Background

- February 2001: BS in Geography from Romania
  - Minor in Meteorology-Hydrology
- May 2007: MSE (Environmental) at UA
- December 2008: Ph.D. in Civil Engineering at UA
  - Concentration: Water Resources / Environmental
- Graduate Research Assistant since Jan. 2002
- Engineering Math Advancement Program - Graduate Program Coordinator since Jan. 2005

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Land Development Characteristics in the Southeastern United States

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Objectives

1. Determined the nature of impervious surfaces
   - How they vary for different land uses
   - How the different surface configurations affect stormwater quality and quantity
2. Describe the method of field data collection and data processing necessary to examine land use characteristics
   - Jefferson Co. Storm Water Management Authority (SWMA) five outfalls (40 neighborhoods)
   - Little Shades Creek Watershed (125 neighborhoods)

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Main Findings of Literature Review

- Purpose of this research was to provide more detail on impervious surfaces for different land uses in the Southeast United States
- There is a general recognition that directly connected impervious areas (DCIA) are the most important feature affecting most runoff characteristics
- Very little data available and published to support the many assumptions that people have about impervious surfaces
- Impervious surfaces have not been described in enough detail to be efficiently used in association with biological condition observations

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Approach

- Investigated many land uses in the Birmingham, AL, area:
  - 1 large watershed, the Little Shades Creek Watershed (125 neighborhoods / 6 land uses) (original data collected in mid 1990s by USDA *Earth Team* volunteers)
  - 5 drainage areas (40 neighborhoods having 2 -6 land uses each) which are part of the Jefferson County, AL, Stormwater Permit Monitoring Program (intensive field investigations and surveys were conducted as part of this thesis research)
- Used WinSLAMM to:
  - Calculated runoff characteristics
  - Estimated the biological conditions of the receiving waters due to quantity of runoff for different land use and development characteristics

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Field Data Collection

- Delineation of the watersheds and neighborhoods
- Single land use neighborhood surveys: 6 to 12 per study area land use to determine the variability of the development characteristics
- Site Inventory had 2 parts:
  - Field data collection
  - Aerial photographic measurements of different land covers
- Each site had at least two photographs taken:
  - one as a general view
  - one as a close-up of the street texture

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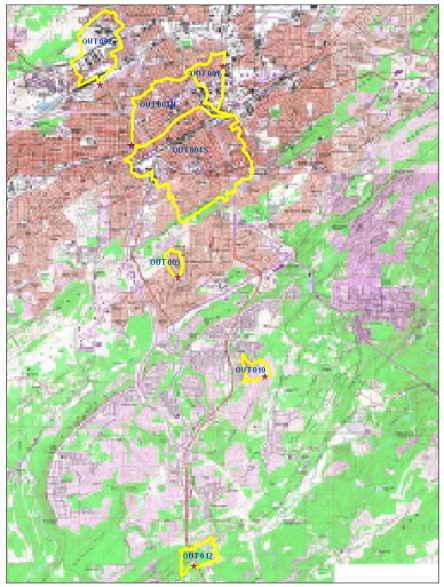

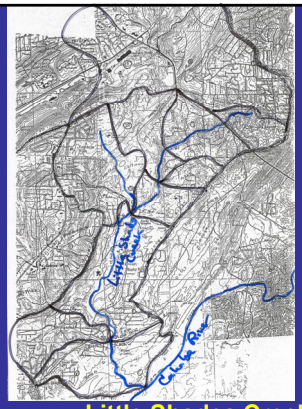

Little Shades Creek Jefferson Co, AL

Jefferson Co. MS4 Monitoring Sites Birmingham, AL

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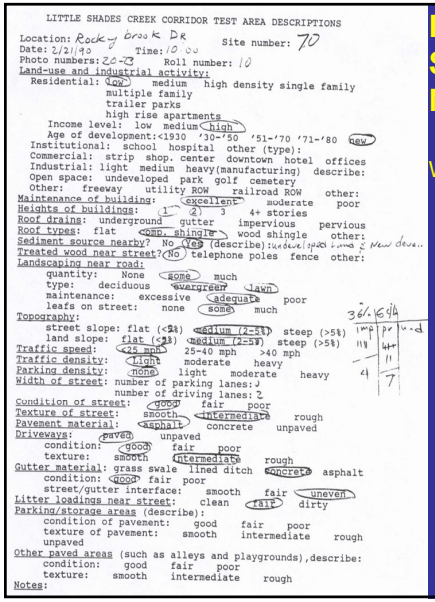

LITTLE SHADES CREEK CORRIDOR TEST AREA DESCRIPTIONS

Location: Rocky brook Dr Site number: 70
Date: 2/21/90 Time: 10 00
Photo numbers: 20-23 Roll number: 10
Land-use and industrial activity:
Residential: (low) medium high density single family
multiple family
trailer parks
high rise apartments
Income level: low medium (high)
Age of development: <1930 '30-'50 '51-'70 '71-'80 (new)
Institutional: school hospital other (type):
Commercial: strip shop. center downtown hotel offices
Industrial: light medium heavy(manufacturing) describe:
Open space: undeveloped park golf cemetery
Other: freeway utility ROW railroad ROW other:
Maintenance of building: (excellent) moderate poor
Heights of buildings: 1 (2) 3 4+ stories
Roof drains: underground gutter impervious pervious
Roof types: flat (comp. shingle) wood shingle other:
Sediment source nearby? No (Yes) (describe) undeveloped land & new deve...
Treated wood near street? (No) telephone poles fence other:
Landscaping near road:
quantity: None (some) much
type: deciduous (evergreen) lawn
maintenance: excessive (adequate) poor
leafs on street: none (some) much
Topography:
street slope: flat (<2%) (medium (2-5%)) steep (>5%)
land slope: flat (<2%) (medium (2-5%)) steep (>5%)
Traffic speed: (<25 mph) 25-40 mph >40 mph
Traffic density: (light) moderate heavy
Parking density: (none) light moderate heavy
Width of street: number of parking lanes: 0
number of driving lanes: 2
Condition of street: (good) fair poor
Texture of street: smooth (intermediate) rough
Pavement material: (asphalt) concrete unpaved
Driveways: (paved) unpaved
condition: (good) fair poor
texture: smooth (intermediate) rough
Gutter material: grass swale lined ditch (concrete) asphalt
condition: (good) fair poor
street/gutter interface: smooth fair (uneven)
Litter loadings near street: clean (fair) dirty
Parking/storage areas (describe):
condition of pavement: good fair poor
texture of pavement: smooth intermediate rough
unpaved
Other paved areas (such as alleys and playgrounds), describe:
condition: good fair poor
texture: smooth intermediate rough
Notes:

Field Inventory Sheet Prepared for Each Neighborhood

When in the field we look for:

1. Roof types *(flat or pitched)*
2. Roof connections *(connected, disconnected)*
3. Pavement conditions and texture *(smooth, interm., rough)*
4. Storm drainage type *(grass swales, curb and gutters, and roof drains)*

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Land Use Categories Examined

- Residential
  - High, medium, low density
  - Apartments, Multi- family units
- Commercial
  - Strip commercial, shopping centers
  - Office parks, downtown business district
- Industrial
  - Manufacturing (power plants, steel mills, cement plants)
  - Non-manufacturing (warehouses)
  - Medium Industrial (lumber yards, junk and auto salvage yards, storage areas)
- Institutional
  - Schools, churches, hospitals, nursing homes
- Open Space
  - Parks, cemeteries, golf courses
  - Vacant spaces, undeveloped areas
- Freeways – drained by swales

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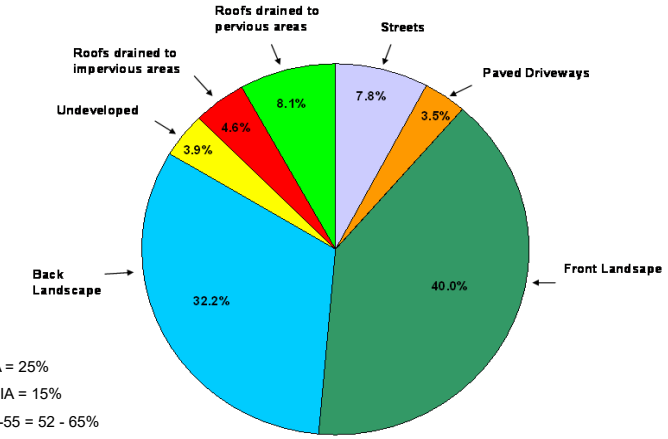
Little Shades Creek Watershed
Average Land Cover Distribution
High Density Residential (6 houses/acre)



TIA = 25%
DCIA = 15%
TR-55 = 52 - 65%

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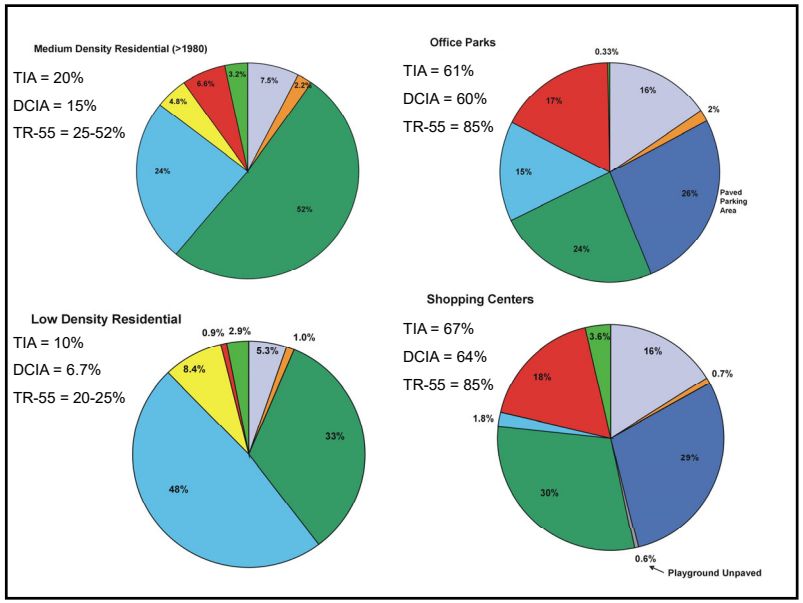
Medium Density Residential (>1980)
TIA = 20%
DCIA = 15%
TR-55 = 25-52%
Office Parks
TIA = 61%
DCIA = 60%
TR-55 = 85%
Paved Parking Area
Low Density Residential
TIA = 10%
DCIA = 6.7%
TR-55 = 20-25%
Shopping Centers
TIA = 67%
DCIA = 64%
TR-55 = 85%
Playground Unpaved

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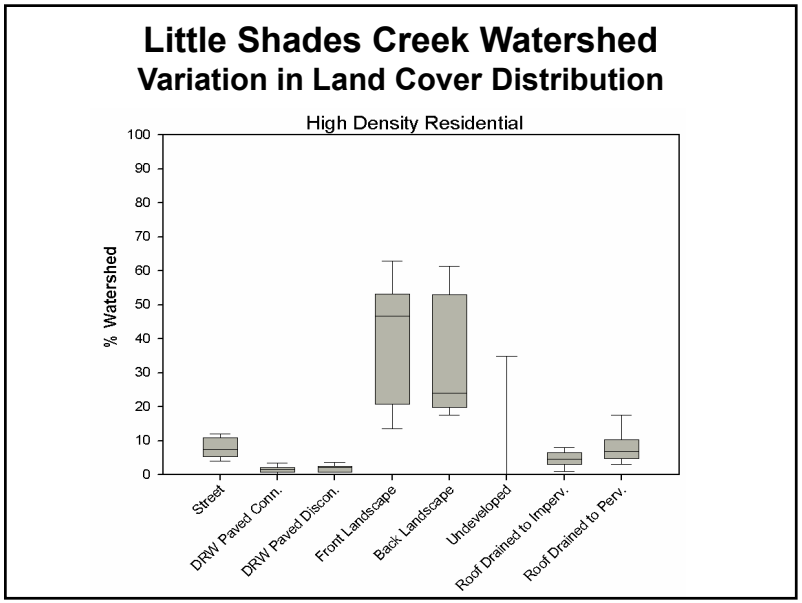
Little Shades Creek Watershed
Variation in Land Cover Distribution
High Density Residential
% Watershed
Street
DRW Paved Conn.
DRW Paved Discon.
Front Landscape
Back Landscape
Undeveloped
Roof Drained to Imperv.
Roof Drained to Perv.

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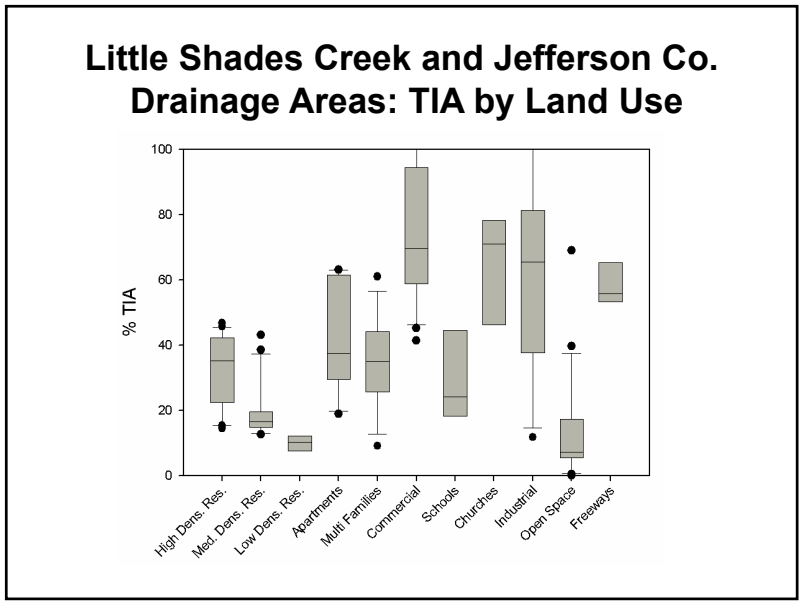
Little Shades Creek and Jefferson Co.
Drainage Areas: TIA by Land Use
% TIA
High Dens. Res.
Med. Dens. Res.
Low Dens. Res.
Apartments
Multi Families
Commercial
Schools
Churches
Industrial
Open Space
Freeways

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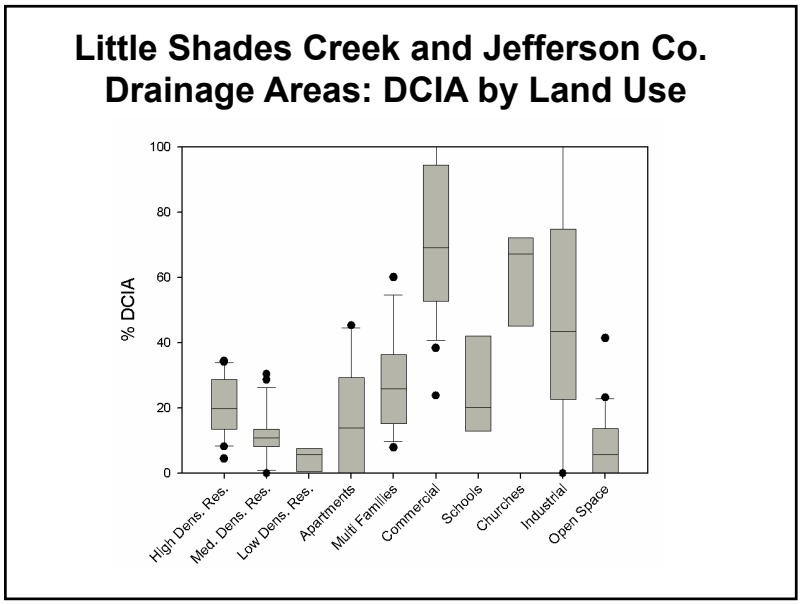
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Apartments
Multi Families
Commercial
Schools
Churches
Industrial
Open Space

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Average Percent Directly Connected Impervious Area

Land Use	Local Conditions	TR – 55 (using interpolation)
HDR (> 6 units/ac)	21	52
MDR (2-6 units/ac)	11	39
LDR (< 2 units/ac)	5	23
APARTMENTS	23	65
COM	71	85
IND	50	72

- TR- 55 assumes all impervious areas to be directly connected to the drainage system
- Overestimation of impervious cover for local conditions

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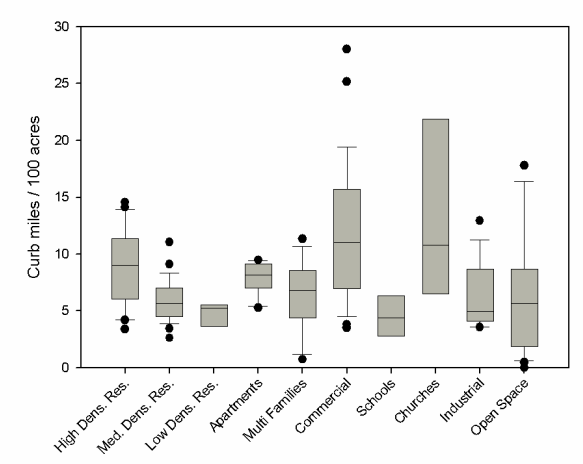
Curb Length vs Land Use



1 mile = 1.6 km **1 ac = 0.4 ha**

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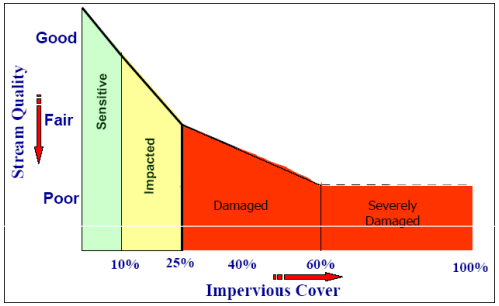
Figure and Table from Center of Watershed Protection



Urban Steam Classification	Sensitive 0 – 10% Imperviousness	Impacted 11– 25% Imperviousness	Damaged 26–100% Imperviousness
Channel Stability	Stable	Unstable	Highly Unstable
Aquatic Life Biodiversity	Good/Excellent	Fair/Good	Poor

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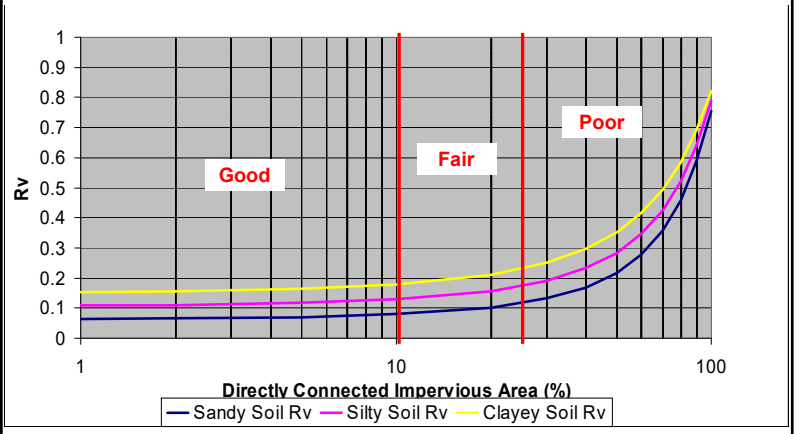
Relationship between Directly Connected Impervious Areas, Volumetric Runoff Coefficient, and Expected Biological Conditions



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Watershed ID	Major Land Use	Area (ac)	Pervious Areas (%)	Directly Connected Impervious Areas (%)	Disconnected Impervious Areas (%)	Vol. Runoff Coeff. (Rv)	Expected Biological Conditions of Receiving Waters
ALJC 001	IND	341	25	72	2.8	0.67	Poor
ALJC 002	IND	721	40	53	7.3	0.51	Poor
ALJC 009	Resid. High Dens.	102	54	34	12	0.37	Poor
ALJC 010	Resid. Med. Dens.	133	64	28	7.9	0.30	Poor
ALJC 012	COM	228	36	61	3.4	0.61	Poor
Little Shades Creek	RES	5120	67	21	12	0.29	Poor

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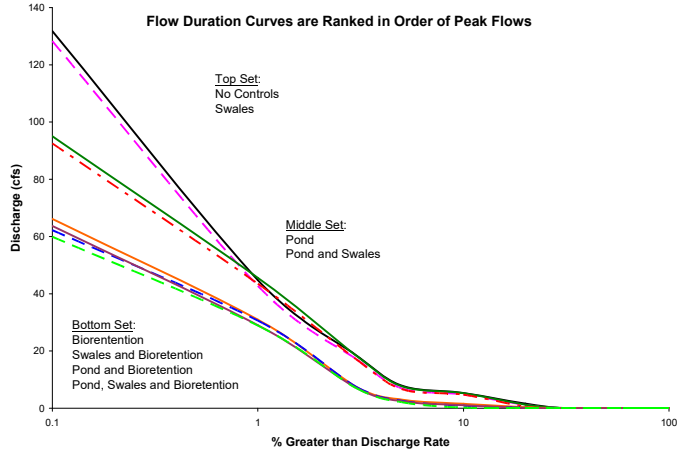
Flow-Duration Curves for Different Stormwater Conservation Design Practices



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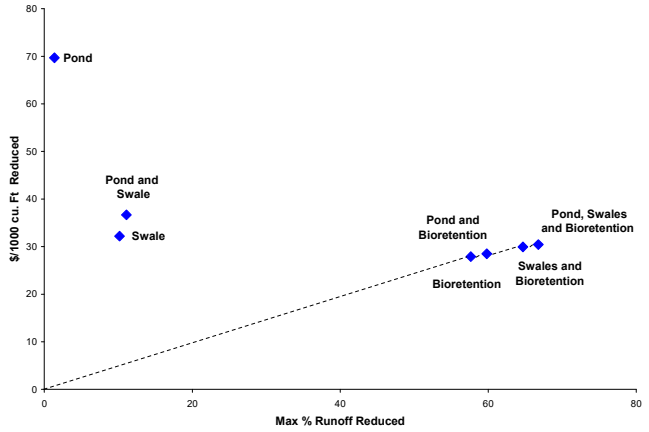
Cost Effectiveness of Stormwater Control Practices for Runoff Volume Reductions



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Example of Stormwater Control Implementation

	No controls	Pond Only	Swales Only	Bioretention Only	Pond, Swales and Bioretention
Annualized Total Costs ($/year/ac)	0	118	404	1974	2456
Runoff Coefficient (Rv)	0.61	0.60	0.54	0.26	0.20
% Reduction of Total Runoff Volume Discharges	n/a	1.4%	10%	**58%**	67%
Unit Removal Costs for Runoff Volume ($/ft^3)	n/a	0.07	0.03	0.03	0.03
Expected biological conditions in receiving waters (based on Rv)	poor	poor	poor	poor	**fair**

- Site ALJC 012
- Area 228 acres = 92.3 ha
- Bioretention devices give the greatest reduction in runoff volume discharged
- The biological conditions improved from “poor” to “fair” due to stormwater controls

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Conclusions

- Literature assumptions on impervious cover are not very accurate when applied to SE US conditions
- Almost all impervious surfaces are directly connected in the Jefferson County study areas examined
- Impervious cover variability within land uses need to be considered when modeling runoff conditions
- WinSLAMM showed that stream quality in the receiving waters is in poor condition, a fact confirmed by in-stream investigations by the SWMA biologists,
- Substantial applications of complimentary stormwater controls are needed to improve these conditions.

Acknowledgments

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- **SWMA employees who helped in this research**
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