North Carolina GIS Conceptual Design document

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1.0 Overview

Historically, all 9-1-1 calls utilized the telecommunications service provider for carriage and delivery of 9-1-1 to the Public Safety Answering Point (PSAP). The system has worked well for creating an emergency call system that connects a caller to a PSAP when the 9-1-1 digits are dialed. 9-1-1 in its purest form operates best with fixed locations and essentially hard coded databases that combine data attributes about a call location to route the call through the network to the PSAP.

Over the years the methods available for users to contact 9-1-1 has changed. Today the devices and systems that can trigger an emergency call has caused the existing 9-1-1 systems to pursue several augmentations, patches and significant system upgrades to meet the demand. While the current (often called legacy) 9-1-1 system continues to perform well it is quickly becoming obsolete and is generally limited. NG9-1-1 is a specialized system made up of network components and functional elements that are integrated to deliver 9-1-1 services over a flexible Emergency Services IP Network.

The North Carolina 911 Board will implement a fully functional and standards compliant NG9-1-1 system comprised of an interconnected and interoperable ESInet. The ESInet will be the operational foundation for the NG9-1-1 systems and functions. The ESInet will allow connection for all State PSAPs to enable NG9-1-1 capabilities.

One of the primary components of a 9-1-1 call is the determination of caller location. Within a legacy 9-1-1 call flow this is often done through using databases that contain a fixed address and fixed database comprised of addresses, address ranges, boundaries, points and landmarks. Information today is based upon multiple tabular databases which are referenced during the call to gather information as the call is being routed. Legacy databases are often developed from the Service Order Interface (SOI) records. The SOI record is a database record that contains a service order name, address or where the telephone number is assigned. While SOI records are still utilized in the wireline networks today, there are also other methods of database development such as the Master Street Address Guide (MSAG). The MSAG is developed by the 9-1-1 authority (often a county) that contains the address ranges and street names for the county. Along with the MSAG the Automatic Location Information (ALI) and the Automatic Number Identification (ANI) databases are used to link a 9-1-1 call with a location. If attributes are not present in the databases, or is inconsistent the call will still route to the PSAP but can cause the PSAP receiving the call difficulty in accurately identifying where the caller is calling from due to gaps that may be present in any one of the databases. This is especially a concern with the mobility of the general public.

In NG9-1-1 calls are routed in a similar manner to the legacy 9-1-1 system. The call is still routed through the network to a PSAP, however rather than collecting the location

and attribute information along the way the call is routed based upon the geographic location of the caller. The multiple database lookups to determine the location are essentially eliminated; however other database lookups for attribute information remain.

Caller location is validated by engaging NG9-1-1 functional elements designed to identify, store and transmit location information with the call to a PSAP. Emergency call routing and location validation occurs through a Geographic Information System (GIS) that has been aggregated into regional or state-level datasets. These functions are defined in NENA i3 Standards as Emergency Call Routing Function (ECRF) and Location Validation Function (LVF). The ECRF and LVF transactions utilize the spatial information provisioned by GIS to route calls through the NG9-1-1 Emergency Services IP Network (ESInet).

The purpose of this conceptual design is to provide a strategy for procuring a common GIS platform and management / maintenance capability for all NG9-1-1 GIS activities throughout North Carolina. In addition, this document may be used as a GIS standard for development and maintenance of PSAP GIS data. The board recognizes that implementation of the information contained in this document as a standard may be completed by a combination of PSAPs and other local agencies with authority for GIS and mapping authorities or mapping divisions.

The Board recognizes that many GIS mapping applications have already been established throughout the state. It is not the Board's intent to question or change these existing programs. Local government geospatial programs will remain the authoritative source for accurate GIS data to be used in NG9-1-1. Agencies utilizing their own "in house" standards are encouraged to modify or update these standards, if necessary, to meet or exceed the Standard. The Standard was developed to support interoperable NG9-1-1 systems, databases, call routing, location validation, and call handling and other related processes.

1.1 Background

Typically PSAPs throughout North Carolina rely on local GIS expertise and data management programs perform the day-to-day maintenance and ensure that all data used for 9-1-1 contains the most accurate information. This operation works very well since the local expertise normally has the best access to the ever-changing data attributes. As streets are added and removed, addresses are added, changed or altered the local GIS platforms are the first to ensure that a change to the GIS has occurred.

The main challenge with this approach is that GIS management and maintenance procedures are often different for each PSAP. Multiple data attributes may exist that have been created by differing processes defined locally or for specific purposes in that locality.

Thus, creating a composite dataset from local GIS data for NG9-1-1 requires consistency of attributes and geometry between local datasets.

The primary goal of this GIS conceptual design is in creating the strategic outcomes necessary for establishing a common platform for the PSAPs in North Carolina. In addition, the conceptual design is intended to provide guidance on the current standards and proposed NG9-1-1 GIS data schema that has been developed to increase the ability to resolve a PSAP based, statewide GIS dataset.

GIS plays many roles in the operation of 9-1-1. It is often used by a PSAP as a tool to review and locate a caller statically. This means that the caller identifies an address and uses GIS to visually locate the call on a map. The NC 911 Board is pursuing this conceptual design to ensure that all state PSAPs are able to utilize GIS in a tactical fashion that levels the mapping capability for the entire state.

GIS can also be used in call routing. As mentioned briefly in Section 1.0, GIS identifies the location of the call and routes the call to the correct PSAP. Along with the Emergency Services Routing Proxy (ESRP) the ECRF essentially maps the route for the call to take through the NG9-1-1 system.

GIS systems must have a standard set of attribute information available. At a minimum, most GIS systems designed for 9-1-1 offer the following features and data such as:

- A County street layer that also contains address ranges
- A County boundary layer that aligns with the PSAP borders
- Emergency Service layers with a numbering system that identifies supportive information to aid call routing and response
    - Law Enforcement boundary layer
    - Fire boundary layer
    - Emergency Medical Service (EMS) boundary layer

There have been some varying methods of implementing GIS to support NG9-1-1. Some solutions offer an interim path to ensure that all GIS operations are scaled to meet the initial ECRF capability. An interim path can be beneficial to permit the creation of accurate data in the ECRF and structure the LVF operation. Regardless of steps, the outcome desired is a location based call routing platform that uses where the call is placed. In order to route 9-1-1 calls in the NG9-1-1 system the solution must:

- Integrate with the current legacy call routing systems
- Be user friendly to manage and update

- Allow for the display of wireless, wireline, Voice over Internet Protocol (VoIP), Automatic Vehicle Location (AVL) and other potential routable location information; some of which may be undefined at this time
- Receive automatic or re-bid updates to location
- Be built on a standard industry GIS platform

NENA has already defined a basic interim path defined in the NENA interim i2 NG solution. This interim solution is capable of providing a path to fully operational ECRF where a GIS capability is not yet in place. This process constructs the call routing database via the existing MSAG data integrated with the GIS and creates the ECRF based upon the availability of data attributes at the time. Over time, this model can be expanded as GIS attributes are refined. The interim solution offers a migration path that can benefit those areas which GIS is suspect or GIS is not yet utilized to its potential.

In an NG9-1-1 call routing platform all attribute data associated with call routing and the plotting of a location on a map display must be provided in a NENA NG standard format. Presently the format for NENA NG is undergoing a revision, but the primary database components are presented in the appendix to aid in understanding what they are with respect to current GIS operations.
The ECRF capability is comprised of generally two functions. One is the routing of the call to the proper NG9-1-1 functional element for further routing and the other is to ensure that the call address is validated through the Location Validation Function (LVF). As the ECRF performs these functions the data supplied from GIS is critical to match the location with the call. Originating call network operators (often called Communications Service Providers or CSPs) are expected to verify civic address location information against the NG9-1-1 GIS data using the LVF included in the ESInet and utilize interfaces described in the ESInet and Hosted CPE conceptual design.

Additionally, 9-1-1 call routing requires that data be present in a Location Information Server (LIS). The LIS is very similar to the existing Selective Routing database that utilizes the MSAG to contain ALI information for 9-1-1. The LIS is used for management and provisioning of the database records that trigger NG9-1-1 call routing. The registered addresses of subscribers would reside in the LIS and would be triggered by the ECRF to bounce up against the MSAG validated address.

Of particular note is the operation of a Spatial Interface (SI) capability that is used to replicate the GIS layers to external databases. The ECRF / LVF provisioning uses the SI to manage and maintain the GIS data. The SI may in fact be a separate GIS system or module that ensures the NG9-1-1 interfaces are operational. The SI often is often used to allow a Quality Assurance / Quality Control (QA/QC) mechanism for NG9-1-1. NENA has defined the SI provisioning interface in Section 4.7 of NENA-STA-010.

Regardless of this migratory path the focus is on developing a GIS database solution that can ensure that all location information databases can perform the functions necessary to:

- Validate a caller location
- Identify a route to send the call to within the NG9-1-1 system
- Offer the ability to enhance the data through a database management platform
- Provide the ability to normalize GIS records as necessary

1.2 GIS Survey results

The NC 911 Board established a GIS work group tasked with establishing the baseline needed to transition the GIS data and the management of the location information used for call routing and dispatch functions.

A survey was conducted to assess the existing capabilities employed by the PSAP's and determine the availability of GIS and spatial data systems. The survey did not collect GIS sample data to determine the accuracy of information during the survey.

The resulting tables are a reflection of the GIS survey information which represents a 61% return rate on the survey, and points out areas for consideration during this conceptual design and the subsequent Request for Proposal.

As shown in the tables the existing PSAP centric GIS activity represents a robust and functional GIS capability as measured in legacy 9-1-1 terms. GIS activities at the local level have been implemented through various means. Many local systems have relied upon an enterprise system that may utilized multiple agencies to support the GIS management and maintenance process.

While the GIS capabilities are consistent from an implementation standpoint, the spatial information utilized by 9-1-1 is very inconsistent. In most cases boundaries, centerlines and address ranges are not matched with the adjacent county which can cause delay in determining the accurate location of a caller. Counties do not typically share or join the GIS system information with adjacent agencies which can lead to each county GIS system to remain an island.

Based on table 3, just shy of 1/3 of jurisdictions do in fact integrate GIS data from all neighbors. In whole, table 3 indicates there is a distinct continuum between all, some, and none.

The implementation of NG9-1-1 requires that all counties share their GIS information and spatial data to create a seamless platform that can be used for call routing, and location determination. This includes normalization of edges (edgmatching) of boundaries and streets. This is an important step in ensuring that there are no overlaps in GIS or the attribute data that it represents. So all PSAP information must be collected, stored, verified, corrected and secured in a statewide GIS system specifically designed to support NG9-1-1.

The tables below show the results of the survey and can be a valuable tool to assist potential GIS vendors in supporting the NC NG911 Board.

Next Generation 911 GIS Data Survey

For each of the following GIS datasets, please indicate whether it is maintained exclusively for PSAP/ emergency response use only, maintained and used for multiple agencies across the local government jurisdiction, or not used for PSAP / emergency response.

GIS Dataset Utility

Answer Options	This dataset in maintained exclusively for PSAP / emergency response.	This dataset is maintained for use by multiple agencies within the local government.	This dataset in not used for PSAP / emergency response.	Response Count
Street centerline data with address ranges	3 (4%)	70 (96%)	0 (0%)	73
Address points (includes structures, sub-addresses, and/or ancillary or navigation points)	2 (3%)	64 (88%)	7 (9%)	73
PSAP response boundary polygons	30 (41%)	37 (51%)	6 (8%)	73
Dispatch response boundaries for first responders	36 (49%)	32 (44%)	5 (7%)	73
Governmental unit boundaries (state, county, municipal)	1 (1%)	71 (98%)	1 (1%)	73
Cell tower locations	6 (8%)	55 (75%)	12 (17%)	73
Building footprints	1 (1%)	50 (69%)	22 (30%)	73
Parcel boundaries	0 (0%)	71 (97%)	2 (3%)	73
Landmarks	5 (7%)	49 (67%)	19 (26%)	73
Ancillary / Navigation points	8 (11%)	38 (52%)	27 (37%)	73

	Question Totals
Other (please specify)	3
answered question	73
skipped question	0

Table 1: Overall survey results and response

Next Generation 911 GIS Data Survey		
Which GIS data quality issues concern you the most?		
Answer Options	Response Percent	Response Count
Inaccuracies within the GIS data	43.5%	27
Lack of regular data maintenance	30.6%	19
Lack of data standardization	37.1%	23
Lack of strong workflows / quality control	24.2%	15
GIS datasets not synchronized with MSAG and ALI	33.9%	21
Lack of GIS staff resources	43.5%	27
Lack of GIS data sharing with neighboring PSAPs / jurisdictions	29.0%	18
Other (please specify)	16.1%	10
	answered question	62
	skipped question	11

Table 2: GIS quality metrics

Next Generation 911 GIS Data Survey		
Does your PSAP acquire or exchange GIS datasets with neighboring jurisdictions for use in emergency response or CAD?		
Answer Options	Response Percent	Response Count
We acquire and exchange GIS datasets with all neighboring PSAPs / jurisdictions.	32.9%	24
We acquire and exchange GIS datasets with some neighboring PSAPs / jurisdictions.	39.7%	29
We do not acquire or exchange GIS datasets with neighboring PSAPs/ jurisdictions.	27.4%	20
	answered question	73
	skipped question	0

Table 3: GIS and data sharing capability

Next Generation 911 GIS Data Survey		
Which work unit assigns NEW addresses in your jurisdiction		
Answer Options	Response Percent	Response Count
Addressing Office	37.7%	26
PSAP / 9-1-1 Center	4.3%	3
GIS Office	43.5%	30
Other (please specify)	14.5%	10
	answered question	69
	skipped question	4

Table 4: GIS process and workflow

Next Generation 911 GIS Data Survey		
Is the PSAP / 9-1-1 Center included in the workflow for assigning NEW addresses in your jurisdiction?		
Answer Options	Response Percent	Response Count
Yes	52.2%	36
No	47.8%	33
	answered question	69
	skipped question	4

Table 5: GIS addressing process

In summary, the GIS systems in operation at the PSAP today are very capable, but are disjointed. This causes a substantial amount of duplication and siloed implementations that results in a lack of operational control over a key component for NG9-1-1. The NC 911 Board must employ a strategy that integrates the GIS systems and spatial information into a common seamless system to allow call routing, location determination and dispatch.

1.3 GIS data

GIS as it relates to NG9-1-1 can be broken into two primary functions. First the ability to route calls to an appropriate PSAP based upon the location of the caller and the supplemental information gathered within the network. Second, the ability to display the call location on a common map display system regardless of where the call is received within the system.

GIS is capable for handling multiple sources of spatial information that may be in the form of structures, points or other relationship based data may enhance the GIS database. The spatial information can be beneficial in NG9-1-1 to determine elevations, points or landmarks that may be supplemental to the location when responding to an emergency.

GIS data matching can aid in situations where adjacent areas may not have a fully capable GIS to support their services. By combining that information at the outset, the GIS data sets can minimize discrepancies in the beginning rather than finding out once an incident occurs.

The ability to route calls is described in the NENA i3 Next Generation 9-1-1 standard 08-003 which defines the placement and operation of standard routing components within the network. These components are defined within the standards as “functional elements” which serve the entire NG9-1-1 network. The primary functional elements which rely on GIS attribute data are:

- Location Information Server (LIS)
- Location Database (LDB)
- GIS data store

These data storages are the primary areas where the attribute data is stored within the network. They are accessed by functions performed within the network to capture, carry and manage the attribute information through the NG9-1-1 system. These functions are:

- GIS Database Management System
- ECRF / LVF
- Spatial Interface (SI)

In order to ensure that all of the data servers and functions can operate as designed, the GIS schema must follow the standards.

GIS will be necessary to ensure that the attribute data contained in the NG9-1-1 functional elements (primarily but not limited to the ECRF) allows the routing of calls through network

without exception. GIS and the linkage to data and location is critical to the success rate of call delivery and increases the ability of call-takers, dispatchers and first responders in situational awareness about a 9-1-1 call. Layers presented above must be "normalized". Normalization can mean many things and we will discuss some of those perspectives throughout this document. For the sake of defining it here we mean that the GIS attribute data is:

- Verified through a Quality Assurance / Quality Control (QA/QC) step
- That all edges between counties have been "matched"
- That all overlaps of GIS features (points, lines, polygons) have been corrected

1.4 Current Capabilities for call routing

Existing legacy 9-1-1 systems utilize data that assists in determining the location of a call. This data has historically been tied directly to telephone company records that use the fixed address of the structure to link to the telephone number, and billing records. This method of location identification has become obsolete with the introduction and proliferation of wireless and VoIP callers. Location is not directly tied to a physical location as it was when Enhanced 9-1-1 (E9-1-1) was deployed in the early to mid-1990's.

However, some of the routing information and data associated with the current 9-1-1 system can be valid in structuring the NG9-1-1 database that will be managed, and maintained through a GIS system. Furthermore, the data can be used as attribute information in the GIS to spatially link a GIS feature with the attribute data. The result is a fully capable and functional location based system that can display a map and link to the attribute information about the location. This system can also be used to identify a location of a caller and trigger the NG9-1-1 system to route the call to the correct PSAP based upon location.

Examples of the data that can be used to develop a GIS data management structure that are used in legacy 9-1-1 include but are not limited to:

1) Valid MSAG's per county
2) Selective Routing database information
3) County based Geo-files
4) Emergency Service Zones (ESZ) and Emergency Service Numbers (ESN)
5) Street Centerlines and Address ranges
6) Additional county and regional GIS layers

During transition to NG9-1-1 call routing the databases used in the legacy 9-1-1 system will serve as a baseline to ensure that migration operates in a consistent manner as the current 9-1-1 routing system. Over time, the manner in which the data is managed and maintained through GIS will allow for a more effective and efficient update and correction method.

As transition occurs there will be areas that may require attention including:

1) Disparate GIS management agencies and systems
2) Disparate GIS data layers
3) Sharing of GIS information
4) Inconsistent attribute data
5) Reconciliation of GIS data with MSAG
6) Normalization of GIS data
7) Existing ALI management tools and services

1.5 GIS strategic planning

Over time, management of the MSAG (and in many cases, multiple MSAG's) will migrate into the combined ECRF system where the master copy of the States combined MSAG is managed through GIS. GIS can spatially link the existing tabular data used with legacy 9-1-1 with the streets and boundary information provided by a PSAP. GIS can also join with other database tools and all other systems using MSAG type data will get their updates from the ECRF system.

The process and workflow of this strategy is discussed further throughout this conceptual design. An advantage to use GIS to manage and maintain the data is that it can expedite changes to a number of records at a time. In addition GIS can dynamically alter entire geographic areas which may be useful in critical emergencies.

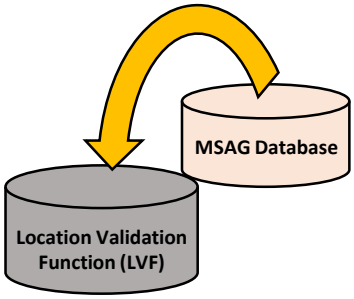

Figure 1: MSAG to LVF

The 9-1-1 authority (in this case the NC 9-1-1 Board will support the collection of the MSAG information from the PSAPs. GIS data management must employ integrated

procedures that ensure call routing data is kept current. Based upon the GIS data assessment in Section 1.3, this process is currently handled by the PSAP, and may not specifically utilize a GIS system to manage any changes to the data. The objective of this conceptual design is to replace the disparate processes with a common workflow that utilizes GIS to manage and maintain the tabular data.

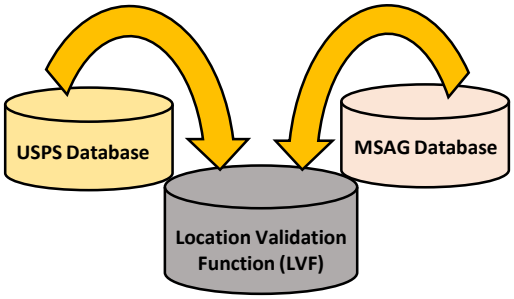

Figure 2: MSAG to LVF matched with USPS database

The MSAG and available addressing data (typically USPS Pub 28 addressing standards or other addressing authority) are combined to create a comprehensive validation system. The result is a new type of MSAG containing links to alternative location information such as “also known as” or “AKA’s”. AKA’s are not shared publically but are supportive to the information required to route calls to the correct PSAP. Discrepancies with the data and of these processes may be cleaned up with help from the GIS system or MSAG Source.

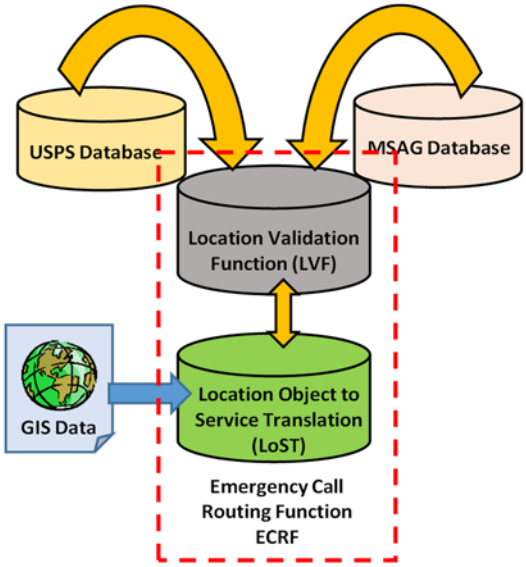

Figure 3: ECRF capability

This is the critical process which GIS information becomes part of the data management process. The ECRF has access to GIS data to help it make the routing decision.

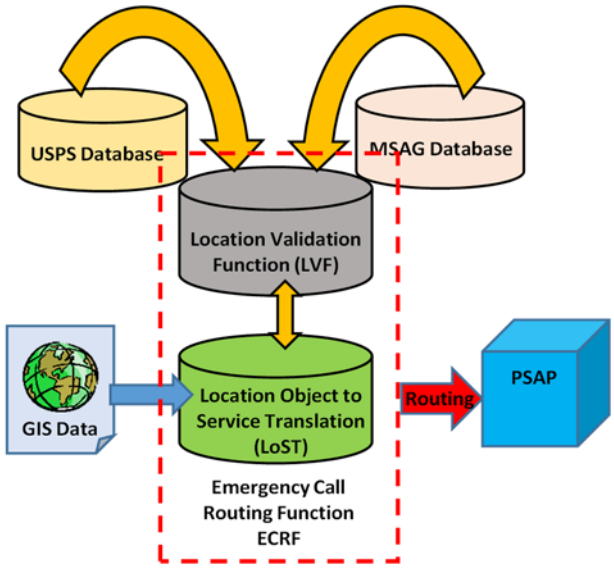

Figure 4: ECRF routing to PSAP

GIS data is managed with the combined MSAG and Postal data to support routing based on civic address and/or geocoded data (latitude & longitude).

Over time, management of the MSAG will migrate into the ECRF system where the master copy of the MSAG is managed in a spatial database. In Next Generation all other systems using MSAG type data will get their updates from the ECRF system and be managed and maintained by GIS.

For NG9-1-1 to become viable and efficient, it will be important to have correct data, updated data, and data that is seamless across the entire region, the state, the nation, and internationally.

2.0 NG9-1-1 differences from Legacy

In NG9-1-1, civic addresses will utilize the basis the CLDXF and PIDF-LO to replace ALI with location information that must match the data contained in a GIS layer. CLDXF and PIDF-LO offer the potential for more detailed address information than traditional ALI. In a transitional model all ALI records must be modified to meet the CLDXF framework. GIS is the best option for a tool to do that. CLDXF and PIDF-LO usage is known in NG9-1-1 as ***location-by-value***.

NG9-1-1 can also route based upon geodetic coordinates which typically are referred to as X,Y coordinates. Latitude and Longitude coordinates can is known as ***location-by-reference***.

2.1 NG9-1-1 data

NG9-1-1 uses spatial information and GIS data for many purposes. A key component is that the routing of calls must (at a minimum) offer the same reliable routing as the legacy 9-1-1 system. Primarily the GIS data is used for validation of locations and for determining the correct routing after the location is validated. But, GIS data can also offer greater insight into the location.

Using GIS data alone may not provide the best source of information during transition. While GIS data can provide quick results after a call has arrived at the PSAP (such as Google maps) calls cannot route using that same method. Therefore regardless of phases, stages or other NG9-1-1 implementation migration, the MSAG will be required during transition. The MSAG will eventually be replaced by the ECRF / LVF once the GIS system, MSAG and postal information have been fully integrated into a validation and routing engine specific for 9-1-1 calls. The integration of the databases can lead to better local knowledge attributes over time.

The GIS attribute information and location data is vital to ensure that the call routing platform that utilizes the LVF function to query the ECRF via the LoST protocol to determine the address information. This establishes the URI of where to send the call. GIS data must follow the NENA standard to allow for NG9-1-1 call routing platforms to interoperate across multiple counties, regions and states.

2.2 Assumptions

In NG9-1-1 the routing of calls is driven by location based geographic data derived by the calling party. This is a migration from the current routing capability that is provided by the primary local exchange carrier that handles the geography of the PSAP.

In the legacy 9-1-1 operation the PSAPs are responsible for maintaining the data and information that the LEC uses to route calls. In NG9-1-1 this process will no longer be handled locally, but will require a statewide solution based on local coordination.

This means that most of the GIS functions must meet a baseline set of requirements that include but are not limited to:

- Compliance with attribution and coordinate system (e.g. WGS84)
- May require some transformation for routing usage
- Will likely include some level of aggregation for a statewide solution.

The exchange of data in particular to how location based information us used to route calls is based upon IETF defined protocols. The two primary protocols are:

- HELD (IETF RFC 5985)
- LoST (IETF RFC 5222)

2.3 Spatial Interface

The NC 911 Board recognizes the need for a Spatial Interface (SI) to allow the local GIS participants to manage the replication of GIS data throughout the NG9-1-1 call routing functional elements. This SI operation will also be responsible for performing QA/QC measures on the 9-1-1 GIS data which may include MSAG to GIS synchronization during transition. This is explained in the potential interworking framework Section 2.5 and described in the sample call routing Section 3.0.

The SI described in this conceptual design is intended to be a single shared SI that all PSAPs will utilize to replicate the GIS data and attribute information to a single platform. This strategy places the authority for normalizing the GIS data into a common platform with the GIS vendor supplying the SI service. As an SI service the vendor will be responsible for ensuring that all GIS data provided:

- Meets the standard for NG9-1-1 functional elements ECRF and LVF
- QA/QC of all data prior to injection into the live system
- Error and discrepancy reporting back to the local PSAP authority for resolution

2.4 Database framework

While NG9-1-1 GIS capabilities minimize some of the multiple databases that are required for legacy 9-1-1, the information must be available for NG9-1-1. For this reason, there are two other primary databases that are used to provide information to the ECRF.

The Location Information Server (LIS) is the access providers' responsibility. Such as the telecommunication provider within a service area that handles the conversion from ALI. This includes small ISP's that may not have their own LIS but utilize a service from a larger provider. Eventually within the NG9-1-1 routing capability; a LIS will be used to route calls.

The expected additional data sources (call, location, caller) may not happen immediately once a LIS is deployed.

In NG9-1-1 the Call Information Database (CIDB) offers a method for gaining what would be ALI data spill in legacy 9-1-1.

- ALI vs. LIS
    - ALI: Automatic Location Identification
        - Limited size and content
        - A "de-normalized" data structure with data about the caller, location, and call characteristics
        - Generally operated by an agency or by a 3rd party on behalf of the agency
- LIS: Location Information Server
    - Based on HELD protocol to discover "locations" on a network.
        - Limited to location only
        - Envisioned to be provided by the access provider and/or service provider

2.5 Potential Interworking framework

The following table represents a comparison of where the information regarding a location. Data may not be contained in one single database (as shown) but may be manipulated and maintained by the GIS system.

Data Field	Variables	Description
NPA	330	*Area code*
NXX	555	*NXX*
Calling Number	1212	*Extension*
Class of Service	RES	*Residential, Business, etc*
Date	6062016	*Date of call*
Time (24hr)	1645	*Time*
Customer name	Bad Bunnies Eggs and Sweets	*Customer name if available*
House Number	2315	*Address info*
House Number Suffix	A	*Address info*
Main NPA	330	*Area code - if a MLTS may be different*
Main Number	555	*NXX - if a MLTS may be different*
Main Extension	1212	*Extension - if a MLTS may be different*
Prefix Directional	S	*Address info*
Street Name	Ashberry	*Address info*
Street Suffix	LN	*Address info*
Location	Rabbitville Plaza	*Address info*
ESN	12345	*Emergency Service Number (not generally used in NG9-1-1)*
State	NC	*Address info*
Community Name	Easter Bunny	*Address info*
Company ID1	Frontier	*Primary Telco provider*
Law Info 1	Easter Bunny PD	*Police dispatch (primary)*
Fire Info 1	Peep County FD	*Fire dispatch (primary)*
EMS Info 1	Rabbitville EMS	*EMS dispatch (primary)*

CIDB - Call Information Database
LIS - Location Information Server
Additional Caller info - Supplemental to call
Additional Location data - Supportive to Dispatch

Table 6: Sample configuration of Legacy to NG9-1-1 data

The table represents the common information that is received at a PSAP and how that data will be reflected in NG9-1-1.

3.0 Sample call routing

The following diagram represents the sample call routing while utilizing location based call routing. This is representative of how calls will flow through the NG9-1-1 routing engine.

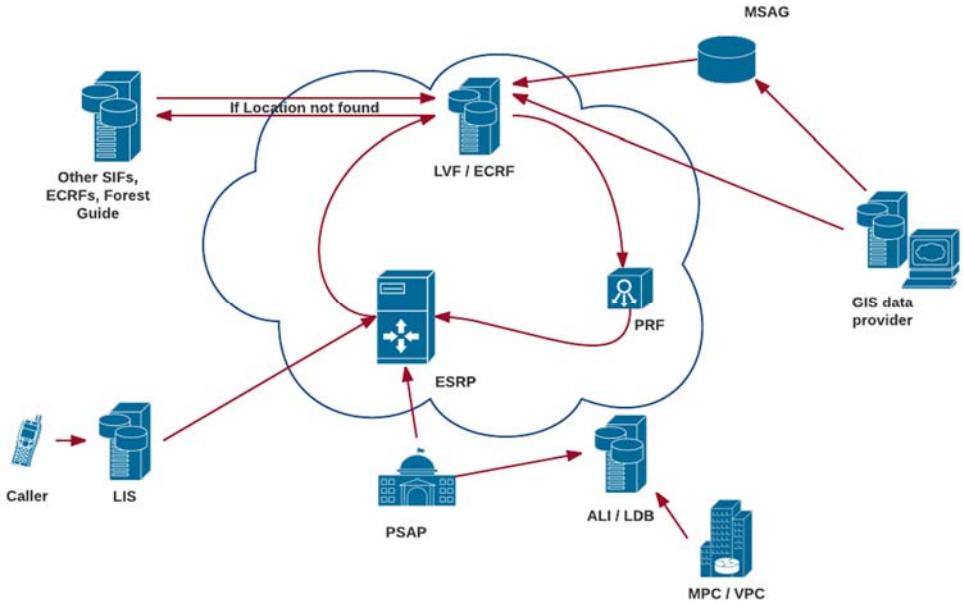

Figure 5: NG9-1-1 call routing engine

Once calls are into the ECRF they utilize one of 2 methods for routing:

The first uses the geodetic location (X, Y coordinates) to compare to the Polygon layer representing PSAPs to route to. The second uses the civic location geocoded compared to the Polygon layer representing PSAPs to route to.

Calls that enter the NG9-1-1 system utilize a Service URN to reference the type of service of the call and to provide instructions that the ECRF / LVF will use to determine routing to a PSAP.

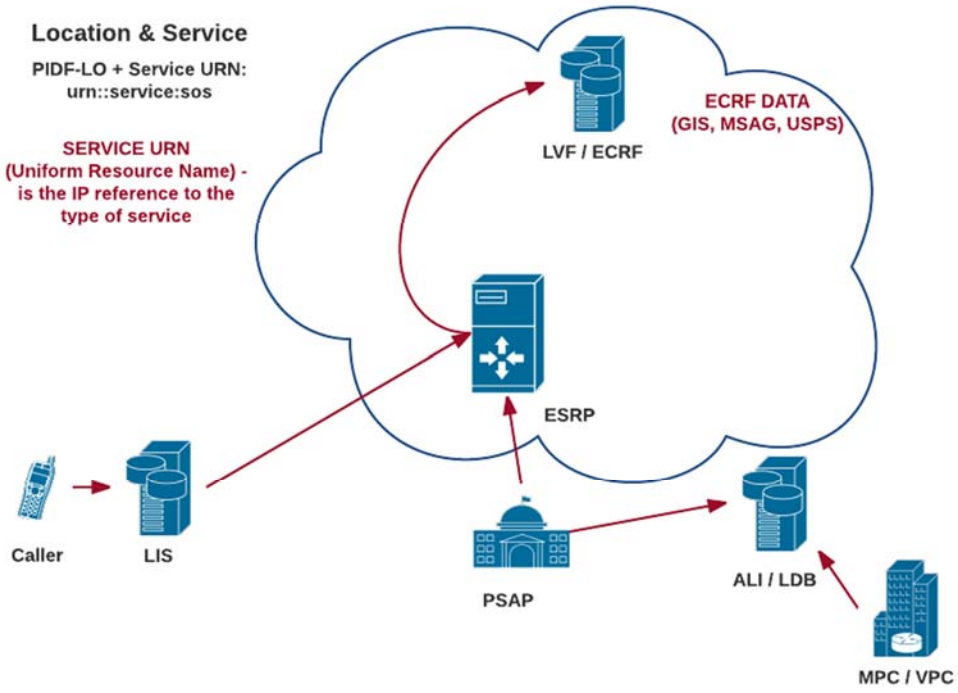

Figure 6: Calls coming into the NG9-1-1 system

The ECRF establishes the PSAP URI to send the call to based upon the location information contained in the call, and validated with the ECRF / LVF. The PSAP URI also utilizes the PRF and ESRP to finalize the route based upon the instructions contained within the system.

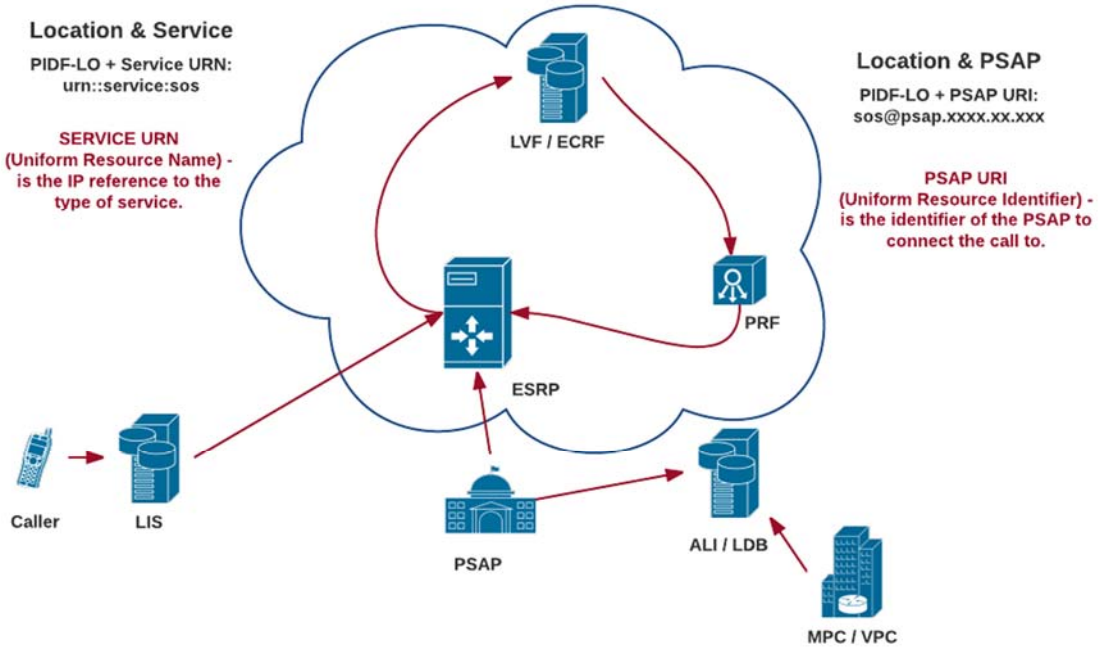

Figure 7: Calls going out of to a PSAP

4.0 GIS data schema

Along with the items described in section 1, the NC 911 Board will follow the NENA standard recommendations for a statewide GIS data schema. At this time, the *NENA Standard for NG9-1-1 GIS Data Model*[1] *is in the review process*, however the features of the standard are presented throughout this document as a reference to guide the development of a state wide schema and guide. Several NG9-1-1 capable systems have been implemented and almost all follow this current standard, or are using the framework to guide the development of a GIS platform. The States of Indiana, Vermont, Michigan, Tennessee, Alabama, and Washington DC are using the same standard as a reference guide as they transition into solely routing through an ECRF.

The GIS vendor will be required to support the most current version of the standard and verify that their solution will continue to meet the standard.

4.1 Initial NG9-1-1 database information

At the present time, the initial database information to allow for transition into a location based call routing system are listed below. The GIS management and maintenance activity will focus on developing the standard information below from existing datasets and carry forward with adding further spatial attributes that may not be available in the present GIS database.

The forthcoming NENA NG9-1-1 data standard has categorized these layers as Required, Strongly Recommended, or Recommended. The NC 911 Board wishes to adhere to the standard as closely as possible.

The NG9-1-1 GIS / database standard outlines the layers that are ***required, strongly recommended and recommended*** to support location validation, geospatial call routing, map viewing and other related functions for 9-1-1 service. Layers that are identified as required and/or strongly recommended are typically used to validate location and route 9-1-1 calls to a correct PSAP. Required and Strongly Recommended layers are provisioned within the Emergency Call Routing Function (ECRF) and the Location Validation Function (LVF) to provide the foundation for location based routing of 9-1-1

[1] *The NENA Standard for NG9 1 1 GIS Data Model presented throughout this section is currently still in DRAFT form. While much of the GIS data schema and its operation are presently in operation in several locations there may be some modifications to the structure of the standard before it is released for general use. The intent of including this structure is to link the objectives of this conceptual design with a common standards based strategy for NG9-1-1 GIS data.*

calls. The recommended layer designation applies to public safety mapping applications only. The Recommended layers will not be provisioned into the LVF or the ECRF, but are required for PSAP map display and 9-1-1 call taking. However, public safety mapping applications may utilize any GIS data or layer that is provided in the implementation.

The GIS data implemented to support NG9-1-1 must remain backwards compatible with E9-1-1 GIS and mapping. The NG9-1-1 system relies upon standardized, accurate and up-to-date GIS data and spatial attributes that can be related within a GIS system that define a location. Spatial attributes and information can be linked with a location to allow greater context about a particular location.

NG9-1-1 utilizes a location conveyance format, called the "Presence Information Data Format Location Object" or PIDF-LO. PIDF-LO was defined in the Internet Engineering Task Force (IETF) Request for Comments (RFC) 4119 and extended by RFC 5139 and RFC 6848. PIDF-LO is defined as an international format for location. The United States Civic Location Data Exchange Format (CLDXF) Standard (NENA-STA-004) is the United States profile of the IETF PIDF-LO civic address standard.

The relationship between the NENA standard and CLDXF is straightforward. The GIS layers and the data required to route 9-1-1 calls conform to CLDXF for the representation of addresses.

The structure presented in the NG9-1-1 data standard and the categories is shown below:

a. Required database information
    i. Road Centerline Requirements
    ii. PSAP Boundary Requirements
    iii. Emergency Service Boundary Requirements
b. Strongly Recommended database information
    i. Street Alias
    ii. Site Structure / Address point
    iii. Landmark point
    iv. Landmark Alias
    v. State polygon
        1. The North Carolina Geodetic Survey maintains the state boundary GIS data layer, and works with local governments to maintain a statewide county boundary dataset. These datasets are updated on "as needed" basis and will not need to be duplicated by the selected GIS vendor.
    vi. Counties polygon

vii. Incorporated Municipality polygon
    1. The North Carolina Secretary of State's Office and NC DOT are in the process of assembling an authoritative GIS data set for municipal boundaries. These datasets will be updated based on digital submissions from municipal governments as annexations are filed with the Secretary of State's office and will not need to be duplicated by the selected GIS vendor.
viii. Unincorporated Community polygon
    1. This layer is listed in STA-006. Inserted for completeness, but does not exist as a statewide dataset. It may be maintained by some local governments.
ix. Neighborhood Community polygon

c. Recommended database information
    i. Railroad lines
    ii. Hydrology lines
    iii. Hydrology polygons
    iv. Cell sites points
    v. Mile marker points

In Appendix B of this document (Section 12) provides a table of the entire NG9-1-1 data structure identified by NENA. The table is structured to provide only category and whether the data field is Mandatory, Conditional or Optional (M,C,O). This is the initial table structure that may allow for implementation to a location based routing system.

4.2 Standards assessment

The NENA Standard for NG9-1-1 GIS Data Model is currently being developed. Some of the material presented here has been under review by the work group and is not considered final.

The GIS data schema is presented as a framework for the future and represents a "snapshot in time" that may change as the final schema evaluated. The objective in presenting the data structure is to provide a link to the direction of the National GIS standards bodies and NENA while preparing the NC 911 Board and the State of North Carolina for the changes that are going to be required.

The initial recommendation for this GIS conceptual design is to review the schema and determine a path to migrate to the NENA Standard for NG9-1-1 GIS Data Model when the standard becomes final. The initial recommendation may be considered the bare minimum that counties must achieve before becoming fully NG9-1-1 ready.

4.3 Data Format

The data format for the NC NG9-1-1 state-level GIS database will be a shapefile or geodatabase

4.4 Field Names

Each attribute in the standard is identified by a field name. Field names have been standardized on ten characters or less to enable the ability to convert data from various sources including shapefiles. Field names utilized by local agencies or PSAPs may be customized from the required list for submission to the state-level GIS database. A detailed description of how the local fields correlate to the required field names must be provided in the Attribute Description field (section 5.1.2.2) of Federal Geographic Data Committee (FGDC) compliant metadata for each data layer.

4.5 Attribute Tables and Descriptions

Each data layer is described in this document with a table listing the attributes followed by a more detailed attribute description. The tables are formatted with the following information:

Field	Recommendation for the attribute field name. These recommended names were selected to be ten characters or less so the full field name would be retained if the data is ever converted to shapefile format.
XML Element	Tag used in the NENA Standard to transfer the data between systems.
Non-XML Tag	Tag used when native software restricts field names to 10 characters or less. Recommended field name use.
M/C/O	Whether populating the attribute is mandatory, conditional or optional
Type	Required attribute type.
Field Width	Maximum field width.

Table 8: NENA standard – Fields and Attribute tables

4.6 Mandatory/Conditional/Optional

In the NENA Standard, attributes are tagged as Mandatory (M), Conditional (C), or Optional (O). That convention has been kept throughout this document.

Mandatory- Implies the data field must be populated.

Conditional- Implies that if an attribute value exists for a given feature, it must be populated. If no value exists for a given feature, the data field is left blank unless other guidance is given.

Optional- Implies the data field may or may not be populated

4.7 Attribute Types

Attribute types are listed as per the NENA Standard. The types are defined as:

A Alphanumeric (any combination of upper and lower case letters from A to Z and/or any number from 0 to 9 or special characters). Example: Text fields in ESRI geodatabase feature classes and shapefiles.

D Date and time. The field type shall be specifically chosen for storing date and time data. Example: Date fields in ESRI geodatabase feature classes and shapefiles. – Note: NENA requires the ISO 8601 date/time format with time zone information. Many GIS applications cannot easily produce this particular format. Local data stewards shall store date attributes in a more common format, and the attributes will be converted in the state-level dataset –

N Numeric (consisting of whole numbers only) Example: In ESRI geodatabase feature classes and shapefiles, these shall be Short Integer or Long Integer fields. Note that address number fields must be Long Integer fields.

F Floating (decimal). Example: In ESRI geodatabase feature classes or shape files, these shall be numeric values with fractional values within specific range

4.8 eXtensible Markup Language (XML) Element Tags

NENA began using Extensible Markup Language (XML) as a method to exchange and share data for all 9-1-1 activities in 2006. XML is used for many IP related transactions where data and information must be shared among agencies and between machines

performing NG9-1-1 functions. The flexibility of XML allows for GIS data and spatial attribute information to be used for other needs and services beyond public safety.

Utilizing XML will allow the NC NG911 Board to ensure that local PSAP data can be aggregated, provisioned, shared, and used among a wide variety of databases, applications, and organizations.

XML tags are case sensitive; however, the acceptable Domain of Values provided in the database tables must be strictly adhered to.

XML is used as the data format because:

- Different entities can use different data field names and the data can still be exchanged and be interoperable.
- XML protects content producers and content consumers from changes in data formats and naming conventions.
- Data field order is unimportant.
- Allows attribute data to be loaded into many diverse systems by only loading the XML tagged data required for the application(s).
- Missing or nonexistent data fields do not hinder the exchange of data.
- Extra data fields do not hinder the exchange of data.
- XML is extensible – users can add other information for specific purposes.

4.9 Non-XML Element Tags

Non-XML Element tags are recommended for use when native software restricts field names to 10 characters or less, and/or when XML tagging is not supported in data exports or transfers.

4.10 Coordinate Reference System and Datum

GIS content standards developed by North Carolina state and local governments are referenced to state plane. The translation from State Plane coordinates will be responsibility of the GIS vendor as part of the aggregation process. Discrepancies between the coordinate translations will be identified and documented by the GIS vendor prior to correction to ensure that the coordinate system is universal.

While local GIS data may be kept in any projection desired, prior to loading the data into the Emergency Call Routing Function (ECRF) or the Location Validation Function (LVF) the data must be in the following projection:

EPSG:4326 WGS 84 / Latlong	
Projection:	Geographic, Plate Carrée, Equidistant Cylindrical, Equirectangular
Latitude of the origin:	0°
Longitude of the origin:	0°
Scaling factor:	1
False eastings:	0°
False northings:	0°
Ellipsoid:	WGS84
Horizontal Datum:	WGS84
Vertical Datum:	WGS84 Geoid, which is equivalent to Local Mean Sea Level (MSL)
Units:	decimal degrees
Global extent:	-180, -90, 180, 90

Table 9: Coordinate and Reference system information

4.11 Positional Accuracy

Map accuracy is the degree to which any given feature(s) on a map conforms to its true position on the ground. The reported positional accuracy value of a map is the cumulative result of all uncertainties, including, but not limited to, those introduced by errors in original base maps or aerial photography, physical media distortion, photogrammetric compilations errors, GPS differential correction errors, and data production methodology.

The mixing of different sources of digital map data of widely divergent scales into a common database should be avoided. This is because the positional accuracy of the aggregate database would be considered to be no better than that of the smallest scale or the least accurate source. If such mixing should be necessary; however, documentation to that effect should be included in the Meta Data.

Minimum- At a minimum, maps created for the use in emergency services should meet the following positional accuracy:

Positional Tolerance: 5 meters or 16.5 feet
Target Map Scale: 1:2000

5.0 GIS data provisioning and management process

Per the items discussed in Section 1 and 2; a method for establishing a GIS database management system with the ability to provide access to, or the support of GIS data normalization is going to be necessary per NENA MSAG-GIS data integration. (NENA 71-501). Where this GIS data and normalization function is located can be varied. In general the GIS data management system includes:

- The process of maintaining the NG9-1-1 routing database and applying updates to the ECRF
- The collection and logging GIS discrepancies
- The delegation of discrepancy error resolution to the PSAP
- Maintaining addressing standards as required by NENA and the State
- Implementing a flexible / scalable system
- Allowing the interim maintenance activities necessary during transition (MSAG, SOI, etc)

Expected Workflow for provisioning all GIS data to ECRF:

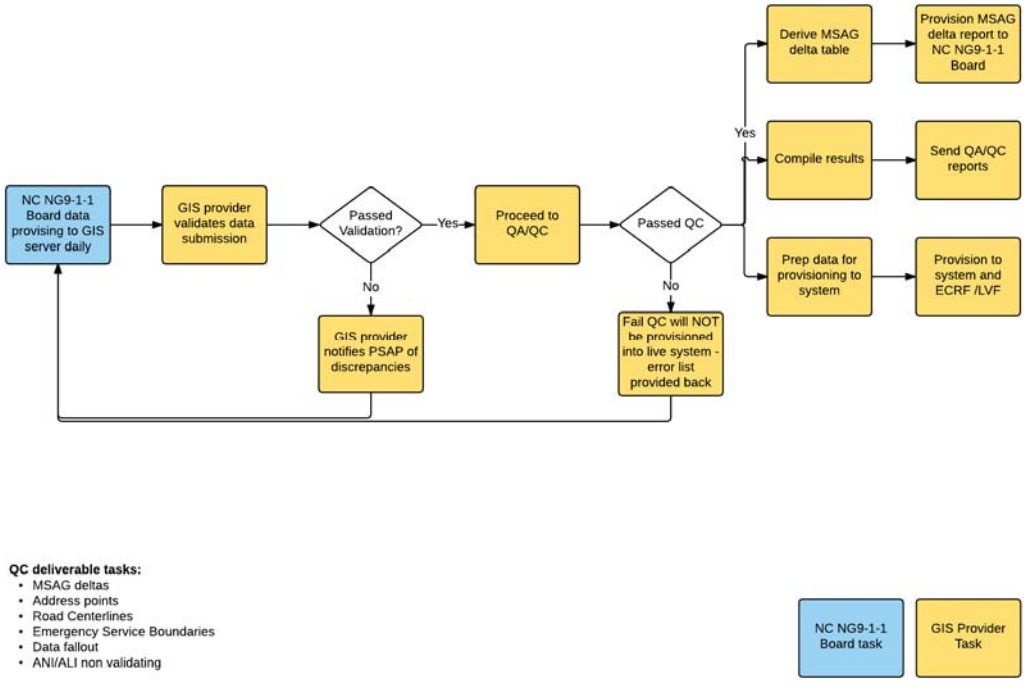

Figure 7: Workflow process diagram for provisioning data to ECRF

5.1 GIS normalization

The NC 911 Board requires GIS data normalization services, GIS database management and maintenance and Transition support to ensure that they geo-based call routing capability meets the NENA i3 and NG9-1-1 standards (The draft NENA GIS and Data Model Standard being referred to are listed in the appendix Section 13).

The GIS data requires normalization with the preferred GIS data schema prior to replication to the ECRF. The GIS vendor will provide assistance to this phase by establishing the baseline schema. The NC 911 Board along with the vendor will determine the most appropriate strategy for the schema and facilitate the gathering of all GIS data from the PSAPs with the GIS vendor. The GIS vendor will perform a validation step on all GIS data to ensure that all GIS data provided follows the schema and that the data can be used to transition into an NG9-1-1 system. The normalization will follow a workflow similar to the one below.

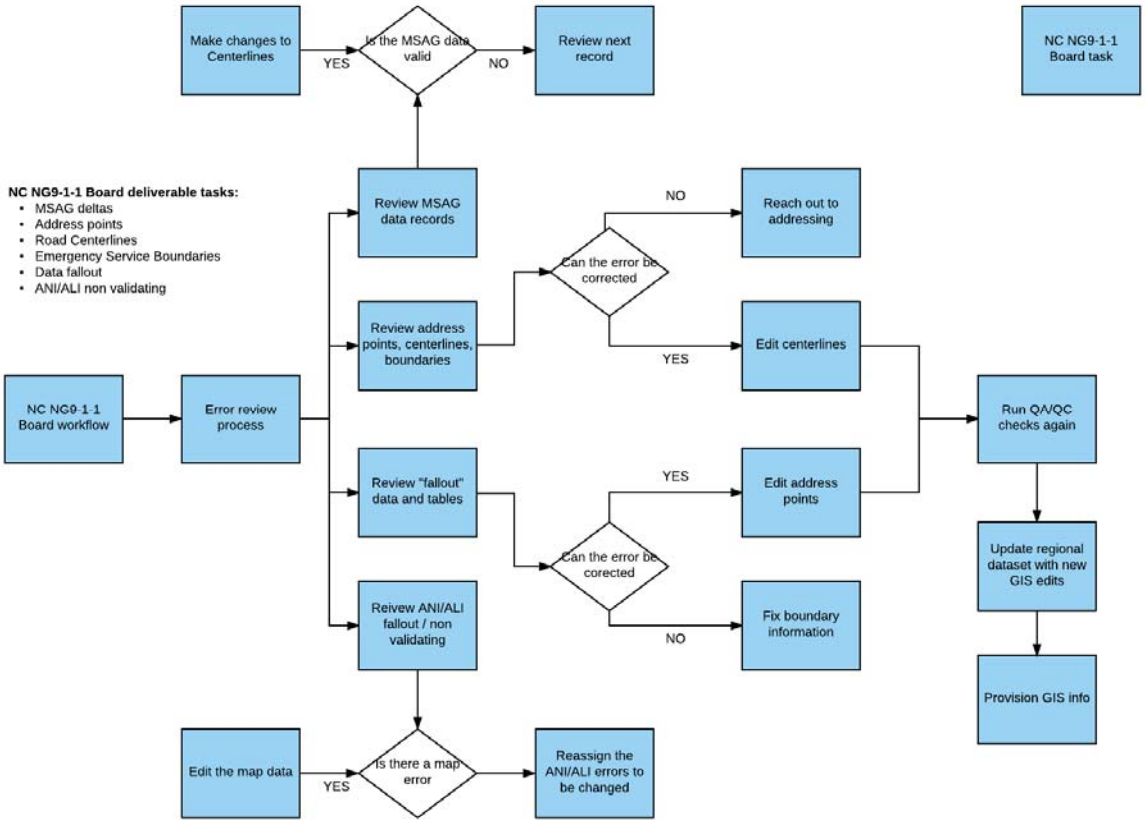

Figure 8: Workflow process diagram for GIS data normalization

During normalization, the GIS vendor will ensure that the data passes the QA/QC for meeting the GIS schema. This workflow will continue each time that GIS data is modified by a PSAP. The GIS vendor will identify all discrepancies and follow the discrepancy workflow for error resolution. GIS normalization will review and report on the following, at a minimum:

- Missing data layers.
- Missing attribute information.
- Standardization of GIS data attributes in adherence to relevant national standards, both centerline and site/structure location points following the FGDC-STD-016-2011, NENA GIS Data Model, NENA Site Structure Address Point.
- Synchronization of GIS data with MSAG and ALI (NENA 71-501 v1).
- Address range parity in centerline, as well as relating to site/structure location points and centerline.
- Duplicate address ranges.
- Direction and flow errors.
- Gaps and overlaps in PSAP and service boundaries and edge matching.
- Centerline breaks at intersections and boundaries.

The GIS vendor will utilize a discrepancy process that ensures timely and accurate error resolution of GIS data. GIS data that passes the normalization stage will be provisioned to the ECRF. GIS data that does not pass normalization will be pushed back to the PSAP for error resolution. Discrepancy logs and reports will be delivered to the NC 911 Board and the PSAP that identify the error and potential correction activities required to ensure that GIS data can be validated and normalized.

The State of North Carolina has begun to use a program to assist in the aggregation of authoritative GIS data sets. The AddressNC program is working with the local agencies to develop the GIS data layers in accordance with the NG9-1-1 schema. The GIS vendor and AddressNC will work in conjunction during the normalization process and during the discrepancy process. AddressNC may also be involved in supporting the correction of GIS data with the PSAPs that may not be able to correct data.

5.2 Data Layers

The GIS data layers listed in this section and further described in the appendix will be utilized for provisioning of the LVF and ECRF. Following the NENA standard ensures that the ability to route 9-1-1 based on location and the ability to share GIS information across the state, regions and adjacent states is possible. The GIS data layers presented comprise the primary foundation for 9-1-1. PSAPs may have additional layers used for local purposes but they are not generally required to create the GIS routing platform.

Although the tables list standardized field names, they are not necessary for provisioning an ECR / LVF. The PSAP or local GIS authority provide a name in the "Field" for what serves their purpose.

However, the data field's XML element tags, associated attribute data, formats, data types and Data Domain values, should strictly adhere to the attribute descriptions provided in the tables below. The XML element tags, or their Non-XML Tag equivalents, are required when sharing this information and when provisioning the data to operate the ECRF / LVF.

The following GIS data layers are required or strongly recommended for NG9-1-1 to function:

Required
The layers below are the minimum layers required to serve LVF and ECRF purposes.

- Road Centerline
- PSAP Boundary
- Emergency Services Boundary (Fire, law, EMS)

Strongly Recommended:
To further refine the required GIS data, and provide even more accurate location validation and call routing, the following layers can be provisioned to the ECRF and LVF.

- Road Name Alias Table
- Site/Structure Address Points*
- State Boundary
- County Boundary
- Incorporated Municipal Boundary

* It is strongly recommended that PSAPs either develop their Site/Structure Address Point data layer or engage with the State to have the Site/Structure information created for NG9-1-1 functionality.

5.2.1 Polygon Boundaries

Polygon boundaries that are required for 9-1-1 include the following, derived from a map of ESNs:

- Public Safety Answering Point Boundaries – non-overlapping boundaries in i3- compatible format for PSAPs.
- Fire service agency boundaries – non-overlapping boundaries in i3-compatible format for fire departments.
- Law enforcement service agency boundaries – non-overlapping boundaries in i3- compatible format for all local, regional, and state law enforcement agencies (police and sheriff departments).
- Emergency Medical Services agency boundaries – non-overlapping boundaries in i3- compatible format for all emergency medical services.

The State of North Carolina will also provide (in order to support QA/QC and normalization) as required:

- MSAG community boundaries, within which number/street name are unique
- Authoritative municipal and state boundaries.

As mentioned earlier, the GIS data must not contain gaps in any layers. Centerlines must be snapped at intersections, and boundaries must not overlap or have gaps. Gaps that are uncovered must be addressed by the GIS vendor in coordination with the local GIS agency. If the local GIS agency cannot provide an update or correction the GIS vendor will manage the maintenance and correction of those gaps.

5.2.2 Centerlines

A complete street centerline file that covers the entire State of North Carolina will be provided. This file will be comprised of the centerlines with an address ranges, street names and alias street names. Additional attributes required for NENA i3 call routing and coordinates will also be introduced as required with the centerlines. Centerlines will be split along polygon intersections to ensure that the appropriate address ranges are consistent on both sides of the split.

NC DOT is considering implementing a snap point database that will anchor geometry intersections, assigned names, and address ranges. The snap point concept in their database would also be able to accommodate other boundary breaks.

5.2.3 Other Spatial Data

The State of North Carolina will provide additional data maintenance as required but only for those layers and spatial information used to enhance call routing, and location determination for 9-1-1. The data used with the ECRF is designed to be the source of all GIS data for the State. As such, the ECRF information and data used at that stage will

be the baseline for all PSAPs. In many cases, the Computer Aided Dispatch mapping systems can allow for additional spatial data that is not included in the ECRF. The PSAP CAD vendor must also utilize the authoritative source for GIS data (the ECRF) to maintain any GIS that is utilized in their CAD system. Initially, the attribute information contained in CAD is not necessary for the operation of NG9-1-1. However, during transition to NG9-1-1 the Spatial Interface is designed to support CAD mapping update in accordance with NG9-1-1.

All GIS data associated with call routing and plotting will be provided in a NENA NG9-1-1 standard format. Originating call network operators will be expected to verify civic address location information against the NG9-1-1 GIS data using the ECRF/LVF.

The NC 911 Board will serve as the 9-1-1 Authority and insure all GIS data elements required by the NG9-1-1 system are provisioned in the system. In addition coordination will include the ability to arrange appropriate automated procedures for exchanging GIS data, system performance data, and for resolving detected errors by either party.

- The NG9-1-1 system will use and or import GIS data developed and maintained by the State of North Carolina.
- All data integrity, functionality and appearance will be transferred to the PSAP call taking positions which may include any CAD interface that may be used.
- Local agencies must provide the updates to the GIS data to the GIS management system on a daily basis.
- The Map display data will be dynamically updated within a 24 hour period at every call-taker position either automatically or manually.
- Any scheduled update will have the capability of being supported by the system administrator(s) and must have the capability of being placed in a test environment before system-wide application.
- The GIS vendor will be able to test, and then apply updates to the operating ECRF by a secure and reliable method that does not create operational problems.
- All call-taking positions will include a map display that is integrated with the call-handling software.
- All calls that have location coordinate information (AVL, wireline, wireless, VoIP) will be displayed on the map.
- Call-Takers will be able to search, at a minimum, based on address, landmarks, intersections, and geographic coordinates and “locations” identified within the CAD (specific to an address/location).
- The map display will allow the call-taker to zoom in and out, pan, and search.
- The map display will have all general map tool functionality including but not limited to; layer legend(s) display, an Identify tool, measuring tools for line and area, manually drawn area selections on at a minimum of address points, search on

addresses with a line or polygon buffer selection with option to define buffer distance, and latitude and longitude searches that auto translates any of the supported ESRI supported formats.

5.3 Preferred Data Exchange Formats

The NENA standard references that the preferred data exchange will utilize the Environmental System Research Institute's (ESRI) Structured Query Language (SQL) Spatial Database Engine (SDE) or geodatabase formats. Typically shapefiles are used as the method to exchange GIS layers and data.

The State of North Carolina has not standardized on ESRI. An open source format to allow the merging and compilation of multiple data exchange formats is necessary.

5.4 GIS Data Updates

The data used by the Emergency Call Routing Function (ECRF) must remain current with the information about each PSAP area. ECRF information will require daily review and update to ensure calls are routing properly. Local agencies must upload their information to the GIS data repository on a daily basis.

Local agencies must provide daily updates of their datasets to the GIS vendor for a QA/QC process before the data is provided to the ECRF to ensure that the spatial information remains consistent across the state. The GIS vendor will assist in validating that data updates are being produced according to the specified schedule.

As described in Section 5, the update process and handling of data / GIS discrepancies must follow an organized and structured process. NENA standards for discrepancy handling are utilized to ensure that updates to all data functions are completed according to the workflow.

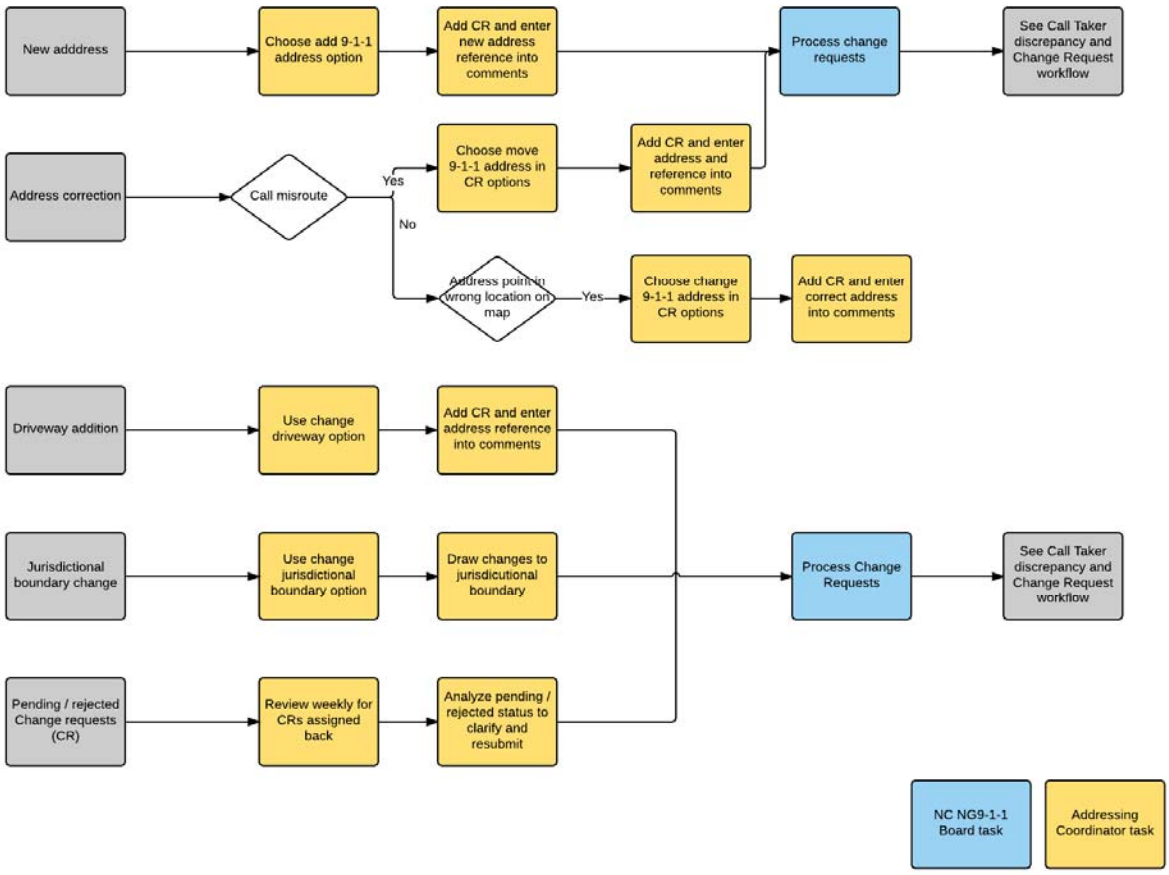

Figure 9: Workflow process diagram for GIS data updates

5.5 QA/QC Testing

The data supplied to the ECRF must be validated. This review by the GIS vendor may result in the logging and reporting of discrepancies found during the QA/QC process. Once the testing is validated, the approved updates may be applied. The call routing system vendor will perform periodic database audits to identify problems and errors, such as gaps, overlaps or number range conflicts, which if encountered, will be referred back to the State of North Carolina for resolution.

6.0 GIS and data discrepancies

GIS is the primary tool that allows management of the call routing information and data associated with NG9-1-1. The ECRF will contain the most accurate location based information that is used to route 9-1-1 calls and provide an accurate location to a GIS or mapping system. Therefore it is important that all discrepancies are handled in a workflow that allows corrections to be applied regularly.

The current legacy databases are shown next to the replacement in NG9-1-1.

Legacy 9-1-1	NG9-1-1
ALI	LIS / LDB
MSAG and SRDB	LVF / ECRF

Table 10: Legacy to NG9-1-1 systems

NG9-1-1 capable databases require that reference data such as the MSAG or even United States Postal address information can be reconciled with the data prior to replication to the ECRF. The GIS vendor will provide assistance during the reconciliation process by completing a compilation process which combines the GIS data sources and scrubs for errors. Any discrepancies resulting from normalization and the QA/QC process must be resolved to ensure calls are always routing with the most current data. Local PSAPs also play a role in the error resolution since they normally have the most current land base information.

Therefore, discrepancies may occur in many more forms than the typical address that is seen today. No Record Found (NRF) may become a thing of the past in many cases, but the discrepancies may grow due to the potential of the many new forms of data such as:

- Newly added or changed streets, renaming of streets, etc.
- Newly added or changed addresses, address ranges, landmarks and points
- Newly added or changed Boundaries
- Additional Spatial information and supplemental or supportive information
- Legacy to NG migration information

6.1 Discrepancy handling

The discrepancy process will follow NENA standards for managing and maintaining the location information as identified in the NENA GIS Data Collection and Maintenance Standards (02-014), and the NENA Standard for Standard for Reporting and Resolving ANI/ALI Discrepancies and No Records Found for Wireline, Wireless and VoIP Technologies (02-015).

GIS discrepancies must be handled in coordination with the 9-1-1 authority policies for the system. This means that only one GIS management function shall be utilized so that the ECRF/LVF capabilities remain consistent. In general a GIS discrepancy must include a copy of map the call takers are looking at and that a log of any and all discrepancies be captured and that said log be accessible by a system administrator(s) through the system's reporting feature. The Network Management and Assistance Center (NMAC) will be notified of all discrepancies and follow up on the correction and elimination of the discrepancy.

Discrepancies found by the GIS vendor will be referred back to the local PSAP where they occur. Discrepancy resolution will be the responsibility of the PSAP to be completed on the attribute data and MSAG and GIS information separately in most cases. In order to correct the legacy 9-1-1 data many counties also need to engage their ALI management tool if one is used during the resolution process

The GIS vendor must provide the structure and error reports to the PSAP so that it is clearly understood what type of error has occurred and what the anticipated correction may be. Once the discrepancy is corrected the local PSAP authority will upload the corrected files through the SI for the reconciliation process to occur again.

Only after all discrepancies have been cleared and validated by the GIS vendor will the GIS data be replicated to the live call routing system.

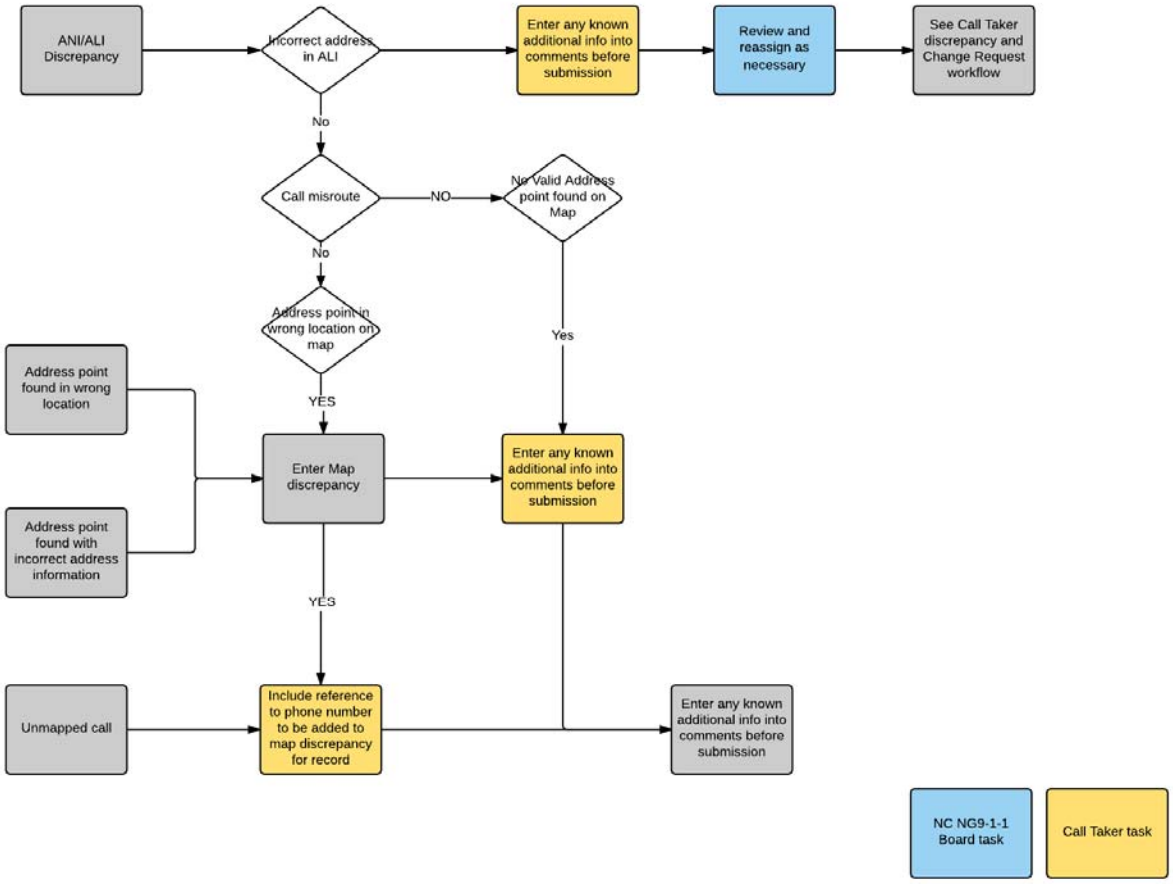

Figure 10: Sample Workflow process diagram for discrepancy resolution step 1

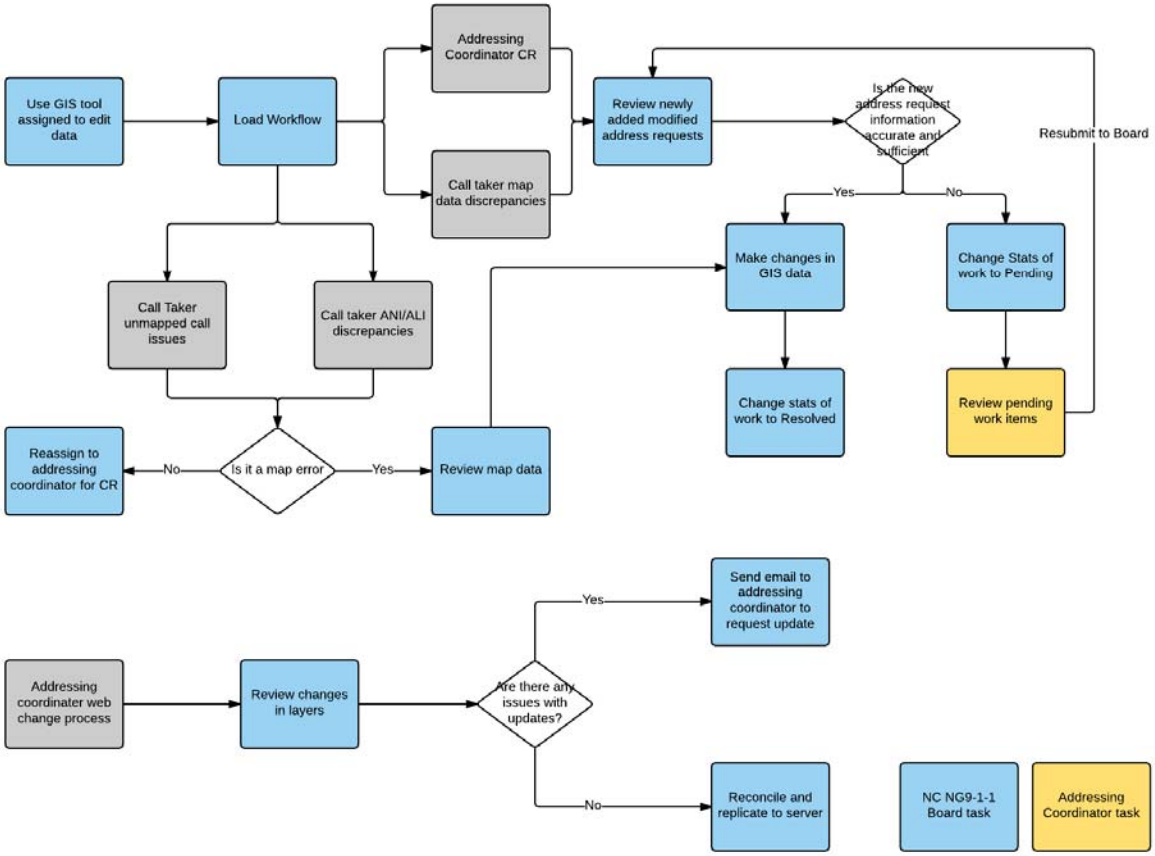

Figure 11: Sample Workflow process diagram for discrepancy resolution step 2

7.0 Appendix A

7.1 Required files

Street Centerlines

Descriptive Name	Field Name	M/C/O	Type	Field Width
Source of Data	Source	M	A	75
Date Updated	DateUpdate	M	D	20
Effective Date	Effective	O	D	20
Expiration Date	Expire	O	D	20
Road Centerline NENA Globally Unique ID	RCL_NGUID	M	A	100
Left Address Number Prefix	AdNumPre_L	C	A	15
Right Address Number Prefix	AdNumPre_R	C	A	15
Left FROM Address	FromAddr_L	M	N	6
Left TO Address	ToAddr_L	M	N	6
Right FROM Address	FromAddr_R	M	N	6
Right TO Address	ToAddr_R	M	N	6
Parity Left	Parity_L	M	A	1
Parity Right	Parity_R	M	A	1
Street Name Pre Modifier	St_PreMod	C	A	15
Street Name Pre Directional	St_PreDir	C	A	9
Street Name Pre Type	St_PreTyp	C	A	25
Street Name Pre Type Separator	St_PreSep	C	A	20
Street Name	StreetName	M	A	60
Street Name Post Type	St_PosTyp	C	A	15
Street Name Post Directional	St_PosDir	C	A	9
Street Name Post Modifier	St_PosMod	C	A	25
Legacy Street Name Pre Directional[1]	LSt_PreDir	C	A	2
Legacy Street Name[1]	LSt_Name	C	A	75
Legacy Street Name Type[1]	LSt_Type	C	A	5
Legacy Street Name Post Directional[1]	LStPosDir	C	A	2
ESN Left[1]	ESN_L	C	A	5
ESN Right[1]	ESN_R	C	A	5
MSAG Community Name Left[1]	MSAGComm_L	C	A	30
MSAG Community Name Right[1]	MSAGComm_R	C	A	30
Country Left	Country_L	M	A	2
Country Right	Country_R	M	A	2

State Left	State_L	M	A	2
State Right	State_R	M	A	2
County Left	County_L	M	A	40
County Right	County_R	M	A	40
Additional Code Left	AddCode_L	C	A	6
Additional Code Right	AddCode_R	C	A	6
Incorporated Municipality Left	IncMuni_L	M	A	100
Incorporated Municipality Right	IncMuni_R	M	A	100
Unincorporated Community Left	UnincCom_L	O	A	100
Unincorporated Community Right	UnincCom_R	O	A	100
Neighborhood Community Left	NbrhdCom_L	O	A	100
Neighborhood Community Right	NbrhdCom_R	O	A	100
Postal Code Left	PostCode_L	C	A	7
Postal Code Right	PostCode_R	C	A	7
Postal Community Name Left	PostComm_L	C	A	40
Postal Community Name Right	PostComm_R	C	A	40
Road Class	RoadClass	O	A	15
One-Way	OneWay	O	A	2
Speed Limit	SpeedLimit	O	N	3

Summary of NG9-1-1 Road Centerline Requirements

- Centerlines shall be continually updated as new roads are constructed or adjustments occur in the existing road network.
- Centerlines shall represent all public and addressed private roads.
- Attributes shall be accurate, complete and standardized (address ranges, ESN's Communities, spelling abbreviations). The abbreviations can be found in USPS Publication 28, Appendix B.
- Road names shall conform to the legal names as assigned by the addressing authority. The abbreviations can be found in USPS Publication 28, Appendix B.
- Centerline segments with no addressing along one or both sides, including small connector pieces shall have zeroes entered into the relevant Address Range fields.
- Roads representing border of maintenance responsibility should contain address ranges for the side of road within the jurisdiction. The ranges for the side of road outside maintenance jurisdiction should contain zeroes to avoid possible overlapping ranges between adjoining jurisdictions. Inter local agreements may be necessary to accommodate special situations.
- Each centerline segment shall share an exact start or end node with another centerline segment, unless it is a dead-end.
- Road centerline segments shall be split at:
    - Intersections with State, County, City, and Emergency Service Boundary (ESB)
    - Intersection with another segment
    - Change in primary road name
- Many mapping systems assume addresses are increasing in the FROM TO Node direction. Some geocoding applications assume addresses are increasing in the

FROM TO Node direction. Many entities are moving to this so they can create one set of base data that can be used for 9-1-1, Engineering, Planning, Taxation, and Transportation Departments.

PSAP Boundaries

Descriptive Name	Field Name	M/C/O	Type	Field Width
Source of Data	Source	M	A	75
Date Updated	DateUpdate	M	D	20
Effective Date	Effective	O	D	20
Expiration Date	Expire	O	D	20
Emergency Service Boundary NENA Globally Unique ID	ES_NGUID	M	A	100
State	State	M	A	2
Agency ID	Agency_ID	M	A	100
Service URI	ServiceURI	M	A	254
Service URN	ServiceURN	M	A	50
Service Number	ServiceNum	O	A	15
Agency vCard URI	AVcard_URI	M	A	254
Display Name	DsplayName	M	A	60

Summary of PSAP Boundary Requirements

- PSAP boundary layer shall be continually updated as service areas change.
- PSAP boundary layer shall completely fill the Authoritative Boundary layer (no gaps and overlaps)
- A geographic location (civic address or coordinate) can only have one designated primary PSAP.

Emergency Service Boundaries

Descriptive Name	Field Name	M/C/O	Type	Field Width
Source of Data	Source	M	A	75
Date Updated	DateUpdate	M	D	20
Effective Date	Effective	O	D	20
Expiration Date	Expire	O	D	20
Emergency Service Boundary NENA Globally Unique ID	ES_NGUID	M	A	100
State	State	M	A	2
Agency ID	Agency_ID	M	A	100
Service URI	ServiceURI	M	A	254
Service URN	ServiceURN	M	A	50
Service Number	ServiceNum	O	A	15
Agency vCard URI	AVcard_URI	M	A	254
Display Name	DsplayName	M	A	60

Summary of ESB Requirements

- ESB boundary layers shall be continually updated as service areas change.

- ESB boundary layers shall completely fill the PSAP Boundary layer (no gaps and overlaps).
- Multiple ESB polygons representing a specific category of emergency responders such as Fire Response that falls within the PSAP Boundary.
- A geographic location (civic address or coordinate) must only have one designated primary Emergency Service Provider category such as Fire Response.

7.2 Strongly Recommended files

Street Alias

Descriptive Name	Field Name	M/C/O	Type	Field Width
Source of Data	Source	M	A	75
Date Updated	DateUpdate	M	D	20
Effective Date	Effective	O	D	20
Expiration Date	Expire	O	D	20
Alias Street Name NENA Globally Unique ID	ASt_NGUID	M	A	100
Road Centerline NENA Globally Unique ID	RCL_NGUID	M	A	100
Alias Street Name Pre Modifier	ASt_PreMod	C	A	15
Alias Street Name Pre Directional	ASt_PreDir	C	A	9
Alias Street Name Pre Type	AStPreType	C	A	25
Alias Street Name Pre Type Separator	ASt_PreSep	C	A	20
Alias Street Name	ASt_Name	M	A	60
Alias Street Name Post Type	AStPosType	C	A	15
Alias Street Name Post Directional	ASt_PosDir	C	A	9
Alias Street Name Post Modifier	ASt_PosMod	C	A	25
Alias Legacy Street Name Pre Directional[1]	ALStPreDir	C	A	2
Alias Legacy Street Name[1]	ALStName	C	A	75
Alias Legacy Street Name Type[1]	ALStType	C	A	5
Alias Legacy Street Name Post Directional[1]	ALStPosDir	C	A	2

The recorded legal road name as assigned by the local addressing authority should be the name used in the Road Centerlines. However, many roads are known by more than the legal road name, and these are known as alias road names. Regardless of how road name aliases are represented in a local GIS system, it must be convertible to the form used by the SIF in 08-003.

Alias road names are common and must be considered. Examples include when a state route or state highway crosses into a city jurisdiction, when several roads “merge” to traverse the same road pavement, or when honorary names are given to previously named and addressed roads. There are many other instances of alias road names.

Agencies may need to accommodate for alias road names during the location validation and call routing process, call handling, and data sharing. To ensure proper civic location validation by the LVF and proper routing by the ECRF, a standardized method of maintaining alias road names is required. The use of this Road Name Alias Table will facilitate the sharing of data in a consistent manner by various local 9-1-1 Authorities.

See NENA Standard for NG9-1-1 GIS Data Model for further information.

Site Structure / Address Points

Descriptive Name	Field Name	M/C/O	Type	Field Width
Source of Data	Source	M	A	75
Date Updated	DateUpdate	M	D	20

Effective Date	Effective	O	D	20
Expiration Date	Expire	O	D	20
Site NENA Globally Unique ID	Site_NGUID	M	A	100
Country	Country	M	A	2
State	State	M	A	2
County	County	M	A	40
Additional Code	AddCode	C	A	6
Additional Data URI	AddDataURI	C	A	254
Incorporated Municipality	Inc_Muni	M	A	100
Unincorporated Community	Uninc_Comm	O	A	100
Neighborhood Community	Nbrhd_Comm	O	A	100
Address Number Prefix	AddNum_Pre	C	A	15
Address Number	Add_Number	C	N	6
Address Number Suffix	AddNum_Suf	C	A	15
Street Name Pre Modifier	St_PreMod	C	A	15
Street Name Pre Directional	St_PreDir	C	A	9
Street Name Pre Type	St_PreTyp	C	A	25
Street Name Pre Type Separator	St_PreSep	C	A	20
Street Name	StreetName	C	A	60
Street Name Post Type	St_PosTyp	C	A	15
Street Name Post Directional	St_PosDir	C	A	9
Street Name Post Modifier	St_PosMod	C	A	25
Legacy Street Name Pre Directional[1]	LSt_PreDir	C	A	2
Legacy Street Name[1]	LSt_Name	C	A	75
Legacy Street Name Type[1]	LSt_Type	C	A	5
Legacy Street Name Post Directional[1]	LStPostDir	C	A	2
ESN[1]	ESN	C	A	5
MSAG Community Name[1]	MSAGComm	C	A	30
Postal Community Name	Post_Comm	C	A	40
Postal Code	Post_Code	C	A	7
ZIP Plus 4	Post_Code4	O	A	4
Building	Building	O	A	75
Floor	Floor	O	A	75
Unit	Unit	O	A	75
Room	Room	O	A	75
Seat	Seat	O	A	75
Additional Location Information	Addtl_Loc	O	A	225
Complete Landmark Name	LandmkName	C	A	150

Mile Post	Mile_Post	C	A	150
Place Type	Place_Type	O	A	50
Placement Method	Placement	O	A	25
Longitude	Long	O	F	-
Latitude	Lat	O	F	-
Elevation	Elev	O	N	6

Site/structure address points ideally represent the location of the site or a structure or the location of access to a site or structure. Site/structure address points can also represent landmarks. The *NENA Information Document for Development of Site/ Structure Address Point GIS Data for 9-1-1 (NENA-INF*-014.1-2015) is an informational document to assist in site structure address point placement which should be referenced in the development of a site/structure address point layer.

It is strongly recommended that agencies develop their SSAP for NG9-1-1 functionality.

Summary of SSAP Requirements

- SSAP shall be continually updated.
- SSAP shall, at a minimum, represent all public and private addressable structures.
- SSAP attributes shall be accurate, complete and standardized.
- Abbreviations of all Street Prefixes and Suffixes shall be incorporated according to NENA Standard. The abbreviations can be found in USPS Publication 28, Appendix B.

Landmarks

Descriptive Name	Field Name	M/C/O	Type	Field Width
Source of Data	Source	M	A	75
Date Updated	DateUpdate	M	D	20
Effective Date	Effective	O	D	20
Expiration Date	Expire	O	D	20
Landmark Name Part NENA Globally Unique ID	LMNP_NGUID	C	A	100
Site NENA Globally Unique ID	Site_NGUID	C	A	100
Alias Complete Landmark Name NENA Globally Unique ID	ACLMNNGUID	C	A	100
Landmark Name Part	LMNamePart	M	A	150
Landmark Name Part Order	LMNP_Order	M	N	1

Landmark Alias

Descriptive Name	Field Name	M/C/O	Type	Field Width
Source of Data	Source	M	A	75
Date Updated	DateUpdate	M	D	20
Effective Date	Effective	O	D	20
Expiration Date	Expire	O	D	20

Alias Complete Landmark Name Globally Unique ID	ACLMNNGUID	M	A	100
Site NENA Globally Unique ID	Site_NGUID	M	A	100
Alias Complete Landmark Name	ACLandmark	C	A	150

State boundaries

Descriptive Name	Field Name	M/C/O	Type	Field Width
Source of Data	Source	M	A	75
Date Updated	DateUpdate	M	D	20
Effective Date	Effective	O	D	20
Expiration Date	Expire	O	D	20
State NENA Globally Unique ID	StateNGUID	M	A	100
Country	Country	M	A	2
State	State	M	A	2

Summary of NG9-1-1 State Boundaries Requirements

- This layer already has a statewide, authoritative process and does not need to be duplicated. Suggest incorporating this reference as a bullet comment beneath table.

County boundaries

Descriptive Name	Field Name	M/C/O	Type	Field Width
Source of Data	Source	M	A	75
Date Updated	DateUpdate	M	D	20
Effective Date	Effective	O	D	20
Expiration Date	Expire	O	D	20
County NENA Globally Unique ID	CntyNGUID	M	A	100
Country	Country	M	A	2
State	State	M	A	2
County	County	M	A	75

Summary of NG9-1-1 County Boundaries Requirements

- This layer already has a statewide, authoritative process and does not need to be duplicated. Suggest incorporating this reference as a bullet comment beneath table.

Incorporated Municipal boundaries

Descriptive Name	Field Name	M/C/O	Type	Field Width
Source of Data	Source	M	A	75
Date Updated	DateUpdate	M	D	20
Effective Date	Effective	O	D	20
Expiration Date	Expire	O	D	20
Incorporated Municipality NENA Globally Unique ID	IncM_NGUID	M	A	100
Country	Country	M	A	2
State	State	M	A	2
County	County	M	A	75
Additional Code	AddCode	C	A	6
Incorporated Municipality	Inc_Muni	M	A	100

Summary of NG9-1-1 Municipal Boundaries Requirements

- This layer already has a statewide, authoritative process and does not need to be duplicated. Suggest incorporating this reference as a bullet comment beneath table.

Unincorporated Municipal boundaries

Descriptive Name	Field Name	M/C/O	Type	Field Width
Source of Data	Source	M	A	75
Date Updated	DateUpdate	M	D	20
Effective Date	Effective	O	D	20
Expiration Date	Expire	O	D	20
Unincorporated NENA Globally Unique ID	UnincNGUID	M	A	100
Country	Country	M	A	2
State	State	M	A	2
County	County	M	A	75
Additional Code	AddCode	C	A	6
Unincorporated Community	Uninc_Comm	M	A	100

Neighborhood boundaries

Descriptive Name	Field Name	M/C/O	Type	Field Width
Source of Data	Source	M	A	75
Date Updated	DateUpdate	M	D	20
Effective Date	Effective	O	D	20
Expiration Date	Expire	O	D	20

Neighborhood NENA Globally Unique ID	NbrhdNGUID	M	A	100
Country	Country	M	A	2
State	State	M	A	2
County	County	M	A	75
Additional Code	AddCode	C	A	6
Incorporated Municipality	Inc_Muni	M	A	100
Unincorporated Community	Uninc_Comm	C	A	100
Neighborhood Community	Nbrhd_Comm	M	A	100

7.3 Recommended files

Railroad Lines

Descriptive Name	Field Name	M/C/O	Type	Field Width
Source of Data	Source	M	A	75
Date Updated	DateUpdate	M	D	20
Rail Segment NENA Globally Unique ID	RS_NGUID	M	A	100
Rail Line Owner	RLOWN	C	A	100
Rail Line Operator	RLOP	C	A	100
Rail Line Name	RLNAME	O	A	100
Rail Mile Post Low	RMPL	O	F	-
Rail Mile Post High	RMPH	O	F	-

Hydrology lines

Descriptive Name	Field Name	M/C/O	Type	Field Width
Source of Data	Source	M	A	75
Date Updated	DateUpdate	M	D	20
Hydrology Segment NENA Globally Unique ID	HS_NGUID	M	A	100
Hydrology Segment Type	HS_Type	O	A	100
Hydrology Segment Name	HS_Name	O	A	100

Hydrology Polygon

Descriptive Name	Field Name	M/C/O	Type	Field Width
Source of Data	Source	M	A	75
Date Updated	DateUpdate	M	D	20
Hydrology Polygon NENA Globally Unique ID	HP_NGUID	M	A	100
Hydrology Polygon Type	HP_Type	O	A	100
Hydrology Polygon Name	HP_Name	O	A	100

Cell Site points

Descriptive Name	Field Name	M/C/O	Type	Field Width
Source of Data	Source	M	A	75
Date Updated	DateUpdate	M	D	20
Country	Country	M	A	2
State	State	M	A	2
County	County	M	A	75

Cell NENA Globally Unique ID	Cell_NGUID	M	A	100
Site ID	Site_ID	C	A	10
Sector ID	Sector_ID	M	A	4
Switch ID	Switch_ID	C	A	10
Market ID	CMarket_ID	C	A	10
Cell Site ID	CSite_Name	C	A	10
ESRD or First ESRK	ESRD_ESRK	C	N	10
Last ESRK	ESRK_Last	C	N	10
Sector Orientation	CSctr_Ornt	M	A	4
Technology	Technology	M	A	10

Mile markers

Descriptive Name	Field Name	M/C/O	Type	Field Width
Source of Data	Source	M	A	75
Date Updated	DateUpdate	M	D	20
Mile Post NENA Globally Unique ID	MileMNGUID	M	N	100
Mile Post Unit of Measurement	MileM_Unit	C	A	15
Mile Post Measurement Value	MileMValue	M	F	-
Mile Post Route Name	MileM_Rte	M	A	100
Mile Post Type	MileM_Type	C	A	15
Mile Post Indicator	MileM_Ind	M	A	1

8.0 Appendix B

8.1 Standards reference

DATA STRUCTURES DOCUMENTS (including NG9-1-1)		
02-010	Standard Legacy Data Formats For 9-1-1 Data Exchange GIS Mapping	2011/03/28
02-501	Wireless (Pre-XML) Static and Dynamic ALI Data Content Information Document	2006/10/16
02-503	XML Namespaces Information Document	2007/02/23
04-005	ALI Query Service Standard	2006/11/21
71-001	NG9-1-1 Additional Data Standard	2009/09/17
NENA-STA-004.1-2014	NENA Next Generation United States Civic Location Data Exchange Format (CLDXF)	2014/03/23
NENA-STA-008.2-2014 (originally 70-001)	NENA Registry System (NRS) Standard	2014/10/06
NENA/APCO-INF-005	NENA/APCO Emergency Incident Data Document (EIDD) Information Document	2014/02/21
DATA MANAGEMENT DOCUMENT (including NG9-1-1)		
02-011	Data Standards For Local Exchange Carriers, ALI Service Providers & 9-1-1 Jurisdictions	2012/05/12
02-013	Data Standards for the Provisioning and Maintenance of MSAG Files to VDBs and ERDBs	2008/06/07 Reviewed 9/12/2014
02-014	GIS Data Collection and Maintenance Standards	2007/06/17
02-015	Standard for Reporting and Resolving ANI/ALI Discrepancies and No Records Found for Wireline, Wireless and VoIP Technologies	2009/06/06
02-502	NENA Company ID Registration Service Information Document	2008/11/12

06-001	Standards for Local Service Provider Interconnection Information Sharing	2004/08/01
71-501	Synchronizing Geographic Information System Databases with MSAG & ALI Information Document	2009/09/08
71-502	An Overview of Policy Rules for Call Routing and Handling in NG9-1-1 Information Document	2010/08/24
NENA-INF-011.1-2014	NENA NG9-1-1 Policy Routing Rules Operations Guide	2014/10/06
NENA-INF-014.1-2015	NENA Information Document for Development of Site/Structure Address Point GIS Data for 9-1-1	2015/09/18
NENA-STA-003.1.1-2014	NENA Standard for NG9-1-1 Policy Routing Rules	2014/12/01
NENA-REQ-002.1-2016	NENA Next Generation 9-1-1 Data Management Requirements	2016/03/10
NG9-1-1 TRANSITION PLANNING DOCUMENTS		
NENA-INF-008.2-2014 (originally 77-501)	NG9-1-1 Transition Plan Considerations Information Document	2013/11/20
SECURITY DOCUMENTS		
04-503	Network/System Access Security Information Document	2005/12/01
75-001	Security for Next-Generation 9-1-1 Standard	2010/02/06
75-502	Next Generation 9-1-1 Security Audit Checklist Information Document	2011/12/14
VOICE OVER INTERNET PROTOCOL (VoIP) DOCUMENTS		
08-001	Interim VoIP Architecture for Enhanced 9-1-1 Services (i2) Standard	201008/11

08-503	VoIP Characteristics Information Document	2004/06/10
08-504	VoIP Standards Development Organization Information Document	2004/06/08
57-503	Procedures for Notification of ERDB & VPC Operators of ESN Changes by 9-1-1 Administrator Information Document	2008/01/08
58-502	VoIP Funding and Regulatory Issues Information Document	2006/06/06
NEXT GENERATION 9-1-1 (NG9-1-1) DOCUMENTS		
08-002	Functional and Interface Standards for Next Generation 9-1-1 Version	2007/12/18
08-003	Detailed Functional and Interface Standards for the NENA i3 Solution	2011/06/14
08-501	Interface between the E9-1-1 Service Provider Network and the Internet Protocol (IP) PSAP Information Document	2004/06/15
08-505	Methods for Location Determination to Support IP-Based Emergency Services Information Document	2006/12/21
08-506	Emergency Services IP Network Design for NG9-1-1 Information Document	2011/12/14
08-751	NENA i3 Requirements Document	2006/09/28
08-752	Location Information to Support IP-Based Emergency Services Requirements Document	2006/12/21
57-750	NG9-1-1 System and PSAP Operational Features and Capabilities Requirements Document	2011/06/14
NENA-INF-003.1-2013	Potential Points of Demarcation in NG9-1-1 Networks Information Document	2013/03/21
NENA-INF-006.1-2014	NG9-1-1 Planning Guidelines Information Document	2014/01/08
NENA-INF-009.1-2014	Requirements for a National Forest Guide Information Document	2014/08/14
NENA/APCO-REQ-001.1.1-2016	NENA/APCO NG9-1-1 PSAP Requirements Document	2016/01/15

WIRELESS 9-1-1 INTEGRATION DOCUMENTS		
57-001	Wireless E9-1-1 Overflow, Default and Diverse Routing Standard & A PSAP Managers' Guide to GIS & Wireless 9-1-1	2004/11/18
57-002	E9-1-1 Wireless Maintenance Call Routing & Testing Validation Standard including Call Routing & Testing Validation Worksheet & Sample Non-Disclosure Agreement	2007/06/09