FINDINGS AND RECOMMENDATIONS

IDAHO TRANSPORTATION FRAMEWORK PROJECT

FINAL

Part of the Idaho Spatial Data Infrastructure Initiative (ISDI)

Prepared for:

ISDI Transportation Technical Working Group

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May 24, 2010

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1. PROJECT BACKGROUND

1.1 Project Initiation and Objectives

The Idaho Transportation Framework Project, initiated in mid-2009 has the primary goal of creating and maintaining a seamless, GIS-based transportation data layer for the entire state. This project is being carried out under the auspices of Idaho's Transportation Technical Working Group (TTWG) and is being financially support by a 2009 Category CAP Grant from the Federal Geographic Data Committee (FGDC). See www.fgdc.gov/grants for more information about this grant program. This project focuses on road centerline Framework data but acknowledges other transportation modes (waterways, railroad, air) that are part of the Transportation Framework data theme as defined by the Idaho Geospatial Council (IGC) and the work of the TTWG. The statewide road centerline data, which is the subject of this project, will be referred to as the Idaho Roads Framework. In large part, this project builds on past and ongoing activities that contribute to the development of a GIS-based statewide road centerline data layer that can serve the needs of multiple organizations and user groups.

Specific objectives of the project include:

- Prepare a road transportation data model and data dictionary with the structure and content that supports business and application needs of all user groups.
- Provide recommendations on the development of the statewide road centerline database taking into account existing sources of road network data.
- Define and work to achieve consensus on data stewardship roles and data maintenance procedures so that the statewide road transportation is regularly updated as actual conditions change (new road development or road closures).
- Provide recommendations on the implementation and use of a Linear Reference Model (LRM) that is compatible with the road transportation data model and data maintenance process.

1.2 Project Participants and Roles

This project is coordinated and managed by Bruce Godfrey, CAP Grant Principal Investigator and GIS Specialist at the University of Idaho (in charge of Idaho's GIS clearinghouse, INSIDE Idaho). The TTWG is the main sponsor of this project and the following individuals have been key project participants:

- Brian Emmen, GIS Manager, Idaho Transportation Department
- Frank Roberts, GIS Manager, Coeur d'Alene Tribe
- Dave Christianson, Kootenai County GIS Manager and Transportation TWG Chair
- Gail Ewart, Idaho Geospatial Information Officer
- Scott Van Hoff, Idaho's USGS Geospatial Liaison

Peter Croswell, President of Croswell-Schulte IT Consultants, has been retained to provide consulting support.

1.3 Project Tasks and Summary of Status

Project work has been organized into the eight tasks summarized in Table 1. A detailed project plan with subtasks and projected timing may be found at http://insideidaho.org/geodata/FrameworkPilot/transportation/2009_FGDC_CAP_grant/projectPlan.pdf.

Table 1: Task Summary-Idaho Transportation Framework Project

Task #	Task Name	Description	Accomplishments (as of 5/20/2010)
1	**Project Management And Administration**	All activities relating to administration of the CAP grant and project planning, tracking, reporting and communications	• Project plan prepared and updated • Grant reporting to FGDC prepared xxxx • Regular email and conference call communications
2	**Assessment Of Status Of Separate Transportation Data Efforts In Idaho**	This task focuses on the status of existing systems/projects in Idaho that involve the collection and maintenance of road data. Includes a summary status, database description, geog coverage, and obtaining application design/data model documentation	• Situation assessment form prepared by Croswell and distributed by Godfrey to key parties (ITD, LHTAC, federal/state agencies, local governments) • Situation assessment results gathered and compiled by Godfrey
3	**Gather And Evaluate Other Statewide GIS Transportation Data Programs**	Examine transportation data models and data stewardship programs in other statewide systems to identify approaches that may be implemented in Idaho	• Information gathered from state transportation Framework programs in AR, OH, MT, ND, TN, WA, WV • Prepared summary of lessons learned and best practices for transportation Framework data management
4	**Conduct Data Model Needs Assessment**	Following Task 2 situation assessment conduct a more detailed assessment of data model and data stewardship needs.	• Needs survey form prepared by Croswell with input from Godfrey and Christianson • Survey form distributed by Godfrey and responses forwarded to Croswell • Croswell tabulated survey responses and reviewed results with Godfrey and Christianson
5	**Review And Provide Input For LLRM Development**	Meet with ITD and become involved as a participant (review and comment role) in their current LRM design project being managed by Cambridge Systems	• Completed initial review of ITD LRM documents • Croswell examined LRM status in other states • Gathered ideas about LRM status and use in on-site meetings (2/9 to 2/11)
6	**Transportation Data Model And Data Dictionary Development**	Preparation of a data model and data dictionary for a common, statewide transportation theme	• Evaluated data models from Idaho sources and from other states • Prepared initial recommendations for an Idaho road centerline data model and distributed to stakeholders • Held on-site review session with project stakeholders (2/9 to 2/11) • Prepared revised final draft recommendations report and submitted for review
7	**Data Sources, Stewardship Roles, And Ongoing Maintenance**	Decide on the specific hardware configuration to support long-term and short-term needs. Select, install, and configure hardware for initial needs during GIS development.	• Croswell has collected data on stewardship approaches in other states and discussed preliminary ideas with Godfrey and Christianson • Held on-site review session with project stakeholders (2/9 to 2/11) • Prepared revised final drafts of the recommendations report and submitted for review
8	**Project Close Out**		• Preparations have been made for a presentation to the IGC on June 17

This report takes into account the information gathered in the Situation Assessment, Needs Assessment, the on-site review meetings in January, 2010, and follow-up comments on three draft versions of the report.

2. SITUATION ASSESSMENT OF ROAD TRANSPORTATION DATA MANAGEMENT

2.1 Information Gathering

To establish a baseline of information regarding the current state of road transportation data development and maintenance in Idaho, a situation assessment was conducted. Status information was gathered from individuals of selected organizations in the state and the responses provided a good picture of current road-related data activities in the state. Survey responses were requested from known state and federal agencies and a representative sample of local governments involved in GIS-based transportation data collection. The situation assessment gathered information on existing transportation infrastructure databases, geographic area of coverage, file formats, update process and frequency, and other status information. See Appendix A for more details about the information gathered. Situation assessment information was gathered from the following organizations:

- Idaho Transportation Department
- Local Highway Technical Assistance Council (LHTAC)
- Idaho Bureau of Homeland Security
- Integrated Road Centerline Project
- Idaho Department of Lands
- Kootenai County
- Fremont County
- Nez Perce County
- Bonner County
- Madison County - City of Rexburg
- City of Nampa
- Coeur D'Alene Tribe
- U.S Geological Survey (Idaho GIS Liaison)
- U.S. Forest Service
- U.S. Bureau of Land Management-Idaho State Office

The organizations above and the following additional organizations were involved in review and comment on the draft recommendations report (January 20, 2010) and in review meetings conducted on February 9 to 11:

- Ada County Assessor's Office
- Ada County Sheriff's Office
- Idaho E911 Emergency Communications Commission
- Idaho Department of Parks and Recreation
- Idaho Community Planning Association (COMPASS)
- Owyhee County
- Bannock Transportation Planning Organization
- Nez Perce Tribe
- Bonneville County
- Boundary County
- GIS Quality Design and Consulting, Inc.
- ESRI
- U.S. Bureau of Reclamation

2.2 Summary of Situation Assessment Results

The situation assessment was conducted in the initial stages of the Framework project to provide a picture of current transportation data collection and management in Idaho as a basis to evaluate future needs. This situation assessment reveals that there are multiple organizations have been developing maintaining road-related GIS databases—some of which are statewide and others covering a portion of the state. The details of the situation assessment responses can be accessed at: http://insideidaho.org/geodata/FrameworkPilot/transportation/2009_FGDC_CAP_grant/situationAssessment.xls.The main findings from this situation assessment are summarized as follows:

- The Idaho Transportation Department is a primary source of statewide transportation for state agencies, some federal agencies, and other organizations including LHTAC, State Bureau of Homeland Security, US Bureau of Land Management, and others. The ITD maintains a GIS-based statewide transportation centerline database that includes all Interstate highways, U.S. and State routes, and selected local roads and streets (streets/roads with a designated ITD functional class, those for which annual traffic counts are collected, and those with an ITD maintained bridges). All local roads and streets are not captured and maintained by ITD but the number of local roads and streets included in the ITD GIS database varies depending on the local area.
- The state's Local Highway Technical Assistance Council (LHTAC), as part of its mission to support local highway districts and jurisdictions, has been collecting road centerline GIS data to augment data being captured and updated by the ITD GIS Section. The primary objective of this data compilation is to provide a basis for calculation of road miles for allocation of highway improvement funds. The LHTAC data compilation includes the capture of local public roads in unincorporated areas. In addition, LHTAC manages an Asset Management grant program that includes funds for the collection of road centerline data inside selected small municipalities (5,000 population or less). LHTAC coordinates its GIS data compilation with the ITD GIS Section and uses the LHTAC data model for storing the centerline data.
- The Integrated Road Centerline Project now has participation from 20 counties providing high quality and accurate road centerline data and attribution. INSIDE Idaho uses custom built tools to import and normalize the data to a common data model (centerline attributes) developed cooperatively with a number of local governments in 2006. A process has been put in place to get data updates from the counties and incorporate the data into the integrated layer. For areas of the state without county participation, less accurate and timely Census TIGER data is used. This project has been extremely useful in testing and resolving many of the detailed technical and logistical issues for an undertaking of this complexity which requires coordination among and processing of data from multiple source stewards. Appendix D contains a more detailed description of the project and valuable "lessons learned" which are useful in planning for a future expanded roads Framework stewardship program.
- The Idaho Department of Lands uses road centerline data from other agencies (e.g., ITD) but also compiles and updates centerline data and attributes for publicly accessible and restricted access roads on state lands that the agency manages. Edits and updates focus on roads on endowment lands first, then adjacent land ownership and finally on other land ownership which offers legal access to the public road system.

- There are a number of local and tribal governments, with active GIS programs which are maintaining GIS-based transportation data. Based on responses from a sample of seven city, county, and tribal governments and information on participating local governments in the Integrated Roads Centerline Project, it is estimated that over 30 counties and two tribes have GIS programs and are actively compiling and updating road centerline data.
- The most common format for maintaining transportation centerline data is the ESRI geodatabase. All of the organizations included in this situation assessment use this format and in many cases generate derivative GIS database products (e.g., Shape Files).
- The State's E911 Emergency Communication Commission (ECC) to assist cities, counties, ambulance districts and fire districts in the establishment, management, operations and accountability of consolidated emergency communications systems, including the compilation of address information and GIS data that supports E911 operations and emergency response. The ECC manages a grant program, funded by a voluntary county fee of 25 cents per phone line per month which may be used for E911 enhancement, including GIS development.
- There is currently no active use of a statewide GIS-based Linear Reference Model. The ITD does maintain a mainframe-based transportation asset database tied to highway log points but there is no GIS interface. The ITD has conducted a detailed study on LRS needs and design issues and is evaluating options for implementation of an enhanced GIS-enabled linear reference system. There is very little use of linear reference systems at the local level but several local government GIS programs have examined the potential use of LRS and dynamic segmentation capabilities of GIS software to support targeted applications (e.g., pavement management).

3. IDENTIFICATION OF ROAD TRANSPORTATION DATA NEEDS AND CURRENT PRACTICES IN IDAHO

Following the situation assessment described in Section 2, a more detailed survey of needs and current data development and data management practices was conducted with selected organizations. The survey gathered information on:

- Application needs
- Priority for different road types
- Positional accuracy needs
- Road centerline segmentation rules
- Road centerline attributes and road-related data needs
- Road data update procedures

Survey forms (see Appendix B) were returned from the following organizations:

- Idaho Transportation Department
- Idaho Department of Lands
- U.S. Bureau of Land Management
- Coeur D'Alene Tribe
- Kootenai County
- Fremont County
- U.S. Forest Service-Payette National Forest
- Nez Perce County
- Bonner County
- City of Nampa

The full results of the survey may be accessed at http://insideidaho.org/geodata/FrameworkPilot/transportation/2009_FGDC_CAP_grant/needsSurvey.pdf. Summary counts for the different survey questions are presented below in Tables 2 to 7. Summary observations about the survey results include:

- Applications that require road centerlines and attributes span a large range but there is a general consensus that, in addition to support for general transportation map display and generation, the Idaho data model should support: a) address matching and address-based incident mapping, b) Emergency planning and dispatch, c) Asset management and maintenance, and d) transportation planning. See Table 2.
- There is very strong consensus that a road centerline database should include all public roads (interstate highways, U.S. routes, state routes, county roads and highways, highway ramps, and municipal streets). The consensus also includes private roads and long driveways. There is some question about the need to include all roads on federal lands (by non-federal organizations) but comments indicate that these roads are fairly high priority. See Table 3.
- Positional accuracy needs show some variance but most respondents indicated that Moderate Accuracy (5 to 20 feet) was acceptable—with comments that an accuracy level at the lower end of this range (5 feet) is desirable. Several respondents supported a goal for higher accuracy (1 to 5 feet) using high-resolution orthoimagery or GPS-based data capture. See Table 4.

- In most cases, respondents indicate that divided roads (with a median) are represented with two centerlines.
- Responses about road centerline segmentation rules show great consistency in segment breaking at: a) at-grade intersections, b) changes to road name or route number, and government jurisdiction boundaries. Some respondents indicated a rule for breaking a segment of rural road, between actual intersections when those intersections are widely spaced. See Table 5.
- Only about half of the respondents provided information about rules for handling centerline segments for "special road configurations" (e.g., highway ramps, cul-de-sacs, loop roads, traffic circles). The survey results suggest that there is not consistency of these "geometry rules" and that in most cases, they are not documented in writing, indicating that a statewide road centerline standard should include reference to these cases and how they should be depicted.
- Respondents provided information about needs for additional road-related map features associated with the centerline. Local governments were unanimous in expressing a need for site addresses. Most of the respondents indicated a need for mileposts and for bridges and overpasses. The largest single organization maintaining road information, the ITD, has a primary need for locating all highway assets that they maintain. See Table 6.
- Responses to the question of priority for centerline attributes showed a significant variance when tribal and local governments are examined separately from state and federal agencies. In addition to attributes on road/street names and route numbers, local and tribal governments indicating a very strong need for: address ranges, road jurisdiction, road classification. State and federal agencies indicated high priority need for: log (mile marker) points, road classification, road jurisdiction, surface type, and maintenance status. There were lower than expected scores (average of 4 or less) for several centerline attributes including: alternate street names and route numbers, emergency service zones, road direction and cardinality flags, number of lanes. But these attributes were scored high by several respondents Also there was a low response for Linear Reference Model Route indicating that, at this time, few of the respondent organizations are using an LRM to support location of road assets and events. Establishing an LRM integrated with GIS remains a major priority with the ITD. See Table 7.

Table 2: Road Related Application Needs

(Number of respondents identifying each application area)

Application Area	# of responses
Transportation Map Generation	9
Address Matching/ Incident Mapping	7
Emergency Dispatch/Planning	7
Maintenance/Asset Management	8
Route Planning	4
Accident/Safety Planning	4
Transportation Analysis/Planning	6
Other: Timber management	1

Table 3: Road Type Priority

(Average priority based on scores of 0 to 10)

Road Type	Average Priority Score
County Highway	7.3
Roads on Federal Lands	7.3
State Highway	7.0
Other: Rural County roads other than HWYs	7.0
Local/Municipal Street	6.7
Private Roads	6.4
Other: Trails, 4-wheel drive/snowmobile routes, river routes	6.0
Interstate HWY	5.5

Table 4: Positional Accuracy Needs

(Number of respondents identifying each accuracy category)

Accuracy Level	# of Responses
Very High (<1 foot)	1
High (1 to 5 foot)	3
Moderate (5 to 20 foot)	8
Low (20 to 50 foot)	0
Very Low (>50 foot)	0

Table 5: Rules for Road Segmentation

(Number of respondents identifying each segmentation rule)

Segmentation Rule	# of Responses
Change of road name or route #	9
Intersections	8
Jurisdictional Boundary	4
Zip Code boundaries	3
Other: Surface Change	1
Other: Address blocks for stretches w/o intersections	1
Water crossing	0

Table 6: Need for Road-related Data/Features

(Number of respondents identifying each application)

Road-Related Feature	# of Responses
Mile Posts	8
Bridges/ Overpasses	8
Site Addresses	6
Traffic Signs/Signals	4
Other: Gates, culverts, route signs	3
Other: Speed limit	1
Other: All HWY assets	1
Other: Jurisdiction, surface type, capacity, status	1
Other: Extent of County Maintenance	1

Table 7: Road Centerline Attribute Priority Scores from Idaho Survey Respondents

(Cumulative and average priority scores—based on respondent scores of 0 to 10. Blank entries given a score of "0" indicating no need for the attribute)

Centerline Attribute	Cumulative Priority Score	Average Priority Score	Average Score for Local Gov't	Average Score for State/Fed. Agencies
Segment ID (primary key)	56	6.2	8.0	4.0
Alternate Segment ID	14	1.6	2.8	0.0
Primary Street Prefix	47	5.2	8.0	1.8
Primary Street Name	66	7.3	8.0	6.5
Primary Street Type	47	5.2	8.0	1.8
Primary Street Suffix	47	5.2	8.0	1.8
Route or Local Road #	52	5.8	4.8	7.0
Alternate Street Names	34	3.8	5.4	1.8
Alternate Route #s	25	2.8	2.8	2.8
Post Direction	39	4.3	6.4	1.8
Left From Address	47	5.2	8.0	1.8
Left To Address	47	5.2	8.0	1.8
Right From Address	47	5.2	8.0	1.8
Right To Address	47	5.2	8.0	1.8
Left Postal ID	29	3.2	5.2	0.8
Right Postal ID	29	3.2	5.2	0.8
Left City	27	3.0	5.2	0.3
Right City	27	3.0	5.2	0.3
Left County	18	2.0	3.4	0.3
Right County	18	2.0	3.4	0.3
Right Community[1]	21	2.3	4.0	0.3
Left Community[1]	21	2.3	4.0	0.3

Centerline Attribute	Cumulative Priority Score	Average Priority Score	Average Score for Local Gov't	Average Score for State/Fed. Agencies
Left Emer. Service Zone	27	3.0	5.2	0.3
Right Emer. Service Zone	27	3.0	5.2	0.3
Number of Lanes	34	3.8	4.6	2.8
Reverse Direction (Y/N)[2]	28	3.1	4.4	1.5
Divided Road (Y or N)	22	2.4	3.2	1.5
Flip Geometry Flag[3]	28	3.1	3.2	3.0
Left Side Odd (Y/N)[4]	21	2.3	3.6	0.8
Map Length[5]	35	3.9	2.4	5.8
3D Length[5]	28	3.1	2.2	4.3
LRM ID6	25	2.8	3.4	2.0
Beginning Log Point	42	4.7	3.6	6.0
Ending Log Point	42	4.7	3.6	6.0
Cardinal (Y/N)[7]	21	2.3	3.0	1.5
Direction Traveled[8]	29	3.2	4.6	1.5
Jurisdiction of Road	59	6.6	6.4	6.8
Surface Type Code	59	6.6	5.8	7.5
Road Classification	63	7.0	6.6	7.5
Maintenance Status	55	6.1	5.6	6.8
Edit or Update Date	53	5.9	5.0	7.0
GIS Data Steward	67	7.4	8.0	6.8
Use Restriction	50	5.6	5.2	6.0
Other: Speed Limit	5	0.6	1.0	0.0

Footnotes:

[1]Any community or place name different from FIPS municipality,

[2]Y means that ascending log points does not correspond to direction of the segment geometry (digitized direction) in the GIS database

[3]Code to indicate that the geometry (digitized direction) of the segment should be flipped

[4]If Y, left side of street has odd number addresses, if N, left side has even addresses

[5]Map Length is length measured from a map source. 3D length is actual traveled distance (on which log points are based)

[6]The Linear Reference Model route number for the segment

[7]Y indicates that the segment follows the standard rule for ascending log points (increasing W to E and S to N)

[8]One-way, One-way non-Cardinal (direction of travel is opposite that of log point progression), or Bi-directional

4. TRANSPORTATION DATA MANAGEMENT PRACTICES IN OTHER STATES

Project consultant Peter Croswell reviewed statewide transportation data programs in a number of other states. This review included the acquisition and evaluation of documentation from the state programs and in person or phone interviews with the state project managers. The purpose was to examine data models, organizational and project management approaches, and practices in place for data compilation and ongoing data maintenance. The following states were included in this review: Arkansas, Ohio, Montana, North Dakota, Tennessee, Washington, and West Virginia. These are not the only states that currently have a statewide transportation data program but they represent many of the most effective programs in the USA and provide a representative sample to help identify technical design choices and practices that make sense for Idaho.

4.1 Summary of State Programs Reviewed for this Project

ARKANSAS:

Name of Program: Arkansas Centerline File Program (standard approved by the Arkansas State Land Information Board)
Web Site URL: www.gis.state.ar.us/Programs/Programs_current/ACF_index.htm
Contact Name(s): Learon Dalby, GIS Program Manager, Arkansas Geographic Information Office
Program Background: Work on the standard was initiated in 2000. It was driven by recognition that multiple federal, state, and local organizations had a need for and in some cases were developing and maintaining road transportation databases without any common standard. The ACF program is designed to compile a standardized statewide road centerline GIS map data layer that can be used by all levels of government, the private sector and individuals. The ACF Program is unique in that the entire dataset is built from many different local source (city and county) datasets using a common standard. The State of Arkansas does not create or develop any data. The State simply integrates the various local sources into a common format in a standardized and consistent manner across jurisdictional boundaries. The centerline standard, documented in the 2002 document identified above is an approved standard and includes general guidelines for data compilation and a description of attribute data fields for centerline segments.
Data Model Summary: The centerline standard, documented in the 2002 document identified above is an approved standard and includes general guidelines for data compilation and a description of attribute data fields for centerline segments. The data model has a basic set of attributes that support a basic cartographic representation of the road network and address-based applications—it includes addresses ranges, jurisdictional identifiers, and other basic information. No firm rules have been defined for common centerline geometry (accuracy, segmentation, handling of divided roads, or other special road configurations).
Database Development and Maintenance Approach: The statewide centerline network has been compiled from a number of available sources by the state Geographic Information Office. An ongoing data maintenance program has been established that relies on updates from county governments (mainly the E911 bodies in each county). The goal is to get monthly data updates from the counties but in practice, updated data often comes in less frequently. Getting data updates from on any regular basis from some counties is difficult. There is no unified positional accuracy requirement of designated source or approach for data update. The Centerline File standard states that the primary source will be USGS orthophoto quarter-quad files but compilation from higher-resolution orthoimagery and GPS data capture is encouraged. There are plans to develop a Web-based maintenance tool for use by the counties but this is not yet in place.

OHIO:

Name of Program: Land Based Response System (LBRS) Program run by the Ohio Geographically Referenced Information Program (OGRIP) in the Ohio Office of Information Technology
Web Site URL: http://ogrip.oit.ohio.gov/ProjectsInitiatives/LBRS.aspx
Contact Name(s): Jeff Smith; (OGRIP); Dave Blackstone, Ohio DOT; Ron Cramer, DDTI (contractor for GPS road data collection)
Program Background: LBRS is a state government managed project, in place for nearly 10 years, established for county participation in the collection and ongoing maintenance of street centerlines, addresses, and other road-related assets. It is a participatory program with partial state funding in which counties opt (through a memorandum of agreement) to carry out the data gathering using specifications of the LBRS program and agree to provide updates. The program has participation of multiple state agencies. OGRIP and the Ohio DOT play lead roles in providing technical support to participants. At this time, 70 out of 88 counties in the state are participating in the program and many of the others in the process of approving an LBRS memorandum of agreement or are considering becoming a participant.
Data Model Summary: The LBRS program includes data models designed for the capture of street and road centerlines, a wide range of attributes for centerlines, site addresses, and road-related point features (e.g., milepost signs, landmarks). The data model for centerlines is extensive and includes R/L address ranges and jurisdictional information as well as attributes that support road-related asset management and emergency management (number of lanes, functional class, road jurisdiction, posted speed limit). The centerline data model includes a number of fields to identify the cardinality of a segment (direction of addressing and mile point progression). There is also route information to allow the model to be used with a linear reference model and a field for 3-D road length (traveled distance). Specifications for LBRS data collection include mature and detailed specifications on centerline geometry include rules for segment breaks and for handling a range of special road configurations (cul-de-sacs, ramps, traffic circles).
Database Development and Maintenance Approach: Detailed LBRS specifications for data capture are required to be followed by counties participating in the program (and contractors hired to do the work). The specification is designed for data capture by GPS (specially equipped vehicles with GPS, video systems, and other equipment). Since the beginning of the program, procedures and tools for data collection and post processing, for segment, site address, and landmark features, have been perfected. Data collected from the vehicle (driving all roads in the jurisdiction), is processed by an operator that has access to ancillary sources (e.g., ortho). The resulting data sets may be used with different GIS software. The Ohio DOT is responsible for ongoing update of data for state maintained roads (Interstates, U.S routes, and state routes). Through a term in the LBRS memoranda of agreement, counties are responsible for providing updated data for local roads. The Ohio DOT has the lead role in working with the counties and has a partnership with a designated entity in the county which may be a GIS Office, the E911 office, or the County Engineer's Office. The DOT accepts the data, performs QA on road geometry, topology, and segment attribution. The DOT does not perform QA checks to validate that street names and addresses are correct. Data may be provided by the counties, at least on an annual basis, in any of several formats (Shape Files or AutoCAD dwg files are common). A contractor in Ohio, DDTI, which has become the principal provider of data collection services also provides a Web-based hosted GIS and provides Web-based tools for counties to update data.

MONTANA:

Name of Program: Transportation Framework Theme project. Part of the Montana Spatial Data Infrastructure Program (MSDI) and the Transportation Working Group
Web Site URL: http://giscoordination.mt.gov/transportation/msdi.asp
Contact Name(s): Joshua Dorris, Transportation Framework Theme Lead, MT Dept. of Administration, Information Technology Services Division
Program Background: The Transportation Framework Theme project is part of Montana's spatial data infrastructure program that includes other Framework data layers. A data model and update process was designed with input from multiple state agencies and local governments. The intent was to include all roads (interstates, federal and state routes, local roads and streets) and to keep the statewide updated. New roads are constantly being built and upgraded, seasonal closures affect certain routes, road names and address ranges change, and road maintenance is a continual occurrence. The project received support and funding largely because of a business case showing benefits for emergency management and response
Data Model Summary: A data model was created that defines attributes for centerline segments. It is designed for implementation with within ESRI's geodatabase architecture. In addition to roads, the data model accommodates other transportation modes (e.g., RR, Trails). This provides for a core set of attributes that include address ranges, jurisdictional information, and other physical road characteristics (surface type, width, lanes, etc.). No specific rules have been defined for road centerline geometry (segmentation, positional accuracy, handling of special road configurations).
Database Development and Maintenance Approach: The goal is to make annual updates to the centerline database. The State Dept of transportation is responsible for making updates to Interstates and State routes. Ongoing data update for county highways and local streets relies in part on data provided by county government groups. This works well for counties with active GIS programs (about ten at the current time). Getting updated data from counties without GIS programs is more difficult. Most of these counties are lower population and have slower growth so road changes are less frequent. The state DOT does collects some local road data through GPS collection. Some data for roads on public lands (e.g., state and national forests) are provided by the US Forest Service and State Natural Resources.

NORTH DAKOTA:

Name of Program: North Dakota Statewide Road Centerline Database
Web Site URL: www.nd.gov/gis/resources/standards/070425.html and www.nd.gov/gis/news/20061117.html
Contact Name(s): Bob Nutsch, State GIS Coordinator, Information Technology Department
Program Background: The program began in 2006 when the state's GIS technical Committee commissioned a study to determine the most feasible and cost-effective approach for developing and maintaining a statewide road centerline dataset. This study by Geocomm included a road data inventory, data model and quality standards, implementation approach and funding estimates. The main project stakeholder is the State Dept. of Emergency Services (DES) and the North Dakota 911 Association. A number of state agencies and Association of Counties representatives participated in the study and information was collected from many of the state's counties. Standards and specifications are still in the process of being finalized and work is underway to development a complete statewide centerline dataset with address information and other attributes to support emergency services and other applications. At this time the State DOT is not a major participant.
Data Model Summary: The data model includes a definition of rules for centerline segmentation, topology, and a full set of attributes for centerlines with an attribute description. The centerline attribution is divided into "base fields" (includes street names and route numbers, address ranges, jurisdictional and ESN codes, surface type and some metadata fields).
Database Development and Maintenance Approach: Database development is underway initially using GIS source data available from the counties and aerial imagery. Work involves capture of centerlines and address points. The intention is to include all roads (federal, state, local, and private roads). Target accuracy is one meter, and various compilation and update sources are being considered, including GPS capture. Full procedures and tools for data update have not been put in place yet but it will rely on individual counties with oversight from the state DES. There has been consideration of implementing a Web-based tool to allow local governments to post road and address changes directly to the state centerline database.

TENNESSEE:

Name of Program: Tennessee Information for Public Safety (TIPS)
Web Site URL: http://gis.state.tn.us/tips.html
Contact Name(s): Patrick Melancon, GIS Services, State Office for Information Services
Program Background: TIPS is one part of Tennessee's statewide base mapping program (TNBMP) managed by the State's GIS Services Section of the Office for Information Resources. The initial version of the statewide centerline database was developed in 2007 and is now in an ongoing maintenance and improvement stage. OIR worked with a number of state agencies (DOT, the Emergency Communications Board) and local entities including E911 districts and county and city governments.
Data Model Summary: The data model includes centerline data attribution and metadata. It includes attribution for driveway and trail centerlines in addition to roads. There is also an attribute table for address points. Road centerline segmentation rules call for breaks at intersections, jurisdiction boundaries, and zip code boundaries.
Database Development and Maintenance Approach: The statewide database has been developed based on data from local sources. The state also paid license fees to TeleAtlas to use their compiled centerlines and attribution. The update process relies on information from county E911 districts or local government sources (e.g., GIS offices, Assessors). OIR attempts to get data updates on a quarterly basis although in practice data updates from local sources do not always adhere to the quarterly schedule. OIR accepts the data and performs QA and posting to the state centerline database. At the current time, the state DOT is not a participant in the update process—they maintain a separate centerline file for cartographic purposes but there is interest in involving the DOT in the update of a unified centerline file.

WASHINGTON:

Name of Program: WA-Trans Program
Web Site URL: www.wsdot.wa.gov/MapsData/TransFramework
Contact Name(s): Tami Griffin, WA-Trans Project Manager, Washington Department of Transportation
Program Background: Planning began in 2002 under the auspices of the state Geographic Information Council and the state DOT. The project was established to create a statewide transportation dataset for use in Geographic Information Systems (GIS) applications. WA-Trans data can be used in Transportation Planning, Transportation Safety, Emergency Management, Law Enforcement, and other business functions benefiting state and local agencies throughout the state. It also supports statewide the development and maintenance of other Framework layers. A business case was prepared early in the project and work proceeded in the preparation of technical specifications and a data model. At the current time, there is a mature data model, technical specifications, and technical tools for importing data from source custodians. A number of pilot projects have been completed in which data from several regions and work is under way to include additional counties. The WA-Trans project has been carried out as part of a multi-state "pooled fund" effort coordinated by the Federal Highway Authority. A number of state transportation agencies, including the Idaho Transportation Dept. have contributed funding to this effort and have the ability to share in the specifications and technical tools that are developed.
Data Model Summary: A mature data model consists of several tables that allow the capture of attributes for centerline and geometry rules for the centerline segments. The WA-Trans project is concentrating on road centerlines, but the data model allows for capture of data for other transportation modes (RR, Trails). The data model is fairly complex. It includes multiple related tables that separate centerline geometry from centerline segment attributes. There is a table that holds street and road identification, address range and related data, and another table that stores route information supporting the DOT's linear reference system. The data model also includes a large number of metadata fields that document update transactions, data sources, and quality.
Database Development and Maintenance Approach: Database development is currently underway through a number of pilot projects, and the WA-Trans team is in the process of getting additional participation from counties with a goal of building a statewide database. The WA-Trans program has, from its inception, been based on the idea that data sources (local governments and tribal governments) will be the primary sources of data and that there will be no data specifications, data model standards, geometry rules, or accuracy requirements imposed on them for their own use. For this reason, the data model includes extensive metadata to document sources and data quality and sophisticated translators and import tools have been developed to accept data from the varied sources.

WEST VIRGINIA:

Name of Program: Statewide Addressing and Mapping Project
Web Site URL: Project site at: www.addressingwv.org, State GIS clearinghouse at: www.mapwv.gov/
Contact Name(s): Hussein Elkhansa, GIS Manager, WV Department of Transportation; Jennings Starcher, IS Manager, WV Division of Homeland Security and Emergency Management.
Program Background: Mapping of road centerlines and capture of point addresses in West Virginia began in 2001 with the creation of the Statewide Addressing and Mapping Board (SAMB). Funding became available to map centerlines and capture point addresses for the entire state, with a primary objective of supporting emergency management and response for state agencies and local emergency organizations. Centerlines were mapped from one-meter resolution orthoimagery (2003) and the SAMB program developed partnerships with counties to carry out address capture. At this time, most of the counties have completed the mapping and address assignment work. Management of road centerline date and addressing is shared between the state Department of Transportation (road centerlines) and the Department of Homeland Security and Emergency Management (address assignment). The DOT is in the process of improving the accuracy of the initial road centerline data and adding attribution that supports state and local use.
Data Model Summary: The current technical specifications (2008 version) include a number of data tables that define attribution for road centerlines and address points. It also includes general guidelines for the capture of metadata, coordinate system standards, and rules for road segmentation. For road centerlines, the data model includes road and route number identification fields, R-L jurisdictional and emergency service zone designations, and other attributes.
Database Development and Maintenance Approach: Update of data relies on data provided by the state DOT and local governments that are formally participating in the SAMB project. The DOT is responsible for the updating interstates, U.S. routes and state routes. GPS-equipped vehicles are used to capture updated road mileage and attributes on an annual basis (for interstates and state routes). Local roads are the responsibility of county governments, and Web-based tools are available to support updates. The state Department of Homeland Security and Emergency is responsible for updating address information through work with individual counties.

4.2 Summary of Findings, Lessons Learned, and Best Practices in other States

The review of statewide transportation data programs has been helpful in identifying best practices and potential pitfalls that help guide decisions for Idaho in development and management of a statewide Idaho Roads Framework. Key points derived from other states include:

- Define the business focus of the statewide transportation data effort. Is the primary goal to support basic cartographic operations or more sophisticated applications (e.g., road asset management, emergency response, routing, etc.)? This will help guide technical design and decisions on the content and format of the data model. A number of states have prepared good business case documents (Ohio, Washington, North Dakota, and North Carolina).
- Put in place a well-defined and strong entity at the state level with a leadership role and authority to coordinate the effort, develop data standards, and oversee database development and ongoing maintenance.

- Make a decision early in the planning and design process about the degree to which individual stakeholders, particularly with local governments, are required to comply with a common statewide set of specifications (road centerline geometry, accuracy, file formats) and data model. Ideally, a high level of acceptance of common standards is best but not always possible given the status of mature GIS programs (maintaining data in formats that do not fully comply with a state standard). The decision about compliance with common formats and standards will dictate the need for tools and services for import/translation/restructuring of data from individual sources.
- If possible, include key state agencies in the design process and ongoing management. Active participation of several key state entities: the state GIS office, transportation agency, and the emergency management or E911 body greatly increase prospects for a successful effort.
- Identify a sustained funding source for data update and distribution. In most states, there are tangible monetary benefits (as well a host of intangible benefits) derived from a collective, coordinated approach for statewide road centerline data management and distribution. While such benefits are acknowledged by most stakeholders, there is still a need to allocate funds to manage the Framework data (e.g., for staff to perform QA, import and updating of the Framework database, posting for access). In most states, money has been budgeted for this work. In some cases, states have set up a grant program (usually through legislative action) to partially fund data compilation efforts by local governments. Allocation of funds from state transportation agencies and a partial allocation of money from a centrally managed E911 fee budgets have been used. NOTE: Idaho has been successful in getting funds through federal grants (FGDC CAP grants) to support the Integrated Roads project but these have been one-time allocations—no sustained funds for future years.
- Include technical specifications that define rules for road centerline segmentation (at what points to break segments) and mapping rules for segmenting special road configurations (divided roads, ramps, frontage roads, cul-de-sacs, loop roads, traffic circles)
- Include clear definition on the types of roads that will be part of the database (Interstate and US highways, roads on federal lands, state highways, county highways and roads, local streets, private roads, long driveways, etc.
- State guidelines for positional accuracy and sources and methodology for centerline capture and update. Identify a minimum accuracy goal and allow data collection using different sources and methods (e.g., heads-up digitizing from orthoimagery, capture from GPS-equipped vehicle). For data capture from orthoimagery, encourage use of high-resolution sources (2-foot pixel or better).
- Define clear responsibilities for ongoing update and for final QA and posting of data. Responsibilities should be split between state agencies (e.g., transportation agency, E911 body) and local entities (county level office). Put in place easy to use tools for the upload of data to the state custodian of the statewide database and provide a Web-based tool for direct data update. Define a schedule (e.g., quarterly) for posting updated data to the statewide database

- Acknowledge that there will be gaps in the update process—particularly with low resourced local governments which do not have the technical capabilities or staff to provide updated data. Assign a role to a state agency (e.g., the transportation agency or state GIS office) to carry out updates for these counties.
- Make sure that the data model has a way to accommodate multiple road names and/or route numbers. It will be necessary to designate a "primary" street name or route number and multiple alternates (sometimes up to five). This can be handled by reserving multiple fields in a primary table (up to the maximum expected number), use of a special "alternate road name/route number table" that can be joining with the main centerline attribute table, or use of a concatenated field with defined delimiter characters).
- If the data set will be used for any routing applications, incorporate ways to define road segment cardinality relationships (one way designation, proper from-to address ranges, adherence to standards for mile post progression, cases in which address progression does not follow the milepost progression).
- Maintain a reasonable set of metadata—most importantly information on source, data quality, update timing, and organization performing update. Store this metadata in fields reserved in a main centerline attribute table or in a separate joinable table.

5. BUSINESS CASE JUSTIFICATION FOR A COMMON STATEWIDE ROAD FRAMEWORK DATABASE

The benefits of establishing and maintaining a unified, statewide GIS-based road centerline database are well established. The benefits and wide use of road centerline data are exhibited by the Federal Geographic Data Committee (FGDC) identification of transportation centerlines as one of several Framework themes. In addition, over 30 states have established or are pursuing development of statewide road centerline data programs. The interest in statewide road centerline databases is based on the applications for which the data may be used—from basic cartographic uses to a wide range of transportation planning, public safety, and service delivery applications. Many of these applications benefit from a statewide centerline database in a GIS format that crosses over county and other jurisdictional boundaries.

The most obvious justification for a statewide road centerline program in Idaho (and other states) is that multiple organizations now expend considerable resources on collecting and maintaining road centerline data. These individual efforts often overlap (in terms of data content) and the fact that individual organizations use their own database formats that serve their own specific business needs complicates the ability for other organizations to use the data. There is an opportunity to save substantial time and resources by better coordination in data compilation and update using a database standard that can serve multiple users and organizations.

The State of Washington, through the WA-Trans program coordinated by the State DOT, conducted a business needs evaluation for statewide road centerline data (see www.wsdot.wa.gov/mapsdata/transFramework). This evaluation has recognized the value of cross-jurisdictional road centerline database that supports the following business needs (of multiple federal, state, and local organizations):

- Cross-jurisdiction communications and collaboration
- Geocoding and event location
- Emergency planning and management
- Environmental analysis
- Transportation infrastructure asset maintenance
- Traffic safety records management and analysis
- Transportation planning
- Freight mobility planning
- Emergency dispatch and response
- Public transit planning and operations

A preliminary return-on-investment study for the WA-Trans project shows a conservatively estimated return of 11% from the establishment of a statewide transportation Framework. Given the amount of money currently spent in the business areas identified above, the 11% represents significant recurring expenditures.

Similar conclusions have been reached in North Carolina. A study of data road centerline data sharing through the state's NC Onemap program (www.nconemap.com/Default.aspx?tabid=304) shows substantial savings by federal, state, and local government agencies—over $130,000 annual savings in current expenditures for road data compilation and maintenance. The North Carolina business case confirms the need for local road data by a wide range of state and federal agencies and private companies and the ability to access road Framework data from a single source will deliver significant benefits.

The state of Ohio established their Location-Based Response System (LBRS) to support development of detailed road centerline and address data for all counties. A cooperative state-local funding program was set up and detailed road centerline and point address information is being collected at the county level-using a unified, consistent database format and data collection methodologies. The main justification is the support for public safety—the use of accurate road centerline data to support emergency planning and response but recognizes the use of these data for business needs.

The Integrated Road Centerline Project, with participation of over 20 counties, provides substantial evidence that the development and maintenance of unified, cross-jurisdictional road centerline database is feasible and of value to participants in Idaho. The needs assessment conducted for this project (see Section 3) confirms the high interest for access to up-to-date road centerline data by a wide spectrum of federal, state, and local agencies. Road centerline data is needed on a regular basis by municipalities and county governments to support effective infrastructure asset management, address-related mapping and service delivery, emergency dispatch, and public safety planning and response. The value of a consistent, cross-jurisdictional road centerline database supports the following business requirements that are important for Idaho organizations:

- Requirements for public safety response and coordination of fire and law enforcement activities between counties and municipalities and among neighboring counties.
- State Bureau of Homeland Security responsibilities for disaster planning, emergency response coordination, recovery support, and mitigation planning.
- Statewide transportation planning and asset management by the Idaho Transportation Department requiring a unified road centerline databases for all federal and state roads and local roads that receive federal or state funding.
- Mapping of road centerline data in support of local highway districts and some municipalities throughout the state under programs managed by the Local Highway Technical Assistance Council (LHTAC)—including GIS data capture and update to support calculations used in funding allocations.
- Work of Idaho's E911 Emergency Communications Commission (IECC) has the responsibility for coordinating work of individual counties to build databases in support of E911 call management. The IECC manages a grant program (supported by telephone fees) that will include the development of GIS databases with address information
- Roads on some federal lands in Idaho are not always mapped or the road data is not easily accessible by agencies that may need it. Local, state, and federal coordination (for emergency planning, emergency response, recreation and tourism) can benefit from a statewide road centerline database that covers all land in the state.
- Natural resource planning and management activities in the areas of timber resource management, recreation, water rights evaluation, wildlife habitat and corridor analysis, disease management, and agriculture for multiple organizations including local, state, and federal government agencies.
- Utility and energy management at local and regional levels impacting such areas as communications tower siting and asset management for utility transmission and distribution networks.

As research for this project was being conducted, licensing of road data from commercial suppliers (e.g., NavTeq, TeleAtlas. Microsoft) was explored. It was determined, at the time of writing this report, that those data are not a viable option for use as roads framework for Idaho for several reason. They sell a license to use their product and with that license comes use limitations such as limited public distribution and use on the Internet. Once payments are stopped the data can no longer be used by agencies in Idaho. The update cycle for data products from the commercial suppliers is variable; low population areas generally have infrequent update which does not serve the business needs for emergency dispatch response. While the commercial suppliers may not be an option at this time, the products and services provided by these companies in the future should be monitored. Data content, quality, and update cycles may be enhanced to the point that the use of these data and possibly a public-private partnership (with favorable license terms) may be an option.

The majority of Idaho stakeholders, who have a need for road centerline data acknowledge the value in establishing an ongoing program for statewide road centerline Framework data development and stewardship. Idaho faces the same challenge that has been encountered in other states that have a statewide road Framework data program: Multiple federal, state, and local organizations are now in the process of compiling road centerline data, but these efforts are not coordinated and are focused solely on the specific business needs of that organization. This results in inconsistent database formats, duplicate and incompatible database formats, and poorly coordinated workflows—making a cooperative, integrated approach difficult to achieve. Overcoming these obstacles will require management decisions and proper allocation of resources.

6. INITIAL ROAD CENTERLINE DATA MODEL RECOMMENDATIONS FOR IDAHO

6.1 Components of a Road Centerline Data Model

A GIS-based road centerline data model is an abstraction of the actual road network with a data format and content that makes it useful for a range of applications. A unified model, a primary goal of this project, is one which serves multiple organizations and user groups—recognizing that data needs and applications will vary. A Framework data model that serves as a foundation for multiple organizations will support organization-specific road centerline databases which may include additional attribute content serving specific business requirements. As a basis for detailed design and ultimate data capture and maintenance, the data model for the Idaho Roads Framework should consist of the following components:

- Types of roads to include: A domain definition that identifies all types of roads that should be included in the common centerline database (e.g., federal, state, local, private). This domain definition is the basis for any road data capture project or data maintenance program.
- Geometry rules governing centerline depiction: Specifications governing how the centerline of roads will be depicted and formatted. This includes rules that govern: a) break points defining individual centerline segments, b) depiction of complex road configurations (divided roads, ramps, traffic circles, etc.), c) cardinality (from-to direction of segment), d) other geometry or GIS topological rules.
- Expected accuracy and sources for capture and maintenance: Standards governing acceptable (and sometimes preferred) positional accuracy level(s) and sources for compilation and update.
- Attribute data elements and validation rules: Information captured for each centerline segment for database storage and use in application and associated rules used to validate acceptable domain values for the attributes.
- Data dictionary: Explanation of the format and meaning for the centerline attributes.
- Metadata: Descriptive information about the centerline database used to provide information to users. Metadata includes information on content, format, source, data quality, maintenance status, and custodians of the database. Metadata elements may be included in the GIS centerline attribute database or in separate data tables or text files. Metadata included should comply with approved Idaho Geospatial Standards.

Defining and getting consensus on these aspects of the Idaho Roads Framework must begin by recognizing that different user groups have a range of needs and application priorities which will dictate road centerline data format and content. The key is to define a "base data model" with geometry rules, accuracy standards, and data content that meets most of the needs of all user groups and which supports efficient enhancement or restructuring by any user group.

Initial recommendations for data model format and content, based on information examined during this project, are presented in the subsections below.

6.2 Types of Roads, Geometry Rules and Accuracy Standards Recommendations

This subsection provides recommendations for "mapping rules"—guidelines and standards for road centerline data capture and format designed to create consistency in data that is compiled and updated for the road centerline database.

Types of Roads for Inclusion: At a minimum, all public roads should be included. This includes all Interstates, all U.S., state, and county highways, and all local roads and streets. This encompasses all public road functional classes—arterial, collectors, local roads as defined in the FHWA Functional Classification Guidelines (www.fhwa.dot.gov/planning/fctoc.htm). It is highly desirable however, to meet the needs of public safety organizations, to also include named and addressed private roads as well.

The decision to include private roads may be made by each Source Steward providing data for the Framework database. Private roads include the following types:

a) Roads maintained by government entities (federal, state, local) that are not open for public access or which have specific restrictions on access. This includes roads on state or federal lands (e.g., BLM or USFS land, State forests, etc.) which are designated for use only by designated vehicles and personnel or which require special permits for public access.

b) Roads maintained by private companies or land owners on privately held land or public land for which transportation easements have been granted which are closed to the public or which require permits or permission for public use

c) Roads inside private developments which are not under the jurisdiction of a public entity (e.g., private roads inside apartment complexities, industrial parks, trailer courts, camp grounds, office parks, etc.).

d) Long driveways or roads on private land, maintained by a non-public entity which connect to a public road. The distinction between a "common driveway" for which centerlines are NOT depicted and a "long driveway" centerline which IS depicted is somewhat subjective and may be defined in detail by specific stewards. The distinction may be based on: a) minimum length (e.g., depict driveway centerlines that have a length greater than 200 feet) and/or b) existence of a minimum number of occupied buildings along the driveway. One county government uses "the rule of 3" in deciding whether or not to depict a long driveway or privately maintained road: include the centerline if there are three or more occupied buildings along the road

In some cases, the examples of private roads above have an assigned name, and in other cases, no formal name is documented. Data stewards capturing these private roads should assign a name or route number based on existing signage or documentation on a map or other source. When no name is documented, a name should be assigned by the data steward. In addition, address ranges, using addressing rules of government authorities may be assigned as centerline attributes.

Road Centerline Segment Break Points: At a minimum, end points of centerline segments should be placed at:

a) At-grade road intersections (bridge or overpass points not included).

b) County Jurisdictional boundaries NOTE: As explained in 6.3, Source Stewards may provide data with attributes for additional jurisdictions (i.e., Zip Code areas, Emergency Service

Zones). If this information is included, segment breaks will need to be included at the boundaries of these areas as well.

c) Point where primary road name or primary route number changes.

d) Points at which there is a change between a divided road (two centerlines) and an undivided road (one centerline).

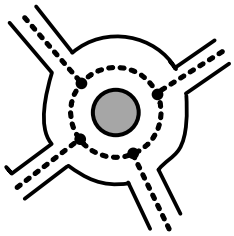
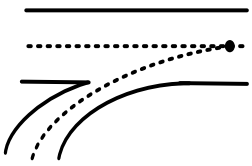
Individual organizations capturing and maintaining road centerline may break segments at additional defined points including those below as long as metadata is provided that identifies the break points:

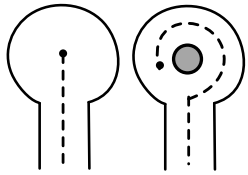
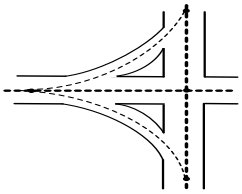
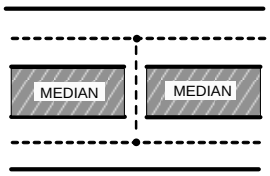
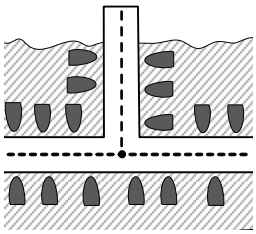
- Other jurisdictional or administrative boundaries such as zip code boundaries.
- Well-defined points between widely spaced intersections (generally ½ mile or more) on rural roads. A well-defined point is one that corresponds to a topographic feature or cultural landmark that can be observed in the field and on source data used for road centerline capture.

Depiction of Divided Roads: Roads that are divided with a median, barrier, or marked gore area in the center, dividing the lanes of opposite traffic flow and restricting turns between the divided lanes, should be depicted as two different centerlines.

Digitizing Direction: Centerlines should be digitized in the direction of established cardinality for roads in which cardinality applies (Interstates, US routes, state and county highways). This is the direction of progression in assignment of highway log points. In Idaho, the cardinality rule is low-to-high progression, south-to-north and west-to-east. Note: Some roads might have a cardinality that does not adhere to this standard. For roads with no formal cardinality assigned (e.g., municipal streets, rural roads), the digitizing direction should correspond to the low to high address progression.

Format Guidelines for Special Road Configurations: The following rules provide guidelines for the depiction of road centerlines in the special cases described below. These special case configurations will each have a specific code for "road type" (see data dictionary in Appendix C). For these special road configurations, some centerline attributes (see data dictionary in Appendix C) will not apply. In these cases, an entry of "-99" will be entered.

 **Traffic Circles**	In these cases where there are multiple roads that connect to points on a traffic circle or other geometric shape (e.g., square, rectangle, ellipse) the centerline of that shape should have a unique name and ID. If it has a formal name, this should be assigned. If there is no formal name, the authority for update should assign a name (e.g., name of major street or highway entering the circle or shape with designation of "circle" or "square"). Centerline segments should terminate on the circle's centerline and define individual centerline segments of the circle.
 **Highway Ramps**	General rule is to plot a tangent of the ramp's centerline from the point at which the edge of the ramp first joins the connecting road to the connecting road centerline.

 **Cul-de-Sacs**	For cul-de-sacs, for which there is no physical island, terminate the centerline at the center of the cul-de-sac. For cul-de-sacs for which there is a physical island, draw the centerline around the island (right side of island) to a point in front of the last lot or building on the cul-de-sac.
 **"Free-ride" Lanes**	"Free ride" lanes, which may be referred to by other names, are one-way lanes branching from a main road before the next intersection which enables smooth flow of traffic for vehicles taking a right hand turn onto the next intersecting road. Centerline depiction of the free-ride lane will follow the general rule described for ramps above.
 **U-Turn Lanes**	U-Turn lanes on divided, limited access highways that connect the two divided lanes of traffic and which are reserved for emergency use. This special road type is optional for inclusion in the Road Centerline Framework dataset. If they are included, they will be depicted as one centerline segment intersecting at the centerlines of each of the main lanes of traffic.
 **Boat Docks/Marinas**	In some cases, local or state government jurisdictions may choose to treat boat docks and marinas on rivers or lakes as streets for addressing-particularly when individual boat slips are managed as real property (sold or rented like a condominium or apartment). There is no requirement to include centerlines for these cases-the decision is left to the government jurisdiction with authority over these areas. In cases where they are included, centerlines should be captured along the longitudinal center of fixed or floating documents. Centerline segments should be named and address ranges may be assigned.

Accuracy and Source Guidelines: Organizations that are performing data capture or update of road centerline data that will be used as an input for the Idaho Roads Framework database should use methodologies and sources that achieve the highest possible horizontal positional accuracy given limitations on cost and time. Metadata should accompany all data to identify sources and accuracy levels. The goal should be for a minimum accuracy level of ten (10) feet.[1] Higher accuracy is desired in cases where source material or data collection methodology supports a higher accuracy level. The Framework Steward may accept centerline data with an accuracy level that do not meet the stated 10 foot accuracy goal as long as metadata, documenting the accuracy level, is included. Sources for road centerline may include: a) medium or high-resolution (1-meter pixel or better) orthoimagery with centerlines captured through a heads-up digitizing, b) large-scale georeferenced subdivision maps or construction drawings, or c) field-based capture using GPS technology (ideally

[1] Statement of horizontal accuracy compliant with the National Standard for Spatial Data Accuracy (NSSDA, FGDC-STD-007.3) in which accuracy figures are presented as a maximum root mean square (RMS) error in the 95% confidence interval. This RMS error is the average of the set of squared distance differences between points in the data set and independently collected points (representing highly accurate positions). All road centerline data sets compiled for the Framework database do not necessary need to be tested for accuracy if the methods and sources are known to deliver the stated accuracy level.

from a specially equipped vehicle with integrated GPS, inertial navigation, and video logging equipment).

6.3 Data Content (Attribution) Recommendations for the Road Centerline Database

Recommendations for road centerline attributes are based on a review of GIS databases in Idaho, the results of the needs survey of Idaho organizations, an examination of centerline data maintained by other states, and comments received by reviewers of the first draft of the recommendations report (January, 2010). Based on the data priority evaluation, recommendations are made for attributes (database table associated with centerline segments) to include in the Roads Framework dataset. Recognizing that there will be a variety of sources for the initial compilation and maintenance of the Roads Framework data, attribute content is presented as a guideline for data capture and update. The recommendations for road centerline attribute content assigns a classification for each attribute that reflects the relative importance in compilation and update by data stewards. This classification is explained as follows:

- Minimum Attribute Set (M): This is a "bare bones" set of attributes that is considered essential for compilation and ongoing update of the Roads Framework.
- Core Attributes (C): Attributes considered to be very important to support GIS applications by multiple user groups. Data stewards and other organizations contributing road centerline data are strongly encouraged to capture these attributes in addition to the minimum (M) attribute set.
- Extended Attributes (E): These attributes provide a richer data content than the core (C) attributes of use to a wide range of user groups. These attributes are needed to support a more extensive set of GIS applications.
- Attributes Not Included (N): These attributes are not formally a part of the Road Centerline Framework. It is recognized that these attributes (and others not identified in this project) do have importance for specific users and applications. These attributes may be added to GIS databases being used and maintained by specific organizations.

Table 8 shows a comparison of various sources and users of road centerline data to examine priority, identify needs, and make recommendations for specific attributes to be included in the Road Centerline Framework. This comparison provides a basis for recommendations on specific attributes and their classification (M, C, E, and N) described above.

Table 8: Idaho Roads Framework Centerline Attributes—Priority Evaluation

Centerline Attribute	Idaho Integrated Statewide Road Centerline	Idaho Department of Transportation	Arkansas Centerline file	Ohio LBRS	Oregon GIS Transportation Framework Theme	Montana Transportation Framework Theme	North Dakota Road Centerline Database	Tennessee TIPS BMP Data	Washington WA-Trans Program	West Virginia SAMB and DOT	**Number of States Centerline Databases Using Attribute**	**Average Idaho Priority Score** (from needs Assessment)	**Combined Score**	**Framework Attribute?***
Comment		X									**1**	**0**	**1**	**E**
Measure Method		X									**1**	**0**	**1**	**N**
Use Status								X			**1**	**0**	**1**	**N**
Road Label								X		X	**2**	**0**	**2**	**N**
Road Width		X[1]				X					**2**	**0**	**2**	**N**
Cardinal (Y/N)				X							**1**	**2.3**	**3.3**	**E**
Left Side Odd (Y/N)										X	**1**	**2.3**	**3.3**	**N**
3D Length				X							**1**	**3.1**	**4.1**	**N**
Flip Geometry Flag										X	**1**	**3.1**	**4.1**	**N**
Reverse Direction (Y/N)				X							**1**	**3.1**	**4.1**	**N**
Left Postal ID										X	**1**	**3.2**	**4.2**	**N**
Right Postal ID										X	**1**	**3.2**	**4.2**	**N**
Left Community				X				X			**2**	**2.3**	**4.3**	**N**
Right Community				X				X			**2**	**2.3**	**4.3**	**N**
Divided Road (Y or N)		X[1]		X							**2**	**2.4**	**4.4**	**C**
Alternate Segment ID					X	X	X	X			**4**	**1.6**	**5.6**	**C**
LRM ID		X		X					X		**3**	**2.8**	**5.8**	**N**
Speed Limit	X	X[1]		X		X	X	X			**5**	**0.6**	**5.6**	**E**
Left Emer. Service Zone				X			X	X		X	**4**	**3**	**7**	**E**
Right Emer. Service Zone				X			X	X		X	**4**	**3**	**7**	**E**
Direction Traveled				X		X	X	X			**4**	**3.2**	**7.2**	**C**
Post Direction	X						X				**1**	**4.3**	**5.3**	**N**
Number of Lanes	X	X[1]		X		X					**3**	**3.8**	**6.8**	**E**
Maintenance Status		X			X						**2**	**6.1**	**8.1**	**N**
Left County			X	X	X			X	X	X	**6**	**2**	**8**	**C**
Right County			X	X	X			X	X	X	**6**	**2**	**8**	**C**
Jurisdiction of Road				X					X		**2**	**6.6**	**8.6**	**M**
Use Restriction	X					X		X	X		**3**	**5.6**	**8.6**	**E**
Alternate Route #s		X[1]	X	X		X	X		X	X	**7**	**2.8**	**9.8**	**C**
Map Length	X				X	X	X		X		**4**	**3.9**	**7.9**	**E**
Beginning Log Point	X	X		X	X		X		X		**5**	**4.7**	**9.7**	**E**
Ending Log Point	X	X		X	X		X		X		**5**	**4.7**	**9.7**	**E**
Alternate Street Names			X	X		X	X		X	X	**6**	**3.8**	**9.8**	**C**
Left City	X		X	X	X			X	X	X	**6**	**3**	**9**	**C**
Right City	X		X	X	X			X	X	X	**6**	**3**	**9**	**C**
Primary Street Type			X	X	X			X	X	X	**6**	**5.2**	**11.2**	**C**
Surface Type Code	X	X[1]		X		X			X		**4**	**6.6**	**10.6**	**C**
Road Classification	X	X			X	X			X		**4**	**7**	**11**	**C**
Edit or Update Date	X	X			X	X	X		X	X	**6**	**5.9**	**11.9**	**C**
Left State			X	X	X			X	X	X	**6**	**6**	**12**	**C**
Right State			X	X	X			X	X	X	**6**	**6**	**12**	**C**
Source Information		X	X			X	X	X	X	X	**7**	**6**	**13**	**C**
Left From Address	X		X	X	X	X	X		X	X	**7**	**5.2**	**12.2**	**C**
Left To Address	X		X	X	X	X	X		X	X	**7**	**5.2**	**12.2**	**C**
Primary Street Prefix	X		X	X	X		X	X	X	X	**7**	**5.2**	**12.2**	**C**
Primary Street Suffix	X		X	X	X		X	X	X	X	**7**	**5.2**	**12.2**	**C**
Right From Address	X		X	X	X	X	X		X	X	**7**	**5.2**	**12.2**	**C**
Right To Address	X		X	X	X	X	X		X	X	**7**	**5.2**	**12.2**	**C**
GIS Data Steward	X		X			X	X	X	X		**5**	**7.4**	**12.4**	**C**
Route or Local Road #		X	X	X	X		X	X	X	X	**8**	**5.8**	**13.8**	**M**
Segment ID (primary key)	X		X	X	X	X	X	X	X	X	**8**	**6.2**	**14.2**	**M**
Primary Street Name	X		X	X	X		X	X	X	X	**7**	**7.3**	**14.3**	**M**
Left Zip Code			X	X	X	X	X	X	X	X	**8**	**8**	**16**	**E**
Right Zip Code			X	X	X	X	X	X	X	X	**8**	**8**	**16**	**E**

[1]These attributes are not included in the main feature attribute table in the GIS databases but are stored in separate data tables, maintained by the ITD, and can be joined with the main GIS attribute table

In the course of the review of attribute content with project stakeholders, ideas for several additional attributes and changes in attribute naming have been suggested. These suggestions, relating to issues of cardinality, public/private status, and other concerns have been taken into account and are reflected in the Data Dictionary for Road Centerline Framework data in Appendix C.

6.4 Road Centerline Metadata

Metadata for the Road Centerline Framework should include both feature-level attributes (attribution for each centerline segment) and dataset metadata that provides information about the entire dataset or well-defined portions of the dataset. Appendix C identifies the recommended feature-level attributes which will be captured along with the other centerline attributes. In most cases, these attributes will have the same value for a specific data compilation and update session carried out by a Source Steward:

- Data Steward
- Data Source/Method
- Accuracy
- Accuracy Verified
- Update Date
- Data Accessibility
- Comment

In addition to this feature-level metadata, dataset metadata will also be required. This metadata that provides information that applies to the dataset overall and should be provided by all Source Stewards when new road centerline data is provided (e.g., initial data provided by a county) and when Source Stewards provide periodic updates. The Framework Steward will be responsible for updating dataset-level metadata as data is provided by Source Stewards. The Idaho Geospatial Committee (to become the "Idaho Geospatial Council") and the ITRMC has approved Standard 4220 (Geospatial Metadata). This standard calls for use of the Federal Geographic Data Committee (FGDC) "Content Standard for Digital Geospatial Metadata" Version 2.0 (FGDC Standard #STD-001-1998, http://www.fgdc.gov/standards/projects/FGDC-standards-projects/). This standard describes specific metadata elements and organizes them into compliance categories "Mandatory", "Mandatory if Applicable," and "Optional" which specifically defines requirements for federal government agencies. In addition, there have been a number of metadata profiles developed which describe how the metadata standard should be applied to specific geospatial data themes. There are no existing standards or guidelines at the Federal level or in Idaho, that define how the metadata standard should be applied to road centerline data. Because of this, it is recommended that the TTWG define an Idaho metadata profile for the road centerline data element (and perhaps for the entire Transportation Framework Theme). It is important to note that the FGDC standard describes metadata content—not a detailed format for storing and managing the metadata. Most GIS software packages now include tools for entry and update of metadata that complies with the metadata standard.

The following recommendations for inclusion of dataset metadata may be used by the TWGG as a guideline for development of a formal transportation metadata standard:

1. Identification Information (Mandatory): Include the FGDC mandatory elements: 1.1) Citation, 1.2) Description, 1.4) Status, 1.5)) Spatial Domain, 1.6) Keywords, 1.7) Access Constraints, 1.8) Use Constraints. Metadata Element 1.3 (Time Period) and all optional metadata elements (1.8 to 1.14) are not likely to be needed.
2. Data Quality Information (Mandatory if Applicable): Include the FGDC mandatory elements: 2.1) Attribute Accuracy, 2.2) Logical Consistency, 2.3) Completeness, 2.4) Positional Accuracy, 2.5) Lineage.
3. Spatial Data Organization Information (Mandatory if Applicable): Include the FGDC mandatory elements: 3.2) Direct Spatial Reference Method, 3.3) Point and Vector Object Information
4. Spatial Reference Information (Mandatory if Applicable): Include the FGDC mandatory elements: 4.1) Spatial Reference Information (horizontal coordinate system information)
5. Entity and Attribute Information (Mandatory if Applicable): Details about the database design (database schema) for map features an attributes (Element 5.1) are captured and managed by the GIS software. Metadata access tools in the GIS software will be used to access this information so there is no need for duplicate entry. An overview of the entity and attribute information should be included in metadata element 5.2. It is important to include, in the GIS database design, data tables that describe any coded fields. These "code description tables normally have three data fields: a) the code for the data value, b) brief description of the code's meaning, and c) a more detailed description of the code. The data dictionary identifies a number of road centerline attributes that will use coded fields (e.g., Segment Type, Public-Private, Surface Type, Street Type, FIPS codes for City and County fields, Emergency Service Zones, and Data Accessibility.
6. Distribution Information (Mandatory if Applicable): Include the FGDC elements: 6.1) Distributor, 6.3) Liability, 6.4) Standard Order Process (includes directions for accessing the data and for downloads if provided)
7. Metadata Reference Information (Mandatory): Include the FGDC elements: 7.1) Metadata Date, 7.4) Metadata Contact, 7.5) Metadata Standard Name, 7.6) Metadata Standard Version

The TTWG will need to specify what constitutes a "dataset" in the context of road centerline data. Since there will be multiple Source Stewards who will be providing data for specific geographic areas or for specific sets of features there are different database design approaches. The simplest approach is to maintain a single dataset that includes all data of the Road Centerline Framework element of the Transportation Framework Theme, but there may be operational decisions to logically organize the dataset by geographic area or by feature content. For instance, in an ArcGIS geodatabase, different Feature Classes could be established for public and private roads. Dataset metadata content could vary by feature class.

7. IDAHO LINEAR REFERENCE SYSTEM RECOMMENDATIONS

7.1 What is a Linear Reference System

A linear reference system, as it relates to road networks, includes a data model and automated tools for locating events and assets relative to the road centerline network. The LRS works together with a spatial coordinate system to identify point locations and road segments referencing as a linear distance from a starting point or anchor point along defined routes. An LRS, when implemented as part of a GIS, can provide a powerful means to manage and visualize road-based information and support a variety of program requirements (e.g., transportation asset management, pavement management, accident and safety analysis, routing, etc.).

7.2 Linear Reference System Status in Idaho

The ITD is the most prominent user of a linear reference system in Idaho. Currently, the ITD does not use a GIS-based linear referencing system, although for over 30 years, the ITD has had an LRS database called MACS (MilePoint and Coded Segment), which is being implemented on a mainframe using a COBOL/CICS platform. This system stores information on highway assets using a linear reference approach (storing milepoint values for the assets). This is considered to be a legacy system which needs to be replaced with a system that supports a relational database and is GIS enabled to support data entry, update, visualization, and management.

The ITD recently completed an LRS needs assessment using consulting services from GeoDecisions and research on LRS products and development costs conducted by Cambridge Systematics, Inc. These studies have confirmed the benefits of a GIS-based LRS system using off-the-shelf GIS software and custom applications either purchased or developed for ITD. Costs for full, statewide LRS implementation are projected to be from about $1.5 to about $3.5 million. This includes costs for setting up the LRS (with defined routes and anchor points), software purchase, application development, and migration/clean up of MACS data. Implementation work would occur over a multi-year period. The ITD is currently in the process of evaluating options, and no decision has been made at this time for proceeding with a GIS-based LRS.

A linear reference system with dynamic segmentation capabilities may also be implemented at a local level by a city or county government agency. Applications used principally by public works and public safety organizations may benefit from LRS implementation (e.g., such applications as pavement management, accident analysis, transportation engineering may be candidates). No current examples of LRS use by local governments in Idaho have been identified in this project although several have indicated interest. The need for an LRS at the local level must be judged on the potential benefits (reduction in staff time and quality of information provided). The potential benefits of using an LRS with GIS-based dynamic segmentation must be evaluated against the more common geographic referencing schemes used for road related assets and event data: a) absolute coordinates from interactive map capture or from GPS devices and b) geocoding based on address ranges for road segments. At this time, it seems quite clear that LRS implementation at the local level is not a priority. This could change in the future as local GIS programs mature and as more useable off-the-shelf GIS applications (using LRSs and dynamic segmentation) become available.

7.3 Initial Recommendations for LRS Implementation

The ITD should remain the leader in LRS implementation in Idaho and it is recommended that LRS implementation by the ITD be strongly considered. Ideally, it would benefit all users of road asset/event data to have a common LRS that was usable statewide—one in which start points and anchor points for defined routes were accepted by all parties. In practice, this is difficult because the needs of different organizations may dictate the need for different route definition (e.g., local government LRS use may not allow for easy use of LRS routes assigned on a statewide basis). Recent studies on LRS implementation by the ITD left open the question whether LRS creation should include local roads (in addition to state maintained roads). At this point, the main recommendation is that the ITD involve the Transportation Technical Working Group (TTWG) in design and implementation issues that might impact potential users outside of the ITD so that the LRS implementation approach does not preclude its use by outside organizations (e.g., other state agencies, local governments, and regional agencies).

8. DATA STEWARDSHIP RECOMMENDATIONS

8.1 Overview of Framework Data Stewardship Principles

Road centerline Framework stewardship should adhere to the basic principles and process defined in the February, 2010 draft document, "Framework Stewardship for the Idaho Spatial Data Infrastructure" (see http://gis.idaho.gov/framework.htm), currently being developed by the Idaho Geospatial Council (IGC) and to be approved by the Idaho Information Technology Resource Management Council (ITRMC). "Data stewardship" implies the establishment of a sustained program, with clear roles and responsibilities for individuals or groups (data stewards), supporting the regular update of and access to the Framework data. In the above-referenced document, an individual Framework dataset (map features and attributes) is referred to as an "Element." Each of the 14 currently defined Framework "Themes" includes one or more Framework Elements. The Roads Centerline dataset is one Element in the Transportation Framework Theme. The Transportation Theme encompasses other Elements such as railroads, trails, and aviation.

In the 2010 document referenced above, the following roles are defined for ongoing stewardship for all Framework Themes and Elements:

- The *Idaho Geospatial Council (IGC) Executive Committee* serves as the governing body for all of ISDI initiatives, including Framework Stewardship. The IGC Executive Committee's role includes approval of stewardship documents, endorsing data standards, and promoting and facilitating data sharing. Policy decisions are made by the Idaho Technology Resource Management Council.
- The *Framework Leadership Team (FLT)*, a body established by the IGC which includes Technical Working Group (TWG) chairs and workgroup leaders, is responsible for coordinating the development, integration and long-term management of Framework data. A *Framework Coordinator* is a facilitator who serves as a central point of contact for stewardship issues that are not specific to a particular Framework element.
- The *Idaho Geospatial Office* (IGO) facilitates Framework Stewardship in general and facilitates stewardship education, tracks stewardship charters and plans, brings issues to the FLT when appropriate, and suggests modifications to the model documents.
- The Stewardship model defines the role of a *Framework Leadership Te*am (FLT) which functions as the *Steward Council* facilitating resolution of intertheme vertical issues. The active members of the steward group for roads will be those theme chairs with elements that have dependencies and correlations with Roads. The overall idea is that as Framework development progresses the current Technical Working Groups will gradually transform to *Steward Groups* with the leads and chairs coordinating activities to address vertical issues and to provide resolution and guidance on stewardship issues and evolution.
- The *Transportation Technical Working Group* (TTWG) is responsible for establishing standards and writing implementation plans for the datasets in the Transportation Theme (including road centerlines). NOTE: As the Framework Stewardship model described in the 2010 document is gradually implemented, the TTWG will be transformed into a *Stewardship Group*. For the time being however, the TTWG and its role in the Roads Framework will continue.

- *Source Stewards* are the primary organizations or individuals creating and updating a Framework Element. Since there will be multiple Source Stewards for road centerline data (i.e., state agencies, local governments, federal agencies), a designated *Framework Steward* is responsible for accepting data from the different *Source Stewards*, performing any needed quality assurance checks or data format translations, facilitating the capture and update of metadata, posting the data for access, and ongoing communication and coordination among *Source Stewards*.

As defined in the Framework Data Stewardship document, Framework Stewardship implementation involves a number of steps including: a) identifying the party or parties to take on the roles identified above, b) preparation of a charter which formally assigns and documents acceptance of responsibility for different stewardship roles, and c) preparation of a stewardship plan (with the assistance and the support of the TTWG and Framework Coordinator).

8.2 Road Centerline Data Stewardship Assumptions

The evaluation of needs from Idaho stakeholders and a review of road centerline data maintenance approaches in other states, gives a basis for the following t tenets that underlie an effective stewardship program for Roads Framework data in Idaho:

- The structure, process, and roles identified in the "Framework Stewardship for the Idaho Spatial Data Infrastructure" document summarized above will be applied to road centerline data stewardship.
- Specific organizations that have been assigned and which have accepted stewardship roles will meet their obligations for maintenance of the Framework data stewardship. This includes providing data and carrying out necessary quality control and data transformation activities to adhere to accepted technical content/format standards and to comply with data update timing standards, all as set forth in the Stewardship Plan.
- Sustained funding will be provided and allocation of staff and system resources necessary to support the Framework Stewardship program will take place.
- There will be an easily understood data dictionary that explains the meaning and domains of all centerline attributes.
- Clear technical standards governing road centerline geometry (rules for segment breaks, placement of nodes, etc.) will be stated and they will be built into data update applications to support quality control.
- Minimum acceptable positional accuracy, spatial reference information, and file formats will be identified. Minimal horizontal positional accuracy requirements (for acceptance in the statewide unified centerline database) will be at least ten feet with an option for higher accuracy. The Framework Steward may approve the acceptance and inclusion of lower accuracy data on a case-by-case basis.
- It is critical to have a state agency take a lead role for data update and management of the unified statewide centerline database.
- Initial compilation of the statewide road centerline database and its regular maintenance will require contributions from multiple organizations. In addition to the lead state agency, this includes designated local government agencies, other state agencies, and federal agencies Responsibilities for maintenance will be clearly defined.

- Building a statewide road centerline database is dependent on getting good quality geometry and attribute data for local roads and streets. The compilation process will draw on ongoing work carried out as part of the Integrated Road Centerline project and data being collected and maintained by the ITD and LHTAC.
- While data update must include local government jurisdictions (county and city governments), it can be assumed that some of these local jurisdictions will not have the resources or technical expertise to capture road centerline data and provide regular data updates. Therefore, there must be an approach, resources, and assigned roles for gathering the data on behalf of the local government.
- Metadata will be updated along with updates to the centerline database.
- Updates to the Idaho Roads Framework Element must follow a regular schedule for posting the updated data from multiple sources.

8.3 Pilot Project and Initial Statewide Compilation of the Road Centerline Framework Dataset

Initial compilation of a Road Centerline Framework should begin with a pilot project that includes multiple Source Stewards and a designated group or individual to assume the role of Framework Steward (during the pilot). The purpose of the pilot project is to explore and create technical tools and procedures for initial data compilation and ongoing update by source stewards and compilation into a combined dataset. In addition, the pilot can be used to explore answers to key questions about data maintenance and use of the Framework data such as:

a) What steps must source stewards carryout (in addition to their normal data maintenance activities) to prepare data for submittal to the statewide Framework dataset?

b) What is the best approach for the establishment of agreement points for edgematching data submittals from adjacent jurisdictions?

c) To what extent will users of the Framework data be able to use it for multiple applications and what level of data restructuring or augmentation (if any) will be required?

Work carried out during the pilot may also identify needed adjustments to the database design specifications which will result in greater efficiencies for statewide Framework data management. The pilot project should define a study area or areas in which there are multiple organizations (Source Stewards) compiling road centerline data. It would be best to choose an area or areas that fall within the multi-county coverage of the Integrated Roads Framework project. The study area(s) should encompass at least 100 square miles with coverage that crosses over two or more counties and which covers urban and rural areas and, ideally, federal land as well. It would best to choose an area that also has relatively recent high resolution orthoimagery (1 meter or better) available.

The pilot project will be approved by the IGC, and the TTWG will serve as a project coordination and review body. The TTWG will assemble a project team and team leader (also serving as the Framework Steward during the pilot). One option is for INSIDE Idaho to take on this Framework Steward role (assuming necessary resources, beyond what is currently available, are allocated). Ideally, Source Stewards to be involved in this pilot project include all entities currently compiling or maintaining road centerline data:

- Idaho Transportation Dept. (ITD) GIS Section: Capture and update of public road centerlines that receive state or federal funding.
- Local Highway Technical Assistance Council (LHTAC): Capturing secondary roads in coordination with local highways districts (for unincorporated areas) and some road centerline data for small municipalities.
- County and city government GIS programs: Compiling public and private roads under their jurisdiction. These local government jurisdictions (e.g., city, county, or tribal GIS offices) will often be the primary sources of local road data and this Source Steward role must be coordinated with potentially overlapping work of LHTAC, local Highway Districts, and emergency service organizations.
- Idaho E911 Emergency Communication Commission (IECC): Currently supporting collection of address data and MSAG databases with local E911 organizations to support E911. The IECC has recently launched a grant program for local E911 authorities for GIS data compilation to support public safety requirements. *NOTE: there is an opportunity now to work with the IECC to adopt the road centerline Framework database specifications so that data compiled through the IECC grant program closely complies with the format specifications and will not require major transformation for import into the statewide Framework dataset.*

The pilot project includes the following main steps:

1. TTWG prepares preliminary plan and budget and gets approval from the IGC.
2. Necessary resources are allocated and the TTWG creates a project team with a lead organization (Framework Steward) and a specific project manager. This includes identification of system resources (hardware and software) to be used for the pilot.
3. Source Stewards for involvement in the pilot project are contacted and agree to participate.
4. The project team and team leader prepare a detailed pilot project plan (tasks, timing, roles, resource allocation).
5. Technical specifications and a physical database design are prepared by the project team.
6. Source data for the pilot area is obtained from the Source Stewards. The project team will work with each Source Steward to define the format for delivery of data.
7. Source data is examined and Extract-Transform-Load (ETL) routines are written and tested for each source dataset. Since the various Source Stewards will provide data with varying road centerline data content and format, the ETL routines are necessary to create a unified dataset adhering to the road centerline Framework dataset design standard.
8. Source data is processed with the ETL routines and the resultant database is examined. This includes checks on: a) Road centerline content and identification of missing road segments, b) road centerline geometry for compliance with stated mapping rules (e.g., segmentation), c) Geographic coincidence of road segments and road "edge matching", c) attribute content and accuracy.
9. Pilot database results are examined and a report is written that explains successes, problems encountered and solutions, shortcomings in source data, suggestions on changes to technical specifications or the physical database design to streamline data integration, and suggestions for changes to the ETL routines.

After the pilot project and the review and documentation of the results, the TTWG, with IGC approval, will seek approval of resources for statewide road centerline compilation. Statewide road centerline compilation may be overseen by the same project team or a different team formed from the full array of stewards to support statewide development and stewardship.

8.4 Ongoing Stewardship of the Statewide Road Centerline Framework Dataset

Assuming that the pilot project is successful and that there is interest and available resources, roles and responsibilities will be filled, procedures will be defined, and technical tools will be put in place for ongoing stewardship. Ideally, a road centerline data stewardship program will be designed in a way that increases coordination among Source Stewards, cuts down on redundant and overlapping data update now occurring, resolves technical design issues in a way that reconciles differences in data format and content that supports multiple applications of use to a wide array of stakeholders. There are currently significant organizational barriers and funding constraints that make this difficult, but the goal is realistic—other states have overcome similar challenges, and the success of Idaho's Integrated Road Centerline project has provided a proof of concept for an expanded effort.

An ideal stewardship program includes the elements and roles explained above and the following actions:

- Acceptance, by the IGC of the road centerline data content and format specifications defined in this document followed by the approval of a road Framework data standard using the process put in place by the IGC.
- Increased coordination among GIS programs at the county and city level and the work of LHTAC, with an objective of eliminating redundant road centerline data capture and update. This will require organizational agreements and a resolution of data content and format differences which now work against collaboration.
- Involvement of the IECC and formal reference to road centerline Framework standards in its grant program supporting GIS database development at the local level. In addition, coordination between the IECC, the local E911 authorities, LHTAC, and local GIS programs needs to be established to avoid redundant road data update.
- Active involvement of the ITD in road centerline data update. This recognizes the ITD, and its cooperative work with LHTAC, is the only party in Idaho that collects and maintains statewide road centerline data. As identified previously, ITD's GIS database maintenance does NOT include all roads (e.g., municipal streets not receiving state or federal funding, secondary roads not captured by LHTAC, private roads, some roads on federal land) and currently the centerline geometry rules and attribution do not fully meet the recommended Framework standards).
- Assignment of a Framework Steward with resources to lead the effort and perform all required work to integrate data from Source Stewards, carry out QA, maintain metadata, and make the Framework dataset available for access. The Road Centerline Framework database should be maintained in an ArcSDE environment, but procedures should be set up that allow data provided by Source Stewards to be provided in several different common formats (e.g., Shape files, AutoCAD DWG files with attribute tables). There is no single apparent candidate organization to play this role, but there are several potential options each of which would require allocation of additional resources, staff assignments, and formal policies to document the new role and responsibilities. The possible candidates for Framework Stewards include:

- ITD: this option implies an expansion of the current duties and augmentation of current staff resources of the ITD GIS Section to include data capture, assignment of attributes, quality assurance, data formatting, etc. that complements existing work but which involves data management activities that go somewhat beyond the specific business needs of ITD.
- INSIDE Idaho (University of Idaho Library): Since this option implies an ongoing role which the INSIDE Idaho program is not currently resourced to provide, assuming this role would require stable, continuing funding for additional staff and resources. INSIDE Idaho could play the role of Framework Steward or provide technical support for data compilation, maintenance, and providing access to the statewide data if necessary resources were made available.
- Idaho Geospatial Office (IGO): This is a possible option and one that has proven successful in other states (in cases where staff resources are available). This option would require a significant change in mission and addition of staff and resources of the IGO which currently includes three state employees and is not carrying out regular GIS data capture or maintenance work at this time.
- E911 Emergency Communications Commission (IECC): The IEEC, with limited staff, has a mission to coordinate emergency communication activities with countyE911 organizations. The IECC and the local governments is serves, has an important interest in the development and maintenance of a statewide road centerline database with address information but the organization is not well-positioned to play a Framework Steward role. Assigning such a role to the IECC would require a change of mission and funding support. While the IEEC is not the best candidate for the Framework Steward Role, it should be assigned a stewardship to help coordinate local (county government) Source Stewards that can provide data for the statewide Roads Framework.

- An approach that will support data update from low population, low-resourced counties that do not have GIS programs in place or staff to provide data updates. This will require funding support and the designation of Source Stewards (e.g., neighboring counties, private companies, a state agency) to provide these updates.
- Establish of a minimum update period—a predictable schedule for update of the Framework with data from Source Stewards. This should be no less frequently than quarterly but could be more frequent for certain geographic areas or types of roads. It is an option also to set-up a Web-based service under which interested Source Stewards could update road data interactively.

The conclusion drawn from this project, after a review of current road data management roles and activities and road Framework stewardship programs in other states, is that the best option for Framework Steward is the ITD GIS Section (or other entity in ITD). This Framework Steward role most closely matches their current mission although, as noted, current resources and defined mission (of the ITD GIS Section) are not sufficient for assignment of this role without organizational and staffing changes. With ITD assigned as Framework Steward, they would coordinate with multiple Source Stewards, including LHTAC, designated federal agencies, and local governments (county or city government offices responsible for GIS road data maintenance) and, potentially local highway districts some of which could play a more active GIS data maintenance role in the future.. The ITD has not accepted the role of Framework Steward but, at this time, senior ITD management

has not yet been briefed about the business benefits or resource requirements for assuming the Framework Steward role and no formal request has been submitted to ITD.

Until such time that a Framework Steward (preferably ITD) is assigned to this role with necessary resource allocations, it is recommended that the Integrated Roads Framework project continue with available funds and expanded participation by additional counties.

If organizational or resource limitations precluded ITD assuming a lead, Framework Steward role, or if there is a delay in assigning this role to ITD, the recommendation would be for INSIDE Idaho to take on the Framework Steward role (if additional resources can be found). Such an approach would extend and expand the role INSIDE Idaho is playing in the current Integrated Road Framework program. Under this option, it would be important that ITD and LHTAC were involved as Source Stewards, along with the local government stewards.

8.5 Technical Issues in Framework Data Compilation and Stewardship

The initial compilation of the Road Centerline Framework should follow a logical design, development, and testing process to be followed by the establishment of roles and procedures for ongoing maintenance. The data dictionary in Appendix C and the "rules" governing road centerline content and geometry (see Section 6) provides a basis for a physical database design for the road centerline dataset. It is recommended that this dataset be stored and managed in an ESRI ArcSDE format. Specific design decisions will need to be made to establish and efficient organization of SDE Feature Classes. The Road Centerline Framework, after import from the original source, quality control, and any necessary format transformation may be stored as a single SDE feature class or multiple feature classes with defined content or based on geographic area. It is not recommended that the road centerline data by portioned geographically (as opposed to creating a seamless statewide database), but operational decisions may necessitate some geographic partitioning. A recommendation for consideration is to define two SDE feature classes one of which includes all public roads (regardless of the jurisdiction with responsibility) and another feature class including private roads and restricted access roads. These two feature classes could be organized into a single ArcSDE "feature dataset" that would support topology rules and network analysis applications with data from both of the feature classes.

As mentioned above, the acceptance of data from Source Stewards will require automated Extract-Transform-Load (ETL) routines that will perform needed translation of format and population of attributes. It is expected that ETL routines will have a similar design but will be specific to each Source Steward to account for variations in data format. The extent to which Source Stewards, over time, can adapt their own designs to match the road centerline Framework data model, the easier it will be to process and import the data.

Maintenance of the Road Centerline Framework will require spatial matching between contiguous geographic areas. Mismatches in centerline placement at the boundaries of adjacent areas are likely to occur. When offsets occur, there must be an edgematching process to adjust centerline segments on one or both of the adjacent areas to ensure that there is the proper spatial continuity across the boundary. Ideally, offsets will be very small and will allow the use of GIS software tools for automatically snapping line segments when the offset is within a stated tolerance. A recommended tolerance for automatic snapping of the two segments is five feet (ground distance). If the offset between the two segments is within this tolerance, use snapping to adjust the position of the segments to meet half the distance from each segment end. Since the specification calls for the

placement of a node (centerline segment breaks) at county boundaries, edgematching must include a process for positioning the node on that boundary (using the most accurate available GIS data with the boundary information. When the displacement between the ends of centerline segments on adjacent areas exceeds 5 feet, an operator must interactively make the necessary line adjustment while viewing the data from each of the adjacent areas along with a recent orthoimage (highest resolution available). In most cases, this will involve redelineating the segments, in a heads-up digitizing process, across the boundary where the mismatch occurs, from the closest road intersection inside each of the areas. One suggested best practice which can simplify the edgematching process is for each Source Steward (e.g., county GIS program) to capture road centerlines for a short distance outside their jurisdiction (e.g., to the first intersection outside the county boundary). It is recommended that edgematching of road segments at the boundaries of source steward jurisdictions for the statewide Framework dataset be carried out using mapping rules that do not require consultation with the Source Stewards who submitted the data. In some cases however, mismatches may be severe enough (over 5 feet) that the Source Stewards may need to be consulted to identify an agreement point at the jurisdictional boundary

APPENDIX A: INFORMATION GATHERED IN THE SITUATION ASSESSMENT

(See http://insideidaho.org/geodata/FrameworkPilot/transportation/2009_FGDC_CAP_grant/situationAssessment.xls for results of the Situation Assessment)

1. Description of current transportation infrastructure databases

- Road centerline data capture: what type of roads? (Interstates, State Hwy, County Hwy, local roads/streets, roads on federal land, private roads)
- Addresses: address ranges, point addresses
- Mileposts
- Structures (bridges, overpasses, etc.)

2. Geographic area of coverage

3. Digital file format of the data: identify the main file format (AutoCAD DWG, Shapefiles, ArcGIS geodatabase, etc.)

4. Update process and frequency

- How current is the database?
- What is the update frequency?
- What sources are used for the update?
- Collect any available documentation about the update process

5. Mapping rules for road segmentation: identify the rules for breaking road segments (e.g., at intersections, overpasses, bridges, jurisdictional boundaries, etc.)

6. Request and gather any available database design/content documentation: formal data model defining entities and relationships, map feature lists, attribute content and format, physical database design documents, full data dictionaries defining the meaning of features and attributes, metadata documentation

7. Status of Linear Reference Models: Get any information available on the status of LRM definition

APPENDIX B: SURVEY FORM-SURVEY OF NEEDS AND FORMAT FOR ROAD-RELATED GIS DATA

Survey Form Page 1

Explanation and Directions:

This purpose of this survey form is to gather information about data needs and approaches for formatting GIS-based road centerline and associated attribute data. Please complete this form and submit your response electronically to Bruce Godfrey (bgodfrey@uidaho.edu) by October 22, 2009. If you have any questions about the survey please contact Bruce Godfrey or Dave Christianson (dchristianson@kcgov.us).

A. Organization Background Information

A.1. Organization/Dept. or Office: _____

A.2. Contact Name(s): _____

A.3. Phone: _____ A.4. E-mail Address: _____

A.5. What are your main GIS application needs for road data (you may check multiple boxes)?

☐ Transportation Map Generation ☐ Address Matching/Incident Mapping ☐ Emergency Dispatch/Planning

☐ Maintenance/Asset Management ☐ Route Planning ☐ Accident/Safety Planning

☐ Transportation Analysis/Planning ☐ Other: _____

A.6. Provide additional comments about your needs for road-related GIS data:

B. Road Type Priority

Indicate the importance or level of need in your organization for each type of road listed below. A score of "8" indicates that the feature is essential on a very frequent basis to support your business, and a "0" indicates that there is no need for this data element by your organization. In the space provided, include comments to elaborate on your scoring.

Type of Road	Priority (0 to 8)	Comments
Interstates		
State Highway		
County Highway		
Local/Municipal Street		
Roads on Federal Lands		
Private Roads		
Other:		

C. Positional Accuracy Needs

Check the appropriate box to indicate the maximum level of horizontal map accuracy for road centerlines that you require for your applications.

Accuracy Level		Explanation
Very High	☐	Within 1 foot or less from true position—obtainable through field survey or survey grade GPS data collection
High	☐	1 to 5 feet from true position—achievable through digitization from high-resolution orthoimagery
Moderate	☐	5 to 20 feet from true position—achievable through digitization from moderate-res. orthoimage or resource grade GPS
Low	☐	20 to 50 feet from true position—achievable from medium scale map or data sources (e.g., TIGER files, USGS Topo)
Very Low	☐	Greater than 50 feet

Survey Form Page 2

D. Rules for Road Centerline Depiction and Segmentation

D1. Describe the rules that are applied or should be applied for depicting the centerline if divided roads (roads or highways with a center median):

D2. Check the boxes below to indicate the rules you apply or rules that you believe should be established for defining endpoints for centerline road segments (endpoints that define centerline segment features in the GIS database).

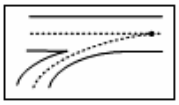
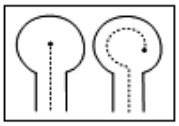
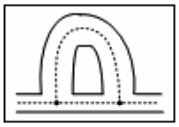
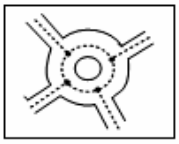
☐ Road intersections ☐ Jurisdictional boundary (type: _____)

☐ Change in road name or route number ☐ Zip Code boundaries

☐ Water crossing ☐ Other: _____

E. Rules for Handling Special Road Configurations

Explain any rules for road centerline delineation or segmentation for special road configurations.

Special Road Configuration		Explanation
Highway Ramps		
Cul-de-Sacs		
Loop Roads		
Traffic Circles		
Other		

F. Need for Road-related GIS Data

Check the boxes for road-related features that are of interest to your organizations.

☐ Site Addresses ☐ Mile Posts ☐ Traffic Signs or Signals ☐ Bridges/Overpasses

☐ Other: _____ ☐ Other: _____

Survey Form Page 3

G. Road Centerline Attributes

Indicate the importance or level of need for attributes applied to road centerlines, A score of "8" indicates that the feature is essential on a very frequent basis to your organization, and a "0" indicates that there is no need for this data attribute by your organization. Add additional attributes in the spaces provided.

Priority (0 to 8)		Priority (0 to 8)		Priority (0 to 8)		Priority (0 to 8)	
	Segment ID (primary key)		Right From Address		Number of Lanes		Direction Traveled[8]
	Alternate Segment ID		Right To Address		Reverse Direction (Y/N)[2]		Jurisdiction of Road
	Primary Street Prefix		Left Postal ID		Divided Road (Y or N)		Surface Type Code
	Primary Street Name		Right Postal ID		Flip Geometry Flag[3]		Road Classification
	Primary Street Type		Left City		Left Side Odd (Y/N)[4]		Jurisdiction of Road
	Primary Street Suffix		Right City		Map Length[5]		Maintenance Status
	Route or Local Road #		Left County		3D Length[5]		Edit or Update Date
	Alternate Street Names		Right County		LRM ID[6]		GIS Data Steward
	Alternate Route #s		Right Community[1]		Beginning Log Point		Use Restriction
	Post Direction		Left Community[1]		Ending Log Point		
	Left From Address		Left Emer. Service Zone		Cardinal (Y/N)[7]		
	Left To Address		Right Emer. Service Zone				

Footnotes:

[1]Any community or place name different from FIPS municipality,

[2]Y means that ascending log points does not corresponding to direction of the segment geometry (digitized direction) in the GIS database

[3]Code to indicate that the geometry (digitized direction) of the segment should be flipped

[4]If Y, left side of street has odd number addresses, if N, left side has even addresses

[5]Map Length is length measured from a map source. 3D length is actual traveled distance (on which log points are based)

[6]The Linear Reference Model route number for the segment

[7]Y Indicates that the segment follows the standard rule for ascending log points (increasing W to E and S to N)

[8]One-way, One-way non-Cardinal (direction of travel is opposite that of log point progression), or Bi-directional

H. Update of GIS Road Data

If you are currently updating road centerline data, please briefly explain: a) main steps, b) software, c) source data for updates, d) type of roads you are updating, and d) frequency of updates. Feel free to include more detailed attachments or to use more space than is provided below if necessary.

I. General Comments

Provide any additional comments you have about the needs and format for road-related GIS data:

APPENDIX C: RECOMMENDED DATA DICTIONARY FOR ROAD CENTERLIN FRAMEWORK ATTRIBUTION

Table C-1: Recommended Attributes and Attribute Descriptions for Statewide Roads Framework Database

Attribute	Priority Class[1]	Data Type	Description	Domain[2]	Comments	Integrated Roads Database Field
Primary Segment ID	M	Text or Integer	Primary unique key field identifying the segment			
Alternate Segment ID	C	Text or Integer	Identifying code used as a unique key in a separate source database maintained by a designated steward.			LOCAL_ID
Segment Type	C	Text	Identification of the type or road or special road configuration for the segment.	Normal Road, Traffic Circle, Ramp, Cul-de-Sac, Free-Ride Lane, U-turn Lane, Dock	Will use an alpha code for the domain values	N/A
Public-Private	C	Text	Identification of the public or private status of the road	Public road on public right-of-way, Public road on private land, Private road on public land, Private road on private land	Will use an alpha code for the domain values.	N/A
Jurisdiction Class	M	Text	The jurisdiction type associated with the primary Road-Street name or Route Number	Private, Restricted Access Road on Public Land, Interstate, US Route, State Route, County Route, Local Road or Street.	Will use an alpha code for the domain values. There may be restrictions which should be defined in dataset metadata that limits access to restricted access roads.	CARTO_TYPE
Functional Class	C	Integer	The functional class (urban and rural categories) as defined by the Federal Highway Administration (FHWA)	Number codes for: Rural Interstate, Rural Principal Arterial, Rural Minor Arterial, Rural major Collector, Rural Minor Collector, Rural Local, Rural Trail, Urban Interstate, Urban Expressway, Urban Principal Arterial, Urban Minor Arterial, Urban Collector, Urban Local, Urban Trail. See www.fhwa.dot.gov/planning/	Will use an integer code for the domain values.	FUNC
One-way Flag	C	Text	Indication of whether the segment is designated for one-way traffic.	Yes or No		N/A
One-way Direction	E	Text	If the one-way flag is "Yes", this field indicates that the	Cardinality-Yes, Cardinality-No, Address Range-Yes, Address	Will use an alpha code for the domain values.	N/A

			direction of travel follows the cardinality or low-to-high address range.	Range-No	In cases where cardinality applies, the Cardinality (Yes or No) would be used. Otherwise the Address Range (Yes or No) would be used	
Divided Road	C	Text	Portion of road is depicted with two centerline segments	Yes or No	Attribution	N/A
Cardinal	E	Text	Indication that segment follows or does not follow the standard cardinality rule for progression of log points (S to N, W to E).	Yes, No, or Not Applicable (code of -99). "Not Applicable" is entered for centerline segments in which cardinality does not apply (e.g., local streets with no assigned log points)		N/A
Surface Type	E	Text	Surface	Surface types recognized by the Idaho Transportation Dept. plus additional surface types recognized by local governments: a) Earth-Unimproved, b) Gravel-Improved, c) Gravel-Unimproved d) Gravel-Improved,, e) F-Improved, f) F-Improved g) G-1, h) G-2, i) J (other)	Will use an alpha code for the domain values. -Category F is: Asphalt treated gravel less than 1" or gravel added dust suppressant, -Category G-1 is: Road or cold plant mix asphalt -Category G-2 is: Hot mix asphalt pavement -Category J (other) includes any other surface type. Separate domain values may be established for specific surface types in this category (e.g., concrete, brick, cobblestone, wood).	SURF_DESC
Speed Limit	E	Integer	Posted speed limit in miles per hour	Range from 10 to 70		SPEED
Number of Lanes	E	Integer	Total number of lanes open for travel	Maximum of 4 in most cases		NUM_LANES
Use Restriction	E	Integer	Indication of official restrictions on motor vehicle use of the road.	Number codes assigned for: 1) All season open to public, 2) Seasonally open to public, 3) Open to public by permit, 4) Not open to public	Will use an integer code for the domain values.	USE_RES
Map Length	E	Decimal	Map length in miles.		Normally, this will be the segment length calculated by the GIS software (length of the arc). It may also be a more precise measurement from a more detailed source (e.g., engineering drawing)	LEN_FEET, LEN_MILES, LEN_METERS
Map Length Measurement	E	Text	Method used to measure the Map Length of the segment			

Method						
3-D Map Length	E	Decimal	The actual driven length of the segment based on a field measurement.			
Primary Road-Street Name	M	Text	The formally documented or most commonly used street or road name for the segment.	The "not applicable" code (-99) is used if only a Route Number is assigned (e.g., for an Interstate Highway).		ST_NAME
Primary Road-Street Prefix	M	Text	Directional prefix that may precede the Street Name	N, S, E, W, NE, NW, SE, SW.		PRE_DIR
Primary Road-Street Type	M	Text	Standard US Postal Service "street suffix" abbreviations (e.g., AVE, ST, BLVD, etc.).	See US Postal Service special publication #128 (Appendix C). See: http://pe.usps.com/text/pub28/pub28apc_002.htm	Will use US Postal service abbreviations. Allow for additional abbreviations to cover all local circumstances.	ST_SFX
Primary Road-Street Suffix	M		Directional suffix that may follow the Street Name and Street Type	N, S, E, W, NE, NW, SE, SW		POST_DIR
Alternate Road/Street 1	C		Used when there are multiple names used to refer to the segment. Includes all the sub-fields shown for "Primary Road-Street: Prefix, Name, Type, Suffix.	N, S, E, W, NE, NW, SE, SW	My be implemented in a specific physical database design in several different ways: a) include all fields for all Alternates in a flat file and only populate the fields if they are needed, b) Create concatenated fields with a standard delimiter (e.g., comma) and enter all alternate names in the field, and c) define a separate table, to include alternate street/road names, that can be joined with the this main table by segment ID.	ALIAS
Alternate Road/Street 2	C					ALIAS
Alternate Road/Street 3	C					ALIAS
Primary Route Number	M	Text	The official route number, assigned by a designated authority. Includes the "jurisdiction class" and the number	Includes route numbers for Interstate Highways, US Routes, State Routes, and County Highways. Null value allowed if no Route Number is assigned.	The primary route number is the "highest" road jurisdiction for the segment. (e.g., Interstate is higher than US Route or State Route).	N/A
Alternate Route Number 1	C	Text	Additional route numbers for any jurisdiction class for the segment. As many of these as applicable may be applied in cases where multiple routes run contiguously	Null value is allowed.		N/A
Alternate Route Number 2	C					
Alternate Route Number 3	C					

Left City	E		City on left side of segment (relative to digitized direction)	Uses accepted FIPS code for cities		COM_NAME (no R-L)
Right City	E		City on right side of segment (relative to digitized direction)	Uses accepted FIPS code for cities		COM_NAME (no R-L)
Left County	C	Integer	ID for county on left side of segment (relative to digitized direction)	5-digit FIPS code (e.g., Ada County is 16001)		
Right County	C	Integer	ID for county on right side of segment (relative to digitized direction)			
Left Emergency Service Zone	E		The zone on he left side of the segment (relative to digitized direction) that corresponds to a geographic area that is defined for primary response by a law enforcement, fire, or EMS organization.		Should comply with standards established by the Public Safety Technical Working Group (see http://gis.idaho.gov/framework.htm)	
Right Emergency Service Zone	E		The zone on he left side of the segment (relative to digitized direction) that corresponds to a geographic area that is defined for primary response by a law enforcement, fire, or EMS organization.			
Left Zip Code	E	Integer	5-digit Zip code for left side of segment (relative to digitized direction)			
Right Zip Code	E	Integer	5-digit Zip code for left side of segment (relative to digitized direction)			
Left State	C	Text	2-letter postal abbreviation for state on left side of Segment (relative to digitized direction)	Will be "ID" in most cases		
Right State	C	Text	2-letter postal abbreviation for state on right side of			

			Segment (relative to digitized direction)			
Left From Address	C		Lowest addressable value for left side of segment (relative to digitized direction)			FROMLEFT
Left To Address	C		Highest addressable value for left side of segment (relative to digitized direction)			TOLEFT
Right From Address	C		Lowest addressable value for right side of segment (relative to digitized direction)			FROMRIGHT
Right To Address	C		Highest addressable value for left side of segment (relative to digitized direction)			TORIGHT
Beginning Log Point	E	Decimal	Lowest log point (miles from beginning of route) for the segment.	Null values allowed. Used for roads with assigned cardinality when log points are documented (e.g., signage on road, documented on map).		BMP
Ending Log Point	E	Decimal	Highest log point (miles from beginning of route) for the segment.			EMP
Feature-Specific Metadata:						
Data Steward	M	Text				GIS_STEW
Data Source/Method	M	Text	Description of the source and method used for capturing centerline geometry.			
Accuracy	M	Integer	Level of horizontal accuracy in feet.	Normal range is 1 to 100.	*statement of horizontal accuracy compliant with the National Standard for Spatial Data Accuracy (NSSDA, FGDC-STD-007.3) in which accuracy figures are presented as a maximum root mean square (RMS) error in the 95% confidence interval.	
Accuracy Verified	C	Text	Indication if the accuracy level identified is assumed (without a verification test) or tested with sample high	Yes or No		

			accuracy, independently collected points.			
Update Date	M	Date	Day, Month, Year of the most recent posting to or edit of the Framework database			EDIT DATE
Data Accessibility	C	Integer	Indication of any restrictions on viewing or distribution of information on this road	Number codes for 1) Open access by anyone, 2) Viewable/accessible restricted		
Comment	E	Text	A limited amount of text, entered by the Source Steward or Framework Steward that provides additional information about the centerline segment or its capture or update		Normally, no text will be entered (enter -99 for "not applicable)	

[1]Priority class includes:

Minimum Attribute Set (M): This is a "barebones" set of attributes that is considered essential for compilation and ongoing update of the Roads Framework data

Core Attributes (C): Attributes considered to be important to support GIS applications by multiple user groups. Assigned data stewards and other organizations contributing road centerline data are strongly encouraged to capture these attributes in addition to the minimum (M) attribute set

Extended Attributes (E): These attributes provide a richer data content than the core (C) attributes of use to a wide range of user groups. These attributes are needed to support a more extensive set of GIS applications.

Attributes Not Included (N): These attributes are not formally a part of the Road Centerline Framework data set. It is recognized that these attributes (and others not identified in this project) do have importance for specific users and applications. These attributes may be added to GIS databases being used and maintained by specific organizations.

[2]Domain values may use coded fields for the entries described here. For all cases in which the attribute field does not apply, a value of -99 should be entered. A value of -88 is used for a value of "Unknown".

APPENDIX D: LESSONS LEARNED FROM THE INTEGRATED ROADS PROJECT

Since June 2006, the Integrated Roads Project has been developing procedures and tools for sharing and integrating geospatial road transportation data in order to reduce time, effort, and expense related to maintaining multi-jurisdictional road data for the state of Idaho. In that time a number of things have been learned about the integration of roads data across the State of Idaho. The following sections attempt to break a variety of the lessons learned by this work.

Data Currentness

Data currentness from source stewards varies considerably. The data generally fall into two categories with updates being either regularly (62% | 13 source stewards) or never (38% | 8 source stewards). The 13 source stewards account for approximately 25% of the road miles in the State of Idaho.

Lesson learned: The optimum solution to date for data currentness is for the source stewards to have an automated method of making a ZIP file containing their data available on their Web server. Based upon the history of this project, it is likely that 25% of Idaho's roads (typically in the higher population locations) will be updated regularly (i.e. about once a week), the remaining 75%, will be updated bi yearly at best.

Attribute Requirements

The Integrated Roads Project requires participating entities to add two data attributes (GIS_STEW and CARTO_TYPE) to their roads data set to participate in the project. This low entry cost of time to get involved in the project has made it relatively successful. However, even with only requiring two attribute to be added there have been some issues. In about 50% of the cases, this manually has been done by the outreach staff. This either occurs when the outreach staff show up at the place of business and the outreach staff perform the task on site. Optionally, the participating entity emails the outreach staff their roads data and the attributing is done at the outreach's staff's computer. One problem that has occurred is that if the local staff do the attributing themselves, is that they may specify attributes values that are not in the domain. Then getting the entities to update and fix the errors can be problematic, since these additional attributes are not part of their business process. In addition, when they add new line segments, they may forget to attribute the new integrated attributes (GIS_STEW and CARTO_TYPE). For the above reasons, it may be impractical to have a truly homogenous data set without paying the contributor to maintain these attributes. This may be particularly important if it is chosen to have four or more attributes as it is put forth in this report.

Lesson learned: Maintaining attributes that are outside of a small organizations business process is difficult. To assist organizations to maintain attributes, participants should be provided an option for a financial incentive for joining the project, perhaps in the form of a competitive matching grant.

Agreement Points

The establishment of agreement points (matching points for road data from adjacent jurisdictions) is a concept that has been attempted to be implemented in the Integrated Roads Project. There are

two separate ways to view agreement points. Conceptually, some organizations have self organized and created agreements between themselves, such as Bonner County and Kootenai County. This has been an informal process done between the GIS Managers. Based upon conversations and emails they have mutually agreed to end line segments at particular locations. The other way to view agreement points is to develop a point feature class within a Geodatabase and use the GIS to track the agreement point. This agreement point can then be used in data assembly process to snap line segments form contributing counties to this point layer. This process is most likely very important if it is desired to perform routing across the data set, because having an agreement point layer will increase data integrity. Early on in the Integrated Roads Project process an automated tool was created to produce agreement points for all contributors' data. It became apparent that the maintenance of this process was greater then what the existing budget could handle, so it was abandoned. It is recommended that this exercise be continued at such a time that full time staff can be hired for this project.

Lesson learned: Once full time funding becomes available for the project, agreement point generation and snapping should be evaluated at part of the harvesting and maintenance of the data.

Participation

Since the Project's inception, there have been regular meetings to coordinate activities, and involve new partners. In addition, a contact list has been created for every county and potential contributing partner (See Table D-1 below). Development of the contact list has been time consuming because not all organizations have the GIS roads layer managed by the same department across organizational structures. Overall, there has been great success in bringing in counties and tribes that have existing GIS staff. Typically, entities that don't seem to have regular GIS staff have not participated. This is for a number of reasons. One is for lack of understanding of GIS. Typically, at the smaller counties the GIS comes and goes due to high turnover rate, or the presence and then absence of contractors. Working with these lesser populated counties will continue to be challenging, but may be overcome in time. It might be recommended that adequate time be dedicated to bringing these future counties online. For example, in the current project we have worked with a number of counties to assist them in making their data compatible with the Integrated Roads data. This has included adding address ranges in some case and in others assisting with data clean up such as removing spaghetti digitizing errors, dangles and overshoots. In one county over 140 hours were spent just doing clean up. There is most likely some synergy that could be achieved by working with organizations such as LHTAC since they plan to digitize these counties. That being the case the project staff could work to attribute the work done by LHTAC and make it useable for the Integrated Roads Project.

It is important to note that no one organization in Idaho is tasked with collating a complete set of road data usable for E911, address geocoding, pavement management or economic development purposes. Although it would appear that ITD or LHTAC would be the logical agency responsible for this task, it must be understood that over the last 4 years they have stated data updated on a less frequent basis meets their current business needs and they do not have the funding or the staff to coordinated such a dataset. Unless these agencies fundamentally change their business scope a different transportation data steward should be chosen.

Lesson learned: Full time funding to the project will assist in participation; this funding should include adequate dollars for a technician to clean some smaller organizations data. To assist

organizations to comply with project data requirements, participants should be provided an option for a financial incentive for joining the project. Leadership by the state GIS clearing house is currently the most neutral location to house the project. Future leadership may come from State Emergency Services, State Framework Coordinator, or Regional Resource Centers. All parties maintaining roads data in Idaho should be continued to be invited into the process.

Staffing and Resource Considerations

Staffing is a key component to the success of the Integrated Roads Project. Due to the relatively small operating budget of the project, there has not been dedicated fulltime staff to focus on the project. Given the small amount of staff time (558 hour of outreach per year and approximately 415 hours of application development per year), a significant goal of over 50% of the counties in Idaho has been reached. However, the counties that have been reached are essentially the low hanging fruit, of easy to get GIS data counties in Idaho. The remaining counties will take significant work. Building long-term relationships with potential partners and current partners will facilitate success of the project. At many smaller organizations GIS data may not typically shared with strangers. Unfortunately, the person doing the outreach phone calls each year for the project has changed, due to staff turnover and lack of full time funding. Developing a full-time funded program will stabilize the outreach portion of the project. This will then bolster relationships that build trust, and make organizations more likely to participate.

To date, grants and cooperative agreements have contributed approximately $185,000 over a 4-year period to this effort. Activities have included producing documentation (~$15,000), outreach (~$60,000), and application programming, web services and computing infrastructure (~$110,000).

Lesson learned: Full-time staff and resources are needed to support the program for continued success. Experience tells us the following resources are needed to continue this effort:

Manager	$100,000 (salary and fringe benefits)
Technician	$ 50,000 (salary and fringe benefits)
DB/Systems Administration	$ 70,000 (salary and fringe benefits)
Travel	$ 5,000
Capital Outlay	$ 5,000
Other Expenses	$ 2,000
Indirect	$ 75,900 (overhead: office space, utilities, insurance)
Partnership	$ 20,000 (technical support for source stewards)
Total	**$333,900**

Table D-1: Participants in the Integrated Roads Project

County	Contact	Organization Affiliation
Ada	Anne Kawalec	Ada County
Adams	Ginger Getusky	Adams County
Adams	Duane Priest	Geographic Mapping Consultants
Bannock	Kindra Serr	GIS TReC Systems Admin. Idaho State University
Bannock	Dennis Hill	City of Pocatello
Bannock	Kirk Mottishaw	Bannock County GIS
Bear Lake	Lynn Lewis	Bear Lake County Assessor
Benewah	Frank Roberts	GIS Manager Coeur d'Alene Tribe
Bingham	Cheryl Robertson	Bingham County GIS
Bingham	Carl Balmforth	Bingham County "Roads Guy"
Blaine	Sam Young	Blaine County GIS Analyst
Boise	Gordon Ravenscroft	Boise County Emergency Manager
Bonner	Dan Spinosa	Bonner County GIS Coordinator
Bonneville	Janet Cheney	Bonneville County GIS
Boundary	Gary Falcon	Boundary County GIS Coordinator
Butte	Mike Blatner	Road and Bridge
Butte	Duane Priest	Geographic Mapping Consultants
Camas	Lynn McGuire	Camas County Assessor
Camas	Duane Priest	Geographic Mapping Consultants
Canyon	Forest Smith	Canyon County GIS Specialist
Caribou	Aaron Cook	Caribou County
Cassia	Martell Holland	Cassia County Assessor
Clark	Chris Baker	Clark County
Clark	Carrie May	Clark County
Clearwater	Angela Vanderpas	Clearwater County
Custer	Christine James	Custer County Assessor
Custer	Duane Priest	Geographic Mapping Consultants
Elmore	County Commissioners	Elmore County Commissioners
Elmore	Tracy Lefever	Elmore County E-911
Elmore	Jo Gridley	Elmore County
Elmore	Duane Priest	Geographic Mapping Consultants
Franklin	Adin Waite	Assessor Dept
Fremont	Bonnie Moore	Fremont County GIS
Gem	John Henderson	Gem County
Gooding	Nancy Moore	Gooding County GIS
Idaho	James Zehner	Idaho County Assessor
Jefferson	Doyle Crane	Jefferson County GIS, Road and Bridge
Jefferson	Sherry Lufkin	Jefferson County GIS

Table D-1: Participants in the Integrated Roads Project (con't)

County	Contact	Organization Affiliation
Jerome	Loretta Bonner	Jerome County GIS
Kootenai	Dave Christianson	Kootenai County
Latah	James Agidius	Latah County Planning & Building GIS Specialist
Lemhi	Gary Goodman	Building Department, Lemhi County
Lewis	Jeff Cronce	Nez Perce Tribe GIS
Lincoln	Mary Norman	Lincoln County
Madison	Craig Rindlisbacher	Madison County GIS Coordinator
Minidoka	Darlene Frieson	Minidoka County
Nez Perce	Bill Reynolds	Nez Perce County GIS
Oneida	Kathleen	Oneida County Assessor's Office
Owyhee	James Ferdinand	911 Coordinator Owyhee County
Payette		
Power	Donna Thornton	Power County
Shoshone	Leslee Stanley	Shoshone County
Teton	Patrick Vaile	
Teton	Susah Wahl	
Teton	Eric Smith	Teton County GIS Manager
Twin Falls	Rhea Lounsbery	Twin Falls County
Twin Falls	Duane Priest	Geographic Mapping Consultants
Valley		
Washington	Sharene Ahlin	Washington County GIS