

NENA Information Document for GIS Data Stewardship for Next Generation 9-1-1 (NG9-1-1)

Abstract: This document provides guidance to aid the development of complete, accurate, and current GIS data layers to be used within NG9-1-1 systems.



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1 Executive Overview

This document will assist Geographic Information Systems (GIS) and Public Safety Answering Point (PSAP) staff in understanding and adopting best practices related to managing specific GIS data layers in support of Next Generation 9-1-1 (NG9-1-1) deployments. GIS data are at the heart of NG9-1-1 systems. Civic addresses associated with fixed caller locations are validated against GIS data to ensure that they can be mapped. When an emergency call is made, it is routed using the caller's location along with the GIS boundaries of responder agencies to determine the correct responder.

A program of GIS Data Stewardship is not limited to the initial creation of data – it involves regular access to tabular inputs such as civic addresses and regular maintenance of spatial data such as service boundaries and road centerlines. Ensuring that data used by the NG9-1-1 system are complete, accurate, and current may require cooperation between multiple data contributors and stakeholder agencies. A comprehensive data management approach includes not only continual data input and maintenance but also on-going communication between stakeholders, internal quality assurance, quality control, dealing with external discrepancy reports, and archiving data.

The Next Generation Core Services (NGCS) that validate addresses and route calls in NG9-1-1 systems are the Location Validation Function (LVF) and the Emergency Call Routing Function (ECRF), respectively. The technical requirements and detailed operation of these services, within the overall NG9-1-1 architecture, are specified in NENA documents referenced in the following sections. These services use GIS data to validate civic locations associated with caller locations and spatial queries to direct actual calls to the correct responding NG9-1-1 PSAP (henceforth known as PSAP). Subsequent versions of this document will consider additional GIS data layers used in the operation of the LVF and ECRF. A complete listing of GIS data layers required or suggested for NG9-1-1 operation can be found in the NENA Standard for NG9-1-1 GIS Data Model, NENA-STA-006.2-2022 [2]. GIS data requirements are subject to change, and consultation of all current NENA standards and requirements is recommended.

The considerations of GIS data stewardship in this document will include:

- datasets needed and how they are used (summarized from other NENA documents)
- quality measures such as completeness, accuracy, and topological consistency
- a need for coordination and best practices for data exchange
- recommendations and guidelines for managing NG9-1-1 layers
- specific recommendations for creation and maintenance of service boundary layers
- specific recommendations for creation and maintenance of civic location layers

The latter part of the document will present a phased approach that incrementally refines and improves GIS data in concert with NG9-1-1 project milestones. Following the

recommendations presented will result in more accurate, efficient, and reliable operation of GIS data-dependent services within NG9-1-1 Systems.

This version of the document provides guidance on the Service Boundaries for PSAPs (PSAP), Service Boundaries for response agencies (Police, Fire, Emergency Medical Service, others), and Road Centerlines (RCL) GIS data layers. Other layers such as Site/Structure Address Points (SSAP) will be covered in a future version of this document.

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2 Document Conventions

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2.2 Reason for Issue/Reissue

NENA reserves the right to modify this document. Upon revision, the reason(s) will be provided in the table below.

Document Number	Approval Date	Reason For Issue/Reissue
NENA-INF-028.1-2020	January 1, 2020	Initial Document
NENA-INF-028.2-2023	September 20, 2023	Addition of stewardship guidance for Service Boundaries and Road Centerlines.

3 Stewardship of GIS data used by the LVF and ECRF

This document presents best practices and recommendations for creating and maintaining GIS data layers that are used in Next Generation Core Services (NGCS). Specifically, this document will focus on the GIS data layers that are used by two core services – the Location Validation Function (LVF) and the Emergency Call Routing Function (ECRF). The LVF validates civic locations so potential call routing issues can be resolved prior to a 9-1-1 call. The ECRF provides information about responder agencies and uses location information to route the initial 9-1-1 call to the correct PSAP. Even though they are described as different functions, the ECRF and LVF are identical Location to Service Translation (LoST) servers. They have the same interfaces and are identically provisioned. The LVF typically validates the location presented if requested. The ECRF always returns a route for a query; therefore, Service Boundaries, as defined by the NENA Standard for NG9-1-1 GIS Data Model, NENA-STA-006.2-2022 [2], are needed for the route. The main difference between the ECRF and the LVF is that the LVF is not real-time and is used before a call and the ECRF is used during the processing of an emergency call in real-time.

The spatial queries performed by the LVF and ECRF are different from the tabular queries used by Enhanced 9-1-1 (E9-1-1) for call validation and routing. For these spatial queries to work as intended, it is critical to correctly develop and populate the required GIS data layers and to ensure the desired topological relationships between these layers are maintained. This is a change from how location validation and call routing work in E9-1-1. E9-1-1 makes use of tabular databases to validate and route calls whereas NG9-1-1 makes use of GIS data and spatial queries. To effectively develop, support, and maintain GIS data for NG9-1-1, it is important to understand how it will be used to validate civic locations and geospatially route calls.

To support information exchange in i3 NG9-1-1 systems, location information is represented in the Internet Engineering Task Force (IETF) Presence Information Data Format – Location Object (PIDF-LO) format. Both the LVF and ECRF receive location queries using PIDF-LO.

Note: This document builds heavily upon the NENA Standards for the Provisioning and Maintenance of GIS data to ECRF and LVFs, NENA-STA-005.1.2-2022 [3], and the NG9-1-1 GIS Data Model, NENA-STA-006.2-2022 [2]. It provides applicable guidance to support the implementation of both these standards. GIS data requirements are subject to change, and consultation of current, applicable NENA standards and requirements is recommended.

Nomenclature clarification: The original NENA Standard for NG9-1-1 GIS Data Model, NENA-STA-006.1 makes reference to a “PSAP Boundary” and “Emergency Service Boundaries,” however, Appendix B of the NENA i3 Standard for Next Generation 9-1-1, NENA-STA-010.3-2021 [4] refers to these boundaries more generically as “Service Boundaries.” Version 2 of the NENA Standard for NG9-1-1 GIS Data Model, NENA-STA-006.2-2022 [2], dropped “Emergency” references and now aligns with the

Service Boundaries terminology. This document makes general reference to Service Boundaries to indicate both the Service Boundaries that represent PSAPs and Service Boundaries that represent response agencies. In areas where a distinction needs to be made to add clarity to text there are references to “Service Boundaries for PSAPs” and “Service Boundaries for response agencies,” these references may be singular or plural based on the context of the text.

The process of creating and refining Service Boundaries for PSAPs may differ from that of the boundaries for the responding agencies such as Fire, Police, Emergency Medical Service (EMS), Coast Guard, Towing, Poison Control, etc. Therefore, Section 6.7.1 First Phase – Initial Service Boundary has been separated into distinct sections reflecting considerations for PSAPs and considerations for response agencies.

This version of the document provides guidance on the following GIS data layers (other layers will be covered in a future version of this document):

- Section 5 Civic Location Layers
 - Section 5.1 Road Centerlines
- Section 6 Service Boundary Layers
 - Section 6.2 Service Boundaries for PSAPs
 - Section 6.3 Service Boundaries for response agencies (Police, Fire, EMS, and others)

3.1 Coordination Roles and Responsibilities

Entities involved in GIS data creation and maintenance must collaborate with the 9-1-1 Authority on what data source(s) will be considered authoritative and the workflows used in Spatial Interface (SI) provisioning. Authoritative data sources are those agencies whose day-to-day operations and official decisions determine the content of the Service Boundaries and civic location data that will be provided to the SI. Since there may be multiple data sources, it is essential to spell out what rules and policies will govern the compilation, creation, and ongoing edits to the GIS data. 9-1-1 Authorities are by definition the authoritative sources for PSAP boundaries used by LVF and ECRF. Agencies other than the 9-1-1 Authority may be responsible for creating and maintaining other service area boundary types, such as police, fire, medical, poison control, Coast Guard, animal control, etc., and for provisioning this data to the LVF and ECRF.

Local government departments will generally be the authorities for address number assignment, street naming, and the mapping of place name boundaries and road rights of way. Since Service Boundaries may not always represent political jurisdictions and often aggregate multiple jurisdictions, there may be more than one data source within a given PSAP service area. The extent of jurisdiction for each data source needs to be carefully delineated. Ultimately, the 9-1-1 Authority determines which source(s) of GIS data are considered authoritative and should be provisioned to the LVF and ECRF.

3.1.1 GIS Data Provider

A GIS Data Provider creates and maintains GIS data provisioned to the SI based on agreed upon rules and policies. A GIS Data Provider may create and maintain the original source data and/or aggregate source data from multiple GIS data sources into a NENA standards compliant format. If there are multiple candidate sources of civic location and address data within the same area, the GIS Data Provider must work with the 9-1-1 Authority to determine the appropriate GIS data source(s). For a given data layer, the GIS Data Provider is responsible for maintaining consistency between all data sources and the GIS data provided to the SI. A GIS Data Provider may provide civic location data for all or only a portion of the Service Boundary area. Each GIS Data Provider is responsible for performing quality control checks on the data within their area and ensuring that it conforms to NENA standards. Data from a GIS Data Provider should be delivered in final form, ready for use within the LVF and the ECRF.

3.1.2 9-1-1 Authority

A 9-1-1 Authority is a State, County, Regional, Tribal, or other governmental entity responsible for 9-1-1 service operations in a given area. A 9-1-1 Authority may be composed of one or more PSAPs. The 9-1-1 Authority may assume the role of GIS Data Provider for the service area boundary, or it may delegate that function to another entity. Similarly, for civic location data, the 9-1-1 Authority may work with multiple GIS data sources within its service area to create and maintain civic location layers, or it may designate one or more GIS Data Providers and specify the provisioning area for which each is responsible.

In situations where there are multiple GIS Data Providers, as for example where local data are aggregated to a regional or statewide service area, the 9-1-1 Authority needs to specify exactly how and by whom local data will be reviewed and edge-matched. Additionally, they will need to specify how boundary issues are resolved and how final quality control measures are performed before the data are provided to the SI. For example, the 9-1-1 Authority may determine that data must be returned to the original GIS Data Provider for review and correction if edits are needed, or the 9-1-1 Authority may assign the responsibility for reviewing data and making corrections over the entire service area to one of several GIS Data Providers.

In all cases where multiple GIS data layers are being aggregated by a higher-level agency or a third party, an agreement with the GIS Data Provider(s) and 9-1-1 Authority is recommended. The agreement should define who is authorized to edit the GIS data, identify types of changes allowed by each entity, and outline the process to notify each party when changes are implemented. All discrepancy reports resulting from NG9-1-1 system operations should be communicated by the system operator to the entity designated by the 9-1-1 Authority to resolve discrepancies for a given provisioning area or service area. Best practice requires that any edits not performed by the original GIS Data

Provider are done in consultation with, and transmitted back to, the original GIS Data Provider to ensure data consistency.

3.2 Aggregation of NG9-1-1 GIS Data Layers to Regional or Statewide Dataset(s)

If every GIS Data Provider across a state or region creates and maintains their own civic location and service boundary layers independent of neighboring GIS Data Providers, it will create several challenges. One way to overcome these challenges is to aggregate the layers to regional or statewide datasets. By having aggregated layers, it can enable the following across a region or an entire state:

- Improves database integrity across a state or region by having a common schema
- Ensures a common coordinate system within the state prior to providing the layer to the NGCS
- Enables the creation and application of consistent topology rules across the aggregated dataset
- Facilitates resolution of topology-related issues, especially gaps or overlaps between neighboring features
- Provides a single reference that could be used to coordinate NG9-1-1 GIS data layers along state or international borders
- Creates a common layer that can be used to support interaction with one or more NG9-1-1 service providers within the state
- Provides a common dataset that can be used to engage a neutral third party to help with NG9-1-1 GIS data layer reconciliation

The absence of regional or statewide layers will increase the coordination role for 9-1-1 Authorities and require each authority to determine with each of their neighbors how to coordinate and resolve issues with NG9-1-1 layers. Additionally, the absence of regional or statewide datasets will make it more difficult to determine the status of NG9-1-1 GIS data layer development both within a region, or a state, and nationwide.

3.3 GIS Data Synchronization

NENA NG9-1-1 Transition Plan Considerations Information Document, NENA-INF-008.2-2013 [5], provides guidance for NG9-1-1 transition planning. Included in this document are database transition considerations that provide recommended next steps. One of the most important steps to preparing GIS data for NG9-1-1 is the process of data synchronization, where the GIS data is compared against E9-1-1 tabular data. Changes should be made to one or both datasets so that attribution in each matches the other. This data synchronization serves as a bridge between the databases used for E9-1-1

and those used for NG9-1-1 by verifying that important Master Street Address Guide (MSAG) and Automatic Location Identification (ALI) legacy information is appropriately represented in new NG9-1-1 GIS data. As stated in the Executive Overview of the NENA NG9-1-1 Transition Plan Considerations Information Document [5], "If an Authority that provides GIS data for 9-1-1 use has not performed this reconciliation work it should take up the task at the earliest opportunity as such reconciliation is viewed as a first step in NG9-1-1 data transition." Failure to complete this step will be costly both in time and resources, and will ultimately delay the development of GIS data that will be migrated towards NG9-1-1.

3.3.1 Topology

Topology describes the spatial relationships between GIS features (e.g., road centerlines within Service Boundaries) and must be considered when developing or maintaining NG9-1-1 GIS data layers. When a specific relationship between features is desired, topology rules need to be developed to enforce that relationship.

For example, when a spatial query is performed to determine which PSAP should receive a call, only one PSAP should be returned for any given location. In this example, to ensure this desired behavior, topology rules should be created stating that GIS features in the PSAP service area boundary layer should not overlap and there should be no gaps between PSAP service areas. For more information on gaps and overlaps in Service Boundary for PSAP layers, refer to Section 6.4.1 No Gaps or Overlaps.

3.3.2 Snap-to-Points

Snap-to-points (also known as "anchor points," "agreement points," "stitch points," "edge-match points," etc.) are points that represent where data from one GIS Data Provider ends and another begins. The establishment of these points will provide a location to which disparate GIS data layers can be snapped together (e.g., end nodes of two road centerlines coming together at a boundary line). This ensures coincidence and edge matching across borders and between GIS data layers. These are not points representing formal or legal boundaries but instead represent an agreed upon location for data maintenance purposes only.

For example, if there is a road centerline that crosses a Service Boundary for PSAP without being split, it will be difficult to ensure that the geocoded address will be routed to the correct PSAP. Therefore, it is necessary to split road centerlines at the boundary. If the Service Boundary for PSAP needs to be adjusted along a road centerline, it is recommended that the snap-to-points be adjusted before editing the related GIS data layers. These best practices may also apply to other relevant boundaries.

The creation of snap-to-points can serve as a focal point for facilitating maintenance discussions along these boundaries.

4 General Requirements Common to all NG9-1-1 GIS Data Layers

While methodologies for GIS data development vary by jurisdiction, NENA has established standards for NG9-1-1 GIS data, so that there are several characteristics that are common to all NG9-1-1 GIS data layers. These include the following:

4.1 Use of Coordinate Systems Within NG9-1-1 Systems

Per the NENA i3 Standard for NG9-1-1 [4], all GIS data that exists within NGCS MUST be in World Geodetic System of 1984 (WGS84) (EPSG:4326). While the local GIS data may be kept in any geographic or projected coordinate system, it MUST be able to be transformed into WGS84, either by the GIS Data Provider or the SI provider.

If reprojection into WGS84 is required, it is likely to introduce error. Choosing a locally appropriate transformation process will minimize error and reduce the chance of creating unintended overlaps and gaps. The transformation process will vary depending on the native projection and the GIS software used for data development and maintenance. Advice from a geodesist, registered surveyor, or the SI provider is recommended for minimization of transformation errors.

Note that the National Oceanic and Atmospheric Administration's (NOAA) National Geodetic Survey provides the framework for all positioning activities in the United States. NOAA, as of this writing, has new datum work underway that will likely replace NAVD88 and NAD83, due for release sometime after 2022. GIS data providers maintaining their GIS data in datums other than WGS84 are encouraged to reference the NOAA web site [6] on this subject for more information, as well as transformation tools that can be utilized to perform this work with the least amount of introduced error.

4.2 NENA Globally Unique IDs (NGUID)

Per the NG9-1-1 GIS Data Model [2], every feature in each GIS data layer must be assigned a NENA Globally Unique Identifier (NGUID). The NGUID differs from other unique identifiers as it is designed to completely differentiate each feature submitted by a GIS Data Provider from any other feature that could exist within a consolidated nationwide GIS dataset. The NGUID is comprised of multiple elements. Please reference the latest NG9-1-1 GIS Data Model [2] for further guidance on how the elements that make up the NGUID are defined and prescribed. The element of the NGUID that is dependent on the GIS Data Provider creation and maintenance is the Local Unique ID. The combination of the Local Unique ID with the rest of the elements that construct the NGUID, provides a unique NGUID when multiple GIS Data Provider submissions are aggregated.

4.2.1 Local Unique ID

A unique ID is an independent attribute created and maintained by the GIS Data Provider used to uniquely identify a specific record in a database. The GIS Data Provider generates a locally assigned ID, which can be numeric and/or text. This local ID MUST be unique

within the GIS Data Provider's dataset for all features associated with a specific Agency Identifier. The process to generate this ID can be manual or automatic.

Note: When developing a method to create the Local Unique ID, it is a good idea to document the method used within the metadata. Documenting within the metadata ensures that the process can be consistently followed without having to solely rely upon institutional knowledge of how the Local Unique ID was developed for the data layer.

4.2.2 Creation and Maintenance of NGUIDs

NGUID creation and maintenance should be a coordinated and documented process between all parties involved. It is important to note that the NGUID maintenance process may differ based on GIS data workflows within various levels of the GIS data maintenance hierarchy (for example: city, county, regional, or statewide data aggregation). The NGUID may not need to be maintained at the most local level, but may be managed at a larger, aggregating level.

A stable and persistent local unique ID is strongly recommended as it serves as the basis for NGUID creation regardless of the level at which the NGUID is maintained. A persistent local unique ID supports tracking errors and discrepancies back to their source. Caution should be used when using an automatically generated unique ID, as those are not always persistent.

4.3 Accuracy and Precision

4.3.1 Horizontal Accuracy

The horizontal accuracy of GIS data layers SHOULD meet the National Spatial Data Infrastructure's "National Standard for Spatial Data Accuracy" at a scale of 1:5000. This equates to a horizontal accuracy of +/- 13.89 feet at 95% confidence.

Where the GIS represents area features or legal boundaries with a point (such as a centroid for a building footprint or parcel) this standard is not applicable, but the GIS feature SHOULD fall within the corresponding area or boundary.

Note: The area represented by site/structure address points can vary greatly in size. Consequently, they should be considered accurate if they fall within the polygon or area uniquely identified by that address (see NENA Information Document for Development of Site/Structure Address Point GIS Data for 9-1-1, NENA-INF-014.1-2015 [7]).

4.3.2 Vertical Accuracy

Based on evolving standards, regulations, and technological capabilities, it can be expected that it will become increasingly frequent that accurate vertical/elevation information will be arriving to PSAPs regarding where a call originated. It will be equally important for GIS professionals to incorporate vertical data and accuracy requirements into datasets used to support NG9-1-1.

Note: Vertical accuracy guidelines for GIS data will be added to a future version of this document.

4.3.3 GIS Database Precision

GIS database precision relates to spatial reference and refers to the number of significant digits used to store spatial coordinates within a GIS database. Coordinate values for GIS features are stored with a level of precision that is set within the GIS database.

When merging data from different GIS databases, differences in the precision value of the GIS databases may create slivers and gaps when consolidating the data into the LVF and ECRF. Currently, NENA has not established a standard for GIS database precision.

Note: GIS Database Precision has been recommended for Additional Development Work from a NENA Standard. Please see Section 8.4 Recommendation for Additional Development Work.

4.4 Metadata

As defined in the NG9-1-1 GIS Data Model [2]:

“Metadata is a file of information that captures the basic characteristics of the data and information resource. It represents *who, what, when, where, why, and how* of the resource. Metadata is strongly recommended to be included and available for each GIS data layer described in this document.”

When maintaining metadata, it is important to document any limitations or constraints of the data including but not limited to the intended use of the data and completeness of the layer. NENA strongly recommends that metadata is developed and maintained for NG9-1-1 GIS data layers. Additionally, state and/or local laws, and agency or provider requirements may include compliance with specific metadata standards and formats.

Although many of the fields within NG9-1-1 GIS data layers have descriptive or self-documenting attributes, it is important that the origination and/or stewardship level of GIS data layers can be determined from an overview snapshot of metadata. As GIS data layers are regionalized or combined, metadata should be updated to reflect the respective level of collection while the contributing GIS data layers are archived, ensuring specific contact information for each data layer remains available to and through the aggregator.

Recommended minimum metadata for NG9-1-1 GIS data layers would include at least the following categories:

Dataset Description: Abstract and Purpose

Date Updated: Calendar date of the last time changes were made to the data (i.e., YYYYMMDD)

Point of Contact: Person, Position, Organization, Mailing Address, and Telephone Number

Data Credits: Project, Group, Organization, or Funding Source

Original Data Collection and Digitization: Datum, Coordinate System, Projection, and Accuracy (if known)

Metadata Reference Information: Metadata Date, Metadata Contact, Metadata Standard Name, and Metadata Standard Version

For additional information, please refer to the metadata standard that you are implementing and requirements of your NGCS Provider.

Additional references pertaining to metadata are available at the Federal Geographic Data Committee website [8] [9] and the International Standards Organization website [10].

Note: Metadata can be maintained at both the layer/table level and at the feature/record level. Record level metadata can be very time consuming and expensive to maintain in large sets of dynamic data. However, in some cases metadata for each individual record can be very valuable, such as when many records are aggregated together from a variety of sources. Jurisdictions will need to determine the level of metadata to be maintained on a case-by-case basis, balancing the benefits versus resources required.

Collecting feature/record level metadata for individual lines that make up a polygon boundary file can be a challenge. A useful practice in the development, maintenance, and data aggregation of boundaries between jurisdictions is to maintain a line layer that represents the edge of each individual boundary feature. This layer can then be used as the source to create a final Service Boundary polygon. This best practice allows source metadata to be stored at the feature/record level for the boundary. A field that documents the source for each edge can then be maintained. Examples of sources for edges include: jurisdictional boundaries such as municipal boundaries; public land survey system; ownership parcels; addressed or unaddressed roads; water features; other administrative boundaries, etc.

5 Civic Location Layers

Note: The content in this section primarily contains material pertaining to the RCL layer. Guidance regarding the SSAP layer will be developed for a future version of this document; in the meantime, see the NENA Information Document for Development of Site/Structure Address Point GIS Data for 9-1-1 [7].

Civic location features represent physical street addresses and/or landmarks using points, lines, or polygons. When a query involving a civic address is made to the LVF or ECRF, an attempt is made to match the address as provided by an Originating Service Provider with a corresponding location based on the address attributes in the GIS data layers. Examples of civic location layers include RCL and SSAP.

The NENA Standards for the Provisioning and Maintenance of GIS data to ECRF and LVFs [3] requires that LVF and ECRF providers handle any combination of civic location geometry types including points, lines, and polygons. The NG9-1-1 GIS Data Model [2] has developed content and format requirements for the RCL and SSAP layers, as they are the most commonly used civic location layers. Future versions of that standard may incorporate other geometry types. The 9-1-1 Authority, with input from their NGCS Provider, will determine which layer(s) are most suitable for representing civic locations in the LVF and ECRF.

Note: While civic location layers that are typically available today may be adequate for use in the LVF and ECRF, NENA's long-range vision expects the evolution of GIS data towards greater accuracy and precision. As such, it is recommended that 9-1-1 Authorities and GIS Data Providers consult the NENA Standards for the Provisioning and Maintenance of GIS data to ECRF and LVFs [3], Section 4.6 GIS Data Recommendations, Tradeoffs, and NENA Long Range Vision. As additional guidance is developed, GIS Data Providers will need to remain aware of these potential enhancements and/or changes which may include 3D location support for NG9-1-1 call routing and sub-parcel and sub-address polygon support for building, floor, suite, room, etc.

5.1 Road Centerlines

5.1.1 Description

A line that represents the center of a road, with attributes attached to it, for the purpose of locating a civic address along its length through the process of geocoding.

5.1.2 Purpose

This layer is used by the LVF to validate a civic address and is also used by the ECRF to perform a geographic query, for a civic location, against Service Boundaries to determine to which PSAP an emergency request is routed and which emergency responders are applicable. An emergency call is routed within the i3 core elements based upon its geographic location, provided either as a civic address or as a geodetic location, as defined in the NENA i3 Standard for NG9-1-1 [4].

5.1.3 Intended Use

From a practical standpoint, the RCL layer should reflect the geographic extent of roads, but not necessarily the actual width, for which a PSAP has 9-1-1 emergency request responsibility. Defining and agreeing on the location and connectivity of road centerlines between jurisdictions could be challenging and may require the cooperation of PSAP Authorities and other local agencies. In addition, attributes of road centerlines must be current, accurate, and suitable for geocoding.

When site/structure address points are unavailable, the primary usages for road centerlines are to support:

1. The Location Validation Function, which provides a civic address “validation service in an NG9-1-1 system and is the logical equivalent of the ALI using the MSAG to validate” (as stated in the NENA Information Document for Location Validation Function Consistency, NENA-INF-027.1-2018 [11]), and
2. The Emergency Call Routing Function, which interpolates the location of a civic address along a road centerline that is then intersected with Service Boundaries that recommend which PSAP to route a call and which agencies provide a response service to that location.

In NG9-1-1, road centerlines will be provisioned by the SI to the ECRF and LVF.

5.2 Civic Location Layers Requirements

RCL and SSAP layers are required as specified in the NG9-1-1 GIS Data Model [2]. Site/structure address points are essential for those areas where the RCL layer is incapable of providing location validation accurately. Jurisdictions should plan on developing a complete SSAP layer if they do not already have one. After RCL and SSAP layer synchronization with the MSAG and ALI database (see Section 5.5.2 Second Phase – Modify and Refine the Civic Location Layers), the RCL and SSAP layers should allow for verification of all addresses that were validated by the MSAG. The appropriate attributes need to be fully spelled out according to the requirements of the NENA Next Generation 9-1-1 (NG9-1-1) United States Civic Location Data Exchange Format (CLDXF) Standard, NENA-STA-004.1.1-2015 [12], before upload to the NGCS databases. For more information regarding the SSAP layer, see the NENA Information Document for Development of Site/Structure Address Point GIS Data for 9-1-1 [7].

5.3 Considerations When Developing Civic Location Layers

Civic location layers are used throughout government organizations to support the many needs of the public. Therefore, when creating and maintaining civic location layers, there are several concepts to keep in mind when attempting to meet all business needs of these required NG9-1-1 data layers. For the purposes of this document their primary role, as noted throughout, is for NG9-1-1 location validation by the LVF and call routing determination by the ECRF. However, the same data used for call routing and location validation can and likely should also be used for other purposes to mitigate conflicts between the 9-1-1 system and the PSAP’s ancillary systems.

Considerations for RCL data from other systems:

- **Computer Aided Dispatch (CAD)** – These systems will add additional concerns as to where road centerlines should be split, as well as the extent to which additional attribution may be required by a given CAD (e.g., one-ways or speed limits). Road centerlines already created for use in a CAD system may meet or exceed the basic requirements of an LVF or ECRF.

- **Mapped ALI Displays** – Road centerlines are used for mapping the 9-1-1 caller's location and, in some cases, to determine proper emergency response. Dependent on the quality and completeness of the dataset, road centerlines used in a Mapped ALI display may meet the basic requirements for use by an LVF or ECRF.
- **Transportation Planning Data** – Departments of Transportation typically maintain their own RCL data in a GIS but base the attribution on a Linear Referencing System where attribution is associated to the road centerline by measured distances from a single starting point without requiring the feature to be split. From a geometry completeness point-of-view, this data can have most, if not all, of the required information needed by an LVF or ECRF. However, historically, road centerlines created for transportation planning use do not contain complete information needed by the LVF for location validation or the proper line splits to support call routing and, therefore, may not meet the basic requirements needed by an LVF or ECRF.

Other considerations for the RCL layer:

- The RCL layer's data is used to locate a 9-1-1 caller's civic address through geocoding by using address attribution along the road centerline, and routes the 9-1-1 call with the use of right and left offsets, as applicable, so as to fall into the appropriate polygon for each Service Boundary layer. When validating call routing based on a road centerline, in some cases, it may be necessary to modify address ranges, offset distance, or geometry so offset address location will not change existing call routing. For example, when intersecting road centerlines come together at an acute angle, the offset may jump across the intersecting road centerline and fall in an adjacent service boundary. Specific guidance for handling offset issues should be discussed with your NGCS Provider.
- While it is not expected that data providers adopt the NG9-1-1 GIS Data Model [2] for the internal use and maintenance of RCL and/or SSAP layers, it is expected that data providers be capable of exporting their internal GIS data model into a format that complies with the NG9-1-1 GIS Data Model [2]. Leveraging this standard for internal use and day-to-day maintenance would have an added benefit of eliminating the need for an export process (and thereby also eliminating potential unforeseen issues that may arise during this process).

5.4 Recommendations for Civic Location Layers

5.4.1 Single, Multiple, and Stacked Road Centerlines

A road centerline represents a thoroughfare that is sufficient in detail for the LVF and ECRF to identify a civic location and perform their functions. This allows a level of flexibility for representing the road centerline. A road can be represented by a single road centerline, or

it can be represented with two or more road centerlines. Some examples include: each road centerline represents a different direction of travel or single lane of traffic; a physical barrier exists between travel lanes; or the authoritative street name is different on each side of the road. Decisions on how to best represent divided or multilane roads as road centerlines should focus first on usage in the LVF and ECRF, which is different from their usage for vehicle routing. When road centerlines are along, or align with, Service Boundaries, special care should be taken with the road centerline and Service Boundary polygon placements to ensure that the 9-1-1 caller's geocoded civic address will fall into the appropriate polygons within each of the Service Boundary layers.

Stacked geometry (a road centerline with attribution on top of another road centerline with different attribution) is often used to capture unusual addressing situations such as a road with a different authoritative street name on each side of the road. While stacked geometry does not prevent the LVF from validating the geocoded location of a civic address or the ECRF from placing the geocoded location of a caller's location into the correct PSAP, as a best practice, stacked geometry is not recommended, particularly if the data is going to be used for other purposes such as vehicle routing in a CAD system. Instead, a road centerline can be created for each travel direction, even if a physical barrier does not exist, and the street name and address ranges can be populated on the outward facing sides of the road centerlines.

5.4.2 Spatial Gaps and Overlaps Between Road Centerlines

To ensure that road centerlines are usable for NG9-1-1, it is critical that the RCL layer's topology is free from unintended gaps and overlaps. Road centerline end points should be "snapped" together to avoid unintended overlapping geometry or spatial gaps.

This is especially important when aggregating RCL data from multiple sources. For example, a road centerline ending at a Service Boundary must snap to the same end point on the Service Boundary as the road centerline in the adjacent jurisdiction. It is a best practice that neighboring GIS Data Providers work together to reconcile overlapping road centerline geometry and spatial gaps between road centerlines where they meet at the edge of their area of responsibility.

5.4.3 Cul-de-Sacs/Coves

These circular features should be represented with linework that supports geocoding of a civic location with the use of right and left offsets, as applicable, so that the geocoded location falls into the appropriate routing polygons within each Service Boundary layer. True curves and Bézier curves (i.e., curves that are mathematically derived rather than being represented by a series of connected vertices) should be avoided as they have been known to be problematic with data transformation.

For LVF processing of location validation and ECRF call routing purposes, cul-de-sacs and coves can be represented with a single, straight line segment, even if a physical island exists in the cul-de-sac.

5.4.4 Road Centerline Splits at Boundaries

Splitting of road centerlines will naturally occur where an NG9-1-1 GIS Data Model [2] attribute value changes. Road centerline splitting is critical when fields such as Country, State, County, Incorporated Municipality, Neighborhood Community, Unincorporated Community, or Emergency Service Number (ESN) (legacy usage) change as these fields are frequently used in routing the call to the correct PSAP. At all locations where a road centerline is split, attributes, especially address ranges, will need to be reviewed and adjusted as needed for most accurate usage by the LVF and ECRF.

There are two additional use case considerations the practitioner should consider when determining if additional road centerline splits are needed.

1. **Geocoding:** When geocoding a civic address against a road centerline, the provided civic address is matched to a single road centerline and the estimated location of the address is interpolated along the feature. This interpolation, based on theoretical equal spacing of address numbers for the total range assigned to the street, is based on where the address falls within that address range (illustrated in Figure 5-5 and Figure 5-6 in Section 5.4.8.1 Potential Address Ranges). A single long street centerline is even more susceptible to large accuracy discrepancies from the actual location of the address.

Careful consideration must be given for road centerline splitting to ensure a geocoded civic address falls within the appropriate boundaries during the interpolation process. It is best practice to split road centerlines where the road centerline crosses an NG9-1-1 required boundary (i.e., PSAP, Police, Fire, Emergency Medical Service, Provisioning Boundary) because these public safety boundaries are not road centerline attributes in the NG9-1-1 GIS Data Model [2].

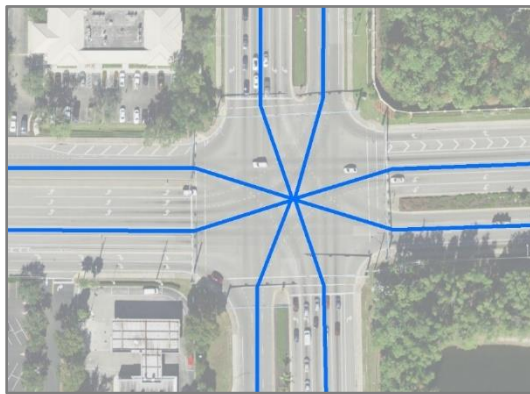
2. **Other Road Centerline Usage:** Although this document primarily focuses on guidance related to the application of the NG9-1-1 GIS Data Model [2] and the use of this information in Next Generation Core Services, the practitioner should be aware that locally maintained road centerlines may have many uses beyond call routing and location validation.

The RCL layer is often used for other transportation or public safety software systems (e.g., CAD, records management systems, transportation routing, responder driving directions). These systems may have additional attribution needs/use cases which may have additional and/or alternative splitting requirements.

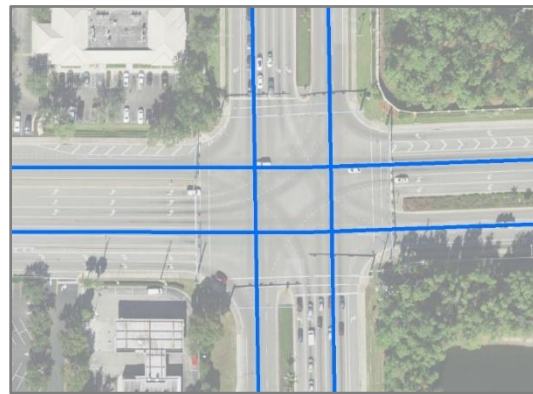
To reduce the amount of road centerline splitting, some 9-1-1 Authorities have adopted best practices recommending Public Safety agencies develop jurisdictional boundaries that coincide with existing/natural centerline breaks such as intersections, bridges, etc.

5.4.5 Representing Multi-Lane Road Intersections

A road is sometimes represented by two parallel road centerlines. This is usually done where there is a physical median, separating the different (opposing) lanes of travel, which restricts left turns. There are two basic options to handle intersections when using parallel road centerlines, Pinched Intersection (Figure 5-1) and Real Ground Truth Intersection (Figure 5-2).



1
2 *Figure 5-1 Pinched Intersection*



3
4 *Figure 5-2 Real Ground Truth Intersection*

While either option is viable for the LVF and ECRF, the requirements of other software/systems, such as CAD or Vehicle Routing, will likely dictate which is preferable.

5.4.6 Road Centerline Splits at Intersection and Multi-Level Roadways

It is standard practice to split road centerlines at intersections where two roads physically come together at the same elevation (at-grade intersections). Grade is the vertical position relative to ground level. This practice will not affect the functionality of the LVF or ECRF. To maintain vehicle routability in a road network, road centerlines must either contain elevation attributes (expressed as grades) or be split only at intersections where each intersecting road centerline is at the same grade. An example of two roads that are not at the same grade would be an overpass going over a highway. Recognizing the impact that splitting road centerlines at intersections may have on internal uses of an RCL layer, it is recommended that these best practices are followed:

- If road centerline elevations are maintained internally, splitting them at intersections should not affect other business uses and they may be split at the discretion of the 9-1-1 GIS Data Provider. For example, the proper attribution of elevation in Figure 5-3 allows the road centerlines to be split at all intersections (regardless of whether the two intersecting road centerlines are at the same grade), if desired.

- In the absence of elevation attribution, splitting of road centerlines at intersections should only occur where the intersecting roads are at the same grade as shown in Figure 5-4.

One advantage of splitting road centerlines at intersections where two roads physically come together at the same elevation is that a geocoded location will then have cross-street information in systems such as CAD. Aside from considering other internal uses of the RCL data, it is a general best practice to represent the road centerline as it appears physically. Intersections in RCL data tend to represent physical intersection of roads. Roads that are not at-grade are not physically connecting; therefore, the two should not be split where they intersect without the proper elevation attribution.

Relative elevation (grade separation) is represented in the figures below as grades 0, 1, and 2. The labels represent the “from elevation” and “to elevation,” respectively.

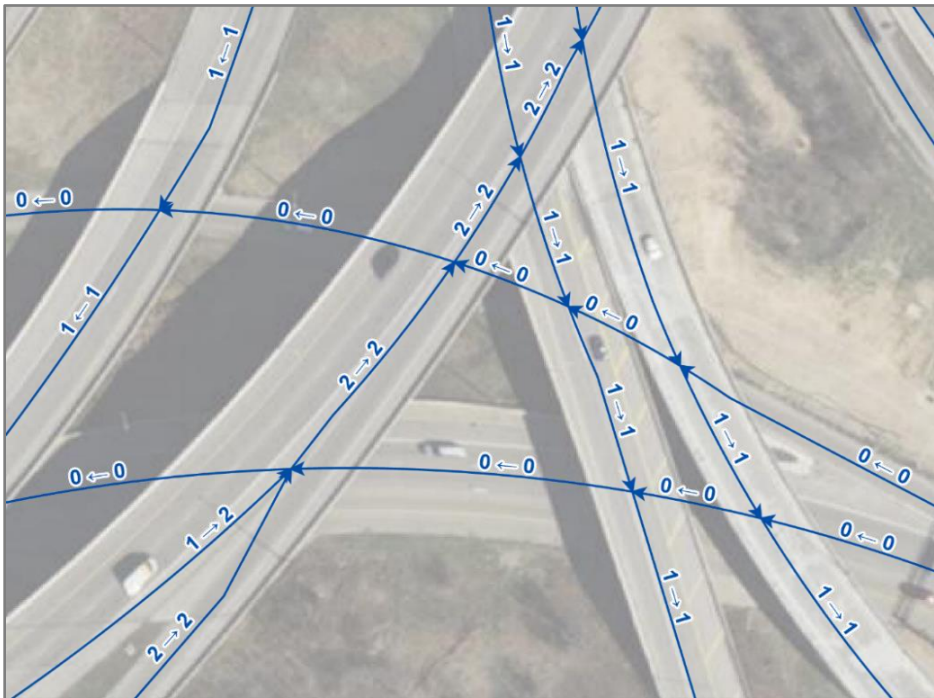


Figure 5-3 Road Centerline Segments with Elevation Attribution

Figure 5-3 shows a junction of ramps where the road centerlines carry proper elevation attributes and therefore can be split at all intersections (regardless of whether these are true at-grade intersections) without affecting other business uses such as vehicle routing. Arrows along a road centerline indicate the end of that road centerline (i.e., a split).

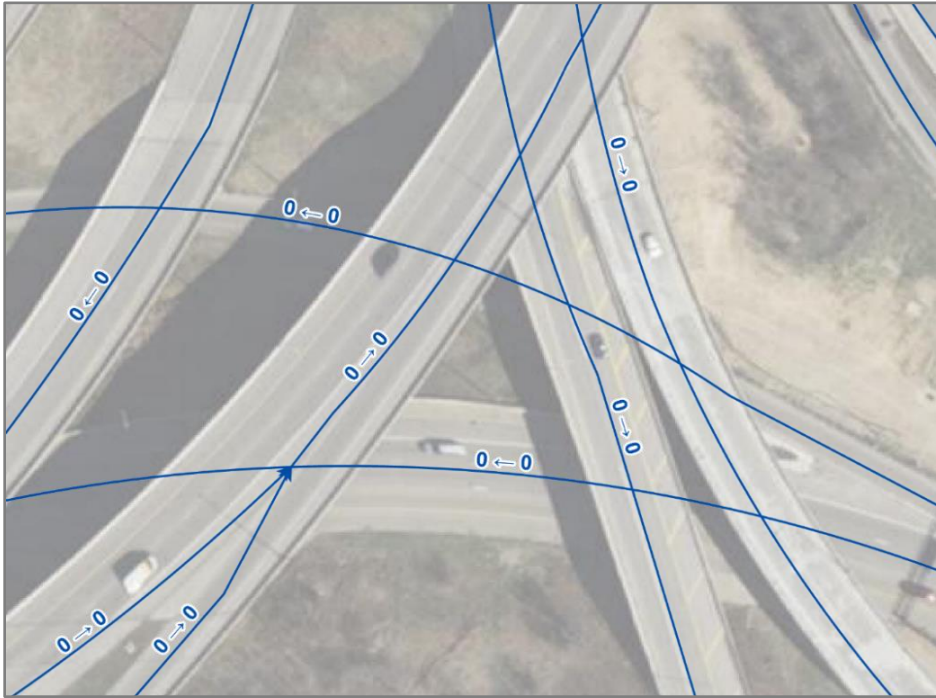


Figure 5-4 Road Centerlines Without Elevation Attribution

Figure 5-4 shows the same junction of ramps as in Figure 5-3, but the road centerlines do not carry proper elevation attributes and therefore are only split at true at-grade intersections so as not to interfere with other business uses such as vehicle routing. Arrows along a road centerline indicate the end of that road centerline (i.e., a split).

5.4.7 Digitized Direction of Road Centerlines

As a general best practice, road centerlines should be digitized in the same direction of increasing addresses with the lower address range values at the start point (left from/right from) and the higher address range values at the end point (left to/right to).

In cases where the order of address numbers is inconsistent (i.e., there is no single direction of increasing address numbers along the road centerline), digitizing direction should follow the digitizing direction of other nearby roads. For example, if there is one road centerline where addresses increase in opposite directions and all adjacent road centerlines are digitized in the same direction, the road centerline with the addressing inconsistency should be digitized in the same direction as the other adjacent road centerlines. It is important to note that the One-Way directional attribute (From-To, To-From, Both) indicating direction of travel is interpreted based on the digitization direction of the road centerline. If the One-Way directional attribute is populated and digitization direction is changed, it must be updated to maintain appropriate vehicle network routing.

5.4.8 Address Range Attribution

In the absence of a matching Site/Structure Address Point, the ECRF and LVF will use the address ranges on a road centerline for geocoding the location of a civic address. There are two methods used for attributing road centerline address ranges: potential or actual. Both range types provide pros and cons in location validation. Jurisdictions may use one address range type or the other, or may use a combination of both address range types on various road centerlines.

Jurisdictional boundaries can contain urban areas, as well as rural areas, where addressing standards differ. Urban areas are typically “hundred-block” addressing where each block is allotted 100 addresses between intersections. Rural areas generally use interval-based addressing where individual road segments can be several miles long. Interval-based addressing assigns addresses based on the number of measured intervals from the beginning of the road centerline to the addressed structure (e.g., from a starting intersection, a new address number is available every 5.28 feet, 52.8 feet, 1 meter/metre, 10 meters/metres). Particular attention should be paid to making the address range attribution as close to reality as possible to support better location accuracy. For the practitioner, choosing the appropriate address range attribution method is beyond the scope of this stewardship document and should be researched separately.

In some cases, a 0-0 range is used for some non-addressed roads for local purposes either to prevent address assignment which conflict with a neighboring GIS Data Provider (e.g., road coincident with a jurisdiction boundary, stacked [coincident] road centerlines) or where addressing assignment is not permitted. It should be understood that using 0-0 ranges may conflict with some quality control processes but should not impact the functionality of the ECRF or LVF.

Figure 5-5, Figure 5-6, and Figure 5-7 are fishbone diagrams where the lines represent the relationship between the actual address location (red circle) and the geocoded address location (blue triangle). The placement of the geocoded point does not represent the physical location of the structure, but where the geocoder interpolates the address to be along the road centerline based on the address range attribution. The figures illustrate how different address range methodologies can impact geocoding results.

5.4.8.1 Potential Address Ranges

Potential (theoretical) address ranges are used to ensure self-assigned, missing, or future addresses are captured in the road centerline attribution. Use of potential address ranges can relieve an undue burden on daily GIS data maintenance, especially in rapidly expanding jurisdictions. However, potential address range values can cause inaccurate geocoding results and may lead to call routing issues to the appropriate PSAP and/or vehicle routing issues for emergency responders.

5.4.8.1.1 Hundred-Block Addressing

Hundred-block addressing is a type of potential address range that is more frequently found in urban areas. The address ranges typically allow for 100 address numbers between two intersecting streets.

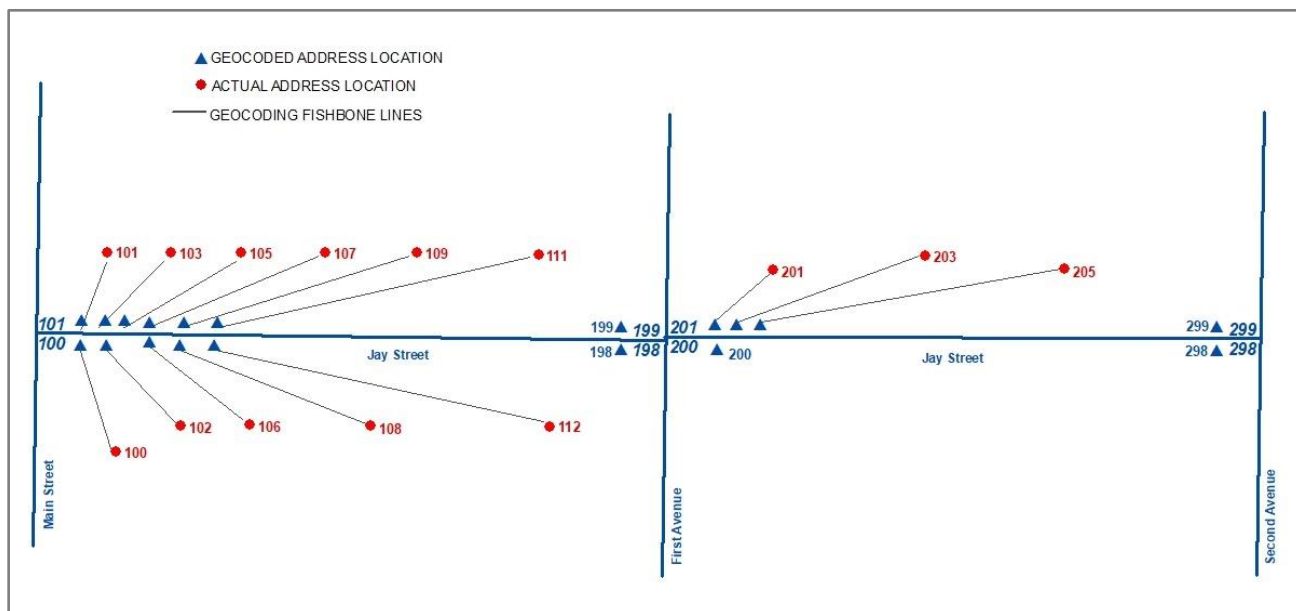


Figure 5-5 Effect of Geocoding Addresses against Hundred-Block Potential Address Ranges

5.4.8.1.2 Interval-Based Addressing

Interval-based addressing is a type of potential address range that is found in both urban and rural areas. The address ranges are based on a measured distance interval from the beginning of the road centerline to its end, as described in Section 5.4.8 Address Range Attribution.

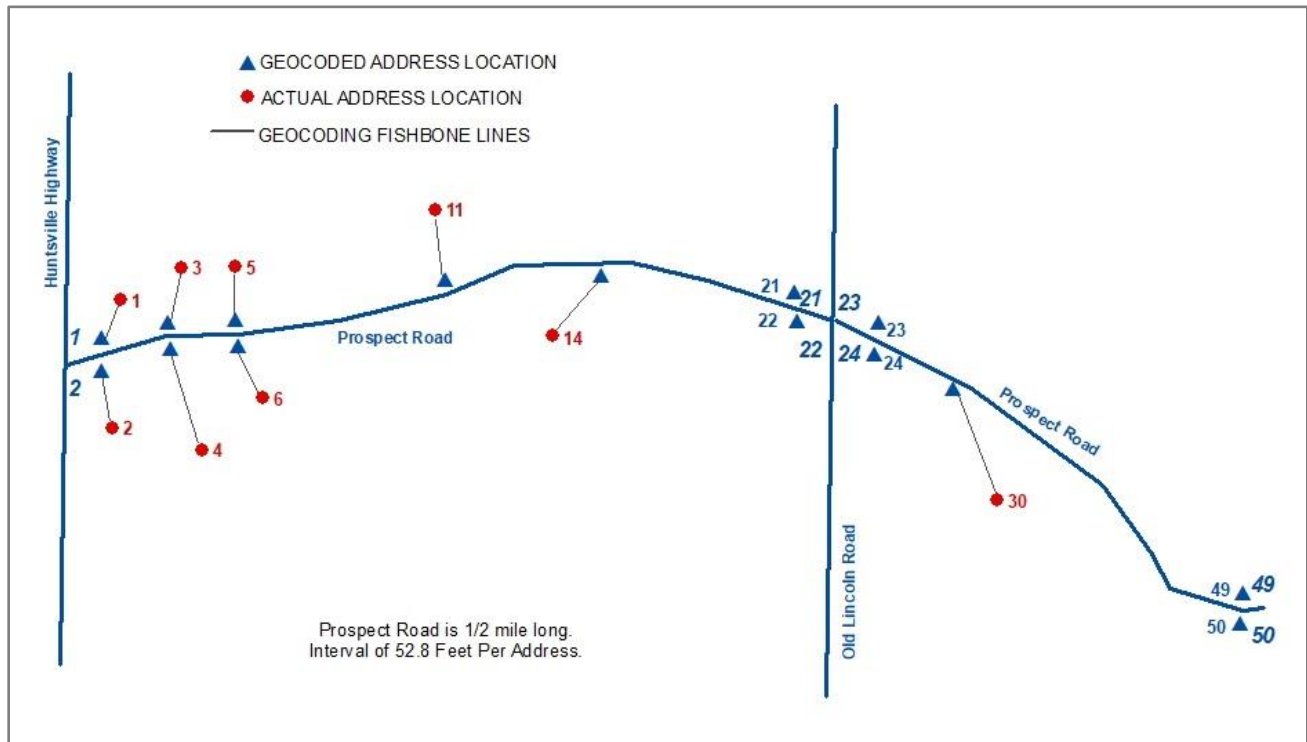


Figure 5-6 Effect of Geocoding Addresses against Interval-Based Potential Address Ranges

5.4.8.2 Actual Address Ranges

Actual address ranges are used to capture the addresses assigned to existing structures along a road. This address range attribution type may place an undue burden on daily GIS data maintenance, especially in rapidly expanding jurisdictions, because the address attribute values must be updated constantly in order to incorporate any newly assigned or modified addresses.

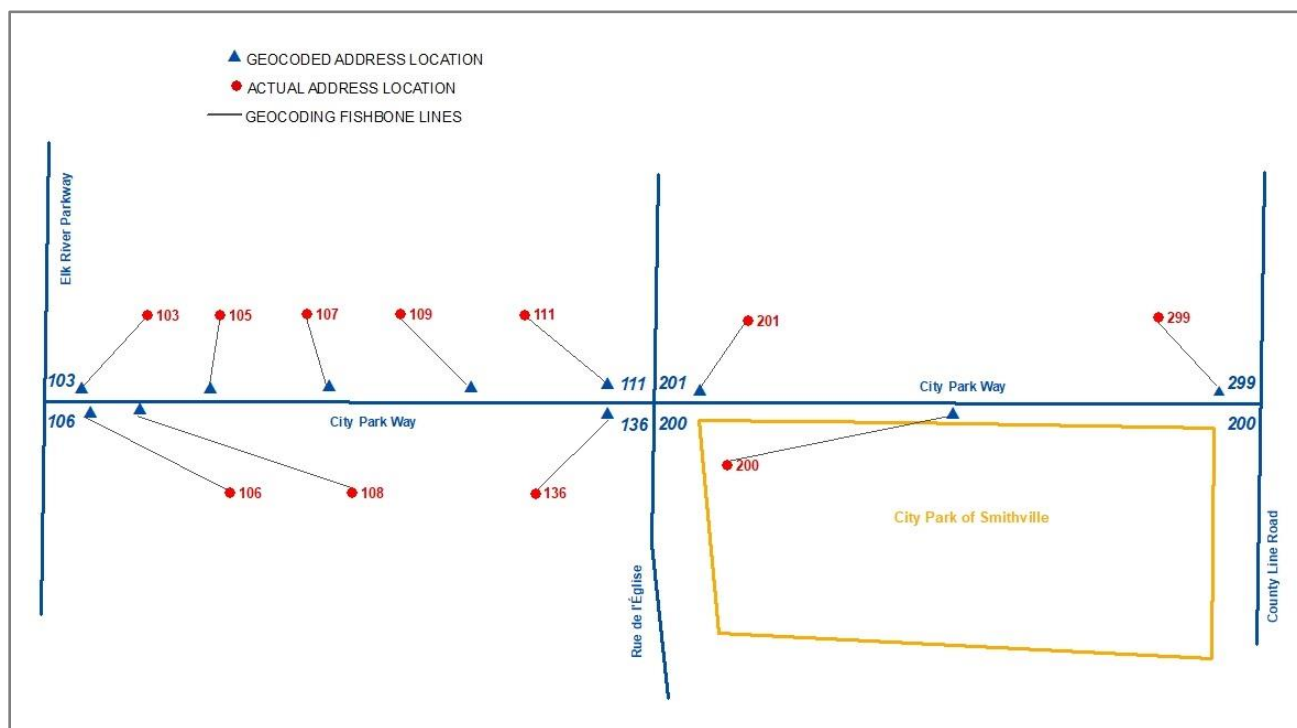


Figure 5-7 Effect of Geocoding Addresses against Actual Address Ranges

5.4.9 Address Range Gaps and Overlaps Between Road Centerlines

To ensure that road centerlines are usable for NG9-1-1, it is critical that their address attributes are free from unintended gaps and overlaps. Address ranges on road centerlines with the same street name that are within the same jurisdiction should be scrutinized to verify that there are no overlapping address numbers or unintentional gaps in the address ranges.

This is especially important when aggregating RCL data from multiple sources. Neighboring GIS Data Providers should work together to resolve issues with overlapping address ranges or unintentional gaps in address ranges at the edge of their area of responsibility.

5.4.10 Left/Right Road Centerline Address Attribution Based on Jurisdiction

The purpose of the RCL layer in NG9-1-1 is to validate the civic location of the 9-1-1 call when a site/structure address point is unavailable. By validating the location, the RCL data allows the NG9-1-1 system to determine that the civic location falls within the responsibility of the respective 9-1-1 jurisdiction and, as such, it is appropriate to route the call based on the PSAP recommended by the Service Boundary for PSAPs layer. To support this purpose, road centerlines should be populated with attribution relevant to the addresses along each side of the road. This includes the NG9-1-1 GIS Data Model [2] place name attributes to

denote the areas within which individual addresses are located, regardless where the physical road is located. These place name attributes are:

- Country Left/Right (Required)
- State or Equivalent Left/Right (A1) (Required)
- County or Equivalent Left/Right (A2) (Required)
- Incorporated Municipality Left/Right (A3) (Required)
- Unincorporated Community Left/Right (A4) (Not Required)
- Neighborhood Community Left/Right (A5) (Not Required)
- Postal Code Left/Right (Not Required)
- Postal Community Name Left/Right (Not Required)

The ESN Left/Right and MSAG Community Name Left/Right fields also should be populated in order to support the migration to NG9-1-1 and then should be maintained until no longer needed, based on local requirements.

To support call routing, the development of the RCL layer is reliant upon the completeness of its attribution as well as its spatial relationship to a Service Boundary for a PSAP. RCL layer development should consider how geocoding, within the ECRF, will interpret the civic location of the 9-1-1 call, using attributes of the road centerline to generate a geodetic location.

A geodetic location is determined by identifying a unique matching road centerline that corresponds to the civic location of the call. Interpolation of the civic location via theoretical distance along the road centerline, based upon its left/right address ranges, generates a geodetic location. Some NGCS Providers may use offsets for their geocoding solution that will place the geodetic location a set distance to the right or left of the road centerline (not directly on the road centerline). Working with your NGCS Providers to understand the configuration and resulting impact of offsets is important. The offset distance is typically not an attribute of a road centerline and it is not an attribute in the NG9-1-1 GIS Data Model [2]. Point-in-Polygon querying of the geodetic location and a Service Boundary for a PSAP polygon will determine into which boundary the location falls, and route the 9-1-1 call to the correct PSAP. In all cases, it is important to ensure that Left/Right attribution of each road centerline is complete, accurate, and consistent with the call routing supported by the Service Boundary layers.

For roads physically located along boundaries of neighboring entities, the GIS and 9-1-1 professional should work with the neighboring agency to prevent conflicting validation and routing recommendations.

Due to the complexity of the RCL layer's role within an NG9-1-1 environment, the process to build an RCL layer completely and to support the needs of NG9-1-1 location validation and call routing, may be iterative, requiring multiple steps and decisions. Section 5.5 Phased Approach for Creating the Civic Location Layers will assist the GIS and 9-1-1

professional in accomplishing these tasks. However, during creation and remediation, the purpose of the RCL layer needs to be the foremost consideration.

5.4.10.1 Road Centerline and Jurisdiction Boundary are Coincident

In general, a road centerline may be coincident with a jurisdiction boundary, as shown in Figure 5-8. It is recommended that left and right attributes be populated with the values that correspond to the left and right polygons.

For example, in Figure 5-8, where County Road D West is digitized in the direction of increasing address numbers, all right side address attributes of County Road D West would reflect the City of Shoreview and all left side address attributes would reflect the City of Roseville.



Figure 5-8 Coincident Road Centerline and Jurisdiction Boundaries

5.4.10.2 Road Centerline in a Different Jurisdiction than Addressed Properties

In general, addresses are assigned based on the jurisdiction in which the property is located, though there are times when the road centerline with corresponding address ranges falls within a neighboring jurisdiction. Guidance in this section focuses primarily on situations where the RCL layer is the only mechanism for validating civic address locations and routing of calls. However, it is generally understood that in many instances the SSAP layer can compensate for unique location validation and call routing decisions, and consideration for this is outlined below. Future versions of this document will incorporate a section dedicated to the SSAP layer and further considerations for its impact on location validation and call routing.

SSAP data, when available for use by the ECRF and LVF, may impact the development, maintenance, and/or attribution of the RCL layer. Before decisions are made regarding the attribution applied to a road centerline, based on address point availability, the GIS Data Provider and the 9-1-1 Authority should consider:

- the completeness of the SSAP layer;
- the use of the RCL layer for routing of calls that do not have an associated address point;
- and whether modification of the Service Boundary(ies) would be more applicable.

Figure 5-9 illustrates a road centerline that is within the boundary of one jurisdiction (Roseville), yet has address attributes related to site/structure address points which are located within a different jurisdiction (New Brighton). Where County Road D West is digitized in the direction of increasing address numbers, the left side address attributes such as Incorporated Municipality Left, Left FROM Address, and Left TO Address, reflect the addressed properties in New Brighton.



Figure 5-9 Road Centerline and Associated Addresses in Different Jurisdiction

5.4.10.3 Road Centerline with Differing Primary Street Names

Addresses are generally assigned based on the jurisdiction in which the property is located. Complications can arise when the same road has differing primary street names for each side of the road based on jurisdiction addressing. This is a common occurrence as a result of annexation. The NG9-1-1 GIS Data Model [2] allows for only one primary street name. Using alias street names to resolve this issue is not an option given the guidance in the NENA Information Document for Location Validation Function Consistency [11] which states "Alias names shall not be used when determining if a civic location is valid." If

possible, it is recommended that the local jurisdictions come to agreement on one official street name for use on both sides of the road. When the primary street names differ and agreement on one street name is not attainable, the solution may be limited by local use of the data and the requirements of the NGCS Provider.

Figure 5-10 and Figure 5-11 below illustrate a border road with a different primary street name and jurisdiction on each side of the road. Lino Lakes (right side of the road) has assigned the street name of "Ash Street" to addresses in their city. Shoreview (left side of the road) has assigned the street name of "County Road J West" to addresses in their city. Because the LVF needs an exact match to the street name, the different street names are only valid for their respective jurisdictions. Below are two proposed methods to resolving this discrepancy. Regardless of the method used (stacked or parallel), it is important to understand the impact it may have to other public safety systems and that potential vehicular routing and/or driving direction anomalies may be introduced.

5.4.10.3.1 Coincident (Stacked) Road Centerlines Method

In Figure 5-10, two coincident (stacked) road centerlines are shown. One represents the valid street name (Ash Street) for the jurisdiction on the right side of the road (Lino Lakes) and a second coincident (stacked) road centerline represents the valid street name (County Road J West) for the jurisdiction on the left side of the road (Shoreview).

When using this technique, the road centerline related to the jurisdiction on the left side is populated with attributes appropriate to the left side of the road such as Incorporated Municipality Left, Left From Address, Left To Address, etc. The Validation Right field is populated with a value of "N" to indicate the attributes for the right side of the road centerline should not be used for validation. The Right From Address and Right To Address attributes should be populated with 0-0 as discussed in Section 5.4.8 Address Range Attribution.

Similarly, the road centerline related to the jurisdiction on the right side is populated with attributes appropriate to the right side of the road such as Incorporated Municipality Right, Right From Address, Right To Address, etc. The Validation Left field is populated with a value of "N" to indicate the attributes for the left side of the road centerline should not be used for validation. The Left From Address and Left To Address attributes should be populated with 0-0 as discussed in Section 5.4.8 Address Range Attribution.

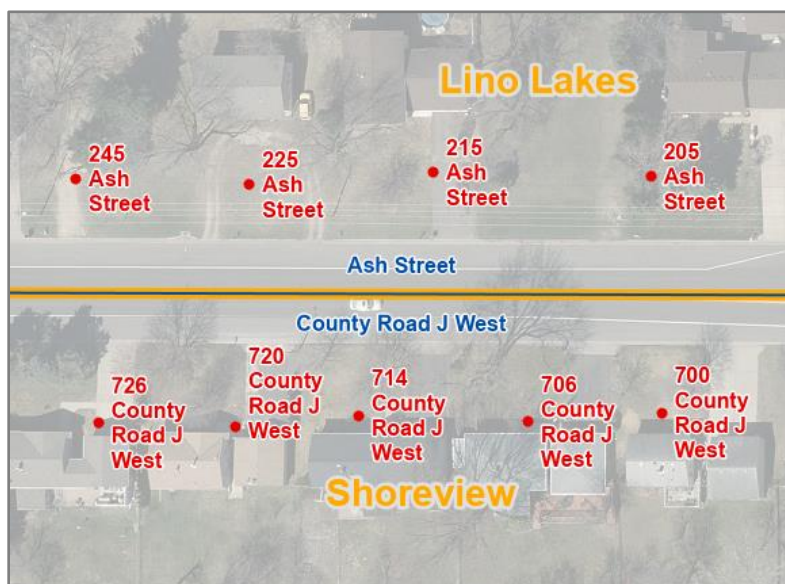


Figure 5-10 Coincident (Stacked) Road Centerlines Method

5.4.10.3.2 Parallel Road Centerlines Method

Figure 5-11 illustrates a similar situation but with this method, address range, Validation Left, and Validation Right attributes are populated the same as with the Coincident (Stacked) road centerlines method, but the road centerline geometries are parallel.

Using this method has the advantage of a clear visual display that two independent road centerlines are in use.

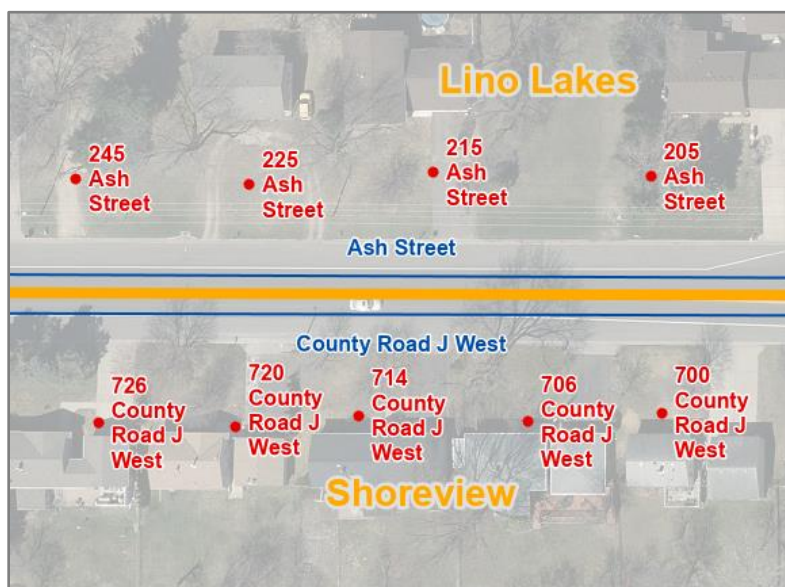


Figure 5-11 Parallel Road Centerlines Method

5.4.11 Unnamed Roads

If an unnamed road centerline is needed for the LVF and the ECRF, then it needs to be modified to meet all the requirements of the RCL layer (e.g., range attributes and a unique street name within that jurisdiction). To ensure a dispatchable location, the combination of address range, street name, and jurisdiction(s) needs to be unique. Attributing unnamed road centerlines with a non-unique street name such as Unnamed Road, Connecting Road, Access Road, Alley, or Private Road may be identified as a discrepancy upon provisioning to the SI, can be confusing in general, and can cause a delayed response.

It is strongly recommended that the road be officially named by the appropriate road naming authority in partnership with the 9-1-1 Authority. For those cases where there is no such authority, choose a road name that is commonly used by the residents or, if no name exists, choose a road name that describes the thoroughfare's practical use, is easily recognizable to first responders, and/or considers national conventions related to roads on public lands (e.g., numbered forest roads).

The following subsections provide guidance for the most common scenarios that might involve unnamed roads. As a reminder, this is an informational document and the use of the guidance provided needs to be weighed against local needs, existing E9-1-1 data usage, and NG9-1-1 compatibility.

5.4.11.1 Ramps

Locations on highway ramps are often sites of 9-1-1 calls for service. Unnamed ramps maintained within the RCL layer should be attributed with a street name such that the street name describes the named road from which a traveler has departed and the named road to which the traveler is headed.

Travel directions (e.g., northbound, southbound, eastbound, westbound) for the departure and destination Street Names should be included for both street names to indicate the direction of travel of the departure and destination thoroughfares.

The following ramp/connector naming syntax is recommended. It incorporates the FROM and TO roads along with direction of travel and places them all into the Street Name field:

Exit <Exit Number> <FROM Street> <travel direction> To <TO Street> <travel direction>

The inclusion of the Exit Number is optional. The travel direction of the TO Street may be omitted if the ramp connects to a two-way street. When concatenating the FROM Street name and TO Street name of complex ramp/connector names, GIS Data Providers need to be aware of the character width limitations of the Street Name field, especially if they have been following version 1 of the NENA NG9-1-1 GIS Data Model [2] for populating their data, as that field width increased in version 2 published in 2022. GIS Data Providers should refer to the current version of the NG9-1-1 GIS Data Model [2] to understand the

character width constraints. Examples of ramp naming convention(s) are shown below in Section 5.4.11.1.2 Ramp Naming Examples.

5.4.11.1.1 Abbreviations for Ramp Naming

The NENA NG9-1-1 United States CLDXF Standard [12] requires all street name elements to be fully spelled out. Due to the complexity of ramp/connector names, the following abbreviations may be used for the travel directions, pre/post directionals, and pre/post types. Whatever ramp naming practice is adopted should remain consistent throughout the GIS Data Provider's data to avoid conflicts. The following abbreviations are meant to be used only when populating the Street Name field with composite ramp names and MUST NOT be used as substitutes for spelled out street name types, directionals, or travel directions in the Street Name Pre Type, Street Name Post Type, Street Name Pre Directional, Street Name Post Directional, and Street Name Post Modifier field.

Recommended abbreviations for travel directions:

NB – northbound
SB – southbound
EB – eastbound
WB – westbound

Recommended abbreviations for pre/post directionals:

N – North, Nord
S – South, Sud
E – East, Est
W – West
O – Ouest
NE – Northeast, Nord-Est
NW – Northwest
NO – Nord-Ouest
SE – Southeast, Sud-Est
SW – Southwest
SO – Sud-Ouest

Recommended abbreviations for the pre/post types should align with the abbreviations in USPS Publication 28 [22], Appendix C. Example abbreviations for the TO/FROM road jurisdiction that are part of the ramp name:

I – Interstate
US – United States Highway, United States Route
PA, TX, CA, WV, etc. – State Highway, State Route

The GIS Data Provider's chosen road jurisdiction abbreviations should be consistent with the State's Department of Transportation abbreviations and local usage. The intent is to

model what is on the actual highway/road signage in that jurisdiction. It may be useful to populate the Road Class field with "Ramp" when using this ramp naming convention.

5.4.11.1.2 Ramp Naming Examples

Exit <Exit Number> <FROM Street> <travel direction> to <TO Street> <travel direction>

- In Figure 5-12, the ramp from Interstate 15 northbound to Interstate 215 eastbound is populated as: **I15 NB to I215 EB**
- In Figure 5-12, the ramp for Las Vegas Boulevard to Interstate 15 northbound is populated as: **Las Vegas Blvd to I15 NB**

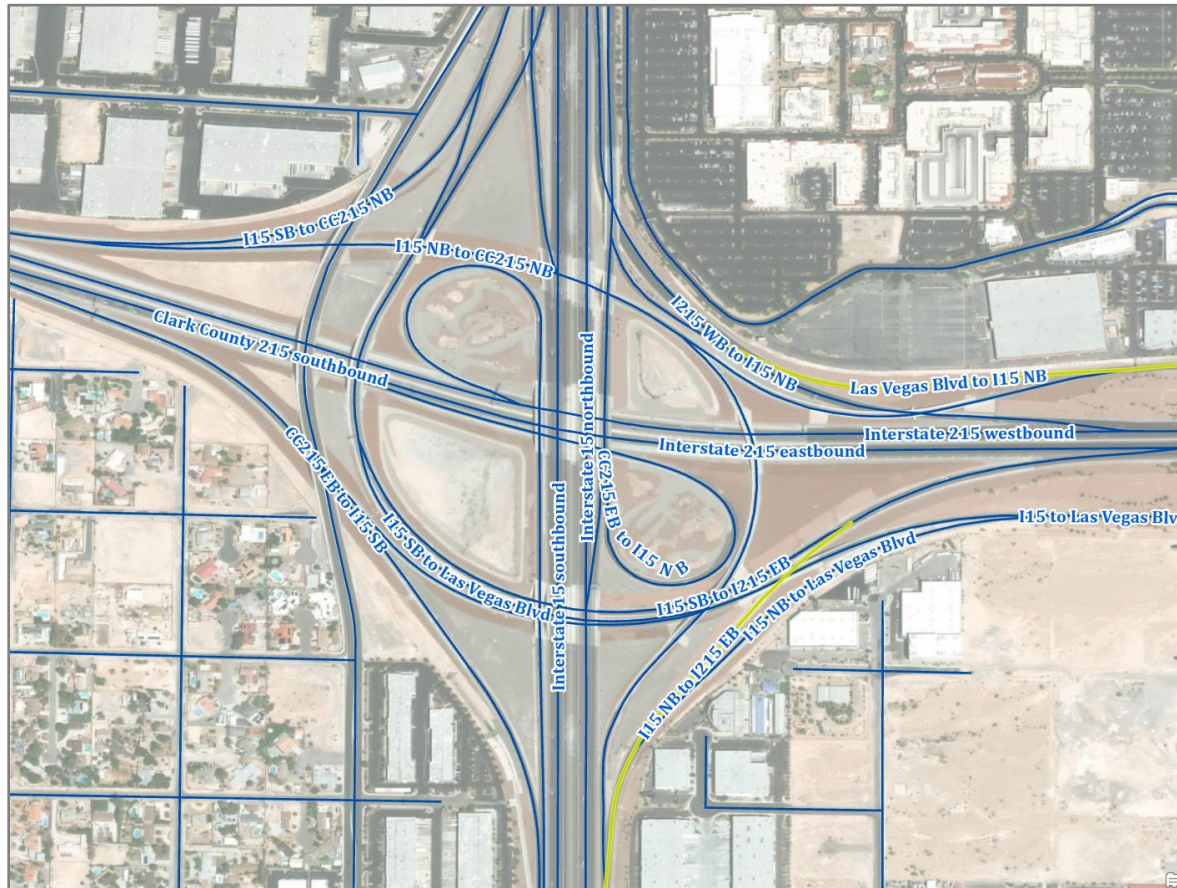


Figure 5-12 Example of Ramp Naming

When a ramp exits a limited access road and leads to more than one connected road, the order of the connected street names used for the TO street should follow this hierarchy:

1. Interstate Name
2. Interstate Business Route name
3. US (or equivalent) Route name

4. US (or equivalent) Business, Alternate, or Truck Route name
5. State (or equivalent) Route name
6. State (or equivalent) Business, Alternate, or Truck Route name
7. County (or equivalent) Route name
8. Other local or memorial street name (lowest priority)

Once the ramp merges into a local neighborhood of interconnected roads, the Street Name on the road centerline will drop the ramp naming syntax and adopt local street names matching local addressed properties. Similarly, ramp naming syntax will start as one leaves a neighborhood of interconnected roads and enters the connecting ramps.

In Figure 5-13 below, the exit from Interstate 15 northbound exits to both Interstate 215 and Las Vegas Boulevard. The first ramp exiting Interstate 15 northbound is populated as **I15 NB to I215** (which is both the local 9-1-1 street name and the highest hierarchical road) using the priority of the destination road. When the ramp diverges, the road centerline representing the ramps going eastbound are updated to match the local 9-1-1 street names and are populated as **I15 NB to I215 EB** and **I15 NB to Las Vegas Blvd**. The ramp continuing to I215 westbound is populated as **I15 NB to I215 WB**.

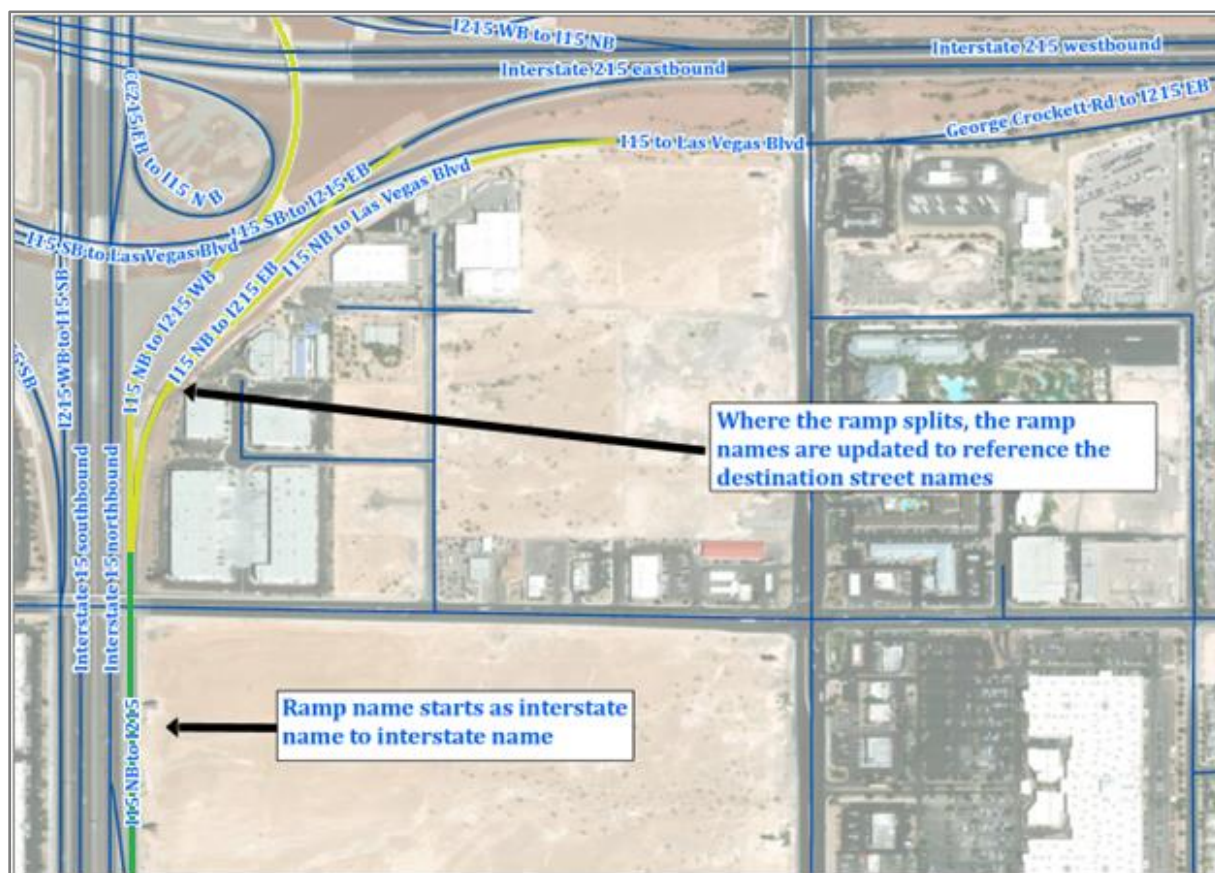


Figure 5-13 Naming of a Ramp Leading to a Highway and a Local Road

Road centerlines for ramps should be drawn in the direction of travel and the Road Class field (if present) should be populated as "Ramp."

5.4.11.1.3 Address Ranges on Ramps

Address ranges on road centerlines for ramps are optional; however, if the local jurisdiction deems it useful for addressing or incident location, ramps should be assigned standard numeric address ranges based on the address assignment methodology. The addition of an address range will also support the inclusion of the road centerline in the ECRF and LVF. Dispatchers, call takers, and field responders are often aware of the overall address ranges in a jurisdiction. Inclusion of an address range can assist those responders with the incident location. Addresses and address points may also be created for call boxes and other telephonically connected devices, especially if the device can initiate a 9-1-1 call for service.

5.4.11.2 Frontage Roads

These roads typically run parallel to a limited access highway and may not have an official name. Where a name does not already exist for a frontage road, it is strongly recommended that the road be officially named by the appropriate road naming authority in partnership with the 9-1-1 Authority especially if there already are, or will be, addresses assigned to the frontage road.

If the frontage road is not named, at a minimum, the road centerline should be named with the associated limited access highway name and travel direction.

For those frontage roads that run along a limited access highway with a recognized travel direction (e.g., northbound, eastbound), the following syntax is recommended:

<limited access highway name with travel direction> Frontage Road

where the limited access highway name includes the travel direction of the limited access highway in lowercase and "Frontage Road" is the Street Name Post Type.

In Figure 5-14 below, the unnamed frontage road runs alongside the northbound lanes of Interstate 35. The unnamed frontage road should have the street name fields populated as:

Street Name:	Interstate 35 northbound
Street Name Post Type:	Frontage Road



Figure 5-14 Frontage Road Designated by Limited Access Highway Name with Travel Direction

Alternatively, if the associated limited access highway does not have a recognized travel direction and the travel direction of the limited access highway lane closest to the frontage road is not distinct, the side (e.g., northside, eastside) of the limited access highway that the frontage road is on may be used to establish the frontage road name:

<limited access highway name> Frontage Road <highway side>

where the limited access highway name does not include a travel direction of the limited access highway, "Frontage Road" is the Street Name Post Type and <highway side> is the Street Name Post Modifier.

In Figure 5-15 below, the unnamed frontage road running along the north side of Airport Way should have the street name fields populated as:

Street Name:	Airport Way
Street Name Post Type:	Frontage Road
Street Name Post Modifier:	northside

Whichever method is chosen should be consistently utilized.

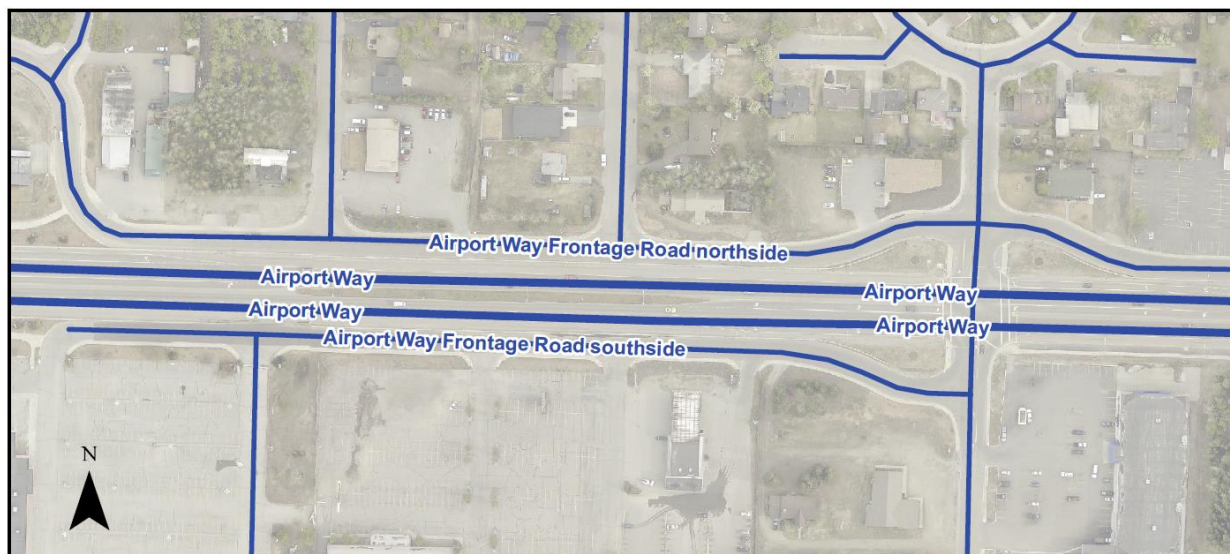


Figure 5-15 Frontage Road Name Designated by Side of Limited Access Highway

Where a road name already exists for a frontage road, but this road name is not unique to other frontage road names (e.g., they are all named "Frontage Road"), the data provider should bring this issue to the appropriate road naming authority, addressing authority, and 9-1-1 Authority. If this cannot be resolved, adding a travel direction or highway side to the road centerline to establish uniqueness may be considered at the discretion of the data provider.

The goal for each of these approaches is to provide meaningful and consistent road names (where one does not already exist) for 9-1-1 call takers and responders in locating incidents. These recommendations are predicated on current NG9-1-1 data standards and may be optimized as standards undergo further development. Implementation of these recommendations should be considered in coordination with local and regional road-naming conventions and needs.

5.4.11.3 Inclusion of Driveways

For the purposes of this guidance, driveways are road centerlines, used to determine access, that are unnamed or non-uniquely named. There are benefits and consequences to maintaining unattributed driveways and other access road centerlines (e.g., containing empty Street Name or address range fields) in a response GIS data layer.

When provisioning road centerlines to the ECRF and LVF databases, they must meet the requirements for the Required field attribution, as defined by the NG9-1-1 GIS Data Model [2], Section 4.1.1 Road Centerlines-REQUIRED. Provisioning unattributed access road centerlines will result in a discrepancy for each record not meeting the requirements outlined in the NG9-1-1 GIS Data Model [2].

If you choose to store unattributed driveways and other access road centerlines within the RCL layer to support map display, vehicle routing, and other emergency response functionality, it is recommended to develop business processes to exclude or classify these features to assist in reducing the number of discrepancies and improve location validation processes. Consulting with your vendor or NGCS Provider on managing this category of road centerlines in your organization is highly recommended.

5.4.12 Synchronization Across Multiple Civic Location Layers

When more than one civic location GIS data layer is present (for example both SSAP and RCL data) it is strongly recommended that the layers be reconciled with each other so that their feature attribution is consistent and in agreement. When an address is matched to a site/structure address point, and the same address is matched to a road centerline, there are instances where the location of these matches may vary by some distance. When the discrepancy is large, it typically means that there is an issue with the attribution and/or the placement of one, or both, of the GIS features. This type of a discrepancy reduces the confidence in the location of the civic address, thereby lowering the confidence in the call being routed to the correct PSAP or response agency.

5.4.13 Resolution of Duplicate Features Between Neighboring Jurisdictions

GIS data layers supporting E9-1-1 often include GIS features beyond the PSAP's area of responsibility. If these layers are used as a starting point for developing NG9-1-1 layers, there is a possibility that a single civic location could be represented in multiple layers provided by different GIS Data Providers. By identifying and resolving which GIS Data Provider is responsible for maintaining the GIS features in question, it will eliminate the duplication of GIS data and help to identify the locations of civic addresses that would be expected to fall within PSAP and other service boundaries. Duplicate data will result in a discrepancy report.

5.5 Phased Approach for Creating the Civic Location Layers

REMINDER: The content in this section primarily contains material pertaining to the RCL layer. Guidance regarding the SSAP layer will be developed for a future version of this document; in the meantime, see the NENA Information Document for Development of Site/Structure Address Point GIS Data for 9-1-1 [7].

Road centerlines have multiple use cases within a jurisdiction to include E9-1-1, NG9-1-1, the transitional states between both, as well as emergency and non-emergency response activities. A balance between the multiple uses of an RCL layer can be difficult and may require the GIS Data Provider to consider including data elements not currently supported in their RCL layer. Leveraging a "build once, use many" data development strategy allows for a more efficient workflow and provides cost efficiencies. Each GIS Data Provider will need to structure a process of creating, editing, and maintaining data quality of the RCL layer that serves all its users.

The recommended approach to creating and maintaining the RCL layer is a phased approach to preparing the data for NG9-1-1 readiness, especially for those communities that do not currently have one. Populating attributes within the RCL layer in a phased approach prioritizes those fields that facilitate call routing to achieve NG9-1-1 data readiness as soon as possible. However, locally existing workflows may streamline populating some attributes in earlier phases (e.g., Parity R/L, Road Class, One-Way, Speed Limit) or in later phases (e.g., Unincorporated Municipality R/L, Neighborhood Community R/L) at the discretion of the local data provider. Regardless of the order in which these fields are populated, priority should be given to those fields required for LVF and ECRF functionality.

Prior to initiating the phased approach, it is recommended the GIS Data Provider review the RCL layer's schema in its entirety. While some data elements are not required to be populated and are not required for NG9-1-1, due to the multiple use cases this layer supports, there may be other uses outside of NG9-1-1 that require population of these data fields. The goal is for the layer to be as complete as possible for NGCS and to meet the needs of the maximum number of stakeholders and purposes.

The recommended phases are:

- First Phase – Initial Development
- Second Phase – Modification and Refinement
- Third Phase – Preparing the Layer for NG9-1-1 Requirements

The NG9-1-1 GIS Data Model [2] describes the schema and field definitions for the RCL layer. This schema can be extended and applied to the phased approach in order to populate field attributes at the most relevant time for NG9-1-1 readiness. When creating an RCL layer using the phased approach, it is recommended that some attributes are populated in the First Phase and Second Phase by the GIS Data Provider while the remaining required fields are populated in the Third Phase by the GIS Data Provider in coordination with their 9-1-1 Authority and NGCS Provider. The primary goal of the phased approach is to front load data development and refinement work so that some coordination issues can begin to be addressed prior to selecting an NGCS Provider. The remaining fields not referenced during the phased approach recommendations are not required fields and may be populated by the GIS Data Provider at any point during the data development or maintenance phases.

While this approach is not a requirement, it is strongly recommended as it may provide neighboring 9-1-1 Authorities an opportunity to identify and resolve road centerline placement and attribution concerns prior to NG9-1-1 deployment. Additionally, it helps to ensure that some baseline GIS data layers are available when the 9-1-1 Authority begins to work with their chosen NGCS Provider.

Note: Section 5.5 Phased Approach for Creating the Civic Location Layers and the included Table 5-2, Table 5-3, Table 5-4, and Table 5-5 contain schema attributes from the Road Centerlines schema defined in the NG9-1-1 GIS Data Model, NENA-STA-006.2-2022 [2]. Changes in the schema attributes are subject to revision. Consult the most recent NG9-1-1 GIS Data Model [2] document for current schema requirements.

5.5.1 First Phase – Initial Development

The initial development of an RCL layer for many jurisdictions starts with a self-assessment of current road centerline GIS data layers and other tabular datasets readily available. The two critical components of an RCL layer are the geometry that graphically represents physical roads and the associated attributes. These components can be secured from unique, unrelated sources and/or obtained from traditional GIS resources.

For those communities that do not currently have an RCL layer, a determination needs to be made whether RCL data exists for the entirety of the area as this will dictate your path forward. It is recommended when creating the RCL layer to start by creating an inventory of existing spatial and non-spatial datasets which contain relevant attribute information, depict road centerlines graphically, or both. The use of existing datasets eliminates duplication of effort and can result in cost savings for all entities involved.

Identify the owner of each dataset and determine who is responsible for maintaining the data. When aggregating data from external sources for developing road centerlines, permission from the data owner to use, modify, and redistribute the data, even if it is provided by a data steward, may be applicable depending on local best practices and/or laws. Determine the maintenance frequency and secure the most recent version in a timely and preferably automated manner.

When no, or only questionable, road centerline information is available, base datasets can be enhanced from other sources such as field verifications or future data acquisitions. For example, point datasets containing situs information can be used to assist with populating address attributes. Regardless of sources used, a successful approach to building an NG9-1-1 compliant RCL layer requires a documented process, that supports updates over time, by coordinating stakeholders to build, maintain, and verify the geometry and attributes of this critical data layer.

There are many potential sources of geometry and attributes for the RCL layer. Users should reach out to local, state, and federal government agencies or commercial data providers for potential sources. Many of these are identified in Table 5-1 below but this list is not exhaustive. Whether publicly or privately sourced, evaluate whether the budget can support data acquisition costs. Preliminary research may save many months or years of unnecessary data development. The data sources below may be a useful resource yet should not be considered authoritative or assumed to be accurate. Consideration should be

given to whether an available data source will be more time consuming to fix and adapt, rather than developing from other sources or even from scratch.

Table 5-1 below is organized by group (GA-geometry and attribute, GO-geometry only, and AO-attribute only) and numbered priority within each group. These sources will likely not have all of the attributes needed for NG9-1-1 and all sources will have to be adapted to meet your specific needs. Finally, Table 5-1 is currently focused on United States sources with some information found for Canada and limited information found for Mexico [13]. Future versions of this document should include additional information as it becomes available.

Table 5-1 Potential Data Sources for Road Centerlines

Group-Priority	Source	Geom	Attrib	Notes
Potential Sources for Geometry and Attributes				
GA-1	Road network layers from transportation authorities (municipal, county, regional, state, provincial, etc.)	Yes	Yes	In the United States, State Departments of Transportation maintain statewide layers, often as part of the federal All Road Network of Linear Referenced Data (ARNOLD) and Highway Performance Monitoring System (HPMS) programs. However, these layers may lack address range information, may carry a route name instead of the 9-1-1 street name, and may be in a Linear Referencing System format which will require conversion. In Canada, the National Road Network is distributed in the form of thirteen provincial or territorial datasets and consists of two linear entities (Road, Ferry Connection) and three punctual entities (Junction, Blocked Passage, Toll Point) with which are associated a series of descriptive attributes. Atlas of Canada contains numerous road data, some national and some provincial. In Mexico, data for major highways is available.

Group-Priority	Source	Geom	Attrib	Notes
GA-2	Parcels from municipal, county, regional, state, provincial, or other sources	Yes	Yes	Assessors or other data providers may have parcel data containing road right-of-way polygons (or even a centerline) and the parcels may also contain situs address information which can be used to populate road centerline address fields or authoritative street names.
GA-3	Road centerlines from utilities	Yes	Yes	Utilities may have road centerlines used for service routing and address point locations representing their service addresses which can be used to populate road centerline address fields. Often these databases can be considered proprietary and may have use restrictions.
GA-4	Road centerlines and address points from school district databases	Yes	Yes	School districts may have road centerlines and/or address point databases that they use for school bus routing.
GA-5	Road centerlines from national census files	Yes	Yes	US Census Topologically Integrated Geographic Encoding and Referencing (TIGER) Files [14] contain a federally maintained database of roads. It may not be complete, and the spatial quality/accuracy may vary across a given geographic area. The Census of Canada Road Network Files [15] may be helpful as well.
GA-6	Road centerlines from commercial vendors	Yes	Yes	Acquiring data from a commercial vendor may save time but it might be expensive, the accuracy is variable, and it may not be able to be shared outside of the 9-1-1 center. These may be available internationally

Group-Priority	Source	Geom	Attrib	Notes
GA-7	Road centerlines from OpenStreetMap [16]	Yes	Yes	This is a free data source worldwide. In the United States and its territories, it is based on US Census TIGER data and may be under maintenance from crowd-sourcing efforts. However, it is not authoritative, has little or no metadata, and may be of inconsistent quality and coverage. These are available internationally.
Potential Sources for Geometry Only				
GO-1	Aerial imagery from various public and private sources	Yes	No	Aerial imagery is a possible source to create road centerlines if none exist. Check with local, county, regional, state, provincial, or national Planning, Transportation, Public Works, Agriculture (NAIP), GIS departments, etc. Some have contracts with companies to provide aerial imagery on an annual or bi-annual basis. Sometimes these are offered via web services. Ask how often these are updated and use the most recent. There may be other commercial sources of imagery available for your area. Aerial imagery can also be used to identify new or missing road centerlines, but the main quality control is done in Phase 2.
Potential Sources for Attributes Only				
AO-1	MSAG tables from ALI service providers or PSAPs	No	Yes	MSAG tables likely will be available and can be used to help populate road centerline fields. Review and synchronization between the MSAG and GIS data will be needed in Phase 2.
AO-2	Address points from various public and private sources	No	Yes	Address points may be available from one or more jurisdictions or sources in your jurisdiction.

Group-Priority	Source	Geom	Attrib	Notes
AO-3	Tabular address information from utilities	No	Yes	Utilities may maintain their own address information in tabular format which can be used to assign road centerline address attributes. Often these databases can be considered proprietary and may have use restrictions. They may include addresses for utility infrastructure as well as habitable structures.
AO-4	Address grids or an addressing policy from local address authorities	No	Yes	In absence of more specific address point or road centerline address ranges, address grids can be used to assign theoretical address ranges, especially in more developed areas having block address assignments. Address grids define the beginning (zero) point and the block by block increment of addressing usually within an urban area. It may not always be clear how the grid fits the road segments, so one should be cautious in assignment.

Group-Priority	Source	Geom	Attrib	Notes
AO-5	Postal Services	No	Yes	These data sources can be useful, but are not authoritative and often incomplete. In the United States, the United States Postal Service (USPS) maintains an Address Management System that includes road names, delivery addresses, and postal community names along with potential road ranges for delivery. Access is through the Website Portal at https://tools.usps.com/zip-code-lookup.htm In Canada, Canada Post maintains address information that includes civic addresses, road names, community names, and postal codes. There is a free postal code lookup at https://www.canadapost.ca/info/mc/personal/postalcode/fpc.jsf Other postal data is available commercially, including postal code polygons and a Postal Code Conversion File which links 7-character postal codes to Statistics Canada geographic areas. In Mexico, the Correos de Mexico maintains the address information.

After gathering data for the foundation of the RCL layer, GIS Data Providers should determine whether the attributes will use a schema that supports all of the NG9-1-1 GIS Data Model [2] fields, or to maintain attributes in a more general schema that supports the needs of additional systems. If GIS Data Providers elect to follow the NG9-1-1 GIS Data Model [2] schema, the associated NG9-1-1 GIS Data Template, NENA-REF-006 [17], includes example template files, data structures, and automated scripts in both vendor specific and open-source formats. These resources may be useful in migrating the foundational data into the NG9-1-1 GIS Data Model [2] structure. If GIS Data Providers elect to use a non-NG9-1-1 specific schema, they will have to employ methods to translate the attributes into the NG9-1-1 GIS Data Model [2] schema. NGCS Providers may be able to supply, assist, or recommend other methods.

Table 5-2 below details the minimum attributes included in the NG9-1-1 GIS Data Model [2] schema that are recommended to be initially populated during the First Phase and be continually updated as needed (e.g., if an attribute or geometry changes, Date Updated

will need to be updated). The GIS Data Provider is responsible for building and maintaining attributes that can be migrated or translated into the NG9-1-1 GIS Data Model [2] schema.

Street names are often captured in source datasets as concatenated strings with unseparated street name elements. It may be helpful during the First Phase to import the full street name (e.g., "Boyer School Road," "N Main St") into a temporary field prior to separating (parsing) the street name elements into the NG9-1-1 GIS Data Model [2] schema fields. As early as possible in the process, whether in this phase or the Second Phase, the street name elements should be separated (parsed) to support the NG9-1-1 GIS Data Model [2] schema fields, with specific attention paid to the Data Model field data types and data domains. In general, parsed street name fields are easier to manipulate and the separate elements can easily be concatenated as needed.

Road centerlines, from sources GA-1 to GA-7, may be available with pre-existing address information and attributes listed in Table 5-2 below. If available, they should be captured during the First Phase. In some cases, the address information and other attributes may be available as point features or in tabular form, from sources AO-1 to AO-4. Occasionally the data will be readily incorporated into the road centerlines (e.g., MSAG tables) but, in general, the integration and synchronization of the attribute-only sources will be accomplished in the Second Phase.

Table 5-2 Road Centerlines Schema – First Phase Attributes

Responsible Roles: GIS Data Provider

Descriptive Name	Field Name	Required	Type	Field Width
Date Updated	DateUpdate	Yes	D	--
Left Address Number Prefix	AdNumPre_L	Conditional	P	15
Right Address Number Prefix	AdNumPre_R	Conditional	P	15
Left FROM Address	FromAddr_L	Yes	N	6
Left TO Address	ToAddr_L	Yes	N	6
Right FROM Address	FromAddr_R	Yes	N	6
Right TO Address	ToAddr_R	Yes	N	6
Street Name Pre Modifier	St_PreMod	Conditional	P	15
Street Name Pre Directional	St_PreDir	Conditional	P	9
Street Name Pre Type	St_PreTyp	Conditional	P	50
Street Name Pre Type Separator	St_PreSep	Conditional	P	20

Descriptive Name	Field Name	Required	Type	Field Width
Street Name	St_Name	Yes	P	254
Street Name Post Type	St_PosTyp	Conditional	P	50
Street Name Post Directional	St_PosDir	Conditional	P	9
Street Name Post Modifier	St_PosMod	Conditional	P	25
Legacy Street Name Pre Directional*	LSt_PreDir	Conditional	P	2
Legacy Street Name*	LSt_Name	Conditional	P	75
Legacy Street Name Type*	LSt_Typ	Conditional	P	4
Legacy Street Name Post Directional*	LSt_PosDir	Conditional	P	2
Country Left	Country_L	Yes	P	2
Country Right	Country_R	Yes	P	2
State or Equivalent Left (A1)	State_L	Yes	P	2
State or Equivalent Right (A1)	State_R	Yes	P	2
County or Equivalent Left (A2)	County_L	Yes	P	100
County or Equivalent Right (A2)	County_R	Yes	P	100
Additional Code Left	AddCode_L	Conditional	P	6
Additional Code Right	AddCode_R	Conditional	P	6
Incorporated Municipality Left (A3)	IncMuni_L	Yes	P	100
Incorporated Municipality Right (A3)	IncMuni_R	Yes	P	100

* Used in Legacy Systems and is not used in a full NG9-1-1 implementation

As features are created or modified (geometry and/or attributes), required attributes (e.g., Date Updated) must also be updated. If features are created, modified, or deleted, metadata must be documented. See Section 4.4 Metadata for more details.

5.5.2 Second Phase – Modify and Refine the Civic Location Layers

In order to ensure that the RCL layer properly supports the LVF and ECRF, it will be necessary to assess the completeness and quality of the attributes and geometry within the RCL layer, and ensure any address geocoded to a road centerline results in only a single location along the road centerline. This may require additional assessments to consider a community name, county, and state along with the address number and the full street name.

Subsequent assessments can iteratively improve the completeness and quality of the RCL layer. These assessments typically involve geocoding tabular lists of authoritative addresses, such as the ALI lists, the tabular address of site/structure address points, and ancillary tabular service address lists from utility companies and communication service providers.

Table 5-3 below identifies the place name attributes included in the NG9-1-1 GIS Data Model [2] schema that are recommended to be populated during the Second Phase. The GIS Data Provider may need to consult with their 9-1-1 Authority for assistance and clarity on how to best complete the recommended attribution and whether fields that are not required to be populated, as per the NG9-1-1 GIS Data Model [2], do need to be populated for local use.

Table 5-3 Road Centerlines Schema – Second Phase Attributes

Responsible Roles: GIS Data Provider and 9-1-1 Authorities

Descriptive Name	Field Name	Required	Type	Field Width
ESN Left*	ESN_L	Conditional	P	5
ESN Right*	ESN_R	Conditional	P	5
MSAG Community Name Left*	MSAGComm_L	Conditional	P	30
MSAG Community Name Right*	MSAGComm_R	Conditional	P	30
Unincorporated Community Left (A4)	UnincCom_L	No	P	100
Unincorporated Community Right (A4)	UnincCom_R	No	P	100
Neighborhood Community Left (A5)	NbrhdCom_L	No	P	100
Neighborhood Community Right (A5)	NbrhdCom_R	No	P	100
Postal Code Left	PostCode_L	No	P	7
Postal Code Right	PostCode_R	No	P	7
Postal Community Name Left	PostComm_L	No	P	40
Postal Community Name Right	PostComm_R	No	P	40

* Used in Legacy Systems and is not used in a full NG9-1-1 implementation

As features are created or modified (geometry and/or attributes), required attributes (e.g., Date Updated) must also be updated. If features are created, modified, or deleted, metadata must be documented. See Section 4.4 Metadata for more details.

5.5.2.1 RCL Layer to MSAG Comparison

If the PSAP has implemented E9-1-1 and an MSAG, one of the most useful steps in assessing the RCL layer involves a comparison of road centerlines to their corresponding MSAG records. The objective is to synchronize the MSAG and RCL layer, per the requirements detailed in the NENA Information Document for Synchronizing Geographic Information System Databases with MSAG & ALI, NENA 71-501 [18]. This will involve comparing both the road names and address information across the two datasets, resolving discrepancies, and documenting those that cannot be resolved. Assessing completeness and quality of road centerline attributes requires the legacy street name attributes to be entered in the First Phase along with the road centerline address attributes.

Potential discrepancies that may be identified in the comparison can include street name misspellings, inconsistencies in street names, address value discrepancies, invalid street names, and community name errors due to the disparate nature of independently maintained datasets.

An RCL layer, with discrepancies resolved and verified as accurate, can be used as a source to correctly geocode any address falling within the range of address values for a road contained in the MSAG. Along with the SSAP layer, it is one of the source layers to geocode ALI address records and related address record databases, as detailed below in Section 5.5.2.2 ALI to RCL Layer and Other Address List Comparison. All place name fields should be considered when geocoding an address. The MSAG Community is the primary legacy place name. Due to the non-standardized way E9-1-1 was implemented, the MSAG Community Name may be equivalent to an Incorporated Municipality, a Neighborhood Community, an Unincorporated Community, or a Postal Community Name. Some or all of these will need to be populated to ensure uniqueness.

5.5.2.2 ALI to RCL Layer and Other Address List Comparison

The process of comparing the RCL layer to the ALI database may be initiated with a legacy services provider or by each agency with access to their own ALI database. The ALI is a database of fixed wire telephone subscriber addresses in tabular format. The addresses in the ALI are typically provided by the incumbent local exchange carrier. It is the most important address list to compare to the RCL layer to ensure continuity between legacy 9-1-1 and NG9-1-1 so that all telephone records are accounted for in the transition process. It is recommended to investigate ALI addresses that do not geocode to road centerlines within the RCL layer to determine whether the ALI records or RCL layer needs correction. The ALI and RCL datasets should be properly reconciled.

Additional address lists are potentially available for geocoding and are beneficial to improving completeness and consistency of the RCL layer. The SSAP layer is another address source that can be synchronized with the RCL layer to improve completeness and accuracy. Other sources of civic address lists include regional and national

telecommunications companies (e.g., VoIP), exchange carriers, utility companies, and local governments.

5.5.2.3 Neighboring 9-1-1 Authority Coordination

It is important to identify conflicting data issues that may impact neighboring authorities so that the geometry and attributes line up at the boundaries, addresses are not duplicated, place names are accurate, and street name issues are identified. This requires coordination with neighboring 9-1-1 Authorities, PSAPs, and GIS Data Providers at the borders of a PSAP's responsibility area. If not already completed, this is an opportune time to coordinate and develop snap-to-points along the shared boundaries with neighboring jurisdictions as described in Section 3.3.2 Snap-to-Points.

5.5.3 Third Phase – NG9-1-1 Readiness Support – Add Third Phase Attributes

In the Third Phase, the remaining required fields identified in Table 5-4 below from the Road Centerlines schema in the NG9-1-1 GIS Data Model [2] must be populated. These fields will be used by the NGCS Provider to support location validation and call routing. They should be populated by the GIS Data Provider based on guidance through discussions with the 9-1-1 Authority and the NGCS Provider.

Table 5-4 Road Centerlines Schema – Third Phase Attributes

Responsible Roles: GIS Data Provider, 9-1-1 Authorities, and their NG9-1-1 Core Services Provider

Descriptive Name	Field Name	Required	Type	Field Width
Discrepancy Agency ID	DiscrpAgID	Yes	P	100
NENA Globally Unique ID	NGUID	Yes	P	254
Parity Left	Parity_L	Yes	P	1
Parity Right	Parity_R	Yes	P	1

The remaining fields in the NG9-1-1 GIS Data Model [2] may be needed to support map display, vehicle routing, or civic location validation. These fields are shown in Table 5-5 below.

Important: The Validation Left and Validation Right attributes are not required to be populated but may be used by the NGCS Provider to support validation by the LVF (and not used by the ECRF). These fields do not affect routing of emergency calls, nor display of GIS data. They control how the LVF determines its response when an address does not match an address point but is within a valid range of a road centerline.

If an "N" value is entered as an attribute value for one of these fields for a particular road centerline, the LVF will ignore that record for validation purposes. A "Y" value (or if the field is not populated) will result in that record being available for validation. Range-based addressing can result in false positives during a validation process. For example, if a submitted address falls within the range of address attribute values for a road centerline, then it will be considered valid even if that specific address does not exist. For a specific road centerline, using the "N" value as an attribute in one of the validation fields will instruct the LVF that the Address Number should only be validated using the SSAP layer and ignore the range-based addressing of the road centerline. Doing so will enhance the accuracy of the customer address data being submitted by originating service providers by only validating those that match a record in the SSAP layer. This overcomes a limitation in the existing E9-1-1 system, which is purely address range based. A more detailed description of the Validation Left and Validation Right fields can be found in the NG9-1-1 GIS Data Model [2].

Discussions of Validation Left and Validation Right use can be found in the following sections of this document:

- Section 5.4.10.3.1 Coincident (Stacked) Road Centerlines Method
- Section 5.4.10.3.2 Parallel Road Centerlines Method

Population of some of these fields may require guidance from a system administrator or the NGCS Provider, if implemented.

Table 5-5 Road Centerlines Schema – Remaining Attributes

Responsible Roles: GIS Data Provider and 9-1-1 Authorities

Descriptive Name	Field Name	Required	Type	Field Width
Effective Date	Effective	No	D	--
Expiration Date	Expire	No	D	--
Road Class	RoadClass	No	P	15
One-Way	OneWay	No	P	2
Speed Limit	SpeedLimit	No	N	3
Validation Left	Valid_L	No	P	1
Validation Right	Valid_R	No	P	1

As features are created or modified (geometry and/or attributes), required attributes (e.g., Date Updated) must also be updated. If features are created, modified, or deleted, metadata must be documented. See Section 4.4 Metadata for more details.

6 Service Boundary Layers

Service Boundary polygons show the geographic extent for an agency, such as a PSAP or responder agency. Service Boundaries are used by the ECRF during routing requests, and they are used by the LVF to validate whether a given location is routable.

Two fields within Service Boundaries that are required to facilitate call routing in NG9-1-1 are the "Service URN" and "Service URI." When a location is queried in a LVF or ECRF, this query specifies the requested service, using a "Uniform Resource Name" or URN. The Service URN identifies a category of resource (e.g., PSAP, police, fire, EMS, Coast Guard, State Police) within an Emergency Services IP Network (ESInet). As defined by NENA standards, Service Boundaries must be attributed with specific URN values that are registered with IANA as part of their urn:emergency:services registries. The most commonly used values are:

- PSAP – "urn:emergency:service:sos.psap"
- Police – "urn:emergency:service:responder.police"
- Fire – "urn:emergency:service:responder.fire"
- EMS – "urn:emergency:service:responder.ems"

The ECRF then performs a spatial query using the Service URN at the given location. If a feature is found, the network location for that service is returned as a "Uniform Resource Identifier" or URI. The Service URI identifies the network location for the responder agency and is used to route the call to that agency.

For a complete detailed functional and interface specification for LVFs or ECRFs, please refer to the NENA i3 Standard for NG9-1-1 [4].

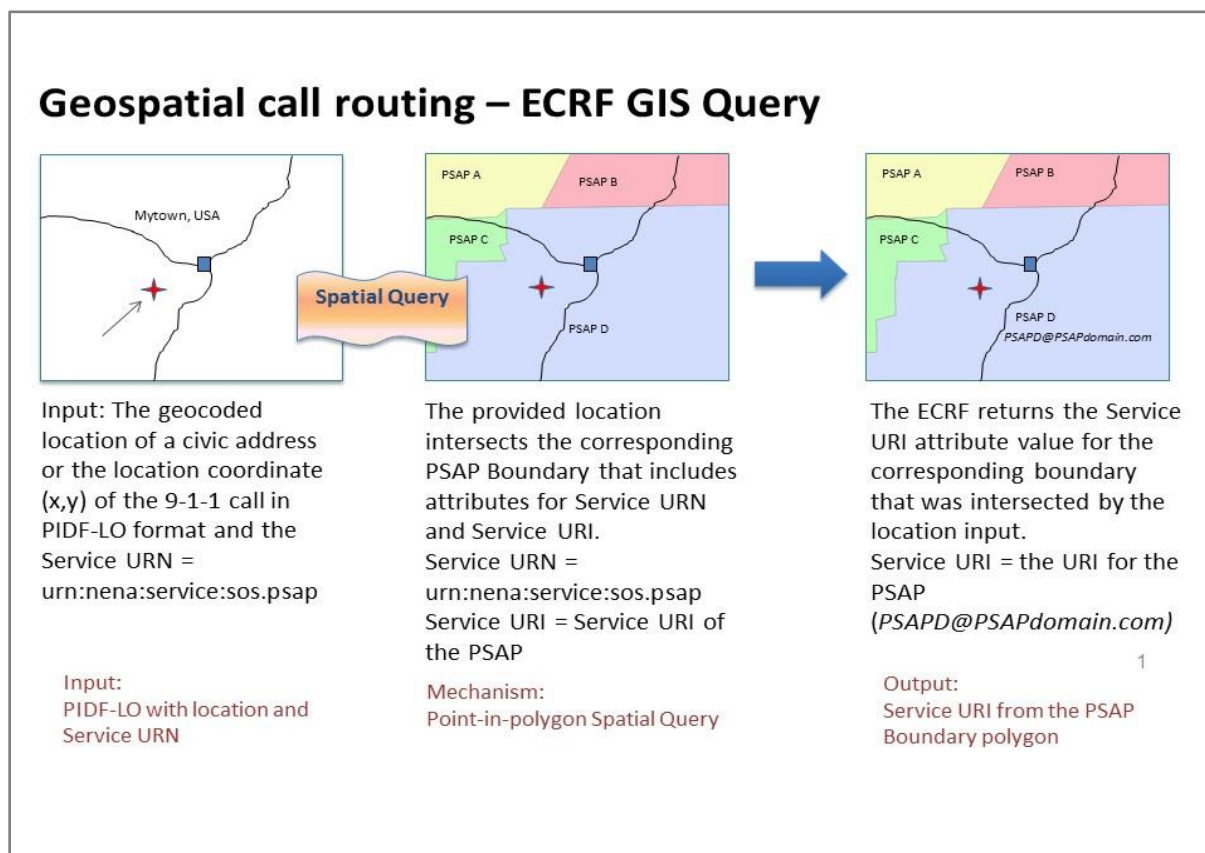


Figure 6-1 GIS Query for Geospatial Call Routing

6.1 Relationship of Legacy ESN/ESZ to Service Boundaries

It can be difficult to understand the relationship between legacy 9-1-1 and NG9-1-1 functionalities. The relationship between legacy Emergency Service Numbers (ESN) and their associated Emergency Service Zones (ESZ), and Service Boundaries utilized in NG9-1-1 is one of the easier relationships to explain, as they both deal with call routing and response boundaries.

6.1.1 Legacy ESZ/ESN

In an E9-1-1 environment, an Emergency Service Zone is a geographic area that is typically contiguous to other areas and is serviced by a specific PSAP, Police, Fire, and EMS Service. The intersection of the overlapping emergency service areas is an ESZ. An ESZ is assigned to an ESN. An ESN is a unique identifier which is used for tabular based routing in a selective router. A Selective Router determines where to route the call based on a tabular lookup, not a spatial query.

An ESZ/ESN has two different functions:

- route a 9-1-1 call to the assigned PSAP, either directly or as a transfer

- provide the proper emergency response service agency(ies)

6.1.2 Relationship of Legacy to NG9-1-1

Legacy ESN/ESZ and NG9-1-1 Service Boundaries are used for the same primary purposes: to route 9-1-1 calls to the appropriate PSAP and to define the response agencies; albeit in NG9-1-1 with greater accuracy and timeliness. Legacy ESN/ESZ utilizes a tabular query to route calls and identify responders, whereas NG9-1-1 utilizes a spatial query to route calls and identify Service Boundaries.

6.1.3 NG9-1-1 Service Boundaries

Service Boundaries define the geographic area of the primary providers of response services. There is a separate Service Boundary layer for each type of service. At a minimum, there must be a Service Boundary layer for the following: PSAP, Police, Fire, and Emergency Medical Services. Additional Service Boundaries may include but are not limited to: Poison Control, Forest Service, and Animal Control.

The primary use for the Services Boundaries is to route calls. The ECRF uses a spatial query that intersects the location of the call (whether civic or geodetic [latitude/longitude]) to the associated Service Boundary and is used to route the call to the appropriate agency.

Nomenclature clarification: The original NENA Standard for NG9-1-1 GIS Data Model, NENA-STA-006.1 makes reference to a "PSAP Boundary" and "Emergency Service Boundaries," however, Appendix B of the NENA i3 Standard for Next Generation 9-1-1, NENA-STA-010.3-2021 [4] refers to these boundaries more generically as "Service Boundaries." Version 2 of the NENA Standard for NG9-1-1 GIS Data Model, NENA-STA-006.2-2022 [2], dropped "Emergency" references and now aligns with the Service Boundaries terminology. This document makes reference to Service Boundaries generally to indicate both the Service Boundaries that represent PSAPs and Service Boundaries that represent response agencies. In areas where a distinction needs to be made to add clarity to text there are references to "Service Boundaries for PSAPs" and "Service Boundaries for response agencies," these references may be singular or plural based on the context of the text.

6.2 Service Boundaries for PSAPs

6.2.1 Description

The boundary that defines the geographic area for which a Public Safety Answering Point (PSAP) has emergency request/call handling responsibility.

6.2.2 Purpose

This layer depicts the polygon(s) and related attribute information that defines the geographic area of all Service Boundaries for PSAPs within a given 9-1-1 Authority's geographic coverage area. The Service Boundaries for PSAP layer may have one or many

PSAP Boundaries contained in the layer. Each Service Boundaries for PSAP defines the geographic area of a PSAP that has primary responsibilities for an emergency request. A geographic location can only have one designated primary PSAP. This layer is used by the ECRF to perform a geographic query to determine to which PSAP an emergency request is routed. An emergency request is routed within the i3 core elements based upon the geographic location of the request, provided by either a civic address, or geographic coordinate or geodetic shapes as defined in the NENA i3 Standard for NG9-1-1 [4], or the current NENA i3 Standards document.

6.2.3 Intended Use

From a practical standpoint, Service Boundaries for PSAPs should reflect the geographic extent for which a PSAP has 9-1-1 emergency request responsibility. Defining and agreeing on these shared boundaries could be challenging and may require the cooperation of PSAP Authorities and local responding agencies. In addition, Service Boundaries for PSAPs attributes need to reflect current, accurate, and routable Service URNs and Service URIs.

The primary use for Service Boundaries for PSAPs is to route call/emergency requests for NG9-1-1. In NG9-1-1, Service Boundaries for PSAPs will be provisioned by the SI to the ECRF and LVF. Call routing in the i3 environment is a function of spatial queries and boundaries. The ECRF uses a spatial query that intersects the location of the call/emergency request to the Service Boundary for PSAPs and is used to route the call/emergency request to the appropriate PSAP. A call/emergency request location may either have a location based on geocoding (geocoding from road centerline or address point or address polygon) or a geographic coordinate (latitude/longitude).

To ensure that Service Boundaries for PSAPs are usable for NG9-1-1, it is critical that Service Boundaries for PSAPs are free from gaps and overlaps and consider topological relationships.

6.3 Service Boundaries for response agencies (Police, Fire, EMS, and others)

6.3.1 Description

The boundaries that define the geographic area for the primary providers of response agency services, such as Police, Fire, EMS, and others; these may differ from legal boundaries.

6.3.2 Purpose

Service Boundaries for response agencies should reflect the geographic extent for which an agency has responsibility.

As stated in the NG9-1-1 GIS Data Model [2], the set of Service Boundaries for response agencies MUST include, at a minimum, the following layers:

- Police

- Fire
- Emergency Medical Services

Other Service Boundaries MAY be included based on the unique needs of the 9-1-1 Authority. These could include, but are not limited to:

- US Coast Guard
- Animal Control
- Tow Companies

6.3.3 Intended Use

Each Service Boundary layer for a response agency is used by NG9-1-1 systems to identify responding agencies, based on Service URN, for a geographic area. When a 9-1-1 call is placed, the Emergency Service Routing Proxy (ESRP) initiates a LoST query to the ECRF. The ECRF performs a spatial query to determine which responding agency is responsible for providing service to the location of a caller or incident. During a 9-1-1 call, a Functional Element at an agency may make additional queries to an ECRF to determine a response agency.

Examples of uses for Service Boundaries for response agencies include:

- Identify the agency to route/transfer 9-1-1 Calls (voice/text) depending on type of emergency service needed.
- Identify the agency to route/transfer 9-1-1 Non-Interactive Calls (from an alarm alert such as fire alarm) depending on type of emergency service needed.
- Identify the agency to route/transfer "Incident Data," as may be found in an Emergency Incident Data Object, depending on type of emergency service needed.

6.4 Service Boundary Requirements

The following requirements apply to all Service Boundary layers, regardless of type:

6.4.1 No Gaps or Overlaps

Service Boundaries should not have unintentional gaps or overlaps with neighboring Service Boundaries of the same Service URN and differing Service URIs. A location that falls within a gap would mean that the ECRF is unable to use the Service Boundary layer to identify which agency should receive the call. Similarly, a location that falls within an area of overlapping Service Boundaries with the same Service URN and differing Service URIs would mean that the ECRF will struggle to correctly determine which emergency service agency should receive the call. Gaps and/or overlaps between neighboring Service Boundaries with the same Service URN and differing Service URIs should be reconciled in order to ensure proper functioning of the layer when used in the LVF and ECRF.

Figure 6-2 below depicts overlapping Service Boundary features that come from different sources. In the larger map, the boundaries appear to align, however the inset clearly shows that the boundaries overlap one another. When aggregating data from different sources there may be gaps and/or overlaps. If you are using US Census TIGER files, they don't have gaps or overlaps and can be used as a starting point, or reference layer, for creating topologically clean Service Boundaries, especially for agencies that generally cover an entire county. For any reference datasets used, a best practice is to verify that the topology is clean.

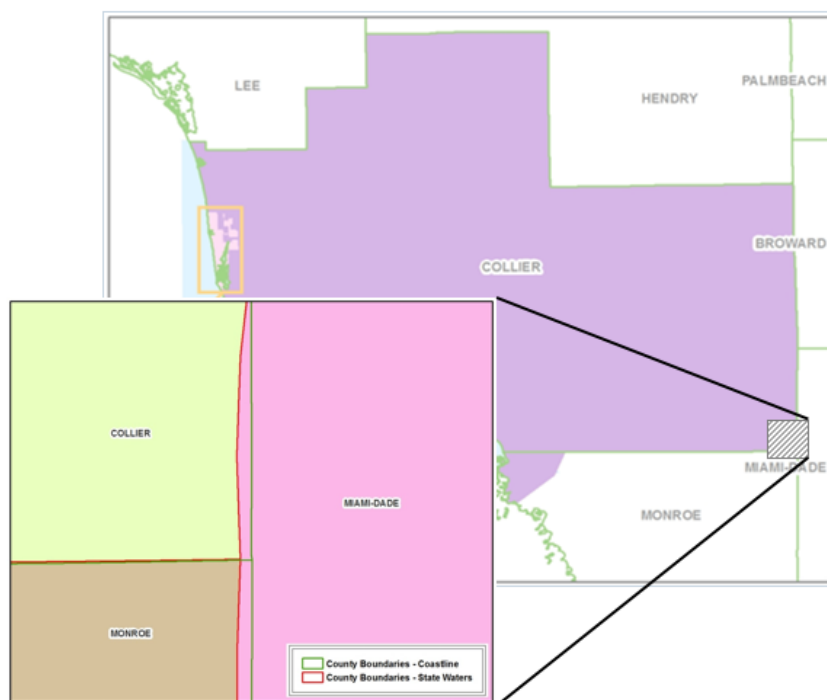


Figure 6-2 Differently Sourced County Boundaries Resulting in Overlapping Service Boundaries

6.4.2 Common Boundaries Along State and/or International Borders

For common boundaries along state/or international borders, the reference layer used will need to be edge-matched across the boundary. Ensuring that reference layers are edge-matched decreases unintentional gaps and overlaps.

If neighboring 9-1-1 Authorities from both states agree that a Service Boundary should extend in either direction beyond this boundary, then a new polygon can be carved out on that side of the boundary and correctly attributed.

Service Boundary splits will naturally occur where an NG9-1-1 GIS Data Model [2] attribute value changes, such as state and/or country.

Figure 6-3 below shows an example of a Service Boundary for PSAPs, but is equally applicable to any Service Boundary.

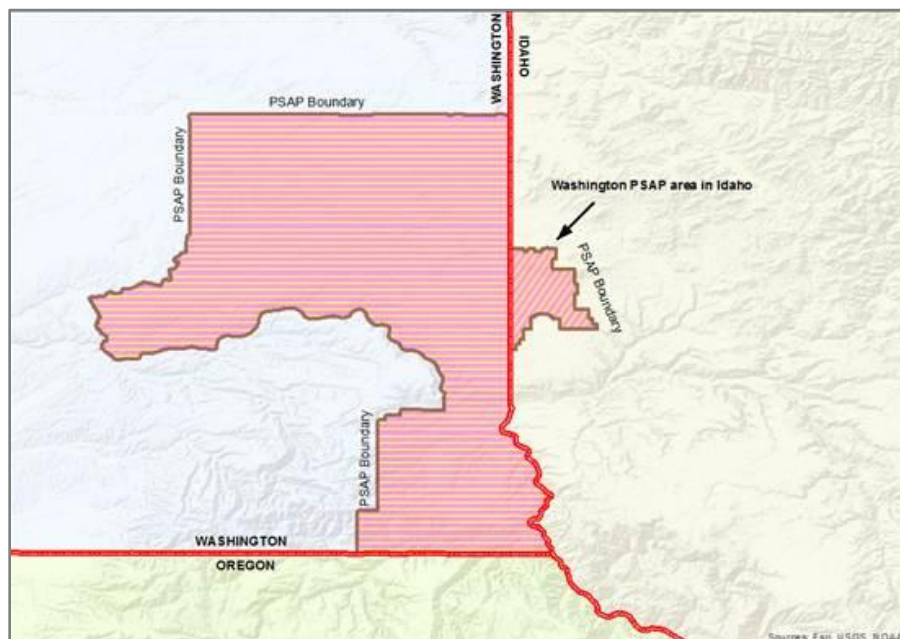


Figure 6-3 Splitting Service Boundaries for PSAPs at State or International Borders

6.5 Considerations When Developing Service Boundary Layers

Conditions or limitations that determined how E9-1-1 Service Boundaries were drawn, may not exist in NG9-1-1 and how the boundaries are depicted may need to be reconsidered.

The boundaries of many Service Boundaries today can be approximated by other boundaries that represent the extent of a defined geographic entity such as a county, city, town, or township. However, Service Boundaries should not be confused with these administrative or jurisdictional boundaries. When creating Service Boundaries for NG9-1-1, it will be important to consider any existing agreements impacting how 9-1-1 calls are routed today. In some instances, these may be formal agreements between 9-1-1 Authorities defining their areas of responsibility. However, in many cases, this will be more informal, relying upon how the two 9-1-1 Authorities have chosen to represent call routing in today's MSAG ESN values.

Historical considerations include, but are not limited to:

- Existing extent of the area for which the PSAP receives calls based on the MSAG
- More efficient location-based PSAP call routing (i.e., to minimize transfers)
- Legacy wireline telecommunications boundaries such as Local Exchange Carrier or Local Access Transport Area boundaries

- Fire/EMS/Police response zones or Emergency Service Zones (ESZs)
- Radio dispatch coverage areas
- Areas with automatic mutual aid or mutual-dispatch (i.e., CAD2CAD) agreements
- Natural or manmade geographic features that serve as natural breaks for handling or responding to calls for service (e.g., mountain ridges, bodies of water, levees)
- Other administrative boundaries (e.g., military bases, national parks or forests, universities)

6.5.1 Service Boundaries Do Not Always Follow Jurisdictional Boundaries

While several PSAPs and response agencies provide service for a single jurisdiction (e.g., city, county, and township), Service Boundaries may not precisely follow legal or jurisdictional boundaries. When this occurs in a place where Service Boundary layers do not exist, it is very easy to assume an individual Service Boundary serves the same area as the jurisdiction boundary. This assumption can lead to confusion as to which PSAP or other agency is responsible for a given area. The coverage area for each Service Boundary should not be assumed, and coordination between neighboring 9-1-1 Authorities will be needed to correctly depict each Service Boundary.

In Figure 6-6 below, the Service Boundary for PSAPs for Collier County, FL, is shaded in purple; a red border denotes the county boundaries. Calls from extreme northwestern Monroe County are not handled by the PSAP in Monroe County, but should instead be routed to the Collier County PSAP. While the Collier County PSAP primarily serves the geographic area of Collier County, the Service Boundary for PSAPs should NOT be confused with the jurisdictional boundary. In this example, this portion of Monroe County can be “cut out” from the existing Monroe County polygon and attributed correctly so it will route to the Collier County PSAP instead. Resolving this type of scenario will require working with the neighboring PSAP.

While the example above refers to a Service Boundary for PSAPs, a similar situation can occur for any Service Boundary and can be resolved in a similar fashion.

It is important to note that many Agency boundaries may have associated formal legal descriptions that define the geographic description of the recorded boundary. These legal descriptions may utilize Government Lands Surveys such as Public Land Survey System (Township/Range/Section), Metes and Bounds (distance and direction coordinates), or they may reference parcel base descriptions such as Lots and Blocks or individual parcel numbers. In older legal descriptions, natural features were often used to define and describe legal boundaries such as rivers, mountain ridges, or other naturally occurring features which relocate over time. A legal description may contain a combination of these various types of boundary descriptions.

Service Boundaries are created to coordinate 9-1-1 responses and do not necessarily represent legally defined boundaries. Legal descriptions may provide an authoritative resource to develop the Service Boundary. A boundary described by the recorded legal description may vary greatly from what the local agency perceives as their service boundary. Differences may be due to official Memorandums of Understanding (MOUs) defining a different Response Area, or in some cases, may be based on local agreements that have not been formalized – often known as “handshake agreements.” These types of agreements, whether formal or informal, may change the “functional” boundary of a given provider by modifying their response area to geographic areas that vary from their legal boundary description. Legal Description boundaries can be maintained for other purposes; however, Service Boundaries should reflect geographic areas of response.

6.5.2 Shorelines Shouldn’t Be Used to Depict Service Boundaries

Emergencies don’t just occur on dry land. When a caller is on a major body of water or on a bridge over a body of water, it will be necessary to know which PSAP should receive the call and which response agencies are available to respond to a call from that location. As a result, Service Boundaries SHOULD cover all waterbodies. For Service Boundaries that cover offshore waters, the Service Boundaries should generally include all offshore waters that are included in the TIGER features for the county or state. Since the TIGER dataset already includes these offshore waters, it makes sense to consistently use the offshore extent from these features when depicting service boundaries along coastal areas. If neighboring service boundary jurisdictions do not require higher resolution offshore water layers, it makes sense to consistently use the offshore waters that are included in the TIGER features for the county or state when depicting Service Boundaries along coastal areas. This will enable a more consistent coverage for coastal Service Boundaries across the country.

Figure 6-4 below shows two renderings of a county boundary. The first boundary has a very detailed shoreline, and the second has a more generalized boundary that extends to include coastal waters. The second option is preferred for Service Boundaries because it ensures that calls from offshore will get routed to a PSAP. From there, the PSAP can use Service Boundaries for response agencies to determine which agencies might be able to respond to that location. For example, if the call should be transferred to another agency with marine resources such as the US Coast Guard, then a Service Boundary for that response agency should be available to facilitate the handling of the call.

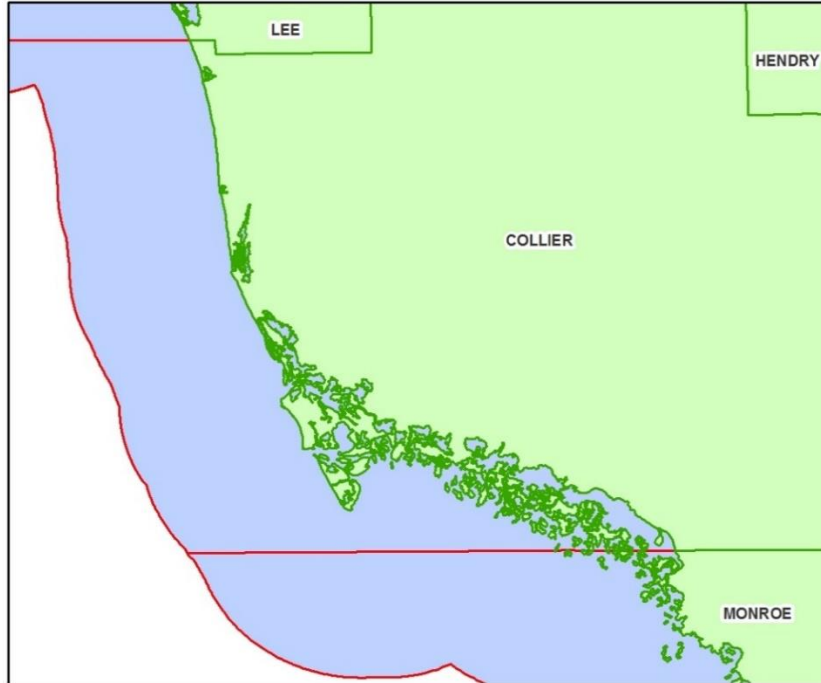


Figure 6-4 Extending Service Boundaries Beyond Shorelines

The TIGER files not only delineate offshore waters, they also draw simpler lines to denote the county and state boundaries in interior waters such as the Great Lakes, or in larger bays, sounds or bodies of water such as the Chesapeake Bay or Puget Sound.

Note: The only times when a shoreline should be used to delineate a Service Boundary are when two neighboring 9-1-1 Authorities agree to use the shoreline as their shared boundary, or when no agency for the given Service URN would handle the call past the shoreline.

6.5.3 Policy Routing Rules

As stated in the NENA NG9-1-1 Policy Routing Rules Operations Guide, NENA-INF-011.2-2020 [19], in a NG9-1-1 system, "Policy Routing Rules (PRRs) are a powerful tool that allow 9-1-1 authorities to address a wide range of operational situations to ensure 9-1-1 calls are delivered to a PSAP that can provide assistance consistent with established mutual aid agreements. . . . The NENA NG9-1-1 Policy Routing Rules Operations Guide outlines guidance to enable multi-layered call treatment policies for call diversion within NG9-1-1 using PRRs that will provide more options to a PSAP to divert calls to another destination based upon multiple conditions defined in the PRRs."

Policy Routing Rules will likely affect the creation and maintenance of Service Boundaries. Call diversion, alternate call routing, and mutual aid agreements that do not pertain to the entire geographic extent of a service boundary may require splitting boundaries into two or

more areas (polygons) to reflect these policies. It is important to document these call diversion policies and mutual aid agreements during the first phase of developing service boundaries and then refine the boundaries to reflect their requirements. A likely impact of the implementation of Policy Routing Rules is a more complex and granular set of service boundaries. They heighten the importance of collaboration and coordination with your neighboring jurisdictions and the responding agencies.

Figure 6-5 below provides an example of how Service Boundaries can be split to accommodate Policy Routing Rules used by the ESRP.

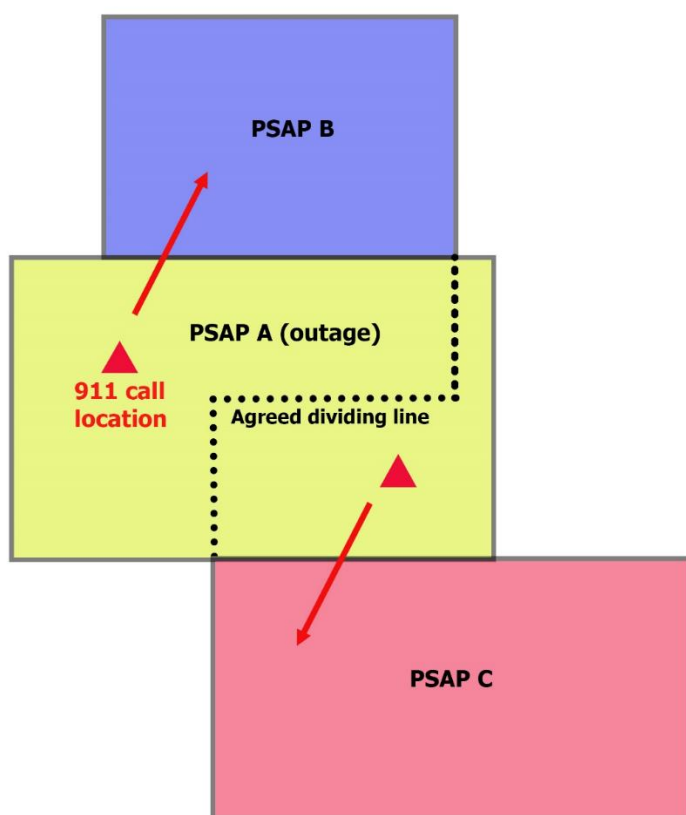


Figure 6-5 Splitting of a Service Boundary for PSAPs to Reflect Policy Routing Rules

In this example, if PSAP A cannot receive calls, Policy Routing Rules can be established beforehand so calls from PSAP A can be automatically diverted to another PSAP based on many criteria. To facilitate this, the Service Boundary for the PSAP boundary has been split into two individual features along the mutually agreed dividing line to allow the Policy Routing Rules to be applied so calls from PSAP A can be diverted to PSAP B and PSAP C.

6.6 Recommendations for Service Boundary Layers

In most cases, 9-1-1 Authorities may already have GIS data that supports E9-1-1, but many may not have existing layers for Service Boundaries (e.g., PSAP, Police, Fire, EMS). Because of this, it will be important for 9-1-1 Authorities to create Service Boundaries that depict the coverage areas.

6.6.1 Use State or County Level Boundaries from the US Census as a Starting Point

While there is typically better feature resolution in local or state datasets, it will be challenging to start with smaller datasets, aggregate them over a larger area, and then coordinate the edge-matching of neighboring service boundary features to resolve gaps and overlaps. There are various data sources to aid in this process and data availability will vary per state (e.g., some states have authoritative county boundaries). One recommendation would be to use US Census TIGER state or county boundaries as a starting point for delineating service boundaries. This dataset is suggested for several reasons:

- US Census Boundaries do not contain gaps or overlaps, even when re-projected
- US Census Boundaries extend beyond the shoreline to include coastal waters
- US Census Boundaries cover the entire United States
- US Census Boundaries are politically neutral, which can facilitate the coordination process

It is important to note that a statewide County Boundary dataset usually has greater precision than one available through US Census Bureau.

6.6.2 Keep It Simple... “Cut It Out”

In many cases, Service Boundaries can be approximated by a county boundary, however there are often several PSAPs or response agencies within a given county. Instead of drawing each service boundary from scratch, it may be easier to start with the existing TIGER county boundary and use GIS editing tools to “cut out” a new polygon for each agency located within the county. In Figure 6-6 below from Collier County, FL, most of the county is served by the Collier County PSAP. However, there is also a separate PSAP for the City of Naples. There are a few GIS tools that can be used to “cut out” the area in the city from the polygon for the county to create separate polygons for both PSAPs.

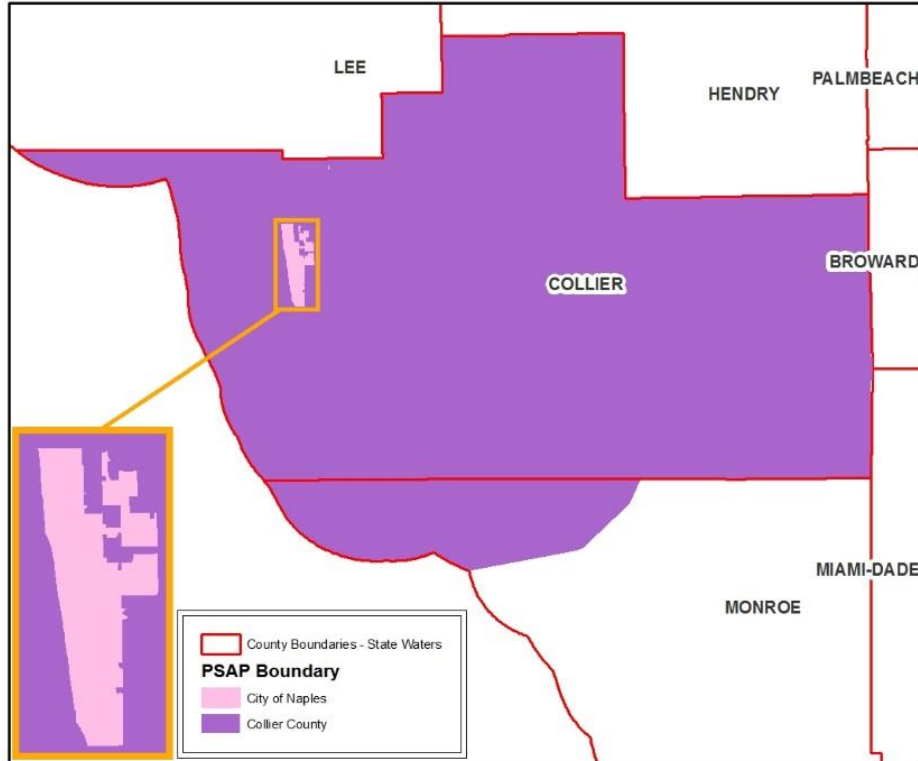


Figure 6-6 Using GIS Tools to Cut Out Existing Polygons

6.6.3 Maintenance Lines to Depict the Edge of Boundaries

NG9-1-1 Service Boundaries are represented as GIS polygons. Typically, a boundary represents a series of agreements between neighboring jurisdictions. Using multiple line features to create and document a boundary, rather than one polygon, allows the source and metadata to be more easily recorded for each of these agreements. Typically, many portions of these polygons are formed from other source datasets such as road centerlines, administrative boundaries, legislative boundaries, water features, and other reference lines and points, as well as raster datasets such as orthoimagery and bare ground digital elevation models depicting geographic topography. Maintenance lines can be used to construct the boundary polygon, and the lines and edges of the polygons should be coincident.

Documenting the source of data forming Service Boundaries is important to defining collaborative agreements. Line features can assist in validating correct topology, avoiding gaps or overlaps when a line is used between two or more jurisdictions. It is recommended that the data providers follow the phased approach as outlined in the next section enabling the line features to be created and maintained throughout all phases.

Maintenance of line features for polygon boundaries is a best management practice and is not defined as a layer in the NG9-1-1 GIS Data Model [2], as such there is no required or recommended schema associated with them.

Suggestions for attributes include:

- Capturing the Service Boundary Agency ID to be able to tie each line back to the agencies whom are involved with the maintenance of each section of the lines.
- References to Memoranda of Understanding
- Dates of Agreements
- It is important to identify the points where jurisdictions change along the polygon boundaries; these occur at snap-to-points such as junctions.

Maintenance lines help facilitate collaboration. Collaboration between jurisdictions typically involves two or more jurisdictions sharing common boundary segments and/or snap-to-points. Collaborative sessions are most effective in person or via screen sharing sessions. Agreement on shared edges and snap-to-points may occur during one or more collaborative sessions. A best practice is to structure the data sharing in a manner that does not require specific GIS software or licensing level for a specific GIS software to contribute to the self-service data sharing. Examples of using maintenance lines to reflect mutual agreement with neighbors and to create polygons for use in NG9-1-1 Systems can be found in Virginia's NG9-1-1 deployment; information related to the method used can be found at <https://vgin.vdem.virginia.gov/pages/ng9-1-1-gis>.

6.7 Phased Approach for Creating Service Boundaries

Service Boundaries have use cases for E9-1-1, NG9-1-1, and transitional states between both, and as they can be continually refined, it is recommended that these layers are created and updated in a phased approach. The recommended phases are:

- First Phase – Initial Development
- Second Phase – Modification and Refinement
- Third Phase – Preparing the Layer for NG9-1-1 Requirements

The NG9-1-1 GIS Data Model [2] describes the schema and field definitions for Service Boundary layers. This schema can be extended and applied to the phased approach in order to populate field attributes at the most relevant time. When creating Service Boundaries using the phased approach, it is recommended that some attributes are populated in the First Phase by the GIS Data Provider while the remaining fields are populated in the Third Phase by the GIS Data Provider in coordination with their 9-1-1 Authority and NGCS Provider. The primary goal of the phased approach is to front load data development and refinement work so that some coordination issues can begin to be addressed prior to selecting an NGCS Provider. While this approach is not a requirement, it is strongly recommended because it provides neighboring 9-1-1 Authorities an opportunity to identify and resolve Service Boundary placement concerns prior to NG9-1-1 deployment.

Additionally, it helps to ensure that some baseline GIS layers are available when the 9-1-1 authority begins to work with their chosen NGCS Provider.

6.7.1 First Phase – Initial Service Boundary Development

The First Phase of Service Boundary development is an iterative process and focuses on acquiring or developing initial layers that will be refined throughout.

The purpose of the First Phase is to create initial GIS data layers that can roughly define the footprints of the participating PSAP(s) and response agencies' Service Boundaries. These preliminary layers will be a coarse representation of the Service Boundary coverage areas derived from existing data sources and institutional knowledge. These initial GIS data layers will be further modified and refined during subsequent phases. All Service Boundaries should be developed in a coordinated manner.

This first phase layer development requires minimal attribute population. Once Service Boundaries are created, the GIS Data Provider is responsible for populating the attributes listed in Table 6-1 below. For required fields, the GIS Data Provider should work with the 9-1-1 Authority and NGCS Provider to ensure that field values work with their vendor's NGCS system, this may also be addressed in the Third Phase of development.

Table 6-1 Service Boundary Schema – First Phase Attributes

Responsible Roles: GIS Data Provider

Descriptive Name	Field Name	Required	Type	Field Width
Date Updated	DateUpdate	Yes	D	--
Country	Country	No	P	2
State or Equivalent (A1)	State	No	P	2
Service URN	ServiceURN	Yes	P	50
Display Name	DsplayName	Yes	P	60

6.7.1.1 Considerations for PSAPs

The First Phase is to determine and/or obtain a suitable dataset that can roughly define the footprints of the participating PSAPs. This preliminary dataset will be a coarse and approximate representation of the PSAP's coverage area derived from existing data sources that will be further modified and refined during subsequent phases.

In some instances, 9-1-1 Authorities may have an existing PSAP boundary layer; however, in many cases, 9-1-1 Authorities may not have a specific layer for PSAP boundaries. This is a typical scenario, especially when the PSAP provides 9-1-1 service to a specific city,

county, town, or other defined jurisdictional area. While a PSAP boundary does not necessarily follow this jurisdictional boundary, the First Phase involves estimating the boundary. The US Census TIGER county and incorporated place files may provide a suitable estimated boundary.

Regardless of the data source, when choosing to use an existing data source as the foundation for Service Boundaries for PSAPs, it is recommended that a state or region agree upon a dataset that is seamless and does not contain topological discrepancies such as gaps and overlaps. This is especially critical when creating Service Boundaries for PSAPs at a smaller scale, at the regional, and/or statewide level(s) because the initial First Phase of boundary development will serve as the basis for discussion and refinement in the later phases of development. By eliminating gaps and overlaps from this initial discussion, it focuses coordination between neighboring 9-1-1 Authorities, PSAPs, and their GIS Data Providers on the placement of the existing polygon boundaries to meet mutual needs.

In making the determination for an appropriate data source for a Service Boundary for PSAPs file, it is important to consider the geographic extent of coverage and the data sources available at those scales.

6.7.1.2 Considerations for response agencies

Service Boundary development for response agencies may proceed after the Service Boundary for PSAPs development is completed. Service Boundary layers developed for PSAPs may be the template layer to assist in the development of other seamless and topologically clean Service Boundary layers.

Service Boundary development for response agencies may involve coordination with a variety of responding agencies that have varying levels of GIS-related technical knowledge. Service Boundary development is intended to support NG9-1-1 services. Please note that these boundaries might not strictly represent the legal or funding boundaries associated with the service.

The following steps provide an example approach to developing these layers:

1. Create a list of responding agencies grouped by response type
2. Contact each responding agency requesting one or more of the following:
 - a digital representation of their response area in a GIS or other acceptable digital format
 - a map of their response boundary
 - existing ESN boundaries derived from the MSAG
 - a written legal description of their response boundary

If a digital GIS representation or map of the response agency's boundary is not available, an initial GIS representation will need to be derived. There are a number of ways these can be created including: from an ESN representation of the MSAG, a legal description, or a

description based on expert local knowledge. The end goal of the First Phase is to have an early draft GIS representation of each responding agency's Service Boundary to proceed on to the Second Phase – refinement and modification.

Regardless of the data source supplied by each Agency, the GIS Data Provider combines the identified boundaries into a combined draft layer to identify gaps and overlaps to be resolved in subsequent phases.

6.7.2 Second Phase – Modify and Refine Service Boundaries

The Second Phase involves the modification and refinement of the boundary created in the First Phase. In order to ensure that the Service Boundaries properly support NGCS, it will be necessary to assess the placement of each boundary layer relative to civic location layers. In some cases, the boundary may need to be adjusted and in other cases, the civic location features may need to be moved so the boundary includes the correct civic location features.

6.7.2.1 MSAG/ALI/GIS Data Synchronization

Critical to the development of Service Boundaries, MSAG/ALI/GIS Synchronization should be included as part of the modification and refinement process. In many areas, it is common that GIS layers and MSAG tables with associated ALI records are not synchronized with one another. As mentioned in Section 3.3 GIS Data Synchronization, prior to use in NG9-1-1 call routing and transfers, it will be necessary to reconcile GIS layers with MSAG and ALI data. This is critical because ESNs associated with civic locations on either side of the Service Boundary need to correspond with the correct PSAP and/or responding agency. This has an impact on boundary development because Service Boundaries need to encompass the civic locations included in today's MSAG.

When developing the Service Boundaries, it is important to have a record and accounting of the ALI and MSAG records associated with a PSAP and ensure those address records are reflected in the GIS layers. It is recommended to perform data synchronization at the beginning of the Second Phase (if not already completed) so as to avoid duplication of coordination and refinement efforts. If synchronization has not yet occurred, then this phase has the potential to be the most time consuming. Data synchronization requires iterative steps to perform detailed data review, quality assurance and quality control, and data editing. It is heavily dependent on coordination between 9-1-1 Authorities, PSAPs, and their respective GIS Data Providers, and will also rely greatly upon coordination between neighboring authorities. All parties will need to coordinate to ensure that there is agreement upon which civic location features are assigned to each PSAP. They will also need to agree on the depiction of the boundary to best represent those decisions.

6.7.2.2 Recommended Steps to Manage Refinement of Service Boundaries

The following steps are recommended to manage the process of development and refinement. It is important to note that this is an iterative process and these steps will be repeated, as needed, until data validation and synchronization results have met the agreed upon data requirements. It should also be noted that the First Phase boundaries should be a prerequisite for refining Service Boundaries. In some cases, additional checks or refinement to the existing Service Boundaries and related GIS datasets may exist, but that is dependent upon individual LVF or ECRF providers.

1. Perform data validation and synchronization to identify data inconsistencies:
 - Multiple iterative tasks to compare RCL and/or SSAP layers to service provider MSAG/ALI datasets to find discrepancies.
 - Ensure that MSAG data is represented in the RCL and/or SSAP layers.
 - Resolve MSAG/ALI/GIS data synchronization issues that don't impact Service Boundaries.
2. Identify data synchronization issues that may impact neighboring 9-1-1 Authorities and their associated PSAPs, response agencies, and GIS Data Providers:
 - 9-1-1 Authority, PSAP, response agency, and GIS Data Providers review and identify discrepancies at borders of a PSAP and/or response agency's responsibility area.
 - Requires coordination with neighboring 9-1-1 Authorities, PSAPs, response agencies, and GIS Data Providers.
 - Provides an opportunity to address issues between neighboring agencies in a coordinated fashion.
3. If available, make use of snap-to-points and maintenance boundary lines (see Section 3.3.2 Snap-to-Points and Section 6.6.3 Maintenance Lines to Depict the Edge of Boundaries).
4. Resolve border data synchronization issues (road centerlines and/or site/structure address points, snap-to-points) and refine the related datasets:
 - 9-1-1 Authority, PSAP, response agency, and GIS Data Providers review and resolve discrepancies at borders of a PSAP or response agency's responsibility area in associated datasets.
 - Must be done in coordination with neighboring 9-1-1 Authority, agencies, and GIS Data Providers.
 - Determine how best to resolve the discrepancies to ensure seamless coverage across boundaries.
 - Discrepancy resolution may impact RCL and/or SSAP and snap-to-point datasets.
 - Ensure snap-to-points represent the agreed upon edges of a PSAP or response agency's area of responsibility.

- 1231 5. Update the Service Boundary to consider any data changes to the RCL layer and/or
1232 SSAP layer in Step 4:
- 1233 • Adjustments made to a Service Boundary to ensure that road centerlines
1234 and/or site/structure address points associated with the responsibility area
1235 are encompassed by the associated PSAP or response agency's boundary file.
 - 1236 • Ensure that new topology errors (gaps, overlaps) are not introduced.
 - 1237 • Ensure that existing topology errors (gaps, overlaps) are resolved.

1238 **6.7.2.3 Using Calls for Service to Refine Service Boundaries**

1239 After the initial Service Boundary is obtained and initially refined by working with each of
1240 the PSAPs and responding agencies, it may need further refinement based on how 9-1-1
1241 calls are geolocated.

1242 A Service Boundary layer, made up of one or more polygons, depicts the geographic area
1243 in which a PSAP or a responding agency provides services. In some circumstances,
1244 adjustments may be needed to ensure calls that come in at edges of boundaries are
1245 assigned to the appropriate PSAP and responding agencies.

1246 The nature of the location information (civic versus geodetic) determines how that call is
1247 plotted. This can complicate how a boundary needs to be drawn in order to give the
1248 desired response.

1249 The accuracy of a plotted location for wireless calls is less consistent than that based on
1250 civic location. The geodetic coordinates of a wireless call can vary in accuracy due to the
1251 following factors:

- 1252 • Wireless Phase I or Wireless Phase II information
- 1253 • Global Positioning System accuracy, which can be affected by the nature of the
1254 locality
- 1255 • number of sensors available on the device
- 1256 • limitations of the device and its operating system

1257 Due to the factors above, when a wireless call originates from a location near jurisdictional
1258 boundaries, the unintended results of the LoST spatial query may identify the incorrect
1259 PSAP and/or responding agency. Examining previous call history in the area may help to
1260 refine the boundary. Reviewing effectiveness of the Service Boundary after a period of
1261 operation is recommended.

1262 In contrast to wireless locations, the plotted location based on a civic location should be
1263 predictable and consistent. The plotted location can vary based on the geocoding process,
1264 which is dependent on the GIS data available:

- 1265 • Address points for the civic location are preferable, as they don't require
1266 interpolation. Additionally, address points have the ability to provide sub-address

information that further refines the location to determine a correct boundary placement.

- Road centerlines only provide an approximation of the location and this interpolation process may include offsets. This tends to complicate the process of drawing a boundary. Road centerlines reflect a linear range of addresses; road centerline attributes do not and are not capable of capturing sub-addressing information.

In the absence of having address points for the entire community, where there are boundary issues, creating address points in that specific area could help to resolve those issues.

Due to the differences in how geodetic (wireless) and civic locations (wireline) are plotted, with geodetic using a latitude, longitude (y,x) or geocoding to an x,y, there may be competing requirements for how to draw a boundary in a specific area. Drawing the Service Boundary will have to accommodate plotting both wireless and wireline calls. A compromise may be necessary. Looking towards long-term maintenance, a process of ongoing refinement based on experience should lead to an optimum solution, and it should be part of your long-term maintenance plan.

6.7.3 Third Phase – NG9-1-1 Readiness Support – Add Third Phase Attributes

In the Third Phase, the remaining fields from the Service Boundary schema in the NG9-1-1 GIS Data Model [2], should be populated. In the Third Phase the Service URN for each Service Boundary should be confirmed with the NGCS provider. These fields support call routing and will be used by the NGCS Provider for several purposes. These fields should only be populated by the GIS Data Provider based on guidance and discussions between the 9-1-1 Authority and the NGCS Provider. This is essential in order to ensure that the features will correctly support location validation and call routing.

It is important to consult with your NGCS Provider to determine the following:

- If they have a requirement that each Service Boundary is provisioned as an individual layer or as a consolidated Service Boundary layer (one combined layer of all Service Boundaries).
- If there is a specific requirement for Service Boundary features that mandates a single versus multipart geometry.

Table 6-2 Service Boundary Schema – Third Phase Attributes

Responsible Roles: GIS Data Provider, 9-1-1 Authorities and their NG9-1-1 Core Service Provider

Descriptive Name	Field Name	Required	Type	Field Width
Discrepancy Agency ID	DiscrpAgID	Yes	P	100

Descriptive Name	Field Name	Required	Type	Field Width
Effective Date	Effective	No	D	--
Expiration Date	Expire	No	D	--
NENA Globally Unique ID (Primary Key)	NGUID	Yes	P	254
Agency Identifier	Agency_ID	Yes	P	100
Service URI	ServiceURI	Yes	U	254
Service URN	ServiceURN	Yes	P	50
Service Number	ServiceNum	No	P	15
Agency vCard URI	AVcard_URI	Yes	U	254

7 Long-Term Maintenance of NG9-1-1 GIS Data

Topological and attribute dependencies exist between the various GIS data layers. Therefore, modifications in one layer may drive subsequent modifications in other layers, requiring important maintenance considerations and planning. Maintenance workflow plans should be made as each layer is being developed. In addition to dependence among layers, each GIS data layer also has specific maintenance considerations.

7.1 Road Centerlines Maintenance

Following the Phased Approach for Creating the Civic Location Layers, described in Section 5.5, is the establishment of a long-term maintenance routine. The creation phases were concerned with the actual development, refinement, modification, and finalization of the RCL layer to support initial implementation into NG9-1-1 services. The maintenance process emphasizes the continued maintenance tasks associated with sustaining the RCL layer in an NG9-1-1 environment while also supporting local processes such as road construction, road naming, road renaming, and the evolution of the thoroughfare infrastructure.

The long-term maintenance of the RCL layer will rely upon iterative processes similar to the tasks outlined in the three development phases and will evolve as a 9-1-1 Authority, PSAP, or GIS Data Provider's business requirements change. As a result, the maintenance of the RCL layer will require continuous updates as the road network evolves. As part of data maintenance, planned changes (e.g., bridge replacements, road realignments, or new road construction) may be managed by using the Effective Date and Expiration Date fields that are included in the NG9-1-1 GIS Data Model [2] schema.

Layers containing civic locations are likely to change more frequently than the boundary layers, and as a consequence, will need a more comprehensive maintenance plan. A

well-documented plan will need to identify sources for data updates and mechanisms of notification for when they occur. Once drafted, these processes need to be stored in a common location that is known and accessible to all participants in the workflow. In order to ensure that the documented workflows continue to be valid, it is recommended that all workflow participants review, discuss, and potentially update documentation on at least a yearly basis. Because of the multiple business needs for road centerlines, they will require continual maintenance and update.

Long-term maintenance will seek feedback from telecommunicators and responders to reduce confusing or inaccurate geometry and attribution in the RCL layer. GIS Providers can provide feedback to local planners, addressing authorities, etc., of data errors within the RCL layer. Similarly, public safety GIS providers can aid local planners that maintain, influence, and build road networks which are more easily served by 9-1-1 dispatch and responders. A road network that is rapidly served by emergency services will serve the community's business and commerce as well.

When GIS data is updated, data validation tasks should be repeated to align supporting GIS datasets. The potential for misroutes can be minimized by vigilant maintenance of data integrity. Processes that support a holistic approach to data maintenance for NG9-1-1, such as assessing the impact of all NG9-1-1 layers when changes are made, will help to ensure data integrity and completeness. Coordination with neighboring stakeholders will minimize data conflicts, reinforce continuity, and provide assurances of proper location validation and call routing.

NENA i3 Standard for NG9-1-1 [4], Section 3.7.11 GIS Discrepancy Report, describes discrepancy reporting that uses automated mechanisms to report errors and discrepancies related to GIS data such as Gap, Overlap, Bad Geometry, Duplicate Attribute, Omitted Field, Incorrect Data Type, and Address Range. As part of GIS data maintenance, discrepancy reports need to be reviewed, reported issues researched, and GIS or customer record data updated.

7.2 Service Boundary Maintenance

Following the Phased Approach for Creating the Civic Location Layers, described in Section 6.7, is the establishment of a long-term maintenance routine. The creation phases were concerned with the actual development, refinement and modification, and finalization of the Service Boundary files to support initial implementation into NG9-1-1 services. Long-term maintenance emphasizes the continued maintenance tasks associated with sustaining these boundaries in an NG9-1-1 environment.

The long-term maintenance of the Service Boundaries will require those tasks as outlined in the Second and Third Development Phases. These boundaries will evolve as 9-1-1 Authority, PSAP, responding agencies, and GIS Data Providers' business requirements change. As a result, the continued maintenance of these boundaries will require ongoing

updates. As underlying GIS data is updated, the data validation tasks should be completed to ensure adequate synchronization across the supporting datasets. By maintaining this level of data integrity, the potential for misrouting emergency requests can be minimized.

7.2.1 Service Boundary Data Maintenance Workflows

A critical component to the long-term maintenance is the establishment of workflows and guidelines associated with data maintenance and error reporting. It is recommended that intra agency and interagency workflows be established to facilitate the continued coordination and maintenance of the boundaries and related GIS datasets. By establishing such guidelines, the efficiency and reliability of provisioning GIS data to support NG9-1-1 services can be maintained to an acceptable and agreed upon level between participating PSAPs, Responding Agencies, and GIS authorities.

Building and maintaining relationships across agencies is a best management practice to ensure the success of agreed upon maintenance practices and guidelines. Formalizing the roles of various agencies through an MOU can help in facilitating long-term success.

7.2.2 Service Boundary GIS Data Updates

Updates to Service Boundaries are usually driven by either a jurisdictional boundary change or the addition of, or changes to, civic location data such as road centerlines or site/structure address points. A jurisdictional boundary change may result in a response change; Service Boundaries should be reviewed to determine if an update is required. Changes to civic location data occurring near the edge of a PSAP's or response agency's area of responsibility may require boundary modifications. Changes to civic location data occurring well within the interior of a PSAP's or response agency's area of responsibility may have little to no impact on the corresponding boundary. It is imperative to coordinate with neighboring 9-1-1 Authorities, PSAPs, responder agencies, and GIS Data Providers to establish proper agreement on where and how the impacted boundary(ies) should be realigned to appropriately meet the needs of each agency's business requirements.

It is important that after NG9-1-1 GIS data modifications occur, the Second Phase data validation and synchronization tasks should be repeated until synchronization across the supporting datasets has achieved an appropriate and agreed upon level of completeness.

Note: The Effective Date and Expiration Date fields that are part of the NG9-1-1 GIS Data Model [2] schema can be useful in managing the implementation of changes and additions to the NG9-1-1 GIS data layers.

7.2.3 Service Boundary Error Reporting/Feedback Loop

The interdependency of GIS data workflows and NG9-1-1 business requirements will necessitate an effective procedure by which 9-1-1 Authorities, PSAPs, response agencies, and GIS Data Providers can communicate data discrepancies and resolutions. Error reporting and/or feedback mechanisms are an effective pathway in providing critical

information to both data providers and end users. As the scale of implementation grows, this procedure becomes an increasingly critical component of the implementation itself, as it provides a single means to streamline communication between all stakeholders and facilitates the coordination process.

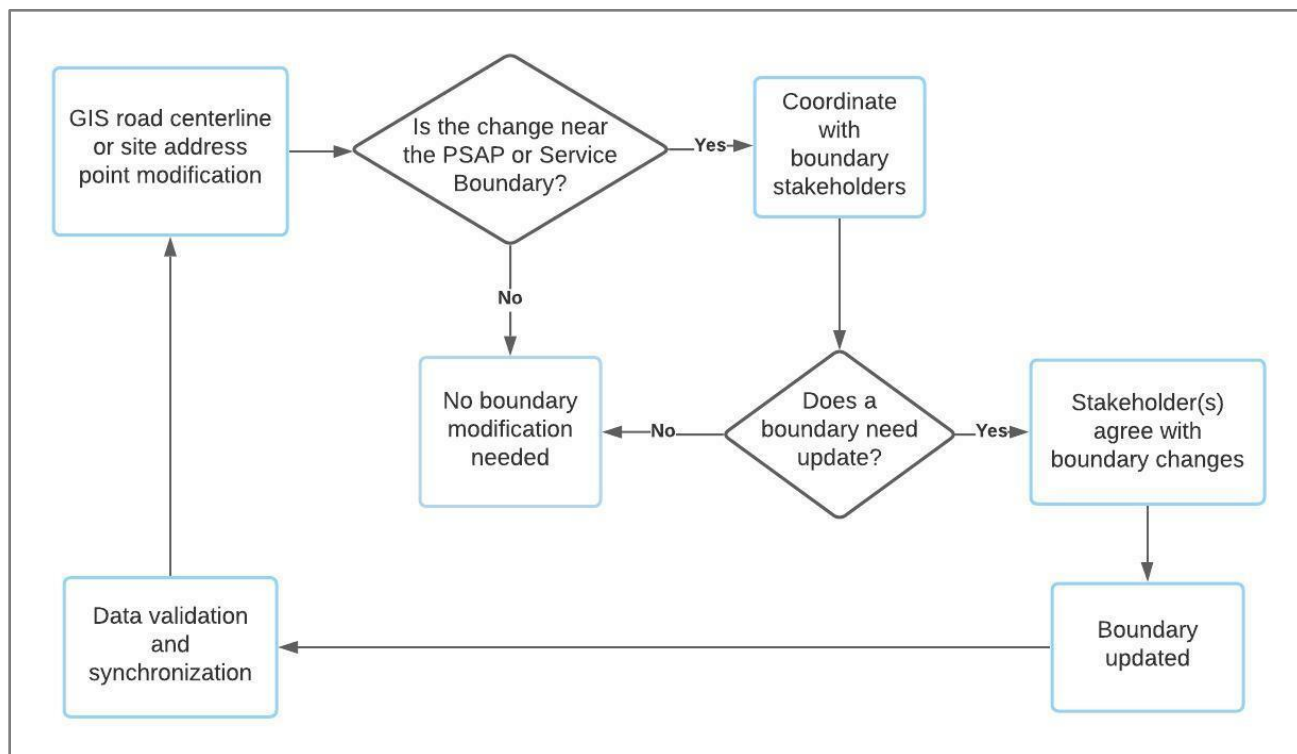
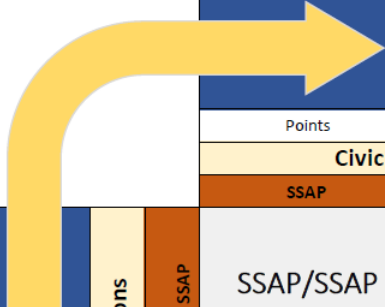


Figure 7-1 Error Reporting/Feedback Loop Flowchart

7.3 Guide to GIS Data Layer Cross-Dependencies

The long-term maintenance of NG9-1-1 GIS data will involve editing layers which have fundamental attribute and geometry dependencies. GIS Data Providers must be aware of these dependencies as they edit these layers to avoid creating conflicts with other layers. *One change in a layer may impact multiple layers and therefore create a cascade of necessary modifications.* Table 7-1 below is only a high-level conceptual guide for data maintenance. The detailed descriptions that follow the table identify some of the anticipated effects and cross-dependencies between GIS data layers. Details of the interactions are included in each layer's stewardship guidance. Table 7-1 outlines the data maintenance considerations for the layers in each column, as edits are made to layers in each row. In this version of the document, the Provisioning to Service Boundary compare is not yet available.

Table 7-1 Layer Dependency Considerations During NG9-1-1 Data Maintenance



		Might affect these layers					
		Points	PolyLines	Polygons			
		Civic Locations		Service Boundaries		Provisioning	
		SSAP	RCL	PSAP	response agency		
Changes in these layers	Civic Locations	SSAP	SSAP/SSAP	SSAP/RCL	SSAP/PSAP	SSAP / response agency	SSAP/PROV
		RCL	RCL/SSAP	RCL/RCL	RCL/PSAP	RCL/ response agency	RCL/PROV
	Service Boundaries	PSAP	PSAP/SSAP	PSAP/RCL	PSAP/PSAP	PSAP/ response agency	---
		response agency	response agency / SSAP	response agency / RCL	response agency / PSAP	response agency / response agency	---
	Provisioning		PROV/SSAP	PROV/RCL	---	---	PROV/PROV

Acronyms Used in Table 7-1

SSAP: Site/Structure Address Points

RCL: Road Centerlines

PSAP: Public Safety Answering Point Service Boundary

PROV: Provisioning Boundary

Each Table 7-1 cell entry, [Edited Layer]/[Affected Layer], indicates what attention might need to be given to the Affected Layer, upon changes made to Edited Layer.

7.3.1 Civic Locations – SSAP Layer Changes

SSAP/SSAP - Future work will describe considerations for the SSAP layer.

SSAP/RCL - Ensure that attribution of associated road centerlines align with updated site/structure address point attributes (e.g., street name, address range). Additions to, or

removals from, the SSAP layer may require adjustments to existing road centerline geometry and/or attribution, as well as possible creation of new road centerlines. Refer to Section 5.4.8.

SSAP/PSAP - Service Boundaries for PSAPs may need to be modified to maintain desired call routing for newly created or edited site/structure address points.

SSAP/response agency - Service Boundaries for response agencies may need to be modified to maintain alignment between the SSAP and Service Boundaries for response agency layers, if appropriate.

SSAP/PROV - As addressable areas develop, care must be taken to ensure that the provisioning boundaries align with their associated site/structure address points. Future work will be needed to conform with Provisioning Boundary stewardship guidance as it is available.

7.3.2 Civic Locations – RCL Layer Changes

RCL/SSAP - Ensure that attribution of associated site/structure address points aligns with updated road centerline attributes (e.g., street name, address number). Road centerline additions, removals, or geometry changes may indicate changed, or new, access routes to site/structure address points. This may require additional site/structure address points to be created or modifications made to those which already exist. Future work will be needed to conform with SSAP stewardship guidance as it is available. Refer to Sections 5.4.7, 5.4.10.2, and 5.4.12.

RCL/RCL - Ensure that (1) updated road centerline endpoints are snapped to leading and preceding road centerline endpoints, (2) newly created road centerline intersections are split and endpoints snapped, as appropriate, and (3) attribute changes in the updated road centerline are consistent with adjacent road centerlines and related stacked and/or parallel road centerlines that represent the same physical road. Refer to Sections 5.4.2, 5.4.4, 5.4.6, 5.4.9.4.9, and 5.4.10.3.

RCL/PSAP - Upon road centerline additions and/or geometry changes, ensure that the associated Service Boundaries for PSAPs align with road centerline changes so as not to interrupt intended call routing. Refer to Figure 7-1 Error Reporting/Feedback Loop Flowchart and Sections 3.3.1, 5.4.4, and 5.4.13.

RCL/response agency - Upon road centerline additions and/or geometry changes, ensure that each Service Boundary for a response agency aligns with road centerline changes. Refer to Figure 7-1 Error Reporting/Feedback Loop Flowchart and Sections 3.3.1, 5.4.4, and 5.4.13.

RCL/PROV - Upon road centerline additions and/or geometry changes, ensure that the Provisioning Boundary aligns with road centerline changes. Future work will be needed to

conform with Provisioning Boundary stewardship guidance as it is available. Refer to Figure 7-1 Error Reporting/Feedback Loop Flowchart and Sections 3.3.1, 5.4.4, and 5.4.13.

7.3.3 Service Boundary – Service Boundary for PSAPs Layer Changes

PSAP/SSAP - Future work will be needed to conform with SSAP stewardship guidance as it is available.

PSAP/RCL - Check that road centerlines are split at Service Boundaries for PSAPs. Where the extent of a Service Boundary for a PSAP is defined by a road, ensure that the road centerline representing the road is aligned with that boundary and that the road centerline does not undesirably cross or fall into a neighboring Service Boundary for a PSAP polygon. Refer to Section 5.4.10.1. If your location validation process involves offsets, they may be impacted by changes made to Service Boundaries for PSAPs. Ensure any address geocoded from the road centerlines falls within the intended Service Boundary for a PSAP polygon. Refer to Section 5.4.10.2.

PSAP/PSAP - Check for topological gaps and overlaps between Service Boundary for PSAP polygons. Ensure that PSAP attributes, especially Discrepancy Agency ID, are correctly updated. Refer to Sections 6.4.1 and 6.7.

PSAP/response agency - Check for unintentional topological gaps and overlaps between the Service Boundary for a PSAP and each Service Boundary for a response agency layer. It is important to note that PSAP and Service Boundary for response agency are not necessarily coincident. Refer to Section 6.4.

7.3.4 Service Boundary – Service Boundary for response agencies Layer Changes

response agency/SSAP - Future work will be needed to conform with SSAP stewardship guidance as it is available.

response agency/RCL - Check that road centerlines are split at Service Boundaries for response agencies. Where the extent of a Service Boundary for the response agency is defined by a road, ensure that the road centerline representing the road is aligned with that boundary and that the road centerline does not undesirably cross or fall into a neighboring Service Boundary for a response agency area polygon. Refer to Section 5.4.10.1. If your location validation process involves offsets, they may be impacted by changes made to Service Boundary for response agencies. Ensure any address geocoded from the road centerlines falls within the intended Service Boundary for response agency. Refer to Section 5.4.10.2.

response agency/PSAP - Note Service Boundaries for PSAPs and Service Boundaries for response agencies are not necessarily coincident. Review and, when appropriate, resolve topological gaps and overlaps between the Service Boundary for response agencies and Service Boundaries for PSAPs layers. Refer to Section 6.4.

response agency/response agency - Check for unintentional topological gaps and overlaps between Service Boundaries for response agencies polygons. Refer to Section 6.4.

7.3.5 Provisioning Boundary Layer Changes

The Provisioning Boundary layer does not play a role in call routing; however, it gives critical guidance for discrepancy reporting and maintenance of the other NG9-1-1 layers. Although Provisioning Boundary stewardship will be completed in a future version of this document, preliminary guidance is provided below.

PROV/SSAP - Changes to the Provisioning Boundary or its attributes may impact the attribution in the SSAP layer; these changes should be mutually understood and agreed to between adjacent providers. Ensure that any changes in 9-1-1 provisioning are represented in the SSAP Discrepancy Agency ID, if necessary. Future work will be needed to conform with SSAP stewardship guidance as it is available.

PROV/RCL - Changes to the Provisioning Boundary or its attributes may impact the attribution or geometry in the RCL layer; these changes should be mutually understood and agreed to between adjacent providers. Provisioning Boundary edits may require splitting of road centerlines at new locations. Ensure that any changes in 9-1-1 provisioning are represented in the RCL Discrepancy Agency ID, if necessary.

PROV/PROV - Check for topological gaps and overlaps between provider polygons. Ensure that provisioning attributes, especially Discrepancy Agency ID, are correctly updated. These changes must be mutually understood and agreed to between adjacent providers. Future work will be needed to conform with Provisioning Boundary stewardship guidance as it is available. Refer to Section 6.4.2.

8 Impacts and Considerations

8.1 Operations Impacts Summary

The level of impact on Operations is related to the degree to which GIS programs have been established and are maintaining GIS data to NG9-1-1 standards. Additional impacts may be dependent on workflows chosen and the level of precision targeted. It is worth noting that GIS data benefits 9-1-1 services by increasing location precision (not necessarily spatial accuracy), both in the PSAP and in an NG9-1-1 i3 routing environment.

GIS data has vital applications for both 9-1-1 Authorities and PSAPs. Today, 9-1-1 Authorities may or may not support GIS data layers for use within the PSAP. GIS data is essential for location validation (both civic and geodetic) and geospatial call routing in the i3 environment and 9-1-1 Authorities will be responsible for provisioning of maintained GIS data to their NG9-1-1 network. Further, the development, maintenance and stewardship of GIS data per the NG9-1-1 GIS Data Model [2], may have additional impacts, including "to meet local, regional, and other organizational needs . . ."

8.2 Technical Impacts Summary

The focus of this document is limited to the development and maintenance of GIS data. The technical impacts of this document on Customer Premise Equipment and network hardware are negligible.

In terms of software impacts, the methodologies used for GIS data creation, and the precision associated, may impact the accuracy of the networks' geospatial routing decisions. Additionally, considerations may need to be made to the potential impact to CAD software assignment of resources, mapping solutions, vehicle routing, and other software that require GIS data.

8.3 Security Impacts Summary

Although GIS attributes are not the subject of this document, it is worth noting that GIS datasets (the combination of the geographic data and related attributes) may contain confidential, proprietary, and/or sensitive information that must not be introduced into the public domain. Certain data are confidential under many state laws. Such information is considered confidential when included in databases and on maps used by entities in the provision of emergency services and may also be considered proprietary. Sensitive information implies a loss of security when disclosed to others. Such information may include wireless cell tower locations, military bases, refining facilities, airports, water treatment and distribution facilities, law enforcement facilities, federal offices, emergency management information and resources, and power generation/distribution facilities.

More information about data, information, and guidelines for data and physical security can be found in the NENA Security for Next Generation 9-1-1 Standard (NG-SEC), NENA 75-001.1 [20].

8.4 Recommendation for Additional Development Work

- Stewardship information for Site/Structure Address Locations
- Stewardship information for Sub-Addressing
- Stewardship information for Provisioning Boundary
- Stewardship information for Policy Routing
- Stewardship information for Data Aggregation
- Stewardship information for Boundaries depicting Primary versus Secondary PSAP Status for Call Routing
- MSAG Conversion Service should be considered by the appropriate working group. – See NENA i3 Standard for NG9-1-1 [4]
- Geocode Service should be considered by the appropriate working group. – See NENA i3 Standard for NG9-1-1 [4]

- Mapping Data Service should be considered by the appropriate working group. – See NENA i3 Standard for NG9-1-1 [4]
- Additional guidance for creation of the Local Unique ID should be considered in a future version of this document, such that they remain static and unique in perpetuity. Multiple ways to accomplish this should be discussed, including UUIDs and other options.
- Additional guidance is needed for GIS database precision. As with GIS data projection and scale accuracy, a uniform GIS Database Precision should be defined. The decimal precision, expressed as the number of decimal places stored in feature geometry, directly correlates to the snapping tolerances of the GIS data. Unexpected topological errors causing gaps and overlaps and less than optimal query performance (due to extraneous decimal precision) could result from the lack of a GIS database precision standard. GIS database precision should be considered by the appropriate working group.
- Guidance for horizontal accuracy is needed between NENA standards, other government standards (e.g., FCC, the National Spatial Data Infrastructure [NSDI]), and local GIS data maintenance practices.
- Additional guidance is needed for short road centerlines with 0-0 address attribution for the cases where there are duplicate 0-0 ranges with the same Street Name.
- Consider including street name fields for both the left and right sides of the road centerline in the NG9-1-1 GIS Data Model [2] document.
- Add Canadian ramp naming hierarchy to Section 5.4.11.1 Ramps.

8.5 Anticipated Timeline

The time to implement these guidelines will be contingent upon the resources applied by a local government or other entity to develop, manage, and/or provide the data.

8.6 Cost Factors

Following the methodologies outlined in this document can have both financial and human resource cost implications when developing GIS data. The amount of resources required to develop and properly maintain GIS data as noted in this document may range from significant, if existing data either does not exist or needs to be modified to follow any guidelines listed herein, to minimal if data exists and meets the accuracy needed for 9-1-1 use.

For those with existing data, implementing one or more of these guidelines will involve reevaluating current workflows and processes. This could potentially be a manual, labor intensive and time-consuming effort.

For those considering how to build GIS data from scratch, these guidelines should have a negligible cost impact beyond those resources planned for developing this type of data.

8.7 Cost Recovery Considerations

Collaborating, coordinating, and sharing the cost of data development and maintenance with neighboring 9-1-1 entities and other stakeholders outside of 9-1-1 may offset the cost of collecting and maintaining high quality data. Other stakeholders include local, regional, and state emergency management, planning departments, engineering, and taxing authorities, as well as public/private partnerships with utilities, development permitting organizations, and other organizations. Consistent data development, scrubbing, and maintenance will benefit all stakeholders.

8.8 Additional Impacts (non-cost related)

The information or requirements contained in this NENA document may have additional impacts. The impacts expected may include, but are not limited to:

- highly accurate location validation
- ability for geospatial routing
- better performance of some 9-1-1 applications
- reduced probability of misrouted calls
- improved response time
- improved communication of response location
- more efficient use of limited resources
- improvement of public domain, commercial, and interorganizational mapping products, when data is not subject to issues raised in Section 8.3 Security Impacts

9 Abbreviations, Terms, and Definitions

See the NENA Knowledge Base (NENAb) [1] for a Glossary of terms and abbreviations used in NENA documents. Abbreviations and terms used in this document are listed below with their definitions.

Term or Abbreviation (Expansion)	Definition / Description
<i>9-1-1 Authority</i>	A State, County, Regional, or other governmental entity responsible for 9-1-1 service operations. For example, this could be a county/parish or other local government, a special 9-1-1 or Emergency Communications District, a Council of Governments, or other similar body. <u>Also known as:</u> <i>AHJ (Authority Having Jurisdiction)</i> <i>9-1-1 Governing Authority</i>
<i>ALI (Automatic Location Identification)</i>	The automatic display at the PSAP of the caller's telephone number, the address/location of the telephone and supplementary emergency services information of the location from which a call originates.
<i>CAD (Computer Aided Dispatch)</i>	A computer-based system, which aids PSAP Telecommunicators by automating selected dispatching and record keeping activities.
<i>Civic Address</i>	Any city-style address that includes a house number and a street name is considered a Civic Address. Civic Addresses include a community name that may or may not be recognized by the USPS or be MSAG valid. Civic Addresses may be used as Postal address if recognized by the USPS. Civic Addresses may be used as MSAG addresses if they are an exact match to the MSAG address. A rural route delivery address or FPO or APO address is not considered a Civic Address.
<i>CLDXF (Civic Location Data Exchange Format)</i>	A United States profile of PIDF-LO that defines a set of standard data elements that describe detailed street address information.

Term or Abbreviation (Expansion)	Definition / Description
<i>Data Domain</i>	An enumerated listing or range of valid values that may be used as an attribute. If no Data Domain is provided, then any value that meets the format criteria may be used.
<i>E9-1-1 (Enhanced 9-1-1)</i>	A telephone system which includes network switching, database and Public Safety Answering Point premise elements capable of providing automatic location identification data, selective routing, selective transfer, fixed transfer, and a call back number. The term also includes any enhanced 9-1-1 service so designated by the Federal Communications Commission in its Report and Order in WC Docket Nos. 04-36 and 05-196, or any successor proceeding.
<i>ECRF (Emergency Call Routing Function)</i>	A functional element in NGCS (Next Generation Core Services) which is a LoST (Location-to-Service Translation) protocol server where location information (either civic address or geo-coordinates) and a Service URN serve as input to a mapping function that returns a URI used to route an emergency call toward the appropriate PSAP for the caller's location or towards a responder agency. <u>Related Terms:</u> <i>External ECRF</i> An ECRF instance that resides outside of an NGCS instance. <i>Internal ECRF</i> An ECRF instance that resides within and is only accessible from an NGCS instance.

Term or Abbreviation (Expansion)	Definition / Description
<i>EMS (Emergency Medical Service)</i>	A service providing out-of-hospital acute care and transport to definitive care, to patients with illnesses and injuries which the patient believes constitute a medical emergency.
<i>ESInet (Emergency Services IP Network)</i>	A managed IP network that is used for emergency services communications, and which can be shared by all public safety agencies. It provides the IP transport infrastructure upon which independent application platforms and core services can be deployed, including, but not restricted to, those necessary for providing NG9-1-1 services. ESInets may be constructed from a mix of dedicated and shared facilities. ESInets may be interconnected at local, regional, state, federal, national and international levels to form an IP-based internetwork (network of networks). The term ESInet designates the network, not the services that ride on the network. See NG9-1-1 Core Services.
<i>ESN (Emergency Service Number)</i>	A 3-5 digit number that represents one or more ESZs (Emergency Service Zone), stored as a 3-5 character numeric string in a GIS database. An ESN is defined as one of two types: Administrative ESN and Routing ESN.
<i>ESRP (Emergency Service Routing Proxy)</i>	An i3 functional element which is a SIP proxy server that selects the next-hop routing within the ESInet based on location and policy. There is an ESRP on the edge of the ESInet. There is usually an ESRP at the entrance to an NG9-1-1 PSAP. There may be one or more intermediate ESRPs between them.

Term or Abbreviation (Expansion)	Definition / Description
<i>ESZ (Emergency Service Zone)</i>	A geographical area that represents a unique combination of emergency service agencies (e.g., Law Enforcement, Fire, and Emergency Medical Service) that is within a specified 9-1-1 governing authority's jurisdiction. An ESZ can be represented by an Emergency Service Number (ESN) to identify the ESZ.
<i>Geospatial Call Routing</i>	The use of an ECRF (Emergency Call Routing Function) and GIS (Geographic Information System) data to route an emergency call to the appropriate PSAP or emergency service provider based on the civic location or geographic coordinates provided with the call.
<i>GIS (Geographic Information System)</i>	A system for capturing, storing, displaying, analyzing, and managing data and associated attributes which are spatially referenced.
<i>GIS Data Provider</i>	A person or group who is responsible for maintaining authoritative GIS data for a given service area.
<i>LoST (Location-to-Service Translation) Protocol</i>	A protocol that takes location information and a Service URN and returns a URI. Used generally for location-based call routing. In NG9-1-1, used as the protocol for the ECRF and LVF.
<i>LVF (Location Validation Function)</i>	A functional element in an NGCS (Next Generation 9-1-1 Core Services) that is a LoST protocol server where civic location information is validated against the authoritative GIS database information. A civic address is considered valid if it can be located within the database uniquely, is suitable to provide an accurate route for an emergency call, and adequate and specific enough to direct responders to the right location.

Term or Abbreviation (Expansion)	Definition / Description
<i>MOU (Memorandum of Understanding)</i>	A document written between parties to cooperatively work together on an agreed upon project or meet an agreed upon objective.
<i>MSAG (Master Street Address Guide)</i>	A database of street names and house number ranges within their associated communities defining Emergency Service Zones (ESZs) and their associated Emergency Service Numbers (ESNs) to enable proper routing of 9-1-1 calls.
<i>NENA (National Emergency Number Association)</i>	NENA is the National Emergency Number Association, also referred to as The 9-1-1 Association, which is fully dedicated to the continued improvement and modernization of the 9-1-1 emergency communication system. NENA's approach includes research, standards development, training, education, certification, outreach, and advocacy through communication with stakeholders. As an ANSI-accredited Standards Developer, NENA works with 9-1-1 professionals, public policy leaders, emergency services and telecommunications industry partners, like-minded public safety associations, and more. Current NENA activities center on awareness, documentation, and implementation for Next Generation 9-1-1 (NG9-1-1) and international three-digit emergency communication systems. NENA's worldwide members join with the emergency response community in striving to protect human life, preserve property, and maintain the security of all communities. www.nena.org

Term or Abbreviation (Expansion)	Definition / Description
<i>NG9-1-1 (Next Generation 9-1-1)</i>	An IP-based system comprised of hardware, software, data, and operational policies and procedures that: (A) provides standardized interfaces from emergency call and message services to support emergency communications; (B) processes all types of emergency calls, including voice, data, and multimedia information; (C) acquires and integrates additional emergency call data useful to call routing and handling; (D) delivers the emergency calls, messages, and data to the appropriate public safety answering point and other appropriate emergency entities; (E) supports data or video communications needs for coordinated incident response and management. <u>Also known as:</u> <i>Next Generation 9-1-1 Services</i>
<i>NGCS (Next Generation 9-1-1 Core Services)</i>	The set of services needed to process a 9-1-1 call on an ESInet. It includes, but is not limited to, the ESRP, ECRF, LVF, BCF, Bridge, Policy Store, Logging Services, and typical IP services such as DNS and DHCP. The term NG9-1-1 Core Services includes the services and not the network on which they operate. See Emergency Services IP Network.
<i>NGCS (Next Generation 9-1-1 Core Services) Provider</i>	An entity providing one or more of the Next Generation 9-1-1 Core Services (NGCS) elements.

Term or Abbreviation (Expansion)	Definition / Description
<i>NGUID</i> <i>(NENA Globally Unique ID)</i>	A globally unique ID generated and maintained within a GIS database as defined in NENA-STA-006. Each NGUID MUST be unique.
<i>PIDF-LO (Presence Information Data Format – Location Object)</i>	Provides a flexible and versatile means to represent location information in a SIP header using an XML schema.
<i>PRR (Policy Routing Rules)</i>	Define how calls are diverted when a target PSAP is unable to take calls.
<i>PSAP (Public Safety Answering Point)</i>	A physical or virtual entity where 9-1-1 calls are delivered by the 9-1-1 Service Provider. <u>Related Terms:</u> <i>Primary PSAP</i> A PSAP to which 9-1-1 calls are routed directly from the 9-1-1 Control Office. <i>Secondary PSAP</i> A PSAP to which 9-1-1 calls are transferred from a Primary PSAP. <i>Alternate PSAP</i> A PSAP designated to receive calls when the primary PSAP is unable to do so. <i>Consolidated PSAP</i> A facility where multiple Public Safety Agencies choose to operate as a single 9-1-1 entity. <i>Legacy PSAP</i> A PSAP that cannot process calls received via i3-defined call interfaces (IP-based calls) and still requires the use of CAMA or ISDN trunk technology for delivery of 9-1-1 emergency calls. <i>Serving PSAP</i> The PSAP to which a call would normally be routed.

Term or Abbreviation (Expansion)	Definition / Description
	<i>NG9-1-1 PSAP</i> This term is used to denote a PSAP capable of processing calls and accessing data services as defined in NENA's i3 specification, NENA-STA-010, and referred to therein as an "i3 PSAP." <i>Virtual PSAP</i> An operational model directly enabled through NG9-1-1 features and/or network hosted PSAP equipment in which telecommunicators are geographically dispersed, rather than working from the same physical location. Remote access to the PSAP applications by the dispersed telecommunicators requires the appropriate network connections, security, and work station equipment at the remote location. The virtual work place may be a logical combination of physical PSAPs, or an alternate work environment such as a satellite facility, or any combination of the above. Workers are connected and interoperate via IP connectivity.
<i>SI (Spatial Interface)</i>	A standardized interface between the GIS data and the functional elements that consume GIS data, such as the ECRF, LVF, Mapping Data Service, etc.
<i>Topology</i>	The spatial relationships between adjacent or neighboring GIS features.

Term or Abbreviation (Expansion)	Definition / Description
URI (Uniform Resource Identifier)	An identifier consisting of a sequence of characters matching the syntax rule that is named <URI> in RFC 3986. It enables uniform identification of resources via a set of naming schemes. A URI can be further classified as a locator, a name, or both. The term "Uniform Resource Locator" (URL) refers to the subset of URIs that, in addition to identifying a resource, provides a means of locating the resource by describing its primary access mechanism (e.g., its network "location"). The term "Uniform Resource Name" (URN) has been used historically to refer to both URIs under the "urn" scheme [RFC2141], which are required to remain globally unique and persistent even when the resource ceases to exist or becomes unavailable, and to any other URI with the properties of a name. An example of a URI that is neither a URL nor a URN is sip:psap@example.com.
URN (Uniform Resource Name)	A type of URI. Uniform Resource Names (URNs) are intended to serve as persistent, location-independent, resource identifiers and are designed to make it easy to map other namespaces (which share the properties of URNs) into URN-space. An example of a URN is urn:service.sos.
WGS 84 (World Geodetic System 1984)	The reference coordinate system used by the Global Positioning Systems and in cartography and navigation.

10 Recommended Reading and References

- [1] National Emergency Number Association. "NENA Knowledge Base Glossary." Updated June 16, 2022. <https://kb.nena.org/wiki/Category:Glossary>.
- [2] National Emergency Number Association. *NENA Standard for NG9-1-1 GIS Data Model*. [NENA-STA-006.2-2022](#). Arlington, VA: NENA, approved September 23, 2022.

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- [4] National Emergency Number Association. *NENA i3 Standard for Next Generation 9-1-1*. [NENA-STA-010.3-2021](#), Appendix B. Arlington, VA: NENA, approved July 12, 2021.
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- [6] US Department of Commerce, and NOAA. "National Geodetic Survey - Main (DRAFT)." *New Datums / National Geodetic Survey*, October 3, 2018, <https://www.ngs.noaa.gov/datums/newdatums/index.shtml>.
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- [15] Statistics Canada, Last updated November 1, 2019, Road Network Files, <https://www12.statcan.gc.ca/census-recensement/2011/geo/RNF-FRR/index-eng.cfm>. Accessed August 8, 2022.
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