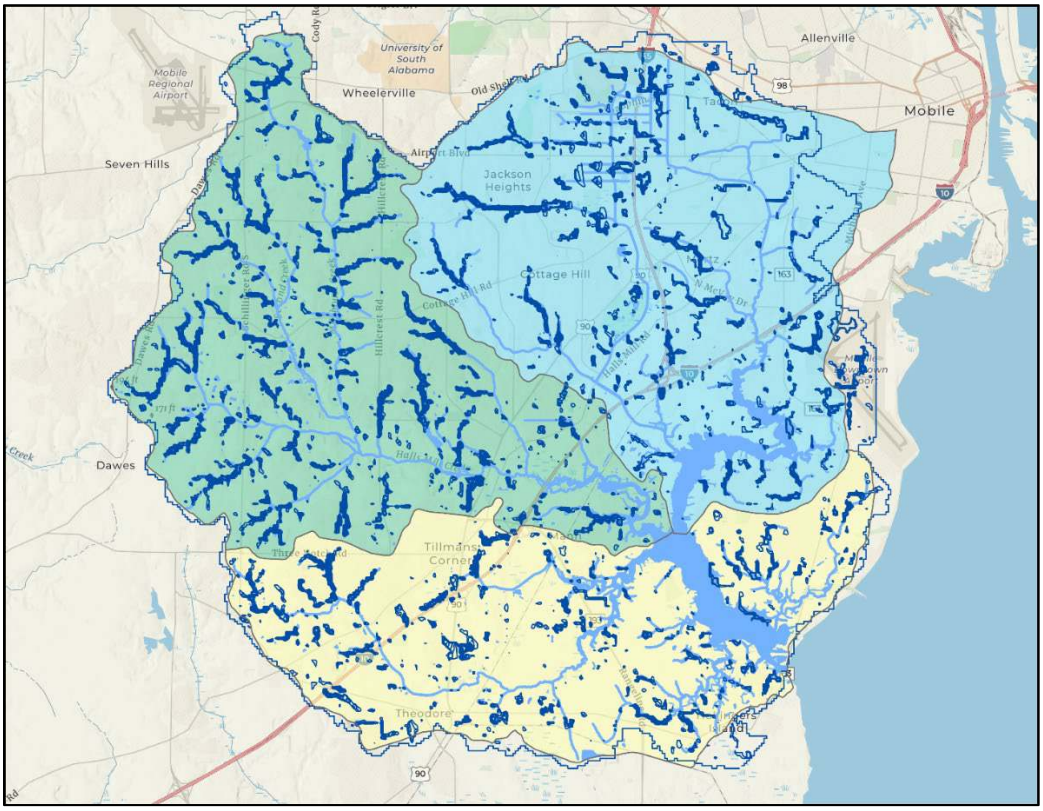
Dog River Watershed Trash Abatement Program Hydrologic and Land Use GIS Analysis to Identify Trash Concentrations



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Introduction

Of all the efforts to better manage trash throughout the Dog River Watershed, no previous studies were designed to determine the composition of the trash; its sources; or the types of businesses, institutions, or neighborhoods responsible for the trash escaping into area waterways. This information is necessary to determine how best to stop the generation of waterborne trash at the source.

This study was undertaken as a component of the Dog River Clearwater Revival's U.S. Environmental Protection Agency (EPA) Gulf of Mexico Program-funded Dog River Watershed Comprehensive Trash Abatement Program. To better reduce occurrences and extent of waterborne trash in the Dog River Watershed and the City of Mobile, the Mobile Bay National Estuary Program performed an analysis of the landscape, land uses, hydrology, demographics, and types of businesses, institutions, or neighborhoods responsible for trash escaping into area waterways. This study combined outputs of a hydrologic model with geospatial analysis of the Watershed to identify correlations between high-velocity runoff during peak flows, various upstream land uses, and high volumes of litter accumulation. It is intended to identify areas within the Watershed with the highest potential for stormwater-conveyed trash to enter waterways and locations where investments in enhanced litter abatement, recovery, and capture activities will be most productive.

The purpose of this effort is to promote the wise stewardship of the Dog River Watershed. The project goal was to guide reductions in waterborne trash/litter by informing strategies for infrastructure placement, citizen engagement, regulatory improvements, and City of Mobile resource management. Our objectives were to:

1. Use hydrologic models and geographic information system datasets to identify likely pathways of litter to receiving waters,
2. Identify strategic locations for placement of instream litter capture devices,
3. Identify areas to promote community clean-ups, and
4. Identify areas to mitigate litter near or related to commercial uses.

Watershed Landscape Characterization

The Watershed

The Greater Dog River Watershed encompasses approximately 93.3 square miles with 174 miles of streams and waterways (USGS, 2017). Its boundary begins just inland from Mobile Bay, runs west through the City of Mobile, sweeps north then runs south just east of the Mobile Airport before turning east again towards Mobile Bay and curving back to the north to encompass most of the commercial and many of the residential portions of the City of Mobile.

According to the Center for Business and Economic Research at the University of Alabama, in 2014 the population of the Greater Dog River Watershed was 146,237 and projected to increase to 152,627, or by 1.5%, by 2030.

Hydrologic Units

Occupying much of the area of the City of Mobile and located in Mobile County Alabama, the Greater Dog River Watershed, or Dog River Watershed Complex, is the geographical area comprising three individual U. S Geological Survey (USGS) 12-digit hydrologic unit codes (HUCs): the Upper Dog River (HUC 031602050102), Halls Mill Creek (HUC 031602050102), and Lower Dog River (HUC 031602050103) watersheds shown in Figure 1 (USGS, 2017). The Complex encompasses approximately 59,703 acres (or 93.3 square miles)(USGS, 2017), stretches approximately 12 miles inland from the

western shore of Mobile Bay, and spans almost 11 miles from north to south. This Complex also includes 101 smaller individual drainage areas, called "catchments."

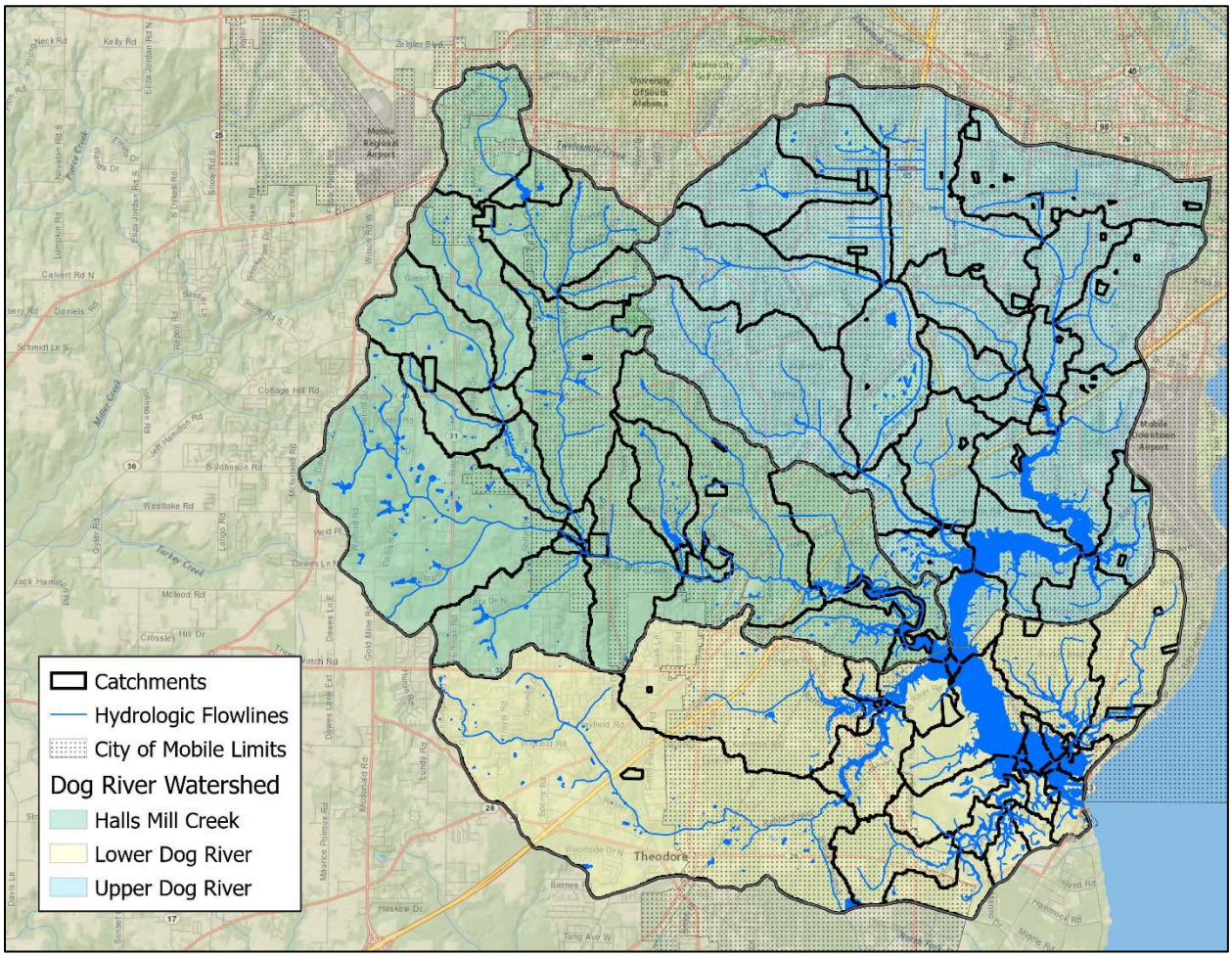

Figure 1. The greater Dog River Watershed, comprising three 12-digit HUCs, the Upper Dog River, Halls Mill Creek, and Lower Dog River watersheds, and 101 smaller drainage units, called catchments.

Land Use/Land Cover

Land use and land cover within the Dog River Watershed Complex is predominantly developed. The three greatest land uses are urban (60.4%), upland forests (17.7%), and woody wetlands (13.3%). Together, these three-major land use and land cover classifications account for 91.4% of the Complex (NLCD, 2011). Of the area of urban land use, 17,943 acres (or 30% of total Complex area) includes low, medium and high intensity urban centers, shown in Figure 2 (NLCD, 2016). Impervious cover includes elements in the urban landscape that limit water infiltration, like roads, parking lots, sidewalks, rooftops, and other hard surfaces. Increases in areas of impervious cover in a watershed are associated with increased volume and velocity of stormwater runoff and increased loading of pollutants, including litter.

Impervious surfaces cover an estimated 16.1% of the Dog River Watershed Complex, 21.9% of the Upper Dog River Watershed, 13.6% of the Halls Mill Creek Watershed, and 11.7% of the Lower Dog River Watershed (MBNEP, 2017).

Of the Dog River Watershed Complex's approximately 174 miles (918,819 linear feet) of surface drainage systems that flow to Dog River, approximately 57.7 miles (304,761.79 linear feet) occur in the Upper Dog River Watershed (USGS, 2017). Named streams in this Watershed include Bolton Branch (East and West), Dog River, Eslava Creek, Montlimar Canal, Michael Boulevard Canal, Moore Creek, Robinson Bayou, and Spencer Branch. Approximately 65.2 miles (344,073 linear feet) of surface drainage occurs in the Halls Mill Creek Watershed, including Campground Branch, Halls Mill Creek, and Spring Creek. Approximately 51.1 miles (269,819 linear feet) of Lower Dog River Watershed streams include Alligator Bayou. Perch Creek, Rabbit Creek, Rattlesnake Bayou, and Whiskey Branch (MBNEP, 2017).

The National Land Cover Database (NCLD) defines "low intensity developed" areas as a mixture of constructed materials and vegetation with impervious surfaces accounting for 20 to 49 percent of total cover. These areas mostly commonly include single-family housing units. "Medium intensity developed" areas are defined as those accounting for imperviousness between 50 to 79 percent and containing a mixture of constructed materials and vegetation. "High intensity developed" areas are largely impervious (80 to 100 percent) and include apartment complexes, row houses, and commercial and industrial units (NLCD, 2016). Developed areas within the Dog River Watershed Complex are shown in Figure 2.

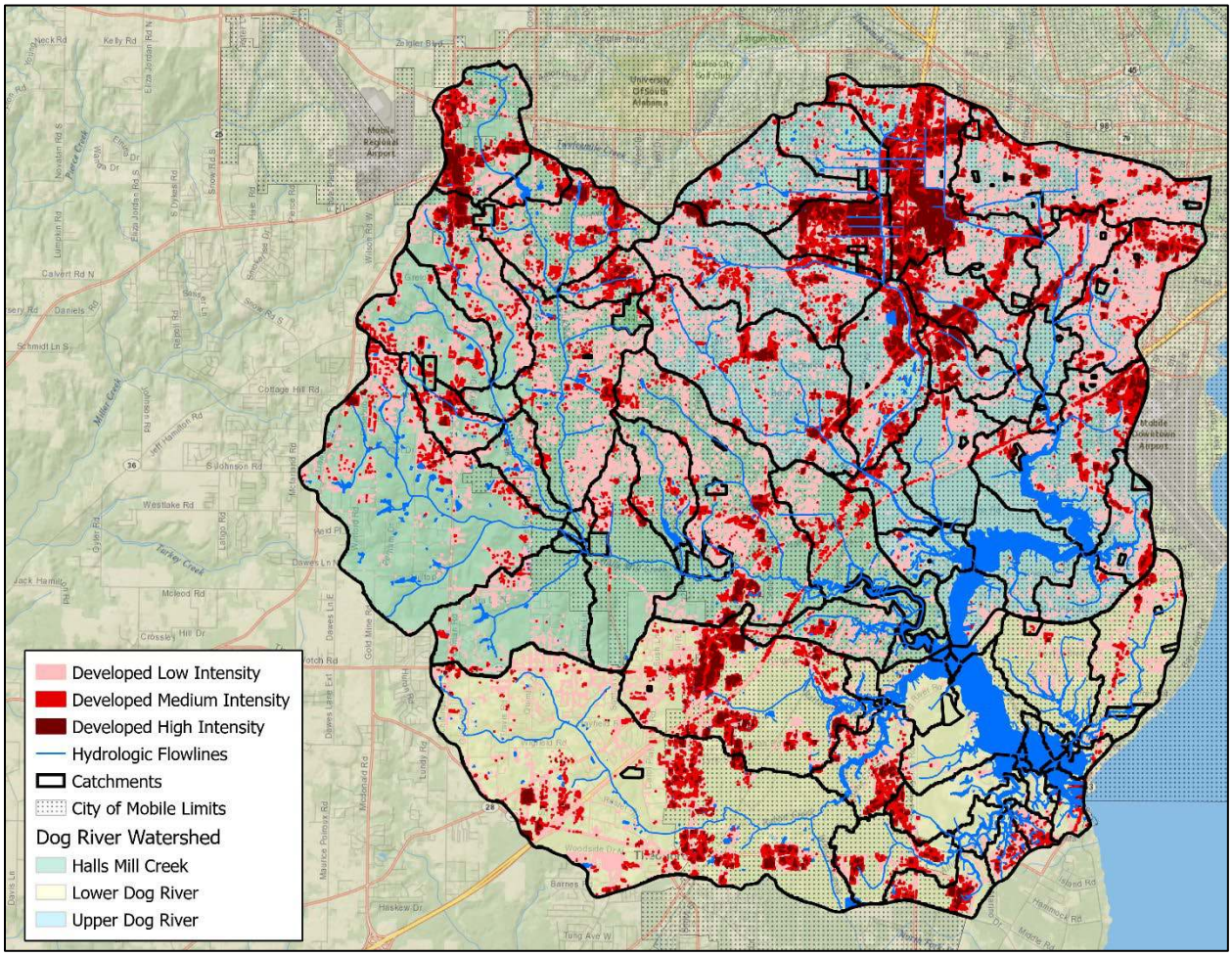

Figure 2. Developed areas within the Dog River Watershed Complex with catchment boundaries indicated.

Hydrologic Flows

The outputs of a hydrologic model built for the Dog River Watershed using the U.S. Army Corps of Engineers Gridded Surface Subsurface Hydrologic Analysis (GSSHA) system were introduced to the geospatial analysis described above. The hydrologic model output was developed using rainfall distributions, meteorological information supplied by the weather stations, and level loggers with telemetry supplemented by USGS gauges to determine where water aggregates and enters waterways in a watershed during different rain events. This output provided quantitative estimates of loadings simulating both upland runoff and instream processes, indicating how water moved through the system during rain events. The geospatial dataset used in the analysis indicated locations in each catchment, shown in Figure 3, where water accumulation, or pooling, reached depths of at least two inches during a six-inch rain event. This depth is indicative of stormwater runoff volumes sufficient to carry discarded litter towards or into receiving waters.

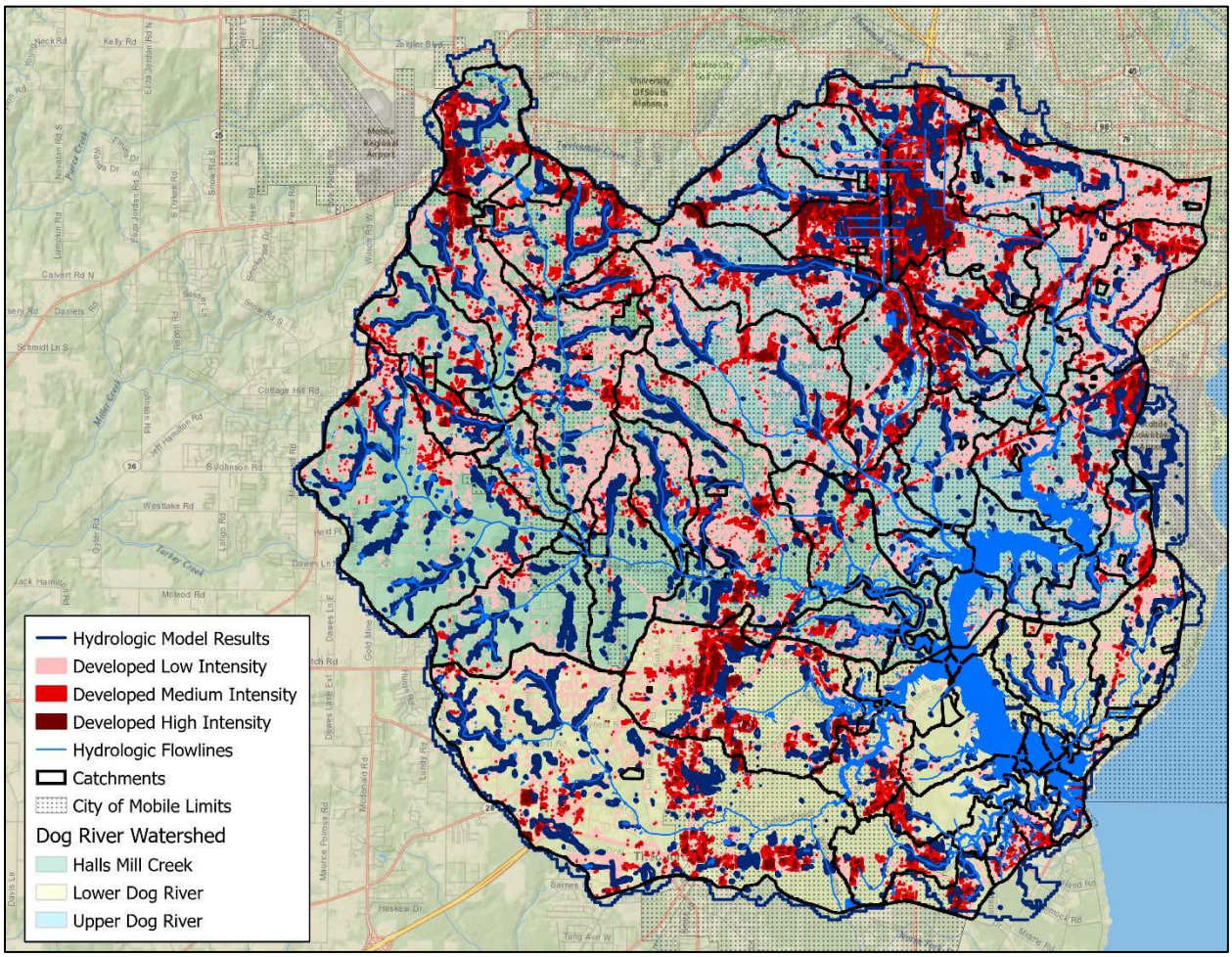

Figure 3. Hydrologic model results for the Dog River Watershed Complex showing areas where water accumulates or pools to depths of at least two inches during a six-inch rain event.

Methodology

This study combined outputs of a hydrologic model with geospatial analysis of the Watershed to identify correlations between areas of water accumulation/pooling during significant rain events, various upstream land uses, and high volumes of litter accumulation. The purpose of this analysis was to strategically target trash abatement and management efforts within the Dog River Watershed Complex and City of Mobile to areas where the greatest impact could be achieved.

Towards development of strategies to mitigate stormwater-conveyed and delivered waterborne trash and litter, the MBNEP first gathered datasets, then undertook a desktop geospatial (using geographic information systems [GIS] data) analysis to identify potential target catchments, identify the locations of instream waterborne-trash-capture devices, and guide field surveys to ground truth desktop analysis conclusions and refine selection of target catchments.

Data

The data used in conducting this analysis included data produced by federal and local agencies and data collected in the field, including through installation and maintenance of Litter Gitter instream trash capture devices by Osprey Initiative, LLC (Osprey). They evaluated and documented litter collected over a period between April and October 2020. Litter collected was characterized using the Escaped Trash Assessment Protocol (ETAP) developed by the EPA as a quantitative survey tool providing a standard method for collecting and assessing litter data (https://www.epa.gov/trash-free-waters/best-management-practices-tools).

Datasets secured to conduct the geospatial analysis included the following:

- USGS Watershed Boundary Dataset 12-digit HUCs
- National Hydrography Dataset Plus Version 2 (NHDPlus)
- Hydrologic Model Data 2019, John Curry, Hydro-Engineering Solutions. Model output indicated areas of two inches or greater of water accumulation/pooling during a six-inch rain event.
- Hydrologic Model Data 2019, John Curry, Hydro-Engineering Solutions. Model output identified instream eddy systems.
- National Land Cover Database (NLCD) 2016
- City of Mobile, Land Use 2010 (periodically updated)
- American Community Survey Dataset, Low to Moderate Income Census Tracts 2011-2015
- Osprey Initiative Litter Gitter Escaped Trash Assessment Protocol (ETAP) Collection Data

Geospatial Analysis: The Landscape

The USGS Watershed Boundary Database was used to delineate the Dog River Watershed Complex and its three constituent 12-digit HUCs, both within and outside the geopolitical boundaries of the City of Mobile.

The NHDPlus dataset was applied to the Dog River Watershed Complex to reduce this almost-60,000-acre area into *catchments*, smaller drainage areas more manageable for both analysis and subsequent mitigation. The 101 catchments of the Dog River Complex (shown in Figure 1) range in area from 25 to 6,406 acres.

Geospatial Analysis: Litter Zones

Contracted by the City of Mobile to collect litter from Dog River and its tributaries using the City's trash boat and walking banks, Osprey designated stream reaches as numbered "zones" for management, tracking,

and analysis. Figure 4 shows these 45 Zones, represented by a stream with a 250-foot buffer. Darker colors indicate greater total masses of litter collected. While these data were useful for management purposes and even informed locations for initial Litter Gitter installation, they were exclusively derived from wider, deeper, and more navigable stream reaches. With concerns that smaller, less-accessible waters were not as well represented by these data, this investigation employed a more inclusive analysis of data sets incorporating hydrology and land uses across the entire Dog River Watershed Complex.

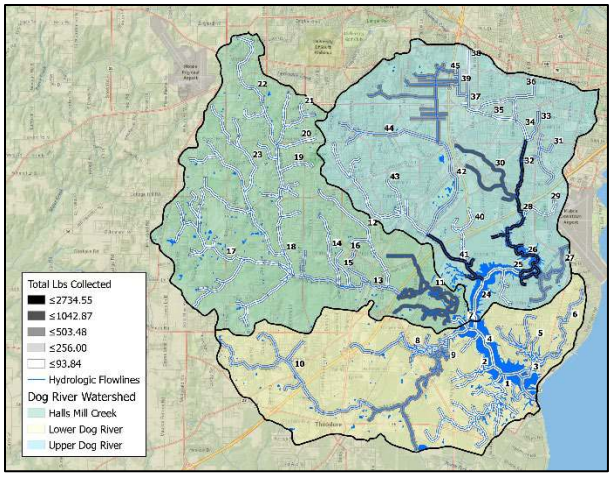

Figure 4. Litter zones identified by Osprey Initiative during City-contracted trash collection and analysis.

Geospatial Analysis: The Hydrology

By combining the landscape data and hydrologic model outputs, catchments were identified where intersections were found between areas experiencing at least two inches of pooling during six-inch rain events and concentrations of urbanization. These catchments included both potential sources of litter and sufficient stormwater runoff to carry it into receiving waters.

Since eddy systems, often associated with stream confluences, were thought to be potential areas of litter accumulation, the hydrologic model output was used to identify their locations, which are shown in Figure 5. Upon field surveys, eddies were found to occur only during particularly high flow events, so no further assessments of this potential were examined in this exercise.

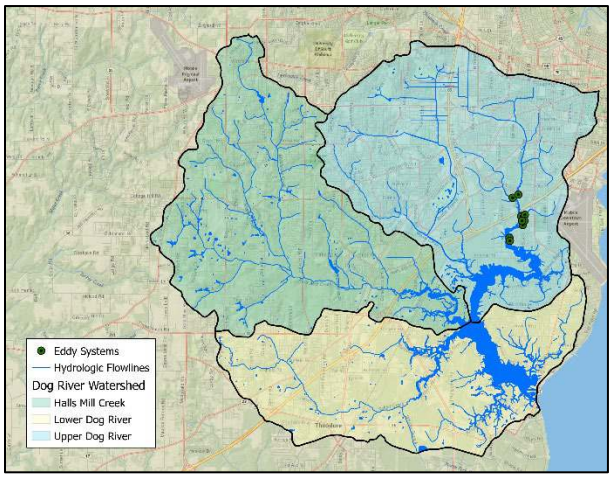

Figure 5. Eddy locations identified in hydrologic model locations.

Geospatial Analysis: Litter Gitters

During this analysis, six Litter Gitter instream trash capture devices were in operation throughout the Watershed. The geospatial analysis assessed where Litter Gitters intersected with target catchments.

Ground Truthing of Geospatial Data

To validate the results of the geospatial analysis, several potential target catchments were ground-truthed through field surveys. Since five Upper Dog River Watershed target catchments were already equipped with Litter Gitter capture devices supplying field data, these target catchments were not ground-truthed. Locations field surveyed were informed by intersection of areas of pooling indicated by hydrologic models with significant development indicating potential for litter conveyance. Field surveys were undertaken to collect data at each of the remaining target catchments to secure data, including but not limited to waterbody type, site conditions and land use impacts.

Refinement of Geospatial Analysis: Commercial and Residential Concentrations

To characterize land uses as Residential or Commercial, and with the City of Mobile Land Use dataset only providing individual points to designate single units as Residential or Commercial, the NLCD

dataset was used to identify areas of low, medium, and high-intensity development. Low-intensity development includes areas with a mixture of constructed material and vegetation with impervious surfaces accounting for 20 to 49 percent of total cover, most commonly including single family housing units. Medium intensity development is also a mixture of constructed material and vegetation but with 50 to 79 percent impervious cover. High intensity development is characterized by highly developed areas with 80 to 100 percent impervious cover. Although both medium and high intensity areas of development include apartment complexes and row houses, they are where people reside or work in high numbers and include commercial and industrial units. Therefore, this analysis interpreted low intensity development as a proxy for Residential concentrations and medium and high intensity development as the proxies for Commercial concentrations. These data were incorporated into the analysis to better understand sources of trash; i.e., did litter emanate from commercial establishments indicating a need for better grounds maintenance, or did it emanate from residential areas indicating a need for community education, engagement, and involvement?

Refinement of Geospatial Analysis: Low-Income Areas

The American Community Survey Dataset was overlaid to identify catchments intersecting census tracts with greater than 50% low-to-moderate-income households, since these areas meet eligibility criteria for U.S Department of Housing and Urban Development Community Development Block Grant (CDBG) funding. These data were calculated using U.S. Census blocks in which 51% of households earn less than 80% of the area median income. By identifying where correlations exist between these neighborhoods and high volumes of litter, the potential exists for use of CDBG funds to support interim assistance measures such as neighborhood clean-up campaigns.

Results: Overview of Target Catchments

Prioritization Criteria

Since Schueler et. al. (1994) and others have described the well-established relationship between impervious cover and increased pollutant loads, including litter, the analysis identified all catchments with urbanization of 25% or greater, the threshold at which Schueler's work characterized receiving waters as "degraded."

Criteria used for designation as a *target catchment* included:

1) The catchment area is at least 25% urbanized, and
2) Hydrologic model output for the catchment indicates it includes areas of pooling or accumulation of at least two inches of water during a six-inch rain event, or
3) The catchment includes waters or streams draining an adjacent catchment meeting the first two criteria.
4) The catchment falls below the 25% urbanization threshold but includes areas of concentrated urbanization near water pooling.

Table 1: Area of target catchments

Catchment	Name	Acres
1	Airport/Milkhouse Creek	1,074
2	Creekwood/2nd Creek	1,201
3	Grelot/UT-Milkhouse Creek	355
4	Eslava Creek	2,187
5	Michael/Montlimar Creek	712
6	Mertz/Bolton Branch	772
7	Morningside/Bolton Branch	486
8	Halls Mill/Moore Creek	1,263
9	Hwy 90/Rattlesnake Bayou	2,805
10	Carol Plantation/Rabbit Creek	6,406
11	Providence Hospital	278
12	Springhill Hospital	687

Based on these criteria, 12 catchments, with numbers retained from the NHDPlus dataset (see Table 1), were designated as *target catchments,* and are shown in Figure 6. One of the twelve catchments, #10, located in the Lower Dog River Watershed, fell below the 25% impervious threshold but was selected and validated through field survey, due to the intensity of urbanization along Highway 90 including areas near Hamilton Boulevard and in Tillman's corner.

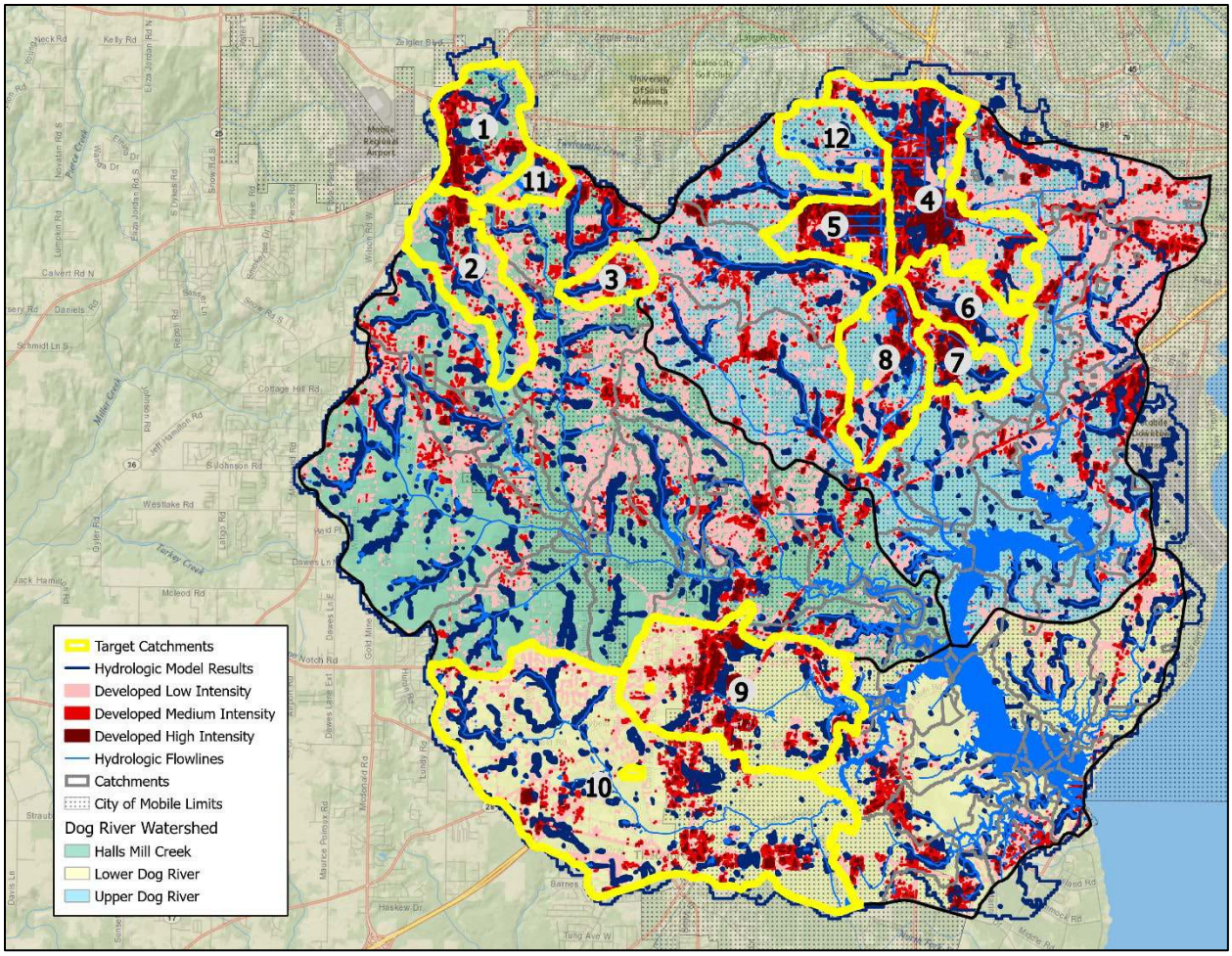

Figure 6. Map of Dog River Watershed Complex showing the 12 catchments meeting criteria for designation as target catchments. These target catchments retain the numbers designated in the NHDPlus dataset.

Table 2 provides data about the 12 target catchments (percent imperviousness, percent of catchment area within Mobile City Limits, and whether a Litter Gitter is installed there). Target catchments range between 20 to 81 percent impervious cover.

Table 2. Target Catchments with percent imperviousness, percent area within Mobile City Limits, and whether a Litter Gitter is installed.

Catchment	Name	Percent Imperviousness	Percent of area within Mobile City Limits	Litter Gitter Installed
1	Airport/Milkhouse Creek	42	72	No
2	Creekwood/2nd Creek	41	20	No
3	Grelot/UT-Milkhouse Creek	62	100	No
4	Eslava Creek	67	100	Yes
5	Michael/Montlimar Creek	81	100	Yes
6	Mertz/Bolton Branch	52	100	Yes
7	Morningside/Bolton Branch	48	100	Yes
8	Halls Mill/Moore Creek	43	100	Yes
9	Hwy 90/Rattlesnake Bayou	34	78	No
10	Carol Plantation/Rabbit Creek	20	37	No
11	Providence Hospital	41	54	No
12	Springhill Hospital	25	100	No

Of the 12 target catchments, five in the Upper Dog River Watershed were already equipped with a total of six Litter Gitters with maintenance and ETAP assessments already providing data. Figure 5 shows the location of these devices, numbered one through six clockwise from the northernmost device.

Based on ETAP data, an average of 16.9 lbs. of litter per device per cleaning event was collected during the period of April through October 2020, along with data characterizing the type and condition of the litter collected.

With maintenance schedules varying for the devices complicating comparisons, litter amounts were quantified in average mass (lbs.) captured per device per maintenance event. With these devices already providing data about these five target catchments, site assessments/ground truthing were not undertaken there. However, their status as target catchments remains. The location of the City of Mobile's Bandalong Boom System, located downstream of the target catchments, is also indicated in Figure 7.

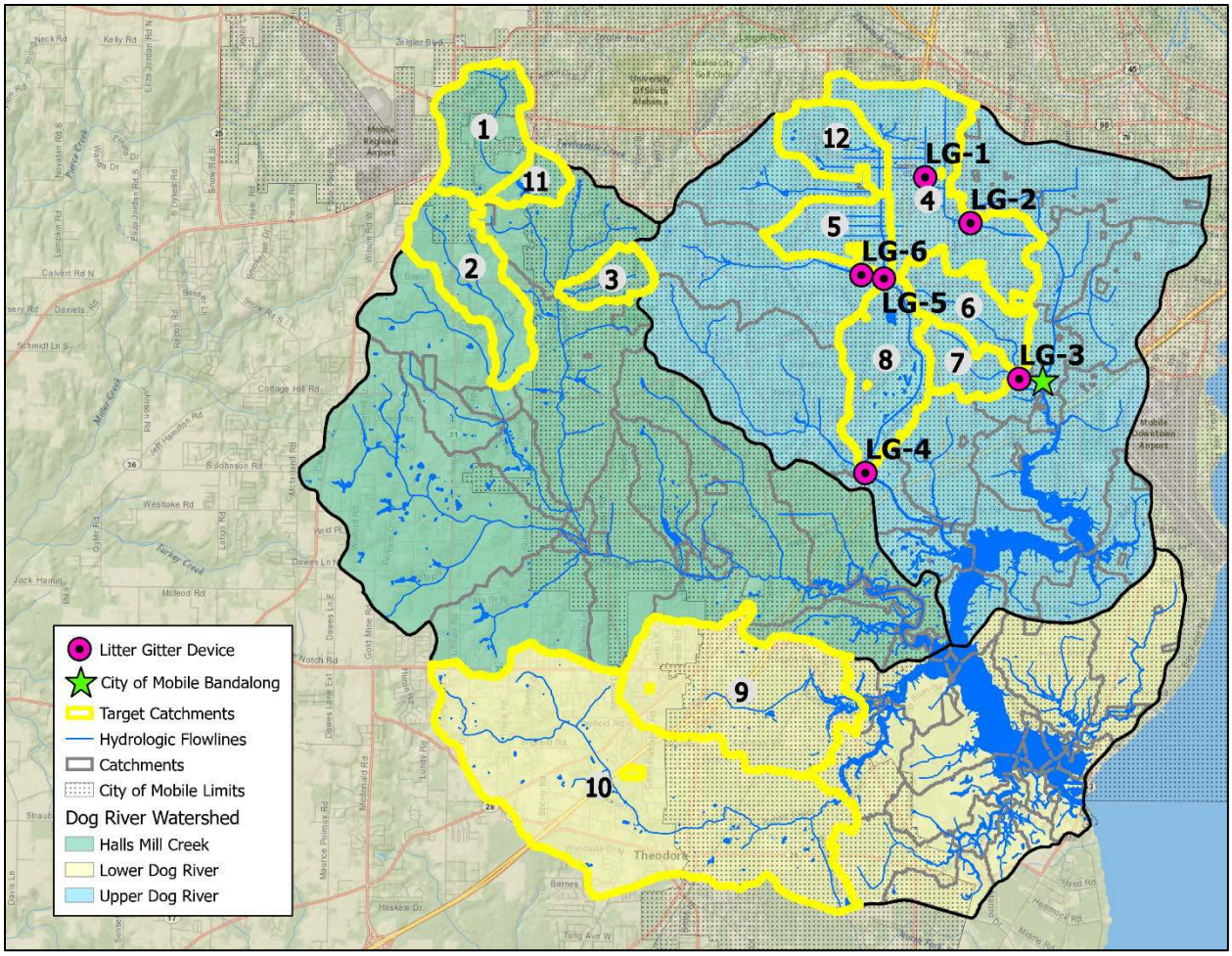

Figure 7. Locations of Litter Gitter instream litter capture devices. The location of the City of Mobile's Bandalong Boom System (not within a target catchment) is also indicated.

Field Surveys

Field surveys were conducted at the seven remaining target catchments at a total of 11 sites shown in Figure 8. Each site surveyed was assigned a Site ID that included an abbreviation for the receiving water body (i.e., EC-Eslava Creek, MC-Milkhouse Creek, SC-Second Creek, RB-Rattlesnake Bayou, RC-Rabbit Creek, and UT-unnamed tributary), numbered to differentiate between sites draining to the same receiving water.

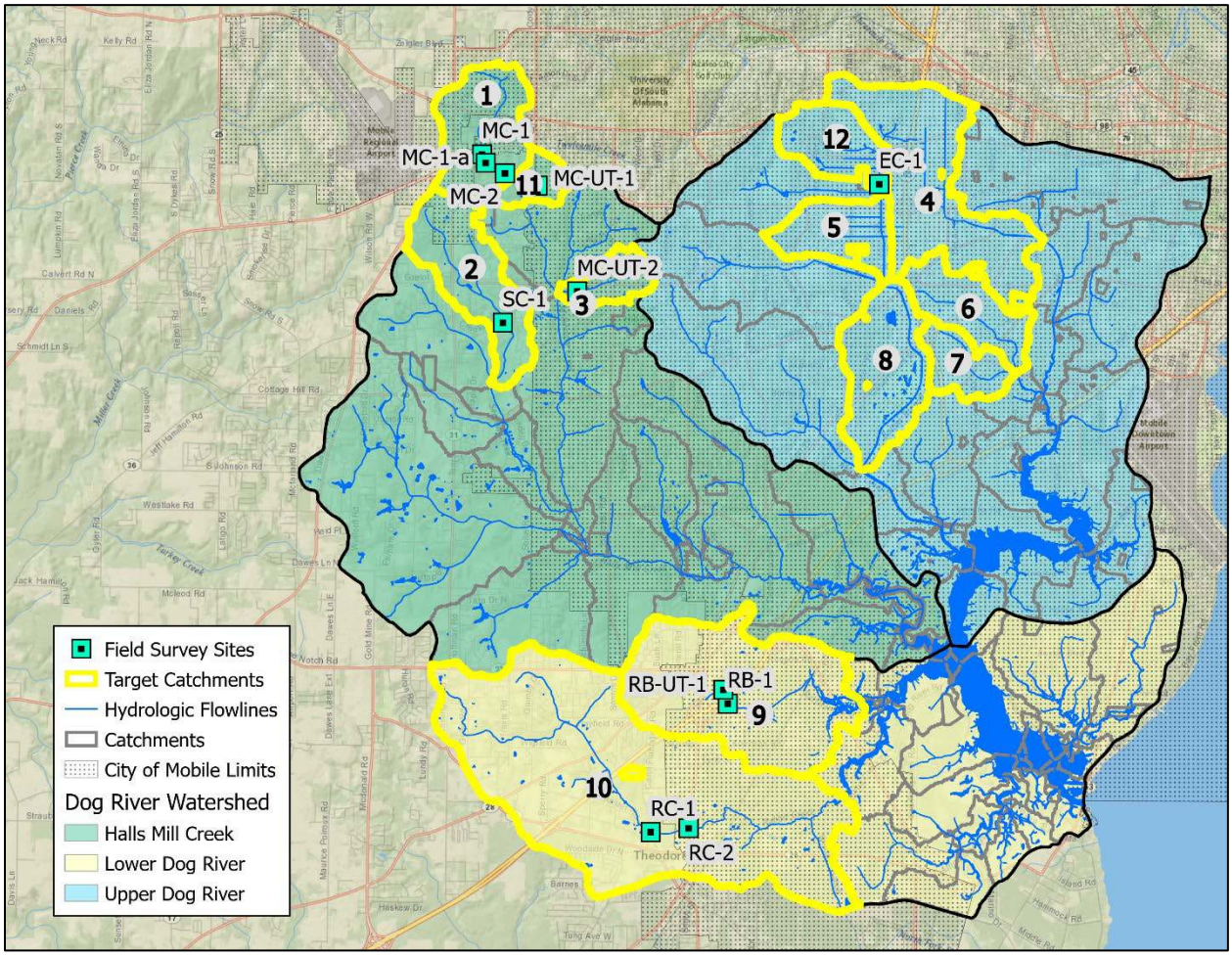

Figure 8. Locations of the 11 sites ground-truthed through field surveys within the seven target catchments without Litter Gitters collection devices.

Appendix A summarizes field survey data for the ground-truthed sites within the seven target catchments without Litter Gitters, including a highway-referenced location, target catchment number, Site ID, waterbody type, litter characterizations, impacted land use, adjacent land use, impairment rating (1 to 5 from least to most impaired), and whether the site was suitable for installation of a Litter Gitter.

Excluded Catchments

Despite meeting target catchment criteria and based upon these site assessments, two target catchments, shown in Figure 9, were excluded from the initial list of 12. Catchment 12, with assessment Site ID EC-1, was excluded from the list because the primary land use within this catchment is the Spring Hill Golf Course. The other, Catchment 11, with assessment Site ID MC-UT-1 near the Providence Hospital, was removed because it contained an accumulation/pooling area (a drainage basin/lake) with no connecting streams. Despite both having been significantly urbanized, site assessments confirmed that golf courses and hospitals represent land uses where poor trash management and litter accumulation are less likely.

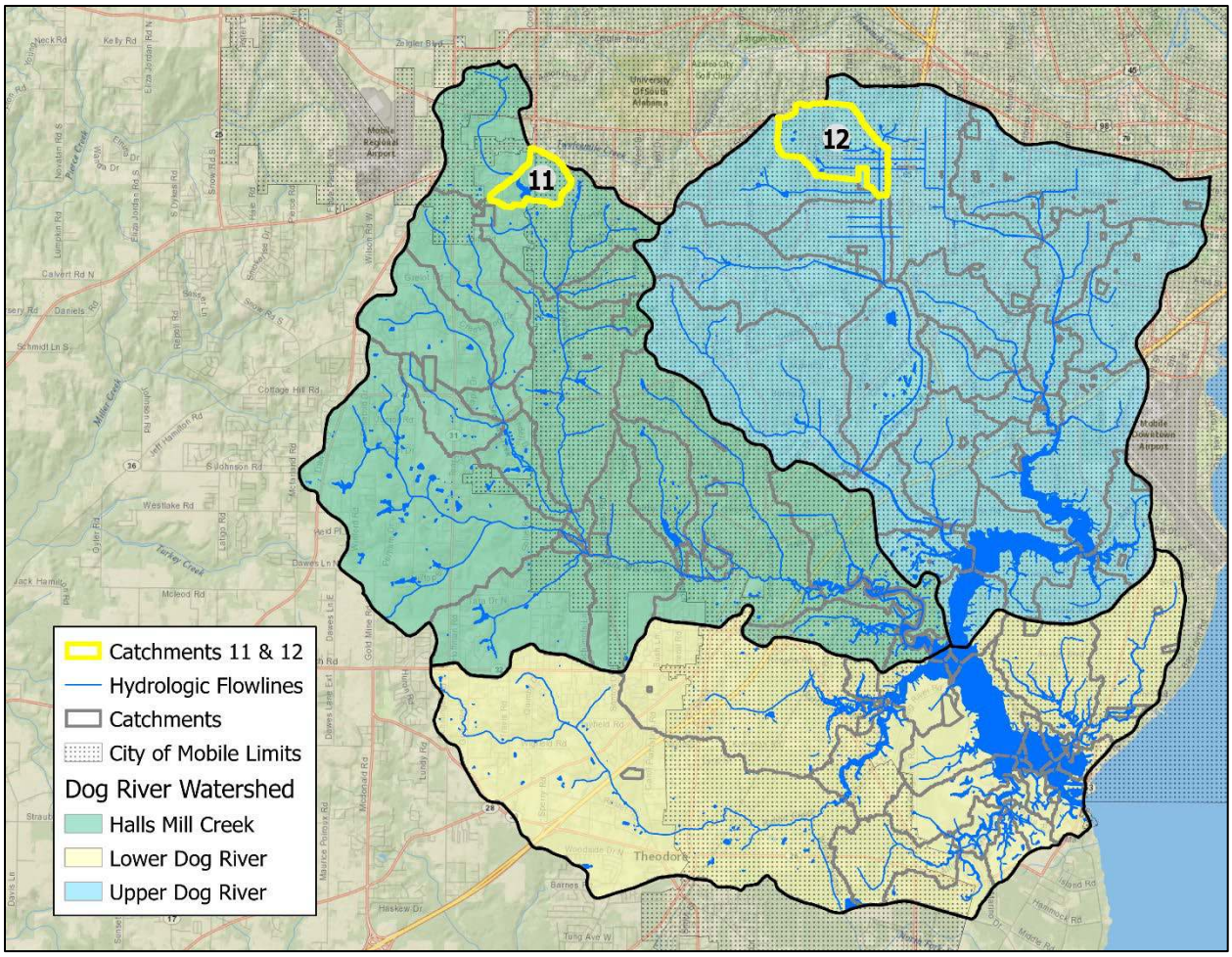

Figure 9. Catchments 11 and 12, which were excluded from further analysis.

Residential vs. Commercial Areas

Table 3 Target catchments with percent Residential and percent Commercial.

Target Catchment	Name	Percent Residential	Percent Commercial
1	Airport/Milkhouse Creek	17	25
2	Creekwood/2nd Creek	27	13
3	Grelot/UT-Milkhouse Creek	30	31
4	Eslava Creek	23	44
5	Michael/Montlimar Creek	23	57
6	Mertz/Bolton Branch	22	29
7	Morningside/Bolton Branch	20	28
8	Halls Mill/Moore Creek	19	24
9	Hwy 90/Rattlesnake Bayou	16	18
10	Carol Plantation/Rabbit Creek	12	8

Table 3 shows the percentage of the urbanized areas within target catchments designated as Residential and Commercial land uses. With only individual points from City of Mobile Land Cover data available to designate single units as Residential or Commercial, percent imperviousness was used as a proxy for this characterization. Since low intensity development, ranging from 20 to 49 percent imperviousness, is found most specifically in single family residential developments, this category was designated Residential. While both medium and high intensity development, ranging in imperviousness from 50 to 100 percent, include some single family residential, apartment complexes, and row houses, this level of imperviousness is more indicative of commercial and industrial land uses. For the purpose of this analysis, both medium and high intensity development were designated as Commercial. Overlying the NLCD polygons based on imperviousness with the City of Mobile Land Cover points designating single units to validate the designations based on imperviousness provided a level of confidence about this analysis strategy. Concentrations of Residential and Commercial land uses are shown in Figure 10, respectively.

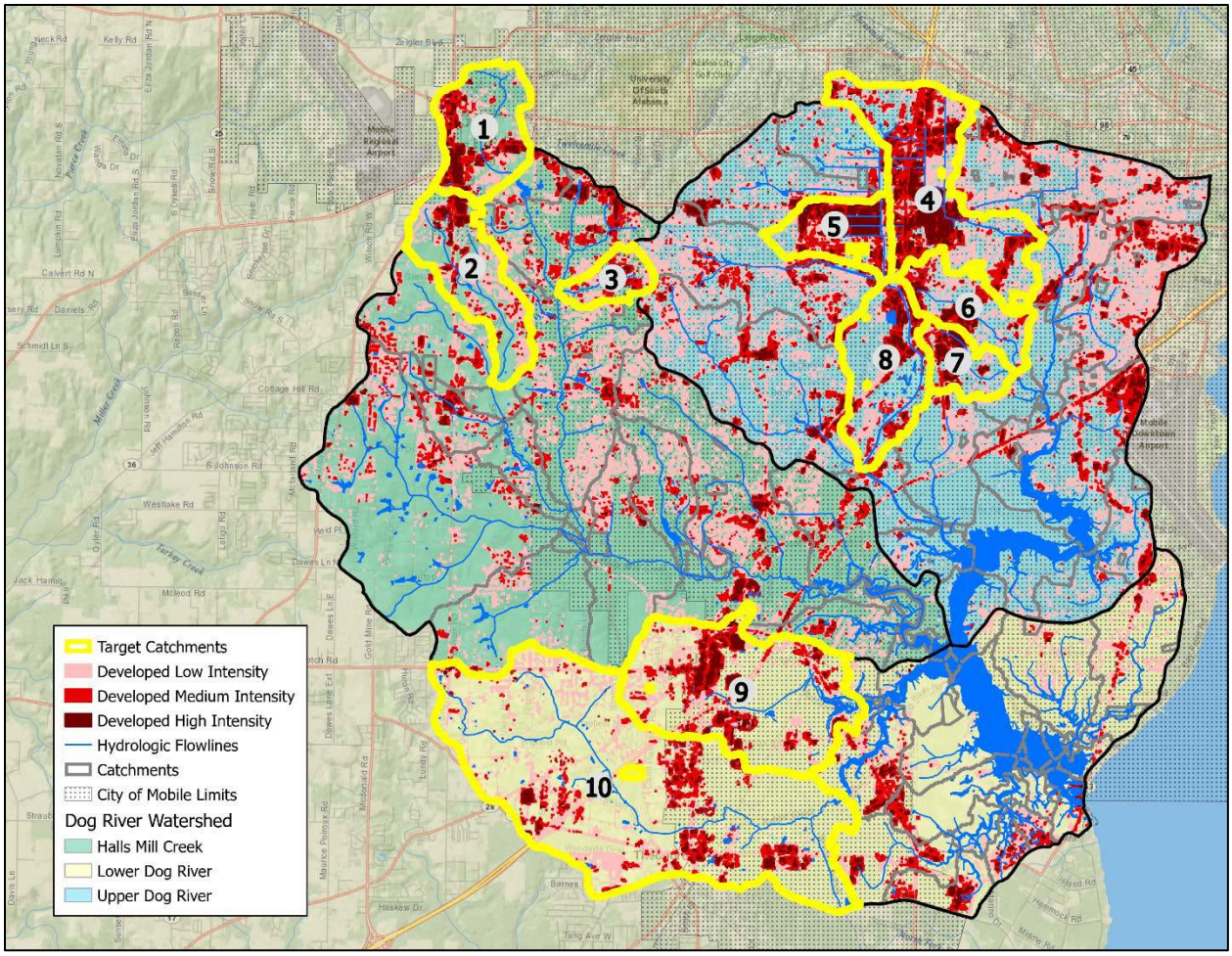

Figure 10. Residential and commercial areas represented by low, medium, and high intensity developed.

Low-to-Moderate-Income Areas

Figure 11 shows five of the 10 target catchments intersected census blocks with greater than 50% of the households earning less than 80% of the median income. Four low-to-moderate-income census blocks lie entirely within City of Mobile geopolitical boundaries. A fifth block in target catchment #10 lies in unincorporated Mobile County.

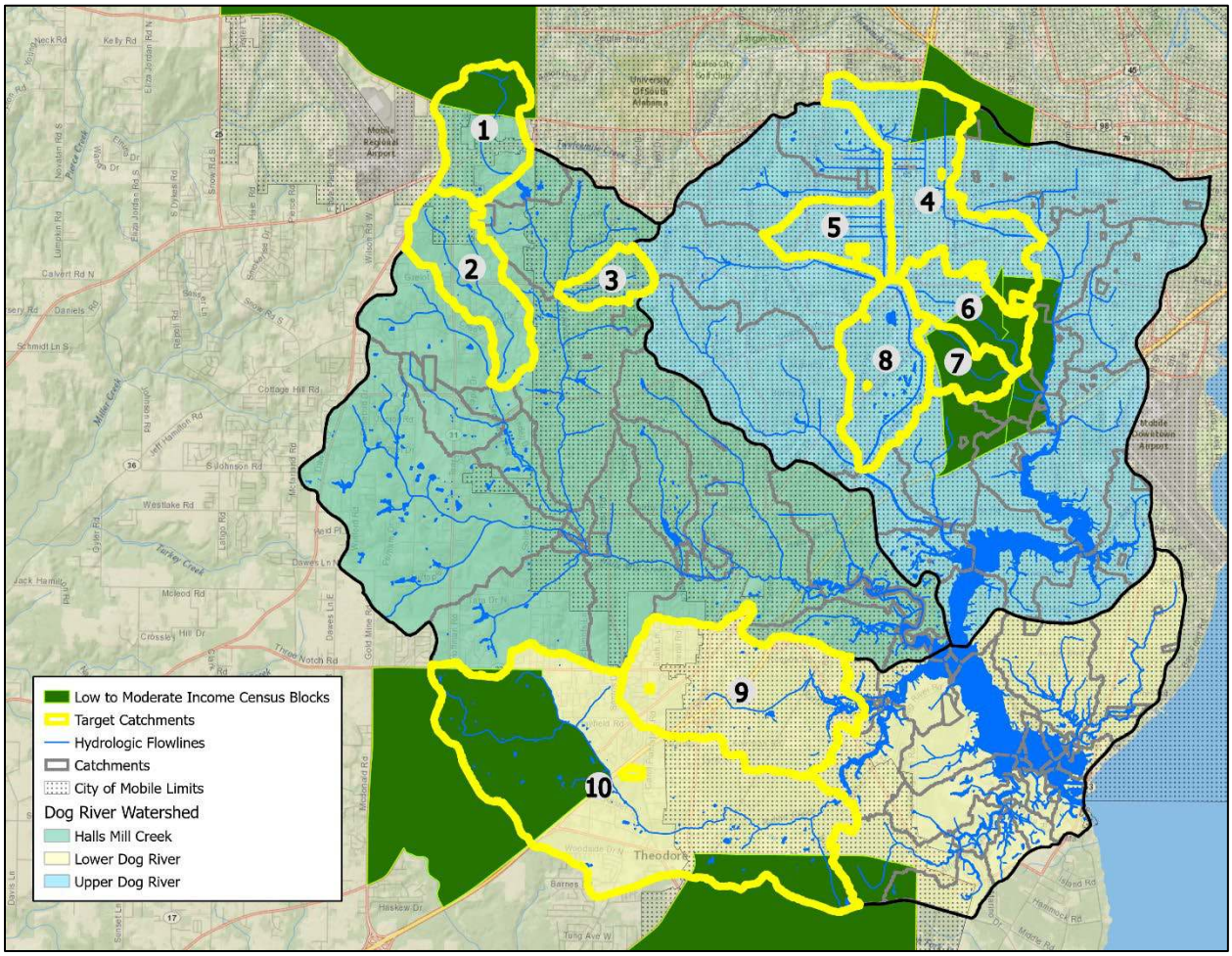

Figure 11. Catchments intersecting census blocks with greater than 50% of the households earning less than 80% of the area's medium income.

Results: The 10 Target Catchment Descriptions

The following maps will provide specific information on each of the 10 target catchments. Information on each of the five field-surveyed catchments will be presented first, with map, catchment descriptions, and site-specific field survey data, including:

- Site IDs with location of survey sites with GPS coordinates and major highway intersections for reference,
- specific data related to waterbody type, site condition, predominant litter type and condition, land use and adjacent land use impacted, impairment rating for each site, and
- and potential strategy for management. Appendix B summarizes assessments and potential strategies for each surveyed site.

The remaining five catchments were not field surveyed, and data from those catchments and material collected from Litter Gitters and ETAP assessments will be presented subsequently.

Figure 12 shows complete outputs of the hydrologic model with geospatial analysis of the Dog River Watershed Complex. Data layers include watershed boundaries, NHDPlus catchments (with designated target catchments numbers), hydrologic data indicating areas of water accumulation/pooling, areas of urbanization, Mobile City Limits, locations of Litter Gitter instream trash capture devices and the City's Bandalong Boom System, and locations of field survey sites.

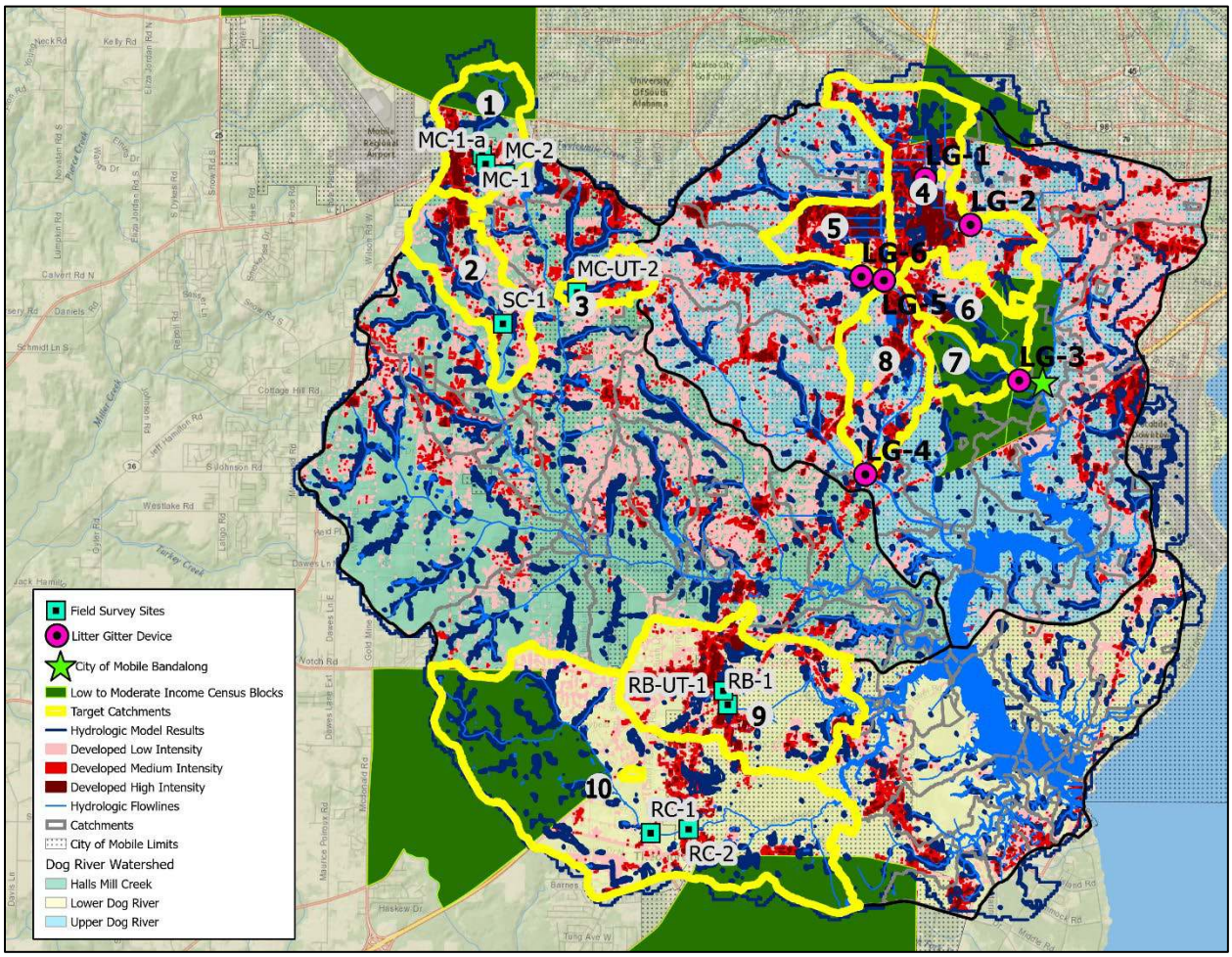

Figure 12. The Dog River Watershed Complex geospatial analysis.

Field Surveyed Target Catchments

Results of target catchment analyses will be presented first for the five target catchments surveyed in the field. Results from sites surveyed in target catchments 2, 1, 10, 3 and 9, follow.

Target Catchment 2 – Site SC-1: Creekwood Drive

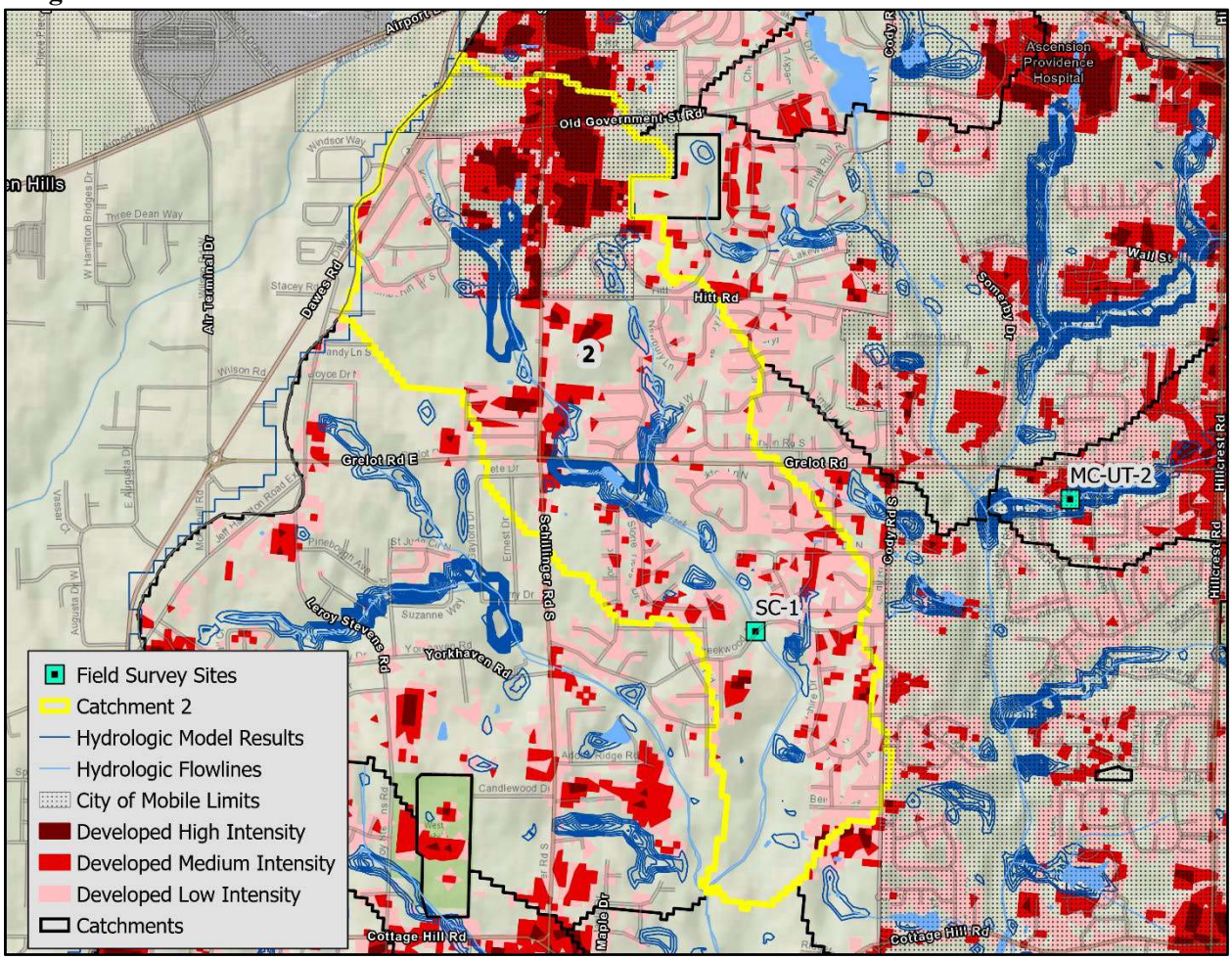

Figure 13. Target catchment 2 with field survey site SC-1.

Data from Site SC-1 within Target Catchment 2, shown in Figure 13 and located near Creekwood Drive between Schillinger Road and Cody Road is summarized below. Twenty percent of this catchment lies within Mobile City Limits with the remaining 80% in unincorporated Mobile County.

Site ID: SC-1
Latitude: 30° 39' 13.68" N
Longitude: -88° 12' 51.4794" W
Near road/intersection: Creekwood Drive between Schillinger Road and Cody Road
Water body type: Stream
Site condition (1 clean – 5 heavily impacted): 3
Predominant litter type: Styrofoam, plastic
Predominant litter condition: Intact
Land use impacted: Wetlands, roadside
Adjacent land use: Residential

Site Assessment: This site is located along a cut-through road between Schillinger Road and Cody Road. It is heavily littered with obvious areas of illegal dumping. The stream is mostly clean and in good condition.

Potential Strategy: Site is easily accessible for volunteer or tactical cleanups. Installation of watershed signage is recommended. Installation of an instream Litter Gitter is not recommended.

Target Catchment 1 – Sites MC-1, MC-1a, and MC-2: Schillinger Road/Airport Boulevard

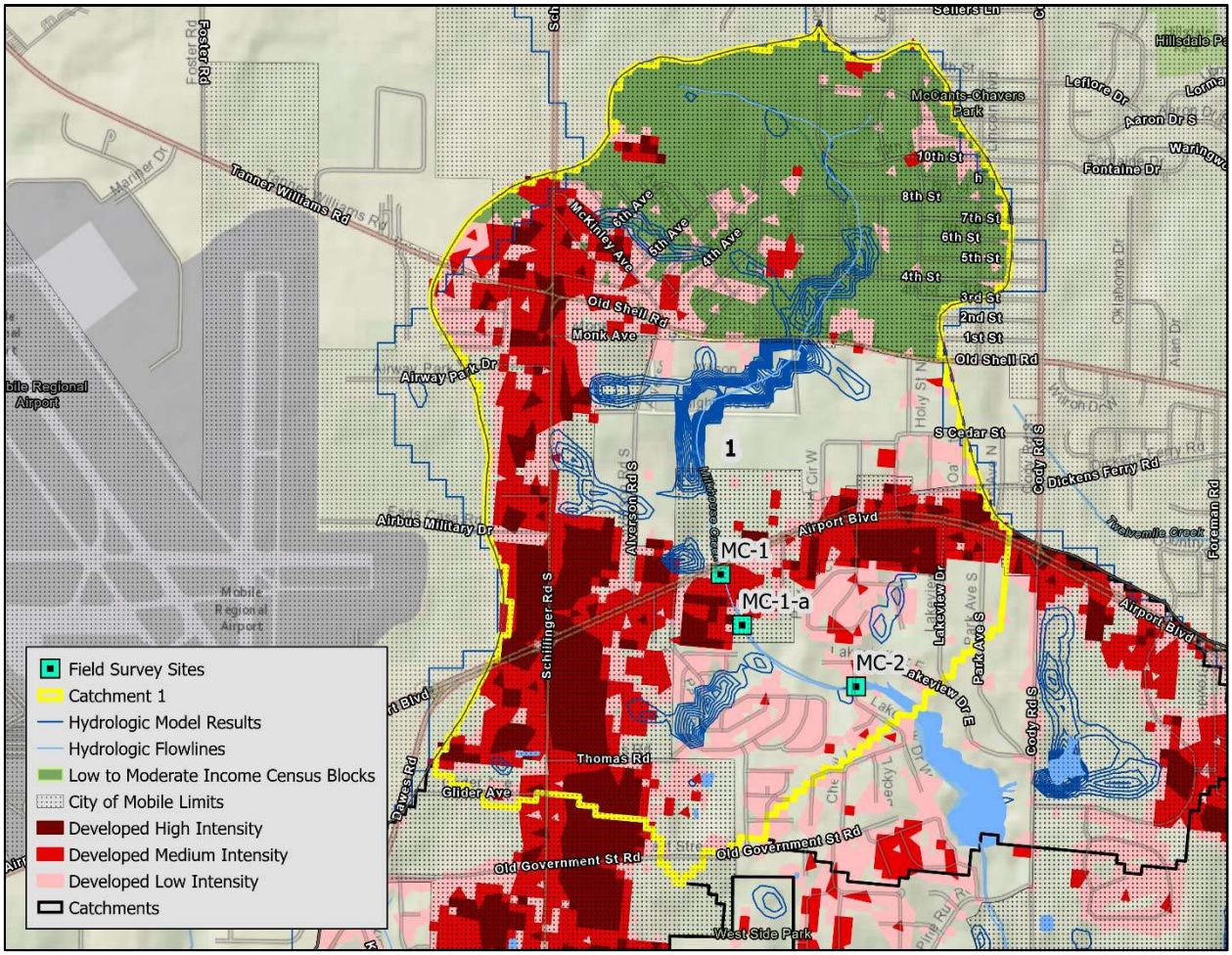

Figure 14. Target catchment 1 with field survey sites MC-1, MC-1a, MC-2.

Data from Sites MC-1, MC-1a, and MC-2 within Target Catchment 1, shown in Figure 14 and located near Schillinger Road and Airport Boulevard, are summarized below. Seventy-two percent of this catchment lies within Mobile City Limits with the remaining 28% within unincorporated Mobile County.

Site ID: MC-1
Latitude: 30° 41' 7.08" N
Longitude: -88° 13' 9.12" W
Near road/intersection: Airport Blvd.
Water body type: Ephemeral stream

Site condition (1 clean – 5 heavily impacted): 3
Predominant litter type: Styrofoam
Predominant litter condition: Intact
Land use impacted: Roadside
Adjacent land use: Commercial
Site Assessment: Site has roadside, lined ditches, and trash discarded from vehicles drains down Airport Boulevard into these ditches. Types of litter observed were mainly fast food and beverage containers. Rich's Car Wash is located next to the site, and discolored water (purple) was observed in the ditch.

Potential Strategy: Site is accessible for volunteer or tactical cleanups. The site should be routinely inspected. Installation of an instream Litter Gitter is not recommended.

Site ID: MC-1a
Latitude: 30° 41' 1.32" N
Longitude: -88° 13' 6.24" W
Near road/intersection: Airport Boulevard
Water body type: Stream, ditch
Site condition (1 clean – 5 heavily impacted): 4
Predominant litter type: Styrofoam
Predominant litter condition: Partially degraded
Land use impacted: Wetlands
Adjacent land use: Commercial
Site Assessment: Site is easily accessible through an adjacent church property. Volunteer cleanups here would be difficult, due to uneven terrain and heavy vegetation. The end of a concrete-lined ditch (and a culvert crossing Airport Boulevard flows into a degraded channel. The site has a head cut and is failing due to stormwater drainage. It appears to be holding litter from upstream MC-1 and prevents the majority of litter from flowing downstream into Optimist Lake.

Potential Strategy: Tactical/professional cleanups with routine inspections. Installation of an instream Litter Gitter is not recommended.

Site ID: MC-2
Latitude: 30° 40' 54.4794" N
Longitude: -88° 12' 51.12" W
Near road/intersection: Lakeview Drive West
Water body type: Stream
Site condition (1 clean – 5 heavily impacted): 1
Predominant litter type: Aluminum
Predominant litter condition: Partially degraded
Land use impacted: Roadside
Adjacent land use: Residential
Site Assessment: Site was sparsely littered, mostly on the roadside and not in the stream. The site has sediment accumulating from the degraded MC-1a channel. Instream litter appears to have escaped from Site MC-1a upstream.

Potential Strategy: Installation and maintenance of an instream Litter Gitter should be considered at this site or upstream, and the site should be routinely inspected.

Target Catchment 10 – Sites RC-1 and RC-2: Highway 90/Carol Plantation Road

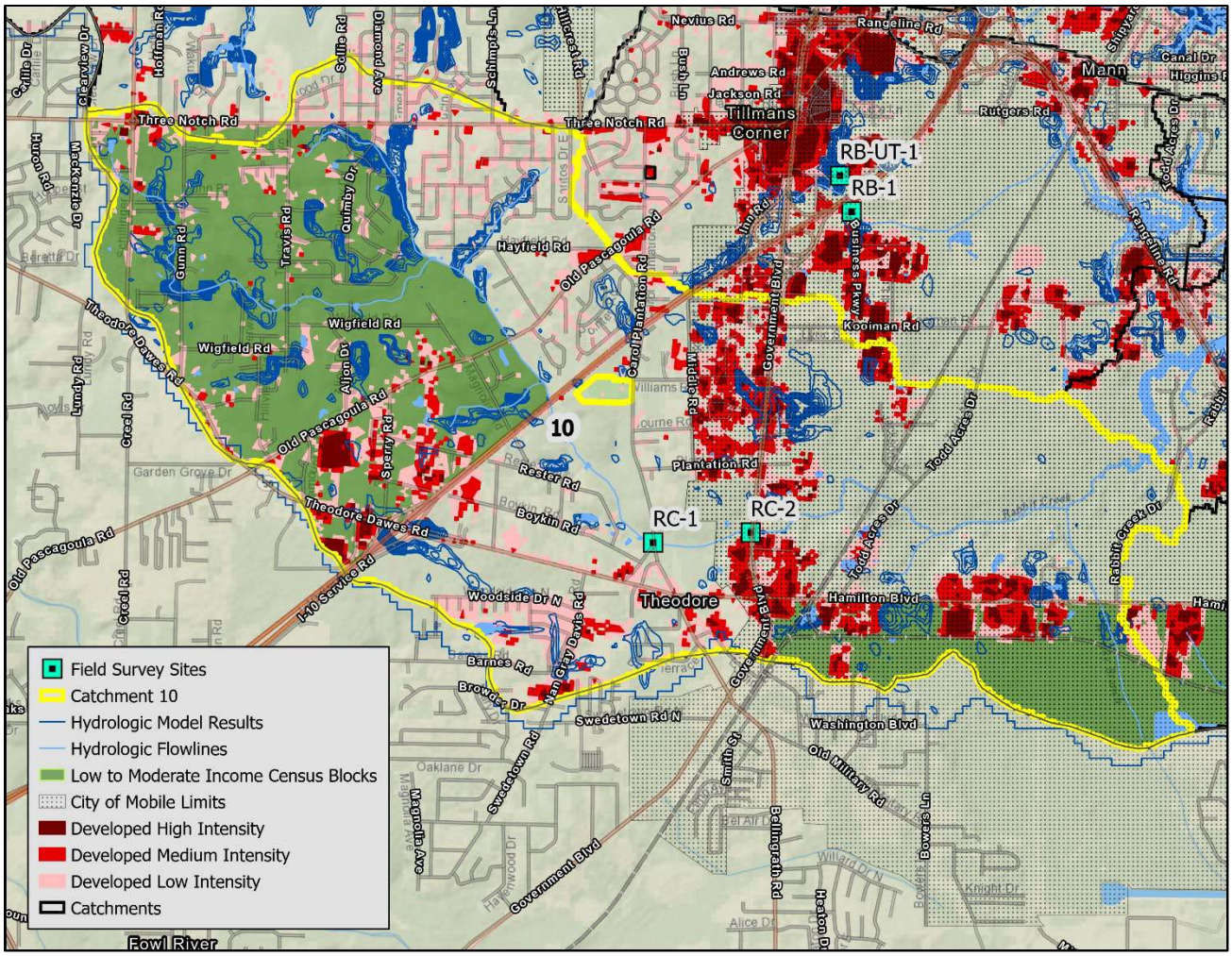

Figure 15. Target catchment 10 with two field survey sites, RC-1, and RC-2.

Data from Sites RC-1 and RC-2 within Target Catchment 10, shown in Figure 15 and located near Highway 90 in Tillman's Corner, AL, are summarized below. Only 37% of this catchment lies within Mobile City Limits with the remaining 63% within unincorporated Mobile County.

<u>Site ID</u>: RC-1
<u>Latitude</u>: 30° 33' 31.32" N
<u>Longitude</u>: -88° 10' 51.96" W
<u>Nearby road/Intersection</u>: Carol Plantation Road
<u>Water body type</u>: Stream
<u>Site condition (1 clean – 5 heavily impacted)</u>: 2
<u>Predominant litter type</u>: Styrofoam, plastic
<u>Predominant litter condition</u>: Intact
<u>Land use impacted</u>: Wetlands, roadside
<u>Adjacent land use</u>: Residential
<u>Site Assessment</u>: Trash instream is minimal. Stream appears in good condition. Roadside litter was observed.

Potential Strategy: Site is accessible for volunteer or tactical cleanups. It is currently an Adopt-A-Stream location. The adopter is the Theodore High School Science Club. Installation of watershed signage is recommended. Site should be routinely inspected. Installation of an instream Litter Gitter is not recommended.

Site ID: RC-2
Latitude: 30° 33' 34.1994" N
Longitude: -88° 10' 22.4394" W
Nearby road/Intersection: Highway 90/Government Blvd.
Water body type: Stream
Site condition (1 clean – 5 heavily impacted): 1
Predominant litter type: Styrofoam, plastic
Predominant litter condition: Intact
Land use impacted: Wetlands, roadside
Adjacent land use: Commercial
Site Assessment: Litter is concentrated in a roadside ditch that drains the Theodore Oaks Shopping Center and Highway 90. The site is easily accessible. Litter also observed in wooded area east side of road deposited from highwater events.

Potential Strategy: Site is accessible for volunteer or tactical cleanups. Site should be routinely inspected. Installation of an instream Litter Gitter is not recommended.

Target Catchment 3 – Site MC-UT-2: Hillcrest Road/Grelot Road

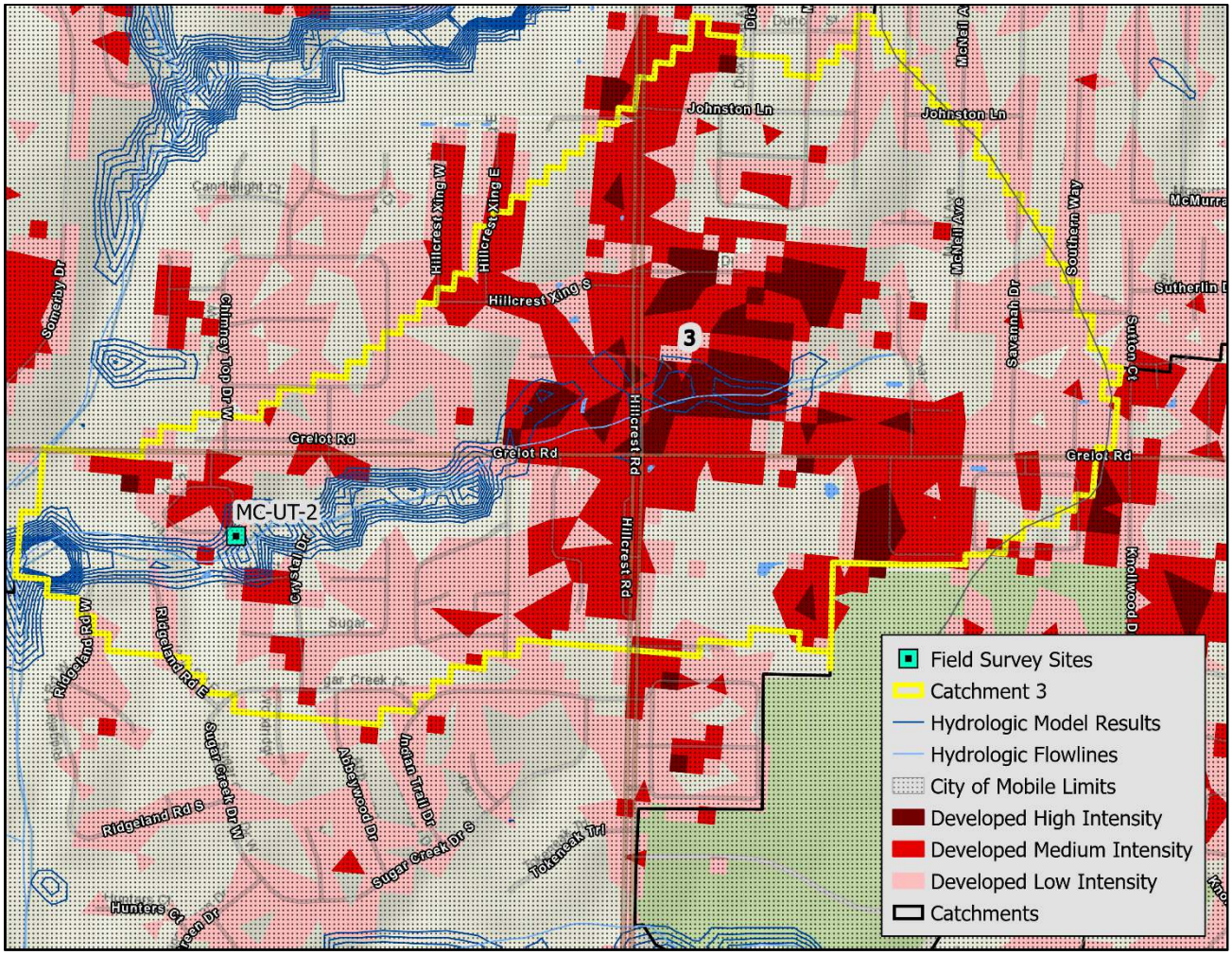

Figure 16. Target catchment 3 with field survey sites MC-UT-2.

Data from Site MC-UT-2 within Target Catchment 3, shown in Figure 16 and located near the intersection of Hillcrest Road and Grelot Road, is summarized below. The entirety of this catchment lies within the Mobile City Limits.

<u>Site MC-UT-2</u>
<u>Latitude</u>: 30° 39' 35.64" N
<u>Longitude</u>: -88° 11' 54.5994" W
<u>Near road/intersection</u>: Hillcrest Road/Grelot Road near the Autumn Chase Apartments
<u>Water body type</u>: Stream
<u>Site condition (1 clean – 5 heavily impacted)</u>: 4
<u>Predominant litter type</u>: Styrofoam, plastic, glass, aluminum
<u>Predominant litter condition</u>: Intact, partially degraded, and degraded
<u>Land use impacted</u>: Parking lot
<u>Adjacent land use</u>: Commercial and residential
<u>Site Assessment</u>: Site was observed with heavy litter.

Potential Strategy: This site is accessible and suitable for volunteer or tactical cleanups. It should be routinely inspected. Installation of an instream Litter Gitter is not recommended.

Target Catchment 9 – Sites RB-1 and RB-UT-1: Highway 90/Tillman's Corner

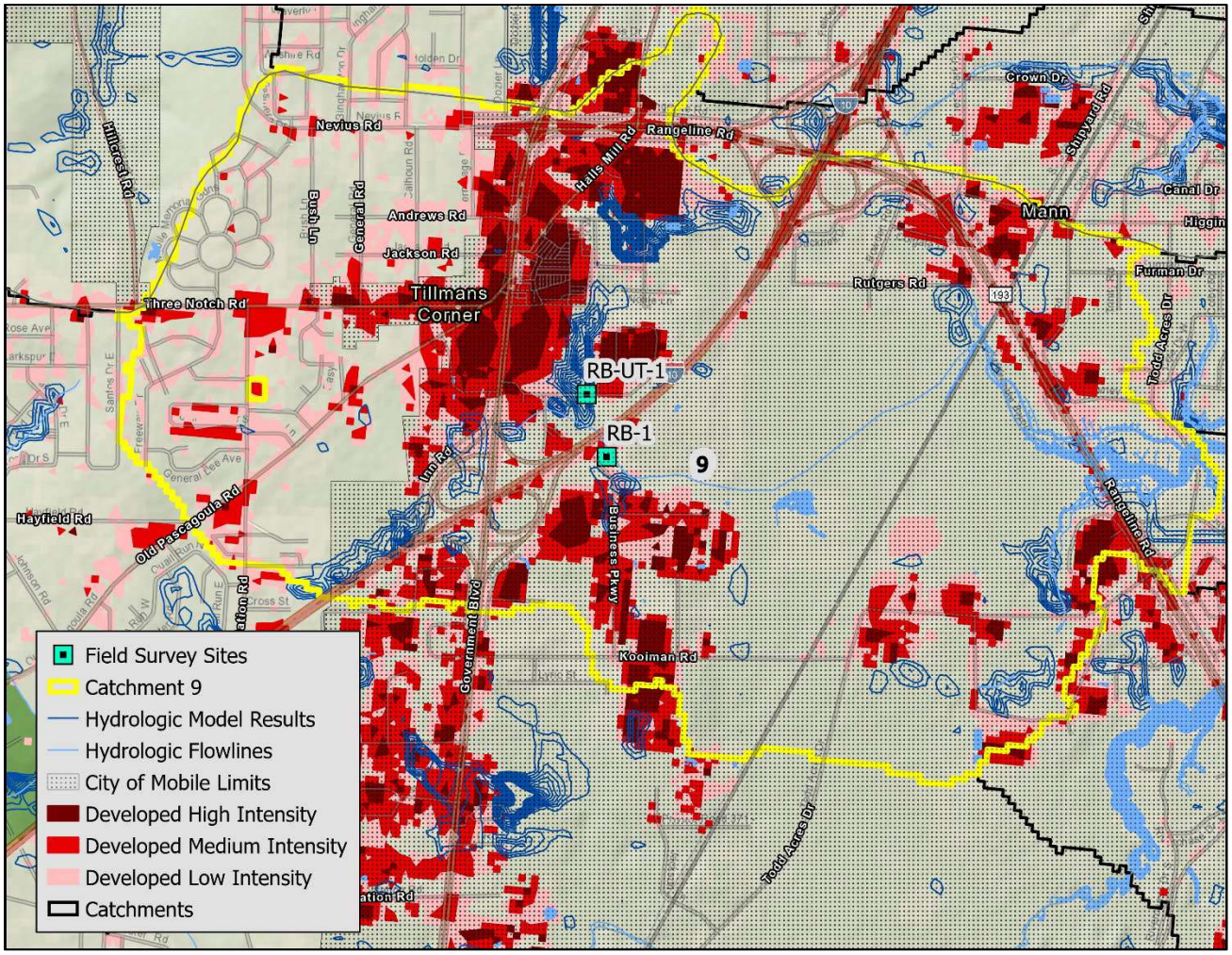

Figure 17. Target catchment 9 with two field survey sites, RB-1, and RB-UT-1.

Data from Sites RB-1 and RB-UT-1 within Target Catchment 9 of the Lower Dog River Watershed, shown in Figure 17 and located near Highway 90 in Tillman's Corner, AL, are summarized below. Seventy-eight percent of this catchment lies within Mobile City Limits with the remaining 22% within unincorporated Mobile County.

Site ID: RB-1
Latitude: 30° 34' 58.4394" N
Longitude: -88° 9' 52.9194" W
Nearby road/intersection: Business Parkway, Kooiman Road
Water body type: Stream
Site condition (1 clean – 5 heavily impacted): 3
Predominant litter type: Styrofoam, plastic
Predominant litter condition: Partially degraded

Land use impacted: Instream
Adjacent land use: Commercial
Site Assessment: Site is downstream of two smaller drainages in Tillman's Corner and is easily accessible. Litter accumulates in a small lagoon on the east side of the bridge.

Potential strategy: Installation, maintenance, and routine inspection of an instream Litter Gitter is recommended for this site.

Site ID: RB-UT-1
Latitude: 30° 35' 7.7994" N
Longitude: -88° 9' 56.52" W
Nearby road/intersection: Coca Cola Road, Highway 90/Government Boulevard
Water body type: Ephemeral stream
Site condition (1 clean – 5 heavily impacted): 2
Predominant litter type: Plastics
Predominant litter condition: Partially degraded
Land use impacted: Roadside
Adjacent land use: Commercial
Site Assessment: Site drains a mixture of undeveloped, shopping centers, and residential areas and is easily accessible.

Potential strategy: Site is accessible for volunteer or tactical cleanups and should be routinely inspected. Installation of an instream Litter Gitter is not recommended.

Target Catchments with Installed Litter Gitters

The following results capture data on the five target catchments with six Litter Gitters installed in their receiving waters. Information on these catchments includes a map, catchment descriptions, Litter Gitter locations, and data secured through application of ETAP to collected material. Results from target catchments 8, 4, 7, 6, and 5 follow.

Target Catchment 8 –Litter Gitter 4 on Moore Creek

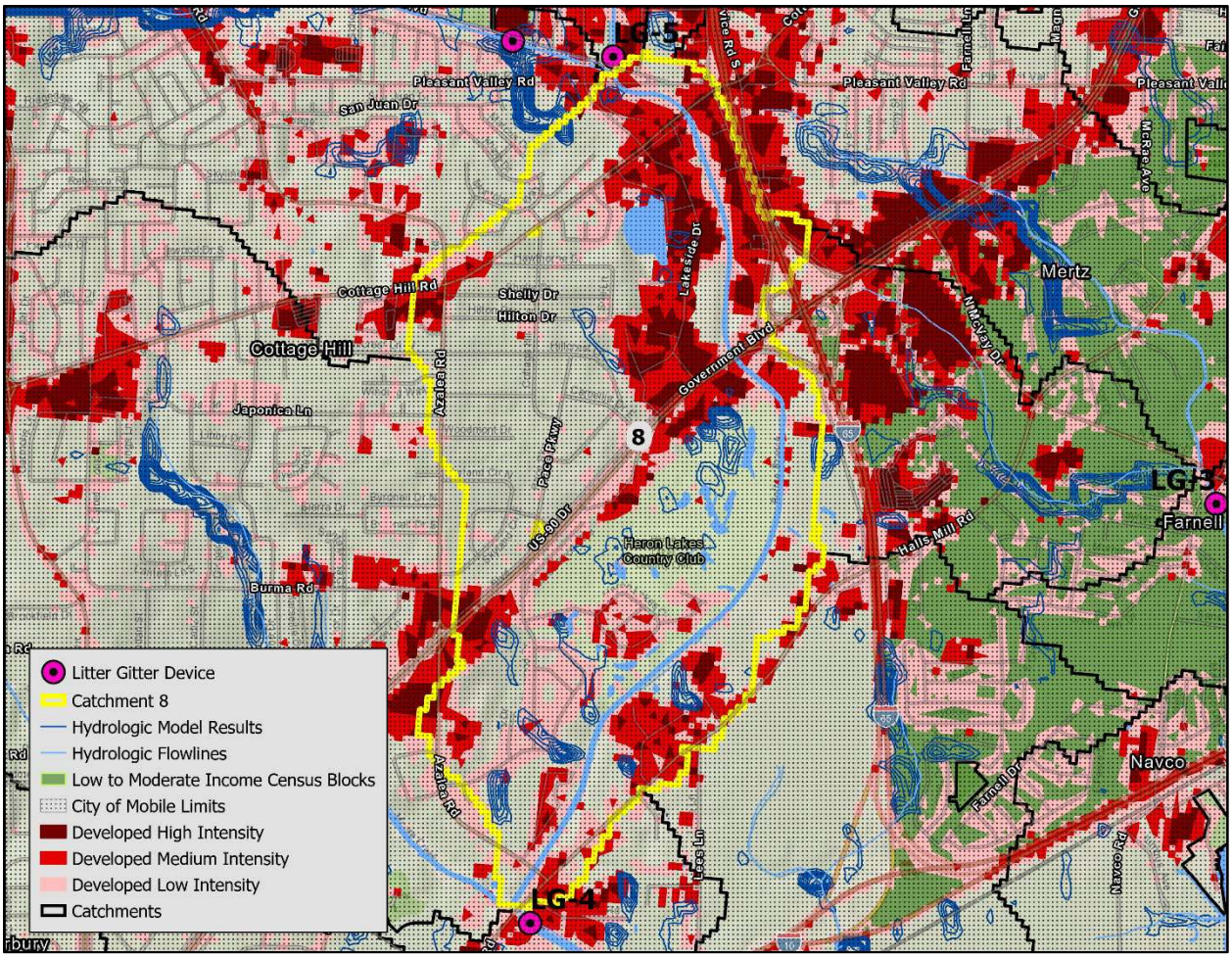

Figure 18. Target catchment 8 with Litter Gitter downstream of confluence of Moore Creek and Montlimar Canal indicated.

Target Catchment 8, shown in Figure 18, located on Moore Creek downstream of its confluence with the Montlimar Canal, drains an area running north to south along and west of I-65 past the Government Boulevard interchange before turning southwest between Heron Lakes Country Club and Halls Mill Road to a southern point near the confluence of Montlimar Creek (to which it drains) and Moore Creek, before turning north along Azalea Road, then northeast along Cottage Hill Road. The entirety of target catchment 6, which is 43.8% impervious, lies within Mobile City Limits.

Litter Gitter 4 location (waterbody and road/intersection): Moore Creek south of the intersection of Azalea Road and Halls Mill Road
Litter Gitter 4 Latitude/Longitude: 30° 37' 34.5792" N, -88° 7' 54.4866" W
Number of maintenance events: 24

Total mass of material collected: 358.4 lbs.
Average mass of material collected per maintenance event: 14.9 lbs.
Primary litter types collected: Plastic (81.9%) Other (including Styrofoam) (11.8%) Metal (3.7%) Glass (1.3%) Paper (1.3%)
Condition of material collected: Intact (54.0%) Partially degraded (42.0%) Degraded (4.0%)
Brands collected: Coke (28.9%) Swisher (11.7%) Gatorade (10.2%)
Primary upstream land use: Mixture of Commercial (24.7%) and Residential (19.1%)

Target Catchment 4 – Two Litter Gitters (1 and 2) installed in Eslava Creek

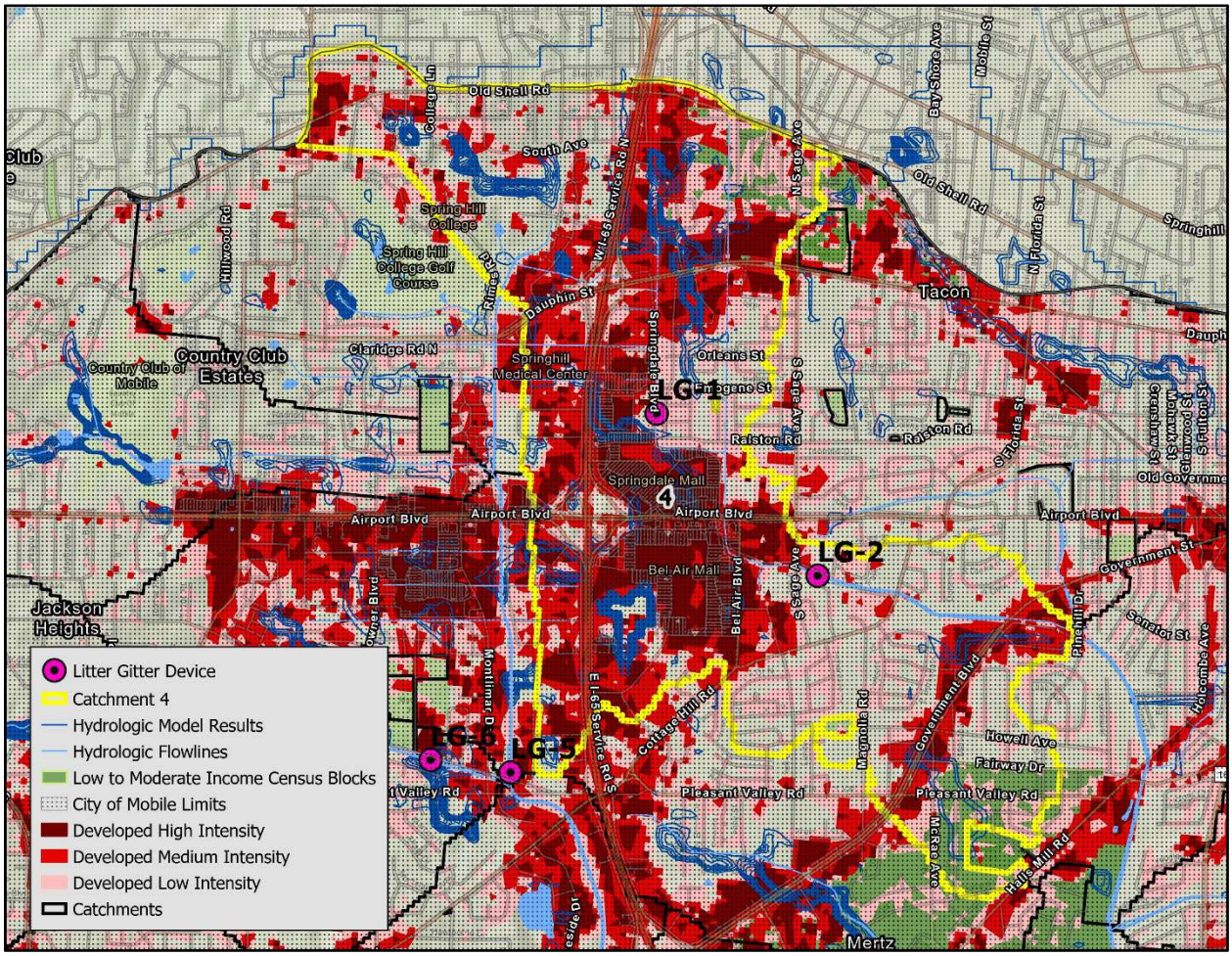

Figure 19. Target catchment 4 with two Litter Gitters installed in Eslava Creek.

Figure 19 show target catchment 4, which includes two Litter Gitters, 1, downstream of Emogene Street, and 2, downstream off Sage Avenue. This catchment is a large, roughly-L-shaped catchment with a western border along the I-65 corridor from Key Street north to Old Shell Road with narrower northern portions extending eastward to Sage Avenue and broader southern portions extending eastward across Government Street/Highway 90 to Pinehill Drive. This highly urbanized catchment includes several car dealerships along the South Beltline Highway, the Bel Air and Springdale malls, and the commercial portion of Dauphin Street between Spring Hill Hospital and Sage Avenue. The entirety of this catchment, which is 67.9% impervious, lies within Mobile City Limits.

Litter Gitter 1 location (waterbody and road/intersection): Eslava Creek downstream of Emogene Street
Litter Gitter 1 Latitude/Longitude: 30° 40' 54.0834" N, -88° 7' 23.1342" W
Number of maintenance events: 21
Total mass of material collected: 176.4 lbs.
Average mass of material collected per maintenance event: 8.3 lbs.
Primary litter types collected: Plastics (74.3%) Other (including Styrofoam) (8.2%) Metal (5.9%) Paper (1.5%) Glass (1.5%)
Condition of material collected: Intact (62.1%) Partially degraded (33.8%) Degraded (4.1%)
Brands collected: Coke (20.9%) Walmart (16.3%) Swisher (12.0%)
Primary upstream land use: Commercial

Litter Gitter 2 location (waterbody and road/intersection): Eslava Creek downstream of Sage Avenue
Litter Gitter 2 Latitude/Longitude: 30° 40' 23.5842" N, -88° 6' 47.3796" W
Number of maintenance events: 26
Total mass of material collected: 486.3 lbs.
Average mass of material collected per maintenance event:18.7 lbs.
Primary litter types collected: Plastics (85.5%) Other (including Styrofoam) (7.9%) Metal (4.0%) Paper (1.6%) Glass (1.0%)
Condition of material collected: Intact (62.0%) Partially degraded (32.0%) Degraded (6.0%)
Brands collected: Coke (30.8%) Dasani (13.6%) Polar Pop (13.3%)
Primary upstream land use: Commercial

Target Catchment 7 –Litter Gitter 3 on Bolton Branch

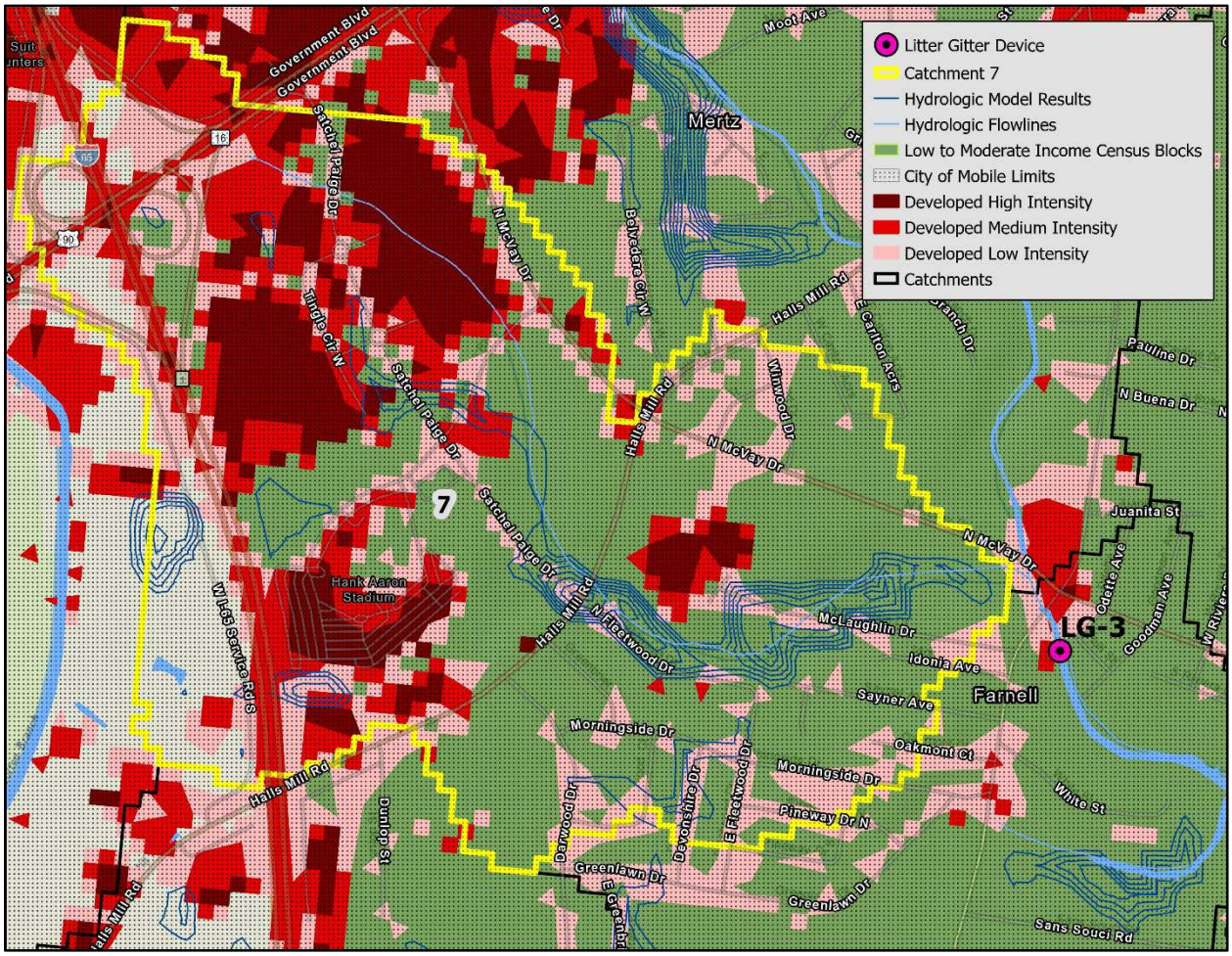

Figure 20. Target catchment 7 with location of Litter Gitter (the same one catching target catchment 6 drainage) indicated.

Target Catchment 7, shown in Figure 20, downstream of the confluence of an unnamed tributary (target catchment 7) and Bolton Branch (target catchment 6), drains an area running diagonally from the I-65/Government Boulevard interchange (in the northwest portion) southeast along McVay Drive N., almost to confluence of an unnamed tributary draining this catchment and Bolton Branch (which drains target catchment 6). Halls Mill Road bisects this catchment, which includes the McGowan Park Shopping Center, Satchel Paige Drive, and Hank Aaron Stadium. The entirety of target catchment 6, which is 52.3% impervious, lies within Mobile City Limits.

Litter Gitter 3 location (waterbody and road/intersection): Bolton Branch downstream of the McVay Dr. N./Navco Rd. intersection
Litter Gitter 3 Latitude/Longitude: 30° 38' 38.9718", N 30° 38' 38.9718" W
Number of maintenance events: 25
Total mass of material collected: 646.0 lbs.
Average mass of material collected per maintenance event: 25.8 lbs.

Primary litter types collected: Plastics (73.2%) Other (including Styrofoam) (12.7%) Metal (9.2%) Glass (3.5%) Paper (1.4%)
Condition of material collected: Intact (66.4%) Partially degraded (32.7%) Degraded (0.9%)
Brands collected: Coke (29.4%) Busch (12.6%) Swisher (11.9%)
Primary upstream land use: Mixture of Commercial (28.2%) and Residential (20.6%).

Target Catchment 6 –Litter Gitter, 3, on Bolton Branch downstream of Navco Road/McVay Drive

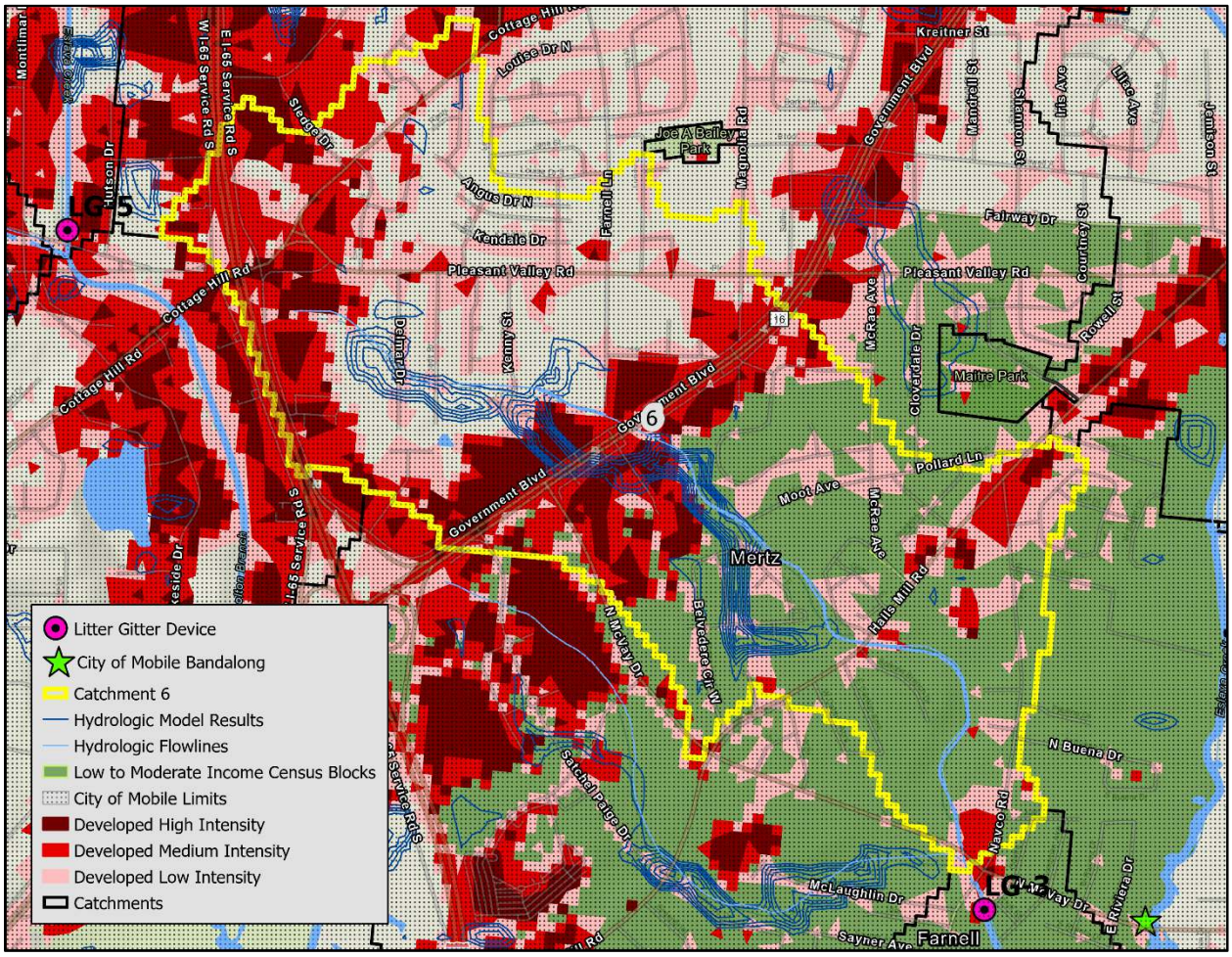

Figure 21. Target catchment 6 with location of Litter Gitter 3, downstream of the southeastern catchment boundary, (and City of Mobile Bandalong System) indicated.

Target catchment 6, shown in Figure 21, stretches diagonally from northwest along the I-65 corridor, directly south of catchment 4, southeast to the intersection of Navco Road and McVay Drive N. Litter Gitter 3 is positioned outside of the catchment boundaries on Bolton Branch, which drains this catchment as well as an unnamed tributary (draining target catchment 7), whose confluence with Bolton Branch lies within this catchment. The entirety of target catchment 6, which is 52.3% impervious, lies within Mobile City Limits.

Litter Gitter 3 location (waterbody and road/intersection): Bolton Branch downstream of the McVay Dr. N./Navco Rd. intersection
Litter Gitter 3 Latitude/Longitude: 30° 38' 38.9718", N 30° 38' 38.9718" W

Number of maintenance events: 25
Total mass of material collected: 646.0 lbs.
Average mass of material collected per maintenance event: 25.8 lbs.
Primary litter types collected: Plastics (73.2%) Other (including Styrofoam) (12.7%) Metal (9.2%) Glass (3.5%) Paper (1.4%)
Condition of material collected: Intact (66.4%) Partially degraded (32.7%) Degraded (0.9%)
Brands collected: Coke (29.4%) Busch (12.6%) Swisher (11.9%)
Primary upstream land use: Mixture of Commercial (28.2%) and Residential (20.6%).

Target Catchment 5 –Litter Gitters: 5 on the Montlimar Canal and 6 on the Michael Boulevard Canal

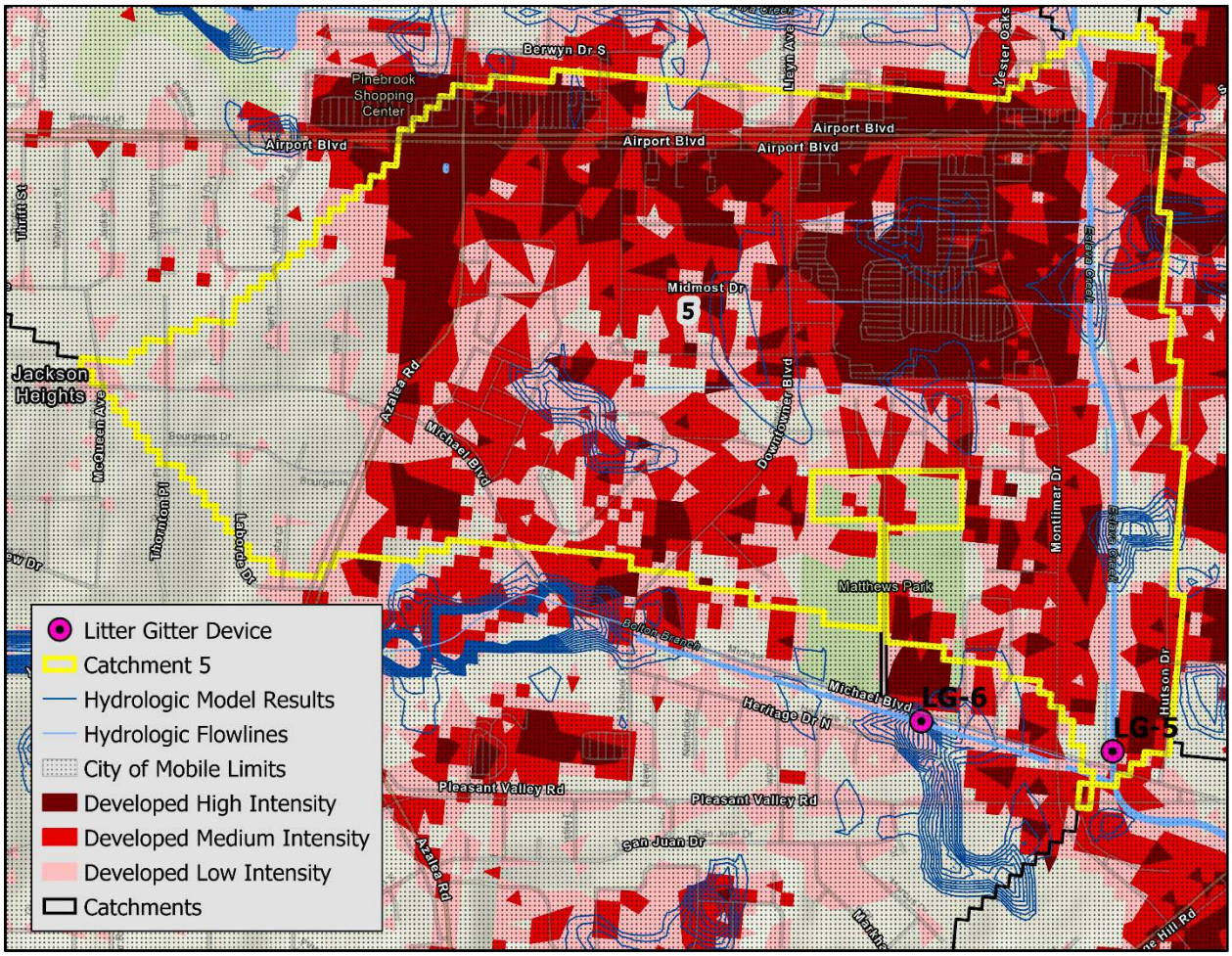

Figure 22. Target catchment 5 with Litter Gitter 5 on the channelized Montlimar Canal just upstream of its confluence with the Michael Blvd. Canal and Litter Gitter 6 on the Michael Blvd. Canal indicated.

Target catchment 5, shown in Figure 22, lies west of the I-65 corridor abutting the southern portion of target catchment 10. Its northern boundary extends west along Airport Boulevard to the Pinebrook Shopping center before turning to the southwest to McQueen Avenue before turning back to the east along Michael Boulevard just north of the Davidson High School campus. The entirety of target catchment 5, which is 81% impervious, lies within Mobile City Limits.

Litter Gitter 5 location (waterbody and road/intersection): Montlimar Canal upstream of confluence of the Montlimar and Michael Blvd. Canals near Michael Blvd within catchment boundaries
Litter Gitter Latitude/Longitude: 30° 39' 47.8692" N, -88° 8' 12.084" W
Number of maintenance events: 19
Total mass of material collected: 282.8 lbs.
Average mass of material collected per maintenance event: 15.7 lbs.
Primary litter types collected: Plastics (82.0%) Other (including Styrofoam) (10.9%) Metal (4.4%) Paper (1.7%) Glass (1.0%)
Condition of material collected: Intact (68.8%) Partially degraded (29.1%) Degraded (2.1%)
Brands collected: Coke (26.3%) Great Value (14.7%) Dasani (11.5%)
Primary upstream land use: Commercial (57.7%)

Litter Gitter 6 location (waterbody and road/intersection): On the Michael Blvd. Canal south of catchment boundaries and ~0.2 mi west of its Montlimar Drive crossing.
Litter Gitter Latitude/Longitude: 30° 39' 45.63" N, -88.131802 W
Number of maintenance events: 24
Total mass of material collected: 403.6 lbs.
Average mass of material collected per maintenance event: 16.8 lbs.
Primary litter types collected: Plastics (81.7%) Other (including Styrofoam) (9.6%) Metal (6.0%) Paper (2.2%) Glass (0.5%)
Condition of material collected: Intact (68.3%) Partially degraded (29.9%) Degraded (1.8%)
Brands collected: Coke (36.59%) Swisher (8.7%) Dasani (8.7%)
Primary upstream land use: Commercial (57.7%)
Average mass of material collected per maintenance event: 16.8 lbs.
Primary upstream land use: Commercial (57.7%)

Since Litter Gitters depend upon stream flow to capture waterborne litter, as evidenced from the information above, most of the recovered material was plastic, (ranging from 73.2 to 85.5 percent), with other (including Styrofoam) second (ranging from 7.9 to 12.7 percent). Osprey routinely performed single-pass tactical shoreline cleanups along upstream and downstream shorelines before Litter Gitters were installed to remove legacy litter and establish a clean baseline condition. Therefore, the condition of collected material trended from 54.0 to 68.8 percent intact and 29.1 to 33.8 percent partially degraded. In each of these Litter Gitters, very little degraded, or legacy, trash was captured.

Discussion

This study was undertaken to promote the wise stewardship of the Dog River Watershed with the goal of guiding reductions in waterborne trash/litter. It is intended to use hydrologic models and GIS datasets to identify and inform:

- Likely pathways by which improperly discarded litter is conveyed into receiving waters/tributaries to Dog River,
- Strategic locations for installation of Litter Gitter instream litter capture devices,
- Opportunities to engage communities to voluntarily clean up residential areas contributing to or impacted by waterborne trash, and
- Strategies for City of Mobile to deploy resources related to litter reduction near or related to commercial uses.

Litter Gitters are relatively low-cost, highly portable, and easily maintained instream capture devices supported by floating booms which direct flowing waterborne trash into collection baskets. They were developed and initially piloted in 2016 by Osprey Initiative LLC (Osprey) in the quarter-mile-long Maple Street tributary to One Mile Creek in the Three Mile Creek Watershed. Osprey was initially contracted by the Mobile Bay National Estuary Program to install and maintain these devices in the Three Mile Creek Watershed, where collected litter was characterized using and refining the EPA's ETAP before material was either recycled or appropriately discarded. This Protocol was designed to be applied to a broad range of site types – e.g., parks, streets, parking lots, etc. – and environmental conditions across various hydrological and climatic regimes. This universally accessible and applicable method for trash monitoring provides practitioners and citizen scientists with a comprehensive and rigorous method for quantifying and characterizing trash loadings. ETAP can be used to assess item age and level of fouling and to analyze and compare across specific material types and categories of trash collected to guide upstream source reduction decisions.

The Dog River Clearwater Revival secured funding from the EPA's Gulf of Mexico Program for the Dog River Watershed Comprehensive Trash Abatement Program in 2019 to strategically install and maintain six Litter Gitters in Dog River tributaries and to conduct this hydrologic and geospatial study. The six devices were installed prior to this study, based upon Osprey litter management observations and anecdotal knowledge of highly urbanized Watershed areas with the potential for pooling. Litter Gitters function in instream locations with flowing water. Accessibility for routine maintenance and ETAP analysis according to a prescribed schedule or after rain events is a necessary requirement for Litter Gitter installation.

With only a seven-month, somewhat-irregular maintenance schedule, ETAP's use in this assessment was limited to informing average mass of litter collected per maintenance event per device across five target catchments. This value ranged from 25.8 lbs. in Litter Gitter 3, servicing Catchments 7 and 6, both with mixed land uses and together draining 1,258 acres, to 8.3 lbs. in Litter Gitter 1, one of two devices draining heavily commercial catchment 4, covering an area of 2,188 acres.

Cleanups/Community Engagement. In non-stream locations where stormwater runoff conveys accumulations of litter or along streambanks where access for routine Litter Gitter maintenance is challenging or not feasible, volunteer or professional/tactical cleanups provide useful, but temporary, means of eliminating litter along its path to marine waters. In relatively safe areas, like those serving as annual Alabama Coastal Cleanup zones (without uneven terrain, heavy vegetation, or dangerous fauna), volunteer cleanups effectively remove the litter from the environment, raise awareness among

participating volunteers and their communities about the problem, and provide data to guide resource management strategies related to abating litter.

Neighborhoods with significant populations of low-to-moderate-income residents impacted by high volumes of litter may benefit from the use of CDBG funds to support interim assistance measures such as clean-up campaigns including educational signage.

In areas with conditions unsafe or too challenging for volunteer cleanups (and routinely before Litter Gitter installations), Osprey and other professional firms can be contracted to undertake tactical cleanups, often with application of ETAP to characterize material and collect data related to source determination. Tactical cleanups are more effective than volunteer cleanups in removing litter from the environment and provide data to guide trash management, but they are not as effective in raising community awareness.

Deployment of Municipal Resources to Address Litter Near or Related to Commercial Uses. Several City of Mobile departments, including, but not limited to, Engineering, Environmental Enforcement, Environmental Services, Neighborhood Development, Public Works, and Stormwater Management, allocate resources towards litter abatement and the City's "War on Litter." In 2014, John Smart reported that the City of Mobile, in an effort to reduce litter entering its waterways, focused on several changes within its litter ordinance (Smart, 2014). These changes include:

- Requiring litter receptables, including cigarette receptacles, to be placed at entrances to commercial businesses, employee smoking areas, and common pedestrian transition points.
- All dumpsters must be enclosed.
- Prohibition of "junk" vehicles kept by owners, tenants, or occupants.
- Multi-family residential premises (apartments) must be free of litter.
- Cigarette butts are prohibited from being deposited in City streets, alleys, stormwater structures, ditches, or waterways.
- Signs on trees or utility poles in the City's rights-of-ways are not allowed without exception.
- All responsible parties – both owners and occupants – will be held responsible for a property in question.

A common recommendation to reduce illegally generated litter entering waterways from commercial roadways and parking lots is increased enforcement of existing regulations. With City staffs and budgets already stretched and environmental infractions related to illegal littering and dumping difficult to track and enforce, lack of implementation and enforcement results in these regulations frequently falling short of what is required to address environmental challenges and reduce volumes of stormwater-borne trash.

Apart from regulatory "sticks" related to enforcement to discourage bad behavior, providing "carrots" or incentives to encourage positive changes from businesses may be a more effective approach. Desired changes include increased availability of trash and cigarette receptacles near business entrances/exits and around parking areas, enhanced maintenance of dumpster or parking lot areas, and decreased use of plastic and Styrofoam single use packaging.

Potential incentives include public recognition touting the accomplishments of businesses or establishments for "doing the right thing, just because...". The Create A Clean Water Future website, Facebook, and Instagram are examples of social media platforms which could be used to advertise good trash management behavior. Public/private partnerships could secure and utilize grant funding to improve management (e.g., to purchase additional trash receptacles for businesses or establishments willing to install and maintain them or materials to construct fencing or wooden enclosures around dumpsters).

Operation of the City's fleet of street sweepers could prioritize areas within target catchments or use data related to areas of stormwater pooling around areas of urban development to eliminate trash before it is carried into storm drains by stormwater runoff.

The City's Litter Patrol, utilizing residents performing court-ordered community service for infractions, responds to complaints around the City by removing litter from hot spots and City rights-of-way. Supervisors could prioritize target catchments, including Interstate interchanges and major traffic intersections serviced by traffic signals as hotspots to service between complaint responses.

Data Gaps. This hydrologic/geospatial analysis of drainage areas was not exhaustive and could be improved. Across the Dog River Watershed Complex, certain areas are used by concentrations of homeless people who lack services necessary to properly manage their output of trash and litter. Some encampments have been shut down, but displaced populations quickly relocate to another location, frequently along creeks, streams, or other tributaries, where impacts are shifted. These areas were not the focus of this study, but the impacts associated with them are significant.

Use of data generated from application of ETAP to collected material was limited in this study by an irregular maintenance schedule of relatively short duration (six months) to mass of material collected per device per maintenance event and broad classification of predominant types of litter collected (i.e., plastics, other [including Styrofoam], and aluminum). Outputs from ETAP include data related to identification of brands and sources. Analysis of this brand data may be useful in establishing partnerships with businesses whose products are frequently recovered from Litter Gitters as a mechanism for targeting awareness campaigns or effecting changes in business practices.

Monitoring of success downstream should be a consistent part of any strategy to truly track the effectiveness of best management practice implementation like Litter Gitters. While this study informed development of strategies, its scope could be expanded to determine post-implementation trends and measure success.

Conclusions. This study employed an inexpensive protocol to focus limited resources on areas where management implementation will have the "best bang for the buck" in reducing stormwater-conveyed waterborne litter in the Dog River Watershed Complex and City of Mobile. While developed as a portion of the Dog River Clearwater Revival's Dog River Watershed Comprehensive Trash Abatement Program, the methods used involved only the use of the output of a GSSHA hydrologic model, secondary GIS datasets produced by federal and local agencies, and data collected in the field through the installation and maintenance of Litter Gitter instream trash capture devices. With hydrologic modeling envisioned for both the Three Mile Creek and Eight Mile Creek watersheds, this protocol will be useful to the City of Mobile in effectively directing its resources across its jurisdiction to reduce trash conveyed by runoff into its receiving waters.

This use of hydrologic models with GIS datasets is broadly transferable to geopolitical entities nationwide and beyond to address increasing problems related to trash and marine debris. This analysis model could potentially be useful in informing management of other nonpoint source pollution problems, including identification of areas particularly susceptible to sanitary sewer overflows.

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Appendices

Appendix A. Target catchment site assessments

Location/Waterbody	Catchment	Site ID	Latitude	Longitude	Waterbody Type	Impairment Rating (1 clean-5 impacted)	Predominate Litter Type	Predominate Condition	Land Use Impacted	Adjacent Land Use	Suitable for Capture Device	Site Assessment
Creekwood Dr.	2	SC-1	30° 39' 13.68" N	-88° 12' 51.4794" W	Stream	3	Styrofoam; Plastic	Intact	Wetlands; Roadside	Residential	Yes	This site is located along a cut-through road between Schillinger Road and Cody Road. It is heavily littered with obvious areas of illegal dumping. The stream is mostly clean and in good condition.
Schillinger's Rd./Airport Blvd.	1	MC-1	30° 41' 7.08" N	-88° 13' 9.12" W	Ephemeral	3	Styrofoam	Intact	Roadside	Commercial	No	Site has roadside, lined ditches, and trash discarded from vehicles drains down Airport Boulevard into these ditches. Types of litter observed were mainly fast food and beverage containers. Rich's Car Wash is located next to the site, and discolored water (purple) was observed in the ditch.
	1	MC-1-a	30° 41' 1.32" N	-88° 13' 6.24" W	Stream; Ditch	4	Styrofoam	Partially Degraded	Wetlands	Commercial	No	Site is easily accessible through an adjacent church property. Volunteer cleanups here would be difficult, due to uneven terrain and heavy vegetation. The end of a concrete-lined ditch (and a culvert crossing Airport Boulevard flows into a degraded channel. The site has a head cut and is failing due to stormwater drainage. It appears to be holding litter from upstream MC-1 and prevents the majority of litter from flowing downstream into Optimist Lake.
	1	MC-2	30° 40' 54.4794" N	-88° 12' 51.12" W	Stream	1	Aluminum	Partially Degraded	Roadside	Residential	Yes	Site was sparsely littered, mostly on the roadside and not in the stream. The site has sediment accumulating from the degraded MC-1a channel. Instream litter appears to have escaped from Site MC-1a upstream.
Hwy. 90 Theodore/ Carol Plantation Rd.	10	RC-1	30° 33' 31.32" N	-88° 10' 51.96" W	Stream	1	Styrofoam; Plastic	Intact	Wetlands; Roadside	Residential	Yes	Site is accessible for volunteer or tactical cleanups. It is currently an Adopt-A-Stream location. The adopter is the Theodore High School Science Club. Installation of watershed signage is recommended. Site should be routinely inspected. Installation of an instream Litter Gitter is not recommended.
	10	RC-2	30° 33' 34.1994" N	-88° 10' 22.4394" W	Stream	2	Styrofoam	Intact	Wetlands; Roadside	Commercial	Yes	Site is accessible for volunteer or tactical cleanups. Site should be routinely inspected. Installation of an instream Litter Gitter is not recommended.
Hillcrest Rd./ Grelot Rd.	3	MC-UT-2	30° 39' 35.64" N	-88° 11' 54.5994" W	Stream	4	Styrofoam; Plastic; Glass; Aluminum	Intact; Partially Degraded; Degraded	Parking Lot	Commercial; Residential	No	Site was observed with heavy litter.
Hwy. 90/ Tillman's Corner	9	RB-1	30° 34' 58.4394" N	-88° 9' 52.9194" W	Stream	2	Styrofoam; Plastic	Partially Degraded	Instream	Commercial	Yes	Site is downstream of two smaller drainages in Tillman's Corner and is easily accessible. Litter accumulates in a small lagoon on the east side of the bridge.
	9	RB-UT-1	30° 35' 7.7994" N	-88° 9' 56.52" W	Ephemeral	2	Plastic	Partially Degraded	Roadside	Commercial	No	Site drains a mixture of undeveloped, shopping centers, and residential areas and is easily accessible.

Appendix B. Potential strategies for management of each field surveyed site.

SC-1	2	Site is easily accessible for volunteer or tactical cleanups. Installation of watershed signage is recommended. Installation of an instream Litter Gitter is not recommended.
MC-1	1	Site is accessible for volunteer or tactical cleanups. The site should be routinely inspected. Installation of an instream Litter Gitter is not recommended.
MC-1a	1	Tactical/professional cleanups with routine inspections. Installation of an instream Litter Gitter is not recommended.
MC-2	1	Installation and maintenance of an instream Litter Gitter should be considered at this site or upstream, and the site should be routinely inspected.
RC-1	10	Site is accessible for volunteer or tactical cleanups. It is currently an Adopt-A-Stream location. The Adopter is the Theodore High School Science Club. Installation of watershed signage is recommended. Site should be routinely inspected. Installation of an instream Litter Gitter is not recommended.
RC-2	10	Site is accessible for volunteer or tactical cleanups. Site should be routinely inspected. Installation of an instream Litter Gitter is not recommended.
MC-UT-2	3	This site is accessible and suitable for volunteer or tactical cleanups. It should be routinely inspected. Installation of an instream Litter Gitter is not recommended
RB-1	9	Installation, maintenance, and routine inspection of an instream Litter Gitter is recommended for this site.
RB-UT-1	9	Site is accessible for volunteer or tactical cleanups and should be routinely inspected. Installation of an instream Litter Gitter is not recommended.