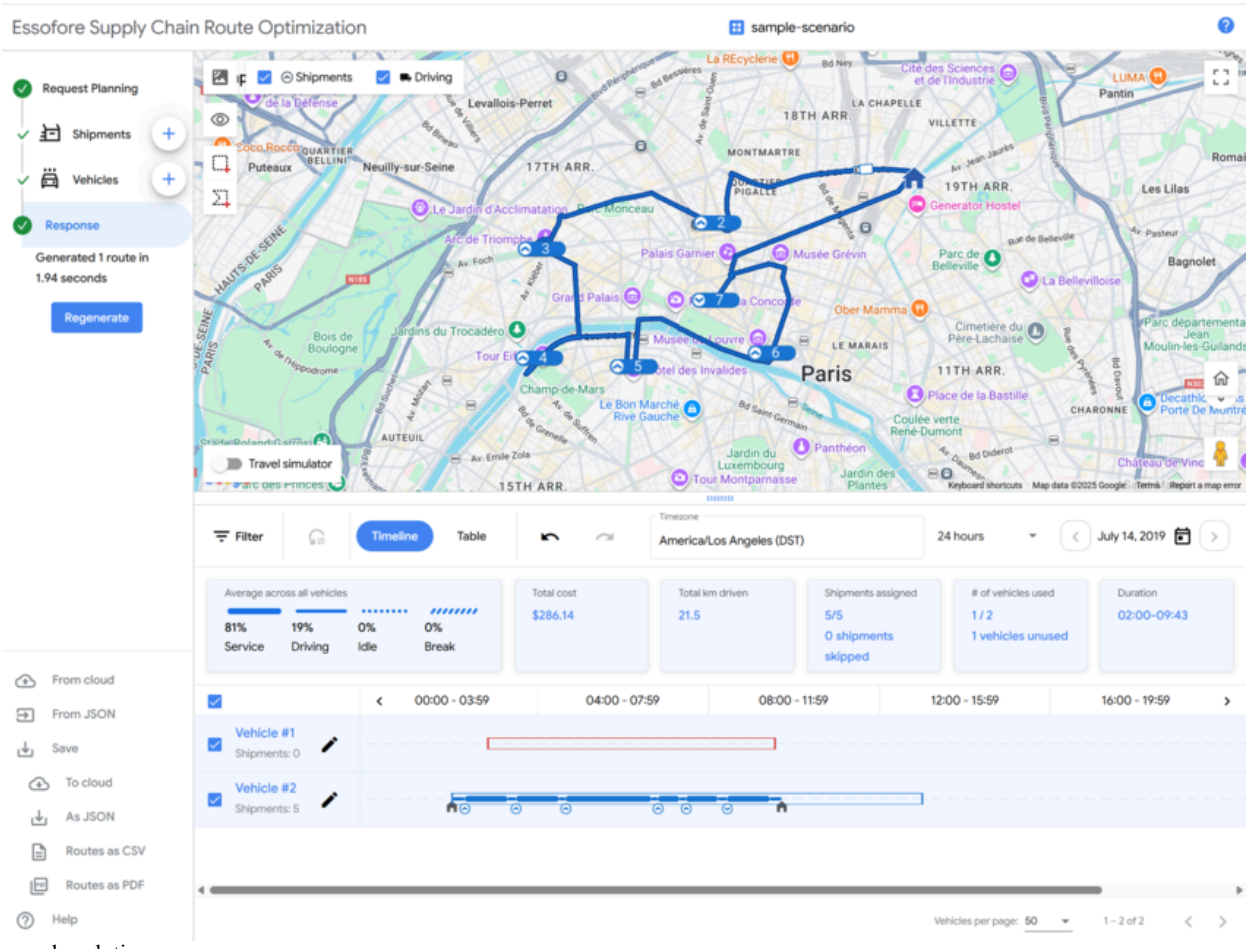
shipment selections

3. Click on *Vehicles* and select them all by clicking on the checkbox in the top row. Now that you have at least one Shipment and at least one Vehicle selected, the *GENERATE* button is available.

5. Click *Generate*.

    1. You will briefly see a *Cancel* button. If this were a more complex scenario you would have time to click it.

    2. Fleet Routing App just submitted this small scenario representing a vehicle routing problem to the backend. It got a solution to the problem. The application switched to the Timeline view.



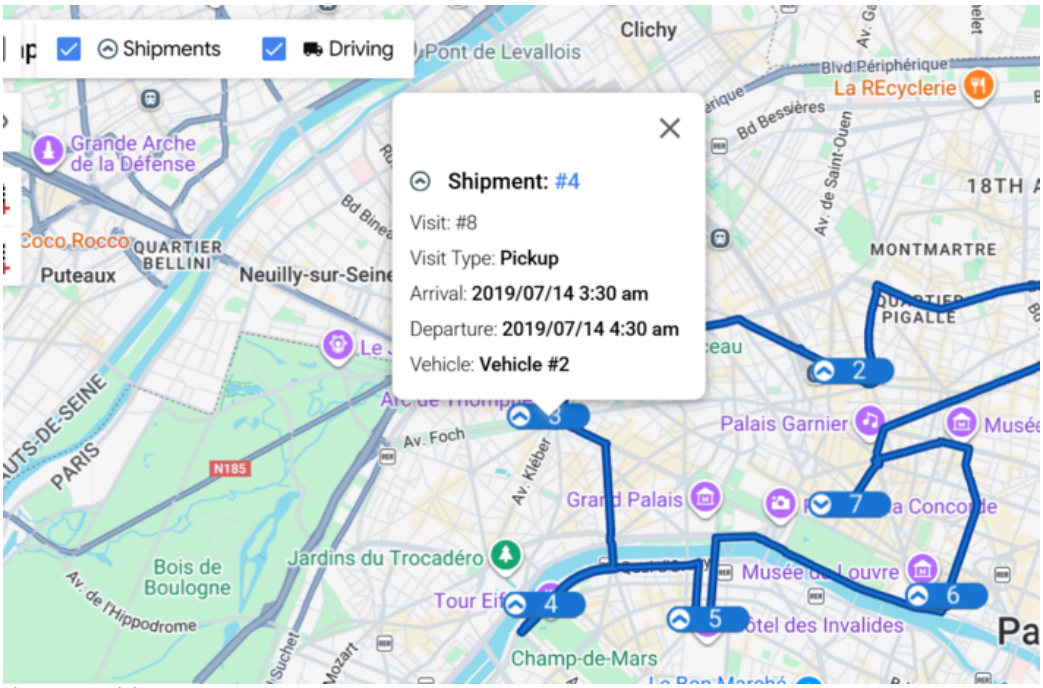
sample solution

6. The map is displayed over the top half of the page. You can see a map of central Paris with the planned vehicle route. There's an icon showing the Depot, and little circular icons showing pickup locations.

    1. Pickups are shown as circles with a caret pointing up, whereas drop-offs have downward-pointing caret.
    2. On the Timeline chart, an upward triangle represents a pickup and a downward triangle represents a drop-off.

7. Click on one of the shipments on the map.

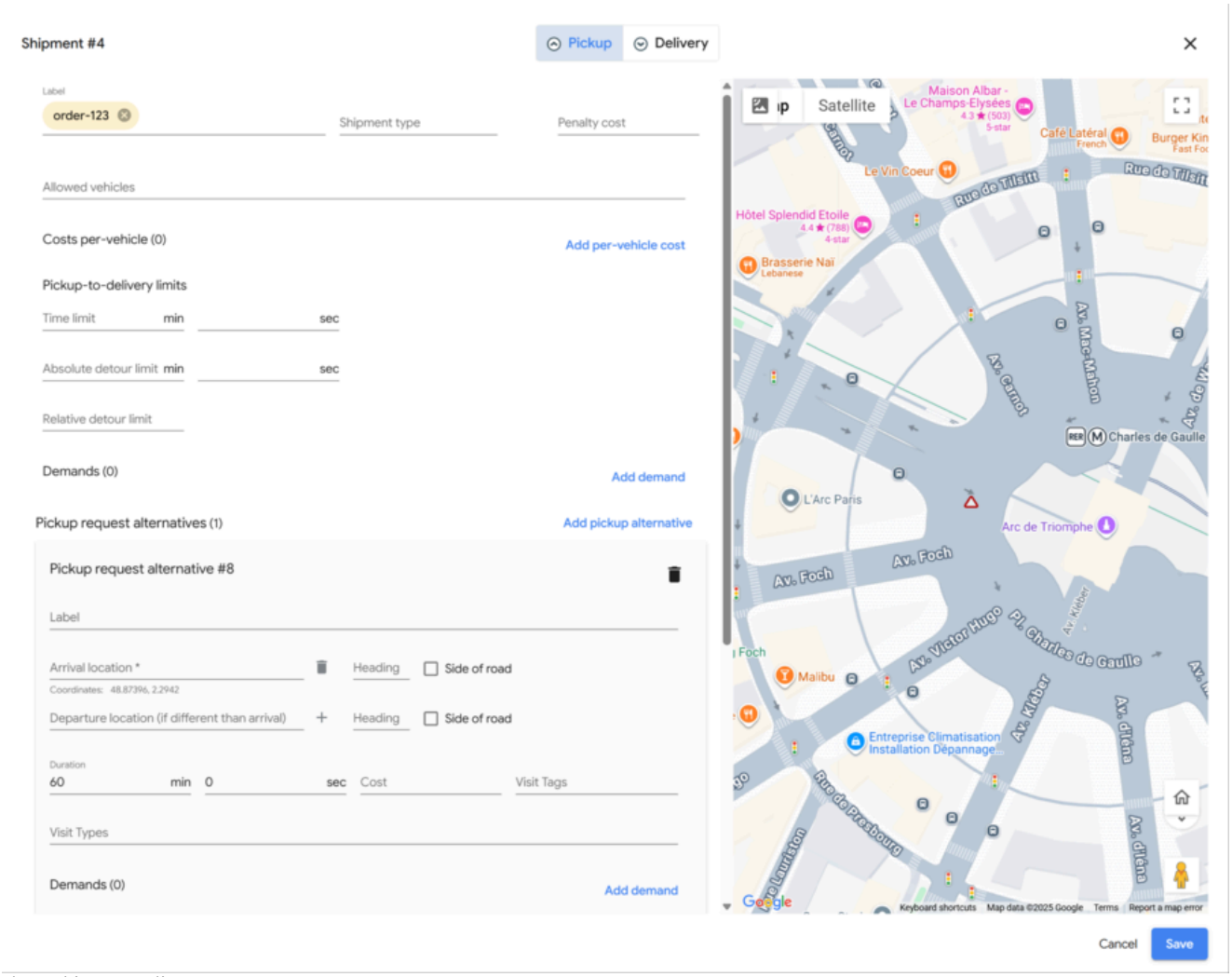
    1. This reveals the Visit popup. You can see the related Shipment and the Vehicle that will be making the visit.



show map visit

2. **TIP:** Shipments are pickups or deliveries. The act of making a pickup or a delivery in the Route Optimization API is called a **visit**. So if you see *Visit* in Fleet Routing App, just know that it's a specific vehicle making a stop at a location to pickup or drop something off.

8. Click the small link on the popup window for the Visit to open the Shipment for this visit to open the *Shipment Detail*. There's a lot on this screen but for now let's change the label from a simple number to something more helpful.



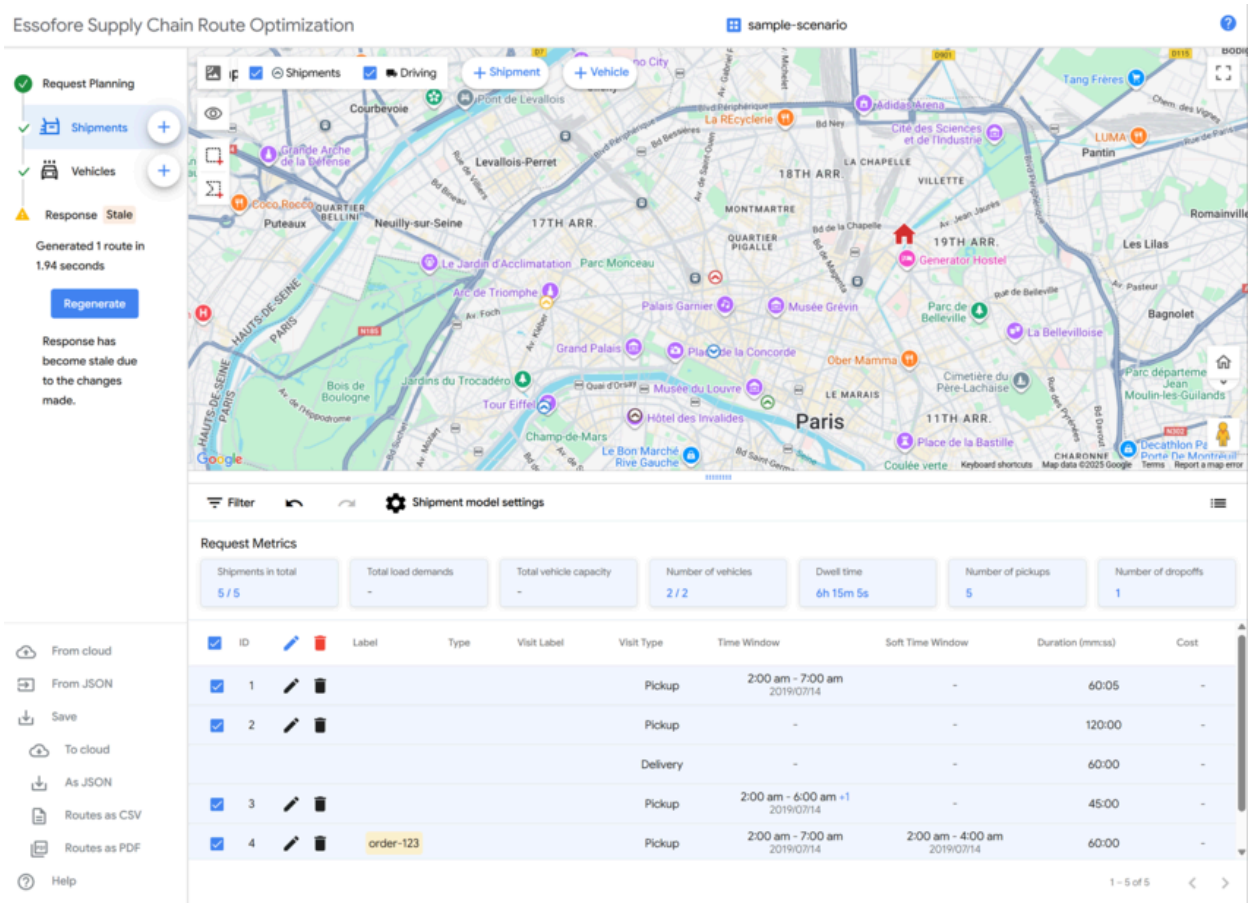
show shipment edit

9. Click on the *Label* field and type a short label, e.g., `order-123`.
    1. TIP: Pressing the `Tab` key on your keyboard or clicking outside the field will turn that text into a label. You can also type a comma `,` to add another label.
10. Press the *Save* button on that *Shipment Detail* page.
    1. You can see that your map popup now shows a meaningful label.

**Make some adjustments**

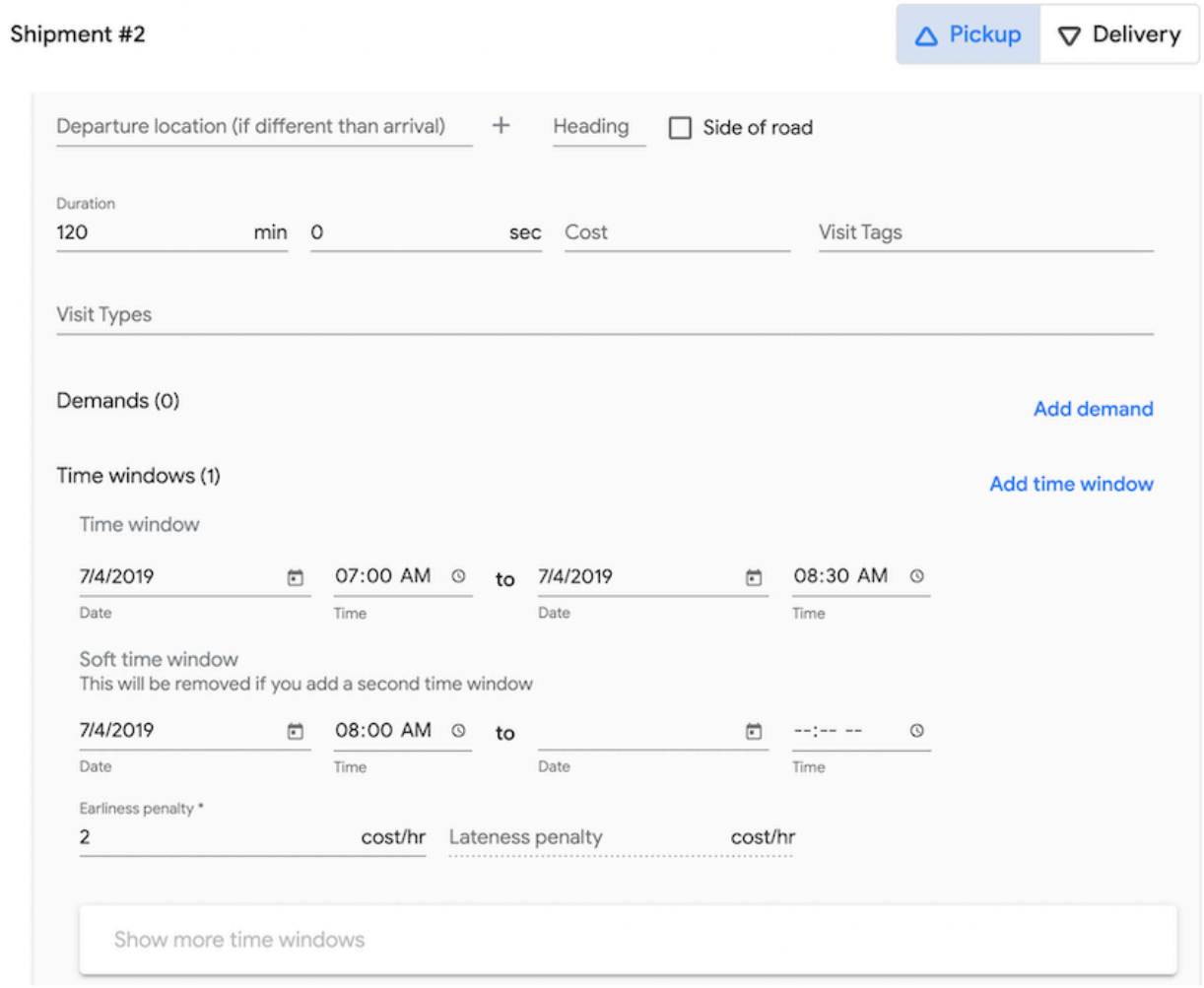
Having a plan is great, but what if you have new information and want to get a fresh solution from the Route Optimization API? Fleet Routing App has you covered. Let's make some changes:

1. Open *Request Settings* > *Shipments* to see the current VRP definition.
    1. Notice that Shipment #2 has both a pickup and a delivery. In the app a pickup and delivery are treated as a combination.



solution inputs

2. Click the *Edit* icon (little pencil) on the row for Shipment #2 to open the *Shipment Detail* view. Now that we're looking at the Pickup part of the shipment, we notice a few missing elements that we know should be changed.
    1. Notice that it's possible to provide more than one set of constraints (time windows, penalties) for a single pickup or delivery. Those are called visit request alternatives. But for now, we'll just update the one that has been provided.
    2. Update the `Time window` (also called the 'hard time window') for 7:00-8:30AM on July 4th, 2019. This is the time window within which the shipment **must* be picked up, otherwise the Route Optimization API solver will consider it a missed shipment.
    3. Update the `Soft time window` to *start* at 8:00AM on the same date. This indicates that the Route Optimization API should **try** to get that shipment picked up after 8:00AM. That's different than the (hard) time window, which **must** be picked up during the 7:00-8:30AM window.
    4. You can also tell the solver that there is a penalty for not hitting the soft time window. Change the `Earliness penalty` to `2 / hour`. The units are value-less, but you might assume that this means *"2 euros penalty for each hour that the shipment is picked up early"*. Why Euros? Because it's in Paris, France!




edit sample shipment

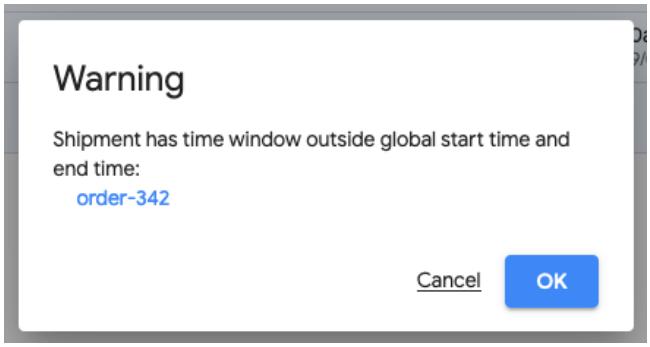
5. Finally, we'll switch to the delivery part of this shipment by clicking the *Delivery* icon at the top of the *Shipment Detail* form.
6. Change *Penalty cost* to `30.00`. This means that the penalty for missing this delivery altogether is 30.00 (following the previous statement about units, we can assume this is 30 Euros, but we don't specify the units).


add delivery penalty

7. Click the *Save* button to see the updated information in the Shipment list view.

3. You have updated your Shipment. The action button changes from *Generate* (first time) to *Regenerate*. Click the *Regenerate* button.

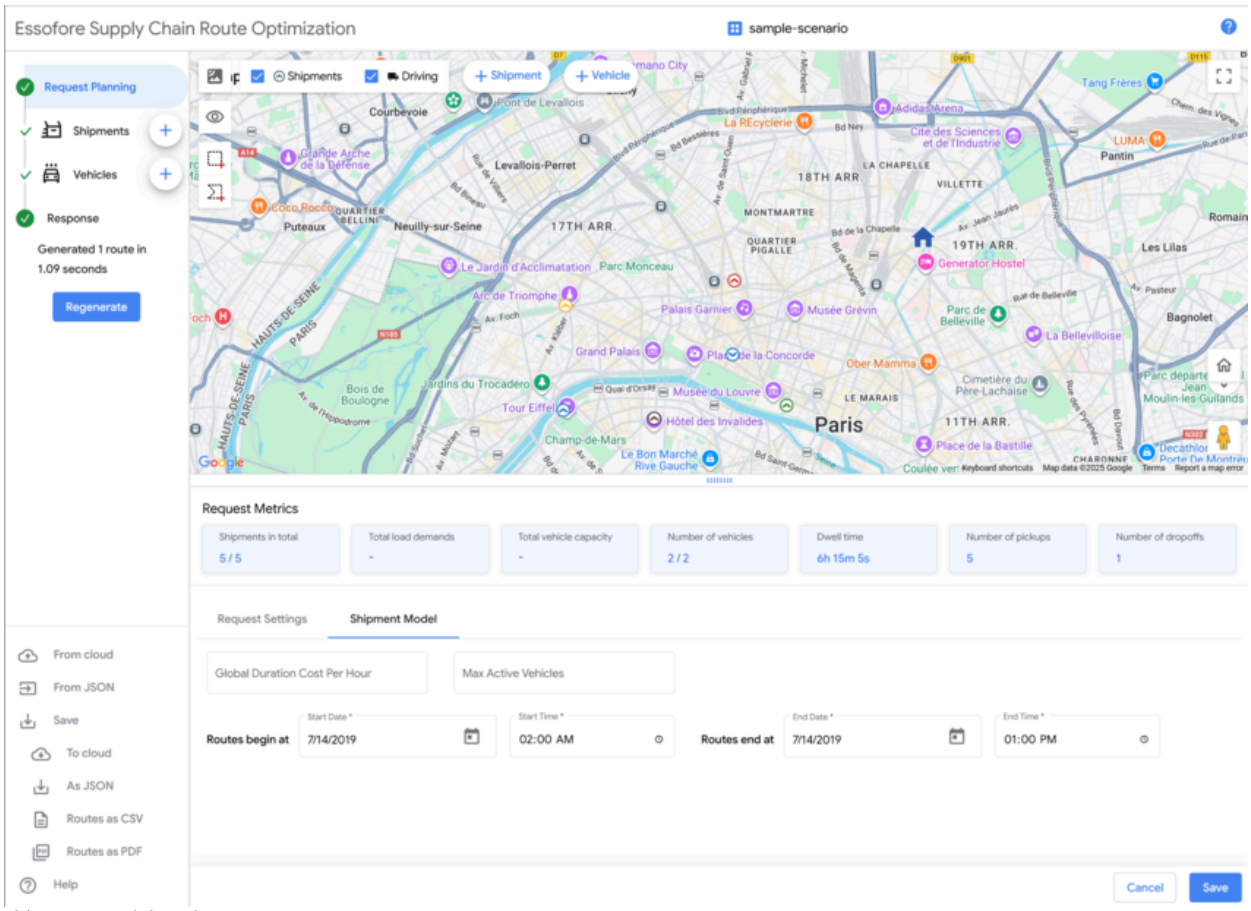
1. Oh no! We have a problem. One of the dates or times cannot be accommodated due to a global setting.



global time violation

4. Click on the *Request Planning* button on the top left of the application window.

    1. There are plenty of settings to adjust here *(Hint: You can grab the divider between this view and to adjust how the space is shared between the two views.)*. Go to *Shipment Model* tab. Notice that the *Routes begin at Start Date* field is July 14, 2019? Compare that with the *Time Window* column in the *Shipment List* table: we accidentally entered a shipment date of July 4th. That violates the global time window. We need to either adjust the global time window or adjust the shipment.



shipment model settings

    2. Reopen the *Shipment Detail* view for that shipment, adjust the date to July 14th, 2019 on the Pickup screen.

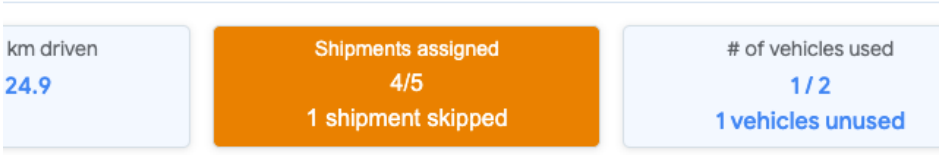
    3. Click the *Save* button.

5. With our errors fixed, click the *Regenerate* button again.

**Using metadata**

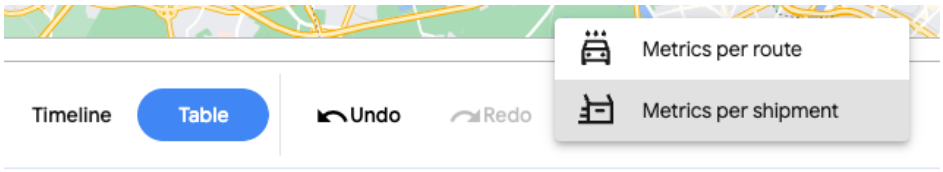
back

Looks good…until you see in the key performance indicator (KPI) summary that a shipment was skipped. We'll use the table view to figure out what's happened.



skipped shipment kpi

1. Switch to the *Table* view then choose *Metrics per shipment* to see the complete list of shipments.




shipment metadata

2. Sure enough, Shipment #2 was skipped.

| | ID | Label | Status | Reason | Visit Label | Visit Type | Start Time |
|---|---|---|---|---|---|---|---|
| ☐ | 1 | | Shipped | - | | Pickup | 7:00am |
| ☐ | 2 | order-342 | Skipped | - | | Pickup | - |
| | | | Skipped | - | | Delivery | - |
| ☐ | 3 | | Shipped | - | | Pickup | 2:18am |
| ☐ | 4 | | Shipped | - | | Pickup | 4:23am |
| ☐ | 5 | | Shipped | - | | Pickup | 6:16am |

shipment metrics list

**Understanding the solver**

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Fleet Routing App uses a Route Optimization solver for vehicle routing problems. The solver can make all kinds of optimizations to accommodate a wide variety constraints and demands, including setting penalty costs on shipments or fixed costs on vehicles.

Looking at the brief description of Skipped Shipments, we would hope to see a helpful *Skipped Shipment Reason* in the *Table View*. However, while there are some obvious reasons for one or more shipments to be skipped, the complexity of input scenarios can be very high, and that leads to shipments being skipped for reasons that may not be easy to reason about. The solver will not provide a *Skipped Shipment Reason* unless it can be very explicit about the reason. That means the reasons you see in the *Table View* are quite actionable, but when no reasons is given for a skipped shipment it can be hard to know where to start.

> TIP: We recommend an iterative approach to handling skipped shipments. Because the app generates solutions relatively fast, you can tweak a value using the Shipment or Vehicle detail views, or the Scenario settings, and *Generate* a new solution. For example, if a Shipment is skipped and you see that it has a very low *Penalty cost*, try looking at the average cost of reach vehicle route in the solution, and *at least* making the penalty for that shipment higher than the average route cost. That will provide a strong hint to the solver that it is really expensive to skip that shipment.

Feel free to tweak, remove, or add additional parameters, shipment, and vehicles to get a sense for how the route optimization solver works.

### Saving your work

back

Use the *Download* button to save the solution to your local computer. You can open the result text file to see exactly what Fleet Routing App is sending to the backend.

## Application components

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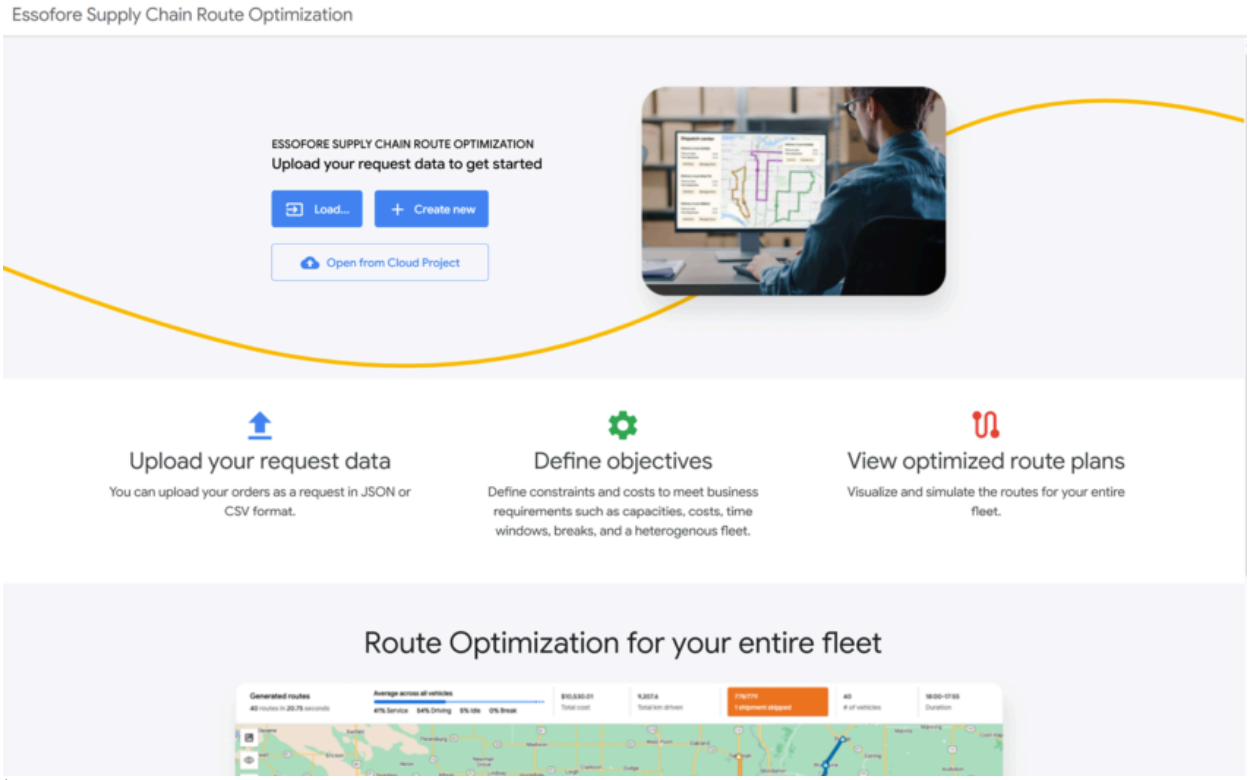
The main parts of the application are described here. This is not exhaustive, and screenshots might look a little different from the version in your browser as the application evolves.

### Home screen

back

The home screen gives you three choices when you first open the application.

- Upload an existing scenario or solution. You have a JSON file that contains a VRP scenario you want to solve.
- Upload from CSV.
- Open a saved scenario or solution. The application is integrated with your TMS and you want to open a file exported from the TMS, or saved ready for use by the TMS.
- Build a new scenario. Start from an empty scenario and add shipments and vehicles manually.

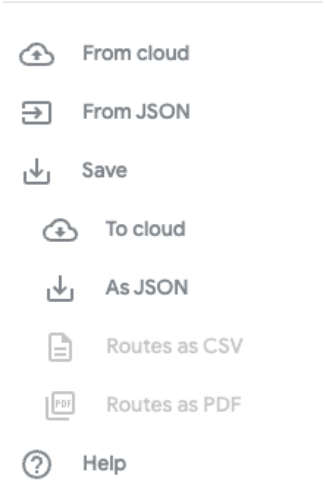


home-screen

### App actions

back

Application actions work with scenario and solution files. *Download* and *Upload* work with local files from your computer, whereas *Open* and *Save* work with files that will integrated with the TMS.

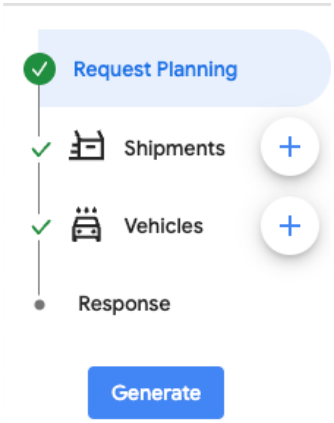


app-actions

### Sidebar

back

The sidebar gives you a quick overview of the number of shipments and vehicles and uses gray (in progress), green (completed), and orange (warning) colors to indicate where you are in the application workflow. Possible solution actions are shown as buttons, like *Generate*.



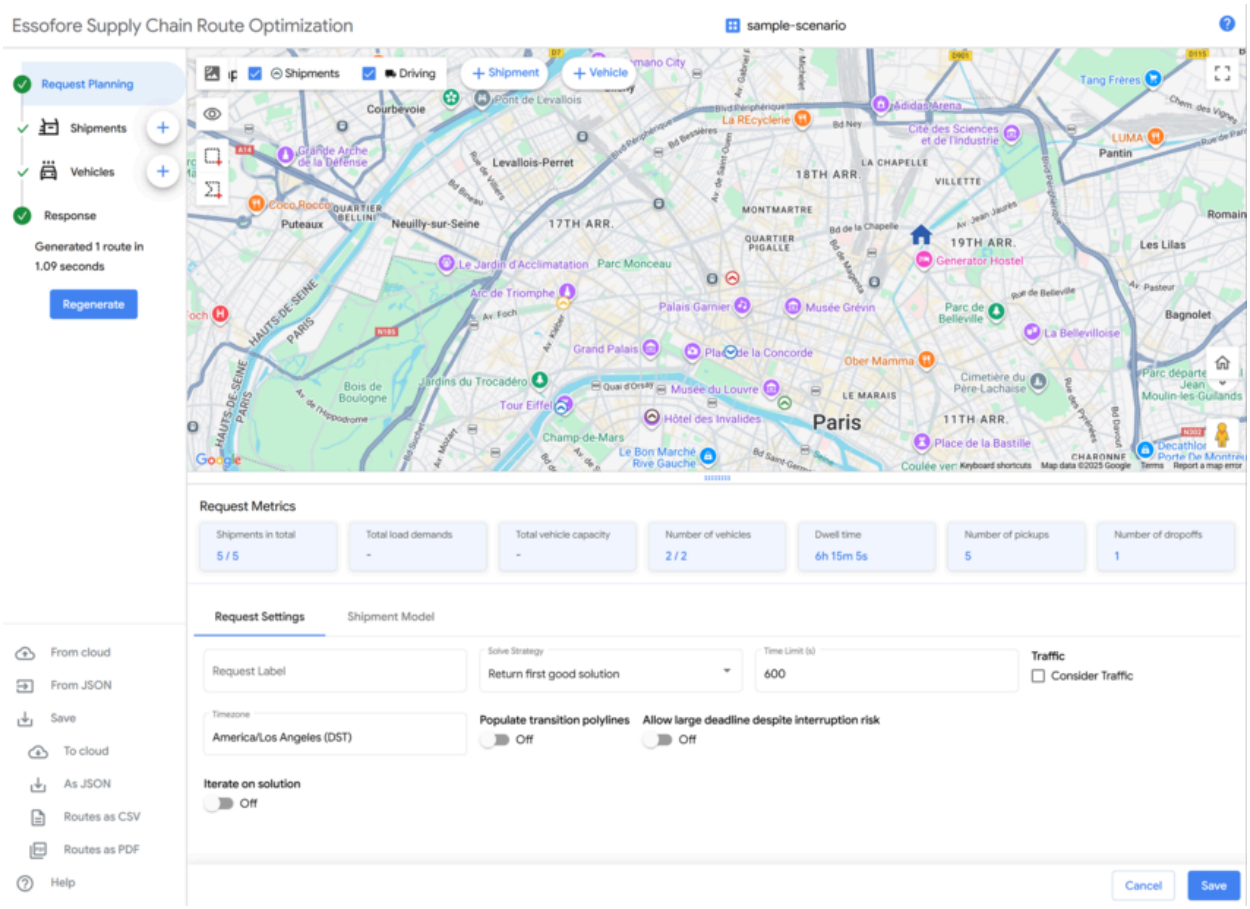

sidebar

### Scenario settings

back

Scenario settings contains personal application settings like the local time zone. All times in the application are stored as Coordinated Universal Time (UTC). Changing the time zone just adjusts how it is displayed in the application; it **does not change the underlying times**.

Most other Scenario Settings affect how the Route Optimization API solver will act on a given input VRP scenario.



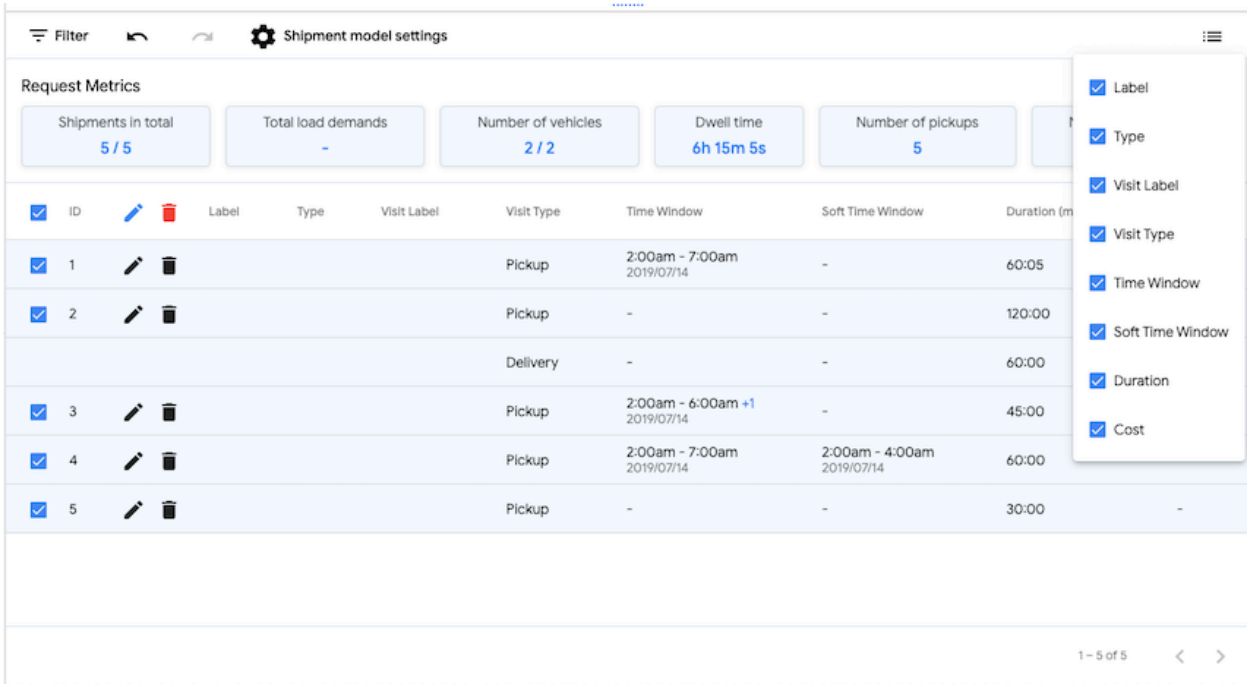

global-settings

### Shipment and vehicle planning views

back

Whether you create them or load them from an existing file, the Shipment Planning View (and related Vehicle Planning View) give you a list of items in the scenario and a way to select which items will be sent to the solver. Clicking on the checkbox next to the *ID* column will select or unselect **all** items. Use the Undo button if you make a mistake. Filters can be applied, and the list can be sorted by clicking on any column heading. Bulk Edit to edit multiple

Shipments or Vehicles in one go. Choose which columns are visible using the column picker. Click on the pencil icon to edit any fields in the shipment or vehicle.




shipment-planning

### Add Item button

back

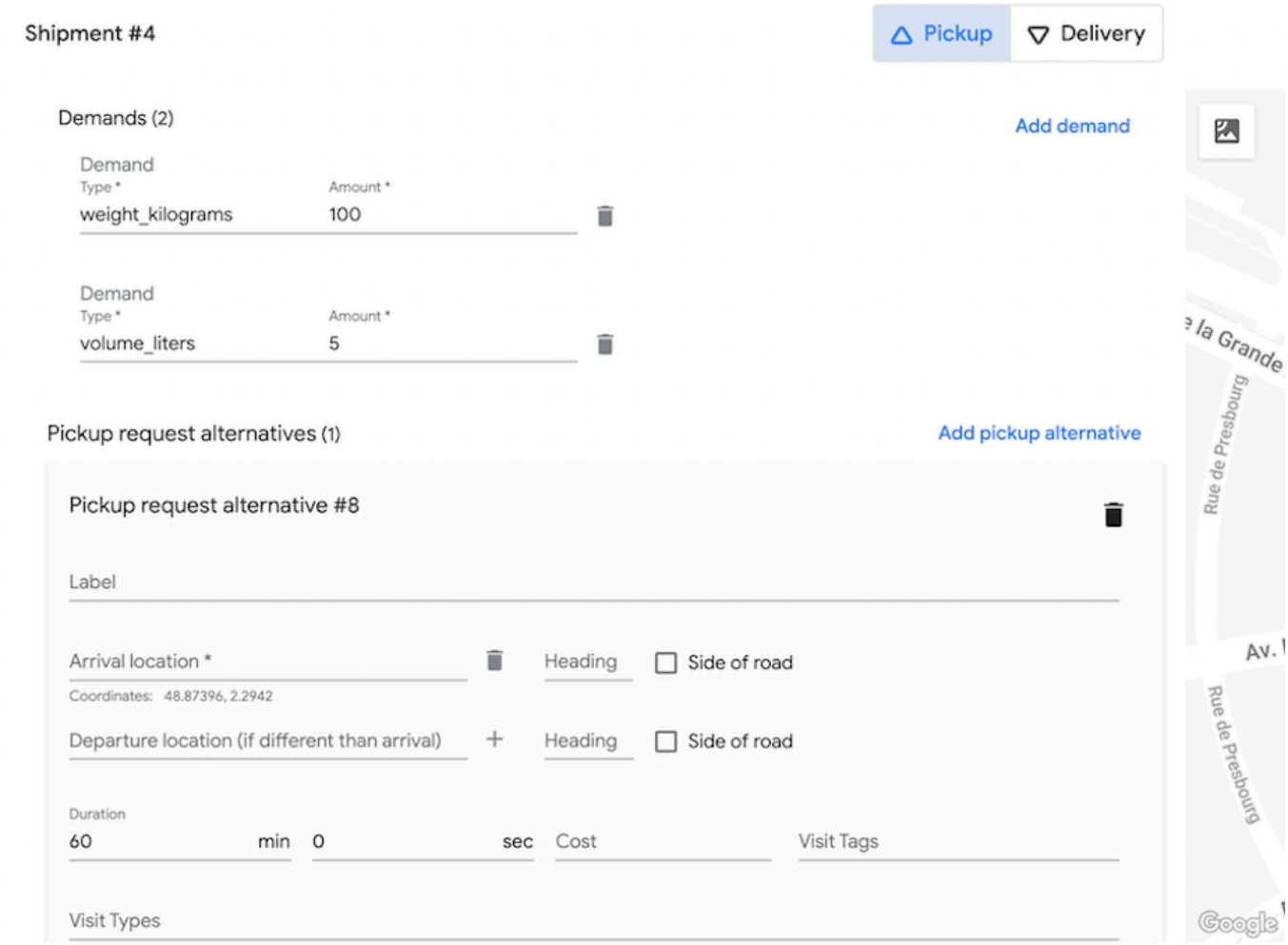
The *Add Item* button is visible on the bottom right of the Shipment and Vehicle planning list views. It's a large plus sign button floating in the lower-right corner. Clicking on the Add Item button will create a new empty Vehicle or Shipment, depending on which list is currently displayed.

### Shipment edit view

back

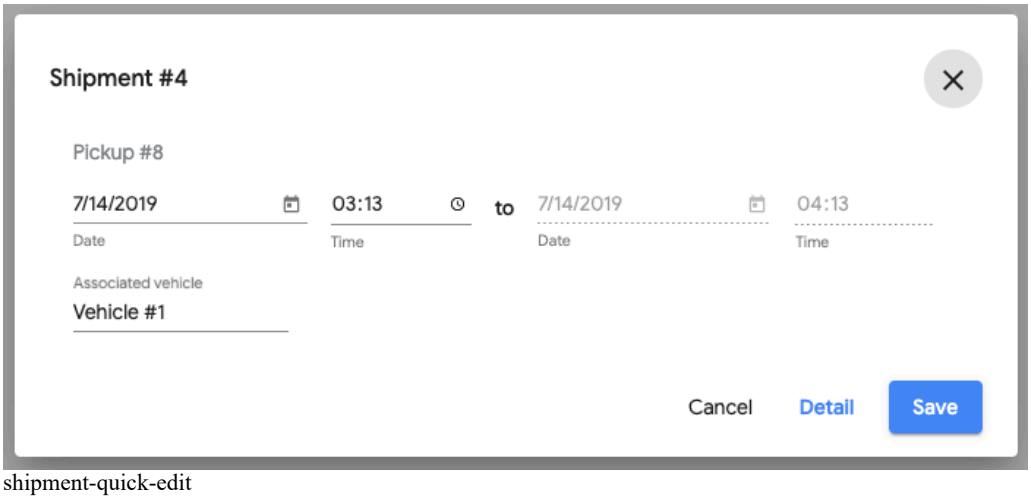
> NOTE: Not all of the capabilities or data supported by the Route Optimization API are available in this form.

Clicking the pencil icon on any Shipment Planning List row opens the Shipment Edit View form. A Shipment has minimal required information: a single pickup or drop-off request alternative with a location defined. Everything is optional, but in almost all cases you will want to define demands, and likely also time windows and fixed costs and penalties.




shipment-edit

Once a solution has been built, an abbreviated version of the form is available, called the Shipment Quick Edit view. The primary purpose of the Quick Edit is to tie a shipment to a subset of vehicles, or to change the pickup or drop-off time window. The Quick Edit form replicates the actions performed by dragging-and-dropping a shipment on the Timeline View.




shipment-quick-edit

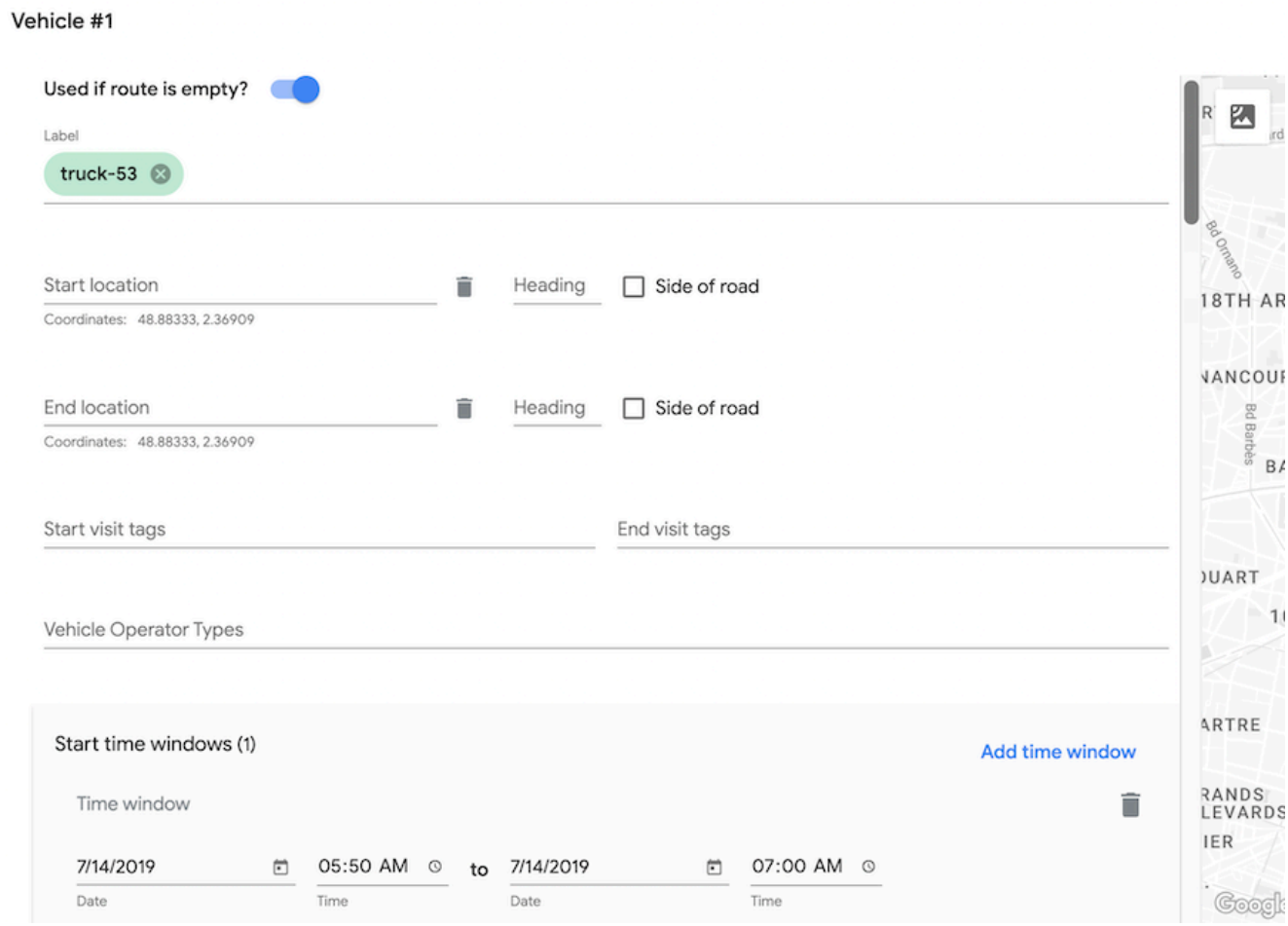
### Vehicle edit view

back

NOTE: Not all of the capabilities or data supported by the Route Optimization API are available in this form.

Clicking the pencil icon on any Vehicle Planning List row opens the Vehicle Edit view form. There are zero required fields for Vehicles. So you can just click the Add Item and press *Save* on the the Vehicle Edit View and get a perfectly valid vehicle. Now typically, there will be a lot more going on: a start and end location; a start and end time; vehicle Capacities (Load Limits) that match shipment demands, etc.

If you are adding a new Vehicle in this way, we recommend at least adding a label so that you can differentiate vehicles in the list view.



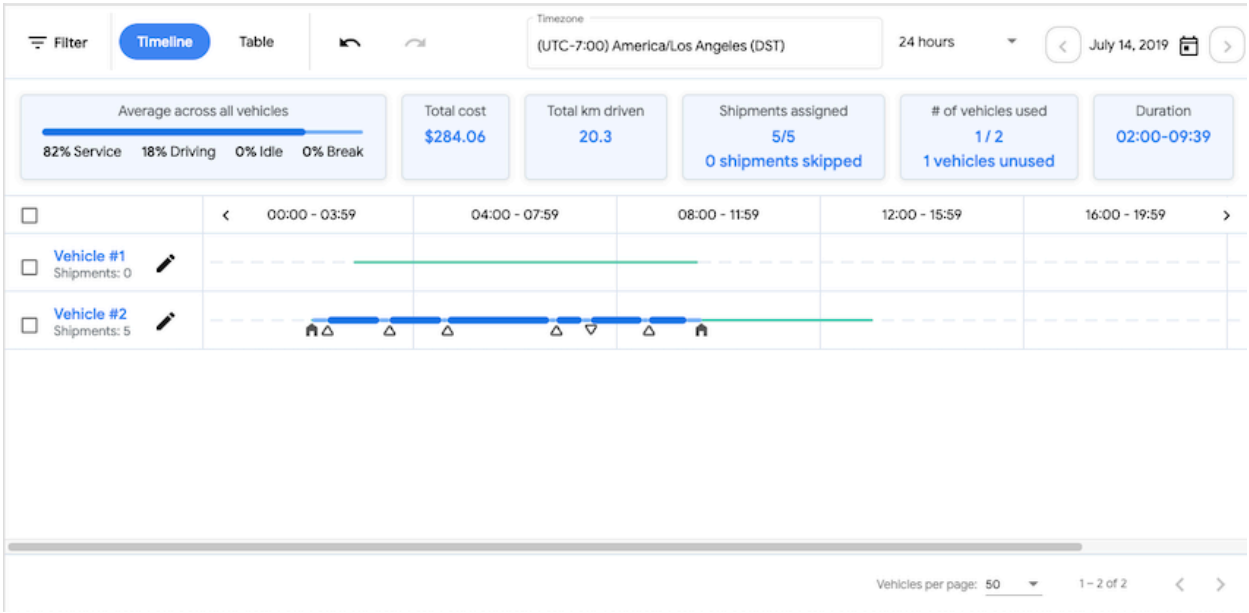
vehicle-edit

back

### Timeline View

back

Once a solution has been generated, the default view is the Timeline view. Timeline charts show time windows and dependencies between tasks. In Fleet Routing App, each row in the chart is one route and it's associated visits. Pickups are shown using a triangle pointing up; drop-offs use a downwards-point triangle.



timeline-view

While on the Timeline view you can:

- Click on the pencil icon on any row to open the vehicle edit view for that route.
- Click on the name of the vehicle servicing a route to open the Table View filtered to just that route.
- Apply filters to reduce the number of routes you see
- Click the < and > icons on the timeline heading to slide backwards and forwards in time.
- Zoom in and out on time slices using the time slice dropdown. For example, choose *24 hours* to see an entire day or *1 hour* to fine tune a solution.`
- Quickly switch time zones. Remember that this does not change the underlying data; it helps you communicate local time zones to your team.

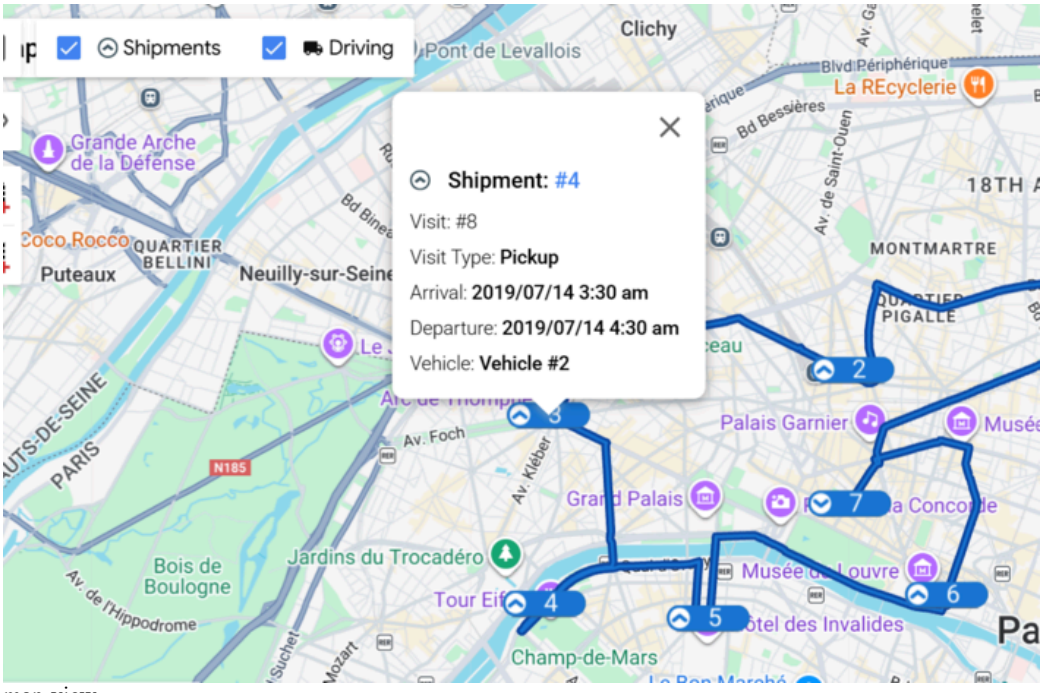
### Map View

back

At the top of the view is a Google map that can optionally use your estimated location to center the map in a helpful spot. The map has several useful tools.

- Select routes. Select one or more individual routes.
- Toggle selected. Switches between displaying all routes and shipments, or just the selected routes and associated shipments.
- Satellite view. This is particularly handy when trying to find a precise location for a shipment pickup or drop-off. Enable Satellite view to find exactly where the vehicle must be.

Clicking on a single visit provides shortcuts to associated shipment and vehicle, plus some brief summary information.

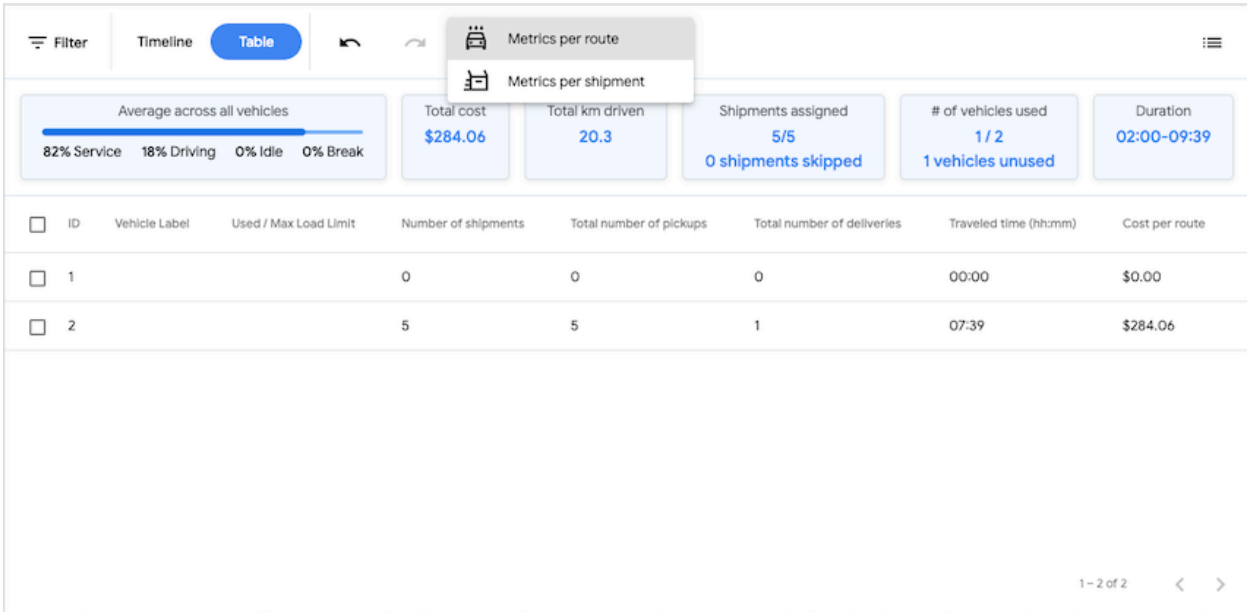


map-view

### Table View

back

The Table View lets you focus on the solution and drill down to specific routes and visits so you can understand and tweak them if needed. Use the *Metrics per route* and *Metrics per shipment* dropdown to toggle between Route (vehicle) and Visit (shipment) summaries. Filters are very capable to help focus on a subset. You can edit an existing filters by click on them.

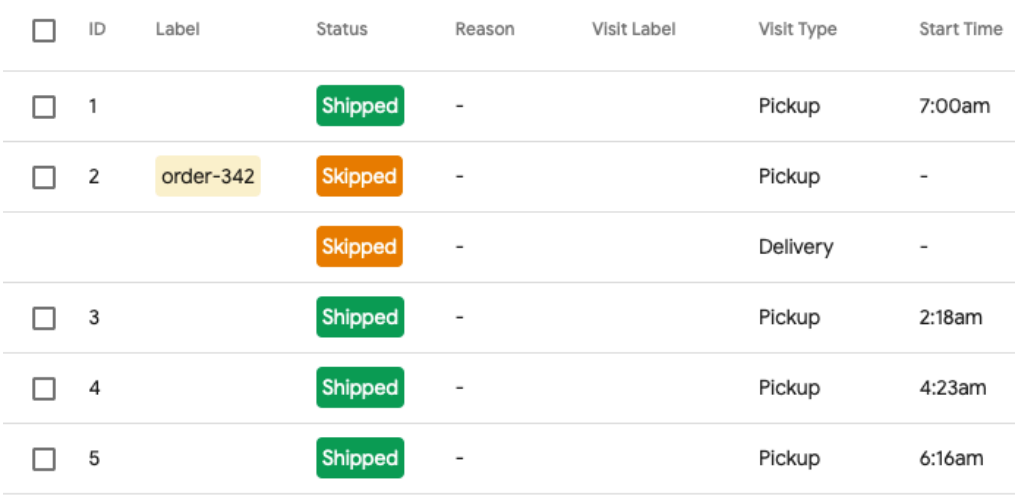



metadata-view

The *Skipped Shipment* button is a quick way to access the Table View with the appropriate filter already in place. The button will be highlighted in orange if your solution has skipped shipments.


skipped-shipments

Any skipped shipments will have similar highlighting:

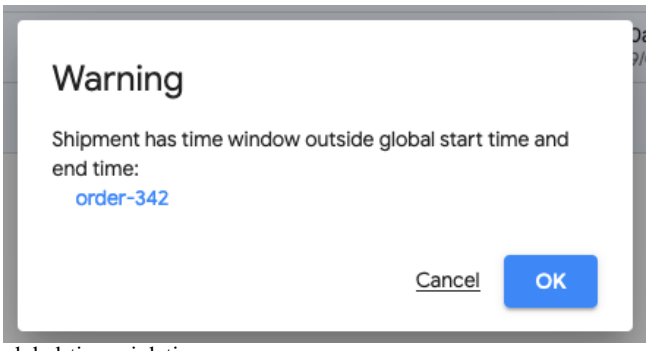



skipped-shipments-label

## Warnings and messages

back

Warnings are presented in the app whenever it can detect that you have a potential cause for error or confusion, or are taking an action that might result in a suboptimal solution. For example, if you set the start or end time for a single shipment outside of the global time window defined in *Global Settings* you will see this:



global-time-violation

Similar messages will show up on edit forms, e.g., if you define a Load Demand in a Shipment, but no Vehicles have a related Load Limit (capacity) you will see a hint.

# How To Guides

The basic process in Fleet Routing App is to either *Open* or *Upload* a scenario; *Generate* a solution; optionally adjust the parameters of the problem; then either *Save* or *Download* the solution.

back

Unless your organization has set up Fleet Routing App differently, you will need the following before you can:

- A desktop web browser. Fleet Routing App is not designed to work on a mobile web browser. It may work, but will be difficult to use because it has a complex user interface that assumes at least a laptop-size screen.

### Planning routes and visits

back

1. Open the application.
2. Click on the *Open saved scenario or solution*
3. Find then select one Scenario from the *Open* dialog. Click *Open*.
4. Select one or more Shipments in the *Request Settings* > *Shipments* window.
5. Select one or more Vehicles in the _Request Settings > Vehicles window.
6. Click *Generate*
7. Make any adjustments and iteratively use the *Request Settings* > *Regenerate* function.

### Save a solution

back

Once you have planned a scenario or started from scratch you want to pass the work on to the TMS for scheduling, or save the file for further use.

1. **Either** click *Save* and follow the instructions in the dialog,
2. **or** click *Download* to store the scenario and solution on your local machine.

If you *Download* a file you can subsequently *Upload* it back into Fleet Routing App. It's a handy way to experiment with scenarios.

> TIP: If you save any file that you *Download* with the file extension `*.json`, as in `my-scenario.json`, then you can open it in a web browser or text editor to see what data the application actually uses.

### Starting from an empty scenario

back

1. Open the application
2. Click on the *Build a new scenario* button. This opens the *Request Settings* > *Shipments* view.
3. Click on the *Add shipment* button in the lower right corner of the app window.
4. Shipments must have at least one pickup or drop-off. Choose the *Pickup* or *Delivery* screen using the toggle button in the top-center of the *Shipment Detail* window.
5. A pickup or delivery **must** have at least one *Pickup request alternative*. Click *Add pickup request alternative* and enter the required data.
6. Click on the *Request Settings* > *Vehicles* view in the sidebar.
7. Click on the *Add vehicle* button in the lower right corner of the app window.
8. Everything in the *Vehicle Detail* is optional. You can just click *Save* to continue.
9. Use the checkboxes next to vehicles and shipments to include them in the scenario.
10. Click *Generate* to solve the VRP.

### Using csv or json files for input

back

If you have many shipments and vehicles, using the UI to input the information can be tedious. Alternatively, you can provide the input in the form of a json file that encodes a complete VRP request **or** in the form of two csv files - one for the shipments and another for the vehicles. Both these options are available when you select the *Load* option from the home screen. To effectively use this mode, please familiarize yourself thoroughly with the format used by the Google Route Optimization API to express a VRP. You can find many sample files to help you learn and model complex scenarios over here.

# Concepts

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## Terminology

- **Vehicle routing problem (VRP).** Given a set vehicles and locations, a solution to a VRP finds the optimal routes so that each location is visited by a vehicle.
- **Shipment.** A shipment is either a pickup or a delivery (or both) that must be performed by a vehicle at a location. In addition to vehicles, shipments are the primary input to a VRP that Fleet Routing App handles. Shipments must have at least one potential pickup or delivery window. Shipments may also have Load Demand(capacities) stated in the same units as the capacities of vehicles. For example, if a shipment has a weight of 200 kilograms, that is how much *Load Demand (capacity)* that shipment will *demand* of a single vehicle.
- **Vehicle.** A vehicle performs pickups or dropoffs of shipments. Vehicles have properties called Load Limits (capacities) that are used by Fleet Routing App to find the optimal vehicle to perfrom a pickup or dropoff. For example, a vehicle might have a Load Limit (capacity) of '2 pallets' or '20 cubic meters'. Vehicles may also have a starting and ending location, and various time constraints. The visits that make up a Shipment
- **Scenario.** A scenario is a vehicle routing problem (VRP) logistics problem that Fleet Routing App can solve. It consists of one or more vehicles and one or more shipments.
- **Solution.** A solution is what the Route Optimization solver produces in response to a request to solve a scenario. Solutions are visible in Fleet Routing App via the Timeline chart, on a map, or in the Table View.
- **Transportation management system (TMS).** A TMS is a generic term for the system or systems that an organization uses to generate a scenario for the planners using Fleet Routing App to solve. TMSs typically contain order information that becomes a shipment, and information about the fleet of vehicles that will be used to deliver or pick up those shipments.
- **Soft time window.** Sometimes there is flexibility when a shipment needs to be picked up or dropped off. For example, a customer may say that they **must** have a delivery.
- **Skipped shipment.** The Route Optimization solver optimizes for minimum cost while considering a list of constraints. Given those inputs, it is possible or even likely that the solver cannot find a solution that has every shipment being picked up or deliver. Sometimes the reason that the solver has skipped a shipment is very clear. In those cases the *Table* view will list that reason. E.g., `DEMAND_EXCEEDS_VEHICLE_CAPACITY` is a representative example.
- **Pickup request alternative.** It is common for a shipment pickup or shipment delivery to support more than one possible pickup or delivery alternative. For example, a package delivery company may have offered two potential delivery windows for a customer. The *Pickup/Delivery Request Alternative* is how that is modeled in the app.
- **Load Demand.** A load demand is what a vehicle will be delivering or picking up to satisfy a shipment. For example, a load demand might be *'One pallet'* or *'200 kilograms'* or *'15 refrigerated cases'*. A load demand must have a type ('weight') and an amount ('2') and optionally units ('kilograms'). Load Demand types and amounts match up with similarly defined Load Limits (capacities) of vehicles. Matching one or more shipment load demands with one or more vehicle capacities is a key capability of the solver.

# Frequently Asked Questions

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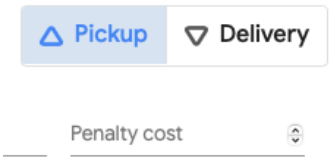
**Q: What's the difference between a penalty cost of zero (0) and a penalty cost that is not defined (empty)?**

A: An *undefined* penalty cost on a shipment is interepreted as an *infinite* penalty cost. In the application UI this looks like an empty field:




infinite penalty cost

An infinite penalty cost will cause the solver to attempt to handle that shipment at–almost literally–any cost.

Conversely, a penalty cost field that has defined numeric value is interpreted as a specific penalty cost. For example, if your assumed units of cost are Euros, then a penalty cost of `300` will be interpreted by the solver as: *'the cost of **not** handling this shipment is 300 Euros'*.

As a result, setting a specific penalty cost on one shipment but not others can likely cause a shipment to be skipped.

**Q: Why does Fleet Routing App ask for access to my location?**

A: This is just a convenience. If you do grant access to Browser Location and you are starting from an empty scenario, the Google Map will automatically be centered on your approximate location. If you are working on an existing scenario, the map will use the locations of the shipments and vehicles instead.

If you do not grant location permission, the app will use a default location specified in the configuration. You cannot override this default location.