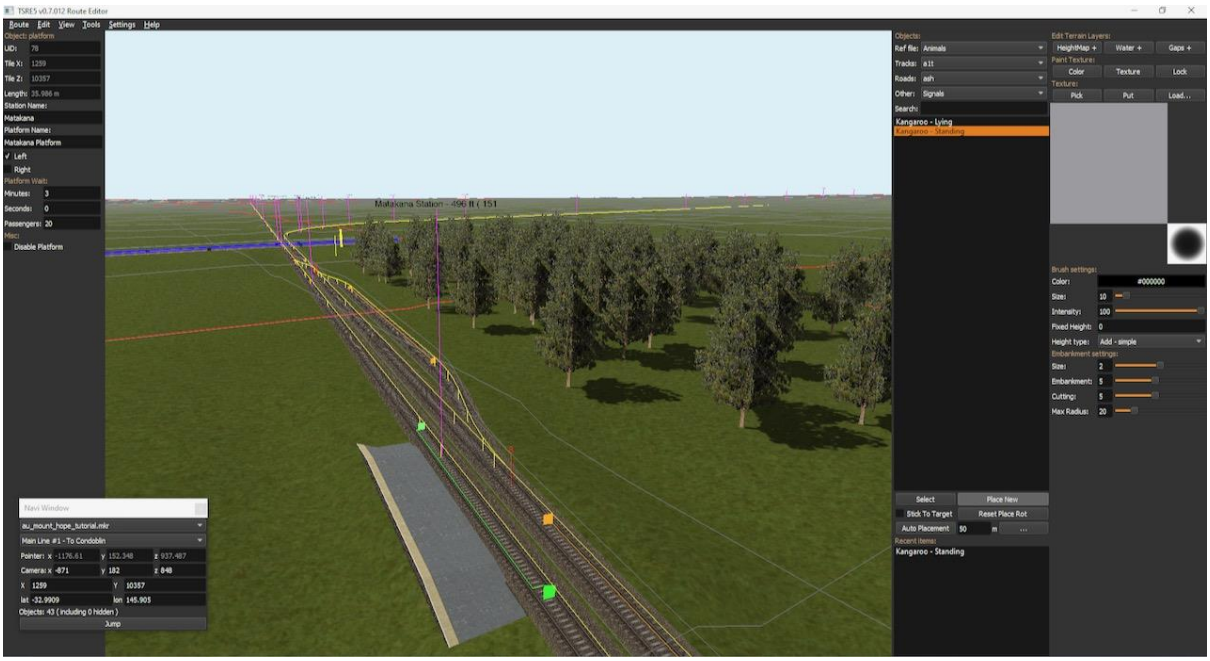
Open Rails Route Building Tutorial



A starter guide to route building for the Open Rails Train Simulator

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Introduction

This tutorial will teach you the basic skills and knowledge that you need to build route for the Open Rails Train Simulator (ORTS). By building a small tutorial route you will be introduced to the various route building concepts, tools and resources that are needed to build a route. Upon completion of the tutorial you can continue to expand your route building expertise by building your own routes, based on real world scenarios or wherever your imagination takes you. Included in the **Open Rails Route Building Tutorial Pack** is the small **Mount Hope - Example Route** that you can use as a reference while building your own route.

This tutorial will guide you through the following tasks:

- Research Route
- Create New Route
- Set up a Route File Structure
- Create Terrain Tiles
- Create Route Geographical Terrain

- Lay tracks and roads
- Add static objects
- Add vegetation objects
- Add interactive track and road objects
- Run your first train

This tutorial assumes that you have installed the following free resources on your computer (see the Route Building Tutorial webpage for download instructions):

- The Open Rails Train Simulator
- The Open Rails Route Build Tutorial Pack
- The Train Simulator Route Explorer (TSRE)

 Make sure that you have a working copy of the TSRE route editor installed. Familiarize yourself with the TSRE manual and keep it nearby when building your route, so that you can find the detailed information on how to use the TSRE tools.

For any questions you may have while building your route, get answers on the Elvas Tower - Open Rails Route Building Forum.

Route Background

The Mount Hope Railway was built to service a copper mine at Mount Hope, New South Wales (NSW), Australia. It diverged from the Sydney to Broken Hills railway at Matakana, and was approximately 10 miles (16 kms) in length. In this tutorial you will build a small part of the mainline between Sydney and Broken Hill, east and west of the Matakana station and the historic branch line to Mount Hope.

Railways are built following the contours of the landscape. The terrain at Mount Hope was fairly flat so the railway was relatively straight with only a few curves and limited earthworks. It was built to NSW light branch line standards.

The line was opened on the 10 February, 1919, and carried both freight and a weekly passenger service. Sadly, as the Mount Hope copper mine closed four months before the railway officially opened, it was only short lived. Once it became obvious that no further copper mining would occur, the line was closed with the last train running on 5 July, 1924.

Research Route

When building a route after a historic or existing railroad, the goal is often to be realistic and accurate. This requires gathering and reviewing as much information as possible before commencing work on the route, for example:

- Maps of the route. This might be a mixture of modern and/or contemporary maps, especially as in this case where the route is over 100 years old.
- Photos, internet search engines are sometimes a great source of information
- Curve and gradient profiles
- The track plan (single / dual track, switches and wyes, yards, tunnels, bridges and overpasses, track grade, etc)
- Timetables and any other relevant operating material
- The scenery plan (forest, hills and mountains, towns and cities, rivers, lakes, roads, etc.)
- Collecting scenery objects like buildings, roads, bridges, forests and foliage, etc.

- Gather track, signal and road shapes (for your Tutorial route all tracks and scenery objects are included in the **Mount Hope - Example Route**)
- Materials as those included in the ***(C:)/Open Rails Train Simulator - Mt Hope/Route Build Resources*** folder. Please familiarize yourself with those materials:
  - Topographical map
  - Parish Map
  - Historical map of NSW
  - Signal layouts Track layout for the stations / yards covered
  - Gradient diagrams
  - KML (Keyhole Markup Language) GPS location data. This data can be loaded in Google Earth and used to study the terrain and the route.
  - Digital Elevation Model (DEM) files. The DEM consists of terrain height maps sourced from satellite data. The data is not meant to study but will be used later on by TSRE to shape the terrain.

 As this route was built well before metrification in Australia most measurements are in imperial values. A quick conversion of some of the key values are as follows:

- 1 ft = 0.3048 m
- 1 chain (ch) = 20.1168 m
- 1 mile = 1609.34 m

Create New Route

Start TSRE and point it to the new folder structure: ***(C:)/Open Rails Train Simulator - Mt Hope*** (see TSRE manual for details). Enter the following information in the New Route screen:

Name ID: **au_mt_hope** This will be the route name in all the sub folders and files.

Lat: -32.99064 Long: 145.90468 - This will position the geological starting point for the route at Matakana, New South Wales, Australia.

 Routes that span a large geographical area will show distortions in the measured distances that are displayed in the engine's information screens. To minimize the distortion of distances, choose the latitude and longitude of your route's first tile at the geographical centre of your planned route. The first tile does not necessarily have to be along the tracks and may be discarded after starting your route.

Update the following on the Route Settings screen:

Route Display Name Can be changed to a legible name like Mount Hope Railway Tutorial. This will not change the folder and file names.

Terrain Error Scale Set this to zero for best performance. The Terrain Error Scale controls the number of polys/faces on each tile. More polys allow for more graphical detail but demands more computer resources which can affect performance.

TSRE will set up the ***au_mt_hope*** route folder structure and will populate it with basic content and configuration files. TSRE also creates the initial terrain tile for the route based upon the Lat/Long you have supplied.

To avoid having to browse to your route's folder every time you open TSRE. Using a text editor, set **gameRoot = *C:/Open Rails Train Simulator - Mt Hope*** in the ***(C):/TSRE/settings.txt*** file.

Set up a Route File Structure

Route file structure

The Route File Structure for your Tutorial route has already been setup but needs to be populated with resources that are needed to build your route. When you installed the **Route Building Tutorial Pack**, it created the **Open Rails root** folder ***(C:)/Open Rails Train Simulator - Mt Hope*** with the base folder structure that Open Rails needs to operate.

In future, for new routes you can manually set up an empty Open Rails root folder structure:

```
C:/OPEN RAILS - ROOT  /GLOBAL   /SHAPES
                                /TEXTURES
                      /ROUTES
                      /SOUND
                      /TRAINS   /CONSISTS
                                /TRAINSET
```

Before you can create a new route with TSRE, that will be stored in the ROUTES folder, you will have to download the latest TSection.dat file and install it in your root GLOBAL folder.

The Tutorial route folder ***au_mt_hope*** was created by TSRE in the Open Rails root ***(C:)/Open Rails Train Simulator - Mt Hope/Routes*** folder.

Tsection.dat files

There are two ***Tsection.dat*** files: The ***GLOBAL/Tsection.dat*** file is a regularly extended database of all common road and track sections and provides the Open Rails Train Simulator with invisible vectors along which trains and cars travel. The route's Local ***au_mt_hope/Tsection.dat*** file is for storing data about dynamic tracks used in this route only. Note that track and road objects are stored in the ***GLOBAL/Shapes*** folder while their textures (***.ace*** or ***.dds***) are stored in your your route's local Textures folder.

Geo files

Place the ***mt_hope_railway.kml*** marker file (found in the **Route Build Resources**) in the ***(C:)/Open Rails Train Simulator - Mt Hope/Routes/au_mt_hope*** folder. You can add multiple marker files to your route folder that can be selected in TSRE.

The markers in the ***.kml*** file provided in Route Building Reference are very far apart and sometimes hard to find in TSRE. To add additional markers you can load the provided ***.kml*** file in a GPS mapping program like Google Maps (see **References** section). Mark switch locations, curves and other landmarks as reference points for laying your route. Place the updated ***.kml*** marker file in the ***Routes/au_mt_hope*** folder.

You can jump to any marker location in the TSRE Navi window. If you have multiple marker files, first select the relevant marker file.

Scenery Objects

All objects that are used to build up the scenery of your route will have to be added to your route's file structure. You can build objects yourself (not part of this tutorial) or find objects in other routes and many can be downloaded from other route builders, train simulation forums and websites. Please adhere to the license conditions of the objects' creators. If in future you are adding new objects to your route you must:

1. Copy the object shape ***<objectname>.s*** and object definition ***<objectname>.sd*** files to your route's ***Shapes*** folder.

2. Copy textures ***<objectname>.ace*** to your route's **Textures** folder. Textures add color to your shape. Note that texture names do not always align with the object. Textures can be found with the **Shape Viewer** application. It came with your TSRE installation and can be started with the ***C:/TSRE/ShapeViewer.bat*** file.

3. Add an entry for the object at the bottom of your ***<myroutename>.ref*** file. Example for an object called ***emu.s***:

```
Static (
        FileName ( emu.s )
        Class ( "Australian Livestock" )
        Align ( None )
        Description ( "My Emu" )
)
```


To make life easy, there are tools that let you select objects from a source route and add them to your route. The **Route Riter** application (see **References** section) takes care of moving the selected object's shape files and textures to the correct folders and updates your route's ***<myroutename>.ref*** file.


For the Tutorial Route you can use the **Route Riter** tool to copy all objects in the ***../Routes/au_mount_hope_example/Shapes*** source folder to the ***../Routes/au_mt_hope*** destination folder. Route Riter will copy all shape files (****.s*** and ****.sd***) plus all textures (****.ace)*** to the correct Tutorial route folders and will add entries for each object to the file.

Once the desired object files are in place, restart TSRE to continue building your Tutorial route.

Rolling stock

The **Route Building Tutorial Pack** came with the Light Engine 1905 steam locomotive and tender. The locomotive files are stored in the ***../Trains/Trainset*** and ***../Trains/Consists*** folders. All rolling stock (locomotives, freight cars, passenger cars, etc.) installed in the OR root folder can be used in all routes in this Open Rails root folder structure.


When importing one of the many free and paid routes, make very sure that it does not alter any OR configuration files, as this will corrupt your other routes. To avoid any issues, you can store downloaded routes in their own separate OR root file structure as a so-called mini route.


Another advantage of keeping your route development in a separate root folder is that it simplifies making backups of the route, as this will allow you to recover from any mistakes. Making backups is a good practice in general and saving your work after each route editing session in TSRE can save you a lot of time if anything goes wrong.

Create Terrain Tiles

When the route is initially created, only the base terrain tile will be visible, all other tiles will be white. Turn on **Markers** (*TSRE menu: >View>Markers*), which will show the markers from the **Route Build Resources**' ***.kml*** file. You will see the markers as red lines on white areas. Also turn on the **Compass** (*TSRE menu: >View>Compass)* to help you navigate the terrain. Create a few new terrain tiles beside the initial tile using TSRE.


It is suggested that at least one terrain tile be created on either side of the markers. Each terrain tile is approximately 2km square, so this will give a good amount of terrain on either side of the track.


Get familiar with the keys to navigate the terrain in TSRE (*this should go to the TSRE manual*):

- A-key = move Left, W-key = move Forward, S-key = move Backward, D-key = move Right (or use arrow keys)
- Shift + AWSD keys = fast moves, Crtl + AWSD keys = slow moves
- Spacebar+W-key = move Up, Spacebar+S-key = move Down
- Period (.) toggles the view from a fixed elevation on and off while flying over the terrain
- To avoid crashing through the terrain surface, turn on **Stick Camera to Terrain** in TSRE **Settings** menu

Create Route Geographical Terrain

Real world geography of the landscape around your track can be loaded on a tile using DEM data (Digital Elevation Model). Loading DEM data on a tile will create the hills and valleys that your train will run through. Satellite based DEM data of the earth geography is available from several free internet resources (see **References** section).

- Copy the complete DEM data folder with height map files (***.hgt***) that is included the **Route Build Resources** to your **(C:)/TSRE** folder.
- Edit the **C:/TSRE/settings.txt** file with a text editor and change **geoPath = C:/TSRE/DEM**
- Restart TSRE.
- Use the TSRE's **Geo** tool (*TSRE Menu >Tools>Geo*) to load height maps onto the few first tiles


A caution with regard to the accuracy of satellite based DEM data: The horizontal interval of terrain elevation data-points is usually 3 arc seconds (90 meters) and sometimes 1 arc second (30 meters). The vertical accuracy is around 2 - 3 meters but may be three or four times higher due to the presence of objects above the land surface, for instance forests, settlements and water surfaces.


When creating tiles in mountainous areas with steep grades on the edges of tiles, gaps or holes may emerge between tiles. This is only a display issue. The tiles should be aligned perfectly after reloading the route in TSRE.

Loading height maps on tiles can either be done on a tile by tile basis when manually creating tiles with, or automatically (see the tip below).

TSRE can help you create new terrain tiles and load height maps by ticking **Create new tiles if not exist**, and **Create terrain from Geodata** in the **Geo** tool (*TSRE menu: >Tools>Geo*). When moving along your track markers the new tiles will automatically be created as you move into a new unpopulated tile (white space). When you have completed the tiles that you wish to generate, untick these two options.

The **Geo** tool (*TSRE menu: Tools>Geo*) can also import and overlay maps (as a texture layer) on tiles from the free OpenStreetMap service. The maps are a great help with positioning tracks, roads and structures. See TSRE manual on how to use the Load Map feature.

In addition to the free OpenStreetMaps, the TSRE map API (Application Program Interface) can also be configured to load satellite and other maps from Google Maps or Mapbox, who's websites (see **References** section) provide information on map options and pricing models.

When using the OpenStreetMap as tile texture, the mainline between Broken Hill and Condobolin is plotted on the terrain, as this railway still exists today. The Matakana to Mount Hope branch line has been recovered (removed and used elsewhere), so you will need the **.kml** markers to plot the track.

Lay Track and Roads

Once you have created enough terrain tiles, and loaded the relevant geo data, it is time to start laying tracks using TSRE (*TSRE menu >Tools>Objects*).

To prevent rework in a later stage, the following order of work is recommended:

1. Place tracks
2. Test, fix and change tracks until the track work is complete
3. Place interactive track objects after completing the tracks. Changing track can break interactive objects, as these have entries in the Track Database (TDB)
4. Place roads
5. Add interactive road objects (car-spawners)
6. Place static objects and enhance the terrain. The scenery is usually built around the train tracks and roads and should therefore be done last.

For larger projects, many route builders build their route section by section.

Once track laying has commenced it is possible to see an overview of the route and which terrain tiles are included, by using the **Track Viewer** application that is included with the Open Rails installation (***<your Open Rails program folder>/Contrib.TrackViewer.exe***).

It is important that the first piece of track is laid as accurate as possible, as it is the reference point for all other track pieces in your route. It is best to find a long straight section of track as this can be placed more accurate over the longer distance. A small directional angle variation at the start of the straight will be significantly magnified at the end of the straight.

Track Orientation

For the tutorial route it is suggested that track laying commence near Matakana station, and head back towards Condobolin (looking east). Find the longest piece of straight track (say 500m) and lay track pieces to the end of the straight, so you can check if the track is as close as possible to the correct position. If the track is not correctly aligned then you can go back to the first piece laid and rotate it slightly so that the orientation is a better fit. You can either move or delete and redo the adjoining piece of track.

 A few hints for editing track: Remember to remove a track piece from the TDB before making any changes to it (use **Z**-key). Not doing so will corrupt the TDB and cause re-work. Use the **Ctrl**-key to make small adjustments when rotating or translating track. Check "Stick to target" to make sure track pieces are connected properly.

Track Height

If you can identify track height reference points during your route research, this will make your track laying even more accurate. The Mount Hope Railway was part of the New South Wales Government Railway (NSWGR) system that published the heights of stations across the system. These heights were the track height at the relevant signal box at the station. Matakana station, which according to the track layout diagram was approximately 1094ft (333.5m) from the road crossing (see marker), had a height of 496ft (151.2m).

Delete the first long track section at Matakana station and replace it with more realistic smaller track sections back to the station. The small track piece at the station now has the correct direction. You can now correct it's height until it equals the published station height for Matakana. Once you have done this, delete all small and long track sections, except for the piece at the station. You have now successfully created your starting track piece and can build the rest of the track using the GPS markers as guide. Try out dynamic track in long curves. Opposite to curved and straight fixed shape tracks, dynamic track is shaped based on its begin and end-point and can be adjusted afterward.

 Helpful information on the naming convention and usage of track pieces can be found in the Primer in Track tutorial on the Steam4me website.

Track Gradient

Matakana station is at 496ft (151.2m) and at Mount Hope 10 miles (16 kilometres) away is around 722ft (220m). This is an average 4 pro-mille climb to Mount Hope, however the branch line from Matakana to Mount Hope varies in grade with some steep inclines and some sections with decline. The Matakana station platform is 100ft in length, the Crossing loop (side line) at Makatana is 1320ft, The grade at the platforms is level. The grade of the mainline west of the station to Broken Hill is a fairly steady 0.8 pro-mille decent. The grade along the mainline east of the platform to Condobolin is fairly level.

 For a very smooth a gradient transition, use 1.5 meter (or smaller) track pieces with each piece's elevation greater or less than the previous track piece by 0.1 per-cent or 1.0 per-mille or 0.058 degrees. It will still look good when you elevate / descend in 2 per-mille steps (0.116 degrees).

 Remember that you can load the **Mount Hope - Example Route** in TSRE as an example of how to build your route.

Roads

Laying road sections in TSRE is similar to laying track sections, but changes in gradient are probably not as critical.

 When laying track it is possible to miss inserting a piece, and the track piece can "end up anywhere" so keep an eye out for these pieces and delete them. The **Track Viewer** application in Open Rails can help you locate the lost track pieces. Track Viewer shows a very useful overview of your route while building.

 On long grade transitions, check the variation of each piece once completed and prior to moving onto more track laying. It is possible to sometimes have one transition piece incorrectly set, and this might cause the need to come back and re-lay a lot of track to correct.

 It is also suggested, especially for routes with lots of track transitions, that as track is laid, a check is done by running a train over all new track sections and watching the Gradient value in the HuD, this will help identify any inconsistencies in track laying.

Add Static Objects

After completing the track and any roads you can now enhance the scenery with TSRE by placing static objects such as buildings, bridges, trees, wildlife etc.

 The orientation of an object can be aligned with an existing object, for example to place a platform or bridge object with the same orientation as the track, "copy" the orientation of the track in TSRE and "paste" it into the new object being placed.

Add Vegetation objects

Vegetation can be added by two different methods as follows:

- **Specimen vegetation** – where it is desired to have an individual standalone tree, then the vegetation can be placed as a static object where you like.
- **Forest Objects** – for areas which have dense vegetation growth it is possible to place a forest object which fills an area that you define with trees. Forest objects are not described in the TSRE documentation. In the object properties you can set the size of the forest area with **Width** and **Height**, and the tree density with either **Population** or **Density/KM**. Sometimes trees inadvertently end up on the tracks. To avoid this issue please see this note on tree clearing.

Place some of each of the above vegetation types using TSRE.

 You can study satellite maps like Google Earth to get a feel for the landscape type and vegetation appropriate for the area.

Add interactive Track and Road objects

Track interactive objects are items which are linked to the track and as a consequence they are stored in the track (and road) databases. These items include speed posts, mile posts, level crossings, signals, station and siding markers, etc.

While laying tracks it is possible to corrupt track interactive objects that have already been placed and linked to the track database. This may cause errors in the operation of these items. Therefore, it is recommended that these interactive objects only be placed after all track laying has been completed.

As Mount Hope is a pioneer branch line with no signaling, the only signals to be added are at Matakana station. Study the track layout for the station and place the signals required. Make sure that they are facing in the "correct" direction. To determine the location of the signal, use provided research material. The first table in the description of the opening of the line shows that there were three different figures for the mileage measured from Sydney. This can also be seen in the two gradient diagrams. Whilst the gradients are the same the mileages varied somewhat. For the purposes of the route we will assume that the mileage to the signal box was 409 miles 10 chains.

Mileposts

There are several ways to measure where to place mileposts. Start measuring from a known reference point, for instance an intersection, a signal or a marker location. For the Tutorial route you can use the signal box at Makatana station. Here are a few examples of how to measure the milepost locations:

- Use the TSRE Ruler object (TSRE>Objects tool, select "TSRE Tools"; in the righthand "Object tool window, select "Other:" dropdown box "TSRE Tools". You can place the ruler in your route and either use the free-draw or point-to-point draw tool (see checkboxes in Properties window on the left). Remove the rulers when ready.
- Use (temporary) track pieces of which you know the length, to build the route and measure the distance between mileposts. Given the fact that track laying may produce slightly different distances in OR compared to reality, some minor adjustments may need to be made to the position of the mileposts.
- Drive a train in Open Rails and use the distance "Travelled" in the extended-HUD (Alt-F5, then cycle with Shift-Alt-F5) . At the distance where you want to place a milepost, note the Lat/Lon coordinates from the Compass ("0") and use these coordinates later in TSRE to place the mileposts. Typically mileposts were inserted on the Down side of the line, ie on the lefthand side when travelling towards Broken Hill.

Running your first train

Once you have track in place, even before completing the route, you can run a train to test and check out what the route looks like. Use TSRE's Debug Path option (*TSRE Menu:>Route>Create Debug Paths*) to create small test paths at each of the extremities of your route. A 'path' lets the Open Rails Train Simulator know where it can place the train and which direction it is facing. Note that every time you use the Debug Path option it will delete all previous paths.

TSRE can only build the debug paths. More complex paths for use in Activities (operational scenarios and game challenges) can be built with the **Track Viewer** application. The Track Viewer application is included in the Open Rails Train Simulator installation. Track Viewer does not destroy

previously defined paths, like TSRE. If you are working with TSRE on an existing route that already has paths that you would like to keep, make sure to back these up before you use the TSRE Debug Path option. The manual for Track Viewer can be found in the Open Rails application and on the Open Rails Website in the Learn > Manual and Tutorials section.

 Note that if track along a path is modified in any fashion, the path may become corrupted and needs to be deleted and recreated.

Where to from here

Now that you have completed the above tasks you have learnt basic route building techniques. You can move on to bigger route building projects and enhance your skills and knowledge.

Explore other free or paid routes to gain new ideas. Review the threads on various topics on train simulator forums (see **References** section). Besides a great source of information these forums are an open and welcoming community of train enthusiasts that are most willing to share their knowledge. A few examples of topics that you can research further after completing this tutorial are:

- Set-up a signalling and speed control system.
- Enhance terrain and scenery, adding rivers and lakes, 'painting' the scenery.
- Build new or enhance existing objects like locomotives, passenger and freight cars, and scenery objects, using 2D and 3D editors.
- Build an operating container terminal, turntable or transfer-table.
- Run train missions in activity mode.
- Develop your own train operation scenarios and create activities for your route.
- Learn realistic train operations like braking physics and controlling the temperature and pressure on steam engines.
- Operate trains in the Open Rails Multiplayer mode

- Share your findings, knowledge and creations with the Open Rails community.

References

- TSRE Route Editing Tips and Tricks
- Open Rails Community Links to many forums supporting Open Rails.
- Steam4me Tutorials created for Microsoft Train Simulator; most of the information is applicable to Open Rails.
- Geographical information useful for TSRE terraforming can be obtained from for example:
  - Open Street Map, Google Maps, Google Earth
  - GPS Visualizer Creates and export GPS tracks and markers.
  - ViewfinderPanoramas or NASA Eartdata DEM height map data download (NASA requires a free login account).
- Rail Serve Huge collection of links to railway hobby, industry and travel websites.
- Shape Viewer - Display's selected objects and related texture files (***C:/TSRE/Shape Viewer.bat***).
- Track Viewer - Display's and overview of the route, shows missing track pieces and is used to create complex Path's (***<your Open Rails program folder>/Contrib.TrackViewer.exe***).
- Route Riter is a versatile tool that has many utilities related to route file management. It was originally developed for MSTS and many functions can be used for Open Rails. A few examples of Route Riter functions are:
  - copy objects into a new route and place all related files in the right directory while

- check and optionally repair a routes and rolling stock for missing files
- edit configuration files in a user friendly format
- covert file-types, for instance .ACE to .BMP
-
- compress a route and prepare it for distribution