SOFTWRIGHT LLC

TAP 6 Demo Quick Tour

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1. Example Path Profile

Objective: Add basic facility information to the Fixed Facility database and draw a path profile.

Procedure: Draw a path profile between the sites:

Transmitter at:
Training Centennial Site
39 33 09 N latitude
104 44 51 W longitude
(WGS84 coordinates)
455MHz
Antenna center 50 ft Above Ground Level

Receiver at:
Training Aurora Site
39 43 42 N latitude
104 57 18 W longitude
(WGS84 coordinates)
455MHz
Antenna Center 30 ft Above Ground Level

Note that all values and settings discussed in this article are for illustration purposes only. It is important for you to determine the particular settings and values applicable to your equipment and application when using TAP.

1. From the TAP6 menu, click the Path button:
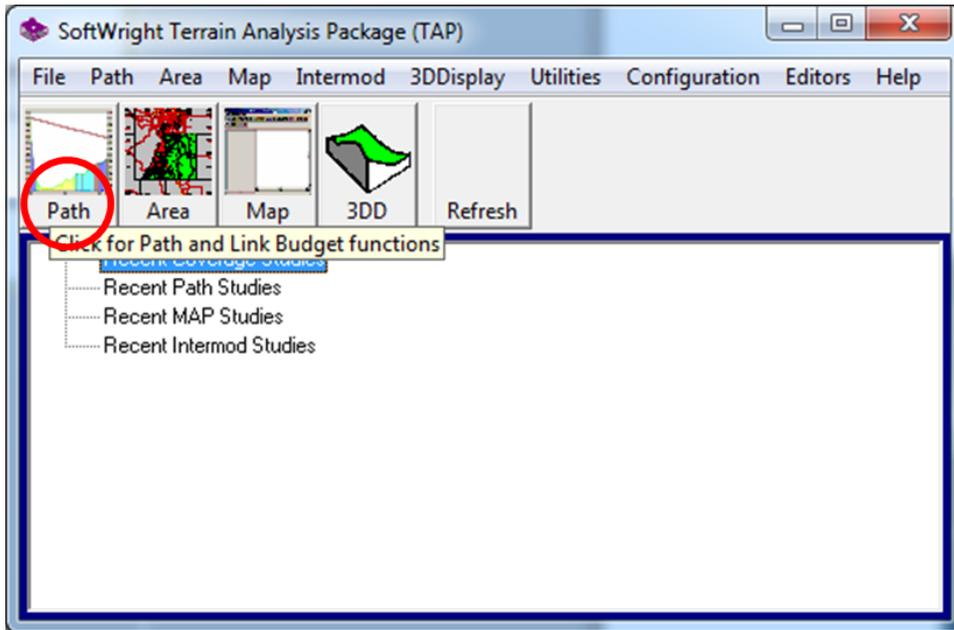

2. The HDPath form is displayed:
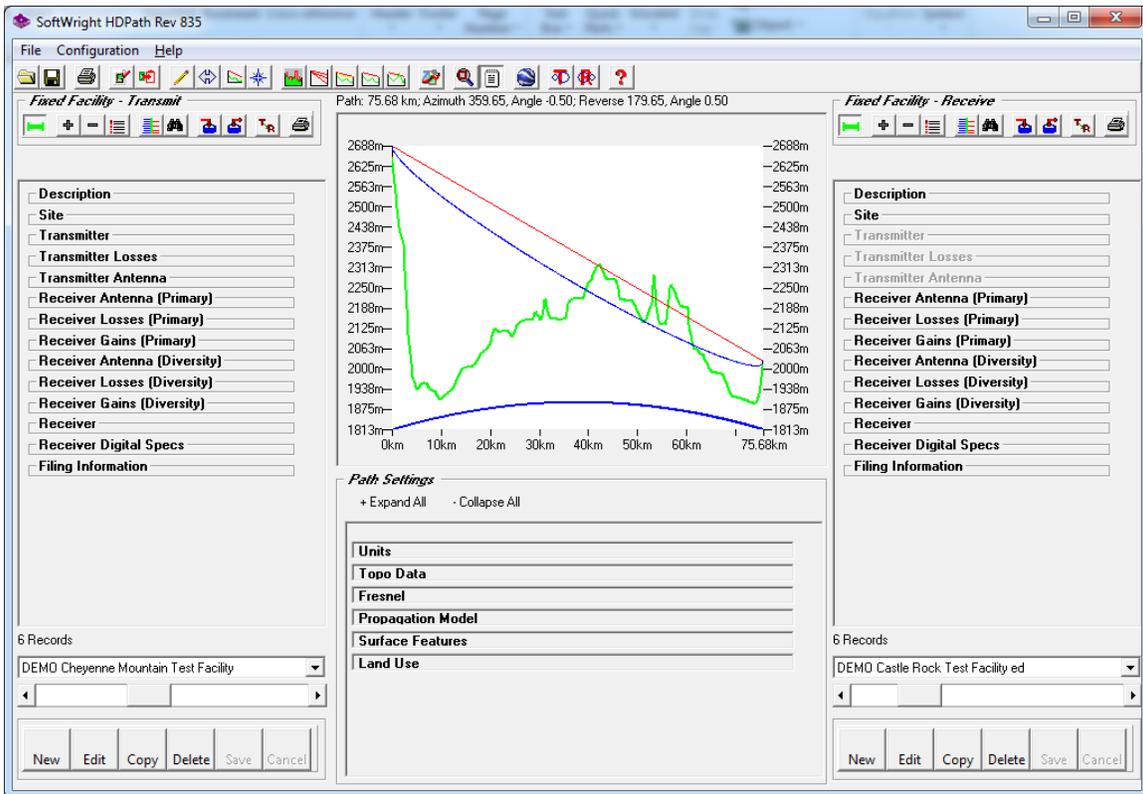
3. Note the four basic areas of the form:

- The Fixed Facility for the transmitting site is shown on the left side of the form.

- The Fixed Facility for the receiving site is shown on the right side of the form.

- The parameters for the path profile are shown in the lower half of the center of the form.

- The path profile graphic is shown in the upper half of the center of the form.

4. (Depending on the configuration of your TAP software, a default path may be shown when the form is loaded, or a blank graphic. If a default path is shown, just ignore the graphic and follow the steps listed below.)

5. To add a new facility to the Fixed Facility database, click the New button at the bottom of the Fixed Facility interface on the left (Transmit) side of the HDPath form:
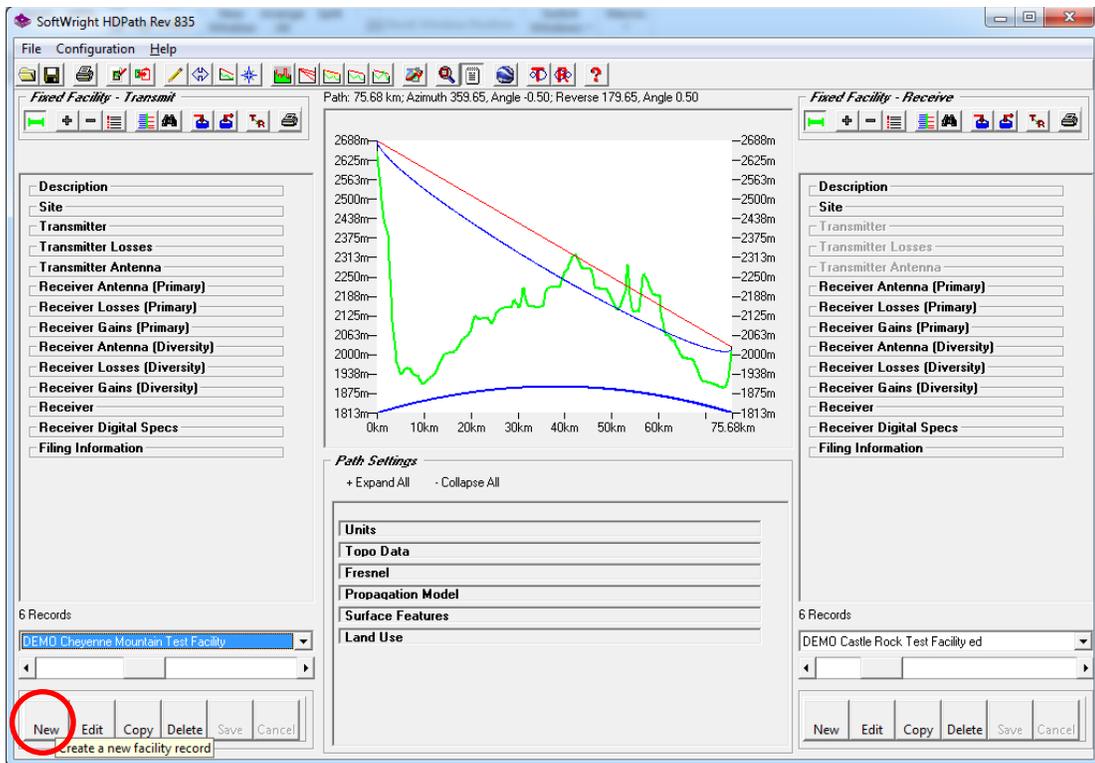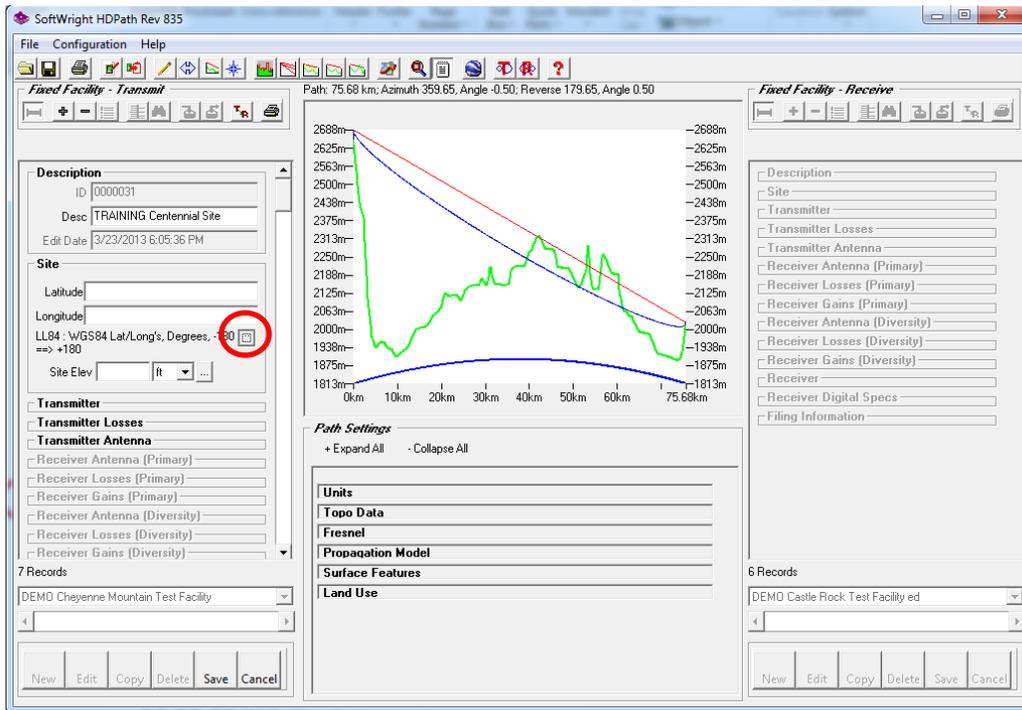

6. (Both the Transmitter and the Receiver side of the HDPath form are connected to the same database. We are just using the Transmitter side to avoid confusion.)

7. When the New button is clicked, a record is created. Notice that the other Fixed Facility interface (the Receiver side of the form) is dimmed out. You can only edit one record at a time in the database.

8. If the Description section of the form is not expanded, click the "Description" heading so you can view the contents of that section.
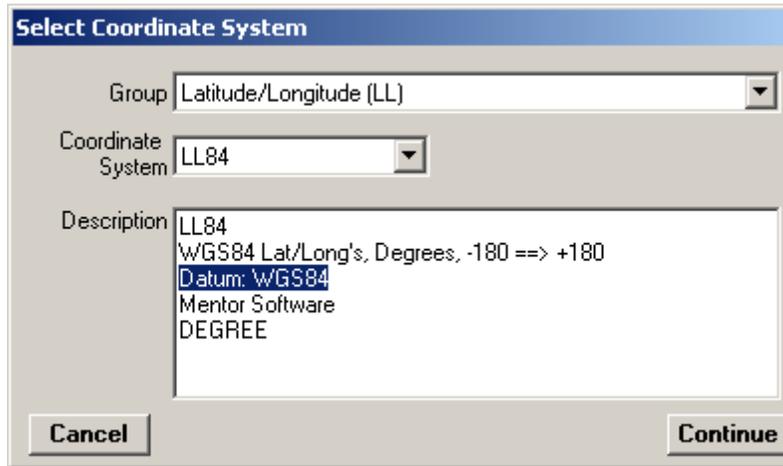
9. An ID or index key is created automatically for the record. Enter the description for the site, such as "TRAINING Centennial Site"
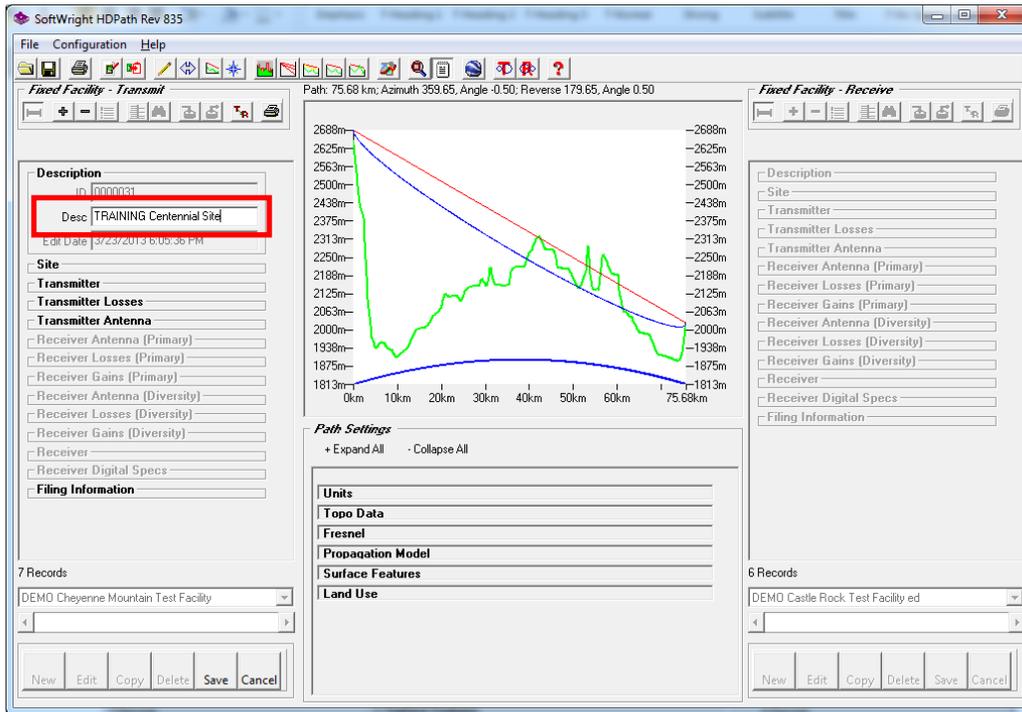
10. If necessary, click the Site section so you can view the contents of that section. Since the coordinates we have are WGS84, and that is the default datum, it is not necessary to change the setting. For other coordinate systems you could click the Coordinate System lookup button ("…") to select a different system:
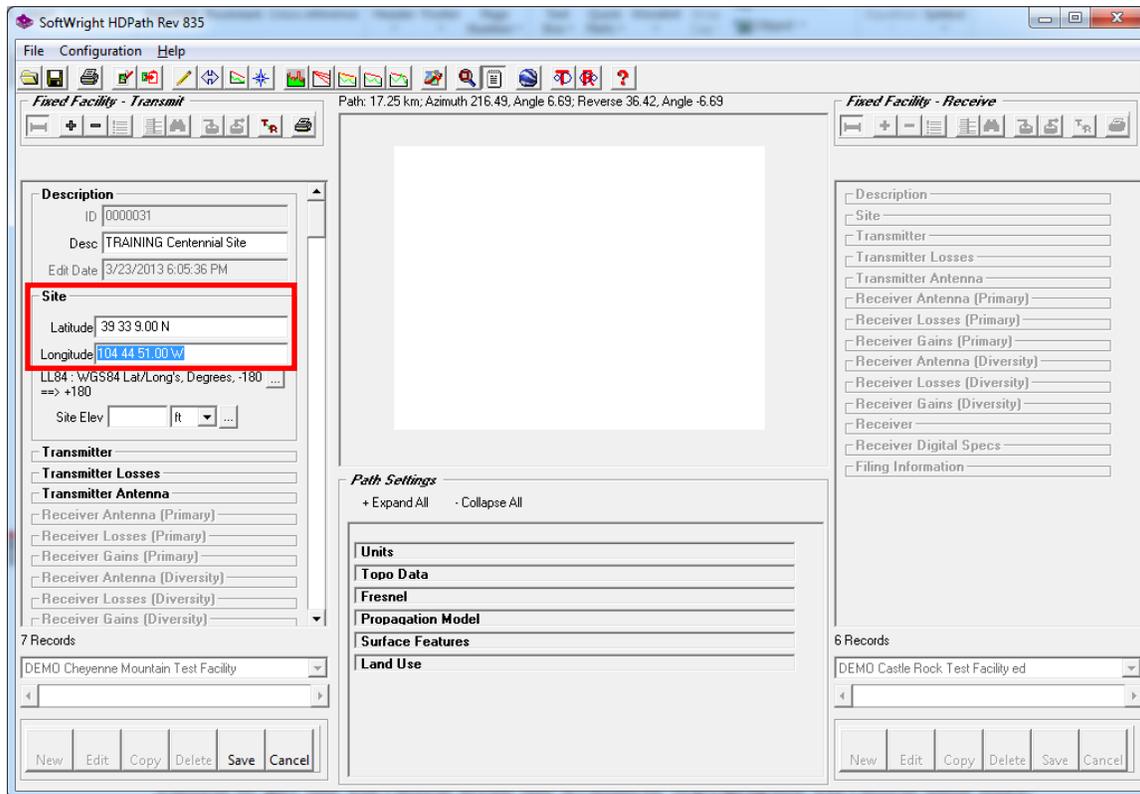
11. The Coordinate System selection form is shown below:

Select Coordinate System

Group | Latitude/Longitude (LL)

Coordinate System | LL84

Description |
LL84
WGS84 Lat/Long's, Degrees, -180 ==> +180
Datum: WGS84
Mentor Software
DEGREE

Cancel   Continue

12. Enter the coordinates of the Centennial site:
    39 33 09 N latitude
    104 44 51 W longitude

13. When the coordinates are entered, you can click the Site Elevation lookup ("…") button to get the elevation from the available topographic elevation data files:
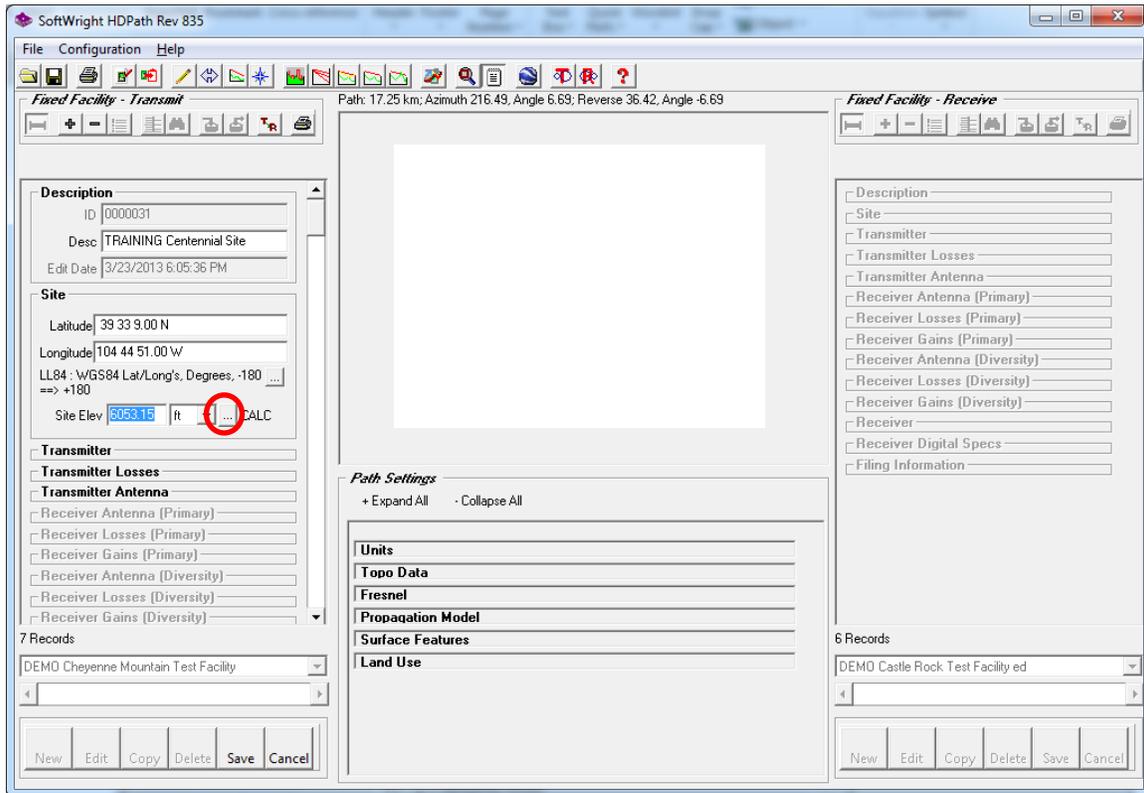
14. Next to the Site Elevation Lookup button, you will see "CALC," indicating that the elevation was calculated from available topographical data. If you have a known elevation for the site from a map, survey, or other source, you can enter the value manually. It would then say "SPEC" next to the button.

15. In the Transmitter section, enter the frequency (455MHz):
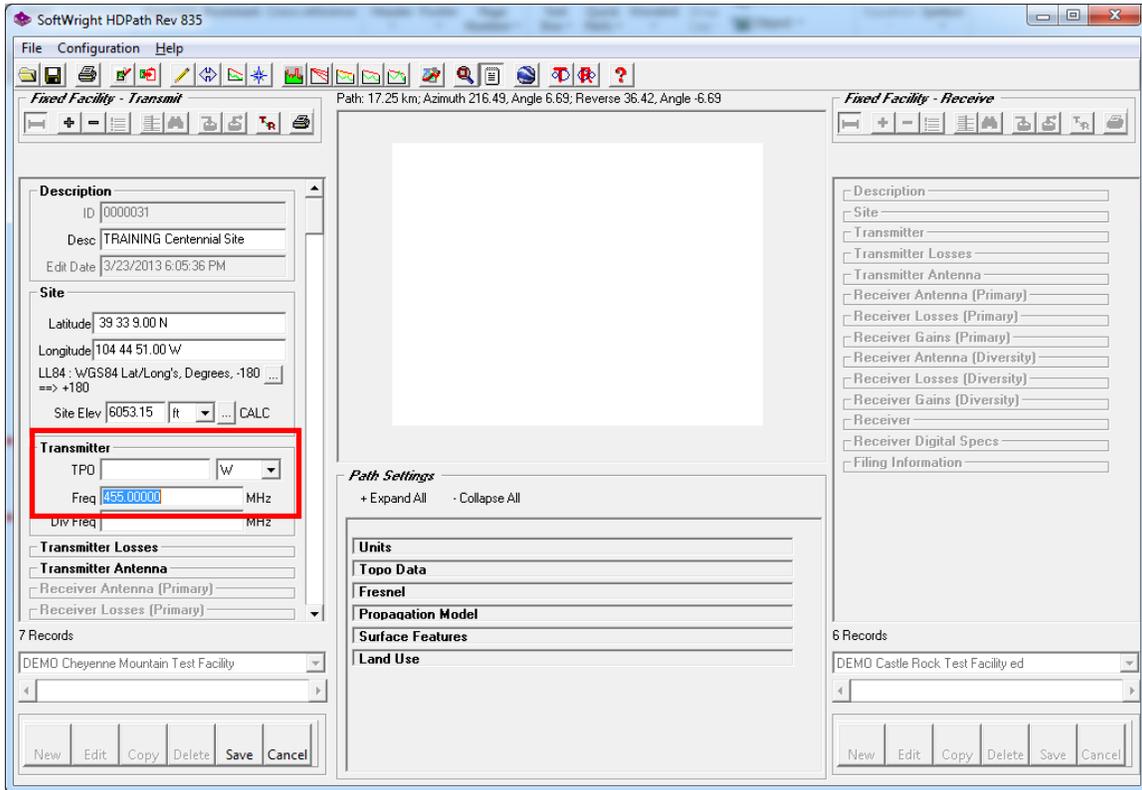
16. The frequency value is needed when a profile is drawn if we want to see the Fresnel zone clearance along the path. (Additional information will be added later.)

17. In the Transmitter Antenna section, enter the antenna height above ground level (50 ft AGL). Note that you now have multiple sections open. You may wish to collapse the Description, Site, and Transmitter sections, since you are done entering information into these, for now. You can expand/collapse each section by clicking on the section title.
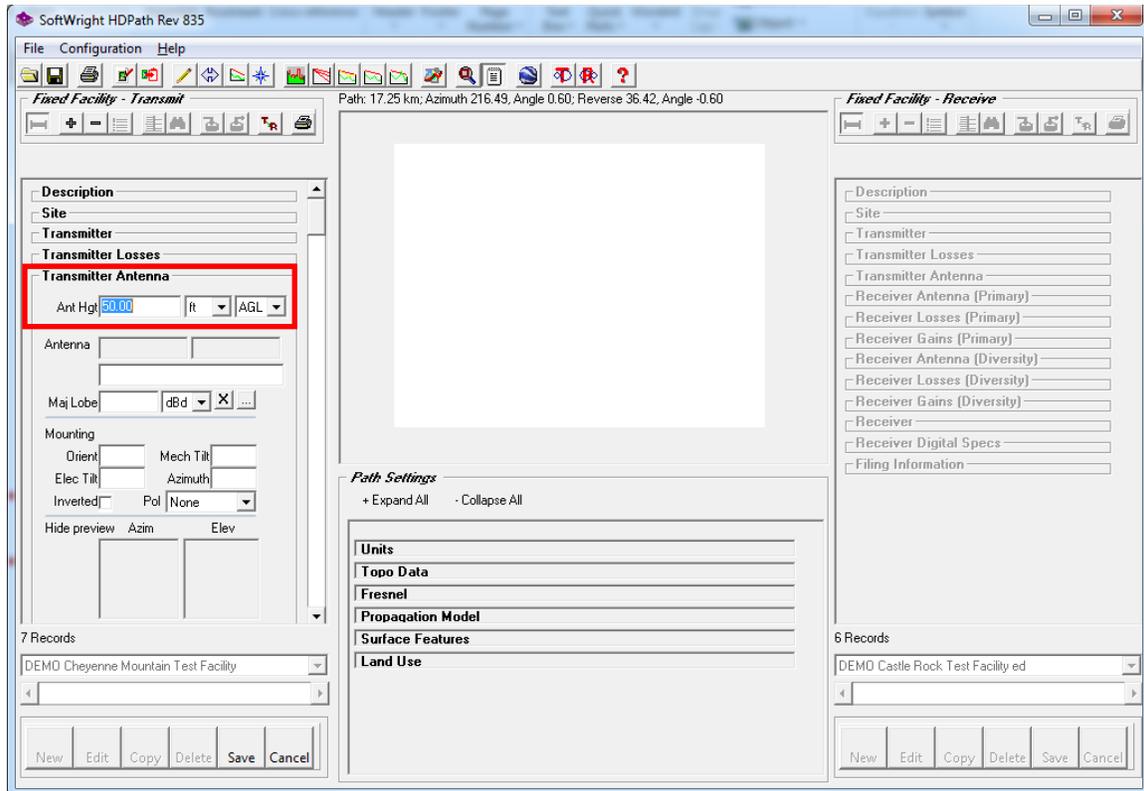
18. At the bottom of the Fixed Facility interface, click the Save button to write the new record to the database. (The Cancel button is used to abandon the changes made to the record.) If you just entered a value in a box, be sure to click in another box prior to saving. This will ensure that the value is saved.
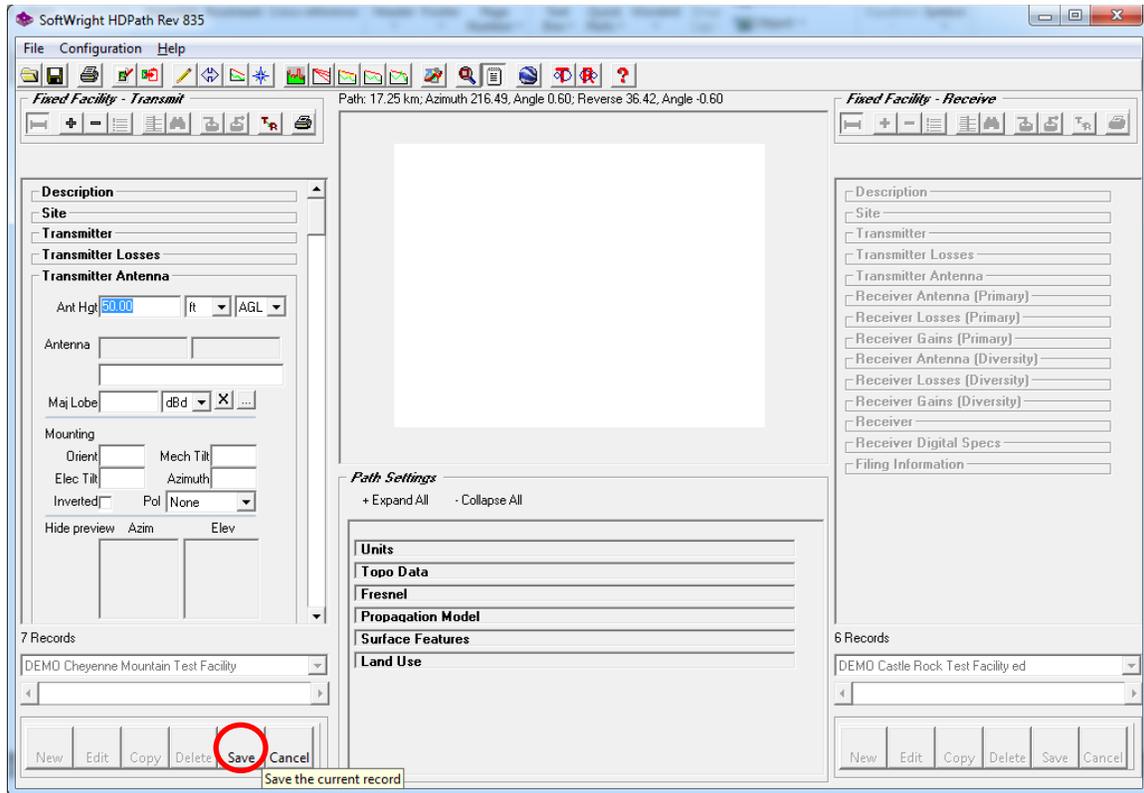
19. On the Receiver side of the form, click the New button to create a new record:
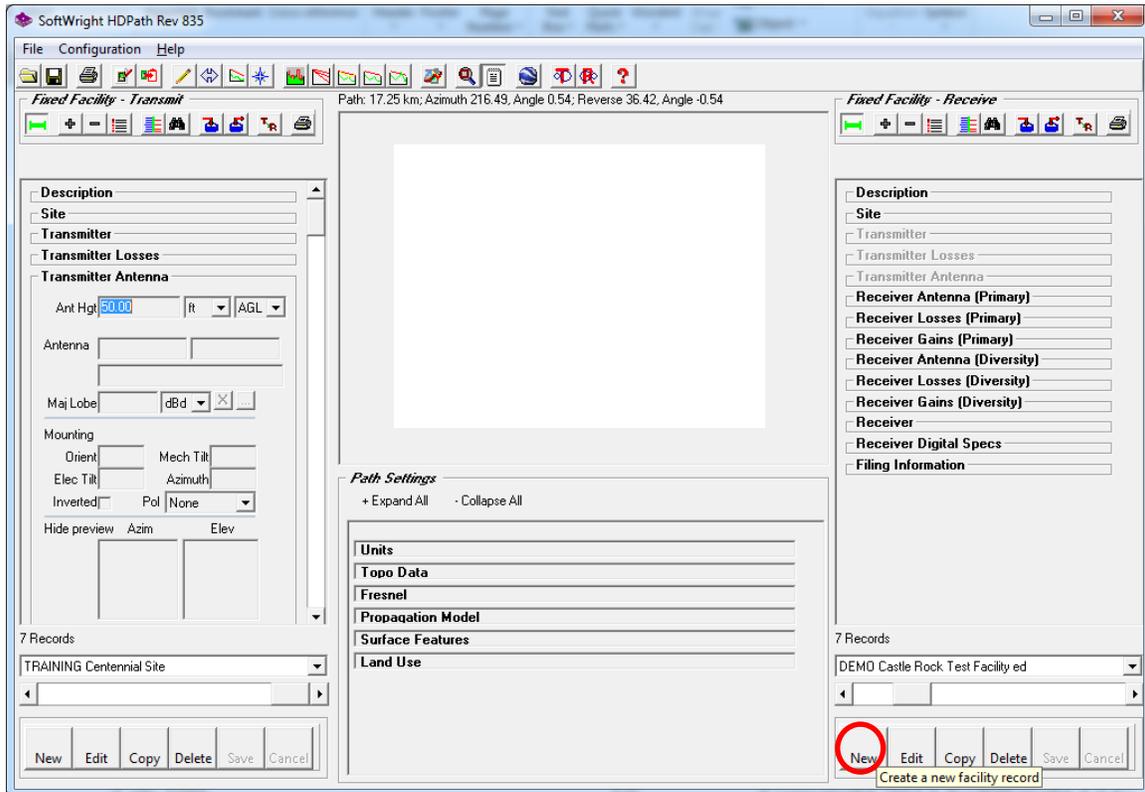
20. Enter the parameters for the other site:

Desc:	Training Aurora Site
Latitude:	39 43 42 N
Longitude:	104 57 18W
Datum:	(WGS84 coordinates)
Receiver Frequency:	455MHz
Receiver (Primary) Antenna:	30 ft Above Ground Level
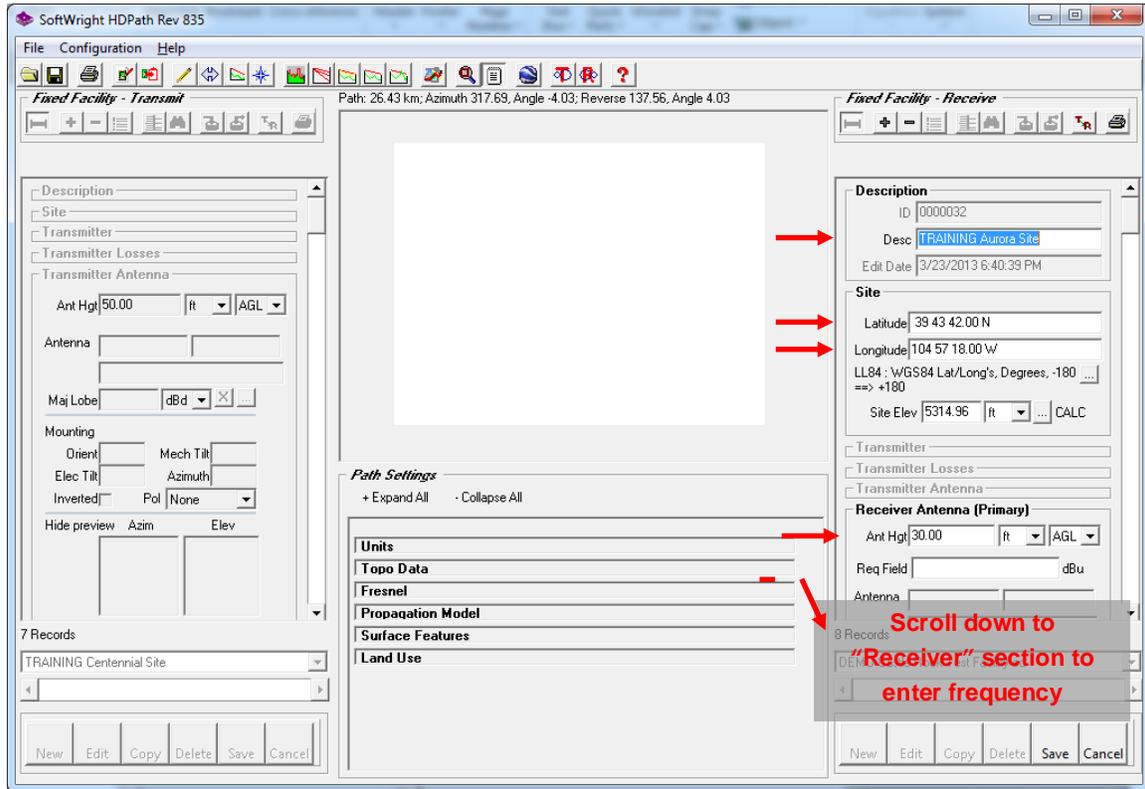
21. Click the Save button to save the new record:
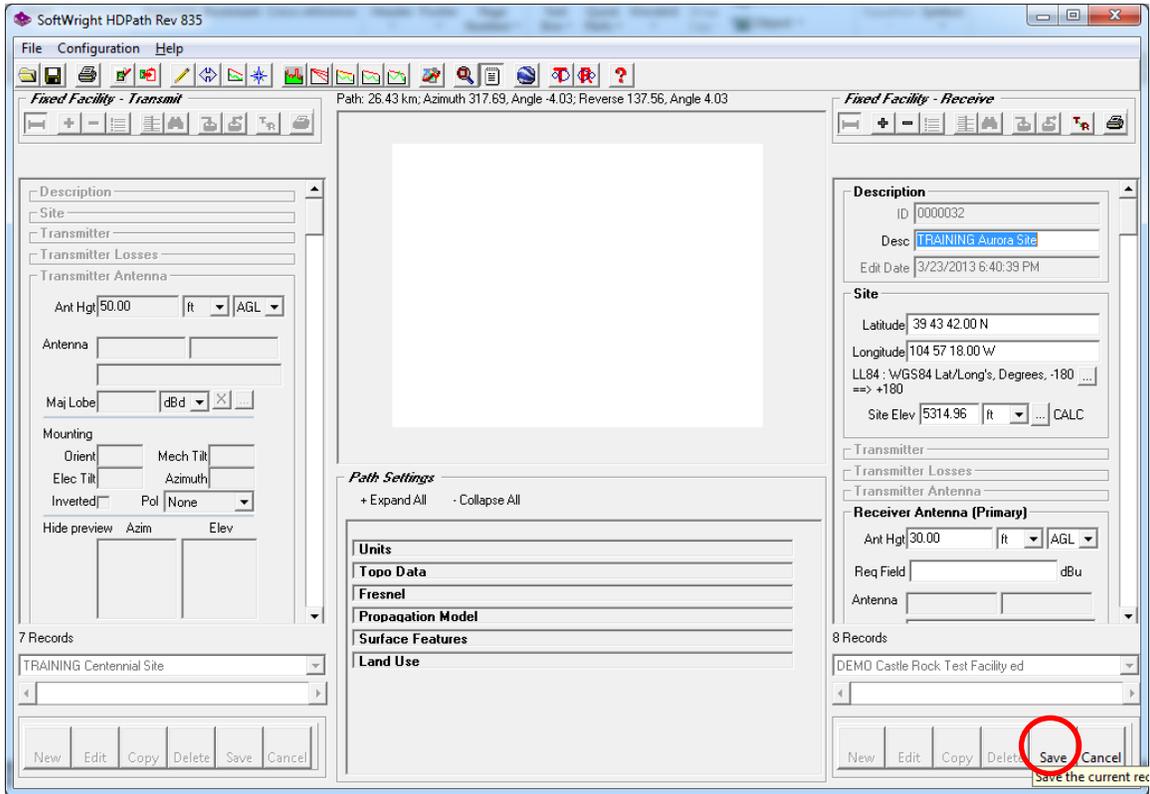
22. Click the Draw button (the small pencil icon on the toolbar at the top of the HDPath form) to draw the profile:
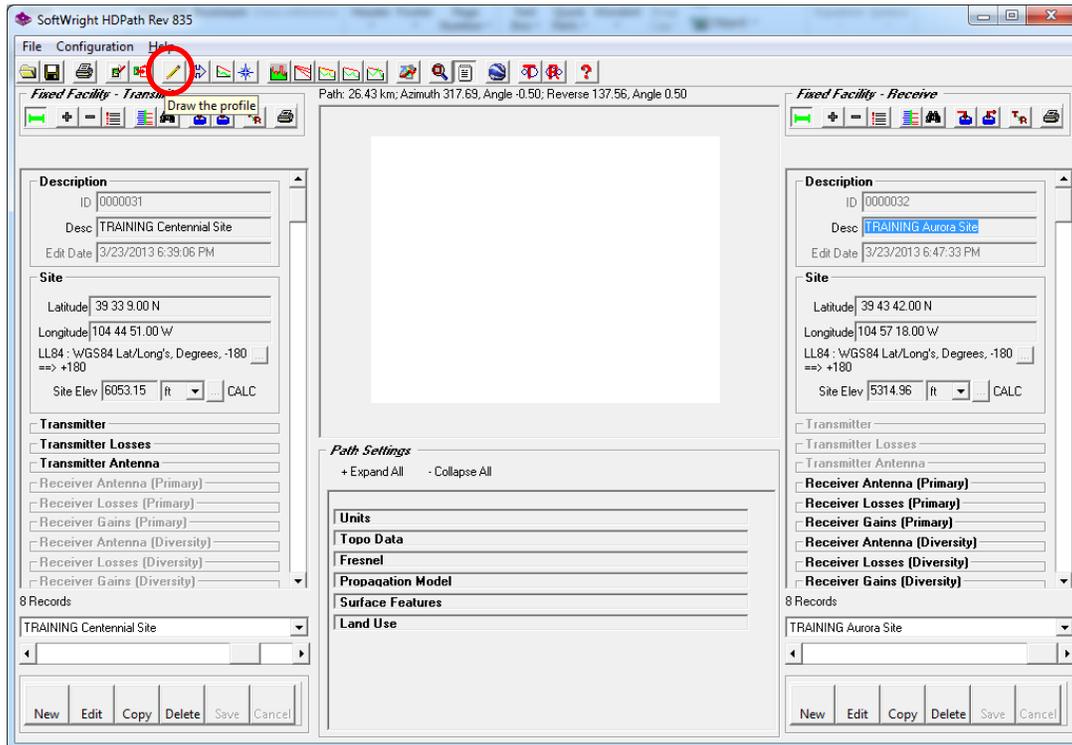
23. The path profile is drawn, and when you move the mouse over the graphic, the location of the mouse on the path is shown in the "Mouse Location on Path" form:
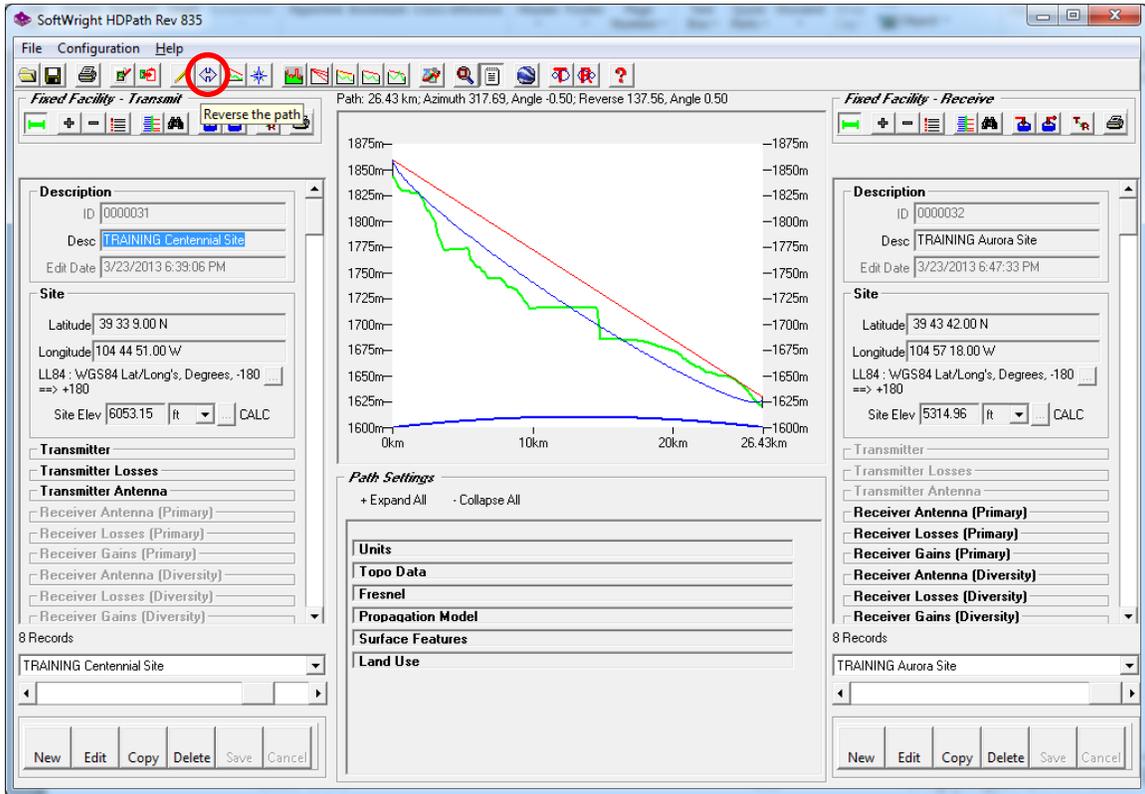

24. Click the Zoom button on the top toolbar.

25. When you click that button you will be prompted to draw a box (mouse down for one corner, drag to the opposite corner) to zoom into the profile:
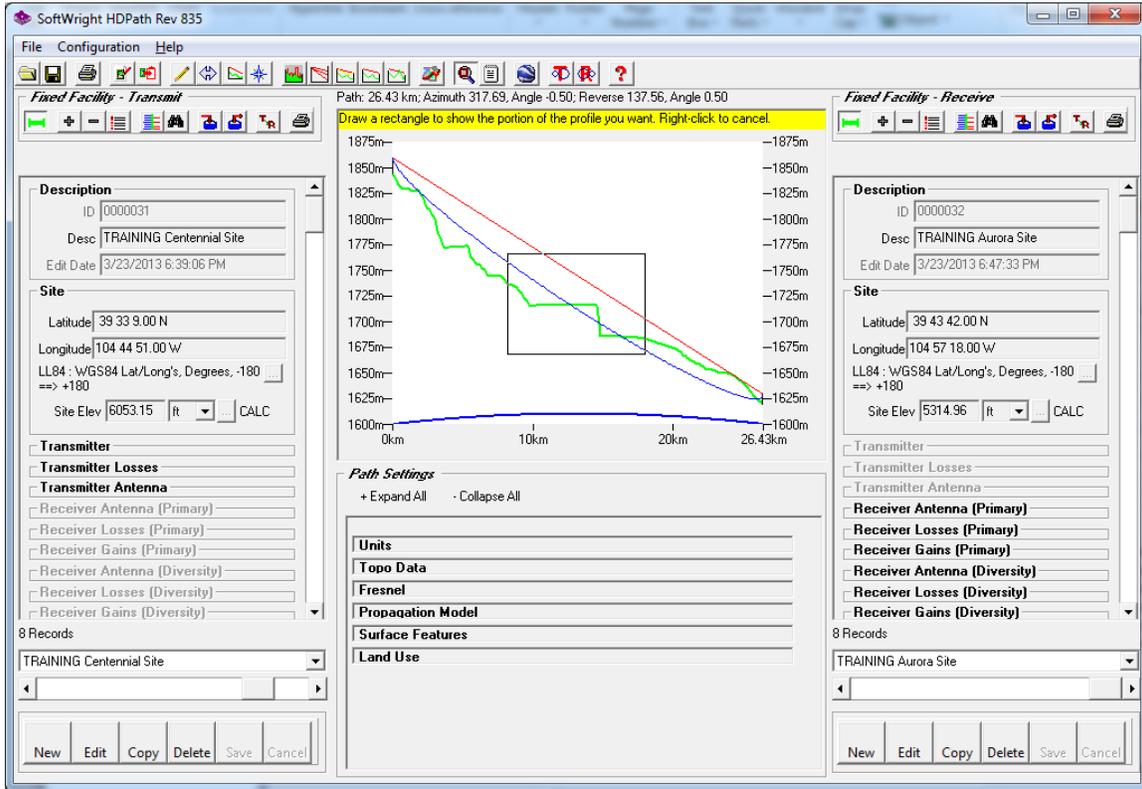
26. You can Right-Click to cancel the zoom out and restore the original scale.
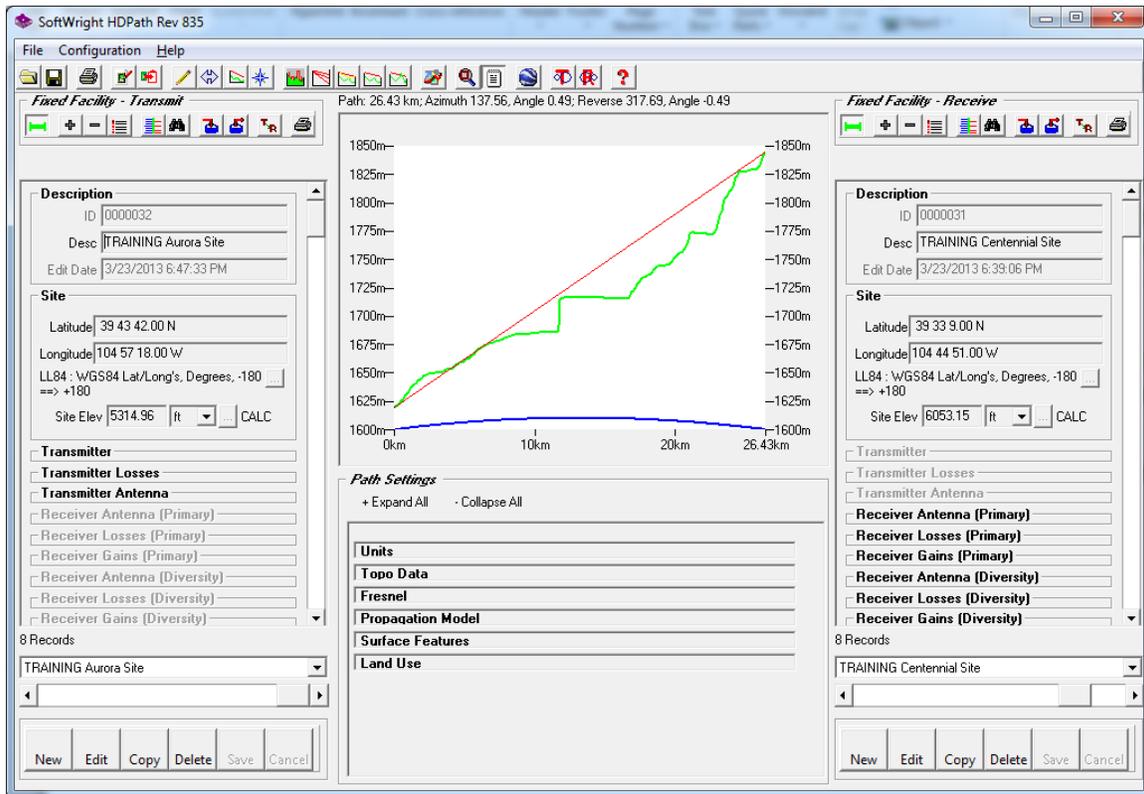
27. To see the reverse path, click the Reverse Path button:

28. The path is drawn from the Aurora Site to the Centennial site.

29. Note that the Fixed Facility records have separate data values for the Transmitter Antenna height and the Receiver Antenna height. Since we have not yet entered a value for the Transmit Antenna height at the Aurora site or for the Receive Antenna height at the Centennial site, the path profile is drawn with heights of zero at each end.

30. Also, since no transmitter frequency was entered for the Aurora site (only the receiver frequency), no Fresnel zone is shown for this path. The transmitter frequency is used to determine the Fresnel zone on the profile.

31. Click the Reverse Path button again to restore the Centennial to Aurora path profile.

32. In the Path Settings section of the form (below the profile graphic) click the Topo Data header to expand that section:

33. Enter a different earth curvature value, 0.667, ("2/3 earth"). Click the Draw button to redraw the profile with the new setting:

34. You can see that the earth curvature reference line at the bottom of the graphic shows the increased effect of the new value.

35. You can also see that more of the Fresnel zone is obstructed with this value of effective earth curvature. Different values of earth curvature are used to represent different values of atmospheric conditions and the resultant refraction effects.

2. Calculate Path Profile Field Strength

Objective: Compute RF field strength values on a path profile.

Procedure: Add transmitter information to the Fixed Facility database record for the TRAINING Centennial site created in Lab 100 and compute field strength at the receiver location on the path as well as at points along the path.

The additional necessary transmitter information includes:

| Transmitter Power Output (TPO)	10 Watts
Losses:	0.5dB Connector Loss
Transmission Line Type:	Andrew LDF2-50 3/8" Foam
Transmission Line Length:	65 feet
Antenna Library File:	Celwave Base Station VHF-UHF
Antenna Description:	ALR10-A PENETRATOR FOR UHF WIDEBAND APPLICATIONS

Note that all values and settings discussed in this article are for illustration purposes only. It is important for you to determine the particular settings and values applicable to your equipment and application when using TAP.

1. In HDPath, select the sites to view the profile between the Centennial site and the Aurora site (created in Lab 100):
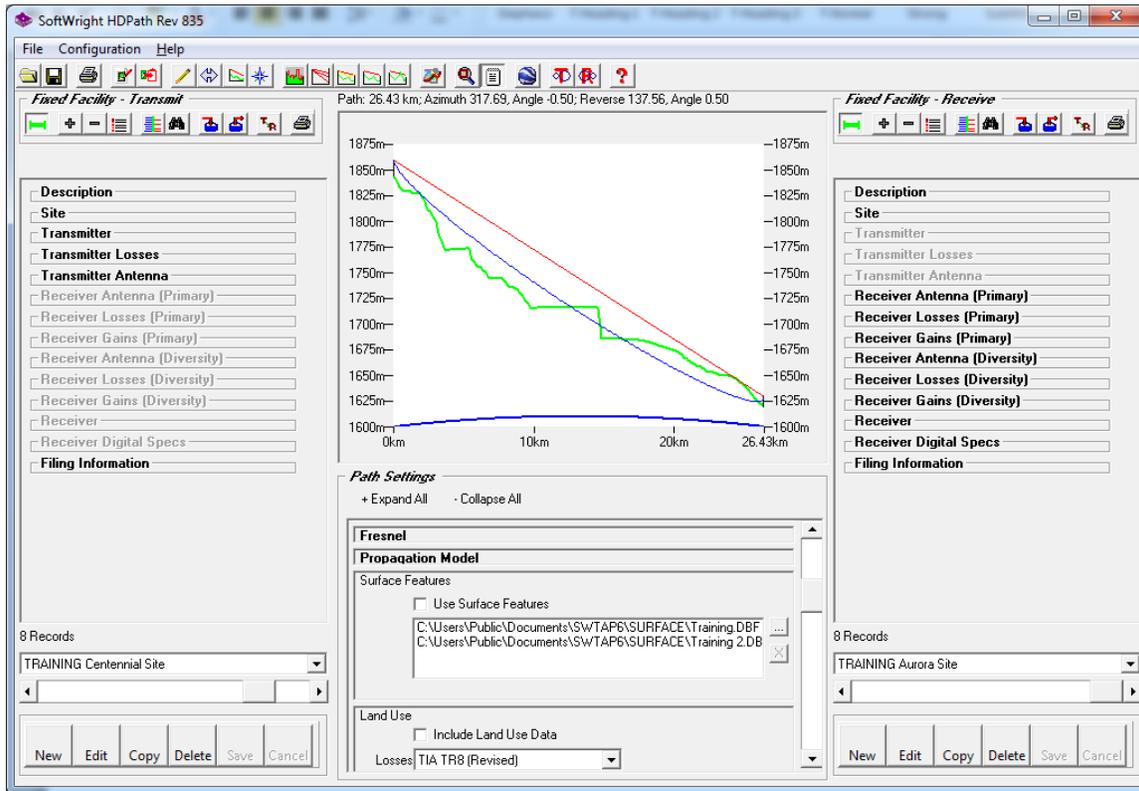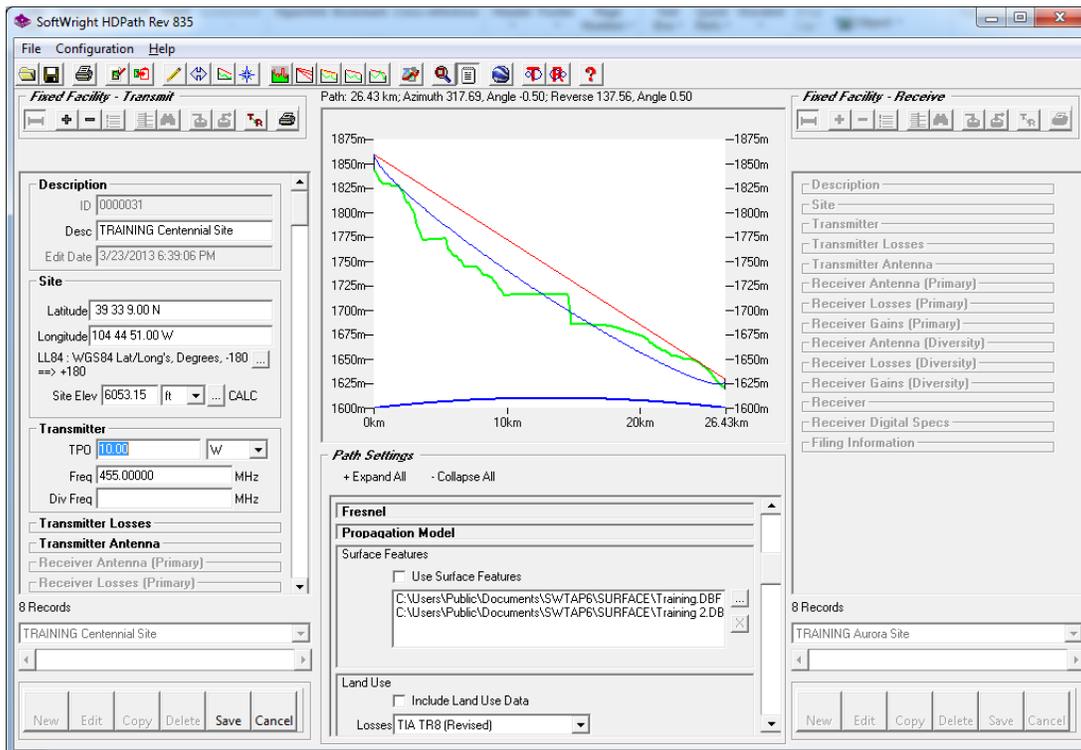

For the start of this example, be sure the "Use Surface Features" box and the "Include Land Use Data" box are not checked.
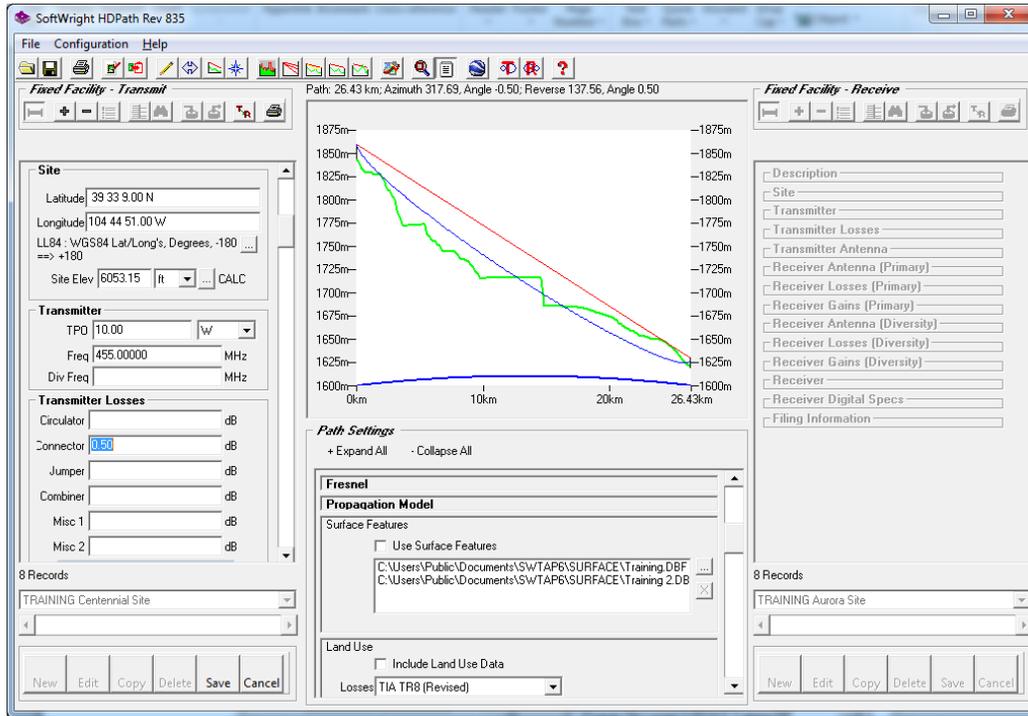
2. To add more information to the Centennial transmitter site, be sure that is the site on the Transmit side of the HDPath form and click Edit:
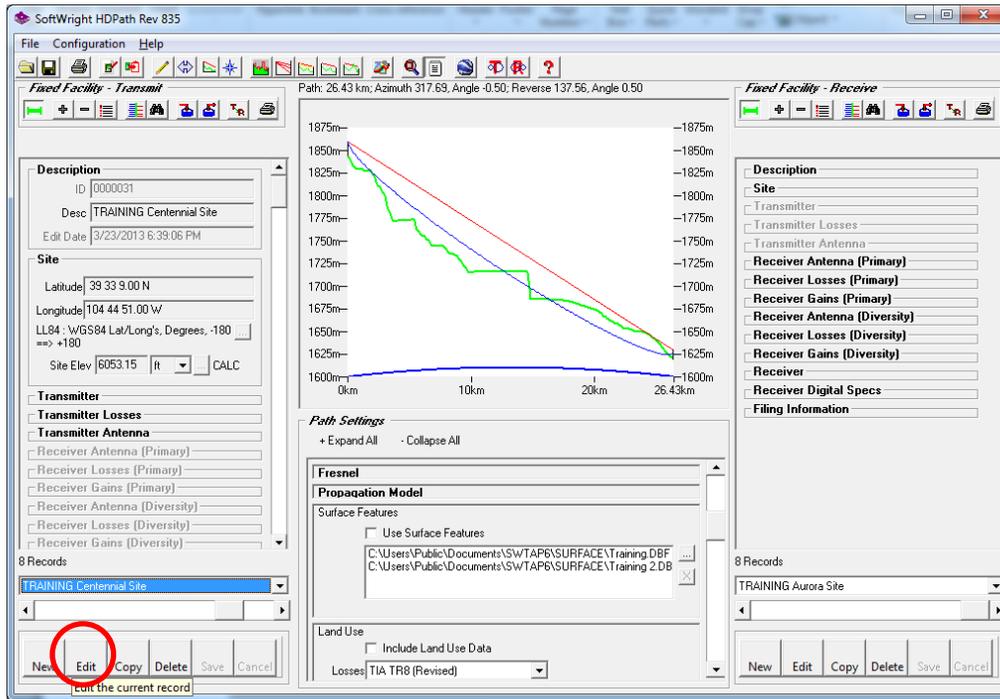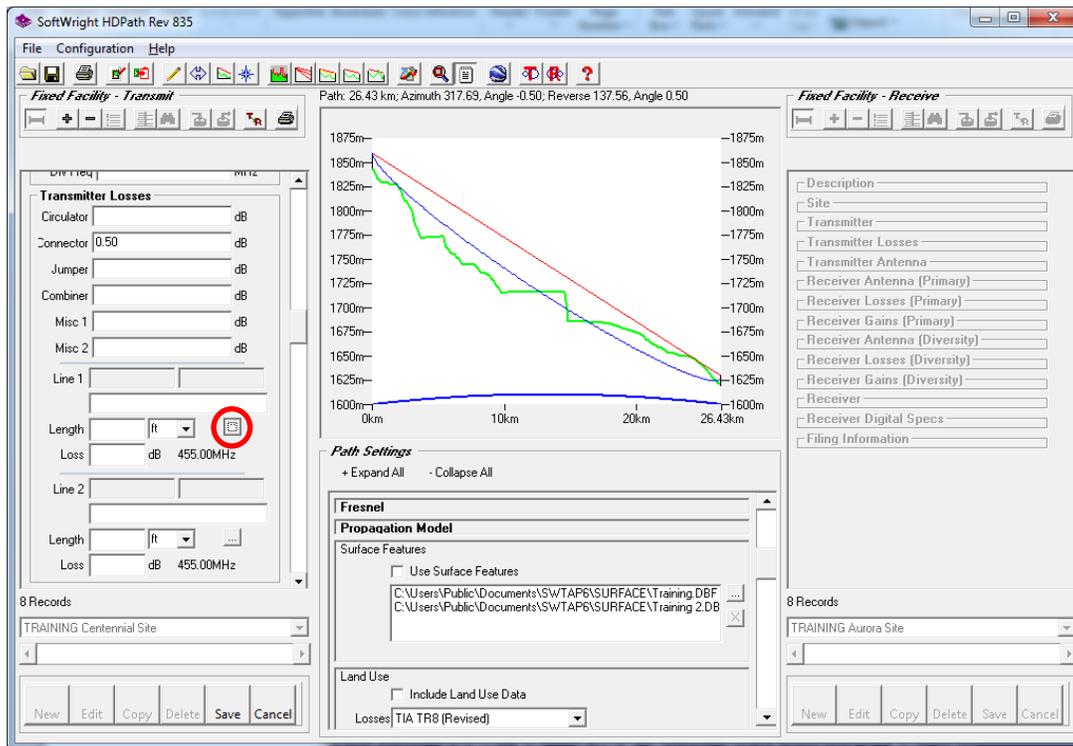

3. In the Transmitter section of the facility, set the units to W (Watts) and enter the TPO of 10 Watts:

4. In the Transmitter Losses section, enter 0.5dB for connector losses in the system.


5. In the Transmitter Losses section under Line 1, click the lookup ("…") button to select the transmission line you want to use:

(Note you can also enter an estimated line loss directly. The lookup function is used to select a particular transmission line type and length to compute the loss value.)

6. Scroll down the list to find the Andrew LDF2-50 3/8" Foam line. Click the line to highlight it:
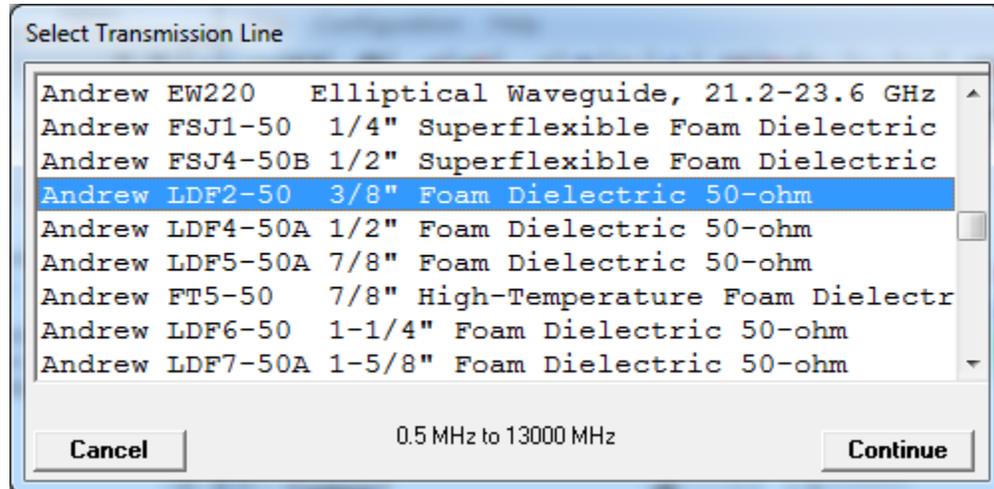

Click the Continue button to select the line type you have highlighted.

The TAP installation includes sample transmission line files. You should verify the current manufacturer's specifications for your application.

7. Enter the length of the transmission line (65 feet for this example):
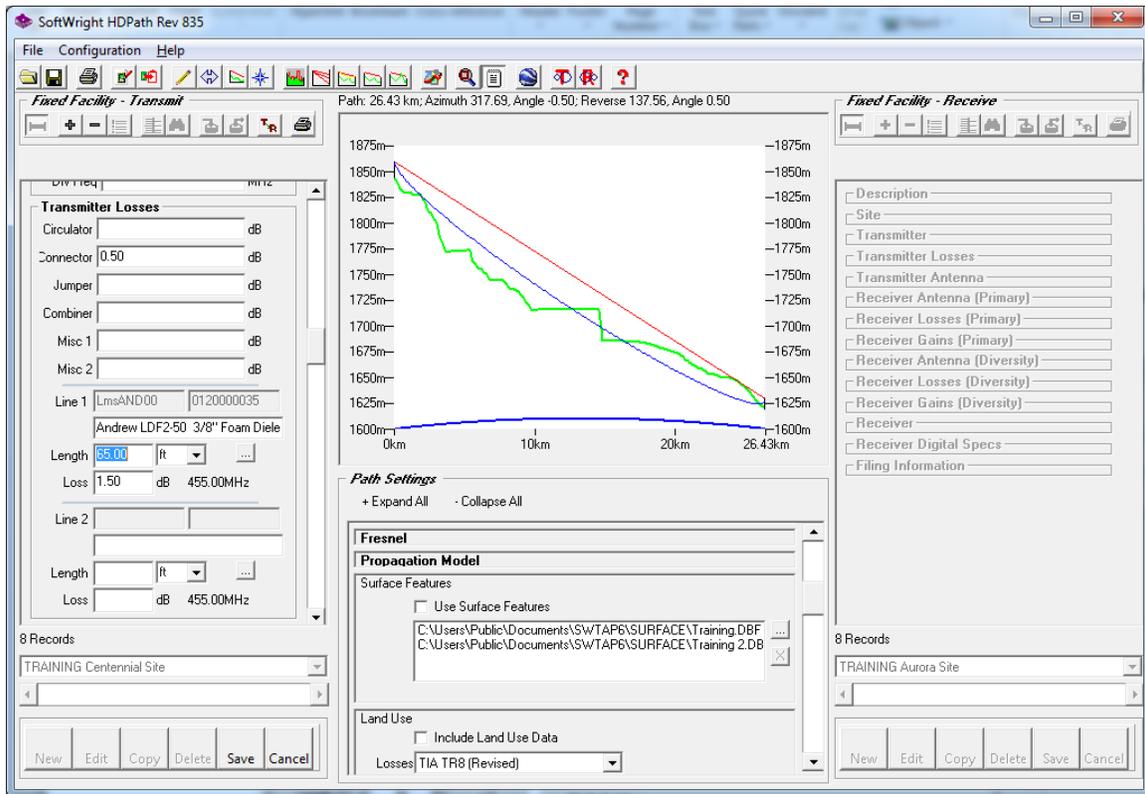
8. When you move the mouse cursor out of the box for the line length, the loss value is computed:
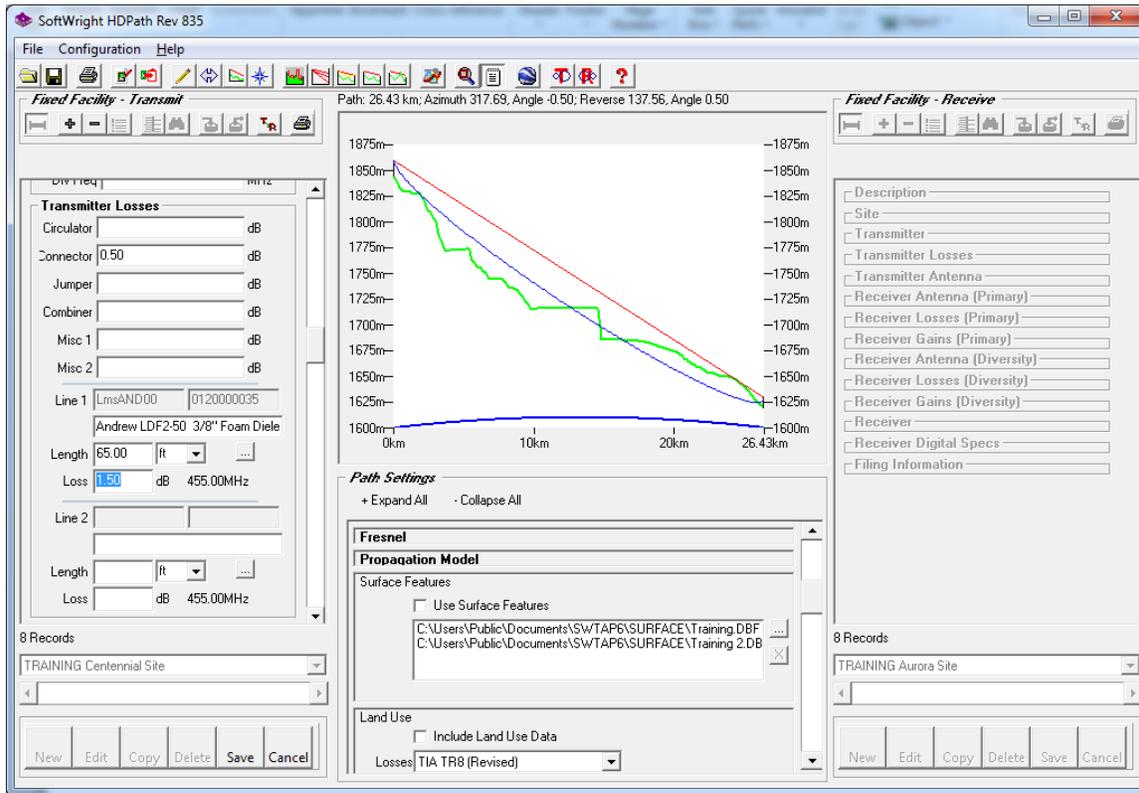
If you want to enter a loss value manually, this is the box where you would type it. Note that when you enter a value, the line type information is removed to avoid confusion with computed values.

9. In the Transmitter Antenna section, click the lookup ("…") button to select the antenna you want to use.
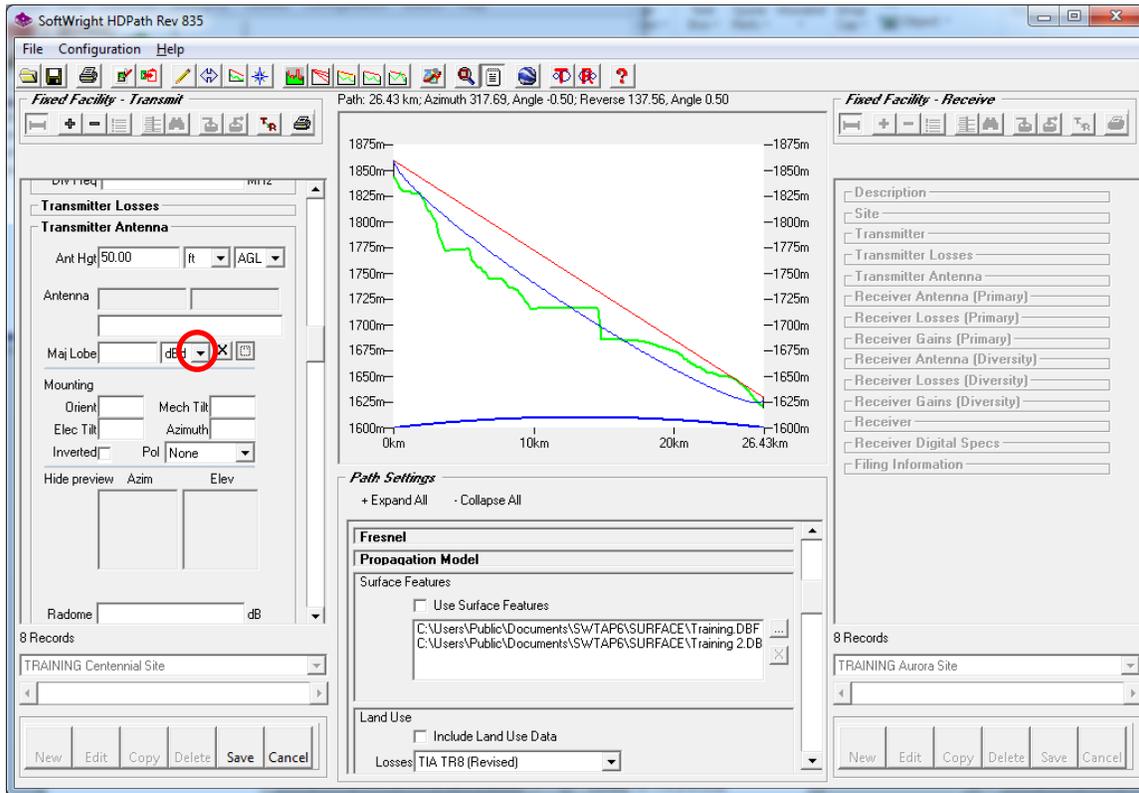

If you do not know the specific antenna you want to use, you can enter a gain value directly in the "Maj Lobe" box in this section. A manually entered value will assume an isotropic omnidirectional antenna with equal gain in all directions. If you want to use a directional pattern (including the vertical plane pattern for an omni-directional antenna), you must use the antenna lookup function.

The TAP installation includes several sample antenna library files. You should verify the current manufacturer's specifications for your application. You can also add or modify antenna library patterns as described in other FAQs.

10. Select the antenna library from the list displayed (Celwave Base Station VHF-UHF):
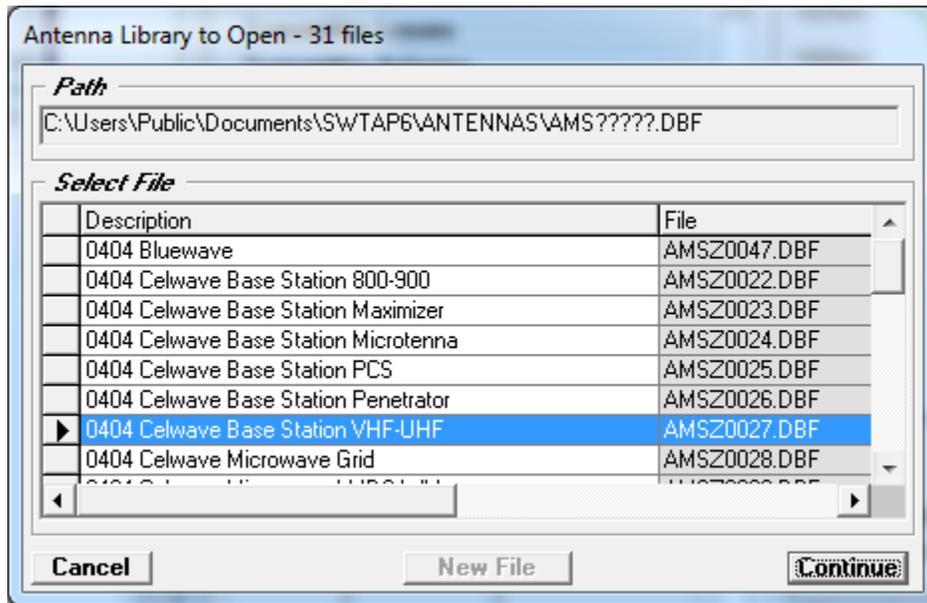
11. The antenna library will be displayed. Select the desired antenna from the list (ALR10-A PENETRATOR FOR UHF WIDEBAND APPLICATIONS). Click the selection button at the left end of the row line to highlight it:
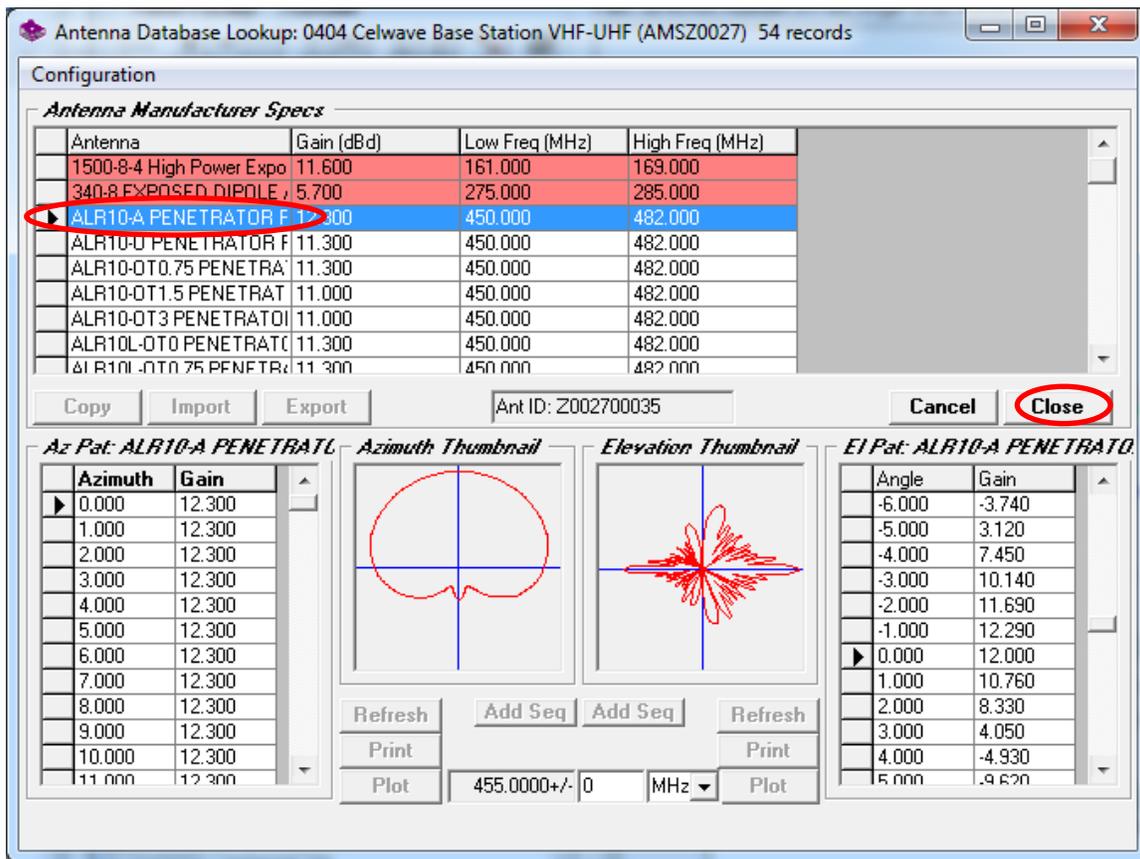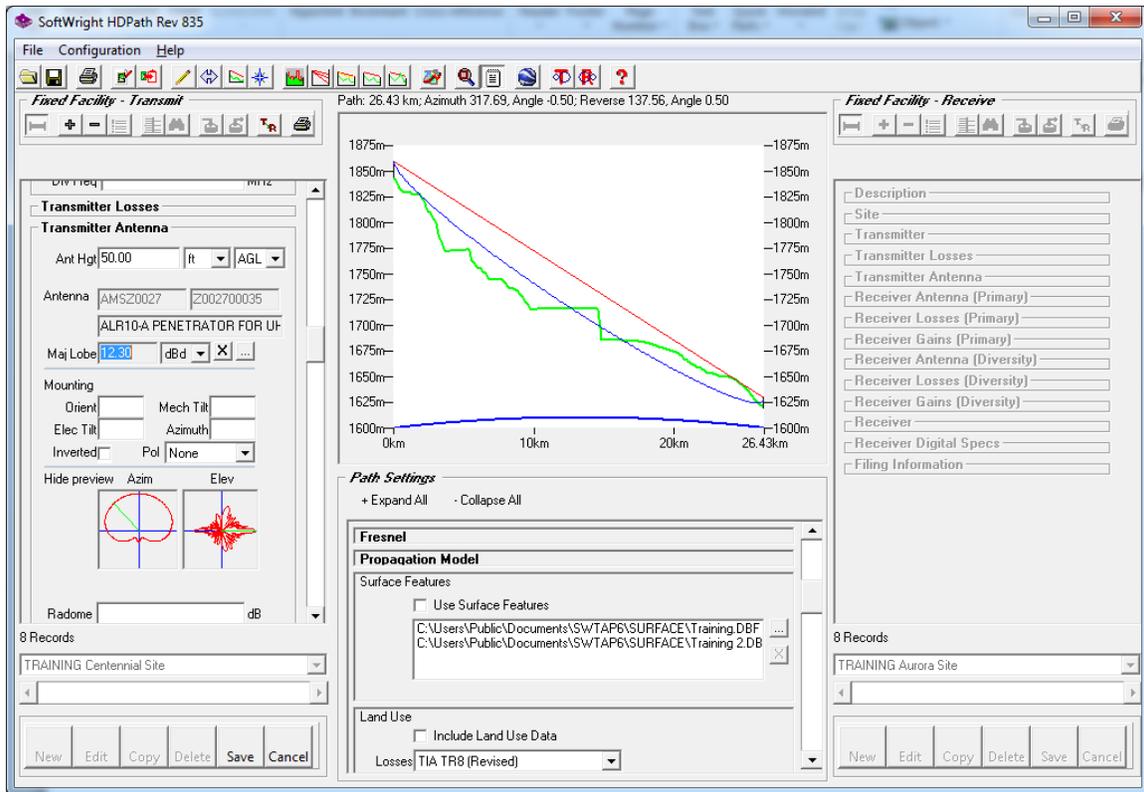

Click the Close button (near the middle on the right side of the form) to select this antenna.

12. The antenna gain information and a thumbnail of the directional pattern information are displayed for the Fixed Facility:
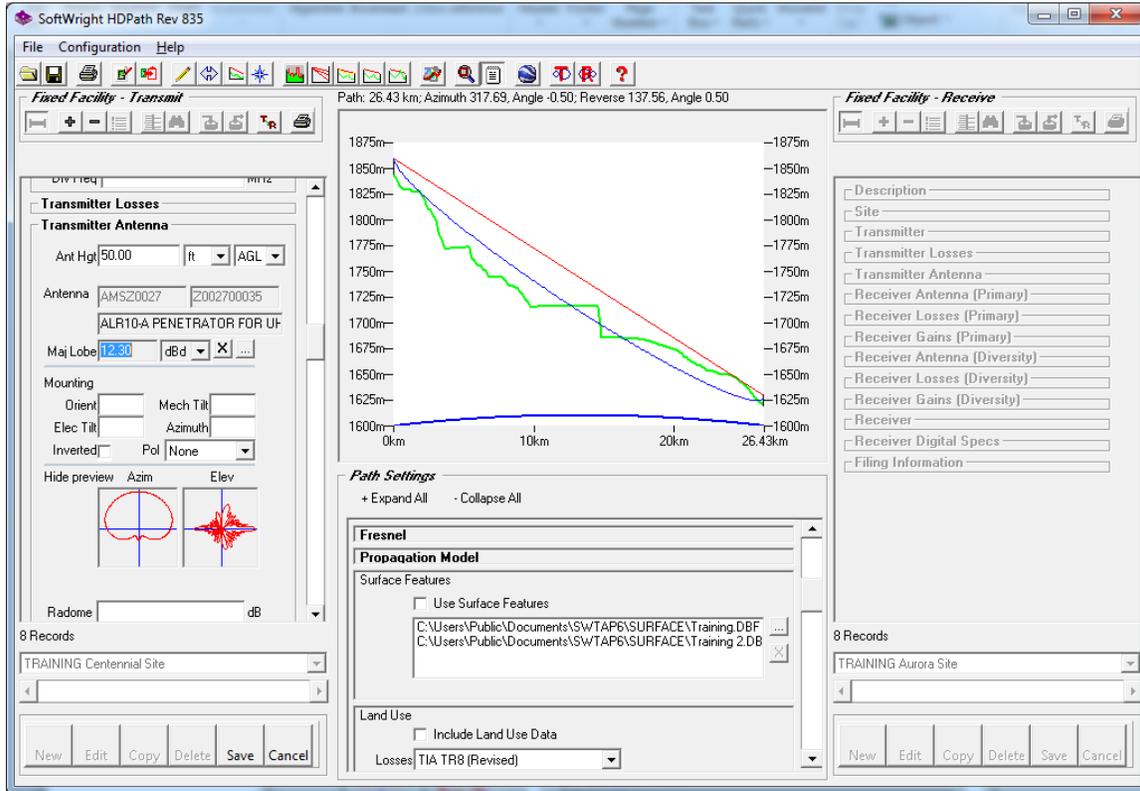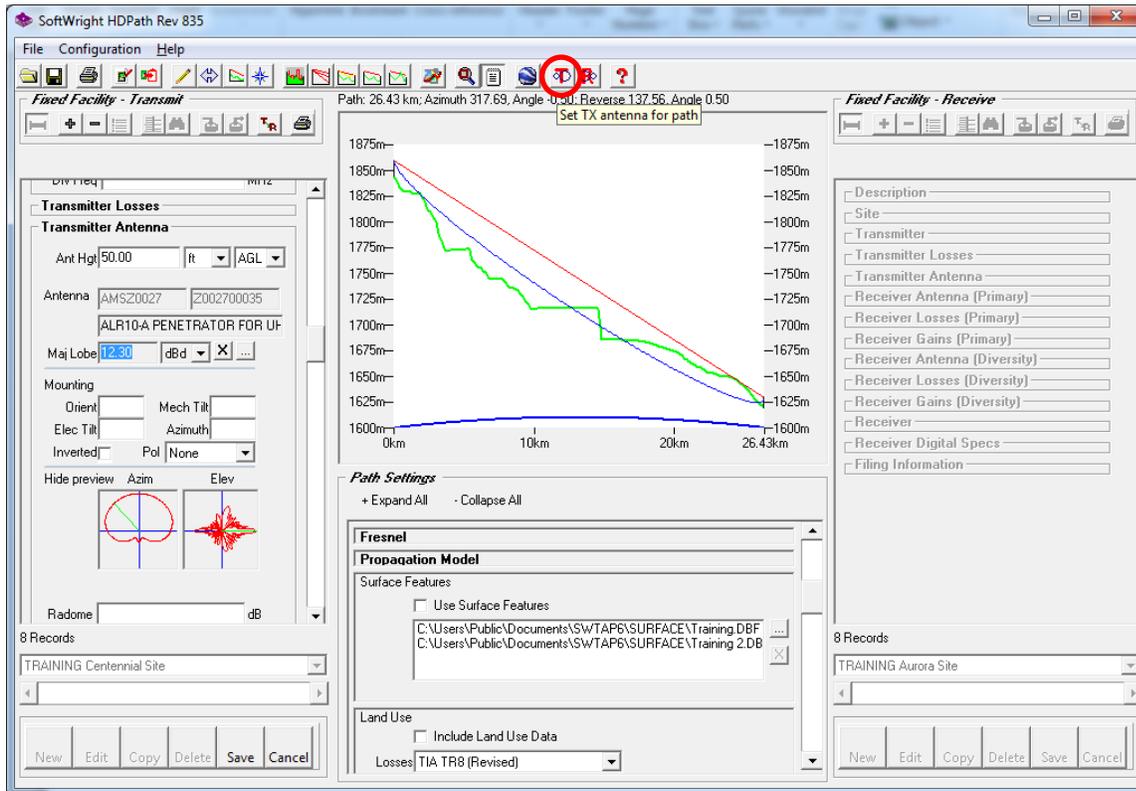
13. Click the Draw button again to redraw the path.

Note the green line in the Azimuth pattern thumbnail showing the azimuth of the path. The azimuth value is also shown in the label above the profile graphic.

14. In order to orient the antenna major lobe of this directional pattern, click the "Set TX antenna for path" button (the "**T**" button).


You may get the following confirmation dialog box. If so, click OK.
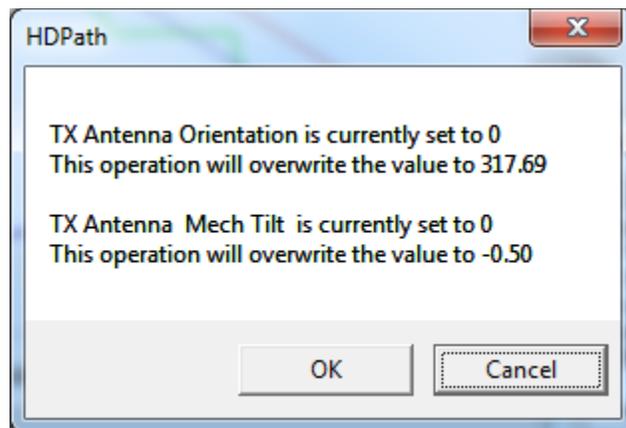
You can also enter the antenna mounting values manually if desired.

The orientation is the adjustment of the antenna pattern from the library (usually, but not always, with the major lobe to the north). The antenna pattern from the library file is rotated by the amount of the Orientation value. The azimuth value remains for reverse compatibility.

15. Note that as the TPO value, losses, and the antenna gain are adjusted, the program updates the Effective Radiated Power value. This is the ERP relative to an ideal dipole.
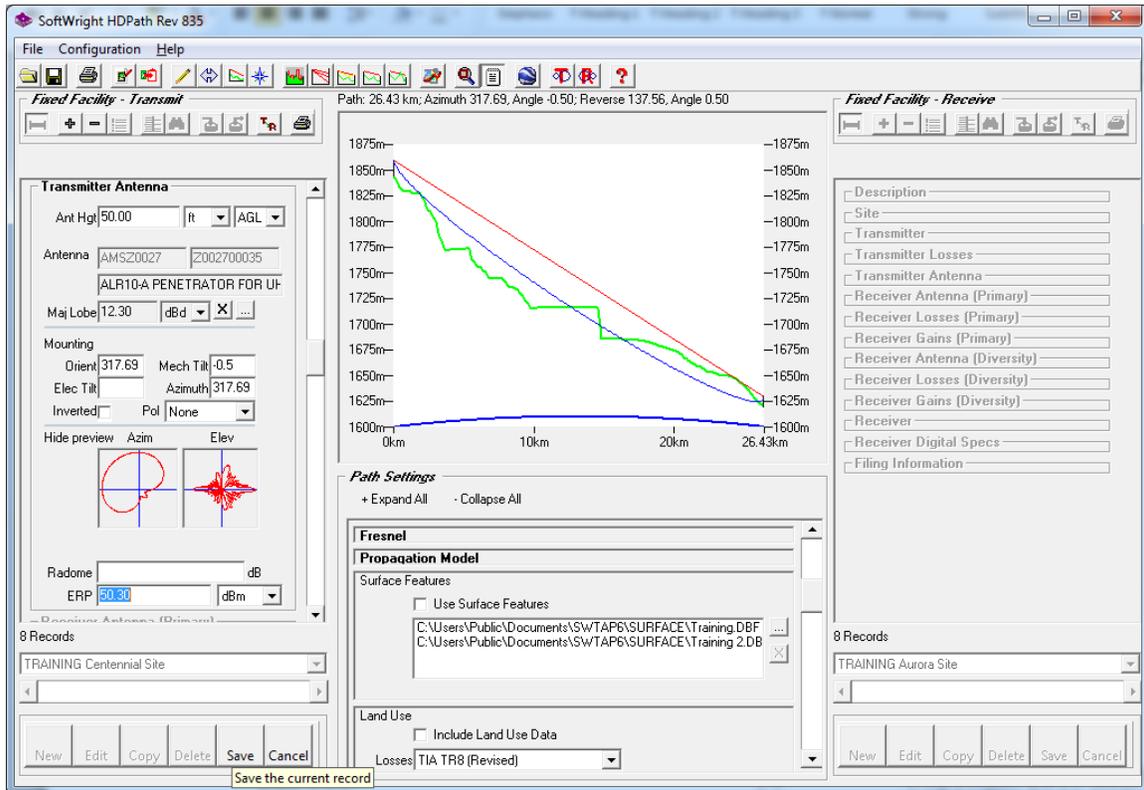

16. Click the Save button to save the changes to the Centennial site record. (The record may have already saved when you set the TX antenna orientation.)

17. In the Propagation Model section, select the Longley-Rice model.
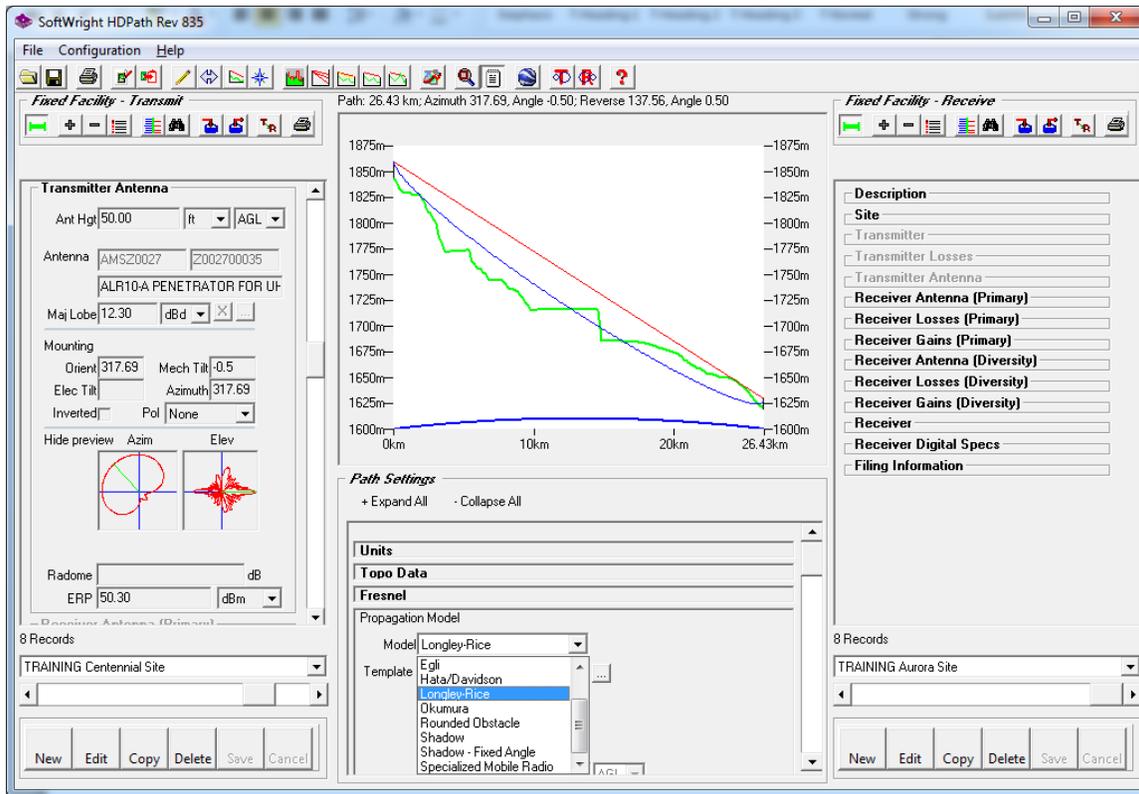
Several propagation models are available in TAP. There are numerous FAQs that describe each model and compare the models. Longley-Rice is used for this example. You should select the model best suited to your application.
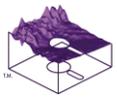
18. Each propagation model has various parameters associated with the model. These parameters are contained in templates, enabling you to have multiple standard configurations you can create. For this example, click the lookup ("…") button to display the available Longley-Rice templates. (This window may display behind the HDPath window.)

Select the LR Defaults template and click the Close button. These values are used for this example. You should select values that are most suited to your application.

19. Now that the Fixed Facility transmit information and propagation model settings have been entered, you have several ways to compute the field strength values associated with this path.

20. First, if you want to know the field strength value at the receiver location at the end of the path, click the "Calc Field at RX Location" button:
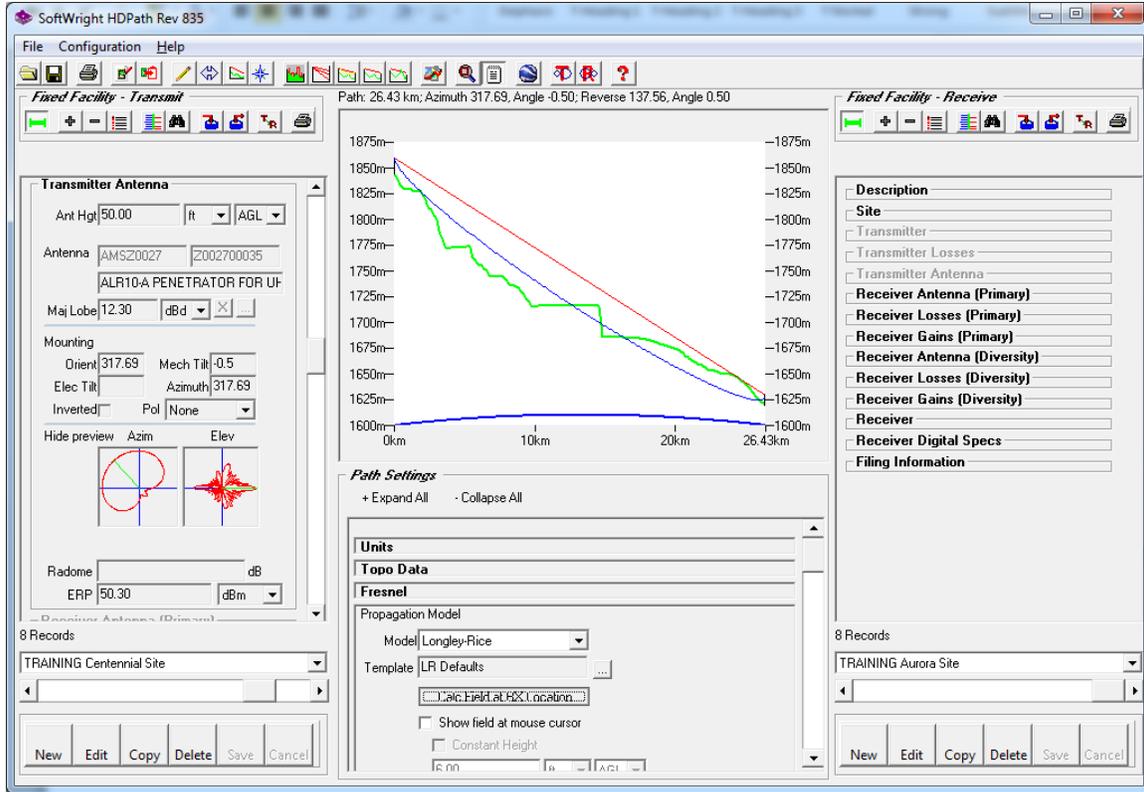
21. The program will compute the field strength and display the details:

Field Strength Calculation

```
TX Facility at TRAINING Centennial Site
39 33 9.00 N 104 44 51.00 W WGS 84
Frequency: 455.00000 MHz ERP: 50.3000 dBm
TX Ant: ALR10-A PENETRATOR FOR UHF WIDEBAND APPLICATIONS
         Orient: 317.69
         M Tilt: -0.5  on Az 317.69

RX Facility at TRAINING Aurora Site
39 43 42.00 N 104 57 18.00 W WGS 84
RX Antenna: 30.00ft AGL

Path: 26.43 km Azimuth: 317.69°
Topo Data Step: 0.10 km Effective Earth Curvature: 1.3330
Topo Data: 3s; 30m; 30s; VMB; DTED; FLT; BIL; HGT
Interpolation: FCC Interpolation (4 points)

TX Site MSL adjusted to: 6053.15 ft
TX Ant: 6103.15ft MSL (Site 6053.15ft + 50.00ftAGL)
Ant: ALR10-A PENETRATOR FOR UHF WIDEBAND APPLICATIONS
Orientation: 317.69
          Mech Tilt -0.50 on Azimuth 317.69
RX Ant: 5344.96ft MSL (Site 1620.00m + 9.14mAGL)
Azimuth: 317.689
Propagation Model: Longley-Rice
LR Defaults
TX Antenna Gain:  Az 0.00 dB;  El -0.30 dB (angle = -0.501)
Free Space Field: (50.001 dBm @ 16.421 mi)     68.48 dBu
Additional Estimated transmission loss :20.53 dB
Line-of-sight path
LR Mode:  11
          Individual; No Location Var
Polarization: V
Surface Refrac: 0.00(300.90)
Permittivity: 15.00  Conductivity:  0.0050
Climate: Continental Temperate
Confidence: 90.00  Reliability: 90.00
Path terrain Delta-H: 228.44 ft
Effective antenna heights: 190.72 ft      15.15 m
Net received field: 47.95 dBu

Receiver Input Power: -80.26dBm
          Total RX Gains: 2.15dB
          Total RX Losses: 0.00dB
          Margin -80.26dB for input requirement 0.00dBm
```

Print   Close

The actual content of the details will be different for different propagation models, but the site and path information, and the "Net received field" are displayed for each model.

22. If this path is intended as a point to point link, then the field strength at the receiver location may be all you need to know. (Note this does not yet include the receiver specifications, loss values, antenna gain, etc. Those values are discussed in the Link Budget lab.)

23. On the other hand, if you are interested in the field strength along the path, HDPath also enables you to make those calculations. (For example, if the Centennial site was also going to be used for mobile communications as well.)

24. For example, suppose you want to know the field strength at points along the path with an antenna height of six feet above ground. In the Propagation Model section, click the "Show Field at Mouse Cursor" box, and check the "Constant Height" box. Enter a value of 6ft.
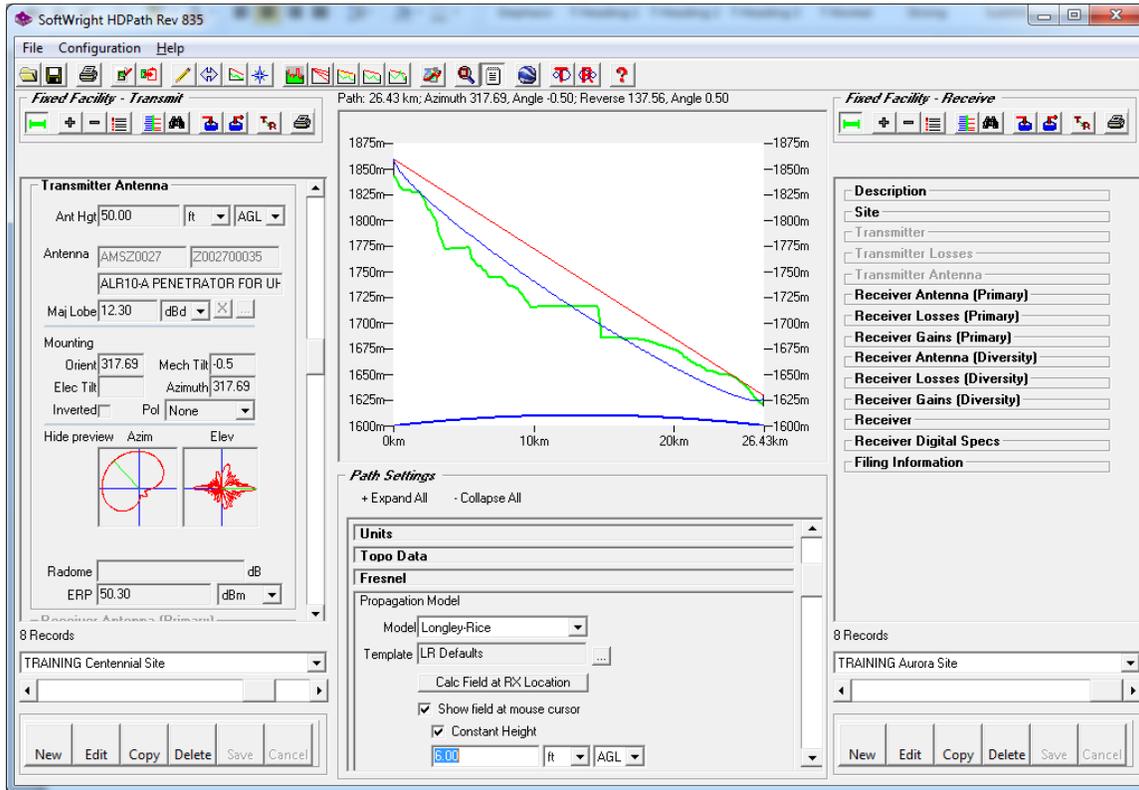
(If the constant height box is not checked, the field is computed at the mouse location above the terrain on the drawing.)

25. Now when you move the mouse on the drawing you will notice a delay while the field strength is calculated at each location. (Be sure the Mouse Location on Path form is open. If it is not, the field is not computed. You can force the form to open again by clicking the Draw button with the pencil icon on the toolbar near the top of the HDPath form.)
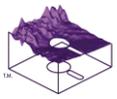
26. You can expand the size of the form to display the computed field value at the bottom of the information as you move the mouse along the path. When you left click at a location, the calculation details are opened in a Notepad file:

The computed values at each location can be compared to the Required Field value computed for various mobile units (as described in several FAQs) to determine if sufficient field strength is available at locations of interest.

27. When you are through computing the field values along the path you should uncheck the "Show Field at Mouse Cursor" box.
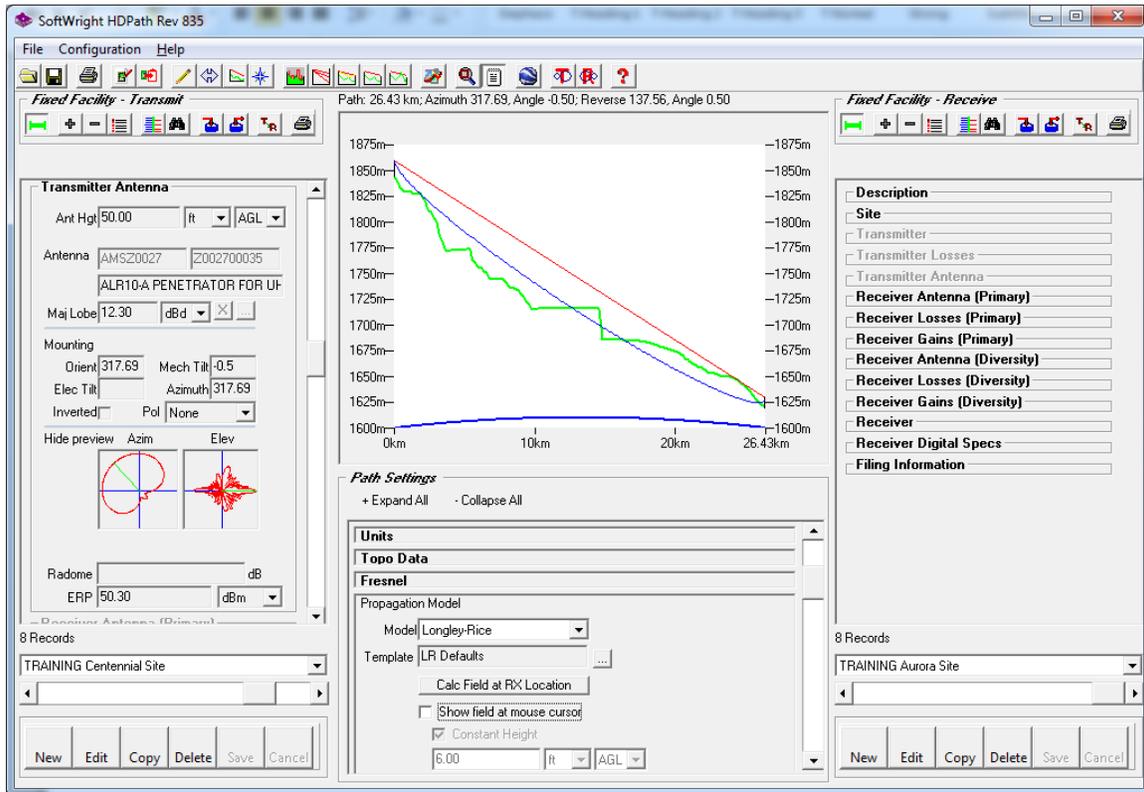
3. Example Microwave Link Budget

Objective: Compute a microwave path link budget and check the path for potential reflection points.

Procedure: Using the sites created for Section 1 (Path Profile), add microwave facilities and compute the path reliability with the Microwave Link Budget function.

The microwave facilities at the same locations are:

	Centennial Site TX	Aurora Site RX
Frequency:	6.1GHz	6.1Ghz
TPO:	1Watt	
Receiver Sensitivity:		-110dBm
Antenna Gain:	45dBi	45dBi
Antenna Height:	400 ft AGL	1020 ft AGL
Transmission Line:	Andrew EWP52S Elliptical Waveguide	Andrew EWP52S Elliptical Waveguide
Line Length:	420 ft	1030 ft

Note that all values and settings discussed in this article are for illustration purposes only. It is important for you to determine the particular settings and values applicable to your equipment and application when using TAP.

1. In HDPath, select the sites to view the profile between the Centennial site and the Aurora site (including the Centennial transmitter information added in Lab 300):
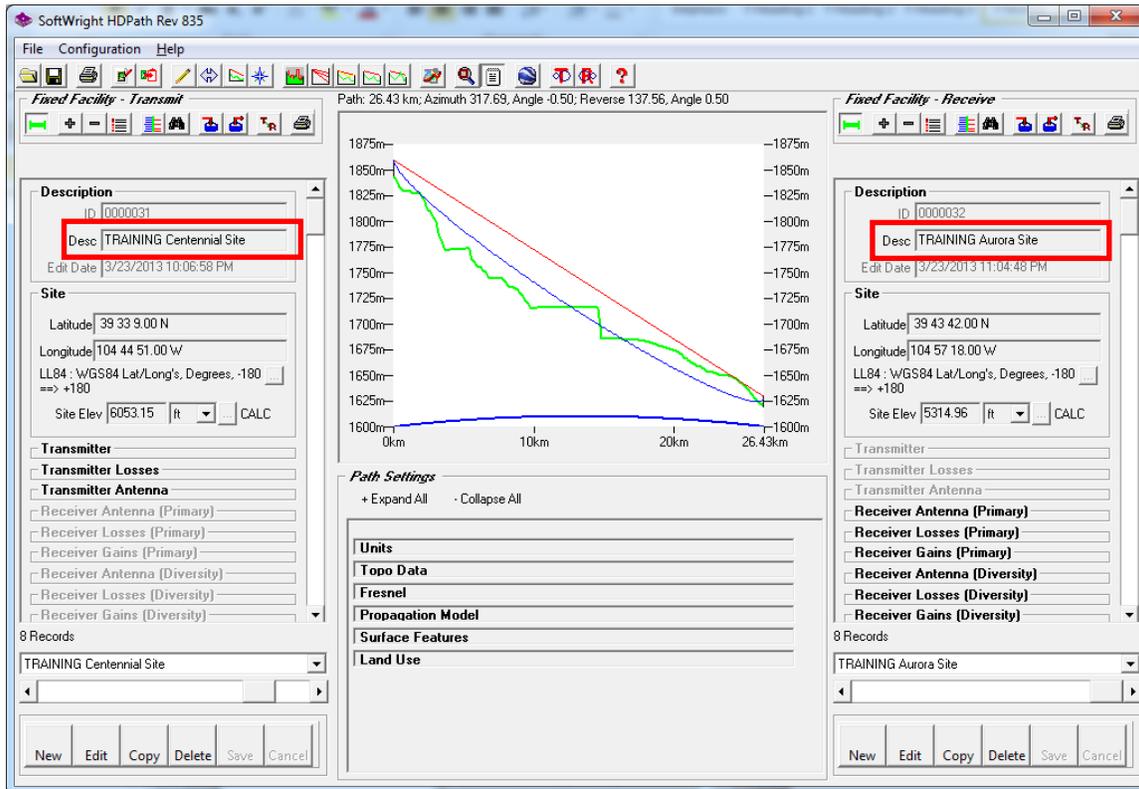
2. It is common to share towers at common base stations by mounting antennas at different heights on the tower. When this is the circumstance, you can use the Fixed Facility interface Copy function to make a duplicate record with the same coordinates (representing the same tower or other mounting location). Then you can edit the new record to make the necessary changes.

3. Click the Copy button near the bottom of the Fixed Facility interface for the Centennial site on the left side of the HDPath form:
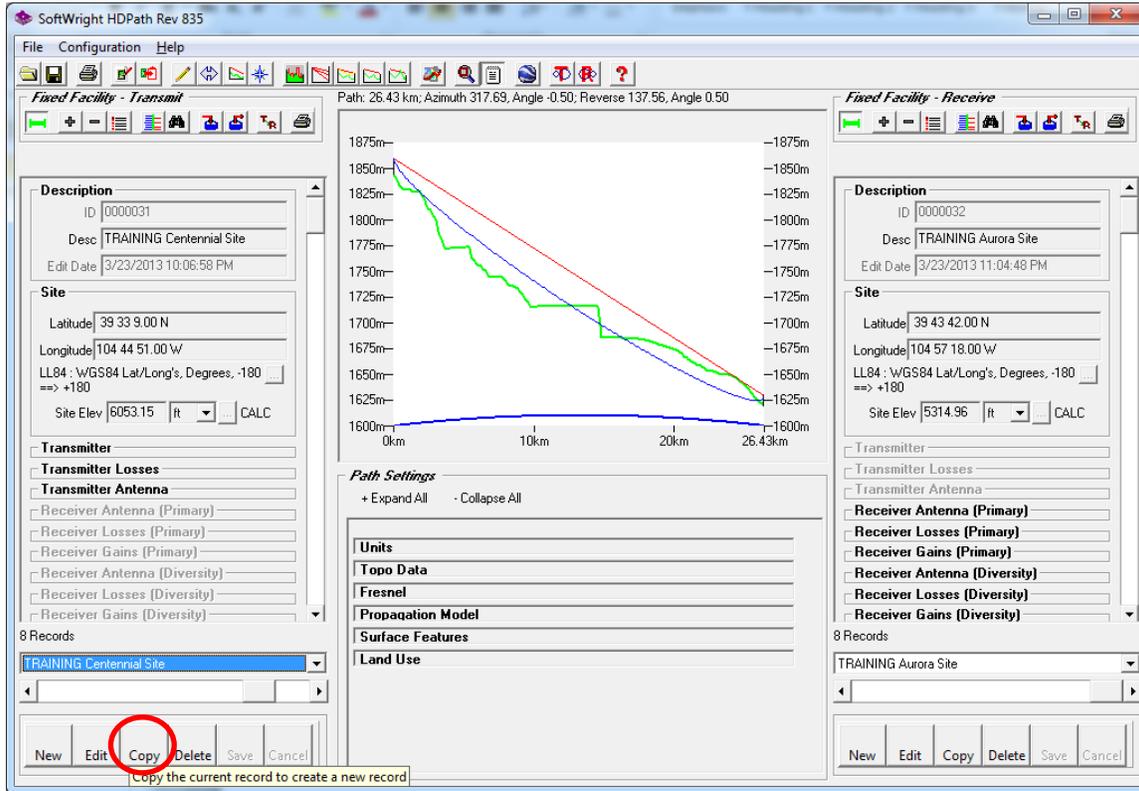
4. A new record is created, with a new ID assigned, and the description as "Copy of …" the original record description:
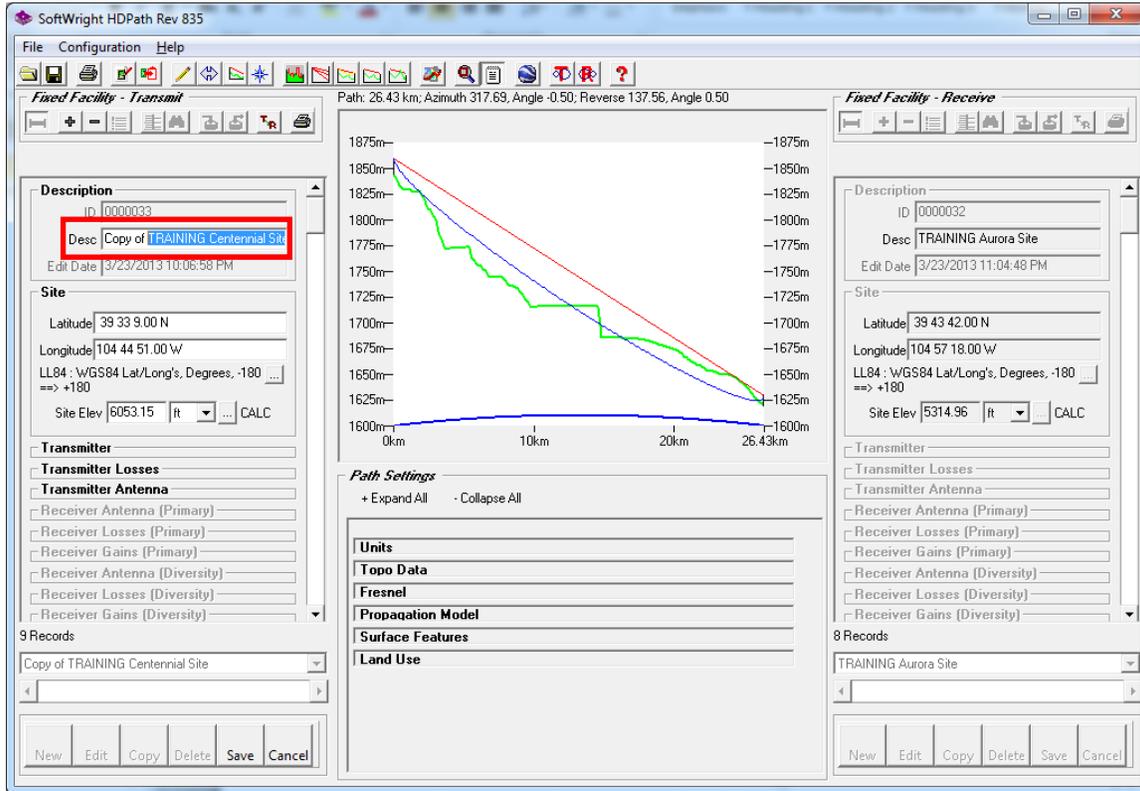
Note that the coordinates and other site information are the same as the original Centennial site.

5. Change the description to indicate the function of the new facility record:
   "**TRAINING Centennial Microwave Site**"

6. In the Transmitter section, change the values for this example:
   1.0 Watt Transmitter Power Output
   6.1GHz (6100MHz)

7. In the Transmitter Losses section under Line 1, note that the loss value has been recomputed for the new frequency. Since we are using different transmission line for this microwave example, click the lookup button ("…") to select the line type:
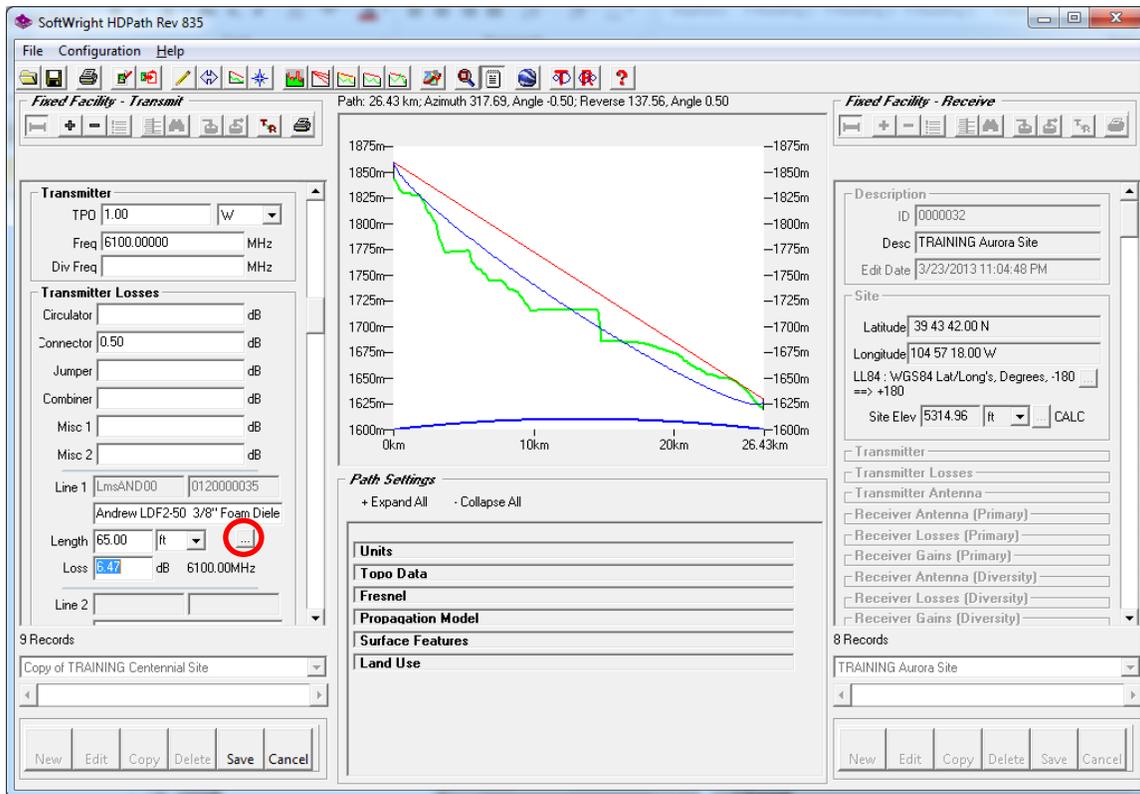
8. Find the specified line (**Andrew EWP52S Elliptical Waveguide**) and click the line to highlight it:
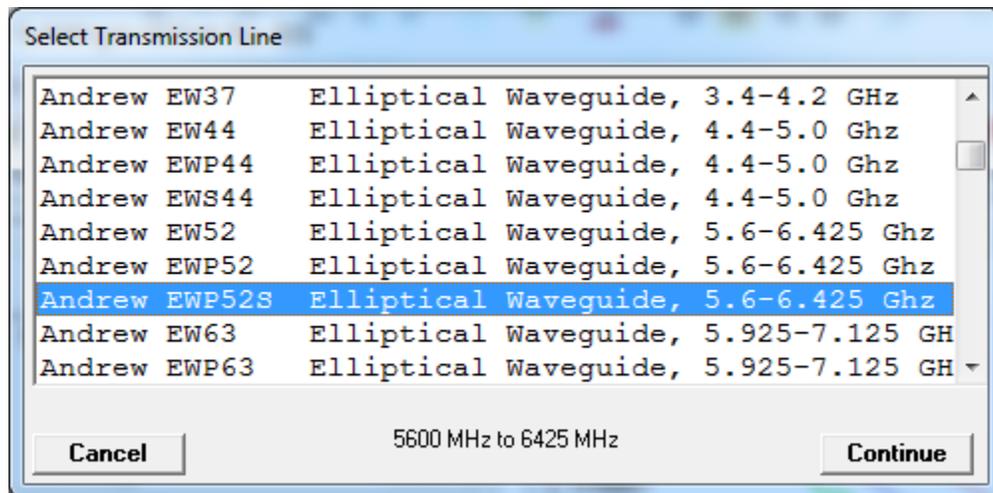
Click the Continue button to select the line type.

9. Enter the line length for this example
   420 ft:
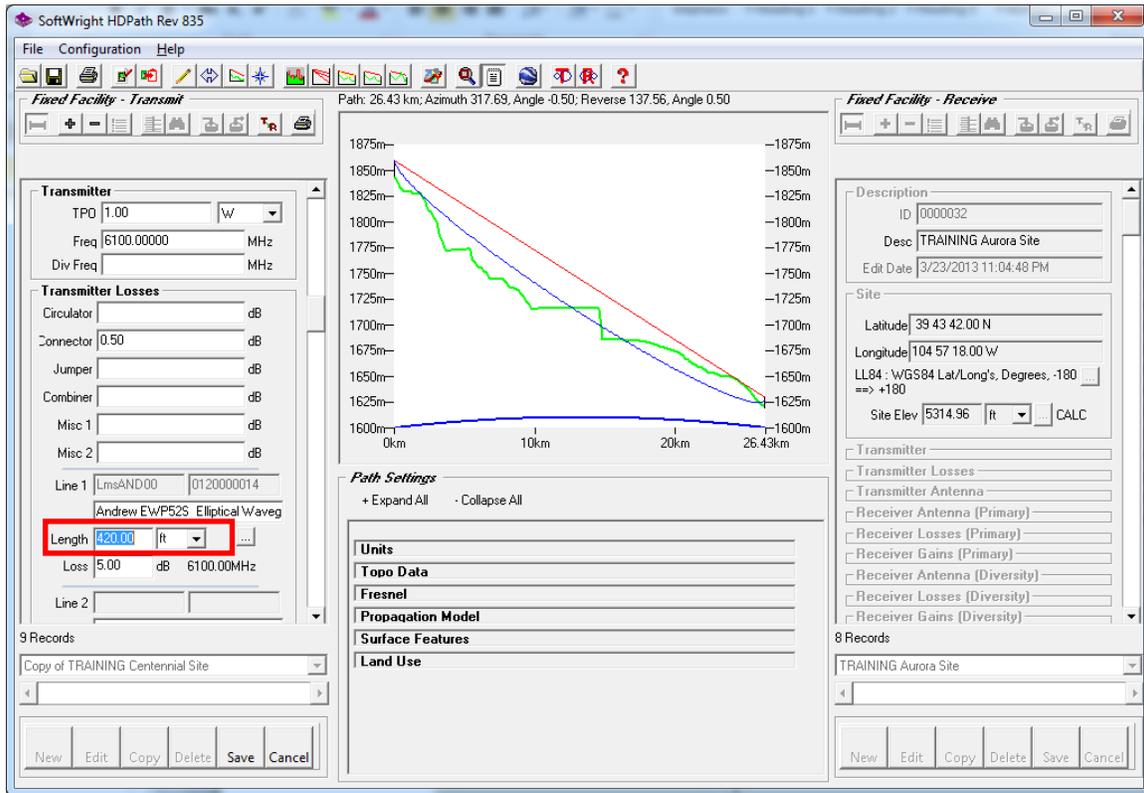
Note that the line loss value is recomputed for the new length, frequency, and line type. Also, be sure to **remove the 0.5dB Connector loss** value, since that loss was not a part of this example, but the value was copied when we made the new record. Whenever you use the facility copy function, remember that all parts of the record are being copied and you may need to edit or remove information that does not apply to the new site record.

10. In the Transmitter Antenna section of the Centennial Microwave record, we still have the UHF antenna specified for the previous record. To remove this antenna information, click the "**X**" button next to the antenna gain value:
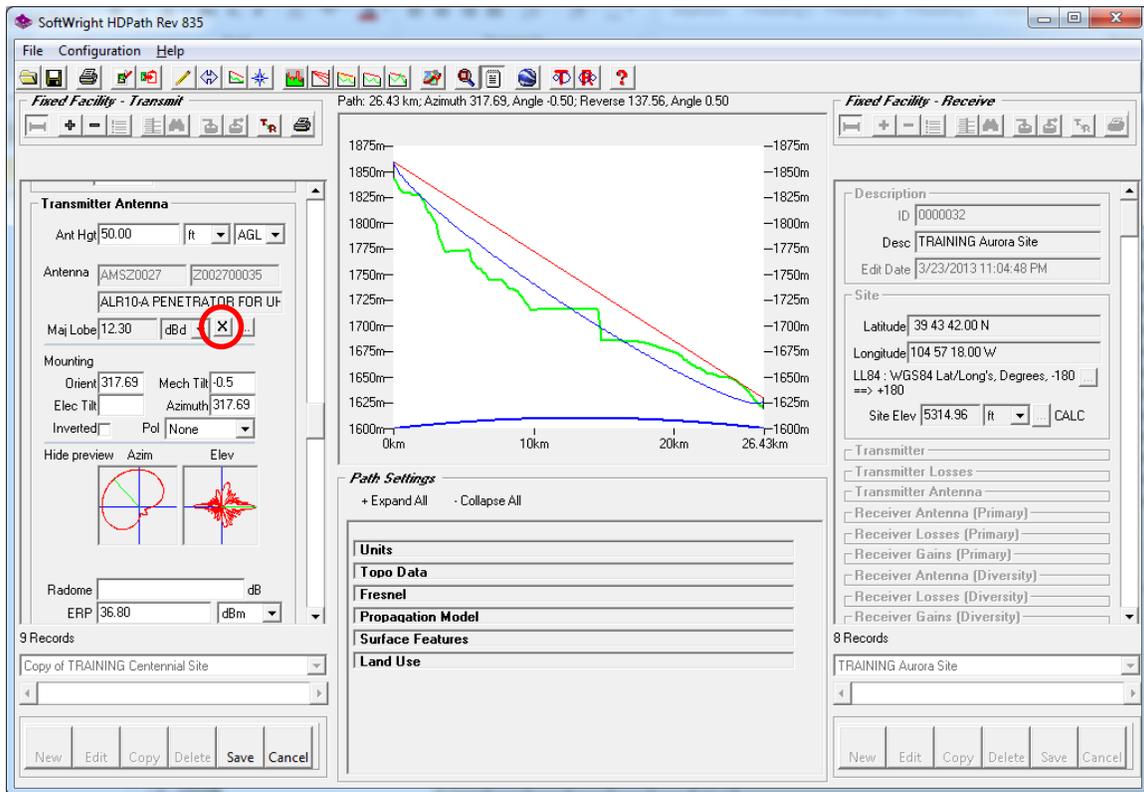
11. Click OK to confirm that you want to remove the antenna:
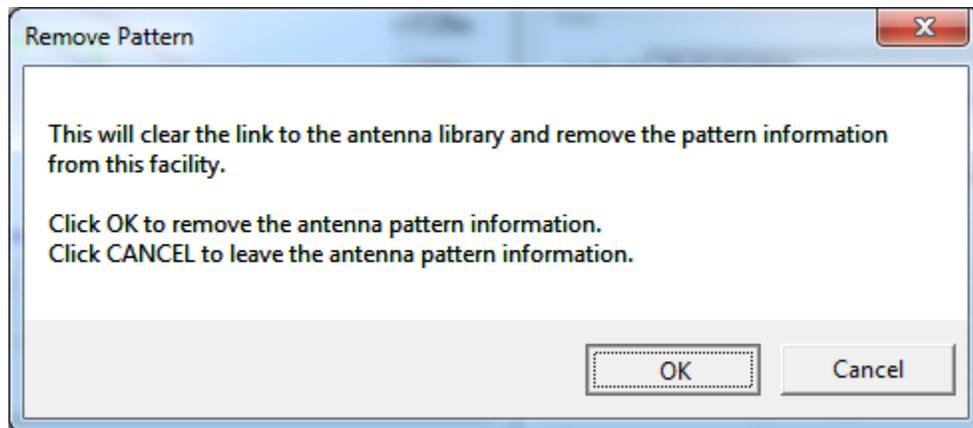
12. While directional antenna pattern information can be added for microwave link budget calculations, the general assumption is that the high-gain, narrow-beamwidth antennas are properly aligned and the directionality off-axis is not a factor. In this case, the major lobe gain can be entered without the need to actually lookup the microwave antenna pattern. First set the units to **dBi** (usually the units used for microwave antennas), then enter the gain specified for this example
45dBi
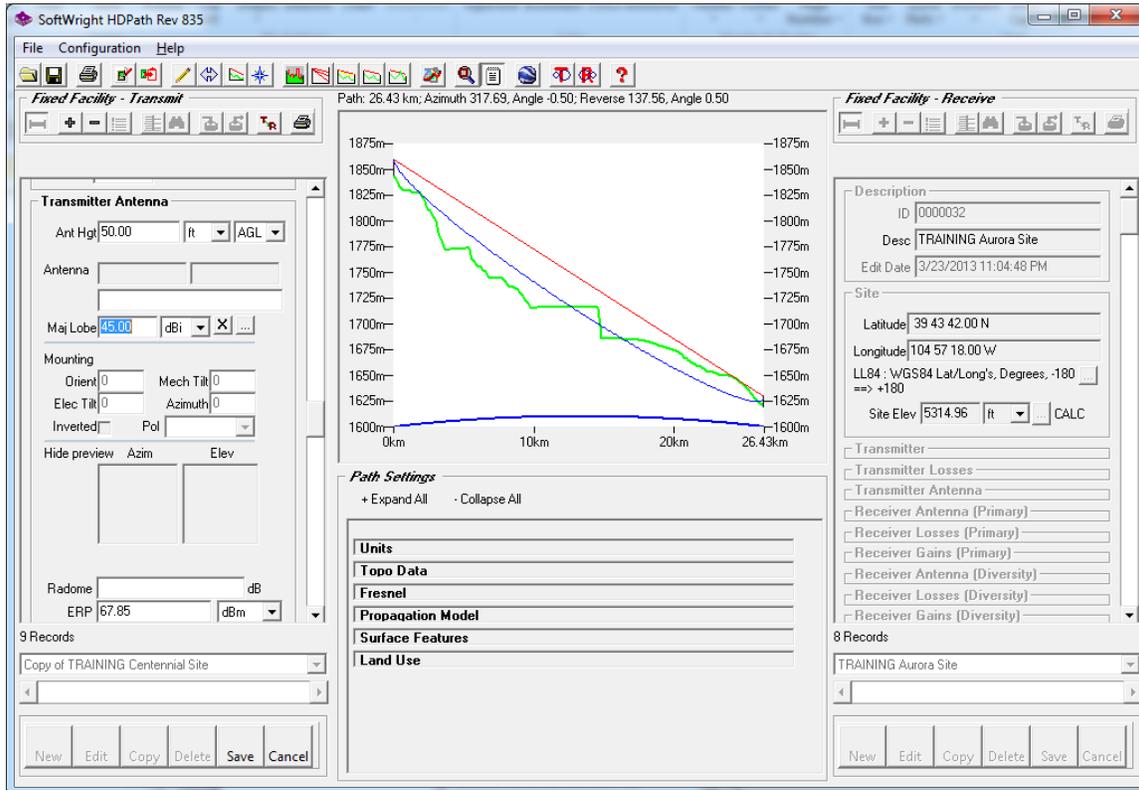
Since no pattern information is being used, you can also remove the Orientation value for the antenna, since it will not be used.

13. In the Transmitter Antenna height, enter the specified value
    400ft AGL
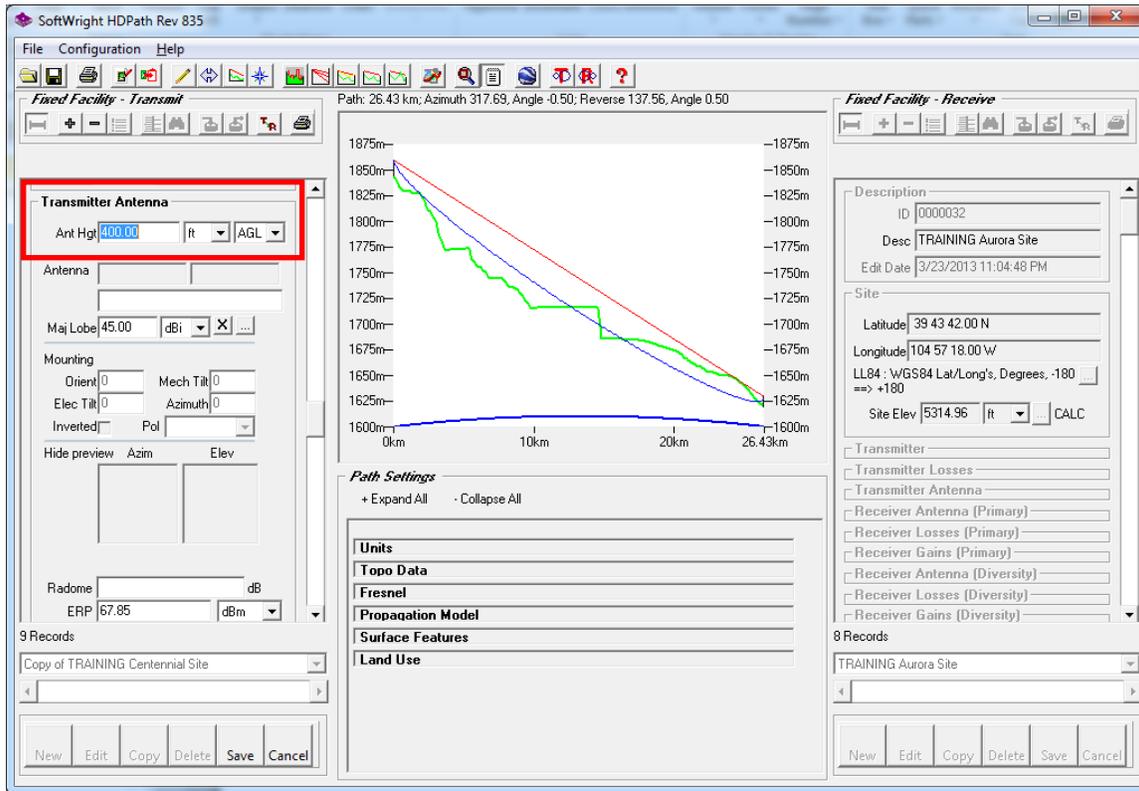
(As elsewhere in this example, this value is for illustration only. There are very few 400 foot towers in Centennial, and even fewer 1000 foot towers in Aurora. The values will be used to illustrate the Reflection Analysis later in this Lab.)

14. Click the Save button to save the changes to the new record:
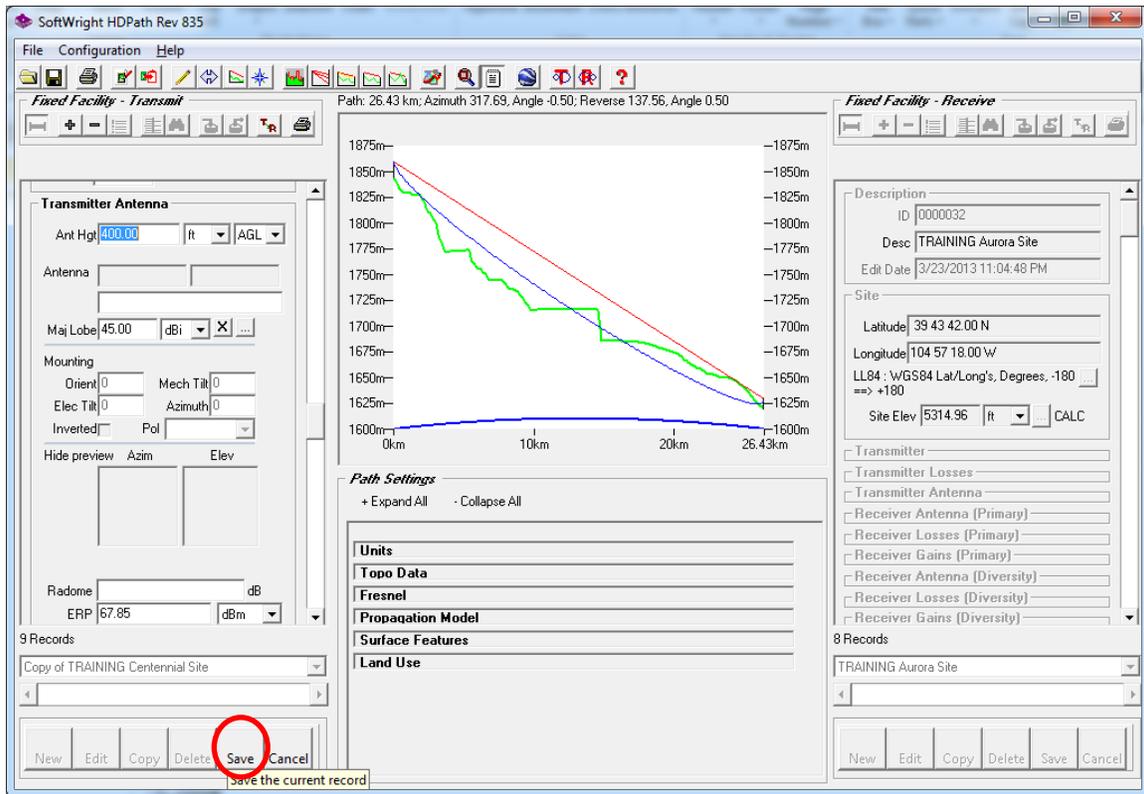
15. Now make a copy of the Aurora Site on the Fixed Facility – Receive interface on the right side of the HDPath form:
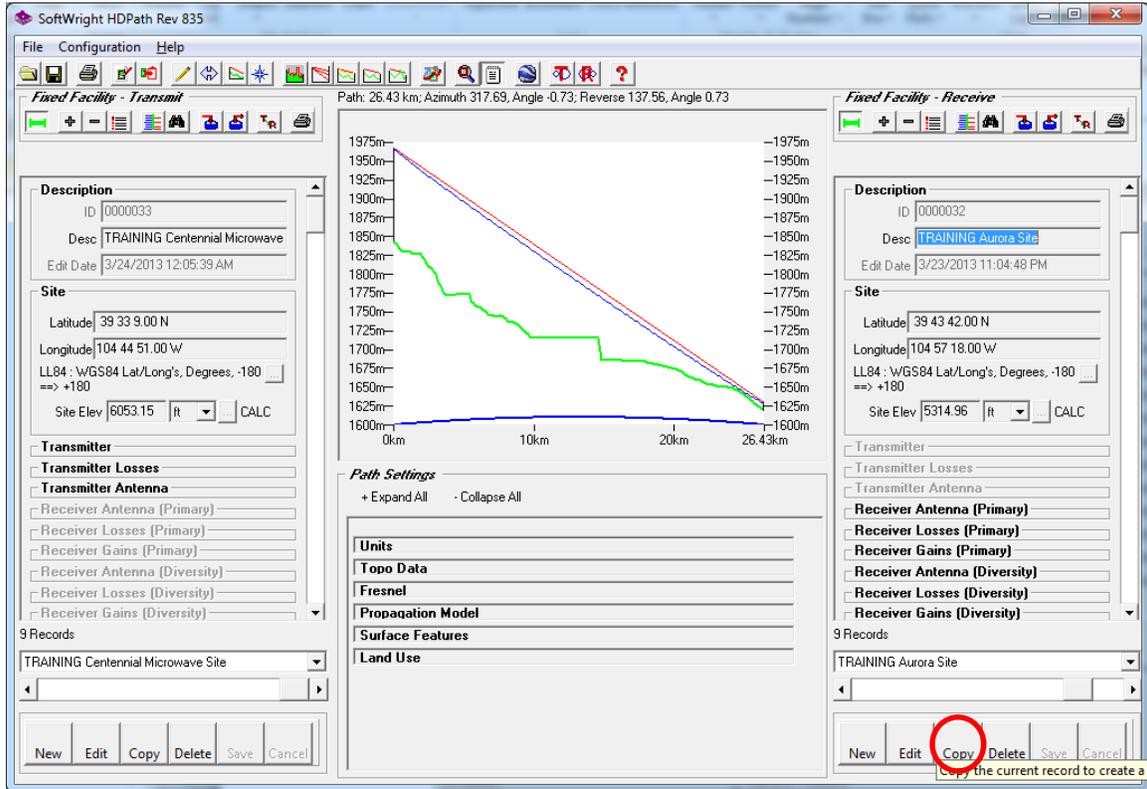
16. Make the changes to the new record:

Description: _____ TRAINING Aurora Microwave Site
Receiver Frequency: _____ 6100MHz
Receiver Sensitivity: _____ -110dBm
Receiver Antenna (Primary) Height: _____ 1020 ft AGL
Receiver Antenna (Primary) Gain: _____ 45dBi
Receiver Losses (Primary) Line: _____ Andrew EWP52S
Receiver Losses (Primary) Line Length: _____ 1030 feet
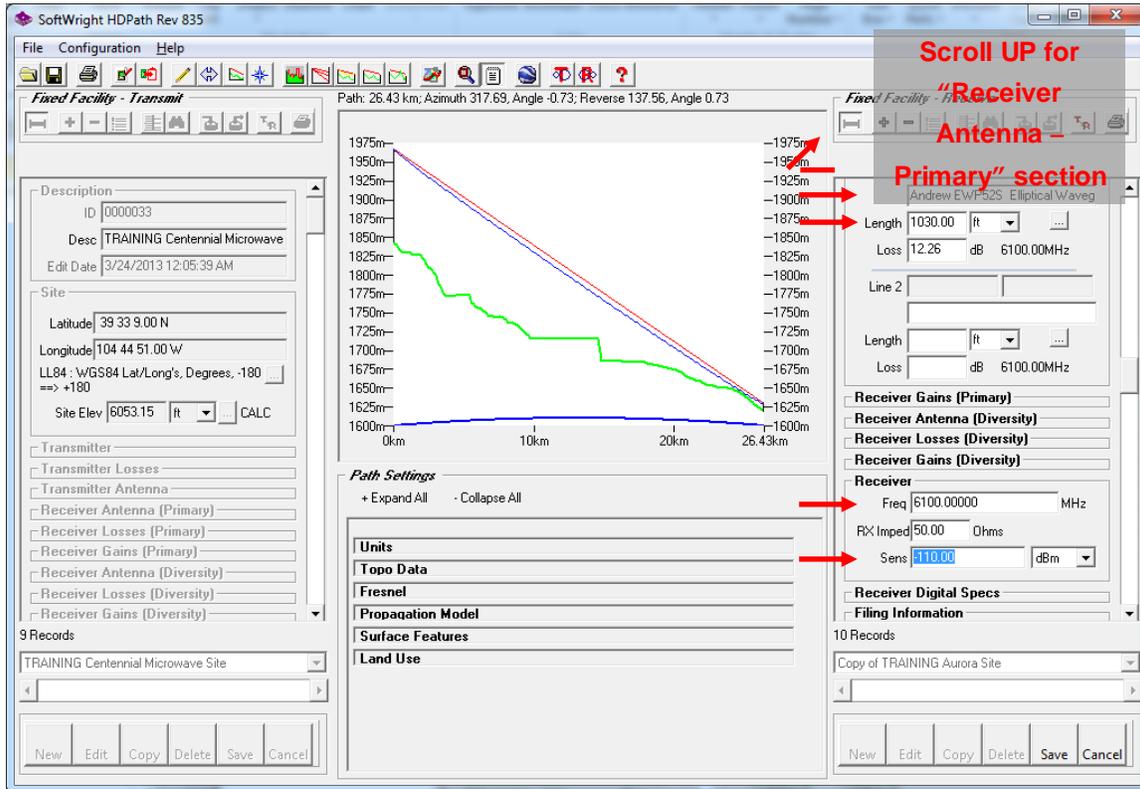
Remember to remove the antenna pattern reference (the "**X**" button) and the 0.5dB connector loss value. Note that the Required Field value is recomputed as you make changes to the record, such a frequency, line specification, antenna gain, etc.

Note that if you change the antenna height before you change the length of the transmission line, you will get a warning (that you can disregard) that the line length is less than the antenna height.

Click the Save button to save the changes to the new record.

17. With all the changes made, it is clear that the path between the two antennas provides line-of-sight and Fresnel clearance.
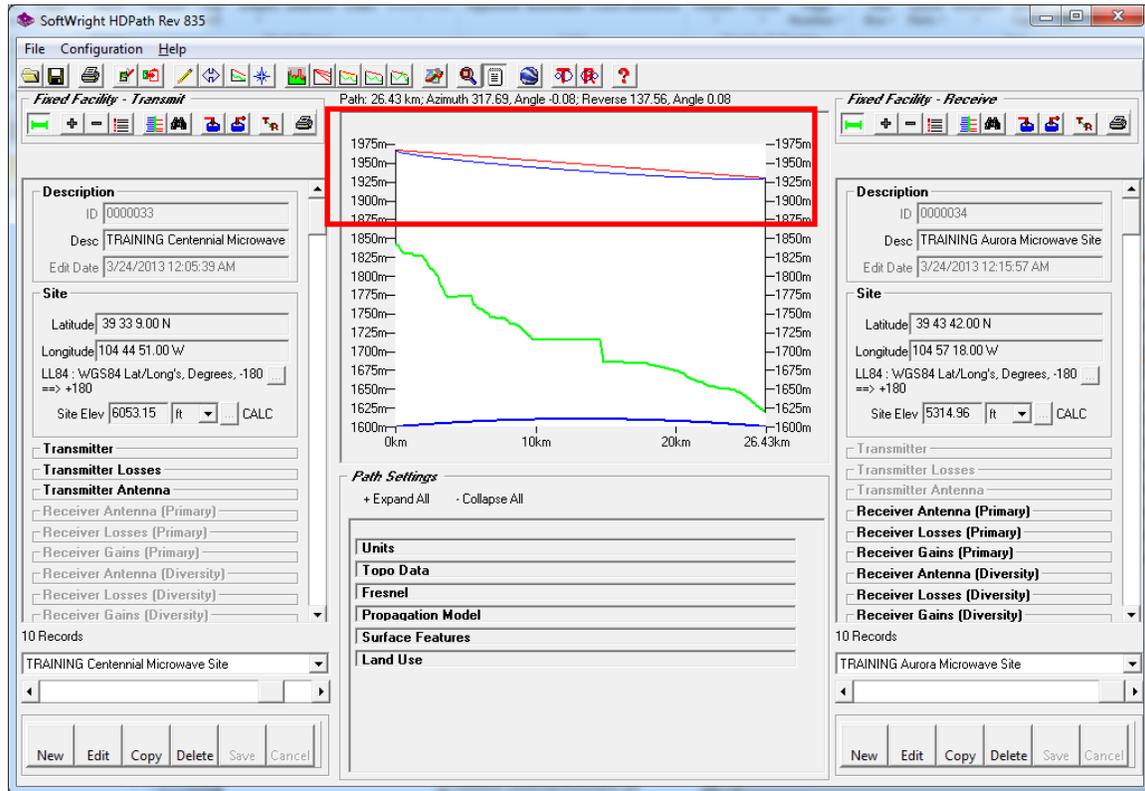
Microwave Link Budget calculations must be based on adequate path clearance. The statistical portions of the calculations (such as outage times and reliability) assume a clear path. While additional losses can be added later, obstructed line-of-sight or even partial Fresnel zone obstructions (0.5 of the first Fresnel zone) will violate the assumptions used for the microwave reliability calculations and make the results suspect.

18. To actually compute the Link Budget for the path, click the Microwave Link Budget button on the toolbar near the top of the HDPath form:
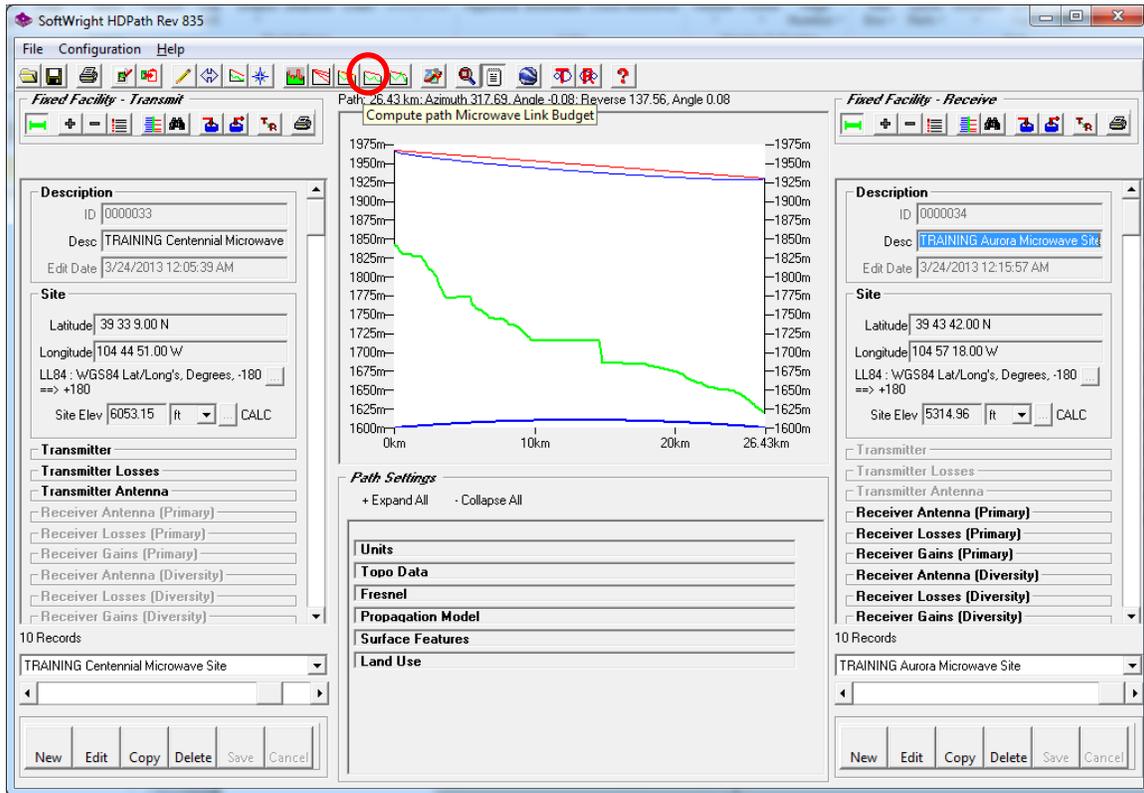
The subtle difference between the Microwave button and the VHF/UHF Link Budget button to its right is the fact that the VHF/UHF button has a peak blocking the line of sight.

- VHF-UHF Link
- Microwave Link
- Reflection Analysis
- Antenna Elevation
- Surface Features
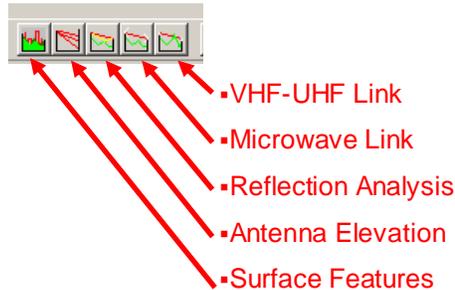
19. The Microwave Link Budget form is displayed:

20. The Microwave Link Budget form enables you to enter additional details about the particular path and conditions for the link budget. You can scroll to the bottom of the form to see the computed Reliability as a percentage value:

4. Example Area Coverage Study

Objective: Run an area coverage radial study from HDCoverage.

Procedure: Using the Centennial site created in previous sections, create a radial study with 72 radials, computing the field strength every 0.1 mile, out a distance of 30 miles. Determine the coverage for a handheld unit 6-feet above the ground, requiring 0.5uV input and having a 0dB gain antenna.

Note that all values and settings discussed in this article are for illustration purposes only. It is important for you to determine the particular settings and values applicable to your equipment and application when using TAP.

1. From the TAP6 menu form, click the Area button:
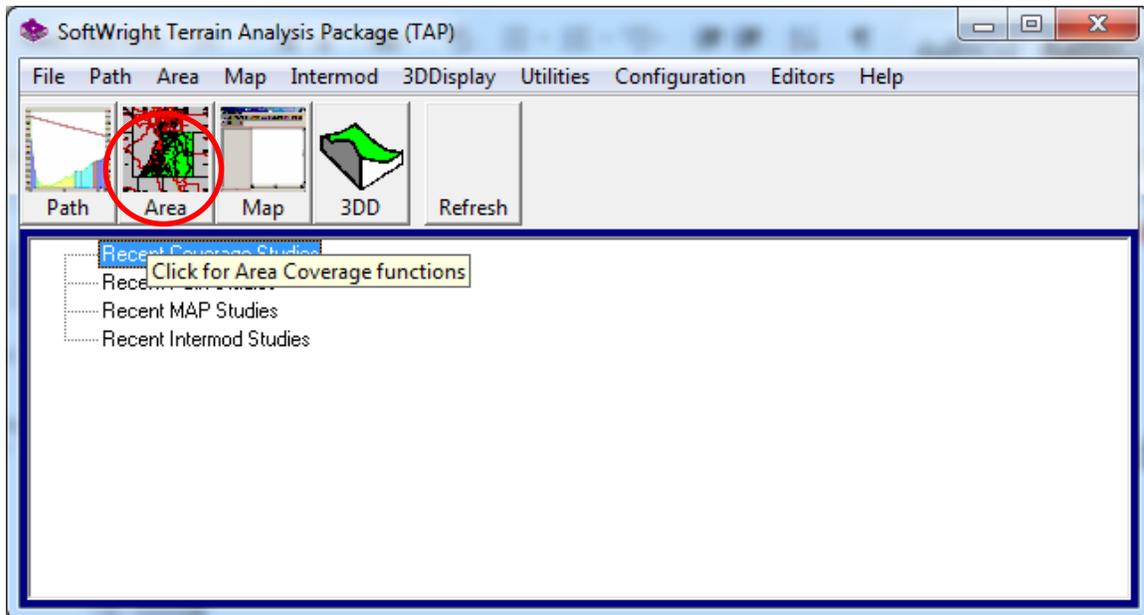
2. The HDCoverage function is displayed:
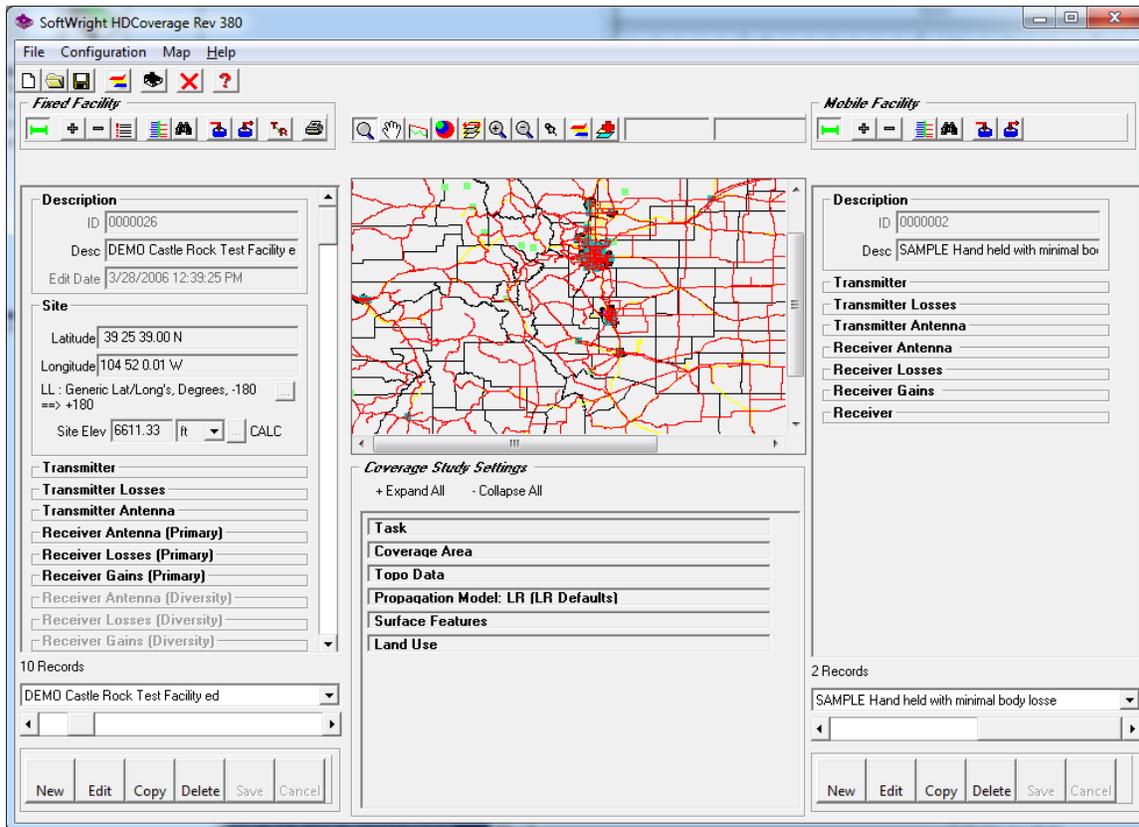
Note the four basic areas of the form:

- The Fixed Facility for the base station site is shown on the left side of the form.

- The Mobile Facility information is shown on the right side of the form.

- The parameters for the coverage study are shown in the lower half of the center of the form.

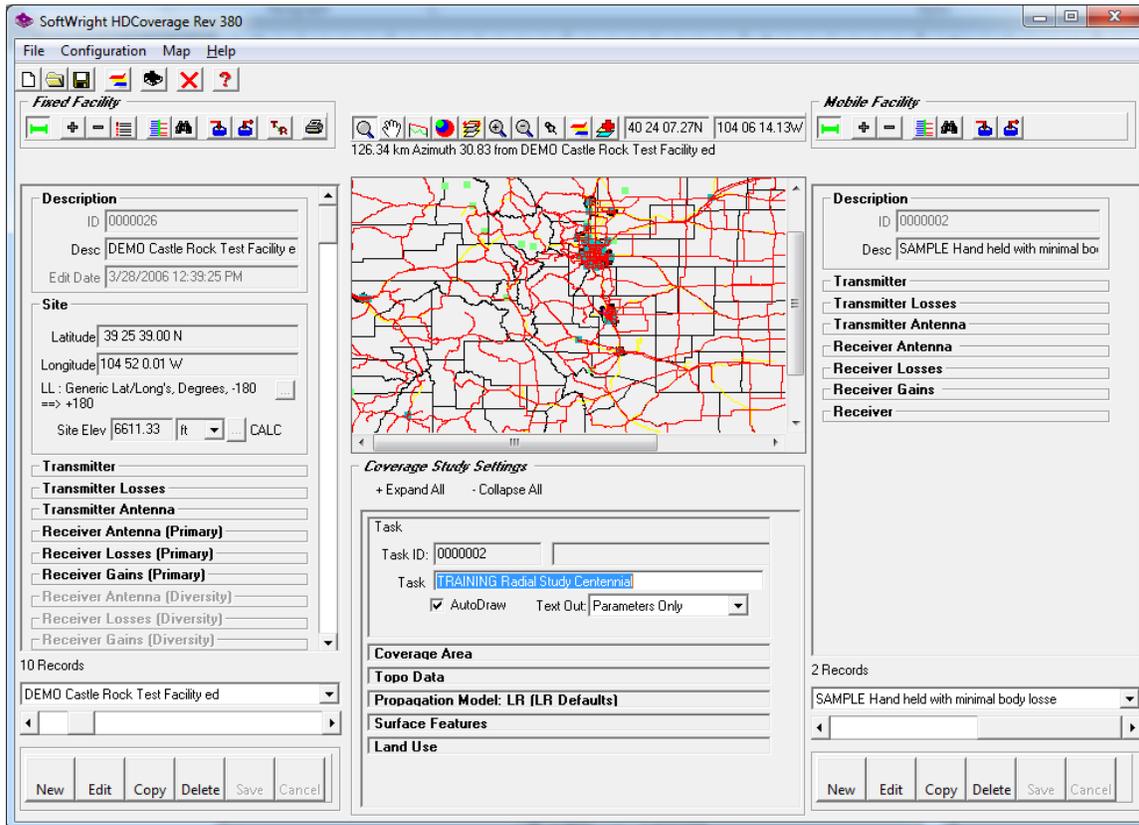- The map graphic is shown in the upper half of the center of the form.

3. To run a coverage study, a TAP "Task" must be created. If the Task section is collapsed, click the heading to expand the section:
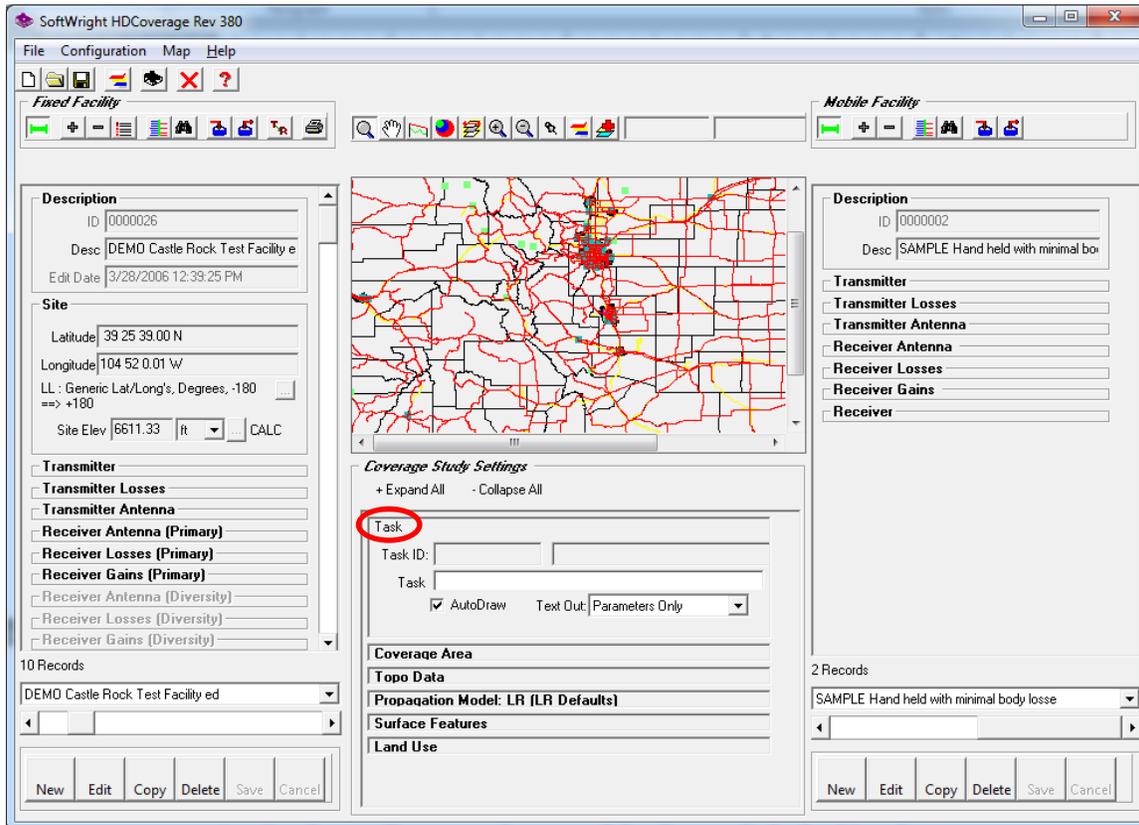
4. On the toolbar near the top of the form, click the New button:
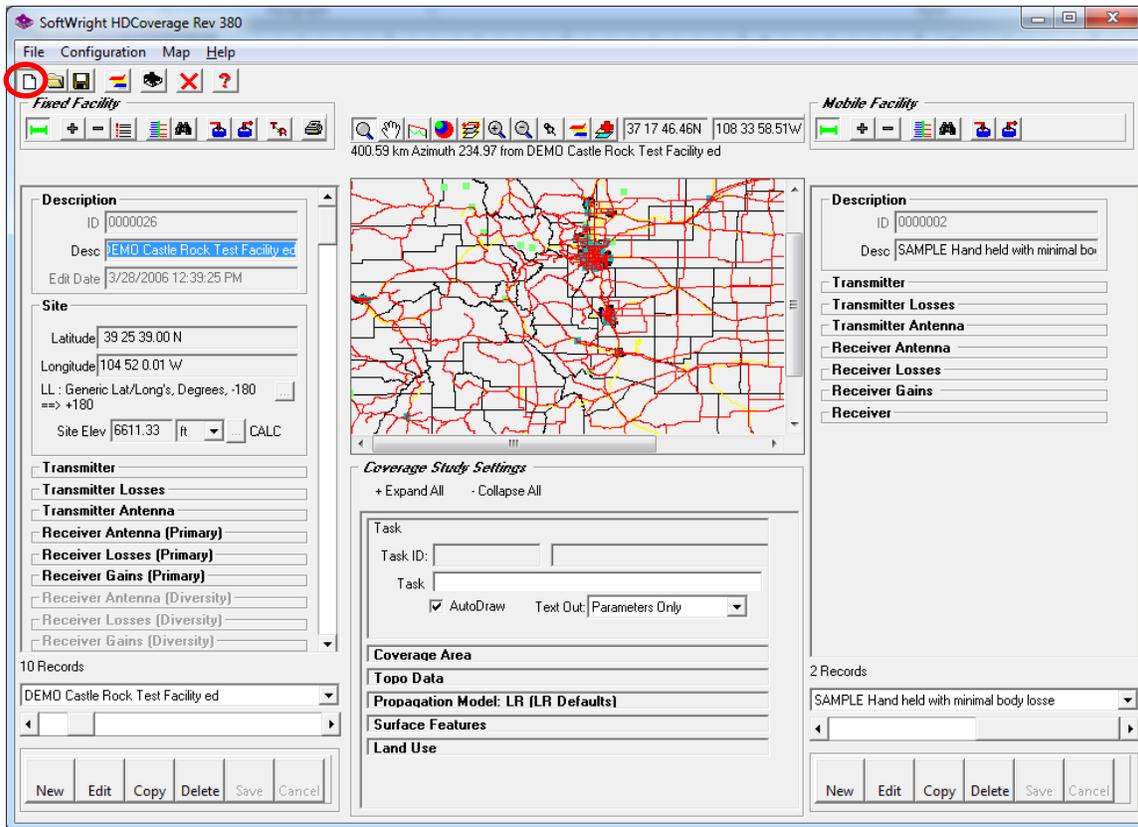
5. A Task ID will be assigned. Enter a description for the study as "TRAINING Radial Study Centennial":

The Task Description is used later in TAP when you want to find this study to draw a map or other uses. The description you use should be something that will be helpful to you when you need to refer back to a study.

Be sure the AutoDraw box is checked so the study will be displayed in HDMapper when completed.

6. In the Fixed Facility section on the left side of the form, use the pulldown list near the bottom to select the Centennial facility (created in previous section):
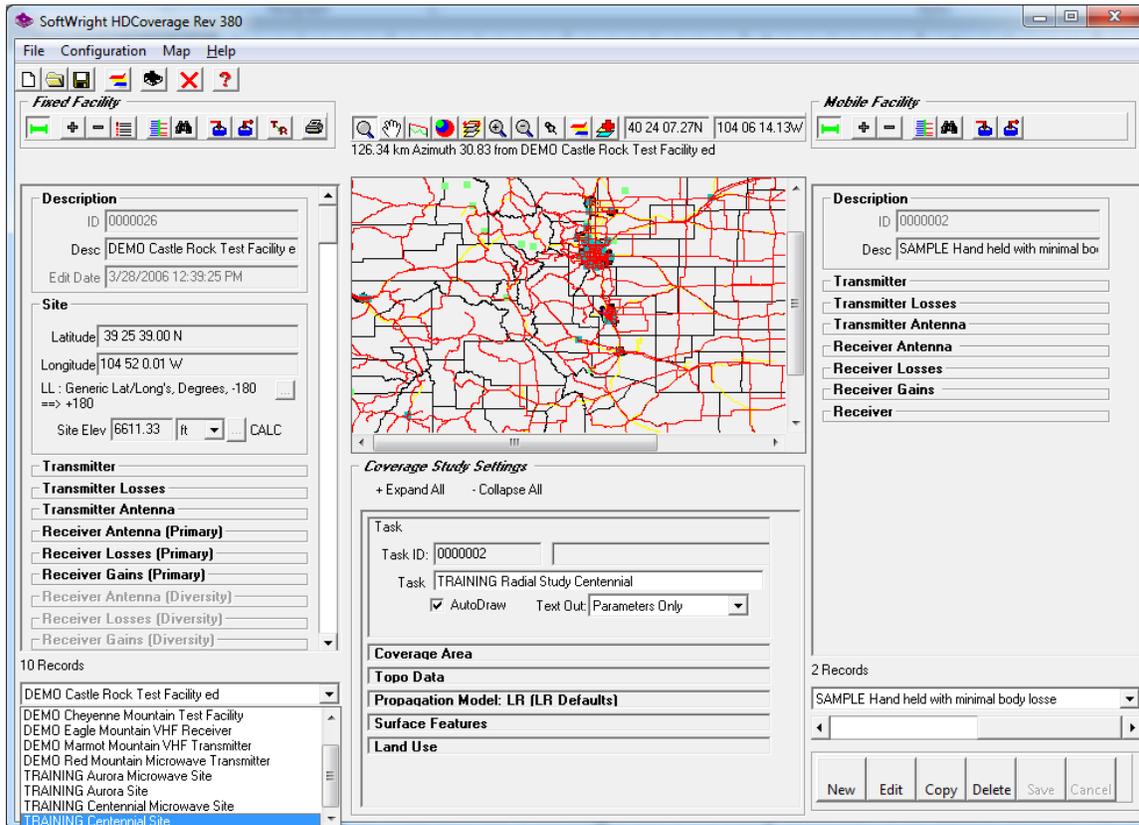
This example will use an existing Fixed Facility record. For more details on creating a new record for a facility, see Section 1.

7. When a Fixed Facility is selected, the program will display a map of the area (if the shapefiles for the area are available). The button with the pin icon in the map toolbar can be clicked to display the site location (the green triangle shown below):
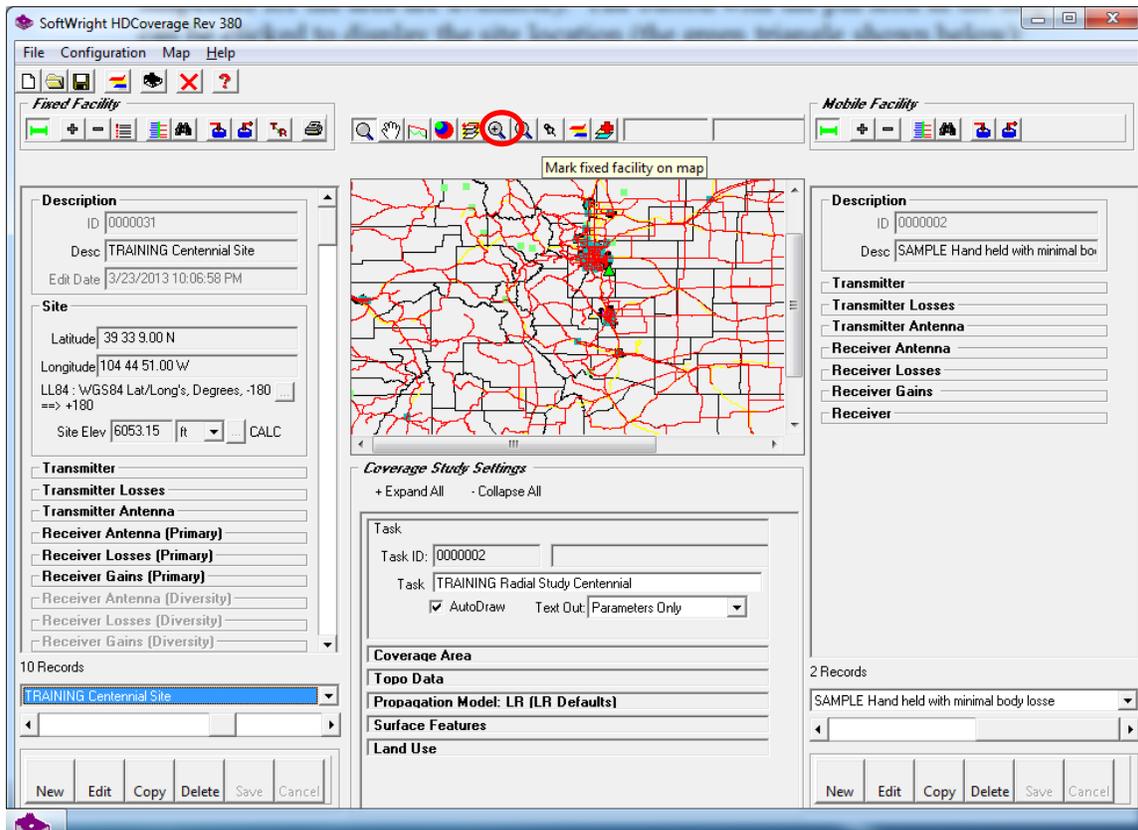
8. With the Zoom button (the magnifying glass icon on the map toolbar) depressed, draw a rectangle on the area you want to enlarge on the map. Click a point on the map and hold the mouse button down to drag a rectangle over the area. Release the mouse button to complete the rectangle and zoom into the map.
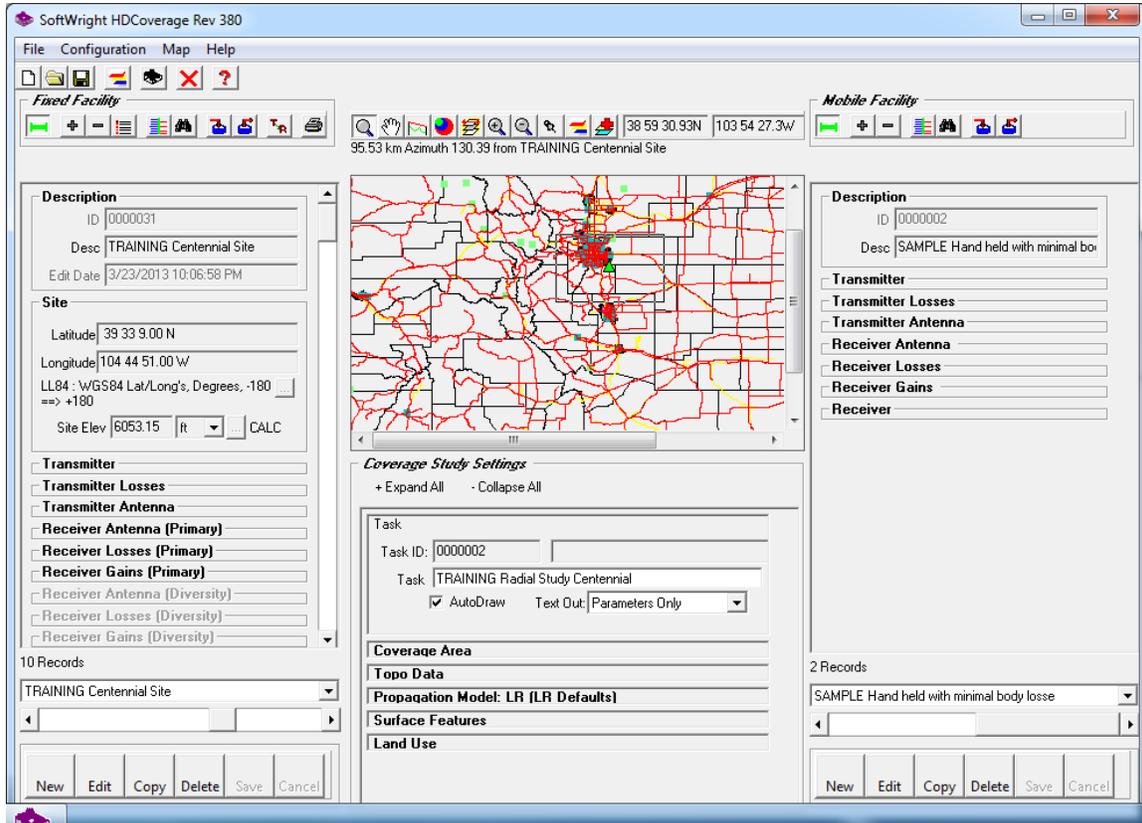
9. Click the Propagation Model section in the Coverage Study portion of the form to open that section. In the pulldown list, select the Longley-Rice model:

Several propagation models are available in TAP. There are numerous FAQs that describe each model and compare the models. Longley-Rice is used for this example. You should select the model best suited to your application.

10. Each propagation model has various parameters associated with the model. These parameters are contained in templates, enabling you to have multiple standard configurations you can create. For this example, click the lookup ("…") button to display the available Longley-Rice templates.

Select the LR Defaults template and click the Close button. These values are used for this example. You should select values that are most suited to your application.
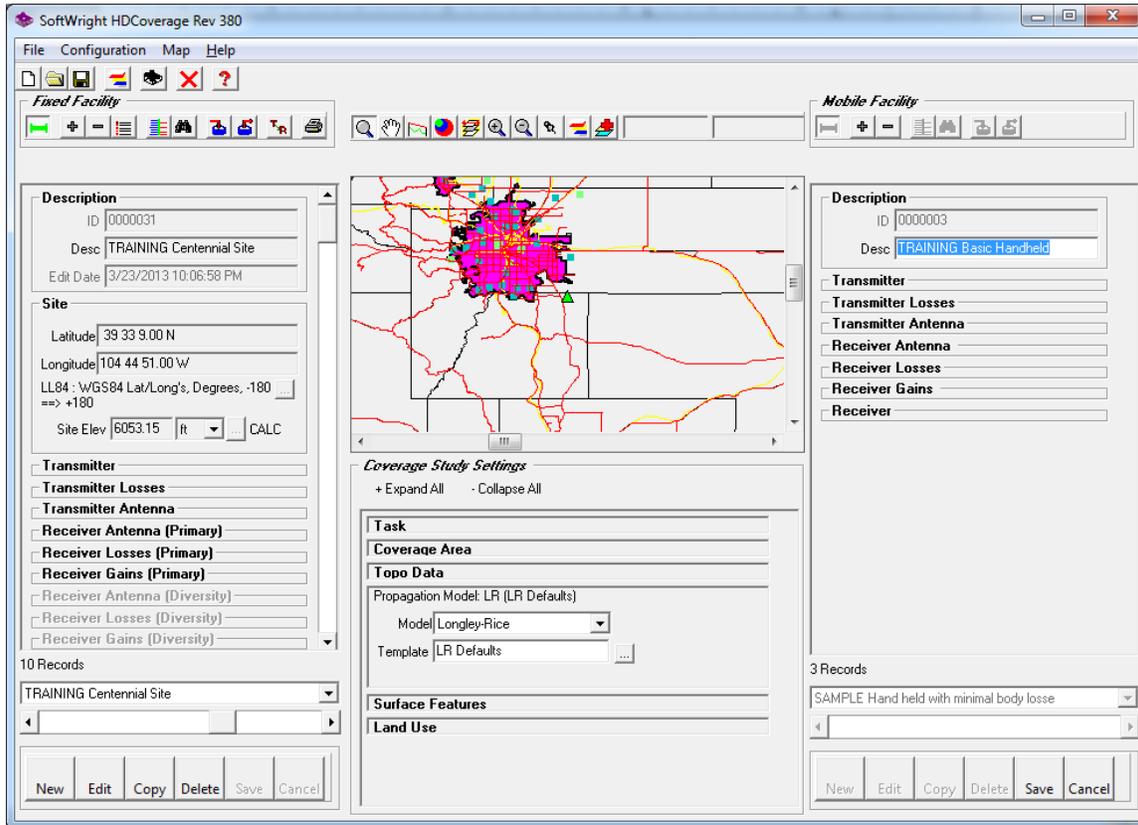
11. The selected template description is displayed in the Propagation Model section.
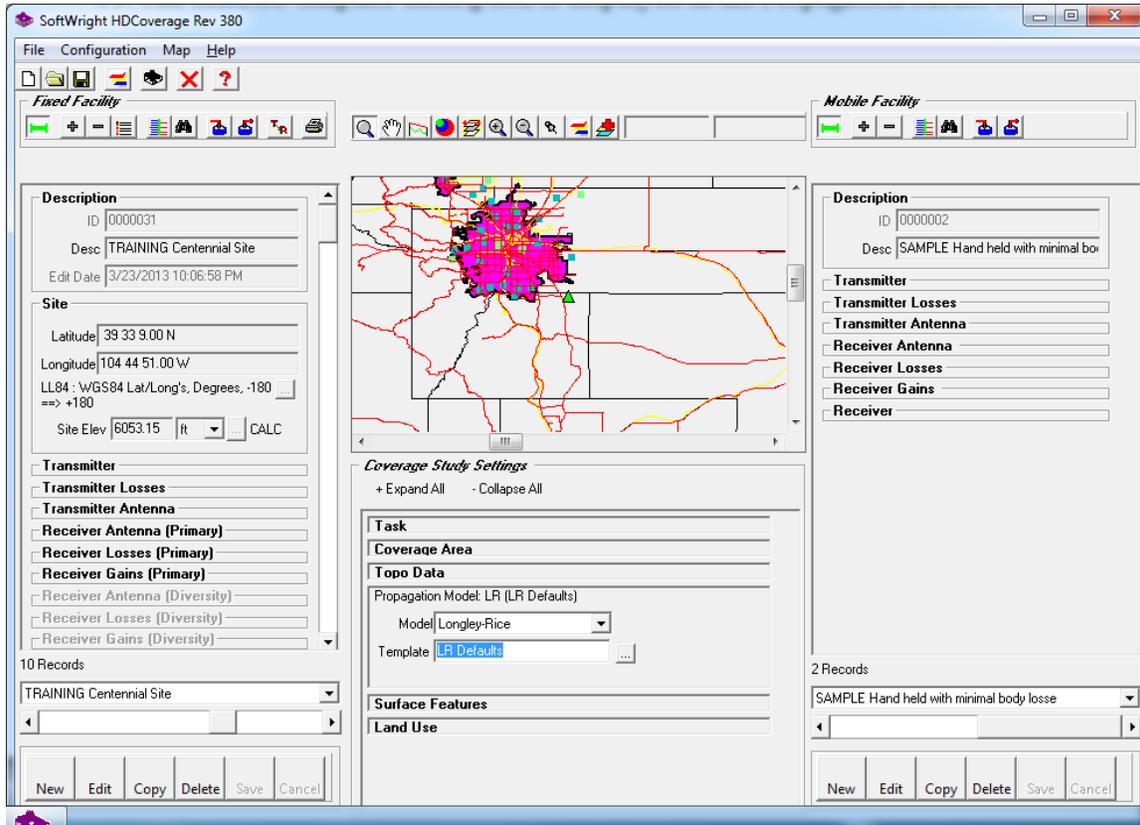
12. The Mobile Facility record needs to be created for the mobile we want for this study. In the Mobile Facility section on the right side of the HDCoverage form, click the New button near the bottom to create a new record:
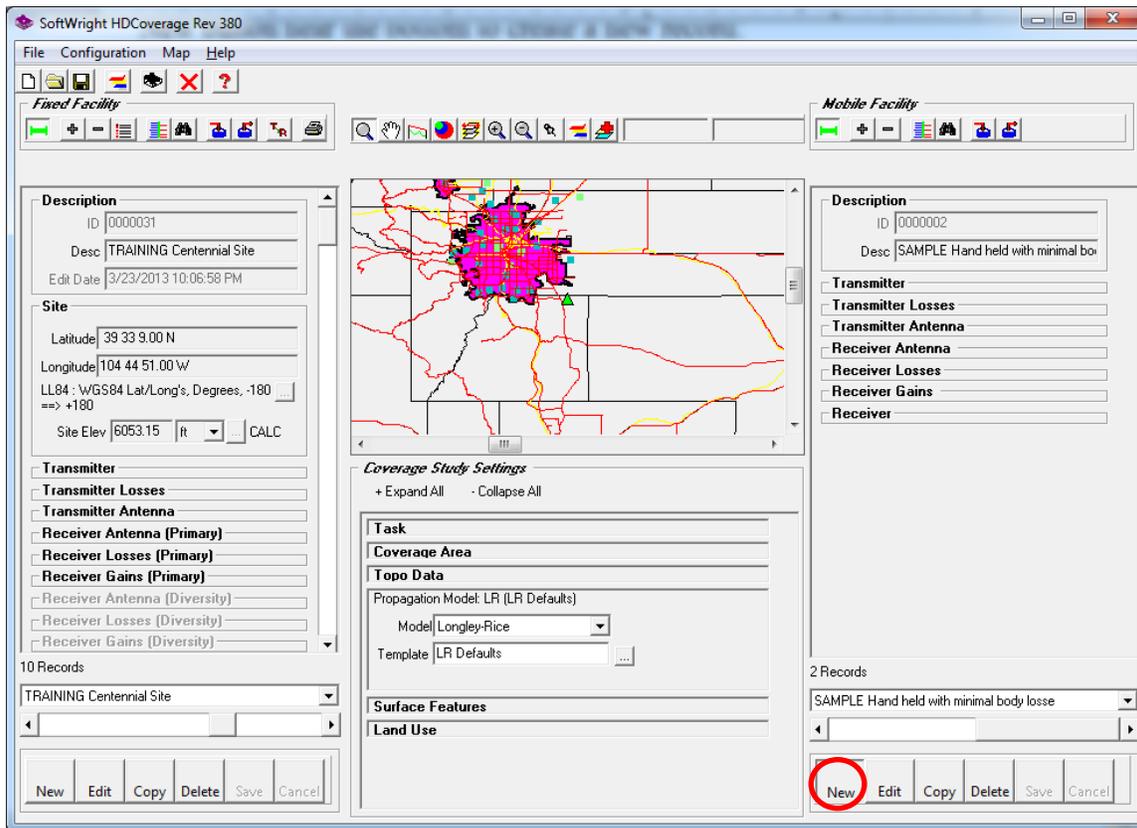
13. In the Description section, enter a description for the mobile: "Basic Handheld"

14. In the Transmitter section, enter the frequency (455 MHz) and the handheld power (1W). The power for the mobile is needed if we decide later to do TalkBack calculations:
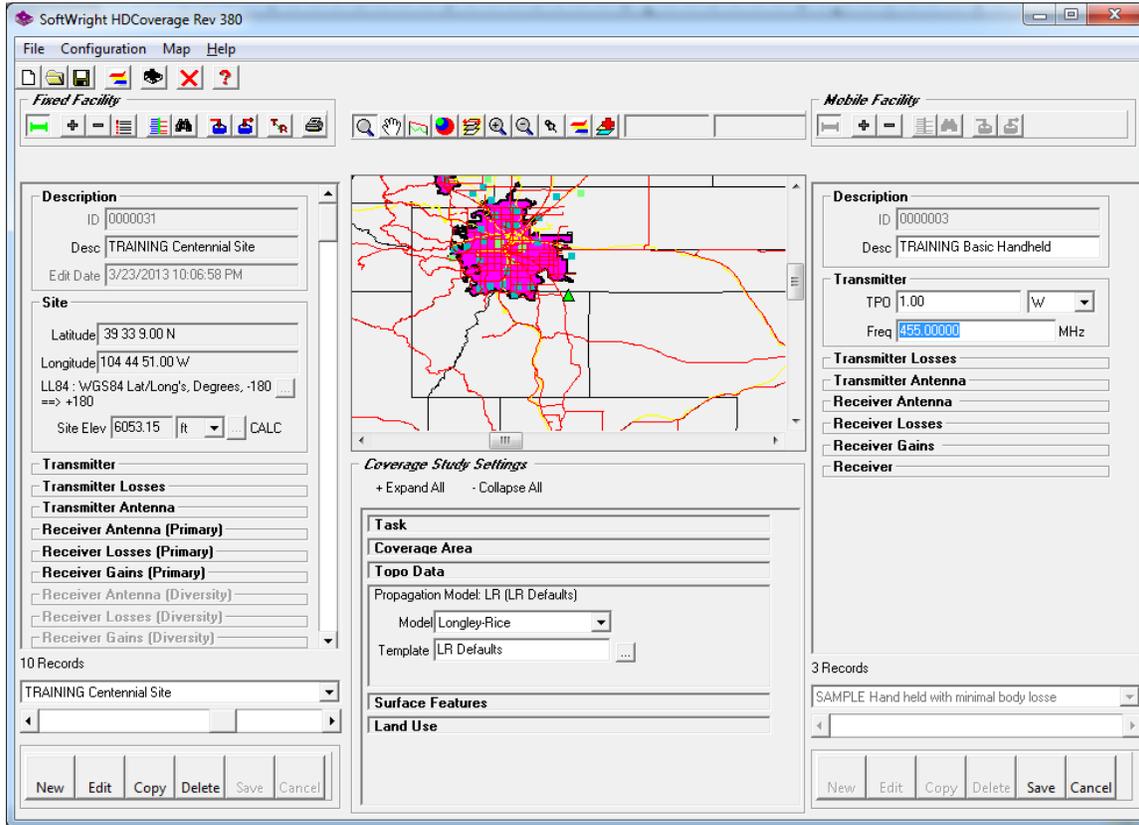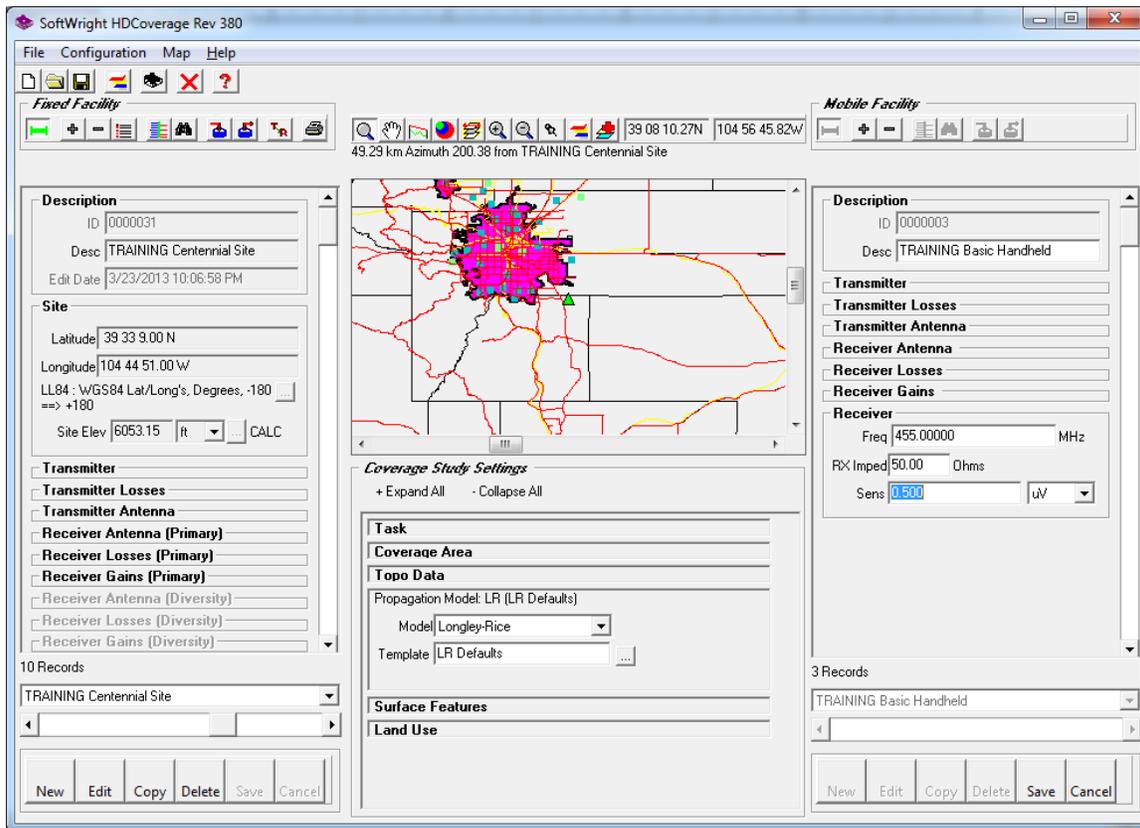
15. In the Transmitter Antenna section, enter the height for the mobile (6ft AGL) and the antenna gain (0dBd). (No Transmitter losses are included in this example.) Note that the ERP is computed (1W) based on the TPO and gains and losses associated with the mobile transmitter information. When you start entering values in the facility database, you may get warnings to let you know that you have incomplete information for a TalkOut study. You can disregard these. They will resolve when you fill in all of your information; they mostly serve as reminders.
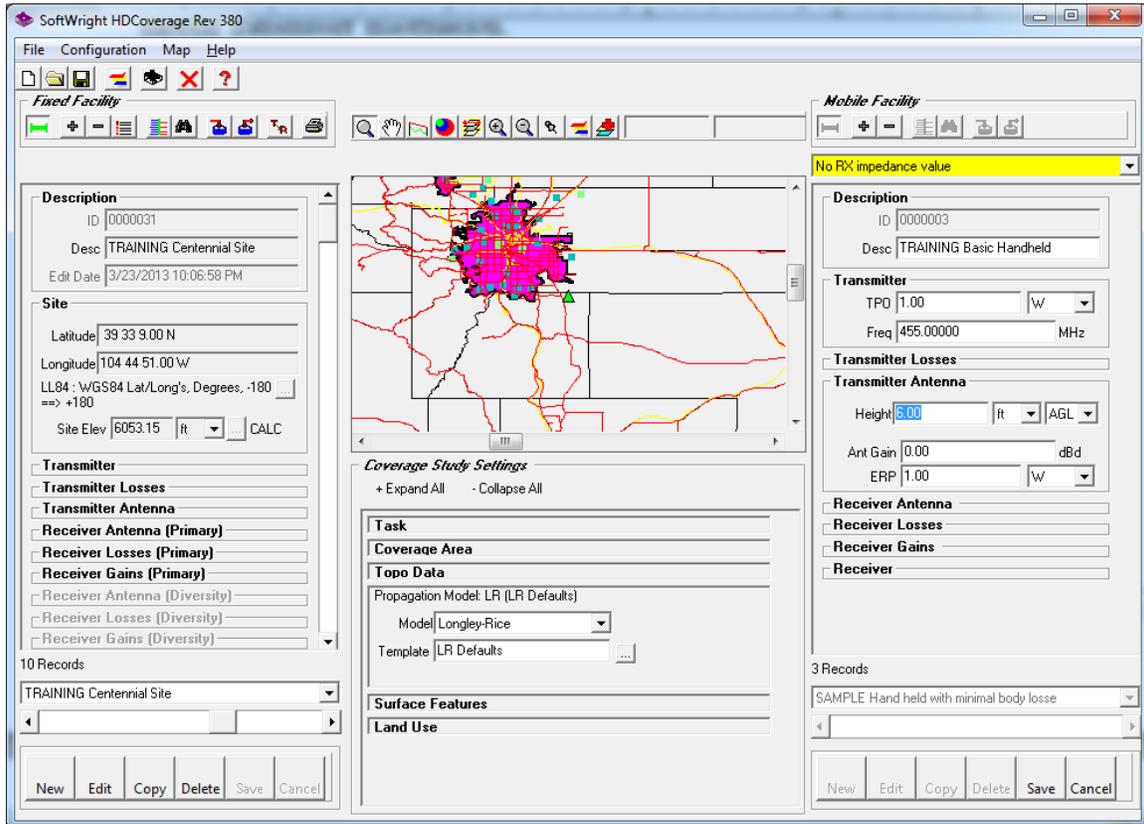

Note that for mobile units, the Transmitter Antenna height is used for both the transmit and receive mobile antennas.

16. In the Receiver section, enter the frequency (455MHz) and impedance (50Ohms). Be sure the Sensitivity units are microVolts (uV) and enter the 0.5uV value (Select the desired units first, then enter the value.):

17. In the Receiver Antenna section, enter the antenna gain (0dBd). Note that the Required Field value is computed based on the receiver sensitivity and the gain and loss values associated with the mobile receiver information.
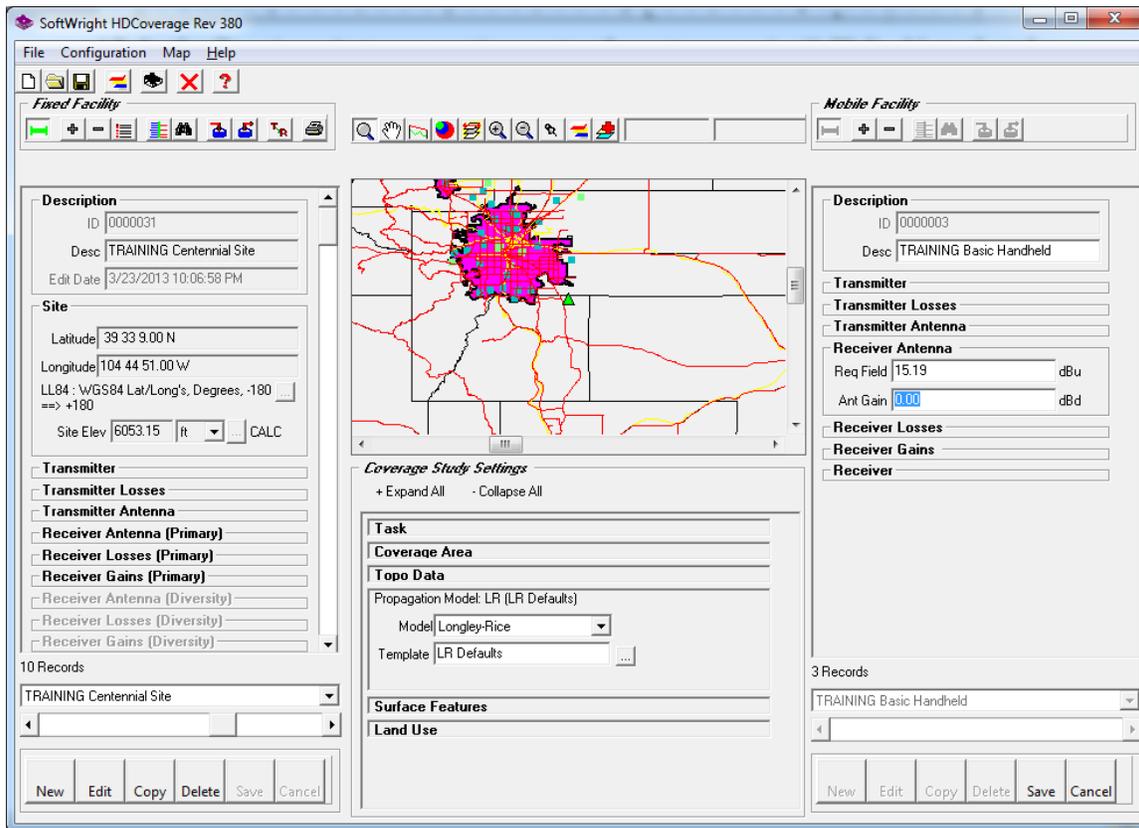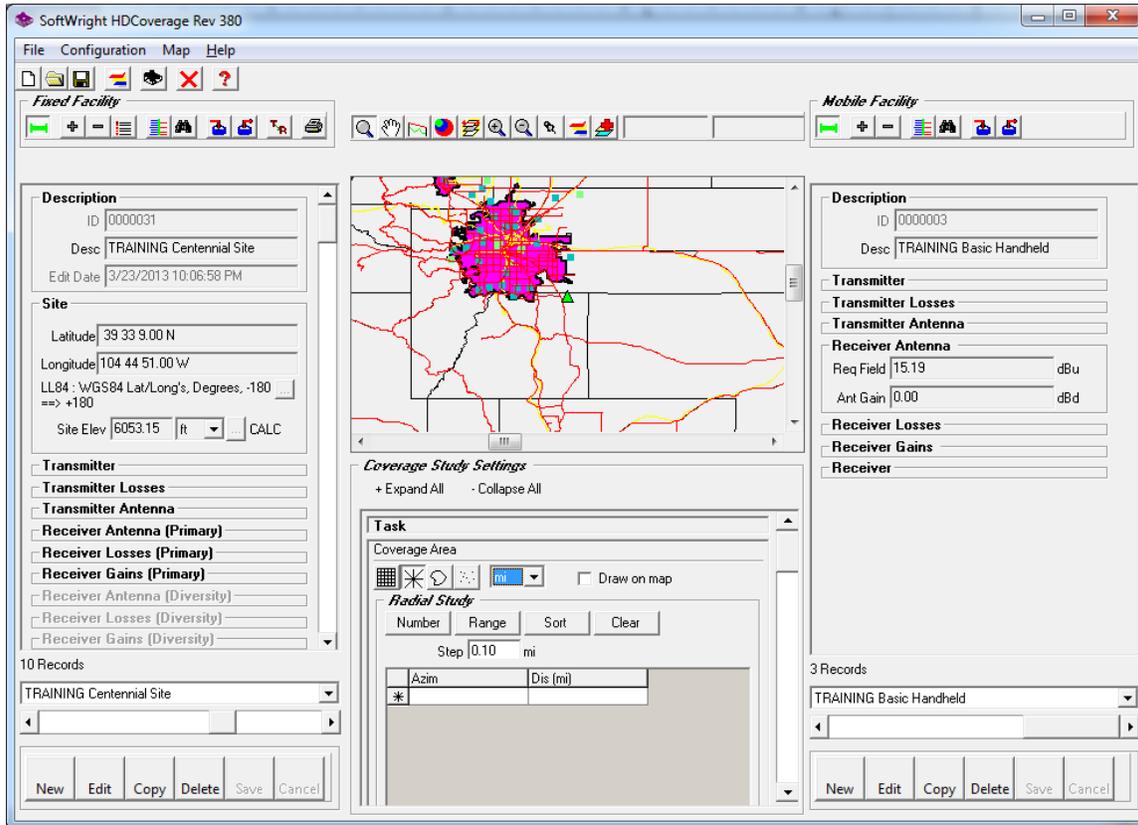
18. Click the Save button near the bottom of the Mobile Facility database interface to save this record.
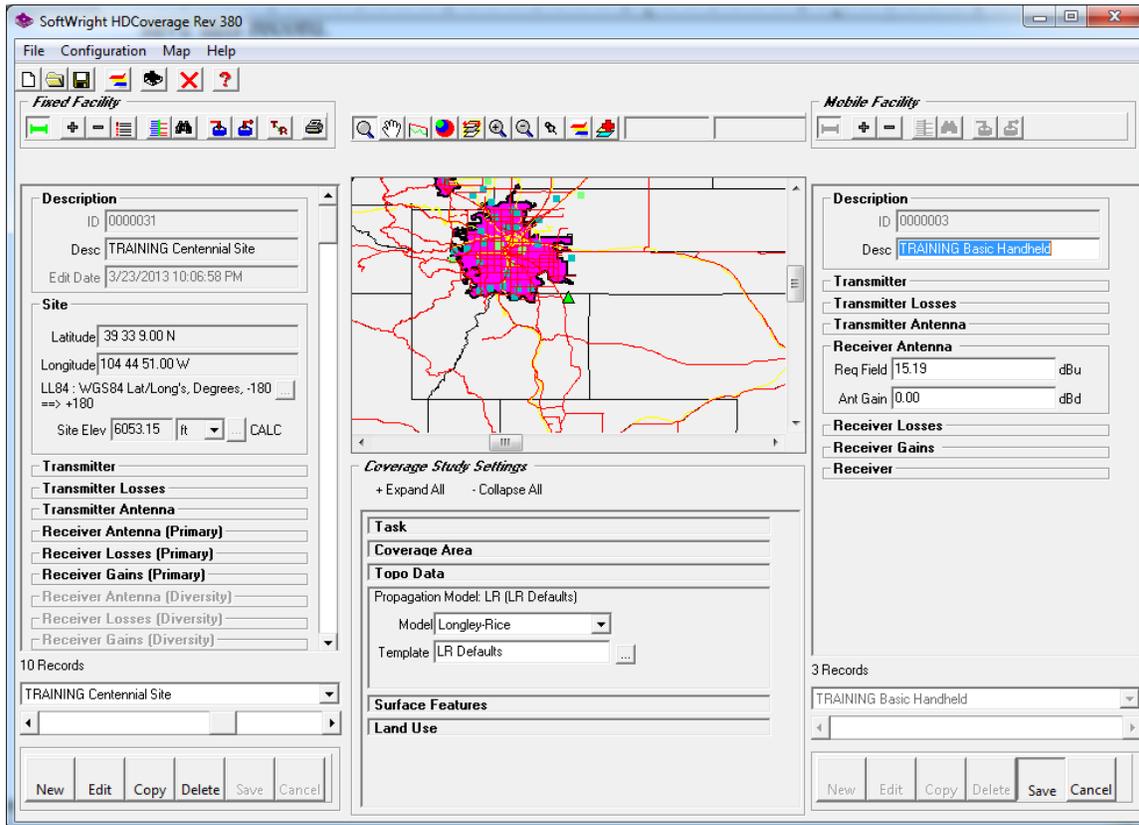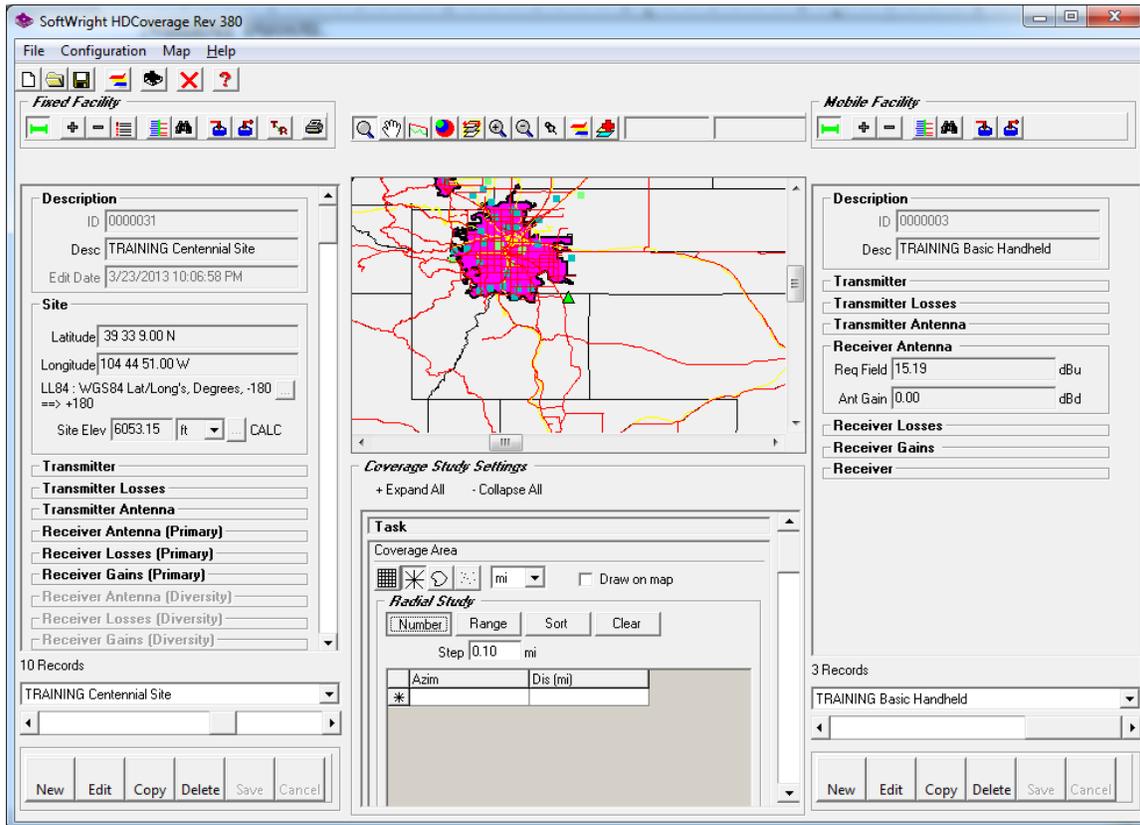
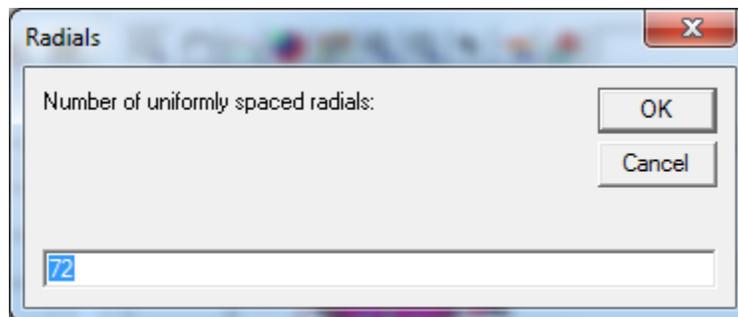19. In the Coverage Area section, click the Radial Study ✳ button:
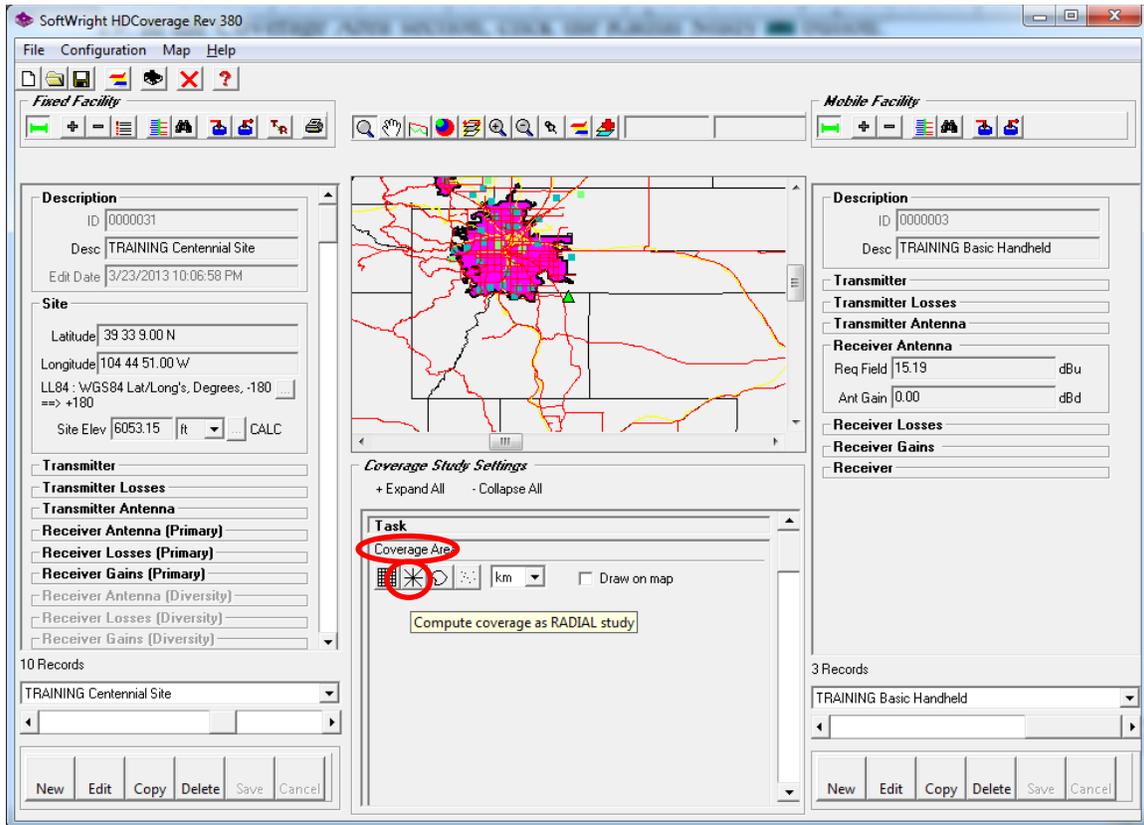
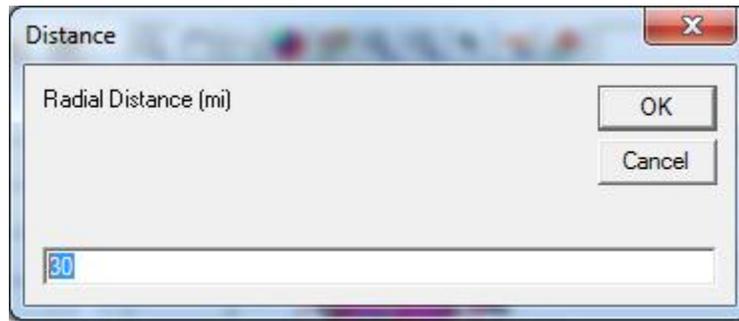20. Since the specifications for this example are in miles, be sure the units are set to "mi":

21. Since we want to compute the coverage along uniformly spaced radials, click the Number button:
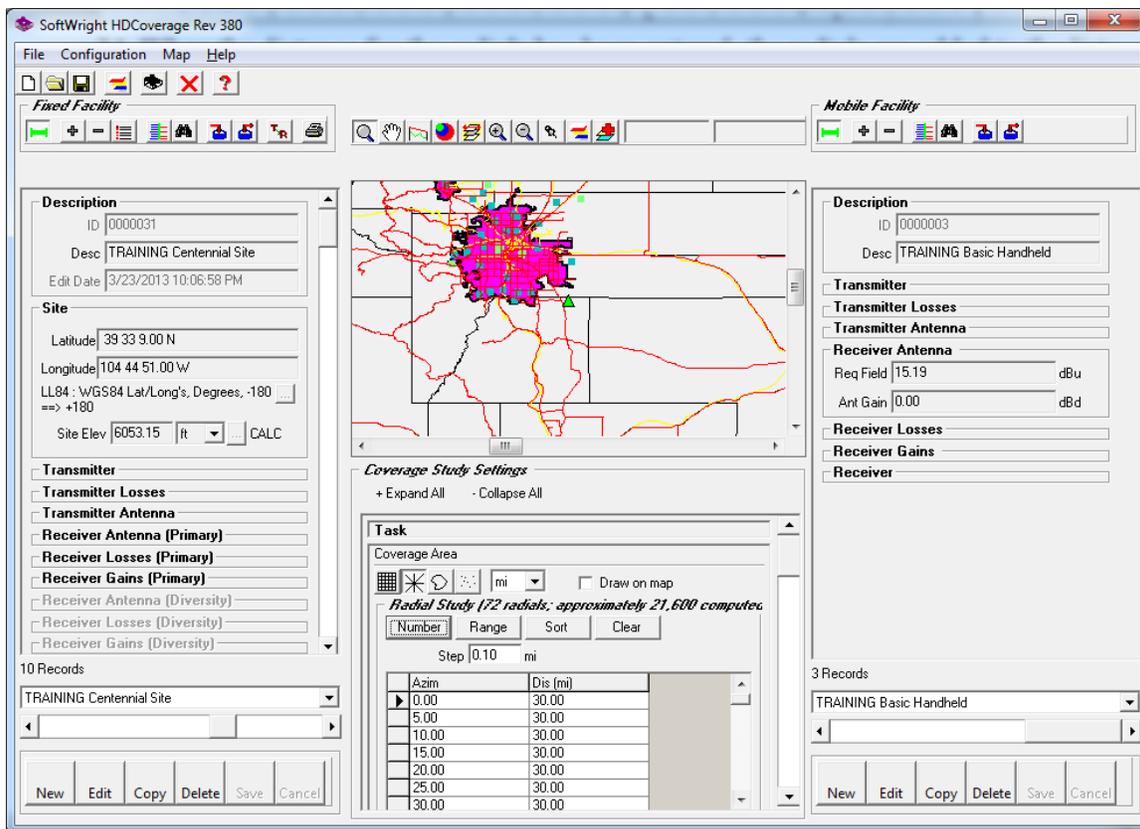

22. Enter the number of radials to compute (72 for this example):
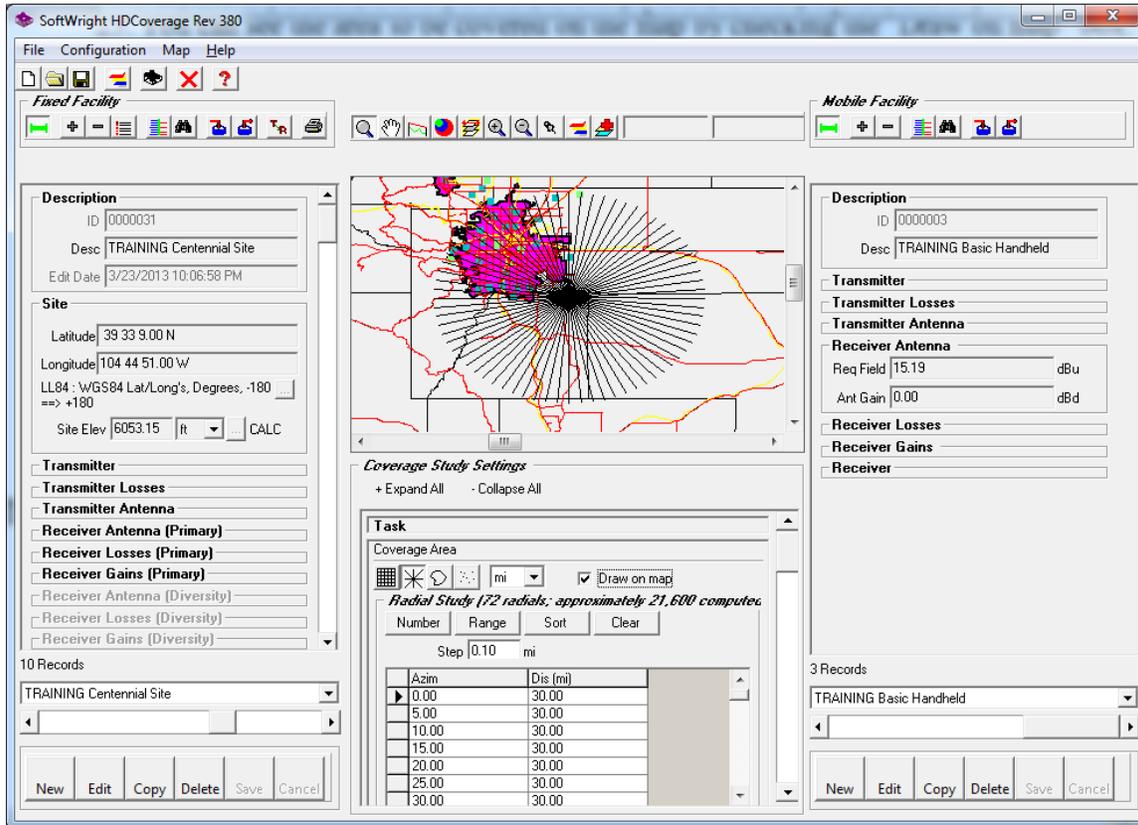
23. Enter the length of the radials you want to compute (30 miles in this example):

24. When the distance for the radials has been entered, the radials are added to the list:

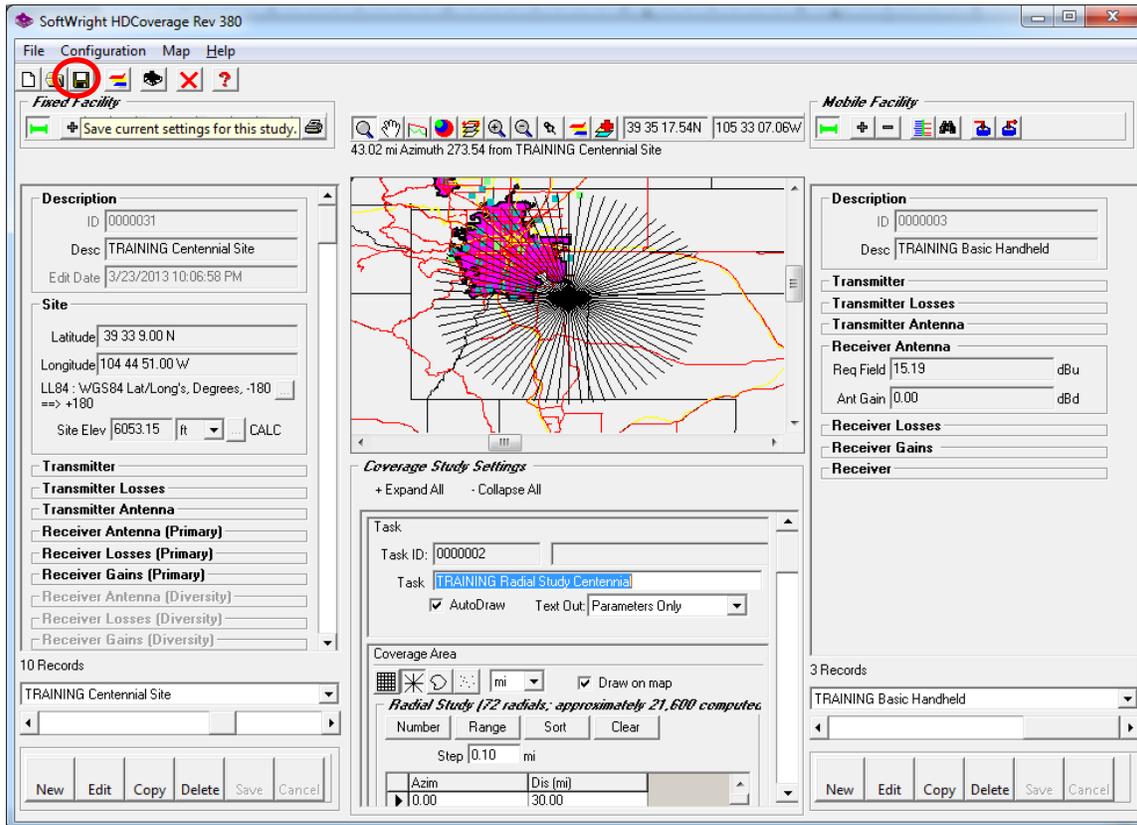25. You can see the area to be covered on the map by checking the "Draw on map" box:

26. On the toolbar near the top of the form click the Save button to save the parameters for this study:

27. Depending on your configuration settings for HDCoverage, you <u>may or may not</u> see the following warning message
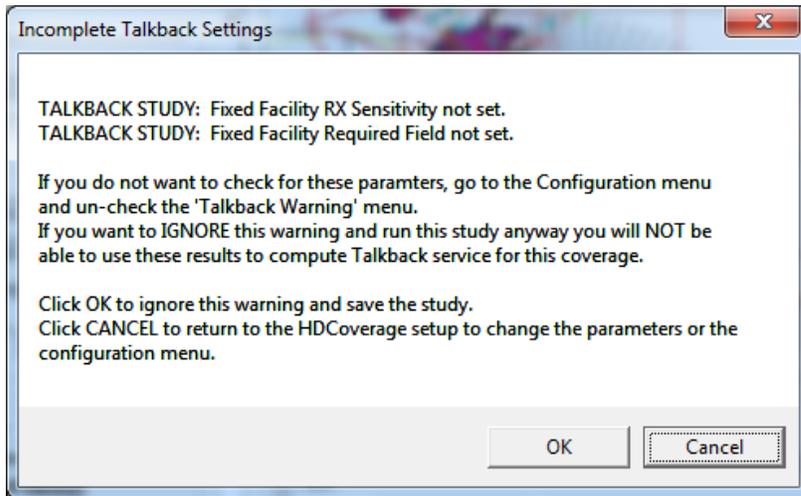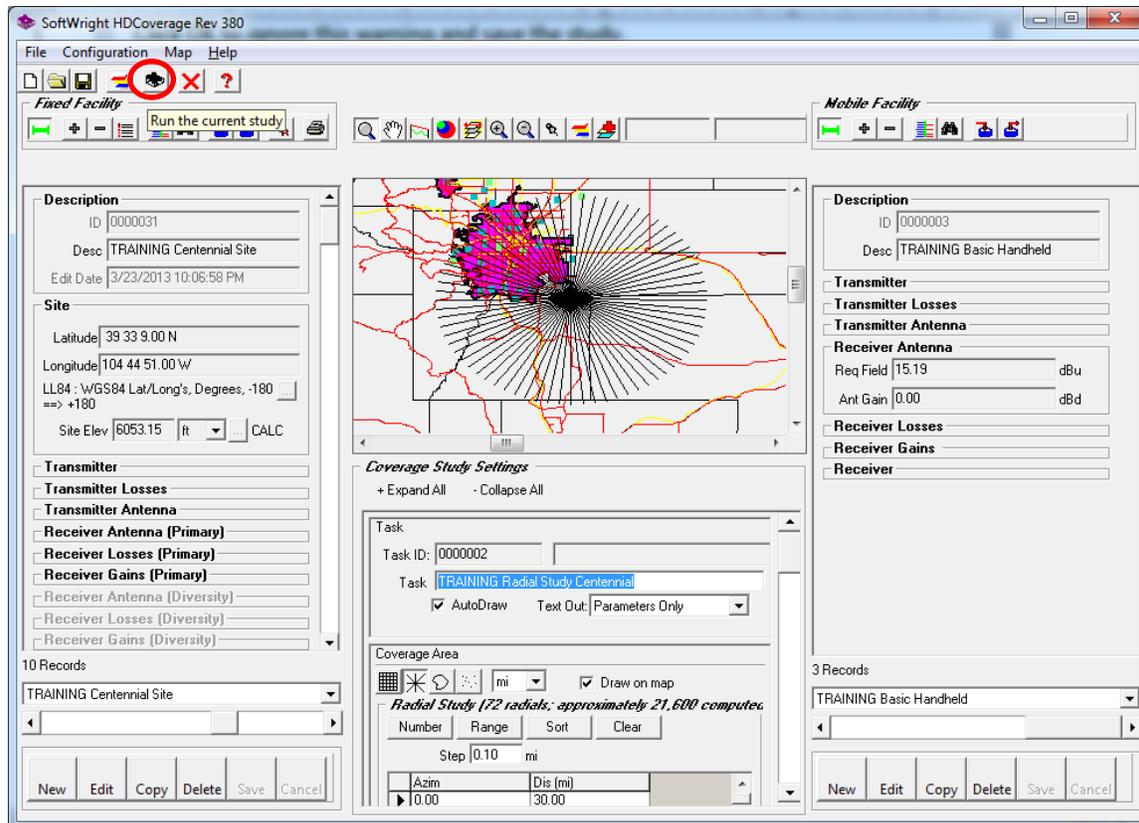

This message warns you if the settings needed for Talkback (sometimes called "Talk-In") have not been set. Since we will not be computing the Talkback for this study, click OK to continue. Talkback calculations will be discussed in Lab 800.)

28. When you are ready to run the study, click the Run button on the toolbar near the top of the form:
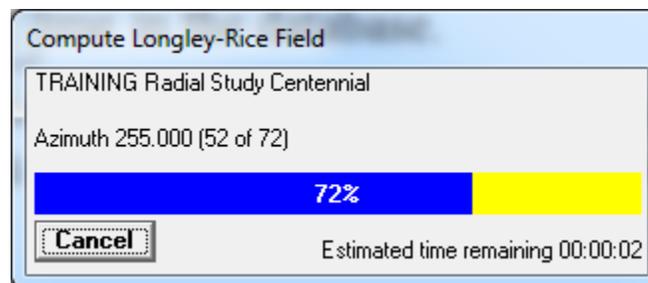
29. The Tasks to Run form will be displayed:
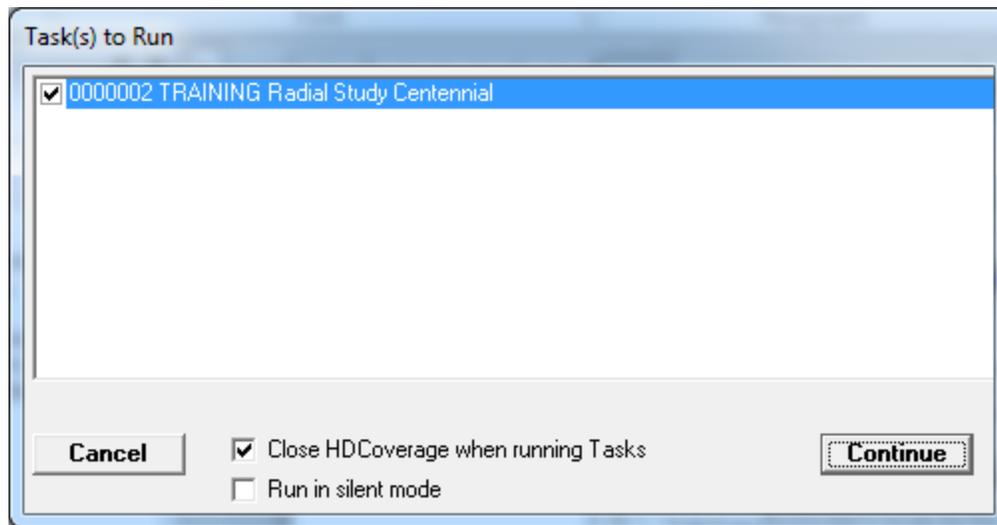
This form shows the Tasks that have been created but not yet run, with the Tasks created during the current HDCoverage session marked with a checkbox. To start the marked tasks, click the Continue button.

30. The study will take a few seconds to set up, then a progress form will be displayed:

31. When the study is complete, HDMapper will be loaded to display the coverage map. The map may be exported to Google Earth using one click of the Google Earth icon.
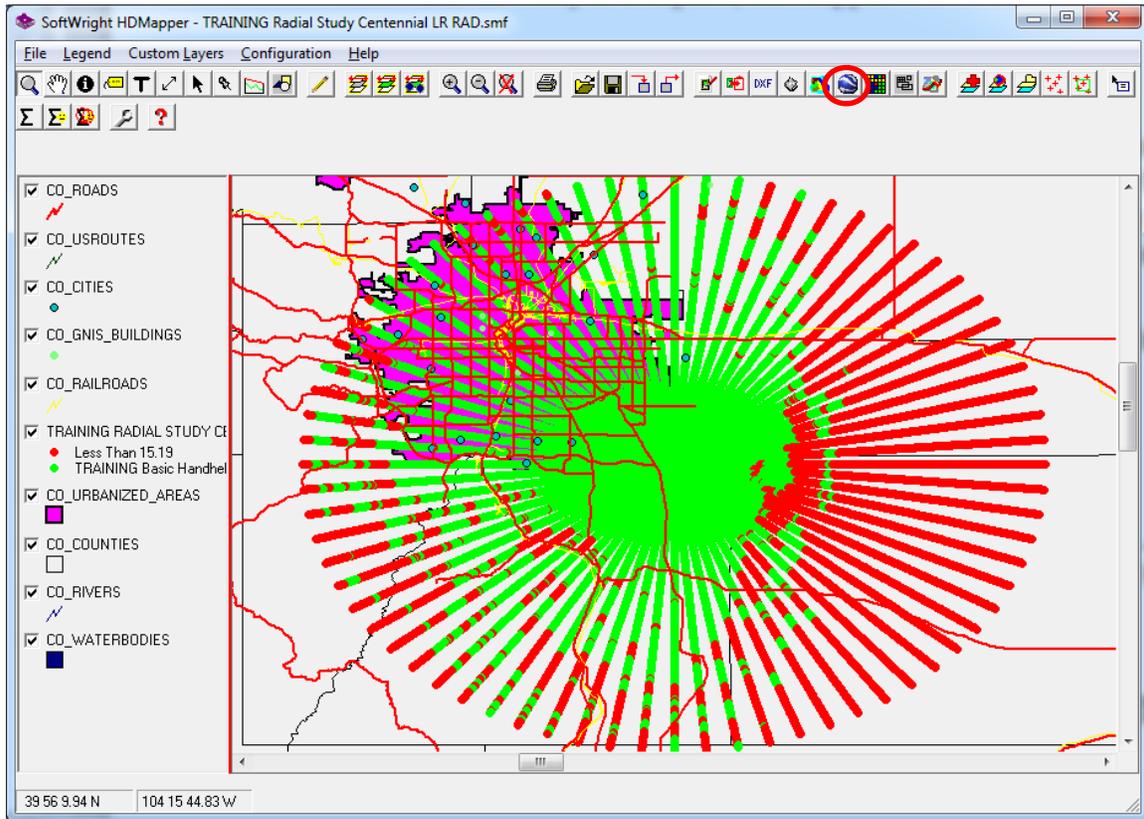
32. This map shows the results for the study, based on the Required Field value computed for the mobile facility. The locations marked in green (note the legend on the left) indicate points on the radials where the computed field strength meets or exceeds the required field value. At the red locations, the field strength is below the required value.

33. You can also display multiple field strength levels.