

Standards for Road Data Collection & Maintenance
Using

Global Positioning System Techniques

Version 1, June 30, 2004



Merging With a Common Focus

Kentucky Transportation Cabinet

Department of Highways

Division of Planning

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INTRODUCTION

The Division of Planning has been responsible for road inventories and the preparation of county highway maps since 1936 when the state first began collecting information about its highways. The initial set of county maps was completed in January 1940. Since that time, the Division has been the primary source of roadway inventory data, including the number of miles of state and local highways, for the Department of Highways. Over the past 50 years, the Division has continued to update the data by conducting field inventories, which were then used to redraw the county highway maps and update state road mileage data files.

Because the data was available in this Division from our road inventories and our maps, the Division has been responsible for providing mileage data and land area information after every Census for funding allocations for county and rural secondary roads under KRS 177.320. With the passage of legislation in 1986, Rural and Municipal Aid was given the responsibility for allocations under KRS 177.320(1). County Road Aid Maps are adopted by fiscal courts, by resolution, as their "official" county road system.

The Kentucky Transportation Cabinet (KYTC) has incorporated the use of Global Positioning System (GPS) technology to reduce the cost and time involved in field data-gathering to acquire road alignments and to accurately measure over-the-road travel distances for all public and Master Street Addressing Guide (MSAG) roads. However, to regularly collect and update this data on a statewide basis, KYTC has made the decision to work through partnerships with the regional Area Development Districts (ADD).

A GPS-based data collection system can be a highly effective and useful tool. But, by itself, a GPS receiver will not solve all data collection needs. To ensure the success of geospatial data collection, attention must be paid to the following three concepts:

- **SAFETY** – exercise as much caution as possible while driving along the roads. This work involves collecting linear features from within a vehicle (**D**on't **D**rive and **C**ollect). This is a TWO-person operation. For example, you may need to type comments or other entries or segment a road to indicate a surface change.
- **EQUIPMENT** - GPS accuracy requires complex location calculations. It is important that the GPS unit is capable of collecting real-time submeter accuracy. All GPS measurements relate to the exact location of the antenna. Therefore, its precise relationship to the ground is critical to the process of obtaining quality results.
- **STAFF** - Standards and specifications are easily defeated by the ill-prepared or untrained. The best method of ensuring the proliferation of reliable data is to be sure staff members have preparation and training.

ACRONYMS

ADD

Area Development District

DOQQ

Digital Orthophoto Quarter Quadrangles (geo-referenced aerial photographs)

DRG

Digital Raster Graphs (geo-referenced topographic maps)

ESRI

Environmental Systems Research Institute

GIS

A Geographic Information System is an organized collection of computer hardware, software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced information.

GPS

The Global Positioning System is based on a constellation of 24-28 satellites orbiting the earth at a very high latitude. GPS devices can be taken into the field to record data while driving, flying, or hiking. Ground locations are calculated using signals from three or more of the satellites. <http://www.navcen.uscg.gov/gps/geninfo/>

HIS

Kentucky Transportation Cabinet's Highway Information System database of roadway attribute information.

MSAG

Master Street Addressing Guide used for E911 purposes

WGS-84

The World Geodetic System (1984) is the mathematical ellipsoid used by GPS to calculate locations.

DEFINITIONS

Accuracy

An indication of how close a measurement is to the true value. The accuracy any GPS receiver can expect to attain depends on the quality of the receiver, position of the satellites, environmental variables (weather, sunspots, terrain, etc.) and Selective Availability (SA). Greater accuracy is obtained when the occupation time is increased and differential correction techniques are applied.

Attribute

Characteristics of features in a Geographic Information System (GIS). Every identifiable feature has attributes. One common attribute of all survey features is geographic position. Other attributes vary by the type of feature. For example, a road has a name or designation number, surface type, etc. Each attribute has a range of possible values, called domain.

Cardinal Direction

The direction a road is mile pointed. On state maintained roads, the origin is from the county line or beginning point to an ending mile point at another location, as described in the county Official Order listing. Generally this is north or eastbound. On city streets or county roads the cardinal direction is the direction of traffic flow away from a US, state or more highly traveled county road toward a lesser traveled street, county road or dead end. If a local road travels between two roads of equal system level (i.e. US Highway to US Highway), then the origin point would be from the lower numbered road. When referring to one-way streets, cardinal direction is the direction of traffic flow.

Connector

A short roadway whose purpose is to provide access from one road to a separate road and has no name or LRS_ID of its own. (Connectors utilize the LRS_ID of the road being accessed with the section ID number 70 through 79.)

Control Point (NGS Control Point)

An accurately known reference point used for verifying field data collection. Control points must achieve an accuracy level of Horizontal B-order stations (a relative accuracy of 8 mm +/- 1:1,000,000 relative to other A-order and B-order stations).

County Number

A three-digit identification number assigned to each Kentucky county in alphabetical order (001 – 120).

County Quadrant (Quad or County Quad)

Every county has been split into four sections for road-name indexing purposes by the KYTC Department of Rural and Municipal Aid. Quads are numbered from the northeast quadrant progressing clockwise. See Section 2.2.5 for the road numbering scheme. *There is no intended correlation with USGS 7.5' topographic quad boundaries. If any occurs it is purely coincidental.*

Couplet-ID

The traditional name for an identifier in the road identification attribute field (LRS_ID) that indicates a non-standard section of the roadway, as for example, non-cardinal divided highways, cross-over, connector, rest area, weigh station, etc. Its position in the LRS_ID is after the suffix. The "Couplet-id" is being replaced by the Section-ID.

Coverage

A digital version of a map layer forming the basic unit of vector data storage for ARC/INFO. A set of thematically associated data considered as a unit. A coverage usually represents a single theme such as soils, streams, roads, or land use.

Crossover

A short roadway that connects both sides of a divided highway. Crossovers may be a continuation of a road that intersects either lane of a divided highway and continues across a median to the opposite lane before terminating. (This type crossover carries the LRS_ID of the crossing road. When two separate roads terminate opposite one another, the crossover is designated with the lower numbered and/or number of the higher priority road, US – KY – CR – CS – PR, plus a section number.) Crossovers may also be a median-crossing roadway that is an entrance to a private road or parking lot, provided that it has a traffic signal or flashing light. An emergency crossover connects full-access-control cardinal and non-cardinal lanes. For further information, see <http://www.kytc.state.ky.us/planning/gisourky/cross.html> (Crossovers utilize Section-ID numbers 30 through 69.)

Data dictionary

Information that describes features located in the field including data type classification (point, line, or area), attribute name, attribute type and a list of valid attribute values. The data dictionary is downloaded to a data logger and used when collecting data in the field.

Differential GPS (DGPS)

The term "differential" is generally used with pseudorange methods, which resolve the errors in a single position. One of these methods is real-time DGPS, which resolve the errors in real time, in contrast to the approach of relative GPS. This is achieved by clear acquisition (C/A) code-phase (pseudo-range) error measurements at one or more stations and transmitting the data to the remote station(s).

Epoch

The measure interval of a GPS receiver.

GPS Pathfinder Office

Software used in the office to prepare for field work and for post-GPS-fieldwork data manipulation to prepare for importing into a GIS.

Local Road

Non-state maintained road.

Local frontage roads and bays

Subordinate roadways that are adjacent to a more primary county road or city street and function to reduce the number of private access locations to the primary road. They must have the identical name and address scheme as the primary road. Typically, frontage roads are generally straight and parallel to the primary road whereas bays are partial circles located around the outside of a sharp curve. If there is no island or barrier to distinguish it from the primary road, omit it from the coverage. (Frontage roads and bays should use Section ID numbers 80 through 99.)

National Standard For Spatial Data Accuracy (NSSDA)

Implements a well-defined statistic and testing methodology for positional accuracy of maps and geospatial data derived from sources such as aerial photographs, satellite imagery, or maps. Accuracy is reported in ground units. The testing methodology is a comparison of a dataset's coordinate values with coordinate values from a higher accuracy source for points that represent features readily visible or recoverable from the ground. http://www.fgdc.gov/standards/status/sub1_3.html

Non-cardinal Couplet

A section of state maintained roadway that carries non-cardinal direction traffic and is completely separate from the cardinal direction roadway. Typically, it consists of one way streets, south or westbound, in cities or towns where city blocks separate the non-cardinal from the cardinal roadways. (Non-cardinal couplets carry Section-ID numbers 1 through 9.)

Non-cardinal Direction

The direction that is opposite to the cardinal direction. This term is primarily used to refer to the traffic flow lanes of a divided road that are not in the cardinal direction.

Official Order

In this context, it is a legal document prepared by the Division of Planning (approved by the Commissioner of Highways or an authorized representative), that officially modifies the State Primary Road System, the National Truck Network, or the Scenic Highways and Byways Program. Possible modifications may include to accept,

transfer, reclassify, close, redefine and/or re-describe various state-maintained routes. *NOTE: there are many other sources of Official Orders within the Cabinet that do not impact the GIS/GPS effort. These orders are not intended to be referenced here and would not meet the above definition.*

Private Road

A road is considered a private road if it: (1) serves only one home, business, or other facility, (2) Is signed as private, or (3) is closed to the public by a gate or chain, (*unless* it is maintained by a public authority, i.e., cemetery road owned by a local government or a county park.) All private roads in the KYTC coverages/shapefiles are accessible to the public.

Public Road

A "Public Road" is any road that is open to public travel. A road is usually not considered a public road if it: (1) serves only one home, business, or other facility, (2) Is signed as private, or (3) is closed to the public by a gate or chain (*unless* it is maintained by a public authority, i.e., cemetery road owned by a local government or a county park).

Rest areas and weigh stations

Roadways adjacent to interstates and parkways that are not connecting to intersecting routes. (These use Section ID numbers 11 through 19. Section numbers are normally odd numbers on the cardinal direction lane and even numbers on the non-cardinal lane. Multiple roadway rest area or weigh station section numbers increase, from furthest to nearest, as roadways pertain to the main route.)

Road Centerline

This is a graphic representation of a road in which the spatial position follows the approximate center of the road. It is commonly used on small-scale maps to represent roads.

Section-ID

The name for a marker in the road identification field (LRS_ID) that indicates a non-standard configuration of the roadway. Examples include non-cardinal divided highways, cross-overs, connectors, rest areas and weigh stations. In the LRS_ID, the Section-ID follows the suffix. The Section-ID field replaces the previous "Couplet-id" field.

Selective Availability (SA)

Artificial degradation of the satellite signal by the United States of America Department of Defense (disabled as of the date of this document but could be reactivated at any time).

Shapefile

An ESRI-based file format for storing spatially enabled data. For more information, see the "ESRI Shapefile Technical Description" on the ESRI web site.

State Road

A road that is under the jurisdictional and operational control of the Commonwealth of Kentucky.

"Y" intersection

Roads that "fork" into two or more separate roadways at an intersection, with the forks continuing to carry the same route number. They may vary in length and may be formed by grass or raised traffic islands. Typically, "Y" intersections are to facilitate turning onto intersecting roads. The mainline road of the "Y" should not use

a section number and is determined by the following four factors: 1) the direction of the continuance of the road; 2) it carries the most traffic; 3) it carries traffic toward an arterial or population center; 4) it has better pavement. All other forks will carry a Section ID from 20 through 29.

1. GPS ACCURACY STANDARDS

The Kentucky Transportation Cabinet, Division of Planning accepts the Geospatial Positioning Accuracy Standards recommended by the Federal Geodetic Control Subcommittee. Thirteen bands are defined by the radius of the relative positional error circle of 95% confidence. Details regarding computation of the 95% confidence relative error circle can be found in the FGCS proposal. For a more complete description, please see the referenced document or its successor.

http://www.fgdc.gov/standards/status/sub1_1.html

http://www.fgdc.gov/standards/status/sub1_2.html

http://www.fgdc.gov/standards/status/sub1_3.html

http://www.fgdc.gov/standards/status/sub1_5.html

The KYTC standard is Classification Band IX providing horizontal accuracy of 0.500 to 2.000 meter at the 95% accuracy level.

1.1 TECHNIQUE

It is the responsibility of the user to assess which GPS technique or combination of GPS techniques are required to achieve the FGCS Classification Band IX Standards for establishing and maintaining a GIS transportation layer for all roads within the scope of this project.

1.2 EQUIPMENT & EQUIPMENT VALIDATION

1.2.1 Equipment & Software

The Kentucky Transportation Cabinet recommends that GPS data submitted to the Cabinet be collected using the following GPS equipment and software.

- [Trimble's GPS Pathfinder Pro XRS System \(Real-Time DGPS\)](#)
- Trimble's ASPEN Software or [Trimble's TerraSync software](#)
- [OmniStar worldwide DGPS Service](#)

1.2.2 Equipment Validation

To test the system being utilized and the post-processing software, the equipment should be validated on an appropriate land survey network (i.e. National Geographic Survey control point.) GPS observations totaling 1200 points (approximately 20 minutes collection time) shall be made at each Control Point. The results should be employed by the user to verify equipment accuracy and be retained for audit upon request. If repeated tests do not yield sub-meter results, advice should be sought from the equipment manufacturer.

- The epoch recording rate should be 1 second.
- Should be receiving data from a minimum of five satellites using Trimble's ASPEN or TerraSync software
- Wherever possible, use the highest order of existing geodetic stations (Control

Points) with known geocentric coordinates that are easily accessible and in close proximity to the road network.

2. DATA COLLECTION

2.1 POSITIONAL DATA COLLECTION

Field data collection is one of the most important and costly components in building and maintaining a GIS. Customarily, when using GPS to collect road alignments and attribution, users are in motion while recording those line features. It is common for individual attribute values to change at different locations along the line requiring the user to stop in place to make the change to the data collected. For this reason it is important that safety, for the collection staff and the public, be the number one priority.

2.1.1 Technique

KYTC aspires to obtain sub-meter accuracy for road centerlines via GPS. The Area Development Districts (ADDs) will do the collection of new road centerlines, in close cooperation with, and subject to the requirements of, KYTC. While collecting the spatially correct alignments of the roads, the ADDs will also collect road attribute information. The methods/procedures for attribute collection and road numbering are outlined in Section 2.2. The Division of Planning retains the authority to revise those procedures throughout the collection and maintenance process as deemed necessary.

2.1.2 Requirements

2.1.2.1 Roads To Be Collected

- All public roads such as state maintained roads, county maintained roads, state park roads, city streets, federally owned roads (forest service, national park, etc.), private roads, private subdivision roads, coal mine owned roads (open to public travel), etc.
- All MSAG roads as identified by the Kentucky State Police street-addressing process
- All ramps, Y-intersections, crossovers, and connectors
- Main drives to and within areas maintained by other state agencies such as state parks, state schools, state hospitals, correctional facilities, etc. Include boat ramps, but do not include service drives, parking areas, picnic areas, campgrounds, cabin drives, etc.

2.1.2.2 Collection Technique

- KYTC recommends Trimble's ASPEN or TerraSync software for the collection of road centerline GPS data. Pre-loaded background maps are suggested to make it easy for field workers to navigate and monitor data collection.
- GPS or technology of greater accuracy should be used to collect 95% of all new road mileage. Alternative methods for determining positional accuracy can be employed where proper functionality of the GPS technology cannot be obtained. An example of an alternative method is the derivation of the centerline from DOQQ's or DRG's.
- Epoch recording rate is to be 1 second for all roads.

- Elevation (vertical) data shall be collected and retained in the GPS source files. Care should be taken to record the proper antenna height to ensure the best possible data is collected.
- Raw observational data (rover files) must be retained.
- The line representing the center of the road is to be collected by placing the antenna on the driver's side of the vehicle and driving at normal traffic speeds. To make it possible to determine the correct centerline location using the appropriate offsetting method, it is vitally important to make an effort to maintain a constant distance from the centerline, especially around curves.
- Some roadways may have more than one type of pavement. The GPS line should be segmented at the pavement change.
- Routes should have arcs pointing in correct direction. All state maintained routes should be pointed in the cardinal direction. (See Page 3 for a description of cardinal direction.) Arcs on non-state maintained roads should point away from state maintained roads.
- Roadways must be driven as follows:

Undivided, two-way, State-Maintained only:

- ◆ Driven on both sides (Centerline will be derived from an average of both lines using KYTC's collapse script.)
- ◆ Must be driven at constant offset from the **Left** side of the centerline

Undivided, Local (Non State-Maintained), and all one-way (State & Local)

- ◆ Driven in one direction
- ◆ Centerline derived from the offset
- ◆ Must be driven at constant offset from centerline

Divided, State & Local. Defined as the center of through lanes on each side:

- ◆ Driven once on each side
- ◆ Must be driven at constant offset from intended center line
- ◆ Each centerline is derived using the offset
- ◆ Odd number of lanes – set offset to the center of middle lane.
- ◆ Even number of lanes – set offset to line between center two lanes.
- ◆ **A continuous left turning lane is considered to be an auxiliary lane and should not be treated as a divided highway.** Therefore, the centerline should be derived from the collapse script.

Note: See exhibits for detailed examples.

2.1.3 Accuracy Testing Requirements

To ensure credibility of, and to achieve the desired standards, KYTC has adopted and

implemented a testing methodology in accordance with the National Standard For Spatial Data Accuracy (NSSDA), endorsed by the Federal Geodetic Control Subcommittee (FGCS), as certification of positional accuracy. To employ this testing methodology KYTC has set forth the following requirements:

- During the initial GPS collection of centerlines within the state, KYTC required a **minimum of 20** road intersections to be located within each county, using GPS equipment, to be used as "Intersection control points". These locations were to be distributed proportionately throughout each county to reflect the geographic area of interest and the distribution of error.
- Once initial collection of public road centerlines is accomplished throughout the state, one "Intersection Control Point" per day of field collection in each county is required. This will assure the accuracy of the data collection is the same (or higher) for the maintenance cycle data as for the initial collection data.
- There shall be a minimum of 180 positions taken in the intersection to be used as an Intersection Control Point with a point logging interval rate of 1 second. Intersection selection and placement, driving methodology, and post-processing techniques can directly affect the accuracy calculated. Care should be taken to properly select the intersection and the placement within that intersection. [Intersection Selection Examples](#)
- The apparent intersection of the pavement centerlines is to be marked with a P.K. or Mag nail. This point of measurement does not represent the legal intersection of the road rights of way, and it is not to be used as a boundary point in a land survey of any adjoining parcel.
- The collection of at least one "NGS Control Point" will be required weekly during the road centerline collection process for the purpose of equipment validation and determining proper differential correction methods. At least 1200 GPS points (approximately 20 minutes collection time) shall be collected on an appropriate land survey network (i.e. National Geodetic Survey Control point) of horizontal "B" order or above.

2.2. DATA ATTRIBUTE CODING

2.2.1 Gps Road Centerline Data Dictionary

A data dictionary will be provided by KYTC to the ADD's and will include the following road centerline attribution:

- *Field 1*
Name: LRS_ID
Content: County, State, Local, and/or City Route Number
Description: Linear Referencing System (LRS) Identifier
Data Type: Character, 15
The **LRS_ID** is recorded as follows XX-YYYYZZ-NNN.
[XX = Route prefix \(up to two Characters followed by a hyphen\)](#)
[YYYY = Route number \(up to four characters\)](#)
[ZZ = Route suffix's \(up to two characters example: bypass, business route, etc.\)](#)
[NNN = Section Number](#)
Examples of LRS_ID: CR-1000, KY-2250, CS-1401, US-31E, US-31E-1
- *Field 2*
Name: Co_rd_nm
Content: Fiscal Court Name For CRs and MSAG Road Name For All Others
Description: Full road name using the NENA standards for suffix abbreviations

- Data Type: Character, 40*

• *Field 3*
 Name: **SURFTYPE**
 Content: *Roadway Surfacing Type*
 Data Type: *Selection Menu*
 Entries are:
 Unimproved
 Gravel, Soil, or Stone
 Bituminous
 Concrete

- *Field 4*
 Name: **Owner***
 Content: *Road Ownership Indicator*
 Data Type: *Selection Menu*
 Entries are:
 State HWY Agency
 County HWY Agency
 Township HWY Agency
 Municipal HWY Agency
 State Park
 Local Park
 Other State Agencies
 Other Local Agencies
 Private
 Other Federal Agencies
 Bureau of Indian Affairs
 US Forest Service
 National Park
 Bureau of Land Mgr
 Military Reservation
 Future State Maint.

* This field represents ownership and does not reflect agreements between government agencies for snow removal or other maintenance

- *Field 5*
 Name: **Date**
 Content: *Date that the road was GPSed*
 Data Type: *Date, Day-Month-Year*
- *Field 6*
 Name: **Direction**
 Content: *Driving Direction Indicator*
 Data Type: *Selection Menu*
 Entries are:
 Cardinal
 Non Cardinal
 One Way
 TBD

- *Field 7*
 Name: **MapSource**
 Content: *Road centerline data source*
 Data Type: *Selection Menu*
 Entries are:
 GPS
 DOQQ
 DRG

OTHER

2.2.2 GPS Control Point Data Dictionary

- *Field 1*
 Name: **Control Point**
 Content: NGS or Intersection Identifier
 Data Type: Character, 6
- *Field 2*
 Name: **Type**
 Content: Control Point Type
 Data Type: Selection Menu
 Entries are:
 NGS
 Road Intersection
 Other
- *Field 3*
 Name: **Monument**
 Content: Control Point Monument Type
 Data Type: Selection Menu
 Entries are:
 P-K(Found)
 P-K(Set)
 Rebar(Found)
 Brass Disk (NGS) Hrz
 Brass Disk (NGS) Hrz
 Steel Rod
 Other
- *Field 4*
 Name: **Comment**
 Content: Any Miscellaneous Control Point Details
 Data Type: Character, 32

2.2.3 Maintenance Editing Table Format

COLUMN	ITEM NAME	WIDTH	OUTPUT	TYPE	N.DEC	ALTERNATE NAME	INDEXED
1	FNODE#	4	5	B	-		-
5	TNODE#	4	5	B	-		-
9	LPOLY#	4	5	B	-		-
13	RPOLY#	4	5	B	-		-
17	LENGTH	8	18	F	5	I	-
25	MARS_GPS#	4	5	B	-		-
29	MARS_GPS-ID	4	5	B	-		-
33	LRS_ID	17	17	C	-		-
50	BEGIN_MP	7	7	N	3		-
57	END_MP	7	7	N	3		-
64	DRAWCODE	4	4	I	-		-
68	RD_NAME	40	40	C	-		-
108	SURFTYPE	2	2	I	-		-
110	GRAPHIC_LEN_MI	7	7	N	3		-
117	DMI_LEN_MI	7	7	N	3		-
124	GOV_LEVEL	2	2	I	-		-
126	LOCAL_KEY	50	50	C	-		-
176	LAST_UPDT	8	10	D	-		-
184	OWNER_DATE	8	10	D	-		-
192	STATUS	25	25	C	-		-
217	CHANGE_TYPE	4	4	C	-		-
221	COMMENT	100	100	C	-		-

The Maintenance Arc Attribute Table structure should be defined and formatted as above. An ArclInfo aml routine has been provided to the ADDs for conversion of the field data dictionary to this format and coding. Any deviation from this format will result in the cover being returned for correction of the structure and formatting.

Field Definitions:

- FNODE # – Internal sequence number of the from-node column
- TNODE # – Internal sequence number of the to-node column
- LPOLY # – Internal sequence number of the left polygon column
- RPOLY # – Internal sequence number of the right polygon column
- LENGTH – Actual arc length in coverage units: feet
- COVER # - Internal sequence number of the arc in the ARC file column
- COVER-ID - User assigned feature identifier
- LRS_ID - Linear Referencing System (LRS) Identifier - The LRS_ID is recorded as follows <CCC XX-YYYYZZ-NNN>. Its structure is a three-digit county number (CCC), white space (ASCII Character #32), route prefix (XX), dash, route number (YYYY), route suffix (ZZ), dash, section-ID (NNN). (A “section-ID”, sometimes called a couplet-ID, designates highway network anomalies such as one-way streets, Y-intersections, etc.) An example of an LRS_ID for a segment of US Highway 127 in Franklin County is “037 US-127X-002”. *NOTE: the LRS_ID field is a replacement to the RSE_UNIQUE. All future project development should reference LRS_ID rather than the RSE_UNIQUE field.*
- BEGIN_MP - Beginning Milepoint - This data represents the official KYTC beginning milepost value of a route. Example: 111.327
- END_MP - End Milepoint - This data represents the official KYTC ending milepost value of a route. Example: 125.435
- DRAWCODE - Drawing code represents highway system or pavement types. These values are used to produce colored lines during editing sessions and do not contain official highway characteristic information. See <http://www.kytc.state.ky.us/planning/gisourky/Documents/RtPrefix.doc> for a list of valid code values.
- RD_NAME - Road Name - This is the complete city street or county road name as defined by the local authorities using the NENA standards for suffix abbreviations. There are two sources for road names. The County Fiscal Court and the MSAG emergency database. These should be in agreement, but if the local authorities cannot reach agreement the Fiscal court name will be recorded.
- SURFTYPE - Roadway surfacing type - The corresponding HIS field is SURFTYPE in Pavement View. An additional KYTC reference document is the *HIS-Inventory Types/Attributes/Values Report*.
 - Values:
 - 20 Unimproved
 - 40 Soil, Gravel, or Stone
 - 52 Bituminous
 - 70 Concrete
- GRAPHIC_LEN_MI - is the computed length of each arc (in miles). This is computed from the arc length in map units (feet) divided by 5280.
- DMI_LEN_MI - This is the KYTC length of the road based on an official order measured with a Distance Measuring Instrument (DMI). This value should be the same as the ‘begin_mp’ value less the ‘end_mp’ value.

- GOV_LEVEL - the ownership or government level of control for the roadway. Valid entries are:
 - 01 - State
 - 02 - County
 - 04 - City
 - 11 - State Park or State Forest
 - 12 - Local Park or Forest
 - 21 - Other State Agency Roads
 - 25 - Other Local Agency Roads
 - 26 - Private Roads
 - 60 - Other Federal Agency Roads
 - 64 - U S Forest Service Roads
 - 66 - National Park Service Roads
 - 70 - Military & Corps of Engineers Roads
 - 89 - New Location: Open to traffic, but not yet accepted
 - 98 - Route belongs to adjacent state (e.g. US-52, Grant Bridge, etc.)
 - 99 - New Location: Proposed or Under Construction
- LOCAL_KEY - This is a new field added (12/2001) in order to accommodate the incorporation of locally collected data and to allow for external databases (like local address ranges) to be tied to KYTC spatial data. The field is intentionally large in order to accommodate a variety of possible structures for a unique ID. If a local entity is in the process of developing a GIS, we recommend using the FIPS County Code plus a "-" plus a five digit arbitrary number for each unique arc. The Structure would look like 001-00001. These unique IDs should not be repeated and if an arc is split or combined with another arc the unique ID should be retired and a new ID assigned.
- LAST_UPDT - Last Update - The date that the last changes (spatial or arc attribute) were made to the record. (This field will be populated for GPS coverages with a single date based on when the roads were collected then updated as revisions are made.)
- OWNER_DATE - Date of arc's last recognition of its ownership status. Dates will be assigned as follows. For *state maintained roads*, it will be the date of the Official Order. For *county or city roads*, it will be the date the Fiscal Court signed off on ownership. *Private roads* will be assigned a date based on when the roads were last verified by local officials as private. *During the initial population of this field*, a global date of 1/1/2000 will be assigned. Any subsequent road changes will result in specific dates assigned to only the affected roads.
- STATUS - The current status of the arc. This field will allow the inclusion of arcs that have not been through the complete KYTC evaluation process. The "Not Evaluated" coding should always be used by ADD staff to signify arcs that have had some type of change. KYTC will then assign "Accepted" or "Not Accepted" during the process of updating the Master Highway Cover. See further discussion of road update cycles in GIAC's *Standards for Address-Enabled Road Centerlines* (<http://giac.state.ky.us/standards.htm>). Valid entries are:
 - Accepted

Not Evaluated (Only valid on Maintenance submittals)

Not Accepted (Not valid on Maintenance submittals)

- **CHANGE_TYPE** – A temporary field to relay information from the ADD to KYTC concerning the specific type of change being made to the arc. Standardized coding has been developed to assure clear understanding of the action to be taken. This field will not be retained after updates are accomplished. Further explanation of valid coding follows in Section 2.2.4.
- **COMMENT** – A 100-character temporary field for the purpose of relaying more specific information from the ADD to KYTC about the type of change being made to the arc. Additional space is available for the ADD to fully explain any anomalies. Standardized coding has been developed to assure clear understanding of the action to be taken. This field will not be retained after updates are accomplished. Further explanation of valid coding follows in Section 2.2.4.

2.2.4 Maintenance Cycle Coding

Two new fields have been added to the editing coverage to describe the type of revision made to each arc. These fields are for road centerline processing purposes only and will not be used for public distribution. They will be added to the cover when it is “Checked Out” from the KYTC master GIS server and will be stripped off when the cover is “Checked In” after all updates have been made. The attribute codes have been standardized to ensure the most efficient and accurate flow of information from the ADD collecting the information to KYTC staff incorporating the changes into the statewide centerline file and into HIS (Highway Information System database.) The *Change_type* field shows the general type of change using only standardized coding. The “Comment” field uses a standardized code but also allows the ADD to insert more specific information. The fields will only be useful if all codes are properly entered, with correct spelling, abbreviations, and all letters capitalized. Following are the valid entries.

CHANGE TYPE

SP	= SPATIAL CHANGE
AT	= ATTRIBUTE CHANGE
BOTH	= BOTH SPATIAL AND ATTRIBUTE
DEL	= DELETE (MUST ALSO HAVE DELETE IN COMMENT FIELD)
NR	= NEW ROAD

COMMENT

MP	= MILEPOINT ADJUSTMENT might be necessary
NR	= NEW ROAD (assumes new <i>lrs_id</i> , new <i>name</i> , new <i>local key</i>)
N_LRS	= NEW LRS_ID
N_NAME	= NEW NAME
N_LK	= NEW LOCAL_KEY
SUF_CH	= SUFFIX CHANGE (i.e. was LANE now ROAD)
SUF_SP	= SUFFIX SPELLING CHANGES
SP_CH	= SPELLING CHANGE IN ROAD NAME
N_ALIGN	= NEW ALIGNMENT OF ROAD
DELETE	= MUST ACCOMPANY DEL IN <i>Change_type</i>

2.2.5 Road Numbering

Maintenance Phase “New Road” Temporary Numbering (Road number assignments applied to initial collection effort and to maintenance updates by KYTC are listed in Appendix A.)

- Use owner route prefixes as specified in the following table: [Allowable Route Prefix Values](#)
- According to instructions from the Department of Rural and Municipal Aid, typically there should be no county roads (CR prefix) within a city boundary. Ultimately however, the county and Rural and Municipal Aid, will cooperatively determine which roads are part of the County Road Aid System.
- New locally-owned roads (except city streets) should be numbered sequentially according to quad location using the prefix followed by a three digit number series. The 900 –999 series should be used for any quad with more than 200 roads requiring new numbers.

New County Road Numbering by Quad

Quad 1	Quad 2	Quad 3	Quad 4
100-199	200-299	300-399	400-499
500-599	600-699	700-799	800-899

- New city streets will also use a three-digit number with the 100 series going to the county seat, the 200 series going to the next largest city, the 300 series to the next largest city, until all city streets are numbered.

New City Street Road Numbering

County Seat g., Alexandria)	(e. Next Largest City (e.g. Newport)	3rd Largest City	4th Largest City
100-199	200-299	300-399	400-499

- New State Park and Other State Agency roads that have not had an official number assigned will be coded with a prefix of ST, a Gov_level of 21, and the same numbering scheme as local roads using a three-digit number by quad. The 900 –999 series should be used for any quad with more than 200 roads requiring new numbers.
- Permanent numbers will be assigned by KYTC staff during the update of the Master Highway Cover.

2.2.6 Road Naming

- **Locally-maintained roads: Verify all road names with local officials.** The **CO_RD_NM** (or “Rd_name” in Master Hwy Cover and editing cover) is the road name used to identify the roadway. If a road is signed differently than the KYTC map index, then change the road name to reflect the name on the sign. If there is a road that is not on the current or editing coverage or map index, and without a road sign, enter "UNNAMED ROAD" in this field and check with local officials to verify the correct road name.

- **State-maintained roads.** Use the listing of the [State Primary Road System \(SPRS\)](#) maintained and provided by the Division of Planning to identify state maintained roads. Check with local officials to verify the correct road name.

2.2.7 Attribution Issues

- All state maintained routes should be portrayed according to official order.
- All routes should be correctly labeled as to the correct owner and prefix.
- Populating the Comment field is essential when county maintained routes have major alignment or length differences (< or > 0.1 miles) when compared to the most recent County Road Aid Series maps.
- For line attributes, use the GPS data dictionary data structures.
- For point attributes (intersections), only a unique identifier is required.

3. DATA PROCESSING

GPS data processing includes the review and cataloging of collected data files, processing phase measurements to determine line vectors and/or unknown positions, and performing adjustments and transformations to the processed vectors and positions. Each step requires quality control analysis, using statistical measures and prudent judgement to achieve the desired level of confidence.

3.1 TECHNIQUES

It is the responsibility of the ADDs to determine which GPS post-processing technique, or combination of post-processing techniques, will be used to meet KYTC specifications described in Section 3.2 for the GIS transportation layer.

3.2 GIS MAP SPECIFICATIONS

- Map Format: Arc/Info Version 7.2.1 (minimum)
- Map Projection: State Plane Coordinate System (SPCS),(North or South)
- Map Units: U.S. Survey Feet
- Datum: North American Datum NAD83 NADCON
- SPCS FIPSZone North: KIPDA, Bluegrass (most), Gateway, FIVCO, Buffalo Trace, Northern KY
- SPCS FIPSZone South: All other ADD's, + Bluegrass (Mercer, Boyle, Garrard, Madison, Estill, Powell, Lincoln)

3.3 VECTORIZATION

- Set Arc Info session to double precision before Arc Info cover is created. Do not, at any time during the editing process, use the coverage in any precision other than double.
- Trimble Standard Storage Format (SSF) files (or COR) shall be converted to ESRI ARC/INFO coverages for graphic editing and data processing.
- Highway centerlines shall be cleaned and smoothed so that all lines are topologically correct. Arcs should be sufficiently cleaned up:

- ◆ Undershoots and overshoots eliminated.
- ◆ Small jags around intersections eliminated.
- ◆ Duplicate arcs eliminated.
- ◆ Remove excess nodes - all arcs unsplit (so long as doing so will not lose attribution such as pavement changes.)
- Be sure that all snap tolerances are tight enough, especially to connect at intersections.
- Produce an intersection node only for an at-grade intersection. (Don't include nodes at non-grade intersections such as over- or underpasses.) This is a system connectivity requirement.
- Where a county boundary can be accurately observed in the field produce a node. Where it cannot be physically observed, the next road intersection shall be classified as the county boundary.

3.4 PROCESSING ISSUES

KYTC evaluates the accuracy of the submitted coverages. One accuracy measure is the degree to which the submitted arcs match the points that were collected in the field. To make this determination, KYTC buffers all roads from the finished coverage and clips out points that do not fall within the buffer. The percentage of points that do not fall inside the buffer is calculated for each individual road and also for the full coverage. To provide the ADDs the best opportunity to meet the required accuracy required level, the submitted points should reflect the coverage as closely as possible.

Please review field data often in Pathfinder. Add the precision records: In Pathfinder, after correcting the data, go to the dropdown list *Utilities/other/check .ssf files/add precision records*. This will create a new set of corrected rover files with an underscore before the filename. Open the new files and turn on *View/layers/precisions*. This will give you precision circles around each point in proportion to its horizontal accuracy. Large circles = poor precision. Closely examine the GPS files (as driven) to locate any bad points. If deleting points with high horizontal accuracy values does not damage the integrity of the road (for example, as in curves), this will allow the opportunity to weed out the bad points. The submitted point coverage will more closely align with the submitted arc coverage.

Exporting attributes in Pathfinder: in *export menu/change setup options/attributes* check all of the attributes except for *Area Features*.

3.5 PREPARE DOCUMENTATION FOR SUBMITTAL TO KYTC

- Prepare a coverage of only the GPS points used to build the centerline coverage (the "build points".) A large part of the KYTC review team's analysis of the ADD road coverages consists of reviewing the horizontal accuracy and alignment of the GPS points used to create the centerlines. The purpose of the build point coverage is to allow a quicker assessment of the project and a faster turn-around time for a recommendation for approval or disapproval. This cover should be generated with fields exported from Pathfinder Office software. Providing this cover with the exported fields (with all of the Pathfinder attributes) assures KYTC that the points are bona fide collected field points not edited in a shapefile or coverage. Following are the attributes to be included in the build points coverage:

LRS_ID (from spatial join)

PDOP

<i>Height</i>	<i>Correction Status</i>
<i>Standard Deviation</i>	<i>Receiver Type</i>
<i>Horizontal Precision</i>	<i>Date Recorded</i>
<i>Vertical Precision</i>	<i>Time Recorded</i>
<i>Position (X,Y)</i>	<i>Feature Name</i>
<i>Datafile Name</i>	

- Do not delete the log file in ArcInfo coverage folders.
- Separate the arcs from the points (intersections & controls) in the Trimble files, placing each in a different folder.
- Export the data file field on all files out of Pathfinder office. Include all export text files (*.inf & exp*.txt) and methods of corrections (cor*.txt). These fields and files, along with the build points, make the evaluation process much more efficient.
- Prepare a list of roads that are on the most recent County Road Aid Series map, but are not included in the new coverage, with documentation as to reason excluded.

4. DOCUMENTATION & SUBMITTAL

4.1 INITIAL GPS COLLECTION DELIVERABLES

A written project report is required from each ADD. It should be completed by the personnel directly responsible for supervising the KYTC GPS/GIS centerline work and provided to the managing ADD, if applicable, where it should be reviewed and delivered to the Division of Planning. The final report will be documentation of the successful completion of the project, and will include, at a minimum, the following:

- A narrative description of the project which summarizes the project extent, objectives, methodologies, and conclusions.
- A listing and discussion of the equipment and staff used.
- Description of data processing. Note the software used (i.e., Pathfinder, Arc/info , Arcview), the version number and the techniques employed.
- Provide a summary of the GPS road centerlines attribution, including the total miles.
- Identify any data or road centerlines excluded from the county road network with an explanation for exclusion.
- Include a digital map of the county, at an appropriate scale (1:125000 or 1:62500), identify all road network and control points, including road intersections. A sample of this desired cartographic output will be provided by the Division of Planning to the ADD's.
- An accompanying CD-ROM including all data files, GPS rover files, maps, etc. shall be submitted with the project report. A meeting should be scheduled with Co personnel to provide the data and review the information

4.2 GPS MAINTENANCE DELIVERABLES

4.2.1 ArcInfo Coverage Naming Convention

All new covers will be named with the four-letter county identifier name and the suffix corresponding to the type of cover.

- ****_upd = the updated gps cover
- ****_intr = the intersection control cover collected by the ADD
- ****_ngs = the NGS control cover collected during the road centerline collection process.
- ****_pnts = the gps points cover of only the points that were used to define the arcs.

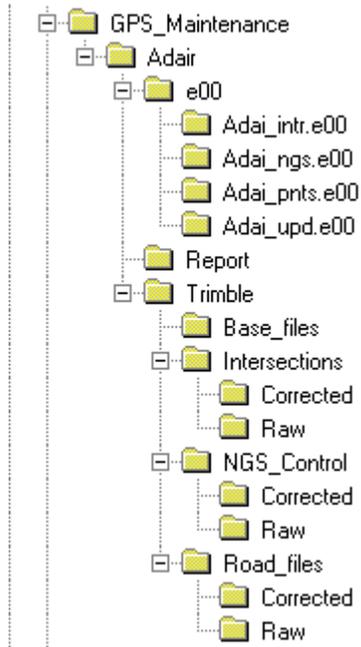
4.2.2 Required Information

The submittal must include the following information:

- An interchange file of the Arc/Info cover (****_upd) showing all changes to be incorporated including correct coding and comments. All fields must be correctly defined according to the standard "Maintenance Arc Attribute Table Format." See Section 2.2.3.
- An interchange file of the Arc/Info cover (****_pnts) of all gps points used to define all new arcs.
- An interchange file of the Arc/Info cover of all NGS control monument readings (****_ngs). At least one horizontally-adjusted NGS control marker should be collected per week **during** the road centerline collection process with a minimum of 1200 readings captured per visit.
- An interchange file of the Arc/Info cover (****_intr) of intersection control points collected. At least one intersection will be collected per day **during** gps road centerline collection
- All raw and differentially corrected gps files.
- A report listing all changes (what used to be and how it has changed) and any other explanations that may be necessary to more clearly communicate intended changes.

4.2.3 Final Submittal Process

The final submittal files should be copied to the KYTC ftp site (ftp://kytcftp/GPS_Maintenance) in the appropriate county folder. After the information has been uploaded to the ftp site, an email should be sent to Ed Whittaker (Ed.Whittaker@ky.gov), Jay Hoskins (Jay.Hoskins@ky.gov), and copied to Greg Witt (Greg.Witt@ky.gov) advising them of the upload. The submittal will be in the file structure described below. Failure to do so will result in its return to the ADD.



CONTACTS

COORDINATION, SUPPORT, AND GENERAL INFORMATION

**Kentucky Transportation Cabinet, Division of Planning
Assistant Director, Greg Witt
Data Management Branch Mgr., Ed Whittaker
GPS Maintenance Team Leader, Keith Dotson
GIS Team Leader, Bill Hieronymus**

GPS project web site: <http://transportation.ky.gov/planning/index2.asp>

Division of Planning email address: kytc.planningwebpage@ky.gov

Division of Planning telephone number: 502-564-7183

Division of Planning fax number: 502-564-2865

APPENDIX

Prefixes that may be used temporarily in the field:

NR = New Road (County or City)

NC = Non County

(Note: NR and NC are not valid prefixes for a finished cover. Research must be done to identify the correct prefix code, owner and government level and reflected in the finished cover.)

County Road Numbering Scheme

(Numbering Shortage Procedures)

In counties where roads outnumber the currently used numbering scheme, and all original 1000 numbers have been assigned, the suffix “Q1, Q2, Q3, or Q4” for the corresponding quad, shall be assigned and the original numbering scheme of that county repeated. **All original 1000 numbers must be used first.** For instance, if the county numbering scheme has a pattern of:

Quad 1 1000-1099 1500-1599

Quad 2 1100-1199 1600-1699

Quad 3 1200-1299 1700-1799

Quad 4 1300-1399 1400-1499

1800-1899 (assigned to first quad that needs more than 200 numbers)

1900-1999 (assigned to second quad that needs more than 200

numbers)

and the numbers for the individual quads have been exhausted, then the numbers already assigned to each quad shall be repeated and a “Q” with the corresponding quad number added as a suffix. One example, assuming quad 3 had used all 200 numbers, originally assigned, plus the additional numbers (1800 and/or 1900 series) and it is then found that quad 3 needs still more numbers. The next step would be to use the numbers that have already been assigned to quad 3 with “Q3” added as a suffix (CR-1200Q3, CR-1201Q3, CR-1202Q3, and so on).

It is important that the original numbering scheme of the individual counties stays intact and then repeated once all other options have been exhausted. This would preclude using the same route number with different suffixes for different roads in an inset since the “Q1” would already occupy the suffix position. Therefore, neither the number “CR-1001Q1A” nor “CR-1001AQ1” are valid for use in an inset since the “Q1” is already in the suffix position. In this case, “CR-1001Q1” would be used and then the next sequential number “CR-1002Q1” would be used.

NUMBERING PRIVATE ROADS

Private; Driveway, Road, and Subdivision Numbering Scheme

PR – A privately owned and maintained route that is public in use

PS – A privately owned and maintained development (e.g. trailer park, recreational development, or private subdivision) that is public in use.

PV – A privately owned and maintained route that is **not** public in use (factory entrance, driveway)

The numbering convention for “PR” (Private Road), “PS” (Private Subdivision), and “PV” (Private Driveway) should follow the same format as County Road Series maps (C.R.A.P. map) numbering. For example, the first private road in quad #1 should begin with the number of “PR-1001”, with following roads numbered consecutively (e.g., the second private road “PR-1002, and so on). The sequence of numbering the roads should be as follows:

Quad 1 PR-1001 – PR-1099

Quad 2 PR-1101 – PR-1199

Quad 3 PR-1201 – PR-1299

Quad 4 PR-1301 – PR-1399

Since the prefix field (PR, PS, or PV) allows the number to be unique the same rules will also apply to the “PS” and “PV” roads.

OTHER AGENCY ROADS

For many of these facilities, KyTC already has an Interagency Charge agreement and has assigned an IC-8___ number. [Please check the listing of IC- numbers](#) and use the assigned number if listed. If the facility is not listed, assign the number ST-8000 and KyTC will establish a new number. Be sure to assign the appropriate Gov_Level: 11 for State Parks and State Forests and 21 for other state agencies. If there are multiple roads for the facility, use suffixes A, B, C, etc. to distinguish. (Note: This listing may be outdated and some features may no longer exist.)

FEDERAL AGENCY ROADS

Some roads that go through a National Forest or Park are maintained by the county. These should be coded with the assigned CR- number and Gov_Level = 02. Route identification of other roads owned and maintained by Federal Agencies that have had a number previously assigned by that agency should retain the agency number with an “FD” added in the prefix position. Be sure to assign the appropriate Owner (Gov_Level) code.