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Development of Potential Strategies for Unmarked and Low Traffic Volume Roadways in Illinois

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16. Abstract

The present study was initiated by the Illinois Department of Transportation (IDOT) to better understand characteristics of roadway segments categorized as unmarked in IDOT's Transportation Asset Management Plan and to suggest recommendations to manage, vacate, abandon, retain, or transfer individual routes. The researchers developed a methodology, labeled JARM, to identify potential candidates for jurisdictional transfer, abandonment (or vacation), reconfiguration, or maintenance. The JARM methodology is an easy-to-use and stand-alone spreadsheet tool for IDOT districts. It includes all unmarked routes as well as their key database variables and visual attributes. The study identified that over 90% of unmarked route centerline mileage is recommended for jurisdictional transfer to move off IDOT's inventory and to be better served by local agencies, while reducing maintenance costs and future funding needs. To identify maintenance strategies for unmarked routes and low-volume roads, the researchers reviewed best practices of various state agencies and developed treatment catalogues for rural and urban routes. Additionally, they conducted two surveys: (1) a survey of other state DOTs to understand management of similar routes and (2) a survey of local public agencies within Illinois to understand their familiarity and willingness to accept unmarked routes. Twenty-five DOTs responded to the survey to provide insight into how they manage similar routes. The results demonstrated that 70% of local public agency respondents were amenable to a discussion of jurisdictional transfer. The next logical step is to build off this network-level research and to identify execution strategies at the project level in the most cost-effective manner.

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EXECUTIVE SUMMARY

The Illinois Department of Transportation (IDOT) classifies unmarked routes (UMRs) as roadways that are not designated by interstate, US, or Illinois signage. Unmarked routes exist throughout the state and vary in centerline length. A review of IDOT's databases results in 1,889 UMRs, amounting to 2,590.73 miles. The length of UMRs varies from 0.1 miles to 24 miles. The average length is 1.37 miles, with 68% less than or equal to one mile in length. Traffic, in terms of annual average daily traffic (AADT), varies from no traffic to 91,200. The average AADT is 4,027, with about 40% of UMRs subjected to AADT in the range of 0 to 100.

A look at functional classifications demonstrates a greater majority (61%) of UMRs are present on the local streets or roads functional class, with about 35% on major/minor collectors. Another important attribute investigated was the condition rating system (CRS), which is reported on a 0 to 9 scale. About 45% of UMRs have a CRS less than 5. IDOT initiated the present study to better understand characteristics of roadway segments that are categorized as unmarked in IDOT's Transportation Asset Management Plan (TAMP). The goal of the project was to create recommendations to manage, vacate, abandon, or transfer individual segments or routes within the network of UMRs as well as to evaluate and recommend best practices for repairing and maintaining low-volume roadways. IDOT anticipates the results of this study to identify UMRs that can be moved off the agency's inventory and to decide how to implement cost-saving measures by recommending jurisdictional transfer (JT) of certain roadway segments that would be better served by local agencies, while reducing maintenance costs and future funding needs.

To accomplish the objectives of the study, the researchers developed a methodology, labeled JARM. This methodology enabled IDOT to identify potential candidates for jurisdictional transfer (J), abandonment (or vacation) (A), reconfiguration (R), or maintenance and rehabilitation of retained routes (M). The JARM methodology was detailed in four steps, beginning with an individual review of each UMR within IDOT's IROADS (Illinois Roadway Analysis Database System) database to collect key database attributes and visual attributes. Next, image snapshots were generated to understand visual attributes while also displaying the key database attributes for instant reference within the spreadsheet tool. After compiling highway continuity attributes for potential transfer and vacation candidates, recommendations were made for each UMR.

The JARM methodology was presented in an easy-to-use and stand-alone spreadsheet tool that can be used by IDOT districts. The methodology included all 1,889 UMRs and highlighted the relative importance of key variables such as traffic, length, functional class, condition rating, presence of structures along the route, number of homes and businesses served by the UMR, adjacent jurisdictional highway networks, and so forth for each route. For a quick visual reference, a link to a snapshot was provided for each UMR. A document describing various elements of the spreadsheet and how to use it was included for ready reference. This tool can adequately serve the primary goal of this study.

Another important goal of the study was to identify appropriate maintenance treatments for UMRs and low-volume roads (LVRs). The researchers conducted a review of published literature to identify

the best practices. The report presented a list of best practices used by various state agencies and provided a brief description of each treatment option. Treatment catalogues were developed for rural and urban routes. The treatment catalogues identified several feasible preservation and rehabilitation treatments for candidate projects based on traffic volumes as well as the type and severity of pavement distresses present on the pavement.

Another objective of this effort was to conduct two surveys. The first survey targeted other state departments of transportation (DOTs) to understand if they have similar routes to UMRs and how they manage them. The second survey targeted local public agencies (LPAs) within Illinois to understand their awareness of UMRs and their level of willingness for conditional acceptance of jurisdictional transfers.

Twenty-five DOTs responded to the survey to provide insight into how they classify, monitor, and manage similar type routes. The results from the LPA survey found that 70% of Illinois LPA respondents were amenable to a discussion of jurisdictional transfer under a variety of conditions even though 42% (84 of 199) of the respondents are not familiar with any UMRs in their jurisdiction. In fact, 23% (46 of 198) of the survey respondents indicated they already maintain some known IDOT UMRs within their jurisdiction anyway.

The next logical step is to build off this network-level research and to identify how to execute on the recommendations identified in this study at the project level in the most cost-effective manner for Illinois based on deterioration rate/life-cycle analysis models for rehabilitation candidates and how to approach specific jurisdictions for transfers.

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LIST OF ACRONYMS

AADT: Average Annual Daily Traffic

AC: Asphalt Concrete

ADT: Average Daily Traffic

ADTT: Average Daily Truck Traffic

CIR: Cold In-place Recycling

CRS: Condition Rating System

FC: Functional Classification

FDR: Full-Depth Reclamation

GIS: Geographical Information System

HIR: Hot In-place Recycling

HMA: Hot-Mix Asphalt

IDOT: Illinois Department of Transportation

IHIS: Illinois Highway Information System

IRI: International Roughness Index

IRIS: Illinois Roadway Information System

IROADS: Illinois Roadway Analysis Database System

ISIS: Illinois Structure Information System

JARM: Jurisdictional transfer (J), Abandonment (or vacation) (A), Reconfigure (R), or Maintenance and rehabilitation (M)

JT: Jurisdictional Transfer

LPA: Local Public Agency

LVR: Low-Volume Road

M&R: Maintenance and Rehabilitation

MFT: Motor Fuel Tax

MR: Marked Route

NCHRP: National Cooperative Highway Research Program

NHS: National Highway System

OPA: Other Principal Arterial

PAS: Principal Arterial System

TAMP: Transportation Asset Management Plan

TRP: Technical Review Panel

UMR: Unmarked Route

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CHAPTER 1: INTRODUCTION

The Illinois Department of Transportation (IDOT) classifies its pavements and bridges as either National Highway System (NHS) or non-NHS. Roadways are sorted into three categories: interstate and other NHS routes (non-interstate), non-NHS marked routes, and non-NHS unmarked routes.

Roadways on the NHS consist of all interstate and some non-interstate US and state highways. NHS roadways are selected based on their importance to the nation's economy, defense, and mobility. Non-NHS routes include the remaining US and state highways. The IDOT routes in this category are further classified into two subcategories—namely, marked routes and unmarked routes (Illinois Department of Transportation, 2019).

Marked routes include non-NHS highways that are designated as US or state marked routes. IDOT classifies unmarked routes (UMRs) as roadways that are not designated by interstate, US, or Illinois signage. They are remnants of old alignments and spurs spread throughout the state. They are the result of modifications made to an existing roadway, resulting in portions of the former alignment no longer marked as the through route but left for continuity of historical access points. The State of Illinois intends to address each UMR to classify and to recommend what to do with them—one possible option being to transfer to local jurisdictions.

Unmarked routes are unique to the State of Illinois by their designation. While IDOT classifies UMRs as roadways that are not designated by interstate, US, or Illinois signage, other states carry a definition of an "orphan road" for similar highway routes.

The North Carolina Department of Transportation maintains orphan roads in unincorporated areas. The DOT created an Orphan Roads Maintenance Program Grant Fund for the improvement of subdivision streets that do not meet DOT standards for addition to the state highway system—appropriating $75 million to the DOT from the Highway Fund for 2023–24 to establish the orphan roads fund. Effective until June 30, 2028, the DOT then must transfer any unused funds to the Highway Fund (University of North Carolina School of Government, 2022).

The West Virginia Division of Highways has a program to acquire and maintain roads and bridges that are not maintained by any governmental agency (West Virginia Legislature, 2022). These roads and bridges are designated as orphan roads and bridges.

In Oregon, orphan roads are relics of a pre-interstate era. They were built to get produce and other items from farms into the central city. When freeways were built in the 1950s through 1970s, Oregon DOT discontinued their maintenance, and they became known as "orphan highways" (Maus, 2020). Orphan highways are district and regional state highways owned by Oregon DOT, but functionally serve as city streets or county roads. This may be due to changes in surrounding land uses or the transportation network that result in longer-distance regional trips shifting to nearby interstates or other highways. While Oregon DOT can transfer control of state highways to cities or counties, the roadways must first be brought to a state of good repair and meet current design standards. The cost of doing so is a major hurdle to jurisdictional transfers.

The Franklin County Code in Kentucky (State of Kentucky, 2022) defines an orphan road as a given roadway located in the county, outside the corporate limits of the City of Frankfort, not presently being maintained by any governmental entity, having at least 10 permanent single-family residences suitable for human occupancy per mile of said roadway, and which has been laid off as a public road and used without restriction by the general public for at least 15 consecutive years immediately prior to the petition for adoption as required by Kentucky Revise Statutes Ch. 178. The Fiscal Court shall consider adopting an orphan road provided that more than 55% of the property owners on the roadway have petitioned the court to adopt an orphan road into the county road system and more than 55% of the property owners abutting the roadway have signed a petition stating they are willing to dedicate the road for public use.

Other states also contend with routes the agency has little financial means for responsible ownership. Thus, orphan roads (akin to UMR routes) tend to be in poor shape and not in a condition amiable for low-cost preventive maintenance options. Because most of these routes are not getting the maintenance needed, there is little information concerning such routes and best practice strategies for maintenance.

CHAPTER 2: CONSEQUENCES OF UNMARKED ROUTE OWNERSHIP

According to IDOT's *Highway Jurisdiction Manual* (2006), two factors play an important role in assuming ownership of a route—namely, expense and liability. Expense includes the cost of (i) routine maintenance activities such as removal of debris, snow removal, pothole patching, signing, ditch cleaning, and vegetation control and (ii) major improvements, as needed. IDOT also assumes tort liability involving the condition of highways.

Some options that may be available to IDOT for the management of UMRs are as follows:

- Jurisdictional transfer (JT) to local agencies such as a township, municipality, or county
- Vacation
- Abandonment
- Reconfiguration
- Maintenance and rehabilitation (M&R) strategy

JT is a process of transferring the jurisdiction of a highway or structure from one authority to another—in the present case, from IDOT to a local agency. Per 605 ILCS 5/1-102 [Legislative Declaration], the State of Illinois seeks the cooperation of county and municipal highway agencies to accomplish JT of a highway or structure (IDOT, 2006).

Vacation is a process by which a highway is completely removed from the system. However, IDOT approval is required for vacation of county highways, while no such approval is needed for township roads.

When a township road has not been used for several years, and in some cases, has been gated, IDOT treats this as abandoned by non-use but considers it a public highway unless officially vacated.

A rehome strategy describes the option to transfer a UMR to another jurisdiction. A rehab strategy is an option to upgrade the condition of the pavement. In some cases, as a condition for acceptance of transfer, both a rehab and rehome strategy may be employed. Additionally, UMRs may be upgraded to the marked category and continue to be held by IDOT. Such a process may eventually result in the elimination of the unmarked category.

CHAPTER 3: PRESENT STUDY

The primary goals of this study are listed below:

- Better understand roadway segments, which are generally categorized as unmarked in IDOT's Transportation Asset Management Plan (TAMP)
- Better understand roadway segments with low traffic volumes under IDOT jurisdictions
- Verify IDOT's roads are in the correct TAMP category
- Categorize routes into general functions
- Identify potential candidates for JT, vacation, abandonment, reconfiguration, or maintenance
- Create recommendations for IDOT to manage, vacate, abandon, or transfer individual segments or routes within the network of UMRs
- Evaluate and recommend best practices for repairing and maintaining low-volume roadways

IDOT may use the results of this study to identify UMRs that can be moved off its inventory and decide how to implement cost-saving measures by recommending JT of certain roadway segments that would be better served by local agencies, while reducing maintenance costs and future funding needs.

The results are expected to help IDOT perform the following tasks:

- Select segments/routes to be vacated, abandoned, or transferred.
- Identify routes that no longer need to be maintained.
- Identify abandoned and transferred sections that are no longer needed to maintain records or develop rehabilitation plans.
- Identify maintenance strategies for the network of UMRs by average annual daily traffic (AADT), average daily truck traffic (ADTT), functional classification (FC), and distress triggers.
- Develop an overall improvement in UMRs and low-volume roads due to the use of distress-based guidelines for maintenance and abandonment/transfer of rarely used roads, which will result in improved safety.
- Reduce total mileage and thereby long-term system preservation costs.

CHAPTER 4: EXTENT OF UNMARKED ROUTES

In Illinois, businesses, residents, and visitors have access to one of the largest and most effective multimodal transportation systems in the US. This network includes roads, railways, airways, waterways, canals, and terminals such as airports, railway stations, bus stations, warehouses, and intermodal facilities. Illinois' centralized geographic location, as well as the diversity of available transportation options, places the Illinois transportation system in an essential role in the nation's ability to move goods and people.

The scope of this project is to focus on the portion of the Illinois highway network that is classified in the UMR TAMP category and low-volume marked routes. The marked routes category includes highways that are not included in the National Highway System that are signed as US or state marked routes, whereas the UMR category includes any supplemental highways that are included in the jurisdictional responsibility of the state (IDOT, 2019).

IDOT classifies UMRs as roadways that are not designated by interstate, US, or Illinois signage. Modifications are continuously made to segments of the Illinois state route system, which results in segments of former alignments. Typically, however, the road is repurposed as a special route by the local community. Common special routes are presented in Figure 1.

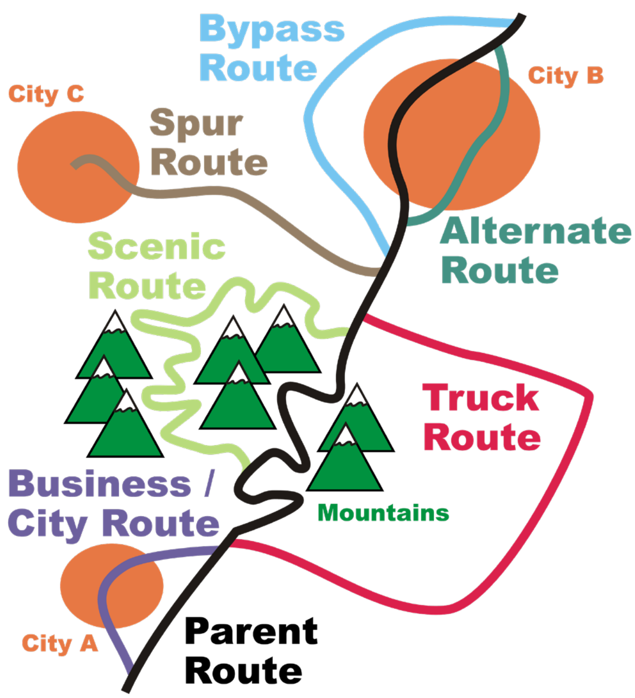

Figure 1. Illustration. Common special routes in Illinois (Wikimedia Commons, 2022).

Unmarked routes exist throughout the state and vary in centerline length. Also, many UMRs are significantly longer than some posted routes. Just as with marked routes and structures, there are three information systems that are used to record and maintain roadway data:

1. IHIS—Illinois Highway Information System
2. IRIS—Illinois Roadway Information System
3. ISIS—Illinois Structure Information System

The data related to UMRs were extracted from these three information systems. IHIS is an inventory of roadways and structures within the state and is maintained by IDOT. Roadway information is collected for all public highways and entered into IRIS. IRIS information is collected for two primary reasons: (1) to qualify for funding and (2) to anticipate and prioritize highway rehabilitation needs. A public highway is defined as the entire width, between right-of-way lines, of a highway that is open for public travel. This definition includes existing and proposed roads as well as dedicated right-of-way. However, this definition does not include roadways or driveways provided by a business or landowner for access to their property. Previously unreported public highways must be 0.04 miles or longer to be added to IRIS. Existing IRIS alignments are revised for changes affecting 0.01 miles or more (IDOT, 2014).

ISIS was developed to provide an information system to better serve IDOT as well as local agencies throughout the state with identified structures along highways. The term “structure” is broad, and in the context of this system, it includes bridges, culverts, pedestrian overpasses, pipeline structures, tollway restaurant overheads, and other structures that accommodate or limit the continuity of highways.

A bridge is generally defined as a structure carrying a roadway over a stream, railroad, another roadway, or depression. A culvert is generally defined as a structure that carries a stream under the roadway. The ISIS database contains data for all structures that meet or exceed the minimum length specified to be designated as a bridge for the National Bridge Inspection Standards. There are also structures of lesser lengths recorded in the database to satisfy various tracking needs (IDOT, 2021).

The IHIS dataset can be accessed via IROADS, which is a map-centric web-based application that provides access to planning and roadway data (IDOT, 2014).

The procedure followed by the researchers was to identify UMRs governed by criteria set by the IDOT Technical Review Panel (TRP). Specifically, the researchers were directed to first identify unmarked highway segments (records) within the T2HWY2020 database and shapefile that is part of IHIS and provided by the TRP. The total number of highway segments in the database was 571,594, of which 99,515 (17.4%) highway segments are the jurisdictional responsibility of the Illinois Division of Highways. Another 1,630 (0.3%) of the highway segments are the jurisdictional responsibility of another state agency. The breakdown of the remaining highway segments belongs to municipalities (266,644, 46.6%), townships/road districts (151,031, 26.4%), counties (44,669, 7.8%), private—including toll authorities (7,611, 1.3%), or federal agencies (494, 0.1%). Figure 2 presents a breakdown of highway segments according to jurisdictional responsibilities.

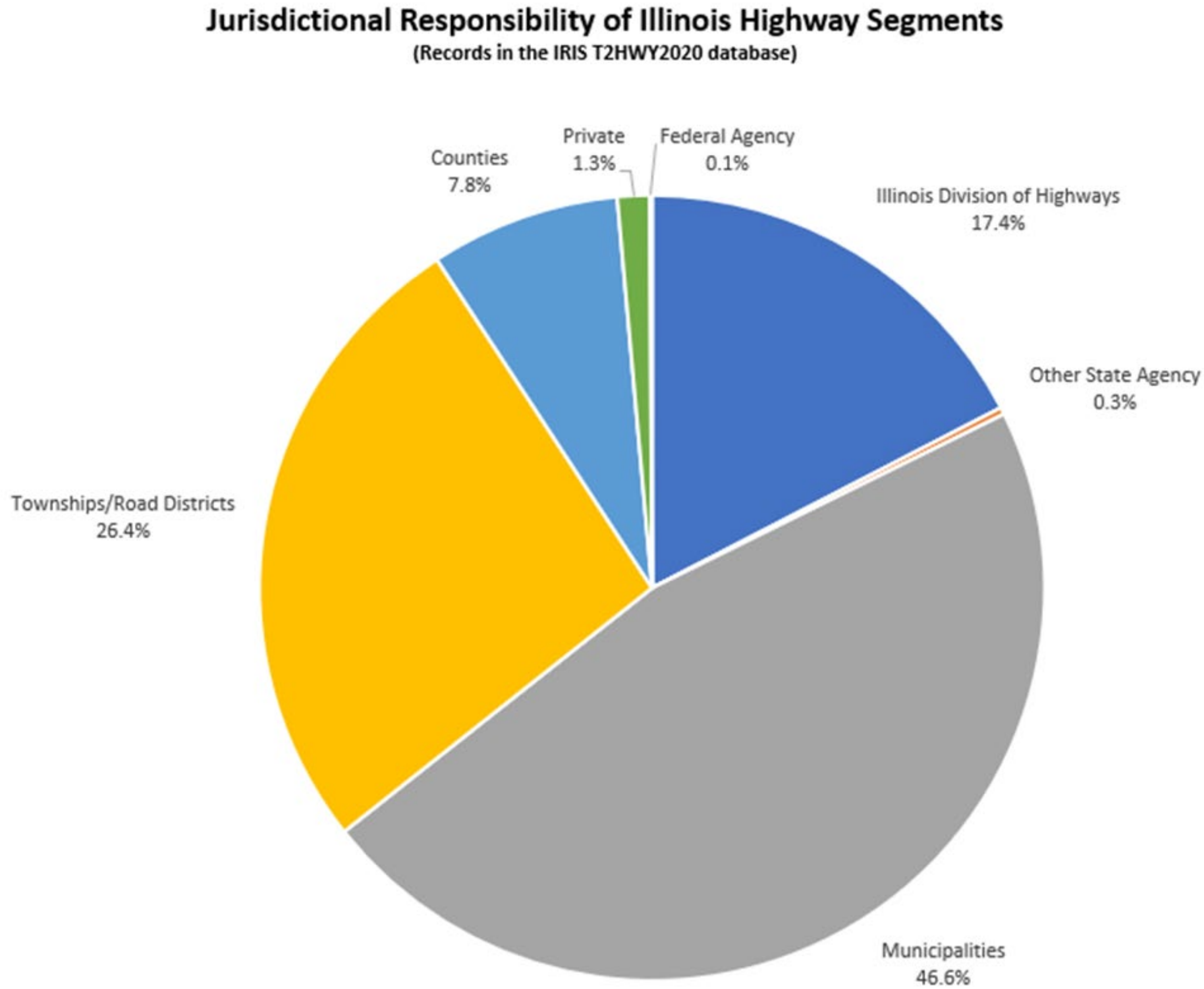

Figure 2. Pie Chart. Jurisdictional responsibility of Illinois highway segments.

Of those 99,515 highway segments (records) within the T2HWY2020 database belonging to the Illinois Division of Highways, 74,901 (75.3%) highway segments were identified as marked by filtering on IRIS Item #39 Name, Marked Route, leaving the remaining 24,614 highway segments (24.7%) as unmarked. The additional 1,630 highway segments under the jurisdiction of other state agencies were also included for a total of 26,244 unmarked highway segments.

The next step to determine the extent of UMRs was to use a geographic information system (GIS) tool (dissolve function) to aggregate the state highway segments (records) in the T2HWY2020 database into routes, which is the TRP-prescribed unit of reference for this study. This process allows for the aggregation of features within the T2HWY2020 shapefile based on specified attributes. The data collected (e.g., AADT, condition rating system, functional classification, etc.) in IRIS is recorded by segment records, so when converted to routes it will have ranges of field values within each specific route. The database was directed to be dissolved by the TRP using IRIS Item #2, Inventory Key Route Number, to create the UMRs. As a final step, the TRP directed the researchers to remove routes from the analysis that have an IRIS Item #4 (Key Route Appurtenance) type of 4 or 7, corresponding to ramps and collector/distributor, respectively. As a result, there are a total of 1,889 UMRs comprised of 2,590.73 miles that have been identified. Figure 3 presents the distribution of UMRs across the state.

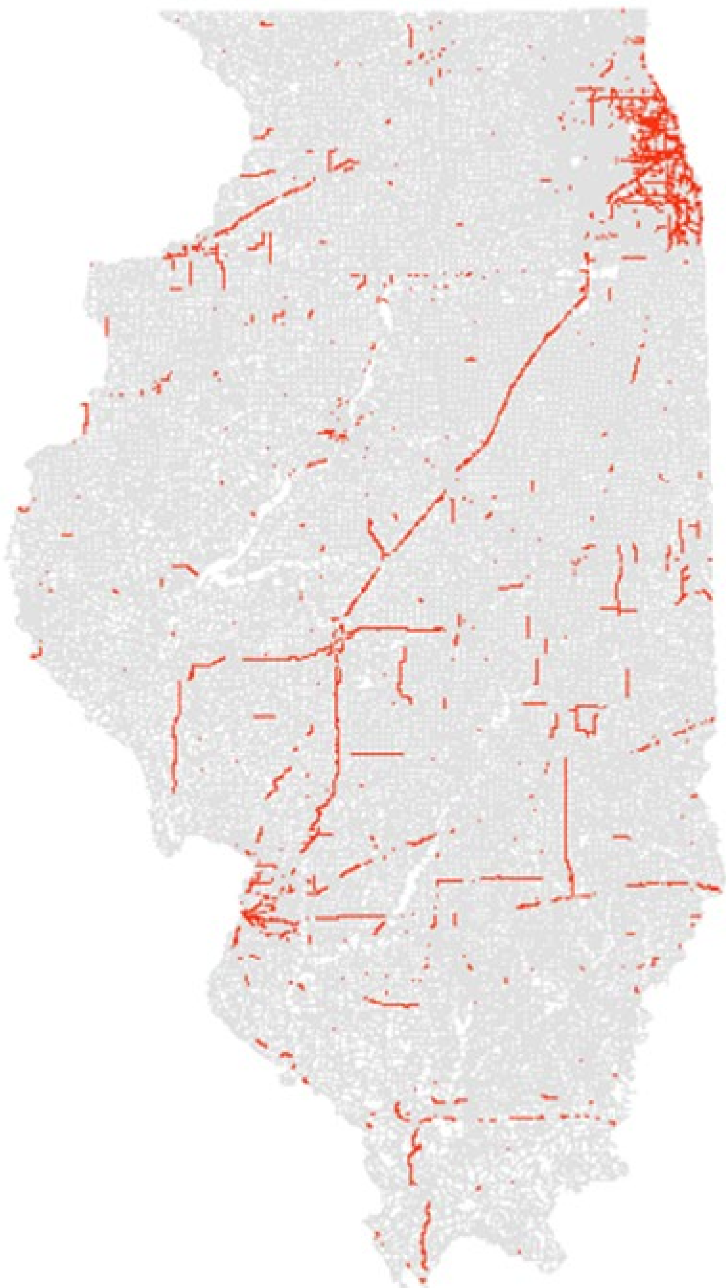

Figure 3. Map. Distribution of unmarked routes across the state of Illinois.

The distribution of UMRs for analysis (which excludes key route appurtenance types of 4 or 7) by IDOT district is presented in Table 1.

Table 1. Extent of Unmarked Routes in Various Districts

District #	Centerline Miles of Identified Unmarked Routes
1	888.91
2	216.14
3	97.58
4	88.69
5	191.21
6	368.92
7	275.94
8	341.83
9	121.51
State	**2,590.73**

The total mileage of the UMR dataset for this study is approximately 2,600 miles. Based on route length, District 1 (the Greater Chicago Area) is home to about one-third of all UMRs.

Unmarked routes exist throughout the state and vary in their attributes. For example, the length of UMRs varies from 0.1 miles with little or no traffic to as high as ~24 miles with traffic up to 91,200 AADT. Pavement condition of the UMRs, in terms of condition rating system (CRS), vary across the entire scale, from 0 to 9. Some UMRs have structures such as bridges and culverts along the routes. The maximum number of structures along a UMR is 36. Figure 4 provides general statistics of the identified set of UMRs for this study.

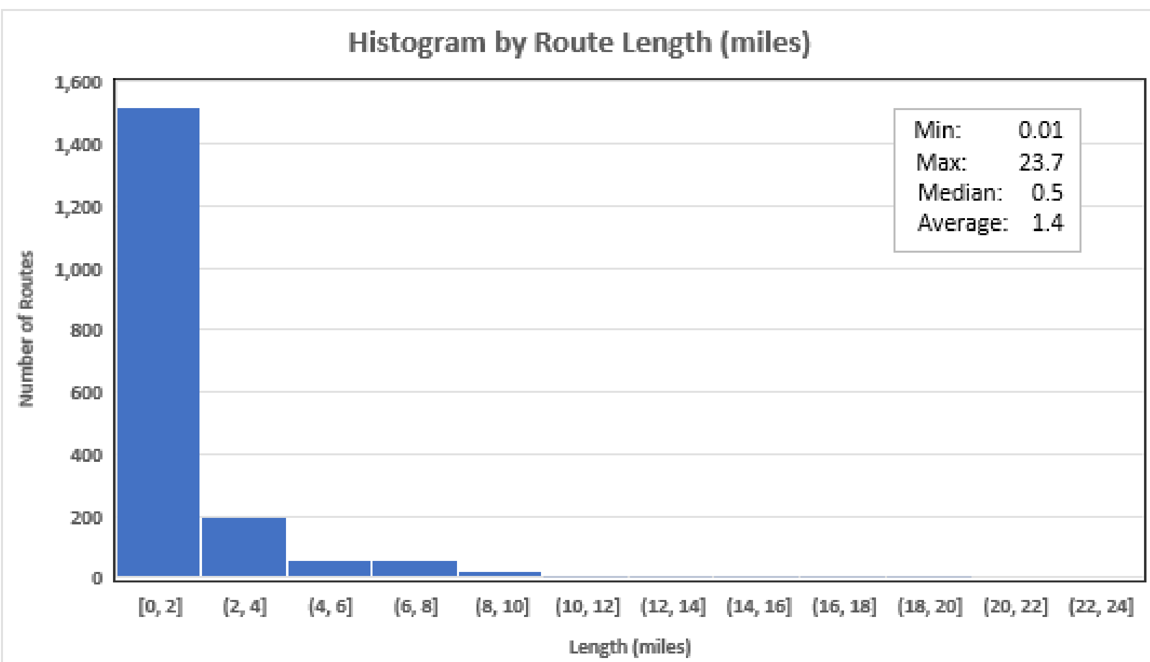

Figure 4A. Chart. Histogram of unmarked routes by length with statistics.

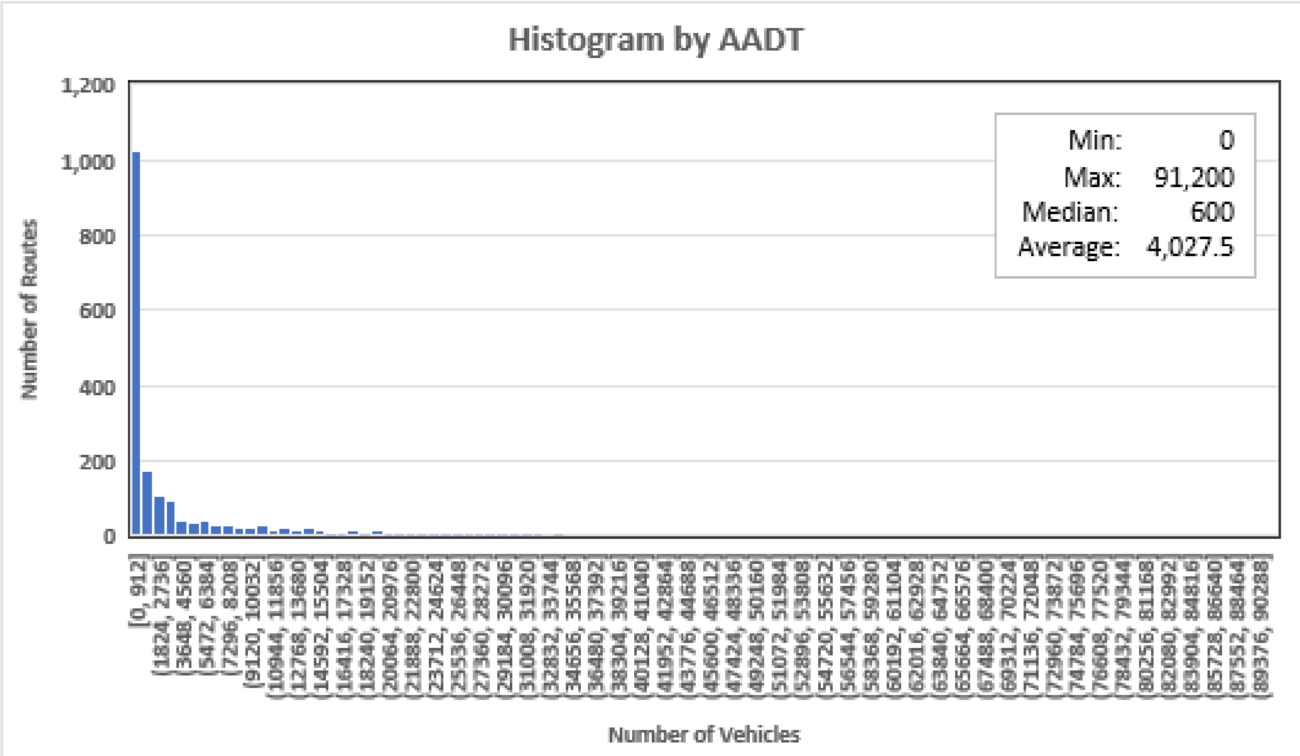

Figure 4B. Chart. Histogram of unmarked routes by AADT with statistics.

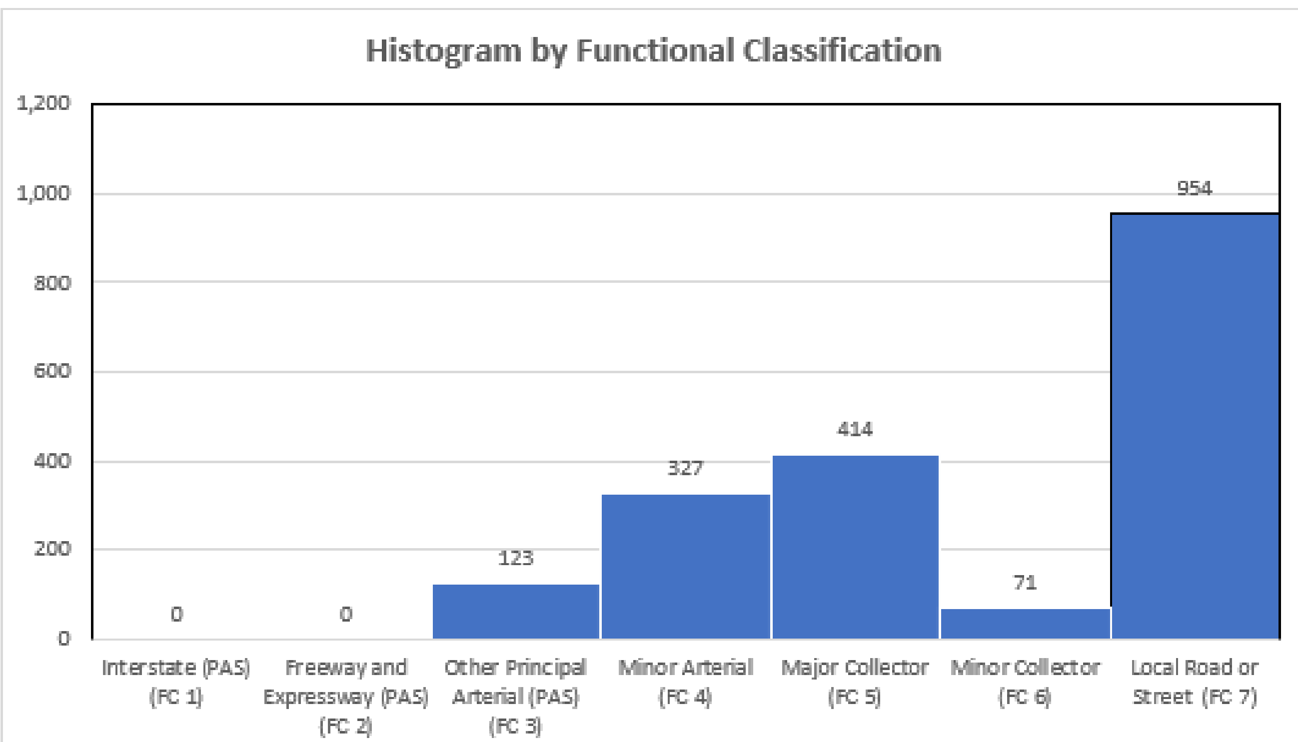

Figure 4C. Chart. Histogram of unmarked routes by functional classification with statistics.

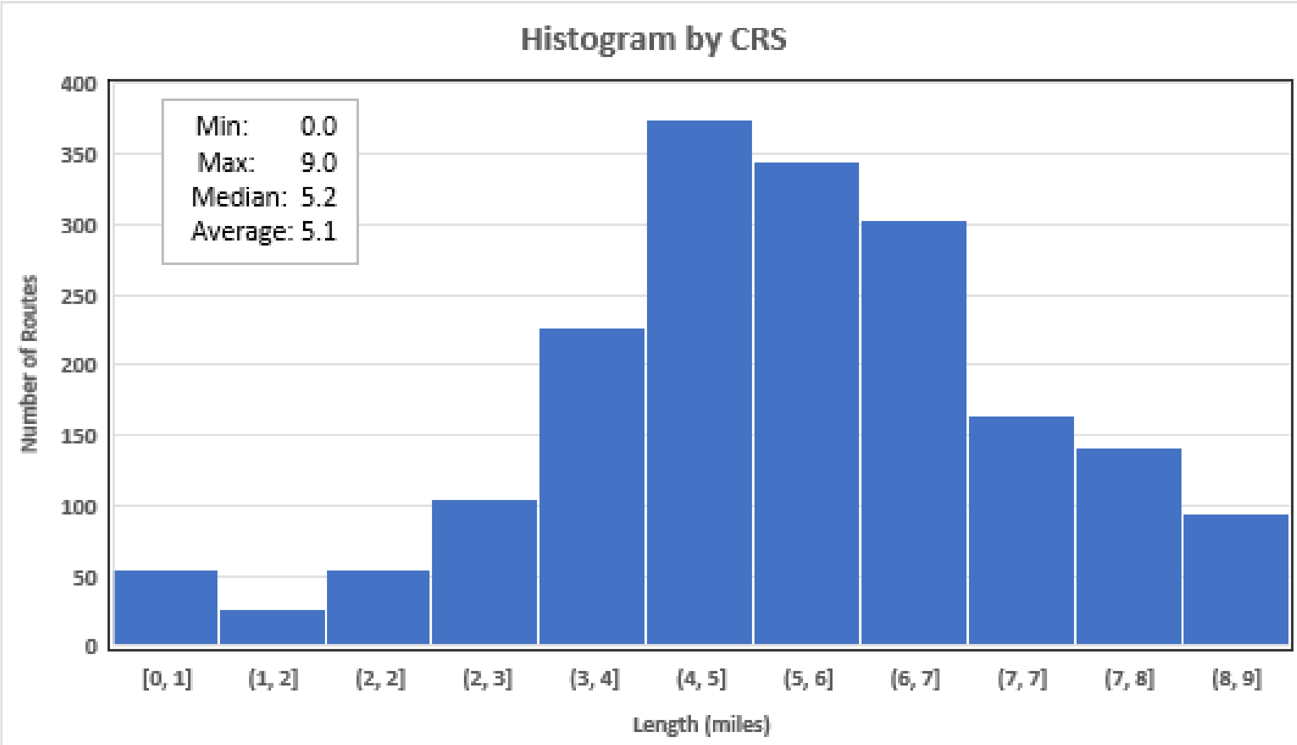

Figure 4D. Chart. Histogram of unmarked routes by CRS with statistics.

Figure 4. Charts. Histograms of identified set of unmarked routes for this study.

The average length of UMRs is 1.37 miles, and the median value is 0.45 miles (Figure 4A). There are 1,287 UMRs that are less than or equal to 1 mile in length. There are 33 UMRs that are greater than 10 miles in length. Of these, ten of these 33 UMRs are located in the Chicago area while the remaining UMRs are in rural areas or connect rural and other urban areas in Illinois.

Traffic in terms of AADT varies from 0 to 91,200. The average AADT is 4,027.5 with a median of 600 (Figure 4B). From the data used in Figure 4, AADT is 0 to 100 on 744 of the 1,889 UMRs, which is ~40% of all UMRs. However, these records also include routes where AADT data is not reported in the system, which are predominately local roads or streets with very low volumes. Conversely, 471 UMRs have AADT greater than or equal to 4,000, which comprises 25% of all UMRs.

IDOT reports the condition of pavements using the CRS. This index is calculated on a 0 to 9 scale and is a function of visible distresses on the pavement surface. IDOT has a program to collect the required data annually using a data-collection vehicle equipped with lasers, line scanners, high-definition cameras, GPS, and computers. A CRS of 9 indicates a pavement with no visible distresses, while 0 represents a pavement at the end of its service life and ready for reconstruction or major rehabilitation. UMRs in Illinois have an average CRS of 5.15 with a median of 5.2 (Figure 4D). Of the 1,889 UMRs identified, 841 (or 44.5%) have a CRS less than 5.0, which is the acceptable condition level threshold in the IDOT TAMP (IDOT, 2019). The breakdown of UMRs with a CRS less than 5.0 is as follows:

- Local streets or roads (512 UMRs, 60.9%)
- Major/minor collectors (292 UMRs, 34.7%)
- Minor arterials (115 UMRs, 13.7%)
- Other principal arterials (41 UMRs, 4.9%)

Conversely, 134 UMRs have a CRS less than or equal to 8.0, corresponding to 7.1% of all UMRs.

The functional classification of a road or street is based on the character of service it is intended to provide. IDOT categorizes its routes into seven functional classifications with their respective codes, as follows:

1. Interstate
2. Freeways and expressways
3. Other principle arterial
4. Minor arterial
5. Major collector
6. Minor collector
7. Local road or street

In general, the principal arterial system, which comprises FC categories 1 through 3, carries the highest traffic volumes and accommodates the greatest trip lengths. The principal arterial system is subdivided into routes functionally classified as interstates (FC 1), other freeways and expressways (FC 2), and other principal arterials (FC 3). Interstates and freeways/expressways routes are excluded from the UMR dataset.

Compared to the principal arterial system, minor arterials (FC 4) provide lower travel speeds and accommodate shorter trip lengths and lower traffic volumes, but they also provide more access to property.

The major collector road system (FC 5) generally includes routes where the predominant travel distances are shorter than trips on arterial routes but are longer than the shorter trips characteristic of the local road functional system. Consequently, more moderate speeds may be typical on average.

Minor collectors (FC 6) provide service to any remaining small communities and are typically located at intervals, consistent with population density, to collect traffic from local routes and to connect all developed areas within a reasonable distance from a major collector route. They include more stub sections than the major collector classification and are designed for relatively reliable and year-around safe travel, with more emphasis on property access than mobility.

The remaining routes are functionally classified as local roads or streets (FC 7) and generally have the following characteristics:

- Constitute mileage not designated as part of higher classifications
- Provide access to abutting property and connections to higher classified routes, in general
- Lower average daily traffic (ADT) typically
- Reflect minimal design criteria with primary consideration to access needs
- Offer the lowest level of mobility and usually contain no bus routes
- Discourage through traffic movements

From the data depicted in Figure 4C on functional class, 50.5% of UMRs are on local roads or streets, followed by 20.5% on major collectors, 13.2% on minor arterials, 5.2% on other principal arterials, and 2.7% on minor collectors. The remaining 7.8% is comprised of segments that are mixed highway segments of functional class—typically arterials reducing to collectors or collectors reducing to local roads or streets.

CHAPTER 5: ANALYSIS OF UNMARKED ROUTES—STUDY METHODOLOGY

The primary intent of this task is to develop a nonstandard classification approach to address the unmarked route TAMP category to assist IDOT in identifying potential candidates to be vacated, abandoned, transferred, reconfigured, or retained.

When a roadway is proposed for transfer from one jurisdiction to another, it is fair to expect the receiving jurisdiction to be concerned about various aspects such as those presented below:

- How well has the route been maintained?
- What would it cost us to maintain the roadway in the future?
- What is the traffic level and composition?
- Are the geometrics and signages adequate?
- Are there structures that are expensive to maintain?
- Does it need an upgrade?
- What type of assistance do we get from the transferring agency?
- Are there any safety and/or liability issues?

The data used in this study should address the above concerns. The primary source of data available is IHIS. The roadway information consists of 120 attributes, including agency, begin, end, geometrics, location, AADT, condition rating survey, international roughness index, jurisdiction, maintenance agency, functional class, marked/unmarked, surface type, and so forth. After a thorough review of these attributes, a list of key attributes was generated from IHIS, as follows: CRS, AADT, functional class, and structures.

An initial attempt to create a rules-based approach for categorizing recommendations was based on the above key database attributes. For example, consider an UMR in District 6 with an inventory ID of 086 40003 200000. This is a local road and serves as a private road to a farm field. The route is 0.06 miles long. The CRS value is 1.2, and AADT is not available and reported as 0. It has very little to no traffic, and its pavement condition is very poor. This led to the conclusion that an approach to recommend jurisdictional transfer, abandonment, vacation, reconfiguration, and maintenance/rehabilitation solely from the IHIS key database attributes was not possible.

This route is presented on the map in Figure 5. The pop-up box in the figure displays the known key attribute data to supplement the visual data obtained by analyzing the UMR's setting in regards to functional use, service, and adjacent jurisdictional highways. This UMR serves only as a private property access road or driveway. The route displayed on the map helps users to visualize additional information about the route such as its location, its connectivity to adjacent jurisdictional networks, the type and number of properties served, and so forth. This visual information is not available within the database alone. This example demonstrates the need for visual attributes to supplement the key attributes derived from IRIS. Consequently, these additional visual attributes that include supplemental information to the key database attributes are pertinent to making recommendations. Therefore, the researchers proposed an individual analysis of each UMR to include a combination of key database attributes and visual attributes observed through GIS (which together comprise the key route attributes) as determined by the research team.

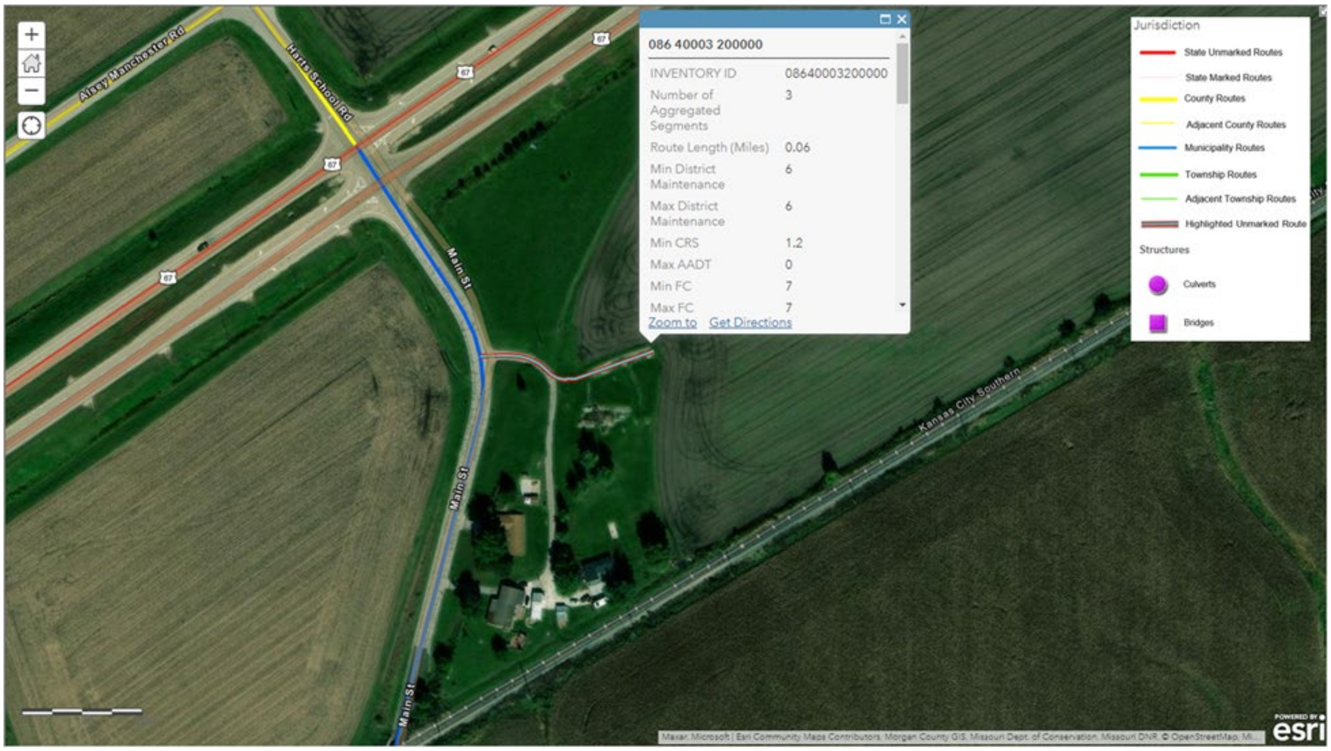

Figure 5. Map. Aerial view of an unmarked route in District 6, Inventory ID: 086 40003 200000.

Based on this experience, the following visual attributes were assembled for each UMR segment in addition to the key database attributes.

- Number of homes/businesses served (0, 1, multiple)
- Number of structures along route
- Assessment of logical continuity to other adjacent jurisdictional highways
- Oddities (stragglers based on configuration)
- Redundant access
- Very low activity

- Lack of connectivity
- Frontage/service road

It should be recognized that while database attributes are collected by the State of Illinois for each segment within a route within IHIS, the TRP prescribed that this UMR study will focus on unmarked routes as the smallest unit for consideration. Consequently, following the aggregation of segments into routes using the Key Route Identification item, the research team decided to use the most conservative approach for recommendations by collecting the minimum CRS and the maximum AADT of all segments within each route for assignment. For each UMR in the study, a snapshot was captured with the key attribute data from IRIS needed for the recommendation. Table 2 presents the complete list of attributes.

Table 2. List of Database Attributes and Visual Attributes Used for the Analysis of Unmarked Routes

Database Attributes Filtered from IHIS	**Visual Attributes (manually derived for each UMR segment)**
Minimum Condition Rating System	# of Homes/Businesses Served
Maximum Annual Average Daily Traffic	# of Cities/Routes Runs Through
Functional Classification	Is route an oddity? • Serves single owner • Redundant access • Very low activity • Frontage road • Driveway • Lack of connectivity
Structures (Bridge, Overpass, Culvert)	Adjacent jurisdictional highway networks
Key Route Attributes = Key Database Attributes + Visual Attributes	

After assembling key attribute data for each UMR, the researchers developed a methodology, labeled JARM, to identify potential candidates for jurisdictional transfer (J), abandonment (or vacation) (A), reconfiguration (R), or maintenance and rehabilitation of retained routes (M). The network methodology is depicted in Figure 6.

Figure 6. Illustration. JARM methodology.

Figure 7 illustrates the process of combining database attributes and visual attributes for each UMR, making a recommendation, and populating a spreadsheet. The spreadsheet tool incorporates the developed methodology that will assist IDOT in pursuing the recommendations of unmarked routes as candidates for vacated, abandoned, transferred, reconfigured, and/or retained routes. The IHIS database was filtered to the key attributes and combined with visual attributes from the GIS to be assessed by the JARM methodology for recommendation. The spreadsheet tool is an easy-to-use, stand-alone tool that can be used by IDOT districts.

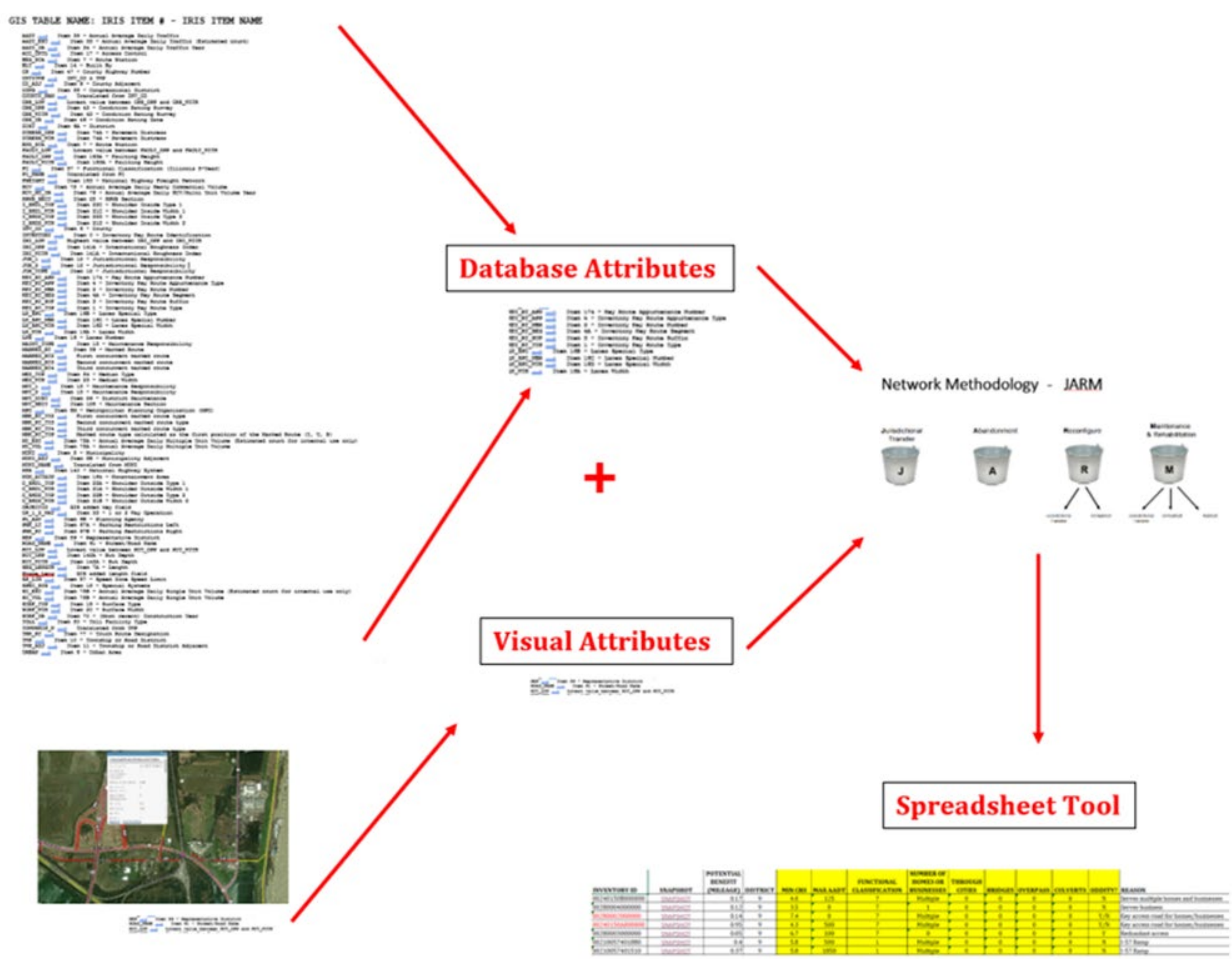

Figure 7. Snapshot. Process of using database and visual attributes, JARM methodology, and development of a spreadsheet tool.

As the review of UMRs proceeded, it became apparent that most of the routes would be potential candidates for jurisdictional transfer. Thus, the researchers created an additional set of highway continuity attributes (adjacent jurisdictions/owners connected to each UMR assessed) to include in the subsequent recommendation process that are governed by the guidance specified in the *Highway Jurisdiction Guidelines for Highway and Street Systems* (IDOT, 2006). The manual covers the difference between jurisdictional ownership versus maintenance agreements, mandatory versus agreed-to transfers, and the application of system continuity and functional classification as a governing mechanism for logical transfer decisions, and the impact of Motor Fuel Tax (MFT) funding to transfer decisions. The highway continuity attributes are listed as follows:

- Is the route adjacent to a township or road district highway/street system?
- Is the route adjacent to a municipality highway/street system?
- Is the route adjacent to a county highway/street system?
- Is the route solely serving less than or equal to one owner (resident/business)?
- Is the route adjacent to a state marked highway/street system?

For each UMR, the key route attributes and the highway continuity attributes described above were compiled into a sortable spreadsheet tool. The highway continuity attribute fields were populated for logical candidates for each UMR. Blank fields (columns R–V) within these highway continuity attributes should be interpreted as not having a logical candidate for transfer considerations.

The key takeaways relevant to this project are listed as follows:

- A maintenance agreement does not transfer jurisdiction. This is an option for jurisdictions that may accept maintenance of pavements within routes without the responsibility of structures. This was proposed as a secondary recommendation for UMRs that may not be initially accepted in negotiation for logical transfer.
- Municipalities are *mandated* to assume jurisdiction of local roads within corporate limits *when annexing*.
- Agreed-to jurisdictional transfers occur because of the *logical need* to transfer authority to another highway system.
- Transfer should begin and end at logical termini in order to preserve an integrated highway network.
- Functional classification often indicates what highway authority would be appropriate for jurisdiction based on the public sector served.
- When negotiating jurisdictional transfers with local agencies, the functional classification of the road in question should be considered.
- Candidate jurisdictional transfers should be governed primarily by *continuity* (adjacent jurisdictional highway systems) and *functional classification*.

Other key considerations noted in the review of the guidance document that impact our analysis include the following items:

- Jurisdiction of state/county roads annexed by municipalities remain with the state/county until a formal agreement is executed for transfer.

- Municipalities can have jurisdiction of roads outside of their corporate limits (to maintain continuity to logical termini if connecting existing streets within the municipality).
- Counties are allotted Motor Fuel Tax funds based on their *vehicle fees share*.
- Townships are allotted MFT funds based on their *mileage share*.
- Municipalities are allotted MFT funds based on their *population share*.
- A township road must be greater than or equal to 0.04 miles to be eligible for MFT funds.
- Vacation is the official process by which the road is removed from the highway system. When a roadway is vacated, the private property created by the vacation of a public right-of-way should be transferred back to the original property owner, or if not known, then equally to the properties on each side of the road.
- IDOT can transfer its land rights to a local entity along with the jurisdictional transfer of a highway. These land rights are to be transferred without any compensation from the recipient. However, any conveyance of land rights associated with this statute is with the understanding that the land will be used for public highway use. If the local entity wants to (1) use the land for a non-highway or non-public use or (2) vacate the property, IDOT approval must be obtained and compensation from the local agency may be required at that time.

The steps involved in the analysis of each UMR and development of a spreadsheet tool are outlined with examples:

STEP 1: Review IROADS to collect key database attributes and visual attributes.

STEP 2: Build ArcGIS to generate image snapshots to understand visual attributes while also displaying the key database attributes for instant reference within the spreadsheet tool.

STEP 3: Compile highway continuity attributes for potential transfer and vacation candidates.

STEP 4: Make recommendations for each UMR.

The four steps are described in detail in the following sections.

STEP 1: REVIEW IHIS, IRIS, ISIS, AND IROADS TO COLLECT KEY DATABASE ATTRIBUTES AND VISUAL ATTRIBUTES

The first step is to collect and record the key IHIS database attributes and visual attributes into the spreadsheet tool. This requires the use of IROADS (Illinois' GIS) for database attributes and viewing each UMR from aerial photos (and van pictures, as needed) in IROADS to manually review conditions (Figures 8 and 9).

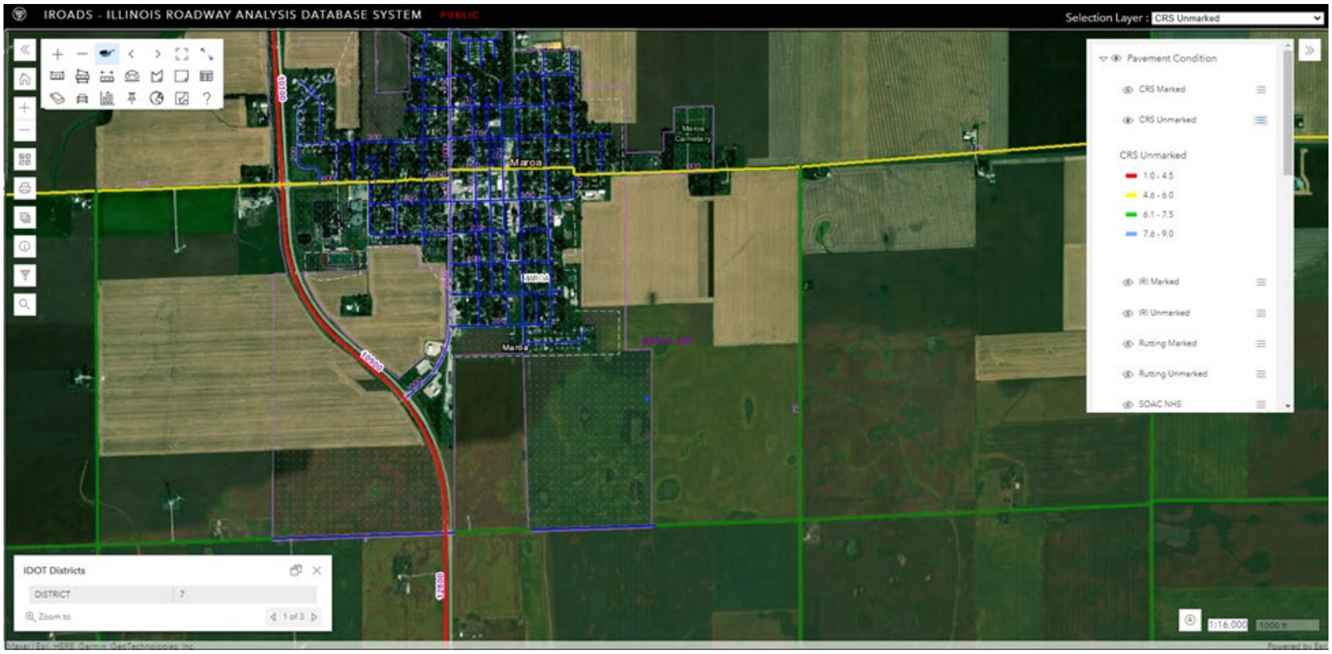

Figure 8. Map. Image of IROADS user interface used to identify jurisdictional boundaries and database attributes.

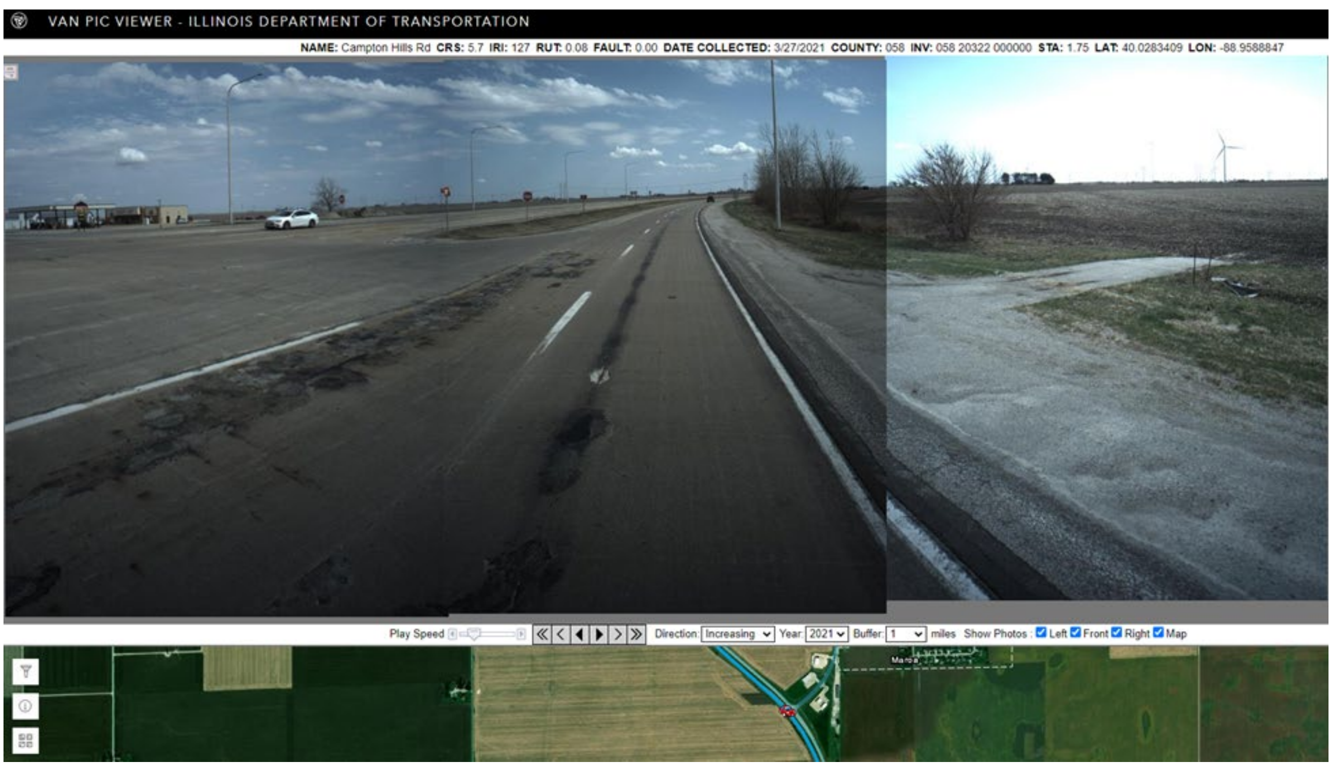

Figure 9. Picture. Image of IDOT van pic viewer used to observe ground-level benchmarks, owners, and route usage.

Additionally, reference of public, third-party web mapping sources (e.g., Bing Maps, Google Maps, County Auditor parcel maps) were consulted in unique situations to confirm information gathered on select UMRs. An example would be an UMR that appears to be located within a single parcel with multiple buildings/residences on it served by the route. A county auditor parcel map can confirm if it serves as a driveway for a single owner or if it serves as a frontage road collecting multiple owners.

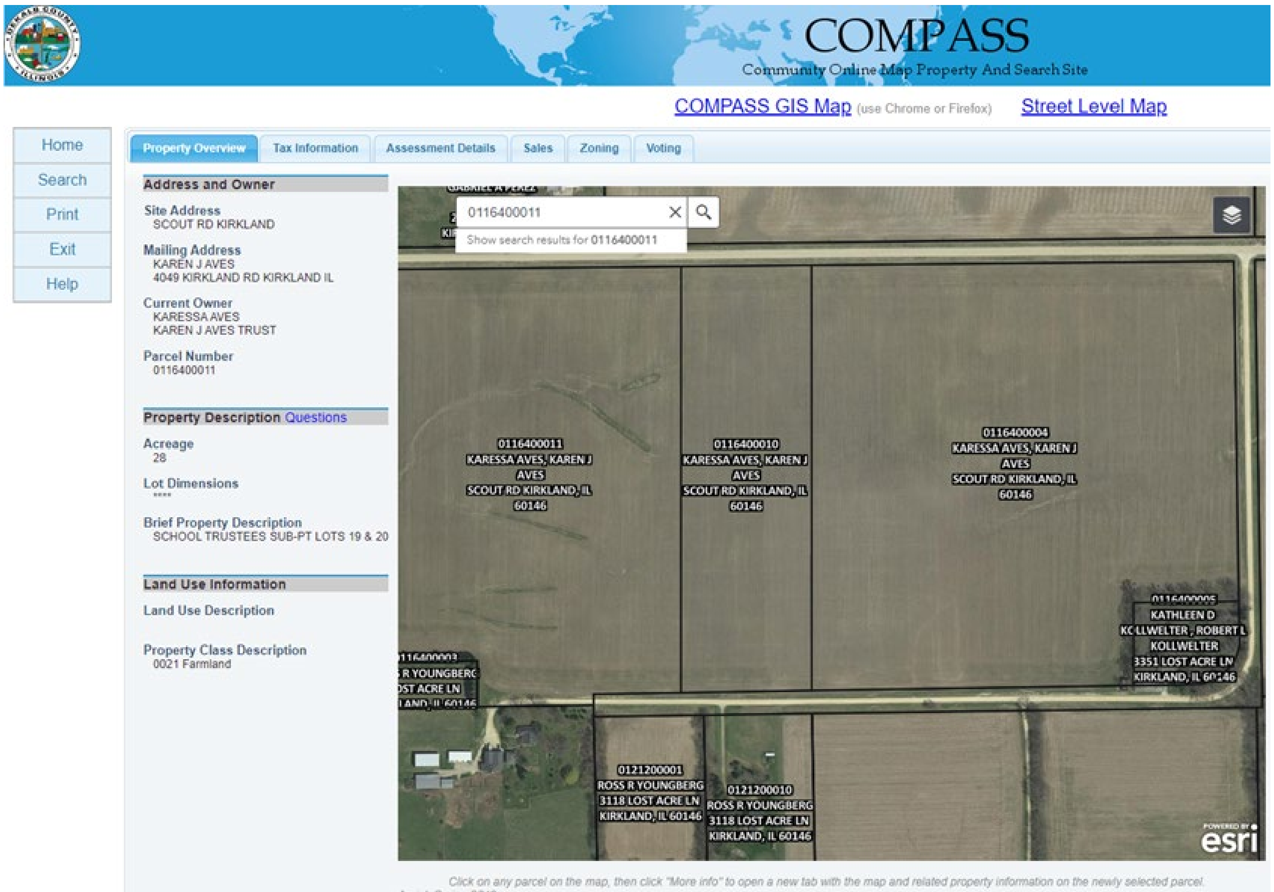

Figure 10. Map. Image of third-party GIS from county auditor site used for parcel confirmation for recommendations *(COMPASS GIS, 2023).*

The key route attributes obtained from the sources referenced in this step were entered into the spreadsheet tool for each UMR record for analysis. Figure 11 presents a screenshot of the key route attributes identified in the methodology (highlighted in orange).

		KEY ROUTE ATTRIBUTES										
ROUTE LENGTH (MILEAGE)	DISTRICT	MIN CRS	MAX AADT	FUNCTIONAL CLASSIFICATION	NUMBER OF HOMES OR BUSINESSES	THROUGH CITIES	BRIDGES	OVERPASS	CULVERTS	ODDITY?	DESCRIPTION/REASON
0.51	1	7.3	10050	4	Multiple	1	0	0	0	Y	Minor Arterial Connecting City Routes with s
2.60	8	5.7	10000	4	Multiple	2	2	1	2	N	Minor Arterial that Runs Through 2 Municip Municipal Routes
0.03	1	7.4	9950	4	Multiple	1	0	0	0	N	Minor Arterial Connecting County Route
1.65	2	3.8	9850	4	Multiple	1	0	0	0	N	Minor Arterial Within Municipality Connecti
5.95	1	5.6	9850	5	Multiple	3	2	0	1	N	Major Collector Connecting adjacent cities - jurisdiction of routes within vicinity with si
0.25	2	7.9	9750	4	Multiple	0	2	0	0	N	Minor Arterial Connecting 2 Municipalities
1.40	8	9.0	9650	3	Multiple	1	6	0	0	N	Move to Marked

Figure 11. Screenshot. Spreadsheet tool displaying the fields of the key route attributes.

STEP 2: BUILD ARCGIS TO GENERATE IMAGE SNAPSHOTS FOR REFERENCE THROUGH SPREADSHEET TOOL

This step is included to create a quick link for each UMR as a visual, aerial snapshot that has key database decision data posted for easy reference for any user of the spreadsheet tool. Because it requires customization to display the key database attributes selected for analysis and to display select GIS layers at customized zoom levels, the researchers needed to build a customized GIS. The researchers used industry-standard ArcGIS Online to display pertinent information to capture snapshots of the extent of the selected UMR for inclusion in the spreadsheet tool (Figure 12).

	A	B	C	D	E	F	G	H	I
1									
2	#	INVENTORY KEY ROUTE IDENTIFICATION	INVENTORY ID	SNAPSHOT	ROUTE LENGTH (MILEAGE)	DISTRICT	MIN CRS	MAX AADT	FUNCTIONA CLASSIFICAT
268	1045	016 92913 000000	01692913000000	SNAPSHOT	0.51	1	7.3	10050	4
269	1864	060 99111 000000	06099111000000	SNAPSHOT	2.60	8	5.7	10000	4
270	1290	049 91230 000000	04991230000000	SNAPSHOT	0.03	1	7.4	9950	4
271	1344	089 95241 000000	08995241000000	SNAPSHOT	1.65	2	3.8	9850	4
272	1821	016 91620 000000	01691620000000	SNAPSHOT	5.95	1	5.6	9850	5
273	1789	098 95571 000000	09895571000000	SNAPSHOT	0.25	2	7.9	9750	4
274	116	082 20799 000000	08220799000000	SNAPSHOT	1.40	8	9.0	9650	3
275	86	099 30287 000000	09930287000000	SNAPSHOT	0.24	1	7.3	9600	4
276	1451	081 95789 000000	08195789000000	SNAPSHOT	0.36	2	6.1	9600	4

Figure 12. Screenshot. Image of spreadsheet tool displaying the field for snapshots.

IDOT personnel will be able to use this spreadsheet tool to quickly sort by their district number and to be able to instantly retrieve the recommendation, the key route attributes, and an aerial snapshot of the extent of the selected route. For each snapshot, a legend is included with the same color schema for jurisdictional highways as is used in IROADS (state routes—red, county routes—yellow, municipal routes—blue, and township routes—green). Structures (bridges—squares and culverts—circles) were added as a layer to be able to quickly identify ownership and maintenance jurisdictions for structures along each UMR.

The selected UMR is presented as a red line (state route) with a thin, cyan line running along the centerline. The maximum AADT is posted as a white label for the selected UMR. Each UMR snapshot will display a pop-up window with a small blue arrow pointing to the selected UMR that contains the number of segments comprising the route, the route length in miles, the IDOT district, the minimum CRS, the maximum AADT, and the range of functional classification over the segments that comprise the UMR. Figure 13 displays all elements described here.

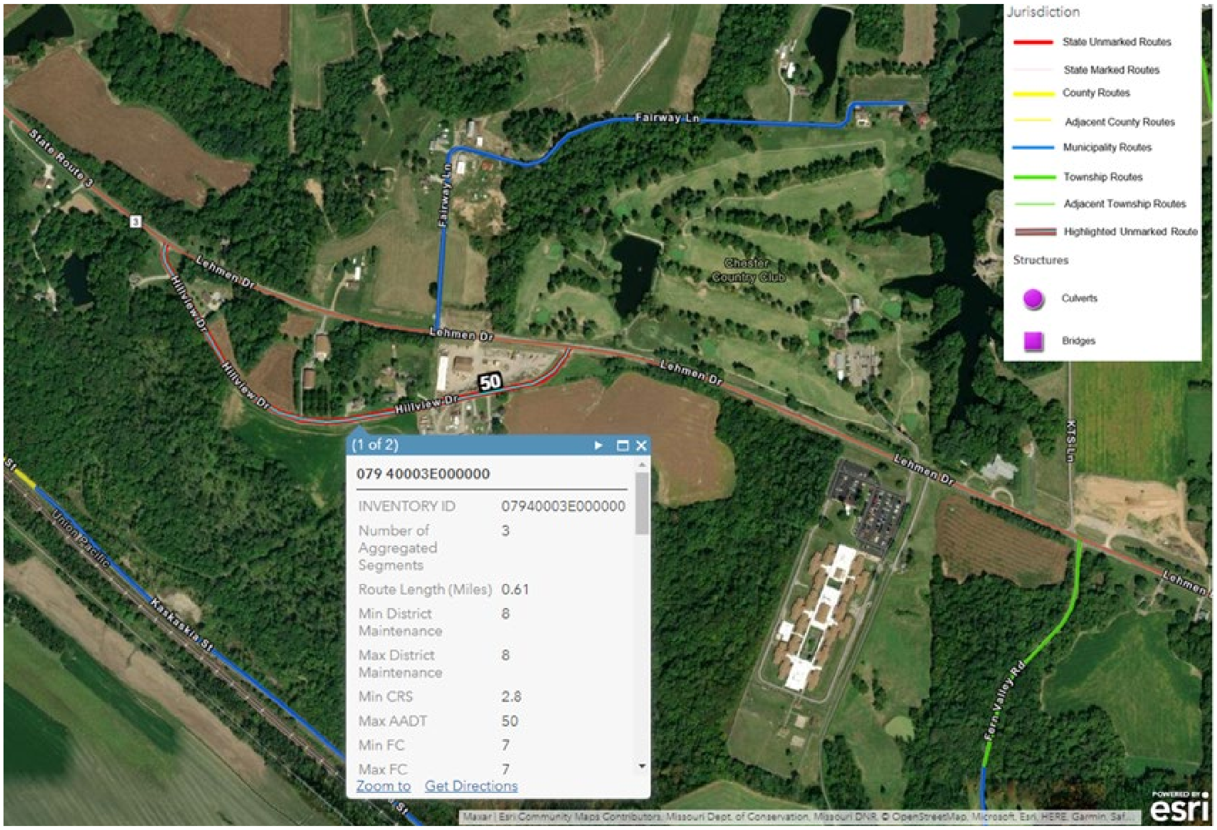

Figure 13. Map. Captured snapshot displaying the extent of a selected unmarked route with key route attributes and structures.

STEP 3: COMPILE HIGHWAY CONTINUITY ATTRIBUTES FOR POTENTIAL TRANSFER AND VACATION CANDIDATES

The inclusion of this step is necessary to describe the adjacent jurisdictional highway networks to be considered. The names of jurisdictions are entered for *only* those that are candidates, as governed by the agreed-to jurisdictional transfer (JT) framework outlined in the *Highway Jurisdiction Guidelines for Highway and Street Systems* (IDOT, 2006), specifically:

- Candidate JTs should be governed primarily by *continuity* (adjacent jurisdictional highway systems) and *functional classification*.
- Agreed-to jurisdictional transfers occur because of the *logical need* to transfer authority to another highway system.
- Transfer should begin and end at logical termini to preserve an integrated highway network.

Figure 14 presents a screenshot of the spreadsheet tool displaying the highway continuity attributes (blue) whose fields are populated based on the potential suitability of another jurisdiction to approach for JT. In many cases, there is an adjacent jurisdictional highway network that will not be entered because it does not satisfy the governing criteria listed in the bulleted list above. For example, a UMR connected to a township route may not have the township listed in the highway continuity attributes if the functional classification (e.g., FC < 4) is not appropriate for the jurisdiction based on the public sector served.

	HIGHWAY CONTINUITY ATTRIBUTES				
COUNTY	ADJACENT TOWNSHIP/ROAD DISTRICT AVAILABLE?	ADJACENT MUNICIPALITY AVAILABLE?	ADJACENT COUNTY AVAILABLE?	ADJACENT RESIDENT/BUSINESS AVAILABLE?	ADJACENT TO MARKED?
COOK		CHICAGO			
MADISON	NAMEOKI	PONTOON BEACH/COLLINSVILLE	MADISON		
LAKE			LAKE		
STEPHENSON		FREEPORT			
COOK	COOK COUNTY FOREST PRESERVE DISTRICT	LANSING/THORNTON/HOMEWOOD	COOK		
WHITESIDE			WHITESIDE		
ST. CLAIR					YES
WILL					YES

Figure 14. Screenshot. Captured snapshot of the spreadsheet tool displaying the highway continuity attributes for candidate jurisdictional transfers.

STEP 4: MAKE RECOMMENDATIONS FOR EACH UMR

For each UMR, INFRAME carefully analyzed the key route attributes in combination with visual data sources and the highway continuity attributes to make recommendations. A screenshot of the preliminary priority recommendations field within the spreadsheet tool is presented in Figure 15.

TTRIBUTES					
ADJACENT COUNTY AVAILABLE?	ADJACENT RESIDENT/BUSINESS AVAILABLE?	ADJACENT TO MARKED?	FIRST RECOMMENDATION	PRIMARY JT	PRELIMINARY PRIORITY RECOMMENDATION(S)
			J	M	JT to Municipality (Harristown)
			J	T	JT to Township (Long Creek)
	YES		A	-	Approach Owner/Abandon/Approach Township (Harristown)
			J	T	JT to Township (Virden) - Consider MA with State, if necessary
			J	T	JT to Township (Carlinville) - MA with State for structures, if necessary
			J	T	JT to Township (Staunton)
			J	M	JT to Municipality (Hamel)
MADISON			J	T	JT to Township (Olive)/JT to County (Madison)

Figure 15. Screenshot. Captured snapshot of the spreadsheet tool displaying the preliminary recommendations.

For UMRs with potential alternatives, a slash "/" separates the recommendations, with the highest priority given to the leftmost, first-listed recommendation. Just over half of the recommendations (~52%) only have a single recommendation due to a clear logic in the attributes and governing jurisdictional guidelines outlined in the section above. The remaining ~48% have at least one alternative recommendation—and as a percentage of that subgroup, ~47% have more than one potential alternative.

Additional relevant information is included in this field that will likely need to be considered. For example, some routes may have a recommendation to potentially split along corporation limits if no logical termini are present. Also, routes that are candidates for transfer may be facilitated by addressing ownership and maintenance of any structures along the route. It is important to recall that a maintenance agreement does not transfer jurisdiction. This is an option for jurisdictions that may be willing to accept maintenance of pavements of UMRs without the responsibility of maintaining the structures on that route.

While all the recommendations are rooted in IDOT guidelines and Illinois law, IDOT personnel should consult the spreadsheet tool and the project report to best prepare for a successful negotiation.

Lower levels of traffic (AADT) reflect lower highway activity. This should make it easier to negotiate/complete the recommendation (e.g., jurisdictional transfer, vacation, or abandonment). Functional classification is also an important attribute suggested by the guideline for assignment to the appropriate jurisdiction. The higher the FC, the easier it should be to negotiate/complete the recommendation (e.g., jurisdictional transfer). The FC codes are as follows:

1. Interstate principal arterial system (PAS)
2. Freeway and expressway (PAS)
3. Other principal arterial (PAS)
4. Minor arterial
5. Major collector
6. Minor collector
7. Local road or street

The number of homes/businesses (owners) is included because a single owner will be relatively easier to vacate the UMR than one with multiple owners. Likewise, a UMR that is a potential candidate for JT based on continuity (adjacent highway network) and functional classification (character of public served) will be relatively easier to negotiate a transfer. Oddities (e.g., a UMR that serves as a driveway) are also less debatable JT candidates versus UMRs that are part of the integrated highway and street systems.

If the first recommendation is to either an owner or a township, then following through on the recommendation should be straightforward. This is founded in the logic of continuity, functional classification, and—with the township—an expected willingness to add UMRs to their managed network based on the allocation of Motor Fuel Tax based on mileage for townships.

For those UMRs that have a recommendation to retain within the state highway network (listed as "Move to Marked" after other alternatives have been unsuccessfully exhausted), moving forward on retaining these UMRs as a recommendation should be straightforward.

In summary, the researchers reviewed GIS and IHIS data to determine routes and structures contained in the unmarked route category to establish appropriate subsets for developing strategies for routes. This task required IROADS/ArcGIS and included a manual review of aerial photos, parcel maps, and other GIS data from third-party websites. A developed JARM methodology and analysis led to the development of this spreadsheet tool, which includes a prioritization of potential alternative recommendations that will assist IDOT in pursuing (or negotiating) UMRs as candidates for vacation, abandonment, transfer, or retention.

CHAPTER 6: MAINTENANCE AND MANAGEMENT OF UNMARKED ROUTES AND LOW-VOLUME ROADS—A REVIEW OF LITERATURE

As reported earlier, traffic on UMRs varies from 0 to 91,200. At the beginning of the study, the research group was under the assumption that most UMRs fall in the low-volume category. Hence, the TRP decided to include all of IDOT's low-volume routes (including those in the marked category) for evaluation of maintenance and rehabilitation (M&R) along with UMRs. However, no guidelines were provided to define the low-volume category of routes. A literature search was conducted to find out how other agencies define low-volume roads and to determine appropriate M&R options as well. The purpose of the literature review was to investigate the maintenance and rehabilitation practices by other state agencies with reference to low-volume roads (LVRs).

TREATMENT OPTIONS FOR LOW-VOLUME ROADS

For DOTs, maintenance and management of low-volume roads pose a great challenge. Owing to nonavailability of adequate resources while at the same time needing to maintain all roads at a certain minimum level to keep network condition rating at the desired threshold value, DOTs have been looking for best practices to maintain LVRs economically.

Several DOT reports and proceedings of international conferences on LVRs discuss various issues related to maintenance challenges, treatments options, evaluation, performance observations, management practices, economics, experiences, construction-related issues, and safety.

Colorado DOT completed a study to investigate best practices for managing LVRs (Hafez et al., 2018). The study compiled national and local practices related to treatment policies through a survey of the Transportation Research Board low-volume roads committee, eight state DOTs, and local agencies in Colorado. In addition, a literature review of available treatment options for LVRs was conducted. The CDOT report listed the following treatment options for LVRs:

- Crack sealing/crack filling
- Chip sealing
- Otta seal
- Slurry seal
- Microsurfacing
- Cold in-place recycling
- Full-depth reclamation
- Thin and ultra-thin overlay

Nearly every treatment option applicable for high-volume roads is applicable for LVRs, but they are not always economical or practical.

Rajagopal and Cline (2020) conducted a survey of local agencies in the Midwest region and summarized treatment options in practice. Fourteen responses were received. Figure 16 presents preventive maintenance and minor rehabilitation treatments that are most practiced by responding agencies on both asphalt and concrete pavements.

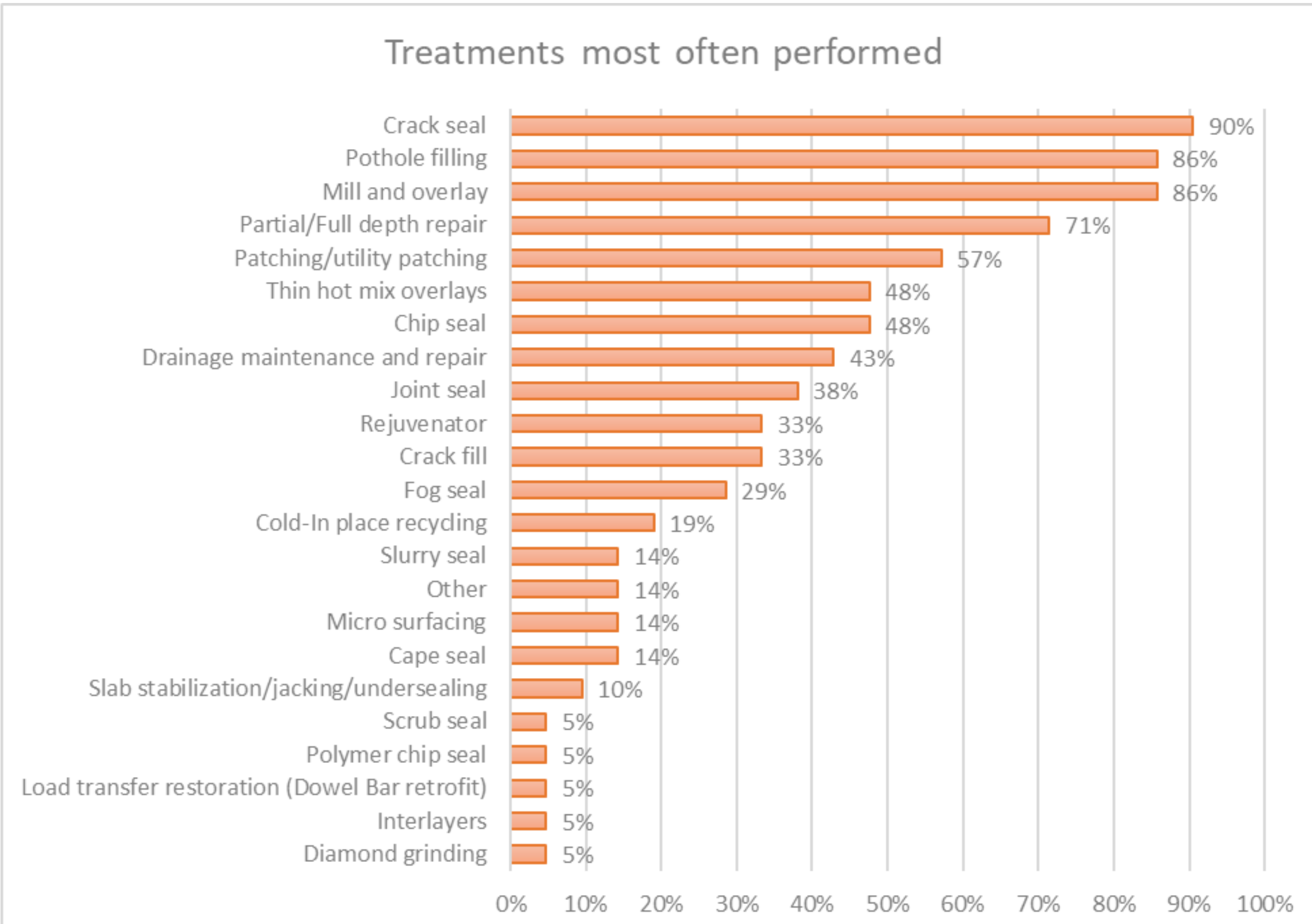

Figure 16. Bar Chart. Survey of pavement treatments most often performed (Rajagopal & Cline, 2020).

Crack sealing is the placement of hot applied material in or over cracks in the pavement. Crack sealing is accomplished using a neat or modified binder, such as a PG 64-22, which may be mixed with polyester or polypropylene fibers. Crack sealing is used to minimize the intrusion of water into the pavement. Crack sealing and filling are the most basic treatment operations performed with the least interruption to traffic. This treatment can slow pavement deterioration, preserve life span, and postpone the need for expensive treatment options (Ohio Department of Transportation, 2022).

Fog seal is one of the simplest and inexpensive forms of pavement preventive treatment. Fog seal is like painting the road surface with a thin layer of liquid asphalt emulsion. This treatment consists of spraying a previously cleaned pavement surface with emulsion using a distributor truck. A combination of fog seal and chip seal treatments is gaining attention for intended benefits. Fog seal, when applied on chip-sealed roads, helps to prevent the loss of chip seal rock during the early stages of construction as well as to prevent snowplow damage. The finished surface provides a better appearance, often like an asphalt overlay, and as a result can be used in urban areas. This treatment can be used as an alternate method to cape seal.

Rejuvenators are like fog seals except they are superior products. Asphalt rejuvenators are products designed to re-enliven original properties to the aged asphalt concrete (AC) and to restore the pavement to its original or new condition. They are designed to protect newly laid asphalt pavement from the effects of oxidization and age hardening. Unlike generic emulsions (such as fog seals), which act to bind and glue, asphalt rejuvenators penetrate the pavement surface, soften the stiffness of the oxidized asphalt pavement surface, and flux with AC, restoring its original properties. Rejuvenating agents are specially formulated, often proprietary, liquids intended to be applied by suitable spraying methods to restore the surface material to a pre-oxidated condition.

Chip seals can be constructed many ways. The most common method is a sprayed application of a polymer-modified asphalt binder covered immediately by a washed aggregate and rolled with a pneumatic roller. Chip seals are most often placed as single course applications. The chip seal method is intended for low-volume roadways to provide a new wearing surface as well as to eliminate raveling, retard oxidation, reduce the intrusion of water, and improve surface friction. The chip seal method is one of the most extensively used treatments in the US and worldwide. A lot of information is available on the design, performance, monitoring, and life expectancy of chip seal treatments. A 2005 National Cooperative Highway Research Program (NCHRP) report summarized chip seal best practices (Gransberg & James, 2005). Various countries have used chip seals on low- and high-volume roads and consistently reported excellent performance. The National Center for Asphalt Technology and the Minnesota Road Research Facility Pavement Preservation Study conducted a field experiment in Alabama and Minnesota (Nordbeck et al., 2019). Test sections were constructed, and performance was periodically monitored. The six-year field monitoring program indicated that cracking is a predominant form of distress.

In a study completed in 2018, Ohio DOT compiled best practices for chip sealing low-volume roads in Ohio (Green et al., 2018). In Ohio, many local agencies apply chip seal treatments to preserve their pavements. However, the performance has varied due to variations among local agencies in the materials used, application rates, lack of inspection personnel, and so on. The purpose of the study was to get a better understanding of chip seal practices in Ohio with the aim to develop best practices. The study tasks consisted of synthesizing best practices through a literature search as well as a survey and interview of Ohio local agencies. The study concluded that Ohio's local agencies typically use chip seal treatment (1) as a reactive, stopgap treatment to provide a serviceable pavement until funds for a hot-mix asphalt (HMA) overlay are available or (2) as a preventive treatment.

Microsurfacing and slurry seal are similar construction products, the difference primarily being application rate and added or removed curing agents. Microsurfacing is a thin surface coat of cold applied paving mixture composed of polymer-modified asphalt emulsion, crushed aggregate, water, and other additives. Microsurfacing is used to retard raveling and oxidation, fill ruts, and to reduce the intrusion of water. Slurry seal comprises of small-sized aggregate, asphalt emulsion, filler, and water. Like other seals, slurry is applied on pavements that are structurally sound but exhibit low to moderate width cracks. Slurry is expected to seal cracks, correct raveling, and prevent pavement from further deterioration as well as to restore flexibility to the pavement surface and rich black pavement surface color. This treatment preserves the pavement structure from early deterioration.

Scrub seal is conceptually like chip seal treatment. In chip seal, the asphalt liquid is sprayed onto the pavement surface using a distributor prior to placing aggregates. In the case of scrub seal, the same asphalt liquid is applied using special brooms. This step results in asphalt liquid filling the cracks. This is considered as an improvement over standard chip seal treatment. However, chip seal treatment still appears to be a more widely accepted treatment option.

Cape seal is a combination of a chip seal followed by a slurry seal or microsurfacing. When a chip seal layer is covered with a layer of another material such as microsurfacing or slurry seal, it is said to be cape sealed. In doing so, the road ends up with a nice-looking smooth surface that binds any loose aggregate, reducing stone loss. In combining the advantages of two treatments, cape seal assists in overcoming deficiencies of the chip seal treatment and further locks it down to make it a suitable preventive maintenance treatment for more urbanized roadways by eliminating the potential for soft AC tracking on tires or possibly shoes. Cape seal is appropriate for use on street pavements exhibiting fair to moderate extent of cracks. It reduces damage to the road structure by minimizing water infiltration, improves skid resistance of the pavement surface, and extends the service life of the pavement (Green et al., 2018).

Cold in-place recycling (CIR) is accomplished by milling, crushing, and mixing asphalt materials in-place without the application of heat. Mixing can be accomplished within the paving train or off-site. The off-site method allows for better gradation and mix control. Additives in the form of aggregates, asphalt rejuvenators, and emulsions are often used to meet a design criterion for a new base pavement. Most experts suggest a surface of virgin mix be used to cap the CIR.

Hot in-place recycling (HIR) is a process of heating the existing pavement to soften the surface and then scarifying/milling of material to a desired depth. The scarified/milled grind off is combined with a recycling agent. New HMA is added to this material if necessary. The mixture is laid with a paver and compacted to the given specifications. This preservation technique can be used for treating pavements on residential roads, airport taxiways/runways, parking lots, and industrial and commercial streets with severely deteriorated pavements exhibiting distresses such as cracking, rutting, raveling, potholes, etc. However, it is important that the pavements selected should have structurally sound bases and subbase pavement layers. Most experts suggest a surface of virgin mix be used to cap the HIR.

Full-depth reclamation (FDR) is also used for poor condition pavement. Depending on many variables, a Portland- or AC-stabilized FDR capped with a virgin mix can be appropriate. FDR is defined as the process of pulverizing all layers of an existing asphalt pavement in place to depths of up to 20 in. Ohio would suggest 16 in. as the maximum for most existing equipment in contractor hands. FDR has grown in popularity as equipment has evolved and recycling efforts have heightened.

All the above treatment options have been routinely used around the country except for Otta seal. The Otta seal method (Figure 17) is gaining attention recently as a viable treatment option for LVRs. As stated by Hafez et al. (2018, p. 41):

> Otta seal was originally developed by the Norwegian Road Research Laboratory (NRRL) in the early 1960s. It derives its name from the location in Norway where it was developed—the Otta Valley. This is an asphalt surface treatment which is very similar to chip seal. Both Otta and chip seals are used to increase surface friction by adding an aggregate layer laid on soft asphalt. The main difference between chip seals and Otta seals is that Otta seals have less costly graded aggregates while chip seals have single-size aggregates. Otta seals can be applied as single or double layers. The gradation of the aggregate ranges from open to dense gradation depending on the traffic volume, with higher traffic volumes requiring denser materials.

The authors also present a detailed review of efforts by other state DOTs.

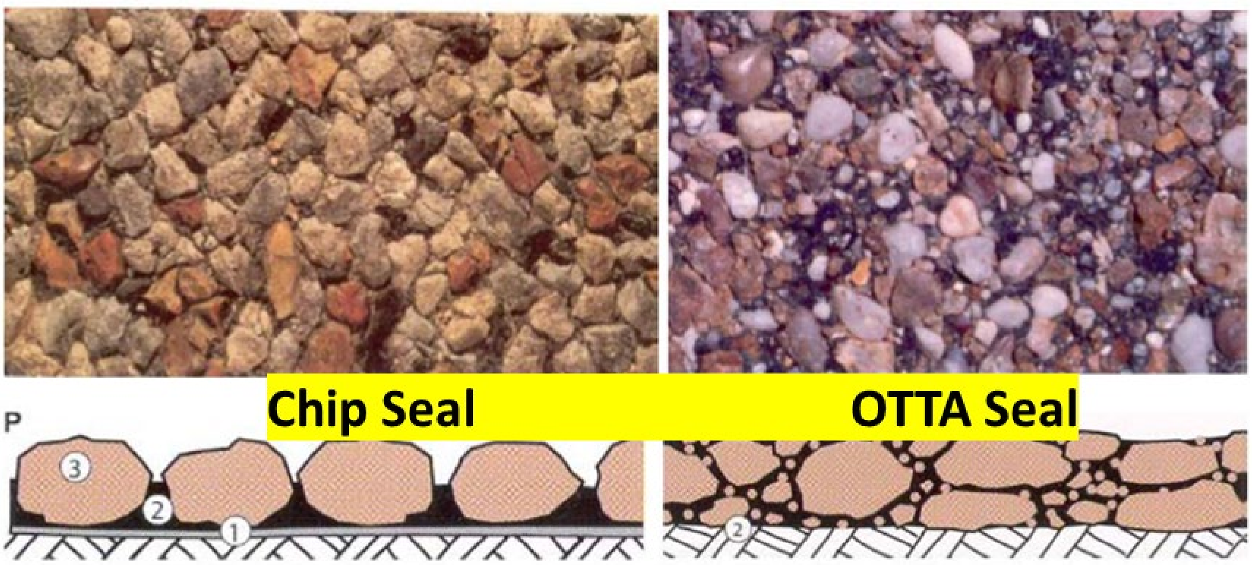

Figure 17. Picture. Chip seals vs Otta seals (Hafez et al., 2018).

Iowa conducted a full-scale field experiment and placed a double-layer Otta seal on a 3.9 mile stretch of cracked asphalt pavement (Gushgari et al., 2019; Moore et al., 2019). The primary goal was to investigate cost-effectiveness and performance of Otta seals compared to traditional bituminous seal coat surfaces and with respect to maintenance of granular-surfaced roads. The report reviewed the practices in other states such as Minnesota and South Dakota. The two states reported the following experiences with Otta seal construction:

- Short-term performance test results indicate that the IRI values changed slightly after Otta seal construction. The IRI values before and after construction ranged from 190.1 to 316.8 in./mile.
- Economic analyses indicate Otta seals could be more cost-effective than chip seals.

Proper aggregate selection within gradation limits and aggregate spread rates were found to be key performance indicators. While the finished surface was reported to be satisfactory from road user and agency requirements perspectives, the treatment did not contribute to structural capacity of the in-service asphalt pavement. The study concluded that the Otta seal method allows the use of uncrushed aggregate (up to 1 in. diameter), leading to cost reduction in aggregate production and transportation. The treatment can seal the surface to prevent water from penetrating into the underlying gravel roads. More importantly, fewer periodic maintenance activities are required between seals. During the short-term performance, Otta seals provided a surface satisfying the same smoothness requirements as an HMA pavement.

Based on the successful research findings, Iowa's technical advisory committee recommended another research project to provide Iowa County engineers with some of the following tools and answers:

1. Establish standard specifications, including quality assurance/quality control procedures for Iowa Otta seal construction projects.
2. Evaluate various local aggregate sources in Iowa for suitability for Otta seal construction.
3. Develop a rational or engineered approach for determining the optimum application rates for asphalt binder and aggregate in Otta seal construction.
4. Identify road surface–base preparation requirements before Otta seal application.

In general, Iowa County engineers are hopeful Otta seal will prove to be a lower cost treatment option for LVRs.

A 2016 NCHRP study reports the practice of converting distressed paved roads to unpaved roads is gaining acceptance in many states. The report cited projects in 27 states where rural, low-volume paved roads were converted into gravel. These projects were carried out with the intent to reduce the cost of maintenance. The report states the local road agencies have experienced positive outcomes by converting low-volume, distressed paved roads to gravel.

SELECTION OF MAINTENANCE STRATEGIES FOR LOW-VOLUME ROADS

Three important considerations in the selection of treatments for the maintenance and management of LVRs are as follows:

1. When to apply treatment: This establishes prior pavement condition in terms of condition indicator (such as Illinois' condition rating system) or specific distress type (such as cracking, rutting, raveling, etc.).
2. Cost of treatments: While there can be more than one treatment option that is applicable for a given set of conditions, the present cost of treatment options becomes an important factor in the decision-making process. Often, more expensive treatments under similar

circumstances are known to last longer. However, the budget allocation process generally picks up projects that require the least cost.

3. Expected service life of treatment: Service life can be an indicator of return on investment. In an ideal situation, not only should the service life of the treatment option be longer, but it should also result in the lowest possible life-cycle cost.

According to Muench et al. (2007), maintenance and rehabilitation treatments for low-volume pavements in Washington State lack the tools, personnel, and funding needed to effectively manage the roads, and, as a result, the decisions do not always follow industry best practices, resulting in inefficient expenditure of limited funds. The researchers conducted extensive studies on low-volume roads in small cities. They related pavement condition rating (0 to 100 scale) of LVRs in the state to four treatment types—namely, chip/cape seal, HMA overlay, FDR, and reconstruction, as presented in Figure 18 (Muench et al., 2007).

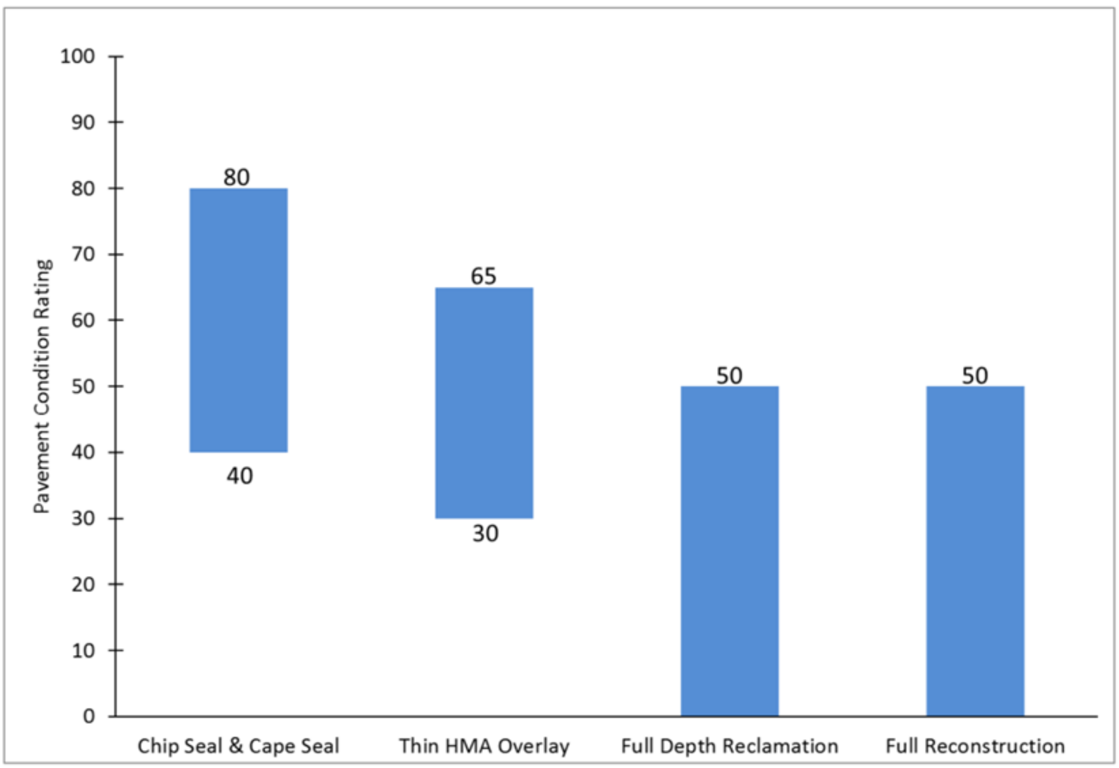

Figure 18. Column Chart. Relating pavement condition to treatment options (Muench et al., 2007).

Chip seal, cape seal, and thin overlays are considered preventive maintenance treatments and are applied on pavements that are structurally sound, while FDR and reconstruction options suggest the pavements are beyond the preventive maintenance phase. The development of the chart in Figure 18 uses the process illustrated in the decision trees in Figures 19 and 20 (Muench et al., 2007).

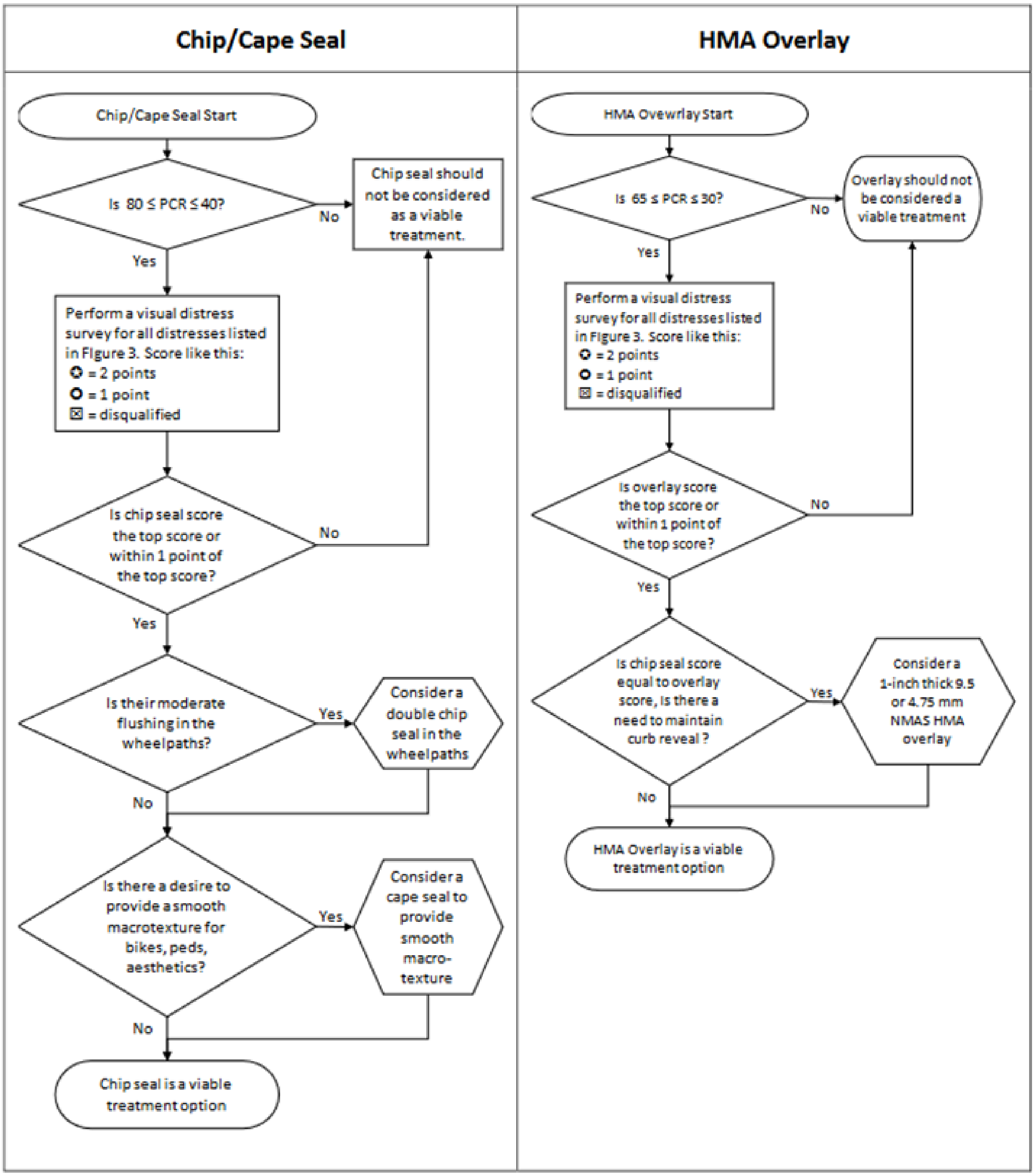

Figure 19. Flowchart. Decision trees for chip/cape seal and HMA overlay treatments (Muench et al., 2007).

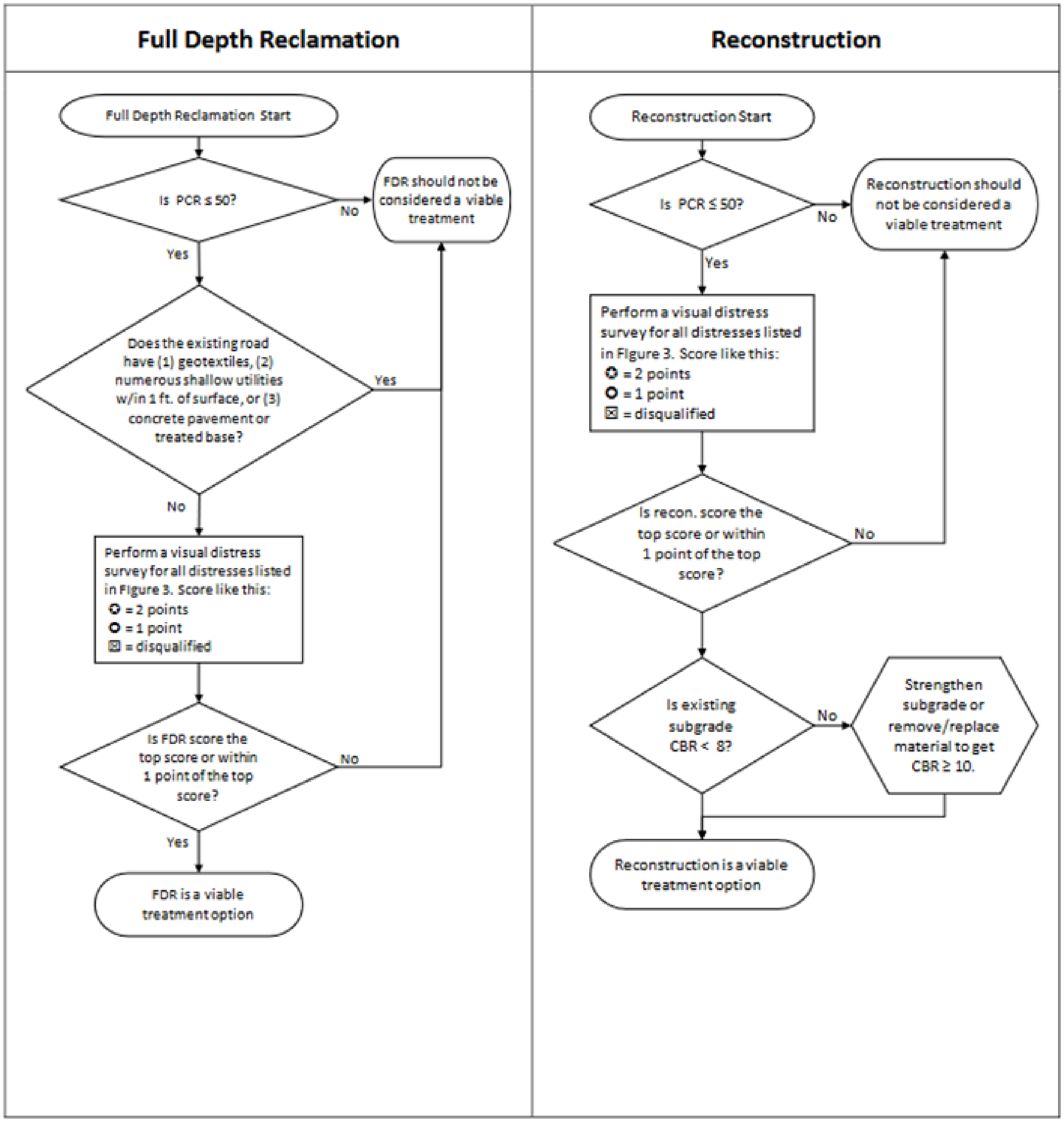

Figure 20. Flowchart. Decision trees for full-depth reclamation and reconstruction (Muench et al., 2007).

Minnesota DOT developed a decision tree for LVRs to identify the appropriate treatment option based on structural status and targeted smoothness, as presented in Figure 21 (Hafez et al., 2018). Colorado DOT included smoothness as a parameter, because the agency uses pavement roughness as an important criterion affecting driving conditions and the included treatments have significant impact on road roughness.

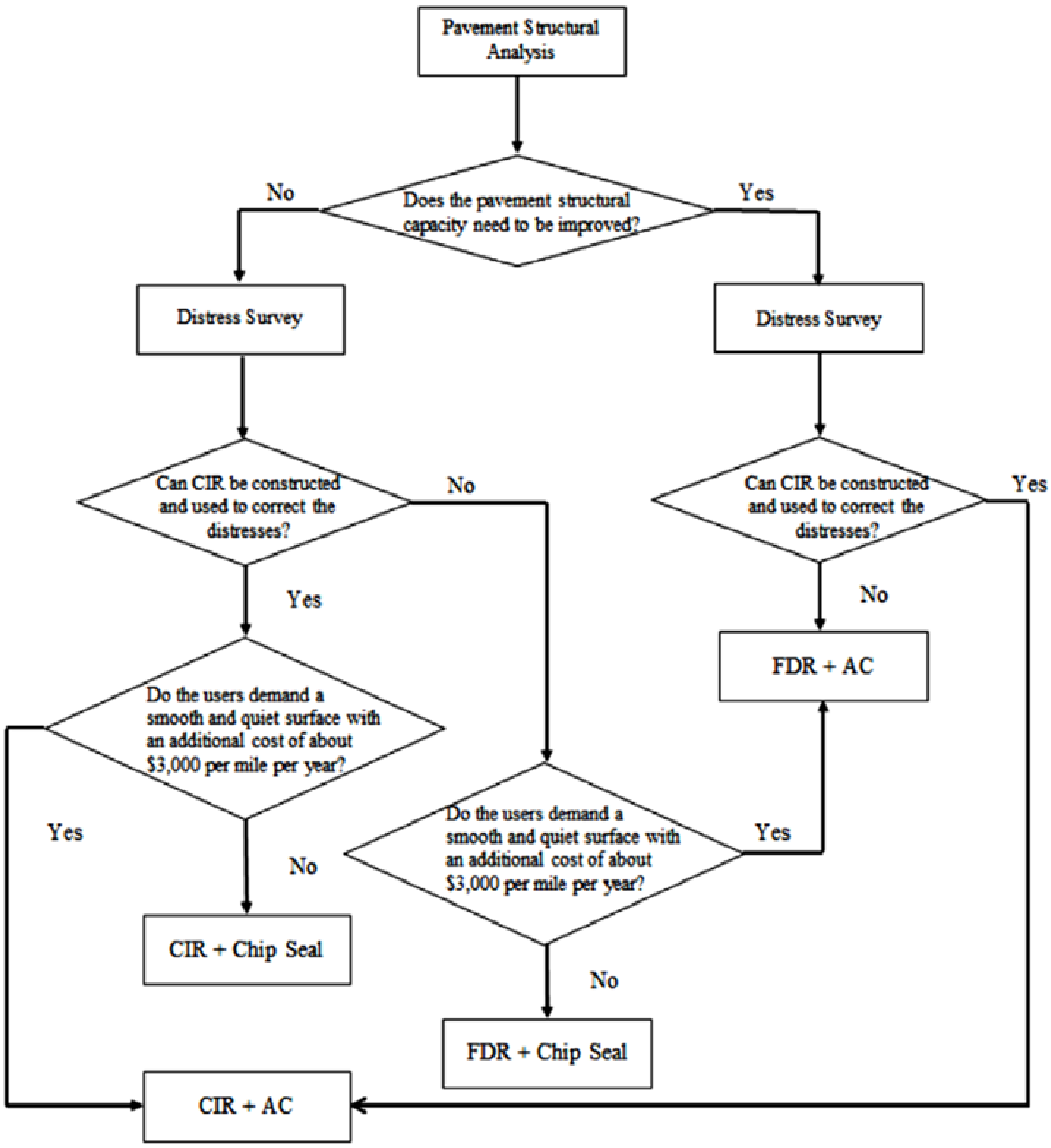

Figure 21. Flowchart. Minnesota DOT decision tree for proposed rehabilitation strategies (Hafez et al., 2018).

Ohio DOT developed guidelines for preventive maintenance of pavements in Ohio to assist in the selection of appropriate treatment options to extend pavement life and to maintain the highest level of serviceability (Ohio Department of Transportation, 2001). Ohio DOT designated routes with less than 2,500 ADT as low-volume roads. The current practice is to allow and to program chip seals up to 4,000 ADT (with a truck ADTT restriction) as described in the following maintenance and rehabilitation strategy section below. Figure 22 presents the preventive maintenance treatment options related to individual distresses and traffic. All listed treatments are applicable to LVRs.

Pavement Applications		Crack Sealing	Chip Seal	Micro-Surfacing	Polymer Modified Asphalt Concrete	Thin Hot Mix Overlay	Concrete Pavement Restoration	Drainage Preservation
Pavement Surface	Concrete	√					√	√
	Asphalt	√	√	√	√	√		√
Reasons For	Friction		√	√	√	√		
	Rideability			√	√	√	√	
	Raveling	√	√	√	√	√		
	Rutting			√	√	√		
	Cracking	√	√		√	√	√	
	Oxidation		√	√	√	√		
	Water	√	√	√	√	√		√
Traffic	Low Volume (<2500 ADT)	X	X	X	X	X	X	X
	High Volume (>2500 ADT)	X		X	X	X	X	X
	Maximum Speed < 45 MPH				Type A			
Average Cost	Weight / Area	$.60 - $1.00 Per Lb.	$1.00 - $1.75 Per S.Y.	$1.25 - $2.00 Per S.Y.	$2.00 - $4.00 Per S.Y.	$2.50 - $3.50 Per S.Y.	$4.00 - $12.00 Per S.Y.	
	Lane Mile (not incl. Shoulders)	$1,000 - $4,000	$8,000 - $12,000	$8,000 - $16,000	$14,000 - $25,000	$17,000 - $25,000	$25,000 - $75,000	$2,000 - $5,000
Average Life (years)		1 - 4	5 - 8	5 - 8	7 - 12	8 - 12	7 - 12	1 - 5

Figure 22. Matrix. Ohio DOT's guidelines for preventive maintenance of pavements (Ohio Department of Transportation, 2001).

While the chart in Figure 22 provides information about applicable treatment options on a network level, decision trees will work at a project or individual level. The trees consider site-specific conditions such as type and extent of distresses present, traffic level, and so forth, and systematically direct the user to the appropriate action. Decision trees form an important component of a pavement management system. Washington State further used the decision trees as an algorithm and developed a stand-alone application called RxPave (2022). RxPave helps the state's Small City Program by enabling the applicants to determine the appropriate grant program to apply for. Such decision trees can assist IDOT and every highway agency to determine appropriate maintenance and rehabilitation treatments for each roadway subset.

SERVICE LIFE AND COST OF TREATMENTS

Every highway agency desires to see their pavement treatments have a long service life. In addition, the treated pavements are also expected to perform well during their service life. The resulting performance and service life following the application of treatments varies with the type of treatment applied. The structural and functional conditions of the in-service pavement that receives the treatment play a significant factor in the performance and life expectancy of the applied treatment in addition to traffic, construction, and environmental variables.

Figure 23 presents information gathered from survey responses conducted for the City of Cincinnati (Rajagopal & Cline, 2020). The treatment options with the least cost have the shortest life span.

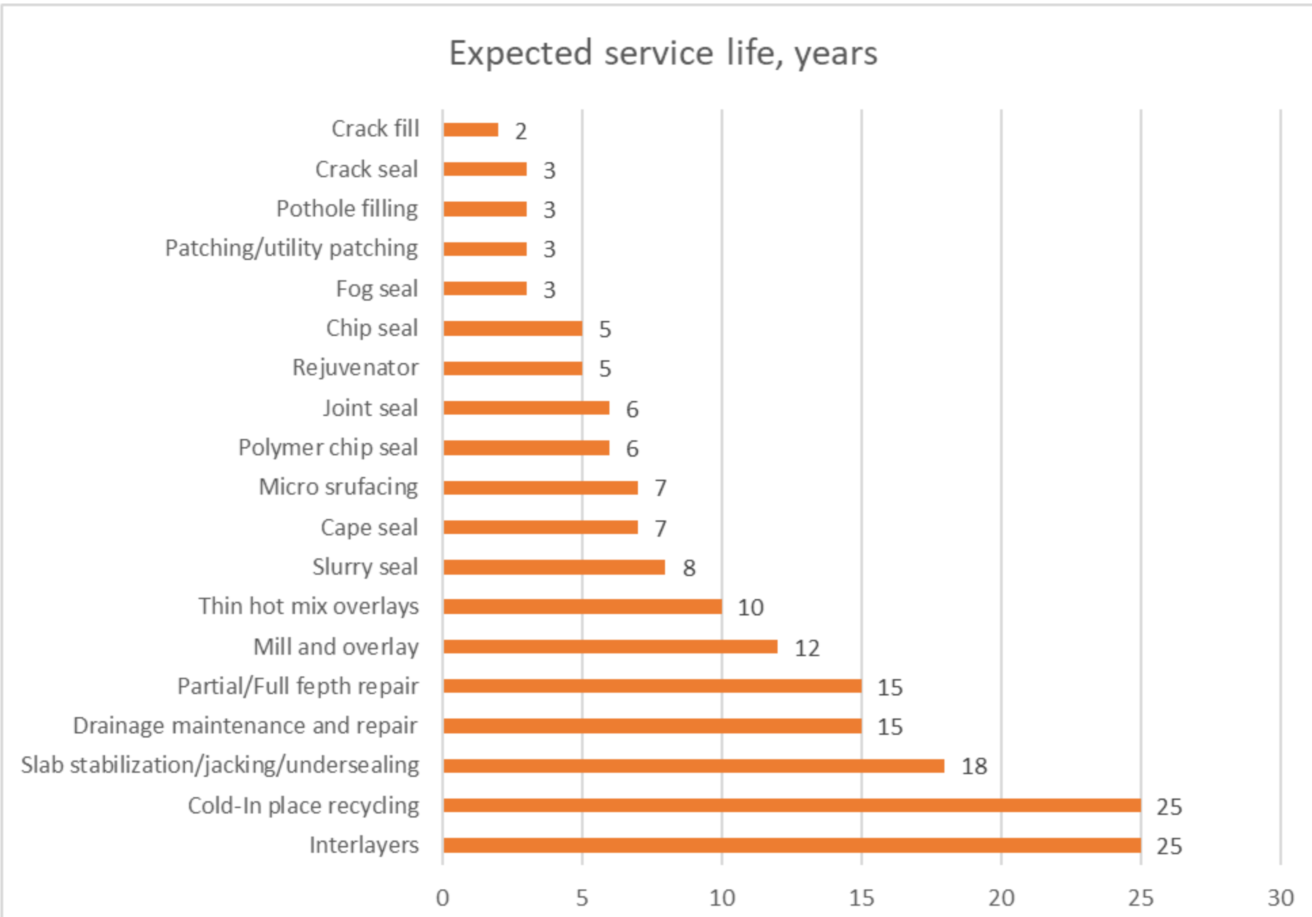

Figure 23. Bar Chart. Expected service life of treatments for pavement maintenance (Rajagopal & Cline, 2020).

The lowest cost options for LVRs include pavement surface treatments. These treatments can be used as a reactive maintenance strategy while a pavement section is in queue for more involved rehabilitation. Although most information sourced would paint this type of work as inefficient, budgets are often short of the funding required for efficient treatments on all roads in need of repair. In general, surface treatments should be used on structurally sound pavements to reduce the infiltration of water through the surface, retard oxidation, and slow top-down cracking. Surface treatments used on low-volume roadways include crack sealing, chip sealing, microsurfacing, cape seals, thin HMA overlays, and asphalt rejuvenation for asphalt surfaces. More robust restorative treatments for low-volume roadways include cold in-place recycling and full-depth reclamation.

Zhou et al. (2019) summarized lifetime and cost of various preservation treatments from previous publications (Figure 24). The treatments for AC-surfaced pavements were grouped into four categories—namely, crack treatments, surface treatments, minor rehabilitation, and treatments using a Portland cement concrete layer. These groups represent the condition of pavements and timing of treatments. Similar data can be seen in Figure 22, developed by Ohio DOT.

Treatment	Reported Extended Service Life Ranges (Years)	Cost ($)
Crack sealing and crack filling	0-4 (3)	Crack sealing: 0.75 to 1.50 per ft (2) Crack filling: 0.10 to 1.20 per ft (2)
Fog seal	4-5 (3)	0.10 to 0.20 per square yard (2)
Chip seal	3-8 (3)	Single course: 1.50 to 3.00 per yd^2 (2)
Cape seal	6-8 (1)	2.25 to 6.00 per yd^2 (adding chip seal and slurry seal/microsurfacing) (2)
Slurry seal	4-7 (3)	0.75 to 1.00 per yd^2 (2)
Microsurfacing	3-8 (3)	Single course: 1.50 to 3.00 per yd^2 (2)
Thin AC overlay	3-23 (3)	3.00-6.00 per yd^2 (2)
Ultra-thin bonded wearing course	4-8 (2)	4.00-6.00 per yd^2 (2)
Hot-in-place recycling	3-8 (3)	2.00-7.00 per yd^2 (2)
Cold-in-place recycling	4-17 (3)	1.25 to 3.00 per yd^2 (2)
Bonded-concrete overlay	3-17 (3)	15.00-25.00 per yd^2 (2)

(1) Alan, 1999

(2) Peshkin et al., 2011

(3) Wu et al., 2010

Figure 24. Snapshot. Preservation treatment lifetime and cost (AC-surfaced pavements) (Zhou et al., 2019).

MAINTENANCE AND REHABILITATION STRATEGIES FOR IDOT'S UNMARKED ROUTES AND LOW-VOLUME ROADS

The research team used the results of the surveys, published research report reviews, information gathered from other states, Chapter 53 of IDOT's *Bureau of Design and Environment Manual*, and the experience within the research team to make the following suggestions and recommendations concerning a maintenance and rehabilitation strategy for UMRs and LVRs within IDOT's responsibility (Illinois Department of Transportation, February 2023).

The strategies that follow are not optimized for cost efficiency, as there is no pavement performance data to create the results needed to allow for an optimal approach. Instead, the approach is based on our experience as well as research reports and conversations with other experts. The research team suggests these strategies be used for a period whereby performance data can be collected on a yearly basis to determine the performance trends of the decisions that fall out of the strategies proposed. These studies will eventually be used to fine-tune this approach for cost efficiency. This type of analysis can be done in-house or by contract after four or five years of performance is collected. However, the details and an effort to carefully classify the strategies into unique families will be crucial to the success of any newly developed optimized solutions.

The strategies provided are presented in a format similar to current M&R strategy tools IDOT uses for all marked routes, both interstate and non-interstate, making it implementation friendly to those who are currently using existing tools. Regardless of the details of tools, individual decisions will need to be made on a project basis for all scope of service details prior to plan development. The complications of addressing the entirety of a distress on a section of roadway, the variability of severity and traffic, and the difficulty of predicting performance until time of construction are sufficient reasons to use the suggested strategies as guidance at best.

It is important to note that reactive maintenance is not considered in this research. The researchers suggest using the identical reactive maintenance guidance currently within IDOT's Contract Maintenance Program Guidelines. Furthermore, conversations with locals are suggested to urge assistance with reactive maintenance. Local assistance can be used to assist in the prioritization of funding projects for preservation or rehabilitation.

The traffic level classifications IDOT uses are found in Chapter 54 of the *Bureau of Design and Environment Manual* (54-1.02). During the creation of the strategies, much effort was made to define low volume. In doing so, the researchers became aware that the difference between 4,000 ADT and 750 ADT was not discerning for these types of treatments, provided distress and truck counts are looked at. Furthermore, it is suggested truck counts be focused on directly. The greater the truck counts, the more robust treatments will be more successful. Thus, when more than one strategy is suggested, it may come down to truck counts to decide whether the more robust treatment is needed. Traffic levels greater than 4,000 ADT can be handled within existing IDOT guidelines for marked routes. The 4,000 ADT traffic criteria is based on work at Ohio DOT where chip seal is routinely scoped for ADT levels up to 4,000. Furthermore, research completed by Hicks et al. (2000) indicated ADT levels below 1,000, with sufficient structure for the traffic, could be treated by chip seal alone. ADT maximums for returning a roadway back to a gravel/dirt road is suggested by Minnesota DOT to be below 150 ADT. *The research team, after reviewing all information, with an emphasis on IDOT have chosen to create recommendations for ADT < 150 and ADT < 4,000*. For pavement sections with traffic greater than 4,000, similar guidelines could be used, but with more emphasis on trucks.

The researchers suggest IDOT limit chip seal operations to less than 250 trucks per day. Moreover, where the daily truck count exceeds 125, a polymer-modified asphalt emulsion for the seal coat is suggested. Fog seals are encouraged after the seal coat has weathered one year. Additional consideration must be made for the use of chip seal for truck routes with turning movements at intersections. With chip seals, truck turning movements at intersections can be correlated to localized bleeding/flushing. A cape seal is suggested where the truck count exceeds 250 trucks per day or truck turning movements are expected along the chip seal section of the roadway.

The treatment catalogue provided identifies several feasible preservation and rehabilitation treatments. When identifying the appropriate treatment for candidate projects, analyze the type and severity of pavement distresses present on the pavement. Truck counts are not specified for all strategies in this tool; however, the project scope of services should take this variable into account when selecting the proper strategy. Distress codes indicating structural issues such as L4, T3, T4, W4, O5, U4, X3, and rut > 1/4" accompanied with wheel-track cracking are important markers for decision-makers when selecting the best strategy.

Tables 3 and 4 relate a single distress to a single treatment. Where there are multiple distresses, examine the appropriate treatment(s) to address each distress type. Then, use the recommended treatment(s) in combination with engineering judgment to make a final treatment selection. Note that this process is not expected to result in the identification of a single treatment that is appropriate for a given set of site conditions. Rather, it is much more likely that there will be a few feasible treatments that address those conditions. Figure 25 is intended to give a more general view of where pavement sections will tend to end up for strategy selection.

Furthermore, composite pavements are not, in general, good candidates for returning roadways to gravel unless the use of rubblization is used, greatly increasing the cost. For this situation, a cost analysis is needed, as funding will need to be secured for this relatively expensive strategy. For this reason, our strategy toolbox does not consider this option.

Key to Tables 3 and 4

R	The recommended treatment for a given distress. Care must be taken to ensure all critical distress types are addressed.
R*	Add milling prior to treatment.
F	A feasible treatment but depends on other projects' constraints, including other distresses.
F*	This is a localized distress and should be treated locally while other distress types present should dictate choice of global treatment.
NR	Treatment is not recommended to correct the specified pavement condition.
N/A	Distress does not impact the treatment selection.
+	The ADTT is less than 250 and applies to chip seal and Otta seal only.
1	Full-depth and partial-depth repair are only allowed as a mitigation activity. A maximum of 0.5% will be allowed with any preservation treatment.
2	The level of this distress could be left alone—other distresses should determine the strategy.
3	This can be used, but considering only this distress, a less expensive fix is more appropriate.
4	If only distress is present, then use the indicated treatment. If other distresses are present, use the treatment that addresses the distresses across the full lane.
5	This is a reactive maintenance treatment, which is not part of a cost-effective strategy. This may hide the distress for a while.
6	This needs an additional structure, and some repairs may be needed.
7	The distress indicated requires full-depth repair or pavement replacement depending on repair quantity. For the case of a widening crack, repair should remove the crack away from the wheel path.

Table 3. Rural Unmarked Route Treatment Catalogue

		Rural UMR Treatment Catalogue					
		Preservation CRS > 5		**Rehabilitation**			
		Flexible or Composite Pavement				**Flexible Pavement Only**	
			+ ADTT < 250				
		ADT < 4,000	**ADT < 4,000**	**ADT < 4,000**	**ADT < 4,000**	**ADT < 4,000**	**ADT < 150**
Distress	Severity	Crack Seal/Fill Spray Patching Drag Patching	Chip Seal[+] Cape Seal Otta Seal[+]	Ultra-Thin HalfSMART	HIR/CIR with Chip Seal Surface	FDR w/ Chip Seal Surface	Return to Unpaved /Gravel Roadway
Alligator (Fatigue) Cracking (bottom up)	L1	NR-2	F-2	F-2	F-3	F-3	F-3
	L2	R-5	R	R-3	R-3	R-3	R-3
	L3	NR-5	R-1	R-1	F-3	F-3	F-6
	L4	NR-5	NR-6	R-6	R-6	R-6	F-6
Block Cracking (top down)	M1	NR-2	F-2	F-2	F-2	F-2	F-2
	M2	R	F-3	F-3	F-3	F-3	F-3
	M3	NR	R*	R*-3	R-3	R-3	R-3
	M4	NR	R*	R*-3	R-3	R-3	R-3
Rutting < 0.25"	N/A	NR	F	F	F	F	F
Rutting > 0.25"	N/A	NR	R*	R*-3	F-3	F-3	F-3
Cracking—Transverse, Reflective (bottom up)	O1	NR	F-2	F-2	F-2	NR	NR
	O2	R-1	R-1	R-5	R-5	NR	NR
	O3	R-1	R-1,5	R-1,5	R-5	NR	NR
	O4	R-1,5	F*-1	F*-1	F*-1	NR	NR
	O5	NR-5,7	NR-7	R-7	R-7	NR	NR
Overlayed Patch Reflective Cracking	P1	NR	F*	F*	F*	NR	NR
	P2	R	F*	F*	F*	NR	NR
	P3	R	F*	F*	F*	NR	NR
	P4	F*-7	F*	F*	F*	NR	NR
	P5	F*-7	F*-7	F*-7	F*-7	NR	NR

		Rural UMR Treatment Catalogue					
		Preservation CRS > 5		Rehabilitation			
		Flexible or Composite Pavement				Flexible Pavement Only	
			+ ADTT < 250				
		ADT < 4,000	ADT < 4,000	ADT < 4,000	ADT < 4,000	ADT < 4,000	ADT < 150
Distress	Severity	Crack Seal/Fill Spray Patching Drag Patching	Chip Seal+ Cape Seal Otta Seal+	Ultra-Thin HalfSMART	HIR/CIR with Chip Seal Surface	FDR w/ Chip Seal Surface	Return to Unpaved /Gravel Roadway
Center—Lane Cracking Longitudinal (top down)	Q1	R-2	R-2,3	NR-2	NR-2	NR-2	NR-2
	Q2	R	F-3	F-3	F-3	F-3	F-3
	Q3	R	F-3	F-3	F-3	F-3	F-3
	Q4	R-4	F	F	F	F	F
	Q5	R-4	F	F	F-3	F-3	F-3
Widening Crack—Reflective (bottom up)	R1	R-2	R-2,3	NR-2	NR-2	NR-2	NR-2
	R2	R-5	R-7	F*-7	F*-7	F*	F*
	R3	R-5	R-7	F*-7	F*-7	F*	F*
	R4	R-5	F*-7	F*-7	R	R	R
	R5	R-5	F*-7	F*-7	R	R	R
Centerline/Lane Line Deterioration (top down)	S1	NR-2	NR-2	NR-2	NR-2	NR-2	NR-2
	S2	R	F-3	F-3	F-3	F-3	F-3
	S3	R	F-3	F-3	F-3	F-3	F-3
	S4	R	F-3	F-3	F-3	F-3	F-3
Edge Cracking (bottom up—lack of edge support)	T1	R	R	R	R	R	R
	T2	R-1	R-1	R-1	R-1	R-1	R-6
	T3	NR-5,6	NR-5,6	R-6	R-6	R-6	R-6
	T4	NR-5,6	NR-5,6	R-6	R-6	R-6	R-6
Permanent Patch Deterioration	U1	NR-2	NR-2	NR-2	NR-2	NR-2	NR-2
	U2	R-5	F*-1	F*-1	F*-1	F*-1	F*-1
	U3	R-1	F*-1	F*-1	F*-1	F*-1	F*-1
	U4	NR	R*-7	R*-7	R-7	R-3,7	R

		Rural UMR Treatment Catalogue					
		Preservation CRS > 5		**Rehabilitation**			
		Flexible or Composite Pavement				**Flexible Pavement Only**	
			+ ADTT < 250				
		ADT < 4,000	**ADT < 4,000**	**ADT < 4,000**	**ADT < 4,000**	**ADT < 4,000**	**ADT < 150**
Distress	Severity	Crack Seal/Fill Spray Patching Drag Patching	Chip Seal⁺ Cape Seal Otta Seal⁺	Ultra-Thin HalfSMART	HIR/CIR with Chip Seal Surface	FDR w/ Chip Seal Surface	Return to Unpaved /Gravel Roadway
Weathering—Raveling	W1	NR-2	R-2	R-2	R-2	R-2	R-2
	W2	NR	R	R-3	R-3	R-3	R-3
	W3	NR	R*	R*-3	R-3	R-3	F
	W4	NR	NR	R*-1	R-3	R-3	F
Reflective D—Cracking (bottom up)	X1	NR-2	NR-2	NR-2	NR-2	NR-2	NR-2
	X2	F*	F-2	F-2	F-2	NR	NR
	X3	F*-7	F*-7	F*-7	F*-7	NR	NR

Table 4. Urban Unarmed Route Treatment Catalogue

		Urban UMR Treatment Catalogue					
		Preservation CRS > 5	Rehabilitation				
		Flexible or Composite Pavement					Flexible Pavement Only
		Unlimited ADT	ADT < 4,000	ADT < 4,000	ADT < 4,000	Unlimited ADT	ADT < 4,000
Distress	Severity	Crack Seal/Fill Spray Patching	Mill & Cape Seal	Mill plus Ultra-Thin HalfSMART	1/2" Milling plus HIR/CIR w/ Cape Seal Surface	Pavement Replacement, incl fractured slab techniques	FDR w/ Cape Seal Surface
Alligator (Fatigue) Cracking (bottom up)	L1	NR-2	F-2	F-2	F-3	F-3	F-3
	L2	R-5	R	R-3	R-3	F-3	R-3
	L3	NR-5	R-1	R	R-3	R-3	F-3
	L4	NR-5	NR-6	R-6	R-3	R-3	R-6
Block Cracking (top down)	M1	NR-2	F-2	F-2	F-2	F-2	F-2
	M2	R	F-3	F-3	F-3	F-3	F-3
	M3	NR	R	R-3	R-3	R-3	R-3
	M4	NR	R	R-3	R-3	R-3	R-3
Rutting < 0.25"	N/A	NR	F	F	F	F-3	F
Rutting > 0.25"	N/A	NR	R	R-3	F-3	F-3	F-3
Cracking—Transverse, Reflective (bottom up)	O1	NR	F-2	F-2	F-2	F-2	NR
	O2	R-1	R-1	R-5	R-5	F-7	NR
	O3	R-1	R-1,5	R-1,5	R-5	F-7	NR
	O4	R-1,5	F*-1	F*-1	F*-1	F-7	NR
	O5	NR-5,7	NR-7	R-7	R-7	F-7	NR
Overlayed Patch Reflective Cracking	P1	NR	F*	F*	F*	NR	NR
	P2	R	F*	F*	F*	F*	NR
	P3	R	F*	F*	F*	F*	NR
	P4	F*-7	F*	F*	F*	F*	NR
	P5	F*-7	F*-7	F*-7	F*-7	F*-7	NR

		Urban UMR Treatment Catalogue					
		Preservation CRS > 5	Rehabilitation				
		Flexible or Composite Pavement					Flexible Pavement Only
		Unlimited ADT	ADT < 4,000	ADT < 4,000	ADT < 4,000	Unlimited ADT	ADT < 4,000
Distress	Severity	Crack Seal/Fill Spray Patching	Mill & Cape Seal	Mill plus Ultra-Thin HalfSMART	1/2" Milling plus HIR/CIR w/ Cape Seal Surface	Pavement Replacement, incl fractured slab techniques	FDR w/ Cape Seal Surface
Center—Lane Cracking Longitudinal (top down)	Q1	R-2	R-2,3	NR-2	NR-2	NR-2	NR-2
	Q2	R	F-3	F-3	F-3	F-3	F-3
	Q3	R	F-3	F-3	F-3	F-3	F-3
	Q4	R-4	F	F	F	F-3	F
	Q5	R-4	F	F	F-3	F-3	F-3
Widening Crack—Reflective (bottom up)	R1	R-2	R-2,3	NR-2	NR-2	NR-2	NR-2
	R2	R-5	R-7	F*-7	F*-7	F*	F*
	R3	R-5	R-7	F*-7	F*-7	F*	F*
	R4	R-5	F*-7	F*-7	R	R-3	R
	R5	R-5	F*-7	F*-7	R	R-3	R
Centerline/Lane Line Deterioration (top down)	S1	NR-2	NR-2	NR-2	NR-2	NR-2	NR-2
	S2	R	F-3	F-3	F-3	F-3	F-3
	S3	R	F-3	F-3	F-3	F-3	F-3
	S4	R	F-3	F-3	F-3	F-3	F-3
Edge Cracking (bottom up—lack of edge support)	T1	R	R	R	R	F*-3	R
	T2	R-1	R-1	R-1	R-1	F*-6	R-1
	T3	NR-5,6	NR-5,6	R-6	R-6	F*-6	R-6
	T4	NR-5,6	NR-5,6	R-6	R-6	F*-6	R-6
Permanent Patch Deterioration	U1	NR-2	NR-2	NR-2	NR-2	NR-2	NR-2
	U2	R-5	F*-1	F*-1	F*-1	F*	F*-1
	U3	R-1	F*-1	F*-1	F*-1	F*	F*-1
	U4	NR	R-7	R-7	R-3,7	F*	R-3,7

		Urban UMR Treatment Catalogue					
		Preservation CRS > 5		**Rehabilitation**			
		Flexible or Composite Pavement					**Flexible Pavement Only**
		Unlimited ADT	**ADT < 4,000**	**ADT < 4,000**	**ADT < 4,000**	**Unlimited ADT**	**ADT < 4,000**
Distress	Severity	Crack Seal/Fill Spray Patching	Mill & Cape Seal	Mill plus Ultra-Thin HalfSMART	1/2" Milling plus HIR/CIR w/ Cape Seal Surface	Pavement Replacement, incl fractured slab techniques	FDR w/ Cape Seal Surface
Weathering—Raveling	W1	NR-2	R-2	R-2	R-2	NR-2	R-2
	W2	NR	R	R-3	R-3	NR	R-3
	W3	NR	R	R-3	R-3	NR	R-3
	W4	NR	NR	R-1	R-3	NR	R-3
Reflective D-Cracking (bottom up)	X1	NR-2	NR-2	NR-2	NR-2	NR-2	NR-2
	X2	F*	F-2	F-2	F-2	F-2	NR
	X3	F*-7	F*-7	F*-7	F*-7	R-7	NR

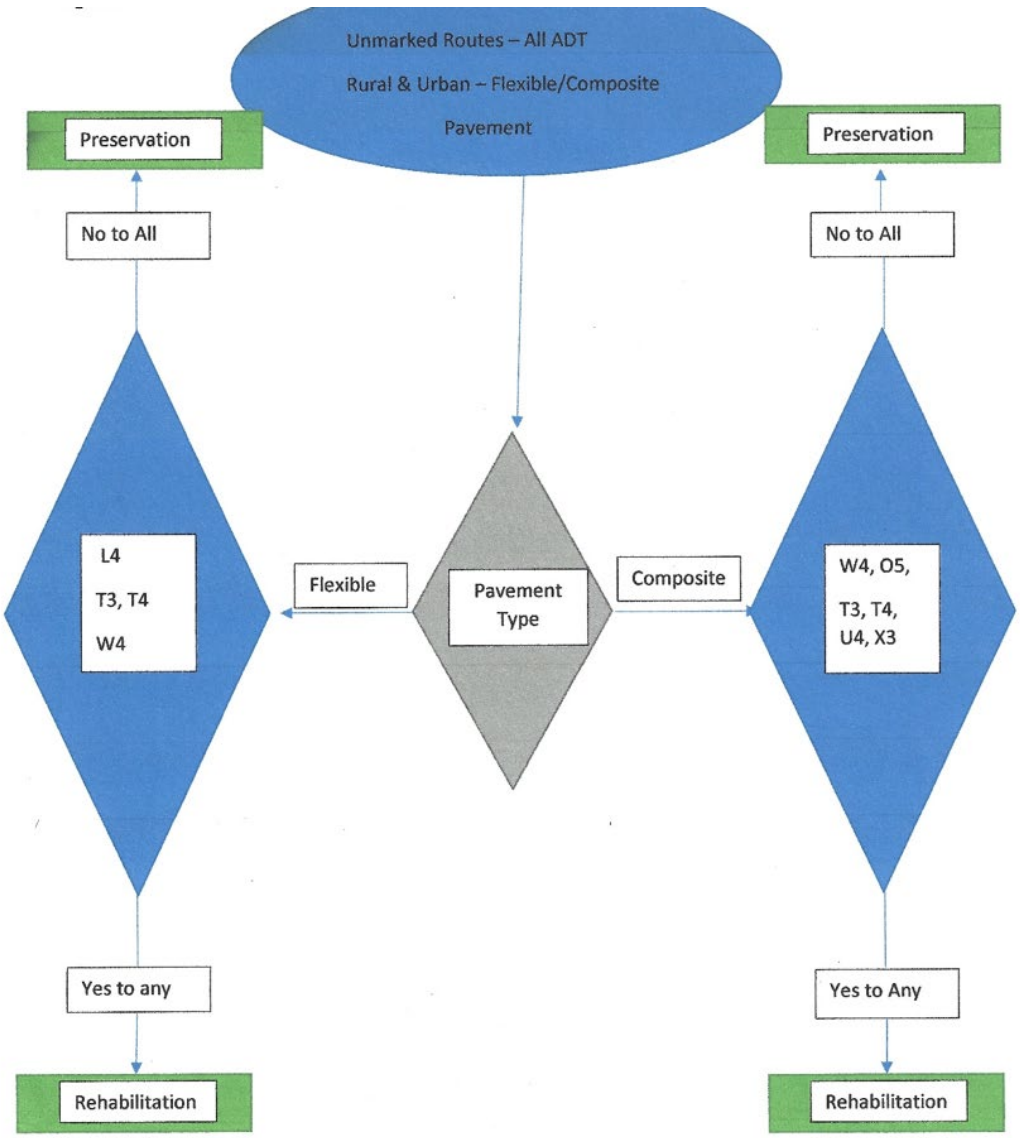

Figure 25. Flowchart. General view of pavement strategy selection.

CHAPTER 7: SURVEY OF DOTS AND ILLINOIS LOCAL PUBLIC AGENCIES

Following the review of published literature, a survey of state and Illinois local public agencies (LPAs) was conducted to inquire about their experiences and concerns regarding maintenance and management of roadways, similar to the UMR category and low-volume roads. The purpose of the survey was to supplement data from the literature review.

SURVEY OF STATE DOTS

The survey consisted of 13 questions. With help from IDOT's Bureau of Research, the survey questionnaire was sent to the American Association of State Highway and Transportation Officials and Research and Advisory Committee members. A total of 25 responses were received. The state DOTs that responded to the survey are Alaska, Arizona, Arkansas, Florida, Georgia, Indiana, Iowa, Kansas, Maine, Massachusetts, Michigan, Minnesota, Nebraska, North Dakota, Ohio, Oklahoma, Pennsylvania, South Dakota, Tennessee, Texas, Nevada, Vermont, Virginia, Wisconsin, and South Carolina. The following sections summarize the responses.

1. *Do you have any routes similar to IDOT's unmarked routes? If YES, please continue.*

All 25 of the participating state DOTs responded by having routes like IDOT's UMRs.

2. *How do you define such routes?*

The majority of the state DOTs responded to this question and reported 12 different classification names for such routes. Figure 26 depicts the variation in the definition of routes like IDOT's UMR and the number of state DOTs that use each route definition.

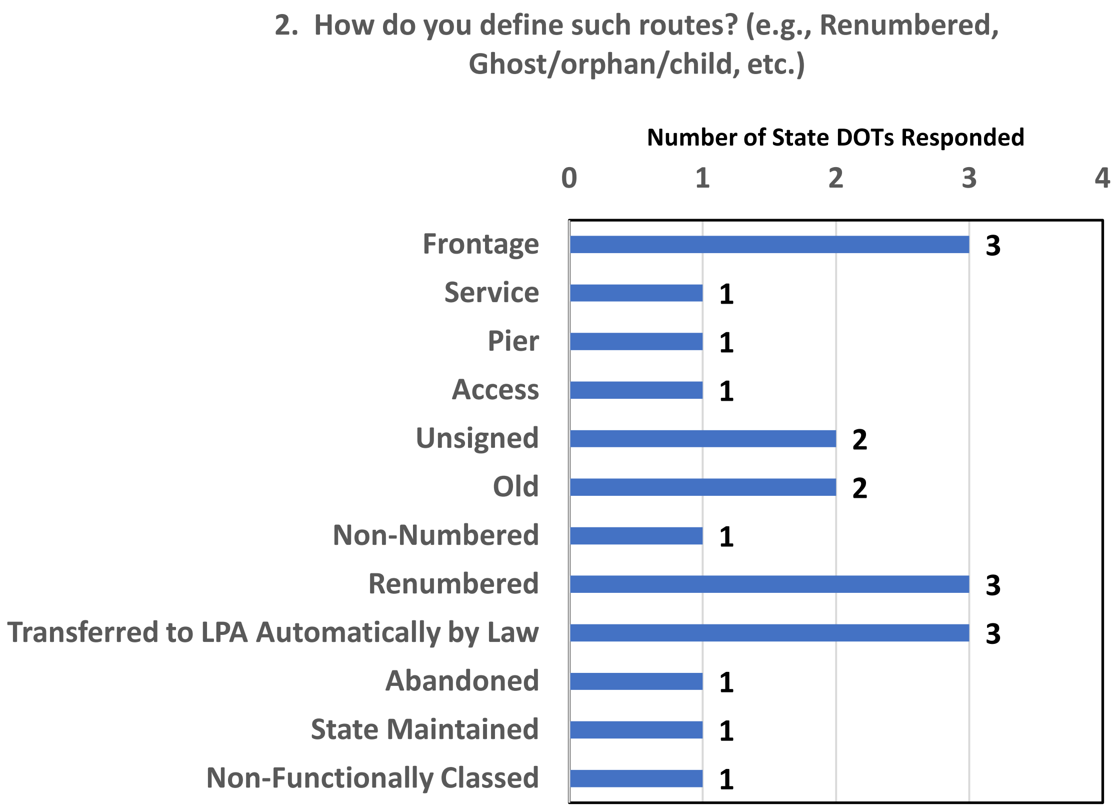

Figure 26. Bar Chart. DOT survey responses for route definition.

3. *What is the estimated extent of such routes?*

Fifteen of the 25 state DOTs that participated in the survey responded to this question. MassDOT reported the highest percentage of such routes within their state system at 18.86% or 7,442.96 centerline miles. Florida was the second highest at 10.2% (1,371.44 centerline miles of state-owned roads). The remaining 13 state DOTs that responded to this question were less than 2.5% of the state route system or did not have statistics readily available for this category. For comparison, IDOT's UMRs make up approximately 1.6% of the state's highway network based on centerline miles, which is consistent with the majority of the other state DOTs that responded.

4. *Estimated percentage of "unmarked" routes with following AADT?*

Only one-third (8 of the 25) of the state DOTs that participated in this survey answered this question. The responses for the eight states are summarized in Table 5.

Table 5. DOT Survey Responses Displaying AADT Distribution Ranges for Unmarked Routes

	AADT (Average Annual Daily Traffic)					
State DOT	**< 400**	**400–2,000**	**2,000–5,000**	**5,000–10,000**	**> 10,000**	**Unknown**
Florida	2%	11%	22%	24%	24%	17%
Michigan	14%	10%	15%	23%	37%	–
Indiana	18%	21%	25%	11%	25%	–
Massachusetts	5%	23%	39%	22%	11%	–
Maine	100%	–	–	–	–	0.03%
South Dakota	90%	8%	1%	0.50%	0.50%	–
Iowa	100%	–	–	–	–	–
Kansas	100%	–	–	–	–	–
Illinois	46%	19%	13%	8%	14%	–

The traffic is found to vary from less than 400 to greater than 10,000. IDOT's UMR data is included in Table 5 for comparison. The UMRs in Illinois have traffic ranging from 0 to 91,200.

5. *Estimated percentage of "unmarked" routes with following functional classification*

Fifteen of the 25 DOTs that participated in the survey responded to this question, and their responses are summarized in Table 6. There is considerable variability in the distribution of UMRs by functional classification. IDOT's statistics were included for comparative purposes.

Table 6. DOT Survey Responses Displaying Functional Classification of Unmarked Routes

	Estimated Functional Classification of Unmarked Routes							
State DOT	**Interstate Ramps**	**Expressway Ramps**	**Principal Arterial**	**Minor Arterial**	**Major Collector**	**Minor Collector**	**Local**	**Unknown, but Mileage Exists**
Florida	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Yes
Michigan	–	–	29%	21%	42%	–	7%	–
Indiana	–	–	31%	15%	32%	3%	19%	–
Massachusetts	1%	1%	1%	39%	8%	1%	54%	15%
Tennessee	–	–	n/a	n/a	n/a	n/a	n/a	Yes
Maine	–	–	–	–	–	–	100%	–
South Carolina	–	–	–	–	–	–	–	Yes
South Dakota	–	–	–	n/a	n/a	n/a	n/a	Yes
Texas	–	–	–	–	–	–	–	Yes
Iowa	–	–	–	–	–	–	100%	–
Kansas	–	–	–	–	–	–	100%	–
Nebraska	–	–	–	–	–	–	–	Yes
Arkansas	–	–	–	–	–	–	–	Yes
Alaska	–	–	–	–	–	–	–	Yes
Georgia	–	–	–	2%	8%	9%	81%	–
Illinois	–	–	6%	17%	22%	4%	51%	–

"–" indicates none

"n/a" indicates statistics not available

While the routes exist on various FCs as in Illinois, a greater majority report the presence of such routes on the local roads system.

6. *Does your agency monitor the conditions of these routes?*

Fourteen of the 25 state DOTs that participated in the survey responded to this question. Only 6 of the 14 indicated that they monitor the conditions of these routes.

7. *Which attributes does your agency monitor? Please check all that apply and indicate the frequency of monitoring.*

Only 6 of the 25 state DOTs that participated in the survey responded to this question. Pavement and structures such as bridges and culverts are included in their annual monitoring program. A summary of the responses is presented in Table 7.

Table 7. DOT Survey Responses Displaying Attributes Monitored with Frequency

	Attributes Monitored with Frequency					
State DOT	**Pavement Condition**	**Culvert Condition**	**Bridge Condition**	**Sign Condition**	**Guardrail Condition**	**Any Other Conditions**
Florida	Annually	2 years	2 years	2 years	2 years	–
Michigan	2 years	?	2 years	?	?	–
Indiana	Annually	3 years	3 years	As Needed	As Needed	–
Massachusetts	1–2 years	As Needed	5 years	As Needed	As Needed	–
Tennessee	2 years	4 years	4 years	2 years	2 years	–
Kansas	Yes	Yes	Yes	Yes	Yes	–

"–" indicates none

"?" – indicates unsure

8. *Does your agency fund the rehabilitation and/or maintenance of these routes?*

Nine of the 25 state DOTs responded to this question. Four state DOTs indicated their agency is responsible for 100% of construction funding: Florida, Indiana, Massachusetts, and South Dakota. Tennessee DOT was the only agency that requires a share of local funding (20%). Michigan and Massachusetts prefer to transfer such routes to local agencies and have resurfaced such routes in order to facilitate acceptance by the LPA. Michigan cites the alternative is to keep it in their inventory and maintain as needed but stated "this is not desirable." Indiana DOT indicated they have another general maintenance fund in addition to the agency's construction funding for these routes. Kansas noted that they agree to retain maintenance on structures if the LPA will accept the transfer.

9. *How do you prioritize maintenance of these routes?*

For the state DOTs that responded to this question, a condition rating, similar to IDOT's CRS, is the basis for funding for the maintenance and management of UMRs (Figure 27).

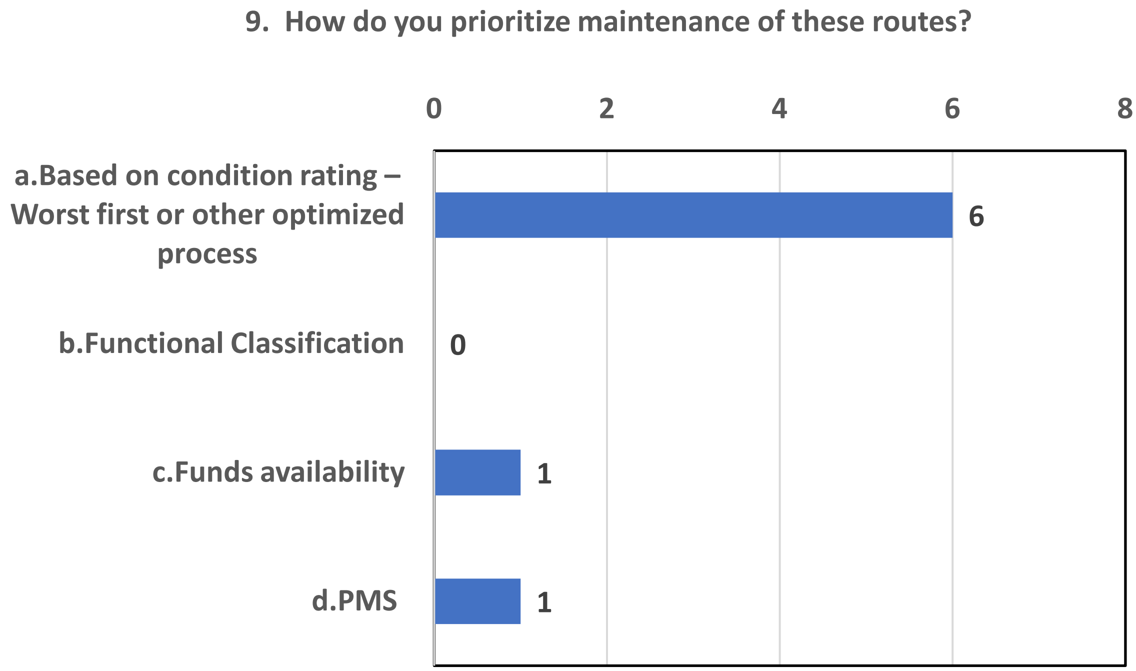

Figure 27. Bar Chart. DOT survey responses for prioritizing maintenance of routes.

10. The list below captures many routine maintenance, preventive maintenance, preservation, and rehabilitation strategies used throughout the midwestern U.S. Please place a check mark next to any strategies used on these orphan routes.

a. _______Crack Seal

b. _______Chip Seal

c. _______Microsurfacing

d. _______Cape Seal

e. _______Otta Seal

f. _______Scrub Seal

g. _______Cold-In-Place Recycling

h. _______Cold Central Plant Recycling

i. _______Hot-In-Place Recycling

j. _______Repair and Overlay

k. _______Other ___________

10. The list below captures many routine maintenance, preventive maintenance, preservation, and rehabilitation strategies used throughout the midwestern U.S. Please place a check mark next to any strategies used on these orphan routes.

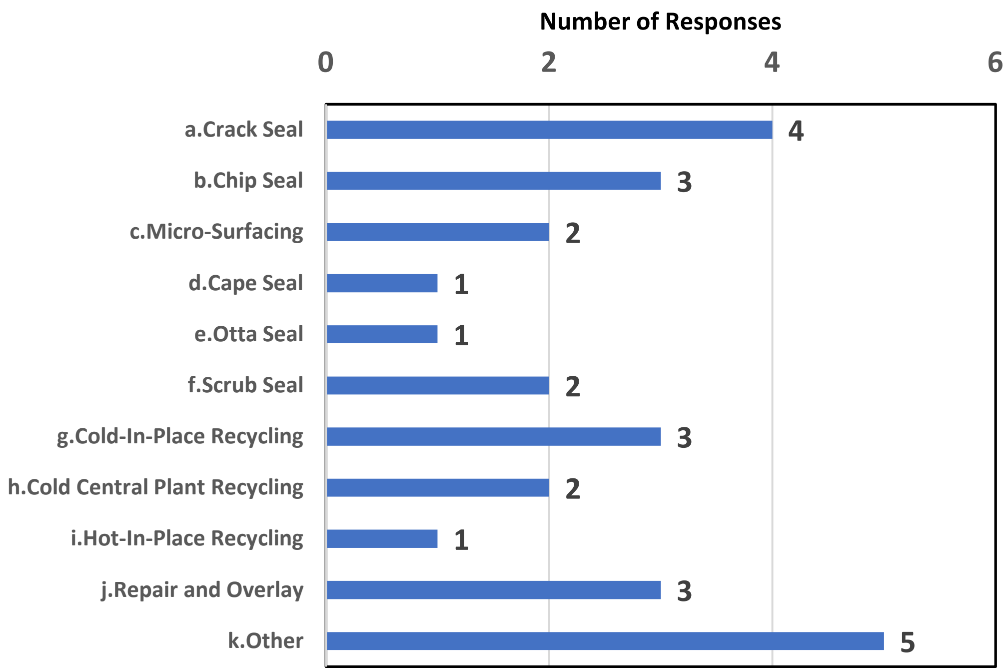

Figure 28. Bar Chart. DOT survey responses for M&R strategies used.

The information obtained in Figure 28 presents the list of M&R activities in practice among the state DOTs that maintain such routes. The literature review chapter presented the same set of alternatives, further confirming activities in practice. Florida, Michigan, Massachusetts, and Kansas were the four DOTs that selected "Other" strategies but did not expand on their practices.

11. Does the condition rating of these routes affect your agencies' condition ratings?

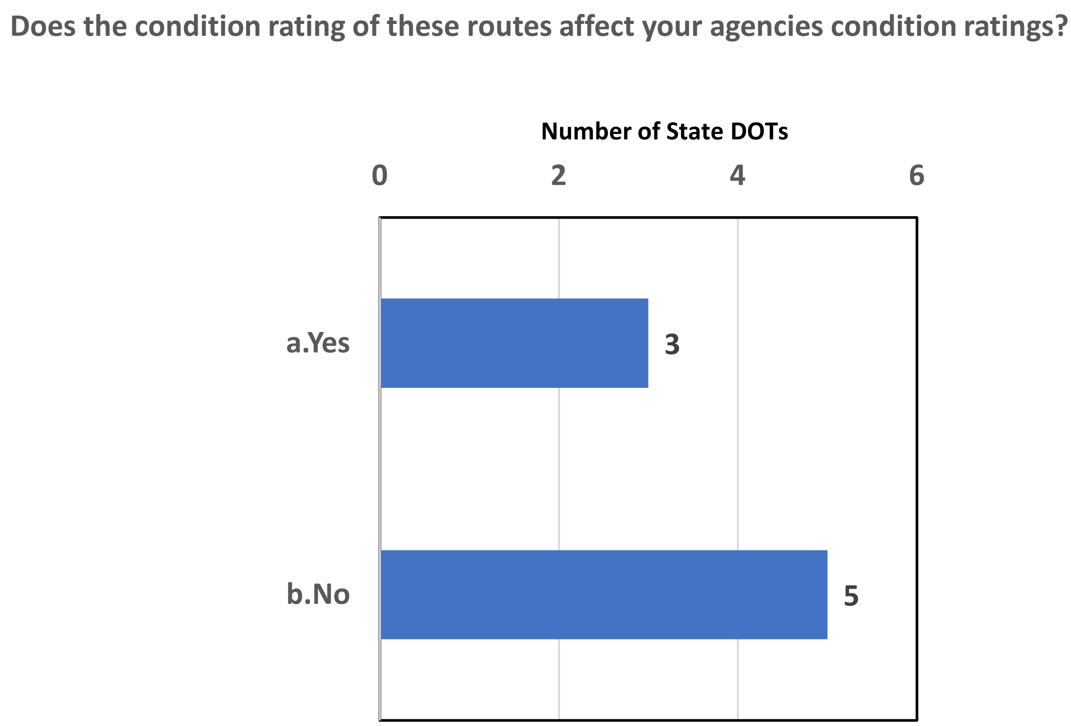

Figure 29. Bar Chart. DOT survey responses for condition ratings of unmarked routes affecting agency condition ratings.

Figure 29 presents that only three of the state DOTs that responded see their agency condition ratings impacted by these routes: Indiana, Massachusetts, and Tennessee. IDOT's CRS includes a condition rating for each UMR. With 1,889 routes and 2,590 miles of UMR, IDOT can calculate the impact of rating of UMRs on the network condition rating.

12. How do you foresee the future management of these routes such as?

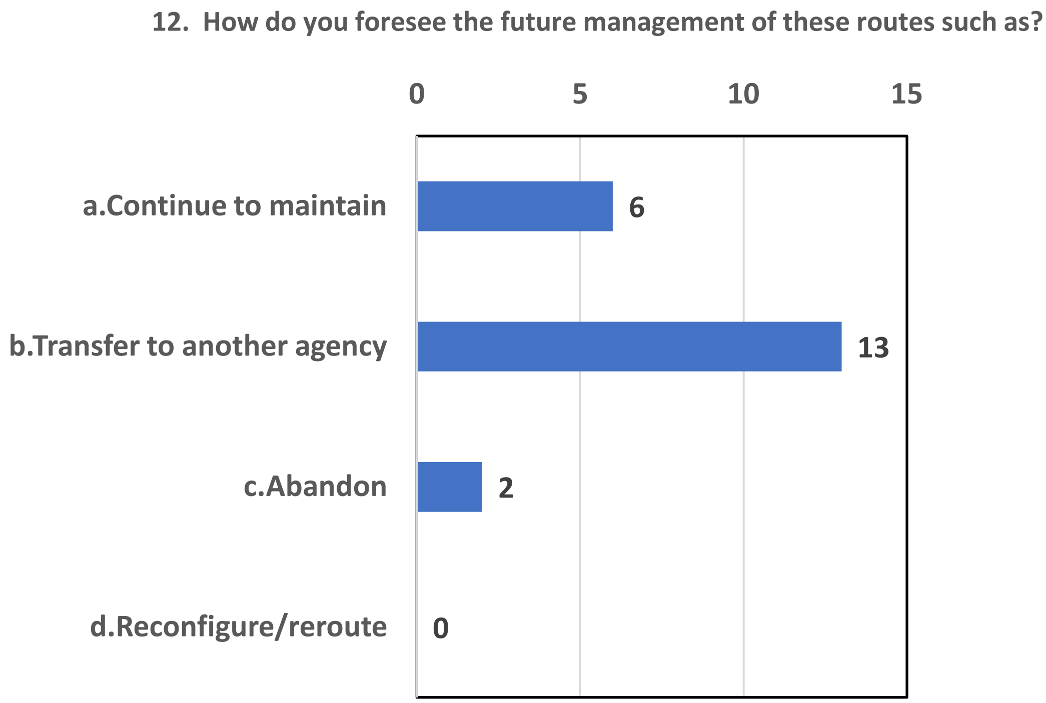

Figure 30. Bar Chart. DOT survey responses for future management of unmarked routes.

Figure 30 presents that most agencies that responded prefer to transfer applicable UMRs to other agencies, consistent with IDOT’s objective. Continuing to maintain responses is likely similar to IDOT’s rehabilitation strategy.

13. *How amenable are other agencies such as counties, townships, cities, etc., to receiving ownership in a transfer decision?*

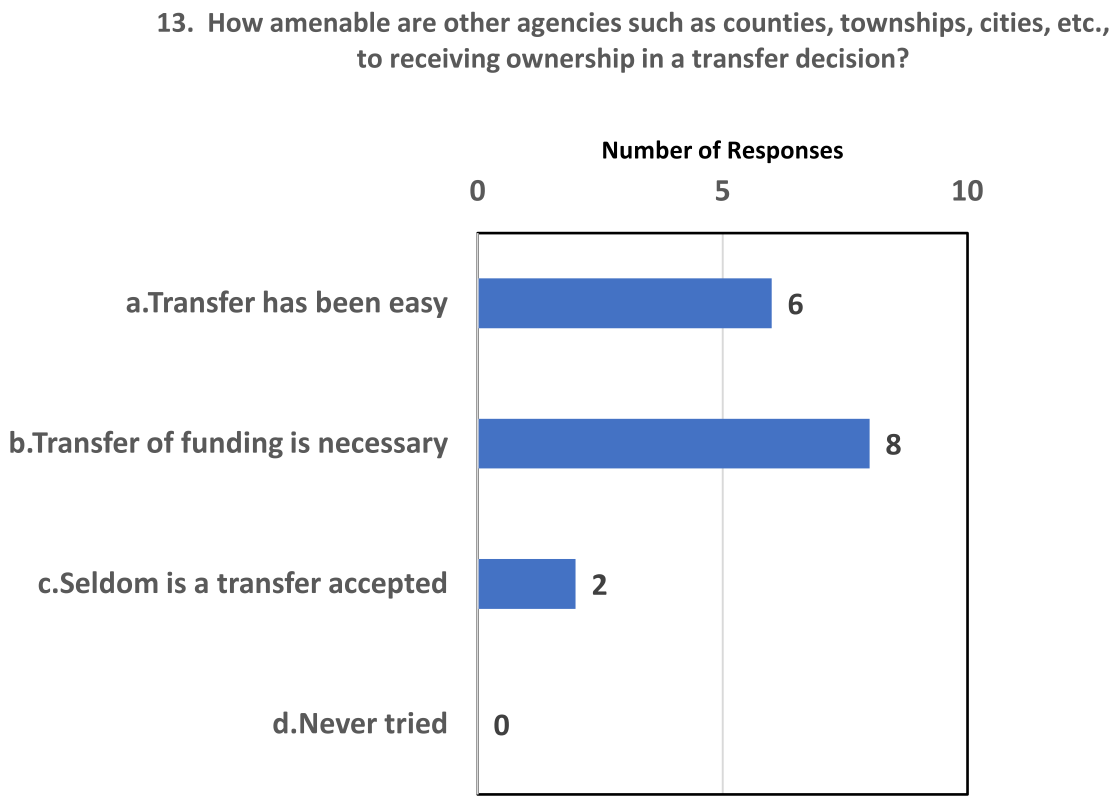

Figure 31. Bar Chart. DOT survey responses for transferring ownership to other jurisdictions.

The majority of states that responded indicated that transfer has been easy when coupled with funding (Figure 31). Only two states reported difficulty in transferring such routes.

SURVEY OF ILLINOIS LOCAL PUBLIC AGENCIES

A survey questionnaire was sent to local public agencies (LPAs) with assistance from the TRP. A total of 199 responses were received.

1. *Are you familiar with the IDOT Unmarked Routes within your (County, Township, Municipality)?*

It was surprising to note that nearly half (~42%) of the local agencies in Illinois are not familiar with IDOT's UMRs within their jurisdiction (Figure 32).

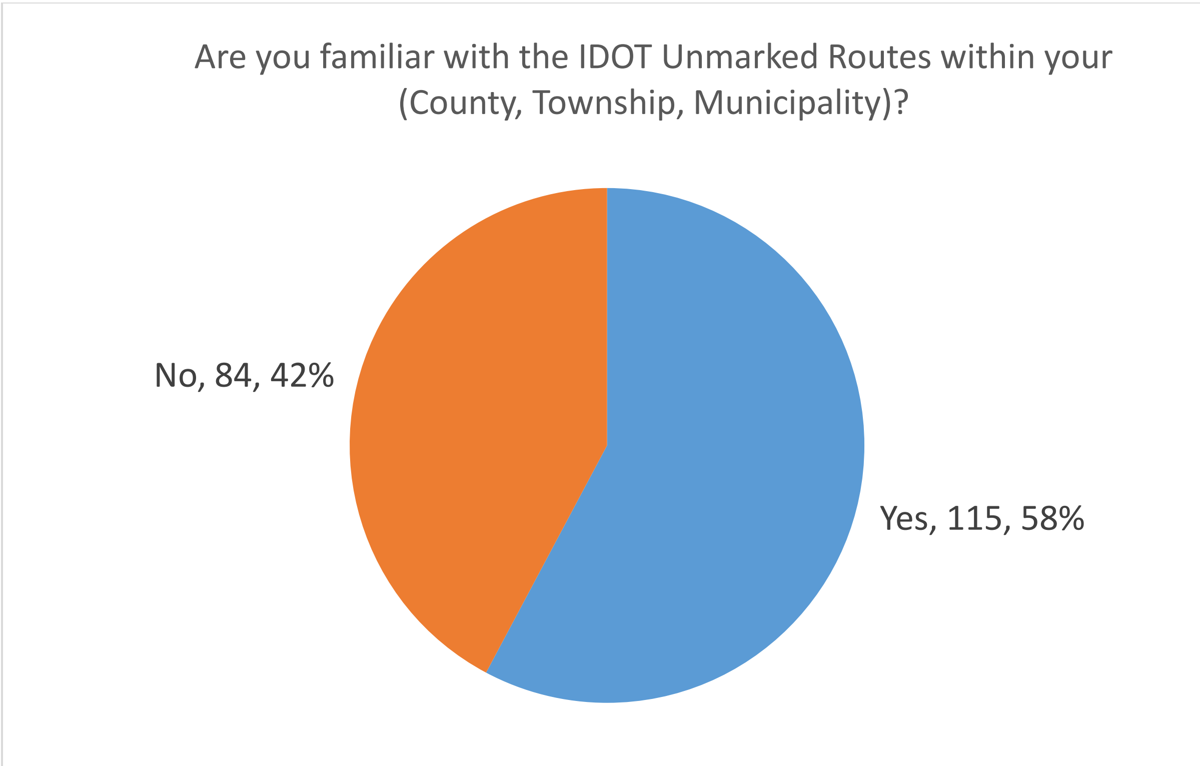

Figure 32. Pie Chart. Local public agencies' survey responses for unmarked route familiarity.

2. *Does your agency perform maintenance on any of the IDOT Unmarked Routes?*

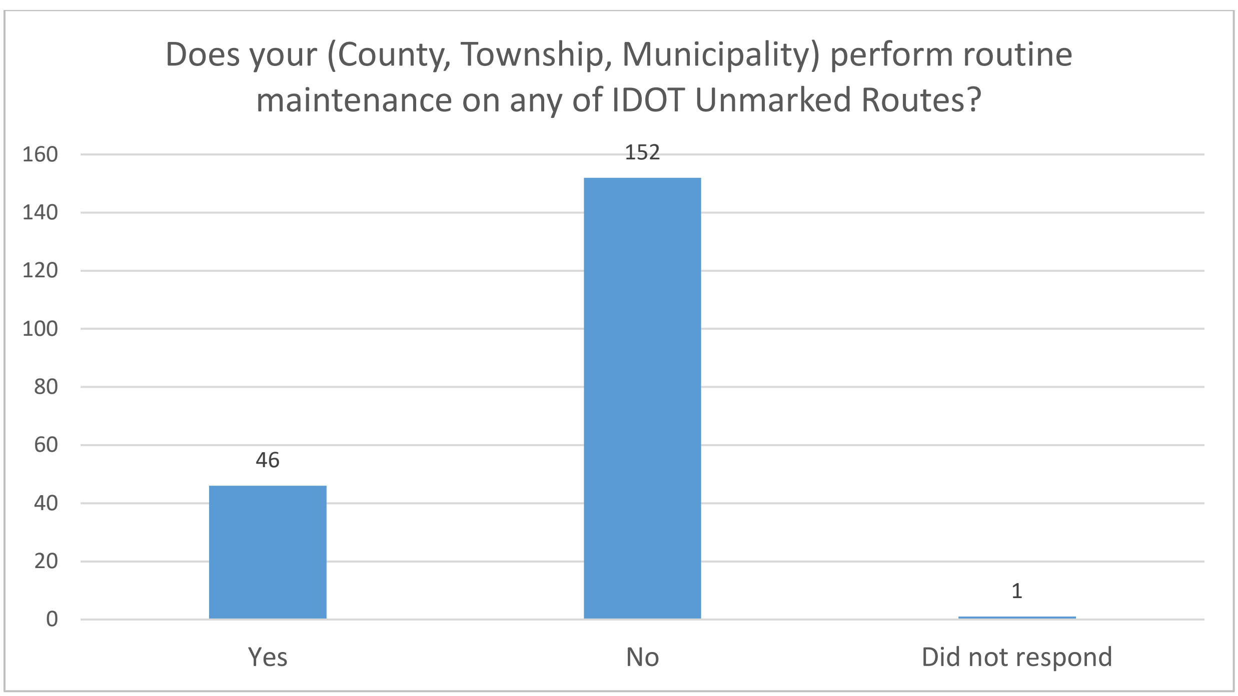

Figure 33. Column Chart. Local public agencies' survey responses for performing maintenance on IDOT's unmarked routes.

The agencies who are not familiar with the UMR program stated that they do not perform maintenance on such routes. Of the 114 LPAs that are familiar with UMRs, 46 of the LPAs (or 40%) already perform maintenance on the UMRs (Figure 33).

3. *The list below captures many routine maintenance, preventive maintenance, preservation, and rehabilitation strategies used throughout the midwestern U.S. Please place a check mark next to any strategies your agency currently has experience in.*

   ______Crack Seal

   ______Isolated Pothole Patching

   ______Drag Patching, Grader Patching

   ______Chip Seal

   ______Microsurfacing

   ______Cape Seal

   ______Scrub Seal

   ______Otta Seal

   ______Cold-In-Place Recycling

   ______Cold Central Plant Recycling

   ______Hot-In-Place Recycling

   ______Repair and Overlay

   ______Other (please list)

Figure 34 presents a column chart of the distributed responses. Pothole patching and crack sealing are the most basic and inexpensive reactive maintenance options available for the maintenance of pavements. While local agencies have demonstrated inclusion of these two activities, chip sealing and repair and overlay have also been commonly adopted by a number of agencies. While chip sealing can be a more preferred option when the pavement surface is beyond crack-sealing or pothole-patching solutions, repair and overlay require comparatively more funds. A significant number of agencies (nearly 20%) signaled they use other methods as well.

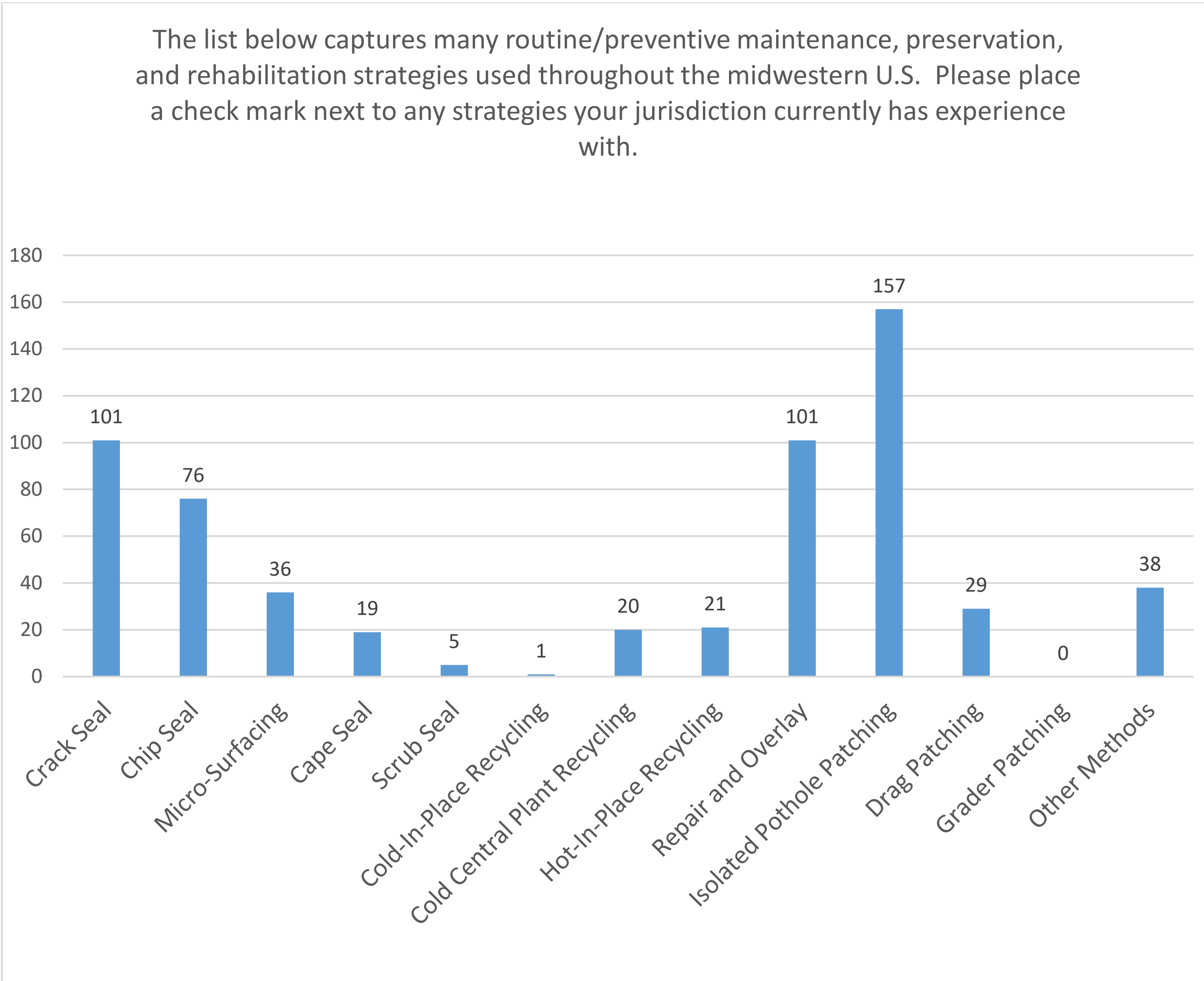

Figure 34. Column Chart. Local public agencies' survey responses for maintenance and rehabilitation strategies used.

4. How likely are you to accept a JT under any condition?

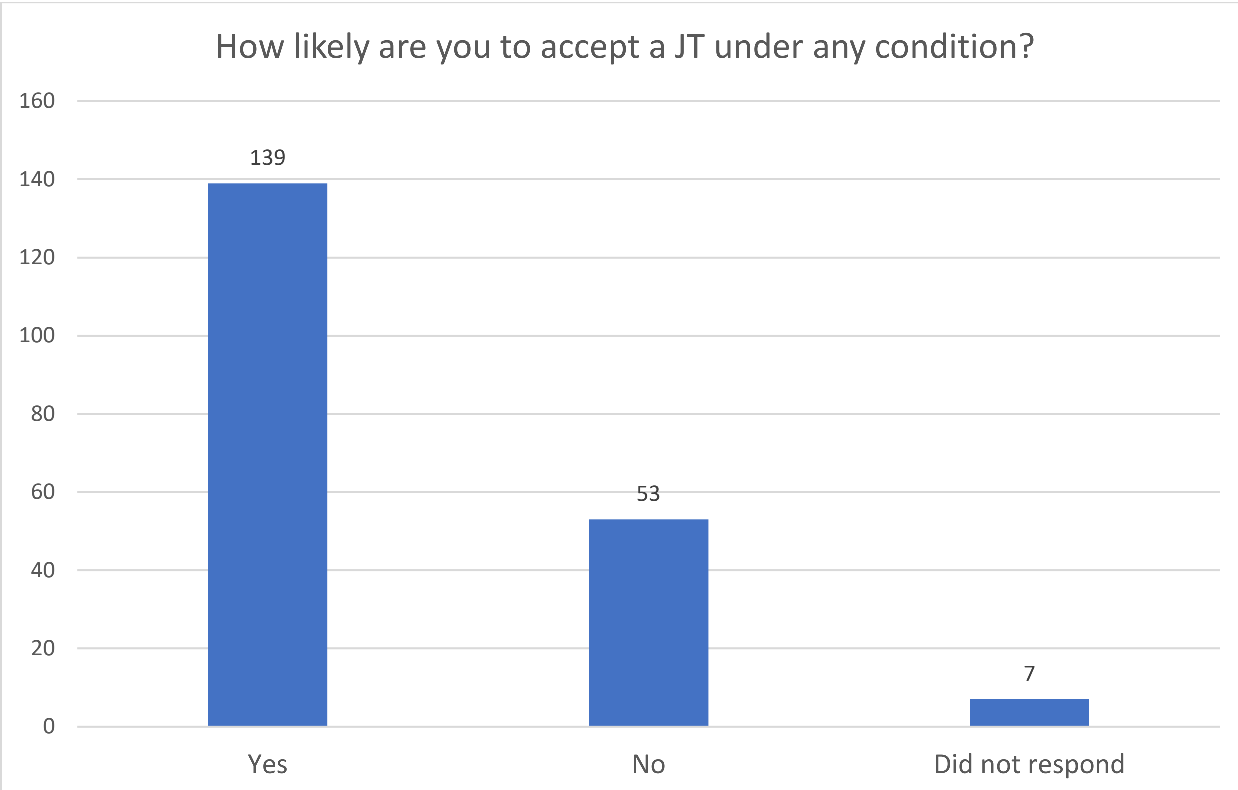

Figure 35. Column Chart. Local public agencies' survey responses for likelihood of accepting unmarked routes for jurisdictional transfer.

For this question, the agencies were asked to answer all conditions applicable to them. Seventy percent of LPA respondents (139 of 199) are willing to accept UMRs within their jurisdiction under certain conditions (Figure 35).

5. Your decision to reject or accept a JT depends on:

Reassignment of the maintenance responsibilities of certain unmarked routes that are within the boundaries and adjacent to routes within your agency can improve the effectiveness of taxpayer dollars. The following questions are intended to understand the concerns of your agency with respect to a jurisdictional transfer (JT).

a. Are there any conditions which your Agency would accept a JT? YES___ NO___

b. Your decision to reject or accept a JT depends on:

i. Bridges within the Route YES___ NO___

ii. Culverts within the Route YES___ NO___

iii. Condition of the Bridges within the Route YES___ NO___

iv. Condition of the Culverts within the Route YES___ NO___

v. AADT, ADTT levels within the Route YES___ NO___

vi. Condition of the Pavement within the Route YES___ NO___

vii. IDOT financial assistance for maintenance of the JT Route YES___ NO___

viii. Are there any other considerations not listed? YES___ NO___

ix. Please list any important considerations not listed above.

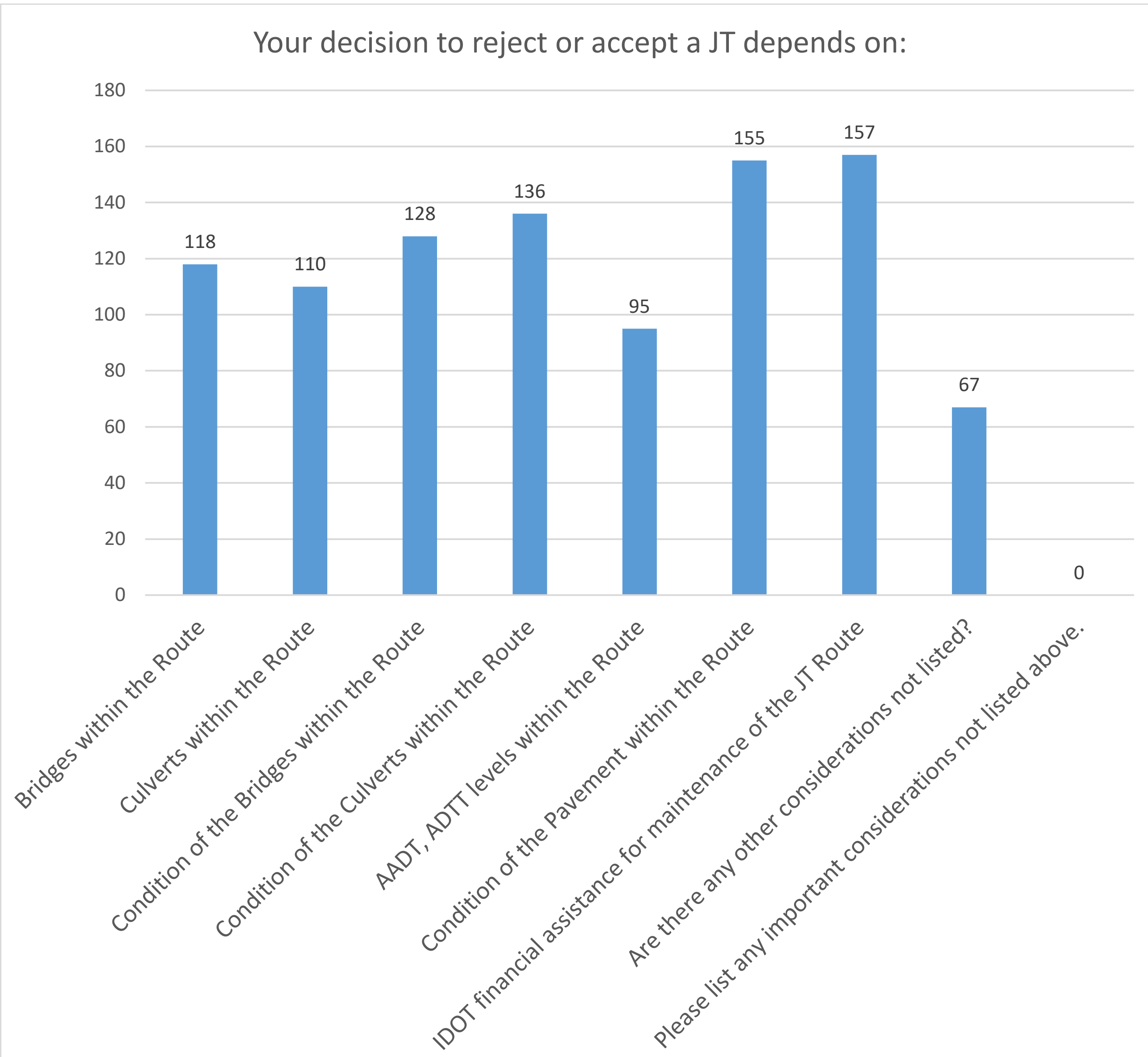

Figure 36. Column Chart. Local public agencies' survey responses for conditions for acceptance of an unmarked route for jurisdictional transfer.

A close review of the chart in Figure 36 indicates that more than half of the conditions stated for accepting a transfer by LPAs are related to physical condition of pavements/structures or financial assistance to presumably fund the maintenance of such UMRs/structures. With some capital investment by IDOT to improve the condition of the pavement/structures of any UMR in need, LPAs appear ready to accept UMRs that are recommended for transfer in most cases.

Under “Please list any important considerations not listed above,” a wide range of responses were submitted. It is not possible to group them. Typical responses are listed as follows:

- Fair cash offer, with real-world cost estimate of improvements, as opposed to using the IDOT formula
- Rewrite of terms of existing highway maintenance agreements
- Cost a major obstacle in accepting a transfer
- Traffic signals
- Limited manpower and equipment resources
- Help development
- Ability to restrict movement of certain type of vehicles
- Set aside funding
- Funding. It is not likely that an agency that will take a road from any other agency unless there is a financial incentive. And honestly, I do not think you could offer enough to an agency to take over maintenance of a road. We all have enough issues with the existing roads we have, and most agencies will not want the additional costs for maintenance that will be associated with additional roads to maintain.
- The roadway should be in an acceptable condition as defined by the roadway industry.
- Conditions/removal/replacement of sidewalks, bike paths, underground utilities, wetlands and detention
- We are willing to take over unmarked state routes after IDOT reconstructs them with concrete pavement
- Any time I’ve been involved with IDOT and jurisdictional transfer, IDOT has offered 80% or less of the cost to upgrade the section. One time it was $1,000,000 to just repave a section and IDOT offered me $100,000. Unless IDOT is serious about upgrading the unmarked routes which in my experience are in terrible condition, then no one is going to take them.

6. *May we contact you to discuss the concept of a Jurisdictional Transfer?*

The final question of the survey to the LPAs asked if we can contact them to discuss the concept of a jurisdictional transfer, in which 78% of the 199 LPAs responded that they are open to discussing transfers of UMRs.

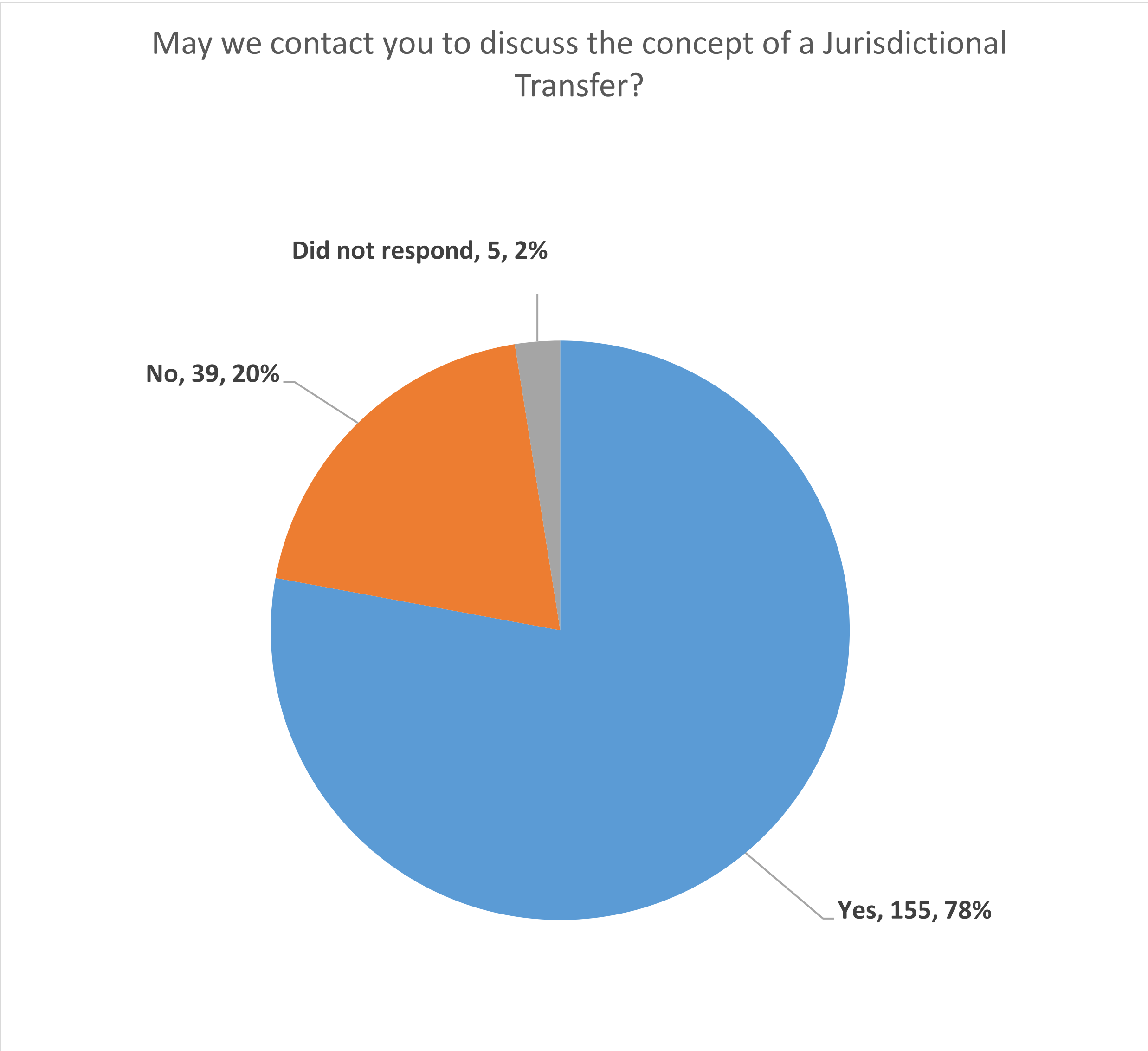

Figure 37. Pie Chart. Local public agencies' survey responses for willingness to discuss jurisdictional transfers.

The majority of LPAs that participated in this survey (144 out of 199, 72%) are receptive to discussing their M&R strategies with IDOT (Figure 37).

CHAPTER 8: CONCLUSIONS

The core objective of this study is to identify unmarked routes as candidates for either a rehome or rehab strategy. A rehome strategy describes the option to transfer a UMR to another jurisdiction. A rehab strategy is the option to upgrade the condition of the pavement. In some cases, as a condition for acceptance of transfer, both a rehab and a rehome strategy may be employed. Additionally, based on similar key database attributes and logical continuity to the marked route network, many UMRs were recommended to be upgraded to the marked category and continue to be held by IDOT. Such a process may eventually result in the elimination of the unmarked category.

The total mileage of the UMR dataset identified in this study is approximately 2,600 centerline miles over 1,889 routes. The UMRs are spread all over the state. Based on route length, District 1 (the Greater Chicago Area) is home to about one-third of all UMRs, and the average length of UMRs is 1.37 miles with a median value of 0.45 miles.

The developed JARM methodology and analysis led to the development of the spreadsheet tool, which includes a prioritization that will assist IDOT in pursuing recommendations for UMRs as candidates for transfer, abandonment, vacation, reconfiguration, or retention. IDOT personnel are able to use the spreadsheet tool to quickly identify UMRs in a particular district, instantly pull a map image via a hyperlink, and be able to view all key database, visual, and highway continuity attributes that were used in making JARM recommendations. The researchers summarized the methodology and the corresponding constructed spreadsheet tool for IDOT personnel to readily reference.

Recommendations were made based on a framework of guidance from IDOT's *Highway Jurisdiction Guidelines for Highway and Street Systems* (IDOT, 2006). In this document, IDOT has outlined that agreed-to jurisdictional transfers should occur because of the logical need to transfer authority to another highway system and that candidate JTs should be governed primarily by continuity (adjacent jurisdictional highway systems) and functional classification. Transfers should begin and end at logical termini in order to preserve an integrated highway network, and functional classification often indicates what highway authority would be appropriate for jurisdiction based on the public sector served.

Where the type of structure or number of structures are a potential hard stop in the negotiation of a JT, a maintenance agreement is an option for jurisdictions that may accept maintenance of pavements within routes without the responsibility of structures. In this study, it is only proposed as a secondary recommendation for UMRs that may not be initially accepted in negotiation for logical transfer. A maintenance agreement does not transfer jurisdiction.

Following the JARM analysis of all 1,889 UMRs included in this study, the following recommendation statistics are depicted in Figure 38.

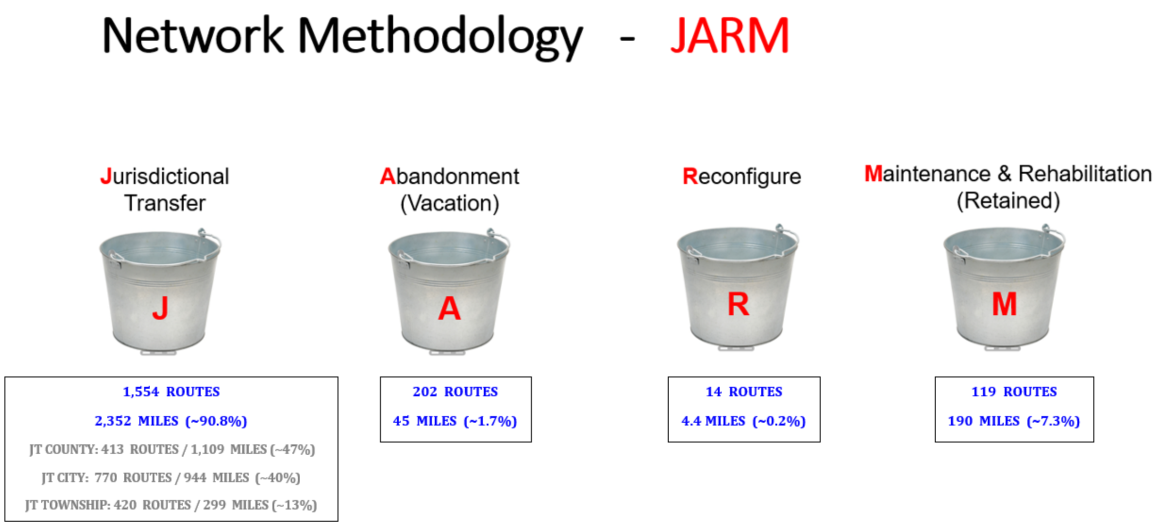

Figure 38. Screenshot. Distribution of JARM recommendations by number of routes and centerline mileage.

The overwhelming majority, over 90% of the UMR centerline mileage (1,554 of 1,889 by routes), are recommended for jurisdictional transfer (rehome), with a distribution roughly split between counties (~47%) and municipalities (~40%) and a small remaining balance to townships (~13%). Because townships are allotted Motor Fuel Tax funds based on their *mileage* share, these UMRs could be considered as the initial set of UMRs to pursue for successful JT. By law, a township road must be greater than or equal to 0.04 miles (212 feet) in order to be eligible for MFT funds. This threshold would impact 24 UMRs that are potential candidates for township JT and should have their route length verified prior to negotiation.

Even though counties are allotted Motor Fuel Tax funds based on their *vehicle fees* share and municipalities are allotted MFT funds based on their *population* share, it is encouraging that ~70% of LPAs surveyed are open to JT under certain conditions and ~40% of LPAs surveyed have already been maintaining state UMRs within their jurisdiction. It is likely that LPAs that are hesitant to accept under any condition (the ~30% of those surveyed) may convert to accepting the maintenance of the UMR pavements with a maintenance agreement. With a well-developed approach and some capital investment in negotiation, the State of Illinois seemingly has an opportunity to rehome a majority of the routes from the TAMP's unmarked category.

Another 45 centerline miles of the UMR dataset (~1.7%) in this study were recommended for vacation or abandonment. Vacation is the official process by which the road is removed from the highway system, whereas abandonment is when a route has been unused for a number of years as a road, is overgrown with vegetation, or gated/dedicated to a property owner. In these cases, the road could be considered abandoned by non-use. When a roadway is vacated, the private property created by the vacation of a public right-of-way should be transferred back to the original property owner, or if not known, then equally to the properties on each side of the road.

IDOT can transfer its land rights to a local entity along with the jurisdictional transfer of a highway. These land rights are to be transferred without any compensation from the recipient. However, any conveyance of land rights associated with this statute is with the understanding that the land will be used for public highway use. If the local entity wants to (1) use the land for a non-highway or non-public use or (2) vacate the property, IDOT approval must be obtained, and compensation from the local agency may be required at that time.

The UMRs recommended for vacation or abandonment in this study should also be an early focus to successfully reduce the number of routes in the unmarked category of TAMP based on State of Illinois law (IDOT, 2006).

Following the JARM methodology, 14 routes (4.4 centerline miles) were recommended for reconfiguration. This process would eliminate or truncate redundant segments of existing unmarked routes while maintaining the functional use and connection to the existing highway network. This would result in less pavement to maintain. In some cases, it was recommended in JARM for IDOT to reconfigure and then seek to transfer.

The remaining 7.3% of UMRs by mileage (190 centerline miles; 119 routes), were recommended through the JARM analysis for rehab solutions. In some cases, these M&R routes are recommended for recategorization into the marked TAMP category based on logical continuity of the marked route network. Access to available funding to marked routes may be an option for these misclassified UMRs.

For the DOTs, maintenance and management of low-volume roads pose a great challenge. Owing to nonavailability of adequate resources while at the same time needing to maintain all roads at a certain minimum level to keep network condition rating at the desired threshold value, the DOTs have been looking for best practices to maintain LVRs economically.

In this study based on the DOT and LPA surveys coupled with the researchers' extensive experience, a M&R matrix was developed for both urban and rural routes based on the traffic levels, functional classification, and distresses encountered. This matrix also serves as a general application for M&R strategies for low-volume routes in the marked TAMP category in conjunction with the survey, other agency approaches, and researched past practices.

In summary, this research will benefit the State of Illinois by reducing the total unmarked route category mileage and long-term system preservation costs. Vacated, abandoned, or transferred sections recommended for rehome will no longer require recordkeeping or rehabilitation plans. For those that are recommended for rehabilitation, the developed M&R matrix identifies maintenance strategies for the network of UMRs and low-volume roads, resulting in overall cost-efficiency improvement and safety.

Applied research is intended to identify solutions to specific problems, or stated differently, to find answers to particular questions. It offers knowledge that is both applicable and implementable. This project is an example of such research and at its conclusion is intended to identify and classify the population of Illinois' UMRs as well as to determine the best preservation strategies for the low-volume routes of both UMRs and marked routes under the responsibility of IDOT. The conclusions contain a final synopsis of findings, missing elements, and future steps needed to allow IDOT to manage the UMR population efficiently and effectively.

Based on IDOT data, 2,590 miles of UMRs exist and are candidates for a practical plan to address these unmarked routes. Of this population, 45 miles of UMRs should be vacated or abandoned, 2,352 miles should be transferred to another jurisdiction, and the rest needs to become marked and adopted by the DOT with funding to preserve the condition and structural integrity of the roadway.

The research team has created a user-friendly software available to IDOT to identify the many attributes, including condition, location, municipality, and approach for UMR disposition. The JARM approach has been thoroughly vetted by the research team. With a DOT work plan and a funding mechanism through TAMP, UMRs can be eliminated by vacation, abandonment, jurisdictional transfer, and reconfiguration/maintenance prior to reclassification as marked routes.

The largest challenge is the funding mechanism to carry out a JT or a preservation strategy. The task to identify and determine the best strategy for each UMR has been essentially completed by this research; however, the funding mechanism will need be debated and created by the DOT to ensure UMRs are eliminated. Without such a funding mechanism, the best planning function cannot carry out such a task.

Survey results make it clear that many jurisdictions would be amenable to a transfer, provided it does not cause monetary hardship. Township transfers include some monetary income, but other jurisdictions do not. Thus, the easiest task would be to begin with township transfers. All transfers will be expensive, and the cost should not be overlooked. Only negotiation will reveal the cost of a transfer. Without a funding mechanism, the negotiation would be an effort without reward. Thus, a mechanism needs to be created within IDOT to allow negotiations to begin. This mechanism would certainly need approval at the highest levels of executive management.

A first draft preservation strategy has been laid out by the research team. The strategy is presented in a format of similar organization as Chapter 53 of IDOT’s *Bureau of Design and Environment Manual*. The strategy provided has been devised to minimize cost but will need to be proven over several years of implementation with performance data. Work will be required to create construction and material specifications where missing. The cost of each strategy will be needed and can be obtained relatively easily with assistance from estimators within IDOT. The biggest hurdle to overcome will be to determine the funding needed to incorporate these routes into the IDOT construction program. The solution to this funding amount is iterative at best and requires executive management decisions regarding acceptable levels of condition. Executive management should rely on a pavement management system, incorporate these routes with best-estimate degradation functions, cost of strategies, and funding appropriation levels. This will allow executive management to understand the risk and rewards of different funding levels. Best-estimate degradation functions can be obtained using the information provided in the background information within the research report. As time and performance reveal Illinois’ specific data, degradation functions can be improved, planning iterations can be run, and Pavement Management System (PMS) optimizations can be used for updated budgets and TAMP documents.

CHAPTER 9: CONSIDERATIONS FOR FUTURE WORK

The present study has resulted in the development of an unconventional classification system of UMRs with the overall goal to identify strategies to either maintain or transfer each route (rehab or rehome). The final product of this effort was a sortable spreadsheet tool for districts to use that individually investigated each UMR with an order of recommendations on how to proceed with each UMR in the class.

A secondary—but critical—goal of this research was to learn about other DOTs and Illinois local public agencies' (LPAs) attitudes about transferring ownership to their jurisdiction. Two robust surveys with significant participation yielded informative insight to this goal. Additionally, a pavement maintenance matrix that identifies specific strategies for types of distresses found on a UMR dependent on traffic volumes was included for guidance.

During discussions throughout the project period, the researchers and the TRP realized that this research addressed the network level of the UMR and low-volume routes, but not the project level. One TRP member pointed out that IDOT has 102 counties that have each made different decisions in the past. The next logical step is to build off this research and to identify how to execute rehab versus rehome recommendations identified in this study at the *project level* in the most cost-effective manner for the State of Illinois based on deterioration rate/life-cycle analysis models for rehab candidates and how to approach specific jurisdictions for transfers.

The results from the LPA survey found that 70% of Illinois LPA respondents were amenable to a discussion of jurisdictional transfer under a variety of conditions, even though 42% (84 of 199) of the respondents are not aware of any UMRs in their jurisdiction. In fact, 23% (46 of 198) of the survey respondents indicated they already maintain some known IDOT UMRs within their jurisdiction anyway.

The findings from this UMR research have identified the UMR class of routes and their logical recommendations from a network level. The natural follow-up to study is to prioritize and proceed with specifics on the individual project level, incorporating the additional parameters of individual LPA attitudes, obstacles, and solutions to most cost effectively rehome or rehab each UMR.

The researchers have three recommendations for proceeding in a follow-up research study. The first recommendation is to assign a priority ranking within the spreadsheet tool. This potential scope is a final component of the spreadsheet tool. It prioritizes the anticipated ease in which the proposed recommendation(s) can be completed successfully through a group rating. A group rating could be computed for each UMR based on a weighted classification system of subjective influential parameters identified by the researchers at the project level. While all the recommendations would be rooted in IDOT's guidelines, the objective would be to understand the relative ease of negotiation for jurisdictional transfer assessed for individual UMRs and low-volume marked routes.

The second recommendation is to use the priority ranking above for review of all UMRs and to make specific recommendations for pavement maintenance of each UMR based on a cost-benefit analysis. The researchers would assist IDOT with identifying the most cost-effective solutions. The scope of this potential project is a detailed review of UMRs with recommended pavement maintenance solutions for each UMR based on a comprehensive cost-benefit analysis. While the solution for each UMR would be considered individually based on its set of unique parameters, it is likely that UMRs that share select setting characteristics will have similar recommendations. Still, the State of Illinois could consider a study to perform estimates within a cost-benefit analysis on each UMR and assign a specific pavement maintenance recommendation.

The third recommendation is to use the priority ranking above for review of all UMRs that are jurisdictional transfer candidates. The researchers would assist IDOT and pre-negotiate on a project level to obtain a cost to include in the spreadsheet. The researchers would make specific recommendations to understand the conditions for a successful JT of each UMR based on specific project-level parameters. The scope of this potential project is a detailed review of UMRs and to identify the project-level parameters for each specific UMR to obtain a successful JT. Starting with the priority rankings above for the easiest transfers, outline a procedure for initiating contact with jurisdictional decision-makers and collect the information for conditional requirements, if any, for a successful transfer. This analysis would strengthen the negotiation process by understanding the cost for improving the pavement condition, if needed, as a condition for transfer, and move more UMRs to other jurisdictional entities in the most efficient way to maximize total cost of ownership savings to IDOT.

REFERENCES

Dekalb County. (2023). *COMPASS GIS.* http://gis.dekalbcounty.org/

Gransberg, D., & James. D. (2005). *Chip seal best practices* (Report No. NCHRP Synthesis 342). National Cooperative Highway Research Program.

Green, R., Buss, A., Robbins, M., Sargand, S., & Guirguis, M. (2018). *Best practices for chip sealing low-volume roads in Ohio* (Report No. FHWA/OH-2018/19). Ohio Research Institute for Transportation and the Environment.

Gushgari, S. F., Zhang, Y., Nahvi, A., Ceylan, H., Kim, S., Arabzadeh, A., Jahren, C. T., & Øverby, C. (2019). Design, construction, and preliminary investigations of Otta Seal in Iowa. *Transportation Research Record*, *2673*(12). https://doi.org/10.1177/0361198119853567

Hafez, M., Ksaibati, K., & Atadero, R. (2018). *Best practices to support and improve pavement management systems for low-volume paved roads—Phase I* (Report No. CDOT-2018-03). Colorado State University/Colorado Department of Transportation—Research.

Hicks, G., Seeds, S., & Peshkin, D. G. (2000). *Selecting a preventive maintenance treatment for flexible pavements* (Report No. FHWA-IF-00-027). Foundation for Pavement Preservation.

Illinois Department of Transportation. (February 2023). *Bureau of Design and Environment Manual*. Illinois Department of Transportation.

Illinois Department of Transportation. (March 2006). *Highway jurisdiction guidelines for highway and street systems*. Illinois Department of Transportation.

Illinois Department of Transportation. (2014). *Illinois highway information system roadway information & procedure manual (IRIS)*. Illinois Department of Transportation.

Illinois Department of Transportation. (2023). *Illinois Roadway Analysis Database System, Version 0.3.9 (IROADS)*. Illinois Department of Transportation, Bureau of Information Processing.

Illinois Department of Transportation. (June 2019). *Transportation asset management plan*. Illinois Department of Transportation.

Illinois Department of Transportation. (June 2021). *Illinois highway information system structure information and procedure manual*. Illinois Department of Transportation.

Maus, Jonathan. (2020). Metro study gives cities a roadmap to adopt state-owned 'orphan highways'. *BikePortland*, September 17. https://bikeportland.org/2020/09/17/metro-study-gives-cities-a-roadmap-to-adopt-state-owned-orphan-highways-320849

Moore, B. P., Keierleber, B., Billings, B., Shutt, A., & Malone, T. (2019). *Full-scale field implementation of Otta Seal in Iowa*, 12th International Congress on Low-Volume Roads, Montana, September 15–18.

Muench, S. T., Mahoney, J. P., Wataru, W., Chong, L., & Romanowski, J. (2007). Best practices for long-lasting low-volume pavements. *Journal of Infrastructure Systems*, *13*(4). https://doi.org/10.1061/(ASCE)1076-0342(2007)13:4(311)

National Cooperative Highway Research Program. (2016). *Converting paved roads to unpaved* (NCHRP No. 485). The National Academies Press. https://doi.org/10.17226/21935

Nordbeck, A. V., Vrtis, M. C., & Worel, B. (2019). *Performance of chip seal treatments in two different climatic regions*. 12th International Congress of Low-Volume Roads, Montana, September 15–18. https://doi.org/10.1177/0361198119853546

Ohio Department of Transportation. (May 2001). *Pavement preventive maintenance program guidelines*. Ohio Department of Transportation, Office of Pavement Engineering.

Ohio Department of Transportation. (2022). 550—Surface Treatments. Ohio Department of Transportation. Retrieved Fall 2022 from https://www.transportation.ohio.gov/working/engineering/pavement/pavement-design-manual/550

Rajagopal, A., & Cline, D. (2020). *Pavement maintenance treatments practices—a survey of highway agencies, Final Report*. Submitted to the City of Cincinnati.

RxPave. (2022). Low-volume roads and small cities in Washington state. Retrieved Fall 2022 from https://rxpave.com/about-rxpave/background/

State of Kentucky, County Franklin. (2022). *Reference statutes.* American Legal Publishing. Retrieved Summer 2022 from https://codelibrary.amlegal.com/codes/franklincoky/latest/franklinco_ky/0-0-0-3856

University of North Carolina School of Government. (2022). *Orphan roads DOT maintenance program.* Retrieved Summer 2022 from https://lrs.sog.unc.edu/bill/orphan-roads-dot-maintenance-program

West Virginia Legislature. (2022). *Reference examples.* Retrieved Summer 2022 from http://www.wvlegislature.gov/WVCODe/code.cfm?chap=17&art=2C

Wikimedia Commons. (2022). Bannered Highways. Retrieved in May 2021 from https://en.wikipedia.org/wiki/Special_route

Zhou, Q., Okte, E., Sushobhan S., Ozer H., Al-Qadi, I. L., Roesler, J. R., & Chatti, K. (2019). *Development of a life-cycle assessment tool for pavement preservation and maintenance on flexible and rigid pavement* (Report No. ICT-19-010). Center for Highway Pavement Preservation.