WFMI Fire Reporting Module Location Data

I.   Overview

For incidents with a spatial location, such as wildland fires, natural outs, and prescribed fires, a location is recorded for the point of origin. The location can be entered in either the Geographic (i.e. Latitude/Longitude) or the Universal Transverse Mercator (UTM) coordinate system, but not both. For both systems, the "address" of a point on the Earth is identified with a pair of coordinates, with a north-south value (Latitude or UTM Northing) and an east-west value (Longitude or UTM Easting and UTM Zone). Both systems also require a third element – Datum (NAD83, NAD27, WGS84, or WGS72) - to accompany the coordinate pair. WFMI calculates the location in the other coordinate system for display and export. So if the user enters UTM, WFMI will calculate the associated Latitude/Longitude. WFMI also calculates Latitude/Longitude in NAD83 for export.

II.   Data Entry

In WFMI, the coordinate system and location coordinates are specified by the user. Once the coordinates are entered for the selected system, WFMI also calculates and stores the location information for the other coordinate system. The location may be entered in any one of three Latitude/Longitude formats or in the UTM format; and also include the datum and quadrant.

A.   Latitude/Longitude

Latitude and Longitude in WFMI is always entered as a positive number. In addition we need to know north/south (Latitude) and east/west (Longitude); see the discussion below on quadrant.

1.   Decimal degrees

Decimal degrees (including up to 6 decimal digits, as needed for precision) for example:

Latitude: 43.5675° north   Longitude: 116.2105° west

2. Degrees and Decimal Minutes

The degrees and decimal minutes format includes an integer for degrees and the minutes field can contain up to 4 decimal digits, as needed for precision. This format requires that the seconds field be blank and degrees field not have a decimal point. For example:

Latitude: 43° 34.05' north   Longitude: 116° 12.63' west

3. Degrees, Minutes and Decimal Seconds

The degrees, minutes, and decimal seconds format includes an integer for the degree and minute fields and the seconds field can contain up to 2 decimal digits, as needed for precision. This format requires that the degrees and minute fields not have a decimal point. For example:

Latitude: 43° 34' 03" north   Longitude: 116° 12' 38" west

B.   UTM

The UTM coordinate set includes the following:

UTM Zone (2-digit) and north/south (see discussion below on quadrant).

UTM Easting in meters (6-digit integer, including 1 decimal digit, as needed for precision)

UTM Northing in meters (7-digit integer, including 1 decimal digit, as needed for precision)

Zone: 11 north   Easting: 563751.2   Northing: 4824141.3

C.   Datum

In addition to the coordinate in one of the above formats, the user must also specify the datum. WFMI supports data entry in the following datums: NAD83, NAD27, WGS84, or WGS72. The user selects the datum from a pick-list.

D.   Quadrant

All coordinate values entered by the user are positive. But each must include an indication of what part of the world the coordinate is in: Latitude (north/south), Longitude (east/west), and UTM Zone (north/south). If you break the world up into north and south hemispheres and east/west of Greenwich, England, you have four quadrants (for lack of a better name). WFMI keeps track of which quadrant each fire reporting unit is in. If the reporting unit is in only one quadrant (most are), then WFMI displays the appropriate direction after the input control and the user only enters the Latitude/Longitude or Zone. For the few reporting units that span more than one quadrant, WFMI provides a pick list after the control and the user must select the appropriate direction from the pick list.

III.   Validation

Validation of location coordinates is a two step process. The data is first checked to insure that it contains acceptable values. If it does, then the entry is accepted and stored. After being stored, a series of validation rules are applied. If the input fails any of these validation rules, warnings are displayed on the fire report view and the fire report is considered incomplete.

A.   Errors

The following tests are applied to the user input before the fire report is saved. If any of these tests fail, the user input is rejected. The entry must be corrected before the fire report will be stored.

The coordinate and zone values are all positive numbers and cannot contain other characters.

Latitudes must be between 0.0 and 90.0.

Longitude must be between 0.0 and 180.0.

UTM Northing must be between 0 and 9,999,999.9.

UTM Easting must be between 0 and 999,999.9.

UTM Zone must be between 1 and 60.

B.   Validation Warnings

After the fire report is stored, a series on validation rules are applied to the data. If the input fails any of these rules, warnings are displayed on the fire report view and the fire report is considered incomplete. Below is a general list of the kinds of rules that can be applied to the location data. Which rules are actually applied is dependent on the bureau, fire type / protection type, and start time of the fire. For a complete list of validation rules, see the Validation Rule Overview and Validation Rule summaries.

1.   Bounding Rectangle

WFMI stores one or more Latitude/Longitude bounding rectangles for each reporting unit. The location coordinate must fall inside at least one of the reporting unit's bounding rectangles. This is intended to be a crude test of the location to prevent typos in the coordinate fields. For UTM coordinates, WFMI computes the Latitude/Longitude from the UTM coordinate and compares the computed value to the bounding rectangles.

2.   Completeness

All of the required fields for the type of coordinate have been entered.

3.   Calculated Latitude/Longitude

All valid UTM coordinates should have a corresponding Latitude/Longitude value. If Latitude/Longitude cannot be calculated from the UTM coordinate, then the UTM coordinate must be invalid.

IV.   Storage

A.   Calculated Value

If the user enters Latitude/Longitude, then WFMI calculates the UTM. If UTM is entered, then WFMI calculates Latitude/Longitude. ESRI's SDE SDK 9.1 is used to make the calculation. The calculated value is rounded to be consistent in precision to the user's input.

B.   Latitude/Longitude

For latitude and longitude, three fields are stored in the WFMI database: the actual value, a flag, and the precision. So for a complete latitude/longitude coordinate, a total of 6 values are stored; 3 values for latitude and 3 values for longitude.

1. **Value**

   This is the coordinate entered by the user converted to decimal degrees. The location is always stored as decimal degrees even if the user enters the location in one of the other formats. This value is stored to 7 decimal places.

2. **Flag**

   The flag field indicates in which Latitude/Longitude format the coordinate was entered (1 = decimal degrees, 2 = degrees and decimal minutes, and 3 = degrees, minutes, and decimal seconds).

3. **Precision**

   This is the precision of the user's data input, expressed as the number of decimal places. For the decimal degrees format, this is the number of decimal places in the degree field. For the degrees and decimal minutes format, this is the number of decimal places in the minute field. For the degrees, minute, and decimal seconds format, this is the number of decimal places in the second field.

C.   UTM

1. **Zone**

   This is the Zone number for the UTM zone. Valid values are 1 through 60.

2. **Northing and Easting**

   For Northing and Easting, two fields are stored in the WFMI database: the value and the precision. So for a complete UTM coordinate, a total of 5 values are stored; 2 values for the northing, 2 values for the easting, and the Zone.

   a) **Value**

      This is the coordinate as entered by the user, stored to two decimal places.

   b) **Precision**

      This is the precision of the user's data input, expressed as the number of decimal places. Valid values are 0 and 1.

D.   Datum

Regardless of the coordinate entered, the user's selection of datum is stored (NAD83, NAD27, WGS84, or WGS72).

V. NAD83 Datum Transformation

WFMI uses ESRI's SDE SDK 9.1 package to attempt to transform all coordinates to NAD83 latitude/longitude decimal degrees. This transformation occurs during the creation of the export dataset; the transformed coordinate is not stored in the WFMI database. Not all coordinates can be transformed to NAD83, which may be due to any of the following: WFMI does not support the transformation of coordinates for a particular location/datum combination; part or all of the coordinate fields are missing; or the entered coordinate is not valid. In those cases, the NAD83 coordinate will be null. See the export details below for details on how the NAD83 coordinate is used in that export.

A. NAD83

No transformation is required.

B. NAD27

The transformations available for NAD27 are grid-based transformations. If the point is not covered by the grid, then it is not converted and the software indicates that it was not converted. The following transformations are attempted, in order, until either the point is converted or all transformations have been attempted. If the point cannot be transformed, the NAD83 coordinate is null.

NAD_1927_To_NAD_1983_NADCON	1241	United States
NAD_1927_To_NAD_1983_Alaska	1243	Alaska
NAD_1927_To_NAD_1983_NTv2_Canada	1313	Canada
NAD_1927_To_NAD_1983_PR_VI	108003	Puerto Rico/Virgin Islands

C. WGS84

There are three transformations that apply to converting from WGS84 to NAD83. Unlike the NAD27 transformations, these are not grid-based and will attempt to convert any point, even if the result would be wrong. WFMI selects which transformation to use based on the location and a bounding rectangle for each transformation below. If there is overlap, the first rectangle that the point falls within will be used. If the point does not fall inside any of the bounding rectangles, the NAD83 coordinate will be null.

NAD_1983_To_WGS_1984_2	1251	Aleutians
NAD_1983_To_WGS_1984_3	1252	Hawaii
NAD_1983_To_WGS_1984_5	1515	North America

Area	Latitude		Longitude	
	Top	Bottom	Left	Right
Aleutians	55.0	51.0	172.0	-163.0
Hawaii	22.5	18.5	-161.0	-154.0

North America	72.0	54.0	-170.0	-135.0
	72.0	15.0	-135.0	-64.0

D. WGS72

There is no transformation from WGS72 to NAD83. WFMI first transforms the coordinate to WGS84 using the following transformation. Then the WGS84 coordinate is transformed as defined above (in section C).

WGS_1972_To_WGS_1984_2   1238   World

VI. Export

A. Excel Export

This export is intended for import into spreadsheet applications, such as Excel, where the user can then process the data using spreadsheet tools. This export contains several coordinate columns for the convenience of the user. All coordinate columns, except the LatitudeNAD83 and the LongitudeNAD83 columns, are in the datum indicated by the Datum column. The LatitudeNAD83 and LongitudeNAD83 columns will be blank (null) if the input location cannot be transformed to NAD83. The LatitudeEntered and LongitudeEntered columns contain the coordinates that the user entered, if the user entered Latitude/Longitude. UTM columns are either user-entered or calculated, depending on the content of the CoordinateType column. All other coordinate columns contain calculated values.

B. PCHA/Fire Family Plus Export

This export is designed to support the fire applications PCHA and Fire Family Plus. If the input location can be transformed to NAD83, then the Datum column will be NAD83 and the NAD83 location will be used for the Latitude/Longitude columns. If the input location cannot be transformed to NAD83, then the datum column will be the datum that the user entered and the Latitude and Longitude columns will contain the location coordinates that the user entered.

C.   WFMI Export

This export is intended for import into other database applications, such as Access, where the user can then process the data using database tools. This export contains several coordinate columns for the convenience of the user. All coordinate columns except LatitudeNAD83 and LongitudeNAD83 are in the datum indicated by the datum column. The NAD83Latitude and NAD83Longitude columns will be blank(null) if the input location cannot be transformed to NAD83. The LatitudeEntered and LongitudeEntered columns contain the coordinates that the user entered, if the user entered Latitude/Longitude. UTM columns are either user-entered or calculated, depending on the content of the CoordinateType column. All other coordinate columns contain calculated values.

VII.   Precision

When WFMI displays and exports location coordinates, WFMI attempts to preserve the precision as entered by the user. This is not a perfect match, because the units used vary from format to format. The chart below shows all the possible input formats and the corresponding display/export format.

	User Input	Decimal Degrees	DD:MM:SS	UTM
		Display/Export format		
Latitude	DD.dddddd	DD.dddddd	DD:MM:SS.ss	DDDDDD.d
	DD.ddddd	DD.ddddd	DD:MM:SS.ss	DDDDDD
	DD.dddd	DD.dddd	DD:MM:SS.s	DDDDDD
	DD.ddd	DD.ddd	DD:MM:SS	DDDDDD
	DD.dd	DD.dd	DD:MM	DDDDDD
	DD.d	DD.d	DD:MM	DDDDDD
	DD	DD	DD	DDDDDD
	DD:MM.mmmm	DD.dddddd	DD:MM:SS.ss	DDDDDD.d
	DD:MM.mmm	DD.ddddd	DD:MM:SS.ss	DDDDDD
	DD:MM.mm	DD.dddd	DD:MM:SS.s	DDDDDD
	DD:MM.m	DD.ddd	DD:MM:SS	DDDDDD
	DD:MM	DD.dd	DD:MM	DDDDDD
	DD:MM:SS.ss	DD.dddddd	DD:MM:SS.ss	DDDDDD.d
	DD:MM:SS.s	DD.ddddd	DD:MM:SS.s	DDDDDD
	DD:MM:SS	DD.dddd	DD:MM:SS	DDDDDD
Northing	DDDDDD.d	DD.dddddd	DD:MM:SS.ss	DDDDDD.d
	DDDDDD	DD.ddddd	DD:MM:SS.ss	DDDDDD
Longitude	DDD.dddddd	DDD.dddddd	DDD:MM:SS.ss	DDDDDDD.d
	DDD.ddddd	DDD.ddddd	DDD:MM:SS.ss	DDDDDDD
	DDD.dddd	DDD.dddd	DDD:MM:SS.s	DDDDDDD
	DDD.ddd	DDD.ddd	DDD:MM:SS	DDDDDDD
	DDD.dd	DDD.dd	DDD:MM	DDDDDDD
	DDD.d	DDD.d	DDD:MM	DDDDDDD
	DDD	DDD	DDD	DDDDDDD
	DDD:MM.mmmm	DDD.dddddd	DDD:MM:SS.ss	DDDDDDD.d
	DDD:MM.mmm	DDD.ddddd	DDD:MM:SS.ss	DDDDDDD
	DDD:MM.mm	DDD.dddd	DDD:MM:SS.s	DDDDDDD
	DDD:MM.m	DDD.ddd	DDD:MM:SS	DDDDDDD
	DDD:MM	DDD.dd	DDD:MM	DDDDDDD
	DDD:MM:SS.ss	DDD.dddddd	DDD:MM:SS.ss	DDDDDDD.d
	DDD:MM:SS.s	DDD.ddddd	DDD:MM:SS.s	DDDDDDD
	DDD:MM:SS	DDD.dddd	DDD:MM:SS	DDDDDDD
Easting	DDDDDDD.d	DDD.dddddd	DDD:MM:SS.ss	DDDDDDD.d
	DDDDDDD	DDD.ddddd	DDD:MM:SS.ss	DDDDDDD