2019 Stump Sound, NC Litter Study

November 2019

Environmental Resources Planning, LLC

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Acknowledgments

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Executive Summary

Environmental Resources Planning, LLC (ERP) was requested to conduct a comprehensive study of litter throughout Stump Sound Township in Onslow County, North Carolina (NC). This included areas with postal addresses for Holly Ridge, Jacksonville, North Topsail Beach, Sneads Ferry, Surf City, and Verona. This study consisted of two litter surveys.

The first (Initial) survey was conducted in April 2019, which is considered the off-season in terms of tourism. The second (Tourist Season) was conducted in July 2019 during the height of the tourist season. Each of these studies surveyed 30 representative sites. These sites were statistically selected from the NC Department of Transportation's Average Annual Daily Traffic (AADT) stations for Stump Sound Township. Additionally, 20 areas that tend to be heavily littered, identified by Onslow County as litter and illegal dumping hotspots, were also surveyed.

The goals of these surveys were to identify the precise components of litter, where it is most problematic and how littering is most likely to occur. Conducting the two seasonal litter surveys was done in order to determine the extent to which littering in Stump Sound is attributable to the local population, tourists or perhaps both.

The resulting data suggested the extent to which vehicles utilizing the local convenience centers or the landfill as well as residential trash setouts and collection practices contribute to littering. This study also took into account the proximity of certain types of establishments and how they correlate to litter tallied at each site. Based on this, recommendations have been provided that take these results and this area's unique dynamics into account.

The project tasks included the following:

1. **Initial Litter Survey: before the tourist season begins.**
   During the first week of April, a survey of 50 sites was conducted in Stump Sound, North Carolina. This included a survey of 30 statistically representative roadway sites along with a separate survey of 20 known litter hotspots throughout Stump Sound. This first set of surveys provided a profile of litter characterization and littering rates most likely attributable to the local and neighboring populations directly adjacent to the Stump Sound area.

2. **Tourist Season Litter Survey: while local tourism is at its peak.**
   During the second week of July, the two litter surveys (Representative and Hotspot) conducted in April were repeated at the same 50 sites during the height of the tourist season. The results of this second litter survey yielded an additional profile of litter that helped determine the rates and types of any litter that might be attributable to the seasonal tourist population in the surveyed locations.

3. **Solid Waste Management Infrastructure Analysis.**
   Since the locations, availability, and schedules of the convenience centers may have a significant effect on littering and illegal dumping in the Stump Sound area, special attention was paid to the solid waste infrastructure particularly in Holly, Sneads Ferry and Verona. ERP noted the proximity of illegal dump sites near or adjacent to these drop-off locations.

4. **Analysis: comparing results of the two litter surveys**
   After separately evaluating the results of each of the litter surveys, the differences between the data from the two surveys were analyzed. The resulting differences formed the basis for actionable recommendations. In addition, the current solid waste management infrastructure, its inadvertent role in the facilitation of littering and how it can be changed to become an effective tool in litter abatement going forward were all addressed.

Conclusions

1. Although litter at the Representative sites rose 14% between the Initial survey and the Tourist Season survey, the types of litter that increased seem to indicate that tourists are not the primary litterers in Stump Sound.

2. Litter at Hotspot sites was 3% lower during the tourist season, indicating that Hotspot litter is more likely attributable to local residents and those living in areas directly adjacent to Stump Sound.

3. Sites in areas with beautification had consistently less litter on average compared to sites that had no beautification, suggesting a positive relationship between beautification and low litter rates.

4. Discarded roofing and other construction debris that was observed suggested that some homes were still in the process of being restored during the first litter survey as demonstrated by construction-related litter in the Initial survey.

5. When Representative and Hotspot data for both surveys were totaled, Paper items were the most prevalent category of litter found in Stump Sound (16%). The largest component was paper pieces that had been mowed over.

6. Trash near convenience centers was most likely dumped primarily by local residents and those living in areas directly adjacent to Stump Sound in order to avoid paying tip fees.

7. Due to comprehensive coverage by grocery stores, only a small portion of Stump Sound seemed to meet the requirements of a food desert.

8. Averaging all four surveys together, about 28% of all litter was recyclable paper and beverage containers.

Recommendations

1. Place hidden cameras at Hotspot sites near convenience centers, ensuring that they are monitored and used by code and police officers to aid enforcement efforts.

2. Consider developing a joint community beautification program between Stump Sound Township or Onslow County and Camp Lejeune.

3. Given how prevalent mowed over items of litter were, obtain mowing schedules and ensure that cleanups are conducted before roadside mowing begins. Put in place and enforce contractual obligations requiring that items of litter are removed prior to mowing.

4. Focus cleanup efforts on litter in ditches as many of the ditches in the area acted as accumulators for beverage containers and other prevalent components of litter and were identified as Hotspot sites.

5. Consider a community-wide program to ensure the proper and timely collection and disposal of construction and demolition debris, especially after natural disasters.

6. In lieu of a trash tip fee, consider having the costs for the convenience centers and the solid waste tip fees included in the County's property tax billings to property owners to help eliminate the incentive for illegal dumping.

Section 1
Introduction

Stump Sound Township is a unique sparsely populated beach-related community of 23,037[1] that becomes a tourist destination during the summer months. It is located south of Jacksonville Township and directly adjacent to Fort Lejeune, a large military base.

Although this area is sometimes referenced as a food desert, only the northwest corner of Stump Sound - a sparsely populated area - actually meets the definition of a food desert, where for many residents, there is not a grocery store within 10 driving miles.

Concerns about litter and trash are growing as an undercurrent of litter-related issues have begun impacting Stump Sound's quality of life and tourist economy.

Environmental Resources Planning, LLC (ERP) was tasked to conduct a comprehensive study of the litter-related issues and the convenience center system currently in place as it relates to litter and effective solid waste management.

The goals of this study were:

1. A litter survey of statistically representative sites during the off-season to reflect base conditions and behavior patterns of the local population.

2. A litter survey of known hotspot sites during the off-season to reflect base conditions and behavior patterns of the local population.

3. A litter survey of statistically representative sites during the tourist season to allow conditions and behavior patterns of tourists to be observed.

4. A litter survey of known hotspot sites during the tourist season to allow conditions and behavior patterns of tourists to be observed.

[1] https://northcarolina.hometownlocator.com/counties/subdivisions/data,n,township%20of%20stump%20sound,id,3713393160,cfips,133.cfm#demographic

5. An analysis of the convenience center system currently in place, its effect on litter and illegal dumping problems and how this system may be modified to play a more effective role in litter abatement.

Based on the resulting data from these goals, conclusions and actionable recommendations are provided. This report includes detailed documentation of the study conducted along with photographic support representing its findings. This litter study focused solely on the roadways within the Stump Sound Township borders, shown in Figure 1.

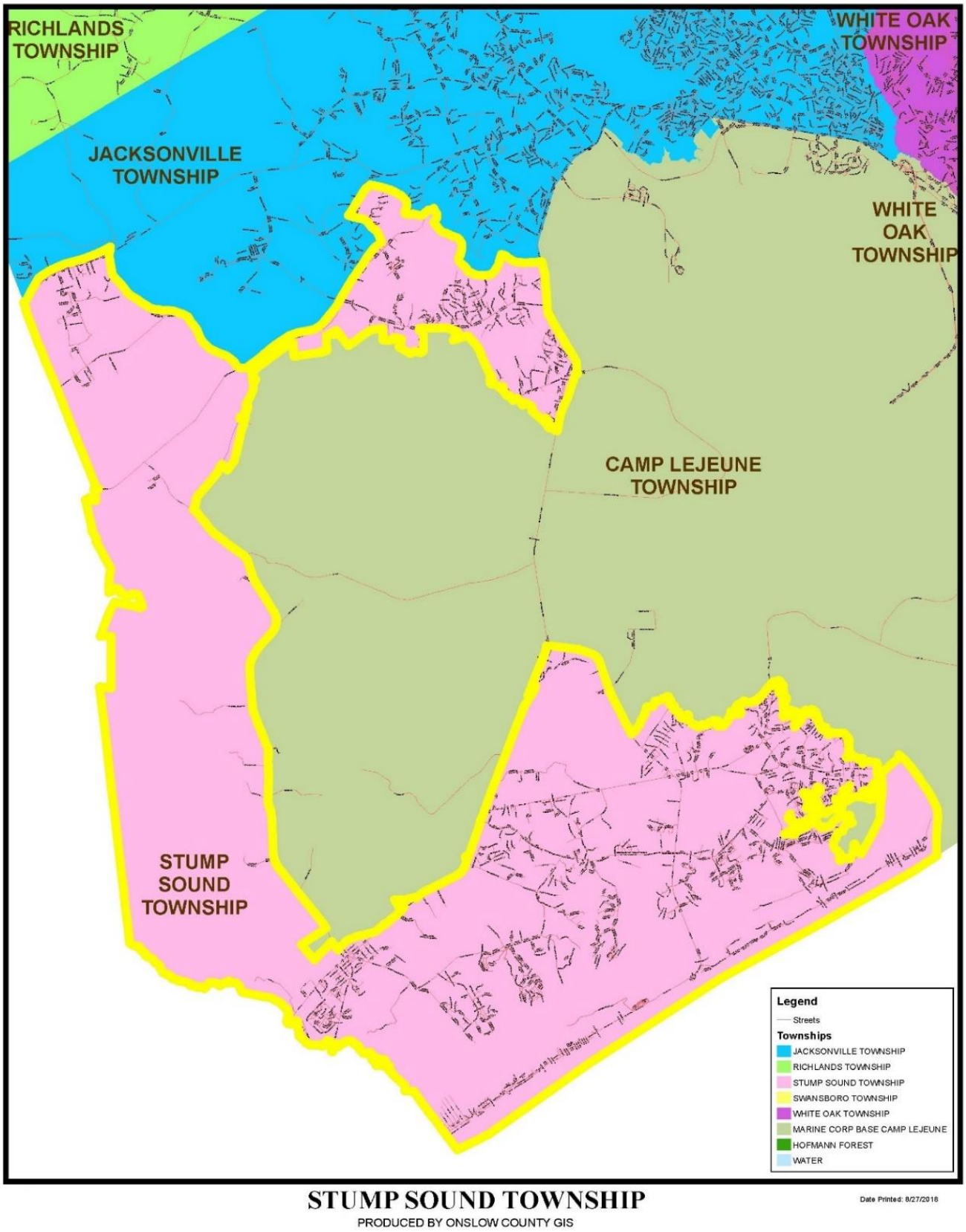

Figure 1 - Stump Sound Township Map

Each of the two litter surveys consisted of tallying all items two inches or larger at 50 sites that were each 256 feet long and 18 feet wide. That was deemed sufficient since Stump Sound is approximately 100 square miles in size. This included 30 statistically Representative sites that accurately reflect Stump Sound traffic levels and population densities, as well as 20 known litter and illegal dumping Hotspot sites. The locations of both site types are shown in Figure 2 below.

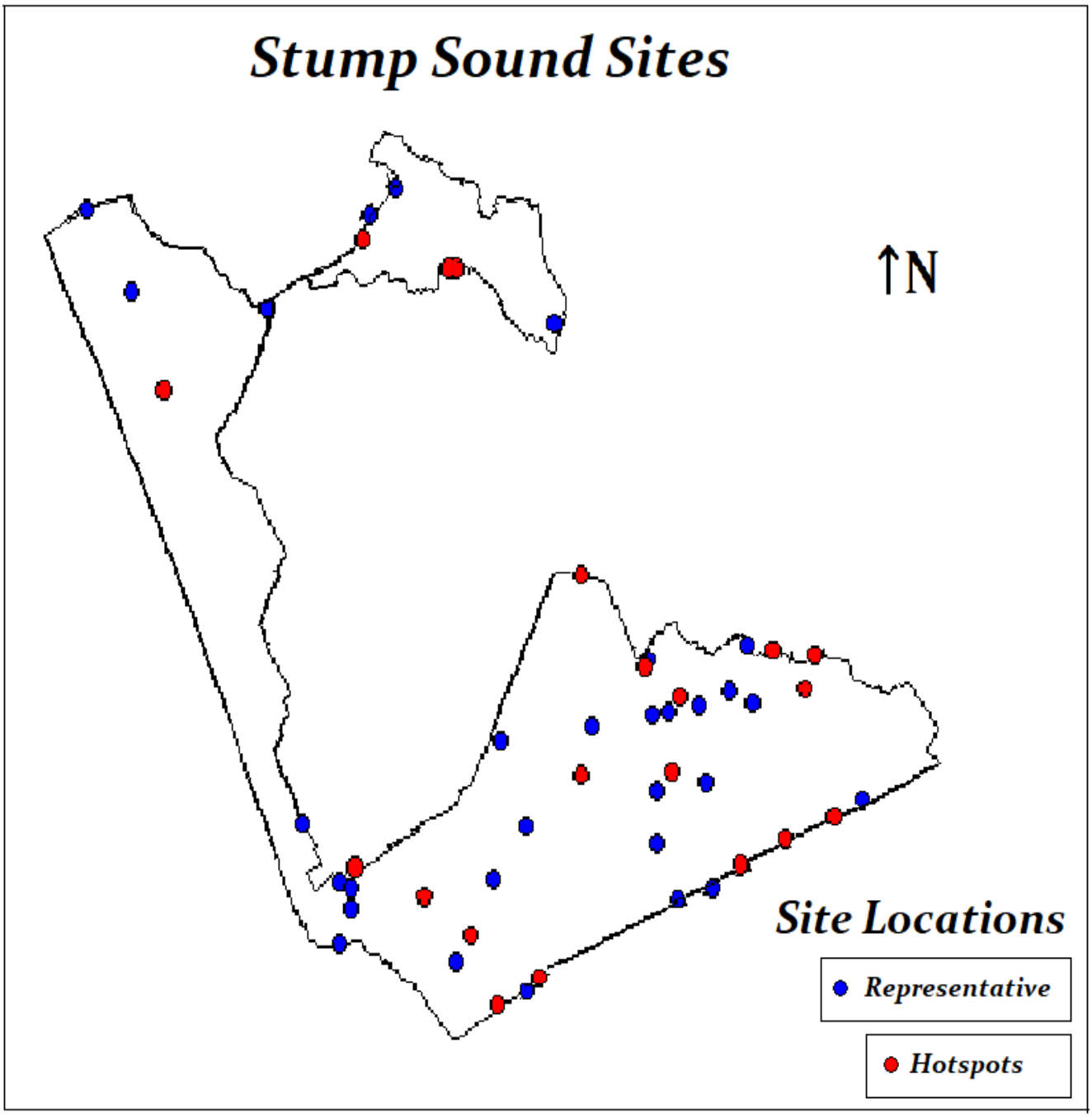

Figure 2 - Stump Sound Sites

Components and Categories

Litter was characterized using 108 components. These components are consistent with those used in other recent litter surveys. These components were subsequently rolled up into 15 major categories of litter that are listed below along with some common examples of each:

1. Beverage Containers: 18 individual components including beer, soda, sports and energy, water, wine and liquor, juice, and tea. Each one was further classified by material type (metal, plastic, glass, composite).
2. Beverage-Related: beverage cartons and six-pack rings. These are minor components but were classified separately to avoid confusion with the beverage containers themselves.

Fast-food related items were broken down into three categories for clarity: cups and lids, straws and wrappers, and other fast food packaging.

3. Cups and Lids: cups used solely for hot drinks, cups used solely for cold drinks and lids found without cups. Each of these was further classified by material type (paper, plastic, foam).
4. Straws and Wrappers: straws and wrappers tallied separately. Each was further classified by material type (paper, plastic).
5. Other Fast-Food (FF) Packaging: burger wrappers, clamshells, condiments, bags, utensils, napkins, plates, and trays. Each of these was further classified by material type (paper, foil, plastic, etc.).
6. Snack Wrappers: sweet snacks (candy, cakes), salty snacks (chips, crackers), and gum. Each of these was further classified by material type (paper, plastic, composite).
7. Home Food: food jars, cans, bottles, lids and tea packets. Each was further classified by material type (glass, metal, plastic, composite).
8. Paper: all non-food/beverage paper items including newspapers, magazines, flyers, lottery tickets, business, school, receipts, packaging, paperboard, corrugated boxes, unidentifiable paper, and paperboard. Each was individually classified. The exceptions were paper grocery bags, which are included in the Bags category and paper fast food bags, which are included in the Other Fast Food Packaging category.
9. Vehicle Debris: automobile parts from accidents, maintenance debris from do-it-yourself car repairs and tire debris. Each was individually classified.

10. Construction/Industrial: construction and demolition debris (e.g., shingles, wood, electrical, drywall, Tyvek, foam insulation, etc.) as well as industrial items such as rags, and tarps.
11. Plastic Pieces[2]: pieces of plastic that have been mowed over so that they are not distinguishable as specific products.
12. Home Items: lamps, clothes, toiletries, home packing materials, and drug-related items. Each was individually classified.
13. Bags: paper, plastic and reusable bags separated by those used for shopping, trash, and leaves. Those with brand names were separately tallied from generic bags such as "thank you" bags. Each was further classified by material (paper, plastic, cloth).
14. Tobacco-Related: lighters, packages, and matchbooks along with any cigarette or cigar butts that were one inch or larger. Each was separately classified.
15. Other: any items not otherwise classified.

Litter Sources

Based on contextual site conditions including the types, amounts and location of littered items as well as the proximity of factors known to influence littering rates, the likely sources of litter were identified at each site. The factors noted include facilities such as fast food establishments, convenience stores and shopping centers. Other factors considered include the particular roadways at each site that may enable pedestrian traffic.

For each of the four surveys (two Representative and two Hotspot), the weighted percentages from each site were compiled, which yielded a total survey-wide estimate. Ten potential categories of litter sources were utilized for each of these surveys conducted. The less frequent categories did not always have resulting data in all four of the surveys. The categories included:

1. Buildings: typically, larger buildings near the site from which litter was deemed to originate.

2. Cars & Trucks: drivers or riders of automobiles or trucks from which littered items are typically tossed.

[2] Some of the statistical tests include Plastic Pieces with Construction/Industrial since those items originate in part from construction activities.

3. Construction: nearby construction-related sites from which litter was deemed to originate or construction-related pickup trucks, dump trucks, etc. from which construction debris originated.

4. Homes: houses near a site from which litter was deemed to have originated.

5. Loading Docks: commercial docks where goods for retail stores are unloaded and from which littered items were deemed to have originated.

6. Pedestrians: where people walking or running at or near a site from whom litter is deemed to originate.

7. Trash Trucks: spillage from trash collection vehicles.

8. Unsecured Vehicles: vehicles whose loads are improperly or insufficiently secured so that portions of those loads may fall or fly out, particularly when bumps in the road or higher winds are experienced.

9. Vehicle Debris: scraps from blown-out tires, residual pieces or automobiles or trucks from roadway accidents that have occurred. This category also includes debris left behind from do-it-yourself (DIY) car maintenance done on or near a site. Except for the DIY components, Vehicle Debris is generally considered 'unintentional litter' and is one of the only categories for which this designation is applied.

10. Other: littered items for which the source is other than those listed above or for which the source is uncertain.

Section 2
Factors Underlying Littering in Stump Sound

Litter – Community Well-Being Indicator

Litter functions as both an indicator of community well-being and as a potential gateway to community decline. Litter is the most visible form of community and environmental decay, but perhaps the most easily neglected.

Litter always tells a story that can only be properly understood once it is studied in context. It is a snapshot revealing evidence of effects with correlating causes - and thus sources - that can be determined. Some littering results from sources such as untarped pickup trucks and insufficiently secured trash collection vehicles. Other littering is the result of carelessness, apathy or reactance.

Litter results from three distinctive problems: (1) deliberate or intentional littering, (2) careless or negligent littering such as items that fall off of uncovered trucks and overfilled litter receptacles or (3) unintentional littering such as scraps from blown-out tires or residual car parts from automobile accidents or related mishaps.

Litter cleanups are helpful, but they are not sufficient by themselves to address these problems. Additionally, outside of volunteer efforts, cleanups are by far the most expensive form of waste management.

Effective litter prevention programs can have clear, positive impacts on Stump Sound's economy, environment and quality of life. The litter assessment conducted as part of this study will provide a baseline from which to measure progress toward these goals.

Six factors that could potentially impact or be impacted by littering in Stump Sound will be discussed:

1. Tourism
2. Coastal Storms
3. Convenience Centers
4. Mowing
5. Food Desert

Tourism

Stump Sound is a rural community that is sparsely populated during the off-season, but experiences a tourist population rise during the summer months, whose demographics may differ from those of the local population. Local communities are aware of the increased littering that occurs once beaches are open for the summer and take steps to address this issue[3], but interviews with residents suggest that local residents may be the ones responsible for the additional littering that occurs during the summer[4].

Coastal Storms

Due to its proximity to the east coast and its long coastline, eastern North Carolina is one of the U.S. regions most vulnerable historically to flooding and damage from hurricanes, coastal storms, heavy rainfall and river overflows.[5] In fact, 17.5% percent of all North Atlantic tropical cyclones have affected portions of North Carolina.[6] These problems have been ongoing and would only be exacerbated by any climate instabilities that occur in the future.

The subsequent damage from these storms and flooding can ultimately lead to a significant amount of construction and demolition debris. To the extent that residents and construction crews set out these materials without regard to collection schedules or illegally dispose of these materials, this can result in a more littered environment.

This dynamic was observed in 2019. Although most homes damaged by Hurricane Florence had been restored well before the first litter survey was conducted, some homes were still in the process of being restored during the first litter survey as demonstrated by discarded roofing and other construction debris that were observed by field crews. For example, during the second litter survey, some asphalt shingles were still being littered.

Convenience Centers

There are five trash and recycling convenience centers located strategically throughout Onslow County. Of the five county-wide convenience centers, only two seem to be located in Stump Sound Township itself: Folkstone and Verona.

[3] https://www.wwaytv3.com/2018/05/23/keep-it-off-our-beach-surf-city-tries-to-tame-beach-trash-problem/.
[4] Interviews between ERP field crews and local residents during the field surveys.
[5] https://northcarolinafloodinsurance.org/flood-history
[6] Ibid.

Both are open Mondays, Wednesdays, Fridays and Saturdays from 8am to 6pm during the summer and from 8am to 5:30pm during the winter months.

The county charges $1.50 per bag for household trash, while tires, electronics, white goods and recyclables can be dropped off free of charge. TV's, monitors and microwaves can be disposed of for $3.00 per item. The County also has five mobile convenience center locations, although none of them seemed to be located inside Stump Sound itself.[7] A significant amount of trash and bulk items were found dumped close to the Verona convenience center as shown in Figure 3. While it is possible that a resident drove to the center after hours, it seems as likely that some may be unwilling to pay the tip fees.

[7] https://www.onslowcountync.gov/324/Convenience-Sites-Trash-and-Recycle-Cent

Figure 3 - Dawson Cabin Road Site near the Verona Convenience Center

Mowing

The field survey teams made detailed notes regarding a variety of ambient site conditions known to affect the presence of litter as well as littering rates. One of the most significant of these is whether the site sampled appeared to have been recently mowed.
This variable is considered important because mowing crews typically do not collect litter in the site before mowing the area. Thus, if litter in the site is shredded by the mowing crew, then the apparent quantity of litter items can be exponentially increased.

It is important for litter to be removed before county or state crews mow the public roadsides in Stump Sound. Mowing on littered portions of the roadside has the following three effects: (1) increases the risk of crews striking unseen objects and harming people, machinery, and passing traffic; (2) causes shredding of larger pieces of litter, resulting in additional time spent picking up the trash by litter crews; and (3) exposes more litter to the views of both passing motorists as well as pedestrians.[8]

The amount of litter on mowed sites may be reduced by collecting and removing accumulated litter before mowing. Otherwise, mowing can easily contribute to the problem of wind-blown litter and inadvertently encourage additional littering.

As Table 4 in Section 4 of the report details, items mowed over instead of being collected first, accounted for half of all paper items found in the Tourist season Representative survey, and were the largest category of litter (plastic pieces) during the Tourist season Hotspot survey as shown in Table 5.

Figure 4 shows a partially mowed site where littered items were not mowed over.

[8] http://onlinemanuals.txdot.gov/txdotmanuals/veg/mowing_and_litter_pickup.htm

Figure 4 - Partially Mowed Site

Food Desert

The U.S. Department of Agriculture (USDA) defines a food desert as a low-income census tract in which at least 33 percent or a minimum of 500 people, live more than a mile from a grocery store in urban areas, or 10 miles from a grocery store in rural areas.[9] Thus, they do not have access to fresh fruits and vegetables. North Carolina has 349 food deserts across 80 counties, impacting 1.5 million residents.

Onslow County has a number of different food resource options for residents who experience such issues. Many of these food assistance programs include free pantries and free groceries provided to low income residents via community outreach programs, the salvation army, and Churches. There are also three County farmers markets.[10]

Of the 23 programs offered by various entities in the County, only three seem to be located within the Stump Sound Township itself. These include the Sneads Ferry Nutrition Site, a food pantry offered by Folkstone Original Freewill Baptist Church and the First United Methodist Church Food Bank.

In its mapping of food desert areas, the USDA only identified one portion of the Stump Sound area as such[11]: the southwestern corner beginning in the north at Everett Creek going southward to the Intracoastal Waterway. This area extends from Rt 210 to the eastern border of Sneads Ferry as seen in Figure 5.

While that area has a number of fast food establishments, it also has a Food Lion grocery store that is within five miles of any point within that entire area and is only 2.7 miles from any of the fast food establishments there.

Other areas that USDA identified as food deserts are outside of the Stump Sound Township borders.

In addition, Stump Sound has a good selection of grocery stores throughout the township that service the entire area. The most visible is Food Lion, which has three local locations (Jacksonville, Sneads Ferry and Surf City) that service the Stump Sound area. The coverage that this chain and others provide would seem to preclude most of Stump Sound from meeting the USDA definition of a food desert.

[9] https://www.eatrightnc.org/assets/betsy%20vetter%20presentation.pdf
[10] https://www.onslowcountync.gov/DocumentCenter/View/4870/Food-Resources-Document-2017-final-both-pages?bidId=
[11] Accessed at: https://www.ers.usda.gov/data-products/food-access-research-atlas/go-to-the-atlas/

A separate issue is low-income residents in these areas who work two jobs and do not have their own vehicles may have limited options regarding access to fresh groceries[12]. But all residents of Stump Sound do live within 10 miles of a grocery store that sells fresh produce.

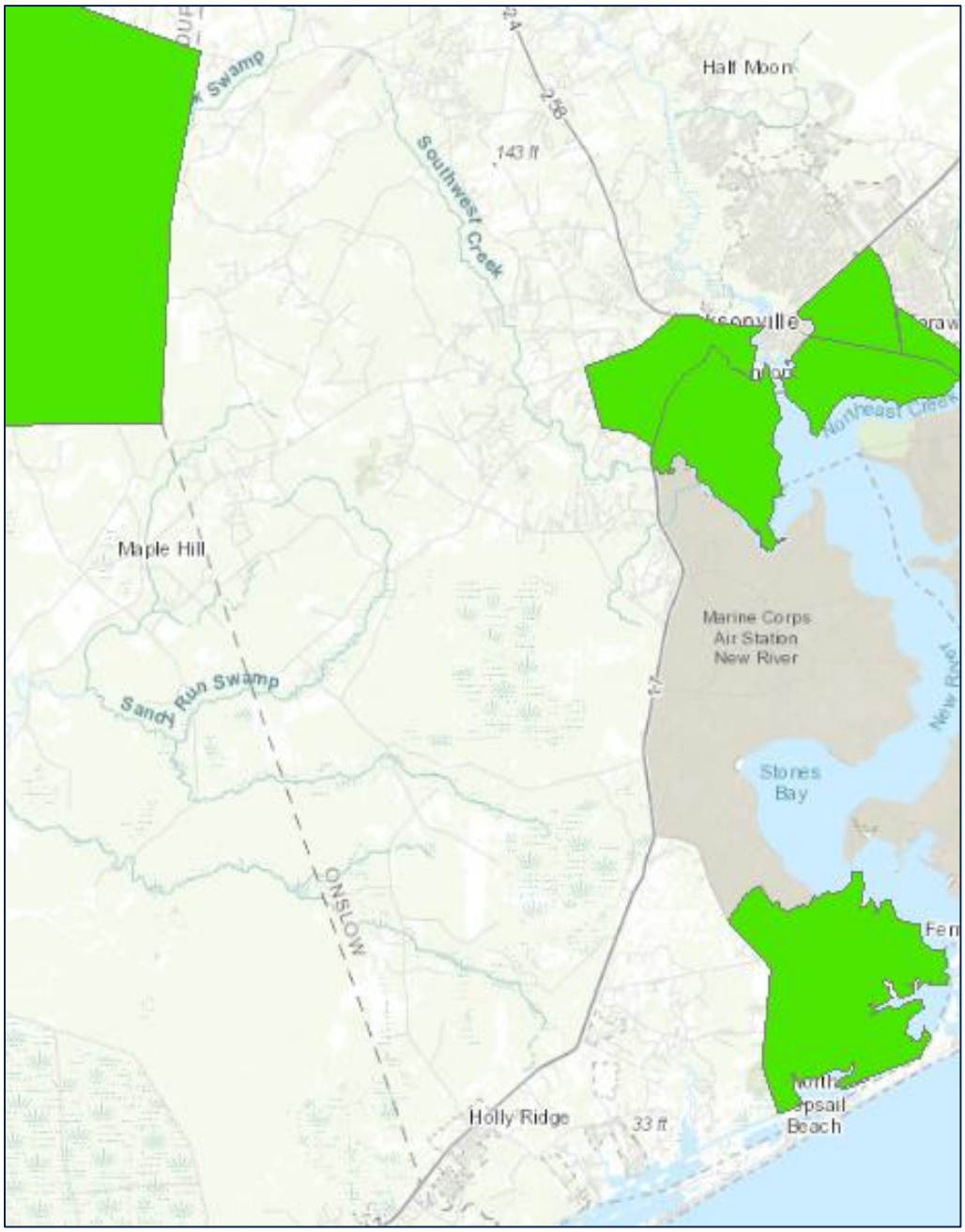

Figure 5 - USDA Food Desert Map

[12] Grocery Store Inequity. Sojourners Magazine. Courtney Hall Lee. April 2017. Accessed at: https://sojo.net/magazine/april-2017/grocery-store-inequity

The map in Figure 6 uses lines to show the coverage that grocery stores provide in the Stump Sound area. Although Food Lion is not the only grocery store chain located there, it provides coverage to most of the township by itself.

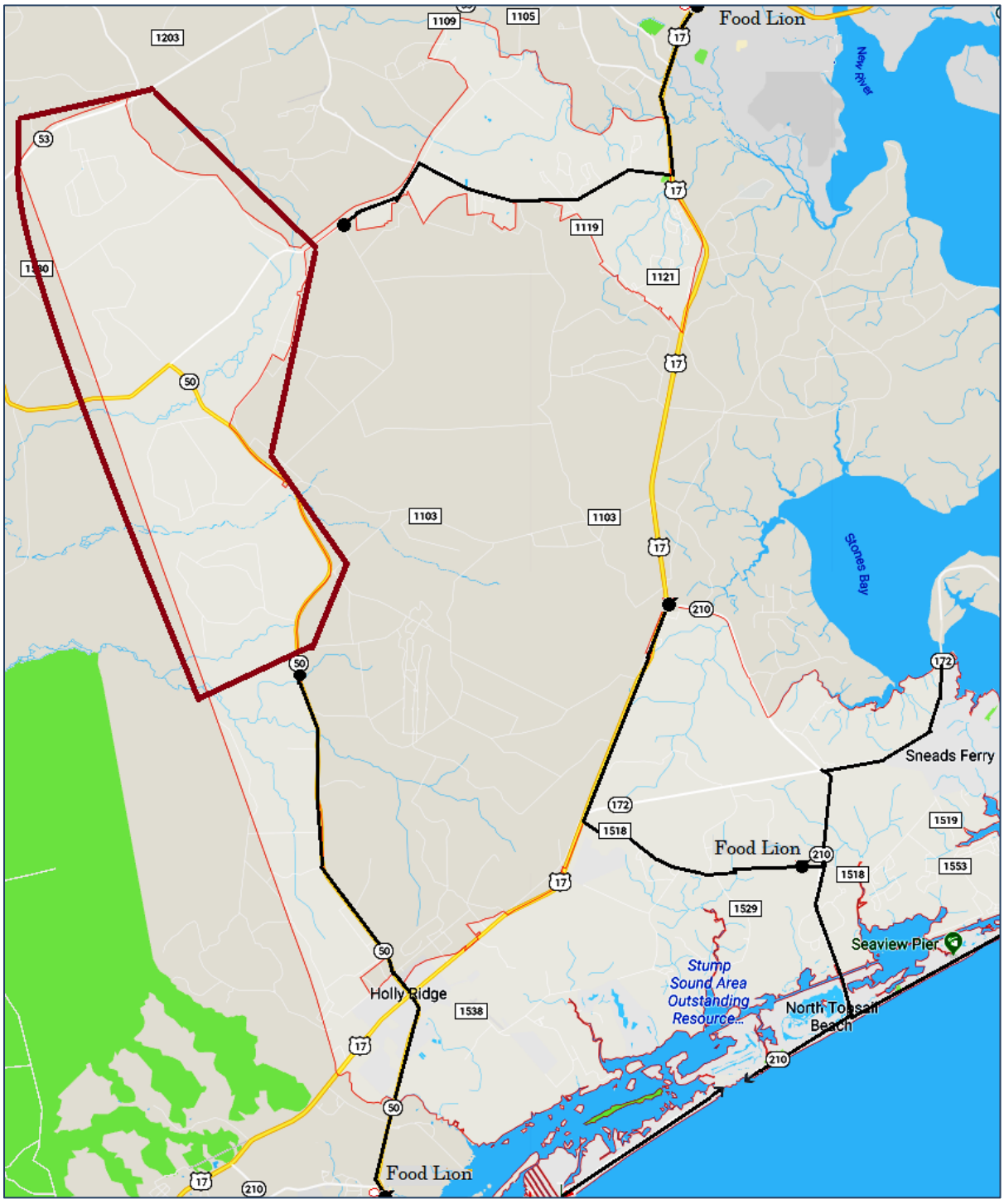

Figure 6 - Food Desert Map for Stump Sound

Section 3
Initial Litter Survey

Initial Representative Survey

An average of 44 littered items were found at the Representative sites. The largest category of litter in the Representative sites of the Initial survey was Fast Food items (15.8%), which consisted predominantly of cups, lids and straws. The second largest category was Paper (15.3%), which included all paper items other than those used in fast food and grocery bags.

Table 1 - Litter by Category: Initial Representative Survey

Category	Percent
Fast Food	15.8%
Paper	15.3%
Construction/Ind.	11.8%
Bev. Containers	11.6%
Plastic Pieces	10.9%
Vehicle Debris	10.2%
Snack Wrappers	9.9%
Home Items	8.5%
Tobacco-Related	3.1%
Paper/Plastic Bags	2.9%
Other	0.1%
Total	**100.0%**

Litter Sources - Initial Representative Survey

While conducting the Initial Representative survey, the likely sources of litter were evaluated. Items intentionally littered by Cars and Trucks accounted for 46% of all litter, followed by Construction (23%) and Vehicle Debris (10%). The results are shown in Figure 7 below.

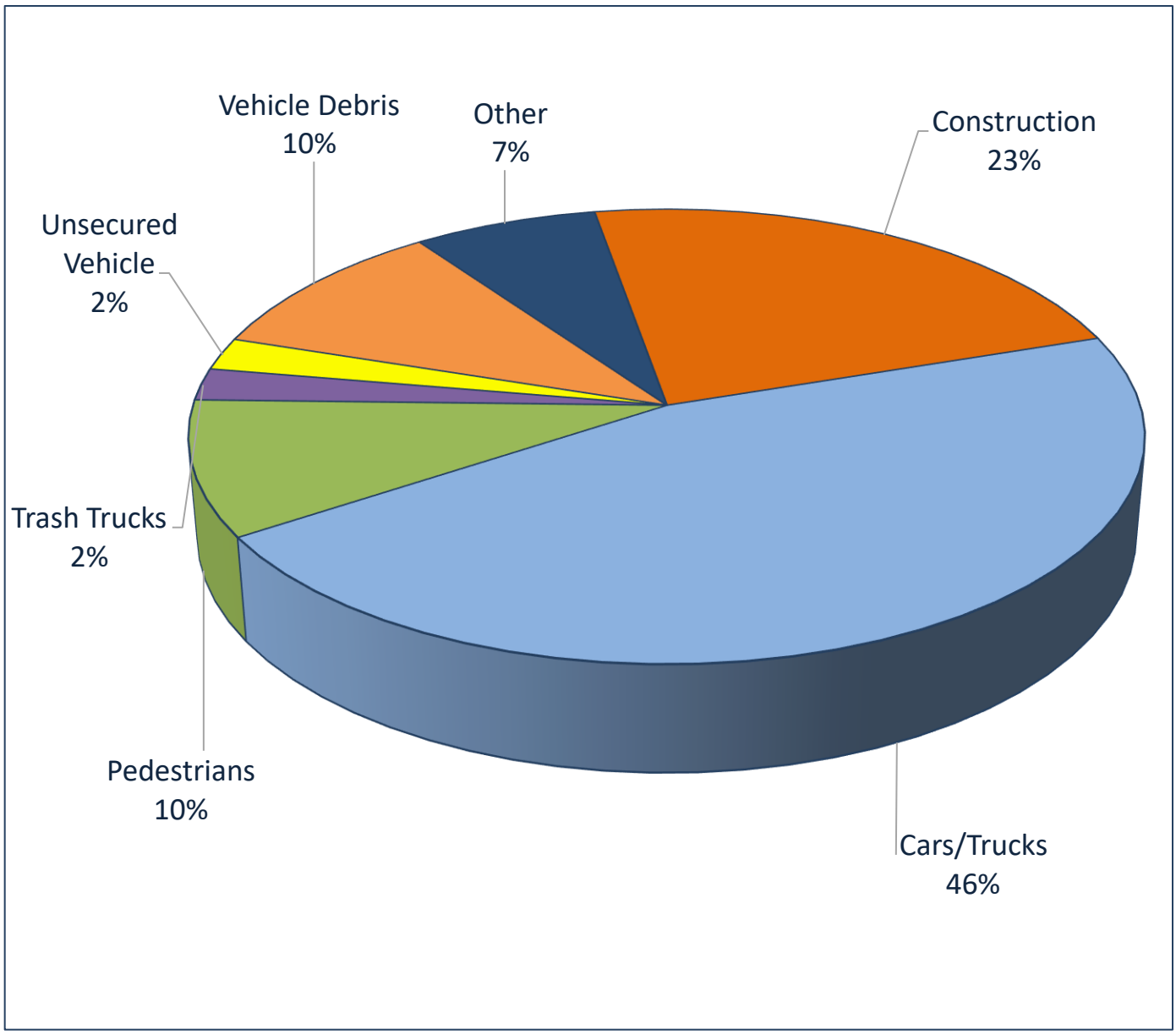

Figure 7 - Litter Sources - Initial Representative Survey

Initial Hotspot Survey

An average of 53 littered items were found at the Hotspot sites, 21% higher than at the Representative sites. The largest category of litter in the Hotspot sites of the Initial survey was Beverage Containers (17.7%) items, which consisted predominantly of beer cans and water bottles and constituted a much higher percentage than at the Representative sites as shown in Table 2.

Table 2 - Litter by Category: Initial Hotspot Survey

Category	Percent
Bev. Containers	17.7%
Fast Food	13.2%
Paper	12.8%
Construction/Ind.	11.9%
Plastic Pieces	11.2%
Vehicle Debris	10.0%
Home	10.0%
Paper/Plastic Bags	6.3%
Snacks	4.0%
Tobacco-Related	3.1%
Other	0.1%
Total	**100.0%**

The second largest category of litter was Fast Food (13.2%). The largest portion of this category consisted of cups and lids. The other portion was attributable to straws and other fast food items. Ten percent of the litter was Vehicle Debris. Most of this was residual debris from automobile accidents.

Litter Sources - Initial Hotspot Survey

In the Initial Hotspot survey, items intentionally littered by Cars and Trucks accounted for the largest amount of litter (35%), followed by Construction (30%) and Vehicle Debris (15%). The category of Homes was designated as a source when it seemed that certain items of litter originated from homes themselves rather than through actions by Pedestrians. However, Homes constituted only 2% as a litter source in the Initial Hotspot survey. The results are depicted in Figure 8.

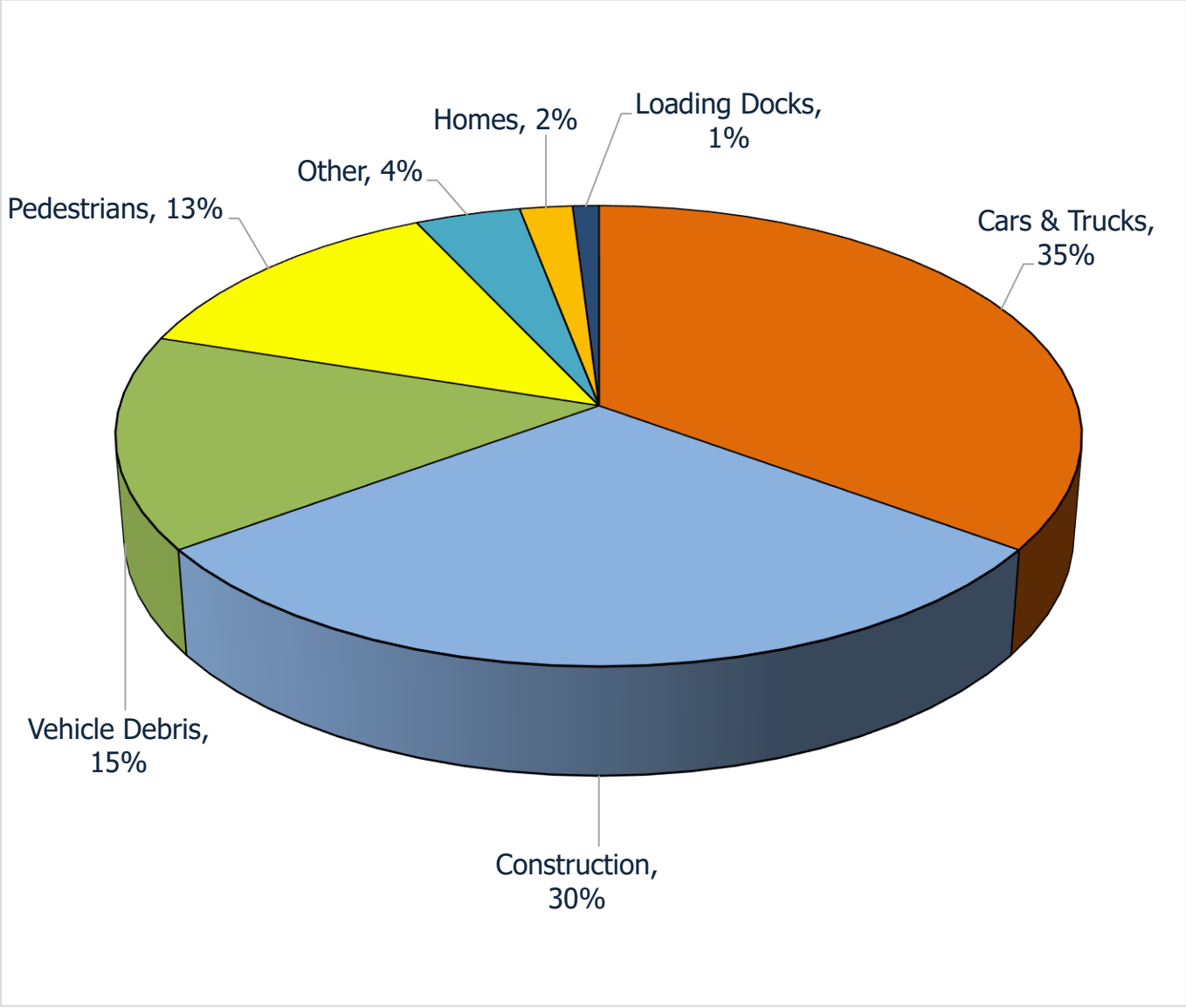

Figure 8 – Litter Sources - Initial Hotspot Survey

Initial Survey - All Sites

When the data from all 50 sites were combined, an average of 48 items were found at each site. Fast Food items were most prevalent (14.6%). More than half of this consisted of cups, lids and straws. This was followed by Beverage Containers (14.3%), primarily beer containers, and Paper (14.2%), which was mostly paper and paperboard that had been mowed over.

Table 3 - Litter by Category: Initial - All Survey

Category	Percent
Fast Food	14.6%
Bev. Containers	14.3%
Paper	14.2%
Construction/Ind.	11.8%
Plastic Pieces	11.0%
Vehicle	10.1%
Home	9.2%
Snack Wrappers	7.2%
Paper/Plastic Bags	4.4%
Tobacco-Related	3.1%
Other	0.1%

Litter was typically observed more often in ditches, which acted as a litter trap as seen in Figure 9.

Figure 9 – Litter in Ditch at Site

Litter Sources - Initial Survey (All Sites)

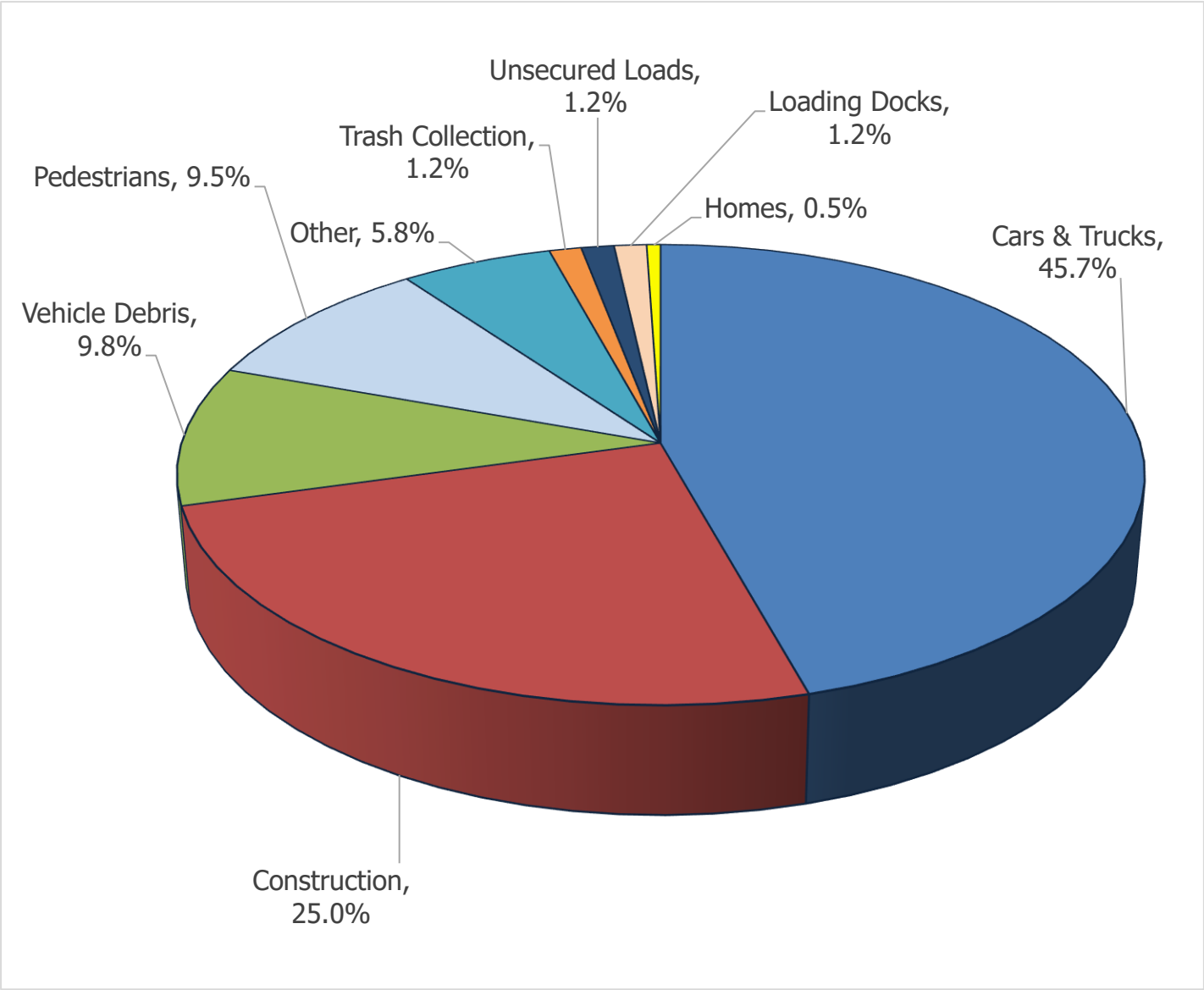

Figure 10 – Litter Sources for the Initial Survey (All Sites)

Section 4
Tourist Season Litter Survey

Tourist Season Representative Survey

An average of 50 littered items were found at the Representative sites during the heart of the tourism season, indicating a 14% increase compared to the Initial survey. The breakdown by category is in Table 4.

Table 4 – Litter by Category: Tourist Season Representative Survey

Category	Percent
Paper	20.0%
Vehicle Debris	16.1%
Fast Food	11.7%
Plastic Pieces	11.8%
Snack Wrappers	11.4%
Bev. Containers	10.1%
Construction/Ind.	7.8%
Home Items	6.8%
Tobacco-Related	2.3%
Paper/Plastic Bags	2.0%
Other	0.0%

The largest category of litter at the Representative sites of the Tourist Season survey was Paper (20.0%), which included all paper items other than those used in fast food and grocery bags. More than half of this was from paper items that had been mowed over.

Since much of the additional litter was due to the increased number of paperboard and corrugated boxes in littered Paper, there is no clear evidence to suggest that additional littering during the second survey was due solely to tourists.

This next highest category of litter was Vehicle Debris (16.1%). Almost two-thirds of this was scraps from tire blowouts.

Litter Sources - Tourist Season Representative Survey

While conducting the Representative survey during the tourist season, the likely sources of litter were evaluated. Items intentionally littered by persons discarding items from Cars and Trucks accounted for 57% of all litter, followed by Vehicle Debris (17%) as shown in Figure 11 below.

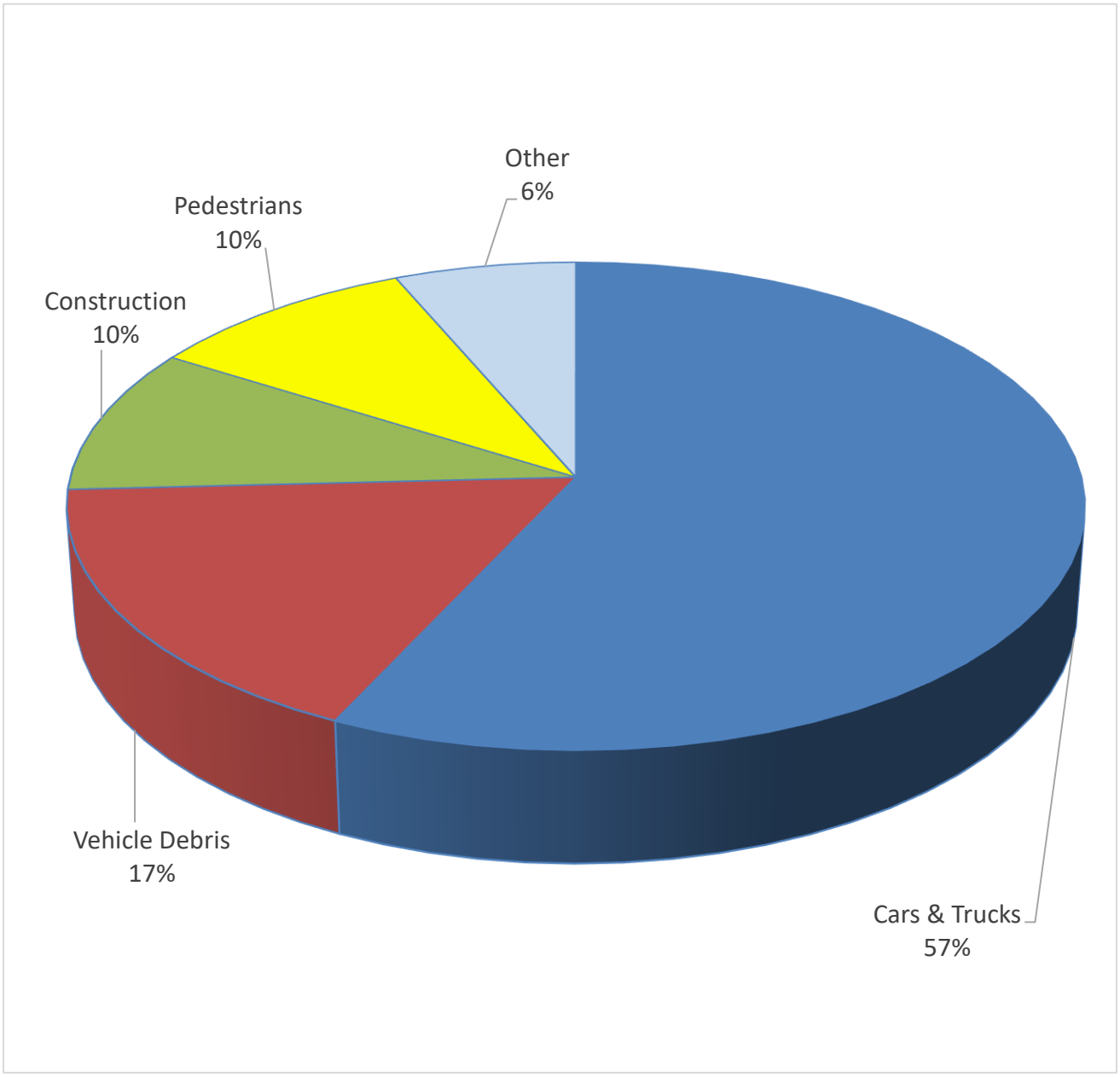

Figure 11 - Tourist Season Representative Survey

Tourist Season Hotspot Survey

An average of 52 littered items were found at the Hotspot sites, a decrease of just one item per site compared to Hotspot sites in the Initial survey.

The largest category of litter in the Hotspot sites of the Tourist Season survey was Plastic Pieces (19.0%), items that had been mowed over as seen in Table 5.

Table 5 – Litter by Category: Tourist Season Hotspot Survey

Category	Percent
Plastic Pieces	19.0%
Vehicle Debris	16.0%
Paper	14.3%
Bev. Containers	11.0%
Fast Food	10.0%
Home Items	10.0%
Construction/Ind.	8.1%
Snack Wrappers	7.3%
Tobacco-Related	2.2%
Paper/Plastic Bags	2.1%
Other	0.0%

The second largest category was Vehicle Debris (16.0%), which consisted of both scraps from tire blowouts and pieces of car parts from automobile accidents.

Litter Sources - Tourist Season Hotspot Survey

As a source of litter for the second Hotspot survey, Cars & Trucks topped the list by accounting for 36% of all litter. This was followed by Vehicle Debris at 20%. These percents are depicted in Figure 12.

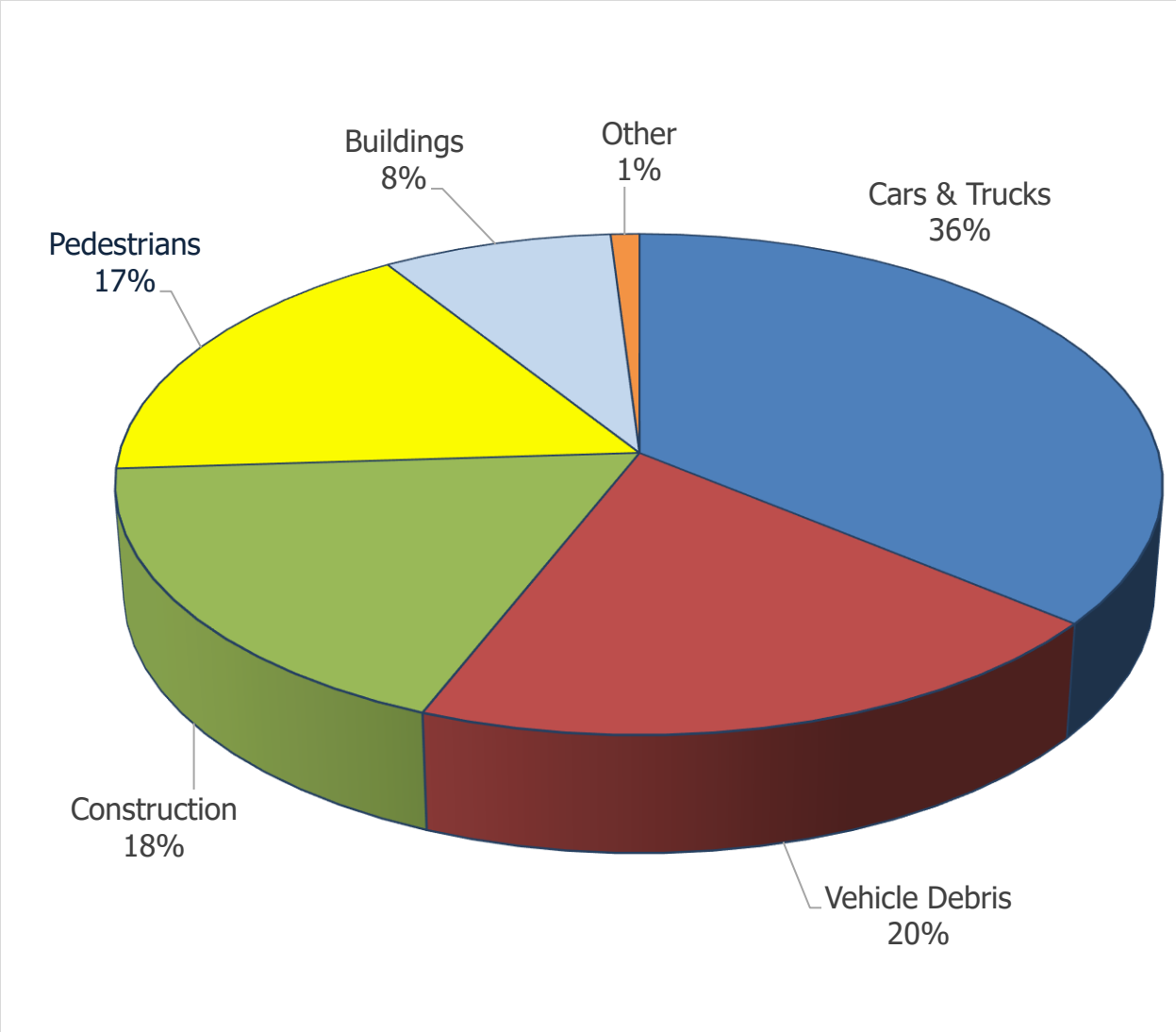

Figure 12 - Litter Sources - Tourist Season Hotspot Survey

Tourist Season Survey - All Sites

When the data from all 50 sites were combined, an average of 51 items were found at each site, an increase of three items per site overall. Paper items were most prevalent (17.6%) and were likely to have been recyclable at the time they were littered.

Table 6 – Litter by Category: Tourist Season - All Sites

Category	Percent
Paper	17.6%
Vehicle Debris	16.0%
Plastic Pieces	14.7%
Fast Food	11.0%
Bev. Containers	10.5%
Snack Wrappers	9.7%
Construction/Ind.	7.9%
Home Items	8.1%
Tobacco-Related	2.3%
Paper/Plastic Bags	2.0%
Other	0.0%

The next highest category was Vehicle Debris (16%), which equally consisted of both car parts from roadway accidents and pieces from blown-out tires. A significant number of Plastic Pieces (14.7%) that had been mowed over were also observed.

Litter Sources - Tourist Season - All Sites

Litter source estimates for both Tourist Season surveys were determined using weighted averages. The resulting data, as seen in Figure 13, shows Cars & Trucks (48%) as the dominant litter source.

Other relevant litter sources included Vehicle Debris (19%), Construction (13%) and Pedestrians (13%).

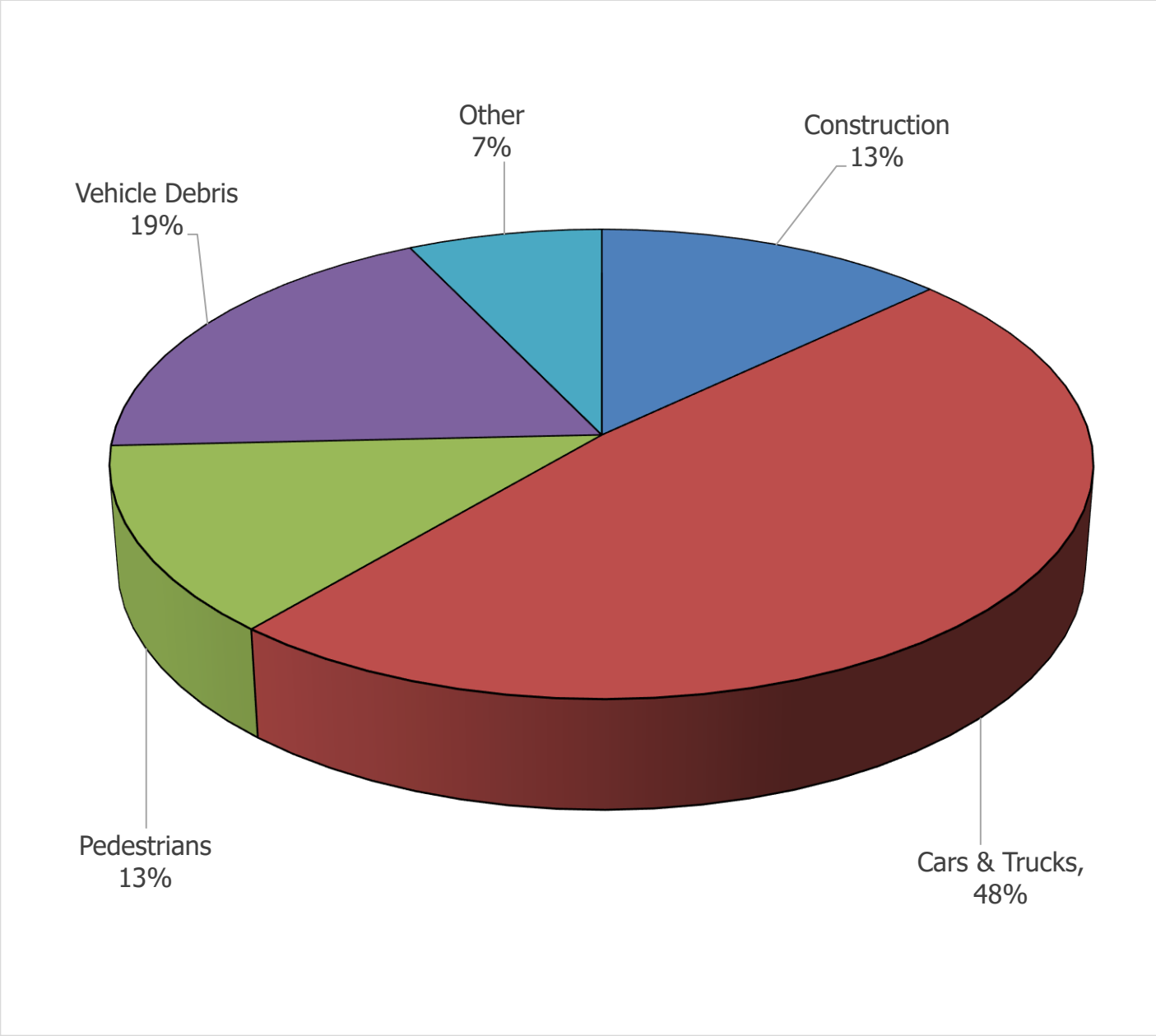

Figure 13 - Litter Sources - Tourist Season - All Sites

Section 5
Statistical Tests

Sampling

In statistical studies, a sample is normally taken, studied, and analyzed in order to draw inferences or make conclusions about an entire population. For the purposes of this study, it would not be feasible to survey every roadside in Stump Sound region. Thus, a representative sample of 30 survey sites was chosen, data was obtained and recorded, and tabulations and analyses were conducted to reach conclusions about Stump Sound roadways overall. In addition, similar methods were used to examine the data for 20 sites identified as Hotspots in the region.

Statistical Significance

When a statistical test is performed, one result is typically a value or number (statistic) which aids in interpretation and understanding of the outcome of that test. In particular, it is usually asked if the resulting value is statistically significant. One factor in determining the answer for a given value is the size of the sample. Another is the chosen level of significance. Often, a level of .05 is the favored choice.

Suppose, hypothetically, we are wondering if roads with a double-center line are littered to a different extent than roads with a single-center line. We survey a sample of each kind, tally the results, compare the averages and run a statistical test. If we get a number "significant" at the .05 level, then the conclusion is reached that double-line roads are, on the average, more heavily littered. The chosen significance level of 0.05 means that there is only a 5% risk (one chance in 20) that such a conclusion is incorrect and that no actual difference exists.

Correlation Analyses

A correlation analysis is a type of statistical test that yields a correlation coefficient, a number (statistic) used to measure the strength of a relationship between two variables. A correlation coefficient can be positive or negative, but is never less than -1 and never greater than +1. A positive correlation means that high scores on one variable are associated with high scores on the other variable, while low scores on one are associated with low scores on the other.

On the other hand, a negative correlation means that high scores on one variable are associated with low scores on the other. Note that a correlation can only indicate the presence or absence of a relationship, not the exact nature of the relationship. A high correlation in itself does not mean that one variable necessarily causes the other.

A correlation of zero, or close to it (either positive or negative), suggests that there is little or no relationship between the variables. Any result between -0.1 and 0.1 would typically be considered weak. The closer you get to +1 or -1, the stronger the relationship. However, the significance of any result would also depend largely on the size of the sample (that is, the number of measurements). Therefore, a correlation coefficient statistically significant at the .05 level for Representative site data (n=30) may not be significant for the Hotspot site data (n=20).

T-tests for Averages

A t-test is a type of statistical procedure used to examine the average values of two sets of data obtained through sampling. The t-test directly compares the difference between those averages or means, but also takes into account other factors. One factor is the standard deviation of each set of values, which is basically a measure of how widely dispersed the values are. The other factor is the number of values within each data set.

Based on these considerations, the t-test addresses the extent to which a true difference exists between the populations of values from which the data have been sampled and expresses the significance that can be attributed to such differences. For the Stump Sound project, each site was surveyed twice: The Initial Survey (Survey #1) and the Tourist Season Survey (Survey #2). Thus, data from the two surveys can be compared by pairing each site with itself; this "paired comparison" approach has advantages over non-paired testing.

Changes from Survey #1 To Survey #2

Representative Sites

Since each of the 30 Representative sites was surveyed twice, it is appropriate to conduct some statistical procedures examining the changes from survey #1 to survey #2. A preliminary approach is to determine, for each litter category, how many sites had increased litter counts and how many had decreased litter counts. Table 7 shows the results.

Table 7 - Changes in Litter at Representative Sites

Category	Increase	Decrease	Same
Bev. Containers	13	12	5
Construction/Industrial	12	18	0
Fast Food (FF) - All	12	15	3
FF - Cups & Lids	10	13	7
FF - Straws/Wrappers	5	15	10
FF - Other Items	13	16	1
Home Items	12	14	4
Paper	19	10	1
Snack Wrappers	17	10	3
Tobacco-Related	12	12	6
Vehicle Debris	18	5	7
Total Litter	**17**	**10**	**3**

Table 7 shows the number of Representative sites where litter increased, decreased or remained the same between the Initial survey and the Tourist Season survey.

Total Litter increased at 17 sites and decreased at 10 sites, with three sites remaining exactly the same. Among the 11 categories from Beverage Containers through Tobacco, a somewhat surprising balance seems to exist. Within four categories more sites increased in litter counts, while in six categories more sites decreased in litter counts; Tobacco had equal numbers (12 up, 12 down). The increases suggest that some sites may not have been cleaned and additional littering may have occurred as well between the surveys. The decreases suggest that some sites were cleaned up and minimally littered during the interval between the surveys.

To examine the changes more closely, averages were calculated and t-tests performed to look for statistically significant changes. The results are shown in Table 8, which shows the average litter by category for both surveys at all Representative sites.

Table 8 - Litter by Category at Representative Sites

Category	Avg. Initial	Avg. Tourist	Avg. Inc/Decrease
Beverage Containers	5.1	5.1	0.0
Construction/Industrial	10.0	9.8	(0.1)
Fast Food (FF) - All	8.7	6.8	(2.0)
FF - Cups & Lids	4.4	3.7	(0.7)
FF - Straws/Wrappers	1.3	0.7	(0.6)
FF - Other Items	3.0	2.4	(0.7)
Home Items	3.3	3.2	(0.1)
Paper	6.7	10.0	3.3
Snack Wrappers	4.3	5.7	1.4
Vehicle Debris	4.5	8.1	3.6
Tobacco-Related	1.4	1.2	(0.2)
Total Litter	**43.9**	**50.1**	6.2

Aside from Total Litter, the greatest change (either increase or decrease) from the Initial Survey to the Tourist Season Survey was for Vehicle Debris, which went from an average of 4.5 to an average of 8.1, an increase of 3.6. Total Litter went up an average of 6.2 items between surveys.

Paired comparison t-tests were conducted for each category, and none of the changes proved to be statistically significant at the .05 level.

Hotspot Sites

Comparable procedures were conducted for the 20 Hotspot sites. Again, for each litter category, there was a tally of how many sites had increased litter counts, how many had decreased litter counts and how many remained the same between the Initial Survey and the Tourist Season Survey. Table 9 shows the results.

Table 9 - Litter by Category at Hotspot Sites

Category	Increase	Decrease	Same
Bev. Containers	6	9	5
FF - Cups & Lids	7	7	6
FF - Straws/Wrappers	4	8	8
FF - Other Items	6	8	6
Snack Wrappers	9	5	6
Paper	9	9	2
Vehicle Debris	8	9	3
Construction/Industrial	9	8	3
Home Items	7	8	5
Tobacco-Related	5	8	7
Total Litter	**8**	**12**	**0**

Here, the balance of increases and decreases is perhaps even more striking than for Representative sites. For Total Litter, only 8 of the 20 sites increased in litter between surveys, while 12 sites decreased.

Again, to gain a difference perspective average litter counts were calculated by category for each survey – these averages were then analyzed using paired comparison t-tests. The results, showing the average litter by category for both Hotspot surveys are reported in Table 10.

Table 10 - Litter for Both Hotspot Surveys

Category	Avg. Initial	Avg. Tourist	Avg. +/-
Bev. Containers	9.3	5.7	(3.6)
Construction/Industrial	12.3	14.0	1.8
FF - Cups & Lids	2.9	1.9	(1.0)
FF - Straws/Wrappers	1.1	1.2	0.1
FF - Other Items	4.1	5.0	0.9
Home Items	4.4	4.6	0.3
Paper	6.6	5.1	(1.6)
Snack Wrappers	2.2	3.9	1.7
Tobacco-Related	1.7	1.2	(0.5)
Vehicle Debris	5.3	8.3	3.0
Total Litter	53.2	51.8	(1.4)

As was the case with Representative sites, the changes in averages from the Initial Survey to the Tourist Season Survey were minimal. Total Litter went down from an average of 53.2 items to an average of 51.8 items, a small decrease of 1.4 items. Among the different categories the largest change was a decrease of 3.6 for Beverage Containers.

Note that the average for Total Litter in Table 10 does not equal the sum of the individual category averages, since there were some miscellaneous items that were counted in the total that do not fall into the established categories. Once again, t-tests were performed within each category and none of the results proved significant at the .05 level.

Proximity Indicators

At each survey site, it was determined whether a proximity indicator was, as the phrase suggests, nearby. Such indicators being tallied included convenience stores, churches, beautified sites, fast food establishments, construction sites and grocery stores. The only proximity indicators that occurred often enough to warrant analysis were beautified sites, convenience stores, and churches.

Analyses were conducted to determine whether the proximity of these indicators was associated with the amount of litter found at the sites surveyed.

Convenience Stores

Nine of the 30 Representative sites were in proximity to a convenience store. One site was in proximity to two convenience stores. The data for both surveys were combined and analyzed. The results are shown in Table 11. Among Hotspot sites, only five of the 20 sites were in proximity to a convenience store. This small number would normally not justify doing a correlation analysis, since it makes the correlations especially susceptible to a single value; however, for completeness these correlations are also reported.

Table 11 - Correlation of Litter Categories to Convenience Store Proximity

Category	Rep. Sites	Hotspot Sites
Bev. Containers	0.0	(0.1)
Construction/Industrial	0.1	0.2
FF - Cups & Lids	(0.0)	0.0
FF - Straws/Wrappers	(0.0)	0.3
FF - Other Items	0.2	0.0
Home Items	(0.2)	(0.1)
Paper	(0.1)	0.3
Snack Wrappers	0.3	(0.0)
Tobacco-Related	0.3	0.3
Vehicle Debris	0.1	0.0
Total Litter	**0.066**	**0.063**

To clarify, a positive correlation coefficient means that, on the average, more litter of a specific category was observed at sites where the convenience store (a proximity indicator) was present. A negative correlation means less overall litter where those proximity indicators occur. Note that for both Representative and Hotspot sites, some correlations are positive and some are negative. No clear-cut pattern emerges. The strongest correlation was for Snack Wrappers in the Representative sites, which may well be expected to occur in the vicinity of convenience stores.

Churches

Eight of the Representative sites and six of the Hotspot sites were in proximity to churches. Correlation analyses were performed to determine whether the litter counts have any relation to the proximity of a church. The results are reported in Table 12.

Table 12 - Correlation of Litter to Proximity of Churches

Category	Rep. Sites	Hotspot Sites
Bev. Containers	(.128)	.224
Construction/Industrial	(.131)	.470
FF - Cups & Lids	(.179)	(.012)
FF - Straws/Wrappers	(.050)	(.071)
FF - Other Items	(.165)	(.063)
Home Items	(.202)	.484
Paper	(.401)	.046
Snack Wrappers	(.401)	(.156)
Tobacco-Related	(.144)	.137
Vehicle Debris	(.017)	(.162)
Total Litter	**(.277)**	**.260**

The correlations for the Representative sites are all negative. For all categories of litter, the counts were lower in proximity to churches. Two of the correlations are highlighted, indicating that these values are significant at the .05 level. For the targeted Hotspot sites, the correlation coefficients are more variable, with some positive (more litter near churches for those categories) and some negative (less litter near churches for those categories). Two positive values were statistically significant.

It should be noted that several of the Hotspot sites near churches had ditches at the survey location. It may well be the presence of ditches, and not the proximity of churches, that contributed most directly to any increase in litter rates; ditches will be addressed below.

Beautified Sites

Some sites were the focus of beautification efforts: 10 Representative sites and 11 Hotspot sites. Correlation analyses examined the effects of these efforts on litter rates in the surveys, and the results are reported in Table 13.

Table 13 - Litter at Beautified Sites

Category	Rep. Sites	Hotspot Sites
Bev. Containers	-.441	-.354
Construction/Industrial	-.324	-.133
FF - Cups & Lids	-.399	-.398
FF - Straws/Wrappers	-.380	-.065
FF - Other Items	-.202	-.491
Home Items	-.336	-.215
Paper	-.378	-.251
Snack Wrappers	-.279	-.128
Tobacco-Related	-.169	-.190
Vehicle Debris	-.184	.179
Total Litter	**-.466**	**-.341**

Every correlation coefficient for Representative sites was negative; none of the values were weak, and five of them were statistically significant at the .05 level. The Total Litter value is quite strong, and it seems very reasonable to conclude that the presence of beautified sites is associated with reduced litter rates. Correlations for Hotspot sites were also all negative, with the exception of Vehicle Debris.

"The Presence of Beautified Sites is Associated with Reduced Litter Rates."

Ditches

While conducting the survey of the Hotspot sites, it was noted that ditches were present at a number of the locations. Since ditches tend to collect and retain litter, this information was recorded, allowing an analysis of any difference in litter counts among sites with or without ditches. Average litter counts by category were calculated for the combined data of both Hotspot surveys. T-tests were performed to determine the potential statistical significance of any differences. The results are shown in Table 14, which shows the average litter counts for sites from both Hotspot surveys with or without ditches present.

Table 14 - Hotspot Litter Counts & Ditches

Category	No Ditch	Ditch
Bev. Containers	5.4	29.3
Construction/Industrial	22.5	31.9
FF - Cups & Lids	1.8	9.3
FF - Straws/Wrappers	1.2	3.8
FF - Other Items	6.3	13.3
Home Items	5.4	14.3
Paper	8.6	16.3
Snack Wrappers	5.3	7.0
Tobacco-Related	1.8	4.4
Vehicle Debris	13.2	14.1
Total Litter	**74**	**151.3**

For every category, the average litter counts for sites with a ditch (n=8) are greater than for sites without a ditch (n=12) as seen in Figure 14. For Beverage Containers, Cups & Lids, and Total Litter, the highlighted categories, t-test results indicate that the differences are statistically significant at the .05 level. Ditches clearly act as accumulators of litter.

It is a striking result that for Beverage Containers and for Cups & Lids, the average "with ditch" value is more than five times greater than the "without ditch" value. Also, the Total Litter average for Hotspot sites with ditches is twice the average for Hotspot sites without ditches.

Figure 14 - Litter in Ditch at H-3

Section 6
Conclusions and Recommendations

Conclusions

1. Although litter at the Representative sites rose 14% between the Initial survey and the Tourist Season survey, the types of litter that increased (e.g. paperboard and corrugated boxes) seem to suggest that tourists are not the primary litterers in Stump Sound.

2. Litter at Hotspot sites was 3% lower during the tourist season, suggesting that hotspot litter is more likely attributable to local residents and those living in areas directly adjacent to Stump Sound.

3. Sites in areas with beautification had consistently less litter on average compared to sites that had no beautification, suggesting a positive relationship between beautification and low litter rates.

4. Although most homes damaged by Hurricane Florence had been restored well before the first litter survey was conducted, some homes were still in the process of being restored during the first litter survey as demonstrated by discarded roofing and other construction debris that was observed. Construction-related litter dropped from 7.5 % in the Initial survey to 4.5% in the Tourist Season, suggesting that restoration from this storm damage was near completion.

5. When Representative and Hotspot data for both surveys were totaled, Paper items were the most prevalent category of litter found in Stump Sound (16%). The largest component was paper pieces that had been mowed over.

6. Intentionally dumped trash near convenience centers was deemed to have been dumped primarily by local residents and those living in areas directly adjacent to Stump Sound in order to avoid paying tip fees.

7. Although the impact of a food desert scenario was discussed, only the northwestern portion of Stump Sound, a rural area, seemed to meet the requirements of that definition.

8. Averaging all four surveys together, about 28% of all litter was recyclable paper and beverage containers.

Recommendations

1. Place hidden cameras at Hotspot sites near convenience centers, ensuring that they are monitored and used by code and police officers to aid enforcement efforts.

2. Consider developing a joint community beautification program between Stump Sound Township or Onslow County and Camp Lejeune.

7. Given how prevalent mowed over items of litter were, obtain mowing schedules and ensure that cleanups are conducted before roadside mowing begins. Put in place and enforce contractual obligations requiring that items of litter are removed prior to mowing.

3. Focus cleanup efforts on litter in ditches as many of the ditches in the area acted as accumulators for beverage containers and other prevalent components of litter and were identified as Hotspot sites.

4. Consider a community-wide program to ensure the proper and timely collection and disposal of construction and demolition debris, especially after natural disasters.

5. In lieu of a trash tip fee, have the costs for the convenience centers and the solid waste tip fees included in the County's property tax billings to property owners. This may help to eliminate the incentive for illegal dumping. Such fees can be based on various factors such as gross floor area, generator category, or and for the number of units for multi-family dwellings.

Section 7
Appendices

Appendix A - Litter Categories by Survey

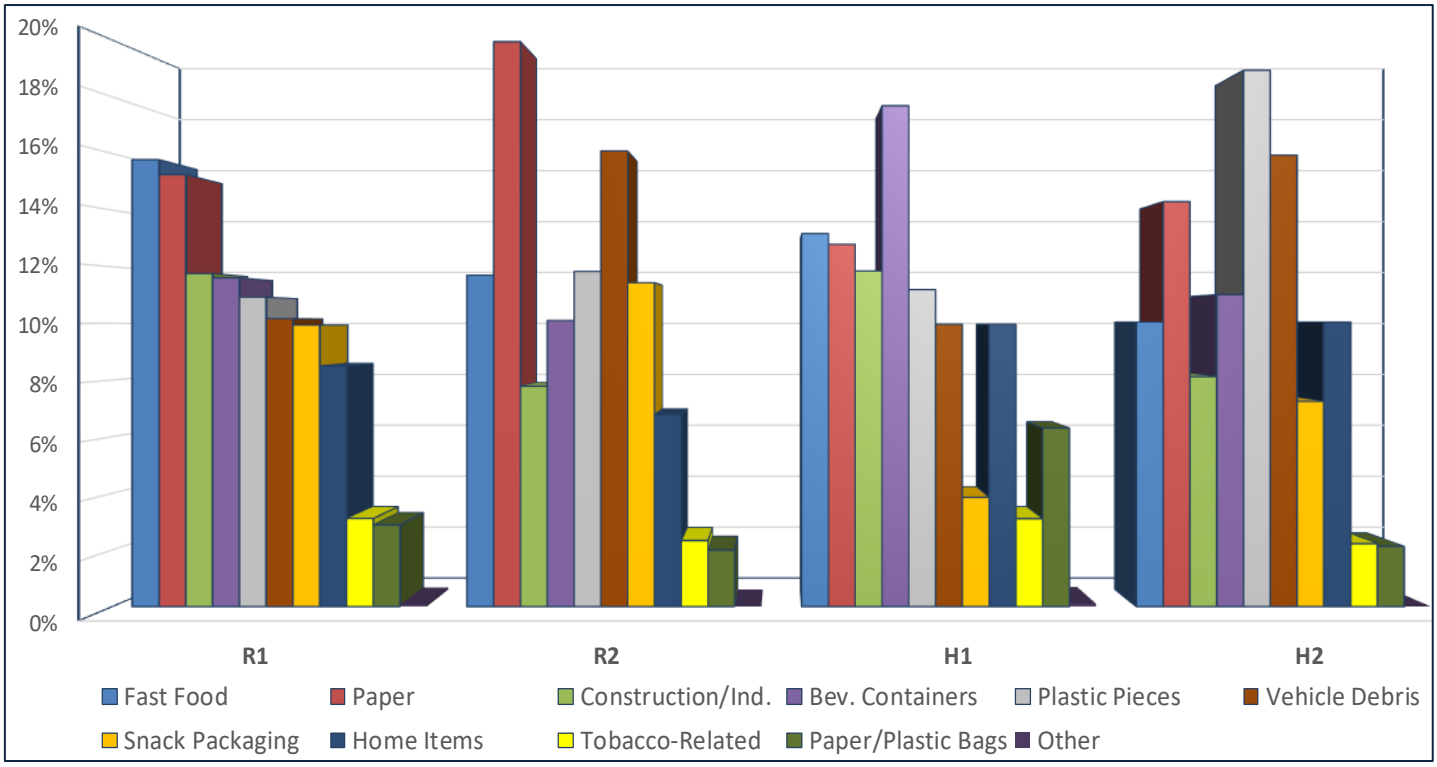

Figure 15 - Litter Categories by Survey

Appendix B - Litter Surveys by Category

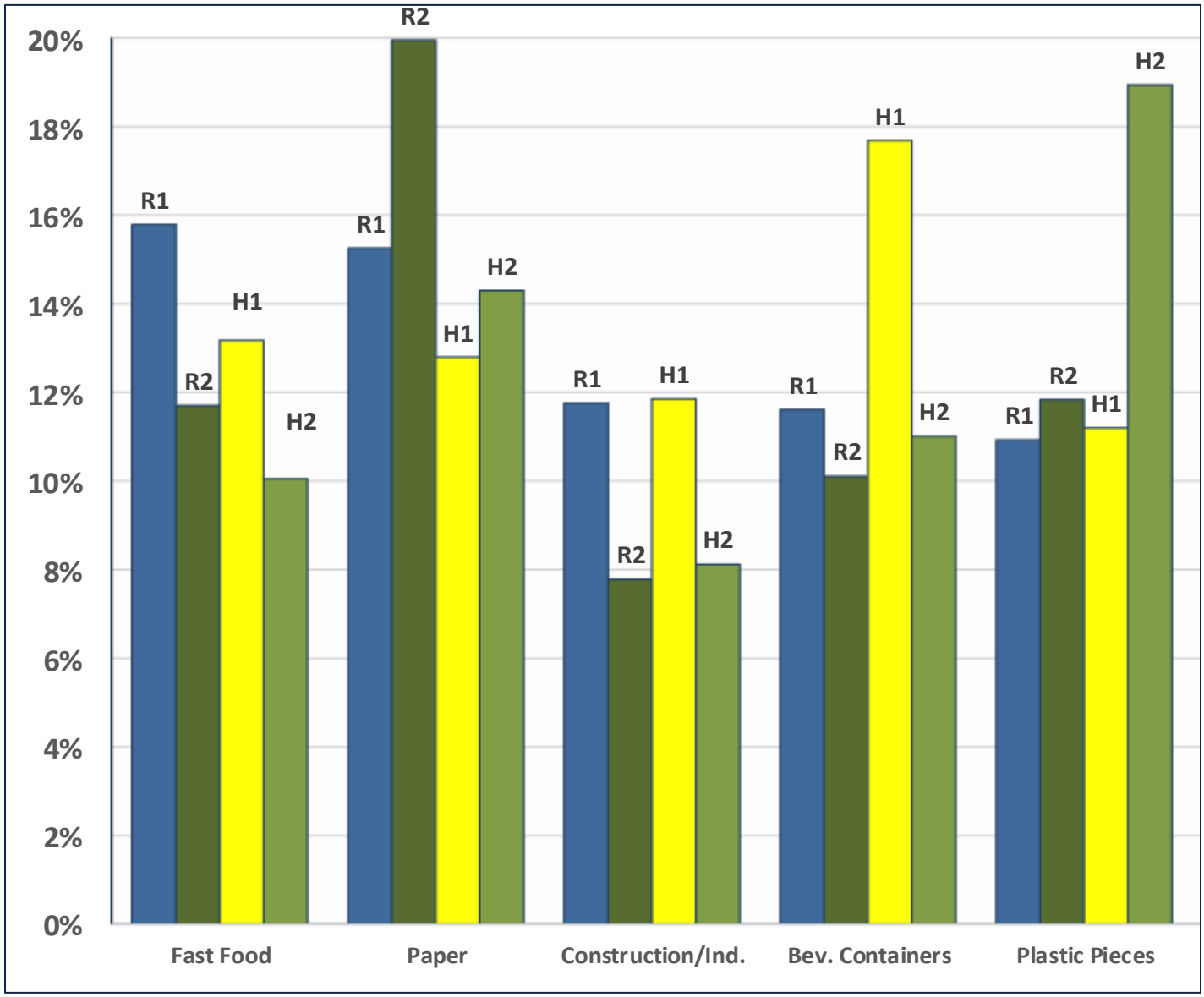

Figure 16a - Litter Surveys by Category

Appendix B - Litter Surveys by Category (cont.)

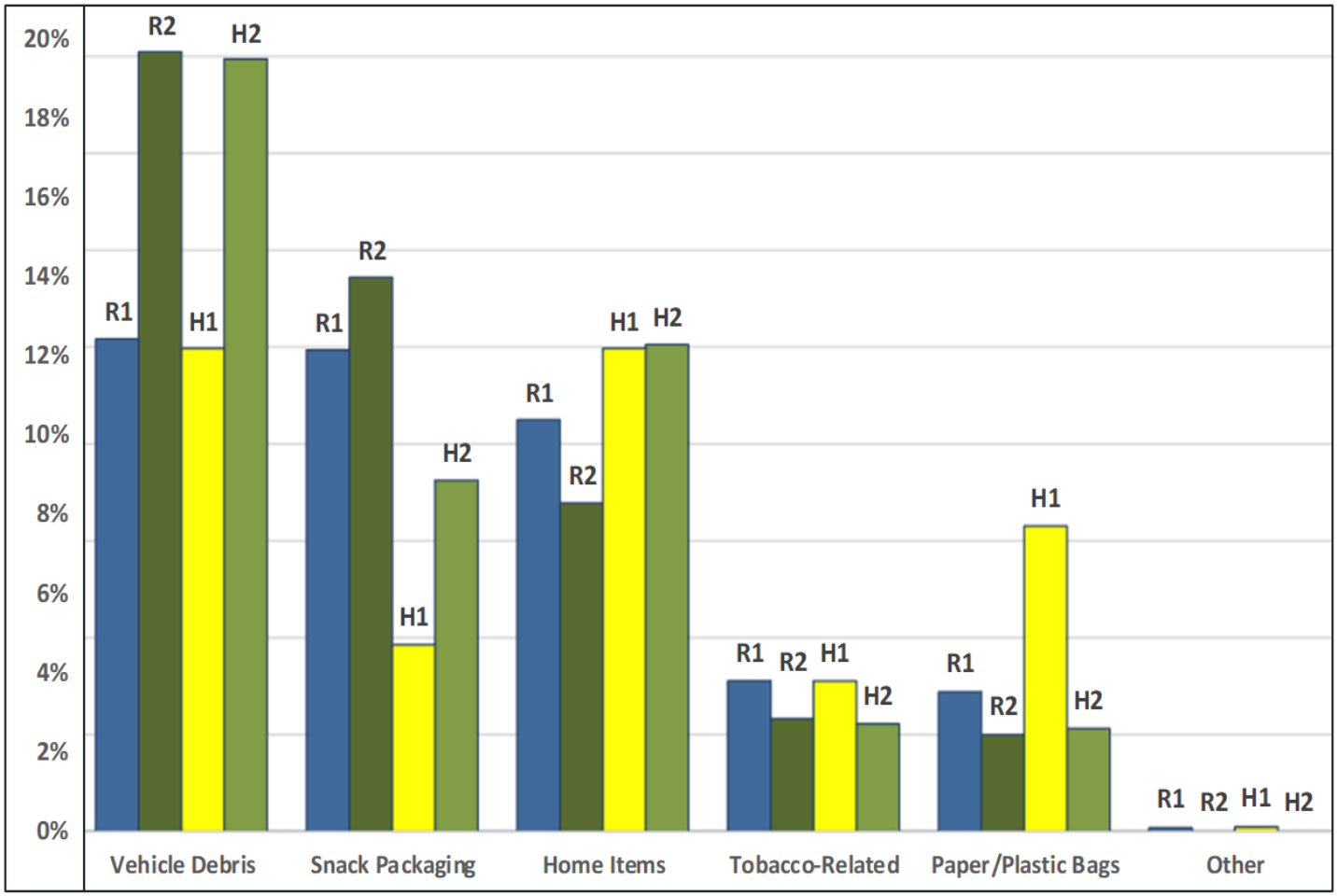

Figure 16b - Litter Surveys by Category

Appendix C - Site Locations - Representative Sites

Representative Sites	
Site #	**Location**
R-1	NC 172, North of NC 210
R-2	NC 172, North of NC 210
R-3	NC 172, North of NC 210
R-4	NC 172, North of NC 210
R-5	NC 210, West of NC 172
R-6	NC 210, West of NC 172
R-7	NC 210, West of NC 172
R-8	Hardy Graham Road, East and near the intersection with Cool Breeze Lane
R-9	Dolly Lane, Past the intersection with Haws Run Road
R-10	Brian's Woods Road, South of the intersection with 53
R-11	Verona Road (SR 1121), Near the intersection with N. Loy Avenue (SR 1153)
R-12	NC 50, East of US 17
R-13	SR 1518, East of NC 210
R-14	SR 1518, East of NC 210
R-15	NC 210, North of SR 1583
R-16	NC 210, South of Seascape Dr
R-17	SR 1568, East of NC 210
R-18	SR 1568, East of NC 210
R-19	NC 50, East of US 17 in Holly Ridge area
R-20	SR 1105, North of SR 1108
R-21	SR 1105, North of SR 1108
R-22	NC 50, West of US 17
R-23	SR 1531, North of SR 1532
R-24	NC 50, West of US 17
R-25	SR 1518, North of NC 210
R-26	SR 1568, North of Bottlenose Blvd
R-27	SR 1515, West of 1519 near Forever Fit fitness center
R-28	SR 1538, East of US 17
R-29	SR 1534, South of SR 1535
R-30	SR 1537, East of SR 1567

Appendix D - Site Locations - Hotspot Sites

Hotspot Sites	
Site	**Location**
Area 1	**Verona Convenience Center (2531 Dawson Cabin Rd. Jacksonville NC): 1-2 miles in either direction**
H-1	Lib Lane off Dawson Cabin Road, Jacksonville
H-2	Dawson Cabin Rd at 948 Haws Run Road traveling east: 2 miles to conv. center
H-3	2531 Dawson Cabin Rd to intersection with Henderson Rd: traveling east 2 miles past conv. center
Area 2	**Hwy 50 toward Hwy 17 (Traveling south to the beach)**
H-4	Hwy 50 near the intersection with Haws Run Rd (SR 1105) traveling south
H-5	Hwy 50 near the intersection with Hwy 17 traveling south
Area 3	**Morris Landing Rd. in Holly Ridge (Rt 1538)**
H-6	Morris Landing Rd (Rt 1538) starts @ intersection with Holly Ridge Rd traveling south
H-7	Morris Landing Rd @ intersection with Hardison Rd traveling south
Area 4	**Old Folkstone Rd (Rt 1518) starting at intersection with Hwy 17 going eastward to Hwy 210**
H-8	550 State Road 1518 (Old Folkstone Rd), Holly Ridge
H-9	Street in front of Food Lion parking lot at 965 Old Folkstone Rd in Sneads Ferry near Hwy 210
Area 5	**1167 NC-210 to 1076 NC-210 (1-mile past Rt 172) toward North Topsail Beach**
H-10	NC-210, Sneads Ferry about one mile north of Rt 172
H-11	212 NC-210, Holly Ridge about 1/2 mile west of Hwy 17 (Wilmington Hwy)
H-12	2896 NC-210 (Island Dr.), Topsail Beach
Area 6	**Hwy 172 from US 17 eastward to the bridge (route to the landfill)**
H-13	NC-172 at intersection with Rt 210
H-14	NC-172 at intersection with Middleton Place
Area 7	**116Wheeler Creek Road to Everett Dr. to Fulchers Landing Campground in Sneads Ferry**
H-15	Sneads Ferry Road/Peru Road @ Fulcher Landing Road
H-16	Fulchers Landing Campground
Area 8	**New River Inlet Road (Rt 1568) in North Topsail Beach**
H-17	New River Inlet Road: beach access parking lot on 41 Ocean Bay Village Dr N
H-18	New River Inlet Road: intersection with Fishing Pier Lane
H-19	555 New River Inlet Road: North Topsail Beach Town Park near Onslow County Park
Area 9	**Surf City**
H-20	2460 Island Dr. to Nelva R. Albury Recreation Area (213 Broadway St.)

Appendix E - Convenience Centers

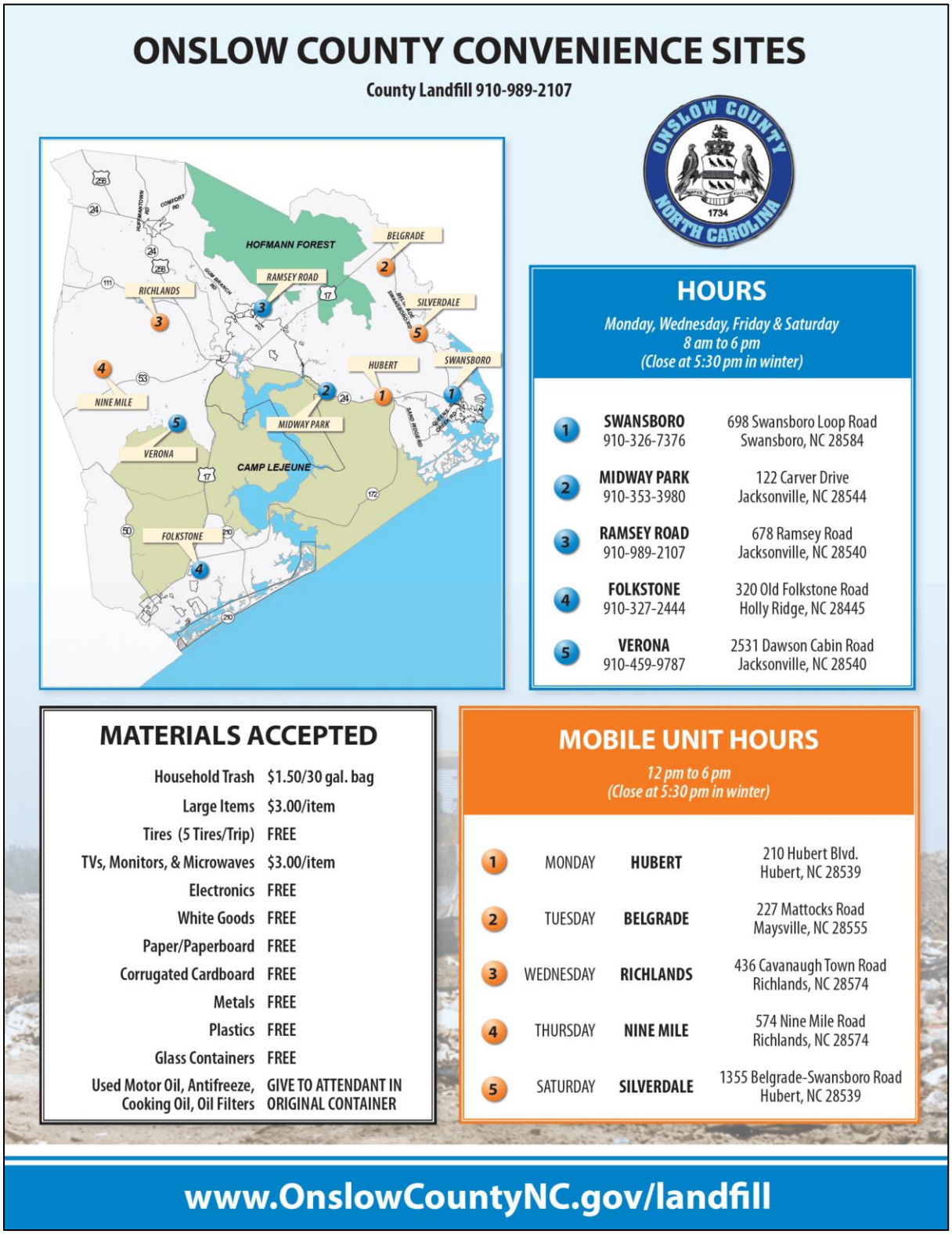

Figure 17 - Convenience Centers Information

Appendix F - Company Background

Environmental Resources Planning, LLC focuses exclusively on litter-related research, studies, surveys and technical assessment reports. Our staff led litter surveys and studies in the Anacostia Watershed, Georgia, Honolulu, Maine, Malibu, New Hampshire, New Jersey, North Carolina, Oakland, Ohio, Rhode Island, San Francisco, Santa Monica, Tennessee, Texas, Toronto, Vermont, Virginia and Washington, D.C. in addition to leading Keep America Beautiful's 2009 National Litter Survey and Litter Cost Study.

Field crews under our direction have surveyed more than 40 million square feet of roadways and recreational areas across North America. Our senior staff has authored a number of key litter-related publications including "Litter: Literature Review" for Keep America Beautiful. Our litter-related work has been featured in National Geographic, Time and the New York Times as well as on NPR and ABC's Good Morning America.

The 2019 North Carolina Litter Survey was led by Steven R. Stein. The statistical aspects of this project were overseen by Dr. Ron Visco, who holds a Ph.D. in Research Design and Statistics. The field work planning was overseen by Emilie Knapp and Kristian Ferguson. Each of these senior staff has worked on at least 15 litter surveys.

For further information, go to: *www.erplanning.com*

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