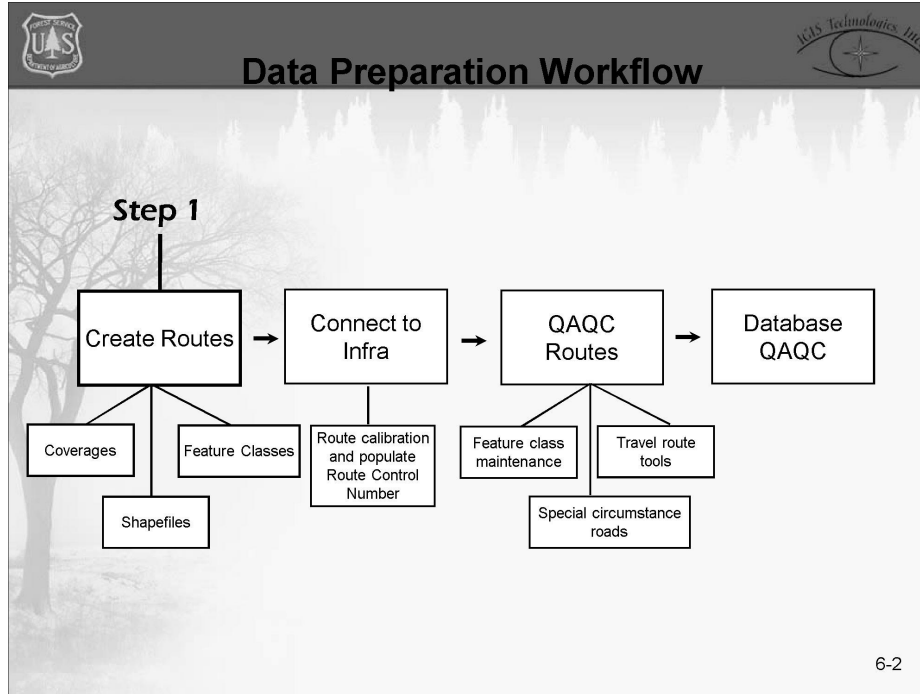






Defining and Creating Routes

Objective: To learn the distinction of routes and how to create them using basic line geometry.

6-1



The first step in working through data preparation is to create your routes. These are based on your roads and trails features that may exist in any of the different geospatial formats that you have maintained. You will be encouraged to create a geodatabase to hold your new roads and trails routes and then import the required layers into these feature classes. In order to create routes you will have to understand the connection between Infra attributes and the geographic features through the process of linear referencing described in this chapter.



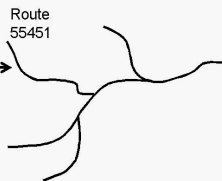
MVUM Routes

- Store relative positions along a measured line feature in addition to XY coordinates
- Linear measures called M values are stored in each vertex
- Allows linear referencing and dynamic segmentation

IWeb GDB TransportationOnly

- Transportation
 - Road
 - Trail
 - TravelManagementArea
 - TravelRoute_In

OBJECTID	Shape *	ID
1	Polyline M	55451
2	Polyline M	55506
3	Polyline M	54650
4	Polyline M	55337



Route 55451

↑
Linear feature

↑
Route label

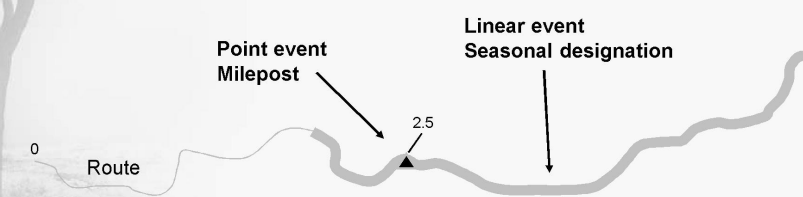
6-3

A route feature class is different from a standard Polyline feature class. Route feature classes have a shape value of Polyline M instead of just Polyline. The Polyline M value can be seen under the shape field of a route feature class attribute table. Routes have an M value that is assigned to every vertex of the line. In addition to XY coordinates, the M value for each vertex in the feature has a value representing its distance from the beginning of that arc. Routes allow for the creation of linear referencing and dynamic segmentation. Dynamic segmentation is the process of using the geometry of a route feature class to display data stored in an event table. This is done through the use of M values and manifests itself as symbolized segments along the MVUM route with different motor vehicle access rules. The event contains linear value data but no geometry. By using the geometry of the route feature class and its embedded M values, event table data can be displayed in an event layer. An event layer, also known as a route event source, is the product of the “add route events” tool which combines the route feature class and an event table. Attributes can be assigned to segments of the line according to the beginning and ending M values without splitting the arc.



Routes based on Linear Referencing



- Locates relative positions along a measured line feature
- Can assign many attributes to portions of a line
- No splitting of underlying line feature



6-4

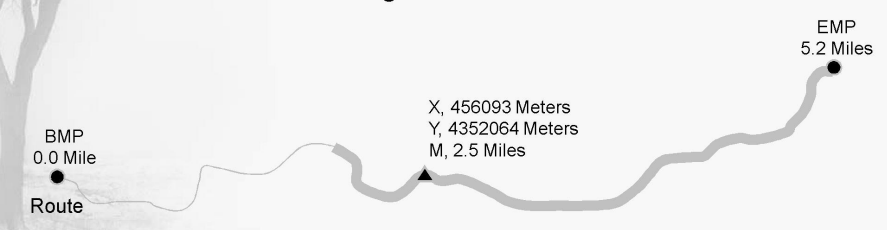
In order to plot events, linear referencing uses relative positions along measured linear features described as M values. A non-route feature would use an XY coordinate system when plotting features. An example of the difference would be recording the location of a No Access sign along a road by how many miles it is from the beginning of the road instead of using latitude and longitude coordinates. Linear referencing is helpful because it is often a logical way to relate associated locations along a linear feature such as a sign, bridge, or tunnel. Linear referencing also makes it possible to associate multiple sets of attributes to a line feature without segmenting or splitting that feature each time an attribute value changes. Linear referencing is used to denote either a point or linear distance along a route. MVUMs use linear referencing to display data such as milepost markers and seasonal designations of individual route segments. In the example above, a point event is downloaded from an Infra table and marks a point 2.5 miles from the beginning of a specified route segment. This could signify a change in seasonal access.

Defining and Creating Routes





Create Linear Events

- All route segments are calibrated according to Infra
- MVUM linear events
 - Jurisdiction
 - Route status
 - System
 - Seasonal designation



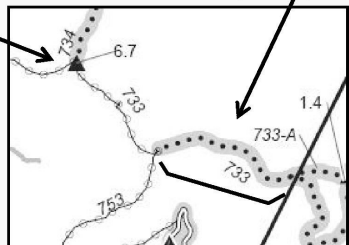
6-5

The ability to create linear events is one of the primary benefits of using feature classes formatted as routes. Data displaying jurisdiction, route status, and the route system are all linear events found on MVUMs. Linear events are created by combining a route feature class that has been calibrated with an event table using the Add Route Events tool. The route feature class contains the geometry while the event table provides all of the data for that event such as beginning and ending measurements and the specific route ID where the event occurs. The calibration process assigns a linear distance measure called an M value to each vertex of the arc. This unit of value can be any unit of measure. MVUM M values are in miles while the map units are meters. By referencing the M value assigned to each vertex of an arc, the beginning and ending points of linear events are determined. Ultimately, a segment of an arc will display specific symbology (the event) without being split. In MVUMs, Infra data in the form of event tables are matched up with route feature classes. The product is an event layer that can be saved as a feature class. This feature class is ultimately symbolized on the end product MVUM.



Linear Route Events vs. Point Routes Events

Point Event	Linear Event
<ul style="list-style-type: none">Requires route ID and a single measure value, ID = 734 BMP = 6.7Ticmark represents a change referenced in the designation tables	<ul style="list-style-type: none">Requires route ID, from and two measure values, ID = 733 BMP = 7.7, EMP = 9.3Represents changes in jurisdiction, route status, system, MOT





6-6

Route events can either be linear or points. For linear route events to be plotted, three fields must be populated: route identifier, from measurement (BMP), and to measurement (EMP). BMP = Beginning Mile Post and EMP = Ending Mile Post.

The route ID field contains the name of the route that the event occurs on. The ID field is also used to label the routes. The from and to measurements tell where the event begins and ends on the route and are located by referencing M values of vertices along the arc. M values are measurements of length starting at the arcs origin. The Event's position is then interpolated between these calibrated M values. An example of a linear route event would be a section of a route that has a change in mode of travel. An example of a point event would be a Milepost ticmark along a roads route signifying a change in seasonal designation. A point route event requires the route identifier field but only the from measurement.

Defining and Creating Routes



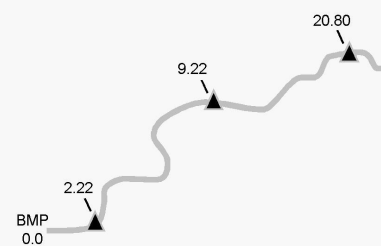
Point Event Table

- Two required fields
 - Route ID- identifies the route the event is located
 - Measure- the location along the route the event occurs
- Milepost Ticmarks are point events

Infra Tick Road Allow V table



RTE_CN	BMP
1324010397	2.22
1324010397	9.22
1324010397	20.804

Route identifier Location



6-7

Point event tables have two required fields: the route control number where the event occurs and the event's location. MVUM routes are identified by their route control number in the RTE_CN attribute field. One point events found on MVUMs are Milepost ticmarks. Milepost ticmarks are used to show a change in designation along a route when no change in the line symbology is made. This commonly occurs when seasonal restrictions occur for segments of a route. Ticmark data is stored in Infra tables. In general the use of ticmarks are seldom seen on MVUMs. Because it takes an uncommon situation for a ticmark to occur, it is likely many Forests will not have an occurrence of them on their MVUMs. Other features along a road may be displayed as point events are culverts, bridges, signs and cattle guards. These are all things that are represented as a single point along a route, features with no real length measurement.




Line Event Table

- Three required fields
 - Route ID – identifies the route on which an event occurs
 - From Measure (BMP) and To Measure (EMP) – identifies the location along the route the event occurs
- MVUM linear events are:
 - Seasons
 - Jurisdiction
 - Strategy
 - Designation

RTE_ID	BMP	EMP
1331010397	37.547	57.372
620010397	36.64	42.27
620010397	32.65	33.17

Route Identifier From Measure To Measure

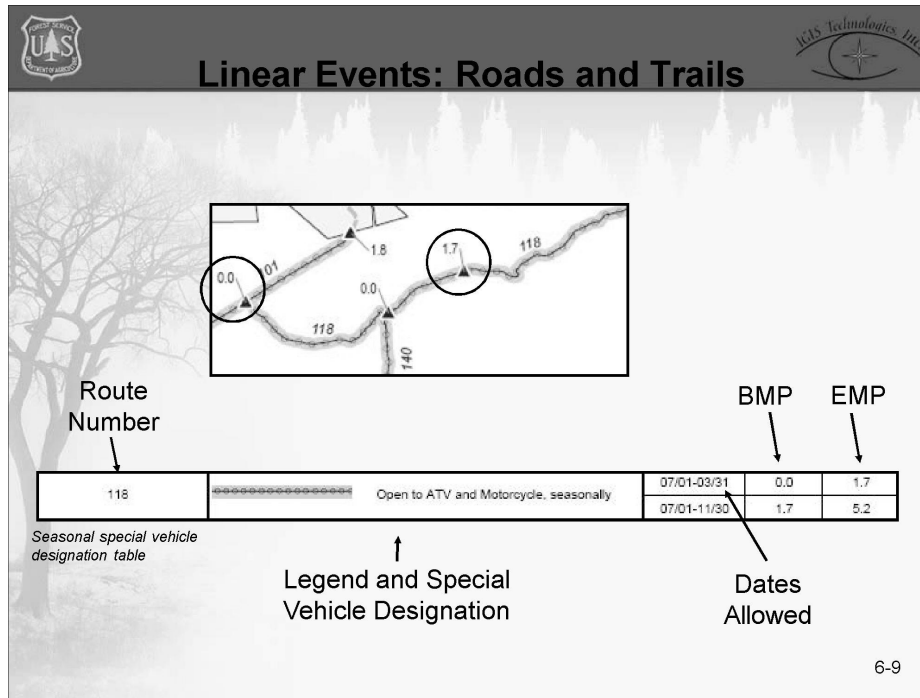


620010397 36.64 Seasonal Designation 42.27

6-8

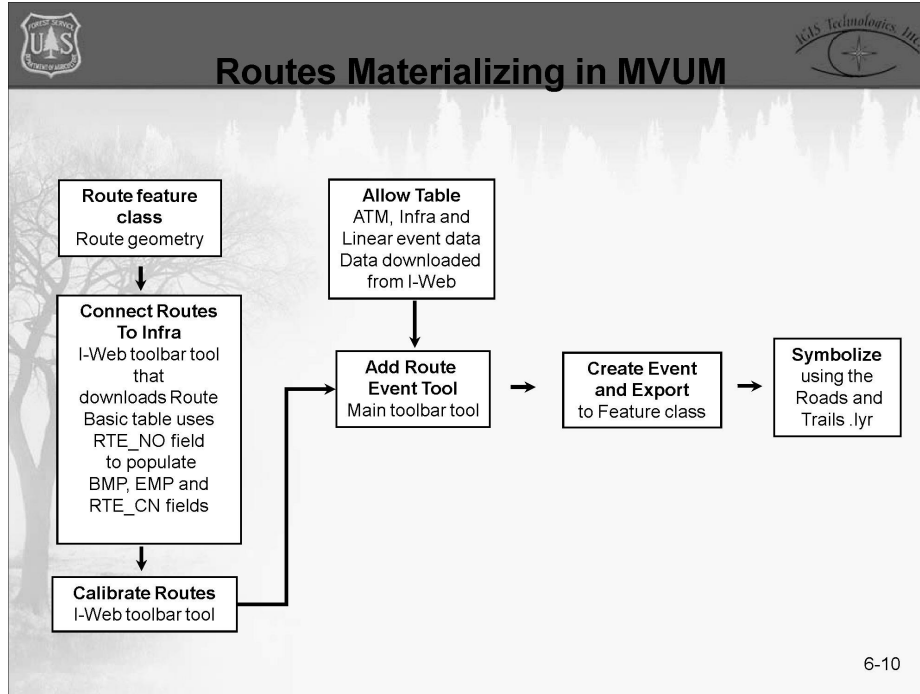
Line event tables require three fields to properly place a linear event: route ID, to measure (BMP), and from measure (EMP). The route ID field identifies the route the event occurs on. The from and to measurements tell the location the event will start and end along a route. MVUMs contain many linear events that display information about routes such as: what season the route is open, the jurisdiction of the route, the strategy of the route, and the designation of the route. The Allow table in Infra is used to incorporate linear events into MVUM route feature classes. In the segment portrayed by this graphic, the linear event might be denoting where high vehicle clearance is required.

Defining and Creating Routes





Linear events display many different attributes. In this example, milepost ticmark point events on route 118 show changes in 'dates allowed'. According to the seasonal and special vehicle designation table, route 118 from mile post 0.0 to 1.7 is only allowed to be used from July 1st, to March 31st. The table also states that on the same route from milepost 1.7 to 5.2 access is allowed from July 1st through November 30th. This example shows how both point and linear events are used together to convey the dates allowed.

Defining and Creating Routes




Here is an overall description of the route creation workflow. The two categories of routes found in MVUMs are trails and roads. Each type of route uses its own route feature class. These routes are used to create linear and point event layers. The process to get the final route feature class requires many steps. The route feature class must have the existing GIS data loaded into it. Using the I-Web Spatial Editor Travel Routes toolbar, the routes are connected to Infra and the Route Basics table is downloaded. The route feature class gets populated with the Route Basics table values for BMP, EMP and RTE_CN fields. The Route Basics table uses the Route_NO field to connect and populate the feature class fields.

The RTE_CN is used for all future 'connections' to tabular data. The routes are then calibrated using the "calibrate selected routes" tool in the I-Web toolbar. The "Add Route Event" tool in the main toolbar is used to combine the Allow table downloaded from I-Web to create an event layer. The Allow table contains Infra, ATM, and linear event data. The event layer created from the "Add Route Event" tool is exported to a feature class. This feature class is used as the source data that becomes symbolized by the standard Roads and Trails .lyr file provided by GSTC. This Roads and Trails .lyr file assigns the correct symbology to both the roads and trails feature classes and their linear events. It is important to know that this process creates a static layer representing Infra at one moment in time. So the process will need to be performed again to either see new updates in ATM values or to generate the MVUM for the annual update.



Open Areas to Cross Country Travel

- Polygon feature class
- Open to cross country travel
- Blanket statement can be used instead of a table if:
 - All areas open to cross country travel have the same mode of travel and date designation

Legend
 Areas Open to Cross-Country Travel

Blanket Statement
The Manti LaSal Travel Management Area(s) is open to Highway Vehicles only from 01/01 to 12/31.

Sample Table

Travel Management Areas		
Area Name	Vehicles Allowed	Season of Use
Pelican Point	All non highway vehicles < 50" wide	05/15 - 10/30



6-11

TravelManagementArea is a polygon feature class in the Transportation dataset, in the IwebGDB. It was created to display on the MVUM, Areas Open to Cross Country Travel. When it is joined with the view II_Travel_Mgt_Area_V, it contains the same Mode of Travel fields as does the RoadAllow trail or the TrailAllow table. The Infra data is entered in the Land Unit form and the Land Unit Subtype is 'Designated Mtr Vehicle Area'. The ATM form can be accessed from this Land Unit form and information on Modes of Travel and Dates are entered, as if this was a road or motorized trail. If all Areas Open to Cross Country Travel have the same mode of travel and date designation then a blanket statement should be used. A blanket statement should be entered into "Blanket Statements for Travel Management" box in the collar of the map using the wording below.

The (insert: *Area Name*) Travel Management Area(s) is open to (insert: *Vehicles Allowed*) from (insert: *mm/dd*) to (insert: *mm/dd*).


If Areas Open to Cross Country Travel have more than one mode of travel and date designation, label the areas on the map, and create a table describing them. This table is created by hand and the vehicles allowed should be described in the same manner as in the Seasonal/Special Designation table.

Defining and Creating Routes



IWeb GDB TransportationOnly geodatabase



- Domains – CulturalSite Type, FSMetadata_DATA_SOURCE, ROS_CODE, ROUTE_ACTION, SOURCEdomain, TravelManagementStatus
- Transportation feature data set - houses transportation feature files
- Road feature class - road route data
- Trail feature class - Trail route data
- TravelManagementArea feature class - Polygon file that shows where cross country travel is allowed
- TravelRoute_In feature class – Optional Storage location for additional route GIS data



6-12

The IWeb GDB TransportationOnly geodatabase shown in this slide and used in the exercises is a stripped down version of the National Transportation GDB available for download.

When working on your forest you can download the National Transportation GDB and stripe out what you don not need to create a scratch geodatabase to develop your routes. This geodatabase is provided with a feature dataset and core feature classes that are attributed with the required fields. Some of the attribute fields in the feature classes have domains assigned to them. These domains help to make the data preparation faster with less potential for errors. The Transportation feature dataset is made up of four feature classes. Each feature class holds a theme of transportation data. The Road feature class is made up of MVUM road routes. The Trail feature class is made up of MVUM trail routes. The TravelManagementArea feature class is made up of MVUM areas open to cross country travel. The last feature class, TravelRoute_In is made up of data such as historical reference material, spatial representations of planned roads, duplicate roads from the Roads feature class or other local custom attributes that the forest finds useful. The use of this file is optional and is intended as a holding place for useful additional data.





Road Feature Class Schema

The following Road attributes are required for route calibration

- RTE_NO – route control number
- BMP – beginning milepost
- EMP – ending milepost
- RT_ACTION – records the status of route calibration (ROUTE_ACTION domain)
- ACTIONSTAMP – date of calibration


6-13

The Road feature class is provided with all of the necessary attribute fields for data preparation. Two of the attribute fields have coded value domains assigned to them. The DATA_SOURCE field has the FSMetadata_DATA_SOURCE domain assigned to it. This field records the data source: GPS uncorrected Data, digitized from hardcopy PGS/SEQ, remotely sensed images, and so on. The RT_ACTION field has the ROUTE_ACTION domain assigned to it. This field records the status of the calibration of the routes. It will commonly have a value of 'calibrated' or 'Null' (indicates that calibration still needs to occur). The ACTIONSTAMP field contains the date when the "Calibrate Selected Routes" tool was used. These last two fields are calculated automatically.





Demo

Load data into template routes feature class from:
Feature classes, Shapefiles and Coverages




6-14



Exercise:



Load data into the Road feature class

- Goal: Review the IWeb GDB TransportationOnly geodatabase and load GIS data in the Road feature class



1. Review the schema of the IWeb GDB TransportationOnly geodatabase and Road feature class
2. Load existing GIS data into the Road feature class

6-15



Summary

- ☑ Routes are calibrated with M values that hold units of linear measurement.
- ☑ Linear referencing represents lines and points by using Infra linear event.
- ☑ Dynamic segmentation virtually segments route geometry using Infra event table data.

6-16

Exercise 6: Loading Data into the Road feature class



Exercise goal: Review the schema of the IWeb GDB TransportationOnly geodatabase and load the road data into the Road feature class.

Why is this important? Existing road GIS data may exist in multiple files for a forest. This data needs to reside in a single route feature class that has all of the required attribute fields.

Upon completion of the exercise, you will be able to ...

- ✓ Navigate and be familiar with the IWeb GDB TransportationOnly geodatabase and the feature classes it contains
- ✓ Load existing roads data into the Road feature class provided

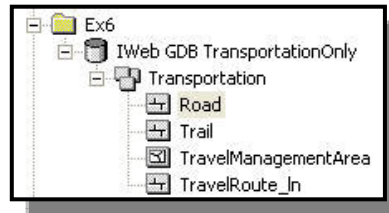
STEP	DESCRIPTION	PAGE
1	Review IWeb GDB TransportationOnly geodatabase schema and feature classes	6 – 18
2	Load existing roads data into the Road feature class	6 – 21
3	Resource for downloading the template geodatabase and feature classes	6 – 24

Step 1: Review IWeb GDB TransportationOnly geodatabase and feature classes

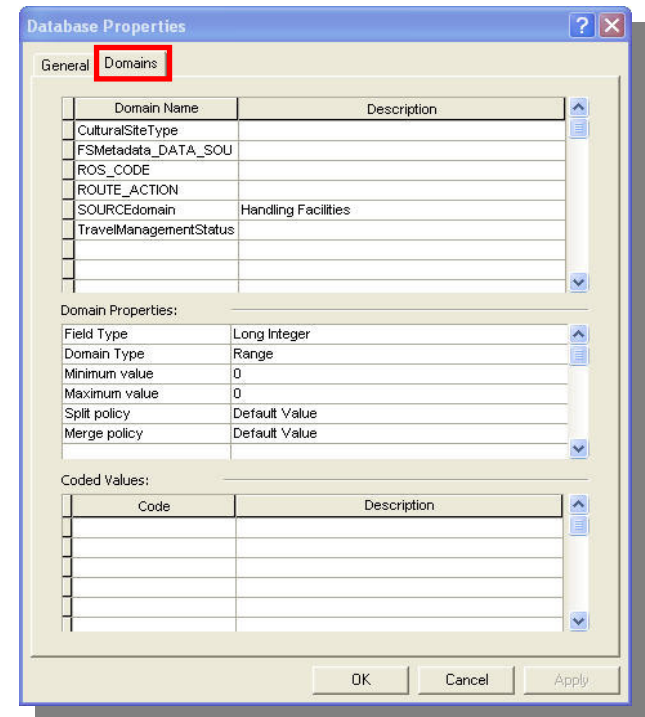
The IWeb GDB TransportationOnly geodatabase comes with established domains and feature classes. The predefined domains of the geodatabase along with the accompanying feature classes, aid in the preparation of MVUM data by providing a template data schema.


- a. In ArcCatalog navigate to the IWeb GDB TransportationOnly geodatabase located in the Ex6 folder. Expand the geodatabase and the transportation feature dataset.

This geodatabase is a template to use for MVUM data preparation and production. MVUM specific domains and feature classes are already setup in this geodatabase.



- b. Right-click on the IWeb GDB TransportationOnly geodatabase and click on **Properties** at the bottom of the drop down list to open the Database Properties window.
- c. Click the **Domains** tab in the Database Properties window. This window shows the domains and the coded values already established for each in the IWeb GDB TransportationOnly geodatabase.



 **NOTE:** When an attribute field of a geodatabase has a domain assigned to it, the coded values for that domain become a dropdown list for that field in the attribute table. Only data listed in the coded value column can be selected for that attribute.


Question:

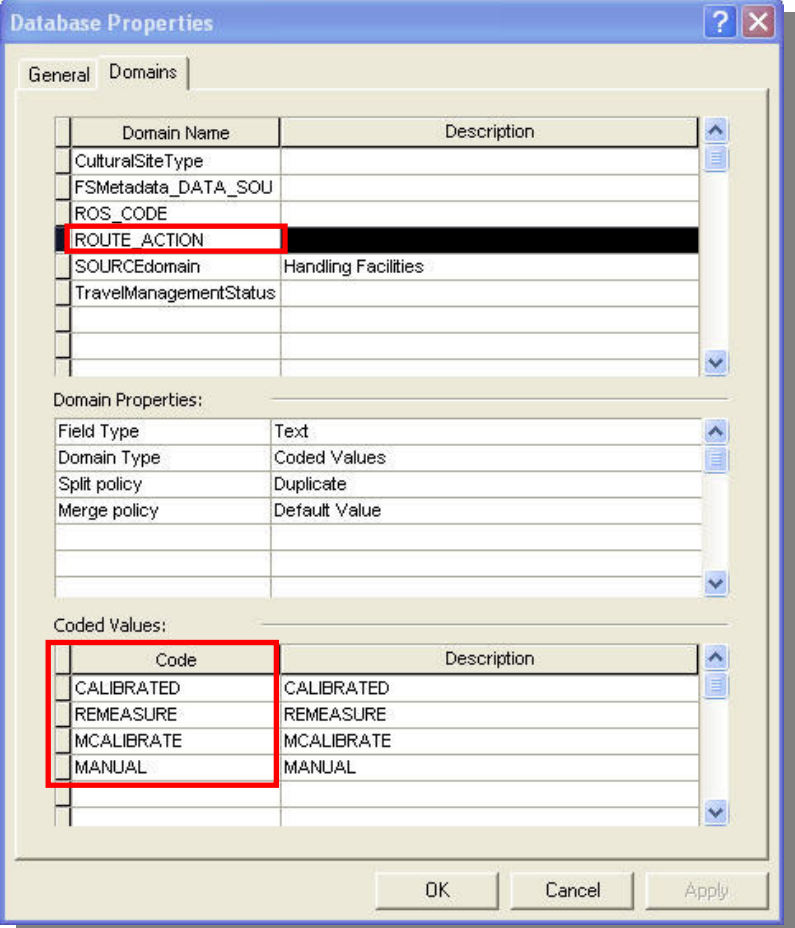
1. What is the TravelRoute_In feature class used for?

Defining and Creating Routes

- d. In the Database Properties window click on **ROUTE_ACTION** under Domain Name. Look below to see the values that appear under **Coded Values**. When the ROUTE_ACTION domain is assigned to an attribute field of a feature class in this geodatabase, the values listed under Coded Values are the only possible options for that field.

The ROUTE_ACTION field describes if and how a route is calibrated. When a route is calibrated a linear distance value is assigned to each vertex of that feature.

 **NOTE:** These domains are used in the MVUM production process because they make attributing fields in a feature class faster and lessen the possibility for data entry errors.



The screenshot shows the 'Database Properties' window with the 'Domains' tab selected. A table lists domains, with 'ROUTE_ACTION' highlighted. Below this, the 'Domain Properties' section shows settings for the selected domain. At the bottom, the 'Coded Values' section displays a list of codes and their descriptions.

Domain Name	Description
CulturalSiteType	
FSMetadata_DATA_SOU	
ROS_CODE	
ROUTE_ACTION	
SOURCEdomain	Handling Facilities
TravelManagementStatus	

Field Type	
Domain Type	Coded Values
Split policy	Duplicate
Merge policy	Default Value

Code	Description
CALIBRATED	CALIBRATED
REMEASURE	REMEASURE
MCALIBRATE	MCALIBRATE
MANUAL	MANUAL

Question:

2. What are the coded values for the TravelManagementStatus domain?

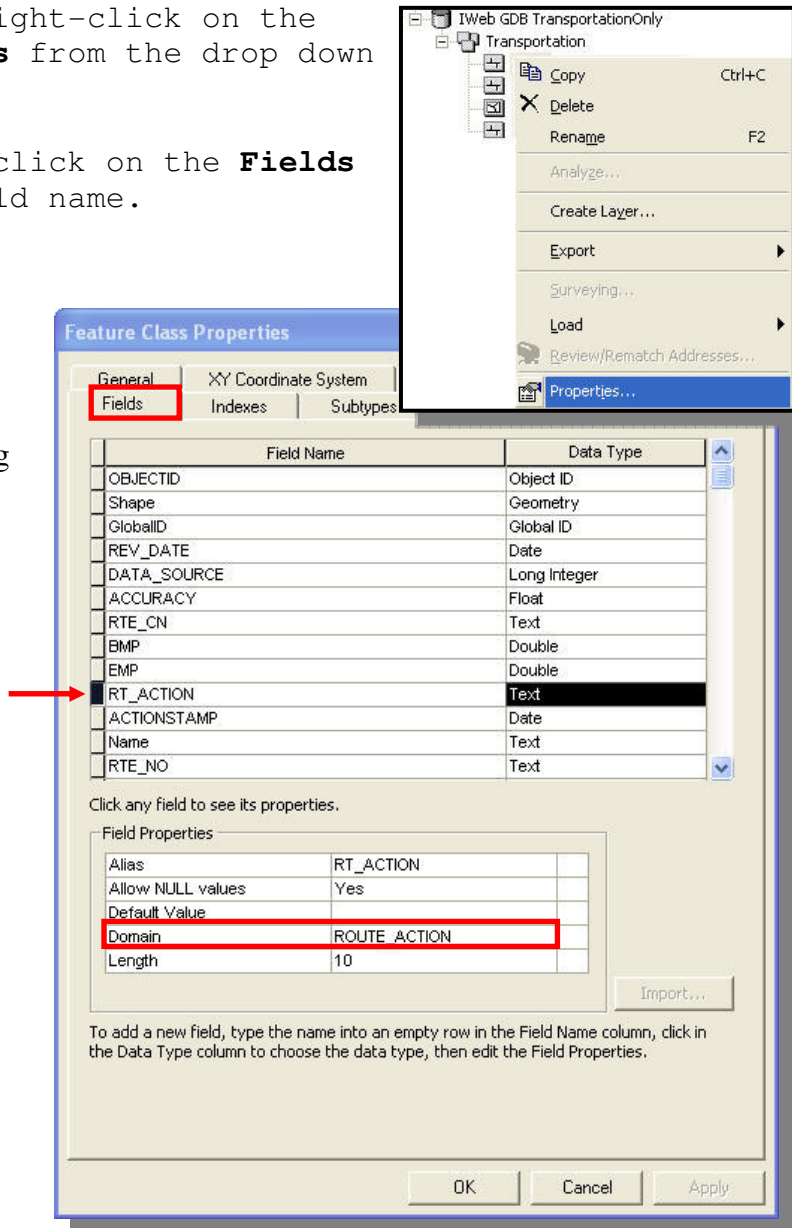
- e. Close the Database Properties window.

Defining and Creating Routes

- f. In the Transportation feature dataset right-click on the **Road feature class** and select **Properties** from the drop down list.
- g. In the Feature Class Properties window click on the **Fields** tab and then click on the **RT_ACTION** field name.


After clicking on RT_ACTION under field name you can see the ROUTE_ACTION domain has been assigned to this field. The domain row under field properties identifies the ROUTE_ACTION domain assigned to this field. This will result in users being presented a pulldown menu with these domain choices when editing this attribute.

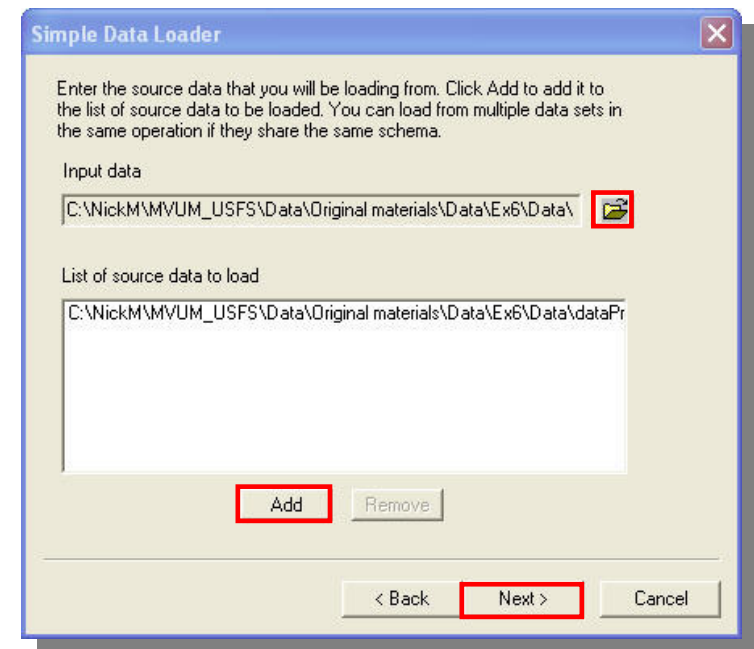
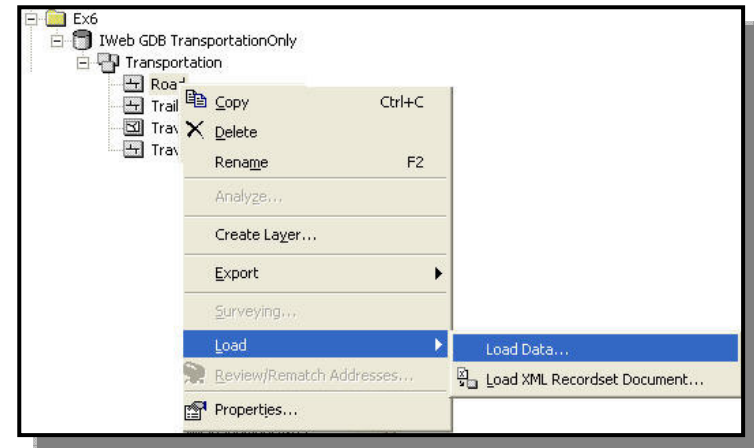
- h. **Close** the Feature Class Properties dialog.



Step 2: Load existing roads and trails data into their assigned feature classes

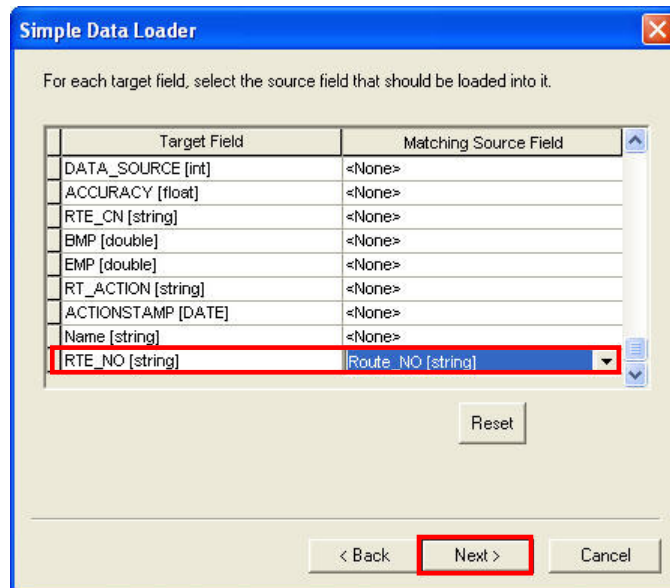
In this step you will load existing road GIS data into the Road feature class provided in the IWeb GDB TransportationOnly geodatabase. You will use the simple data loader to load the existing road data.

- In ArcCatalog right-click on the **Road** feature class in the Transportation feature dataset. Select **Load → Load Data**. This will open the Simple Data Loader.
- In the first window of the Simple Data Loader click **Next**.
- In the second Simple Data Loader window click the open button  and select the **RoadsLineWork** feature class at the following location in the Ex6 folder:
C:\training\Ex6\dataPrepTest.mdb\RoadsLineWork
- In the Simple Data Loader dialog, click the **Add** button and then **Next**.



Defining and Creating Routes

- e. In the next window of the Simple Data Loader ensure the radio button selection: "I do not want to load all features into a subtype" and click **Next**.
- f. In the next window make sure the Target Field **RTE_NO** has a Matching Source Field of **Route_NO** and click **Next**.



Simple Data Loader

For each target field, select the source field that should be loaded into it.

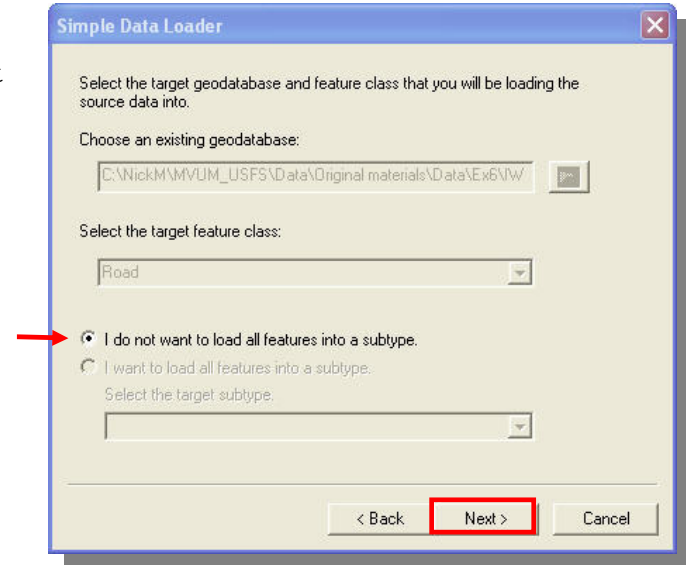
Target Field	Matching Source Field
DATA_SOURCE [int]	<None>
ACCURACY [float]	<None>
RTE_CN [string]	<None>
BMP [double]	<None>
EMP [double]	<None>
RT_ACTION [string]	<None>
ACTIONSTAMP [DATE]	<None>
Name [string]	<None>
RTE_NO [string]	Route_NO [string]

Reset

< Back **Next >** Cancel

This above step allows the route control number (Route_NO) attribute to import directly with the feature it is assigned to.

- g. In the next window of the Simple Data Loader click the radio button next to "Load all of the source data" and click **Next**.



Simple Data Loader

Select the target geodatabase and feature class that you will be loading the source data into.

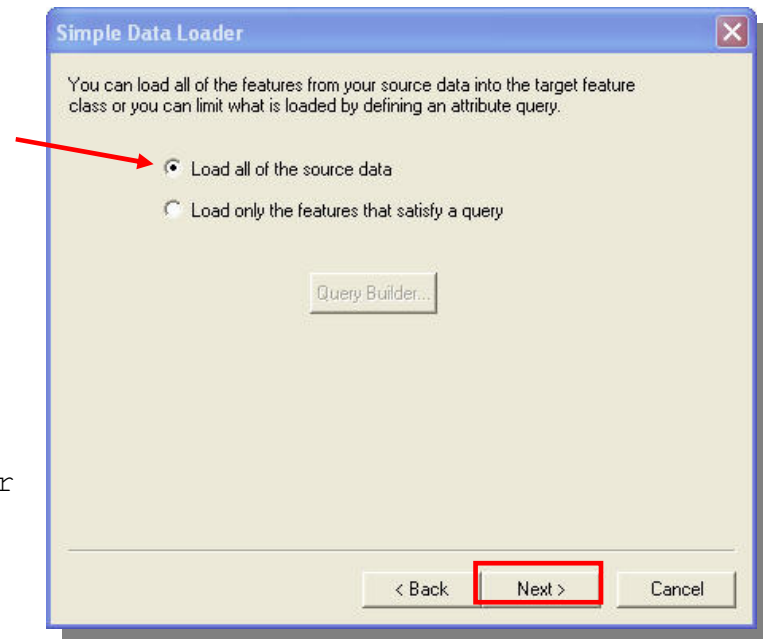
Choose an existing geodatabase:
C:\NickM\MVUM_USFS\Data\Original materials\Data\Ex6\W

Select the target feature class:
Road

☒ I do not want to load all features into a subtype.
☐ I want to load all features into a subtype.

Select the target subtype:

< Back **Next >** Cancel



Simple Data Loader

You can load all of the features from your source data into the target feature class or you can limit what is loaded by defining an attribute query.

☒ Load all of the source data
☐ Load only the features that satisfy a query

Query Builder...

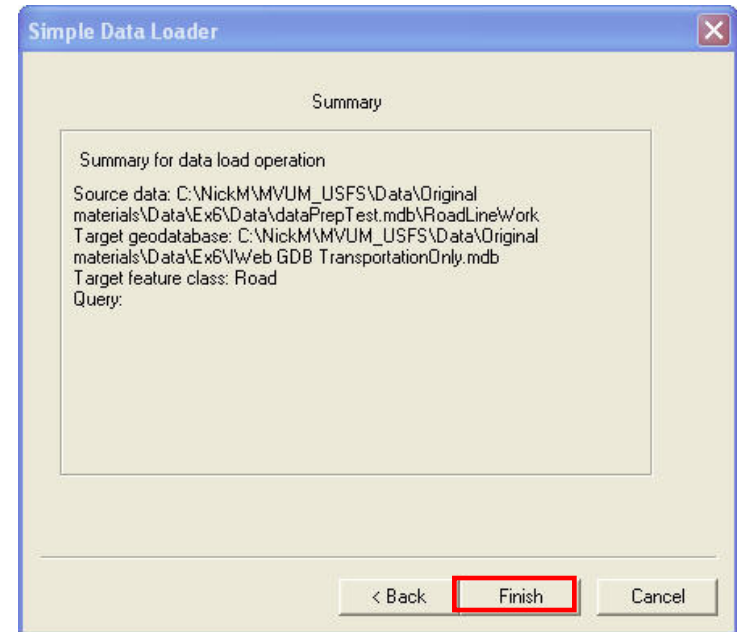
< Back **Next >** Cancel

Defining and Creating Routes

- h. In the final window of the Simple Data Loader click the **Finish** button.
- i. Using the steps above, use the simple data loader to load the trails base data into the template geodatabase. Data is found at:

C:\training\Ex6\dataPrepTest.mdb\TrailsLineWork

The above steps allowed you to successfully load GIS data from the Roads and trails feature classes into the template Road feature class in the template geodatabase.



Step 3: Resource for downloading the templates and tools

The following website is where you can locate MVUM tools and templates.

- a. Open up the **Internet Explorer** web browser.
- b. Navigate to the following url: **`http://gis.gsc.wo.fs.fed.us/wo/mvum/`**.

Question:

3. What are the options listed next to Quick Links?

The IWeb GDB TransportationOnly geodatabase that we provide on this CD will be the same structure that you should use in your MVUM production. The MVUM map team will post any changes at this website should there be a schema change.

In this exercise you became familiar with the template geodatabase and loading data into the Road and Trail feature classes. The domains of the geodatabase and their coded values were also introduced. The template geodatabase is where you will perform all of the data preparation tasks. You were also shown the MVUM website. This resource should be referenced often because new standards and procedures are often posted there.

End Exercise.