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Lorain Police Department: A Study to Improve Patrol Deployment

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Abstract

The Lorain (OH) Police Department requested research assistance from the Ohio Consortium of Crime Science (OCCS) for the purpose of evaluating and revising the current patrol districts and the allocation of resources within the districts. The OCCS is an association of researchers from universities and state agencies working together to provide evidence-based solutions to the real-world problems faced by local criminal justice agencies. The goal of the project was to evaluate and revise the current police districts and the allocation of resources within those districts. The first objective in support of the project goal was to assess calls for service, officers' workload, hotspots, and violent crimes within the existing police districts. The second objective in support of the project goal was to develop new police districts based on the findings of the first objective and to predict future calls for service, officers' workload, hotspots, and violent crimes within those proposed districts.

Calls for service data (N = 56,423) from the Lorain Police Department's computer-aided-dispatch (CAD) system were analyzed for the year 2013. Findings indicate that there is disparity in allocation of patrol resources and calls for service workload across the five current police districts within the city of Lorain. The CHAID algorithm was employed to group 93 existing geographic section tracts within the city into twelve statistically similar groups. Geospatial patterns readily emerged and the five police districts were reconfigured into four new patrol beats. Four recommendations are presented: (1) the proposed new police beats should be implemented; (2) section tracts within the new beats should be used as crime analysis targets; (3) patrol resources should be specifically assigned to each of the new beats on all shifts; and, (4) patrol operations should be fully integrated within the new CAD system scheduled for implementation in early 2015.

Introduction

Patrol is the most visible and recognized function of modern police. On average, about 60 percent of the sworn personnel in police organizations are assigned to patrol (Walker & Katz, 2008). Police officers invariably begin their careers as patrol officers, and the "beat cop" experience provides a common practice that shapes the attitudes and actions of all officers within the organization. Citizens identify with the officer on patrol more than any other aspect of the police organization because the patrol officer is most accessible in times of crisis or when assistance is needed. Routine patrol tends to dominate officer shift time across various types of jurisdictions, including small towns, rural places, and larger urban centers. These facts make clear that patrol is a cornerstone of modern policing—something that is essential to the law enforcement enterprise (Fritsch, Liederbach, & Taylor, 2009).

The patrol function addresses several of the primary goals of police work. For example, patrol creates a visible presence in the community. Patrol officers are readily recognized by citizens. Patrol can promote perceptions of safety and reduce citizen fears concerning local neighborhood crime. The visible presence produced by patrol presumably deters potential crimes. Patrol also works to decentralize—or "scatter"—police across a specified geographical area to allow them to respond to citizen calls for service as quickly as possible. Finally, patrol allows officers to be available or "in-service" and ready to respond to emergencies whose exact nature, location, and time of occurrence remain unknown to police executives and the officer on patrol.

The term *patrol deployment* encompasses the most fundamental issues associated with the patrol function, including where, when, and how patrol officers should be assigned to most efficiently and effectively accomplish the goals outlined above. Patrol deployment issues are not

simple or "cut-and-dried." These issues are inherently complex because police executives must take into account a wide range of concerns—both organizational and community based—in order to maximize departmental resources and address the concerns and priorities of citizens who often disagree as to what problems police should confront and how they should confront them. There is, for all practical purposes, no limit on community demands upon police. In regard to the patrol function, police executives must accomplish an infinite number of jobs using resources that are increasingly constrained and finite.

The Lorain (OH) Police Department requested research assistance from the Ohio Consortium of Crime Science (OCCS) for the purpose of evaluating and revising the current patrol districts and the allocation of resources within the districts. The OCCS is an association of researchers from universities and state agencies working together to provide evidence-based solutions to the real-world problems faced by local criminal justice agencies. The request from the Lorain Police Department involves three closely-related issues that are fundamental to the goal of improving the efficiency of patrol deployment in Lorain. First, the police department has already defined current district boundaries as deficient and out-of-date. The department utilizes geographic boundaries that divide the city into five districts that were created sometime prior to the mid-1960s. Current district boundaries seem to be based on factors other than population, calls for service, and/or crime data; and, the department's Criminal Intelligence Division suspects that current district boundaries negatively impact the distribution of workload and response time.

The second issue relates to the impending installation of a new computer-aided dispatch (CAD) system in early 2015. CAD is a method of dispatching patrol officers through a suite of software packages used to handle calls for service as efficiently as possible and maintain the

status of responding patrol resources in the field. The new CAD system will replace the Lorain Police Department's current CAD system that has been in use since approximately 1988. The department's information technology administrator estimates that only 20% of the current CAD system's capabilities are utilized. The department recognizes the need to devise logical and up-to-date district boundaries prior to installation of the new CAD system so that the organization can exploit the full capabilities of the new system. Third—and perhaps most important in the long view—current district boundaries significantly hamper the implementation of modern proactive patrol strategies and tactics that have recently worked to reduce crime and increase citizen satisfaction within many jurisdictions across the nation. Many of these strategies substantially rely on the availability of accurate and timely crime data and the rapid and efficient deployment of patrol resources to specific geographical units, a situation that demands district boundaries that reflect the current needs of the Lorain Police Department and the city of Lorain in terms of calls-for-service.

The overall purpose of this study is to evaluate and revise the current police districts and the allocation of resources within those districts. The research plan proceeds in two parts. The first part involves an assessment of officer workload using the current district boundaries. We provide a description of current workload in terms of: a) calls for service within each of the five existing districts, b) calls for service workload in terms of the source of the call, c) calls for service workload in terms of the type of call, and d) calls for service workload by shift (day/night) and priority of the call. These data were used as a baseline to develop proposed new beat boundaries based on calls for service workload. The second part of the research plan involves predictions of calls for service workload using the proposed new beat boundaries. We provide a description of "future" workload in terms of: e) calls for service within each of the new

proposed beats, f) calls for service workload in terms of the source of the call, g) calls for service workload in terms of the type of call, and h) calls for service workload by shift (day/night) and priority of the call.

The next section of this report underscores the need for new district boundaries in Lorain and provides a brief overview of some of the most recent patrol strategies that demand timely crime data and district boundaries based on a more accurate assessment of officer workload across these geographic boundaries. The section provides a substantive context for a more detailed description of our methodology and the presentation of research findings. The research team provides specific recommendations in the section that follows the findings.

The City of Lorain, the Lorain Police Department & the Need for New Beat Boundaries

The city of Lorain is located in northeast Ohio at the mouth of the Black River about 30 miles west of Cleveland. The city had an estimated total population of 63,707 in 2012. Lorain is Ohio's tenth largest city in terms of population. Lorain has 2,553 persons per square mile, and ranks 47th among Ohio cities in terms of population density (Zip Atlas, 2013). The city is diverse in terms of race/ethnicity. African-Americans comprise 17.6% of the population, and 25.2% of the residents describe themselves as Hispanic or Latino (U.S. Census Bureau, 2014). Lorain County had the fourth largest Hispanic population in the state of Ohio in 2010 (Kim, 2011). Lorain's median household income is $34,823 and over 29% of the population lives below the poverty level (U.S. Census Bureau, 2014). The city of Lorain ranks at the bottom of all cities in Lorain County in terms of both median household income and median family income (Kim, 2011). In terms of education, 11.4% of the city's residents have earned a Bachelor's degree or higher (U.S. Census Bureau, 2014).

The Lorain Police Department employs 97 sworn officers and 29 civilian personnel. The department is organized within a hierarchical structure typical of police agencies in the United States. The sworn officers work within the Patrol Operations Bureau that includes the Chief of Police, Police Captains (n = 3), Lieutenants (n = 6), Sergeants (n = 14), and Officers (n = 71). Patrol Operations is comprised of several Divisions, including Uniform, Traffic, Community and School Resource Officers, K-9 unit, C.I.T, Negotiations Team, Marine Patrol, Underwater Recovery Team, and Police Auxiliary Unit. In terms of the sworn personnel, The Lorain Police Department is currently operating at 85% of authorized strength overall, and 80% of authorized strength in terms of sworn personnel (City of Lorain, 2014; Rivera, 2014).

The city has changed dramatically since the adoption of the current police district boundaries more than 40 years ago. Lorain's population and economic base expanded into the 1970s as two of the city's primary employers, the Ford Motor Company and United States Steel Corporation, significantly increased operations. The city population peaked in 1975 at 81,045. The economic recession of the early 1980s however initiated both long-term population declines and an erosion of Lorain's economic base. Lorain's population has declined close to 20% over the last 40 years (U.S. Census Bureau, 2014). During the 1980s, the American Shipbuilding Company announced the closure of its Lorain Shipyard, thousands of workers were laid off at Ford's Lorain facilities, and there was reduced employment at the Lorain Steel Works following U.S. Steel's 1989 sale of the Lorain mills to Japan's Kobe Steel (Lorain Public Library System, 2014). The Lorain steel mills were sold again in 1999, this time to Lorain Tubular Company. Then, in 2001, Lorain Tubular merged into U.S. Steel (see, e.g., *Cataldo v. United States Steel Corporation*, 2012). Lorain County's unemployment rate stood at 23.7% in 1982. Chief Rivera of the Lorain Police Department summarized the historical situation in his message posted on the

police department's website: *"Lorain used to be a pretty tough town. Our E. 28th Street and Broadway corridors were filled with bars and taverns from one end to the other, the homicide rate was unacceptably high and bar fights, open drug dealing, and prostitution were common, every day occurrences."* (Rivera, n. d.).

Lorain has recently undertaken initiatives to revitalize the economic base and stem population declines. Over the course of the last 15 years, construction has been completed on a new shopping center and several new housing developments in the Kingswood area and Camden Woods subdivisions. The city has opened Black River Landing and Harborwalk, a 450 home and marina complex in the area formerly occupied by the shipyard. In 2011, Republic Steel announced plans for a new electric arc furnace at their Lorain plant, and plans proceeded for the construction of a new high school and the Black River Sewer Project designed to help the revitalization of the waterfront (Lorain Public Library System, 2014). Long-time Executive Director of the Lorain Port Authority Rick Novak recently summarized the growing level of optimism in regard to recent development initiatives and the future of the city: *"We have all of the pieces of the puzzle here. We need to put them together and move forward"* (Payerchin, 2013).

The expression of optimism is also reflected in the on-line message of the Chief of Police: *"But times have changed...for the better. Crime is sufficiently under control so that we can now take a more proactive approach to policing this great city ... Our goal is to merge community and traditional policing to blend them into a policing model for the future ... and continue the problem solving strategies that our officers have implemented in the last couple of years"* (Rivera, n. d.). The available crime statistics from the Lorain Police Department demonstrate significant declines from 2008 to 2013 in reported rapes (53%), felonious assaults

(24%), burglaries (32%), and motor vehicle thefts (60%) (Rivera, 2014). Lorain Police Department executives clearly understand that further gains will depend on data-driven approaches and at minimum the implementation of new district boundaries.

Since the 1970s and the advent of the earliest empirical studies on patrol, scholars and police executives recognize that "uncommitted" time on patrol—or time spent driving around and waiting for the next call for service—can be more productively spent on a variety of patrol strategies that have been shown to be effective:

- Offender-specific strategies that focus on serious and repeat offenders (Abrahamse, Ebener, Greenwood, Fitzgerald, & Kosin, 1991; Martin & Sherman, 1986; Martin, 1986).
- Place specific strategies, in particular "hot spot" strategies have been effective in reducing call for service and repeat victimization at small geographic locales (Mastrofski, Weisburd, & Braga, 2010; Sherman, Gartin, & Buerger, 1989; Skogan & Frydl, 2004).
- Offense specific strategies that focus on a particular type of offense or category of offenses have also been shown to be effective (Sherman & Rogan, 1995).

Over the course of the last decade, the dissemination of research on the effectiveness of these and other proactive strategies and the wide-scale adoption of computerized information systems and crime mapping software has promoted the implementation of "strategic problem solving" or Compstat-like programs in larger police agencies across the nation (Walsh, 2001; Weisburd, Mastrofski, McNally, Greenspan, & Willis, 2003). There is some disagreement as to the specific components of these strategies; however, advocates define several principles including: 1) the collection and analyses of accurate and timely data, 2) rapid deployment of

patrol resources to comparatively small geographic places, and 3) utilization of problem-solving tactics focused on crime prevention and the ultimate reduction of crime rates.

The further realization of the Lorain Police Department's crime reduction goals and the modernization of patrol deployment strategies will demand continued transformation towards proactive policing anchored on the timely analysis of crime data and the deployment of officers among geographic districts that reflect workload and citizen demands much more accurately than those drawn up prior to the 1970s.

Method

The goal of the project was to evaluate and revise the current police districts and the allocation of resources within those districts. The first objective in support of the project goal was to assess calls for service, officers' workload, hotspots, and violent crimes within the existing police districts. The second objective in support of the project goal was to develop new police districts based on the findings of the first objective and to predict future calls for service, officers' workload, hotspots, and violent crimes within those proposed districts.

Data were made available from the Lorain Police Department's computer-aided dispatch system on calls for service during the years 2005-2014 (N = 484,017). Calls for service data for the year 2014 were available only through the morning of March 20, 2014. Ultimately, the research team decided to clean the data and run analyses on the subset of calls for service data from the year 2013 (N = 56,423). The 2013 calls for service data set provided a robust sample with a high level of statistical power allowing for generalizability across years through predictive analytics.

Data Preparation and Variable Selection

Several variables were recoded to combine elements of several variables into one. For example, the data set provided to the research team included information on three levels of geospatial tracts: *districts* (the patrol beats), *areas* (smaller tracts within each *district*, often divided by labels such as north, south, east, west, and/or central), and *sections* (the smallest geospatial tracts within the *areas* inside each *district*). The data set received, however, did not differentiate the *sections* within the specific variable but instead required one to look to the next column in the data set spreadsheet to determine which *area* and *district* a specific *section* was located. In other instances, variables were collapsed into new categorical variables to reduce the

number of categories within a variable. There were, for example, 120 incident types in the calls for service data set. These incident types were recoded into a new 12-category variable grouped by series based on the first digit of the categorical label for each of the 120 incident types. See Appendix A (Recoded Incident Type Group Series). Incident priority was a 9-point scale, and apparently not currently used by dispatchers and officers to prioritize calls for service. Nevertheless, analysis of crosstabs tables indicated that the 9-point incident type scale data were correlated closely with specific incident types. The variable was collapsed into a new/recoded variable where priorities 1 through 3 = *high priority* call for service, and priorities 4 through 9 = *low priority* calls for service. Computer scripts/syntax were written to alleviate such problems prior to performing predictive analytic operations.

Statistical Analysis

All statistical analyses were performed with IBM/SPSS Modeler 16 and IBM/SPSS Statistics 21. The variables included were *district*, *area*, *section*, *incident type group series*, *incident priority*, *incident source*, and *shift*. Classification tree analysis—also known as decision trees—was utilized as a statistical technique to uncover the causal pathways between independent predictors and dependent variables (including, in separate models, sources of calls for service, incident type groups, calls for service priority, shift, police districts, and new beats). This approach moves beyond the simple one-way additive relationship of linear statistical models by identifying the hierarchical interactions between the independent predictors and their compounding impact. Classification trees examine the entire data set and produce a graphical output that ranks the variables by statistical importance. The most influential variable is represented at the top of the tree (known as the root node). This variable is used to split the data in a recursive manner through the creation of subsets into the lower branches of the tree.

Variable selection and splitting criteria are driven by the algorithm of the tree program. Decision tree techniques have received attention due to their ability to handle interaction effects in data without being bound to statistical assumptions (Sonquist, 1970).

This study used the Chi-Square Additive Interaction Detection (CHAID) predictive analytic decision tree algorithm. The CHAID algorithm differs from other classification tree algorithms through the inclusion of multiple measurement levels for the independent variables. The algorithm can compute nominal, ordinal, and interval levels for both independent and dependent variables. Therefore, the independent variables can have different levels of measurement. If a ratio level variable is included in the analysis, the program will convert the variable into a categorical variable. Kass (1980) was concerned with the computation time when running decision trees and therefore, created his algorithm with time in mind (Wilkinson, 1992). He created an algorithm that partitioned the data in a timely manner without losing its ability to uncover interactions and lose predictive power. Because of this, computation time is saved and CHAID can search through large data sets to produce *T* without a significant reduction in computation time. The CHAID algorithm conducts exhaustive searches of the data, which allows smaller data categories to be partitioned into trees. The CHAID algorithm was used in this study because it fits our problems and produced optimal decision trees by minimizing the generalization error.

Strengths and Limitations

The calls for service data set provided by the Lorain Police Department is large and robust, allowing for more than adequate statistical power in performing predictive analytic and data mining modeling algorithm operations. There are two primary limitations of the data. First, the research is limited by the content and quality of information provided for each case. The

amount of information available on each case varies, and data for several variables of interest are missing for some of the cases. Second, the more general limitations associated with using only calls for service data to discern overall patrol workload and appropriate deployment strategies need to be recognized. Calls for service data do not comprise the totality of demands on patrol officer shift time, nor can they account for all of the variables important to determining relevant patrol deployment issues. For example, patrol officers can be expected to complete other tasks aside from those derived from calls for service while on patrol, including some administrative work (e.g., report writing), more informal face-to-face interactions with citizens (e.g., casual encounters, public relations contacts), and personal breaks. Likewise, some of the factors that impact patrol deployment are best characterized as value judgments made on the basis of the preferences of police executives. These factors include but are not limited to response time goals, visibility objectives, and specific directives to increase community engagement (Fritsch et al., 2009).

Results

The findings of the statistical analyses are presented in this section, which is organized in two parts. In the first part we provide figures and tables, as well as a brief summary, describing and evaluating the current situation in terms of the current police districts and the allocation of resources within those districts. The second part of this section presents a proposal for new police patrol beats and data that predict future calls for service, officers' workload, hotspots, and violent crimes within those proposed beats.

The Current Situation

The City of Lorain is currently divided into five police districts. See Figure 1 (Map of Lorain Police Districts). Patrol personnel are allocated across the districts, although no officer is often assigned to patrol District 5. There were 58,115 calls for service in year 2013 across the five districts. Due to missing data in some of the cases, most of the analyses were conducted with a slightly smaller data set (N = 56,423). When examining the distribution of calls for service across the five districts a few patterns emerge.

There is gross disparity in the workload in terms of calls for service across the five districts. District 3 accounted for 38.8% of all calls for service, whereas District 5 accounted for only 10.9% of the calls for service and District 1 accounted for 12.1% of the calls for service. District 2 accounted for 19.8% of the calls for service, and District 4 accounted for 18.3% of the calls for service. See Table 1 (2013 Calls for Service by Police District).

The sources for the calls for service include 911 calls, desk calls, calls found on patrol, operator's license number, telephone calls, dispatch, and other sources. The highest percentage of five of the seven calls for service sources are accounted for in District 3, including 44.8% of all 911 calls (18.7%% of all calls for service within District 3), 37.8% of calls for service

initiated by telephone calls (52.4% of all calls for service within District 3), and 41.2% of all calls for service found on patrol (28.4% of all calls for service within District 3). District 2 accounted for 89.2% of all desk calls (13.7% of all calls for service within District 2) and 36.7% of all OLN, dispatch, and other sources of calls for service. See Table 2 (Source of 2013 Calls for Service by Police District) and Figure 2 (Sources of 2013 Calls for Service by Police District).

District 3 also accounted for the highest percentage of calls for service within all of the incident type groups except administrative incidents (e.g., internal police operations, warrant service, assistance to other police departments, etc.). For example, District 3 accounted for 44% of all traffic incidents (26.1% of all calls for service within District 3), 40.9% of all miscellaneous incidents (0.3% of all calls for service in District 3), 40.6% of dispute incidents (16.3% of all calls for service within District 3), 39.6% of all nuisance incidents (9% of all calls for service within District 3), 38.7% of all health/welfare incidents (4.5% of all calls for service within District 3), 37.9% of all alarms/thefts incidents (14.2% of all calls for service within District 3), 35.8% of all suspicion incidents (10.1% of all calls for service within District 3), 34.8% of all service incidents (9.5% of all calls for service within District 3), and 32.9% of all vice incidents (0.7% of all calls for service within District 3). See Table 3 (Incident Type Groups for 2013 Calls for Service by Police District) and Figure 3 (Incident Type Groups and 2013 Calls for Service by Police District).

Disparity exists in terms of the distribution of violent crimes reported to the police across the five police districts. The predatory incident type group (N = 1,744) includes the major violent crime categories (including murder, rape, robbery, and felonious assault). Data indicate that District 3 accounted for 40.5% (n = 706) of all predatory/violent crime calls for service

(3.2% of all calls for service in District 3), followed by 20.5% (*n* = 357) in District 2 (3.2% of all calls for service in District 2), 18% (*n* = 314) in District 4 (3% of all calls for service in District 4), 11.1% (*n* = 193) in District 1 (2.8% of all calls for service in District 1), and 10% (*n* = 174) in District 5 (2.8% of all calls for service in District 5).

The districts were also examined in terms of calls for service by shift and calls for service by priority. Citywide, the day shift handled 51.78% of all calls for service, and the night shift handled 48.22% of all calls for service. Within the districts, there is disparity between the shifts in terms of the percentage of calls for service handled. In District 1, for example, 58.1% of calls for service are accounted for by the day shift, whereas in District 1 and District 3 only 48.6% of the calls for service are handled by the day shift. Conversely stated, 51.4% of the calls for service in both District 1 and District 3 are handled by the night shift. See Table 4 (Shifts & Priority of 2013 Calls for Service by Police Districts). In terms of calls for service priority, citywide 57.7% of all calls for service were high priority calls, and high priority calls for service accounted for at least 55% of all calls for service in each of the five districts. In District 5, 62.5% of all calls for service were high priority calls.

The Proposed Solution

The five police districts were examined to determine if the patrol districts could be reorganized based on calls for service data. The districts were analyzed using the CHAID algorithm to group the existing 93 geographic sections into statistically similar groups. CHAID was selected due to its ability to create multiple splits in the data; these splits created numerous subgroups that were statistically similar in relation to priority of calls for service. The CHAID algorithm created a tree with 12 distinct groups (referred to as "nodes" on the tree). See Figure 4 (Geographic Section Groupings by Incident Priority for 2013 Calls for Service). The groups of

section tracts were added to a series of city maps to visualize statistically similar groupings within geographic proximity. Geospatial patterns readily emerged and the police districts were reconfigured into four new beats. See Figure 5 (Map of New/Proposed Lorain Police Beats) and Appendix B (Proposed Patrol Beats – Section Tracts).

The same calls for service data from the year 2013 utilized above in the first part of this section was also analyzed to predict future calls for service, officers' workload, hotspots, and violent crimes in the four new beats. Calls for service workload are more equally distributed across each of the new beats, with each beat accounting for approximately one-fourth of all calls for service: New Beat 1 accounts for 25.9% of all calls for service, New Beat 2 accounts for 26.8% of all calls for service, New Beat 3 accounts for 24.9% of all calls for service, and New Beat 4 accounts for 22.4% of all calls for service. See Table 5 (2013 Calls for Service by New Police Beat).

The sources of calls for service are more evenly distributed in the new beats. None of the source types exceed 30% in any new beat, with the sole exception of desk calls where 90.5% occur in New Beat 2 (where the police station is located). Desk calls account for 10.3% of all calls for service in New Beat 2. New Beat 1 accounts for 30.2% of all 911 calls (18.9% of all calls for service within New Beat 1). 911 calls for service are evenly distributed across the new beats, with between 20% and 30% of all 911 calls occurring in each new beat. The highest percentage of calls for service with the source *found on patrol* are 30% in New Beat 1 (31.1% of all calls for service within New Beat 1) and 29.4% in New Beat 3 (31.7% of all calls for service within New Beat 3), whereas the lowest percentage of calls for service with the source found on patrol are 22.3% in New Beat 2 (22.2% of all calls for service within New Beat 2) and 18.3% in New Beat 4 (21.9% of all calls for service within New Beat 4). See Table 6 (Source of 2013

Calls for Service by New Police Beat) and Figure 6 (Sources of 2013 Calls for Service by New Police Beat).

The calls for service are now distributed more evenly by incident type groups across the new beats. Only three of the incident type groups have a distribution that exceeds 30% in a particular new beat. Service incident and administrative incident calls for service are primarily concentrated in New Beat 2 (accounting for 35.1% of all service-related calls for service citywide and 13.5% of all calls for service within New Beat 2, as well as 44.1% of all administrative calls for service citywide and 10.9% of all calls for service within New Beat 2) and the miscellaneous calls for service are most likely to be in New Beat 3 (accounting for 37.5% of all miscellaneous calls for service citywide and 0.5% of all calls for service within New Beat 3). The other incident type groups (i.e., predatory, disputes, medical assistance, alarms/thefts, traffic, nuisance, suspicions, health/welfare, and vice) have citywide distribution ranges between 19% and 29% across the four beats. See Table 7 (Incident Type Groups for 2013 Calls for Service by New Police Beat) and Figure 7 (Incident Type Groups and 2013 Calls for Service by New Police Beat).

The new beats reduce the workload disparity across the city in terms of calls for service involving predatory crimes (including homicide, rape, robbery, and felonious assault). These violent crime calls for service are now evenly distributed citywide: 29.2% (n = 509) in New Beat 1 (3.5% of all calls for service in New Beat 1), 26.9% (n = 469) in New Beat 2 (3.1% of all calls for service in New Beat 2), 22.9% (n = 400) in New Beat 3 (2.9% of all calls for service in New Beat 3), and 21% (n = 366) in New Beat 4 (2.9% of all calls for service in New Beat 4).

The new beats were also analyzed in terms of calls for service by shift and calls for service by priority. As with the current police districts, we predict that when adopting the new

police beats the day shift will account for 51.78% of all calls for service, and the night shift will account for 48.22% of all calls for service. In New Beat 1, 46.8% (*n* = 6,848) of the calls for service are accounted for by the day shift, and 53.2% (*n* = 7,771) of the calls for service are accounted for by the night shift. In New Beat 2 (where the police station is located), 55.9% (*n* = 8,455) of the calls for service are handled by the day shift, and 44.1% (*n* = 6,677) are accounted for by the night shift. The distribution of calls for service workload between the two shifts is equally distributed in New Beat 3 and New Beat 4. In New Beat 3, 50.7% (n = 7.117) of the calls for service are accounted for by the day shift, and 49.3% (*n* = 6,917) are accounted for by the night shift. Similarly, in New Beat 4 52% (*n* = 6,577) of the calls for service are accounted for by the day shift, and 48% (*n* = 6,061) are accounted for by the night shift. See Table 8 (Shifts & Priority of 2013 Calls for Service by New Police Beat).

Allocation of resources and staffing for the shifts and new beats should include consideration of the workloads in terms of calls for service sources and priority. Calls for service on the night shift are most likely to come from 911/dispatch or found on patrol: 57.4% of calls for service where the source of the call is 911 or dispatch occur on the night shift, and 56% of all calls for service where the source is found on patrol occur on the night shift. Calls for service on the day shift are most likely to originate from telephone, desk, OLN, and other sources. See Figure 8 (Sources of 2013 Calls for Service by Shift). Priority of calls for service also very by source. Sources of high priority calls for service are more likely to be from 911 or other unclassified sources (83.5% are high priority), as well as telephone or desk sources (65.7% are high priority). See Figure 9 (Priority of 2013 Calls for Service by Source).

The data are also presented in trees that predict workload of each new beat based on combined information from the incident type groups, priority of calls for service, and shifts. See

Figure 10 (Predicted Workload in New Beat 1 based on 2013 Calls for Service); Figure 11 (Predicted Workload in New Beat 2 based on 2013 Calls for Service); Figure 12 (Predicted Workload in New Beat 3 based on 2013 Calls for Service); and Figure 13 (Predicated Workload in New Beat 4 based on 2013 Calls for Service). Figures 10-13 are included to assist police executives, administrators, and shift supervisors for consideration in allocation and deployment of resources in conjunction with then-current crime analysis data. In interpreting each tree, the top level is the most influential variable in predicting sources of calls for service within the new beat. The tree then splits into individual samples of calls for service; these groups are unique and offer trends within the various calls for service incident type groups, priority, and shift. The groupings within the tree allows for identification of trends occurring for each individual new beat. The trends will explain what types of crimes are linked to particular sources for the calls for service. Additionally, priority of calls for service and shift trends are also presented in each of the trees based on both the crime type (that is, incident type groups) and sources for calls for service for the individual new beats.

For comparison purposes, calls for service workload data is also presented in CHAID trees analyzing each of the five current police districts. See Figure 14 (2013 Calls for Service Workload in District 1); Figure 15 (2013 Calls for Service Workload in District 2); Figure 16 (2013 Calls for Service Workload in District 3); Figure 17 (2013 Calls for Service Workload in District 4); and Figure 18 (2013 Calls for Service Workload in District 5).

Recommendations

The Lorain Police Department requested research assistance from the Ohio Consortium of Crime Science with the purpose of revising the current police districts and the allocation of resources within those districts prior to upgrade and implementation of a new CAD system that is scheduled to go online in early 2015. The goal of the research project was to evaluate and revise the current police districts and the allocation of resources within those districts. The first objective in support of the project goal was to assess calls for service, officers' workload, hotspots, and violent crimes within the existing police districts. The second objective in support of the project goal was to develop new police districts based on the findings of the first objective and to predict future calls for service, officers' workload, hotspots, and violent crimes within those proposed districts. The section that follows identifies and describes the substantive recommendations of the research team based on our study.

Recommendation 1: Implement the proposed new police beats

The new beats were created based on predictive analytic groupings of the 93 current geographic section tracts (which are the smallest geospatial units within the larger current police districts in Lorain). Current District 3, which acts as a hot spot concentration of calls for service, will be redistributed among the four new beats to provide patrol allocation parity citywide. The proposal also reconfigures all of District 5 with portions of District 3 in a new beat that will maintain calls for service levels consistent with each of the other patrol beats in the city.

Recommendation 2: Use section tracts within the new beats as crime analysis targets

The conclusions drawn from the earliest studies on patrol effectiveness were largely negative and resulting in the popular conception that patrol and rapid response to calls for service do not necessarily reduce crime rates or improve the chances of criminal apprehension (Antunes

& Scott, 1981; Kelling, Pate, Dieckman, & Brown, 1974; Larson, 1975; Skolnick & Bayley, 1986). Scholars and police executives, however, began to emphasize during the 1980s the nonrandom distribution of crime and need to target patrol resources within smaller geographical places or hot spots (Sherman et al., 1989). This line of research has clearly demonstrated how police organizations can increase patrol effectiveness through proactive and focused patrol strategies (see, e.g., Cordner, 1981; Koper, 1995; Mastrofski et al., 2010; Sherman & Weisburd, 1995). An emerging line of hot spots research suggests that an effective crime reduction strategy would be to increase the geographic areas of hot spots to examine street segments and intersections, as well as blocks within neighborhoods (Braga & Clarke, 2014; Braga & Schnell, 2013; Braga & Weisburd, 2014).

The Lorain Police Department's current crime analysis program should include the 93 section tracts mapped within the city to expand the hot spots analyses of geographic clusters at the block or neighborhood level. This will allow for increased police presence and/or directed patrols designed to reduce crime and increase deterrent effects within the new beats that were designed through statistical and data mining modeling algorithms to maximize patterns within and across section tracts. Emerging technologies and the availability of big data have the potential of including variables of interest not currently included in the department's crime analysis initiative (see, e.g., Sampson, 2013).

Recommendation 3: Patrol units should be specifically assigned to each of the new beats

One of the problems identified within the context of the current patrol districts was the fact that on some occasions no officers typically perform routine patrol within District 5, which encompasses the largest geographic area of the city. This situation persists despite the fact that the Lorain Police Department received over 6,000 calls for service within District 5 in 2013. The

absence of routine patrols in District 5 presumably increased response times and reduced potential deterrence and police visibility. The reconfigured map incorporates the current District 5 into the new Beat 4. The line of research on patrol effectiveness has covered the issue of whether mere police presence within a particular geographic area significantly influences levels of crime and citizen attitudes. The earliest studies suggested that variations in levels of patrol had no significant impact on levels of crime, response time, and citizen attitudes (Kelling et al., 1974). Scholars continue to debate the issue, however, based largely on certain methodological limitations, particularly the reality that research designs had failed to produce the expected variations in patrol across beats (see, e.g., Kessler, 1985; Larson, 1975). Since the 1990s and the advent of more proactive patrol strategies, scholars and police executives have focused much less on the issue of police presence within the context of routine patrols and more on the performance of specific police activities (e.g., arrests, field interviews, vehicle stops) performed within the context of directed or targeted patrols.

Still, the issue of police presence on patrol retains both an intuitive appeal and support among citizens. As Langworthy and Travis (2003) point out, it is generally presumed that increasing from a situation of no routine patrol to one of some routine patrol has an effect on rates of crime and citizen satisfaction, or more bluntly, “a little police patrol goes a long way” (p. 291). Routine patrol continues to address some of the basic goals of police organizations, including patrol responsiveness and visibility. For their part, citizens invariably believe that it is important for police to address all sorts of problems while on patrol whether they are related specifically to crime fighting or not (Fritsch et al., 2009). Some sort of police presence is necessary to accomplish these objectives as well as to ultimately engage in more directed and

purposive law enforcement. The Lorain Police Department needs to demonstrate presence within each of the proposed new beats to accomplish these objectives.

Recommendation 4: Fully integrate patrol operations within the new CAD system

It is estimated that the Lorain Police Department only utilizes approximately 20% of the features and functionality of current CAD system. The planned implementation of a new CAD system in early 2015 presents the department with significant opportunities to enhance the dispatch functions as well as big data collection opportunities for crime analysis and data mining opportunities. Inherent with technological advances in any organization is resistance to change. The research team encourages the department to embrace the new CAD and to concentrate on training and retraining of all effected personnel, including dispatchers, line personnel, supervisors, administrators and executives within the Lorain Police Department.

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Table 1. 2013 Calls for Service by Police District (*N* = 56,423)

	n	%
District 1	6,837	12.10%
District 2	11,189	19.80%
District 3	21,902	38.80%
District 4	10,348	18.30%
District 5	6,147	10.90%

Table 2. Source of 2013 Calls for Service by Police District (*N* = 56,423)

	n	%
District 1		
911	1,198	17.50%
DSK	34	0.50%
FOP	1,508	22.10%
OLN	0	0.00%
TEL	4,082	59.70%
DIS	15	0.20%
OTH	0	0.00%
District 2		
911	1,115	10.00%
DSK	1,535	13.70%
FOP	2,658	23.80%
OLN	0	0.00%
TEL	5,826	52.00%
DIS	55	0.50%
OTH	0	0.00%
District 3		
911	4,092	18.70%
DSK	93	0.40%
FOP	6,231	28.40%
OLN	0	0.00%
TEL	11,465	52.40%
DIS	21	0.10%
OTH	0	0.00%
District 4		
911	1,771	17.20%
DSK	23	0.20%
FOP	3,284	31.70%
OLN	1	0.00%
TEL	5,233	50.60%
DIS	35	0.30%
OTH	1	0.00%
District 5		
911	968	15.80%
DSK	36	0.60%
FOP	1,427	23.20%
OLN	1	0.00%
TEL	3,694	60.10%
DIS	21	0.30%
OTH	0	0.00%

Table 3. Incident Type Groups for 2013 Calls for Service by Police District (N = 56,213)

	n	%
District 1		
Predatory (100 series)	193	2.80%
Disputes (200 series)	1,130	16.60%
Medical Assistance (300 series)	115	1.70%
Alarms/Thefts (400 series)	906	13.30%
Traffic (500 series)	1,517	22.30%
Nuisance (600 series)	699	10.30%
Suspicions (700 series)	759	11.20%
Health/Welfare (800 series)	360	5.20%
Vice (900 series)	30	0.40%
Service (1000 series)	692	10.20%
Administrative (1100 series)	381	5.60%
Miscellaneous (1200-3300 series)	25	0.40%
District 2		
Predatory (100 series)	357	3.20%
Disputes (200 series)	1,615	14.50%
Medical Assistance (300 series)	177	1.60%
Alarms/Thefts (400 series)	1,575	14.10%
Traffic (500 series)	1,508	13.50%
Nuisance (600 series)	919	8.20%
Suspicions (700 series)	1,477	13.20%
Health/Welfare (800 series)	402	3.60%
Vice (900 series)	122	1.10%
Service (1000 series)	1,622	14.50%
Administrative (1100 series)	1,380	12.40%
Miscellaneous (1200-3300 series)	11	0.10%
District 3		
Predatory (100 series)	706	3.20%
Disputes (200 series)	3,550	16.30%
Medical Assistance (300 series)	306	1.40%
Alarms/Thefts (400 series)	3,103	14.20%
Traffic (500 series)	5,692	26.10%
Nuisance (600 series)	1,963	9.00%
Suspicions (700 series)	2,178	10.10%
Health/Welfare (800 series)	967	4.50%
Vice (900 series)	142	0.70%
Service (1000 series)	2,066	9.50%
Administrative (1100 series)	1,034	4.70%
Miscellaneous (1200-3300 series)	72	0.30%
District 4		
Predatory (100 series)	314	3.10%
Disputes (200 series)	1,607	15.60%
Medical Assistance (300 series)	159	1.50%
Alarms/Thefts (400 series)	1,407	13.60%
Traffic (500 series)	2,706	26.20%
Nuisance (600 series)	997	9.70%
Suspicions (700 series)	1,104	10.70%
Health/Welfare (800 series)	416	4.00%
Vice (900 series)	92	0.90%
Service (1000 series)	858	8.30%
Administrative (1100 series)	603	5.80%
Miscellaneous (1200-3300 series)	64	0.60%
District 5		
Predatory (100 series)	174	2.90%
Disputes (200 series)	825	13.40%
Medical Assistance (300 series)	103	1.70%
Alarms/Thefts (400 series)	1,150	18.70%
Traffic (500 series)	1,519	24.80%
Nuisance (600 series)	376	6.10%
Suspicions (700 series)	560	9.10%
Health/Welfare (800 series)	358	5.80%
Vice (900 series)	45	0.70%
Service (1000 series)	703	11.50%
Administrative (1100 series)	318	5.20%
Miscellaneous (1200-3300 series)	4	0.10%

Table 4. Shifts & Priority of 2013 Calls for Service by Police District (N = 56,423)

	n	%
District 1		
Day Shift	3,321	48.60%
Night Shift	3,516	51.40%
Low Priority	2,694	43.40%
High Priority	3,873	56.60%
District 2		
Day Shift	6,501	58.10%
Night Shift	4,688	41.90%
Low Priority	4,876	43.60%
High Priority	6,313	56.40%
District 3		
Day Shift	10,645	48.60%
Night Shift	11,257	51.40%
Low Priority	9,176	41.90%
High Priority	12,726	58.10%
District 4		
Day Shift	5,321	51.40%
Night Shift	5,027	48.60%
Low Priority	4,652	45.00%
High Priority	5,696	55.00%
District 5		
Day Shift	3,209	52.20%
Night Shift	2,938	47.80%
Low Priority	2,304	37.50%
High Priority	3,843	62.50%

Table 5. 2013 Calls for Service by New Police Beat (*N* = 56,423)

	n	%
New Beat 1	14,619	25.90%
New Beat 2	15,132	26.80%
New Beat 3	14,034	24.90%
New Beat 4	12,638	22.40%

Table 6. 2013 Source of Calls for Service by New Police Beat (*N* = 56,423)

	n	%
New Beat 1		
911	2,765	18.90%
DSK	50	0.30%
FOP	4,538	31.10%
OLN	0	0.00%
TEL	7,223	49.40%
DIS	43	0.30%
OTH	0	0.00%
New Beat 2		
911	1,852	12.20%
DSK	1,557	10.30%
FOP	3,361	22.20%
OLN	0	0.00%
TEL	8,324	55.00%
DIS	38	0.30%
OTH	0	0.00%
New Beat 3		
911	2,363	16.80%
DSK	52	0.40%
FOP	4,450	31.70%
OLN	1	0.00%
TEL	7,131	50.80%
DIS	36	0.30%
OTH	1	0.00%
New Beat 4		
911	2,164	17.10%
DSK	62	0.50%
FOP	2,759	21.90%
OLN	1	0.00%
TEL	7,622	60.30%
DIS	30	0.20%
OTH	0	0.00%

Table 7. Incident Type Groups for 2013 Calls for Service by New Police Beat (N = 56,213)

	n	%
New Beat 1		
Predatory (100 series)	509	3.50%
Disputes (200 series)	2,486	17.00%
Medical Assistance (300 series)	186	1.30%
Alarms/Thefts (400 series)	1,780	12.20%
Traffic (500 series)	3,671	25.20%
Nuisance (600 series)	1,475	10.10%
Suspicions (700 series)	1,789	12.30%
Health/Welfare (800 series)	636	4.40%
Vice (900 series)	101	0.70%
Service (1000 series)	1,231	8.40%
Administrative (1100 series)	645	4.40%
Miscellaneous (1200-3300 series)	69	0.50%
New Beat 2		
Predatory (100 series)	469	3.10%
Disputes (200 series)	2,279	15.10%
Medical Assistance (300 series)	255	1.70%
Alarms/Thefts (400 series)	2,167	14.40%
Traffic (500 series)	2,465	16.30%
Nuisance (600 series)	1,268	8.40%
Suspicions (700 series)	1,677	11.10%
Health/Welfare (800 series)	621	4.10%
Vice (900 series)	131	0.90%
Service (1000 series)	2,085	13.80%
Administrative (1100 series)	1,639	10.90%
Miscellaneous (1200-3300 series)	34	0.20%
New Beat 3		
Predatory (100 series)	400	2.80%
Disputes (200 series)	2,223	15.90%
Medical Assistance (300 series)	214	1.50%
Alarms/Thefts (400 series)	1,830	13.10%
Traffic (500 series)	3,769	26.90%
Nuisance (600 series)	1,294	9.20%
Suspicions (700 series)	1,426	10.20%
Health/Welfare (800 series)	539	3.90%
Vice (900 series)	108	0.80%
Service (1000 series)	1,346	9.60%
Administrative (1100 series)	784	5.60%
Miscellaneous (1200-3300 series)	66	0.50%
New Beat 4		
Predatory (100 series)	366	2.90%
Disputes (200 series)	1,739	13.90%
Medical Assistance (300 series)	205	1.60%
Alarms/Thefts (400 series)	2,364	18.80%
Traffic (500 series)	3,037	24.20%
Nuisance (600 series)	917	7.30%
Suspicions (700 series)	1,186	9.50%
Health/Welfare (800 series)	707	5.60%
Vice (900 series)	91	0.70%
Service (1000 series)	1,279	10.20%
Administrative (1100 series)	648	5.20%
Miscellaneous (1200-3300 series)	7	0.10%

Table 8. Shifts & Priority of 2013 Calls for Service by New Police Beat (*N* = 56,423)

	n	%
New Beat 1		
Day Shift	6,848	46.80%
Night Shift	7,771	53.20%
Low Priority	6,596	45.10%
High Priority	8,023	54.90%
New Beat 2		
Day Shift	8,455	55.90%
Night Shift	6,677	44.10%
Low Priority	6,430	42.50%
High Priority	8,702	57.50%
New Beat 3		
Day Shift	7,117	50.70%
Night Shift	6,917	49.30%
Low Priority	6,249	44.50%
High Priority	7,785	55.50%
New Beat 4		
Day Shift	6,577	52.00%
Night Shift	6,061	48.00%
Low Priority	4,697	37.20%
High Priority	7,941	62.80%

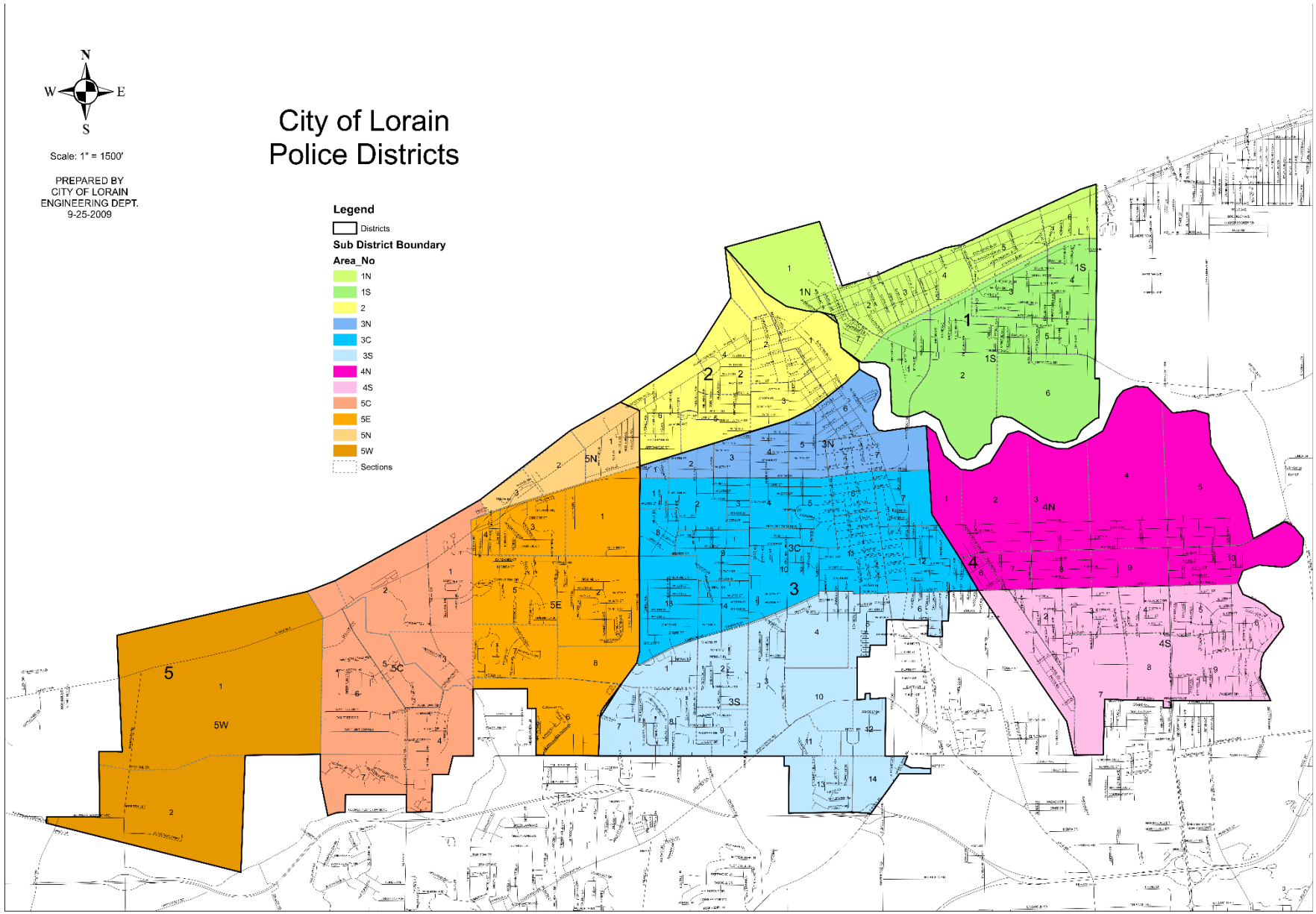

Figure 1. Map of Lorain Police Districts

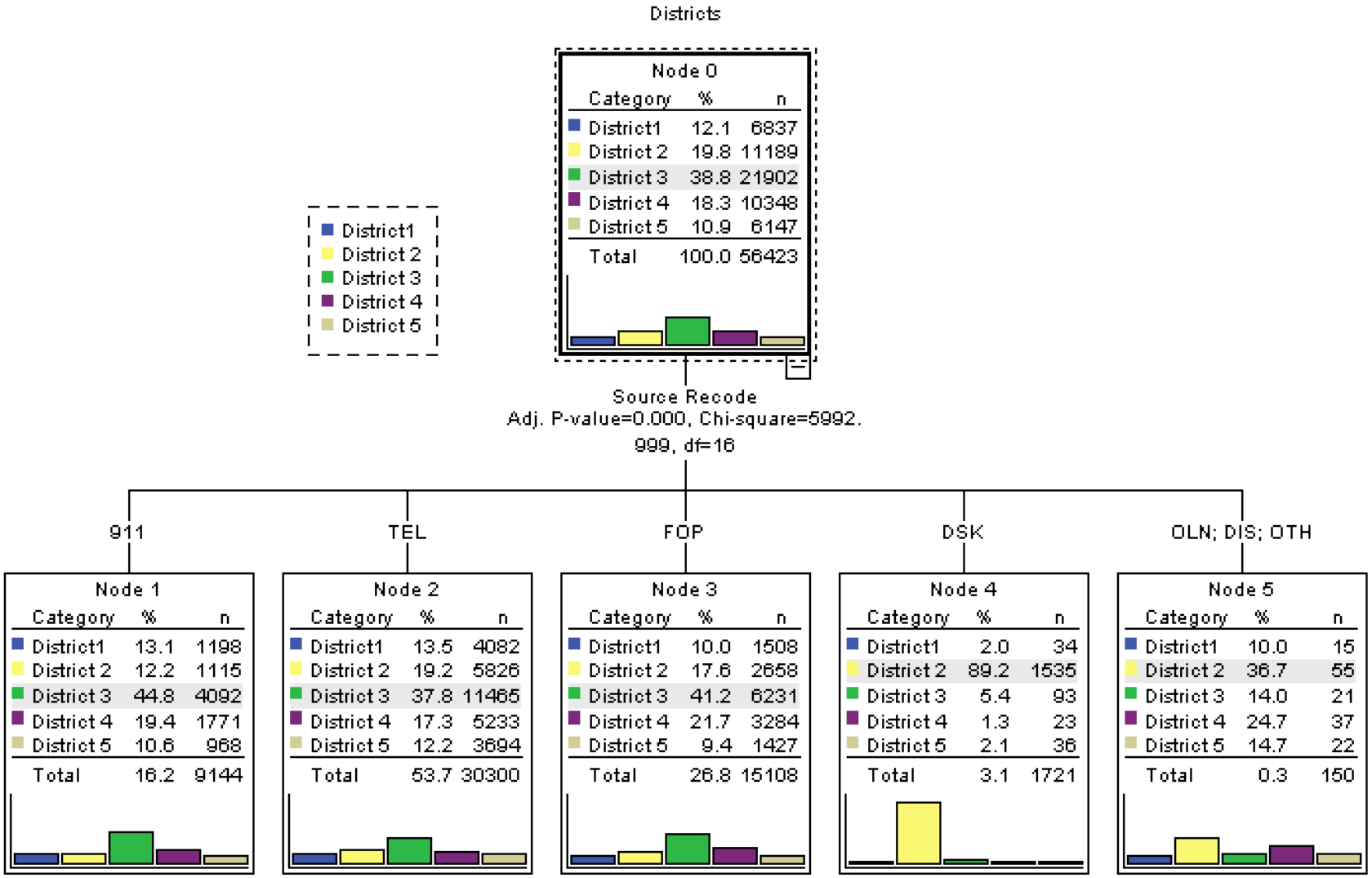

Figure 2. Sources of 2013 Calls for Service by Police District

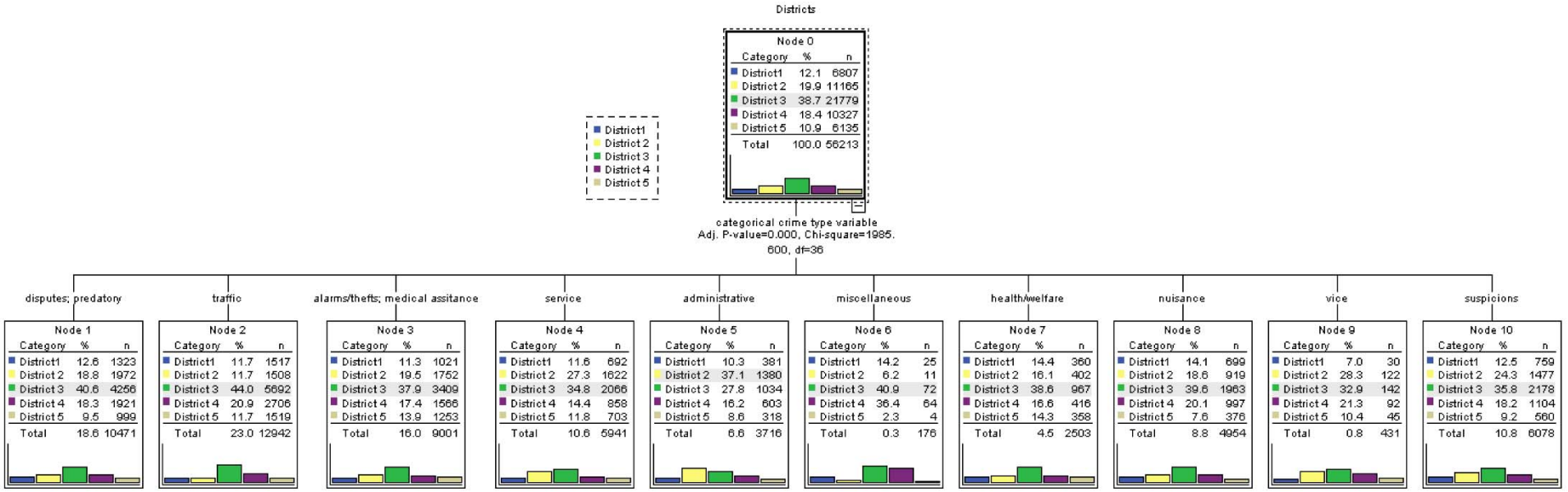

Figure 3. Incident Type Groups and 2013 Calls for Service by Police District

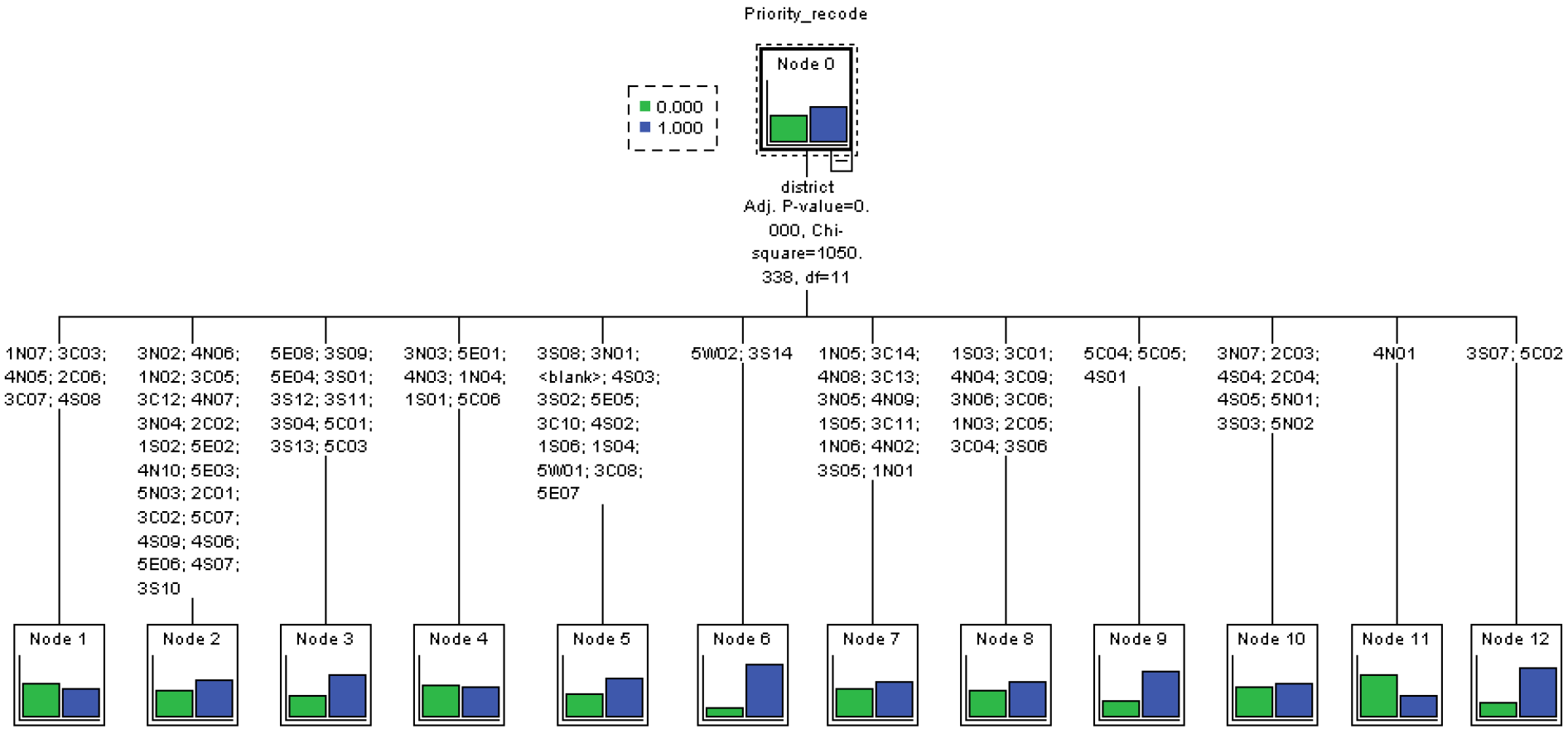

Figure 4. Geographic Section Groupings by Incident Priority for 2013 Calls for Service

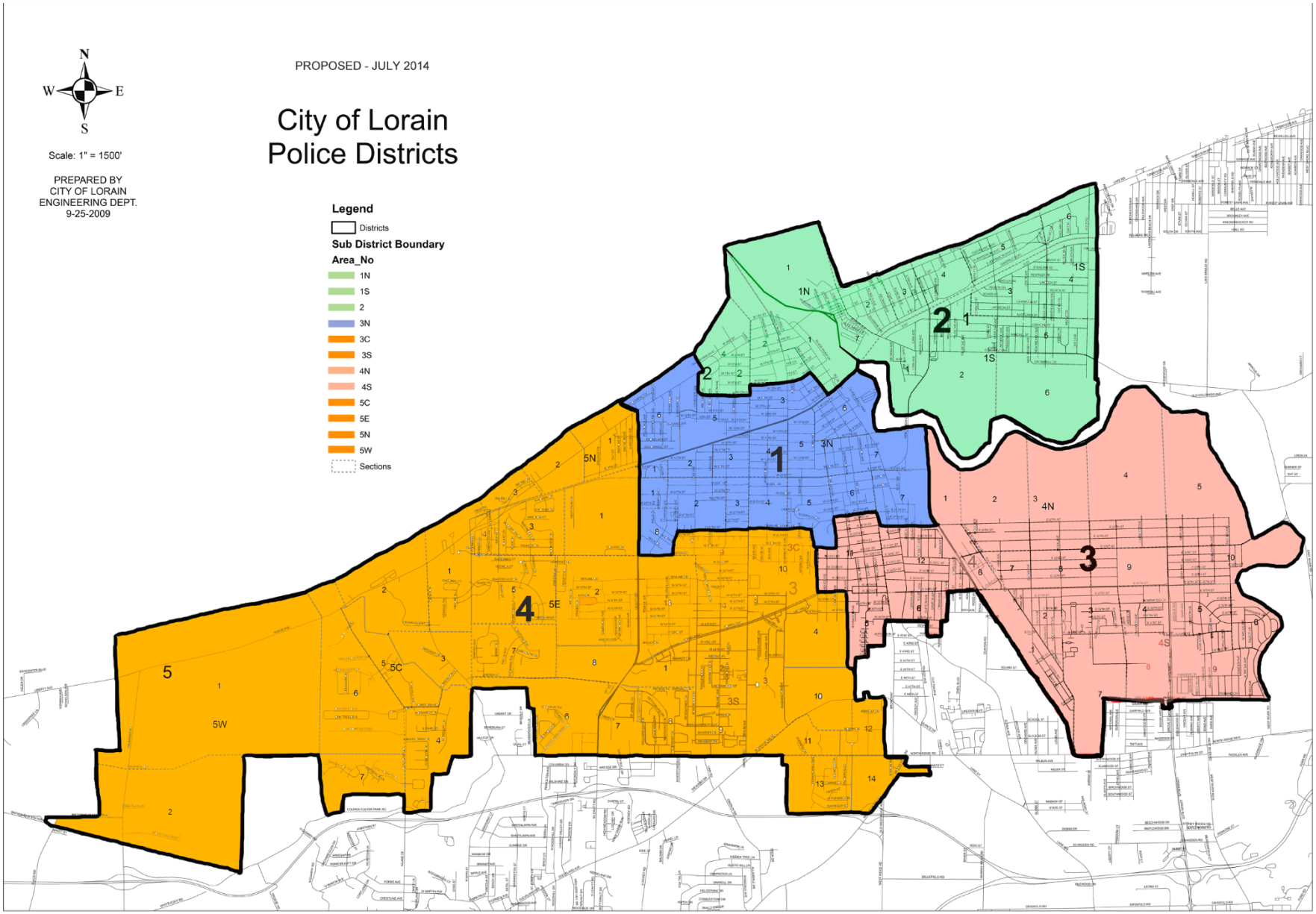

Figure 5. Map of New/Proposed Lorain Police Beats

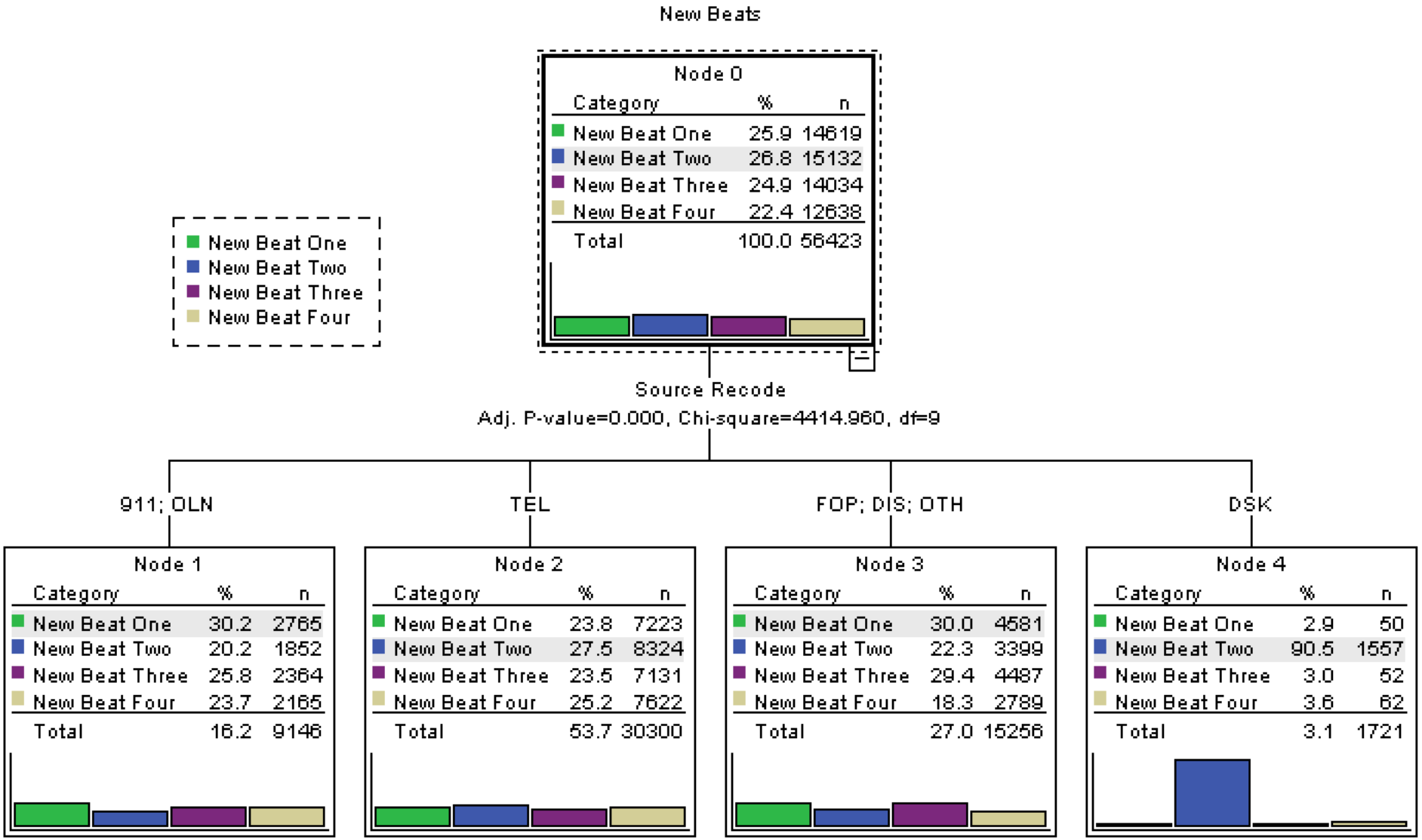

Figure 6. Sources of 2013 Calls for Service by New Police Beat

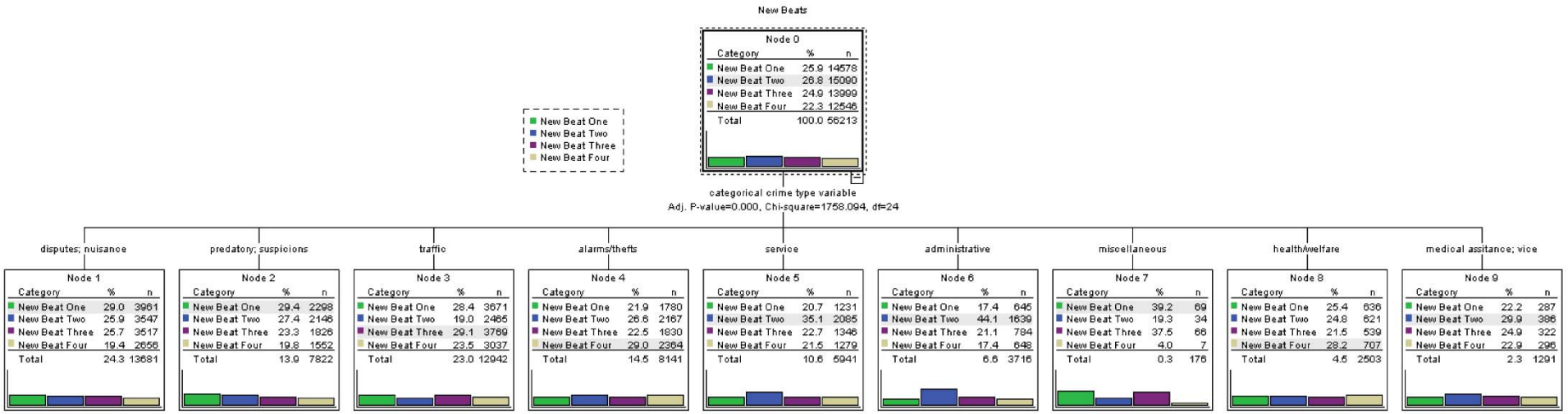

Figure 7. Incident Type Groups and 2013 Calls for Service by New Police Beat

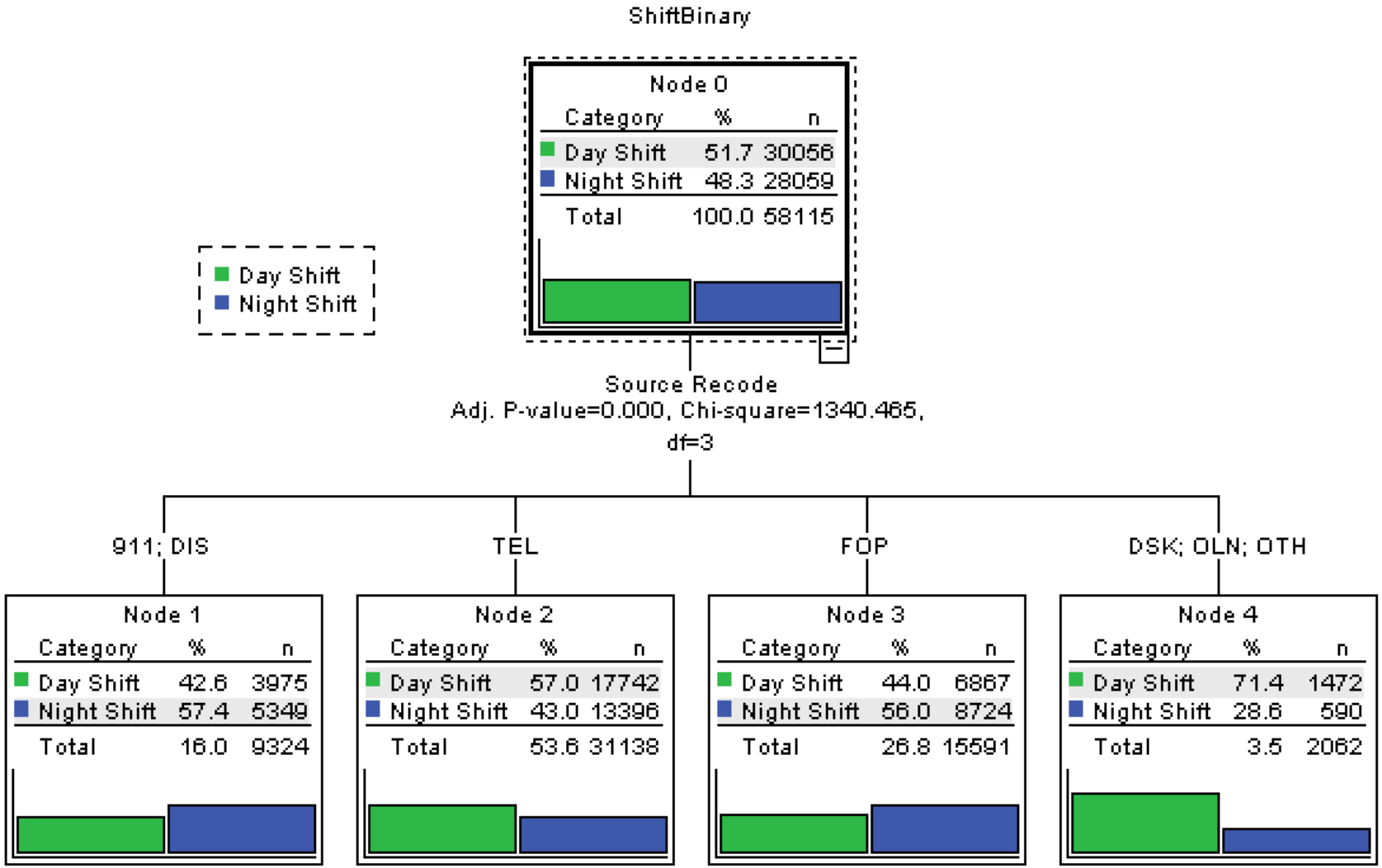

Figure 8. Sources of 2013 Calls for Service by Shift

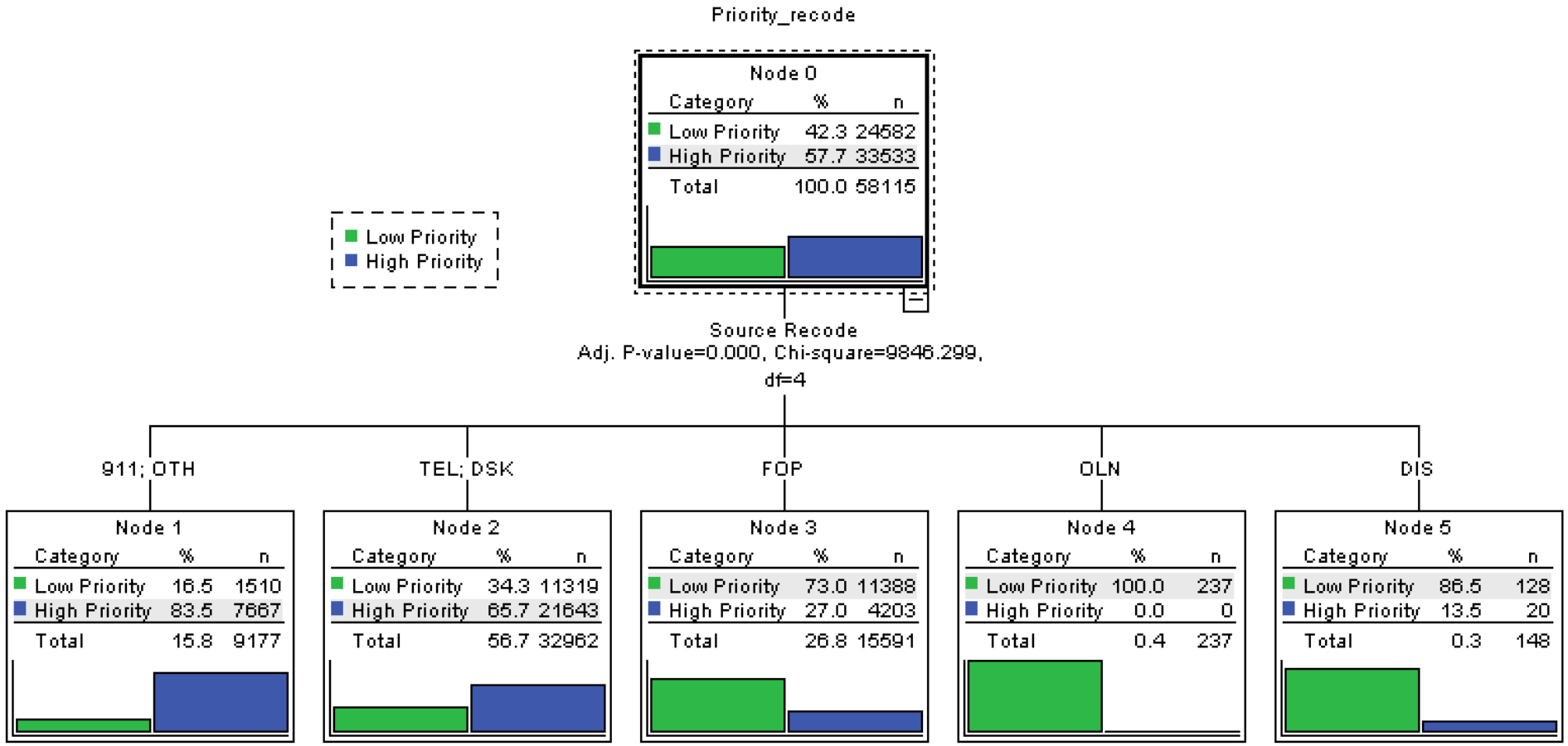

Figure 9. Priority of 2013 Calls for Service by Source

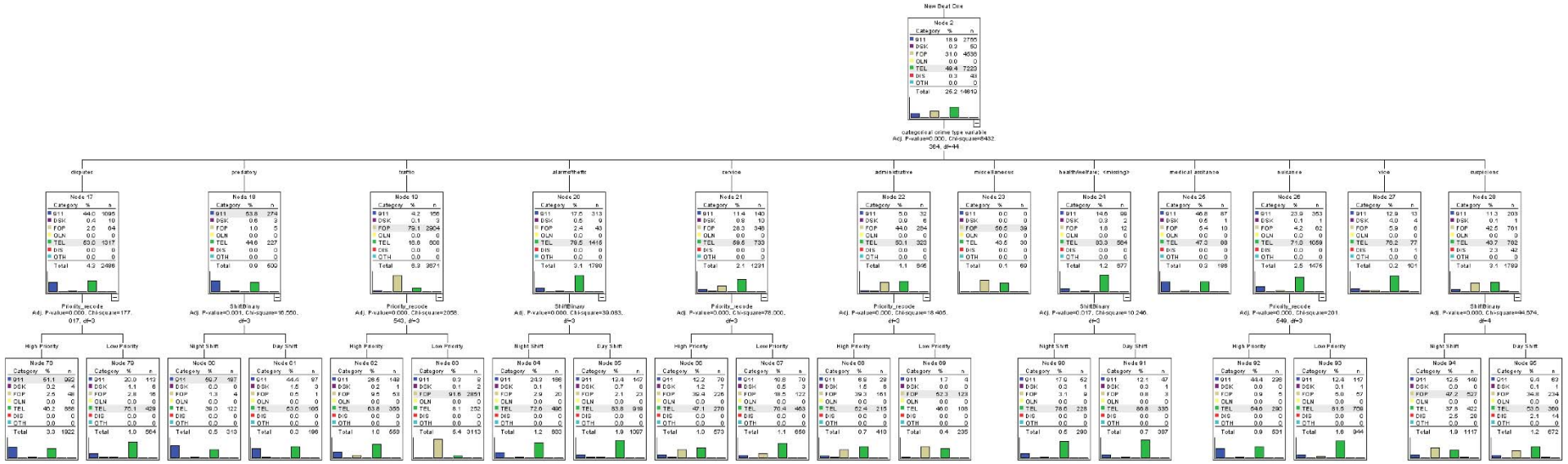

Figure 10. Predicted Workload in New Beat 1 based on 2013 Calls for Service

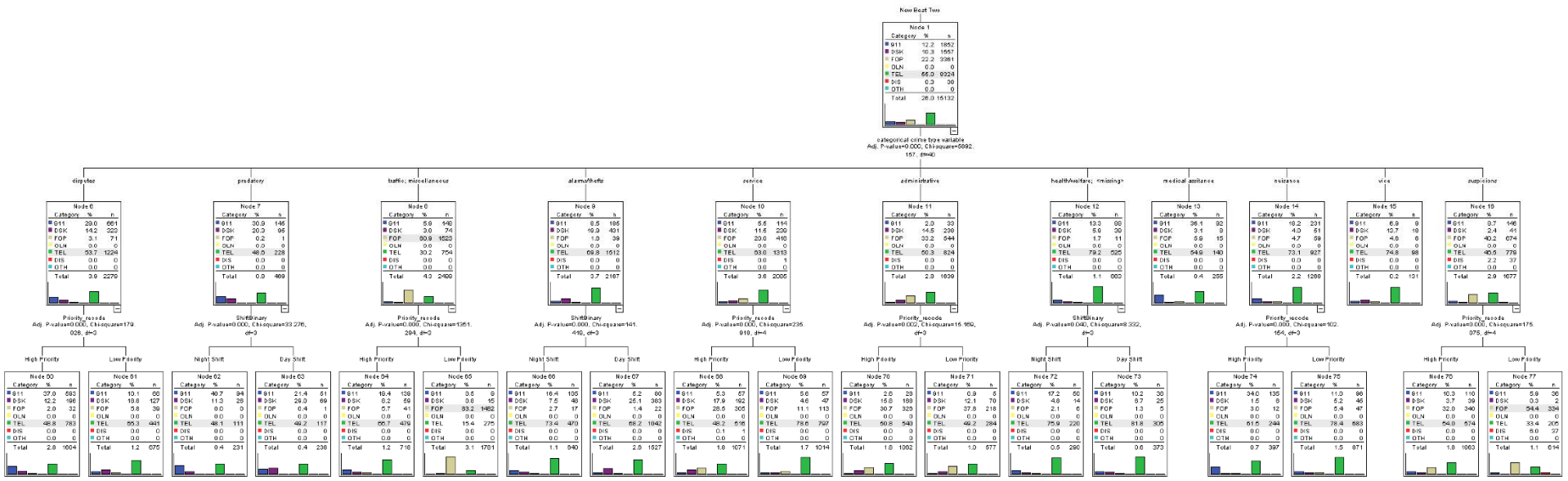

Figure 11. Predicted Workload in New Beat 2 based on 2013 Calls for Service

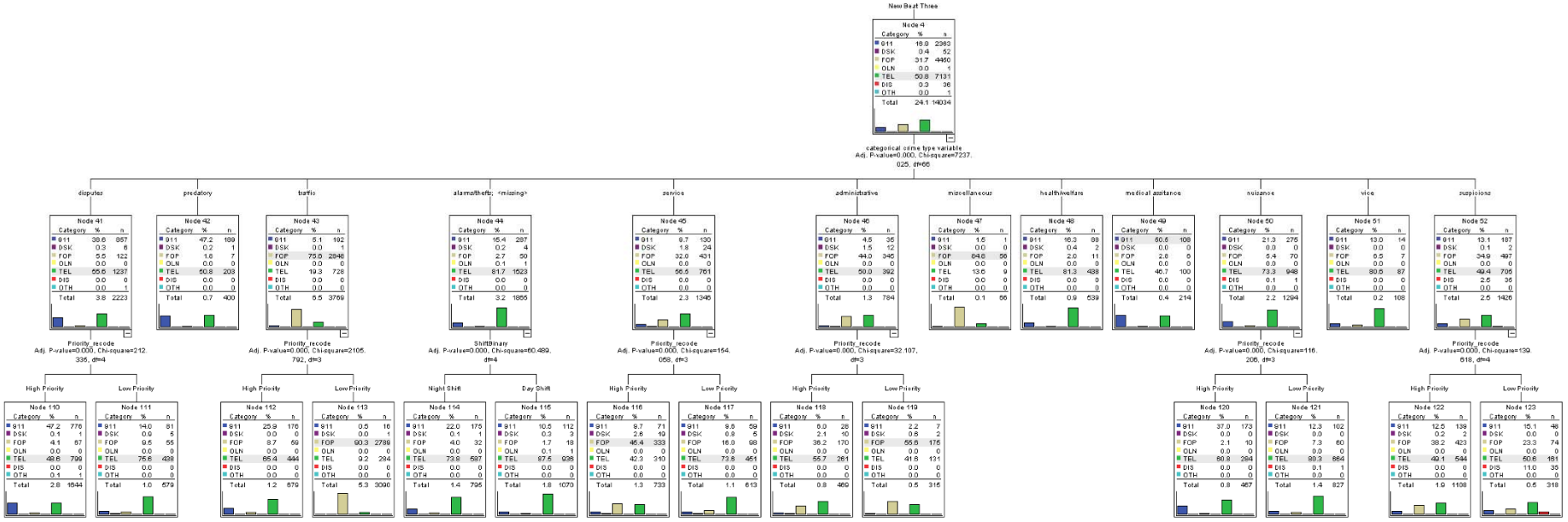

Figure 12. Predicted Workload in New Beat 3 based on 2013 Calls for Service

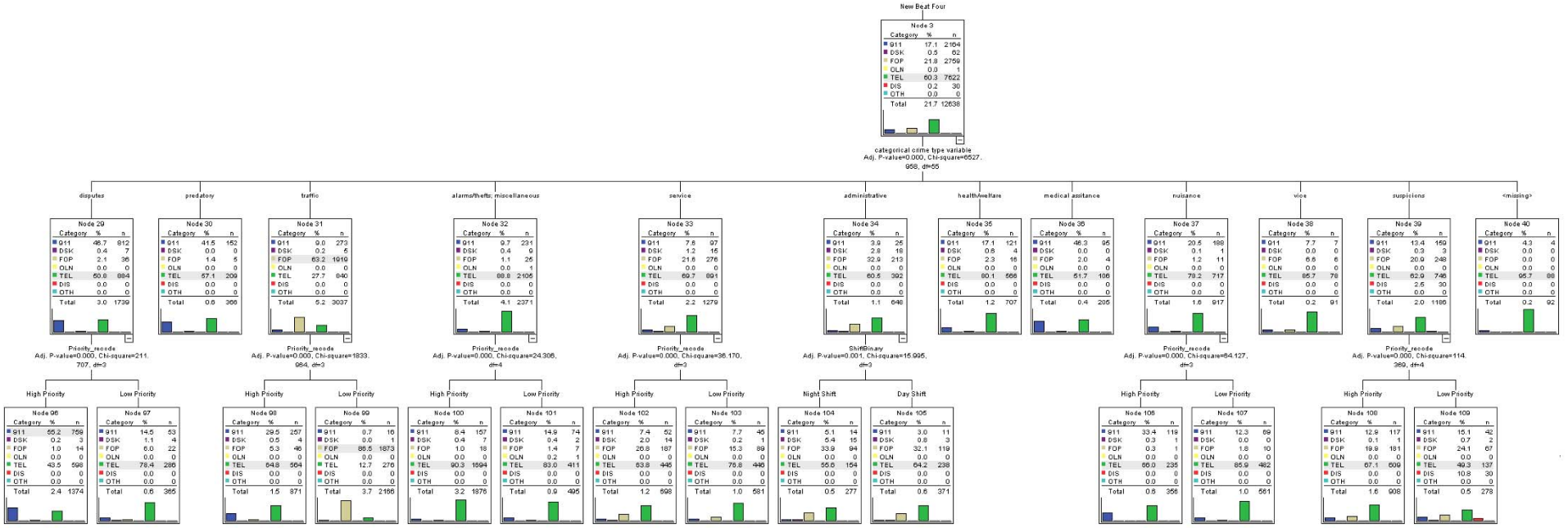

Figure 13. Predicted Workload in New Beat 4 based on 2013 Calls for Service

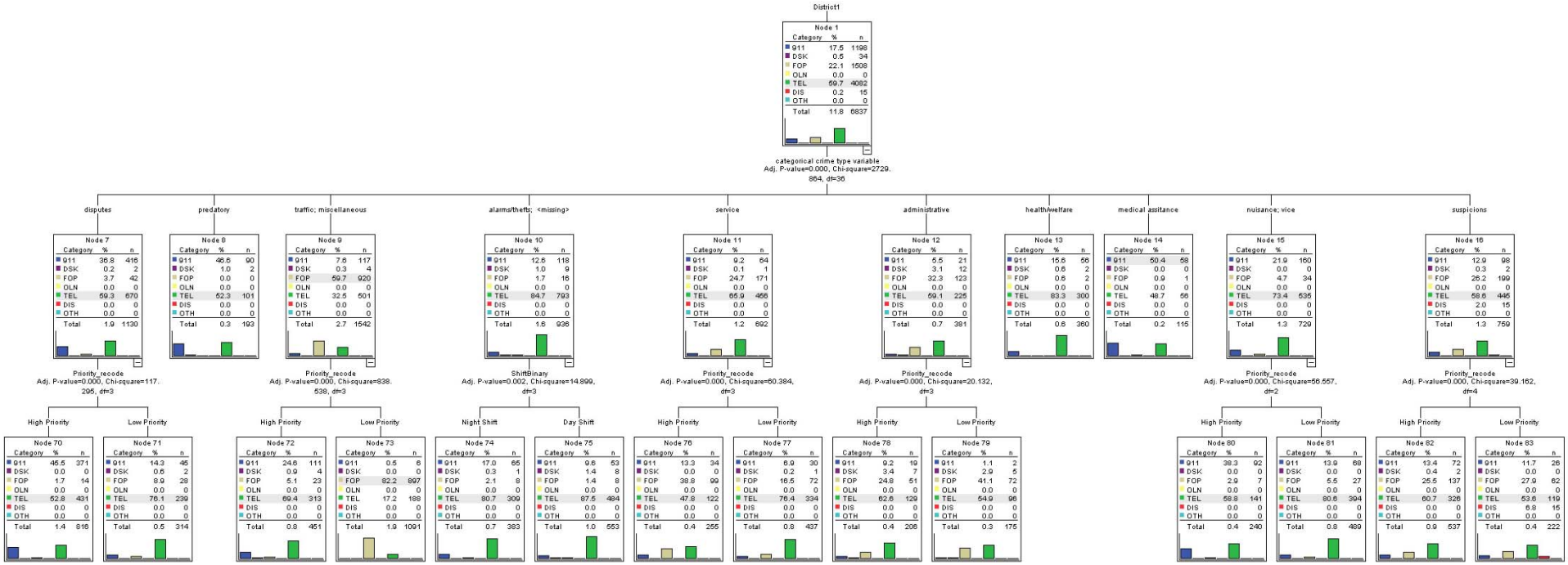

Figure 14. 2013 Calls for Service Workload in District 1

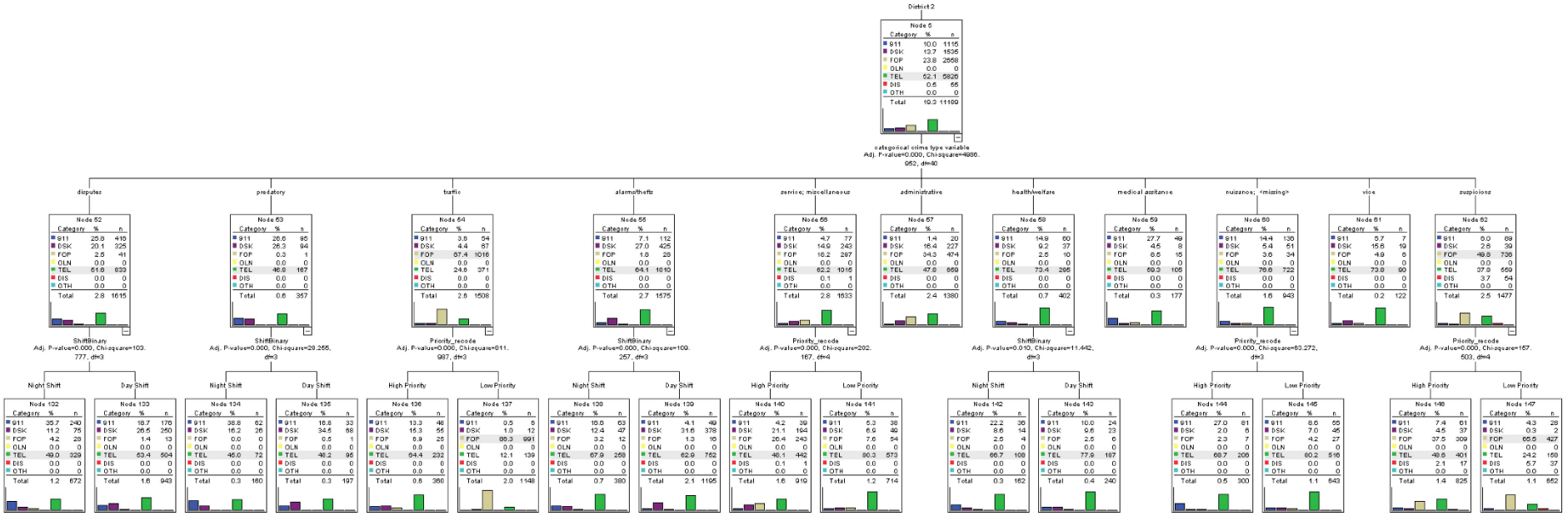

Figure 15. 2013 Calls for Service Workload in District 2

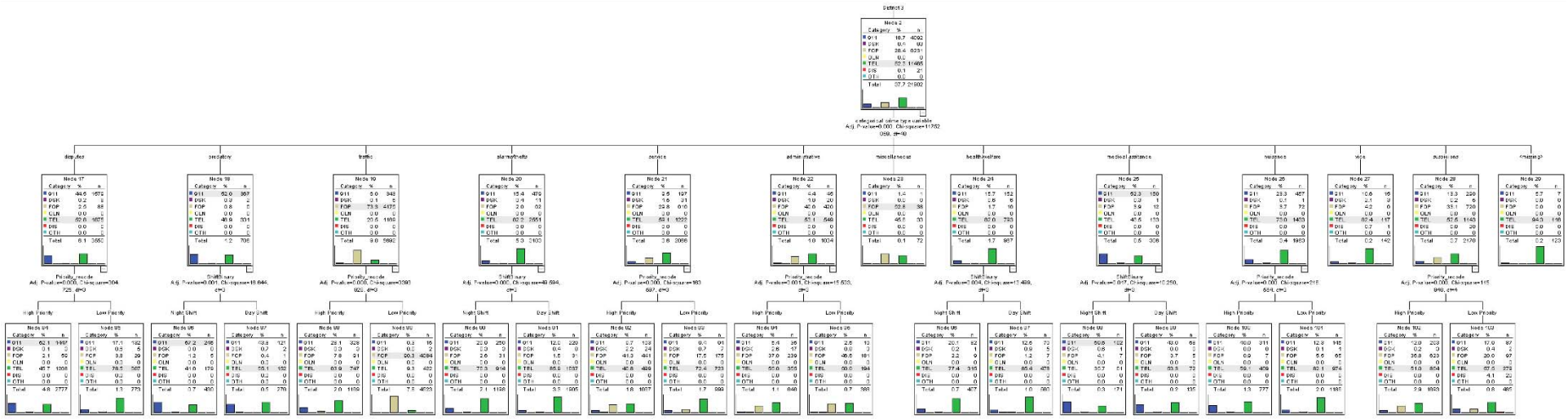

Figure 16. 2013 Calls for Service Workload in District 3

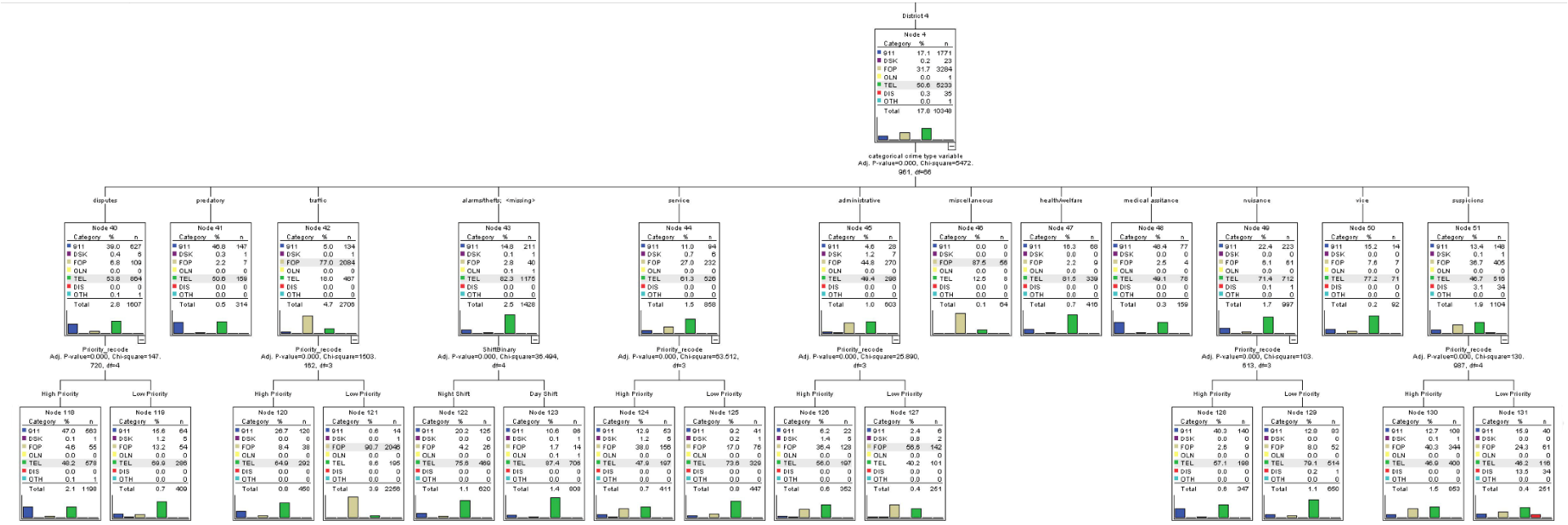

Figure 17. 2013 Calls for Service Workload in District 4

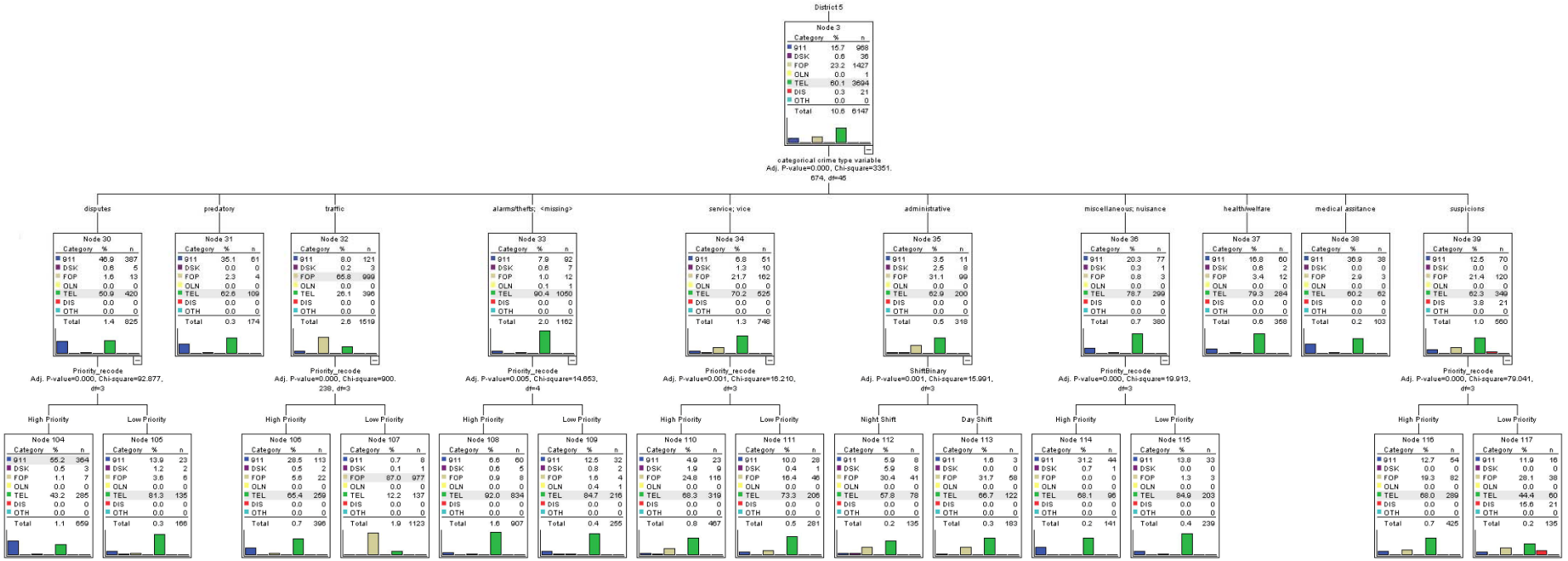

Figure 18. 2013 Calls for Service Workload in District 5

Appendix A

Recoded Incident Type Group Series

100 Series	Predatory
200 Series	Disputes
300 Series	Medical Assistance
400 Series	Alarms/Thefts
500 Series	Traffic
600 Series	Nuisance
700 Series	Suspicions
800 Series	Health/Welfare
900 Series	Vice
1000 Series	Service
1100 Series	Administrative
1200+ Series	Miscellaneous

Appendix B

Proposed Patrol Beats – Section Tracts

New Beat 1: 2C03, 2C05, 2C06, 3C01, 3C02, 3C03, 3C04, 3C05, 3C06, 3C07, 3C08, 3N01, 3N02, 3N03, 3N04, 3N05, 3N06, 3N07

New Beat 2: 1N01, 1N02, 1N03, 1N04, 1N05, 1N06, 1N07, 1S01, 1S02, 1S03, 1S04, 1S05, 1S06, 2C01, 2C02, 2C04

New Beat 3: 3C05, 3C06, 3C11, 3C12, 4N01, 4N02, 4N03, 4N04, 4N05, 4N06, 4N07, 4N08, 4N09, 4N10, 4S01, 4S02, 4S03, 4S04, 4S05, 4S06, 4S07, 4S08, 4S09

New Beat 4: 3C09, 3C10, 3C13, 3C14, 3S01, 3S02, 3S03, 3S04, 3S07, 3S08, 3S09, 3S10, 3S11, 3S12, 3S13, 3S14, 5C01, 5C02, 5C03, 5C04, 5C05, 5C06, 5C07, 5E01, 5E02, 5E03, 5E04, 5E05, 5E06, 5E07, 5E08, 5N01, 5N02, 5N03, 5W01, 5W02

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