PUTNAM COUNTY MASTER STORMWATER PLAN

FINAL SUBMITTAL

Sections 1 - 9

Prepared for:

Public Works Department
Putnam County
223 Putnam County Blvd.
East Palatka, FL 32131

Prepared by:

Ayres Associates
5220 Shad Road, Suite 200-3
Jacksonville, FL 32257

September 2006
Project No. 67-0110.00

EXECUTIVE SUMMARY

In the interest of promoting the protection of the health, safety and welfare of Putnam County residents; protecting the County's surface water and groundwater resources; and mitigating property damage and adverse economic impacts, environmental degradation and other hazards resulting from inadequate stormwater management, a Master Stormwater Plan has been developed for Putnam County.

The objective of this Master Stormwater Plan is to provide Putnam County with a planning tool to guide the decision process for project prioritization, budgetary planning, and implementation of improvements for publicly managed drainage systems. Improved flood protection for the citizens of Putnam County may be achieved through a combination of refinement and enforcement of regulatory standards, a program of preventive system maintenance and timely repair, an expanded hydraulic structure inventory and GIS database, specific structural improvements, and critical mapping and hydrologic data monitoring endeavors to support engineering and flood studies.

The first phase of Stormwater planning for Putnam County has incorporated the following specific goals:

- Integration of an information management database system, compatible with the County's GIS and other systems
- Identification of natural drainage system components, location, and condition
- Identification of maintenance and repair requirements and new or replacement projects needed to allow the systems to function as needed
- Identification of requirements and procedures to mitigate future damages through stormwater management, floodplain management and water quality

Ayres Associates has developed a framework for the Master Stormwater Plan report as well as the GIS database that will allow the County to expand and incorporate additional information, as additional drainage studies, hydraulic component inventories, and aerial mapping/surveying are completed in the coming years.

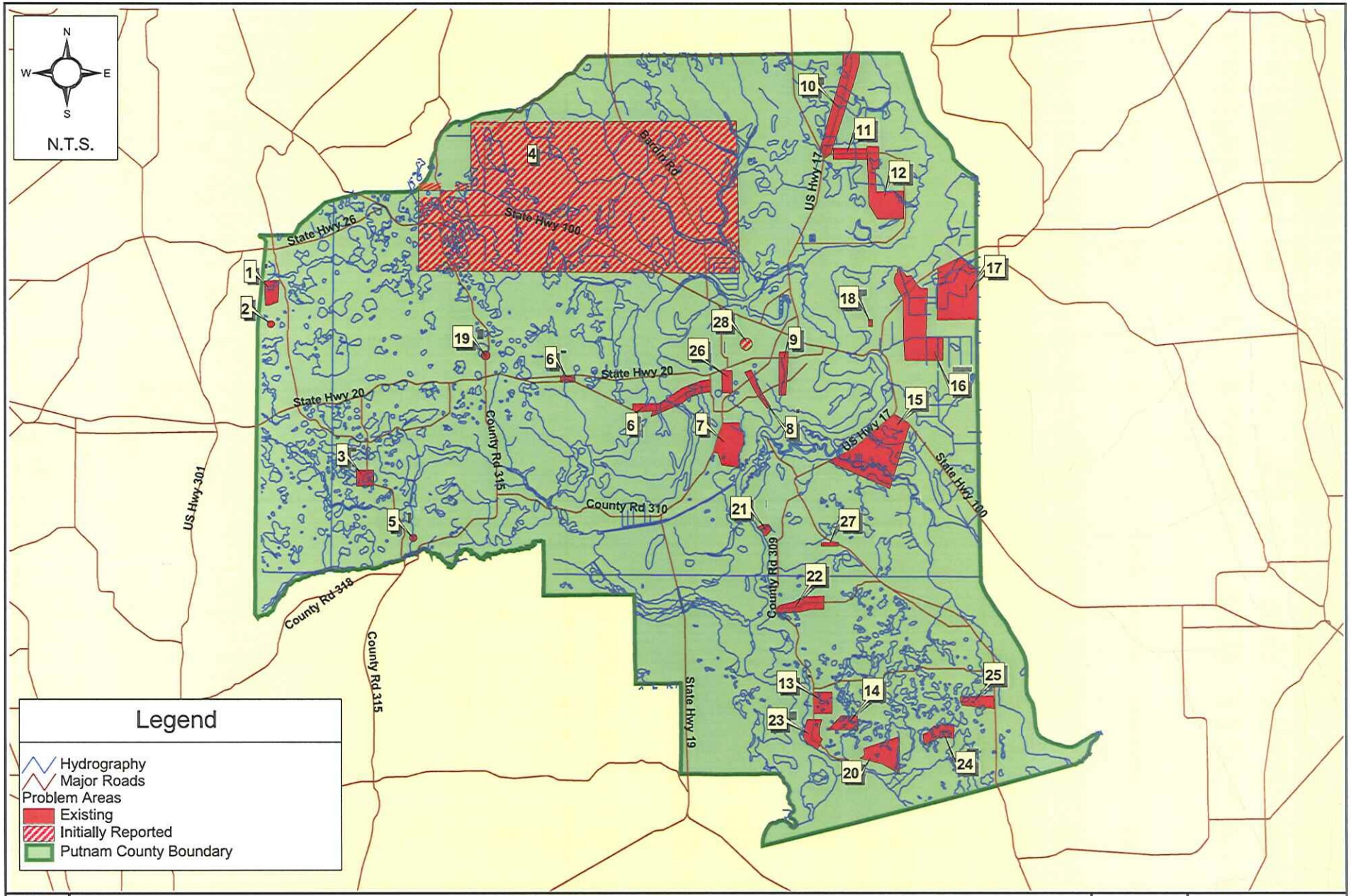
A summary of key findings and recommendations is provided in this Executive Summary for immediate review, along with important graphics and tabular summaries. A Preface follows that describes the general layout and content of the Master Stormwater Plan.

IDENTIFIED PRIORITY PROBLEM AREAS AND RANKING

Chronic flooding and sedimentation areas were identified through County interviews, flood complaint records and field inspection and verification. Twenty-eight "Problem Areas" were identified (some of which are already being addressed by the County and will not require capital improvement project development under the Master Stormwater Plan). the areas are listed below and presented on the subsequent figure.

FLOODING AND SEDIMENTATION AREAS

Location # and Name	Description
1. Bellamy Woods Road	(From Price Road 0.3 miles north on Bellamy Road) Flooding problem
1, 2. Price Road	(From Perry Road east to culvert on Price Road) Road floods in these areas
3. Roops Ditch	Overflow for lakes
4. Florahome Drainage [Maintenance performed in 2005 may have addressed this problem]	(Fulton Road at Keystone Road, 309D at Keystone Road, John's Road, Bannerville (dirt) culvert at Coral Farms Road, Bardin drainage included)
5. Orange Springs Shortcut [County is addressing]	Bridge goes under water during moderate rains
6. Old Gainesville Hwy/Hunter Road	Drainage from timber woods
7. Mondex	(Pinellas Road, Park Avenue, Royal Palm Road) roads go under water with medium rainfall
8. Devall Branch	Maintenance problems, water volume increasing steadily, water backs up during moderate rain
9. Twomile Creek	Volume overload, water backs up during moderate rains
10 West Tocoi [will be out for bid soon]	Floods in several places
11. Palmetto Bluff	Water volume problem, road floods
12. Millican Road	Very slow drainage, flooding
13. River Park Subdivision	Road floods during moderate rain
14. Lakeway Drive Drainage	Lakeway Drive drainage
15. San Mateo Road Dunns Creek	Flooding and erosions
16. East Palatka Drainage District	Slow drainage, roads tend to flood
17. Hastings Drainage District (Rector Road) [Culvert has collapsed – Road Closed]	Drains a large area of farm land
18. East River Road (at Camp Road)	Flooding during moderate rain backs up water to Public Works Department
19. County Road 315 at 64th Street	Road under water during moderate rain
20. Whispering Pines	Low area floods during rain
21. Saratoga Harbor [County is currently addressing]	Drains through small lakes and dams
22. County Road 308 B	Area floods during moderate rain
23. County Road 309	Area floods during moderate rain
24. Harris Fish Camp Road	Flat land area
25. Junction Road	Floods during moderate rain
26. Mud Lake/Monroe Creek [County is currently working in this area]	Concern with additional water from SR 20
27. Sisco Road	Road floods during rain, road is lower than surrounding property.
28. Foxwood Outfall [County is currently addressing]	Drains property south of St. Johns Avenue area floods during rain



G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Location_Big.apr

Problem Areas
Putnam County Master Stormwater Plan

Figure 2.8-1

AYRES ASSOCIATES

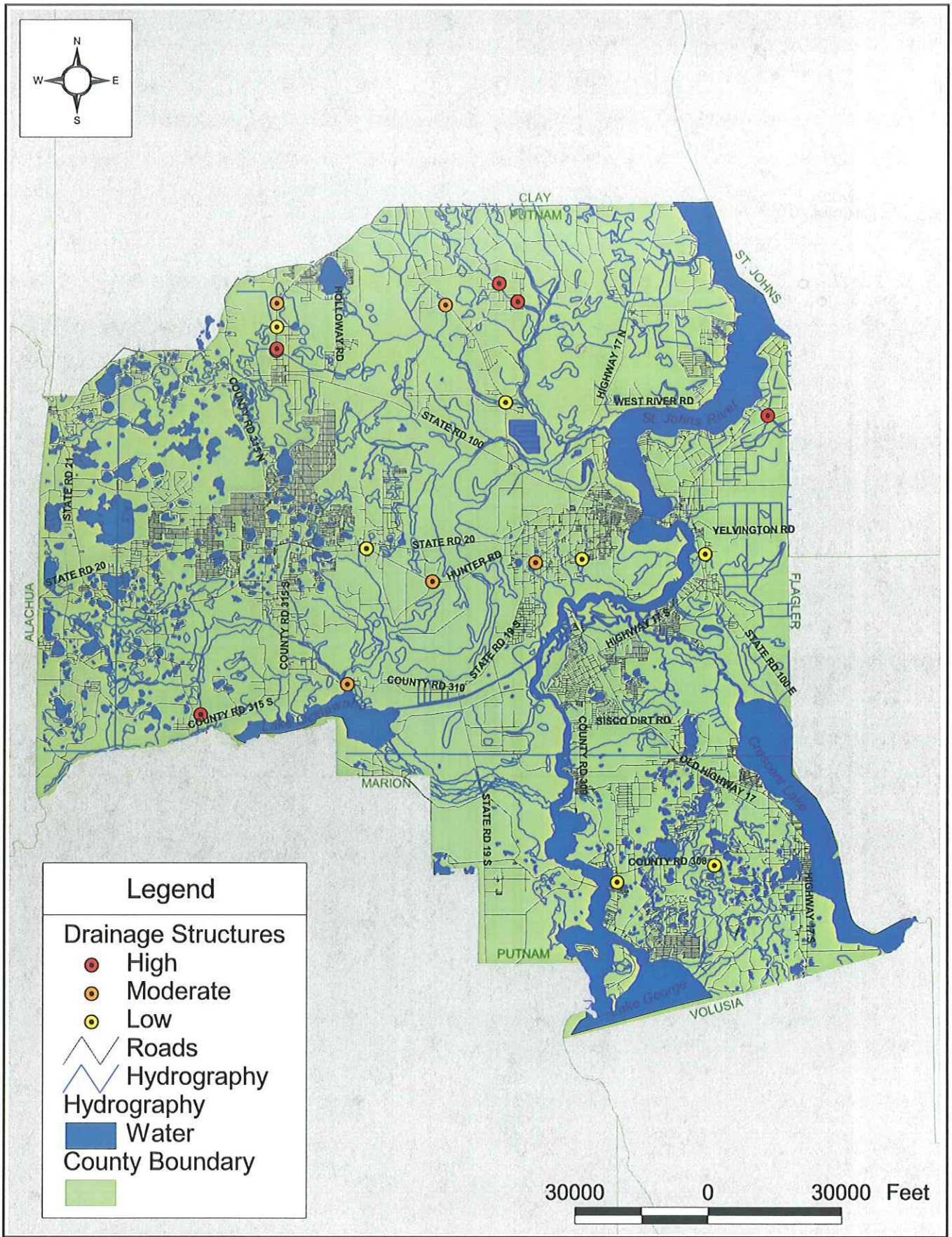
PRIORITY REPAIR AND REPLACEMENT PROJECTS

Projects for repair and replacement have been identified through coordination with Putnam County drainage maintenance staff, field review of identified flood problem and sedimentation areas, additional field investigations performed in selected subwatersheds as part of GIS stormwater facilities inventory and database development, and review of FDOT Bridge Inspection reports. Section 6 of the Master Stormwater Plan covers this topic. The following table and graphic identify these areas, which are listed in order of perceived priority based upon public safety, severity of component disrepair, and potential flooding impacts of the compromised function of the component. Some of these projects are investigated in greater detail as part of the capital improvement program.

REPAIR AND REPLACEMENT PROJECTS

Location	Description	DPU Watershed *Subwatershed*
HIGH PRIORITY		
Silver Lake Drive over Twomile (Duval) Creek	Deteriorated culvert in need of repair or replacement. Primary creek conveyance.	**SOUTH MAINSTEM** Twomile (Duval) Creek
Orange Springs Shortcut Road over Little Orange Creek	Timber bridge with insufficient flood clearance, timber damage and unprotected abutments. Unsafe for traffic during moderate to heavy rains.	**ORANGE CREEK** Orange Creek *Little Orange Creek*
Rector Road at State Road 207	Corroded and sediment-blocked culvert of significant size. Traffic safety concern. Culvert collapsed in 2006 and road was closed.	**SOUTH MAINSTEM** West Run Interceptor D *West Run Interceptor D*
Coral Farms Road over Etonia Creek canal tributary	Corrugated metal culverts (14 to 15 ft diameter) approx. 1 mile north of SR 100. Requires evaluation due to roadway settling.	**ETONIA CREEK** Etonia Creek *Etonia Creek*
John's Place over Unnamed Branch-1	Timber bridge (# 764042) needs replacement. Transfer of ownership to County is complete.	**ETONIA CREEK** Simms Creek *Unnamed Branch - 1*
Songbird Road over Simms Creek	Timber bridge (# 764031) needs replacement. Bank protection failed. Structural and scour risk.	**ETONIA CREEK** Simms Creek *Unnamed Branch - 1*

Location	Description	DPU Watershed *Subwatershed*
MODERATE PRIORITY		
County Road 310 over Deep Creek FDOT Bridge No. 764014	Pile and abutment protection deterioration, heavy channel vegetation restricting flow and significant scour noted at several locations. This structure is rated Scour Critical and needs scour countermeasures implemented.	**RODMAN RESERVOIR** Deep Creek *Deep Creek*
Providence Church Road over Etonia Creek tributary	Double 32-inch culvert cross-drain rusted through and choked with sediment	**ETONIA CREEK** Etonia Creek *Etonia Creek*
Hunter Road roughly 1.2 miles east of Fire Tower Road	Two 24-inch co-located cross-drains severely silted and squashed.	**ETONIA CREEK** Rice Creek *Rice Creek*
Silver Lake Drive over Pine Lake outlet channel	Single 24-inch culvert providing connection between Pine lake and Mud lake is severely silted and squashed.	**SOUTH MAINSTEM** Mudlake Outlet
River Park Subdivision drainage outlet at County Road 309	Outlet cross-drain is undersized causing property flooding.	**LAKE GEORGE** St Johns River *River Park Subdivision*
Coral Farms Road north of Thornton Lane	Single 24-inch culvert severely silted with almost no remaining hydraulic function.	**ETONIA CREEK** Etonia Creek *Etonia Creek*
LOWER PRIORITY		
Coral Farms Road over tributary near Haast Road	Collapsing wingwall at 48-inch cross-drain culvert.	**ETONIA CREEK** Etonia Creek *Etonia Creek*
Bardin Road (CR 309) over Etonia Creek	Bridge No 764007 End Bent undermining and significant scour noted during last bridge inspection. Replace riprap protection	**ETONIA CREEK** Etonia Creek *Etonia Creek*
Heidt Road near Heidt Loop Road	Severely silted and squashed 16-inch cross-drain.	**SOUTH MAINSTEM** Twomile (Duval) Creek
Hunter Road over Sweetwater Creek	Sand-cement headwall needs repair at 48-inch cross-drain.	**RODMAN RESERVOIR** Deep Creek *Sweetwater Creek*
Old San Mateo Road over unnamed tributary	Structure cover eroding at headwall of 72-inch cross-drain.	**SOUTH MAINSTEM** St Johns River
Browns Hammock Road near Gem Lake Drive	Road washout causing severe siltation and crushing of 16-inch cross-drain.	**LAKE GEORGE** Tiger Branch



Repair and Replacement Project Locations
Putnam County Master Stormwater Plan

G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\drainagestructures apr

Figure 6-1

AYRES ASSOCIATES

CAPITAL IMPROVEMENT PROGRAM

Identified problem areas in the County were prioritized for this CIP by ranking based on factors such as:

- Population density affected
- Degree of flooding
- Water quality benefits
- Cost
- Public Acceptance
- Permitability (potential to be issued an Environmental Resource Permit)

The ranking system is neither purely objective nor purely analytical; rather it is a screening and decision making tool to assist managers in organizing a diverse range of projects with differing levels and types of merit and liabilities. It is a flexible way to prioritize practical constraints (fiscal/political etc.).

The original assessment produced a list of 15 top-ranked projects. These projects were selected for analysis of specific potential stormwater strategies to alleviate the local flooding/sedimentation issues. Prior to finalization of this report, but subsequent to field review and engineering analyses, two areas (Saratoga Harbor and Mondex) were re-ranked, which moved the County Road 309 and County Road 308B projects into the top 15. The final project ranking is presented below. Cost estimates (order of magnitude) were provided for those projects with sufficient data available to estimate. Section 7 of the Master Stormwater Plan provides more detail.

15 TOP-RANKED PROJECTS FOR PUTNAM COUNTY

Rank	Project	Cost Projection ($1000)	Planning Unit *Subwatershed*
1	Devall Branch	45 -141	South Mainstem *Devall Branch, Davis Lake Outlet*
2	Twomile (Duval) Creek	Undetermined	South Mainstem *Twomile (Duval) Creek*
3	Palmetto Bluff	230	South Mainstem *Cedar Creek*
4	Millican Road	2,460	South Mainstem *Cedar Creek, Mason Branch*
5	River Park Subdivision	72	Lake George *St Johns River-River Park*
6	Mud Lake/Monroe Creek	154 (eval.-design only)	South Mainstem *Mudlake Outlet*
7	Orange Springs Shortcut	140	Orange Creek *Little Orange Creek*
8	Hasting's Drainage District (Rector Road)	61 (construction only)	South Mainstem *West Run Interceptor D*
9	East Palatka Drainage District (SR 207)	Maintenance Issue	South Mainstem *Mill Branch, Dog Branch*
10	Whispering Pines	Maintenance issue	Lake George *Tiger Branch and St Johns River*
11	County Road 315 at 64th Street	15	Rodman Reservoir *Gum Creek*
12	Florahome Drainage	56 Coral Springs Rd culvert replacement	Etonia Creek *Beecher Run, Blocker Lake Outlet, Clearwater Lake Outlet, Etonia Creek, Falling Branch, etc.*[1]
13	East River Road (at Camp Road)	Maintenance Issue	South Mainstem *Cow Branch*
14	County Road 309	Undetermined	Lake George *St Johns River*
15	County Road 308B - Welaka	Undetermined	Lake George *St Johns River*
Total Estimated Cost		**$3,330 K**	

[1] Lake Grandin Outlet, Lake Suggs Outlet, Long Pond Outlet, Oldtown Branch, Palmetto Branch, Rice Creek, Simms Creek, Unnamed Branch-1,2 and 3, Unnamed Drain 1,5 and 6, Unnamed Run 1 and 2.

ADMINISTRATIVE AND FUNDING RECOMMENDATIONS

Administrative

Putnam County's Comprehensive Plan and Land Development Codes provide an LOS standard for public drainage facilities and design standards for new development which are strict enough to prevent adverse flooding and water quality impacts from future development, so long as the codes are enforced. The following recommendations are put forth for County consideration.

- Exemptions for agriculture and silviculture in the land development codes for erosion control and drainage standards, with a proviso that Best Management Practices (BMPs) are adhered to, creates a potential "weak link." Sediment transport has been identified as a major maintenance issue for Putnam County's stormwater maintenance staff. A concentrated effort must be made to enforce the use of scientifically-supported BMPs through inspection and legal action, as appropriate.

- Maintain the current target LOS of 25-yr/24-hr design capacity and rate control for stormwater ponds, open channels and closed storm sewers for all new development and new public facilities
- Maintain the current closed lake and closed basin criteria for runoff volume (100-yr/24-hr and 25-yr/24-hr respectively)
- Concurrency provisions cannot be evaluated until the existing system's LOS has been determined. Modeling studies are necessary to determine where the County's established LOS standards are not being achieved for the existing drainage system. Responsible growth management would dictate that additional conveyance capacity or flood attenuation would be provided in those areas before new development may be allowed.
- The framework for assessing Development Impact Fees to share the cost of providing infrastructure to new developments has been laid in the Comprehensive Plan. These fees were once assessed but are reportedly no longer collected by Putnam County. Bearing the full financial burden of providing infrastructure for future development is an unnecessary undertaking for a rural County with limited funds. It is strongly recommended that assessment of Development Impact Fees be reinstated.
- The County should begin organizing its drainage issues and projects by DPU and Watershed, so that in years to come, as additional studies are implemented and drainage improvements are made in individual watersheds, the pertinent information may be added to the file for the specific DPU and watershed.
- New developments should be providing the County right-of-way and drainage easements sufficient for the County to adequately maintain systems.
- Require property owners to grant the County drainage easement if they have a waterbody, ditches, streams, etc. that crosses through, or is included in, their property in order for the County to provide flood protection through adequate conveyance.

Funding

A variety of funding sources are potentially available to financially support the objectives of the Master Stormwater Plan, and have been described in Section 4. A combination of funding sources are recommended for various components of the Plan.

- A Stormwater Utility Study is recommended to assess the feasibility of funding ongoing maintenance and repair of the existing public stormwater facilities. Upon establishing where the adopted LOS has been achieved for the existing system, the Utility may also be a viable supplemental funding mechanism for capital improvements to upgrade deficient portions of the system.
- The County should actively pursue cooperative funding through grant applications to those agencies identified in Section 4.1 of this Master Stormwater Plan. Two applications have been completed for agency grants listed in Table 4.1-2, using priority project areas identified in this Master Stormwater Plan. The existence of an adopted Master Stormwater Plan will increase Putnam County's potential for winning these funds, as it represents a good faith effort to systematically address current water resource needs and provide protection of public resources for the future.
- The County should engage grant assistance professionals to assist in identifying and pursuing funding sources that align with County stormwater planning needs and objectives

OPERATION AND MAINTENANCE RECOMMENDATIONS

Staffing and equipment shortages limit the effectiveness of current stormwater operations and maintenance activities of Putnam County. The following recommendations, though badly needed, will require a significant ongoing financial commitment.

- The Proposed Maintenance Plan described in Section 5.4 should be adopted and implemented; including scheduled preventive inspection and maintenance of a fully-inventoried network of drainage components, rehabilitation of compromised system components, development of a formal incident response and documentation program, and acquisition of additional dedicated and shared equipment.
- The current 7-person stormwater maintenance crew is considered adequate for providing the outlined Maintenance Program for one of the four Roads and Bridges service areas within the County. Three additional crews are recommended to provide the necessary man-power for adequate system maintenance. A staffing increase of this level, and the generation of funds to support it, requires time. A stormwater utility or similar fee assessment is recommended as the most effective vehicle for generating necessary funds.

GIS DATABASE AND MAPPING RECOMMENDATIONS

An inventory of maps, topography, hydrologic and hydraulic coverages (including FEMA flood zones), and the first stage of the County's hydraulic structure inventory have been assimilated and integrated into ArcMap projects compatible with the County's GIS system. All files have been translated to a common mapping projection. The following recommendations apply to GIS database and mapping resources:

- Conveyance system data currently available for Putnam County is too course. Additional data collection in the form of field survey, aerial contour mapping and channel cross section determination is needed throughout the County. Priority subwatersheds (Devall Branch, Twomile Creek, Mudlake Outlet, Cedar Creek, River Park and Mondex) should be targeted first, to support engineering designs for the construction of the highest priority CIP projects.
- The hydraulic structure inventory should be expanded to include all County-maintained channel and ditch conveyances; first for the selected subwatersheds and later for the remaining subwatersheds. Customized database templates should be developed for use in the operation and maintenance database as well as for future watershed studies.
- FEMA flood zone coverages reflect base flood elevations for water bodies and conveyances available from existing Flood Insurance Rate Studies. Many tributaries and water bodies have not yet been studied in detail. As the County is able to complete detailed watershed studies and to generate base flood profiles and flood stages for water bodies, the GIS database and mapped coverages should be revised and updated.
- The County land use coverage contains numerous blank polygons, primarily in roadway and waterbody areas. These attribute tables should be populated with appropriate land use categories. It has been noted that a "Rivers, Lakes and Streams" land use category is defined but is not frequently utilized.

TOPOGRAPHIC MAPPING AND SURVEY

Development of aerial mapping is the foundation of any strategic and long-range plan within the County that is aimed at proactively managing its stormwater issues. Ayres recommends:

- Development of 1-foot contour interval mapping, for all selected subwatersheds, beginning with the Devall Branch, Twomile Creek, Mudlake Outlet, Cedar Creek, River Park and Mondex subwatersheds
- Later expanding coverage to the other areas of the county on a timetable consistent with available funding and the subwatershed study ranking described in Section 8.

WATERSHED MODELING FOR ENGINEERING DESIGN AND FLOODPLAIN DELINEATION

The selection of model type or method must be based on reasonable scientific judgment and is influenced by the intended use of model results. The following specific recommendations are made concerning project design modeling and watershed-scale modeling (especially for the purpose of flood plain delineation) in Putnam County.

- The use of simple models such as the Rational Formula, TR-55, FDOT Stormtabs and the like should be limited to the following applications:
    - In-kind culvert replacement and channel restoration (as a maintenance repair activity) on minor systems
    - Design of side drains or driveway culverts, cross drains and roadside ditches on stormwater systems with small contributing drainage areas serving existing development, and with no known capacity-related flood problems
    - Runoff volume generation for planning-level pollutant loading studies
- USGS regression equations are appropriate for estimating riverine flood flows for various return frequencies to be used in bridge replacement or major culvert designs at the concept level, where gaged streamflow data are unavailable. For final design it is recommended that flood flows be generated using more sophisticated models tied to routing programs.
- The majority of County design work for stormwater management is best supported by single event, dynamic models able to general runoff hydrographs from real or synthetic rainfall input and to route runoff through complex networks of pipes, channels, storage areas and control structures. Recommended applications include conceptual and engineering design for:
    - New or modified channel cross sections with large contributing areas or in identified flood areas
    - Culvert and/or bridge installation/replacement on major conveyances or in identified flood areas
    - Stormwater management systems serving new development (altered land use/land cover)
    - Regional flood control facilities

- Floodplain delineations for FEMA DFIRM, FIRM revision, LOMA, or LOMR

- When modeling major conveyances, use a model approved by the Federal Emergency Management Agency (FEMA) so that the County can submit the floodplain elevations to FEMA for incorporation into the next DFIRM, FIRM revision, LOMA, or LOMR. Calibration of simulation models should be based on as many of the following indicators as possible: water elevation (stage) records, streamflow records, hydrologic indicators, and anecdotal/eyewitness accounts of peak stages.
- Continuous simulation models are recommended for:
  - Frequency analysis of rainfall and/or streamflow data to establish typical "wet," "dry" or "average" hydrologic conditions
  - Water quality assessments for pollutant loading, sediment transport, and pollutant decay
  - Assessment of hydroperiod for lakes and wetlands. For hydroperiod assessments, and in flood studies where there is significant water table influence, integrated surface and groundwater models should be considered.

PLAN OF ACTION

Based upon the data collection, review of chronic flooding and sedimentation areas, characterization of watersheds and their inter-relation, LOS goals, prioritization assessment, conceptual solution generation and cost estimates the following action items are recommended.

Short Term (Year 1 - 2):

- Address "High Priority " repair and replacement projects

  Complete engineering designs and construct designed solutions for
  - Johns Place Bridge
  - Orange Creek Shortcut Bridge
  - Songbird Road Bridge
  - Rector Road at SR 207
- Complete engineering designs already in progress and construct designed solutions for identified problem areas
  - West Tocoi
  - Sarasota Harbor
  - Mud Lake
- Aggressively pursue teaming/cost sharing opportunities for LiDAR mapping
- Begin the FDEP-funded watershed studies and alternatives analysis for Devall Branch, Mudlake Outlet & Twomile Creek

- Actively track DCA matching grant status and engage grant assistant professionals (refer to Section 4) to identify other funding sources
- Construct additional precipitation and streamflow monitoring stations
- Budget for needed Maintenance staffing and equipment

Long Term (Year 2 – 10):

- Develop a schedule for "Medium" and "Low" priority repair and replacement projects
- Budget for remaining watershed mapping and modeling studies in order of priority ranking
- Determine the existing LOS for the County's existing stormwater management facilities Compare to the target LOS Identify critical areas of concern Prioritize next set of projects for the Capital Improvement Program
- Perform feasibility studies for alternative/supplemental stormwater improvement funding through Development Impact fees and/or Stormwater Utility fees
- Continue to expand the stormwater feature inventory database
- number of elements documented drainage structure invert elevations adjacent ground/roadway elevations
- Monitor and record precipitation and streamflow at new monitoring station locations
- Periodically update the Master Stormwater Plan

PREFACE

In the interest of promoting the protection of the health, safety and welfare of Putnam County residents; protecting the County's surface water and groundwater resources; and mitigating property damage and adverse economic impacts, environmental degradation and other hazards resulting from inadequate stormwater management, a Master Stormwater Plan has been developed for Putnam County.

The function of a Master Stormwater Plan is to provide a roadmap or travel plan for identifying where the County is, in terms of the present condition, level of service, and general extent of their public stormwater facilities; what special points of interest should be visited (significant system deficiencies) and in what order; what preparations are necessary before taking the "trip" (aerial/topographic mapping, survey, modeling studies); and how the trip will be paid for. It lays a foundation for the specific stormwater projects and studies which must follow, and provides the documentation and justification necessary for Putnam County to apply for supplemental funding from any of several available sources, described in Section 4 of this report.

Stormwater planning for the 827 square-mile Putnam County has incorporated the following specific goals:

- Integration of an information management database system, compatible with the County's GIS and other systems
- Identification of natural drainage system components, location, and condition
- Identification of maintenance and repair requirements and new or replacement projects needed to allow the systems to function as needed
- Identification of requirements and procedures to mitigate future damages through stormwater management, floodplain management and water quality

Recognizing that the financial resources of the County are limited, and that this planning document is but a foundation for future design-level engineering studies, existing data and reports related to physical basin characteristics, land use, hydrology and the management of surface waters were utilized to the greatest possible extent.

Ayres Associates has developed a framework for the Master Stormwater Plan report as well as the GIS database that will allow the County to expand and incorporate additional information, as additional drainage studies, hydraulic component inventories, and aerial mapping/surveying are completed in the coming years.

A summary of the report content follows, with important graphics or tabular summaries included for immediate review.

Section 1 – Introduction and Organization

Describes the general location and climatologic/meteorological setting of the County and reviews the objectives and contracted scope of the Master Stormwater Plan.

Section 2 – Data Collection and Review

Documents the source, extent and application of available data for soils, land use, streamflow, rainfall, topography, watershed delineation, floodplains, hydrography, previous studies, operation and maintenance, historic problem areas, priority subwatershed selection and field investigations for selected subwatersheds. The objective is to make full use of previous studies and to avoid duplication of work effort. The existing data assessment also includes identification of critical data gaps (areas where additional data are needed). Information and data have been gathered in the form of general and detailed studies, mapping, technical publications, record drawings, interviews, and public databases. Collected data and information have been received or downloaded in either hard copy or electronic formats, including GIS coverages and databases.

Spatial data has been incorporated into ArcMap GIS projects for Putnam County's access and use. Field-collected data has been added by Ayres Associates as interactive linkages. Additional coverages are included that were developed under this scope, such as problem area extents, selected priority subwatersheds and additional delineations. Forty-seven (47) subwatersheds were selected for priority evaluation.

The prioritization analysis (described fully in Section 2.9 of the Master Stormwater Plan) took into primary consideration proximity to, or association with, the 28 "Problem Areas" presented above. The second criteria applied concerned current land use, on the assumption that stormwater issues tend to be associated with, and arise out of, human activities such as residential development, commercial/industrial uses and transportation. Using these criteria, each subwatershed in the County was ranked from highest to lowest based principally known flooding or sedimentation issues and on percentage of area developed and undeveloped within a subwatershed.

A formula was then developed to rank each subwatershed by land use. The ranking matrix put greater weight on developed lands, which typically have infrastructure needs or deficiencies. Uses such as silviculture or undeveloped wilderness lands that require little or no infrastructure were de-emphasized (weighted to one-third that of developed lands). The areas for residential, commercial, transportation, industrial, and institutional land uses were weighted with a value of 3. Mining, miscellaneous, public facilities, recreation, agriculture, rivers/lakes/streams, silviculture, and vacant lands were weighted with a value of 1. An area-weighted rank was calculated for each subwatershed (analogous to a weighted runoff curve number (CN) used in hydrology calculations) using the following formula:

$$\text{Basin Rank} = \text{Problem Area Rank} + \frac{\sum \text{Area}}{3(\sum \text{Developed landuse}^{1}\text{Area}) + 1(\sum \text{Undeveloped landuse}^{2}\text{Area})}$$

[1] Commercial, Transportation, Industrial, Institutional and Residential

[2] Mining, Miscellaneous, Public Facilities, Recreation, Agriculture, Rivers/Lakes/Streams, Silviculture, and Vacant Lands

Subwatersheds not containing one of the 28 identified problem areas were assigned a problem area rank of 29.

Finally, although the ranking procedure was designed to be objective, some subjectivity was introduced by selecting several other subwatersheds based on engineering judgment and specific knowledge of the local area within the subwatershed. As a result, subwatersheds

that were upstream and contributing to a main tributary, or subwatersheds adjacent to subwatersheds selected by the procedure described above, were in some cases included as selected subwatersheds.

Section 3 – Drainage Planning Units and Watersheds

Provides a general physical, hydrologic and floodplain description, with supplemental graphics and tables, of each of the 31 primary watersheds within Putnam County and includes discussion of additional field investigation for selected subwatersheds. The section is organized by Drainage Planning Unit (DPU) that are defined by the St. Johns River Water Management District (SJRWMD), thus providing the County with continuity with SJRWMD for future projects or potential funding mechanisms. The following are the DPUs and associated primary watersheds located in whole or in part within Putnam County.

Etonia Creek DPU

1) Etonia Creek
2) Rice Creek
3) Simms Creek

South Mainstem DPU

1) Acosta Creek
2) Cedar Creek
3) Cow Branch
4) Devall Branch
5) Dog Branch
6) Fish Creek
7) Mason Branch
8) Mill Branch
9) Moccasin Creek
10) Mudlake Outlet
11) St. Johns River
12) Twomile (Duval) Creek
13) West Run Interceptor D
14) Unnamed Creek

Crescent Lake DPU

1) Dunns Creek, Crescent Lake

Orange Creek DPU

1) Orange Creek

Rodman Reservoir DPU

1) Bruntbridge Brook
2) Camp Branch
3) Cross Florida Barge Canal
4) Deep Creek
5) Ocklawaha River

Lake George DPU

1) Beecher Run
2) Georgetown Slough
3) Jumping Gully Branch
4) Lake Laura Outlet
5) Patty Wiggins Branch
6) St. Johns River
7) Tiger Branch

Lake Kerr DPU (not included)

Deep Creek DPU (not included)

Of the above DPUs, the Deep Creek and Lake Kerr DPUs contain only very small portions of Putnam County with the vast majority lying outside the County borders. As such, they have not been examined in detail for this study. Each remaining DPU comprises one subsection of the chapter, with description of the primary watersheds of each DPU contained in that subsection.

Section 4 – Funding and Administration Alternatives

Provides evaluation and guidance for administrative and operational issues that are an integral part of stormwater management. Topics discussed in this section include:

- Stormwater Program Funding (current and potentially available)
- County and Municipal Levels of Service and Regulatory Frameworks (Comprehensive Plans/Land Development Codes)
- Prioritizing Future Flooding/Water Quality Problem Areas

These topics address the questions of how to finance the necessary maintenance and capital improvement tasks, as well as future studies; whether existing levels of service for public facilities are adequate and enforceable; and what method of project prioritization will result in the highest and best use of available resources for the public's protection and welfare.

Section 5 – Operation and Maintenance Considerations

Provides documentation of Putnam County's current maintenance program and proposes a plan for improved maintenance of existing drainage facilities. With the stormwater drainage system within Putnam County consisting of over 700 miles of primary drainage canals and ditches that are tributary to the St. Johns River, preserving a stormwater system as close as possible to its original or required design is necessary to allow adequate conveyance of periodic flood flows to avoid flooding within the County. A critical component of this Master Stormwater Plan is to document the current maintenance practices used in preserving the drainage ways associated with County roads and to recommend improvements where it is found to be deficient. In this section maintenance practices for the County are assessed by:

- Reviewing current maintenance and operation
- Reviewing practices in other counties
- Comparing some other counties to Putnam County

The County maintains a computerized database of all construction and maintenance activities and associated costs. There is potential for this database to be linked or incorporated into the GIS database framework developed as part of this Master Stormwater Plan.

Section 6 – Repair and Replacement Projects

Identifies existing drainage system components in need of repair or replacement. Projects have been identified through coordination with Putnam County drainage maintenance staff, field review of identified flood problem and sedimentation areas, Florida Department of Transportation Bridge Inspection Reports and additional field investigations performed in selected subwatersheds as part of GIS stormwater facilities inventory and database development. Table 6-1 lists existing systems or components in need of repair or replacement and includes brief descriptions of the identified problems. Project areas are listed in order of perceived priority based upon public safety, severity of component disrepair, and potential flooding impacts of the compromised function of the component. Some of these projects are investigated in greater detail as part of the capital improvement program. The highest priority repair/replacement candidates are presented in tabular format.

Section 7 - Capital Improvement Program For Localized Flooding

Describes the recommended Capital Improvement Program. A Capital Improvement Program (CIP) should:

- Identify capital improvement needs; including cost estimates for engineering, construction, contingency, operation and maintenance costs, time requirements, cost/benefit ratio and a priority ranking
- Provide engineering design and administration services, if required
- Support the Master Stormwater Management Plan

This section of the Master Stormwater Plan describes the CIP development strategy and project prioritization; provides preliminary engineering designs for 15 priority projects; and evaluates the preliminary cost/benefit ratio of top-ranking projects. It is not, itself, a full CIP but is a starting point for development of the program and centers on the historic flooding and sedimentation problem areas presented in Section 2.8.

Section 8 - Phased Watershed Plan Development

Addresses the development of a phased plan to develop watershed models of the County for prediction of 100-year flood elevations for submittal to the Federal Emergency Management Agency (FEMA). The flood levels will translate to community rating points for reduction of flood insurance rates and also provide minimum first floor elevation requirements for new development. Discussion of model selection and level of detail for watershed studies is also discussed.

A phased watershed plan is presented, along with estimated costs, consistent with the County's needs and budgetary constraints. The plan consists of flood model development recommendations for selected subwatersheds, proposed data collection sites to support future studies, and recommendations for monitoring protocol at data collection sites. The table that follows provides estimates for the costs of detailed engineering studies for the priority subwatersheds. Costs include aerial photographs, surveying, mapping, modeling, flood plain delineation. Note that costs can be significantly reduced if many contiguous watersheds are modeled simultaneously.

Section 9 – Conclusions and Recommendations

Provides a summation of the Master Stormwater Plan findings and recommendations for the forward progress of the CIP program, data collection initiatives, mapping and watershed studies, system operation and maintenance staffing, equipment and scheduling and GIS database expansion. This section also presents a Plan of Action, which identifies responsible parties, estimated budgets and schedules for completion.

TABLE OF CONTENTS

1.0 INTRODUCTION 1-1
1.1 Objectives 1-1
1.2 Scope 1-1
1.3 Location 1-1
1.4 Climate and Meteorology 1-3

2.0 DATA COLLECTION AND REVIEW 2-1
2.1 Soils 2-1
2.2 Land Use and Land Cover 2-1
2.3 Hydrology 2-5
2.3.1 Watershed Boundary and Planning Units 2-5
2.3.2 Surface Water 2-9
2.3.3 Groundwater 2-13
2.4 Flood Profiles and Floodplain 2-14
2.5 Conveyance System 2-14
2.6 Literature Review 2-15
2.6.1 Meteorologic 2-15
2.6.2 Hydrologic 2-17
2.6.3 Hydrogeologic 2-20
2.6.4 Water Quality 2-21
2.6.5 General Basin 2-22
2.6.6 Engineering - Hydraulic 2-24
2.6.7 Funding 2-25
2.7 Operation and Maintenance 2-25
2.8 Historical Flooding And Sedimentation Problems 2-26
2.9 Subwatershed Selection Protocol And Selected Subwatersheds 2-29
2.10 Field Investigation Program and Drainage Inventory 2-37
2.10.1 Field Reconnaissance Plan 2-37
2.10.2 Development of the Drainage Inventory Coverage 2-38

3.0 DRAINAGE PLANNING UNITS AND WATERSHEDS 3-1
3.1 Etonia Creek Drainage Planning Unit 3-3
3.1.1 Etonia Creek Watershed 3-5
3.1.1.1 Physiography and Hydrology 3-8
3.1.1.2 FEMA Flood Zones 3-8
3.1.1.3 Soils 3-10
3.1.1.4 Land Use/ Land Cover 3-10
3.1.1.5 Field Investigations in Selected Subwatersheds 3-13
3.1.1.6 Sewer Network and Point Source Discharge 3-13
3.1.2 Rice Creek Watershed 3-15
3.1.2.1 Physiography and Hydrology 3-15
3.1.2.2 FEMA Flood Zones 3-17
3.1.2.3 Soils 3-17
3.1.2.4 Land Use/ Land Cover 3-17
3.1.2.5 Field investigations in Selected Subwatersheds 3-21
3.1.2.6 Sewer Network and Point Source Discharge 3-21
3.1.3 Simms Creek Watershed 3-23
3.1.3.1 Physiography and Hydrology 3-23
3.1.3.2 FEMA Flood Zones 3-25

TABLE OF CONTENTS (continued)

3.1.2.3 Soils 3-25
3.1.3.4 Land Use/ Land Cover 3-25
3.1.3.5 Field investigations in Selected Subwatersheds 3-29
3.1.3.6 Sewer Network and Point Source Discharge 3-29
3.2 South Mainstem Drainage Planning Unit 3-31
3.2.1 Acosta Creek Watershed 3-33
3.2.1.1 Physiography and Hydrology 3-33
3.2.1.2 FEMA Flood Zones 3-35
3.2.1.3 Soils 3-35
3.2.1.4 Land Use/ Land Cover 3-35
3.2.2 Cedar Creek Watershed 3-39
3.2.2.1 Physiography and Hydrology 3-41
3.2.2.2 FEMA Flood Zones 3-41
3.2.2.3 Soils 3-41
3.2.2.4 Land Use/ Land Cover 3-41
3.2.2.5 Field investigations in Selected Subwatersheds 3-45
3.2.2.6 Sewer Network and Point Source Discharge 3-45
3.2.3 Cow Branch Watershed 3-47
3.2.3.1 Physiography and Hydrology 3-47
3.2.3.2 FEMA Flood Zones 3-47
3.2.3.3 Soils 3-47
3.2.3.4 Land Use/ Land Cover 3-47
3.2.3.5 Field investigations in Selected Subwatersheds 3-52
3.2.4 Devall Branch Watershed 3-53
3.2.4.1 Physiography and Hydrology 3-53
3.2.4.2 FEMA Flood Zones 3-53
3.2.4.3 Soils 3-53
3.2.4.4 Land Use/ Land Cover 3-53
3.2.4.5 Field investigations in Selected Subwatersheds 3-58
3.2.4.6 Sewer Network and Point Source Discharge 3-58
3.2.5 Dog Branch Watershed 3-60
3.2.5.1 Physiography and Hydrology 3-60
3.2.5.2 FEMA Flood Zones 3-60
3.2.5.3 Soils 3-60
3.2.5.4 Land Use/ Land Cover 3-60
3.2.5.5 Field investigations in Selected Subwatersheds 3-65
3.2.5.6 Sewer Network and Point Source Discharge 3-65
3.2.6 Fish Creek Watershed 3-67
3.2.6.1 Physiography and Hydrology 3-67
3.2.6.2 FEMA Flood Zones 3-67
3.2.6.3 Soils 3-67
3.2.6.4 Land Use/ Land Cover 3-67
3.2.7 Mason Branch Watershed 3-72
3.2.7.1 Physiography and Hydrology 3-72
3.2.7.2 FEMA Flood Zones 3-72
3.2.7.3 Soils 3-72
3.2.7.4 Land Use/ Land Cover 3-72
3.2.7.5 Field investigations in Selected Subwatersheds 3-77

TABLE OF CONTENTS (continued)

3.2.7.6 Sewer Network and Point Source Discharge....3-77
3.2.8 Mill Branch Watershed....3-79
3.2.8.1 Physiography and Hydrology....3-79
3.2.8.2 FEMA Flood Zones....3-79
3.2.8.3 Soils....3-79
3.2.8.4 Land Use/ Land Cover....3-83
3.2.8.5 Field investigations in Selected Subwatersheds....3-83
3.2.8.6 Sewer Network and Point Source Discharge....3-83
3.2.9 Moccasin Creek Watershed....3-86
3.2.9.1 Physiography and Hydrology....3-86
3.2.9.2 FEMA Flood Zones....3-86
3.2.9.3 Soils....3-86
3.2.9.4 Land Use/ Land Cover....3-86
3.2.10 Mudlake Outlet Watershed....3-91
3.2.10.1 Physiography and Hydrology....3-91
3.2.10.2 FEMA Flood Zones....3-91
3.2.10.3 Soils....3-91
3.2.10.4 Land Use/ Land Cover....3-91
3.2.10.5 Field investigations in Selected Subwatersheds....3-96
3.2.10.6 Sewer Network and Point Source Discharge....3-96
3.2.11 St. Johns River Watershed....3-98
3.2.11.1 Physiography and Hydrology....3-98
3.2.11.2 FEMA Flood Zones....3-98
3.2.11.3 Soils....101
3.2.11.4 Land Use/ Land Cover....3-101
3.2.11.5 Field investigations in Selected Subwatersheds....3-104
3.2.11.6 Sewer Network and Point Source Discharge....3-106
3.2.12 Twomile (Duval) Creek Watershed....3-108
3.2.12.1 Physiography and Hydrology....3-108
3.2.12.2 FEMA Flood Zones....3-108
3.2.12.3 Soils....3-108
3.2.12.4 Land Use/ Land Cover....3-108
3.2.12.5 Field investigations in Selected Subwatersheds....3-113
3.2.12.6 Sewer Network and Point Source Discharge....3-113
3.2.13 West Run Interceptor D Watershed....3-115
3.2.13.1 Physiography and Hydrology....3-115
3.2.13.2 FEMA Flood Zones....3-115
3.2.13.3 Soils....3-118
3.2.13.4 Land Use/ Land Cover....3-118
3.2.13.5 Field investigations in Selected Subwatersheds....3-121
3.2.13.6 Sewer Network and Point Source Discharge....3-121
3.2.14 Unnamed Creek Watershed....3-123
3.2.14.1 Physiography and Hydrology....3-123
3.2.14.2 FEMA Flood Zones....3-123
3.2.14.3 Soils....3-123
3.2.14.4 Land Use/ Land Cover....3-123
3.3 Crescent Lake Drainage Planning Unit....3-128
3.3.1 Dunns Creek, Crescent Lake Watershed....3-130
3.3.1.1 Physiography and Hydrology....3-130

TABLE OF CONTENTS (continued)

3.3.1.2 FEMA Flood Zones 3-133
3.3.1.3 Soils 3-133
3.3.1.4 Land Use/ Land Cover 3-133
3.3.1.5 Field investigations in Selected Subwatersheds 3-137
3.3.1.6 Sewer Network and Point Source Discharge 3-137
3.4 Orange Creek Drainage Planning Unit 3-139
3.4.1 Orange Creek Watershed 3-141
3.4.1.1 Physiography and Hydrology 3-141
3.4.1.2 FEMA Flood Zones 3-142
3.4.1.3 Soils 3-144
3.4.1.4 Land Use/ Land Cover 3-144
3.5 Rodman Reservoir Drainage Planning Unit 3-148
3.5.1 Bruntbridge Brook Watershed 3-150
3.5.1.1 Physiography and Hydrology 3-150
3.5.1.2 FEMA Flood Zones 3-150
3.5.1.3 Soils 3-150
3.5.1.4 Land Use/ Land Cover 3-150
3.5.2 Camp Branch Watershed 3-155
3.5.2.1 Physiography and Hydrology 3-155
3.5.2.2 FEMA Flood Zones 3-155
3.5.2.3 Soils 3-155
3.5.2.4 Land Use/ Land Cover 3-155
3.5.3 Cross Florida Barge Canal Watershed 3-160
3.5.3.1 Physiography and Hydrology 3-160
3.5.3.2 FEMA Flood Zones 3-160
3.5.3.3 Soils 3-160
3.5.3.4 Land Use/ Land Cover 3-164
3.5.4 Deep Creek Watershed 3-166
3.5.4.1 Physiography and Hydrology 3-166
3.5.4.2 FEMA Flood Zones 3-166
3.5.4.3 Soils 3-169
3.5.4.4 Land Use/ Land Cover 3-169
3.5.4.5 Field investigations in Selected Subwatersheds 3-172
3.5.4.6 Sewer Network and Point Source Discharge 3-172
3.5.5 Ocklawaha River Watershed 3-174
3.5.5.1 Physiography and Hydrology 3-174
3.5.5.2 FEMA Flood Zones 3-174
3.5.5.3 Soils 3-174
3.5.5.4 Land Use/ Land Cover 3-175
3.6 Lake George Drainage Planning Unit 3-180
3.6.1 Beecher Run Watershed 3-182
3.6.1.1 Physiography and Hydrology 3-182
3.6.1.2 FEMA Flood Zones 3-182
3.6.1.3 Soils 3-182
3.6.1.4 Land Use/ Land Cover 3-182
3.6.1.5 Field investigations in Selected Subwatersheds 3-187
3.6.1.6 Sewer Network and Point Source Discharge 3-187
3.6.2 Georgetown Slough Watershed 3-188
3.6.2.1 Physiography and Hydrology 3-188

TABLE OF CONTENTS (continued)

3.6.2.2 FEMA Flood Zones 3-188
3.6.2.3 Soils 3-188
3.6.2.4 Land Use/ Land Cover 3-188
3.6.2.5 Field investigations in Selected Subwatersheds 3-193
3.6.2.6 Sewer Network and Point Source Discharge 3-193
3.6.3 Jumping Gully Branch Watershed 3-195
3.6.3.1 Physiography and Hydrology 3-195
3.6.3.2 FEMA Flood Zones 3-195
3.6.3.3 Soils 3-195
3.6.3.4 Land Use/ Land Cover 3-199
3.6.3.5 Field investigations in Selected Subwatersheds 3-199
3.6.3.6 Sewer Network and Point Source Discharge 3-199
3.6.4 Lake Laura Outlet Watershed 3-202
3.6.4.1 Physiography and Hydrology 3-202
3.6.4.2 FEMA Flood Zones 3-202
3.6.4.3 Soils 3-202
3.6.4.4 Land Use/ Land Cover 3-202
3.6.5 Patty Wiggins Branch Watershed 3-207
3.6.5.1 Physiography and Hydrology 3-207
3.6.5.2 FEMA Flood Zones 3-207
3.6.5.3 Soils 3-207
3.6.5.4 Land Use/ Land Cover 3-207
3.6.6 St. Johns River Watershed 3-212
3.6.6.1 Physiography and Hydrology 3-212
3.6.6.2 FEMA Flood Zones 3-212
3.6.6.3 Soils 3-212
3.6.6.4 Land Use/ Land Cover 3-216
3.6.6.5 Field investigations in Selected Subwatersheds 3-216
3.6.6.6 Sewer Network and Point Source Discharge 3-216
3.6.7 Tiger Branch Watershed 3-218
3.6.7.1 Physiography and Hydrology 3-218
3.6.7.2 FEMA Flood Zones 3-218
3.6.7.3 Soils 3-218
3.6.7.4 Land Use/ Land Cover 3-218
3.6.7.5 Field investigations in Selected Subwatersheds 3-223
3.6.7.6 Sewer Network and Point Source Discharge 3-223

4.0 FUNDING AND ADMINISTRATION ALTERNATIVES 4-1
4.1 Current Funding Methods Review 4-1
4.1.1 Introduction 4-1
4.1.2 Making The System Work For The County 4-2
4.1.3 Grant And Funding Assistance Professionals 4-4
4.1.4 Federal And State Funding Assistance Programs 4-6
4.2 Comprehensive Plans Review 4-16
4.2.1 Element Review 4-16
4.2.2 Level of Service Evaluation 4-19
4.2.3 Other Municipal Comprehensive Plans 4-19
4.3 Land Development Codes Review 4-22

TABLE OF CONTENTS (continued)

4.3.1 Article Review 4-22
4.3.2 Sufficiency Review 4-30
4.3.3 Other Municipal Codes 4-31
4.4 Prioritizing Future Flooding/WQ Problems 4-33

5.0 OPERATION AND MAINTENANCE CONSIDERATIONS 5-1
5.1 Current Maintenance and Operation 5-1
5.1.1 Activities 5-1
5.1.2 Expenditures 5-3
5.1.3 Staffing 5-5
5.1.4 Equipment 5-8
5.2 Practices In Other Counties 5-8
5.3 Comparison With Putnam County 5-10
5.3.1 Organization 5-10
5.3.2 Activities 5-10
5.3.3 Staffing 5-11
5.3.4 Equipment/Resources 5-11
5.3.5 Expenditures 5-12
5.4 Proposed Maintenance Plan 5-12
5.4.1 Program Scope 5-13
5.4.2 Periodic Inspection Program 5-13
5.4.3 Routine Maintenance 5-14
5.4.4 Major Facilities Rehabilitation 5-15
5.4.5 Drainage Incident Response 5-16
5.4.6 Staffing and Equipment 5-16
5.5 Application of Best Management Practices 5-17
5.5.1 Urban Areas 5-18
5.5.2 Unpaved Roads 5-18
5.5.3 Roadside Swales/Ditches 5-19

6.0 REPAIR AND REPLACEMENT PROJECTS 6-1

7.0 CAPITAL IMPROVEMENT PROGRAM FOR LOCALIZED FLOODING 7-1
7.1 Capital Improvement Program Development 7-1
7.2 Localized Flooding and Sedimentation Areas 7-1
7.2.1 Price Road 7-2
7.2.2 Bellamy Woods Road 7-5
7.2.3 Roops Ditch 7-8
7.2.4 Florahome Drainage District 7-11
7.2.5 Orange Springs Shortcut 7-14
7.2.6 Hunter Road (Old Gainesville Highway) 7-17
7.2.7 Mondex 7-20
7.2.8. Devall Branch 7-24
7.2.9 Twomile (Duval) Creek 7-26
7.2.10 West Tocoi Road 7-29
7.2.11 Palmetto Bluff Road 7-34
7.2.12 Millican Road 7-37
7.2.13 River Park Subdivision 7-39
7.2.14 Lakeway Drive Drainage 7-42

TABLE OF CONTENTS (continued)

7.2.15 San Mateo Road To Dunns Creek 7-45
7.2.16 East Palatka Drainage District 7-47
7.2.17 Rector Road 7-49
7.2.18 East River Road 7-52
7.2.19 County Road 315 At 64th Street 7-56
7.2.20 Whispering Pines 7-59
7.2.21 Saratoga Harbor: Saratoga Harbor Estates 7-62
7.2.22 County Road 308 B 7-66
7.2.23 County Road 309 (South) 7-69
7.2.24 Harris Fish Camp Road 7-71
7.2.25 Junction Road 7-74
7.2.26 Mud Lake/Monroe Mill Creek 7-77
7.2.27 Sisco Dirt Road 7-80
7.2.28 Foxwood Outfall 7-83
7.3 Priority Ranking 7-84
7.4 Potential Stormwater Strategies 7-87
7.4.1 Devall Branch (Rank No. 1) 7-87
7.4.2 Twomile (Duval) Creek (Rank No. 2) 7-96
7.4.3 Palmetto Bluff Road (Rank No. 3) 7-98
7.4.4 Millican Road (Rank No. 4) 7-106
7.4.5 River Park Subdivision (Rank No. 5) 7-111
7.4.6 Mud Lake / Monroe Mill Creek Watershed (Rank No. 6) 7-118
7.4.7 Orange Springs Shortcut (Rank No. 7) 7-121
7.4.8 Rector Road (Rank No. 8) 7-126
7.4.9 East Palatka Drainage District (Rank No. 9) 7-135
7.4.10 Whispering Pines (Rank No. 10) 7-138
7.4.11 County Road 315 at 64th Street (Rank No. 11) 7-140
7.4.12 Florahome Drainage District (Rank No. 12) 7-143
7.4.13 East River Road (Rank No. 13) 7-151
7.4.14 Saratoga Harbor (Rank No. 27) 7-156
7.4.15 Mondex (Rank No. 28) 7-163
7.5 Benefit - Cost Analysis 7-171
7.5.1 Description of FEMA Benefit-Cost Analysis 7-172
7.5.2 Results 7-174

8.0 PHASED WATERSHED PLAN DEVELOPMENT 8-1
8.1 Flood Model Development for Selected Subwatersheds 8-1
8.2 Stormwater Models Review 8-4
8.2.1 Simple / Empirical Models 8-4
8.2.2 Single Event Models 8-5
8.2.3 Continuous Simulation Models 8-6
8.2.4 Selection of Numerical Model(s) for Current and Future Watershed Modeling Applications 8-6
8.3 Data Collection Sites 8-18
8.3.1 Rainfall 8-18
8.3.2 Streamflow 8-18
8.3.3 Weather 8-18
8.4 Monitoring Protocol 8-21
8.5 Topographic Mapping Recommendations 8-22

TABLE OF CONTENTS (continued)

8.5.1 Mapping Specifications 8-22
8.5.2 Comparing Quality and Costs 8-23

9.0 MASTER STORMWATER PLAN RECOMMENDATIONS 9-1
9.1 Administrative and Funding Recommendations 9-1
9.2 Operation and Maintenance Recommendations 9-2
9.3 GIS Database and Mapping Recommendations 9-3
9.4 Topographic Mapping and Survey 9-3
9.5 Watershed Modeling for Engineering Design and Floodplain Delineation 9-3
9.6 Plan of Action 9-5

LIST OF FIGURES

Figure 1 Location Map 1-2

Figure 2.2-1 Land Use Distribution (source: Putnam County) 2-2
Figure 2.2-2 Land Use Distribution (source: SJRWMD) 2-3
Figure 2.3.1-1 Sample Map for Planning Units, Watersheds, & Drainage Basins 2-7
Figure 2.3.2-1 Location of Gage Stations in Putnam County with Available Data 2-9
Figure 2.8-1 Problem Area Locations 2-26
Figure 2.9-1 Selected Subwatersheds 2-30
Figure 2.10-1 ArcMap Project File 2-37

Figure 3-1 Putnam County DPUs 3-2
Figure 3.1-1 Etonia Creek DPU 3-5
Figure 3.1.1-1 Etonia Creek Watershed Location Map 3-8
Figure 3.1.1-2 Etonia Creek Watershed FEMA Flood Zones 3-10
Figure 3.1.1-3 Etonia Creek Watershed Soils 3-12
Figure 3.1.1-4 Etonia Creek Watershed Current Land Use 3-13
Figure 3.1.2-1 Rice Creek Watershed Location Map 3-17
Figure 3.1.2-2 Rice Creek Watershed FEMA Flood Zones 3-19
Figure 3.1.2-3 Rice Creek Watershed Soils 3-20
Figure 3.1.2-4 Rice Creek Watershed Current Land Use 3-21
Figure 3.1.3-1 Simms Creek Watershed Location Map 3-25
Figure 3.1.3-2 Simms Creek Watershed FEMA Flood Zones 3-27
Figure 3.1.3-3 Simms Creek Watershed Soils 3-28
Figure 3.1.3-4 Simms Creek Watershed Current Land Use 3-29
Figure 3.2-1 South Mainstem DPU 3-33
Figure 3.2.1-1 Acosta Creek Watershed Location Map 3-35
Figure 3.2.1-2 Acosta Creek Watershed FEMA Flood Zones 3-37
Figure 3.2.1-3 Acosta Creek Watershed Soils 3-38
Figure 3.2.1-4 Acosta Creek Watershed Current Land Use 3-39
Figure 3.2.2-1 Cedar Creek Watershed Location Map 3-41
Figure 3.2.2-2 Cedar Creek Watershed FEMA Flood Zones 3-43
Figure 3.2.2-3 Cedar Creek Watershed Soils 3-44
Figure 3.2.2-4 Cedar Creek Watershed Current Land Use 3-45

LIST OF FIGURES (continued)

Figure 3.2.3-1 Cow Branch Watershed Location Map 3-49
Figure 3.2.3-2 Cow Branch Watershed FEMA Flood Zones 3-50
Figure 3.2.3-3 Cow Branch Watershed Soils 3-51
Figure 3.2.3-4 Cow Branch Watershed Current Land Use 3-52
Figure 3.2.4-1 Devall Branch Watershed Location Map 3-55
Figure 3.2.4-2 Devall Branch Watershed FEMA Flood Zones 3-56
Figure 3.2.4-3 Devall Branch Watershed Soils 3-57
Figure 3.2.4-4 Devall Branch Watershed Current Land Use 3-58
Figure 3.2.5-1 Dog Branch Watershed Location Map 3-62
Figure 3.2.5-2 Dog Branch Watershed FEMA Flood Zones 3-63
Figure 3.2.5-3 Dog Branch Watershed Soils 3-64
Figure 3.2.5-4 Dog Branch Watershed Current Land Use 3-64
Figure 3.2.6-1 Fish Creek Watershed Location Map 3-69
Figure 3.2.6-2 Fish Creek Watershed FEMA Flood Zones 3-70
Figure 3.2.6-3 Fish Creek Watershed Soils 3-71
Figure 3.2.6-4 Fish Creek Watershed Current Land Use 3-72
Figure 3.2.7-1 Mason Branch Watershed Location Map 3-74
Figure 3.2.7-2 Mason Branch Watershed FEMA Flood Zones 3-75
Figure 3.2.7-3 Mason Branch Watershed Soils 3-76
Figure 3.2.7-4 Mason Branch Watershed Current Land Use 3-77
Figure 3.2.8-1 Mill Branch Watershed Location Map 3-81
Figure 3.2.8-2 Mill Branch Watershed FEMA Flood Zones 3-82
Figure 3.2.8-3 Mill Branch Watershed Soils 3-83
Figure 3.2.8-4 Mill Branch Watershed Current Land Use 3-85
Figure 3.2.9-1 Moccasin Creek Watershed Location Map 3-88
Figure 3.2.9-2 Moccasin Creek Watershed FEMA Flood Zones 3-89
Figure 3.2.9-3 Moccasin Creek Watershed Soils 3-90
Figure 3.2.9-4 Moccasin Creek Watershed Current Land Use 3-91
Figure 3.2.10-1 Mudlake Outlet Watershed Location Map 3-93
Figure 3.2.10-2 Mudlake Outlet Watershed FEMA Flood Zones 3-94
Figure 3.2.10-3 Mudlake Outlet Watershed Soils 3-95
Figure 3.2.10-4 Mudlake Outlet Watershed Current Land Use 3-96
Figure 3.2.11-1 St. Johns River Watershed Location Map 3-100
Figure 3.2.11-2 St. Johns River Watershed FEMA Flood Zones 3-101
Figure 3.2.11-3 St. Johns River Watershed Soils 3-103
Figure 3.2.11-4 St. Johns River Watershed Current Land Use 3-104
Figure 3.2.12-1 Twomile Creek Watershed Location Map 3-110
Figure 3.2.12-2 Twomile Creek Watershed FEMA Flood Zones 3-111
Figure 3.2.12-3 Twomile Creek Watershed Soils 3-112
Figure 3.2.12-4 Twomile Creek Watershed Current Land Use 3-113
Figure 3.2.13-1 West Run Interceptor D Watershed Location Map 3-117
Figure 3.2.13-2 West Run Interceptor D Watershed FEMA Flood Zones 3-118
Figure 3.2.13-3 West Run Interceptor D Watershed Soils 3-120
Figure 3.2.13-4 West Run Interceptor D Watershed Current Land Use 3-121
Figure 3.2.14-1 Unnamed Creek Watershed Location Map 3-125
Figure 3.2.14-2 Unnamed Creek Watershed FEMA Flood Zones 3-126
Figure 3.2.14-3 Unnamed Creek Watershed Soils 3-127
Figure 3.2.14-4 Unnamed Creek Watershed Current Land Use 3-128
Figure 3.3-1 Crescent Lake Drainage Planning Unit (DPU) Location Map 3-130

LIST OF FIGURES (continued)

Figure 3.3.1-1 Dunns Creek/Crescent Lake Watershed Location Map 3-132
Figure 3.3.1-2 Dunns Creek/Crescent Lake Watershed FEMA Flood Zones 3-134
Figure 3.3.1-3 Dunns Creek/Crescent Lake Watershed Soils 3-135
Figure 3.3.1-4 Dunns Creek/Crescent Lake Watershed Current Land Use 3-136
Figure 3.4-1 Orange Creek Drainage Planning Unit (DPU) Location Map 3-140
Figure 3.4.1-1 Orange Creek Watershed Location Map 3-142
Figure 3.4.1-2 Orange Creek Watershed FEMA Flood Zones 3-144
Figure 3.4.1-3 Orange Creek Watershed Soils 3-145
Figure 3.4.1-4 Orange Creek Watershed Current Land Use 3-146
Figure 3.5-1 Rodman Reservoir Drainage Planning Unit (DPU) Location Map 3-148
Figure 3.5.1-1 Bruntbridge Brook Watershed Location Map 3-150
Figure 3.5.1-2 Bruntbridge Brook Watershed FEMA Flood Zones 3-151
Figure 3.5.1-3 Bruntbridge Brook Watershed Soils 3-152
Figure 3.5.1-4 Bruntbridge Brook Watershed Current Land Use 3-153
Figure 3.5.2-1 Camp Branch Watershed Location Map 3-155
Figure 3.5.2-2 Camp Branch Watershed FEMA Flood Zones 3-156
Figure 3.5.2-3 Camp Branch Watershed Soils 3-157
Figure 3.5.2-4 Camp Branch Watershed Current Land Use 3-158
Figure 3.5.3-1 Cross Florida Barge Canal Watershed Location Map 3-160
Figure 3.5.3-2 Cross Florida Barge Canal Watershed FEMA Flood Zones 3-161
Figure 3.5.3-3 Cross Florida Barge Canal Watershed Soils 3-162
Figure 3.5.3-4 Cross Florida Barge Canal Watershed Current Land Use 3-163
Figure 3.5.4-1 Deep Creek Watershed Location Map 3-166
Figure 3.5.4-2 Deep Creek Watershed FEMA Flood Zones 3-167
Figure 3.5.4-3 Deep Creek Watershed Soils 3-169
Figure 3.5.4-4 Deep Creek Watershed Current Land Use 3-170
Figure 3.5.5-1 Ocklawaha River Watershed Location Map 3-175
Figure 3.5.5-2 Ocklawaha River Watershed FEMA Flood Zones 3-176
Figure 3.5.5-3 Ocklawaha River Watershed Soils 3-177
Figure 3.5.5-4 Ocklawaha River Watershed Current Land Use 3-178
Figure 3.6-1 Lake George Drainage Planning Unit (DPU) Location Map 3-180
Figure 3.6.1-1 Beecher Run Watershed Location Map 3-182
Figure 3.6.1-2 Beecher Run Watershed FEMA Flood Zones 3-183
Figure 3.6.1-3 Beecher Run Watershed Soils 3-184
Figure 3.6.1-4 Beecher Run Watershed Current Land Use 3-185
Figure 3.6.2-1 Georgetown Slough Watershed Location Map 3-188
Figure 3.6.2-2 Georgetown Slough Watershed FEMA Flood Zones 3-189
Figure 3.6.2-3 Georgetown Slough Watershed Soils 3-190
Figure 3.6.2-4 Georgetown Slough Watershed Current Land Use 3-191
Figure 3.6.3-1 Jumping Gully Branch Watershed Location Map 3-195
Figure 3.6.3-2 Jumping Gully Branch Watershed FEMA Flood Zones 3-196
Figure 3.6.3-3 Jumping Gully Branch Watershed Soils 3-197
Figure 3.6.3-4 Jumping Gully Branch Watershed Current Land Use 3-199
Figure 3.6.4-1 Lake Laura Outlet Watershed Location Map 3-202
Figure 3.6.4-2 Lake Laura Outlet Watershed FEMA Flood Zones 3-203
Figure 3.6.4-3 Lake Laura Outlet Watershed Soils 3-204
Figure 3.6.4-4 Lake Laura Outlet Watershed Current Land Use 3-205

LIST OF FIGURES (continued)

Figure 3.6.5-1 Patty Wiggins Branch Watershed Location Map....3-207
Figure 3.6.5-2 Patty Wiggins Branch Watershed FEMA Flood Zones....3-208
Figure 3.6.5-3 Patty Wiggins Branch Watershed Soils....3-209
Figure 3.6.5-4 Patty Wiggins Branch Watershed Current Land Use....3-210
Figure 3.6.6-1 St. Johns River Watershed Location Map....3-212
Figure 3.6.6-2 St. Johns River Watershed FEMA Flood Zones....3-213
Figure 3.6.6-3 St. Johns River Watershed Soils....3-214
Figure 3.6.6-4 St. Johns River Watershed Current Land Use....3-216
Figure 3.6.7-1 Tiger Branch Watershed Location Map....3-218
Figure 3.6.7-2 Tiger Branch Watershed FEMA Flood Zones....3-219
Figure 3.6.7-3 Tiger Branch Watershed Soils....3-220
Figure 3.6.7-4 Tiger Branch Watershed Current Land Use....3-221

Figure 5-1 Roads and Bridges Map....5-2
Figure 5-2 Organization Chart - Road and Bridge-Dept. of Public Works....5-6
Figure 5-3 Work Area Divisions....5-7

Figure 6-1 Repair and Replacement Project Locations....6-4

Figure 7.2-1 Price Road Problem Area....7-3
Figure 7.2-2 Bellamy Woods Road Problem Area....7-6
Figure 7.2-3 Roops Ditch Problem Area....7-9
Figure 7.2-4 Florahome Drainage Problem Area....7-12
Figure 7.2-5 Orange Springs Shortcut Problem Area....7-15
Figure 7.2-6 Old Gainesville Highway Problem Area....7-18
Figure 7.2-7 Mondex Problem Area....7-22
Figure 7.2-8 Devall Branch Problem Area....7-25
Figure 7.2-9 Twomile (Duval) Creek Problem Area....7-27
Figure 7.2-10 West Tocoi Problem Area....7-32
Figure 7.2-11 Palmetto Bluff Problem Area....7-35
Figure 7.2-12 Millican Road Problem Area....7-38
Figure 7.2-13 River Park Subdivision Problem Area....7-40
Figure 7.2-14 Lakeway Drive Problem Area....7-43
Figure 7.2-15 San Mateo Road - Dunns Creek Problem Area....7-46
Figure 7.2-16 East Palatka Drainage District Problem Area....7-48
Figure 7.2-17 Rector Road Problem Area....7-50
Figure 7.2-18 East River Road (at Camp Road) Problem Area....7-53
Figure 7.2-19 County Road 315 at 64th Street Problem Area....7-57
Figure 7.2-20 Whispering Pines Problem Area....7-60
Figure 7.2-21 Saratoga Harbor Problem Area....7-63
Figure 7.2-22 County Road 308 B Problem Area....7-67
Figure 7.2-23 County Road 309 Problem Area....7-70
Figure 7.2-24 Harris Fish Camp Road Problem Area....7-72
Figure 7.2-25 Junction Road Problem Area....7-75
Figure 7.2-26 Mud Lake Problem Area....7-78
Figure 7.2-27 Sisco Road Problem Area....7-81

LIST OF FIGURES (continued)

Figure 7.4.1-1 Devall Branch Location Map 7-89
Figure 7.4.1-2 Devall Branch Location and Basin Delineation by HNTB 7-90
Figure 7.4.1-3 HEC-RAS Representation of the CMP 7-91
Figure 7.4.1-4 12-foot Conspan Drawing 7-92
Figure 7.4.2-1 Twomile Creek Location Map 7-97
Figure 7.4.3-1 Palmetto Bluff Road Location Map 7-99
Figure 7.4.3-2 Rural Turnout Construction 7-101
Figure 7.4.3-3 Palmetto Bluff Road Maintenance Easement Corridors 7-103
Figure 7.4.4-1 Millican Road Location Map 7-107
Figure 7.4.4-2 Drainage Improvements 7-108
Figure 7.4.5-1 River Park Subdivision Location Map 7-112
Figure 7.4.5-2 Integrated Model Cross-Section and Components 7-115
Figure 7.4.5-3 Existing and Proposed Hydrographs for a Lake 7-116
Figure 7.4.6-1 Mud Lake/Monroe Creek Location Map 7-119
Figure 7.4.7-1 Orange Springs Shortcut Location Map 7-122
Figure 7.4.7-2 16-Foot Conspan Drawing 7-125
Figure 7.4.8-1 Rector Road Location Map 7-127
Figure 7.4.8-2 28-Foot Conspan Drawing 7-130
Figure 7.4.8-3 HEC-RAS Model – Arch Pipes 7-133
Figure 7.4.8-4 HEC-RAS Model - Conspan 7-134
Figure 7.4.9-1 East Palatka Drainage District Location Map 7-136
Figure 7.4.9-2 East Palatka Drainage District Location Map (Detailed) 7-137
Figure 7.4.10-1 Whispering Pines Location Map 7-139
Figure 7.4.11-1 County Road 315 at 64th Street Location Map 7-141
Figure 7.4.12-1 Florahome Drainage District Location Map 7-144
Figure 7.4.12-2 Florahome Drainage District Location Map (Detailed) 7-145
Figure 7.4.12-3 12-Foot Conspan Drawing 7-150
Figure 7.4.13-1 East River Road (at Camp Road) Location Map 7-152
Figure 7.4.14-1 Saratoga Harbor Location Map 7-157
Figure 7.4.14-2 HEC - HMS Model Schematic 7-159
Figure 7.4.14-3 HEC - HMS Summary of Results 7-160
Figure 7.4.14-4 Lake Overflow Slope Stabilization 7-161
Figure 7.4.15-1 Mondex Location Map 7-164
Figure 7.4.15-2 Mondex Location Map (Detailed) 7-165
Figure 7.4.15-3 Mondex FEMA Flood Zones 7-166
Figure 7.4.15-4 SCS Soils Classifications 7-168

Figure 8.2-1 Example of Continuous Simulation and/or Distributed Integrated Models 8-10
Figure 8.3-1 SJRWMD/NCDC Rainfall Gages 8-19
Figure 8.3-2 Proposed Site for Weather Station 8-20

LIST OF TABLES

Table 2.3.2-1 Precipitation Gaging Stations in or Near Putnam County 2-10
Table 2.3.2-2 USGS Stream Gaging Stations in Putnam County 2-12
Table 2.3.2-3 USGS Stream Gaging Stations with Water Quality Data in Putnam County 2-13
Table 2.8-1 Flooding and Sedimentation Areas 2-27
Table 2.9-1 Subbasin Selection Computational Matrix 2-31
Table 2.9-2 Selected Subwatersheds and Ranking 2-34

Table 3.1-1 Land Use and Soils Summary for Etonia Creek DPU 3-6
Table 3.1.2.1 Streamflow Summary for Rice Creek Gages 3-18
Table 3.2-1 Land Use and Soils Summary for South Mainstem DPU 3-34
Table 3.3-1 Land Use and Soils Summary for Crescent Lake DPU 3-129
Table 3.4-1 Land Use and Soils Summary for Orange Creek DPU 3-139
Table 3.5-1 Land Use and Soils Summary for Rodman Reservoir DPU 3-140
Table 3.6-1 Land Use and Soils Summary for Lake George DPU 3-179

Table 4.1-1 Grant and Funding Assistance Professionals 4-5
Table 4.1-2 Federal and State Funding Assistance Programs 4-8
Table 4.3.3-1 Comparison of Municipal Land Development Codes with Putnam County 4-32

Table 5-1 Drainage Activity Costs 5-4
Table 5-2 Costs Comparison 5-12
Table 5-3 Drainage Incident Priority Codes 5-16
Table 5-4 Additional Recommended Equipment 5-17

Table 6-1 Repair and Replacement Projects 6-1

Table 7.3-1 15 Top-Ranked Projects for Putnam County 7-86
Table 7.4.1-1 HEC-Ras Output: Devall Branch 7-93
Table 7.4.1-2 Devall Branch Summary of Activities, Timeline, and Budget 7-95
Table 7.4.3-1 Cost Estimate for Palmetto Bluff Rd/Millican Rd Intersection 7-100
Table 7.4.3-2 List of Owners / Assessed Value 360 Ft Millican 7-102
Table 7.4.3-3 List of Owners / Assessed Value 3000 Ft Crossing 7-104
Table 7.4.3-4 List of Owners / Assessed Value 6000 Ft Crossing 7-104
Table 7.4.3-5 Cost Estimate and Timetable for a Modeling Analysis 7-105
Table 7.4.4-1 Cost Estimate for Millican Road 7-106
Table 7.4.4-2 Costs for Millican Road 7-109
Table 7.4.4-3 Parcel Numbers and Per-Acre Values of ROW 7-109
Table 7.4.5-1 River Park Area Summary of Activities, Timeline, and Budget 7-117
Table 7.4.6-1 Mud Lake Summary of Activities, Schedule & Budget 7-120
Table 7.4.8-1 HEC-Ras Output - Arch Pipes 7-131
Table 7.4.8-2 HEC-Ras Output - Conspan 7-131
Table 7.4.11-1 Cost Estimate for CR 315 at 64th Street 7-142
Table 7.4.13-1 County Complex Elevations 7-154
Table 7.4.14-1 Cost Estimate for Saratoga Harbor 7-158
Table 7.5.1 Projects Evaluated for BCR Analysis 7-171

Table 8.1-1 Prioritized Ranking for Modeling Selected Subwatersheds 8-1
Table 8.2-1 Hydrologic Models Meeting the Minimum Requirement of NFIP 8-11
Table 8.2-2 Hydraulic Models Meeting the Minimum Requirement of NFIP 8-14

LIST OF APPENDICES

Appendix 3-A	Putnam County Flood Insurance Studies (excerpts)
Appendix 3-B	Putnam County Field Investigation Data
Appendix 5-A	Stormwater-Related Maintenance Issues for Putnam County
Appendix 5-B	Putnam County Public Works Equipment List
Appendix 5-C	Maintenance Plan Excerpts from the South Maintenance Unit of Hillsborough County
Appendix 5-D	Maintenance Documents from Pinellas County
Appendix 5-E	BMP Concept Sketches
Appendix 8-A	Copies of Portions of EPA Meteorological Monitoring Guidance for Regulatory Modeling Applications

TABLE OF CONTENTS

1.0 INTRODUCTION 1-1
1.1 Objectives 1-1
1.2 Scope 1-1
1.3 Location 1-1
1.4 Climate and Meteorology 1-3

List of Figures

Figure 1 Location Map 1-2

1.0 INTRODUCTION

1.1 OBJECTIVES

The objectives of this study are to develop a Master Stormwater Plan for the 827 square-mile Putnam County. The specific goals are:

- Collation of information and reports
- Integration of a database and information management system with the County's GIS and other systems
- Identification of natural drainage system components, location, and condition
- Identification of maintenance and repair requirements, and upgrades required, to allow the systems to function as needed
- Identification of requirements and procedures to mitigate future damages through stormwater management, floodplain management and water quality

Furthermore, Ayres Associates was tasked with developing a framework for the report such that the County can expand upon the information herein and incorporate additional information into the County files as it becomes available when additional drainage studies are completed in the coming years.

1.2 SCOPE

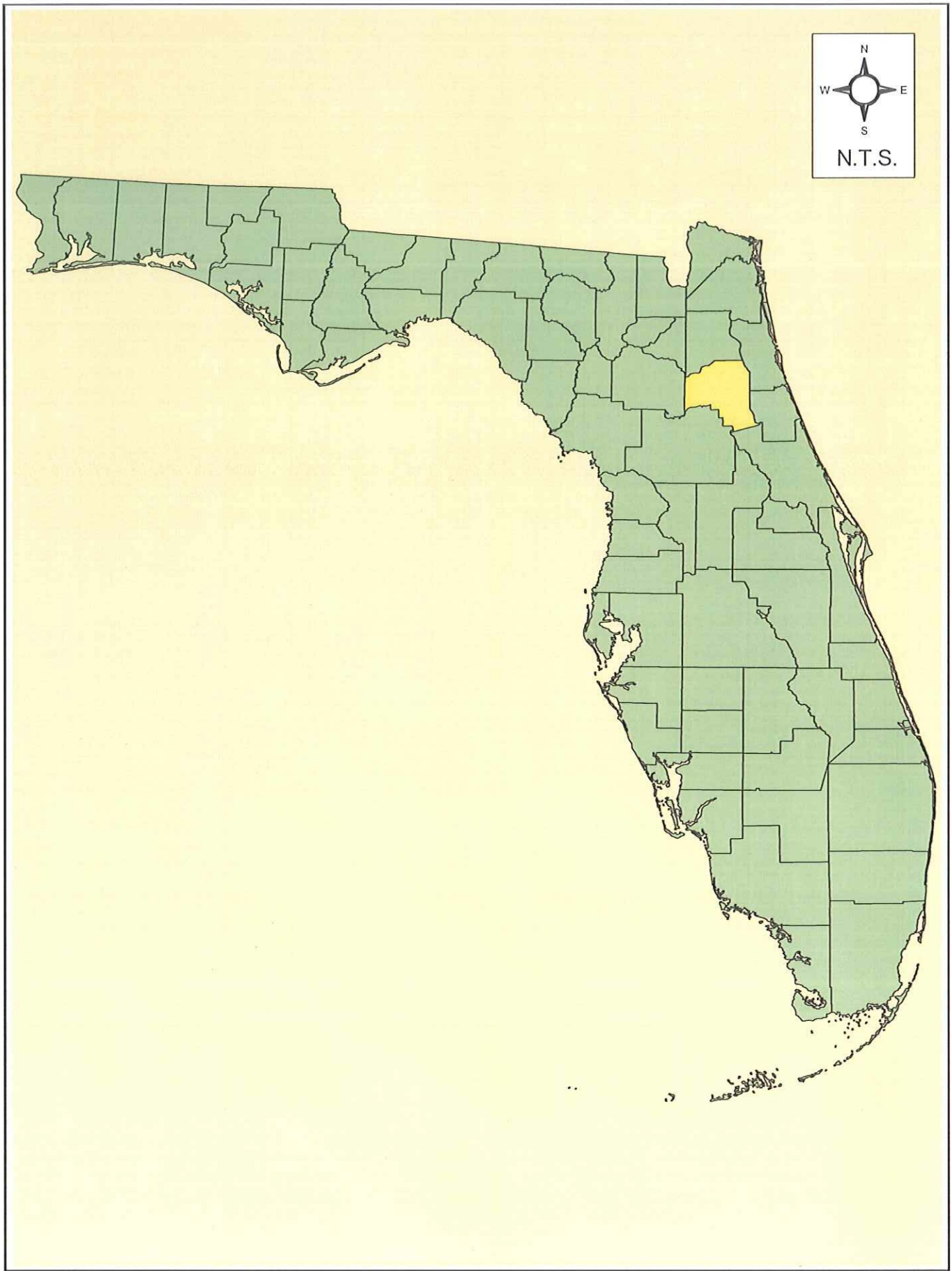
As requested in the scope of services dated December 23, 2003, this report includes:

- Task 1: Data Collection and Review
- Task 2: Determination of Adequacy of Existing Information
- Task 3: Characteristics of Selected Subwatersheds
- Task 4: Funding and Administration Alternatives
- Task 5: Operation and Maintenance Considerations
- Task 6: Repair and Maintenance Considerations
- Task 7: Capital Improvement Program for Localized Flooding
- Task 8: Final Report Preparation

This report is the documentation (Task 8) of the development of a Master Stormwater Plan for Putnam County. Results of all other tasks and conclusions are shown in the associated report sections.

1.3 LOCATION

Putnam County is located in Florida to the east of Gainesville and North of Ocala. It is bordered by Flagler, Marion, Alachua, Bradford, Clay, St. Johns, and Volusia Counties (**Figure 1**).



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\
GIS\APRs\Countylocmap.apr

Location of Putnam County
Putnam County Master Stormwater Plan

Figure
1

AYRES ASSOCIATES

1.4 CLIMATE AND METEOROLOGY

As reported in the Basin Status report for the Lower St. Johns River Basin (FDEP, 1992), the regional climate may be characterized as warm temperate to subtropical. The basin-wide average annual temperature is 69.8 degrees Fahrenheit. The average annual rainfall from the Palatka, Jacksonville and Deland rainfall stations is 53.2 inches. Roughly half of the annual rainfall occurs during the wet season, from June through September. Convective and tropical storms dominate over the summer months, while frontal systems dominate during the rest of the year. Prevailing winds are southeasterly in the spring and summer and northeasterly in the fall and winter.

Data collected in Gainesville, Florida indicate that annual lake evaporation (adjusted from pan evaporation rates) is 52 inches, roughly equal to annual rainfall.

TABLE OF CONTENTS

2.0 DATA COLLECTION AND REVIEW 2-1
2.1 Soils 2-1
2.2 Land Use and Land Cover 2-1
2.3 Hydrology 2-5
2.3.1 Watershed Boundary And Planning Units 2-5
2.3.2 Surface Water 2-9
2.3.3 Groundwater 2-13
2.4 Flood Profiles and Floodplain 2-14
2.5 Conveyance System 2-14
2.6 Literature Review 2-15
2.6.1 Meteorologic 2-15
2.6.2 Hydrologic 2-17
2.6.3 Hydrogeologic 2-20
2.6.4 Water Quality 2-21
2.6.5 General Basin 2-22
2.6.6 Engineering - Hydraulic 2-24
2.6.7 Funding 2-25
2.7 Operation and Maintenance 2-25
2.8 Historical Flooding And Sedimentation Problems 2-26
2.9 Subwatershed Selection Protocol And Selected Subwatersheds 2-29
2.10 Field Investigation Program and Drainage Inventory 2-37
2.10.1 Field Reconnaissance Plan 2-37
2.10.2 Development of the Drainage Inventory Coverage 2-38

List of Figures

Figure 2.2-1 Land Use Distribution (source: Putnam County) 2-2
Figure 2.2-2 Land Use Distribution (source: SJRWMD) 2-3
Figure 2.3.1-1 Sample Map for Planning Units, Watersheds, & Drainage Basins 2-7
Figure 2.3.2-1 Location of gage stations in Putnam County with available data 2-9
Figure 2.8-1 Problem Area Locations 2-26
Figure 2.9-1 Selected Subwatersheds 2-30
Figure 2.10-1 ArcMap Project File 2-37

List of Tables

Table 2.3.2-1 Precipitation Gaging Stations in or Near Putnam County 2-10
Table 2.3.2-2 USGS Stream Gaging Stations in Putnam County 2-12
Table 2.3.2-3 USGS Stream Gaging Stations with Water Quality Data in Putnam County 2-13
Table 2.8-1 Flooding and Sedimentation Areas 2-27
Table 2.9-1 Subbasin Selection Computational Matrix 2-31
Table 2.9-2 Selected Subwatersheds and Ranking 2-34

TABLE OF CONTENTS

2.0 DATA COLLECTION AND REVIEW 2-1
2.1 Soils 2-1
2.2 Land Use and Land Cover 2-1
2.3 Hydrology 2-5
2.3.1 Watershed Boundary and Planning Units 2-5
2.3.2 Surface Water 2-9
2.3.3 Groundwater 2-13
2.4 Flood Profiles and Floodplain 2-14
2.5 Conveyance System 2-14
2.6 Literature Review 2-15
2.6.1 Meteorologic 2-15
2.6.2 Hydrologic 2-17
2.6.3 Hydrogeologic 2-20
2.6.4 Water Quality 2-21
2.6.5 General Basin 2-22
2.6.6 Engineering - Hydraulic 2-24
2.6.7 Funding 2-25
2.7 Operation and Maintenance 2-25
2.8 Historical Flooding and Sedimentation Problems 2-26
2.9 Subwatershed Selection Protocol and Selected Subwatersheds 2-29
2.10 Field Investigation Program and Drainage Inventory 2-37
2.10.1 Field Reconnaissance Plan 2-37
2.10.2 Development of the Drainage Inventory Coverage 2-38

List of Figures

Figure 2.2-1 Land Use Distribution (source: Putnam County) 2-2
Figure 2.2-2 Land Use Distribution (source: SJRWMD) 2-3
Figure 2.3.1-1 Sample Map for Planning Units, Watersheds, & Drainage Basins 2-7
Figure 2.3.2-1 Location of Gage Stations in Putnam County with Available Data 2-9
Figure 2.8-1 Problem Area Locations 2-26
Figure 2.9-1 Selected Subwatersheds 2-30
Figure 2.10-1 ArcMap Project File 2-37

List of Tables

Table 2.3.2-1 Precipitation Gaging Stations in or Near Putnam County 2-10
Table 2.3.2-2 USGS Stream Gaging Stations in Putnam County 2-12
Table 2.3.2-3 USGS Stream Gaging Stations with Water Quality Data in Putnam County 2-13
Table 2.8-1 Flooding and Sedimentation Areas 2-27
Table 2.9-1 Subbasin Selection Computational Matrix 2-31
Table 2.9-2 Selected Subwatersheds and Ranking 2-34

2.0 DATA COLLECTION AND REVIEW

Collection and review of available information has been conducted to determine the nature and extent of existing data relating to the present characteristics of storm water management in Putnam County. The objective is to make full use of previous studies and to avoid duplication of work effort. The existing data assessment also includes identification of critical data gaps (areas where additional data are needed).

Information and data have been gathered in the form of general and detailed studies, mapping, technical publications, record drawings, interviews, and public databases. Collected data and information have been received or downloaded in either hard copy or electronic formats, including GIS coverages and databases.

Collected information covers soils, land use, watershed hydrology and hydrogeology, flood profiles and floodplain, conveyance systems, storm water operation and maintenance, historical flooding problems, and protocols for selection of basins for more detailed assessment. The following sections describe the potential application(s) for collected data, and the data type, extent, and source(s). Significant data gaps that should be filled are identified, where applicable.

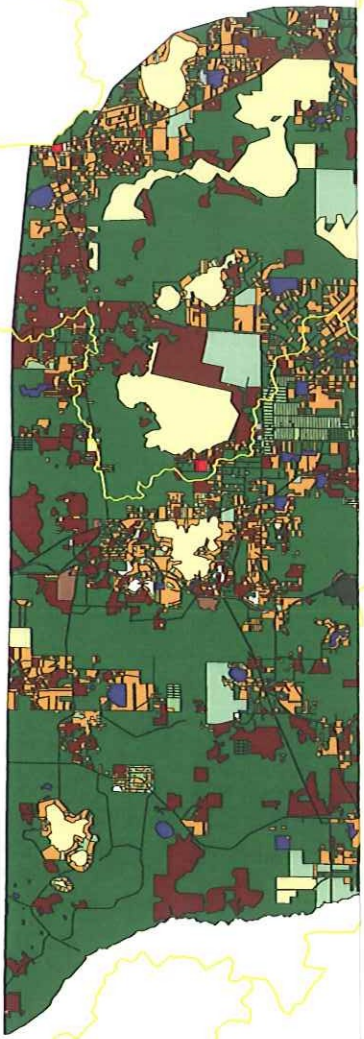
2.1 SOILS

Soils information may be used in storm water master planning to characterize runoff potential, to estimate seasonal high water elevations, to identify historic wetland zones (hydric soils) and to identify potential limitations for certain water management uses. The primary informational source for soils data is the United States Department of Agriculture Natural Resource Conservation Service (formerly Soil Conservation Service). The Natural Resource Conservation Service (NRCS) produces and periodically updates soil survey documents by County. The last update for Putnam County was issued in 1990.

The Soil Survey of Putnam County contains maps and tabular summaries of the different mapped soil units; physical, chemical and engineering properties; and general descriptions for soil series found within the County. The document is available in hardcopy and also as a GIS coverage through the St. Johns River Water Management District (SJRWMD). The SJRWMD GIS coverage has been obtained from Putnam County for use in spatial analysis. Attribute information on specific soil properties is included in the electronic files.

2.2 LAND USE AND LAND COVER

Land use and land cover affect physical and chemical storm water runoff characteristics and must also be taken into consideration when locating future storm water management facilities. Land use data were obtained electronically from Putnam County Planning as GIS coverages. Coverages were available for existing and future land use and have been provided for the entire County. Future land use mapping describes the zoned use and may or may not reflect actual land use. Parcel data, identifying individual parcels and County-owned lands were also provided. **Figure 2.2-1** presents the County land use coverage.



Land Use Distribution in the Putnam County (Source: Putnam County)

Putnam County
Master Stormwater Plan

Legend:

- Watershed Boundary

Land Use:

- Commercial
- General Agriculture
- Industrial
- Institutional
- Mining
- Public Facilities
- Recreation / Open Space
- Residential
- Rivers, Lakes, Streams
- Roads, Railroads, Canals, Utilities
- Silviculture
- Vacant / Undeveloped

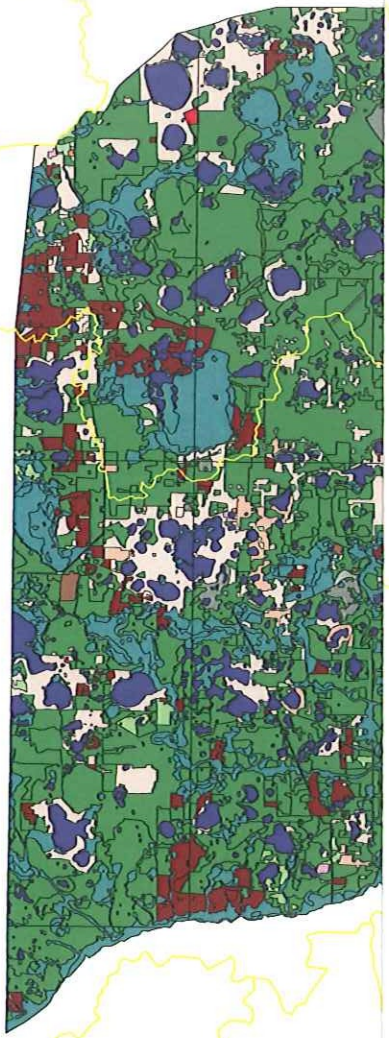
N
W E
S

Not To Scale

PUTNAM COUNTY FLORIDA

AYRES ASSOCIATES

Figure 2.2-1



Land Use Distribution in the Putnam County (Source: SJRWMD)

Putnam County
Master Stormwater Plan

Legend:

- Watershed Boundary

Land Use:

- Agriculture
- Barren Land
- Commercial and Services
- Extractive
- Industrial
- Institutional
- Recreational
- Residential, Low Density - Less than 2 dwelling units per acre
- Residential, Med. Density - Two to five dwelling units per acre
- Residential, High Density
- Transportation, Communication, and Utilities
- Upland Forested
- Upland Non-Forested
- Water
- Wetlands

N
W E
S

Not To Scale

PUTNAM COUNTY FLORIDA

AYRES ASSOCIATES

Figure 2.2-2

Land use data were also obtained from the SJRWMD as GIS coverages for review. **Figure 2.2-2** presents the SJRWMD land use coverage. Categories and polygons are similar for some land uses, but differ for others. Some notable differences are listed below:

- The County land use coverage contains blank polygons which appear to primarily represent water bodies and roadways
- The County land use "Recreation/ Open Space" category does not differentiate between open space, water, wetland, and forest cover
- The County land use "Agriculture" does not differentiate between developed agricultural sites and wetland areas within the polygon
- The County land use "Silviculture" does not differentiate between active silviculture sites and wetland areas, rivers and streams, or uncut forested areas within the polygon
- The County land use coverage for "Rivers, Lakes, Streams," although defined, is not frequently utilized
- The SJRWMD land use coverage does not include silviculture at all, but lumps these areas into "Upland Forested" without differentiating between managed or natural areas

Because the SJRWMD category groupings were better suited for hydrologic description, Section 3.0 watershed descriptions utilize this coverage for figure generation and land use statistics. The Putnam County coverages best describe site activity and use and were utilized for all other master planning analyses, including the capital improvement program subwatershed ranking and project prioritization analyses.

Land cover data differ somewhat from land use, in that the emphasis is on vegetative cover, rather than parcel use, ownership or activity. Land cover data for Putnam County have been obtained through the National Wetland Inventory (NWI) mapping files, obtained through the SJRWMD as a GIS coverage for Putnam County. This map provides wetland locations and classification, as defined by the U.S. Fish & Wildlife service. The wetland classification system is hierarchical, with wetlands and deepwater habitats divided among five major systems at the broadest level. The five systems include Marine (open ocean and associated coastline), Estuarine (salt marshes and brackish tidal water), Riverine (rivers, creeks, and streams), Lacustrine (lakes and deep ponds), and Palustrine (shallow ponds, marshes, swamps, sloughs). Systems are further subdivided into subsystems which reflect hydrologic conditions. Below the subsystem is the class which describes the appearance of the wetland in terms of vegetation or substrate. Each class is further subdivided into subclasses; vegetated subclasses are described in terms of life form and substrate subclasses in terms of composition. The classification system also includes modifiers to describe hydrology (water regime), soils, water chemistry (pH, salinity), and special modifiers relating to man's activities (e.g., impounded, partly drained).

Land use and land cover data, described above, may be augmented by digital orthophotos quarter quandrangles (DOQQs), also available through the SJRWMD.

Available land use and land cover data are suitable for stormwater management master planning.

2.3 HYDROLOGY

Hydrologic data characterize contributory watershed area, surface water conditions, and subsurface or groundwater conditions. The following sections describe the collected data and its adequacy for each of these categories.

2.3.1 WATERSHED BOUNDARY AND PLANNING UNITS

In discussing drainage issues, the most basic level is the contributing drainage area, generally expressed as the watershed or basin. For the purposes of this report, the term "watershed" will be used because the term "basin" is often also used in drainage studies to refer to smaller, drainage areas which do not encompass an entire river or creek tributary area. Note that the St. Johns River Water Management District (SJRWMD) generally uses the term "basin," and that term is found in much of the text that follows and in other documents from the SJRWMD referenced throughout this study.

Watershed boundaries in Putnam County and across the water management district were originally delineated by SJRWMD. *Technical Publication SJ97-1, Surface Water Drainage Basin Boundaries, St. Johns River Water Management District: A Reference Guide*, prepared by the SJRWMD in 1997 was developed to document the current districtwide drainage basin data layer, which is part of the SJRWMD geographic information system (GIS) computer library. The following was directly extracted from the Introduction Technical Publication SJ97-1:

"Before 1991, the only districtwide drainage basin data layer was very general; it was composed of 55 subbasins (subbasins are called planning units in this document). Detailed drainage basin boundaries were created only as needed for specific project areas, often at different scales and levels of detail. The data layer this report documents represents the first detailed districtwide drainage basin data."

From the section titled, "Lineage":

"The U.S. Geological Survey (USGS) delineated SJRWMD drainage basin boundaries on 1:24,000-scale 7.5-minute quadrangle (quad) maps and then digitized them. USGS submitted the data to SJRWMD in 1991. The SJRWMD Divisions of Engineering and Environmental Sciences validated the data through quality assurance checks. Staff from these divisions also extensively modified the data in several ways:

- *Boundaries were corrected based on specific site knowledge.*
- *Basins were added based on specific site knowledge.*
- *Important attributes were added.*
- *Many very large basins (along main river channels) were subdivided to make the data more useful.*

Each basin was given a code to indicate if it was unchanged from the original USGS data or if it had been modified. SJRWMD staff will continue to update the boundaries periodically, based on ongoing project work.

The SJRWMD data layer has been incorporated into a statewide drainage basin data layer by the Department of Environmental Protection in Tallahassee. This statewide data will be revised periodically with updates from the five water management districts."

Generally, comprehensive drainage studies are developed for a watershed or drainage basins. For this reason, it was decided that an organizational format must be developed that was based on a watershed level. However, Putnam County contains 31 individual watersheds, which is too large a number to be effectively used as the highest organizational level. Therefore, it was decided to research ways in which the watersheds could be grouped geographically for the purposes of this report. This effort has already been made by the SJRWMD, in the form of Planning Units, or Drainage Planning Units (DPUs), as they will be called in this report. **Figure 2.3.1-1** depicts an example of the Planning Unit, Watershed, and Subwatershed (termed "Drainage Basin" by the SJRWMD) boundaries

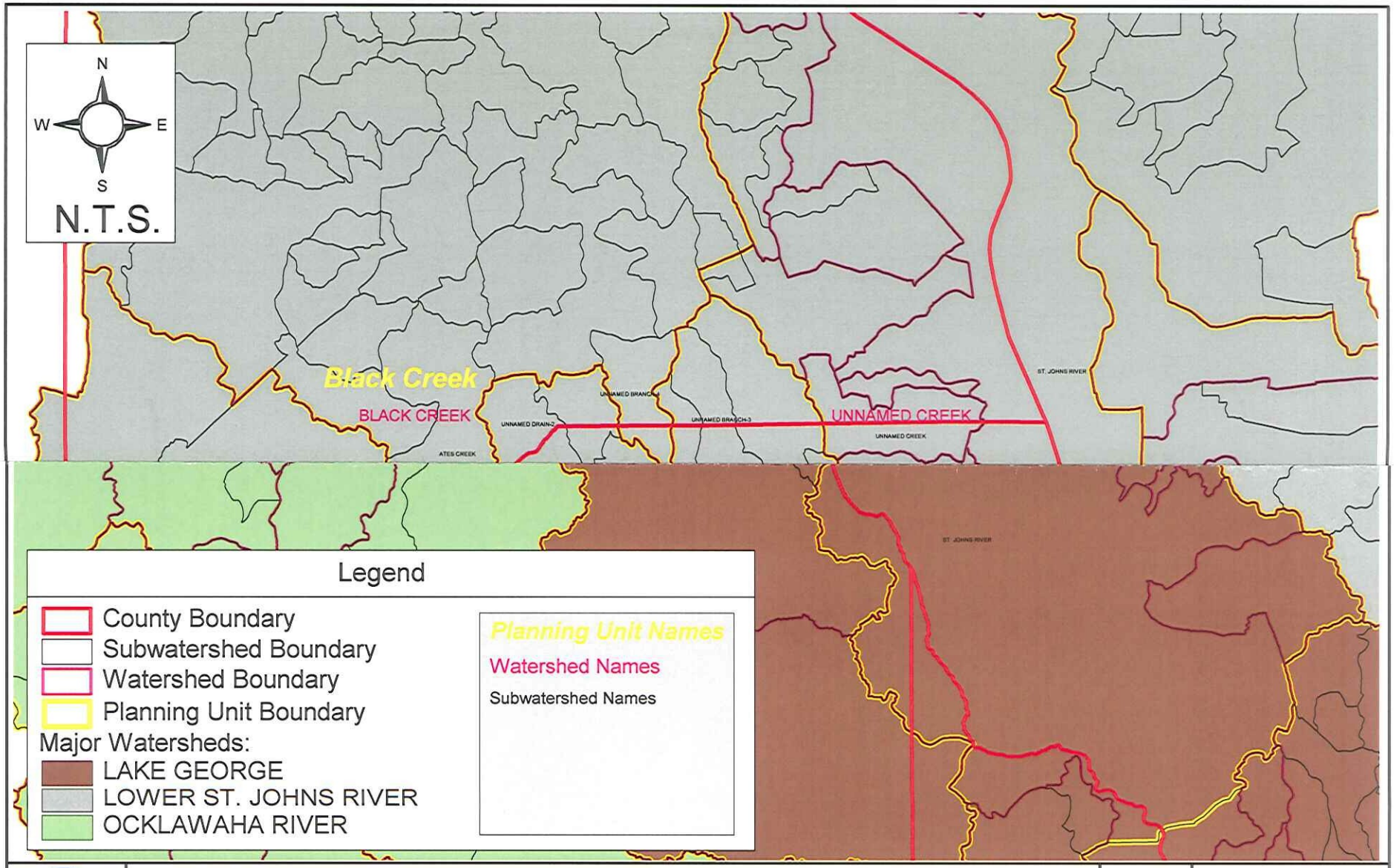
The following information was obtained from Appendix B in the aforementioned *Technical Publication SJ97-1, Surface Water Drainage Basin Boundaries, St. Johns River Water Management District: A Reference Guide*. It defines planning units and describes the rationale for their creation and the rationale for determining their boundaries.

"Planning Unit Definition
Planning units are designations assigned to the USGS drainage basin data layer in order to organize the data in a way that is useful in SJRWMD planning or management efforts. A planning unit is either an individual primary tributary basin or a group of adjacent primary tributary basins with similar characteristics.

- *Large primary tributary basins such as the Econlockhatchee River or Black Creek each comprise a planning unit.*
- *Small, adjacent primary tributary basins were combined into planning units. These aggregate planning units contain the word "Unit" in their name.*

Rationale for Creating Planning Units
SJRWMD staff superimposed the planning unit designations on the USGS data for the following reasons:

- *There are 287 individual primary tributary basins in SJRWMD as delineated by USGS; these are further divided into 1,144 7.5-minute quad basins. When examining regional issues, it is useful to simplify the level of detail.*
- *The USGS delineations needed to be more consistent with the designations that SJRWMD staff had used before the more-detailed data layer was available."*



G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Location_Big.apr

Putnam County - Planning Units, Watersheds, and Subwatersheds

Putnam County Master Stormwater Plan

Figure 2.3.1-1

AYRES ASSOCIATES

Rationale for Determining Planning Unit Boundaries

Planning unit boundaries were created either by designating an entire primary tributary basin as one planning unit or by grouping several primary tributary basins together to form one planning unit. The following list does not represent rules, but rather considerations that in combination led to the planning unit boundaries as they are now.

- *Larger individual primary tributary basins such as the Econlockhatchee River were designated as one planning unit.*

- *Adjacent small primary tributary basins were grouped together into planning units if they were hydrologically similar or had similar management requirements.*

- *Example: Several primary tributary basins were grouped together to form the Deep Creek planning unit (3F) in the Lower St. Johns River Basin. All are dominated by similar soils and land uses (intensive farming) and therefore present similar management problems*

- *Ongoing hydrologic restoration activities were taken into consideration when determining planning unit boundaries in the Upper St. Johns River Basin.*

- *Primary tributary basins were not divided, with the following exception:*

  Some primary tributary basins defined by USGS were divided into different planning units in the Upper St. Johns River Basin. This subdivision was based on current or near-future flow conditions, which were not accurately represented on the USGS 7.5-minute quad maps, the source of the data layer.

- *The St. Mary's River planning unit boundaries were based on the hydrologic subareas reported in A wetland management strategy for the St. Marys River Basin by KBN in 1993 (Special Publication SJ93-SP7. Palatka, Fla.: St. Johns River Water Management District.)*

- *Basin project managers and other knowledgeable staff were consulted.*

  Example: The Upper St. Johns River Basin planning unit boundaries (6A-I) were designated after the authors consulted with staff of the Environmental Sciences Division Upper Basin project, the Engineering Division, and the Resource Management Department, and consulted existing planning maps for the project.

- *SJRWMD historical subbasin designations were mimicked when possible.*

- *Large differences in planning unit sizes were avoided when possible."*

2.3.2 SURFACE WATER

Surface water data include precipitation records, streamflow records, and lake stage records. Limited water quality data were also available. Historic records may be used to:

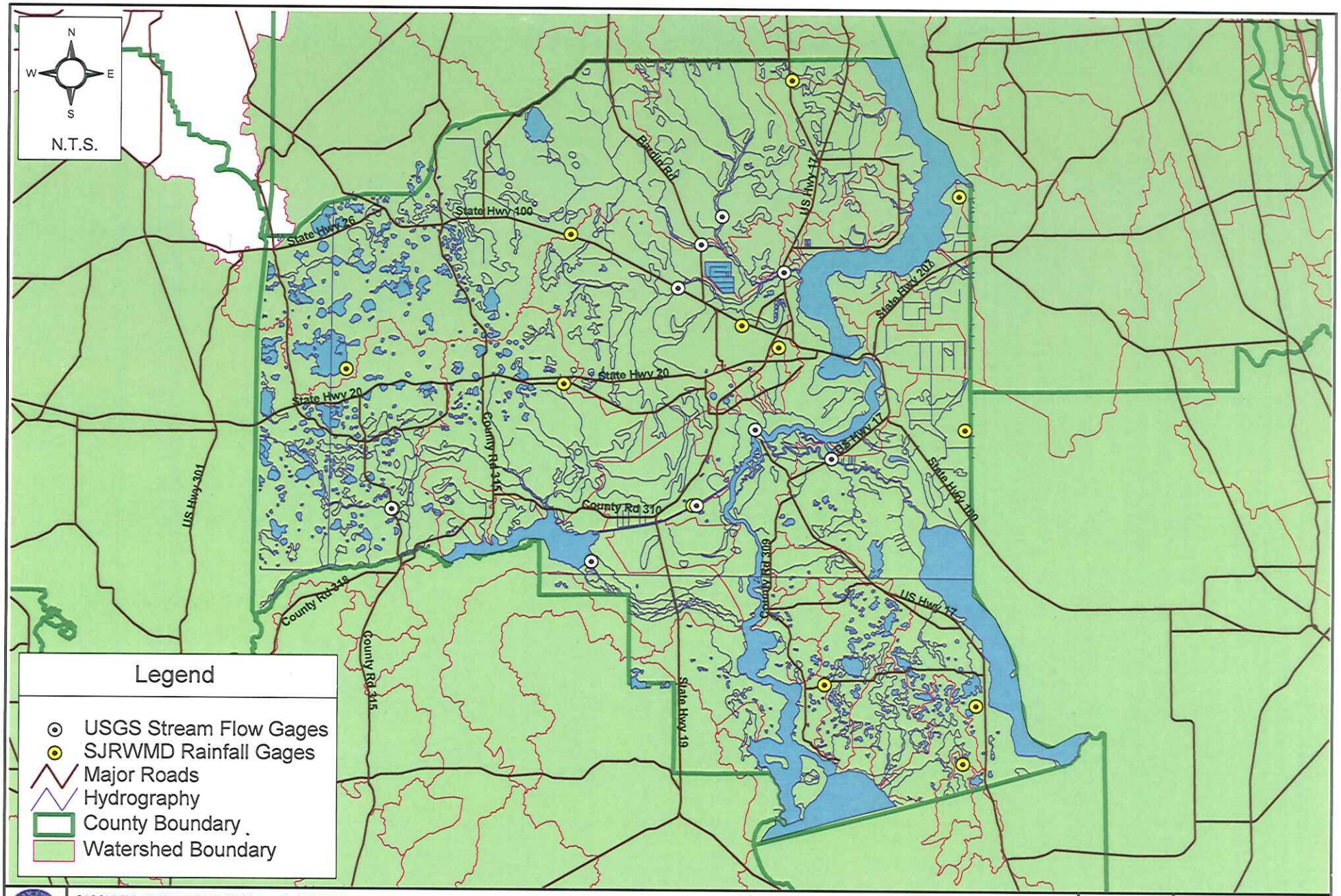
- Characterize stream systems
- Establish average, wet and dry conditions
- Develop rainfall, flood flow or flood stage return frequencies, and
- Calibrate hydrologic and hydraulic simulation models

Figure 2.3.2-1 presents the location of gage stations in Putnam County with available data.

Data collection for precipitation has been limited to identifying precipitation gages within Putnam County boundaries, and determining the available period of record. The majority of available precipitation data are from the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center and gages monitored by the SJRWMD. **Table 2.3.2-1** lists these nine stations, their respective DPU and the associated period of record.

TABLE 2.3.2-1 PRECIPITATION GAGING STATIONS IN OR NEAR PUTNAM COUNTY

DPU	Site Number	Site Name	From	To	Data Set
Crescent Lake	NCDC Co-op 081978	Crescent City, Fl 29°25'N / 81°31'W	1948	Present	- Daily - Monthly
South Mainstem	NCDC Co-op 082915	Federal Point, Fl 29°45'N / 81°32'W	1948	Present	- Daily - Monthly
Etonia Creek	NCDC Co-op 086753	Palatka, Fl 29°39'N / 81°40'W	1948	Present	- Daily - Monthly
Rodman Reservoir	SJRWMD 1697	Buckman Lock 29°32'45"N / 81°43'45"W	2002	Present	- Instantaneous - Daily - Monthly
Etonia Creek	SJRWMD 7010	Chesser Well 29°37'56"N / 81°59'19"W	2002	Present	- Instantaneous - Daily - Monthly
Etonia Creek	SJRWMD 210	District Headquarters 29°39'51"N / 81°41'39"W	1988	Present	- Instantaneous - Daily - Monthly
Etonia Creek	SJRWMD 1784	Etonia East V Road 29°43'21"N / 81°49'21"W	1990	Present	- Instantaneous - Daily - Monthly
Crescent Lake	SJRWMD 243	Hell Cat Bay 29°35'49"N / 81°31'38"W	1994	Present	- Instantaneous - Daily - Monthly
Lake George	SJRWMD 232	Silver Pond Wells 29°22'43"N / 81°31'34"W	1991	Present	- Instantaneous - Daily - Monthly



G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Location_Big.apr

USGS Stream Flow and SJRWMD Rainfall Gages
Putnam County Master Stormwater Plan

Figure 2.3.2-1

AYRES ASSOCIATES

Supplemental rainfall data, including seasonal and frequency analyses, are available from previous studies performed by the SJRWMD and documented in technical publications described in Section 3.2.

Surface water data have come from the United States Geological Survey (USGS) national database at http://waterdata.usgs.gov/nwis/sw. **Table 2.3.2-2** lists the streamflow gaging stations within Putnam County by DPU and identifies the data sets available. No USGS gages for lakes were found within Putnam County. Supplemental data, including lake stages for major water bodies, are available from previous studies performed by the SJRWMD and documented in technical publications described in Section 3.2.

TABLE 2.3.2-2 USGS STREAM GAGING STATIONS IN PUTNAM COUNTY

DPU	Site Number	Site Name	From	To	Data Set
Orange Creek	02243300	Little Orange Creek Near Johnson, Fl	5/24/1995	9/30/1998	- Daily - Peak - Statistics
Rodman Reservoir	02243960	Ocklawaha R. at Rodman Dam Nr Orange Springs, Fl	10/1/1968	9/30/2005	- Daily - Peak - Statistics
	02244032	Cross FL Barge Canal at Buckman Lock Nr Palatka, Fl	11/20/1969	9/30/2004	- Daily - Statistics
South Mainstem	02244040	St. Johns R At Buffalo Bluff Near Satsuma, Fl	10/2/1992	9/30/2005	- Daily - Peak - Statistics
Crescent Lake	02244440	Dunns Creek Near Satsuma, Fl	1/1/1978	9/30/2005	- Daily - Peak - Statistics
Etonia Creek	02244473	Rice Creek Near Springside, Fl	10/1/1973	7/05/2004	- Daily - Peak - Statistics
	02245050	Etonia Creek At Bardin, Fl	10/1/1973	7/06/2004	- Daily - Peak - Statistics
	02245140	Simms Creek Near Bardin, Fl	10/1/1973	7/05/2004	- Daily - Peak - Statistics
	02245200	Rice Creek Near Palatka, Fl	6/1/1995	5/6/1997	- Daily - Statistics

Table 2.3.2-3 lists the streamflow gaging stations within Putnam County with water quality data available.

TABLE 2.3.2-3 USGS STREAM GAGING STATIONS WITH WATER QUALITY DATA IN PUTNAM COUNTY

DPU	Site Number	Site Name	From	To	Data Set
Rodman Reservoir	02243960	Ocklawaha R. at Rodman Dam Nr Orange Springs, Fl	5/07/1970	7/06/1981	- Temperature, Turbidity - Specific Conductance - Color, pH, Hardness - Dissolved Oxygen, BOD - Nitrogen systems - Phosphorus systems - Carbons, Carbonates - TSS, Metals
	02244032	Cross FL Barge Canal at Buckman Lock Nr Palatka, Fl	11/19/1968	5/19/1977	- Temperature, Turbidity - Specific Conductance - Color, pH, Hardness - Dissolved Oxygen, BOD - Nitrogen systems - Phosphorus systems - Carbons, Carbonates - TSS
South Mainstem	02244040	St. Johns R At Buffalo Bluff Near Satsuma, Fl	4/29/1995	5/18/2004	- Temperature - Specific Conductance - Dissolved Oxygen
Crescent Lake	02244440	Dunns Creek Near Satsuma, Fl	12/21/1982	12/21/1982	- Temperature - Specific Conductance
Etonia Creek	02244473	Rice Creek Near Springside, Fl	4/19/1956	9/20/1993	- Temperature - Specific Conductance, Color, pH, Hardness, etc (1 data pt)
	02245050	Etonia Creek At Bardin, Fl	5/24/1965	7/02/1981	- Temperature
	02245140	Simms Creek Near Bardin, Fl	10/10/1973	8/27/1981	- Temperature
	02245200	Rice Creek Near Palatka, Fl	5/12/1967	9/26/1973	- Temperature, Turbidity - Specific Conductance - Color, pH, Hardness - Dissolved Oxygen, BOD - Nitrogen systems - Phosphorus systems - Carbons, Carbonates - TSS, Metals

2.3.3 GROUNDWATER

Groundwater data include subsurface geology and aquifer characteristics, as well as potentiometric and water quality data. Information collected for groundwater is limited to technical publications concerning aquifer characteristic studies and hydrogeologic studies performed by the SJRWMD and described in Section 3.2. These studies provide general

information concerning aquifer transmissivity, leakance, and storage coefficient, underlying geology, springs and natural recharge areas, and groundwater quality.
Additional potentiometric data may be obtained through the SJRWMD Hydrologic Data Services. The SJRWMD publishes a monthly "Hydrologic Conditions Report" using 9 to 10 data wells connected to the Floridan aquifer.

2.4 FLOOD PROFILES AND FLOODPLAIN

Flood profiles and floodplain extent are useful for land management and planning, to minimize development within natural floodplains. Knowledge of predicted flood flows, flood stages and area of inundation is desired for provision of safe location and elevation of habitable structures, reducing potential flood damages, design of public roadways over water conveyances, and design of flood control/flood improvement projects.

Flood profiles and floodplain information for Putnam County are available through the Federal Emergency Management Administration (FEMA) for major conveyances. Floodplain mapping is published on Flood Insurance Rate Maps (FIRM) and has been provided in GIS for all of Putnam County by the SJRWMD.

Description of flood flow derivation and flood profile modeling is presented with graphed flood profiles in the currently effective Flood Insurance Studies (FIS) for Putnam County. Five FIS publications have been obtained for Putnam County, listed below.

- City of Crescent City, Florida, Putnam County – June 1979
- Putnam County, Florida (Unincorporated Areas) – Last Revised August 16, 1994
- Town of Interlachen, Florida, Putnam County – June 1979
- Town of Pomona Park, Florida, Putnam County – June 1979
- City of Palatka, Florida, Putnam County – December 1979

Data are considered adequate for stormwater management master planning associated with the specific lakes and conveyances included in the studies.

Many smaller tributaries, lakes and wetland areas within the County have not yet been studied in sufficient detail to establish 100-year base flood elevations.

2.5 CONVEYANCE SYSTEM

Conveyance system data are used initially to define the drainage network. The drainage network represents the connectivity of the lakes, wetlands, streams and channels and includes predominant flow direction. Detailed information concerning the size, slope and condition of the local conveyances (stream channels, ditches, pipes, inter-connected ponds) is used to prepare simple or complex hydraulic simulation models to support engineering designs for specific storm water management system improvements.

The primary conveyance systems in Putnam County have been identified through hydrography coverages supplied in GIS from both Putnam County and the SJRWMD. According to the metadata, they are based on the Florida Department of Environmental Protection's version of

the U.S. Geological Survey Digital Line Graph (DLG). The DLG represents water and wetland features from USGS 30 by 60 minute quad maps at a 1:100,000 scale. The most complete hydrographic representation of streams and tributaries is found in the SJRWMD "hydro100_line_putnam" shape files. These files lack stream name or lake name identifiers.

Contour data have also been obtained through the SJRWMD, which informs the prediction of flow direction and provides the general floodplain/floodway shape. The five-foot vertical interval for contour data is too course for engineering studies in Florida and will need to be supplemented by field survey or LiDAR before developing flood models for specific watersheds or engineering designs for most flood problem areas.

Limited field reconnaissance, permit document and design plan review has been conducted in historic flood problem areas to obtain local channel and structure dimension data, although no registered field survey has been performed as a part of this stormwater master plan.

The data described above are sufficient to generate a coarse conveyance map for each DPU, but are insufficient to support detailed designs for specific storm water improvements. Without more specific hydraulic data, only conceptual level design based upon engineering assumptions and judgment may be offered.

Additional data collection in the form of field survey, aerial contour mapping, cross section determination for open channels, additional permit document and design plan review, and local storm water management system inventory should be conducted for points of interest, should the County wish to perform detailed design modeling and assessment for selection of flood management projects.

2.6 LITERATURE REVIEW

Numerous reports and technical publications were obtained, primarily in electronic format, pertaining to meteorologic, hydrologic, hydrogeologic, water quality, general basin, engineering-hydraulic, and funding issues associated with the SJRWMD as a whole, the Lower St. Johns River Basin, or specific watersheds within Putnam County. These documents were reviewed to determine whether information would be useful in current characterization of Putnam County watersheds, and for base data in future studies. Documents are grouped by category. A brief synopsis of each document follows.

2.6.1 METEOROLOGIC

Rao, D. V., 1985. The Mean Annual, 10-year, 25-year, and 100-year Flood Profiles for the Upper St. Johns River Under the Existing Conditions, Technical Publication SJ 85-3, St. Johns River Water Management District, Palatka, Florida.

This report presents a collection of computed flood profiles for the St. Johns River at its headwaters near Florida's Turnpike to State Road 46 to be used for determination of flood elevations for any location along the river, within the Upper St. Johns River Flood Valley under the existing conditions. For the "current" basin conditions, synthetic streamflow data have been generated for a period of 35 years (1948-1983) using a continuous hydrologic simulation model coupled with the U.S. Army Corps of Engineers HEC-2 model. Flood flow frequency analyses have been conducted on the annual peak flow data. The mean annual, 10-year, 25-year, and 100-year return frequency flood profiles are computed and presented in this report, along with

descriptions of the general basin conditions and the profile-generation methodology. These profiles are not applicable to the Putnam County area.

Rao, D. V. and D. Clapp, 1986. Rainfall Analysis for Northeast Florida Part I: 24-Hour to 10-Day Maximum Rainfall Data, Technical Publication SJ 86-3, St. Johns River Water Management District, Palatka, Florida.

The SJRWMD recognizes that rainfall data (daily, hourly, monthly) comprise the basic input to several hydrologic and engineering studies, including the design of stormwater management systems, the determination of flood potential under various storm events, and evaluation of water supply and consumptive use issues. The District makes extensive use of rainfall data in its resource management and permitting activities. The rainfall analysis project for Northeast Florida was undertaken to fulfill the needs of the District and to provide the same information to interested agencies and individuals. The project objectives included collection and detailed analyses of rainfall data and the production of a series of reports; each report directed at a specific hydrologic/engineering study goal. This publication represents the first in a six-report series and covers 24-hour to Ten-day maximum rainfall data, gathered from the National Oceanic and Atmospheric Administration (NOAA) and from the Environmental Science Services Administration publications. Data from 1931 through 1983 were utilized. The Part I report presents basic rainfall data, principal rain gage locations, descriptions of data preparation and adjustments, and maximum rainfall evaluation results; but does not include frequency analysis, which is presented in Part VI of the series.

Jenab, S. A., D. V. Rao and D. Clapp, 1986. Rainfall Analysis for Northeast Florida Part II: Summary of Monthly and Annual Rainfall Data, Technical Publication SJ 86-4, St. Johns River Water Management District, Palatka, Florida.

This report is the part of a six-part report series associated with the "Rainfall Analysis for Northeast Florida" project sponsored by the SJRWMD. The objective of the study is to fulfill the rainfall data needs of the District and to provide the same information to interested agencies and individuals. The overall project objectives included collection and detailed analyses of rainfall data and the production of a series of reports; each report directed at a specific hydrologic/engineering study goal. This publication represents the second in a six-part series and provides a compilation of monthly and annual rainfall data for the long-term gaging stations located within and close to the SJRWMD boundaries. The data will be subsequently used in other analyses, e.g., computing seasonal rainfall data, conducting frequency analyses of maximum and minimum seasonal rainfall, etc. Data were gathered from the National Oceanic and Atmospheric Administration (NOAA) and from the Environmental Science Services Administration publications and utilized 43 principal rain gage stations. The Part II report presents basic rainfall data, principal rain gage locations, descriptions of data preparation and methods for estimating missing data, and historical annual and monthly totals for the 43 principal stations. Distribution of the annual "normal" rainfall for Northeast Florida is also presented as an isohyetal map.

Rao, D. V., 1991. 24-Hour Rainfall Distribution for Surface Water Basins within the St. Johns River Water Management District, Northeast Florida, Technical Publication SJ 91-3, St. Johns River Water Management District, Palatka, Florida.

This report presents rainfall distributions for specific surface water drainage basins in the District for the convenience of MSSW (Management and Storage of Surface Waters) permit applicants/ consulting engineers, and other users. The MSSW rules of the St. Johns River Water Management District apply a 'peak discharge criterion' in the evaluation of permit applications for land developments that interfere with natural drainage, storage, recharge, and conveyance of water. According to this criterion, the drainage systems of these developments should be designed and operated so that the post-development peak rate of discharge (from the developed area) would not exceed the predevelopment peak rate of discharge. Peak discharges for a drainage basin are often calculated by rainfall-runoff models using hypothetical or synthetic storm data. Two basic components of a hypothetical storm are the total rainfall amount during the storm event (duration) and the time distribution of rainfall (rainfall distribution). Generalized rainfall distributions, developed by the Soil Conservation Service of the U.S. Department of Agriculture, have been extensively used by agencies and consulting engineers throughout the United States for calculating design or peak discharges. Generalized distributions, however, lack accuracy because they are based on the rainfall magnitude and patterns occurring over a large region. Distributions developed for a specific drainage basin or site-specific distributions predict peak discharges more accurately. Procedures for developing site-specific hypothetical storm distributions were described in development of site-specific hypothetical storm distributions (Rao 1988).

2.6.2 HYDROLOGIC

Suphunvorranop, T., 1985. A Guide to SCS Runoff Procedures, Technical Publication SJ 85-5, St. Johns River Water Management District, Palatka, Florida.

This report was developed as a practical guidance document for hydrologists and engineers and contains discussions of the SCS runoff procedure, including the curve number and the unit hydrograph methods. Detailed discussion is provided on the methods of estimating curve numbers (CN), basin time-of-concentration (Tc), and peak rate factors (K') for different hydrologic conditions. The method for constructing a unit hydrograph for a given peak rate factor is also described. The report includes example problems illustrating the effects of methods used in estimating CN, Tc, and K' on runoff hydrographs. The report recommends use of the effective impervious area method for CN estimates, and the use of the Agricultural Research Service method for basins where soil storage is affected by water table. It further recommends the SCS velocity method for basin Tc estimation and states that K' can be determined either from the proportion of area under the rising limb of the time-area curve or by using the adjustment factor described within the report to account for swampy and ponding areas.

Adamus, C., D. Clapp and S. Brown, 1997. Surface Water Drainage Basin Boundaries – St. Johns River Water Management District: A Reference Guide, Technical Publication SJ97-1, St. Johns River Water Management District, Palatka, Florida.

One of the most important pieces of information the SJRWMD uses for surface water management is drainage basin boundaries. This report documents the 1997 district-wide drainage basin data layer, which is part of the geographic information systems (GIS) computer library. Maps depict the basin boundaries, and tables list descriptive information. The data layer this report documents represents the first detailed district-

wide drainage basin data. Drainage subbasins are termed as planning units and vary in size from 69 to 1,144 acres. Superimposed on these data is an organizational scheme that groups the data into larger units (major basin), thus making it useful for projects with small scope and for projects having a more regional focus. Drainage layer documentation includes description of lineage, sources, and terminology. The SJRWMD data layer has been incorporated into a statewide drainage basin data layer by the Florida department of Environmental Protection and will be periodically revised.

Yobbi, D. K. and G. C. Chappell, 1979. Summary of the Hydrology of the Upper Etonia Creek Basin, Technical Publication SJ 79-5, St. Johns River Water Management District, Palatka, Florida.

This report presents the findings and recommendations of a study, jointly sponsored by the SJRWMD and the USGS, of the hydrology of the 165 square-mile Upper Etonia Creek area. The study was primarily undertaken to evaluate recharge, an important water resource issue. During the period from December 1974 through July 1975, measuring points were established and wells within the project area were identified. Data collection began in the period from July 1975, continuing through December 1976, during which staff gages were installed and read on selected lakes, water level recorders were installed and read on selected wells and surface water bodies, and periodic discharge measurements were made on Upper Etonia Creek and its tributaries. Rainfall data from the national Oceanic and Atmospheric Administration (NOAA) stations nearest to the project area were supplemented by three installed rain gages to complete the monitoring network. Rainfall, evaporation estimates, groundwater levels, lake stages, stream discharges, and drainage areas were measured or computed. This report presents the most significant findings of the investigation, which are summarized as follows: (1) a correlation exists between lake stages and rainfall; (2) a general decline in lake levels was noted during the period of study (1975-1976) which correlated to a period of below normal rainfall; (3) precipitation, evapotranspiration and stream runoff for 1976 were determined to be 47.98 inches, 34.15 inches, and 0.81 inches, respectively; and (4) net recharge to the Floridan aquifer for 1976 was estimated to be 16.82 inches. The report recommends that the Upper Etonia Creek recharge area be protected from pollution of potential recharge; that adequate surface area be maintained for seepage; that withdrawals of water be limited to avoid detrimental effects on downgradient uses during periods of drought; and that a monitoring program (described in the report) be implemented.

Rao, D. V., 1986. Magnitude and Frequency of Flood Discharges in Northeast Florida, Technical Publication SJ 86-2, St. Johns River Water Management District, Palatka, Florida.

This publication presents data on past floods and highest reported flood elevation recorded for surface waters in the SJRWMD area of regulatory jurisdiction. The SJRWMD-regulated surface waters include a major portion of the St. Marys River Basin, all of the Nassau and St. Johns River Basins, and several coastal drainage basins. Data from 68 recording sites with streamflow records of five or more years are presented. For 62 of these sites which have ten or more years of data, flood flow frequency analyses have been performed and peak flow estimates provided for return periods, T= 5 yr, 10 yr, 25 yr, 50 yr, 100 yr, and 500 yr. Regional regression models have been developed for computing approximate peak flows at ungaged sites. This

information will be useful for determining expected flood elevations, project evaluation, and establishing predevelopment discharges in connection with District surface water and environmental resource permitting.

Bergman, M. J., 1992. Volume 2 of the Lower St. Johns River Basin Reconnaissance – Surface Water Hydrology, Technical Publication SJ 92-1, St. Johns River Water Management District, Palatka, Florida.

This report is Volume 2 in a series of reconnaissance reports about the Lower St. Johns River Basin which includes parts of nine counties in northeast Florida. The lower St. Johns River is the northern part of the St. Johns River from the mouth of the Ocklawaha River in Putnam County to the inlet at the Atlantic Ocean in Duval County. The reconnaissance reports compile information and make recommendations to help resource managers identify priority needs for research into and management of the basin. This volume gives an overview of the surface water system and the existing rainfall and streamflow monitoring networks in the lower St. Johns River Basin. The report describes the basin in terms of physiography, soils, climate and tributary basins; presents precipitation, streamflow, evapotranspiration data, and also describes significant hydraulic structures and historic flooding; and discusses rainfall-runoff simulation and streamflow analysis. The report presents recommendations for additional monitoring gages in several basins, development of additional hydrologic simulation models outside Duval County, and development of a basin-wide GIS for hydrologic data and stream cross-section data. Also recommended are investigations into water quality and quantity data from monitoring stations, development of stochastic models for short-term and long-term forecasting, development and use of lake circulation models to supplement the analysis of basin hydrology, and determination of the transport and fate of discharges and pollutants to the main stem of the river using hydrodynamic models.

Adkins, M. and D. V. Rao, 1995. A Surface Water Hydrologic Reconnaissance, Upper Orange Creek Basin, North Central Florida, Technical Publication SJ95-4, St. Johns River Water Management District, Palatka, Florida.

The primary objective of this study is to produce a comprehensive presentation of the surface water hydrology of the 399 mi^2 Upper Orange Creek basin, located immediately west of Putnam County, using existing data. Existing literature was reviewed and existing data were inventoried to summarize and document available hydrologic information on Orange, Lochloosa, and Newnans lakes and Paynes Prairie. This report can serve as a major source of hydrologic information to interested citizens and governmental or private organizations. This information can also be used to assess existing and potential water resources management problems. In addition, the results of this reconnaissance can provide information on surface water conditions used to produce a provisional set of regulatory low flow and flood flow criteria. The report includes basin description (lake features, soil types, land cover, topography, hydraulic modifications), hydrology (climatological/rainfall stations and analyses, streamflow stations and discharge analyses, lake stage stations and surface water stage analyses), and water management concerns.

Suphunvorranop, T. and C. C. Thai, 1982. Upper St. Johns Hydrologic Model (USJM) Users Manual, Technical Publication SJ 82-4, St. Johns River Water Management District, Palatka, Florida.

This publication describes the Upper St. Johns River Hydrologic Model (USJM), primarily developed for study of the surface water management system of the Upper St. Johns River Basin. The Upper St. Johns River Basin is situated in east central Florida and covers a drainage area of approximately 2,000 square miles. The model will serve as a useful tool for simulating surface runoff response resulting from changes in hydrologic and hydraulic conditions, as well as changes in operating schedules to support water management plan development in that region. For the purposes of this study, the entire basin south of State Road 46 was divided into seven (7) planning units. The main river was divided into twelve (12) river reaches. This publication describes the model's basic input requirements, capabilities and limitations, program organization, and the methods of runoff and routing computation. An appendix provides the description of input data format. This specific model is not applicable to the Putnam County area, but the model development methodology may be applied to the Lower St. Johns River.

2.6.3 HYDROGEOLOGIC

Szell, G. P., 1993. Aquifer Characteristics in the St. Johns River Water Management District, Florida, Technical Publication SJ 93-1, St. Johns River Water Management District, Palatka, Florida.

This report presents a collection of the results of aquifer performance tests conducted in and close to the St. Johns Water Management District (SJRWMD). The report compiles baseline data that can be used to help predict the responses of the aquifer to pumping in a particular area or to refine the aquifer characteristics used to develop groundwater flow models. The report states its intent to be used as a reference guide to aquifer performance tests. Data contained in this report have been compiled from a number of sources including: published U.S. Geological Survey reports, Florida Bureau of Geology reports, Consumptive Use Permit applications on file with the SJRWMD and other water management districts, and reports published by consulting engineers. Literature available up to 1992 was researched. Tables are presented for individual tests and cite the following general information: county, section/township/range, latitude/longitude, aquifer tested, test performed for/performed by, test date, test length (duration), and reference. Well information includes: well I.D. number, casing length and diameter, open hole length, aquifer penetration, total depth, screened interval, and discharge (gpm). Characteristics presented include: transmissivity, leakance, storage coefficient and analytical method. Users of the report are cautioned to review the individual pump tests and the aquifer parameters obtained before applying these values to their work, as the SJRWMD does not verify that all aquifer test information or interpretation included in the report is accurate or acceptable. The information used to compile this report is available at SJRWMD headquarters in Palatka, Florida.

Toth, D. J., 1993. Volume 1 of the Lower St. Johns River Basin Reconnaissance – Hydrogeology, Technical Publication SJ93-7, St. Johns River Water Management District, Palatka, Florida.

This report is Volume 1 in a series of reconnaissance reports about the Lower St. Johns River Basin which includes parts of nine counties in northeast Florida. The

lower St. Johns River is the northern part of the St. Johns River from the mouth of the Ocklawaha River in Putnam County to the inlet at the Atlantic Ocean in Duval County. The reconnaissance reports compile information and make recommendations to help resource managers identify priority needs for research into and management of the basin. This volume examines the relationship and influence of the interconnection between the lower St. Johns River and the groundwater flow system associated with the river. The mechanisms of this interconnection are spring flow, diffuse upward leakage from the Floridan aquifer system, and seepage from the surficial aquifer system. Groundwater within the lower St. Johns River groundwater flow system resides in the Floridan, intermediate, and surficial aquifer systems. The publication describes the hydrogeology, general direction of groundwater movement, areas of natural recharge and discharge, significant springs, and groundwater chloride, sulfate and total dissolved solids concentrations for different aquifers and regions within the lower St. Johns River Basin.

2.6.4 WATER QUALITY

Paulic, M. et al., June 2002. Basin Status Report - Lower St. Johns, Florida Department of Environmental Protection, Division of Water Resource Management, Tallahassee, Florida.

This report is part of the first phase of implementation of the Florida Department of Environmental Protection's watershed approach for restoring and protecting water resources and addressing total maximum daily load (TMDL) program requirements. The report provides: (1) a preliminary evaluation of the status of water quality and associated ecological health in the Lower St. Johns Basin; (2) identifies potential water quality impairments and water quality monitoring needs; and (3) provides a summary of plans and projects that are planned or underway for the improvement of water quality. Findings are summarized in Chapter 4 of this report. Table 4.1 summarizes the status of assessed and potentially impaired waters in the Lower St. Johns Basin, based on data from the SJRWMD, the **STO**rage and **RET**rieval (STORET) database, and the City of Jacksonville. Table 4.2 summarizes the status of waterbody types in each planning unit for assessed and potentially impaired waters in the basin, based upon water quality data from 1991 through 2000. The report appendices include descriptions of the ecological setting for the Lower St. Johns Basin, a project list for the Lower St. Johns Basin, listings of permitted domestic and industrial facilities discharging to surface waters in the Lower St. Johns Basin, detailed land use summaries, water quality data summaries by planning unit, and estimated external loadings in the Lower St. Johns Basin.

Keller, A. E. and J. D. Schell, Jr., 1993. Lower St. Johns River Basin Reconnaissance Volume 5 – Sediment Characteristics and Quality, Technical Publication SJ 93-6, St. Johns River Water Management District, Palatka, Florida.

This report is Volume 5 in a series of reconnaissance reports about the lower St. Johns River surface water drainage basin. The lower St. Johns River is the northern part of the St. Johns River from the mouth of the Ocklawaha River in Putnam County to the inlet at the Atlantic Ocean in Duval County. Part of the research funded under the Surface Water Improvement and Management Act of 1987, this reconnaissance report was developed to compile information and make recommendations to help resource managers identify priority needs for research into and management of the Lower St. Johns River Basin. The Volume 5 report presents details on the levels and

trends of chemical contaminants present in the bottom sediments. It describes the characteristics and quality of river sediments as well as the processes that affect sediment formation. This volume also provides a review of the published information on levels of toxic chemicals present in the sediment, and provides an evaluation of the potential impact of these chemicals on biota. The report concludes that the sediments of the Lower St. Johns River Basin are high in total organic carbon content, particularly in its tributaries, making it a sink for hydrophobic chemicals. River sediments are reportedly contaminated significantly by a number of different classes of compounds including heavy metals, PCBs, PAHs, and chlorinated pesticides, with the most severe contamination apparently localized between Julington Creek and the Arlington River (mainstream areas with industrial or residential development). Lastly, the report presents recommendations for future research programs to address current informational needs.

2.6.5 GENERAL BASIN

Vergara, B., 1994. Water Supply Needs and Sources Assessment 1994 - St. Johns River Water Management District, Technical Publication SJ 94-7, St. Johns River Water Management District, Palatka, Florida.

The Water Supply Needs and Sources assessment was designed to identify areas in which water resources problems have become critical or are projected to become critical within 20 years (water resource caution areas) and to identify remedial or preventive actions designed to correct or prevent these problems. The 20-year projection period of the assessment extends through the year 2010, with the intent to revise the assessment at 5-year intervals. Four factors were considered in the assessment of water resource problems: (1) impacts to natural systems; (2) impacts to groundwater; (3) impacts to existing legal users of water; and (4) failure to identify an adequate supply source. Water use needs have been inventoried for the year 1990 and are projected to the year 2010 for three categories: (1) public supply; (2) agricultural irrigation; and (3) recreation self-supply. These categories have historically represented roughly three-fourths of the total fresh groundwater use and are expected to increase more than other categories. A database of water use amounts for agricultural and public supply was created and used in the development of numerical groundwater flow models designed to assess the potential impact of future withdrawals. Various regional, sub-regional, and local assessments of the impact to groundwater flow and water quality from existing and projected withdrawals were performed using the models. These models were used to identify water resource caution areas where water resource problems are anticipated to become critical. Nearly all resulting caution areas are based on 2010 water use, however one area located in eastern Putnam County-western St. Johns County is identified as having an existing critical water resource problem, associated with seasonal agricultural groundwater withdrawals.

Robison, C. P., 2004. Middle St. Johns River Minimum Flows and Levels Hydrologic Methods Report, Technical Publication SJ 2004-2, St. Johns River Water Management District, Palatka, Florida.

The purpose of this report is to describe and document the development of the models used in assessing minimum flows and levels for the Middle St. Johns River, which is being considered as a possible alternative water supply source to help meet

the projected future increased demand for water in the SJRWMD. Establishment of minimum flows and levels are necessary to provide initial limits to surface water withdrawals from the Middle St. Johns River (MSJR), with the understanding that other factors may prove more limiting. By analyzing the output from hydrologic models, reasonable management decisions can be made regarding withdrawals. One model developed by the SJRWMD and used for the establishment of minimum flows and levels is the MSJR SSARR model. This model simulates the flow rate of water at different points in the MSJR using historical rainfall, evaporation, and groundwater levels. At the same time, this model simulates stages at selected locations within the model domain, which covers the MSJR from Lake Harney to Lake George. In order to determine stages between the selected locations of the hydrologic model, SJRWMD also developed a one-dimensional water surface profile model using HEC-RAS. The report contains discussion on model selection, calibration criteria, principal modeling assumptions, and results of existing conditions and hypothetical withdrawal scenarios. Modeling results indicate that the three currently-adopted minimum flows and levels are being met on the MSJR under existing conditions. Depending on withdrawal criteria, the report concludes, between 143 to 175 million gallons per day of water are available from the river before the minimum flows and levels would cease to be met.

SJRWMD, 2000. District Water Management Plan, St. Johns River Water Management District, Palatka, Florida.

The SJRWMD is one of five water management districts (WMDs) in the State of Florida. Each WMD is required to prepare district water management plans and update them every five years. This District Water Management Plan (DWMP) represents the first five-year update. The DWMP sets direction for the District's strategic plans, fiscal plans, and other planning efforts. It also serves as a source of information for local governments and others seeking technical information regarding water resource issues. The format of the plan provides a framework to address water resource issues in four areas of responsibility: water supply, flood protection and floodplain management, water quality, and natural systems. Contained within the DWMP are an overview of the District and its natural resources, statement of the mission, goals and policies of the District, district-wide and watershed-specific issues, objectives, strategies and performance measures related to the four areas of responsibility, cooperation strategies for local government partnerships, and procedures for local government and public participation in plan development.

SJRWMD, 2004. District Water Management Plan (11/18/04 Draft), St. Johns River Water Management District, Palatka, Florida.

The SJRWMD is one of five water management districts (WMDs) in the State of Florida. Each WMD is required to prepare district water management plans and update them every five years. This District Water Management Plan (DWMP) represents the draft version of the first draft of the second five-year update, anticipated for release in 2005. The DWMP sets direction for the District's strategic plans, fiscal plans, and other planning efforts. It also serves as a current source of information for local governments and others seeking technical information regarding water resource issues. The format of the plan provides a framework to address water resource issues in four areas of responsibility: water supply, flood protection and floodplain management, water quality, and natural systems. Contained within the

DWMP are an overview of the District and its natural resources, statement of the mission, goals and policies of the District, district-wide and watershed-specific issues, objectives, strategies and performance measures related to the four areas of responsibility, cooperation strategies for local government partnerships, and procedures for local government and public participation in plan development.

2.6.6 ENGINEERING - HYDRAULIC

David B. Smith Engineers, Inc. 1970. Preliminary Engineering Report on the Duval Creek Watershed, David B. Smith Engineers, Inc., Gainesville, Florida.

The Board of County Commissioners of Putnam County authorized the performance of a study of Duval Creek and its tributaries. The study was to be performed in sufficient depth to establish required drainage structure sizes, typical channel sections and profiles, necessary right-of-way widths, and a preliminary cost estimate for construction and right-of-way acquisition for necessary improvements. The study area includes the entire Duval Creek watershed, from its headwaters north of State Road 20 to the St. Johns River swamp, south of the Seaboard Coastline Railroad. The report document includes the design criteria applied to the development of drainage improvements as follows: 1) that primary structures and creek channel sections should be designed to provide waterway openings in accord with Talbot's and Kutter's formulae (for estimating discharge rates to structures), assuming complete development of the watershed to a level equivalent to medium density suburban residential development; 2) that the controlling slope for use in sizing channel sections should be one-half the nominal "straight-line" slope between structures; and 3) that rights-of-way adequate to provide reasonable access for construction and maintenance of the system should be required throughout its length. The report goes on to provide cost estimates for recommended improvements (described in an appendix not transmitted with the report) and assesses the majority of the existing system as inadequate. Potential funding sources are recommended. Recommended capital improvements are based largely on engineering estimates rather than physical data.

Chance, Eng & Denman, Inc. 1983. Duval Creek Drainage Study for Putnam County Board of County Commission, Chance, Eng & Denman, Inc., Gainesville, Florida.

The Board of County Commissioners of Putnam County authorized the performance of this study of Duval Creek and its tributaries for the purpose of recommending solutions to alleviate current erosion problems. The study followed the implementation of some of the recommended flood control solutions from the 1970 Duval Creek Watershed Engineering Report by David B. Smith Engineers, Inc. Significant erosion problems at various structures and along channel reaches had resulted in siltation and blockage of discharge structures. Channel reaches downstream of some structures had experienced bank sloughing which was threatening to undermine adjacent properties. This report presents the findings of data researched, field investigations, established design criteria, evaluation and identification of existing drainage problems, preliminary designs for solutions, conclusions and recommendations. The report focuses on summary descriptions of problems and solutions, but does not contain raw engineering data.

Howard Needles Tammen & Bergendoff, 1988. Devall Branch Drainage Study, Putnam County, Florida. Howard Needles Tammen & Bergendoff, Orlando, Florida

The 1.925 square mile Devall Branch Watershed is located near the center of Putnam County, Florida. The watershed discharges to the St. Johns River and contains a mixture of agricultural, single-family residential and undeveloped areas. Of particular concern are the point of Woods and Magnolia Manor subdivisions, which have experienced frequent nuisance flooding in the years prior to this study. This report describes the results of the drainage study authorized by Putnam County whose intent was to alleviate the existing drainage problems and properly plan for future development within the watershed. The Devall Branch Study included field surveys and investigations, hydrologic and hydraulic analyses, and the evaluation of specific drainage improvement alternatives. Flood discharge and backwater elevation data generated by the FHWA WSPRO model are included in the report to provide useful information for surface water system design of future developments. The report describes the topographic, soils and land use characteristics of the watershed and delineates subbasin boundaries. Hydrologic and hydraulic modeling and methodology for input development is described, although supporting input data are not included in the report.

2.6.7 FUNDING

SJRWMD, 2003. Stormwater Management Projects Cost-Sharing Application Package – Fiscal Year 2004-2005, St. Johns River Water Management District, Palatka, Florida.

The purpose of the cost-sharing application package is to solicit proposals from local governments within the jurisdiction of the SJRWMD's 18-county area for cooperative funding (up to 50%) of stormwater management projects. The priority of the program is to support stormwater management efforts that contribute toward the improvement of water quality by achieving pollutant load reduction goals or total maximum daily load (TMDL) allocations for identified priority pollutants. The SJRWMD may also consider projects that protect or preserve water quality in designated Surface Water Improvement and Management (SWIM) water bodies. The program discourages proposals for routine maintenance, capital improvement construction projects or required mitigation. Qualified applicants include governmental agencies, municipalities, counties, special districts, and other public entities.

2.7 OPERATION AND MAINTENANCE

Information on current operation and maintenance practices is important for the:

- Identification of deficiencies
- Comparison with other operation and maintenance plans
- Formulation of a proposed operation and maintenance plan that does not include the identified deficiencies
- Development of cost for the proposed plan

Information on current operation and maintenance for Putnam County was obtained from the County Maintenance records section of Putnam County. The County did not have a written maintenance protocol but does store a history of maintenance activities in a computer database.

Information concerning drainage-related activity was downloaded by the County for the 5-year period from 2001 to 2005. The information included:

- Annual performance – Consisting of drainage activities, crew hours, and labor costs
- Annual Costs – Consisting of units of measurements (e.g. linear feet of ditch cleaned), number of units, and total costs
- Equipment – Consisting of equipment type and age

In addition, written maintenance protocols were obtained from Hillsborough and Pinellas Counties. The protocols will be used for comparison and to formulate a written protocol for Putnam County. The above listed information will be presented in Section 5 (Operation and Maintenance Considerations).

2.8 HISTORICAL FLOODING AND SEDIMENTATION PROBLEMS

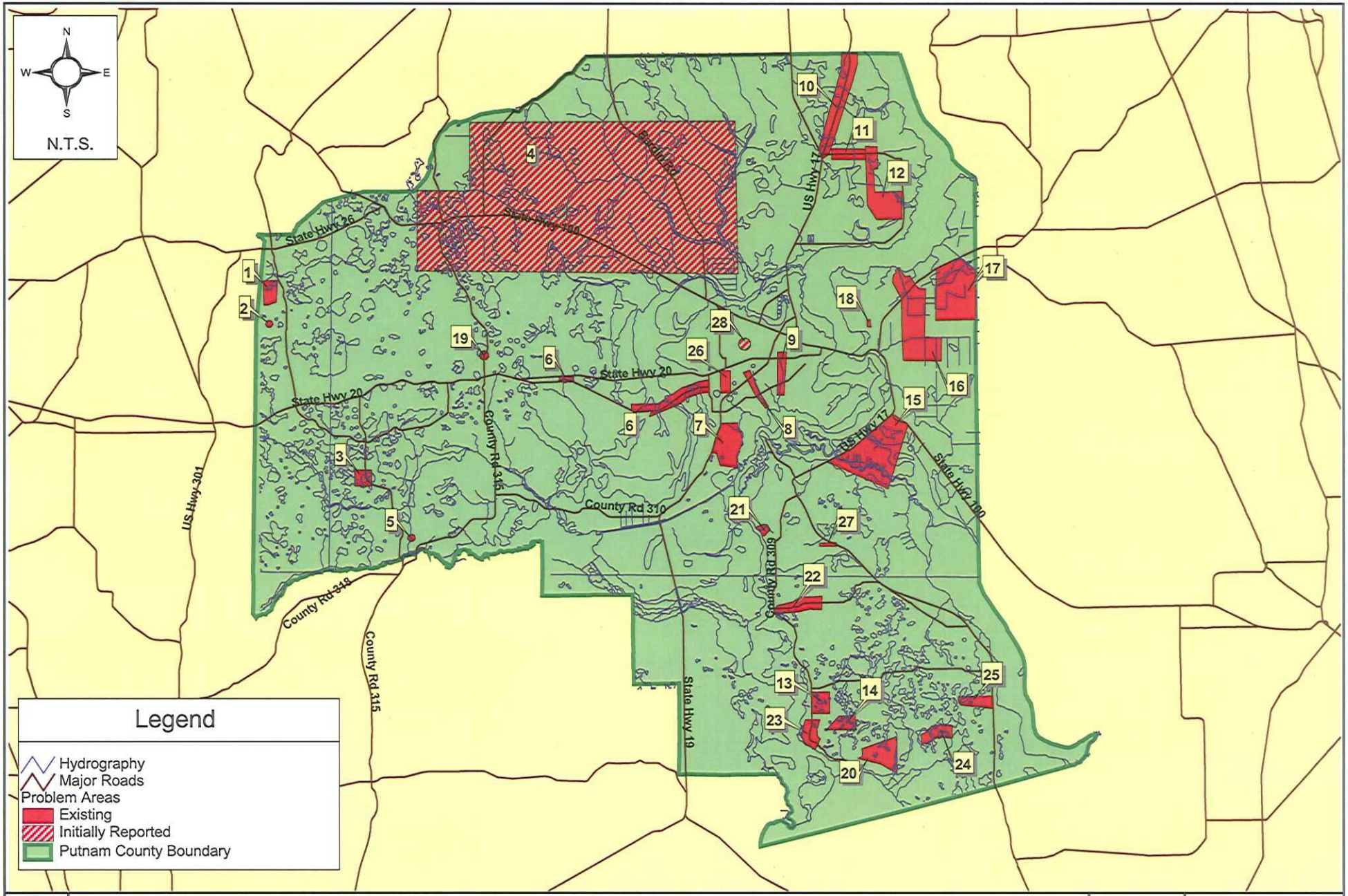
Historical flooding and water quality (primarily sedimentation) problems must be identified to assist in the prioritization of projects for flood relief and sedimentation control. Historical flood data might include anecdotal descriptions of flooding location and frequency, depth of flooding, descriptions of flood damage, high water marks, measured flood stages and flow rates, flood complaint databases and County stormwater maintenance/repair records. Sedimentation problems are generally known by the local maintenance entity. Often the sedimentation issues create a flooding issue.

Historical flooding and sedimentation data for this Master Stormwater Plan was obtained to address two primary objectives:

- Identification of Localized Flooding Areas
- Identification of Drainage Systems with Significant Sediment Contribution

The County, in a meeting on April 16, 2004, identified historic flooding and sedimentation areas based on citizen complaints and maintenance observations. The County provided Ayres Associates with a list of 28 areas and descriptions (Refer to Table 2.8-1). Locations are shown in **Figure 2.8-1**. Both the "Localized Flooding Areas" and "Significant Sediment Contribution" tasks required joint field visits by Ayres Associates and the County maintenance personnel, which are described in Section 7.3.2 of this Master Stormwater Plan.

It should be noted that the County's Roads & Bridge Maintenance Department were able to correct some of these system deficiencies during the course of the Master Stormwater Plan development. As such, those locations are identified and described herein but will be omitted from the priority ranking for the stormwater Capital Improvement Program.



G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Location_Big.apr

Problem Areas

Putnam County Master Stormwater Plan

Figure 2.8-1

AYRES ASSOCIATES

TABLE 2.8-1 FLOODING AND SEDIMENTATION AREAS

Location	Description
1. Bellamy Woods Road	(From Price Road 0.3 miles north on Bellamy Road) Flooding problem
1, 2. Price Road	(From Perry Road east to culvert on Price Road) Road floods in these areas
3. Roops Ditch	Overflow for lakes
4. Florahome Drainage	(Fulton Road at Keystone Road, 309D at Keystone Road, John's Road, Bannerville (dirt) culvert at Coral Farms Road, Bardin drainage included) Florahome drainage district dissolved several years ago; drains a large area of the northwest section of the County.
5. Orange Springs Shortcut	Bridge goes under water during moderate rains
6. Old Gainesville Hwy/Hunter Road	Drainage from timber woods
7. Mondex	(Pinellas Road, Park Avenue, Royal Palm Road) roads go under water with medium rainfall
8. Devall Branch	Maintenance problems, water volume increasing steadily, water backs up during moderate rain
9. Twomile Creek	Volume overload, water backs up during moderate rains
10 West Tocoi	Floods in several places
11. Palmetto Bluff	Water volume problem, road floods
12. Millican Road	Very slow drainage, flooding
13. River Park Subdivision	Road floods during moderate rain
14. Lakeway Drive Drainage	Lakeway Drive drainage
15. San Mateo Road Dunns Creek	Flooding and erosions
16. East Palatka Drainage District	Slow drainage, roads tend to flood
17. Hastings Drainage District (Rector Road)	Drains a large area of farm land
18. East River Road (at Camp Road)	Flooding during moderate rain backs up water to Public Works Department
19. County Road 315 at 64th Street	Road under water during moderate rain
20. Whispering Pines	Low area floods during rain
21. Saratoga Harbor	Drains through small lakes and dams
22. County Road 308 B	Area floods during moderate rain
23. County Road 309	Area floods during moderate rain
24. Harris Fish Camp Road	Flat land area
25. Junction Road	Floods during moderate rain
26. Mud Lake/Monroe Creek	Concern with additional water from SR 20
27. Sisco Road	Road floods during rain, road is lower than surrounding property.
28. Foxwood Outfall	Drains property south of St. Johns Avenue area floods during rain

Field investigations were conducted to provide additional information. The process to investigate the sites included the following tasks:

1. Conducted an assessment by visiting the sites with Area Maintenance Supervisors
2. Took appropriate preliminary measurements (culvert diameters, lengths, channel widths/slopes)
3. Photographed key features
4. Recorded the history of the site as recalled by the area supervisor

To the extent possible, these investigations were verified and refined by discussions with other appropriate County personnel including the County Engineer. In all, twenty-eight (28) sites were investigated.

The information has been used to develop narrative descriptions of problem areas and to develop a project ranking system.

2.9 SUBWATERSHED SELECTION PROTOCOL AND SELECTED SUBWATERSHEDS

The Putnam County Master Stormwater Plan limits the scope of study for some components to specifically selected subwatersheds, the intent being to select hydrologic units at the local level. In order to select subwatersheds for more in-depth study, a selection protocol has been developed, with the concurrence of the County. The procedure used for the selection process in outlined below.

In an effort to make the selection process objective, but also include knowledge acquired about the subwatersheds during the course of the project data collection efforts, an approach has been formulated that sorts and ranks subwatersheds with two different criteria, and then combines them into one rank. The first set of criteria is based on current land use and the assumption that stormwater issues tend to be associated with, and arise out of, human activities such as residential development, commercial/industrial uses and transportation. Using these criteria, each subwatershed in the County was ranked from highest to lowest based principally on percentage of area developed and undeveloped within a subwatershed. The second criteria is based on proximity to, or association with, the original twenty-eight identified "Problem Areas" presented in Section 2.8 as **Table 2.8-1**.

The two ranking criteria, the specific GIS analysis and ranking procedure are described as follows:

1. The following four shape files were obtained and re-projected, where necessary, in the 1983 State Plane coordinate system (NAD 83 State Plane Florida-East):
    a. Land use
    b. USGS drainage basins (subwatersheds)
    c. 5-foot contours
    d. Boundaries for the 28 problem areas

2. Where appropriate, some refinements were made to the USGS subwatershed divides using the 5-foot topographic contours.

3. ArcView was utilized to intersect the subwatershed boundaries with the land use polygons. This provided a database (DBF) file that was used to summarize land use by subwatershed. Portions of subwatersheds that fell outside the County were included, as they remain a hydrologic/hydraulic component of the system that is within the County. The land uses considered in the ranking matrix were Commercial, Agriculture, Industrial, Institutional, Mining, Miscellaneous, Public Facilities, Recreation, Residential, Rivers/Lakes/Streams, Transportation, Silviculture, and Vacant Lands.

4. The DBF file developed in Step 3 was reformatted to summarize the area of each land use for each subwatershed. A formula was then developed to rank each subwatershed by land use, the first of the two different criteria mentioned in the preamble. The ranking matrix put greater weight on developed lands, which typically have infrastructure needs or deficiencies. Uses such as silviculture or undeveloped wilderness lands that require little or no infrastructure were de-emphasized (weighted to one-third that of developed lands). The areas for residential, commercial, transportation, industrial, and institutional land uses were weighted with a value of 3. Mining, miscellaneous, public facilities, recreation, agriculture, rivers/lakes/streams, silviculture, and vacant lands were weighted with a value of 1. An area-weighted rank was calculated for each subwatershed (analogous to a weighted runoff curve number (CN) used in hydrology calculations) using the following formula:

$$\text{Basin Rank} = \frac{3(\sum \text{Area of developed landuses}^{1}) + 1(\sum \text{Area of undeveloped landuses}^{2})}{\sum \text{Area}}$$

[1] Commercial, Transportation, Industrial, Institutional and Residential

[2] Mining, Miscellaneous, Public Facilities, Recreation, Agriculture, Rivers/Lakes/Streams, Silviculture, and Vacant Lands

Because the highest rank had the lowest numerical value, the ranked watersheds were then inverted or recalculated by dividing 1 by the calculated rank.

5. The remainder of the ranking process involved the second set of criteria, knowledge of the subwatershed problem areas, and the combining of the ranks. Subwatersheds that contained one of the 28 "Problem Areas" described in Section 2.8, and which would require aerial mapping, a watershed analysis, or any other type of significant data collection, were assigned the same rank of 1 to 28 previously assigned to the Problem Area in **Table 2.8-1**. This rank superceded the basin ranking described in step 4 above. The final step was to add a value of 29 to those subwatershed rankings that were not superceded by the Problem Area ranking. This step was necessary to force them to rank below 28, but still insure that the relative ranking (the ranking against the other non-superceded watersheds) remained. Finally, although the ranking procedure was objective, some subjectivity was introduced by selecting several other subwatersheds based on engineering judgment and specific knowledge of the local area within the subwatershed. As a result, subwatersheds that were upstream and contributed to a main tributary, or subwatersheds adjacent to subwatersheds selected by the procedure described above, were also included as selected subwatersheds.

Table 2.9-1 presents the ranking computation matrix for the protocol described above. Note that in some cases two or more subwatersheds have the same ranking because a Problem Area crosses subwatershed divides. Also, where multiple problem areas were cited for a subwatershed, multiple ranking entries were made. From the procedure, a total of 47 subwatersheds were selected and recommended for more in-depth evaluation. These subwatersheds are listed in **Table 2.9-2** and illustrated in **Figure 2.9-1.**

TABLE OF CONTENTS

2.0 DATA COLLECTION AND REVIEW....2-1
2.1 Soils....2-1
2.2 Land Use and Land Cover....2-1
2.3 Hydrology....2-5
2.3.1 Watershed Boundary And Planning Units....2-5
2.3.2 Surface Water....2-9
2.3.3 Groundwater....2-13
2.4 Flood Profiles and Floodplain....2-14
2.5 Conveyance System....2-14
2.6 Literature Review....2-15
2.6.1 Meteorologic....2-15
2.6.2 Hydrologic....2-17
2.6.3 Hydrogeologic....2-20
2.6.4 Water Quality....2-21
2.6.5 General Basin....2-22
2.6.6 Engineering - Hydraulic....2-24
2.6.7 Funding....2-25
2.7 Operation and Maintenance....2-25
2.8 Historical Flooding And Sedimentation Problems....2-26
2.9 Subwatershed Selection Protocol And Selected Subwatersheds....2-29
2.10 Field Investigation Program and Drainage Inventory....2-37
2.10.1 Field Reconnaissance Plan....2-37
2.10.2 Development of the Drainage Inventory Coverage....2-38

List of Figures

Figure 2.2-1 Land Use Distribution (source: Putnam County)....2-2
Figure 2.2-2 Land Use Distribution (source: SJRWMD)....2-3
Figure 2.3.1-1 Sample Map for Planning Units, Watersheds, & Drainage Basins....2-7
Figure 2.3.2-1 Location of gage stations in Putnam County with available data....2-9
Figure 2.8-1 Problem Area Locations....2-26
Figure 2.9-1 Selected Subwatersheds....2-30
Figure 2.10-1 ArcMap Project File....2-37

List of Tables

Table 2.3.2-1 Precipitation Gaging Stations in or Near Putnam County....2-10
Table 2.3.2-2 USGS Stream Gaging Stations in Putnam County....2-12
Table 2.3.2-3 USGS Stream Gaging Stations with Water Quality Data in Putnam County2-13
Table 2.8-1 Flooding and Sedimentation Areas....2-27
Table 2.9-1 Subbasin Selection Computational Matrix....2-31
Table 2.9-2 Selected Subwatersheds and Ranking....2-34

TABLE OF CONTENTS

2.0 DATA COLLECTION AND REVIEW 2-1
2.1 Soils 2-1
2.2 Land Use and Land Cover 2-1
2.3 Hydrology 2-5
2.3.1 Watershed Boundary and Planning Units 2-5
2.3.2 Surface Water 2-9
2.3.3 Groundwater 2-13
2.4 Flood Profiles and Floodplain 2-14
2.5 Conveyance System 2-14
2.6 Literature Review 2-15
2.6.1 Meteorologic 2-15
2.6.2 Hydrologic 2-17
2.6.3 Hydrogeologic 2-20
2.6.4 Water Quality 2-21
2.6.5 General Basin 2-22
2.6.6 Engineering - Hydraulic 2-24
2.6.7 Funding 2-25
2.7 Operation and Maintenance 2-25
2.8 Historical Flooding and Sedimentation Problems 2-26
2.9 Subwatershed Selection Protocol and Selected Subwatersheds 2-29
2.10 Field Investigation Program and Drainage Inventory 2-37
2.10.1 Field Reconnaissance Plan 2-37
2.10.2 Development of the Drainage Inventory Coverage 2-38

List of Figures

Figure 2.2-1 Land Use Distribution (source: Putnam County) 2-2
Figure 2.2-2 Land Use Distribution (source: SJRWMD) 2-3
Figure 2.3.1-1 Sample Map for Planning Units, Watersheds, & Drainage Basins 2-7
Figure 2.3.2-1 Location of Gage Stations in Putnam County with Available Data 2-9
Figure 2.8-1 Problem Area Locations 2-26
Figure 2.9-1 Selected Subwatersheds 2-30
Figure 2.10-1 ArcMap Project File 2-37

List of Tables

Table 2.3.2-1 Precipitation Gaging Stations in or Near Putnam County 2-10
Table 2.3.2-2 USGS Stream Gaging Stations in Putnam County 2-12
Table 2.3.2-3 USGS Stream Gaging Stations with Water Quality Data in Putnam County 2-13
Table 2.8-1 Flooding and Sedimentation Areas 2-27
Table 2.9-1 Subbasin Selection Computational Matrix 2-31
Table 2.9-2 Selected Subwatersheds and Ranking 2-34

Land Use Distribution in the Putnam County (Source: Putnam County)

Putnam County
Master Stormwater Plan

Legend:

Watershed Boundary
Land Use:
- Commercial
- General Agriculture
- Industrial
- Institutional
- Mining
- Public Facilities
- Recreation / Open Space
- Residential
- Rivers, Lakes, Streams
- Roads, Railroads, Canals, Utilities
- Silviculture
- Vacant / Undeveloped

N
W E
S

Not To Scale

PUTNAM COUNTY FLORIDA

AYRES ASSOCIATES

Figure 2.2-1

Land Use Distribution in the Putnam County (Source: SJRWMD)

Putnam County
Master Stormwater Plan

Legend:

- Watershed Boundary

Land Use:

- Agriculture
- Barren Land
- Commercial and Services
- Extractive
- Industrial
- Institutional
- Recreational
- Residential, Low Density - Less than 2 dwelling units per acre
- Residential, Med. Density - Two to five dwelling units per acre
- Residential, High Density
- Transportation, Communication, and Utilities
- Upland Forested
- Upland Non-Forested
- Water
- Wetlands

N
W E
S

Not To Scale

PUTNAM COUNTY FLORIDA

AYRES ASSOCIATES

Figure
2.2-2

Land use data were also obtained from the SJRWMD as GIS coverages for review. **Figure 2.2-2** presents the SJRWMD land use coverage. Categories and polygons are similar for some land uses, but differ for others. Some notable differences are listed below:

- The County land use coverage contains blank polygons which appear to primarily represent water bodies and roadways
- The County land use "Recreation/ Open Space" category does not differentiate between open space, water, wetland, and forest cover
- The County land use "Agriculture" does not differentiate between developed agricultural sites and wetland areas within the polygon
- The County land use "Silviculture" does not differentiate between active silviculture sites and wetland areas, rivers and streams, or uncut forested areas within the polygon
- The County land use coverage for "Rivers, Lakes, Streams," although defined, is not frequently utilized
- The SJRWMD land use coverage does not include silviculture at all, but lumps these areas into "Upland Forested" without differentiating between managed or natural areas

Because the SJRWMD category groupings were better suited for hydrologic description, Section 3.0 watershed descriptions utilize this coverage for figure generation and land use statistics. The Putnam County coverages best describe site activity and use and were utilized for all other master planning analyses, including the capital improvement program subwatershed ranking and project prioritization analyses.

Land cover data differ somewhat from land use, in that the emphasis is on vegetative cover, rather than parcel use, ownership or activity. Land cover data for Putnam County have been obtained through the National Wetland Inventory (NWI) mapping files, obtained through the SJRWMD as a GIS coverage for Putnam County. This map provides wetland locations and classification, as defined by the U.S. Fish & Wildlife service. The wetland classification system is hierarchical, with wetlands and deepwater habitats divided among five major systems at the broadest level. The five systems include Marine (open ocean and associated coastline), Estuarine (salt marshes and brackish tidal water), Riverine (rivers, creeks, and streams), Lacustrine (lakes and deep ponds), and Palustrine (shallow ponds, marshes, swamps, sloughs). Systems are further subdivided into subsystems which reflect hydrologic conditions. Below the subsystem is the class which describes the appearance of the wetland in terms of vegetation or substrate. Each class is further subdivided into subclasses; vegetated subclasses are described in terms of life form and substrate subclasses in terms of composition. The classification system also includes modifiers to describe hydrology (water regime), soils, water chemistry (pH, salinity), and special modifiers relating to man's activities (e.g., impounded, partly drained).

Land use and land cover data, described above, may be augmented by digital orthophotos quarter quandrangles (DOQQs), also available through the SJRWMD.

Available land use and land cover data are suitable for stormwater management master planning.

2.3 HYDROLOGY

Hydrologic data characterize contributory watershed area, surface water conditions, and subsurface or groundwater conditions. The following sections describe the collected data and its adequacy for each of these categories.

2.3.1 WATERSHED BOUNDARY AND PLANNING UNITS

In discussing drainage issues, the most basic level is the contributing drainage area, generally expressed as the watershed or basin. For the purposes of this report, the term "watershed" will be used because the term "basin" is often also used in drainage studies to refer to smaller, drainage areas which do not encompass an entire river or creek tributary area. Note that the St. Johns River Water Management District (SJRWMD) generally uses the term "basin," and that term is found in much of the text that follows and in other documents from the SJRWMD referenced throughout this study.

Watershed boundaries in Putnam County and across the water management district were originally delineated by SJRWMD. *Technical Publication SJ97-1, Surface Water Drainage Basin Boundaries, St. Johns River Water Management District: A Reference Guide*, prepared by the SJRWMD in 1997 was developed to document the current districtwide drainage basin data layer, which is part of the SJRWMD geographic information system (GIS) computer library. The following was directly extracted from the Introduction Technical Publication SJ97-1:

"Before 1991, the only districtwide drainage basin data layer was very general; it was composed of 55 subbasins (subbasins are called planning units in this document). Detailed drainage basin boundaries were created only as needed for specific project areas, often at different scales and levels of detail. The data layer this report documents represents the first detailed districtwide drainage basin data."

From the section titled, "Lineage":

"The U.S. Geological Survey (USGS) delineated SJRWMD drainage basin boundaries on 1:24,000-scale 7.5-minute quadrangle (quad) maps and then digitized them. USGS submitted the data to SJRWMD in 1991. The SJRWMD Divisions of Engineering and Environmental Sciences validated the data through quality assurance checks. Staff from these divisions also extensively modified the data in several ways:

- *Boundaries were corrected based on specific site knowledge.*
- *Basins were added based on specific site knowledge.*
- *Important attributes were added.*
- *Many very large basins (along main river channels) were subdivided to make the data more useful.*

Each basin was given a code to indicate if it was unchanged from the original USGS data or if it had been modified. SJRWMD staff will continue to update the boundaries periodically, based on ongoing project work.

The SJRWMD data layer has been incorporated into a statewide drainage basin data layer by the Department of Environmental Protection in Tallahassee. This statewide data will be revised periodically with updates from the five water management districts."

Generally, comprehensive drainage studies are developed for a watershed or drainage basins. For this reason, it was decided that an organizational format must be developed that was based on a watershed level. However, Putnam County contains 31 individual watersheds, which is too large a number to be effectively used as the highest organizational level. Therefore, it was decided to research ways in which the watersheds could be grouped geographically for the purposes of this report. This effort has already been made by the SJRWMD, in the form of Planning Units, or Drainage Planning Units (DPUs), as they will be called in this report. **Figure 2.3.1-1** depicts an example of the Planning Unit, Watershed, and Subwatershed (termed "Drainage Basin" by the SJRWMD) boundaries

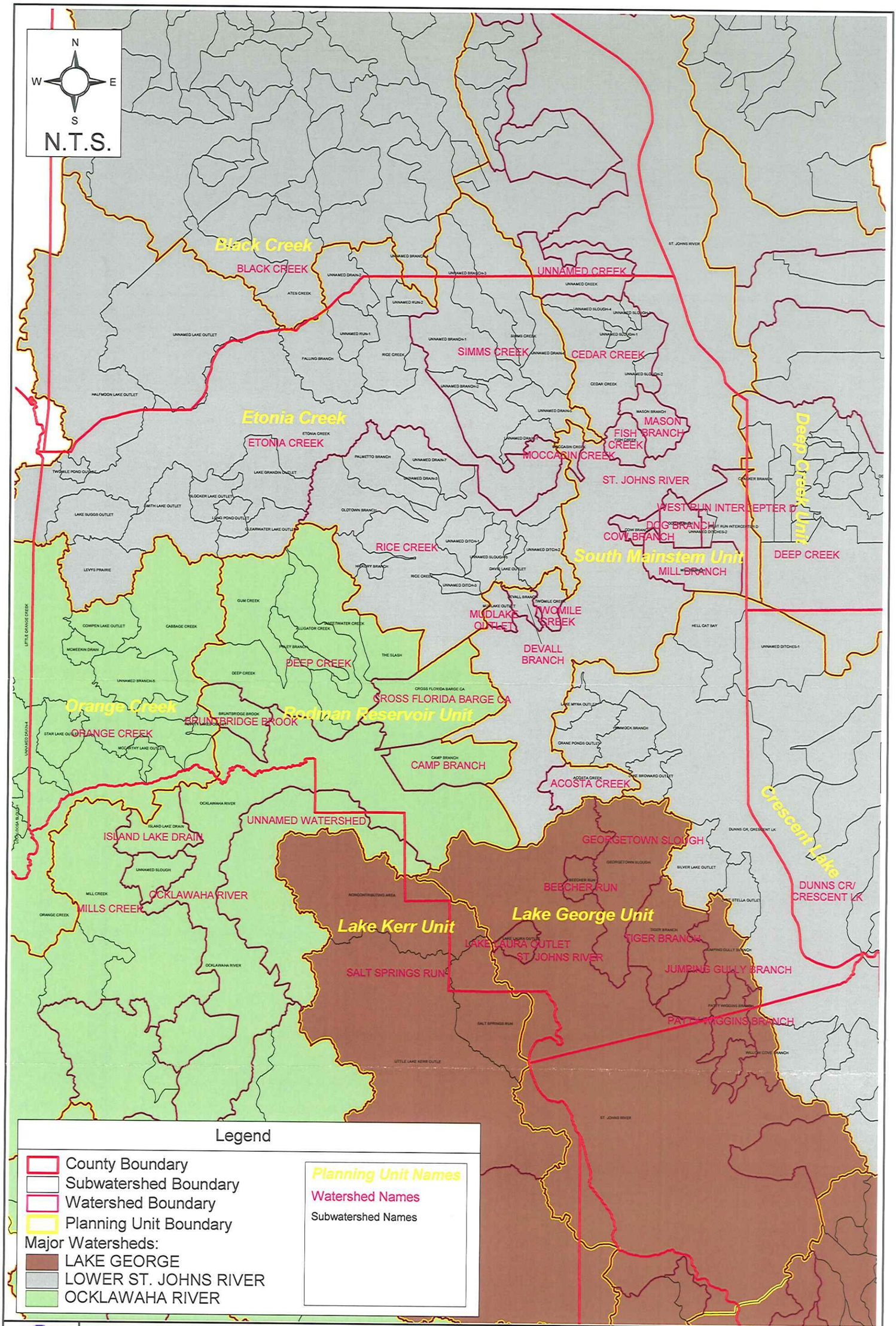
The following information was obtained from Appendix B in the aforementioned *Technical Publication SJ97-1, Surface Water Drainage Basin Boundaries, St. Johns River Water Management District: A Reference Guide*. It defines planning units and describes the rationale for their creation and the rationale for determining their boundaries.

"Planning Unit Definition
Planning units are designations assigned to the USGS drainage basin data layer in order to organize the data in a way that is useful in SJRWMD planning or management efforts. A planning unit is either an individual primary tributary basin or a group of adjacent primary tributary basins with similar characteristics.

- *Large primary tributary basins such as the Econlockhatchee River or Black Creek each comprise a planning unit.*
- *Small, adjacent primary tributary basins were combined into planning units. These aggregate planning units contain the word "Unit" in their name.*

Rationale for Creating Planning Units
SJRWMD staff superimposed the planning unit designations on the USGS data for the following reasons:

- *There are 287 individual primary tributary basins in SJRWMD as delineated by USGS; these are further divided into 1,144 7.5-minute quad basins. When examining regional issues, it is useful to simplify the level of detail.*
- *The USGS delineations needed to be more consistent with the designations that SJRWMD staff had used before the more-detailed data layer was available."*



G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Location_Big.apr

Putnam County - Planning Units, Watersheds, and Subwatersheds

Putnam County Master Stormwater Plan

Figure 2.3.1-1

AYRES ASSOCIATES

Rationale for Determining Planning Unit Boundaries

Planning unit boundaries were created either by designating an entire primary tributary basin as one planning unit or by grouping several primary tributary basins together to form one planning unit. The following list does not represent rules, but rather considerations that in combination led to the planning unit boundaries as they are now.

- *Larger individual primary tributary basins such as the Econlockhatchee River were designated as one planning unit.*

- *Adjacent small primary tributary basins were grouped together into planning units if they were hydrologically similar or had similar management requirements.*

- *Example: Several primary tributary basins were grouped together to form the Deep Creek planning unit (3F) in the Lower St. Johns River Basin. All are dominated by similar soils and land uses (intensive farming) and therefore present similar management problems*

- *Ongoing hydrologic restoration activities were taken into consideration when determining planning unit boundaries in the Upper St. Johns River Basin.*

- *Primary tributary basins were not divided, with the following exception:*

  Some primary tributary basins defined by USGS were divided into different planning units in the Upper St. Johns River Basin. This subdivision was based on current or near-future flow conditions, which were not accurately represented on the USGS 7.5-minute quad maps, the source of the data layer.

- *The St. Mary's River planning unit boundaries were based on the hydrologic subareas reported in A wetland management strategy for the St. Marys River Basin by KBN in 1993 (Special Publication SJ93-SP7. Palatka, Fla.: St. Johns River Water Management District.)*

- *Basin project managers and other knowledgeable staff were consulted.*

  Example: The Upper St. Johns River Basin planning unit boundaries (6A-I) were designated after the authors consulted with staff of the Environmental Sciences Division Upper Basin project, the Engineering Division, and the Resource Management Department, and consulted existing planning maps for the project.

- *SJRWMD historical subbasin designations were mimicked when possible.*

- *Large differences in planning unit sizes were avoided when possible."*

2.3.2 SURFACE WATER

Surface water data include precipitation records, streamflow records, and lake stage records. Limited water quality data were also available. Historic records may be used to:

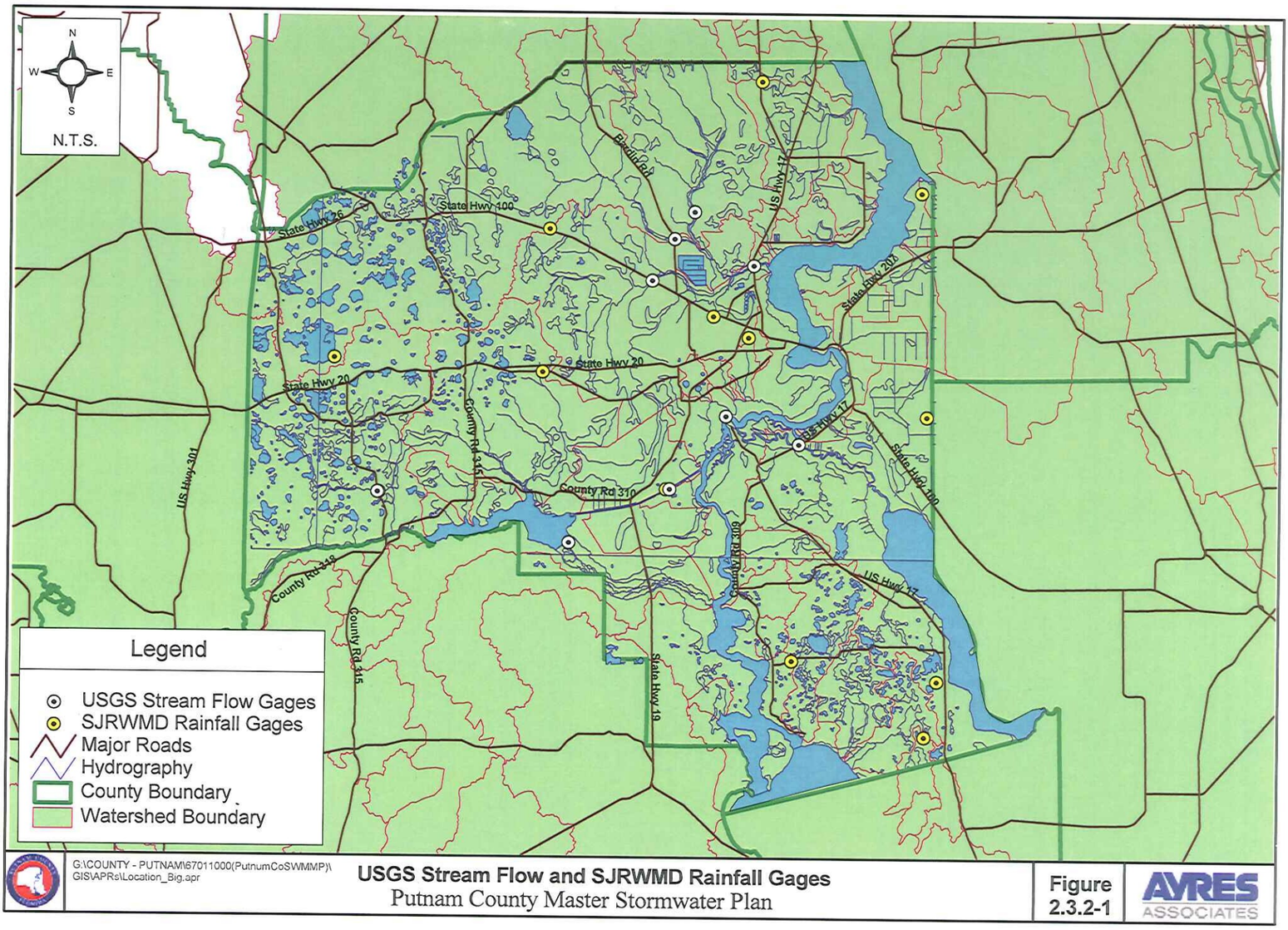
- Characterize stream systems
- Establish average, wet and dry conditions
- Develop rainfall, flood flow or flood stage return frequencies, and
- Calibrate hydrologic and hydraulic simulation models

Figure 2.3.2-1 presents the location of gage stations in Putnam County with available data.

Data collection for precipitation has been limited to identifying precipitation gages within Putnam County boundaries, and determining the available period of record. The majority of available precipitation data are from the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center and gages monitored by the SJRWMD. **Table 2.3.2-1** lists these nine stations, their respective DPU and the associated period of record.

TABLE 2.3.2-1 PRECIPITATION GAGING STATIONS IN OR NEAR PUTNAM COUNTY

DPU	Site Number	Site Name	From	To	Data Set
Crescent Lake	NCDC Co-op 081978	Crescent City, Fl 29°25'N / 81°31'W	1948	Present	- Daily - Monthly
South Mainstem	NCDC Co-op 082915	Federal Point, Fl 29°45'N / 81°32'W	1948	Present	- Daily - Monthly
Etonia Creek	NCDC Co-op 086753	Palatka, Fl 29°39'N / 81°40'W	1948	Present	- Daily - Monthly
Rodman Reservoir	SJRWMD 1697	Buckman Lock 29°32'45"N / 81°43'45"W	2002	Present	- Instantaneous - Daily - Monthly
Etonia Creek	SJRWMD 7010	Chesser Well 29°37'56"N / 81°59'19"W	2002	Present	- Instantaneous - Daily - Monthly
Etonia Creek	SJRWMD 210	District Headquarters 29°39'51"N / 81°41'39"W	1988	Present	- Instantaneous - Daily - Monthly
Etonia Creek	SJRWMD 1784	Etonia East V Road 29°43'21"N / 81°49'21"W	1990	Present	- Instantaneous - Daily - Monthly
Crescent Lake	SJRWMD 243	Hell Cat Bay 29°35'49"N / 81°31'38"W	1994	Present	- Instantaneous - Daily - Monthly
Lake George	SJRWMD 232	Silver Pond Wells 29°22'43"N / 81°31'34"W	1991	Present	- Instantaneous - Daily - Monthly



G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Location_Big.apr

USGS Stream Flow and SJRWMD Rainfall Gages
Putnam County Master Stormwater Plan

Figure 2.3.2-1

AYRES ASSOCIATES

Supplemental rainfall data, including seasonal and frequency analyses, are available from previous studies performed by the SJRWMD and documented in technical publications described in Section 3.2.

Surface water data have come from the United States Geological Survey (USGS) national database at http://waterdata.usgs.gov/nwis/sw. **Table 2.3.2-2** lists the streamflow gaging stations within Putnam County by DPU and identifies the data sets available. No USGS gages for lakes were found within Putnam County. Supplemental data, including lake stages for major water bodies, are available from previous studies performed by the SJRWMD and documented in technical publications described in Section 3.2.

TABLE 2.3.2-2 USGS STREAM GAGING STATIONS IN PUTNAM COUNTY

DPU	Site Number	Site Name	From	To	Data Set
Orange Creek	02243300	Little Orange Creek Near Johnson, Fl	5/24/1995	9/30/1998	- Daily - Peak - Statistics
Rodman Reservoir	02243960	Ocklawaha R. at Rodman Dam Nr Orange Springs, Fl	10/1/1968	9/30/2005	- Daily - Peak - Statistics
	02244032	Cross FL Barge Canal at Buckman Lock Nr Palatka, Fl	11/20/1969	9/30/2004	- Daily - Statistics
South Mainstem	02244040	St. Johns R At Buffalo Bluff Near Satsuma, Fl	10/2/1992	9/30/2005	- Daily - Peak - Statistics
Crescent Lake	02244440	Dunns Creek Near Satsuma, Fl	1/1/1978	9/30/2005	- Daily - Peak - Statistics
Etonia Creek	02244473	Rice Creek Near Springside, Fl	10/1/1973	7/05/2004	- Daily - Peak - Statistics
	02245050	Etonia Creek At Bardin, Fl	10/1/1973	7/06/2004	- Daily - Peak - Statistics
	02245140	Simms Creek Near Bardin, Fl	10/1/1973	7/05/2004	- Daily - Peak - Statistics
	02245200	Rice Creek Near Palatka, Fl	6/1/1995	5/6/1997	- Daily - Statistics

Table 2.3.2-3 lists the streamflow gaging stations within Putnam County with water quality data available.

TABLE 2.3.2-3 USGS STREAM GAGING STATIONS WITH WATER QUALITY DATA IN PUTNAM COUNTY

DPU	Site Number	Site Name	From	To	Data Set
Rodman Reservoir	02243960	Ocklawaha R. at Rodman Dam Nr Orange Springs, Fl	5/07/1970	7/06/1981	- Temperature, Turbidity - Specific Conductance - Color, pH, Hardness - Dissolved Oxygen, BOD - Nitrogen systems - Phosphorus systems - Carbons, Carbonates - TSS, Metals
	02244032	Cross FL Barge Canal at Buckman Lock Nr Palatka, Fl	11/19/1968	5/19/1977	- Temperature, Turbidity - Specific Conductance - Color, pH, Hardness - Dissolved Oxygen, BOD - Nitrogen systems - Phosphorus systems - Carbons, Carbonates - TSS
South Mainstem	02244040	St. Johns R At Buffalo Bluff Near Satsuma, Fl	4/29/1995	5/18/2004	- Temperature - Specific Conductance - Dissolved Oxygen
Crescent Lake	02244440	Dunns Creek Near Satsuma, Fl	12/21/1982	12/21/1982	- Temperature - Specific Conductance
Etonia Creek	02244473	Rice Creek Near Springside, Fl	4/19/1956	9/20/1993	- Temperature - Specific Conductance, Color, pH, Hardness, etc (1 data pt)
	02245050	Etonia Creek At Bardin, Fl	5/24/1965	7/02/1981	- Temperature
	02245140	Simms Creek Near Bardin, Fl	10/10/1973	8/27/1981	- Temperature
	02245200	Rice Creek Near Palatka, Fl	5/12/1967	9/26/1973	- Temperature, Turbidity - Specific Conductance - Color, pH, Hardness - Dissolved Oxygen, BOD - Nitrogen systems - Phosphorus systems - Carbons, Carbonates - TSS, Metals

2.3.3 GROUNDWATER

Groundwater data include subsurface geology and aquifer characteristics, as well as potentiometric and water quality data. Information collected for groundwater is limited to technical publications concerning aquifer characteristic studies and hydrogeologic studies performed by the SJRWMD and described in Section 3.2. These studies provide general

information concerning aquifer transmissivity, leakance, and storage coefficient, underlying geology, springs and natural recharge areas, and groundwater quality.
Additional potentiometric data may be obtained through the SJRWMD Hydrologic Data Services. The SJRWMD publishes a monthly "Hydrologic Conditions Report" using 9 to 10 data wells connected to the Floridan aquifer.

2.4 FLOOD PROFILES AND FLOODPLAIN

Flood profiles and floodplain extent are useful for land management and planning, to minimize development within natural floodplains. Knowledge of predicted flood flows, flood stages and area of inundation is desired for provision of safe location and elevation of habitable structures, reducing potential flood damages, design of public roadways over water conveyances, and design of flood control/flood improvement projects.

Flood profiles and floodplain information for Putnam County are available through the Federal Emergency Management Administration (FEMA) for major conveyances. Floodplain mapping is published on Flood Insurance Rate Maps (FIRM) and has been provided in GIS for all of Putnam County by the SJRWMD.

Description of flood flow derivation and flood profile modeling is presented with graphed flood profiles in the currently effective Flood Insurance Studies (FIS) for Putnam County. Five FIS publications have been obtained for Putnam County, listed below.

- City of Crescent City, Florida, Putnam County – June 1979
- Putnam County, Florida (Unincorporated Areas) – Last Revised August 16, 1994
- Town of Interlachen, Florida, Putnam County – June 1979
- Town of Pomona Park, Florida, Putnam County – June 1979
- City of Palatka, Florida, Putnam County – December 1979

Data are considered adequate for stormwater management master planning associated with the specific lakes and conveyances included in the studies.

Many smaller tributaries, lakes and wetland areas within the County have not yet been studied in sufficient detail to establish 100-year base flood elevations.

2.5 CONVEYANCE SYSTEM

Conveyance system data are used initially to define the drainage network. The drainage network represents the connectivity of the lakes, wetlands, streams and channels and includes predominant flow direction. Detailed information concerning the size, slope and condition of the local conveyances (stream channels, ditches, pipes, inter-connected ponds) is used to prepare simple or complex hydraulic simulation models to support engineering designs for specific storm water management system improvements.

The primary conveyance systems in Putnam County have been identified through hydrography coverages supplied in GIS from both Putnam County and the SJRWMD. According to the metadata, they are based on the Florida Department of Environmental Protection's version of

the U.S. Geological Survey Digital Line Graph (DLG). The DLG represents water and wetland features from USGS 30 by 60 minute quad maps at a 1:100,000 scale. The most complete hydrographic representation of streams and tributaries is found in the SJRWMD "hydro100_line_putnam" shape files. These files lack stream name or lake name identifiers.

Contour data have also been obtained through the SJRWMD, which informs the prediction of flow direction and provides the general floodplain/floodway shape. The five-foot vertical interval for contour data is too course for engineering studies in Florida and will need to be supplemented by field survey or LiDAR before developing flood models for specific watersheds or engineering designs for most flood problem areas.

Limited field reconnaissance, permit document and design plan review has been conducted in historic flood problem areas to obtain local channel and structure dimension data, although no registered field survey has been performed as a part of this stormwater master plan.

The data described above are sufficient to generate a coarse conveyance map for each DPU, but are insufficient to support detailed designs for specific storm water improvements. Without more specific hydraulic data, only conceptual level design based upon engineering assumptions and judgment may be offered.

Additional data collection in the form of field survey, aerial contour mapping, cross section determination for open channels, additional permit document and design plan review, and local storm water management system inventory should be conducted for points of interest, should the County wish to perform detailed design modeling and assessment for selection of flood management projects.

2.6 LITERATURE REVIEW

Numerous reports and technical publications were obtained, primarily in electronic format, pertaining to meteorologic, hydrologic, hydrogeologic, water quality, general basin, engineering-hydraulic, and funding issues associated with the SJRWMD as a whole, the Lower St. Johns River Basin, or specific watersheds within Putnam County. These documents were reviewed to determine whether information would be useful in current characterization of Putnam County watersheds, and for base data in future studies. Documents are grouped by category. A brief synopsis of each document follows.

2.6.1 METEOROLOGIC

Rao, D. V., 1985. The Mean Annual, 10-year, 25-year, and 100-year Flood Profiles for the Upper St. Johns River Under the Existing Conditions, Technical Publication SJ 85-3, St. Johns River Water Management District, Palatka, Florida.

This report presents a collection of computed flood profiles for the St. Johns River at its headwaters near Florida's Turnpike to State Road 46 to be used for determination of flood elevations for any location along the river, within the Upper St. Johns River Flood Valley under the existing conditions. For the "current" basin conditions, synthetic streamflow data have been generated for a period of 35 years (1948-1983) using a continuous hydrologic simulation model coupled with the U.S. Army Corps of Engineers HEC-2 model. Flood flow frequency analyses have been conducted on the annual peak flow data. The mean annual, 10-year, 25-year, and 100-year return frequency flood profiles are computed and presented in this report, along with

descriptions of the general basin conditions and the profile-generation methodology. These profiles are not applicable to the Putnam County area.

Rao, D. V. and D. Clapp, 1986. Rainfall Analysis for Northeast Florida Part I: 24-Hour to 10-Day Maximum Rainfall Data, Technical Publication SJ 86-3, St. Johns River Water Management District, Palatka, Florida.

The SJRWMD recognizes that rainfall data (daily, hourly, monthly) comprise the basic input to several hydrologic and engineering studies, including the design of stormwater management systems, the determination of flood potential under various storm events, and evaluation of water supply and consumptive use issues. The District makes extensive use of rainfall data in its resource management and permitting activities. The rainfall analysis project for Northeast Florida was undertaken to fulfill the needs of the District and to provide the same information to interested agencies and individuals. The project objectives included collection and detailed analyses of rainfall data and the production of a series of reports; each report directed at a specific hydrologic/engineering study goal. This publication represents the first in a six-report series and covers 24-hour to Ten-day maximum rainfall data, gathered from the National Oceanic and Atmospheric Administration (NOAA) and from the Environmental Science Services Administration publications. Data from 1931 through 1983 were utilized. The Part I report presents basic rainfall data, principal rain gage locations, descriptions of data preparation and adjustments, and maximum rainfall evaluation results; but does not include frequency analysis, which is presented in Part VI of the series.

Jenab, S. A., D. V. Rao and D. Clapp, 1986. Rainfall Analysis for Northeast Florida Part II: Summary of Monthly and Annual Rainfall Data, Technical Publication SJ 86-4, St. Johns River Water Management District, Palatka, Florida.

This report is the part of a six-part report series associated with the "Rainfall Analysis for Northeast Florida" project sponsored by the SJRWMD. The objective of the study is to fulfill the rainfall data needs of the District and to provide the same information to interested agencies and individuals. The overall project objectives included collection and detailed analyses of rainfall data and the production of a series of reports; each report directed at a specific hydrologic/engineering study goal. This publication represents the second in a six-part series and provides a compilation of monthly and annual rainfall data for the long-term gaging stations located within and close to the SJRWMD boundaries. The data will be subsequently used in other analyses, e.g., computing seasonal rainfall data, conducting frequency analyses of maximum and minimum seasonal rainfall, etc. Data were gathered from the National Oceanic and Atmospheric Administration (NOAA) and from the Environmental Science Services Administration publications and utilized 43 principal rain gage stations. The Part II report presents basic rainfall data, principal rain gage locations, descriptions of data preparation and methods for estimating missing data, and historical annual and monthly totals for the 43 principal stations. Distribution of the annual "normal" rainfall for Northeast Florida is also presented as an isohyetal map.

Rao, D. V., 1991. 24-Hour Rainfall Distribution for Surface Water Basins within the St. Johns River Water Management District, Northeast Florida, Technical Publication SJ 91-3, St. Johns River Water Management District, Palatka, Florida.

This report presents rainfall distributions for specific surface water drainage basins in the District for the convenience of MSSW (Management and Storage of Surface Waters) permit applicants/ consulting engineers, and other users. The MSSW rules of the St. Johns River Water Management District apply a 'peak discharge criterion' in the evaluation of permit applications for land developments that interfere with natural drainage, storage, recharge, and conveyance of water. According to this criterion, the drainage systems of these developments should be designed and operated so that the post-development peak rate of discharge (from the developed area) would not exceed the predevelopment peak rate of discharge. Peak discharges for a drainage basin are often calculated by rainfall-runoff models using hypothetical or synthetic storm data. Two basic components of a hypothetical storm are the total rainfall amount during the storm event (duration) and the time distribution of rainfall (rainfall distribution). Generalized rainfall distributions, developed by the Soil Conservation Service of the U.S. Department of Agriculture, have been extensively used by agencies and consulting engineers throughout the United States for calculating design or peak discharges. Generalized distributions, however, lack accuracy because they are based on the rainfall magnitude and patterns occurring over a large region. Distributions developed for a specific drainage basin or site-specific distributions predict peak discharges more accurately. Procedures for developing site-specific hypothetical storm distributions were described in development of site-specific hypothetical storm distributions (Rao 1988).

2.6.2 HYDROLOGIC

Suphunvorranop, T., 1985. A Guide to SCS Runoff Procedures, Technical Publication SJ 85-5, St. Johns River Water Management District, Palatka, Florida.

This report was developed as a practical guidance document for hydrologists and engineers and contains discussions of the SCS runoff procedure, including the curve number and the unit hydrograph methods. Detailed discussion is provided on the methods of estimating curve numbers (CN), basin time-of-concentration (Tc), and peak rate factors (K') for different hydrologic conditions. The method for constructing a unit hydrograph for a given peak rate factor is also described. The report includes example problems illustrating the effects of methods used in estimating CN, Tc, and K' on runoff hydrographs. The report recommends use of the effective impervious area method for CN estimates, and the use of the Agricultural Research Service method for basins where soil storage is affected by water table. It further recommends the SCS velocity method for basin Tc estimation and states that K' can be determined either from the proportion of area under the rising limb of the time-area curve or by using the adjustment factor described within the report to account for swampy and ponding areas.

Adamus, C., D. Clapp and S. Brown, 1997. Surface Water Drainage Basin Boundaries – St. Johns River Water Management District: A Reference Guide, Technical Publication SJ97-1, St. Johns River Water Management District, Palatka, Florida.

One of the most important pieces of information the SJRWMD uses for surface water management is drainage basin boundaries. This report documents the 1997 district-wide drainage basin data layer, which is part of the geographic information systems (GIS) computer library. Maps depict the basin boundaries, and tables list descriptive information. The data layer this report documents represents the first detailed district-

wide drainage basin data. Drainage subbasins are termed as planning units and vary in size from 69 to 1,144 acres. Superimposed on these data is an organizational scheme that groups the data into larger units (major basin), thus making it useful for projects with small scope and for projects having a more regional focus. Drainage layer documentation includes description of lineage, sources, and terminology. The SJRWMD data layer has been incorporated into a statewide drainage basin data layer by the Florida department of Environmental Protection and will be periodically revised.

Yobbi, D. K. and G. C. Chappell, 1979. Summary of the Hydrology of the Upper Etonia Creek Basin, Technical Publication SJ 79-5, St. Johns River Water Management District, Palatka, Florida.

This report presents the findings and recommendations of a study, jointly sponsored by the SJRWMD and the USGS, of the hydrology of the 165 square-mile Upper Etonia Creek area. The study was primarily undertaken to evaluate recharge, an important water resource issue. During the period from December 1974 through July 1975, measuring points were established and wells within the project area were identified. Data collection began in the period from July 1975, continuing through December 1976, during which staff gages were installed and read on selected lakes, water level recorders were installed and read on selected wells and surface water bodies, and periodic discharge measurements were made on Upper Etonia Creek and its tributaries. Rainfall data from the national Oceanic and Atmospheric Administration (NOAA) stations nearest to the project area were supplemented by three installed rain gages to complete the monitoring network. Rainfall, evaporation estimates, groundwater levels, lake stages, stream discharges, and drainage areas were measured or computed. This report presents the most significant findings of the investigation, which are summarized as follows: (1) a correlation exists between lake stages and rainfall; (2) a general decline in lake levels was noted during the period of study (1975-1976) which correlated to a period of below normal rainfall; (3) precipitation, evapotranspiration and stream runoff for 1976 were determined to be 47.98 inches, 34.15 inches, and 0.81 inches, respectively; and (4) net recharge to the Floridan aquifer for 1976 was estimated to be 16.82 inches. The report recommends that the Upper Etonia Creek recharge area be protected from pollution of potential recharge; that adequate surface area be maintained for seepage; that withdrawals of water be limited to avoid detrimental effects on downgradient uses during periods of drought; and that a monitoring program (described in the report) be implemented.

Rao, D. V., 1986. Magnitude and Frequency of Flood Discharges in Northeast Florida, Technical Publication SJ 86-2, St. Johns River Water Management District, Palatka, Florida.

This publication presents data on past floods and highest reported flood elevation recorded for surface waters in the SJRWMD area of regulatory jurisdiction. The SJRWMD-regulated surface waters include a major portion of the St. Marys River Basin, all of the Nassau and St. Johns River Basins, and several coastal drainage basins. Data from 68 recording sites with streamflow records of five or more years are presented. For 62 of these sites which have ten or more years of data, flood flow frequency analyses have been performed and peak flow estimates provided for return periods, T= 5 yr, 10 yr, 25 yr, 50 yr, 100 yr, and 500 yr. Regional regression models have been developed for computing approximate peak flows at ungaged sites. This

information will be useful for determining expected flood elevations, project evaluation, and establishing predevelopment discharges in connection with District surface water and environmental resource permitting.

Bergman, M. J., 1992. Volume 2 of the Lower St. Johns River Basin Reconnaissance – Surface Water Hydrology, Technical Publication SJ 92-1, St. Johns River Water Management District, Palatka, Florida.

This report is Volume 2 in a series of reconnaissance reports about the Lower St. Johns River Basin which includes parts of nine counties in northeast Florida. The lower St. Johns River is the northern part of the St. Johns River from the mouth of the Ocklawaha River in Putnam County to the inlet at the Atlantic Ocean in Duval County. The reconnaissance reports compile information and make recommendations to help resource managers identify priority needs for research into and management of the basin. This volume gives an overview of the surface water system and the existing rainfall and streamflow monitoring networks in the lower St. Johns River Basin. The report describes the basin in terms of physiography, soils, climate and tributary basins; presents precipitation, streamflow, evapotranspiration data, and also describes significant hydraulic structures and historic flooding; and discusses rainfall-runoff simulation and streamflow analysis. The report presents recommendations for additional monitoring gages in several basins, development of additional hydrologic simulation models outside Duval County, and development of a basin-wide GIS for hydrologic data and stream cross-section data. Also recommended are investigations into water quality and quantity data from monitoring stations, development of stochastic models for short-term and long-term forecasting, development and use of lake circulation models to supplement the analysis of basin hydrology, and determination of the transport and fate of discharges and pollutants to the main stem of the river using hydrodynamic models.

Adkins, M. and D. V. Rao, 1995. A Surface Water Hydrologic Reconnaissance, Upper Orange Creek Basin, North Central Florida, Technical Publication SJ95-4, St. Johns River Water Management District, Palatka, Florida.

The primary objective of this study is to produce a comprehensive presentation of the surface water hydrology of the 399 mi^2 Upper Orange Creek basin, located immediately west of Putnam County, using existing data. Existing literature was reviewed and existing data were inventoried to summarize and document available hydrologic information on Orange, Lochloosa, and Newnans lakes and Paynes Prairie. This report can serve as a major source of hydrologic information to interested citizens and governmental or private organizations. This information can also be used to assess existing and potential water resources management problems. In addition, the results of this reconnaissance can provide information on surface water conditions used to produce a provisional set of regulatory low flow and flood flow criteria. The report includes basin description (lake features, soil types, land cover, topography, hydraulic modifications), hydrology (climatological/rainfall stations and analyses, streamflow stations and discharge analyses, lake stage stations and surface water stage analyses), and water management concerns.

Suphunvorranop, T. and C. C. Thai, 1982. Upper St. Johns Hydrologic Model (USJM) Users Manual, Technical Publication SJ 82-4, St. Johns River Water Management District, Palatka, Florida.

This publication describes the Upper St. Johns River Hydrologic Model (USJM), primarily developed for study of the surface water management system of the Upper St. Johns River Basin. The Upper St. Johns River Basin is situated in east central Florida and covers a drainage area of approximately 2,000 square miles. The model will serve as a useful tool for simulating surface runoff response resulting from changes in hydrologic and hydraulic conditions, as well as changes in operating schedules to support water management plan development in that region. For the purposes of this study, the entire basin south of State Road 46 was divided into seven (7) planning units. The main river was divided into twelve (12) river reaches. This publication describes the model's basic input requirements, capabilities and limitations, program organization, and the methods of runoff and routing computation. An appendix provides the description of input data format. This specific model is not applicable to the Putnam County area, but the model development methodology may be applied to the Lower St. Johns River.

2.6.3 HYDROGEOLOGIC

Szell, G. P., 1993. Aquifer Characteristics in the St. Johns River Water Management District, Florida, Technical Publication SJ 93-1, St. Johns River Water Management District, Palatka, Florida.

This report presents a collection of the results of aquifer performance tests conducted in and close to the St. Johns Water Management District (SJRWMD). The report compiles baseline data that can be used to help predict the responses of the aquifer to pumping in a particular area or to refine the aquifer characteristics used to develop groundwater flow models. The report states its intent to be used as a reference guide to aquifer performance tests. Data contained in this report have been compiled from a number of sources including: published U.S. Geological Survey reports, Florida Bureau of Geology reports, Consumptive Use Permit applications on file with the SJRWMD and other water management districts, and reports published by consulting engineers. Literature available up to 1992 was researched. Tables are presented for individual tests and cite the following general information: county, section/township/range, latitude/longitude, aquifer tested, test performed for/performed by, test date, test length (duration), and reference. Well information includes: well I.D. number, casing length and diameter, open hole length, aquifer penetration, total depth, screened interval, and discharge (gpm). Characteristics presented include: transmissivity, leakance, storage coefficient and analytical method. Users of the report are cautioned to review the individual pump tests and the aquifer parameters obtained before applying these values to their work, as the SJRWMD does not verify that all aquifer test information or interpretation included in the report is accurate or acceptable. The information used to compile this report is available at SJRWMD headquarters in Palatka, Florida.

Toth, D. J., 1993. Volume 1 of the Lower St. Johns River Basin Reconnaissance – Hydrogeology, Technical Publication SJ93-7, St. Johns River Water Management District, Palatka, Florida.

This report is Volume 1 in a series of reconnaissance reports about the Lower St. Johns River Basin which includes parts of nine counties in northeast Florida. The

lower St. Johns River is the northern part of the St. Johns River from the mouth of the Ocklawaha River in Putnam County to the inlet at the Atlantic Ocean in Duval County. The reconnaissance reports compile information and make recommendations to help resource managers identify priority needs for research into and management of the basin. This volume examines the relationship and influence of the interconnection between the lower St. Johns River and the groundwater flow system associated with the river. The mechanisms of this interconnection are spring flow, diffuse upward leakage from the Floridan aquifer system, and seepage from the surficial aquifer system. Groundwater within the lower St. Johns River groundwater flow system resides in the Floridan, intermediate, and surficial aquifer systems. The publication describes the hydrogeology, general direction of groundwater movement, areas of natural recharge and discharge, significant springs, and groundwater chloride, sulfate and total dissolved solids concentrations for different aquifers and regions within the lower St. Johns River Basin.

2.6.4 WATER QUALITY

Paulic, M. et al., June 2002. Basin Status Report - Lower St. Johns, Florida Department of Environmental Protection, Division of Water Resource Management, Tallahassee, Florida.

This report is part of the first phase of implementation of the Florida Department of Environmental Protection's watershed approach for restoring and protecting water resources and addressing total maximum daily load (TMDL) program requirements. The report provides: (1) a preliminary evaluation of the status of water quality and associated ecological health in the Lower St. Johns Basin; (2) identifies potential water quality impairments and water quality monitoring needs; and (3) provides a summary of plans and projects that are planned or underway for the improvement of water quality. Findings are summarized in Chapter 4 of this report. Table 4.1 summarizes the status of assessed and potentially impaired waters in the Lower St. Johns Basin, based on data from the SJRWMD, the **STO**rage and **RET**rieval (STORET) database, and the City of Jacksonville. Table 4.2 summarizes the status of waterbody types in each planning unit for assessed and potentially impaired waters in the basin, based upon water quality data from 1991 through 2000. The report appendices include descriptions of the ecological setting for the Lower St. Johns Basin, a project list for the Lower St. Johns Basin, listings of permitted domestic and industrial facilities discharging to surface waters in the Lower St. Johns Basin, detailed land use summaries, water quality data summaries by planning unit, and estimated external loadings in the Lower St. Johns Basin.

Keller, A. E. and J. D. Schell, Jr., 1993. Lower St. Johns River Basin Reconnaissance Volume 5 – Sediment Characteristics and Quality, Technical Publication SJ 93-6, St. Johns River Water Management District, Palatka, Florida.

This report is Volume 5 in a series of reconnaissance reports about the lower St. Johns River surface water drainage basin. The lower St. Johns River is the northern part of the St. Johns River from the mouth of the Ocklawaha River in Putnam County to the inlet at the Atlantic Ocean in Duval County. Part of the research funded under the Surface Water Improvement and Management Act of 1987, this reconnaissance report was developed to compile information and make recommendations to help resource managers identify priority needs for research into and management of the Lower St. Johns River Basin. The Volume 5 report presents details on the levels and

trends of chemical contaminants present in the bottom sediments. It describes the characteristics and quality of river sediments as well as the processes that affect sediment formation. This volume also provides a review of the published information on levels of toxic chemicals present in the sediment, and provides an evaluation of the potential impact of these chemicals on biota. The report concludes that the sediments of the Lower St. Johns River Basin are high in total organic carbon content, particularly in its tributaries, making it a sink for hydrophobic chemicals. River sediments are reportedly contaminated significantly by a number of different classes of compounds including heavy metals, PCBs, PAHs, and chlorinated pesticides, with the most severe contamination apparently localized between Julington Creek and the Arlington River (mainstream areas with industrial or residential development). Lastly, the report presents recommendations for future research programs to address current informational needs.

2.6.5 GENERAL BASIN

Vergara, B., 1994. Water Supply Needs and Sources Assessment 1994 - St. Johns River Water Management District, Technical Publication SJ 94-7, St. Johns River Water Management District, Palatka, Florida.

The Water Supply Needs and Sources assessment was designed to identify areas in which water resources problems have become critical or are projected to become critical within 20 years (water resource caution areas) and to identify remedial or preventive actions designed to correct or prevent these problems. The 20-year projection period of the assessment extends through the year 2010, with the intent to revise the assessment at 5-year intervals. Four factors were considered in the assessment of water resource problems: (1) impacts to natural systems; (2) impacts to groundwater; (3) impacts to existing legal users of water; and (4) failure to identify an adequate supply source. Water use needs have been inventoried for the year 1990 and are projected to the year 2010 for three categories: (1) public supply; (2) agricultural irrigation; and (3) recreation self-supply. These categories have historically represented roughly three-fourths of the total fresh groundwater use and are expected to increase more than other categories. A database of water use amounts for agricultural and public supply was created and used in the development of numerical groundwater flow models designed to assess the potential impact of future withdrawals. Various regional, sub-regional, and local assessments of the impact to groundwater flow and water quality from existing and projected withdrawals were performed using the models. These models were used to identify water resource caution areas where water resource problems are anticipated to become critical. Nearly all resulting caution areas are based on 2010 water use, however one area located in eastern Putnam County-western St. Johns County is identified as having an existing critical water resource problem, associated with seasonal agricultural groundwater withdrawals.

Robison, C. P., 2004. Middle St. Johns River Minimum Flows and Levels Hydrologic Methods Report, Technical Publication SJ 2004-2, St. Johns River Water Management District, Palatka, Florida.

The purpose of this report is to describe and document the development of the models used in assessing minimum flows and levels for the Middle St. Johns River, which is being considered as a possible alternative water supply source to help meet

the projected future increased demand for water in the SJRWMD. Establishment of minimum flows and levels are necessary to provide initial limits to surface water withdrawals from the Middle St. Johns River (MSJR), with the understanding that other factors may prove more limiting. By analyzing the output from hydrologic models, reasonable management decisions can be made regarding withdrawals. One model developed by the SJRWMD and used for the establishment of minimum flows and levels is the MSJR SSARR model. This model simulates the flow rate of water at different points in the MSJR using historical rainfall, evaporation, and groundwater levels. At the same time, this model simulates stages at selected locations within the model domain, which covers the MSJR from Lake Harney to Lake George. In order to determine stages between the selected locations of the hydrologic model, SJRWMD also developed a one-dimensional water surface profile model using HEC-RAS. The report contains discussion on model selection, calibration criteria, principal modeling assumptions, and results of existing conditions and hypothetical withdrawal scenarios. Modeling results indicate that the three currently-adopted minimum flows and levels are being met on the MSJR under existing conditions. Depending on withdrawal criteria, the report concludes, between 143 to 175 million gallons per day of water are available from the river before the minimum flows and levels would cease to be met.

SJRWMD, 2000. District Water Management Plan, St. Johns River Water Management District, Palatka, Florida.

The SJRWMD is one of five water management districts (WMDs) in the State of Florida. Each WMD is required to prepare district water management plans and update them every five years. This District Water Management Plan (DWMP) represents the first five-year update. The DWMP sets direction for the District's strategic plans, fiscal plans, and other planning efforts. It also serves as a source of information for local governments and others seeking technical information regarding water resource issues. The format of the plan provides a framework to address water resource issues in four areas of responsibility: water supply, flood protection and floodplain management, water quality, and natural systems. Contained within the DWMP are an overview of the District and its natural resources, statement of the mission, goals and policies of the District, district-wide and watershed-specific issues, objectives, strategies and performance measures related to the four areas of responsibility, cooperation strategies for local government partnerships, and procedures for local government and public participation in plan development.

SJRWMD, 2004. District Water Management Plan (11/18/04 Draft), St. Johns River Water Management District, Palatka, Florida.

The SJRWMD is one of five water management districts (WMDs) in the State of Florida. Each WMD is required to prepare district water management plans and update them every five years. This District Water Management Plan (DWMP) represents the draft version of the first draft of the second five-year update, anticipated for release in 2005. The DWMP sets direction for the District's strategic plans, fiscal plans, and other planning efforts. It also serves as a current source of information for local governments and others seeking technical information regarding water resource issues. The format of the plan provides a framework to address water resource issues in four areas of responsibility: water supply, flood protection and floodplain management, water quality, and natural systems. Contained within the

DWMP are an overview of the District and its natural resources, statement of the mission, goals and policies of the District, district-wide and watershed-specific issues, objectives, strategies and performance measures related to the four areas of responsibility, cooperation strategies for local government partnerships, and procedures for local government and public participation in plan development.

2.6.6 ENGINEERING - HYDRAULIC

David B. Smith Engineers, Inc. 1970. Preliminary Engineering Report on the Duval Creek Watershed, David B. Smith Engineers, Inc., Gainesville, Florida.

The Board of County Commissioners of Putnam County authorized the performance of a study of Duval Creek and its tributaries. The study was to be performed in sufficient depth to establish required drainage structure sizes, typical channel sections and profiles, necessary right-of-way widths, and a preliminary cost estimate for construction and right-of-way acquisition for necessary improvements. The study area includes the entire Duval Creek watershed, from its headwaters north of State Road 20 to the St. Johns River swamp, south of the Seaboard Coastline Railroad. The report document includes the design criteria applied to the development of drainage improvements as follows: 1) that primary structures and creek channel sections should be designed to provide waterway openings in accord with Talbot's and Kutter's formulae (for estimating discharge rates to structures), assuming complete development of the watershed to a level equivalent to medium density suburban residential development; 2) that the controlling slope for use in sizing channel sections should be one-half the nominal "straight-line" slope between structures; and 3) that rights-of-way adequate to provide reasonable access for construction and maintenance of the system should be required throughout its length. The report goes on to provide cost estimates for recommended improvements (described in an appendix not transmitted with the report) and assesses the majority of the existing system as inadequate. Potential funding sources are recommended. Recommended capital improvements are based largely on engineering estimates rather than physical data.

Chance, Eng & Denman, Inc. 1983. Duval Creek Drainage Study for Putnam County Board of County Commission, Chance, Eng & Denman, Inc., Gainesville, Florida.

The Board of County Commissioners of Putnam County authorized the performance of this study of Duval Creek and its tributaries for the purpose of recommending solutions to alleviate current erosion problems. The study followed the implementation of some of the recommended flood control solutions from the 1970 Duval Creek Watershed Engineering Report by David B. Smith Engineers, Inc. Significant erosion problems at various structures and along channel reaches had resulted in siltation and blockage of discharge structures. Channel reaches downstream of some structures had experienced bank sloughing which was threatening to undermine adjacent properties. This report presents the findings of data researched, field investigations, established design criteria, evaluation and identification of existing drainage problems, preliminary designs for solutions, conclusions and recommendations. The report focuses on summary descriptions of problems and solutions, but does not contain raw engineering data.

Howard Needles Tammen & Bergendoff, 1988. Devall Branch Drainage Study, Putnam County, Florida. Howard Needles Tammen & Bergendoff, Orlando, Florida

The 1.925 square mile Devall Branch Watershed is located near the center of Putnam County, Florida. The watershed discharges to the St. Johns River and contains a mixture of agricultural, single-family residential and undeveloped areas. Of particular concern are the point of Woods and Magnolia Manor subdivisions, which have experienced frequent nuisance flooding in the years prior to this study. This report describes the results of the drainage study authorized by Putnam County whose intent was to alleviate the existing drainage problems and properly plan for future development within the watershed. The Devall Branch Study included field surveys and investigations, hydrologic and hydraulic analyses, and the evaluation of specific drainage improvement alternatives. Flood discharge and backwater elevation data generated by the FHWA WSPRO model are included in the report to provide useful information for surface water system design of future developments. The report describes the topographic, soils and land use characteristics of the watershed and delineates subbasin boundaries. Hydrologic and hydraulic modeling and methodology for input development is described, although supporting input data are not included in the report.

2.6.7 FUNDING

SJRWMD, 2003. Stormwater Management Projects Cost-Sharing Application Package – Fiscal Year 2004-2005, St. Johns River Water Management District, Palatka, Florida.

The purpose of the cost-sharing application package is to solicit proposals from local governments within the jurisdiction of the SJRWMD's 18-county area for cooperative funding (up to 50%) of stormwater management projects. The priority of the program is to support stormwater management efforts that contribute toward the improvement of water quality by achieving pollutant load reduction goals or total maximum daily load (TMDL) allocations for identified priority pollutants. The SJRWMD may also consider projects that protect or preserve water quality in designated Surface Water Improvement and Management (SWIM) water bodies. The program discourages proposals for routine maintenance, capital improvement construction projects or required mitigation. Qualified applicants include governmental agencies, municipalities, counties, special districts, and other public entities.

2.7 OPERATION AND MAINTENANCE

Information on current operation and maintenance practices is important for the:

- Identification of deficiencies
- Comparison with other operation and maintenance plans
- Formulation of a proposed operation and maintenance plan that does not include the identified deficiencies
- Development of cost for the proposed plan

Information on current operation and maintenance for Putnam County was obtained from the County Maintenance records section of Putnam County. The County did not have a written maintenance protocol but does store a history of maintenance activities in a computer database.

Information concerning drainage-related activity was downloaded by the County for the 5-year period from 2001 to 2005. The information included:

- Annual performance – Consisting of drainage activities, crew hours, and labor costs
- Annual Costs – Consisting of units of measurements (e.g. linear feet of ditch cleaned), number of units, and total costs
- Equipment – Consisting of equipment type and age

In addition, written maintenance protocols were obtained from Hillsborough and Pinellas Counties. The protocols will be used for comparison and to formulate a written protocol for Putnam County. The above listed information will be presented in Section 5 (Operation and Maintenance Considerations).

2.8 HISTORICAL FLOODING AND SEDIMENTATION PROBLEMS

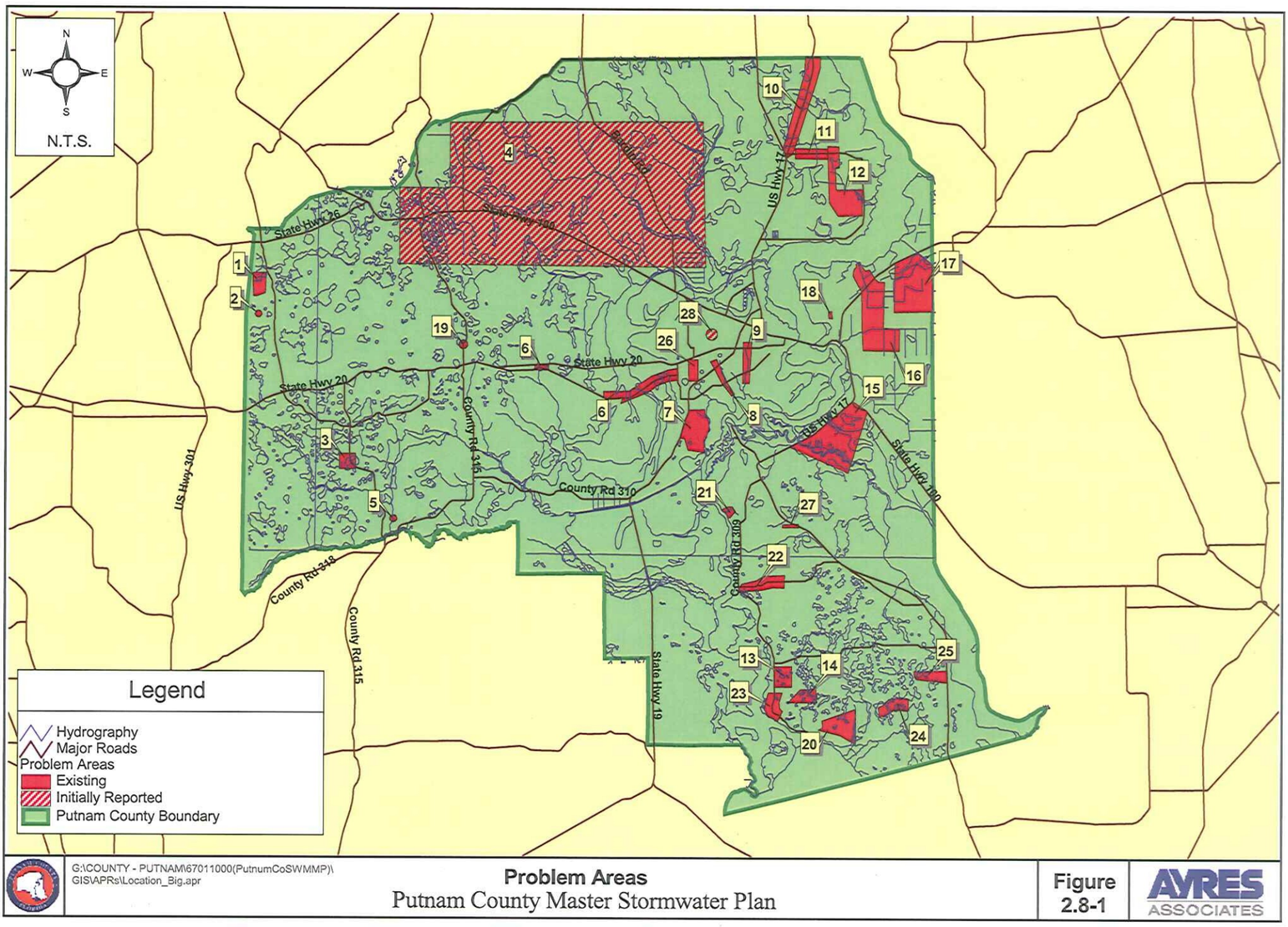
Historical flooding and water quality (primarily sedimentation) problems must be identified to assist in the prioritization of projects for flood relief and sedimentation control. Historical flood data might include anecdotal descriptions of flooding location and frequency, depth of flooding, descriptions of flood damage, high water marks, measured flood stages and flow rates, flood complaint databases and County stormwater maintenance/repair records. Sedimentation problems are generally known by the local maintenance entity. Often the sedimentation issues create a flooding issue.

Historical flooding and sedimentation data for this Master Stormwater Plan was obtained to address two primary objectives:

- Identification of Localized Flooding Areas
- Identification of Drainage Systems with Significant Sediment Contribution

The County, in a meeting on April 16, 2004, identified historic flooding and sedimentation areas based on citizen complaints and maintenance observations. The County provided Ayres Associates with a list of 28 areas and descriptions (Refer to Table 2.8-1). Locations are shown in **Figure 2.8-1**. Both the "Localized Flooding Areas" and "Significant Sediment Contribution" tasks required joint field visits by Ayres Associates and the County maintenance personnel, which are described in Section 7.3.2 of this Master Stormwater Plan.

It should be noted that the County's Roads & Bridge Maintenance Department were able to correct some of these system deficiencies during the course of the Master Stormwater Plan development. As such, those locations are identified and described herein but will be omitted from the priority ranking for the stormwater Capital Improvement Program.



G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Location_Big.apr

Problem Areas
Putnam County Master Stormwater Plan

Figure 2.8-1

AYRES ASSOCIATES

TABLE 2.8-1 FLOODING AND SEDIMENTATION AREAS

Location	Description
1. Bellamy Woods Road	(From Price Road 0.3 miles north on Bellamy Road) Flooding problem
1, 2. Price Road	(From Perry Road east to culvert on Price Road) Road floods in these areas
3. Roops Ditch	Overflow for lakes
4. Florahome Drainage	(Fulton Road at Keystone Road, 309D at Keystone Road, John's Road, Bannerville (dirt) culvert at Coral Farms Road, Bardin drainage included) Florahome drainage district dissolved several years ago; drains a large area of the northwest section of the County.
5. Orange Springs Shortcut	Bridge goes under water during moderate rains
6. Old Gainesville Hwy/Hunter Road	Drainage from timber woods
7. Mondex	(Pinellas Road, Park Avenue, Royal Palm Road) roads go under water with medium rainfall
8. Devall Branch	Maintenance problems, water volume increasing steadily, water backs up during moderate rain
9. Twomile Creek	Volume overload, water backs up during moderate rains
10 West Tocoi	Floods in several places
11. Palmetto Bluff	Water volume problem, road floods
12. Millican Road	Very slow drainage, flooding
13. River Park Subdivision	Road floods during moderate rain
14. Lakeway Drive Drainage	Lakeway Drive drainage
15. San Mateo Road Dunns Creek	Flooding and erosions
16. East Palatka Drainage District	Slow drainage, roads tend to flood
17. Hastings Drainage District (Rector Road)	Drains a large area of farm land
18. East River Road (at Camp Road)	Flooding during moderate rain backs up water to Public Works Department
19. County Road 315 at 64th Street	Road under water during moderate rain
20. Whispering Pines	Low area floods during rain
21. Saratoga Harbor	Drains through small lakes and dams
22. County Road 308 B	Area floods during moderate rain
23. County Road 309	Area floods during moderate rain
24. Harris Fish Camp Road	Flat land area
25. Junction Road	Floods during moderate rain
26. Mud Lake/Monroe Creek	Concern with additional water from SR 20
27. Sisco Road	Road floods during rain, road is lower than surrounding property.
28. Foxwood Outfall	Drains property south of St. Johns Avenue area floods during rain

Field investigations were conducted to provide additional information. The process to investigate the sites included the following tasks:

1. Conducted an assessment by visiting the sites with Area Maintenance Supervisors
2. Took appropriate preliminary measurements (culvert diameters, lengths, channel widths/slopes)
3. Photographed key features
4. Recorded the history of the site as recalled by the area supervisor

To the extent possible, these investigations were verified and refined by discussions with other appropriate County personnel including the County Engineer. In all, twenty-eight (28) sites were investigated.

The information has been used to develop narrative descriptions of problem areas and to develop a project ranking system.

2.9 SUBWATERSHED SELECTION PROTOCOL AND SELECTED SUBWATERSHEDS

The Putnam County Master Stormwater Plan limits the scope of study for some components to specifically selected subwatersheds, the intent being to select hydrologic units at the local level. In order to select subwatersheds for more in-depth study, a selection protocol has been developed, with the concurrence of the County. The procedure used for the selection process in outlined below.

In an effort to make the selection process objective, but also include knowledge acquired about the subwatersheds during the course of the project data collection efforts, an approach has been formulated that sorts and ranks subwatersheds with two different criteria, and then combines them into one rank. The first set of criteria is based on current land use and the assumption that stormwater issues tend to be associated with, and arise out of, human activities such as residential development, commercial/industrial uses and transportation. Using these criteria, each subwatershed in the County was ranked from highest to lowest based principally on percentage of area developed and undeveloped within a subwatershed. The second criteria is based on proximity to, or association with, the original twenty-eight identified "Problem Areas" presented in Section 2.8 as **Table 2.8-1**.

The two ranking criteria, the specific GIS analysis and ranking procedure are described as follows:

1. The following four shape files were obtained and re-projected, where necessary, in the 1983 State Plane coordinate system (NAD 83 State Plane Florida-East):
   a. Land use
   b. USGS drainage basins (subwatersheds)
   c. 5-foot contours
   d. Boundaries for the 28 problem areas

2. Where appropriate, some refinements were made to the USGS subwatershed divides using the 5-foot topographic contours.

3. ArcView was utilized to intersect the subwatershed boundaries with the land use polygons. This provided a database (DBF) file that was used to summarize land use by subwatershed. Portions of subwatersheds that fell outside the County were included, as they remain a hydrologic/hydraulic component of the system that is within the County. The land uses considered in the ranking matrix were Commercial, Agriculture, Industrial, Institutional, Mining, Miscellaneous, Public Facilities, Recreation, Residential, Rivers/Lakes/Streams, Transportation, Silviculture, and Vacant Lands.

4. The DBF file developed in Step 3 was reformatted to summarize the area of each land use for each subwatershed. A formula was then developed to rank each subwatershed by land use, the first of the two different criteria mentioned in the preamble. The ranking matrix put greater weight on developed lands, which typically have infrastructure needs or deficiencies. Uses such as silviculture or undeveloped wilderness lands that require little or no infrastructure were de-emphasized (weighted to one-third that of developed lands). The areas for residential, commercial, transportation, industrial, and institutional land uses were weighted with a value of 3. Mining, miscellaneous, public facilities, recreation, agriculture, rivers/lakes/streams, silviculture, and vacant lands were weighted with a value of 1. An area-weighted rank was calculated for each subwatershed (analogous to a weighted runoff curve number (CN) used in hydrology calculations) using the following formula:

$$\text{Basin Rank} = \frac{3(\sum \text{Area of developed landuses}^{1}) + 1(\sum \text{Area of undeveloped landuses}^{2})}{\sum \text{Area}}$$

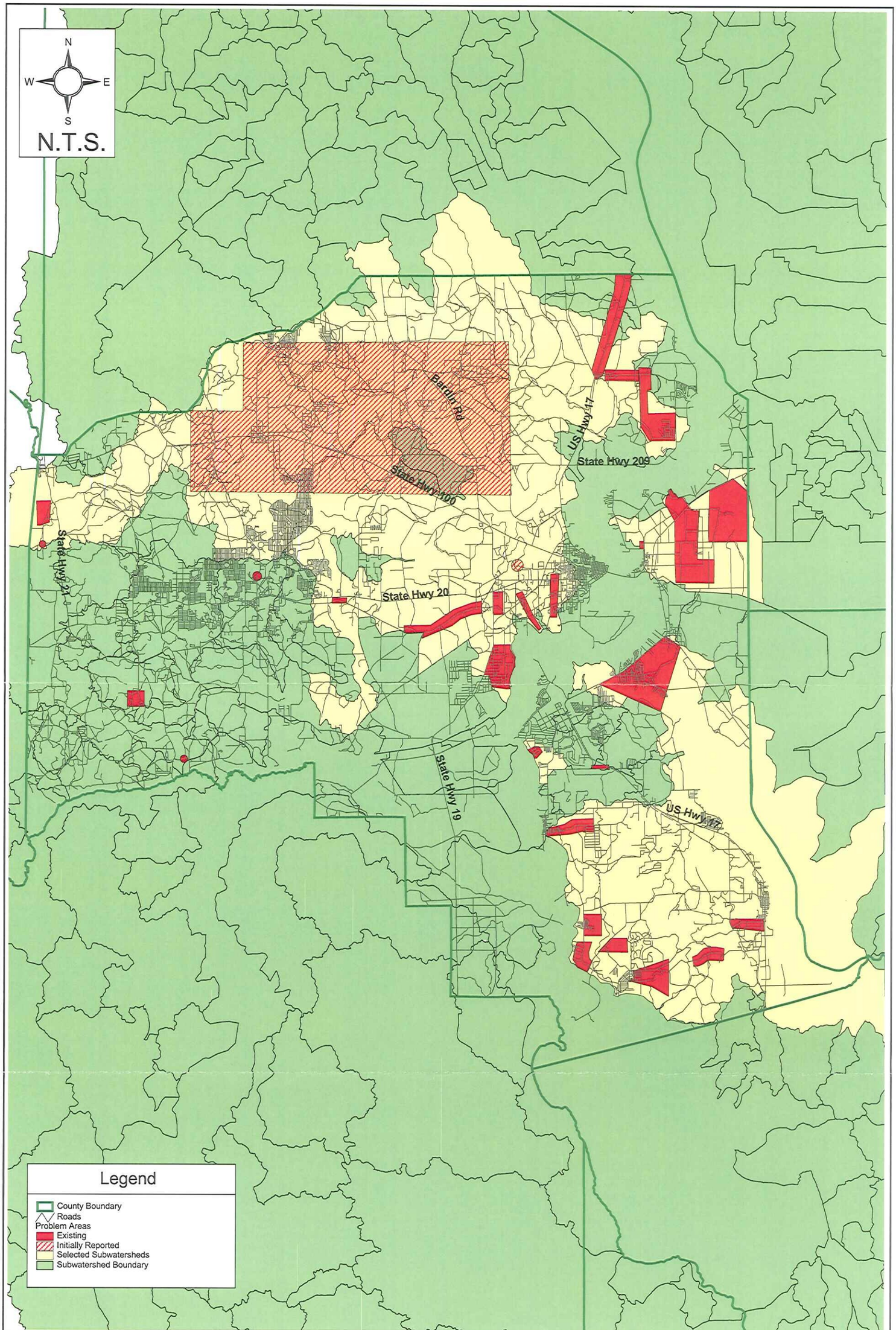
[1] Commercial, Transportation, Industrial, Institutional and Residential

[2] Mining, Miscellaneous, Public Facilities, Recreation, Agriculture, Rivers/Lakes/Streams, Silviculture, and Vacant Lands

Because the highest rank had the lowest numerical value, the ranked watersheds were then inverted or recalculated by dividing 1 by the calculated rank.

5. The remainder of the ranking process involved the second set of criteria, knowledge of the subwatershed problem areas, and the combining of the ranks. Subwatersheds that contained one of the 28 "Problem Areas" described in Section 2.8, and which would require aerial mapping, a watershed analysis, or any other type of significant data collection, were assigned the same rank of 1 to 28 previously assigned to the Problem Area in **Table 2.8-1**. This rank superceded the basin ranking described in step 4 above. The final step was to add a value of 29 to those subwatershed rankings that were not superceded by the Problem Area ranking. This step was necessary to force them to rank below 28, but still insure that the relative ranking (the ranking against the other non-superceded watersheds) remained. Finally, although the ranking procedure was objective, some subjectivity was introduced by selecting several other subwatersheds based on engineering judgment and specific knowledge of the local area within the subwatershed. As a result, subwatersheds that were upstream and contributed to a main tributary, or subwatersheds adjacent to subwatersheds selected by the procedure described above, were also included as selected subwatersheds.

Table 2.9-1 presents the ranking computation matrix for the protocol described above. Note that in some cases two or more subwatersheds have the same ranking because a Problem Area crosses subwatershed divides. Also, where multiple problem areas were cited for a subwatershed, multiple ranking entries were made. From the procedure, a total of 47 subwatersheds were selected and recommended for more in-depth evaluation. These subwatersheds are listed in **Table 2.9-2** and illustrated in **Figure 2.9-1.**



G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\selected_basins_marina.apr

Selected Subwatersheds

Putnam County Master Stormwater Plan

Figure 2.9-1

AYRES ASSOCIATES

TABLE 2.9-1 SUBWATERSHED SELECTION COMPUTATIONAL MATRIX

SUBWATERSHED/ (Problem Area)	Commercial	General Agriculture	Industrial	Institu-tional	Mining	Miscel-laneous	Public Facilities	Recreation / Open Space	Residential	Rivers, Lakes, Streams	Roads, Railroads, Canals, Utilities	Silviculture	Vacant / Undeveloped	Total	Watershed Rank	Basin Rank (Inverse)	Problem Area Rank	Combined Rank	9/29/05 Final Rank
DEVALL BRANCH - (Devall Branch)	363974	5118431	0	584119	0	0	750401	89894	22322768	0	1495586	9328999	1698172	41752344	2.19	4.57	1	1.00	1
DAVIS LAKE OUTLET (Devall Branch portion)	1570471	1162952	88983	1022328	0	0	0	15314776	4927306	0	2157211	12009856	6585586	44839470	1.44	6.97	1	1.00	2
TWOMILE CREEK (Twomile Creek)	4491505	6306021	0	2602419	0	0	2209789	1221543	38720731	312169	919191	1607156	8335995	66726519	2.40	4.17	2	2.00	3
CEDAR CREEK (Palmetto Bluff)	800014	70940366	4072656	334779	1658187	0	244114	150682	45033522	3992383	36908782	228440472	18226141	410802097	1.42	7.02	3	3.00	4
CEDAR CREEK (Millican Road)	800014	70940366	4072656	334779	1658187	0	244114	150682	45033522	3992383	36908782	228440472	18226141	410802097	1.42	7.02	4	4.00	4
MASON BRANCH (Millican Road)	0	16832994	0	0	0	0	0	0	28310058	0	0	47819895	42206169	135169116	1.42	7.05	4	4.00	5
ST JOHNS R. - Lk George DPU (River Park Subd.)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	5	5.00	6
MUDLAKE OUTLET (Monroe-Mill Cr)	1244618	10633322	78423	1416906	0	0	541656	534738	23508348	835938	1073235	13816162	2023968	55707314	1.98	5.05	6	6.00	7
WEST RUN INTERCEPTOR D (RectorRd)	1004354	26745577	0	0	0	0	0	355656	30958181	0	3573547	73175657	21543780	157356751	1.45	6.89	8	8.00	8
DOG BRANCH (E. Palatka Drainage)	883578	43535677	235321	70283	0	0	0	7246366	29802623	445834	16259	39317	14865408	97140666	1.64	6.10	9	9.00	9
MILL BRANCH (E. Palatka Drainage)	2056786	56875930	400976	1112870	0	0	335640	4225991	50303227	0	1527356	106155037	11349564	234343378	1.47	6.79	9	9.00	10
TIGER BRANCH (Whispering Pines)	423947	9306239	0	1450579	0	0	0	162762782	48373421	4370357	3257474	9623785	93095883	332664467	1.32	7.57	10	10.00	11
ST JOHNS R. - Lk George DPU (Whispering Pines)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	10	10.00	6
BEECHER RUN (Florahome)	0	5499505	0	46366	0	0	0	30195577	16040770	0	0	2391863	13133687	67307768	1.48	6.77	12	12.00	12
CLEARWATER LAKE OUTLET (Florahome)	26093	4818344	0	278870	0	0	0	17156388	22608144	1555335	738231	24176990	60366401	131724795	1.36	7.36	12	12.00	13
ETONIA CREEK (Florahome)	2066335	381219270	45035309	9378148	15638700	0	1026255	297163283	109033075	27008576	33176965	841180096	23407875	1785333886	1.22	8.18	12	12.00	14
RICE CREEK of Etonia Basin (Florahome)	1710689	62652577	23859461	926001	0	0	82192	226901842	44256230	1673293	27565506	654840288	17949101	1062417179	1.19	8.44	12	12.00	15
FALLING BRANCH (Florahome)	81088	9048706	0	225146	0	0	0	97930749	12424123	262166	7279938	85879403	27182384	240313704	1.17	8.57	12	12.00	16
UNNAMED DRAIN-5 (Florahome)	0	7770790	46640	0	0	0	0	0	246085	156322	9272999	105820197	218495	123531528	1.15	8.66	12	12.00	17
LAKE SUGGS OUTLET (Florahome)	201366	30102168	0	31941	0	0	0	22654297	12391384	0	799693	122116988	682963	188980800	1.14	8.76	12	12.00	18
LAKE GRANDIN OUTLET (Florahome)	11917	104601785	0	93049	0	0	14335	163777	9710686	2558457	188763	61172699	25723235	204238702	1.10	9.11	12	12.00	19
UNNAMED BRANCH-1 (Florahome)	0	35930683	0	0	0	0	0	0	11508783	0	1706989	233349528	41408	282537390	1.09	9.14	12	12.00	20
UNNAMED RUN-1 (Florahome)	0	933282	0	0	0	0	0	36820651	297788	0	4395227	60742141	79126	103268214	1.09	9.17	12	12.00	21
SIMMS CREEK (Florahome)	169814	10712010	0	203949	31693800	0	0	215090	9641511	0	2833538	309102051	17975	364589739	1.07	9.34	12	12.00	22
PALMETTO BRANCH (Florahome)	0	14453613	0	84304	0	0	0	48159961	2295685	0	3051894	124053000	0	192098457	1.06	9.46	12	12.00	23
UNNAMED BRANCH-2 (Florahome)	0	12692227	0	0	0	0	0	0	1414133	0	238349	48899867	0	63244576	1.05	9.50	12	12.00	24
LONG POND OUTLET (Florahome)	0	47331965	0	0	0	0	0	29337	741101	0	341097	9770251	1701238	59914989	1.04	9.65	12	12.00	25
UNNAMED DRAIN-1 (Florahome)	0	0	0	0	0	0	0	0	0	0	1095471	65724557	0	66820028	1.03	9.68	12	12.00	26
OLDTOWN BRANCH (Florahome)	0	25625086	0	9099	0	0	0	1459056	2908812	0	934711	199181954	11801616	241920334	1.03	9.69	12	12.00	27
BLOCKER LAKE OUTLET (Florahome)	0	55905810	0	0	16507	0	0	0	506810	0	699759	33657174	0	90786059	1.03	9.74	12	12.00	28
UNNAMED RUN-2 (Florahome)	0	2713870	0	0	0	0	0	0	382345	0	0	61332374	0	64428589	1.01	9.88	12	12.00	29
UNNAMED DRAIN-6 (Florahome)	0	8575590	0	0	29010402	0	0	0	272503	0	467341	127962229	113727	166401792	1.01	9.91	12	12.00	30
UNNAMED BRANCH-3 (Florahome)	0	27080	0	0	2382956	0	0	0	25545	0	0	137268869	0	139704451	1.00	10.00	12	12.00	31
COW BRANCH (East River Rd)	39424	20819135	0	0	0	0	0	1119215	16138845	0	0	2695469	6702714	47514801	1.68	5.95	13	13.00	32
ST JOHNS R.-LK George DPU (CR 309)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	1.00	10.00	14	14.00	6
ST JOHNS R. (Welaka -CR 308B)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	15	15.00	33
ST JOHNS R. (Welaka East - CR 308B)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	15	15.00	33
JUMPING GULLY BRANCH (Harris Fish Camp)	30788	23386550	742521	10925	265577	0	0	134322206	56868149	4066881	2588501	22128100	43858058	288268256	1.42	7.05	16	16.00	34
TIGER BRANCH (Harris Fish Camp)	423947	9306239	0	1450579	0	0	0	162762782	48373421	4370357	3257474	9623785	93095883	332664467	1.32	7.57	16	16.00	11
LAKE STELLA OUTLET (Junction Rd)	1475293	28921910	287623	1834981	0	0	515658	2376327	38709054	1276807	119993	5465111	33951703	114934460	1.74	5.75	17	17.00	35
GEORGETOWN SLOUGH (Lakeway Dr)	1887971	51740310	91944	1787866	310759	0	0	955791	185564405	6840799	660763	81923689	192927326	524691622	1.72	5.80	18	18.00	36

TABLE 2.9-1 SUBWATERSHED SELECTION COMPUTATIONAL MATRIX

SUBWATERSHED/ (Problem Area)	Commercial	General Agriculture	Industrial	Institu-tional	Mining	Miscel-laneous	Public Facilities	Recreation / Open Space	Residential	Rivers, Lakes, Streams	Roads, Railroads, Canals, Utilities	Silviculture	Vacant / Undeveloped	Total	Watershed Rank	Basin Rank (Inverse)	Problem Area Rank	Combined Rank	9/29/05 Final Rank
RICE CREEK of Rice Creek Basin (Hunter Road)	1710689	62652577	23859461	926001	0	0	82192	226901842	44256230	1673293	27565506	654840288	17949101	1062417179	1.19	8.44	20	20.00	37
SWEETWATER CREEK (Hunter Road)	713486	49319865	109006	626909	0	0	0	94218510	25310915	1518221	3200826	174861549	23918751	373798038	1.16	8.62	20	20.00	38
ETONIA CREEK (Bellamy Woods Road)	2066335	381219270	45035309	9378148	15638700	0	1026255	297163283	109033075	27008576	33176965	841180096	23407875	1785333886	1.22	8.18	22	22.00	14
ETONIA CREEK (Price Road)	2066335	381219270	45035309	9378148	15638700	0	1026255	297163283	109033075	27008576	33176965	841180096	23407875	1785333886	1.22	8.18	23	23.00	14
CEDAR CREEK (West Tocoi)	800014	70940366	4072656	334779	1658187	0	244114	150682	45033522	3992383	36908782	228440472	18226141	410802097	1.42	7.02	24	24.00	4
DUNNS CR, CRESCENT LK (San Mateo)	7178855	117585086	1659373	3510540	0	0	2079398	271307512	175605923	2533638	1440677	172019698	120924919	876025424	1.43	6.98	25	25.00	39
UNNAMED DITCH-2 (Foxwood Outfall)	14469640	3289007	8055547	7130223	43969	0	5968408	19655025	24430163	815	8199423	42678798	19029825	152950842	1.81	5.51	26	26.00	40
DAVIS LAKE OUTLET (Foxwood Outfall)	1570471	1162952	88983	1022328	0	0	0	15314776	4927306	0	2157211	12009856	6585586	44839470	1.44	6.97	26	26.00	2
ST JOHNS R. (Saratoga Harbor)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	N/C	27	27.00	41
ST JOHNS R. (Mondex)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	28	28.00	42
WILLOW COVE BRANCH	0	127521	0	0	0	0	0	1700301	6303813	2759099	0	175049	1901876	12967660	1.97	5.07	0	34.07	
LAKE BROWARD OUTLET	394393	8124337	162587	213159	0	0	116738	27346614	36791668	0	281446	5358478	12918758	91708177	1.83	5.48	0	34.48	
HALFMOON LAKE OUTLET	125926	15376037	35924	4714628	0	0	160849	22172346	45492304	3546523	2589986	35406933	4322150	133943607	1.79	5.58	0	34.58	
FISH CREEK	0	8258884	0	75722	0	0	0	0	10566288	0	24193907	45940639	1742011	90777452	1.77	5.66	0	34.66	
TWOMILE POND OUTLET	92284	8838877	0	33443	0	0	232742	489086	11084324	62948	2095514	11839888	0	34769106	1.77	5.66	0	34.66	
LAKE MYRA OUTLET	1348334	8861231	263524	132753	0	0	0	3259803	17379174	0	652548	7934726	14217066	54049158	1.73	5.77	0	34.77	
COWPEN LAKE OUTLET	144476	15035237	263820	2403127	0	0	246653	22876822	37506308	314847	4048332	45520518	5172017	133532158	1.66	6.01	0	35.01	
UNNAMED SLOUGH-2	0	4361634	0	0	0	0	0	0	12824003	0	0	13059593	8826768	39071998	1.66	6.04	0	35.04	
MCMEEKIN DRAIN	0	9920770	0	0	0	0	0	3059	11295729	655154	1716884	19172820	1849875	44614290	1.58	6.32	0	35.32	
GUM CREEK	2095140	41583613	197900	6165283	1655703	0	3259093	5036055	61395368	13522280	6590309	95912487	42102880	279516112	1.55	6.46	0	35.46	
SILVER LAKE OUTLET	283314	60531285	37669	799427	0	0	0	527410	46587623	47977	585419	45832682	41903682	197136487	1.49	6.71	0	35.71	43*
HELL CAT BAY	0	24133716	0	36023	0	0	0	4758924	39215224	1847421	24959239	130799657	48582662	274332867	1.47	6.81	0	35.81	
CRACKER BRANCH	21897	6492305	0	96	0	0	0	0	2113593	0	17884	530499	133298	9309572	1.46	6.84	0	35.84	
SMITH LAKE OUTLET	0	36438248	0	30503575	280035	0	0	16542453	29891127	4909767	1535161	156464682	3046239	279611286	1.44	6.93	0	35.93	
ST. JOHNS RIVER	33958516	141325190	12986998	28237144	0	0	5700893	946987654	436236999	21841002	51416741	569570226	314240548	2562501910	1.44	6.95	0	35.95	
HEWITT LAKES OUTLET	0	1042105	0	0	0	0	0	0	6004421	1940158	628932	21096444	37003	30749064	1.43	6.99	0	35.99	
HICKORY BRANCH	0	5955905	0	0	0	0	0	1056030	15891788	0	1551749	56506095	0	80961568	1.43	6.99	0	35.99	
UNNAMED BRANCH-5	0	15247759	2180659	14196257	2466075	0	0	101729	20132833	3731663	3202342	152221284	1892668	215373269	1.37	7.31	0	36.31	
CABBAGE CREEK	1041146	83181718	1101924	1124829	13912956	0	0	1928240	82963246	11637104	7240090	263251518	98147433	565530205	1.33	7.52	0	36.52	
PATTY WIGGINS BRANCH	0	1001201	0	0	0	0	0	40271992	8244842	181475	0	1573564	184801	51457874	1.32	7.57	0	36.57	
MOCCASIN CREEK	263122	7797729	0	43410	0	0	0	0	4118574	1734401	2576133	27582123	5093794	49209286	1.28	7.78	0	36.78	
STAR LAKE OUTLET	101379	9195756	0	0	0	0	0	12487014	16376387	356711	436599	77366392	4457061	120777299	1.28	7.81	0	36.81	
UNNAMED DITCHES-2	0	14592358	0	0	0	0	0	0	3085837	0	0	3564838	3164066	24407099	1.25	7.98	0	36.98	44*
ALLIGATOR CREEK	399039	12045079	178719	8673	0	0	0	83251131	24283547	16873985	2827259	62409046	19580636	221857114	1.25	8.00	0	37.00	
POLEY BRANCH	0	8551984	28464	0	0	0	0	12368645	7022414	170177	3346588	52477755	773918	84739945	1.25	8.03	0	37.03	
LITTLE ORANGE CREEK	335486	110286661	5132480	1846554	0	0	0	5587752	60646463	7133184	7382902	417684330	7738343	623774155	1.24	8.05	0	37.05	
LEVYS PRAIRIE	59939	58344864	0	19945337	0	0	1318680	63364519	7777275	0	1507477	91395434	1853682	245567206	1.24	8.07	0	37.07	
ACOSTA CREEK	33458	19291589	0	18099	0	0	0	108101	18261492	0	0	121444649	9490529	168647917	1.22	8.22	0	37.22	
CRANE PONDS OUTLET	0	19361003	0	179815	0	0	0	13402868	11381243	7671714	1237478	59885084	21771055	134890260	1.19	8.41	0	37.41	
UNNAMED LAKE OUTLET	0	2313484	0	0	0	0	0	0	399488	0	55338	2155769	1651	4925730	1.18	8.44	0	37.44	
DEEP CREEK	42023	100609576	0	57049	14760176	0	0	39675507	22805412	78546	9614124	164521190	2240733	354404336	1.18	8.45	0	37.45	
UNNAMED SLOUGH-5	327115	15347852	0	39768	0	527408	0	9338364	4824347	0	3135805	58183825	19795	91744279	1.18	8.46	0	37.46	45*
UNNAMED DITCH-3	0	2779907	0	0	0	0	0	0	1915195	0	1391285	32122072	25834	38234292	1.17	8.53	0	37.53	46*
UNNAMED DRAIN-7	0	18076624	0	0	0	0	0	959610	880937	0	9979294	104051933	0	133948398	1.16	8.60	0	37.60	
MCCARTHY LAKE OUTLET	0	1312329	0	2298484	0	0	0	3674446	374726	1701724	84605	29675496	0	39121809	1.14	8.76	0	37.76	

TABLE 2.9-1 SUBWATERSHED SELECTION COMPUTATIONAL MATRIX

SUBWATERSHED/ (Problem Area)	Commercial	General Agriculture	Industrial	Institu-tional	Mining	Miscel-laneous	Public Facilities	Recreation / Open Space	Residential	Rivers, Lakes, Streams	Roads, Railroads, Canals, Utilities	Silviculture	Vacant / Undeveloped	Total	Watershed Rank	Basin Rank (Inverse)	Problem Area Rank	Combined Rank	9/29/05 Final Rank
ORANGE CREEK	0	52929523	0	12479117	0	0	0	3177800	5819771	2925116	3124616	224498074	18191	304972207	1.14	8.77	0	37.77	
ATES CREEK	0	18019	0	0	0	0	0	0	32250	0	0	0	417840	468109	1.14	8.79	0	37.79	
HAMMOCK BRANCH	0	494131	0	0	0	0	0	144322148	9228024	83459	0	7472627	12789077	174389466	1.11	9.04	0	38.04	
UNNAMED DRAIN-3	0	342058	0	0	0	0	0	106206	527732	0	1243991	34130385	0	36350372	1.10	9.11	0	38.11	
THE SLASH	0	12036157	0	0	0	0	0	72275958	987076	0	3351183	75554483	0	164204858	1.05	9.50	0	38.50	
NONCONTRIBUTING AREA	204149	367020	0	0	0	0	0	115289941	2563525	0	416740	1894814	0	120736189	1.05	9.50	0	38.50	
UNNAMED CREEK	214367	11247669	406576	0	3430658	0	0	0	1510786	122414	588061	90165914	878302	108564748	1.05	9.52	0	38.52	
CROSS FLORIDA BARGE CANAL	0	48610150	0	0	0	0	0	139553545	2511388	142711	7184392	266204777	1802874	466009838	1.04	9.60	0	38.60	
UNNAMED DITCH-1	90563	9861422	0	0	0	0	0	2339016	1892305	0	0	93835311	0	108018616	1.04	9.65	0	38.65	47*
BRUNTBRIDGE BROOK	0	26745564	0	44123	0	0	0	652204	1147157	190605	1554191	125283306	0	155617150	1.04	9.66	0	38.66	
UNNAMED SLOUGH-3	0	0	0	0	0	0	0	0	100675	0	230054	17735959	1558370	19625058	1.03	9.67	0	38.67	
UNNAMED DRAIN-4	0	4550566	0	0	0	0	0	528501	856222	194390	123779	61693097	773371	68719927	1.03	9.72	0	38.72	
UNNAMED DITCHES-1	0	16959599	0	23385	0	0	0	0	349488	0	139194	25866856	58034	43396556	1.02	9.77	0	38.77	
UNNAMED SLOUGH-4	0	2197944	37264	0	176725	0	0	0	589047	0	228024	86333259	1239404	90801667	1.02	9.82	0	38.82	
OCKLAWAHA RIVER	39475	16663876	0	0	0	0	0	718149080	3788175	12007044	2766057	127867768	1728386	883009861	1.01	9.85	0	38.85	
UNNAMED SLOUGH-1	0	0	0	0	0	0	0	0	61328	0	0	17878632	350134	18290095	1.01	9.93	0	38.93	
CAMP BRANCH	0	3392716	0	0	0	0	0	278881626	331102	0	0	2544031	0	285149476	1.00	9.98	0	38.98	
UNNAMED DRAIN-2	0	0	0	0	0	0	0	0	0	0	11842	43941570	0	43953412	1.00	9.99	0	38.99	
LAKE LAURA OUTLET	0	0	0	0	0	0	0	67306044	0	0	0	0	0	67306044	1.00	10.00	0	39.00	
LITTLE LAKE KERR OUTLE	0	0	0	0	0	0	0	5185454	0	0	0	0	0	5185454	1.00	10.00	0	39.00	
LOCHLOOSA SLOUGH	0	0	0	0	0	0	0	0	0	0	0	234152	0	234152	1.00	10.00	0	39.00	
SALT CREEK DITCHES	0	0	0	0	0	0	0	0	0	0	0	48513	0	48513	1.00	10.00	0	39.00	
SALT SPRINGS RUN	0	0	0	0	0	0	0	116761572	0	0	0	0	0	116761572	1.00	10.00	0	39.00	
UNNAMED BRANCH-4	0	0	0	0	0	0	0	0	0	0	0	32289706	0	32289706	1.00	10.00	0	39.00	
PROBLEM AREA IN BASINS NOT SELECTED																			
LITTLE ORANGE CREEK (Orange Springs Cutoff Rd)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	7	7	
GUM CREEK (CR 315 @ 64th St.)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	11	11	
UNNAMED BRANCH-5 (Roops Ditch)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	19	19	
HAMMOCK BRANCH (Sisco Road)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	21	21	

NC - Not Calculated

TABLE 2.9-2 SELECTED SUBWATERSHEDS AND RANKING

SUBWATERSHED/ (Problem Area)	Watershed Rank (NC=Not Calculated)	Basin Rank (Inverse)	Problem Area Rank	2006 Final Rank
UNNAMED DRAIN-6 (Florahome)	1.01	9.91	12	30
UNNAMED BRANCH-3 (Florahome)	1.00	10.00	12	31
COW BRANCH (East River Rd)	1.68	5.95	13	32
ST JOHNS R. (Welaka and Welake East -CR 308B)	NC	NC	15	33
JUMPING GULLY BRANCH (Harris Fish Camp)	1.42	7.05	16	34
LAKE STELLA OUTLET (Junction Rd)	1.74	5.75	17	35
GEORGETOWN SLOUGH (Lakeway Dr)	1.72	5.80	18	36
RICE CREEK of Rice Creek (Hunter Road)	1.19	8.44	20	37
SWEETWATER CREEK (Hunter Road)	1.16	8.62	20	38
DUNNS CR, CRESCENT LK (San Mateo)	1.43	6.98	25	39
UNNAMED DITCH-2 (Foxwood Outfall)	1.81	5.51	26	40
ST JOHNS R. (Saratoga Harbor)	NC	N/C	27	41
ST JOHNS R. (Mondex)	NC	NC	28	42
SILVER LAKE OUTLET	1.49	6.71	0	43*
UNNAMED DITCHES-2	1.25	7.98	0	44*
UNNAMED SLOUGH-5	1.18	8.46	0	45*
UNNAMED DITCH-3	1.17	8.53	0	46*
UNNAMED DITCH-1	1.04	9.65	0	47*

* Subwatershed related to or tributary to a ranked flooding or sedimentation problem area

A full size exhibit of the selected subwatersheds, problem areas and rankings is provided at the end of Section 2.

TABLE 2.9-2 SELECTED SUBWATERSHEDS AND RANKING

SUBWATERSHED/ (Problem Area)	Watershed Rank (NC=Not Calculated)	Basin Rank (Inverse)	Problem Area Rank	2006 Final Rank
DEVALL BRANCH - (Devall Branch)	2.19	4.57	1	1
DAVIS LAKE OUTLET (Devall Branch, Foxwood Outfall)	1.44	6.97	1	2
TWOMILE CREEK (Twomile Creek)	2.40	4.17	2	3
CEDAR CREEK (Palmetto Bluff, Millican Road, West Tocoi)	1.42	7.02	3	4
MASON BRANCH (Millican Road)	1.42	7.05	4	5
ST JOHNS R. Lk George (River Park Subd., Whispering Pines, CR 309)	NC	NC	5	6
MUDLAKE OUTLET (Monroe-Mill Cr)	1.98	5.05	6	7
WEST RUN INTERCEPTOR D (Rector Rd)	1.45	6.89	8	8
DOG BRANCH (E. Palatka Drainage)	1.64	6.10	9	9
MILL BRANCH (E. Palatka Drainage)	1.47	6.79	9	10
TIGER BRANCH (Whispering Pines, Harris Fish Camp)	1.32	7.57	10	11
BEECHER RUN (Florahome)	1.48	6.77	12	12
CLEARWATER LAKE OUTLET (Florahome)	1.36	7.36	12	13
ETONIA CREEK (Florahome, Bellamy Woods, Price Rd)	1.22	8.18	12	14
RICE CREEK of Etonia (Florahome)	1.19	8.44	12	15
FALLING BRANCH (Florahome)	1.17	8.57	12	16
UNNAMED DRAIN-5 (Florahome)	1.15	8.66	12	17
LAKE SUGGS OUTLET (Florahome)	1.14	8.76	12	18
LAKE GRANDIN OUTLET (Florahome)	1.10	9.11	12	19
UNNAMED BRANCH-1 (Florahome)	1.09	9.14	12	20
UNNAMED RUN-1 (Florahome)	1.09	9.17	12	21
SIMMS CREEK (Florahome)	1.07	9.34	12	22
PALMETTO BRANCH (Florahome)	1.06	9.46	12	23
UNNAMED BRANCH-2 (Florahome)	1.05	9.50	12	24
LONG POND OUTLET (Florahome)	1.04	9.65	12	25
UNNAMED DRAIN-1 (Florahome)	1.03	9.68	12	26
OLDTOWN BRANCH (Florahome)	1.03	9.69	12	27
BLOCKER LAKE OUTLET (Florahome)	1.03	9.74	12	28
UNNAMED RUN-2 (Florahome)	1.01	9.88	12	29

2.10 FIELD INVESTIGATION PROGRAM AND DRAINAGE INVENTORY

Subwatersheds selected for more detailed study, as described in the previous section, were targeted for field reconnaissance. Field investigations have been for the Putnam County Master Stormwater Plan to supplement Geographic Information Systems (GIS) data already collected and to add information to that database. Master Stormwater Plan data to be added to the existing database for selected subwatersheds based on field review includes updates or modification to drainage basin delineations or major conyeyances, a drainage facility inventory, localized flooding areas, sewer networks and point source discharges and roads or drainage systems contributing significant amounts of sedimentation to waterbodies. Information regarding localized flooding, sewer networks and point source discharges, and significant sediment contribution areas were to be provided through the County's field maintenance staff.

Relevant GIS data already collected include the following:

- Soils
- Land Use (Current and Future)
- Hydrology
- Public Land Survey System (PLSS), i.e. Section/Township/Range
- Drainage Basins
- Groundwater Basins
- Outfalls
- Topographic Maps / Digital Contours
- Digital Orthophotographs / Aerials
- Roads
- Property Appraiser Data (Digital Parcels)
- Environmental Resource Permit (ERP) Boundaries
- Rainfall Gages
- Stream Gages
- Drainage Structures

Sources of this information include:

- Putnam County
- St. Johns River Water Management District (SJRWMD)
- Florida Department of Transportation (FDOT)
- United States Geological Survey (USGS)
- Federal Emergency Management Agency (FEMA)
- Florida Department Environmental Protection (FDEP)

The collected GIS feature data were projected to the NAD-83 State Plane Florida East (with units in feet) coordinate system as necessary to be consistent with Putnam County's existing GIS data. Digital Orthophoto Quarterquads (DOQQs) were also collected from the SJRWMD and the projected coordinate system for these images is UTM zone 17 N, NAD-83 HARN, GRS 80, with units in meters.

2.10.1 FIELD RECONNAISSANCE PLAN

With coordination from County staff, a map and route plan was developed identifying which drainage features needed to be inventoried for the selected subwatersheds (described in

Section 2.9), with a total of 360 individual structures targeted for field review and documetation. The field reconnaissance is intended to identify hydraulic features, and to document their specific characteristics. The following items were included in the field reconnaissance:

- Feature ID;
- Type of hydraulic feature (e.g., RCP, CMP, Bridge, Box Culvert, etc.)
- Location description that includes: road name, FDOT bridge number (where applicable), section, township, range; XY coordinates; and a GPS point taken in the field
- Condition of natural or man-made conveyance ways encountered
- Secondary measurements of the structure, in lieu of surveys by a Professional Land Surveyor (e.g., pipe size, length, etc.)
- Maintenance issues

Field equipment for the field reconnaissance included a 100-foot measuring tape, compass, digital camera and GPS system.

Digital photographs were taken for each hydraulic feature and included pictures facing upstream and downstream of the structure. Field reconnaissance forms and photo documentation is provided within the Section 3 watershed descriptions.

2.10.2 DEVELOPMENT OF THE DRAINAGE INVENTORY COVERAGE

An inventory coverage was developed to index and locate the hydraulic features encountered during the field reconnaissance and data evaluation/assembly. During the field reconnaissance, GPS points were collected and a drainage inventory form was completed for each system visited. In addition to the GPS point, photographs were also taken for each system. These photographs were incorporated into reports describing each structure visited in the field. The photographs were labeled with the feature ID, XY coordinate, horizontal datum, structure type and photo orientation.

The field reconnaissance data were compiled into a GIS database. A report for each system has been generated and delivered as part of this database. An ArcMap® project file was developed to illustrate the locations of these drainage structures and the collected GIS data (see **Figure 2.10-1**). Each point is linked to the report generated for that particular structure verified in the field. A DVD-ROM has been compiled consisting of the GIS information collected, and the field reconnaissance data.

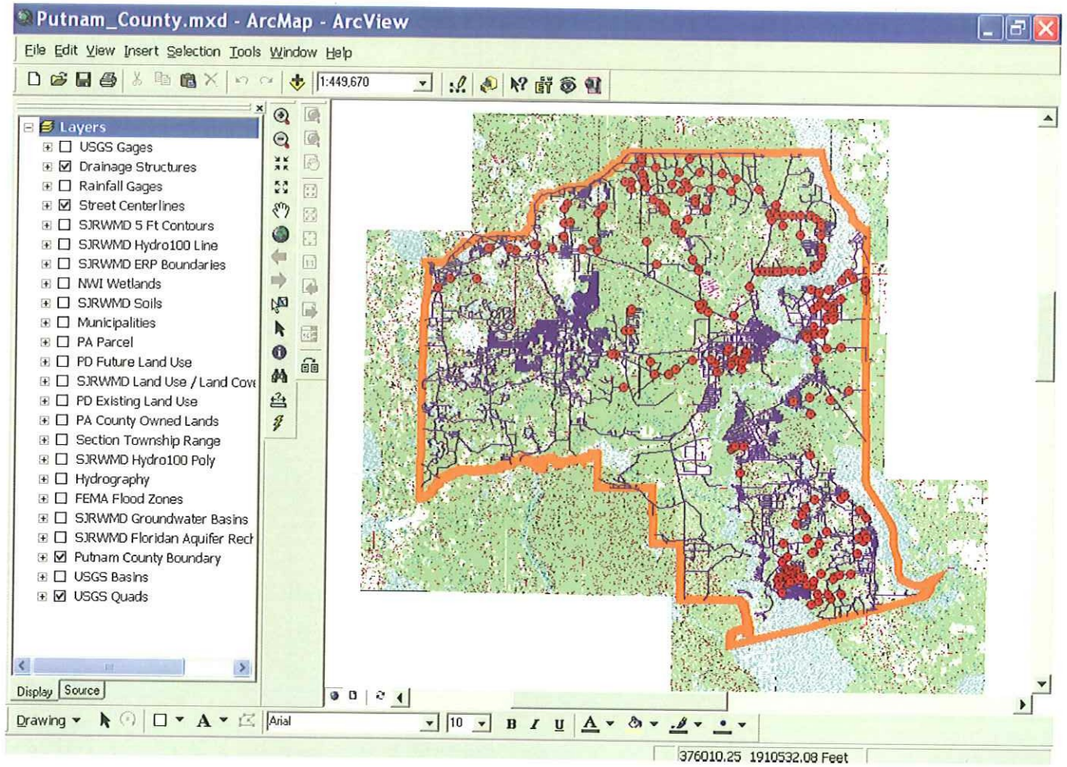


Figure 2.10-1 ArcMap Project File

TABLE OF CONTENTS

3.0 DRAINAGE PLANNING UNITS AND WATERSHEDS 3-1
3.1 Etonia Creek Drainage Planning Unit 3-3
3.1.1 Etonia Creek Watershed 3-5
3.1.1.1 Physiography and Hydrology 3-8
3.1.1.2 FEMA Flood Zones 3-8
3.1.1.3 Soils 3-10
3.1.1.4 Land Use/ Land Cover 3-10
3.1.1.5 Field Investigations in Selected Subwatersheds 3-13
3.1.1.6 Sewer Network and Point Source Discharge 3-13
3.1.2 Rice Creek Watershed 3-15
3.1.2.1 Physiography and Hydrology 3-15
3.1.2.2 FEMA Flood Zones 3-17
3.1.2.3 Soils 3-17
3.1.2.4 Land Use/ Land Cover 3-17
3.1.2.5 Field investigations in Selected Subwatersheds 3-21
3.1.2.6 Sewer Network and Point Source Discharge 3-21
3.1.3 Simms Creek Watershed 3-23
3.1.3.1 Physiography and Hydrology 3-23
3.1.3.2 FEMA Flood Zones 3-25
3.1.2.3 Soils 3-25
3.1.3.4 Land Use/ Land Cover 3-25
3.1.3.5 Field investigations in Selected Subwatersheds 3-29
3.1.3.6 Sewer Network and Point Source Discharge 3-29
3.2 South Mainstem Drainage Planning Unit 3-31
3.2.1 Acosta Creek Watershed 3-33
3.2.1.1 Physiography and Hydrology 3-33
3.2.1.2 FEMA Flood Zones 3-35
3.2.1.3 Soils 3-35
3.2.1.4 Land Use/ Land Cover 3-35
3.2.2 Cedar Creek Watershed 3-39
3.2.2.1 Physiography and Hydrology 3-41
3.2.2.2 FEMA Flood Zones 3-41
3.2.2.3 Soils 3-41
3.2.2.4 Land Use/ Land Cover 3-41
3.2.2.5 Field investigations in Selected Subwatersheds 3-45
3.2.2.6 Sewer Network and Point Source Discharge 3-45
3.2.3 Cow Branch Watershed 3-47
3.2.3.1 Physiography and Hydrology 3-47
3.2.3.2 FEMA Flood Zones 3-47
3.2.3.3 Soils 3-47
3.2.3.4 Land Use/ Land Cover 3-47
3.2.3.5 Field investigations in Selected Subwatersheds 3-52
3.2.4 Devall Branch Watershed 3-53
3.2.4.1 Physiography and Hydrology 3-53
3.2.4.2 FEMA Flood Zones 3-53
3.2.4.3 Soils 3-53
3.2.4.4 Land Use/ Land Cover 3-53
3.2.4.5 Field investigations in Selected Subwatersheds 3-58
3.2.4.6 Sewer Network and Point Source Discharge 3-58

3.2.5 Dog Branch Watershed 3-60
3.2.5.1 Physiography and Hydrology 3-60
3.2.5.2 FEMA Flood Zones 3-60
3.2.5.3 Soils 3-60
3.2.5.4 Land Use/ Land Cover 3-60
3.2.5.5 Field investigations in Selected Subwatersheds 3-65
3.2.5.6 Sewer Network and Point Source Discharge 3-65
3.2.6 Fish Creek Watershed 3-67
3.2.6.1 Physiography and Hydrology 3-67
3.2.6.2 FEMA Flood Zones 3-67
3.2.6.3 Soils 3-67
3.2.6.4 Land Use/ Land Cover 3-67
3.2.7 Mason Branch Watershed 3-72
3.2.7.1 Physiography and Hydrology 3-72
3.2.7.2 FEMA Flood Zones 3-72
3.2.7.3 Soils 3-72
3.2.7.4 Land Use/ Land Cover 3-72
3.2.7.5 Field investigations in Selected Subwatersheds 3-77
3.2.7.6 Sewer Network and Point Source Discharge 3-77
3.2.8 Mill Branch Watershed 3-79
3.2.8.1 Physiography and Hydrology 3-79
3.2.8.2 FEMA Flood Zones 3-79
3.2.8.3 Soils 3-79
3.2.8.4 Land Use/ Land Cover 3-83
3.2.8.5 Field investigations in Selected Subwatersheds 3-83
3.2.8.6 Sewer Network and Point Source Discharge 3-83
3.2.9 Moccasin Creek Watershed 3-86
3.2.9.1 Physiography and Hydrology 3-86
3.2.9.2 FEMA Flood Zones 3-86
3.2.9.3 Soils 3-86
3.2.9.4 Land Use/ Land Cover 3-86
3.2.10 Mudlake Outlet Watershed 3-91
3.2.10.1 Physiography and Hydrology 3-91
3.2.10.2 FEMA Flood Zones 3-91
3.2.10.3 Soils 3-91
3.2.10.4 Land Use/ Land Cover 3-91
3.2.10.5 Field investigations in Selected Subwatersheds 3-96
3.2.10.6 Sewer Network and Point Source Discharge 3-96
3.2.11 St. Johns River Watershed 3-98
3.2.11.1 Physiography and Hydrology 3-98
3.2.11.2 FEMA Flood Zones 3-98
3.2.11.3 Soils 101
3.2.11.4 Land Use/ Land Cover 3-101
3.2.11.5 Field investigations in Selected Subwatersheds 3-104
3.2.11.6 Sewer Network and Point Source Discharge 3-106
3.2.12 Twomile (Duval) Creek Watershed 3-108
3.2.12.1 Physiography and Hydrology 3-108
3.2.12.2 FEMA Flood Zones 3-108
3.2.12.3 Soils 3-108
3.2.12.4 Land Use/ Land Cover 3-108
3.2.12.5 Field investigations in Selected Subwatersheds 3-113

3.2.12.6 Sewer Network and Point Source Discharge 3-113
3.2.13 West Run Interceptor D Watershed 3-115
3.2.13.1 Physiography and Hydrology 3-115
3.2.13.2 FEMA Flood Zones 3-115
3.2.13.3 Soils 3-118
3.2.13.4 Land Use/ Land Cover 3-118
3.2.13.5 Field investigations in Selected Subwatersheds 3-121
3.2.13.6 Sewer Network and Point Source Discharge 3-121
3.2.14 Unnamed Creek Watershed 3-123
3.2.14.1 Physiography and Hydrology 3-123
3.2.14.2 FEMA Flood Zones 3-123
3.2.14.3 Soils 3-123
3.2.14.4 Land Use/ Land Cover 3-123
3.3 Crescent Lake Drainage Planning Unit 3-128
3.3.1 Dunns Creek, Crescent Lake Watershed 3-130
3.3.1.1 Physiography and Hydrology 3-130
3.3.1.2 FEMA Flood Zones 3-133
3.3.1.3 Soils 3-133
3.3.1.4 Land Use/ Land Cover 3-133
3.3.1.5 Field investigations in Selected Subwatersheds 3-137
3.3.1.6 Sewer Network and Point Source Discharge 3-137
3.4 Orange Creek Drainage Planning Unit 3-139
3.4.1 Orange Creek Watershed 3-141
3.4.1.1 Physiography and Hydrology 3-141
3.4.1.2 FEMA Flood Zones 3-142
3.4.1.3 Soils 3-144
3.4.1.4 Land Use/ Land Cover 3-144
3.5 Rodman Reservoir Drainage Planning Unit 3-148
3.5.1 Bruntbridge Brook Watershed 3-150
3.5.1.1 Physiography and Hydrology 3-150
3.5.1.2 FEMA Flood Zones 3-150
3.5.1.3 Soils 3-150
3.5.1.4 Land Use/ Land Cover 3-150
3.5.2 Camp Branch Watershed 3-155
3.5.2.1 Physiography and Hydrology 3-155
3.5.2.2 FEMA Flood Zones 3-155
3.5.2.3 Soils 3-155
3.5.2.4 Land Use/ Land Cover 3-155
3.5.3 Cross Florida Barge Canal Watershed 3-160
3.5.3.1 Physiography and Hydrology 3-160
3.5.3.2 FEMA Flood Zones 3-160
3.5.3.3 Soils 3-160
3.5.3.4 Land Use/ Land Cover 3-164
3.5.4 Deep Creek Watershed 3-166
3.5.4.1 Physiography and Hydrology 3-166
3.5.4.2 FEMA Flood Zones 3-166
3.5.4.3 Soils 3-169
3.5.4.4 Land Use/ Land Cover 3-169
3.5.4.5 Field investigations in Selected Subwatersheds 3-172
3.5.4.6 Sewer Network and Point Source Discharge 3-172
3.5.5 Ocklawaha River Watershed 3-174

3.5.5.1 Physiography and Hydrology 3-174
3.5.5.2 FEMA Flood Zones 3-174
3.5.5.3 Soils 3-174
3.5.5.4 Land Use/ Land Cover 3-175
3.6 Lake George Drainage Planning Unit 3-180
3.6.1 Beecher Run Watershed 3-182
3.6.1.1 Physiography and Hydrology 3-182
3.6.1.2 FEMA Flood Zones 3-182
3.6.1.3 Soils 3-182
3.6.1.4 Land Use/ Land Cover 3-182
3.6.1.5 Field investigations in Selected Subwatersheds 3-187
3.6.1.6 Sewer Network and Point Source Discharge 3-187
3.6.2 Georgetown Slough Watershed 3-188
3.6.2.1 Physiography and Hydrology 3-188
3.6.2.2 FEMA Flood Zones 3-188
3.6.2.3 Soils 3-188
3.6.2.4 Land Use/ Land Cover 3-188
3.6.2.5 Field investigations in Selected Subwatersheds 3-193
3.6.2.6 Sewer Network and Point Source Discharge 3-193
3.6.3 Jumping Gully Branch Watershed 3-195
3.6.3.1 Physiography and Hydrology 3-195
3.6.3.2 FEMA Flood Zones 3-195
3.6.3.3 Soils 3-195
3.6.3.4 Land Use/ Land Cover 3-199
3.6.3.5 Field investigations in Selected Subwatersheds 3-199
3.6.3.6 Sewer Network and Point Source Discharge 3-199
3.6.4 Lake Laura Outlet Watershed 3-202
3.6.4.1 Physiography and Hydrology 3-202
3.6.4.2 FEMA Flood Zones 3-202
3.6.4.3 Soils 3-202
3.6.4.4 Land Use/ Land Cover 3-202
3.6.5 Patty Wiggins Branch Watershed 3-207
3.6.5.1 Physiography and Hydrology 3-207
3.6.5.2 FEMA Flood Zones 3-207
3.6.5.3 Soils 3-207
3.6.5.4 Land Use/ Land Cover 3-207
3.6.6 St. Johns River Watershed 3-212
3.6.6.1 Physiography and Hydrology 3-212
3.6.6.2 FEMA Flood Zones 3-212
3.6.6.3 Soils 3-212
3.6.6.4 Land Use/ Land Cover 3-216
3.6.6.5 Field investigations in Selected Subwatersheds 3-216
3.6.6.6 Sewer Network and Point Source Discharge 3-216
3.6.7 Tiger Branch Watershed 3-218
3.6.7.1 Physiography and Hydrology 3-218
3.6.7.2 FEMA Flood Zones 3-218
3.6.7.3 Soils 3-218
3.6.7.4 Land Use/ Land Cover 3-218
3.6.7.5 Field investigations in Selected Subwatersheds 3-223
3.6.7.6 Sewer Network and Point Source Discharge 3-223

List of Figures

Figure 3-1 Putnam County DPUs....3-2
Figure 3.1-1 Etonia Creek DPU....3-5
Figure 3.1.1-1 Etonia Creek Watershed Location Map....3-8
Figure 3.1.1-2 Etonia Creek Watershed FEMA Flood Zones....3-10
Figure 3.1.1-3 Etonia Creek Watershed Soils....3-12
Figure 3.1.1-4 Etonia Creek Watershed Current Land Use....3-13
Figure 3.1.2-1 Rice Creek Watershed Location Map....3-17
Figure 3.1.2-2 Rice Creek Watershed FEMA Flood Zones....3-19
Figure 3.1.2-3 Rice Creek Watershed Soils....3-20
Figure 3.1.2-4 Rice Creek Watershed Current Land Use....3-21
Figure 3.1.3-1 Simms Creek Watershed Location Map....3-25
Figure 3.1.3-2 Simms Creek Watershed FEMA Flood Zones....3-27
Figure 3.1.3-3 Simms Creek Watershed Soils....3-28
Figure 3.1.3-4 Simms Creek Watershed Current Land Use....3-29
Figure 3.2-1 South Mainstem DPU....3-33
Figure 3.2.1-1 Acosta Creek Watershed Location Map....3-35
Figure 3.2.1-2 Acosta Creek Watershed FEMA Flood Zones....3-37
Figure 3.2.1-3 Acosta Creek Watershed Soils....3-38
Figure 3.2.1-4 Acosta Creek Watershed Current Land Use....3-39
Figure 3.2.2-1 Cedar Creek Watershed Location Map....3-41
Figure 3.2.2-2 Cedar Creek Watershed FEMA Flood Zones....3-43
Figure 3.2.2-3 Cedar Creek Watershed Soils....3-44
Figure 3.2.2-4 Cedar Creek Watershed Current Land Use....3-45
Figure 3.2.3-1 Cow Branch Watershed Location Map....3-49
Figure 3.2.3-2 Cow Branch Watershed FEMA Flood Zones....3-50
Figure 3.2.3-3 Cow Branch Watershed Soils....3-51
Figure 3.2.3-4 Cow Branch Watershed Current Land Use....3-52
Figure 3.2.4-1 Devall Branch Watershed Location Map....3-55
Figure 3.2.4-2 Devall Branch Watershed FEMA Flood Zones....3-56
Figure 3.2.4-3 Devall Branch Watershed Soils....3-57
Figure 3.2.4-4 Devall Branch Watershed Current Land Use....3-58
Figure 3.2.5-1 Dog Branch Watershed Location Map....3-62
Figure 3.2.5-2 Dog Branch Watershed FEMA Flood Zones....3-63
Figure 3.2.5-3 Dog Branch Watershed Soils....3-64
Figure 3.2.5-4 Dog Branch Watershed Current Land Use....3-64
Figure 3.2.6-1 Fish Creek Watershed Location Map....3-69
Figure 3.2.6-2 Fish Creek Watershed FEMA Flood Zones....3-70
Figure 3.2.6-3 Fish Creek Watershed Soils....3-71
Figure 3.2.6-4 Fish Creek Watershed Current Land Use....3-72
Figure 3.2.7-1 Mason Branch Watershed Location Map....3-74

Figure 3.2.7-2 Mason Branch Watershed FEMA Flood Zones 3-75
Figure 3.2.7-3 Mason Branch Watershed Soils 3-76
Figure 3.2.7-4 Mason Branch Watershed Current Land Use 3-77
Figure 3.2.8-1 Mill Branch Watershed Location Map 3-81
Figure 3.2.8-2 Mill Branch Watershed FEMA Flood Zones 3-82
Figure 3.2.8-3 Mill Branch Watershed Soils 3-83
Figure 3.2.8-4 Mill Branch Watershed Current Land Use 3-85
Figure 3.2.9-1 Moccasin Creek Watershed Location Map 3-88
Figure 3.2.9-2 Moccasin Creek Watershed FEMA Flood Zones 3-89
Figure 3.2.9-3 Moccasin Creek Watershed Soils 3-90
Figure 3.2.9-4 Moccasin Creek Watershed Current Land Use 3-91
Figure 3.2.10-1 Mudlake Outlet Watershed Location Map 3-93
Figure 3.2.10-2 Mudlake Outlet Watershed FEMA Flood Zones 3-94
Figure 3.2.10-3 Mudlake Outlet Watershed Soils 3-95
Figure 3.2.10-4 Mudlake Outlet Watershed Current Land Use 3-96
Figure 3.2.11-1 St. Johns River Watershed Location Map 3-100
Figure 3.2.11-2 St. Johns River Watershed FEMA Flood Zones 3-101
Figure 3.2.11-3 St. Johns River Watershed Soils 3-103
Figure 3.2.11-4 St. Johns River Watershed Current Land Use 3-104
Figure 3.2.12-1 Twomile Creek Watershed Location Map 3-110
Figure 3.2.12-2 Twomile Creek Watershed FEMA Flood Zones 3-111
Figure 3.2.12-3 Twomile Creek Watershed Soils 3-112
Figure 3.2.12-4 Twomile Creek Watershed Current Land Use 3-113
Figure 3.2.13-1 West Run Interceptor D Watershed Location Map 3-117
Figure 3.2.13-2 West Run Interceptor D Watershed FEMA Flood Zones 3-118
Figure 3.2.13-3 West Run Interceptor D Watershed Soils 3-120
Figure 3.2.13-4 West Run Interceptor D Watershed Current Land Use 3-121
Figure 3.2.14-1 Unnamed Creek Watershed Location Map 3-125
Figure 3.2.14-2 Unnamed Creek Watershed FEMA Flood Zones 3-126
Figure 3.2.14-3 Unnamed Creek Watershed Soils 3-127
Figure 3.2.14-4 Unnamed Creek Watershed Current Land Use 3-128
Figure 3.3-1 Crescent Lake Drainage Planning Unit (DPU) Location Map 3-130
Figure 3.3.1-1 Dunns Creek/Crescent Lake Watershed Location Map 3-132
Figure 3.3.1-2 Dunns Creek/Crescent Lake Watershed FEMA Flood Zones 3-134
Figure 3.3.1-3 Dunns Creek/Crescent Lake Watershed Soils 3-135
Figure 3.3.1-4 Dunns Creek/Crescent Lake Watershed Current Land Use 3-136
Figure 3.4-1 Orange Creek Drainage Planning Unit (DPU) Location Map 3-140
Figure 3.4.1-1 Orange Creek Watershed Location Map 3-142
Figure 3.4.1-2 Orange Creek Watershed FEMA Flood Zones 3-144
Figure 3.4.1-3 Orange Creek Watershed Soils 3-145
Figure 3.4.1-4 Orange Creek Watershed Current Land Use 3-146
Figure 3.5-1 Rodman Reservoir Drainage Planning Unit (DPU) Location Map 3-148
Figure 3.5.1-1 Bruntbridge Brook Watershed Location Map 3-150

Figure 3.5.1-2 Bruntbridge Brook Watershed FEMA Flood Zones 3-151
Figure 3.5.1-3 Bruntbridge Brook Watershed Soils 3-152
Figure 3.5.1-4 Bruntbridge Brook Watershed Current Land Use 3-153
Figure 3.5.2-1 Camp Branch Watershed Location Map 3-155
Figure 3.5.2-2 Camp Branch Watershed FEMA Flood Zones 3-156
Figure 3.5.2-3 Camp Branch Watershed Soils 3-157
Figure 3.5.2-4 Camp Branch Watershed Current Land Use 3-158
Figure 3.5.3-1 Cross Florida Barge Canal Watershed Location Map 3-160
Figure 3.5.3-2 Cross Florida Barge Canal Watershed FEMA Flood Zones 3-161
Figure 3.5.3-3 Cross Florida Barge Canal Watershed Soils 3-162
Figure 3.5.3-4 Cross Florida Barge Canal Watershed Current Land Use 3-163
Figure 3.5.4-1 Deep Creek Watershed Location Map 3-166
Figure 3.5.4-2 Deep Creek Watershed FEMA Flood Zones 3-167
Figure 3.5.4-3 Deep Creek Watershed Soils 3-169
Figure 3.5.4-4 Deep Creek Watershed Current Land Use 3-170
Figure 3.5.5-1 Ocklawaha River Watershed Location Map 3-175
Figure 3.5.5-2 Ocklawaha River Watershed FEMA Flood Zones 3-176
Figure 3.5.5-3 Ocklawaha River Watershed Soils 3-177
Figure 3.5.5-4 Ocklawaha River Watershed Current Land Use 3-178
Figure 3.6-1 Lake George Drainage Planning Unit (DPU) Location Map 3-180
Figure 3.6.1-1 Beecher Run Watershed Location Map 3-182
Figure 3.6.1-2 Beecher Run Watershed FEMA Flood Zones 3-183
Figure 3.6.1-3 Beecher Run Watershed Soils 3-184
Figure 3.6.1-4 Beecher Run Watershed Current Land Use 3-185
Figure 3.6.2-1 Georgetown Slough Watershed Location Map 3-188
Figure 3.6.2-2 Georgetown Slough Watershed FEMA Flood Zones 3-189
Figure 3.6.2-3 Georgetown Slough Watershed Soils 3-190
Figure 3.6.2-4 Georgetown Slough Watershed Current Land Use 3-191
Figure 3.6.3-1 Jumping Gully Branch Watershed Location Map 3-195
Figure 3.6.3-2 Jumping Gully Branch Watershed FEMA Flood Zones 3-196
Figure 3.6.3-3 Jumping Gully Branch Watershed Soils 3-197
Figure 3.6.3-4 Jumping Gully Branch Watershed Current Land Use 3-199
Figure 3.6.4-1 Lake Laura Outlet Watershed Location Map 3-202
Figure 3.6.4-2 Lake Laura Outlet Watershed FEMA Flood Zones 3-203
Figure 3.6.4-3 Lake Laura Outlet Watershed Soils 3-204
Figure 3.6.4-4 Lake Laura Outlet Watershed Current Land Use 3-205
Figure 3.6.5-1 Patty Wiggins Branch Watershed Location Map 3-207
Figure 3.6.5-2 Patty Wiggins Branch Watershed FEMA Flood Zones 3-208
Figure 3.6.5-3 Patty Wiggins Branch Watershed Soils 3-209
Figure 3.6.5-4 Patty Wiggins Branch Watershed Current Land Use 3-210
Figure 3.6.6-1 St. Johns River Watershed Location Map 3-212
Figure 3.6.6-2 St. Johns River Watershed FEMA Flood Zones 3-213
Figure 3.6.6-3 St. Johns River Watershed Soils 3-214

Figure 3.6.6-4 St. Johns River Watershed Current Land Use....3-216
Figure 3.6.7-1 Tiger Branch Watershed Location Map....3-218
Figure 3.6.7-2 Tiger Branch Watershed FEMA Flood Zones....3-219
Figure 3.6.7-3 Tiger Branch Watershed Soils....3-220
Figure 3.6.7-4 Tiger Branch Watershed Current Land Use....3-221

List of Tables

Table 3.1-1 Land Use and Soils Summary for Etonia Creek DPU....3-6
Table 3.1.2.1 Streamflow Summary for Rice Creek Gages....3-18
Table 3.2-1 Land Use and Soils Summary for South Mainstem DPU....3-34
Table 3.3-1 Land Use and Soils Summary for Crescent Lake DPU....3-129
Table 3.4-1 Land Use and Soils Summary for Orange Creek DPU....3-139
Table 3.5-1 Land Use and Soils Summary for Rodman Reservoir DPU....3-140
Table 3.6-1 Land Use and Soils Summary for Lake George DPU....3-179

List of Appendices

Appendix 3-A Putnam County Flood Insurance Studies (excerpts)
Appendix 3-B Putnam County Field Investigation Data

3.0 DRAINAGE PLANNING UNITS AND WATERSHEDS

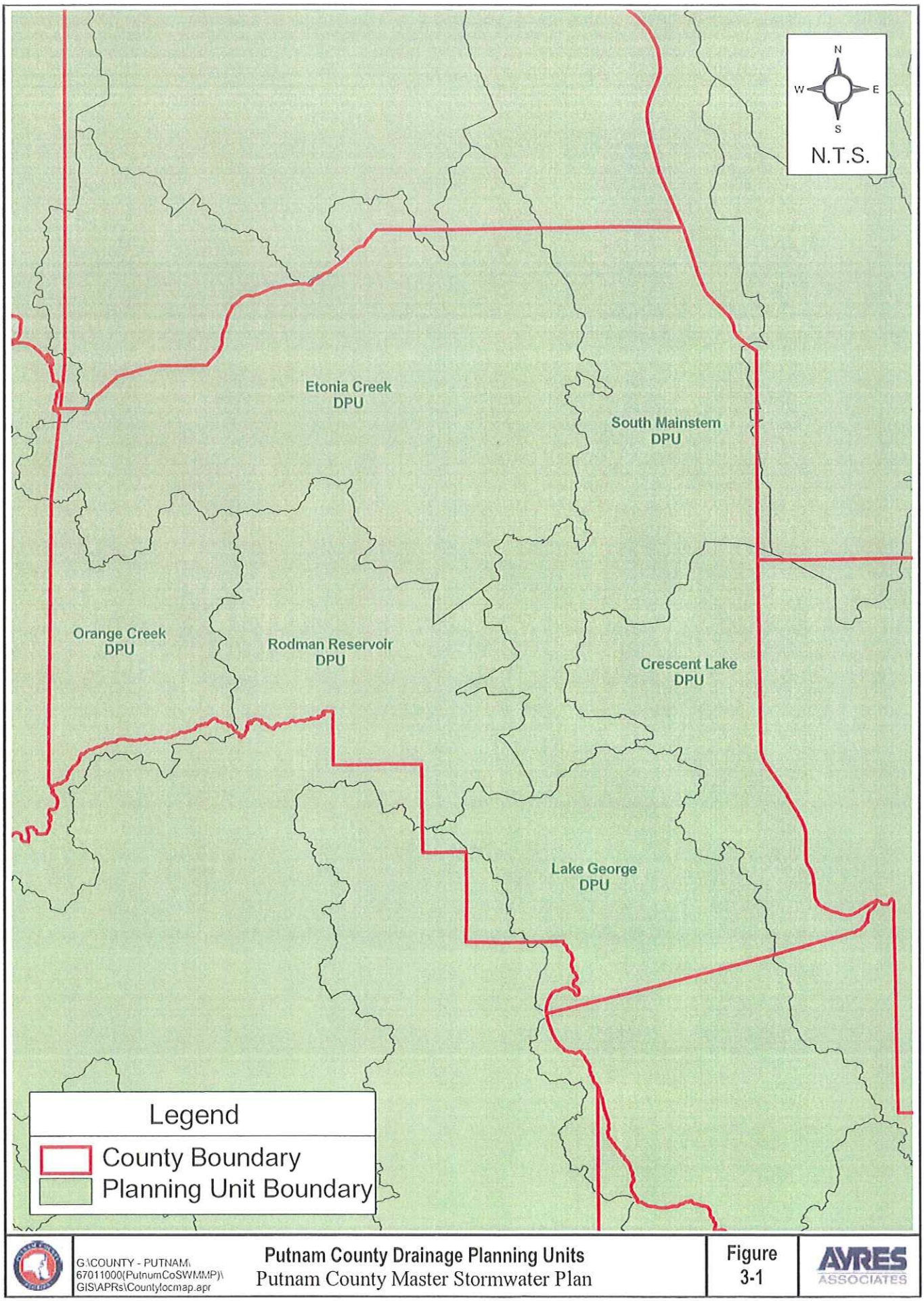
Upon researching both the history and layout of the planning units in Putnam County, it was determined that this study should be organized by Drainage Planning Unit (DPU). This not only provides a means to organize watersheds in a logical manner, but also provides the County with continuity with SJRWMD for future projects or potential funding mechanisms. The following are the DPUs that contain the thirty-one (31) Putnam County watersheds:

- Etonia Creek DPU
- South Mainstem DPU
- Crescent Lake DPU
- Rodman Reservoir DPU
- Lake George DPU
- Orange Creek DPU
- Lake Kerr DPU
- Deep Creek DPU

Of the above DPUs, the Deep Creek and Lake Kerr DPUs contain only very small portions of Putnam County. The vast majority of these DPUs lie outside the County borders and will not be examined in detail for this study. **Figure 3-1** presents the locations of the Putnam County DPUs evaluated for the Master Stormwater Plan.

Each DPU will comprise one subsection of SMP Chapter 3. Additionally, Ayres Associates recommends that the County begin organizing its drainage issues and projects by DPU and Watershed as well. Thus, in years to come, as additional studies are implemented and drainage improvements are made in individual watersheds, the pertinent information will be added to the file for the specific DPU and watershed.

In addition to the DPU subsections, this study includes multiple appendices, allowing for the inclusion of previous drainage studies completed prior to this report, the FEMA flood study for Putnam County, USGS streamflow gauge data for area waterways, etc.



G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Countylocmap.apr

Putnam County Drainage Planning Units
Putnam County Master Stormwater Plan

Figure 3-1

AYRES ASSOCIATES

Following is a list of the primary watersheds in each DPU:

Etonia Creek DPU
1) Etonia Creek
2) Rice Creek
3) Simms Creek

South Mainstem DPU
1) Acosta Creek
2) Cedar Creek
3) Cow Branch
4) Devall Branch
5) Dog Branch
6) Fish Creek
7) Mason Branch
8) Mill Branch
9) Moccasin Creek
10) Mudlake Outlet
11) St. Johns River
12) Twomile (Duval) Creek
13) West Run Interceptor D
14) Unnamed Creek

Crescent Lake DPU
1) Dunns Creek, Crescent Lake

Orange Creek DPU
1) Orange Creek

Rodman Reservoir DPU
1) Bruntbridge Brook
2) Camp Branch
3) Cross Florida Barge Canal
4) Deep Creek
5) Ocklawaha River

Lake George DPU
1) Beecher Run
2) Georgetown Slough
3) Jumping Gully Branch
4) Lake Laura Outlet
5) Patty Wiggins Branch
6) St. Johns River
7) Tiger Branch

3.1 ETONIA CREEK DRAINAGE PLANNING UNIT

The Etonia Creek Drainage Planning Unit (DPU) contains 354.6 square miles across Clay and Putnam Counties, encompassing most of the northern half of Putnam County. Small portions of Alachua and Bradford Counties are included in this DPU. Of the total land area, 258.5 square miles lie in Putnam County. **Figure 3.1-1** depicts the Etonia Creek DPU and its associated watersheds. According to the watershed designation developed by SJRWMD, the Etonia Creek DPU actually contains only one primary watershed: Rice Creek. However, to make drainage analyses more manageable for Putnam County, the Etonia Creek DPU will be divided into three (3) primary watersheds for the purposes of this report:

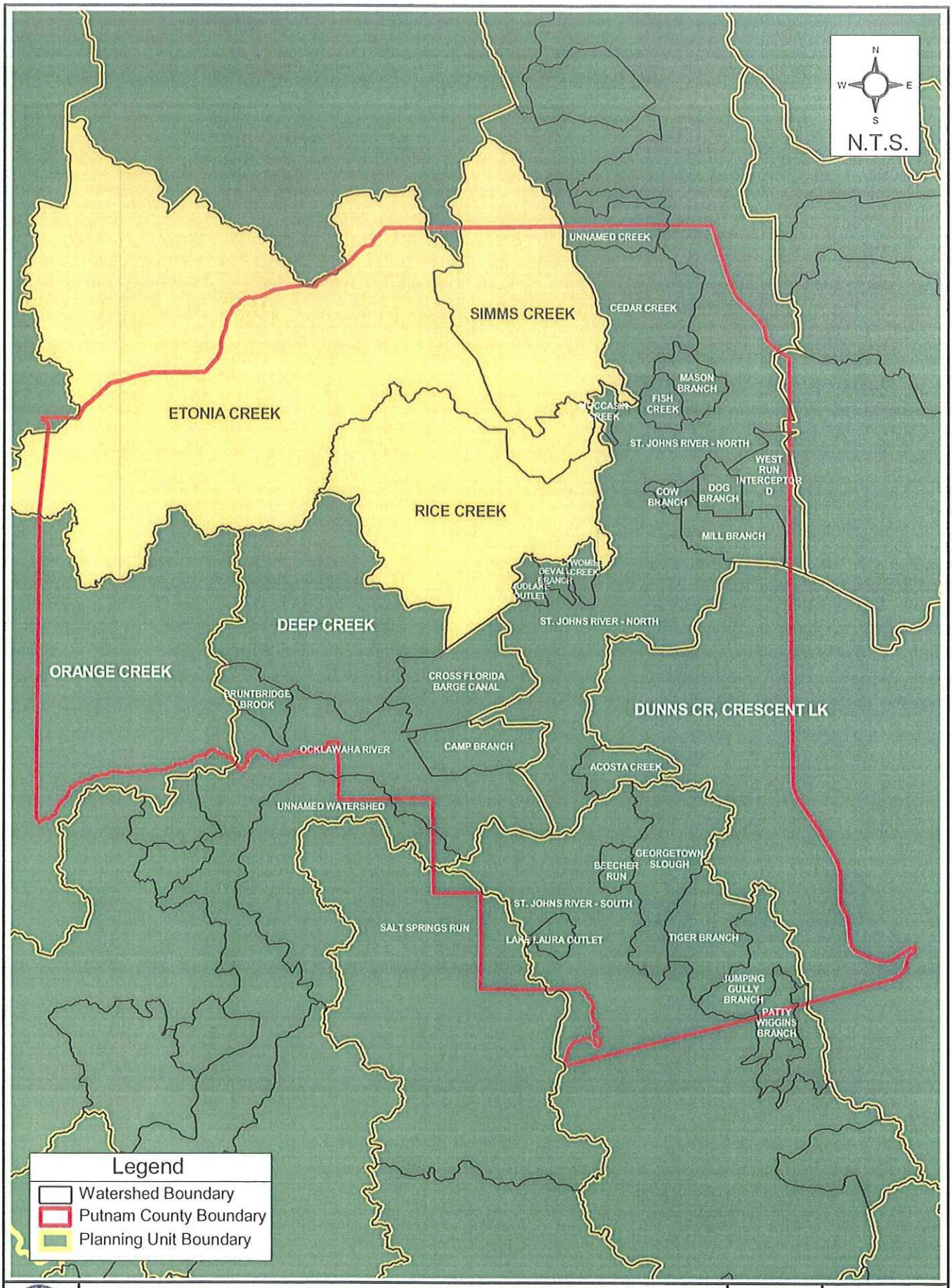
- Etonia Creek
- Rice Creek
- Simms Creek

Hydraulically, Simms Creek drains into Etonia Creek, Etonia Creek flows into Rice Creek, and Rice Creek discharges shortly thereafter to the St. Johns River. Likewise, Rice Creek Swamp drains northward into Rice Creek. However, one area of potential confusion is the fact that there are actually two separate streams named "Rice Creek" in this DPU. The first is the larger stream described above that discharges directly to the St. Johns River. The second is a smaller stream that is tributary to, and lying in the upstream portions of, the Etonia Creek Watershed.

The Etonia Creek DPU is largely undeveloped, dominated by wetlands and forested uplands. Low-density residential land use makes up 8% of the land area, primarily centered around the junction of County Road 315 and State Road 20. Agricultural lands comprise 6% of the land area.

Underlying soils are classified hydrologically as B/D (well drained unless the water table is high) for much of the DPU, and as A (excessively well drained) for a significant portion of the uplands. Wetland areas are characterized by D soils and W (water) designations. A small percentage of the soils are classified as X, indicating the arents group. Arents describes soils that have been disturbed and mixed to an extent that there is little homogeneity. It is common for built-up lands, extractive operations, and highly urbanized areas.

Table 3.1-1 presents a breakdown of existing land use and hydrologic soil group distribution for the Putnam County portion of the Etonia Creek DPU.



G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\DPUs.apr

Location of the Etonia Creek DPU
Putnam County Master Stormwater Plan

Figure 3.1-1

AYRES ASSOCIATES

TABLE 3.1-1 LAND USE AND SOILS SUMMARY FOR ETONIA CREEK DPU

Land Use	Distribution %	Hydrologic Soil Group	Distribution %
Agriculture	6%	A	27%
Barren Land	0%	A/D	0%
Commercial and Services	0%	B	0%
Extractive	1%	B/D	40%
Industrial	1%	C	11%
Institutional	0%	C/D	2%
Open Land	1%	D	15%
Recreational	0%	W (Water)	4%
Residential, High Density	0%	X (Arents)	1%
Residential, Low Density	8%		
Residential, Med. Density	1%		
Transportation, Communication, Utilities	1%		
Upland Forested	50%		
Upland Non-Forested	3%		
Water	3%		
Wetlands	23%		

Several flood problem areas have been identified by Putnam County in the Florahome region.

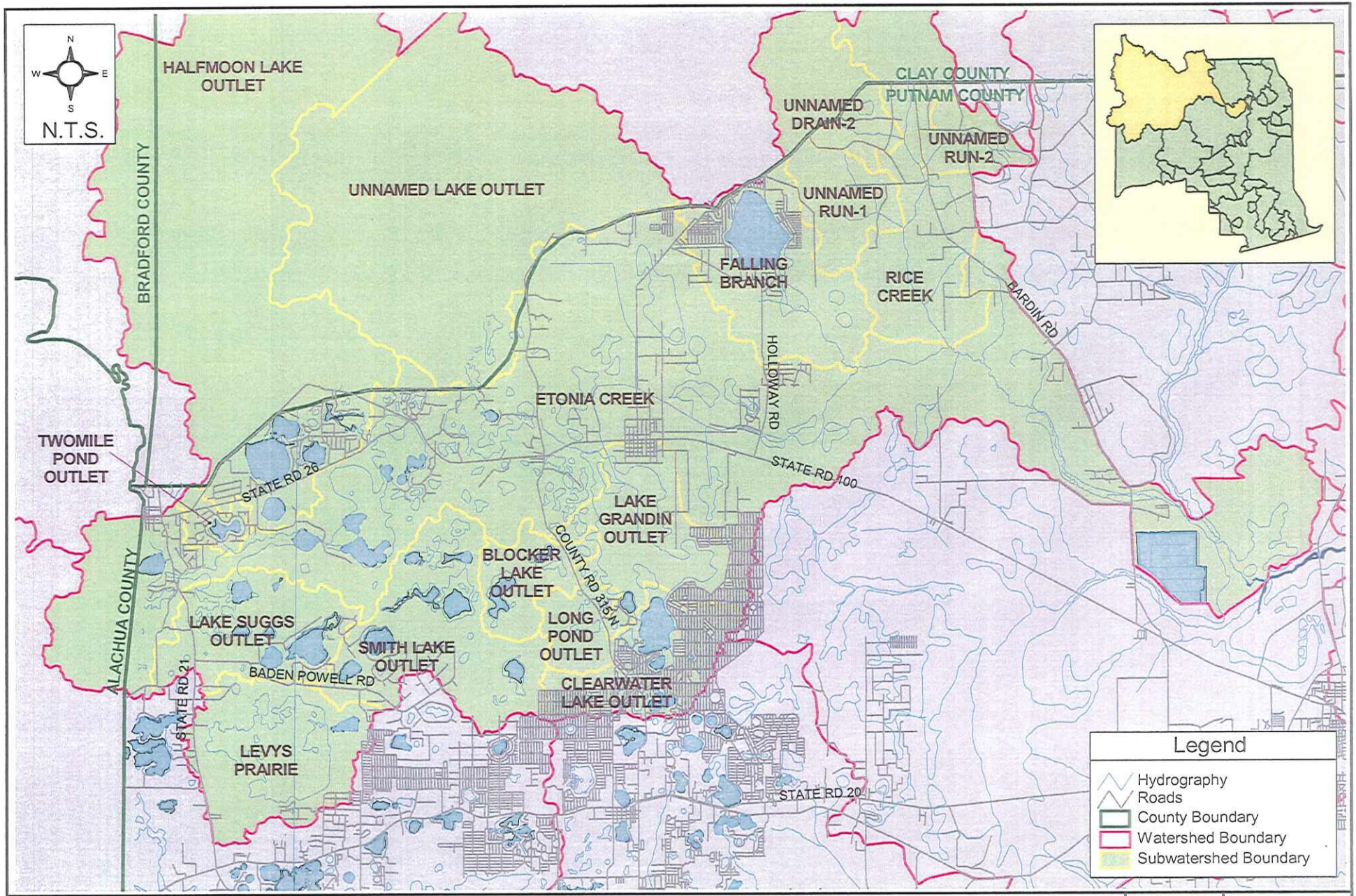
3.1.1 ETONIA CREEK WATERSHED

The Etonia Creek Watershed is located in the northwest corner of Putnam County, spanning the border between Putnam and Clay Counties and including small portions of Alachua and Bradford Counties (**Figure 3.1.1-1**). Of the total 227-square mile drainage area, 141.6 square miles lie in Putnam County. The primary outfall, Etonia Creek, drains from northwest to southeast, eventually discharging into Rice Creek approximately two miles west of its confluence with the St. Johns River. The Putnam County portion of the Etonia Creek Watershed consists of the following fifteen (15) subwatersheds:

1. Blocker Lake Outlet*
2. Etonia Creek*
3. Lake Suggs Outlet*
4. Levys Prairie
5. Smith Lake Outlet
6. Twomile Pond Outlet
7. Halfmoon Lake Outlet (lies predominantly in Clay County)

8. Clearwater Lake Outlet*
9. Long Pond Outlet*
10. Lake Grandin Outlet*
11. Falling Branch*
12. Rice Creek*
13. Unnamed Run-1*
14. Unnamed Run-2*
15. Unnamed Drain-2 (lies mostly in Clay County)

Subwatersheds identified with an asterisk (*) have been selected for additional studies that are described in later subsections.



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Etonia_creek.apr

Location of the Etonia Creek Watershed
Putnam County Master Stormwater Plan

Figure 3.1.1-1

AYRES ASSOCIATES

3.1.1.1 PHYSIOGRAPHY AND HYDROLOGY

Upper Etonia Creek, in the western portion of the Etonia Creek DPU, contains numerous solution depressions that have developed into lakes and wetlands. The most aerially extensive of these depressions are the Florahome Valley, much of which has been ditched and drained, and Levy's Prairie. Sloughs and intermittent streams predominantly connect these lakes and wetlands draining eastward. East of State Road 315 near Florahome, flow is conveyed by canal from Upper Etonia Creek into Etonia Creek.

Falling Branch drains Georges Lake in the northwest corner of Putnam County and outfalls to Etonia Creek roughly 1.5 miles downstream of the canal section. The northern Rice Creek tributary joins Etonia Creek 2 miles further downstream. Downstream of the Rice Creek tributary, the creek widens and natural floodplains are evident on both sides of the channel.

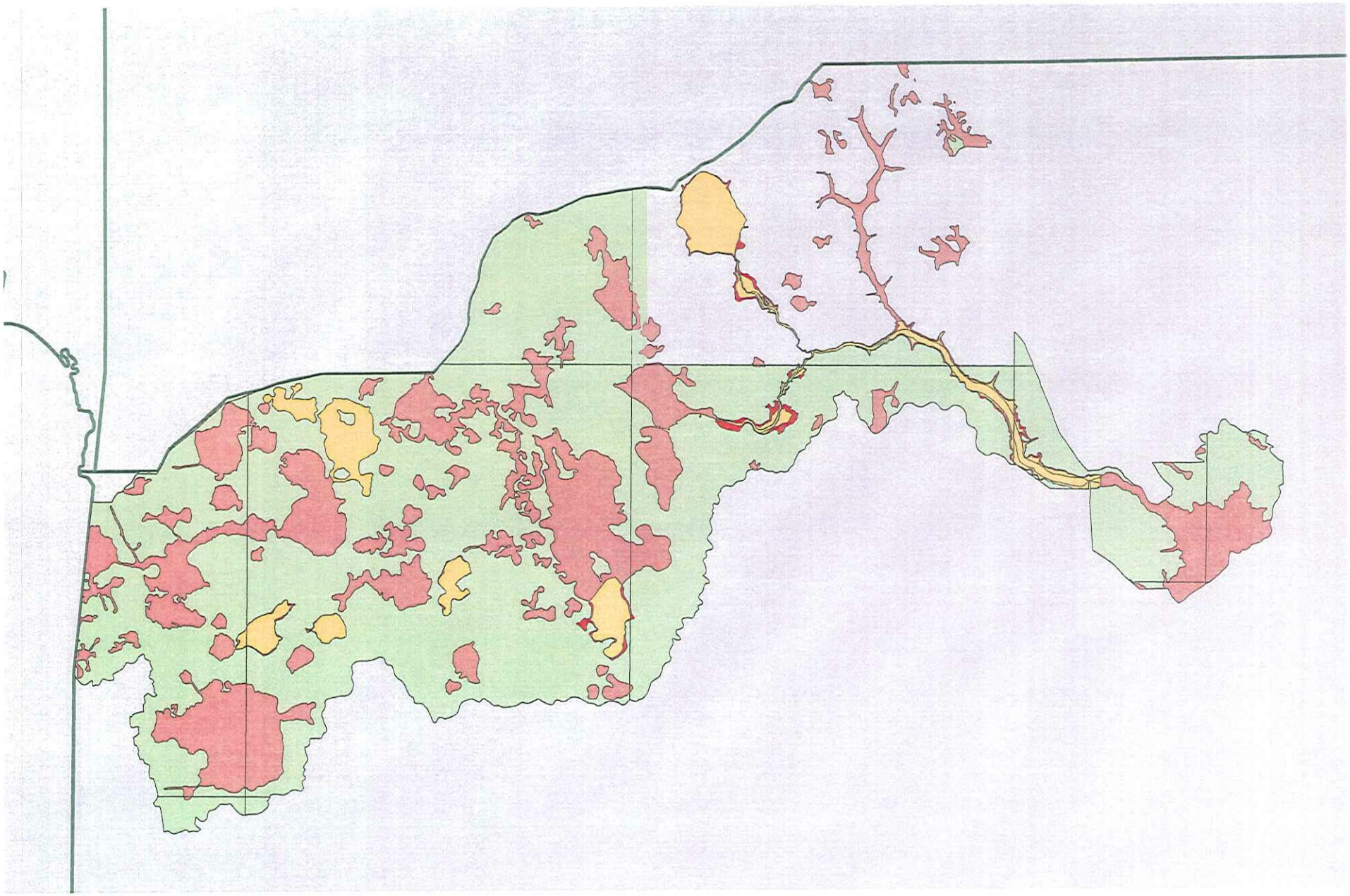
The USGS streamflow gage 02245050 "Etonia Creek at Bardin" is located on Etonia Creek in Putnam County at the Bardin Road crossing, roughly 5 miles downstream of the Rice Creek tributary confluence. The contributing drainage area at the gage is estimated by USGS to be 219 square miles. Monthly mean streamflow data collected from 1973 through 2003 reflect a range from 19 cfs to 393 cfs, with an average mean monthly streamflow of 89 cfs. The highest mean monthly flows are typically seen in February (associated with frontal system rainfall) and August-September (associated with wet-season tropical and convective storms). Lowest mean monthly flows are exhibited in May and November.

Two SJRWMD rain gages are located within or just on the boundary of this watershed. The first, site no. 7010 "Chesser Well", has continuous recorder values from 2002 to the present. The second, site no. 1784 "Etonia East V Road", has continuous recorder values from 1990 to the present.

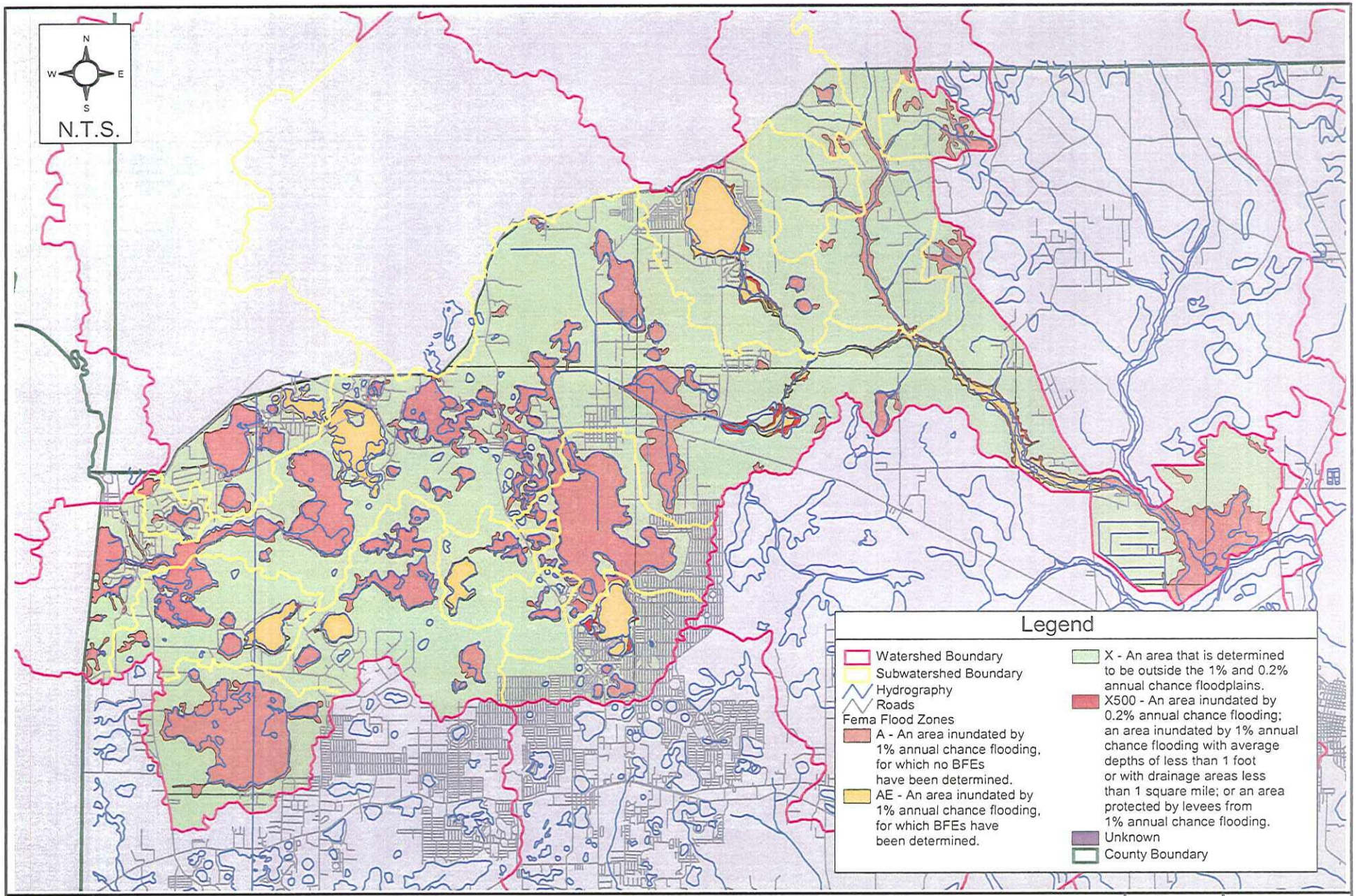
3.1.1.2 FEMA Flood Zones

The vast majority of this watershed is classified Zone X, or area determined to be outside the 500-year floodplain. However, around Etonia Creek and its significant tributaries there are consistent strips of land designated Zone A or AE. Areas in Zone A lie in the 100-year floodplain, but for which no base flood elevations have been determined. Areas in Zone AE lie in the 100-year floodplain, and base flood elevations have been determined. Other areas of Zone A and AE surround the many small lakes in the western portions of the watershed. FEMA floodplain mapping is depicted on **Figure 3.1.1-2**.

Additionally, as part of the Putnam County FIS, Etonia Creek has been studied in detail from a point approximately 1,000 feet south of the Bardin Road crossing to the Holloway Road crossing, which is approximately 69,000 feet upstream. The Falling Branch tributary to Etonia Creek has also been studied in detail as part of the Putnam County FIS for a distance of approximately 15,000 feet, from its confluence with Etonia Creek to its origin at Georges Lake. Etonia Creek and Falling Branch stream profile graphs are located in the Putnam County FIS provided in **Appendix 3-A** of this SMP. Stillwater flood elevations for various return frequencies are presented for Clearwater Lake, Clubhouse Lake, Cue Lake, Georges Lake, Lake Grandin, Halfmoon Lake, Long Lake, and Putnam Prairie/Wall Lake.



FEMA Flood Zones in the Etonia Creek Watershed



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Etonia_creek.apr

FEMA Flood Zones in the Etonia Creek Watershed

Putnam County Master Stormwater Plan

Figure 3.1.1-2

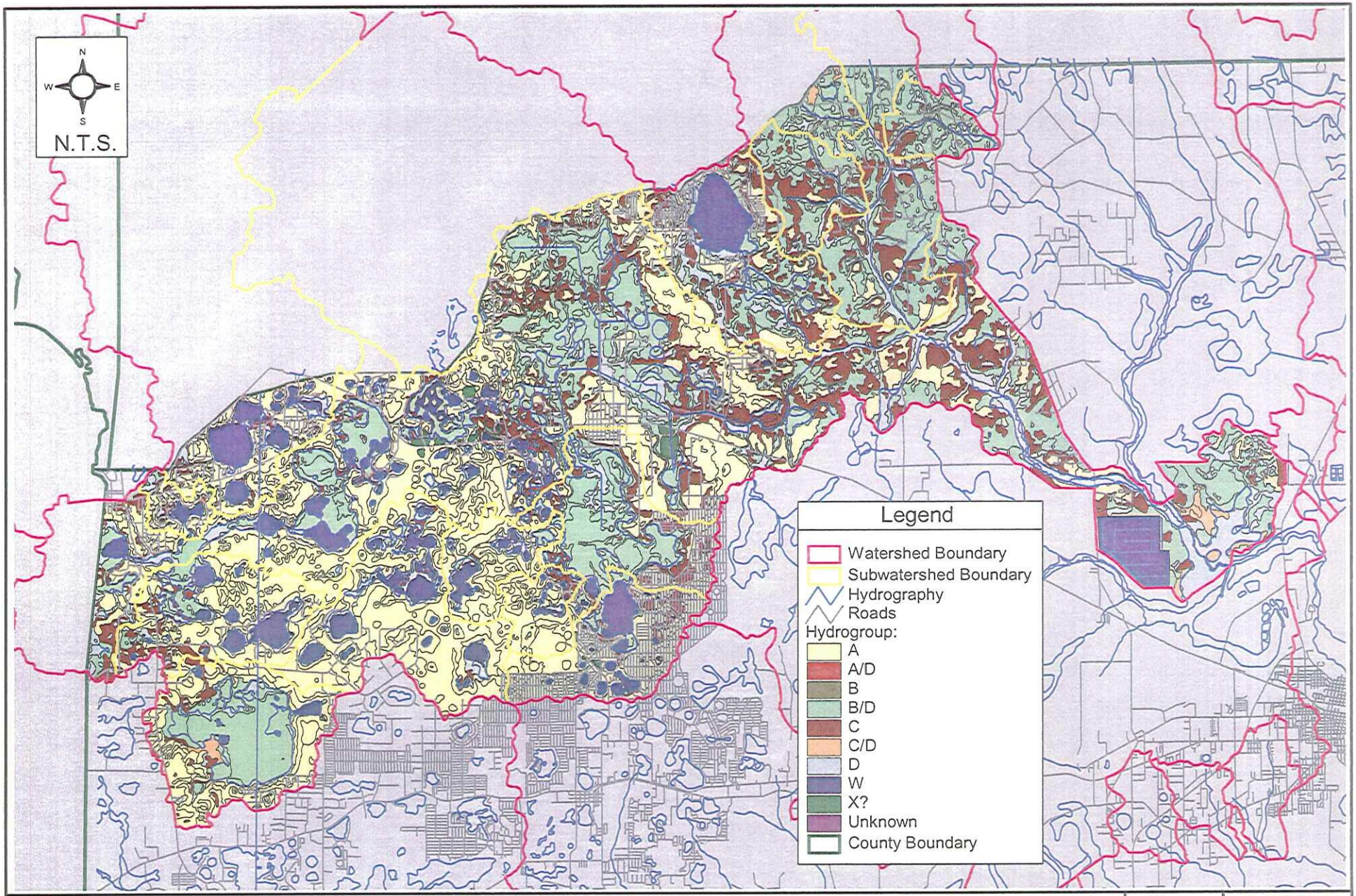
AYRES ASSOCIATES

3.1.1.3 Soils

Hydrologic soil group classifications in this watershed are dominated by A and B/D designations. Water and wetland soils comprise 17% of the watershed area. **Figure 3.1.1-3** depicts the current hydrologic soil groups in the Etonia Creek Watershed.

3.1.1.4 Land Use/ Land Cover

This is a large watershed, and as such, exhibits extremely diverse land uses, including large areas of upland forest, numerous tracts of wetlands around significant waterways and lakes, sizable areas of agricultural lands, and residential developments scattered throughout the watershed. **Figure 3.1.1-4** depicts the current land use in the Etonia Creek Watershed.

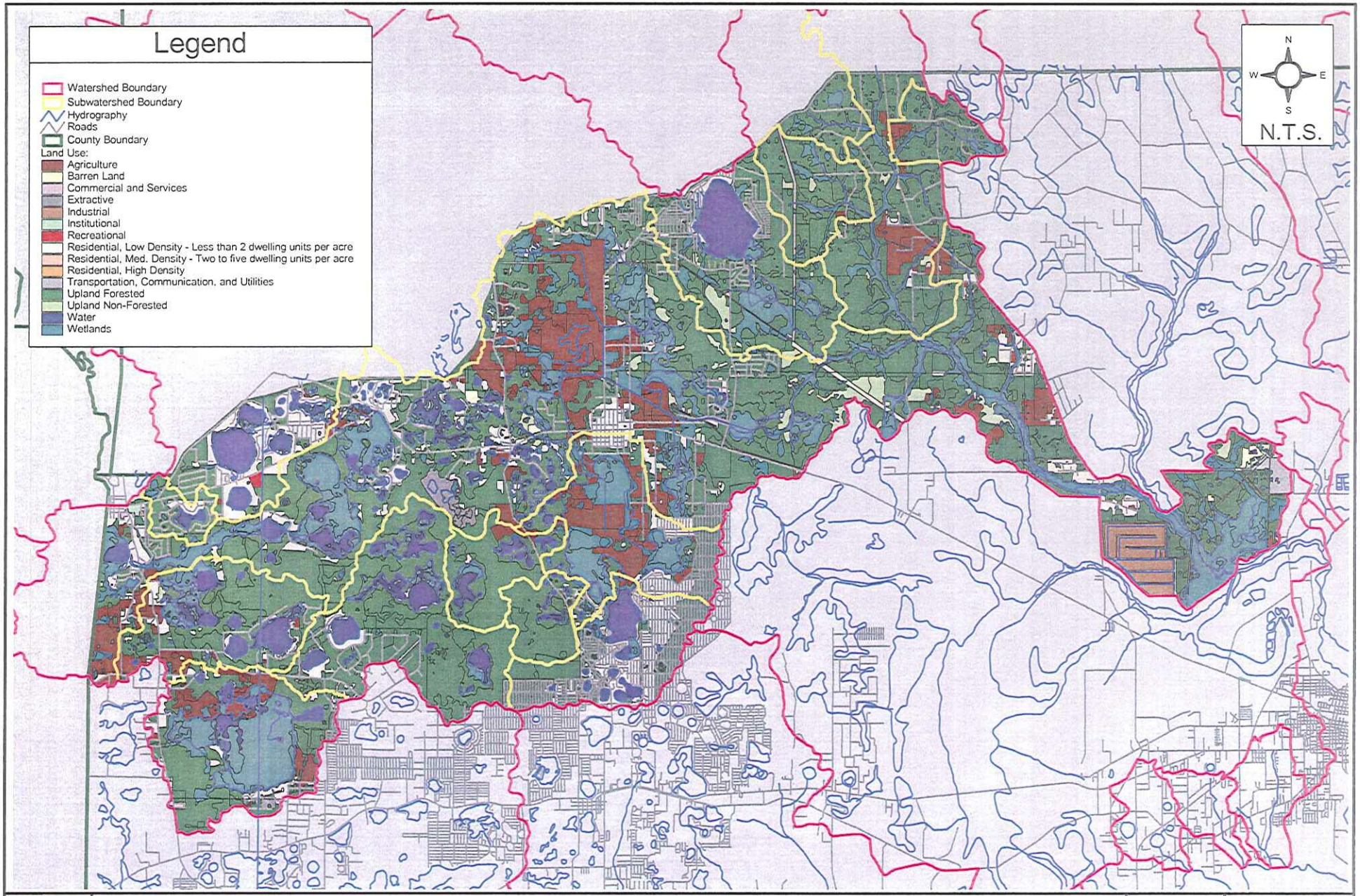


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Etonia_creek.apr

Soils Distribution in the Etonia Creek Watershed
Putnam County Master Stormwater Plan

Figure
3.1.1-3

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Etonia_creek.apr

Land Use Distribution in the Etonia Creek Watershed
Putnam County Master Stormwater Plan

Figure
3.1.1-4

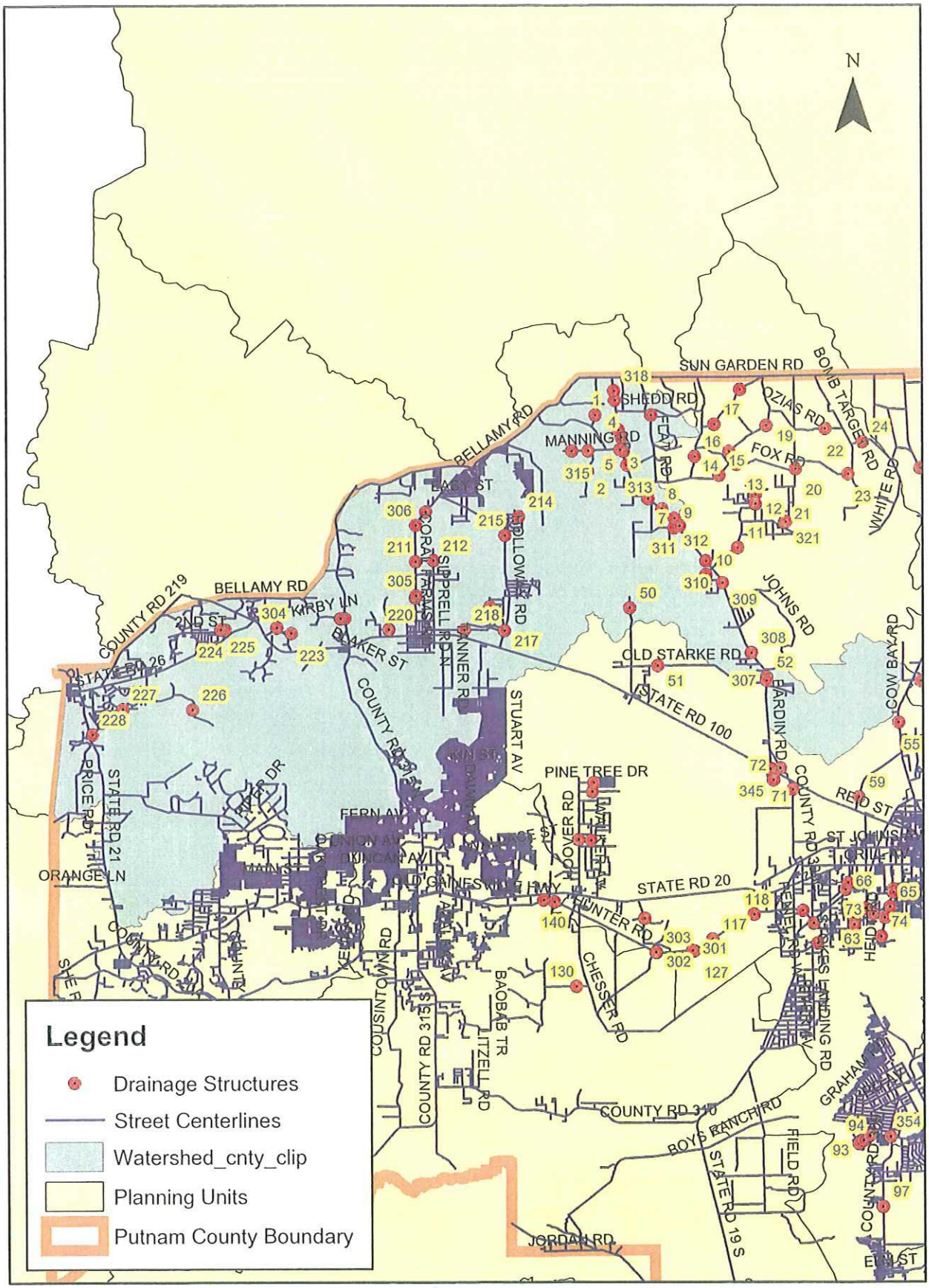
AYRES ASSOCIATES

3.1.1.5 Field Investigations in Selected Subwatersheds

The field reconnaissance program described in Section 2.10 was performed for ten selected Etonia subwatersheds as illustrated on the following index figure. No modifications to basin delineations resulted from field investigations. Field reports for hydraulic structures and photo documentation from the investigation is presented in **Appendix 3-B**. These data have been incorporated into a GIS database for County use.

3.1.1.6 Sewer Network and Point Source Discharge

Sewer networks and point source discharges in this watershed have not been identified by the County. A search of FDEP permitted point source discharges and industrial stormwater dischargers was performed and no permitted point source discharges were found in the Etonia Creek Watershed.



Field Reconnaissance - Etonia Creek Watershed

3.1.2 RICE CREEK WATERSHED

The Rice Creek Watershed is located in north-central Putnam County, and consists of 73 square miles of total drainage area, all of which lie in Putnam County (**Figure 3.1.2-1**). The primary outfall is Rice Creek, but the watershed is actually dominated by the Rice Creek Swamp, a large wetland area lying in the central portion of the watershed. Most of the Rice Creek subwatersheds drain into the Rice Creek Swamp, which is then drained by Rice Creek itself before discharging to the St. Johns River. The Rice Creek Watershed includes the following eleven (11) subwatersheds:

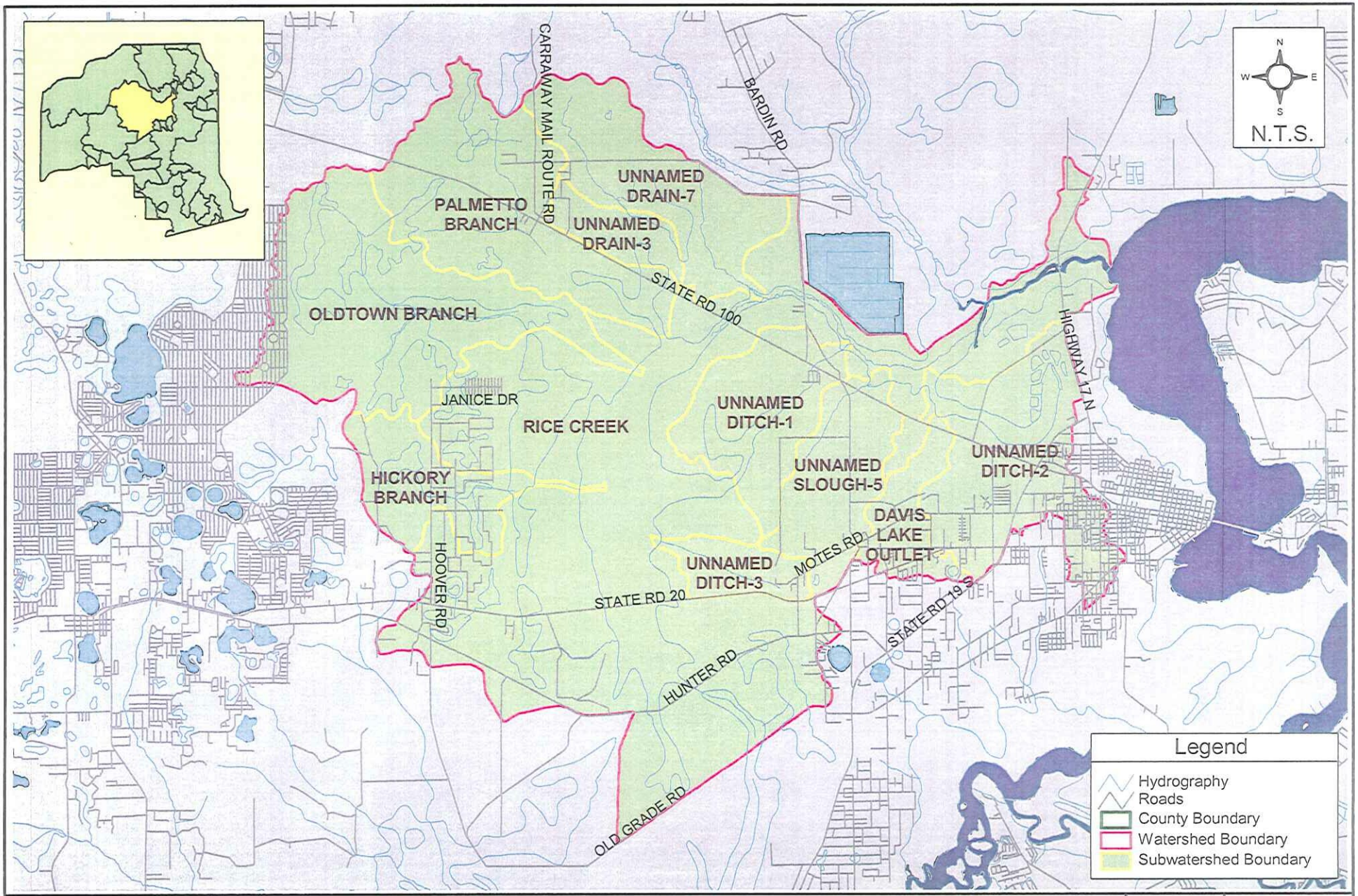
1. Rice Creek*
2. Hickory Branch
3. Oldtown Branch*
4. Palmetto Branch*
5. Unnamed Drain-3
6. Unnamed Drain-7
7. Unnamed Ditch-1*
8. Unnamed Ditch-2*
9. Unnamed Ditch-3*
10. Unnamed Slough-5*
11. Davis Lake Outlet*

Subwatersheds identified with an asterisk (*) have been selected for additional studies that are described in later subsections.

3.1.2.1 Physiography and Hydrology

The northwest portion of the watershed, near State Highway 100 exhibits the highest elevation, 200 feet NGVD, and steepest surface slope as it drains eastward to the Oldtown Branch tributary and into Rice Creek Swamp. Rice Creek Swamp elevations range from 10 to 30 feet NGVD. The Palmetto Branch to the north parallels Oldtown Branch, as does Hickory Branch to the south. On the east side of the Rice Creek Swamp, topographic highs are approximately 70 feet NGVD on the west side of Palatka near State Highways 19 and 20. Drainage patterns are general northwesterly toward the Rice Creek channel.

There are two USGS streamflow gages within the Rice Creek Watershed. The "Rice Creek near Springside" gage, Gage No. 0244473, is located at the State Highway 100 crossing of the Rice Creek Swamp outlet channel. The second gage is USGS Gage No. 0245200, "Rice Creek near Palatka". This gage is located at the US Highway 17 crossing of Rice Creek, just one mile upstream of its outfall to the St. Johns River. **Table 3.1.2.1** summarizes the stream hydrology gathered from USGS streamflow records.



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Rice_creek.apr

Location of the Rice Creek Watershed
Putnam County Master Stormwater Plan

Figure
3.1.2-1

AYRES ASSOCIATES

One SJRWMD rain gage and one NCDC Co-op station with rainfall data are located in the Rice Creek Watershed. Both gages are in the eastern portion of the watershed. The SJRWMD rain gage site no. 210 is located at the District Headquarters. The gage offers continuous rainfall records from 1988 to the present. The NCDC 086753 Palatka station offers daily rainfall data from 1948 to the present. At the northwestern boundary of the Rice Creek Watershed, just inside the Etonia Creek Watershed, the SJRWMD "Etonia East V Road" gage (site 1784) is found, offering continuous recording of rainfall from 1990 to the present.

TABLE 3.1.2.1 STREAMFLOW SUMMARY FOR RICE CREEK GAGES

Gage No. / Recorded Period	Estimated Drainage Area (mi^2)	Monthly Mean Flow Range (cfs)	Average Mean Monthly Flow (cfs)	High Flow Month(s) / Low Flow Month(s)
0244473 / 1973 – 2003	43.2	2.0	43	Feb-Mar, Sep / May
0245200 / 1995 - 1997	349	227 – 925	420	Oct / Jan-Feb

3.1.2.2 FEMA Flood Zones

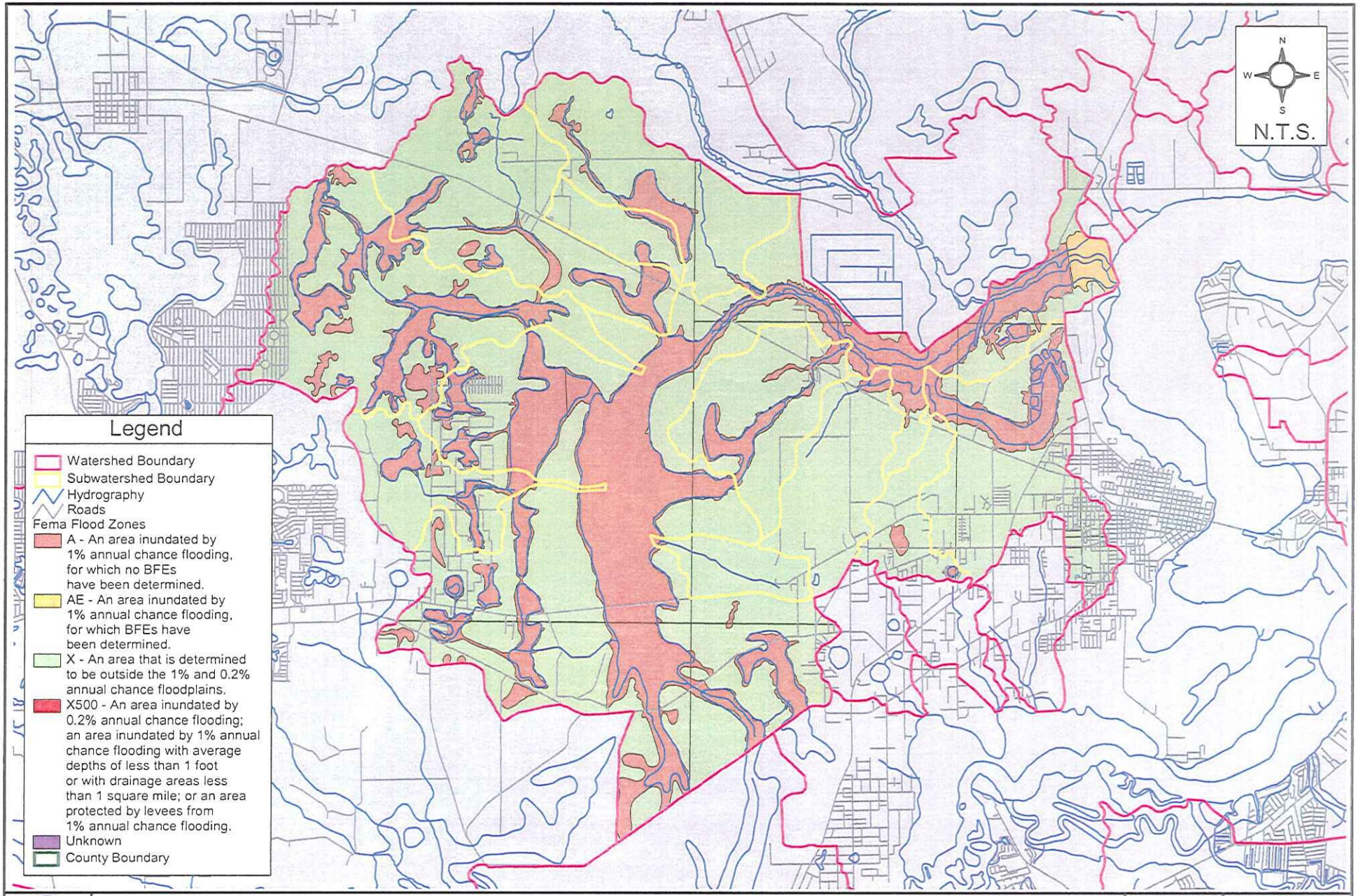
Most of this watershed is classified Zone X, or areas outside the 500-year floodplain. However, all of the subwatersheds contain significant areas designated Zone A, particularly along Rice Creek and in the Rice Creek Swamp area. Areas in Zone A lie in the 100-year floodplain for which no base flood elevations have been determined. None of the streams in this watershed have been studied in detail as part of the FEMA FIS for Putnam County. FEMA floodplain mapping is depicted on **Figure 3.1.2-2** and the entire text of the Putnam County FIS is provided in **Appendix 3-A** of this SMP.

3.1.2.3 Soils

Hydrologic soil groups are classified as B/D and D for the majority of the watershed. **Figure 3.1.2-3** depicts the current hydrologic soil groups in the Rice Creek Watershed.

3.1.2.4 Land Use/ Land Cover

The Rice Creek Watershed exhibits diverse land uses, with all categories except "Extractive" represented within its boundaries. The dominant land uses are not developed, however, consisting of "Upland Forested" and "Wetland" categories. The category with the next highest representation is "Residential" use, comprising only 7% of the watershed, followed by "Agricultural" use at 3%. **Figure 3.1.2-4** depicts the current land use in the Rice Creek Watershed.



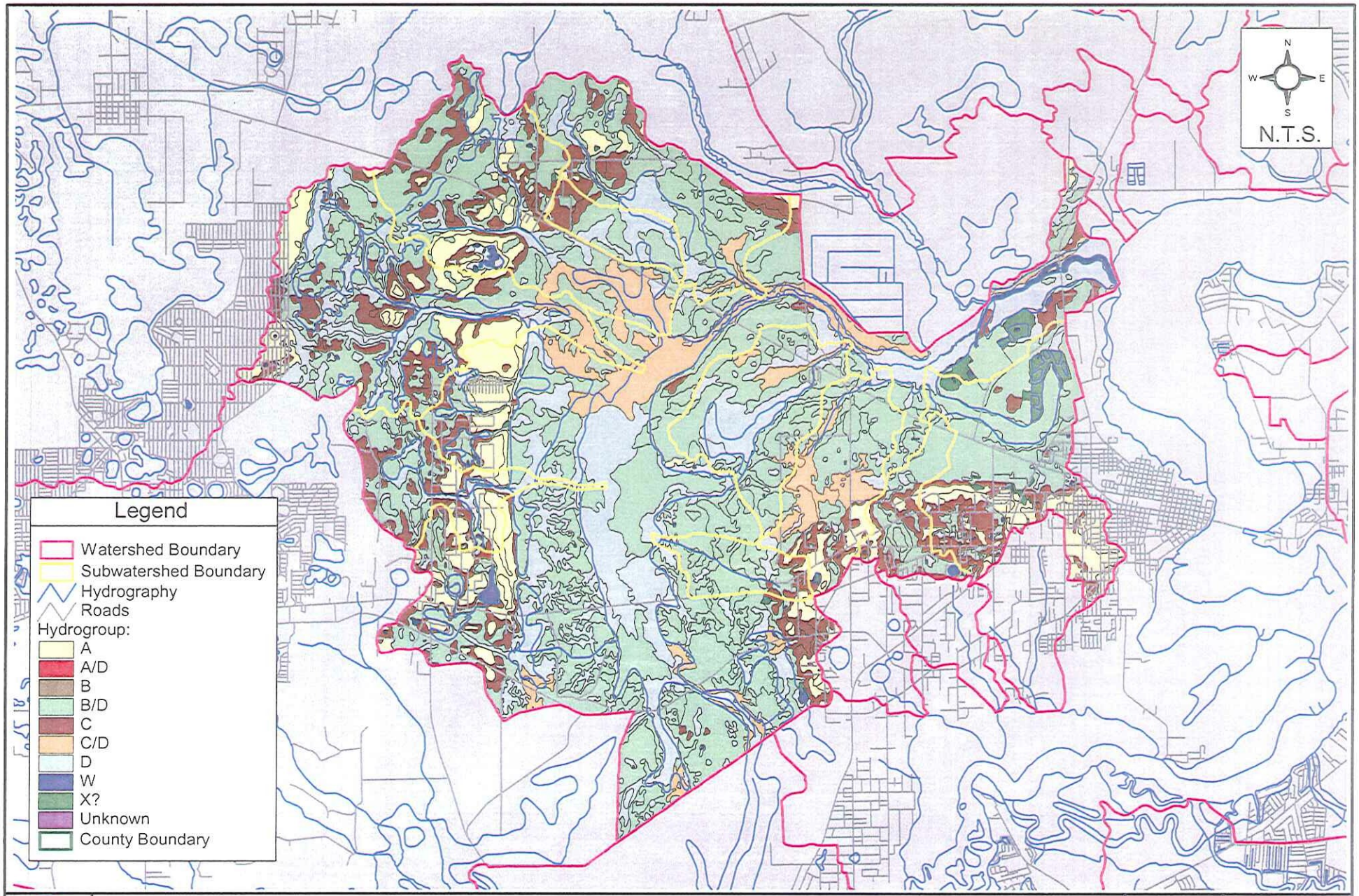
G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\Rice_creek.apr

FEMA Flood Zones in the Rice Creek Watershed

Putnam County Master Stormwater Plan

Figure 3.1.2-2

AYRES ASSOCIATES

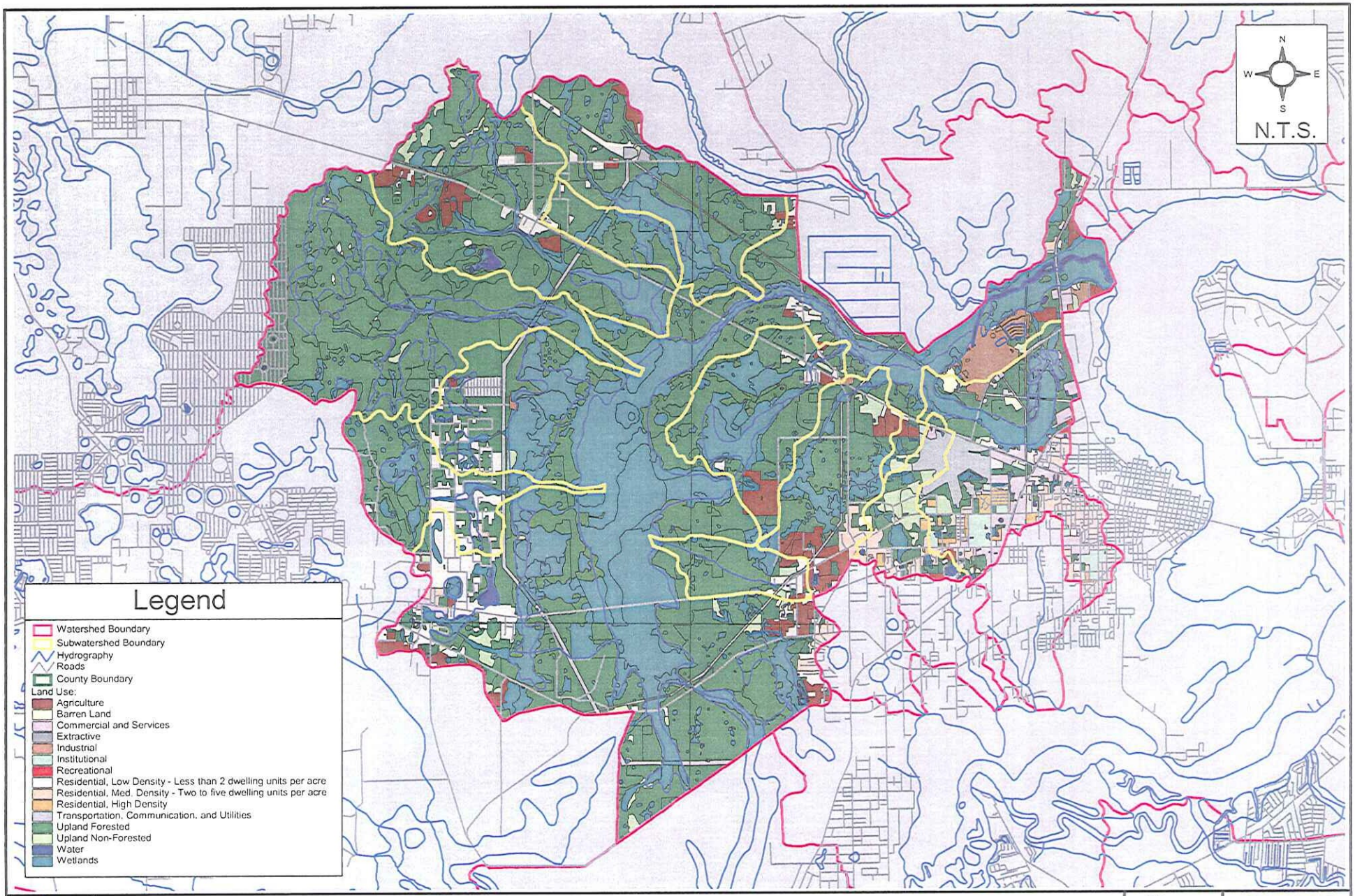


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Rice_creek.apr

Soils Distribution in the Rice Creek Watershed
Putnam County Master Stormwater Plan

Figure
3.1.2-3

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Rice_creek.apr

Land Use Distribution in the Rice Creek Watershed
Putnam County Master Stormwater Plan

Figure
3.1.2-4

AYRES ASSOCIATES

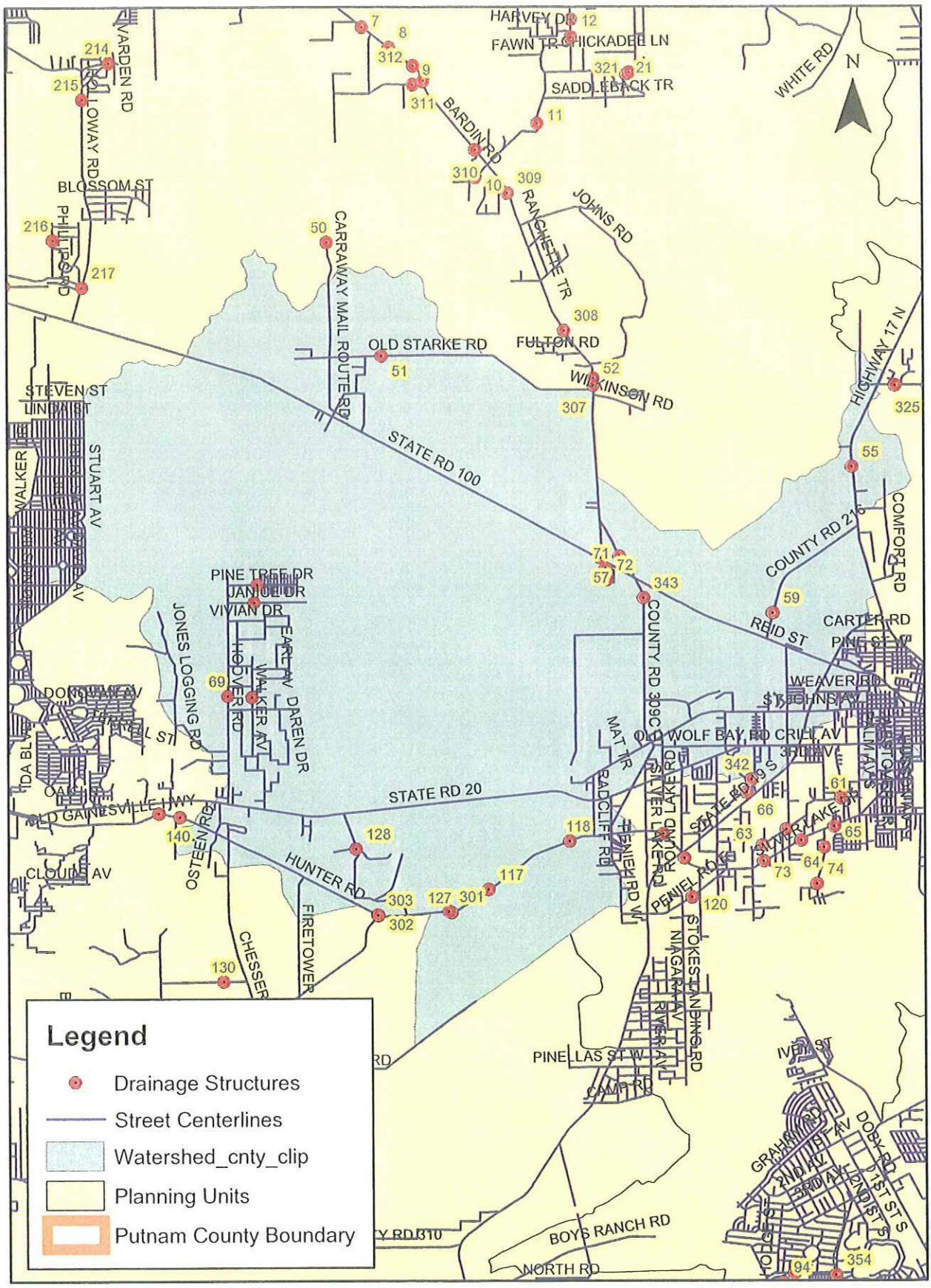
3.1.2.5 Field investigations in Selected Subwatersheds

The field reconnaissance program described in Section 2.10 was performed for eight selected Rice Creek subwatersheds as illustrated on the following index figure. No modifications to basin delineations resulted from field investigations. Field reports for hydraulic structures and photo documentation from the investigation is presented in **Appendix 3-B**. These data have been incorporated into a GIS database for County use.

3.1.2.6 Sewer Network and Point Source Discharge

Sewer networks and point source discharges in this watershed have not been identified by the County. A search of FDEP permitted point source discharges and industrial stormwater dischargers was performed and yielded the following results:

WATER SHED	SUBWATER SHED	FACILITY ID	NAME	FACILITY TYPE	FACILITY ADDRESS	CITY	OWNER SHIP TYPE
Rice Creek	Rice Creek	FLR05C419	CENTRAL LANDFILL	Multi-Sector Stormwater GP	140B COUNTY LANDFILL RD	PALATKA	Public Owner ship
Rice Creek	Rice Creek	FL0002763	GEORGIA PACIFIC CORP - PALATKA	Industrial Wastewater	CR 216	PALATKA	Privately Owned
Rice Creek	Rice Creek	FL0037800	MONTCO RESEARCH PRODUCTS, INC	Industrial Wastewater	END OF JANICE DRIVE	HOLLISTER	Privately Owned
Rice Creek	Unnamed Ditch-2	FLR05B628	GEORGIA-PACIFIC CORP	Multi-Sector Stormwater GP	CR 216	PALATKA	Privately Owned
Rice Creek	Unnamed Ditch-2	FLR05D058	GEORGIA-PACIFIC CORP	Multi-Sector Stormwater GP	CR 216 BUILDING 155	PALATKA	Privately Owned
Rice Creek	Unnamed Ditch-2	FLG110487	TARMAC AMERICA, INC. - PALATKA	Concrete Batch GP	129 PHILLIPS DAIRY ROAD	PALATKA	Privately Owned



Field Reconnaissance - Rice Creek Watershed

3.1.3 SIMMS CREEK WATERSHED

The Simms Creek Watershed is located along a portion of the northern border of Putnam County with Clay County (**Figure 3.1.3-1**). The total area encompassed by the watershed is 54.8 square miles, of which 43.9 square miles lie in Putnam County. Simms Creek drains southward from the northeast quadrant of the Etonia Creek DPU, flowing into Etonia Creek roughly one mile east of Bardin. The Simms Creek Watershed includes the following seven (7) subwatersheds located in whole or in part within Putnam County:

1. Simms Creek*
2. Unnamed Branch-1*
3. Unnamed Branch-2*
4. Unnamed Branch-3* (Harvey Creek)
5. Unnamed Drain-1*
6. Unnamed Drain-5*
7. Unnamed Drain-6* (Hammock Branch)

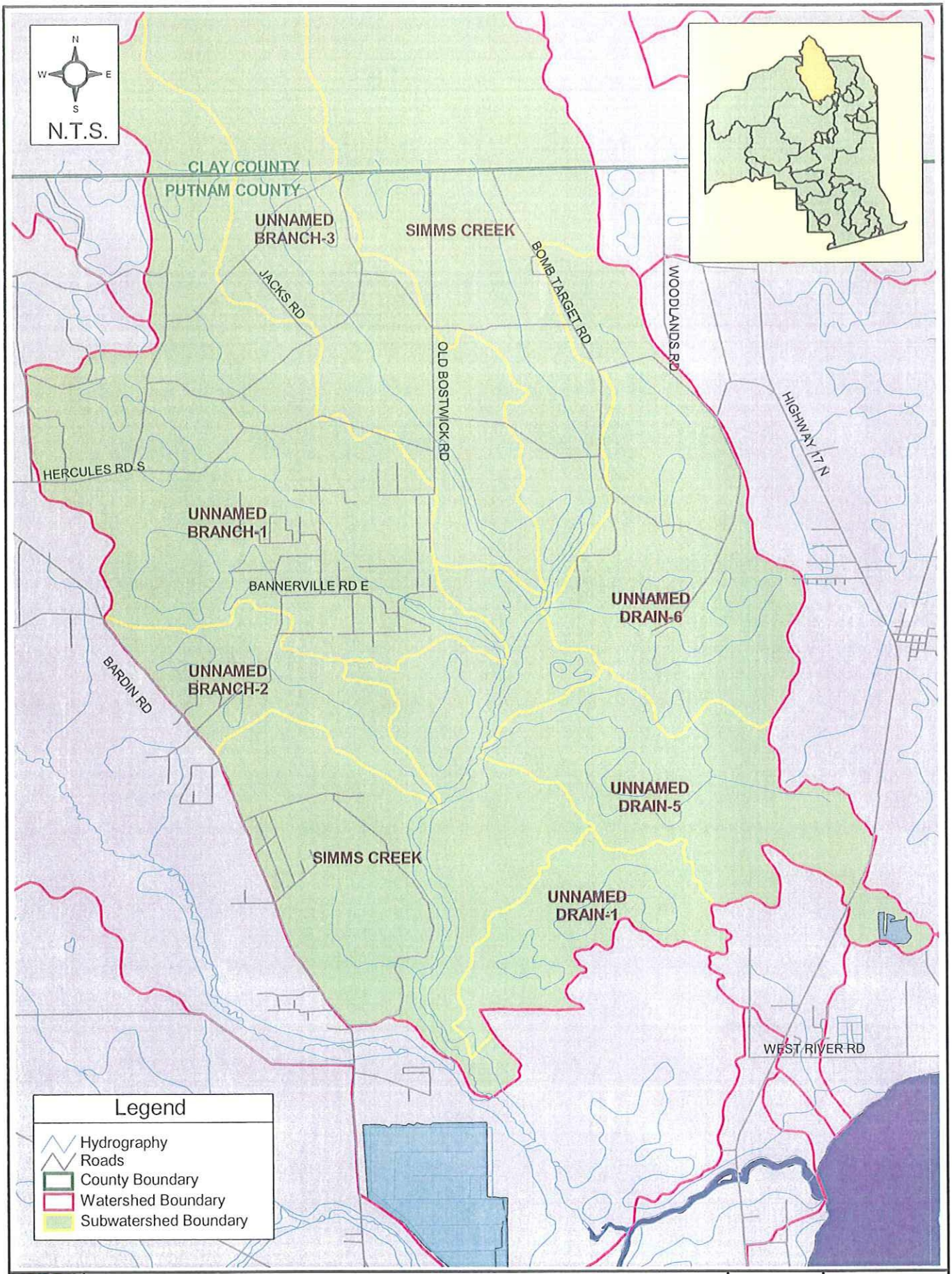
Subwatersheds identified with an asterisk (*) have been selected for additional studies that are described in later subsections.

3.1.3.1 Physiography and Hydrology

Sims Creek runs approximately 10.5 river-miles in a southerly direction, with tributaries feeding in from the east and west. Watershed ground elevations range from 105 feet NGVD at the watershed's northern and western boundaries, to 35 feet NGVD at its confluence with Etonia Creek near Bardin, Florida.

Streamflow is recorded at USGS Gage 0245140, "Simms Creek near Bardin." The gage is located approximately two miles upstream from the Etonia Creek outfall. The contributing drainage area at the gage is estimated by USGS to be 47.3 square miles. Monthly mean streamflow data collected from 1973 through 2003 reflect a range from 5.6 cfs to 374 cfs, with an average mean monthly streamflow 49 cfs. The highest mean monthly flows are typically seen in August-September. Lowest mean monthly flows are exhibited in May.

There are no NCDC or SJRWMD rain gaging stations located within the watershed.



G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\Simms_creek.apr

Location of the Simms Creek Watershed
Putnam County Master Stormwater Plan

Figure 3.1.3-1

AYRES ASSOCIATES

3.1.3.2 FEMA Flood Zones

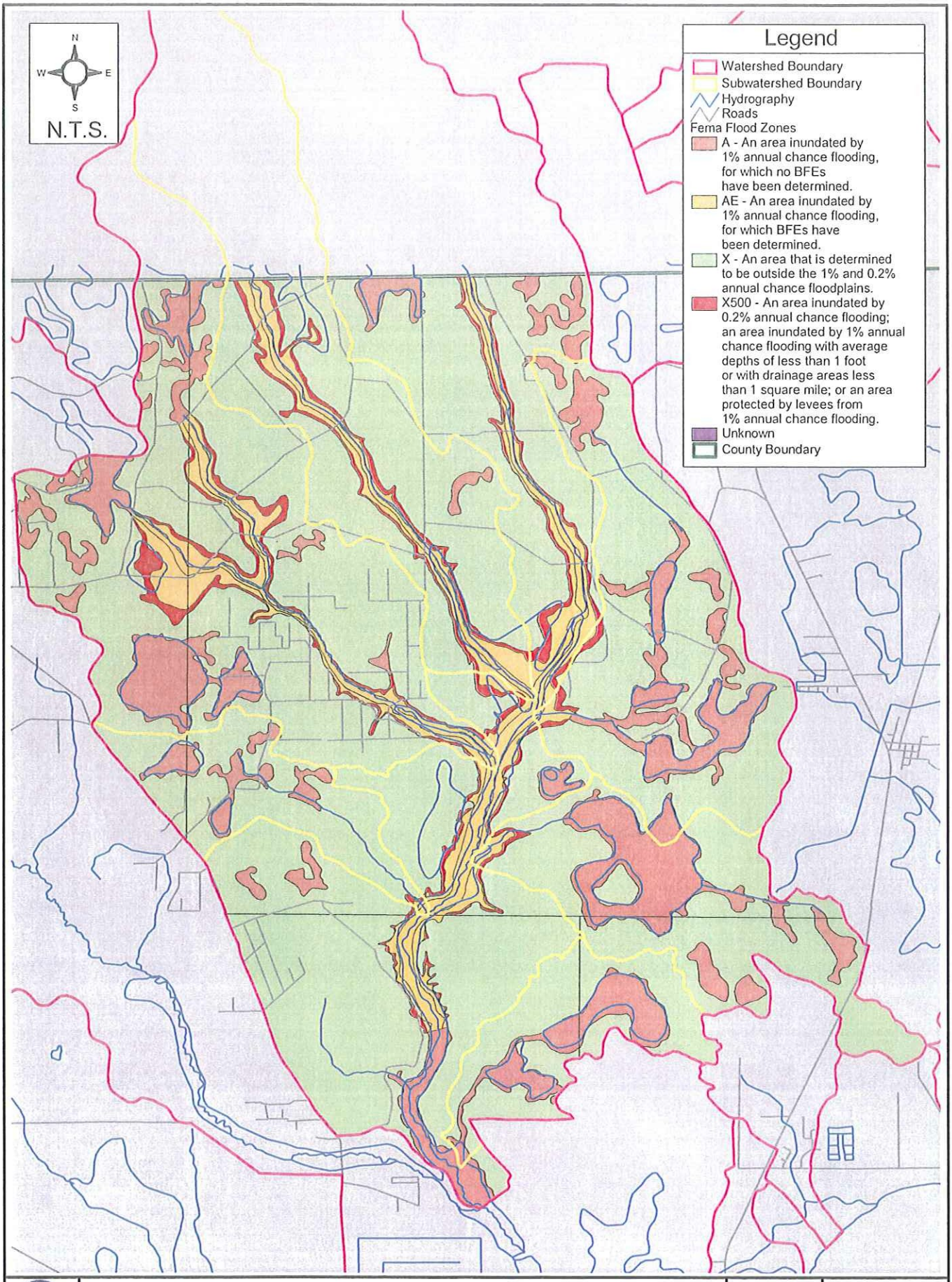
Most of this watershed is classified Zone X, or areas outside the 500-year floodplain. However, all of the subwatersheds contain areas designated Zone A or AE, particularly along Simms Creek and along the tributary channels. Areas in Zone A lie in the 100-year floodplain for which no base flood elevations have been determined. Areas in Zone AE lie in the 100-year floodplain where base flood elevations have been determined. Floodways are designated for the Simms Creek main channel as well as for the Unnamed Branch-1 (FEMA TRIB-1) and Unnamed Branch-3 (Harvey Creek, FEMA TRIB-2) tributaries. These streams have been studied in detail as part of the FEMA FIS for Putnam County. FEMA floodplain mapping is depicted on **Figure 3.1.3-2** and the entire text of the Putnam County FIS is provided in **Appendix 3-A** of this SMP.

3.1.2.3 Soils

Hydrologic soil groups are classified as B/D and D for the more than three-quarters of the watershed. Roughly 12% of the watershed area is comprised of C classification soils. **Figure 3.1.3-3** depicts the current hydrologic soil groups in the Simms Creek Watershed.

3.1.3.4 Land Use/ Land Cover

Figure 3.1.3-4 depicts the current land use in the Simms Creek Watershed. "Upland forested" and "wetland" land use dominate the area. "Extractive" and "Agricultural" land use occupies 9 to 10% of the watershed. Developed land uses occupy very little area, proportionally.

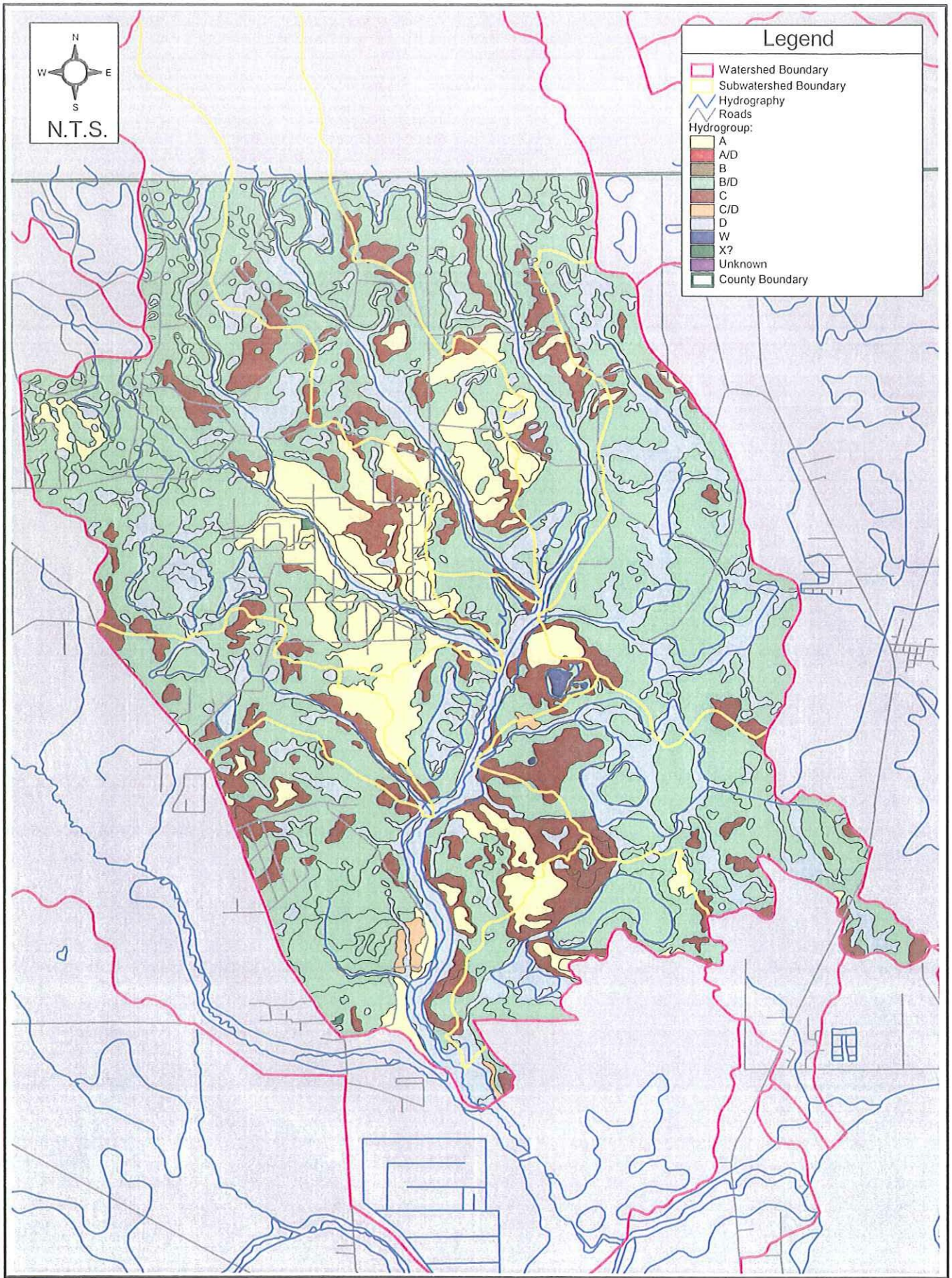


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Simms_creek.apr

FEMA Flood Zones in the Simms Creek Watershed
Putnam County Master Stormwater Plan

Figure 3.1.3-2

AYRES ASSOCIATES

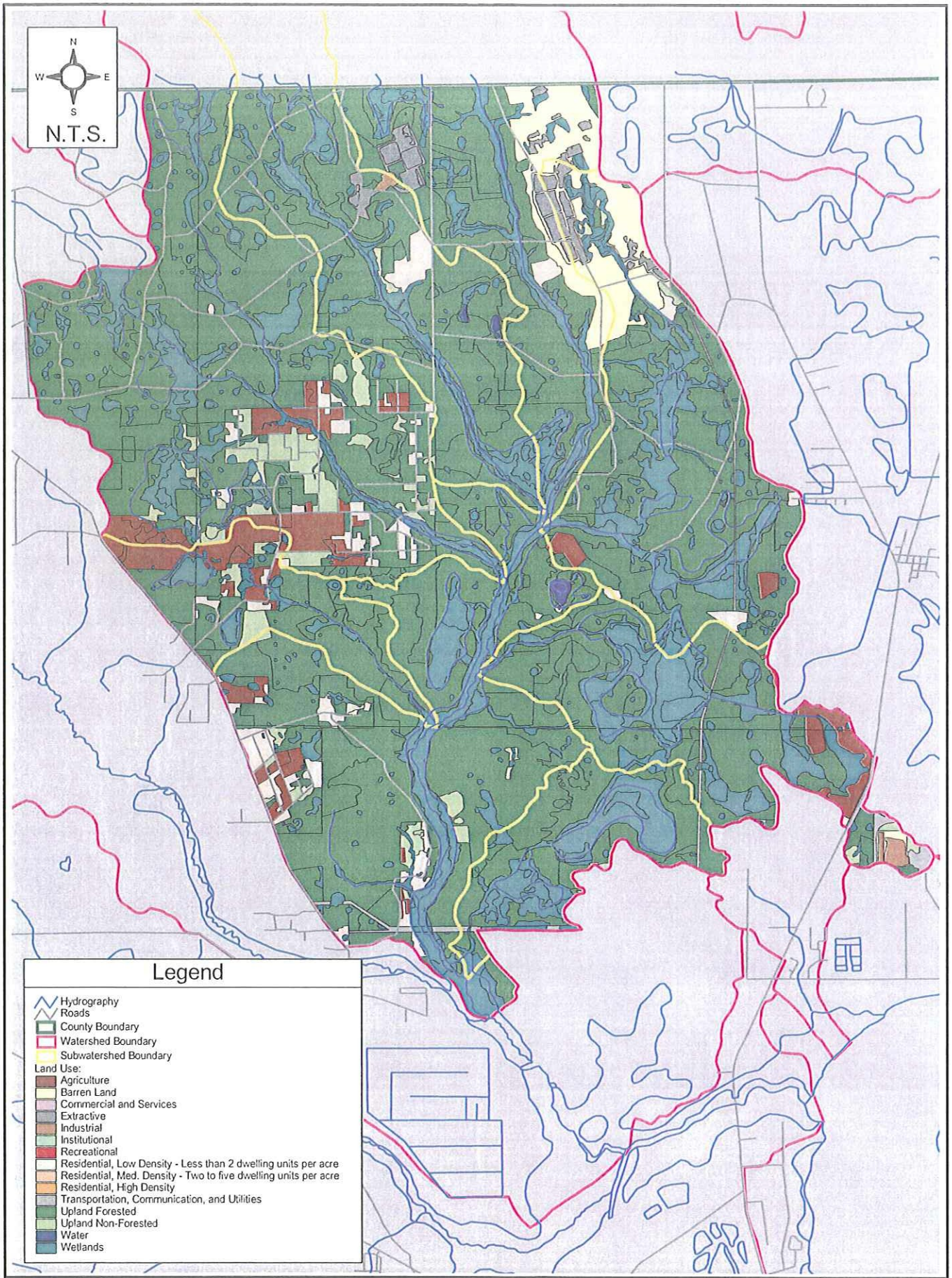


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Simms_creek.apr

Soils Distribution in the Simms Creek Watershed
Putnam County Master Stormwater Plan

Figure
3.1.3-3

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Simms_creek.apr

Land Use Distribution in the Simms Creek Watershed
Putnam County Master Stormwater Plan

Figure
3.1.3-4

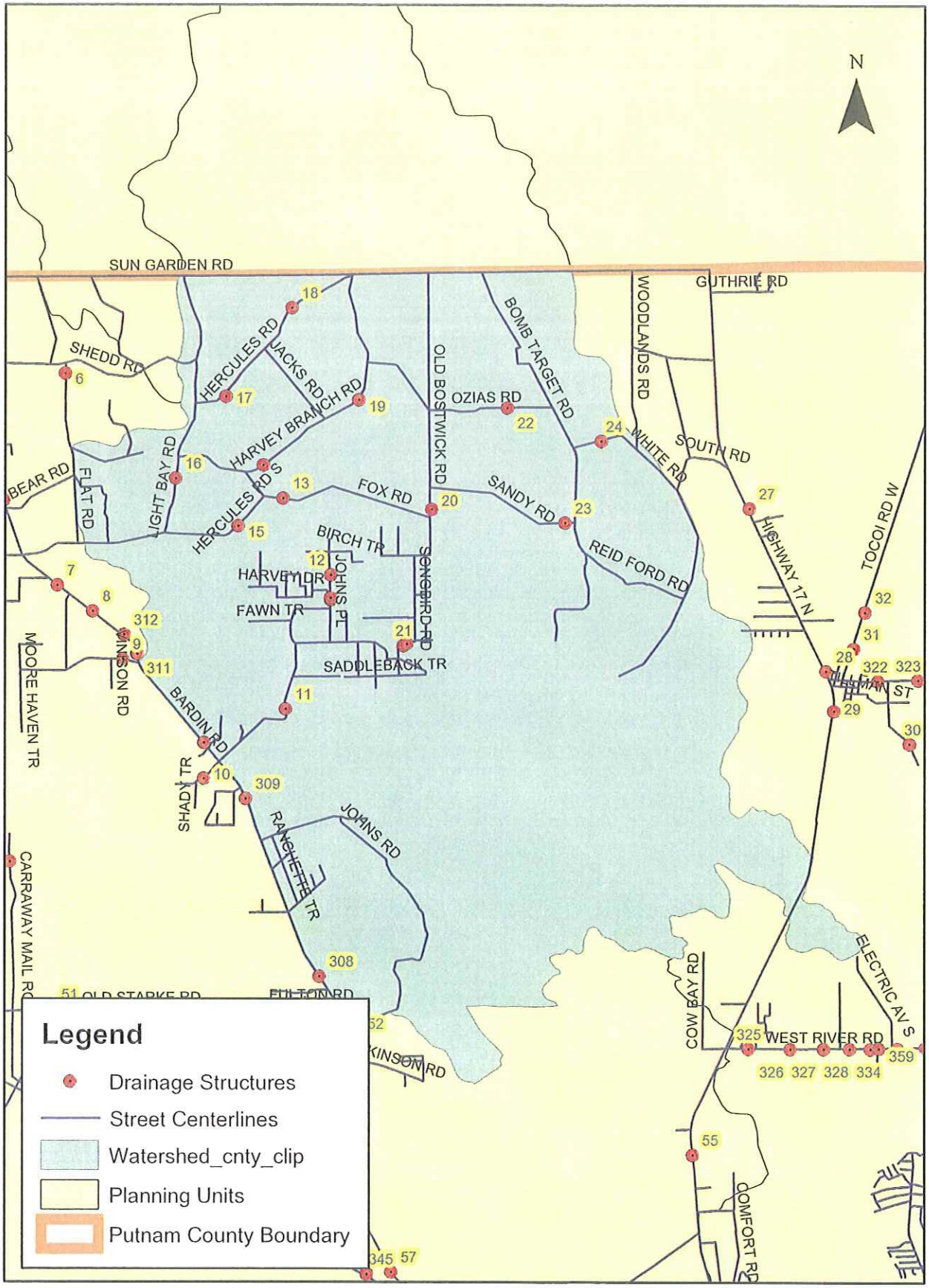
AYRES ASSOCIATES

3.1.3.5 Field investigations in Selected Subwatersheds

The field reconnaissance program described in Section 2.10 was performed for 7 selected Simms Creek subwatersheds as illustrated on the following index figure. No modifications to basin delineations resulted from field investigations. Field reports for hydraulic structures and photo documentation from the investigation is presented in **Appendix 3-B**. These data have been incorporated into a GIS database for County use.

3.1.3.6 Sewer Network and Point Source Discharge

Sewer networks and point source discharges in this watershed have not been identified by the County. A search of FDEP permitted point source discharges and industrial stormwater dischargers was performed and no permitted point source discharges were found in the Simms Creek Watershed.



Field Reconnaissance - Simms Creek Watershed

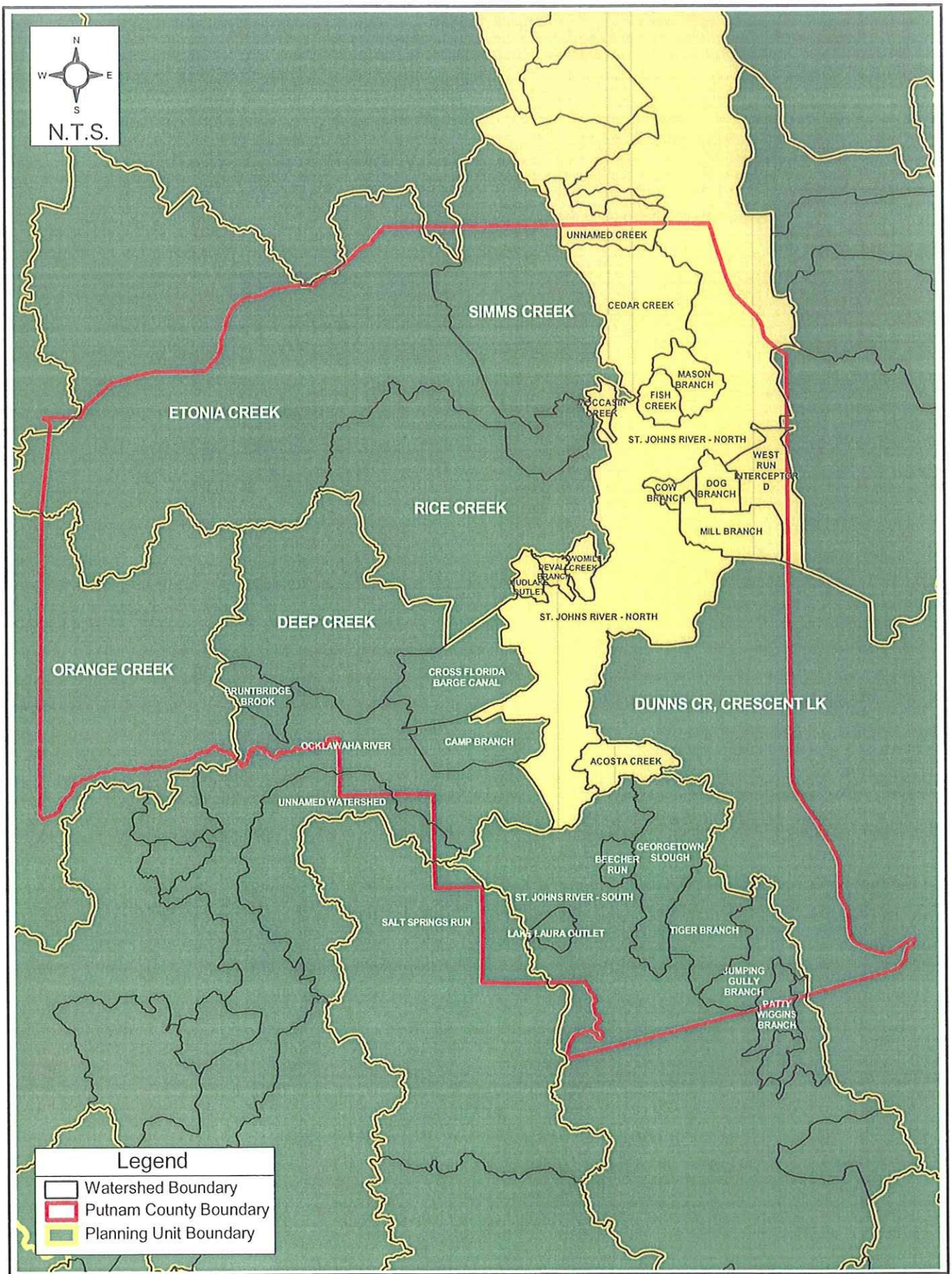
3.2 SOUTH MAINSTEM DRAINAGE PLANNING UNIT

The South Mainstem Drainage Planning Unit (DPU) contains 367.3 square miles across Clay, St. Johns and Putnam Counties, with a small portion of the DPU in Duval County. Of the total land area, 161.3 square miles lie in Putnam County. **Figure 3.2-1** depicts the South Mainstem DPU and its associated primary watersheds. According to the watershed designation developed by SJRWMD, the South Mainstem DPU contains fourteen (14) primary watersheds that are located in whole or in part within Putnam County:

- Acosta Creek
- Cedar Creek
- Cow Branch
- Devall Branch
- Dog Branch
- Fish Creek
- Mason Branch
- Mill Branch
- Moccasin Creek
- Mudlake Outlet
- St. Johns River
- Twomile (Duval) Creek
- West Run Interceptor D
- Unnamed Creek

The St. Johns River primary watershed contains the northward-flowing St. Johns River main trunk, while the remaining South Mainstem DPU watershed tributaries discharge into this conveyance along its length.

Table 3.2-1 presents a breakdown of existing land use and hydrologic soil group distribution for the Putnam County portion of the South Mainstem DPU.



G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\DPUs.apr

Location of the South Mainstem DPU
Putnam County Master Stormwater Plan

Figure 3.2-1

AYRES ASSOCIATES

TABLE 3.2-1 LAND USE AND SOILS SUMMARY FOR SOUTH MAINSTEM DPU

Land Use	Distribution %	Hydrologic Soil Group	Distribution %
Agriculture	11%	A	10%
Barren Land	0%	A/D	0%
Commercial and Services	1%	B	0%
Extractive	0%	B/D	38%
Industrial	0%	C	8%
Institutional	0%	C/D	5%
Open Land	2%	D	21%
Recreational	0%	W (Water)	18%
Residential, High Density	0%	X (Arents)	0%
Residential, Low Density	7%		
Residential, Med. Density	5%		
Transportation, Communication, Utilities	1%		
Upland Forested	27%		
Upland Non-Forested	3%		
Water	18%		
Wetlands	24%		

3.2.1 ACOSTA CREEK WATERSHED

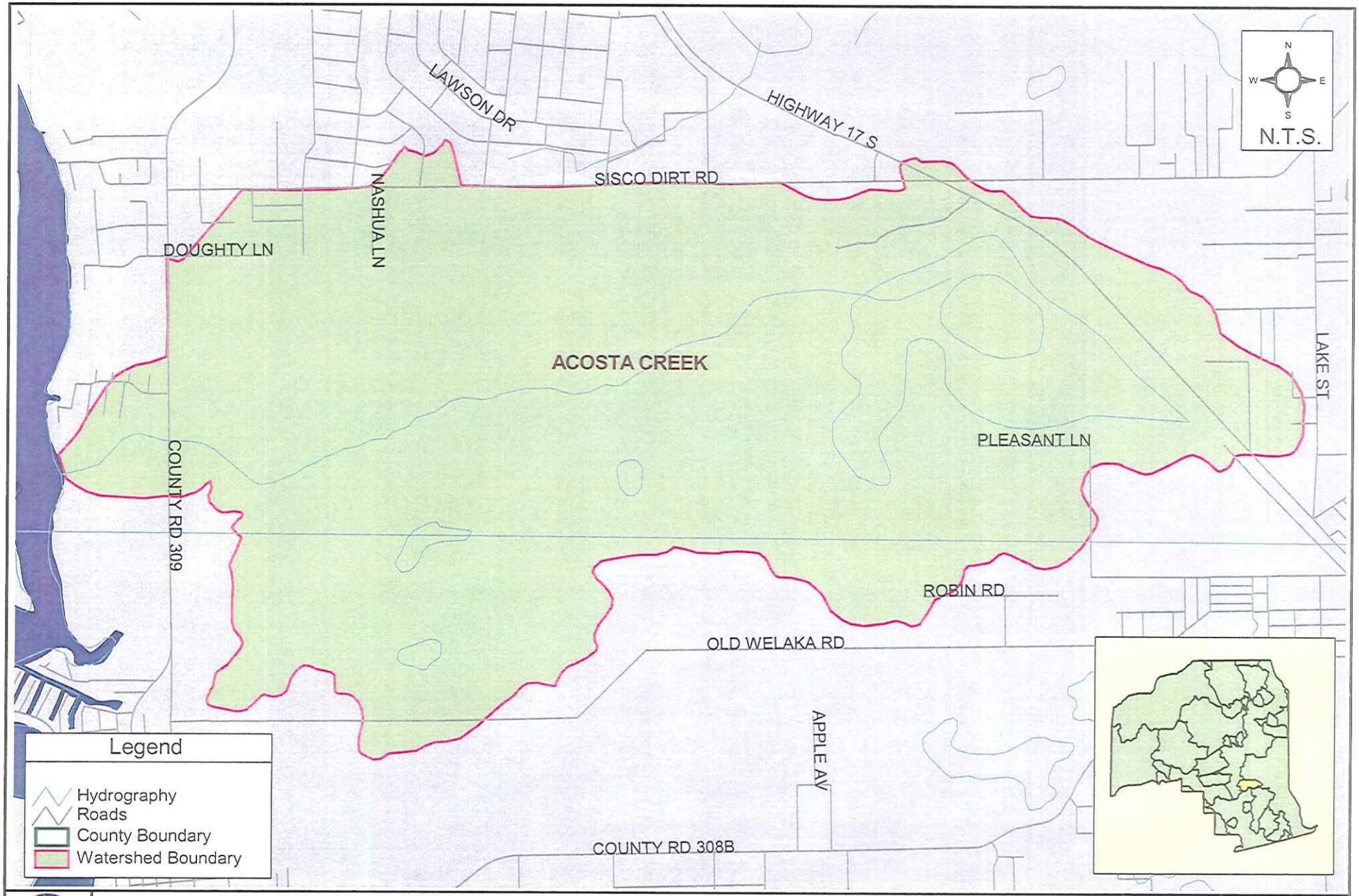
The Acosta Creek Watershed is comprised of 6.2 square miles, located in central Putnam County, just east of the St. Johns River (**Figure 3.2.1-1**). It has not been divided into smaller subwatersheds.

3.2.1.1 Physiography and Hydrology

The primary outfall, Acosta Creek flows westward for a distance of roughly 3.6 miles from the wetland headwaters near U.S. Highway 17 to the St. Johns River just north of Turkey Island. Significant named waterbodies include Fox Lake and Clearwater Lake.

Watershed highs range from 95 to 100 feet NGVD along the boundary, with moderate slopes toward Acosta Creek.

There are no USGS streamflow gages located within this watershed. There are no NCDC or SJRWMD rain gaging stations located within the watershed. The nearest rain gaging station is located at the Cross Florida Barge Canal's Buckman Lock.



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Acosta_creek.apr

Location of the Acosta Creek Watershed
Putnam County Master Stormwater Plan

Figure
3.2.1-1

AYRES ASSOCIATES

3.2.1.2 FEMA Flood Zones

The vast majority of this watershed is classified Zone X, or area determined to be outside the 500-year floodplain. However, along Acosta Creek itself and its headwaters there are consistent strips of land designated Zone A or AE. Areas in Zone A lie in the 100-year floodplain for which no base flood elevations have been determined. Areas in Zone AE lie in the 100-year floodplain, and base flood elevations have been determined. Other areas of Zone A surround the lakes in the southern portion of the watershed. FEMA floodplain mapping is depicted on **Figure 3.2.1-2**.

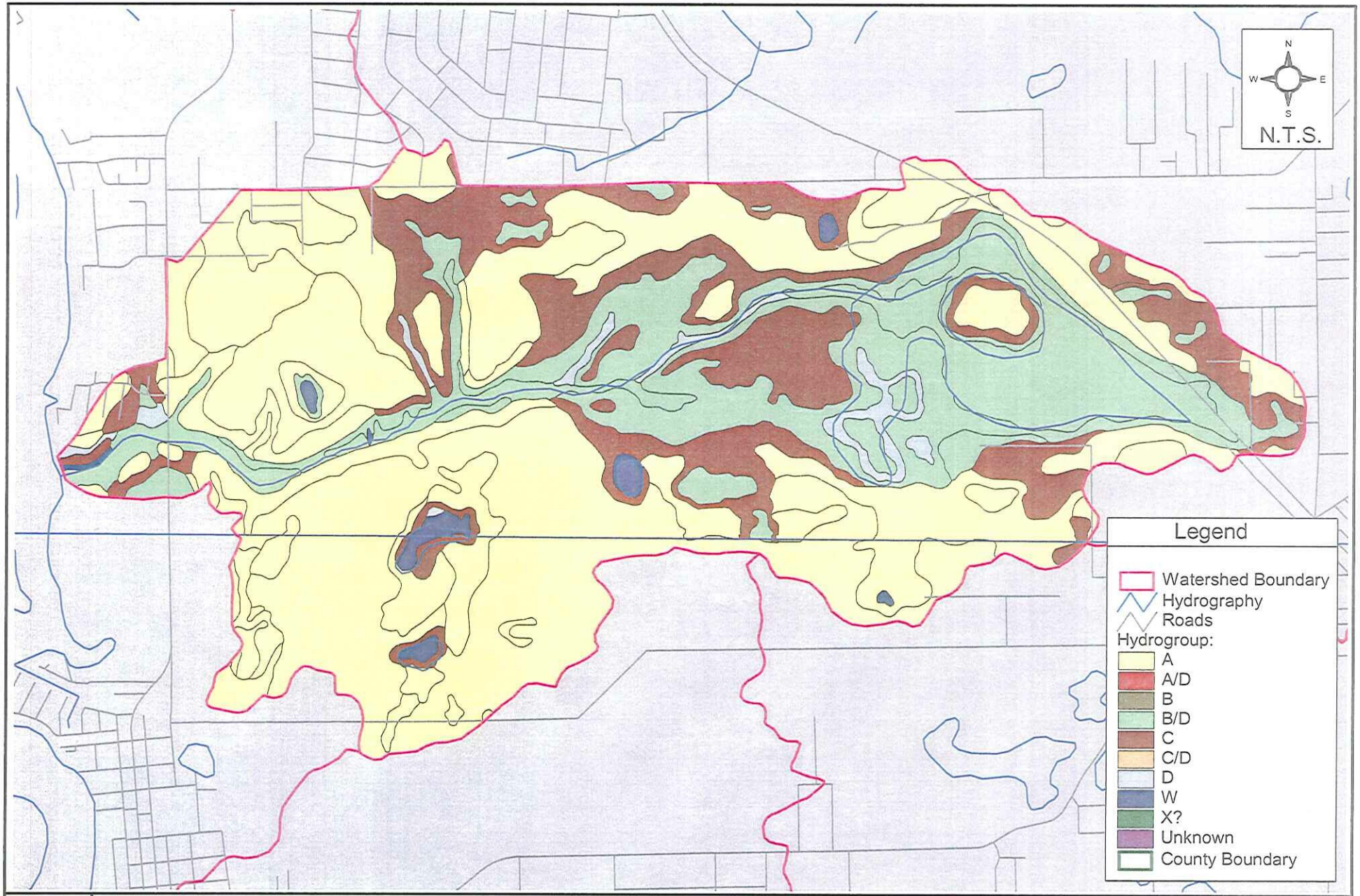
As part of the Putnam County FIS, Acosta Creek has been studied in detail and has been designated with a defined floodway. The Acosta Creek stream profile graph is located in the Putnam County FIS provided in **Appendix 3-A** of this SMP.

3.2.1.3 Soils

Over half of the Acosta Creek Watershed is comprised of very well drained soils with low runoff potential, HSG classification A. Nearly a quarter of the area is underlain by B/D classification soils. Roughly 17% of the area is classified as HSG C, indicating moderate runoff potential. **Figure 3.2.1-3** depicts the current hydrologic soil groups in the Acosta Creek Watershed.

3.2.1.4 Land Use/ Land Cover

The predominant land use, as illustrated in **Figure 3.2.1- 4,** depicting the current land use in the Acosta Creek Watershed, is "Upland Forested." Very little of the watershed is developed, with "Agriculture" representing only 5% of the watershed area and "Residential" representing just 8% of the watershed area. Water and wetlands account for 13% of the watershed.

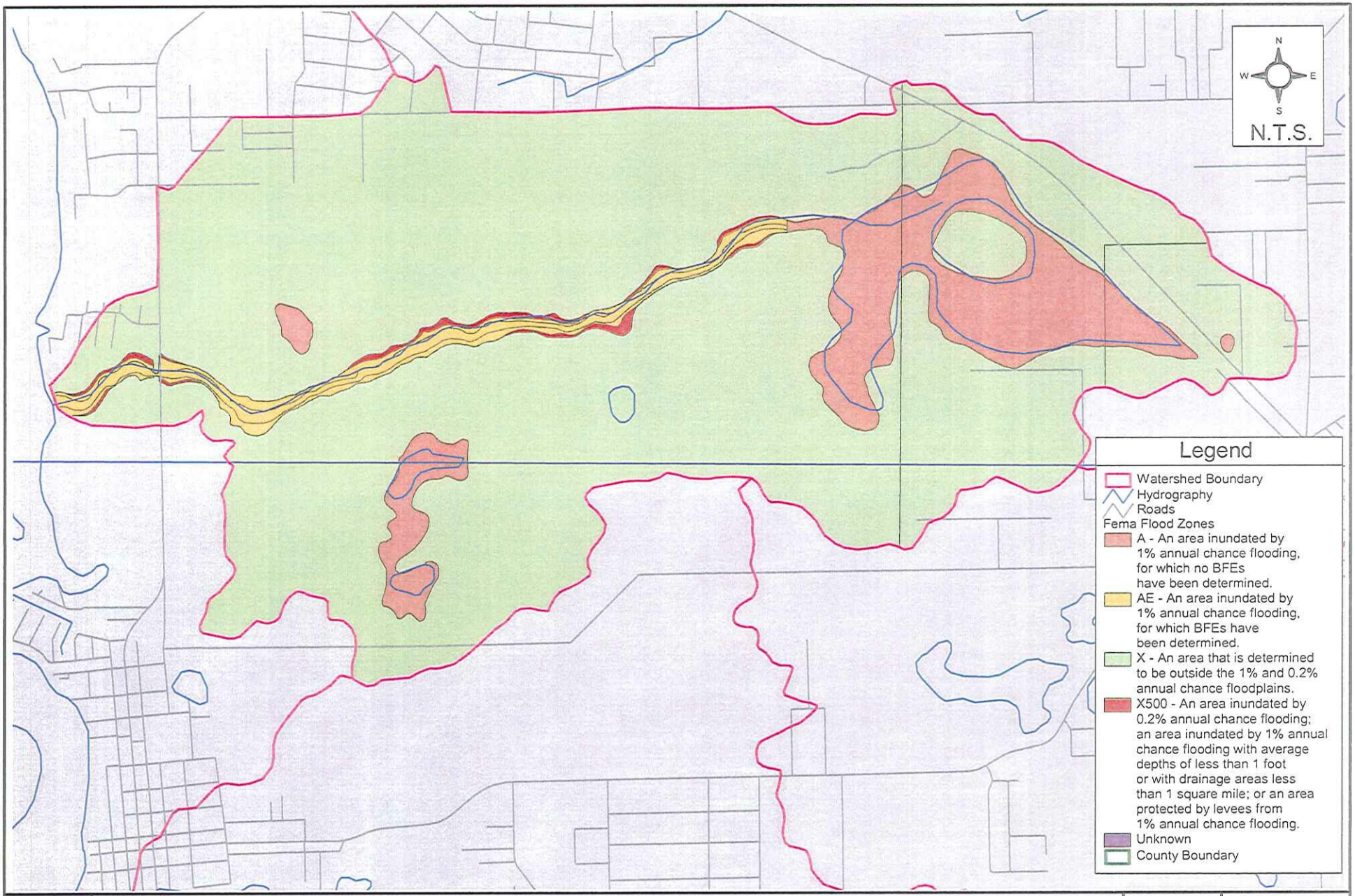


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Acosta_creek.apr

Soils Distribution in the Acosta Creek Watershed
Putnam County Master Stormwater Plan

Figure
3.2.1-3

AYRES ASSOCIATES



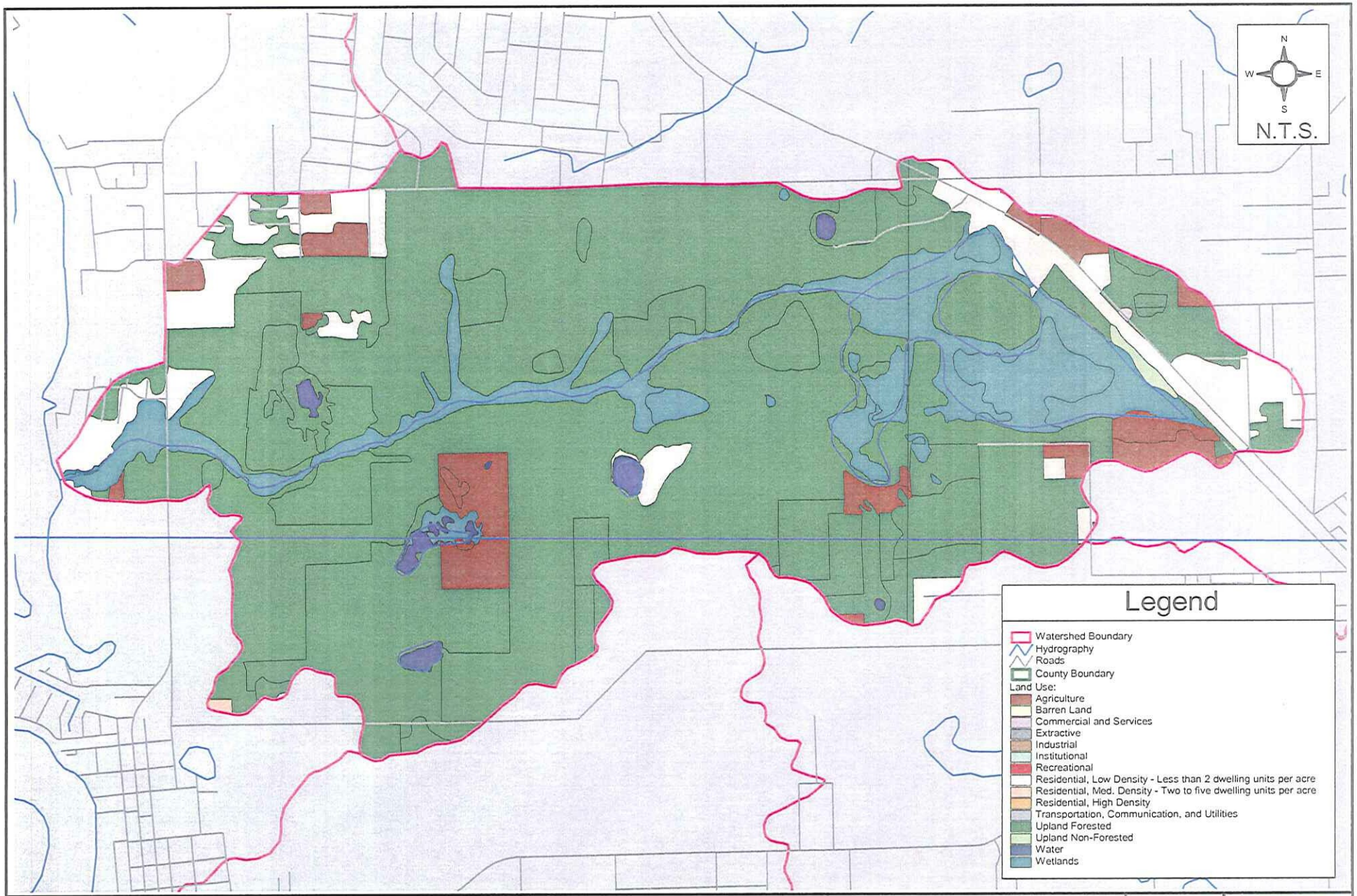
G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Acosta_creek.apr

FEMA Flood Zones in the Acosta Creek Watershed

Putnam County Master Stormwater Plan

Figure 3.2.1-2

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Acosta_creek.apr

Land Use Distribution in the Acosta Creek Watershed
Putnam County Master Stormwater Plan

Figure
3.2.1-4

AYRES ASSOCIATES

3.2.2 CEDAR CREEK WATERSHED

The Cedar Creek Watershed is located entirely in northeast Putnam County (**Figure 3.2.2-1**). The watershed area is roughly 21.3 square miles. The Cedar Creek Watershed consists of the following five (5) subwatersheds:

1. Cedar Creek*
2. Unnamed Slough-1
3. Unnamed Slough-2
4. Unnamed Slough-3
5. Unnamed Slough-4

Subwatersheds identified with an asterisk (*) have been selected for additional studies that are described in later subsections.

Figure 3.2.2-1

3.2.2.1 Physiography and Hydrology

The primary outfall, Cedar Creek, drains eastward for approximately 1.7 miles, collecting flow numerous from tributary slough systems and discharging into the St. Johns River. The land slopes are mild and slow-draining.

No USGS streamflow gage stations are located within this watershed, nor are there NCDC or SJRWMD rain gaging stations located within the watershed. The nearest rain gaging station is located within the South Mainstem DPU, to the southeast – NCDC co-op station 82915 "Federal Point".

3.2.2.2 FEMA Flood Zones

Most of this watershed is classified Zone X, or area determined to be outside the 500-year floodplain. However, significant areas along the wetland tributaries and the Cedar Creek channel are designated Zone A. Zone A areas lie in the 100-year floodplain for which no base flood elevations have been determined. A very small portion of the watershed, at the downstream-most part of Cedar Creek, is designated Zone AE, lying in the 100-year floodplain where base flood elevations have been determined. FEMA floodplain mapping is depicted on **Figure 3.2.2-2**.

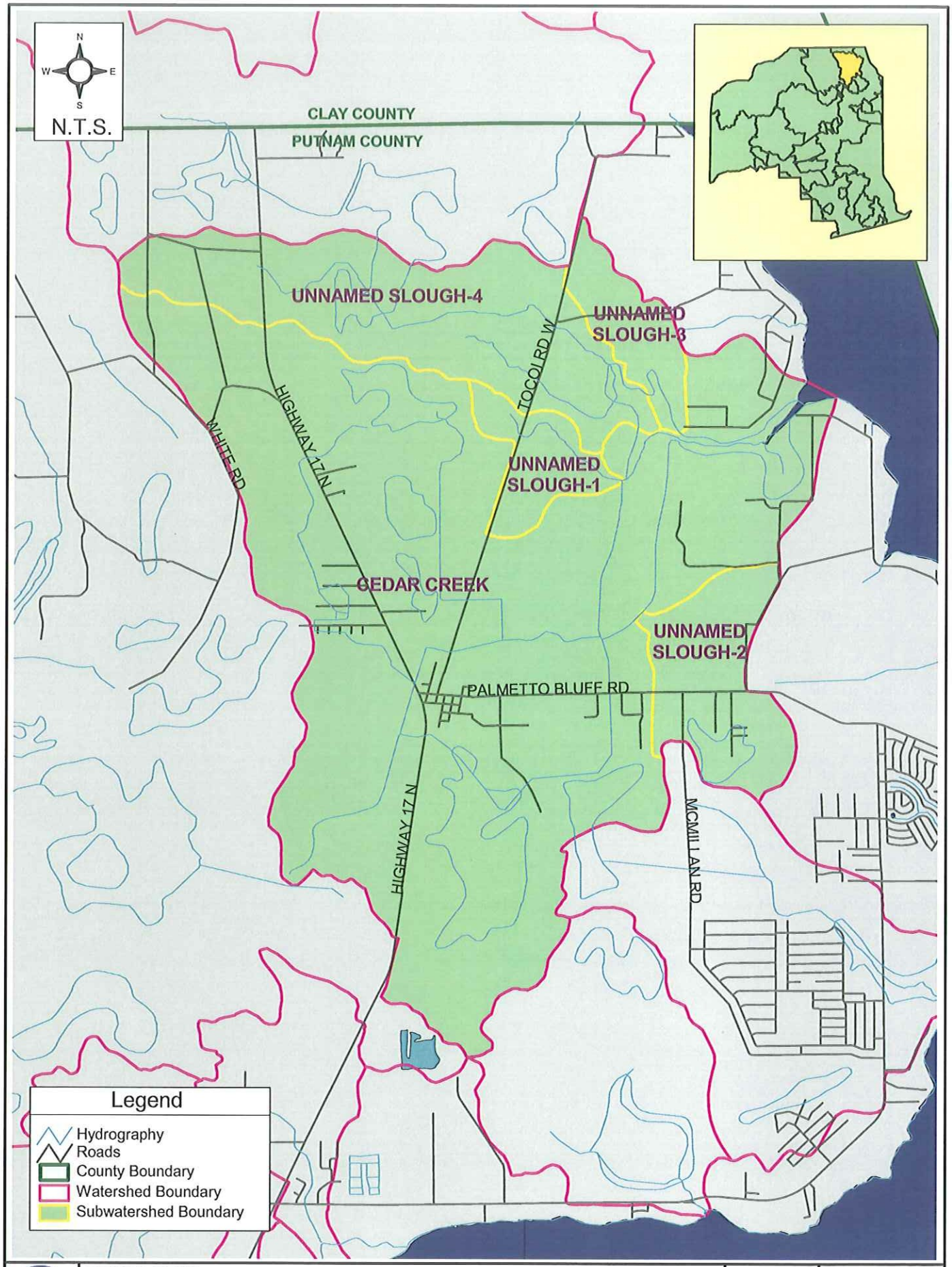
The Putnam County FIS does not include the Cedar Creek Watershed in its detailed study area. The base flood elevations that have been determined within the Cedar Creek Watershed are associated with the flood profiles generated from detailed study of the St. Johns River.

3.2.2.3 Soils

High surficial water table in this watershed, for all or part of the year, results in high runoff potential over most of the watershed area. The dominant soil classification, representing more than half the watershed area, is B/D. Hydric soils (HSG D) and water designations account for 23% of the watershed. Roughly 13% of the area is represented by a HSG classification of C/D. **Figure 3.2.2-3** depicts the current hydrologic soil groups in the Cedar Creek Watershed.

3.2.2.4 Land Use/ Land Cover

Figure 3.2.2-4 depicts the current land use in the Cedar Creek Watershed. Undeveloped land uses dominate this watershed, with "Upland Forested" and "Wetland" designations accounting for 46% and 27% of the area, respectively. "Agriculture" occupies 9% of the area. "Residential" use and "Transportation/Utilities" represent roughly 8% of the watershed area.

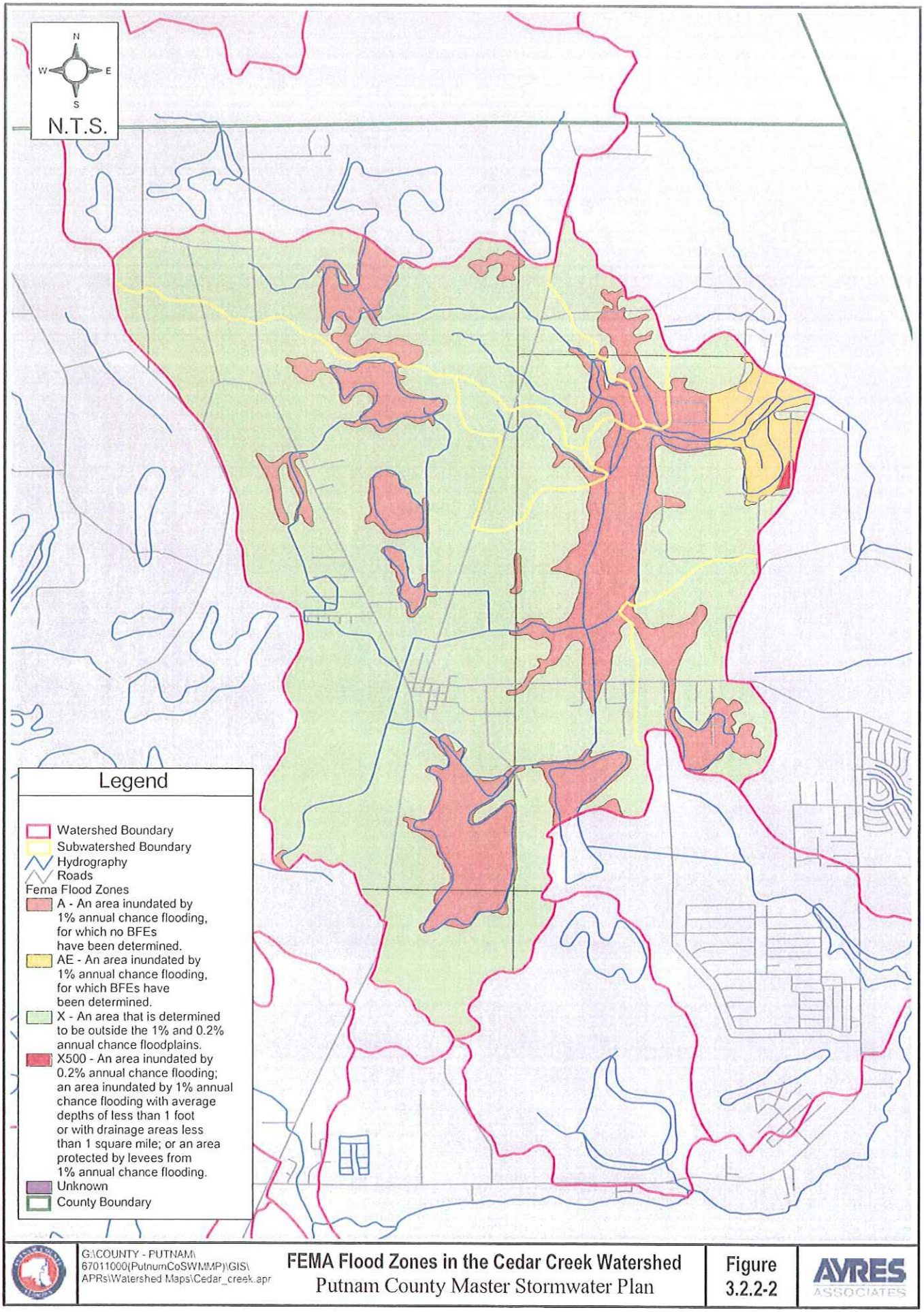


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Cedar_creek.apr

Location of the Cedar Creek Watershed
Putnam County Master Stormwater Plan

Figure 3.2.2-1

AYRES ASSOCIATES

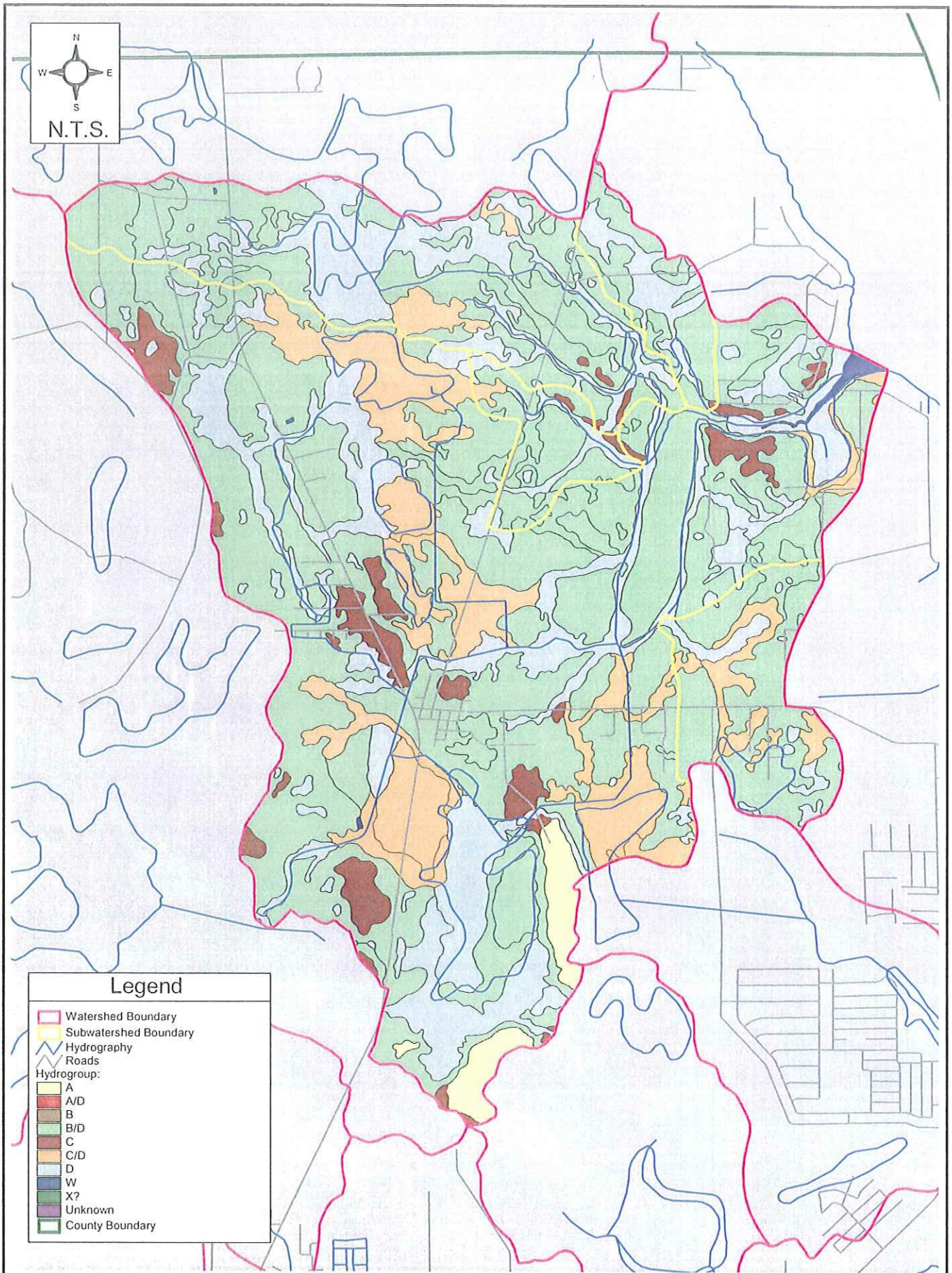


G:\COUNTY - PUTNAM\ 67011000(PutnumCoSWMMP)\GIS\ APRs\Watershed Maps\Cedar_creek.apr

FEMA Flood Zones in the Cedar Creek Watershed
Putnam County Master Stormwater Plan

Figure 3.2.2-2

AYRES ASSOCIATES

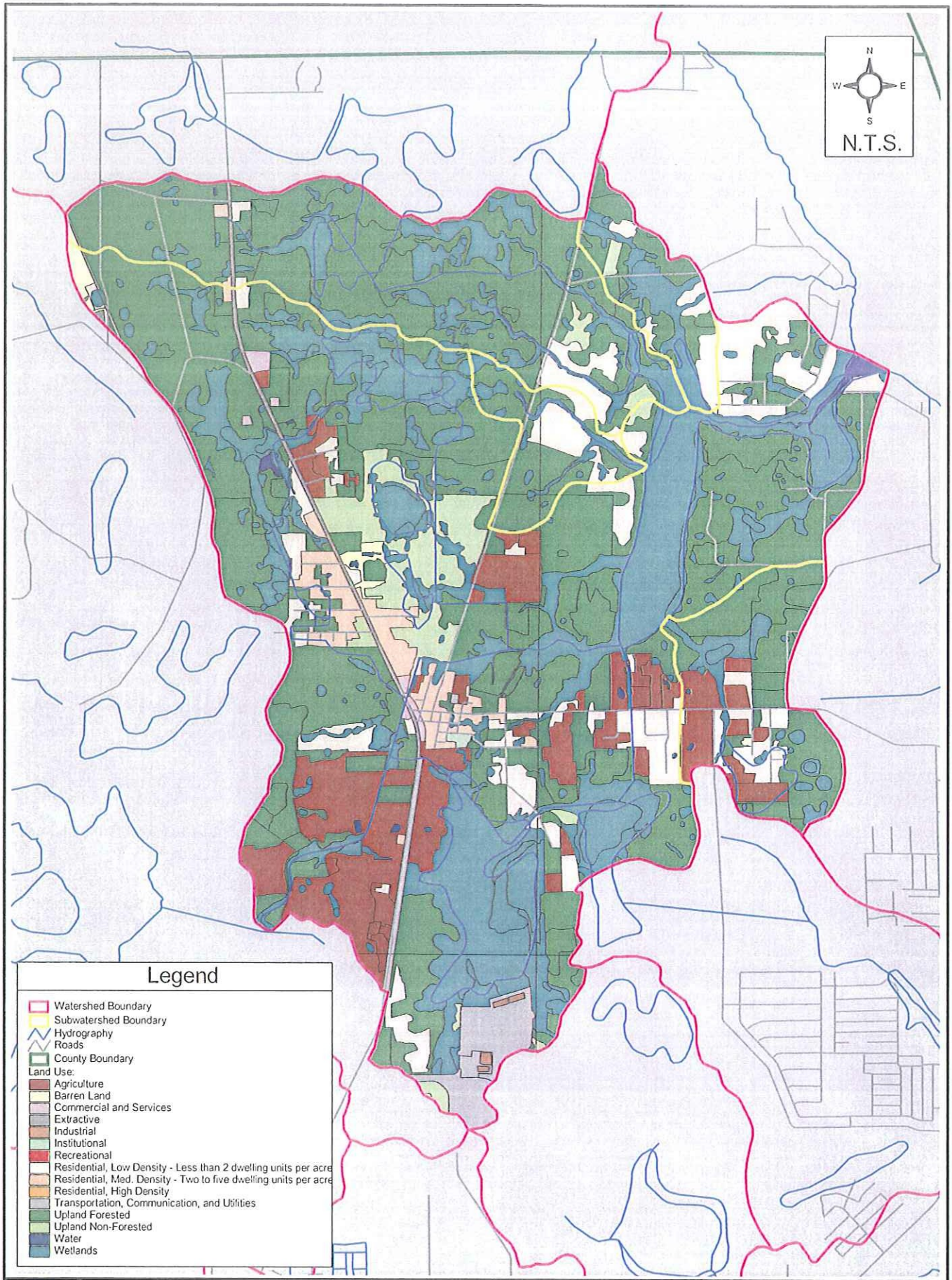


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Cedar_creek.apr

Soils Distribution in the Cedar Creek Watershed
Putnam County Master Stormwater Plan

Figure
3.2.2-3

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Cedar_creek.apr

Land Use Distribution in the Cedar Creek Watershed
Putnam County Master Stormwater Plan

Figure
3.2.2-4

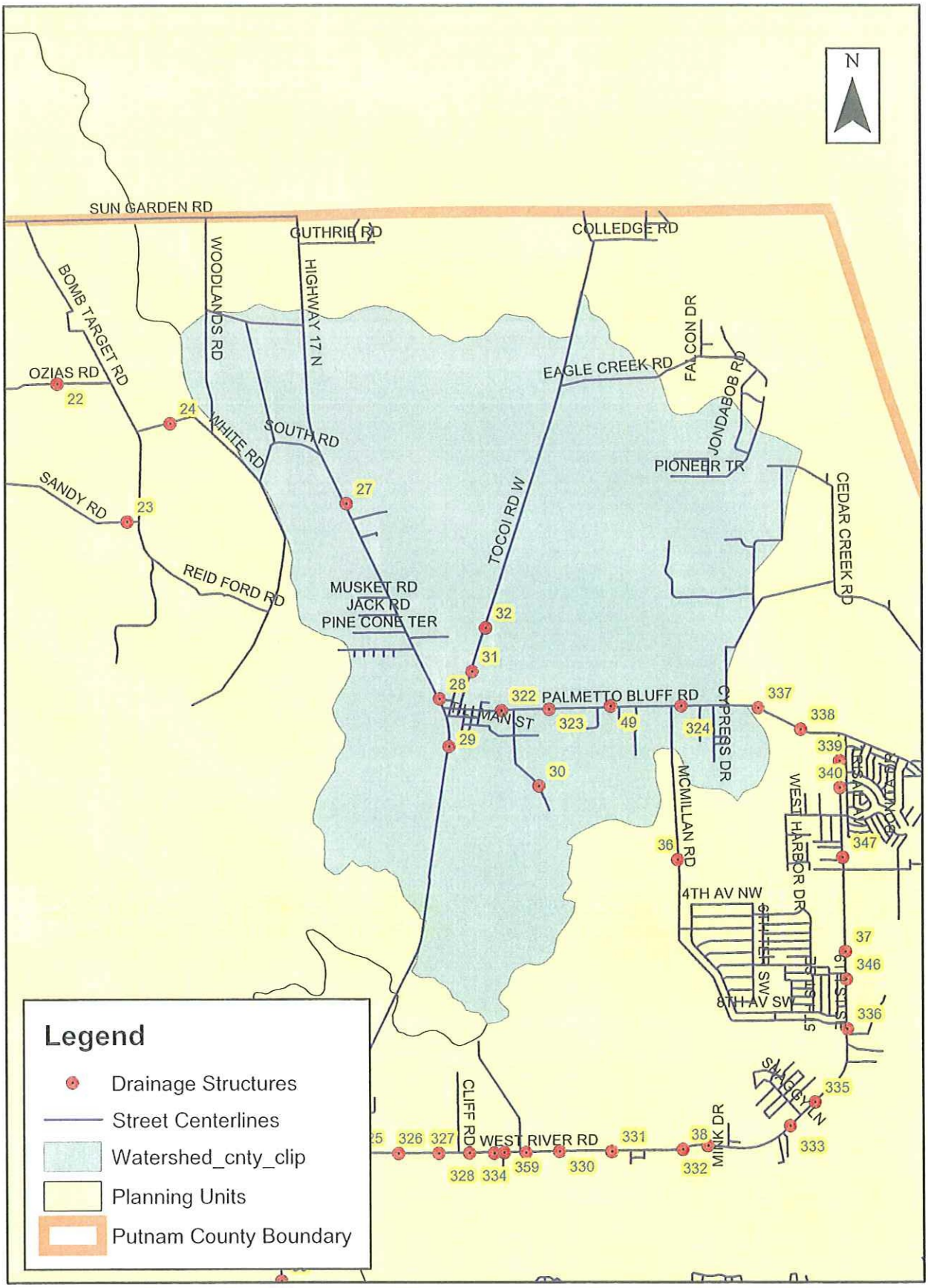
AYRES ASSOCIATES

3.2.2.5 Field investigations in Selected Subwatersheds

The field reconnaissance program described in Section 2.10 was performed for one selected Cedar Creek subwatershed as illustrated on the following index figure. No modifications to basin delineations resulted from field investigations. Field reports for hydraulic structures and photo documentation from the investigation is presented in **Appendix 3-B**. These data have been incorporated into a GIS database for County use.

3.2.2.6 Sewer Network and Point Source Discharge

Sewer networks and point source discharges in this watershed have not been identified by the County. A search of FDEP permitted point source discharges and industrial stormwater dischargers was performed and no permitted point source discharges were found in the Cedar Creek Watershed.



Field Reconnaissance - Cedar Creek Watershed

3.2.3 COW BRANCH WATERSHED

The Cow Branch Watershed is comprised of 1.8 square miles, located in east Putnam County, just east of the St. Johns River (**Figure 3.2.3-1**). It has not been divided into smaller subwatersheds and has been selected for field investigation.

3.2.3.1 Physiography and Hydrology

The primary outfall, Cow Branch flows west for a distance of roughly 1.4 miles before discharging to the St. Johns River. The watershed is very mildly sloped, with topographic highs of roughly 20 feet NGVD and low elevations at the creek of less than 5 feet NGVD.

There are no USGS streamflow gages located within this watershed, nor are there NCDC or SJRWMD rain gages within this watershed. The nearest rainfall station is the NCDC 86753 "Palatka, Florida" co-op station, located on the west side of the St. Johns River, roughly 3 miles to the southwest.

3.2.3.2 FEMA Flood Zones

The vast majority of this watershed is classified Zone X, or area determined to be outside the 500-year floodplain. However, areas along the Cow Creek drainage, west of Putnam County Boulevard are designated Zone A. Zone A areas lie in the 100-year floodplain for which no base flood elevations have been determined. A very small portion of the watershed, at the downstream-most part of Cow Creek, is designated Zone AE, lying in the 100-year floodplain where base flood elevations have been determined through the St. Johns River detailed flood study. FEMA floodplain mapping is depicted on **Figure 3.2.3-2**.

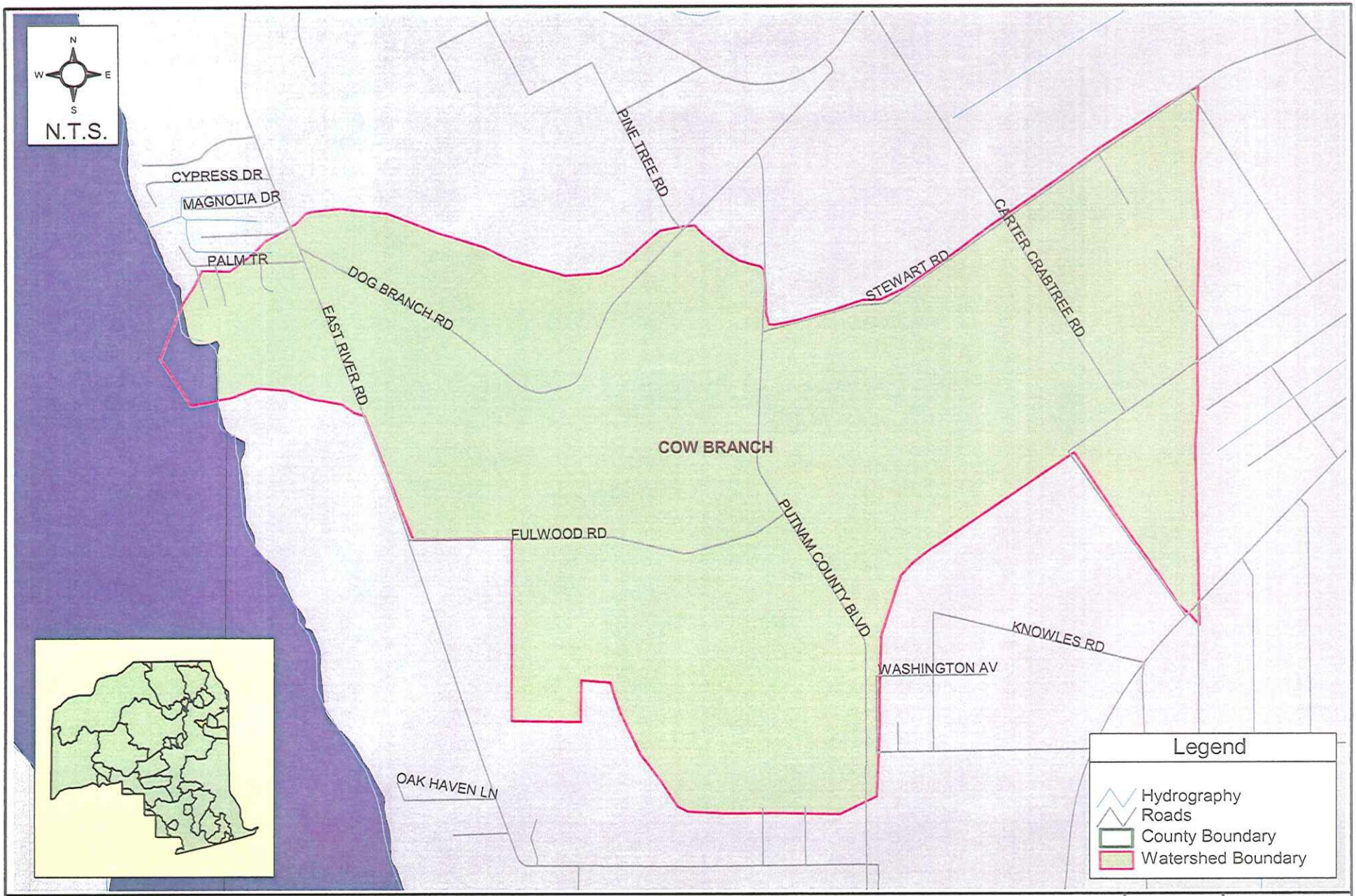
This watershed has not been studied in detail by FEMA.

3.2.3.3 Soils

High surficial water table in this watershed, for all or part of the year, results in high runoff potential over most of the watershed area not ditched and drained by agriculture. The dominant soil classification, representing 72% of the watershed area, is B/D. Roughly 19% of the area is represented by a HSG classification of C or C/D. Hydric soils (HSG D) and water designations account for 8% of the watershed. **Figure 3.2.3-3** depicts the current hydrologic soil groups in the Cow Branch Watershed.

3.2.3.4 Land Use/ Land Cover

The Cow Branch Watershed is predominantly agricultural with 62% of its area designated as "Agriculture" and only 13% of the area designated for "Residential" or "Commercial" land uses. The remainder of the watershed is represented by undeveloped land use codes such as "Wetland", "Upland Forested" and "Upland Non-Forested." **Figure 3.2.3- 4** depicts the current land use in the Cow Branch Watershed.

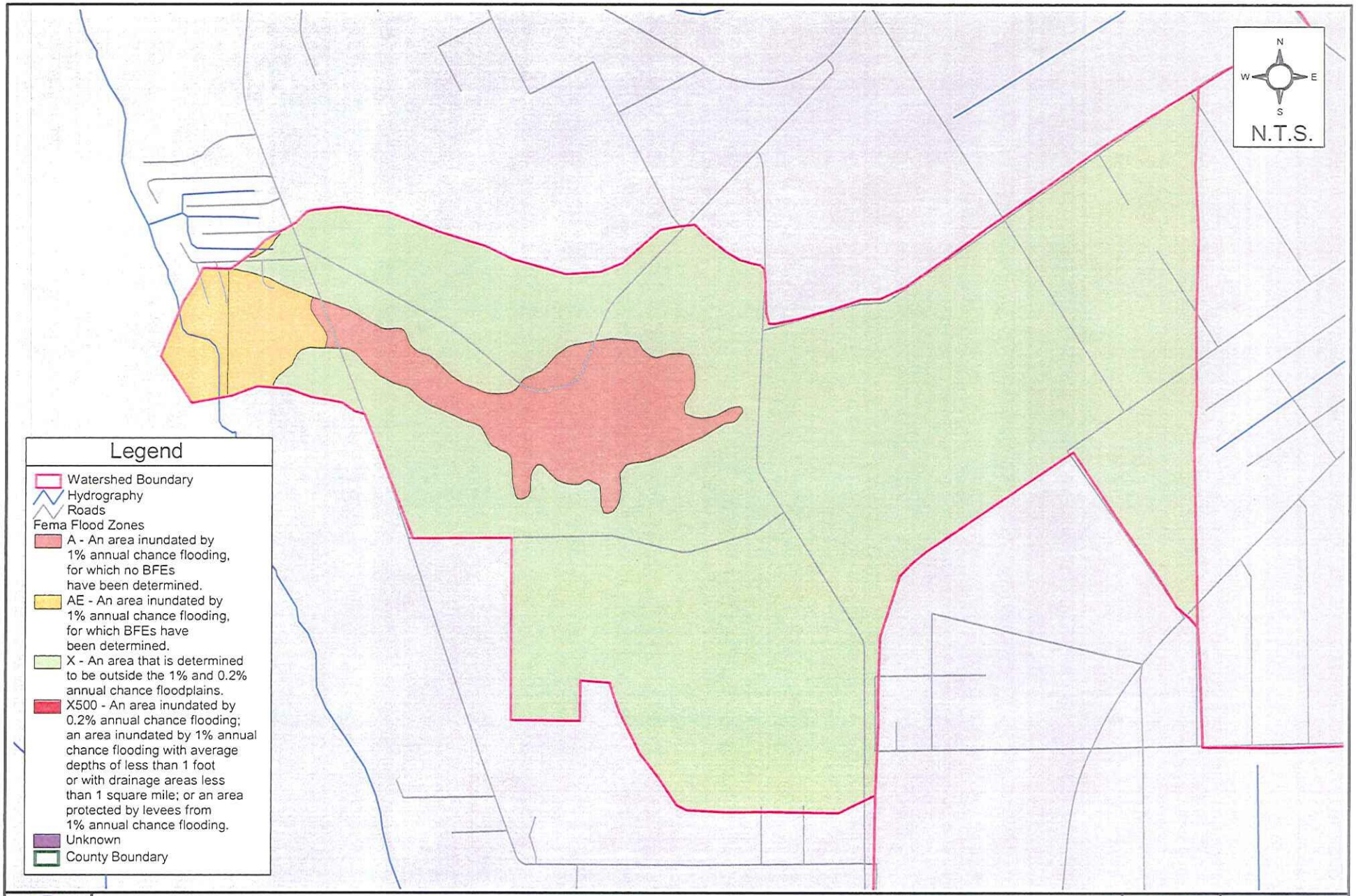


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Cow_Branch.apr

Location of the Cow Branch Watershed
Putnam County Master Stormwater Plan

Figure
3.2.3-1

AYRES ASSOCIATES



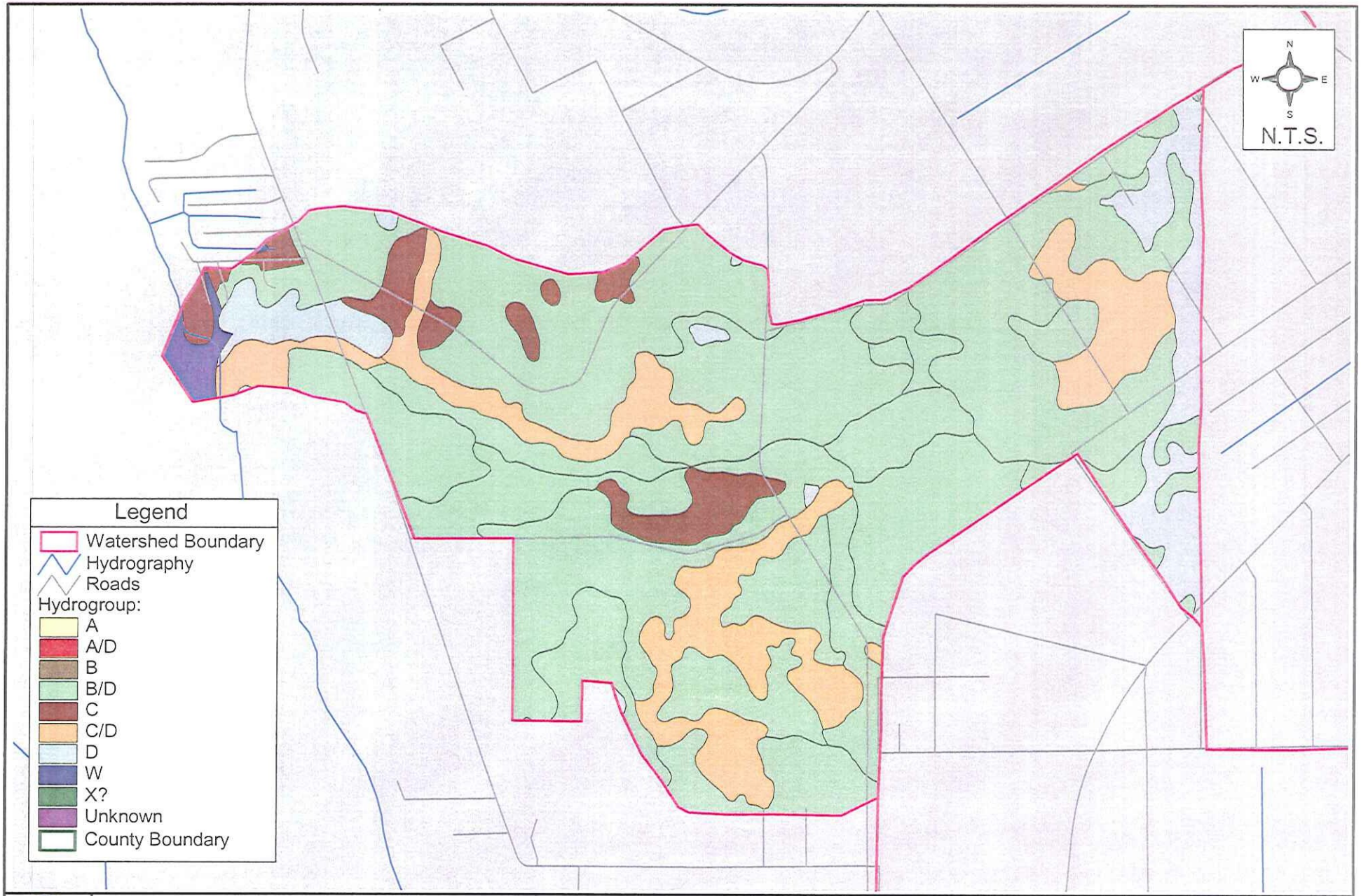
G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Cow_Branch.apr

FEMA Flood Zones in the Cow Branch Watershed

Putnam County Master Stormwater Plan

Figure 3.2.3-2

AYRES ASSOCIATES

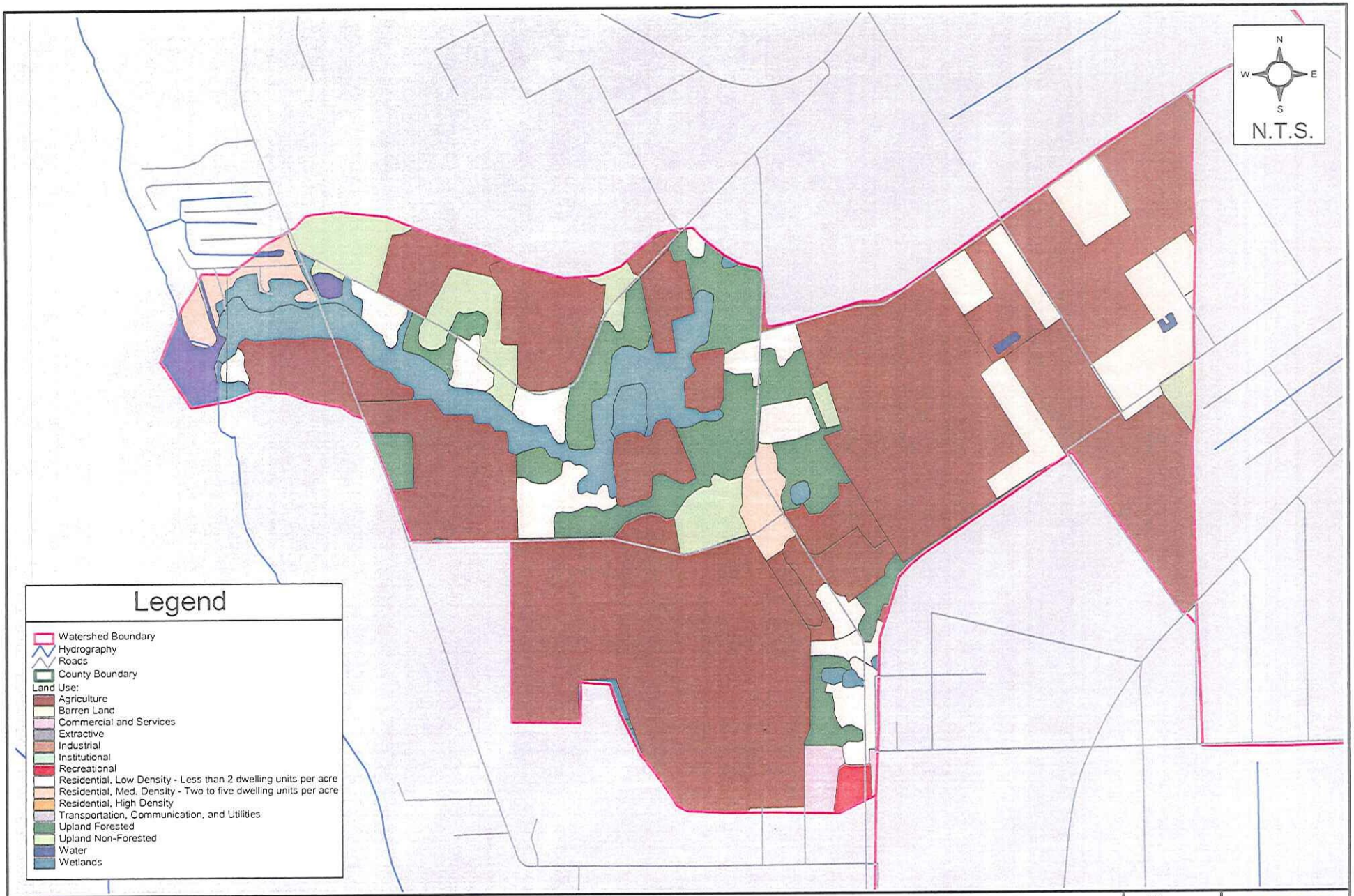


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Cow_Branch.apr

Soils Distribution in the Cow Branch Watershed
Putnam County Master Stormwater Plan

Figure
3.2.3-3

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Cow_Branch.apr

Land Use Distribution in the Cow Branch Watershed
Putnam County Master Stormwater Plan

Figure
3.2.3-4

AYRES ASSOCIATES

3.2.3.5 Field investigations in Selected Subwatersheds

Field reconnaissance was performed for this watershed as part of the capital improvement project development for a flood problem area at East River Road and Camp Road. No modifications to basin delineations resulted from field investigations. Field observations and photo documentation from the investigation is presented in Section 7 of this Master Stormwater Plan.

3.2.4 DEVALL BRANCH WATERSHED

The Devall Branch Watershed is comprised of 1.6 square miles, located in central Putnam County, just west of the St. Johns River (**Figure 3.2.4-1**). It has not been divided into smaller subwatersheds and has been selected for field study.

3.2.4.1 Physiography and Hydrology

The primary outfall, Devall Branch flows southeast from the western outskirts of Palatka for a distance of roughly 1.7 miles before discharging to the St. Johns River floodplain. High elevations range from 65 feet NGVD at the north boundary to 50 to 55 feet NGVD at the eastern and the western boundaries, respectively. The watershed slopes inward toward the Devall Branch conveyance.

There are no USGS streamflow gages or NCDC/SJRWMD rain gages located within this watershed. The nearest rain gage is the NCDC 86753 co-op station in the Palatka area, roughly 2 miles to the northeast.

3.2.4.2 FEMA Flood Zones

Nearly the entire watershed is classified Zone X, or area determined to be outside the 500-year floodplain. However, areas along the northern portion of the Devall Branch, in the vicinity of State Road 19 and the Point of the Woods subdivision, and at the lower end of the conveyance near the outfall to the St. Johns River lie in Zone A. Zone A areas lie in the 100-year floodplain for which no base flood elevations have been determined. A very small portion of the watershed, at the downstream-most part of Devall Branch, is designated Zone AE, lying in the 100-year floodplain where base flood elevations have been determined based on study of the St. Johns River. FEMA floodplain mapping is depicted on **Figure 3.2.4-2**.

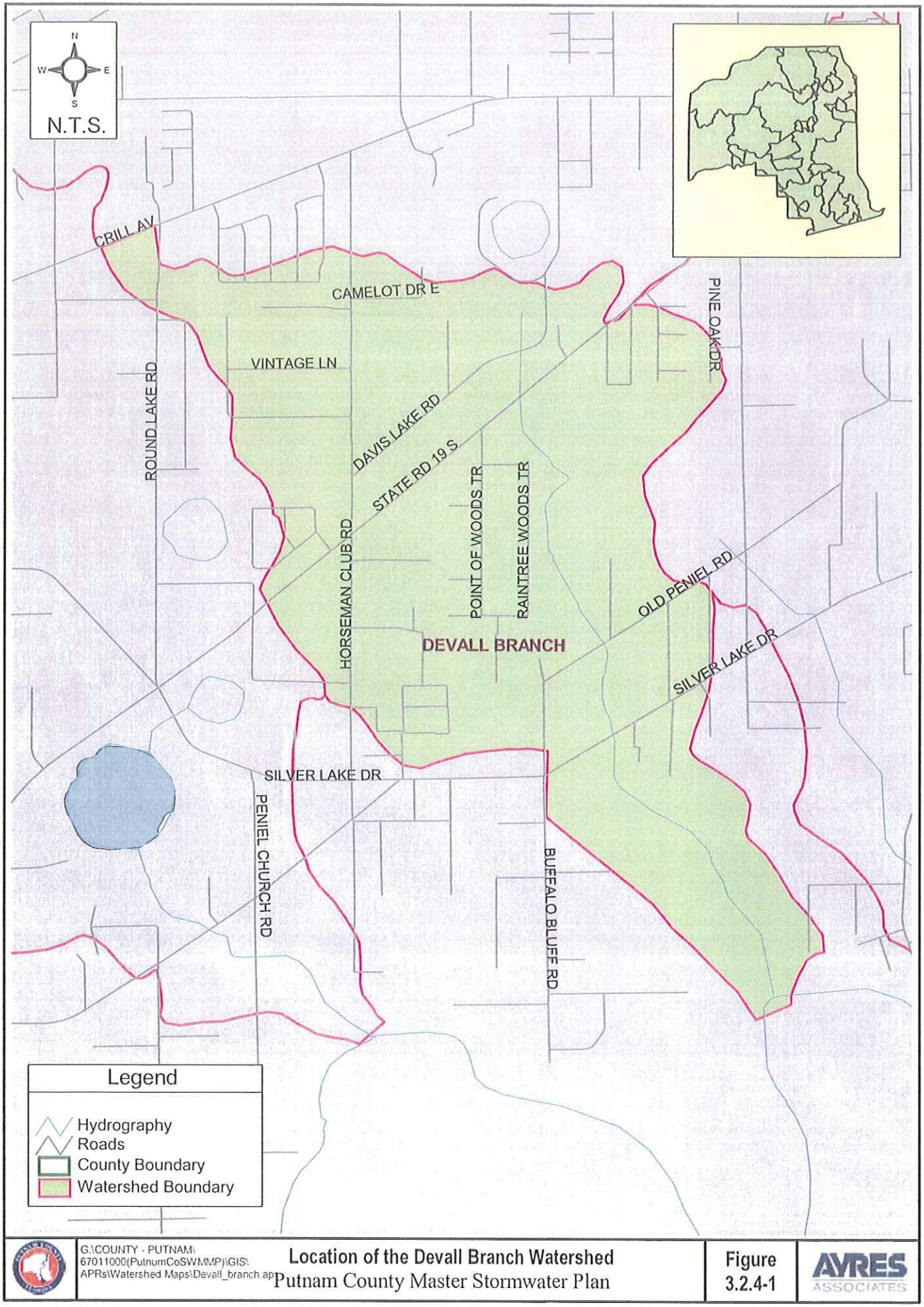
This watershed has not been studied in detail by FEMA.

3.2.4.3 Soils

Over half of the watershed area has soils classified as B/D indicating high runoff potential when the surficial water table is near the surface and low runoff potential if the soils are drained. Other HSG classifications found in this watershed, in order of represented proportion, are C, D and A. **Figure 3.2.4-3** depicts the current hydrologic soil groups in the Devall Branch Watershed.

3.2.4.4 Land Use/ Land Cover

Residential and institutional land uses represent 58% of the watershed area "Agriculture" designations occupy roughly 5% of the watershed. The remaining area is undeveloped. **Figure 3.2.4- 4** depicts the current land use in the Devall Branch Watershed.

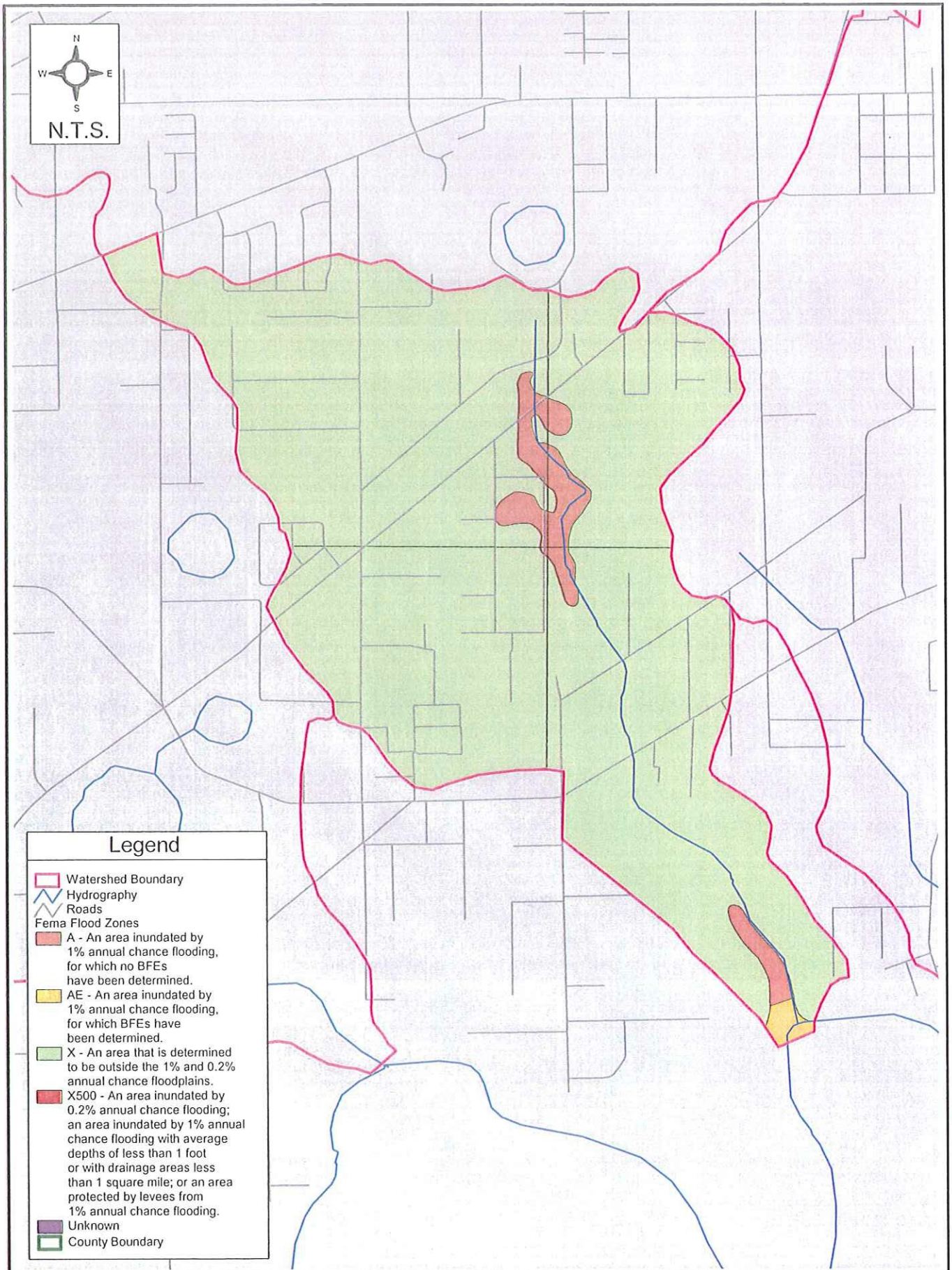


G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\Devall_branch.ap

Location of the Devall Branch Watershed
Putnam County Master Stormwater Plan

Figure 3.2.4-1

AYRES ASSOCIATES

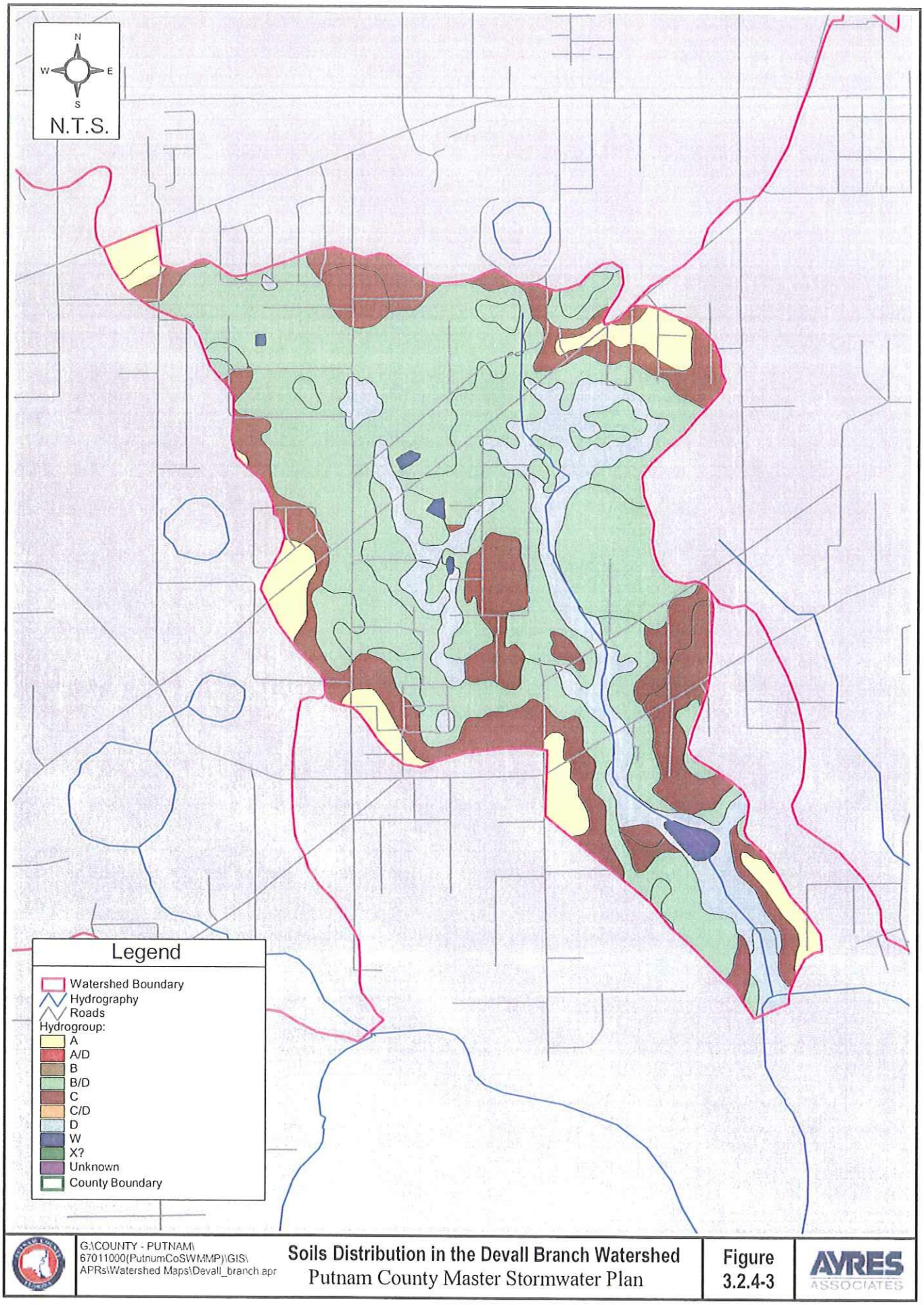


G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\Devall_Branch.apr

FEMA Flood Zones in the Devall Branch Watershed
Putnam County Master Stormwater Plan

Figure 3.2.4-2

AYRES ASSOCIATES

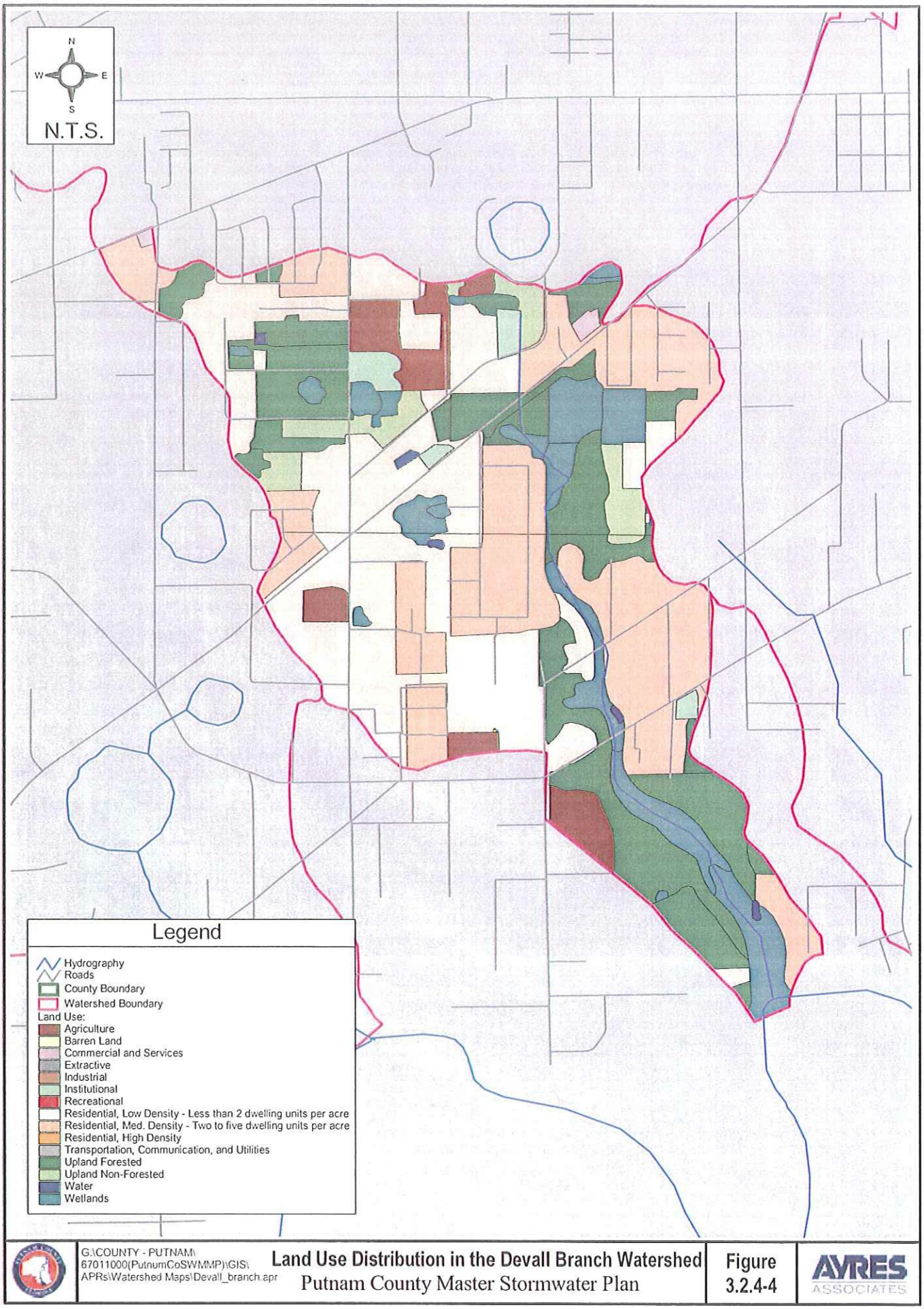


G:\COUNTY - PUTNAM\ 67011000(PutnumCoSWMMP)\GIS\ APRs\Watershed Maps\Devall_branch.apr

Soils Distribution in the Devall Branch Watershed
Putnam County Master Stormwater Plan

Figure 3.2.4-3

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Devall_branch.apr

Land Use Distribution in the Devall Branch Watershed
Putnam County Master Stormwater Plan

Figure
3.2.4-4

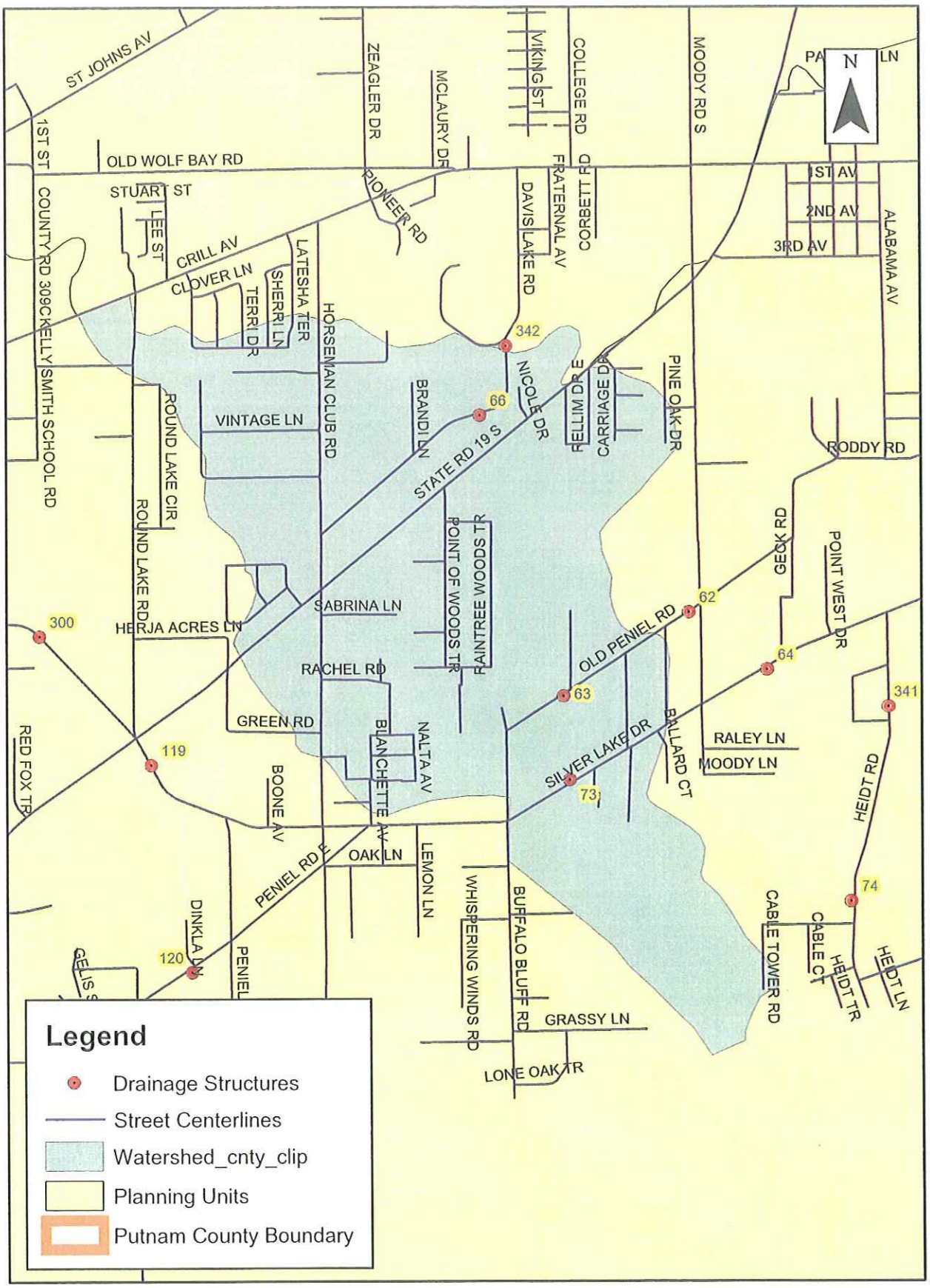
AYRES ASSOCIATES

3.2.4.5 Field investigations in Selected Subwatersheds

The field reconnaissance program described in Section 2.10 was performed for this watershed as illustrated on the following index figure. No modifications to basin delineations resulted from field investigations. Field reports for hydraulic structures and photo documentation from the investigation is presented in **Appendix 3-B**. These data have been incorporated into a GIS database for County use.

3.2.4.6 Sewer Network and Point Source Discharge

Sewer networks and point source discharges in this watershed have not been identified by the County. A search of FDEP permitted point source discharges and industrial stormwater dischargers was performed and no permitted point source discharges were found in the Devall Branch Watershed.



Field Reconnaissance - Devall Branch Watershed

3.2.5 DOG BRANCH WATERSHED

The Dog Branch Watershed is comprised of 3.7 square miles, located in east Putnam County, just west of the St. Johns River (Figure 3.2.5-1). It has not been divided into smaller subwatersheds and has been selected for field study.

3.2.5.1 Physiography and Hydrology

The primary outfall, Dog Branch flows north for a distance of roughly 1.2 miles before discharging to the St. Johns River. The contributing watershed is very mildly sloped. Significant ditching networks are present, draining agricultural lands.

There are no USGS streamflow gages or NCDC/SJRWMD rain gages located within this watershed. The nearest rain gage is the NCDC 86753 co-op station in the Palatka area.

3.2.5.2 FEMA Flood Zones

The vast majority of this watershed is classified Zone X, or area determined to be outside the 500-year floodplain. Significant areas adjacent to Dog Branch, more prevalent on the west side, are designated Zone A, areas lying in the 100-year floodplain for which no base flood elevations have been determined. A very small portion of the watershed, at the downstream-most part of Dog Branch, is designated Zone AE, lying in the 100-year floodplain where base flood elevations have been determined based on study of the St. Johns River. FEMA floodplain mapping is depicted on Figure 3.2.5-2.

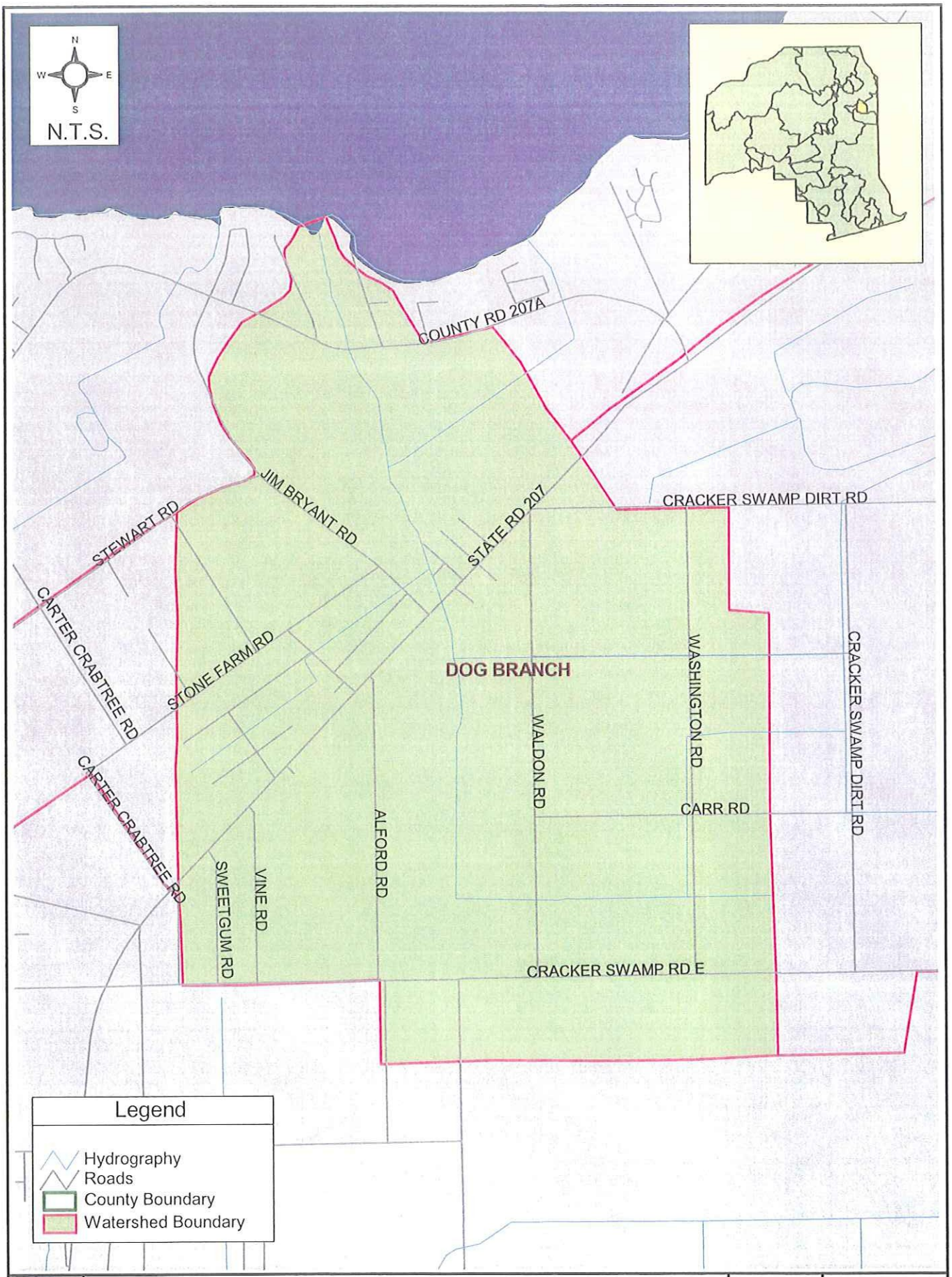
This watershed has not been studied in detail by FEMA.

3.2.5.3 Soils

High surficial water table in this watershed, for all or part of the year, results in high runoff potential over most of the watershed area not ditched and drained by agriculture. The highest representation, covering 46% of the watershed area, is the B/D HSG classification. Hydric soils (HSG D) account for 39% of the watershed. Roughly 14% of the area is represented by a HSG classification of C or C/D. Figure 3.2.5-3 depicts the current hydrologic soil groups in the Dog Branch Watershed.

3.2.5.4 Land Use/ Land Cover

Figure 3.2.5- 4 depicts the current land use in the Dog Branch Watershed. As illustrated by this figure, the Dog Branch Watershed is largely agricultural. Although "Agriculture" land use represents approximately 67% of the land area, other developed land use categories (residential, industrial, commercial) occupy roughly 12% of this watershed. The remainder of the watershed is largely occupied by undeveloped forest or wetland area.

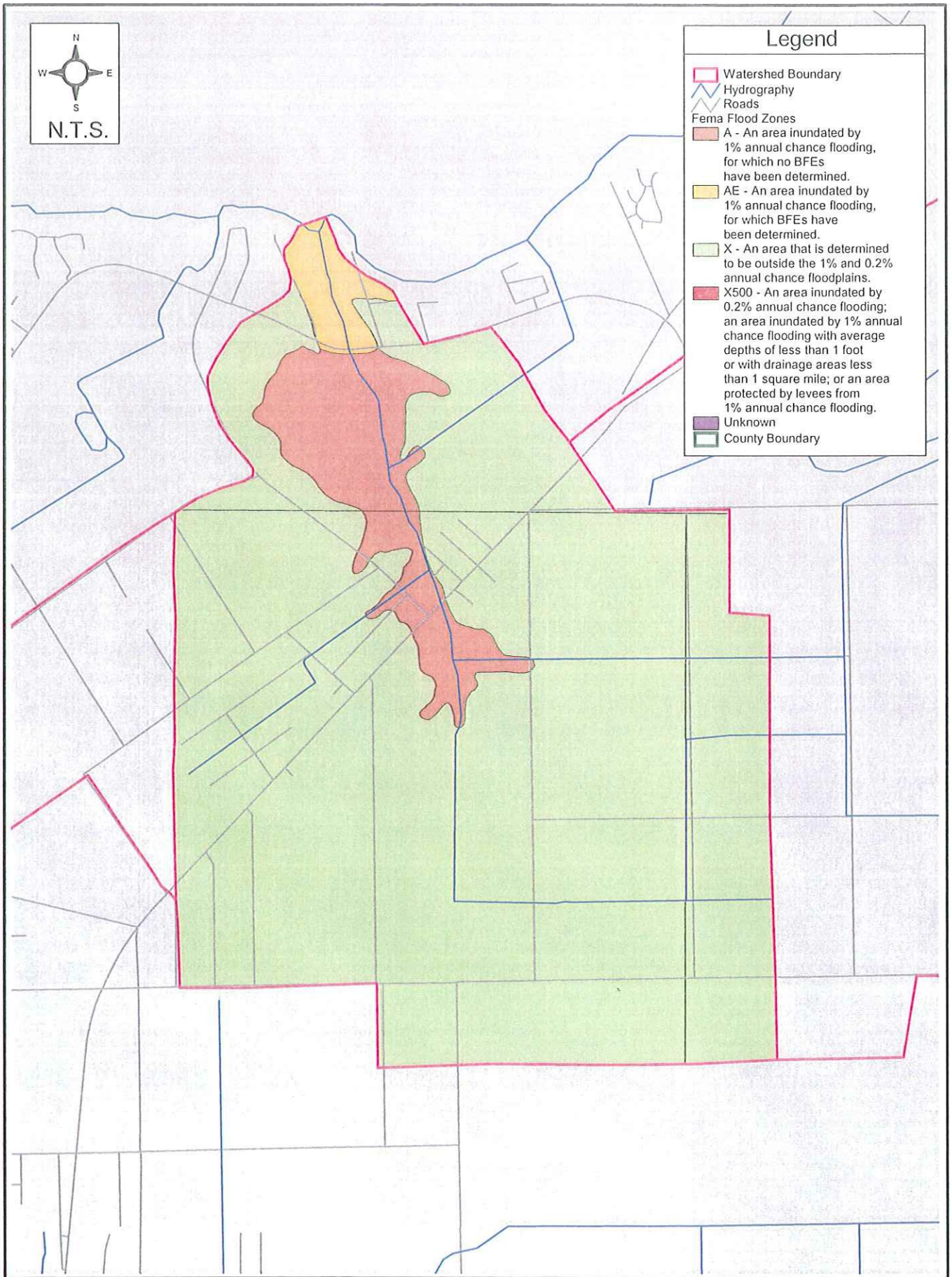


G:\COUNTY - PUTNAM\ 67011000(PutnumCoSWMMP)\GIS\ APRs\Watershed Maps\Dog_branch.apr

Location of the Dog Branch Watershed
Putnam County Master Stormwater Plan

Figure 3.2.5-1

AYRES ASSOCIATES

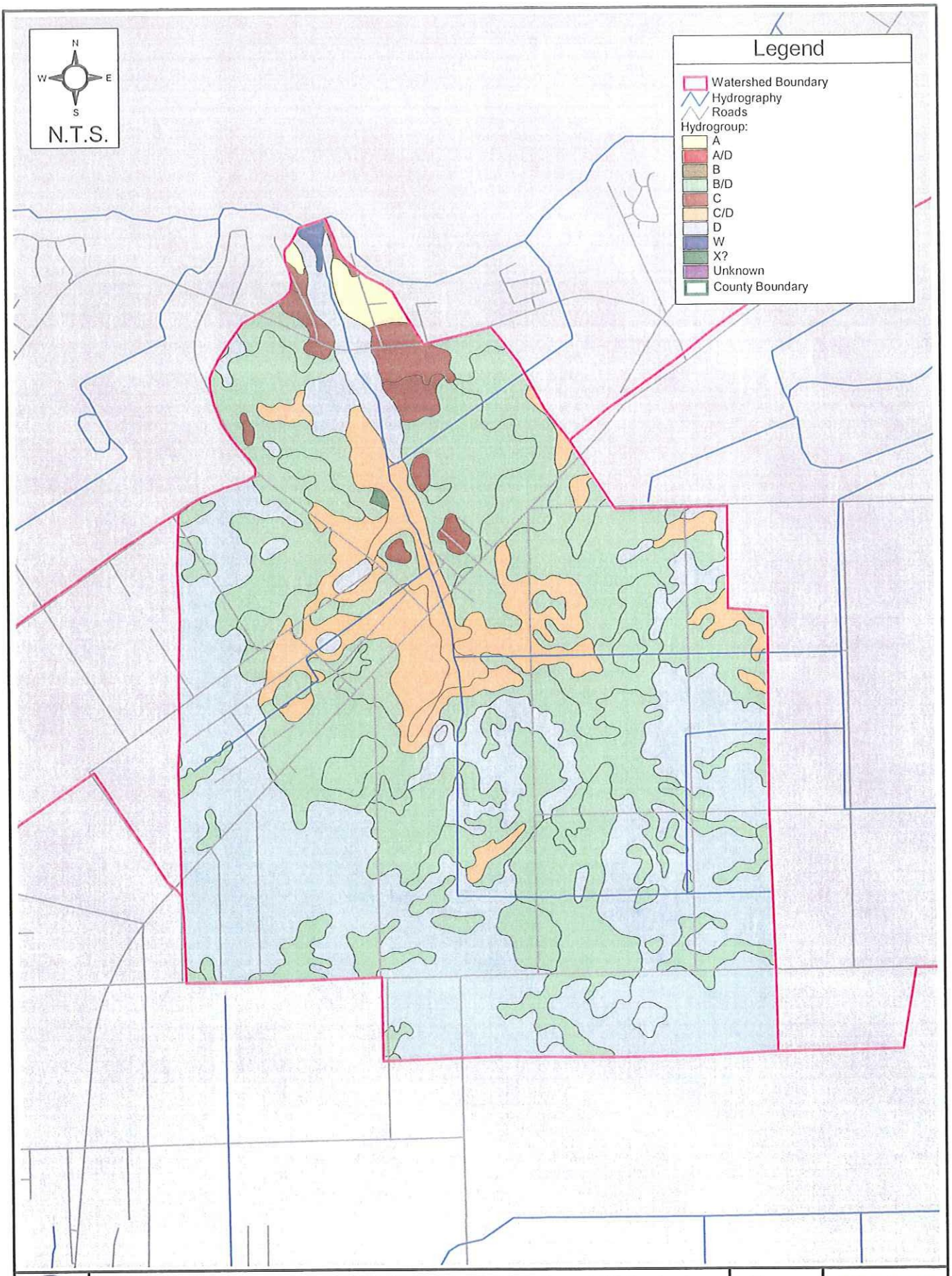


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Dog_Branch apr

FEMA Flood Zones in the Dog Branch Watershed
Putnam County Master Stormwater Plan

Figure
3.2.5-2

AYRES ASSOCIATES

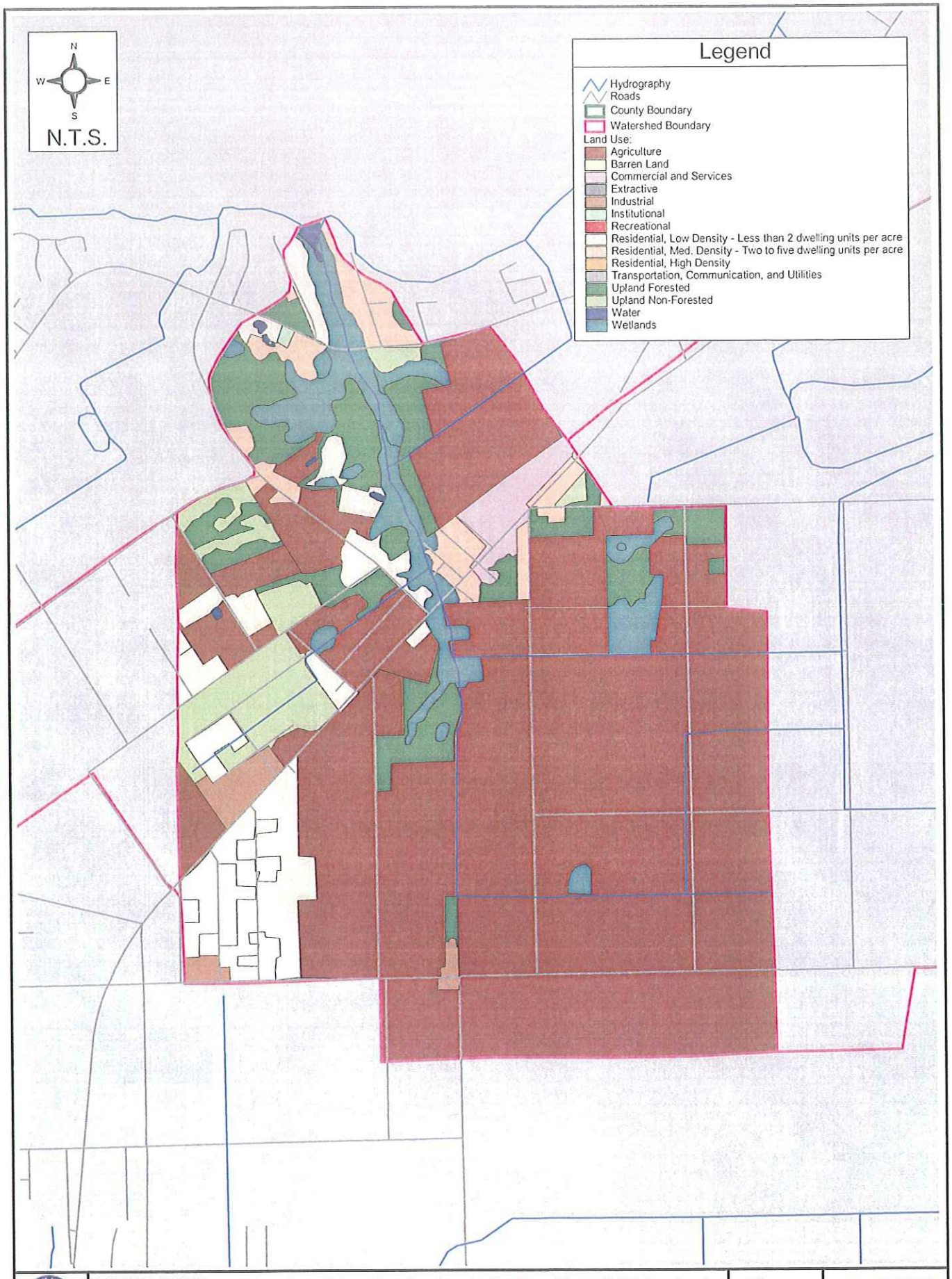


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Dog_branch.apr

Soils Distribution in the Dog Branch Watershed
Putnam County Master Stormwater Plan

Figure 3.2.5-3

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\Dog_branch.apr

Land Use Distribution in the Dog Branch Watershed
Putnam County Master Stormwater Plan

Figure 3.2.5-4

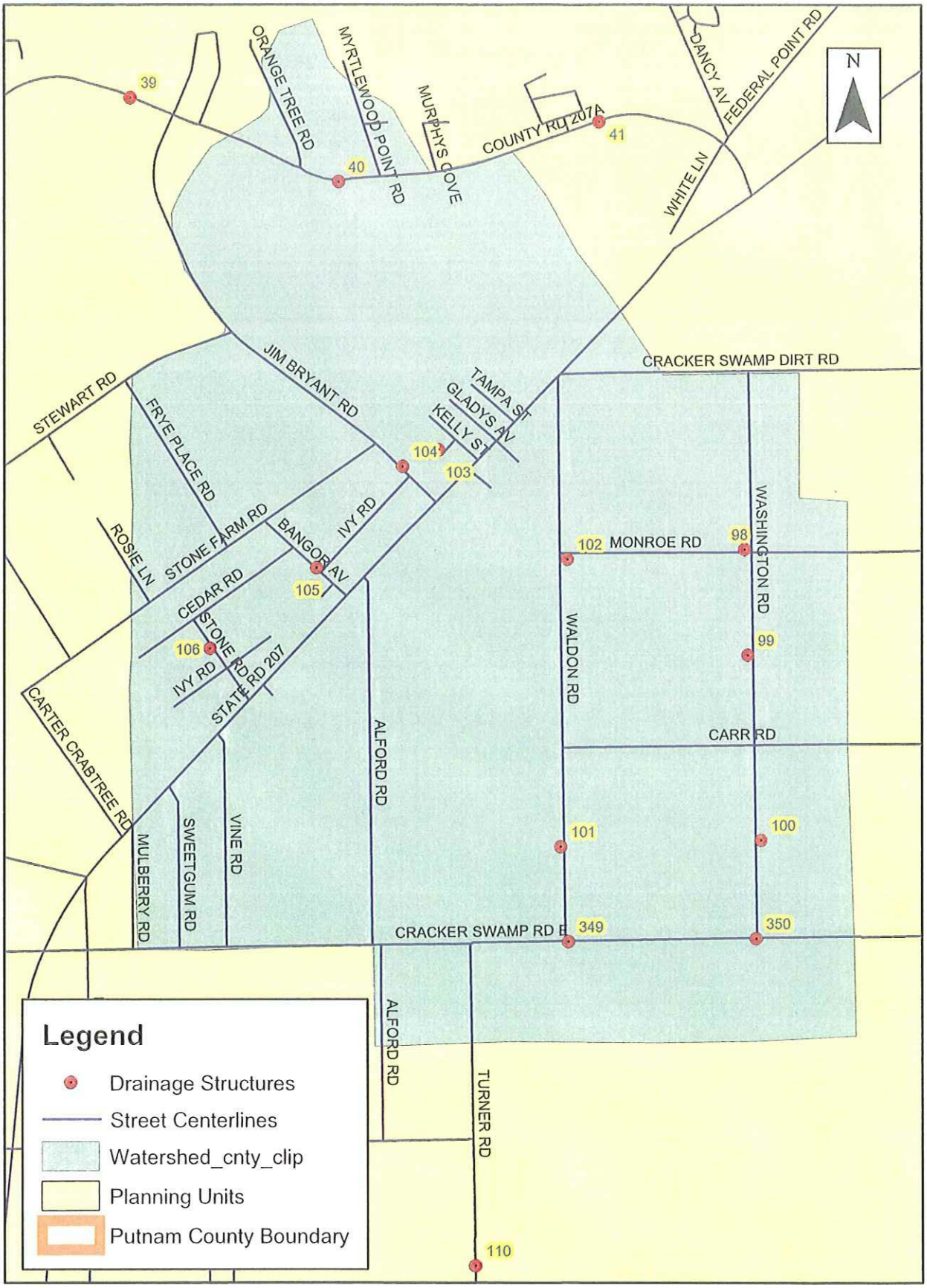
AYRES ASSOCIATES

3.2.5.5 Field investigations in Selected Subwatersheds

The field reconnaissance program described in Section 2.10 was performed for this watershed as illustrated on the following index figure. No modifications to basin delineations resulted from field investigations. Field reports for hydraulic structures and photo documentation from the investigation is presented in **Appendix 3-B**. These data have been incorporated into a GIS database for County use.

3.2.5.6 Sewer Network and Point Source Discharge

Sewer networks and point source discharges in this watershed have not been identified by the County. A search of FDEP permitted point source discharges and industrial stormwater dischargers was performed and no permitted point source discharges were found in the Dog Branch Watershed.



Field Reconnaissance - Dog Branch Watershed

3.2.6 FISH CREEK WATERSHED

The Fish Creek Watershed is comprised of roughly 3.3 square miles, located in north Putnam County, just west of the St. Johns River (**Figure 3.2.6-1**). It has not been divided into smaller subwatersheds and was not selected for field studies.

3.2.6.1 Physiography and Hydrology

The primary outfall, Fish Creek, flows southeast for a distance of roughly 1.5 miles before discharging to the St. Johns River. The Fish Creek watershed includes a large centrally-located wetland, covering approximately 286 acres. Low elevations in the wetland are less than 5 feet NGVD. High elevations of roughly 80 feet NGVD are seen along the western boundary. Watershed slopes on the western side are moderately steep. Flatter terrain is exhibited in the northern and eastern regions, with high elevations in the range of 20-22 feet NGVD.

There are no USGS streamflow gages or NCDC/SJRWMD rain gages located within this watershed. The nearest rainfall station is operated by NCDC, co-op station 82915 "Federal Point," located on the east side of the St. Johns River.

3.2.6.2 FEMA Flood Zones

The central portion of this watershed is classified Zone X, or area determined to be outside the 500-year floodplain. Significant portions of the watershed, specifically the low wetland areas in the northern region and the large wetland area and Fish Creek conveyance in the southern watershed, are designated Zone A, areas lying in the 100-year floodplain for which no base flood elevations have been determined. FEMA floodplain mapping is depicted on **Figure 3.2.6-2**.

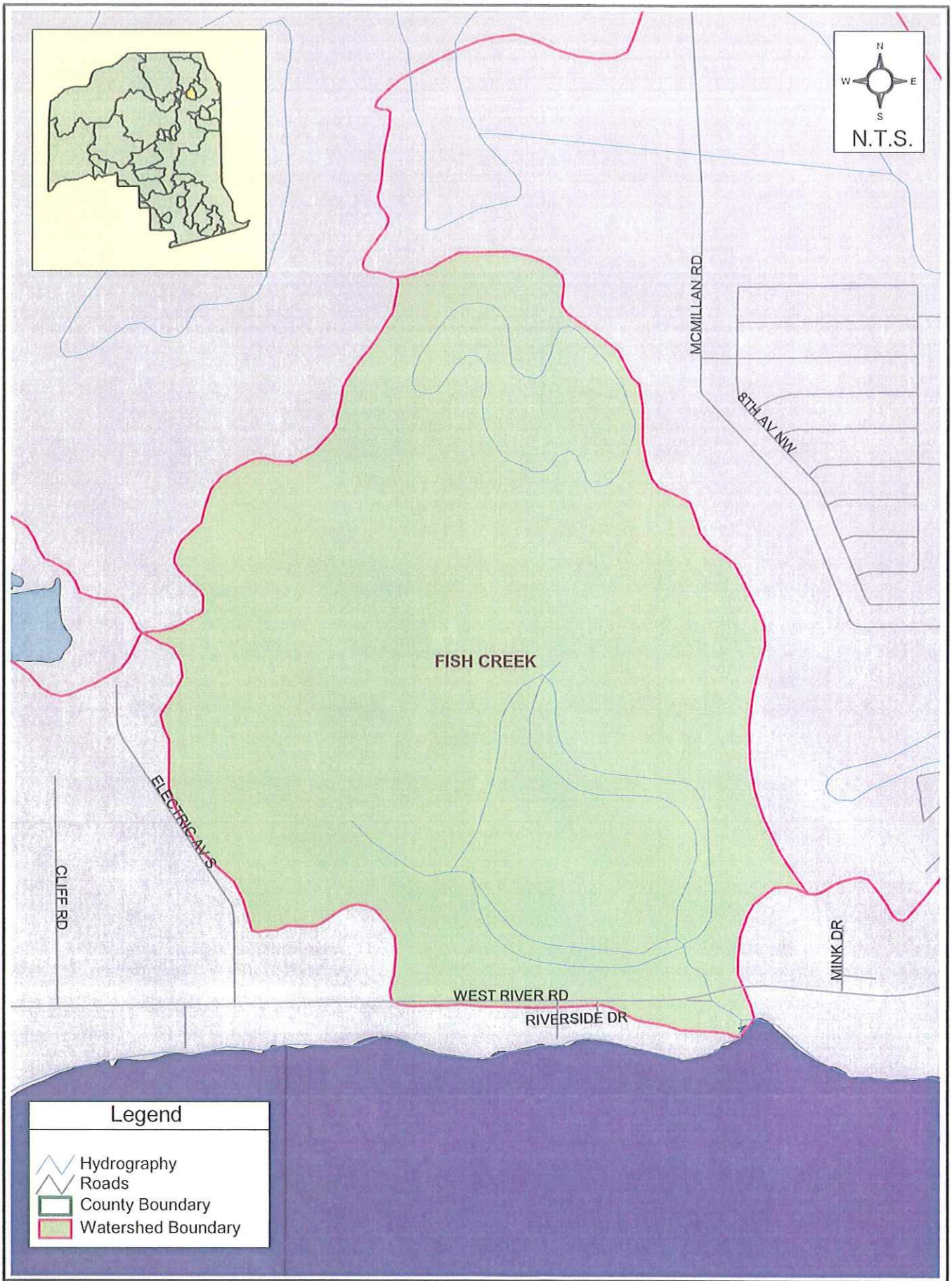
This watershed has not been studied in detail by FEMA.

3.2.6.3 Soils

Figure 3.2.6-3 depicts the current hydrologic soil groups in the Fish Creek Watershed. The watershed exhibits a variety of soil classifications although the B/D classification is most prevalent, occupying 56% of the watershed area. HSG D soils, generally hydric soils associated with wetlands, occupy 25% of the watershed area. Smaller proportions of HSG C or C/D and A designations are also present in the watershed.

3.2.6.4 Land Use/ Land Cover

Only 12% of the Fish Creek Watershed is occupied by developed land uses, primarily "Agriculture" and "Transportation/Utilities." The dominant land use code for the watershed is "Upland Forested" with coverage at 46% and "Wetlands" occupying 39% of the land area. **Figure 3.2.6- 4** depicts the current land use in the Fish Creek Watershed.

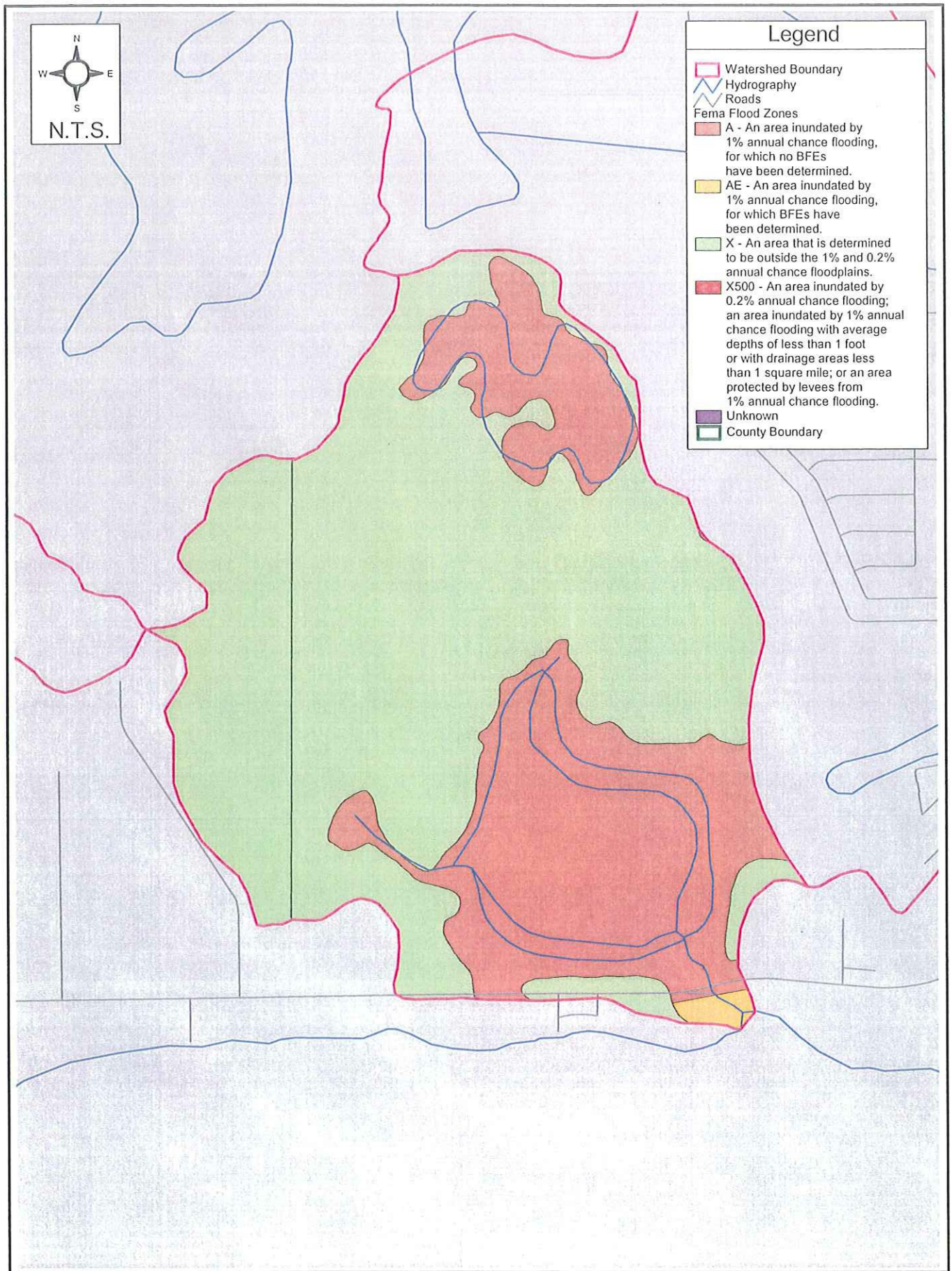


G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\Fish_creek.apr

Location of the Fish Creek Watershed
Putnam County Master Stormwater Plan

Figure 3.2.6-1

AYRES ASSOCIATES

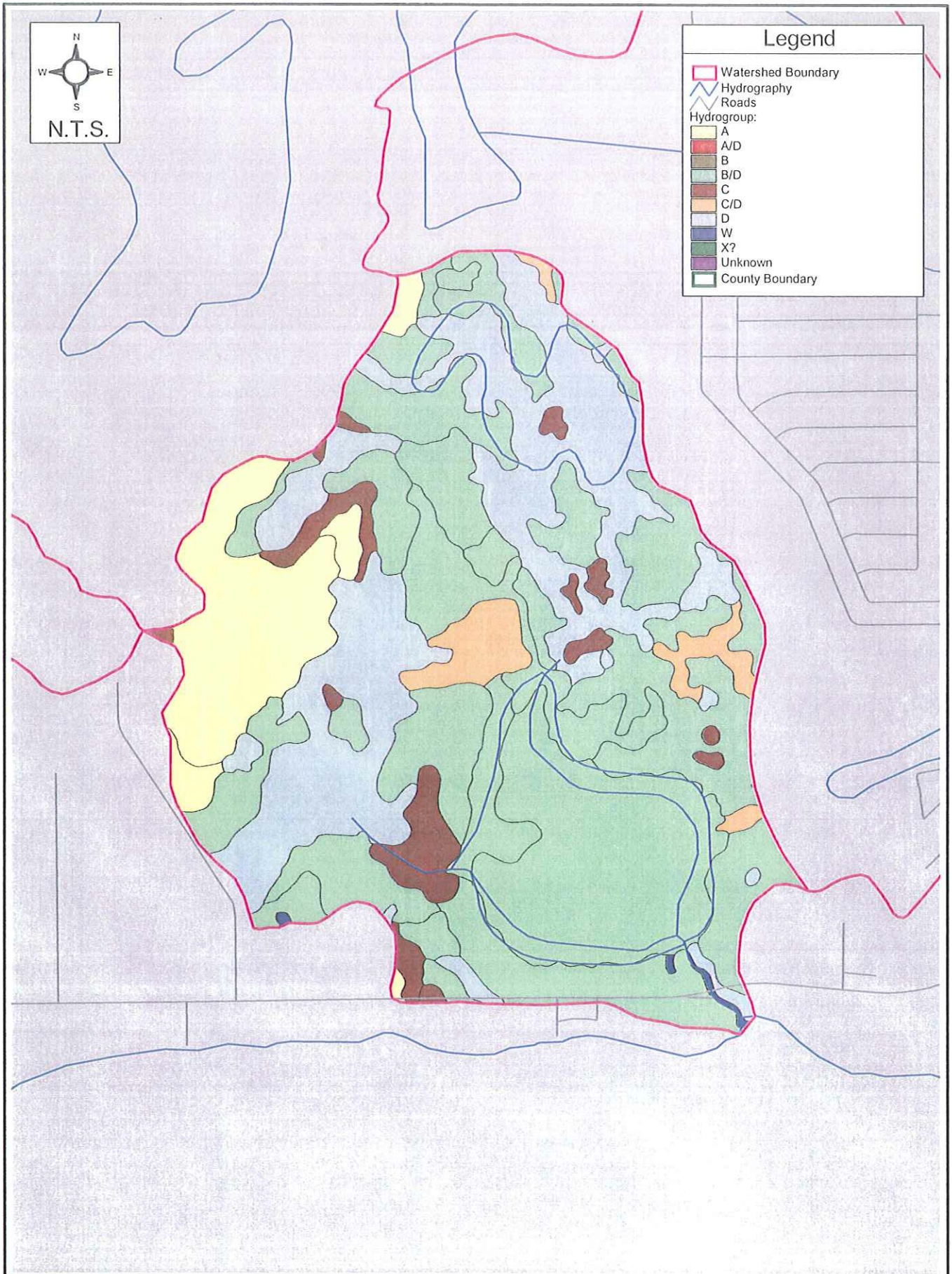


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Fish_creek.apr

FEMA Flood Zones in the Fish Creek Watershed
Putnam County Master Stormwater Plan

Figure 3.2.6-2

AYRES ASSOCIATES

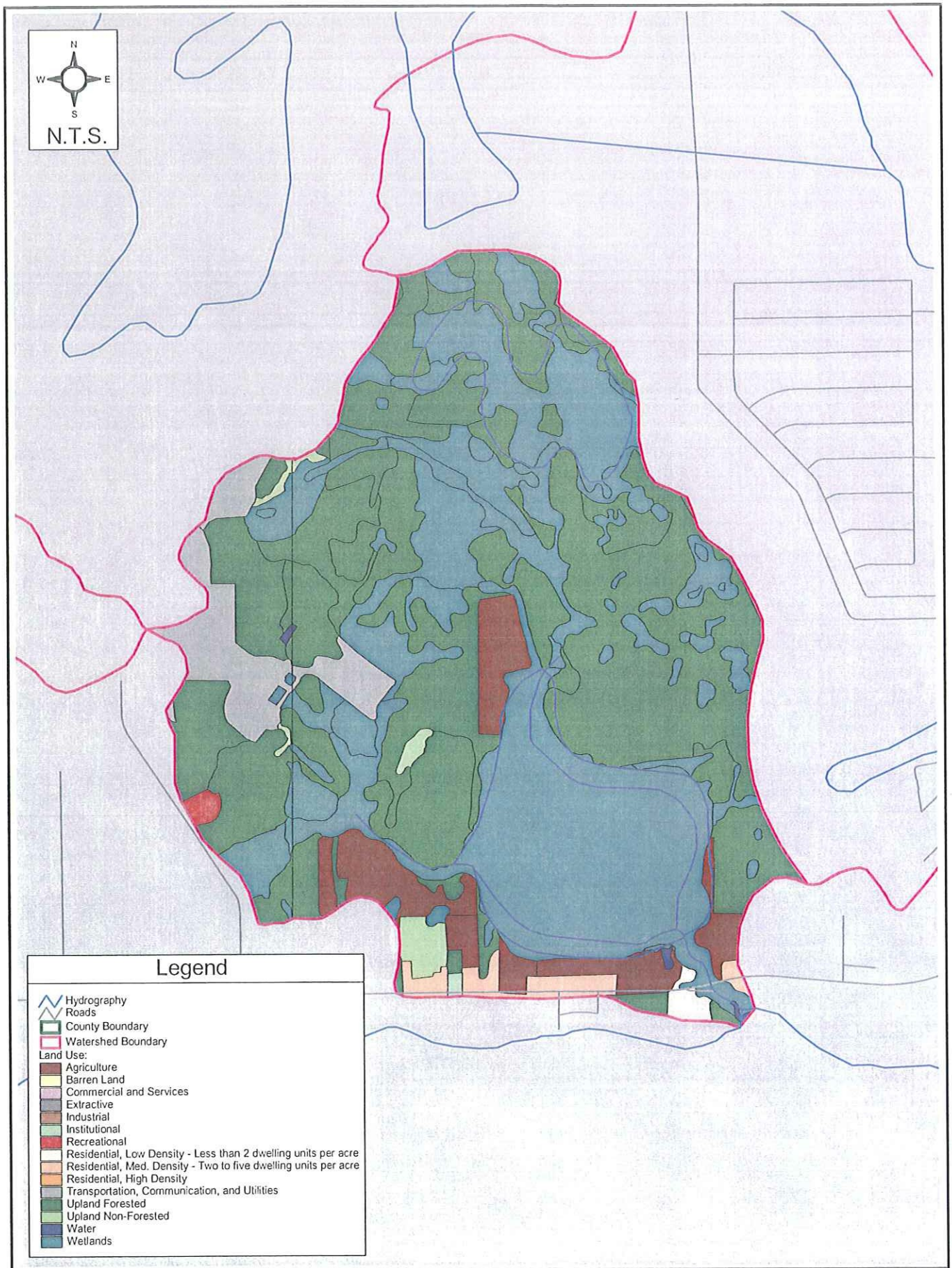


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Fish_creek.apr

Soils Distribution in the Fish Creek Watershed
Putnam County Master Stormwater Plan

Figure
3.2.6-3

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Fish_creek.apr

Land Use Distribution in the Fish Creek Watershed
Putnam County Master Stormwater Plan

Figure 3.2.6-4

AYRES ASSOCIATES

3.2.7 MASON BRANCH WATERSHED

The Mason Branch Watershed is comprised of approximately 5 square miles, located in north Putnam County, just west of the St. Johns River (**Figure 3.2.7-1**). It has not been divided into smaller subwatersheds. The Mason Branch Watershed has been selected for field investigation.

3.2.7.1 Physiography and Hydrology

The primary outfall, Mason Branch flows south-southeast for a distance of roughly 2.9 miles before discharging to the St. Johns River. Significant wetland areas are found in the western portion of the watershed and a potential hydraulic connection with the Cedar Creek primary watershed exists at the northwest boundary. Watershed slope is very mild, with most of the watershed area lying between elevations of 10 and 20 feet NGVD. Topographic highs are seen at the western boundary where the dividing ridge lies at roughly 70-75 feet NGVD.

There are no USGS streamflow gages or NCDC/SJRWMD rain gages located within this watershed. The nearest rainfall station is operated by NCDC, co-op station 82915 "Federal Point," located on the east side of the St. Johns River.

3.2.7.2 FEMA Flood Zones

With the exception of the wetland areas and the Mason Branch conveyance, the vast majority of this watershed is classified Zone X, or area determined to be outside the 500-year floodplain. Wetland areas and stream conveyances are designated Zone A, areas lying in the 100-year floodplain for which no base flood elevations have been determined. Only the downstream-most portion of Mason Branch is designated Zone AE, signifying that base flood elevations have been determined. FEMA floodplain mapping is depicted on **Figure 3.2.7-2**.

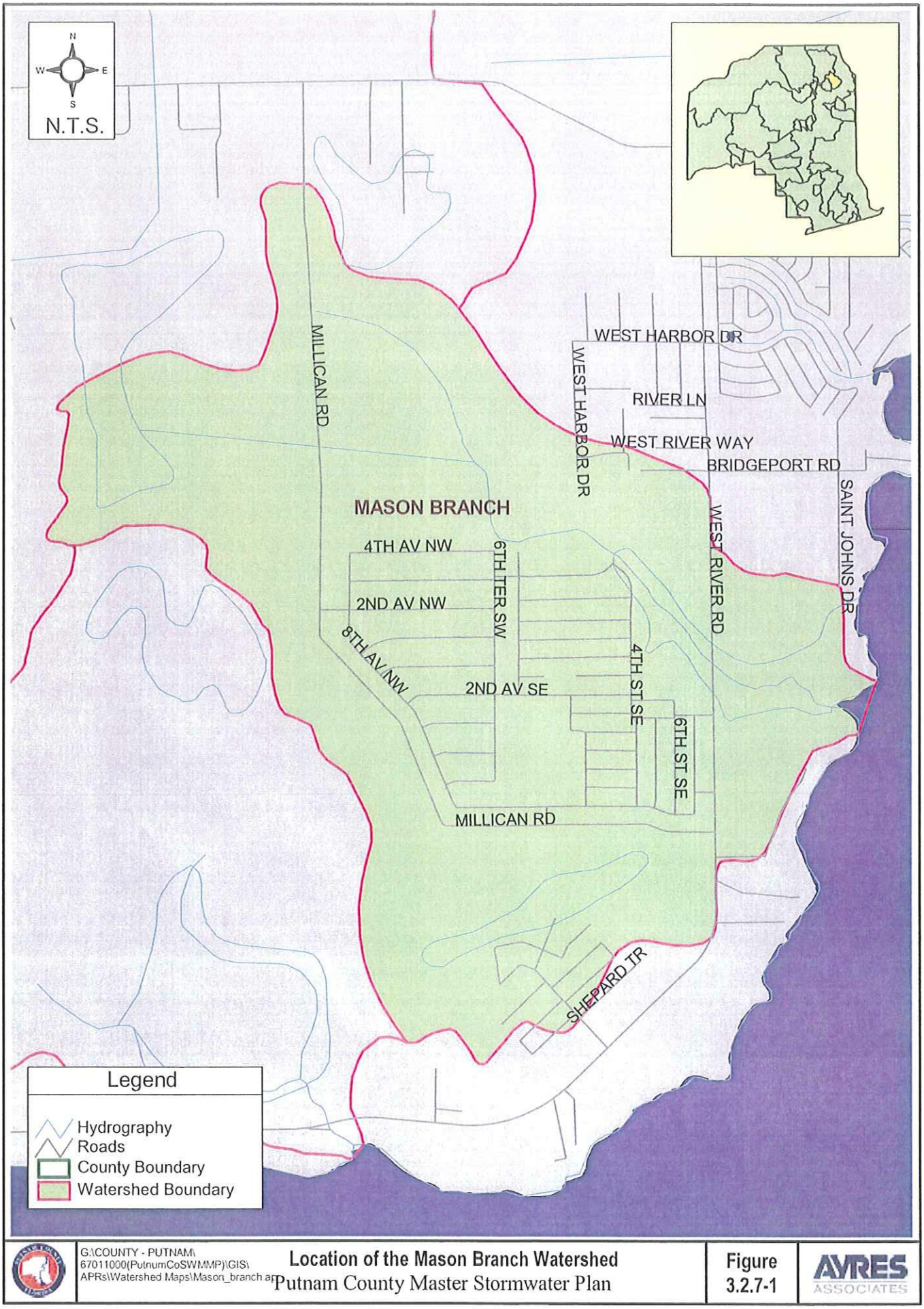
The Putnam County FIS does not include the Mason Branch Watershed in its detailed study area. The base flood elevations that have been determined within the Mason Branch Watershed are associated with the flood profiles generated from detailed study of the St. Johns River.

3.2.7.3 Soils

Figure 3.2.7-3 depicts the current hydrologic soil groups in the Mason Branch Watershed. High surficial water table in this watershed, for all or part of the year, results in high runoff potential over most of the watershed area. Roughly 65% of the watershed is underlain by soils with a B/D HSG classification. Hydric soils (HSG D) account for 18% of the watershed. Roughly 14% of the area is represented by a HSG classification of C/D. HSG C and A classifications represent a small proportion of the watershed.

3.2.7.4 Land Use/ Land Cover

Prevalent land uses in the Mason Branch Watershed are "Upland Forested," "Wetlands," and "Open Land" with respective percent coverage of 38%, 22% and 21%. "Agriculture" accounts for approximately 12% and 'Residential" for 5% of the watershed area. **Figure 3.2.7- 4** depicts the current land use in the Mason Branch Watershed.

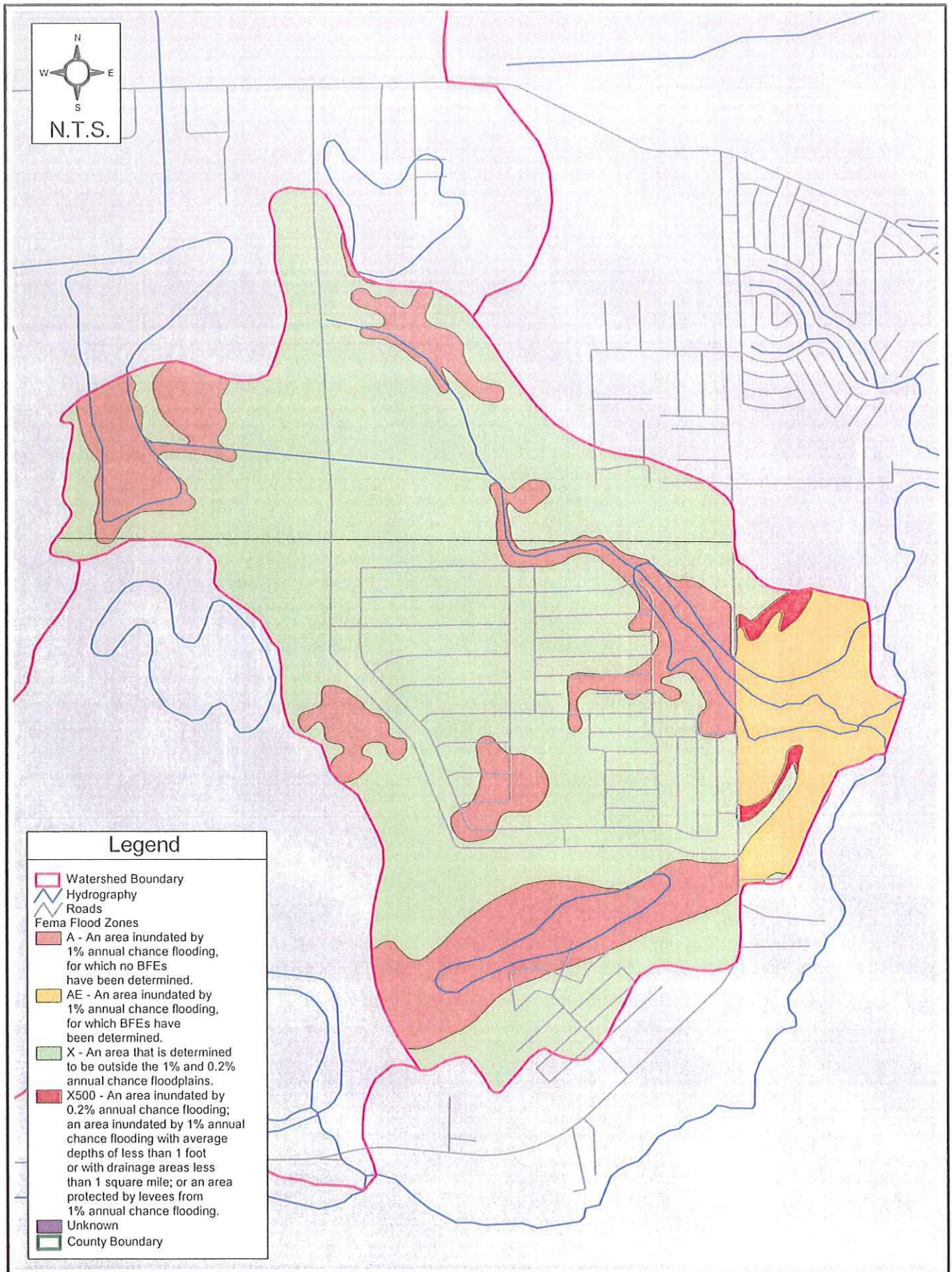


G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\Mason_branch ap

Location of the Mason Branch Watershed
Putnam County Master Stormwater Plan

Figure 3.2.7-1

AYRES ASSOCIATES

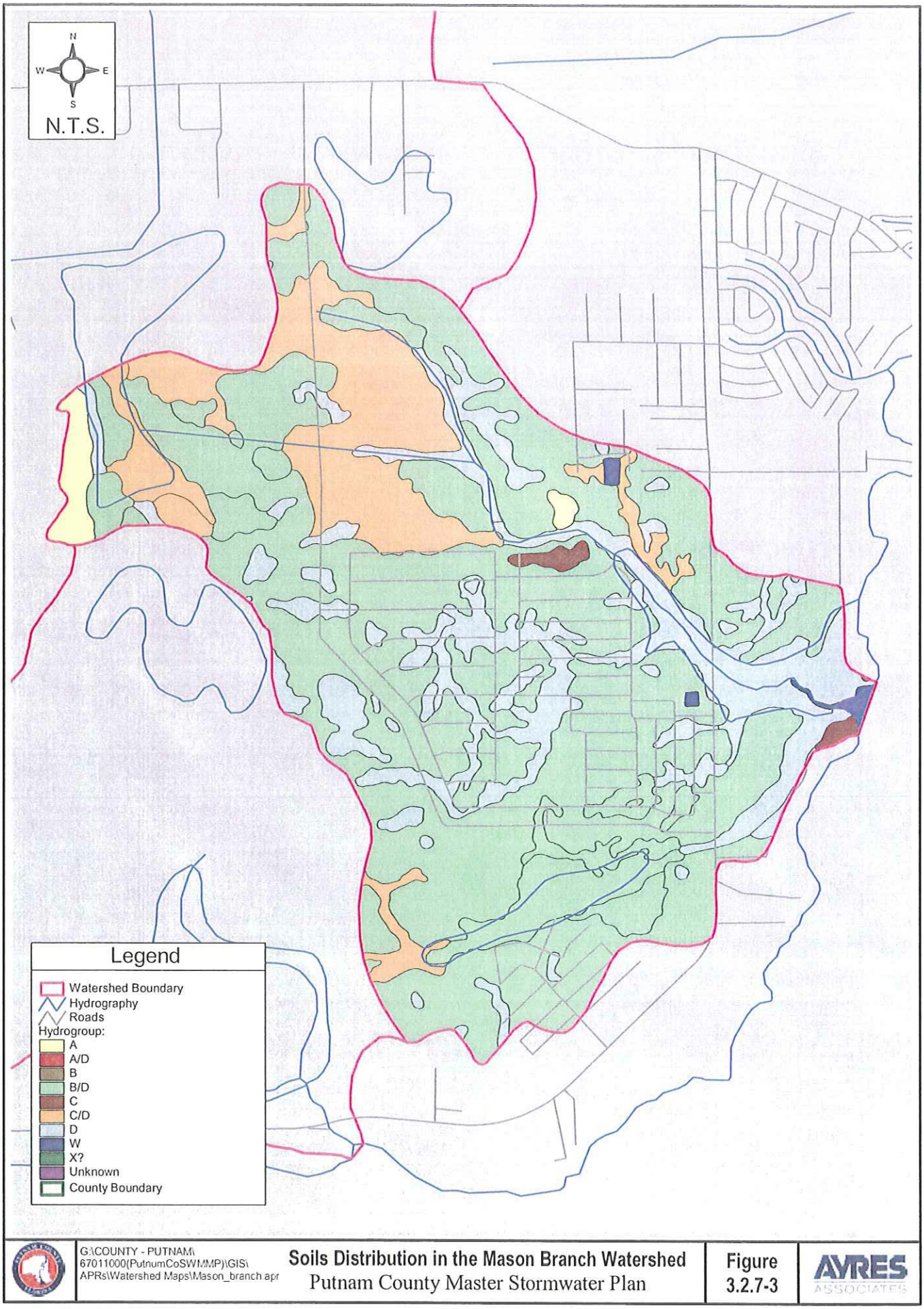


G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\Mason_Branch.apr

FEMA Flood Zones in the Mason Branch Watershed
Putnam County Master Stormwater Plan

Figure 3.2.7-2

AYRES ASSOCIATES

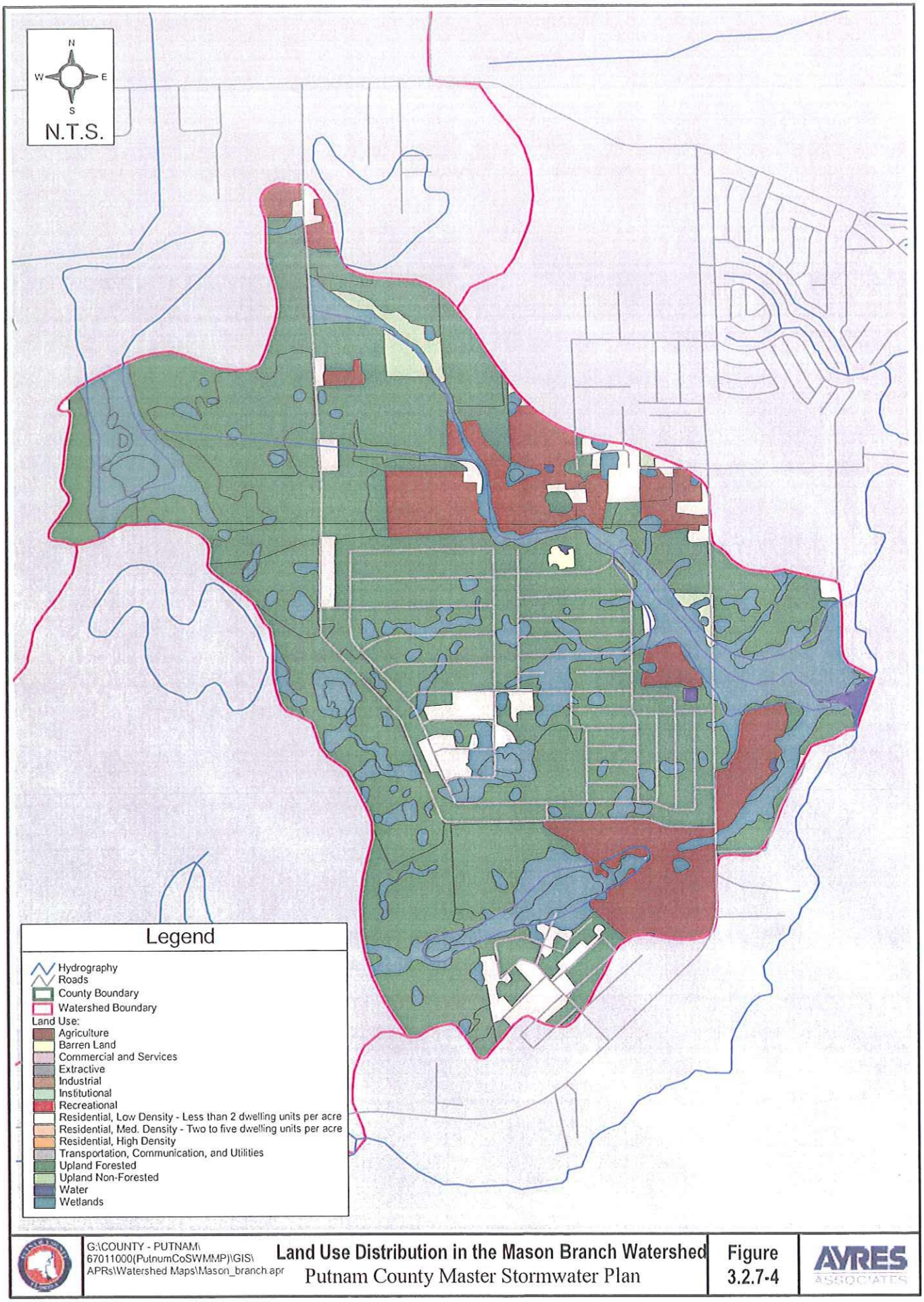


G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\Mason_branch.apr

Soils Distribution in the Mason Branch Watershed
Putnam County Master Stormwater Plan

Figure 3.2.7-3

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\ 67011000(PutnumCoSWMMP)\GIS\ APRs\Watershed Maps\Mason_branch.apr

Land Use Distribution in the Mason Branch Watershed

Putnam County Master Stormwater Plan

Figure 3.2.7-4

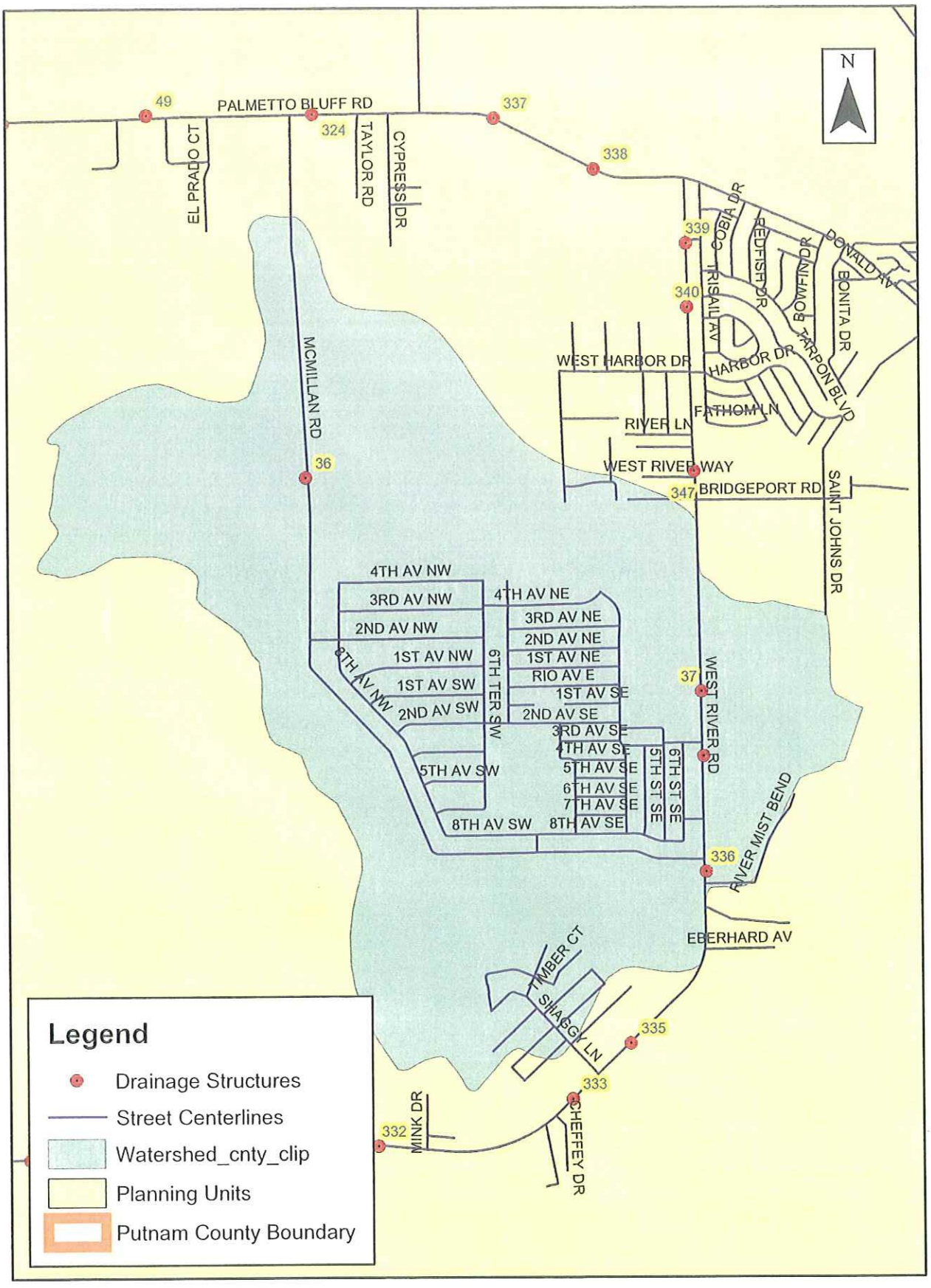
AYRES ASSOCIATES

3.2.7.5 Field investigations in Selected Subwatersheds

The field reconnaissance program described in Section 2.10 was performed for this watershed as illustrated on the following index figure. No modifications to basin delineations resulted from field investigations. Field reports for hydraulic structures and photo documentation from the investigation is presented in **Appendix 3-B**. These data have been incorporated into a GIS database for County use.

3.2.7.6 Sewer Network and Point Source Discharge

Sewer networks and point source discharges in this watershed have not been identified by the County. A search of FDEP permitted point source discharges and industrial stormwater dischargers was performed and no permitted point source discharges were found in the Mason Branch Watershed.



Field Reconnaissance - Mason Branch Watershed

3.2.8 MILL BRANCH WATERSHED

The Mill Branch Watershed is comprised of 8.6 square miles, located in north Putnam County, just east of the St. Johns River (Figure 3.2.8-1). It has not been divided into smaller subwatersheds. The Mill Branch Watershed has been selected for field study.

3.2.8.1 Physiography and Hydrology

The primary outfall, Mill Branch flows west for a distance of roughly 4.5 miles before discharging to the St. Johns River. Several perpendicular collector channels and ditches flow from the north and south to feed into Mill Branch along its length. Most of the watershed is quite flat, lying between the elevations of 20 to 25 feet NGVD. Increased surface slopes are seen on the west end of the watershed near East Palatka.

There are no USGS streamflow gages within this watershed, nor are any NCDC/SJRWMD rain gages located within this watershed. There area two rainfall stations near the watershed. The first is the site 243 "Hell Cat Bay" gage located 1.8 miles to the south and operated by the SJRWMD. The second is operated by NCDC, co-op station 86753 "Palatka, Florida," located roughly 4 miles to the west on the other side of the St. Johns River.

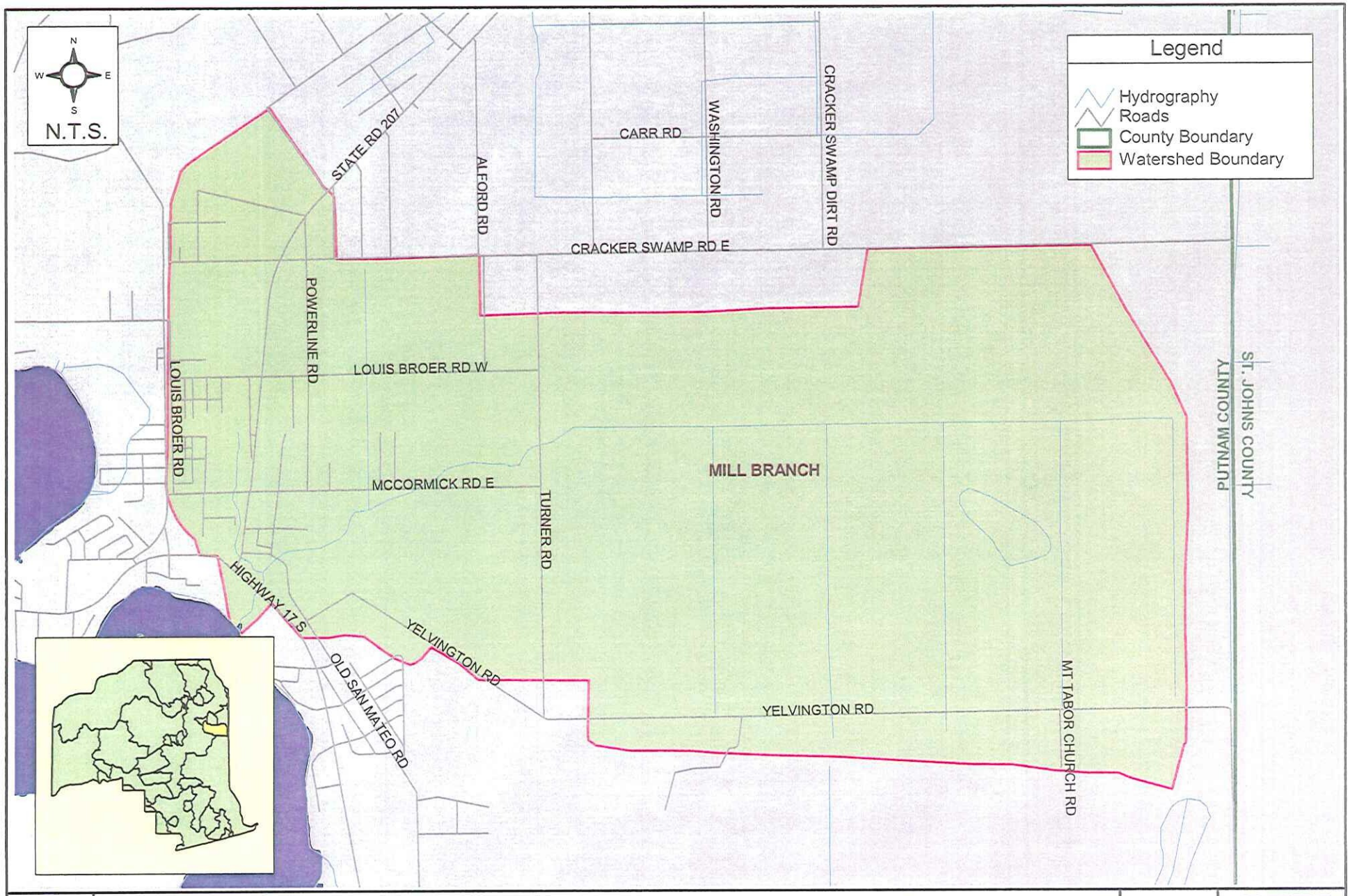
3.2.8.2 FEMA Flood Zones

With the exception of the westernmost portion of the Mill Creek channel and a minor unnamed southward-flowing tributary, and some isolated wetlands located on the east end of the watershed; the vast majority of this watershed is classified Zone X, or area determined to be outside the 500-year floodplain. The aforementioned wetland areas and western stream conveyances are designated Zone A, lying in the 100-year floodplain for which no base flood elevations have been determined. Only the downstream-most portion of Mill Branch is designated Zone AE, signifying that base flood elevations have been determined. FEMA floodplain mapping is depicted on Figure 3.2.8-2.

The Putnam County FIS does not include the Mill Branch Watershed in its detailed study area. The base flood elevations that have been determined at the western outfall are associated with the flood profiles generated from detailed study of the St. Johns River.

3.2.8.3 Soils

Dominant hydrologic soil group classifications in the Mill Branch Watershed indicate high surficial water table influence, for all or part of the year. Areas that have not been ditched and drained will exhibit a high runoff potential. Figure 3.2.8-3 depicts the current hydrologic soil groups in the Mill Branch Watershed. As illustrated in the figure, half of the watershed is underlain by soils with a B/D HSG classification. Hydric soils (HSG D) account for 26% of the watershed. Roughly 22% of the area is represented by a HSG classification of C/D. HSG C soils represent a small proportion, just 2% of the watershed area.

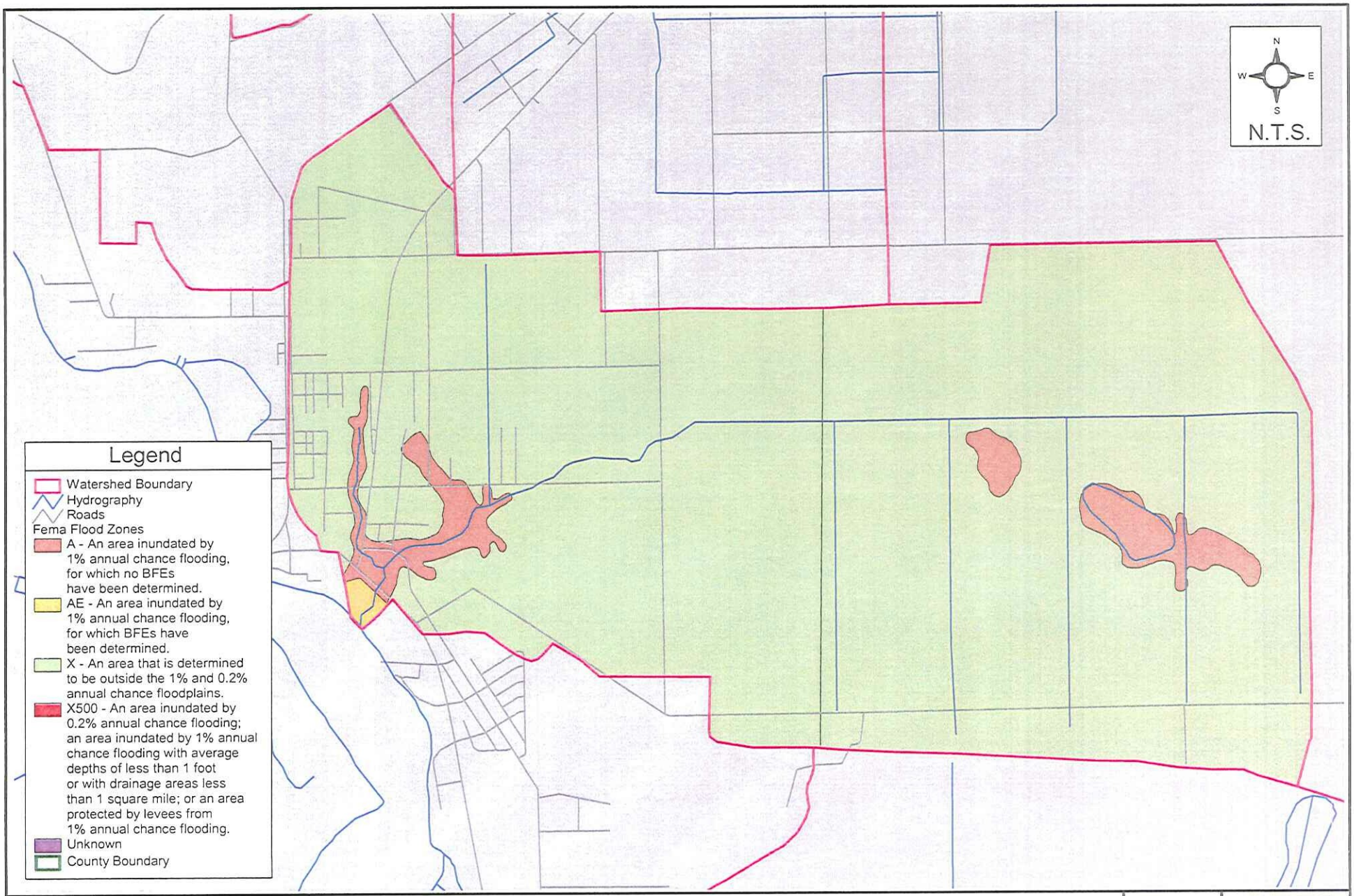


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Mills_Branch.apr

Location of the Mill Branch Watershed
Putnam County Master Stormwater Plan

Figure
3.2.8-1

AYRES ASSOCIATES



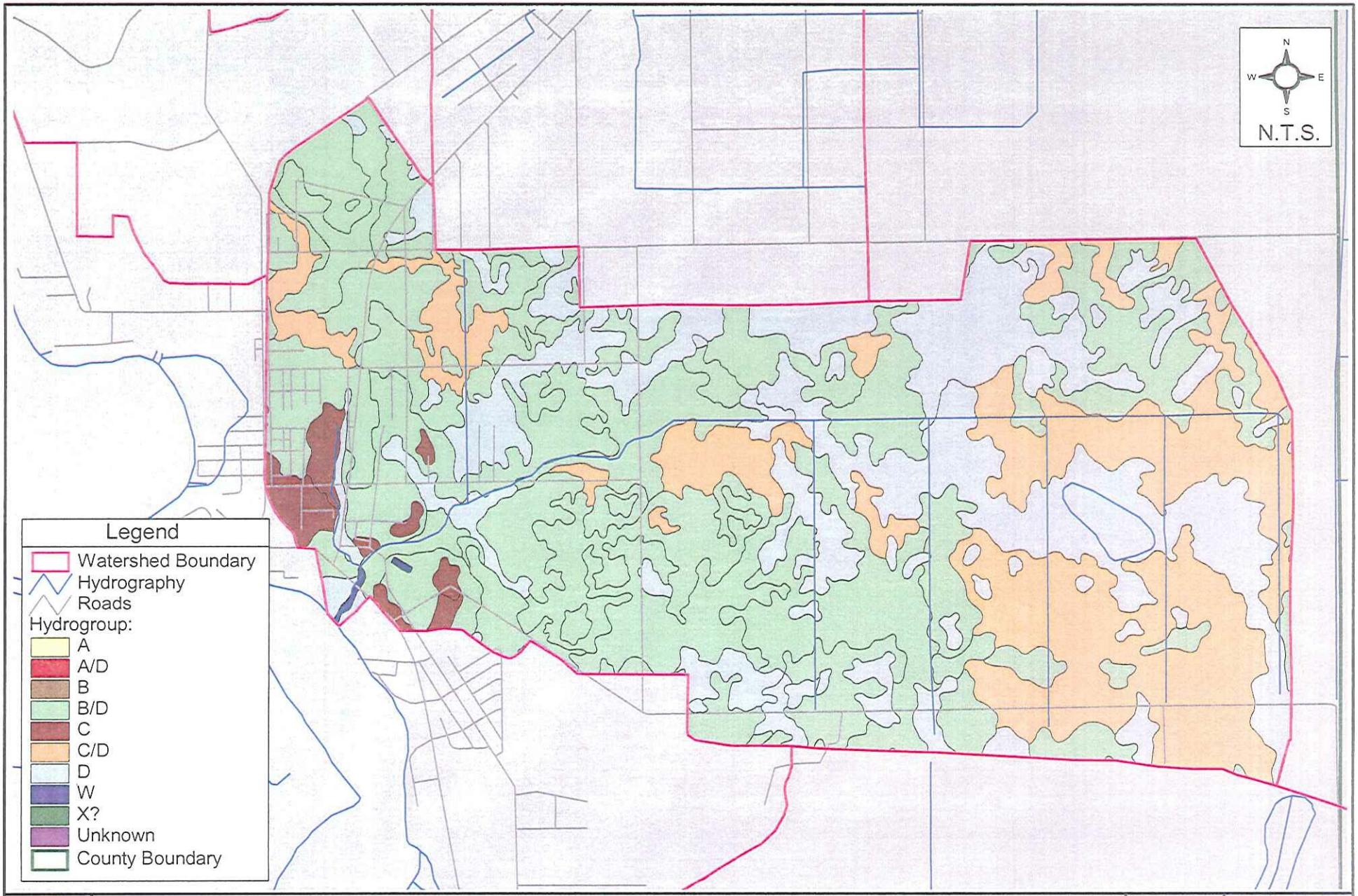
G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Mills_Branch.apr

FEMA Flood Zones in the Mill Branch Watershed

Putnam County Master Stormwater Plan

Figure
3.2.8-2

AYRES ASSOCIATES



C:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Mills_Branch.apr

Soils Distribution in the Mill Branch Watershed
Putnam County Master Stormwater Plan

Figure
3.2.8-3

AYRES ASSOCIATES

3.2.8.4 Land Use/ Land Cover

Figure 3.2.8- 4 depicts the current land use in the Mill Branch Watershed. The most significant developed land use in the watershed is "Agriculture," occupying 26% of the area. "Residential", "Commercial," and "Institutional," and "Transportation" land use codes cover another 10% of the watershed area. The largest land use coverage is "Upland Forested" at 43%. "Wetlands" occupy 16% of the watershed area.

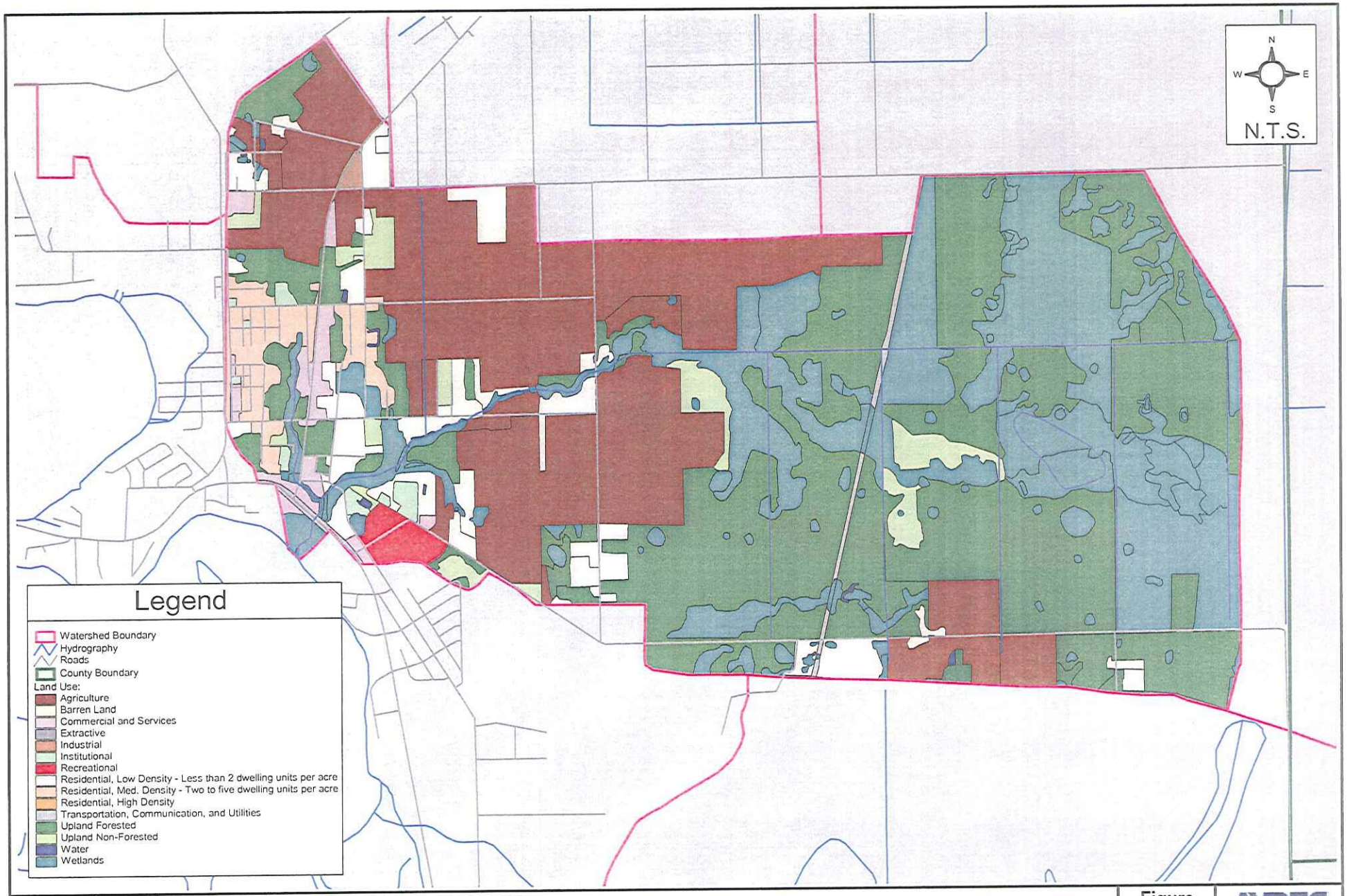
3.2.8.5 Field investigations in Selected Subwatersheds

The field reconnaissance program described in Section 2.10 was performed for this watershed as illustrated on the following index figure. No modifications to basin delineations resulted from field investigations. Field reports for hydraulic structures and photo documentation from the investigation is presented in Appendix 3-B. These data have been incorporated into a GIS database for County use.

3.2.8.6 Sewer Network and Point Source Discharge

Sewer networks and point source discharges in this watershed have not been identified by the County. A search of FDEP permitted point source discharges and industrial stormwater dischargers was performed and yielded the following results:

WATER SHED	SUBWATER SHED	FACILITY ID	NAME	FACILITY TYPE	FACILITY ADDRESS	CITY	OWNERSHIP TYPE
Mill Branch		FL0433365	E. PUTNAM COUNTY RO WTP	Industrial Wastewater	223 PUTNAM COUNTY BLVD.	EAST PUTNAM	Privately Owned

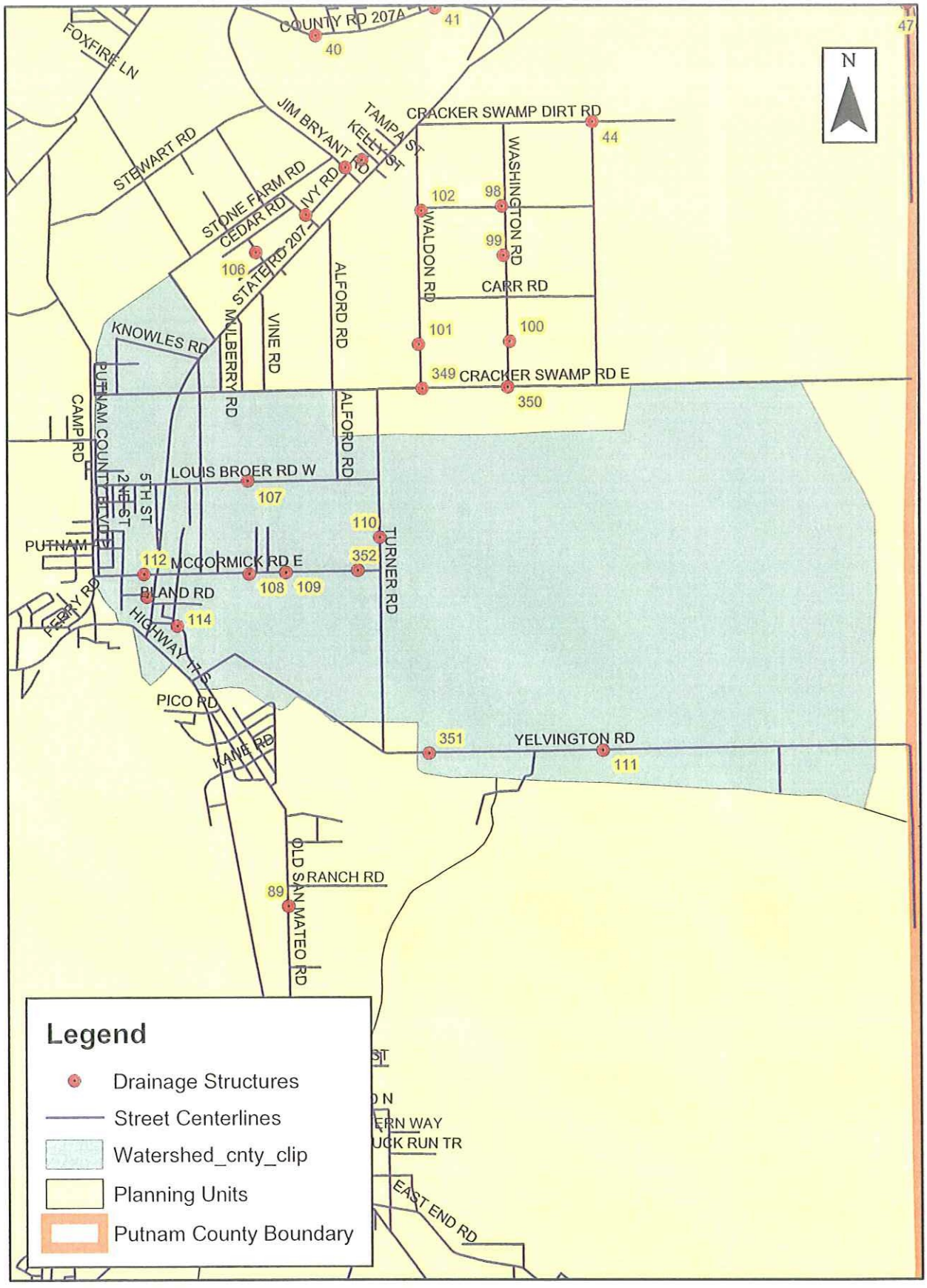


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Mills_Branch.apr

Land Use Distribution in the Mill Branch Watershed
Putnam County Master Stormwater Plan

Figure
3.2.8-4

AYRES ASSOCIATES



Field Reconnaissance - Mill Branch Watershed

3.2.9 MOCCASIN CREEK WATERSHED

The Moccasin Creek Watershed is comprised of 1.8 square miles, located in north Putnam County, just west of the St. Johns River (**Figure 3.2.9-1**). It has not been divided into smaller subwatersheds and was not selected for field studies.

3.2.9.1 Physiography and Hydrology

The primary outfall, Moccasin Creek flows southeast for a distance of roughly 1.5 miles before discharging to the St. Johns River floodplain. Moccasin Creek has no significant tributaries. Watershed slope is moderate, with high elevations ranging from 50 feet NGVD at the northern boundary and as high as 80 feet NGVD along the eastern divide.

There are no USGS streamflow gages located within this watershed. The nearest rain gaging stations, SJRWMD station 210 and NCDC co-op station 86753, are also outside the watershed boundaries, located in the Palatka area roughly 4.5 miles to the south.

3.2.9.2 FEMA Flood Zones

As indicated on the FEMA floodplain mapping, depicted on **Figure 3.2.9-2**, the entire Moccasin Creek Watershed is classified Zone X, or area determined to be outside the 500-year floodplain. Only the outlet of the creek, as it meets the floodplain of the St. Johns River, is designated Zone AE, 100-year floodplain with base flood elevations determined.

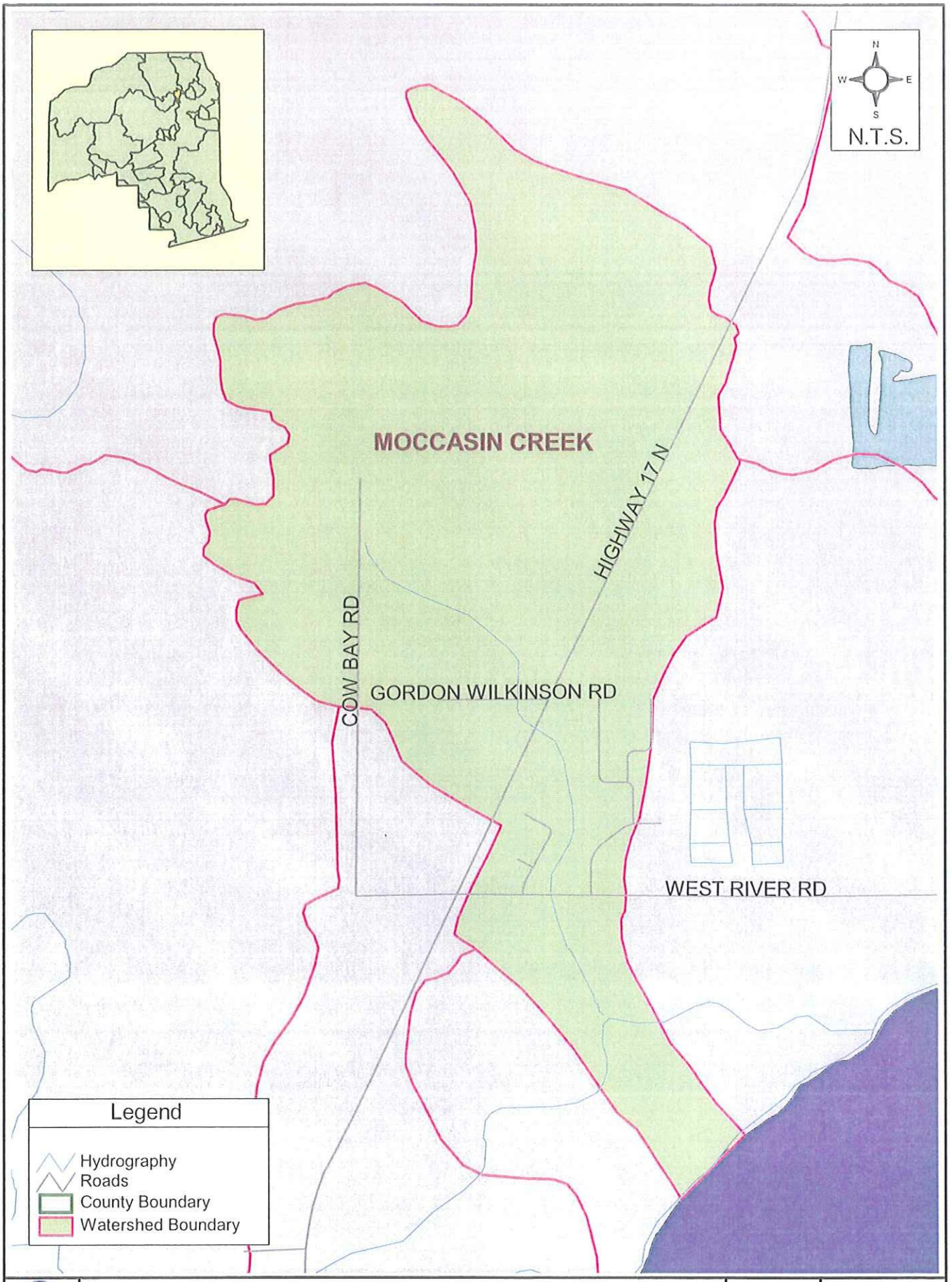
The Putnam County FIS does not include the Moccasin Creek Watershed in its detailed study area. The base flood elevations that have been determined at the outfall are associated with the flood profiles generated from detailed study of the St. Johns River.

3.2.9.3 Soils

Nearly half of the watershed area is underlain by B/D soil groups, as illustrated in **Figure 3.2.9-3** showing the current hydrologic soil groups in the Moccasin Creek Watershed. One quarter of the watershed area exhibits HSG D classification soils with very high runoff potential. Also represented in this watershed with percent coverage of 14% and 10%, respectively, are HSG C and HSG A soil classifications. A very small percentage of the watershed is represented by C/D soil classifications.

3.2.9.4 Land Use/ Land Cover

Figure 3.2.9- 4 depicts the current land use in the Moccasin Creek Watershed. Over 70% of this watershed is occupied by undeveloped land uses such as forest and wetlands. The remaining area is occupied by "Transportation/Communication/Utilities," "Residential," and "Agriculture" land uses at percentages of 12%, 9% and 5% respectively.

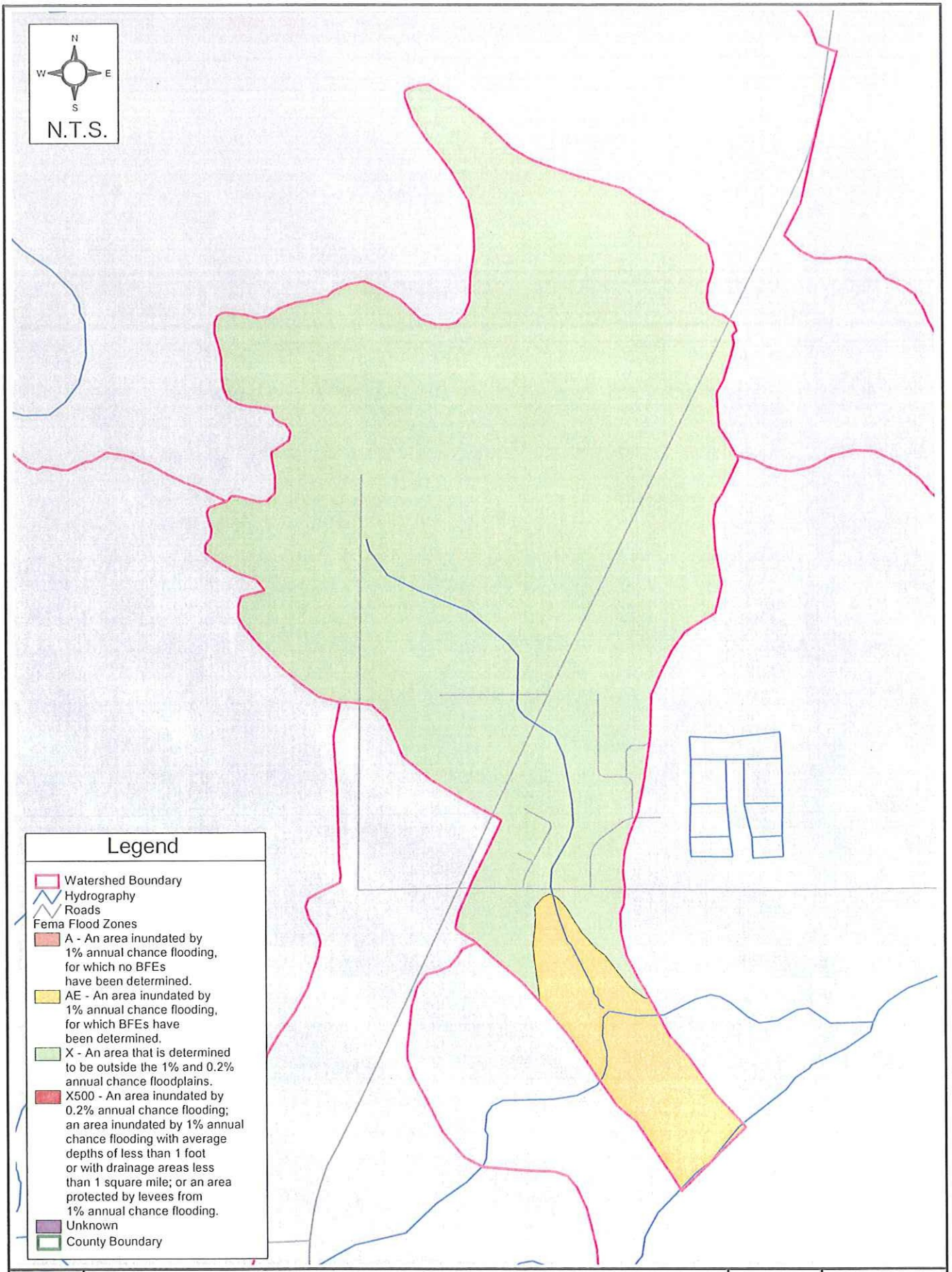


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Moccasin_creek.apr

Location of the Moccasin Creek Watershed
Putnam County Master Stormwater Plan

Figure 3.2.9-1

AYRES ASSOCIATES

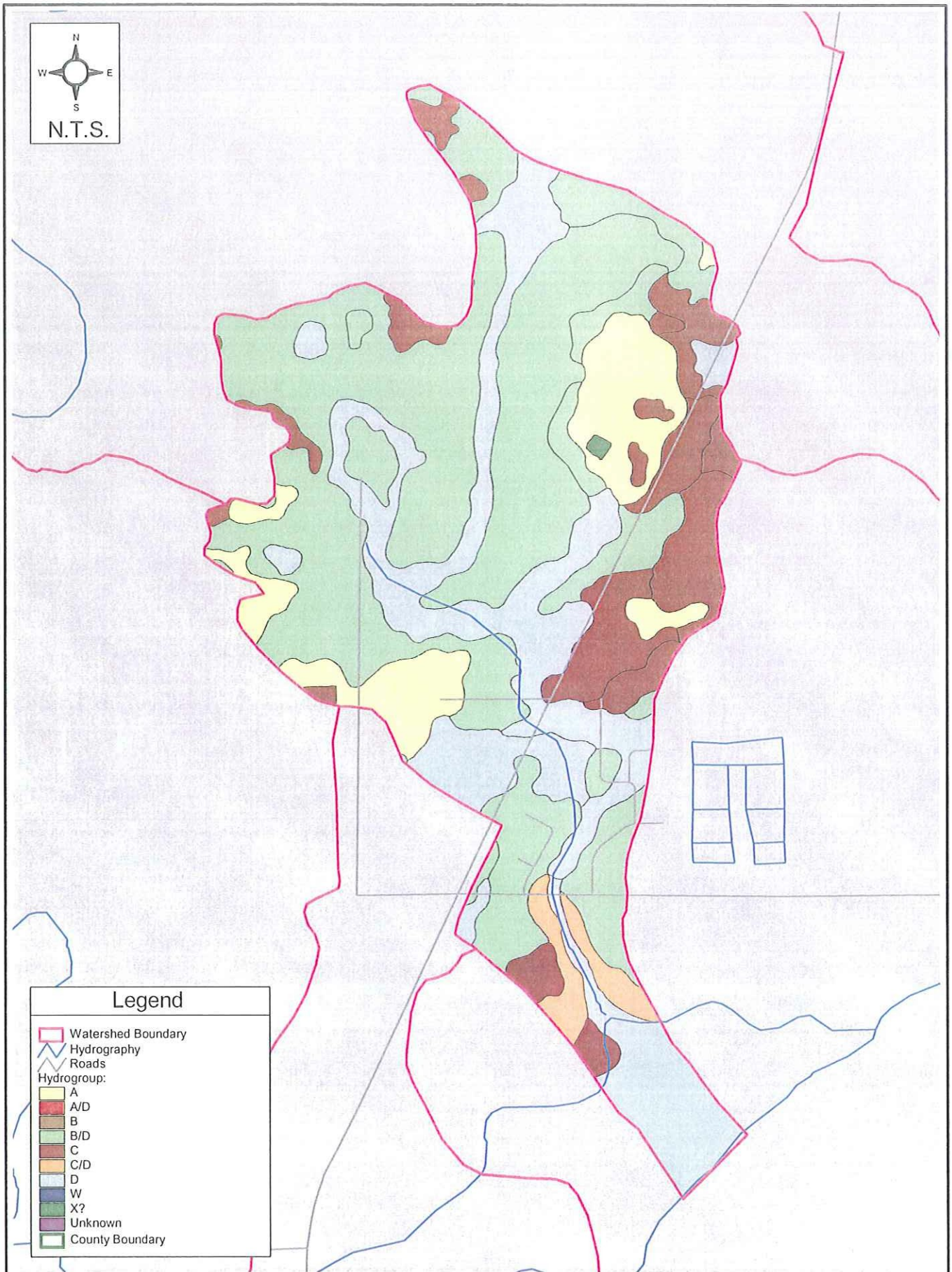


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Moccasin_creek.apr

FEMA Flood Zones in the Moccasin Creek Watershed
Putnam County Master Stormwater Plan

Figure
3.2.9-2

AYRES ASSOCIATES

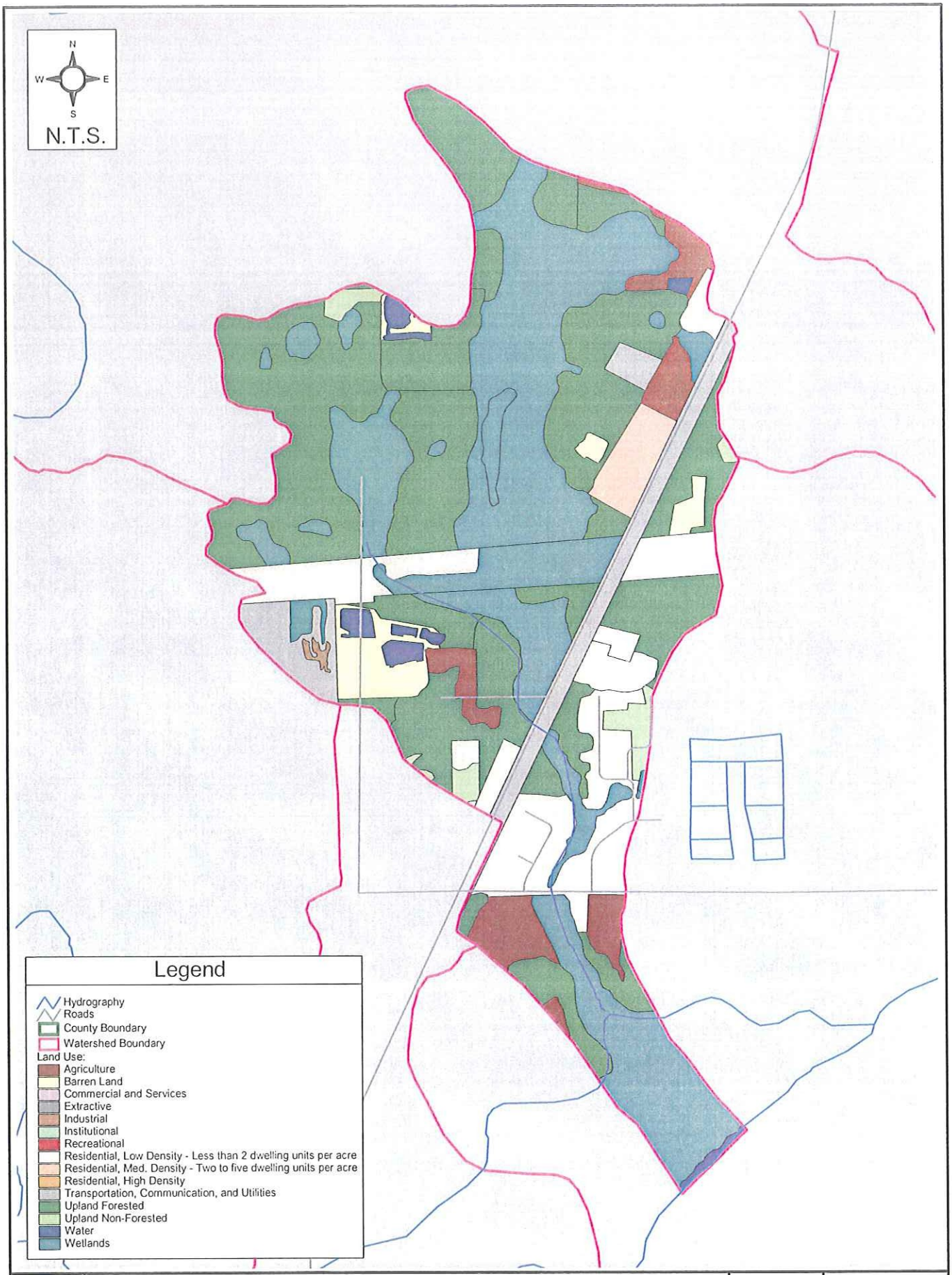


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Moccasin_creek.apr

Soils Distribution in the Moccasin Creek Watershed
Putnam County Master Stormwater Plan

Figure
3.2.9-3

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Moccasin_creek.apr

Land Use Distribution in the Moccasin Creek Watershed
Putnam County Master Stormwater Plan

Figure 3.2.9-4

AYRES ASSOCIATES

3.2.10 MUDLAKE OUTLET WATERSHED

The Mudlake Outlet Watershed is comprised of 2.2 square miles, located in central Putnam County, just west of the St. Johns River (**Figure 3.2.10-1**). It has not been divided into smaller subwatersheds and has been selected for field study.

3.2.10.1 Physiography and Hydrology

The Mudlake Outlet Watershed drains in a southward direction from its northern extent near Francis at State Highway 20, to one of four depression lakes. The 13.6-acre Round Lake and 46.2-acre Silver Lake are located on the west side of State Highway 19. On the east side of State Highway 19 is the smaller Pine Lake, covering 9.6 acres, located upstream of Mud Lake. Pine Lake outfalls to the 39.7-acre Mud Lake via a small tributary passing under Silver Lake Drive. The primary outfall from Mud Lake flows southeast for a distance of roughly 0.8 miles before discharging to the St. Johns River floodplain.

Watershed high elevations are roughly 65 feet NGVD. The watershed slope is mild for most of the watershed area. Steeper slopes are observed just outside of the St. Johns River floodplain.

There are no USGS streamflow gages or NCDC/SJRWMD rain gages located within this watershed. The nearest rain gages are the SJRWMD Headquarters site (Gage No. 210) and the NCDC 86753 co-op station in the Palatka area, roughly 2.3-2.8 miles to the northeast.

3.2.10.2 FEMA Flood Zones

With the exception of Zone A designations for the area immediately surrounding Silver Lake, Round Lake and Mud Lake, the entire Mudlake Outlet Watershed is classified Zone X, indicating areas determined to be outside the 500-year floodplain. Zone A areas lie in the 100-year floodplain for which no base flood elevations have been determined. FEMA floodplain mapping is depicted on **Figure 3.2.10-2**.

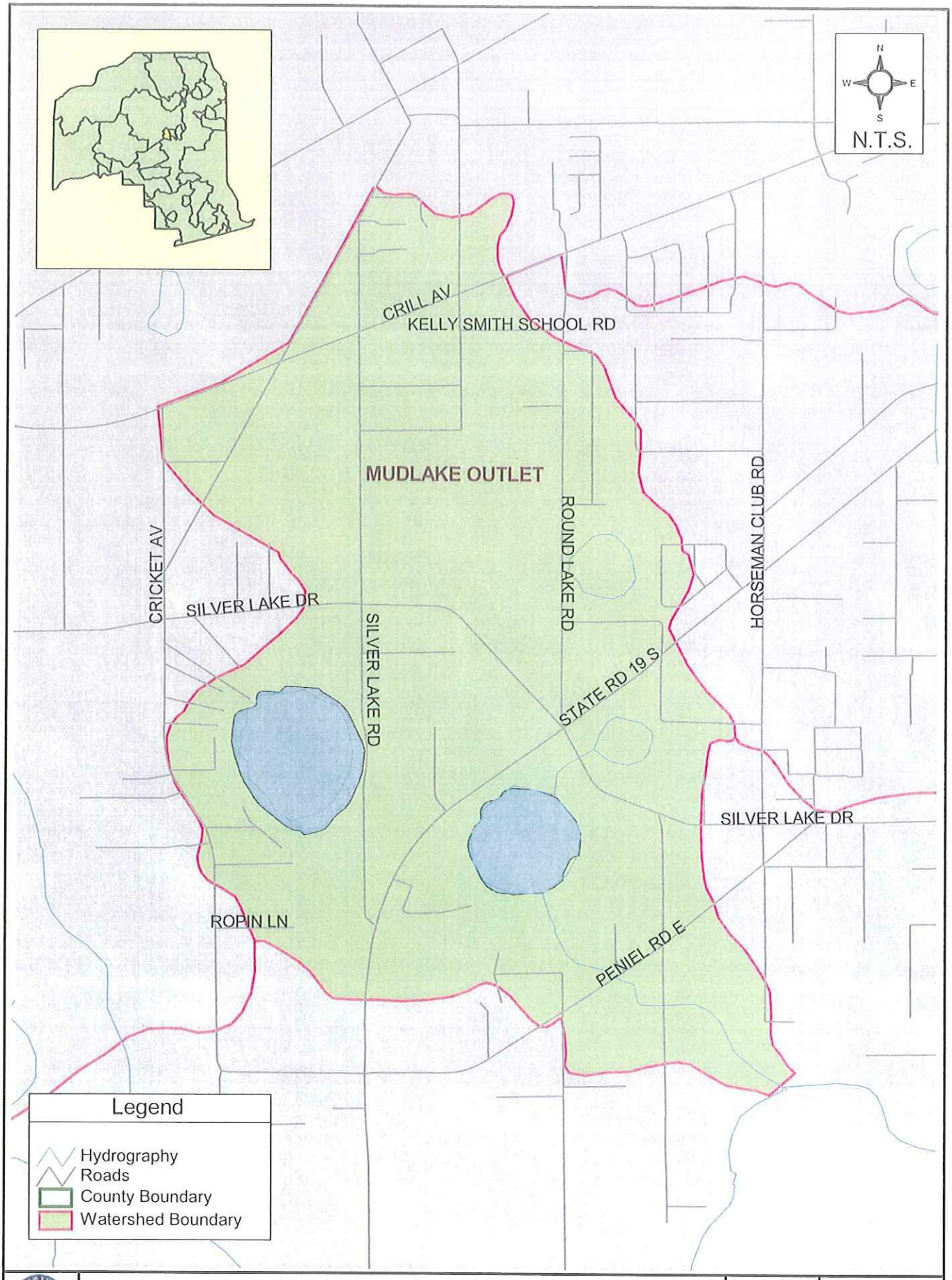
None of the Mudlake Outlet Watershed has undergone detailed study by FEMA.

3.2.10.3 Soils

Figure 3.2.10-3 depicts the current hydrologic soil groups in the Mudlake Outlet Watershed. As illustrated in the figure, three dominant soil classifications are represented. The highest percentage of the watershed, 33%, is underlain by well drained HSG A soils with low runoff potential. Moderately drained soils with fairly high runoff potential, HSG C, occupy 31% of the watershed area. HSG B/D soils, which exhibit low runoff potential when drained but high runoff potential when the surficial water table is near the surface, comprise 25% of the watershed area.

3.2.10.4 Land Use/ Land Cover

The land use type represented in the highest proportion for this watershed is "Residential" covering 56% of the watershed area. Associated "Commercial" and "Institutional" land uses occupy an additional 2% of the area. "Agriculture" occupies roughly 6% of the watershed. The remaining area is largely undeveloped forest or wetland/water land use. **Figure 3.2.10- 4** depicts the current land use in the Mudlake Outlet Watershed.

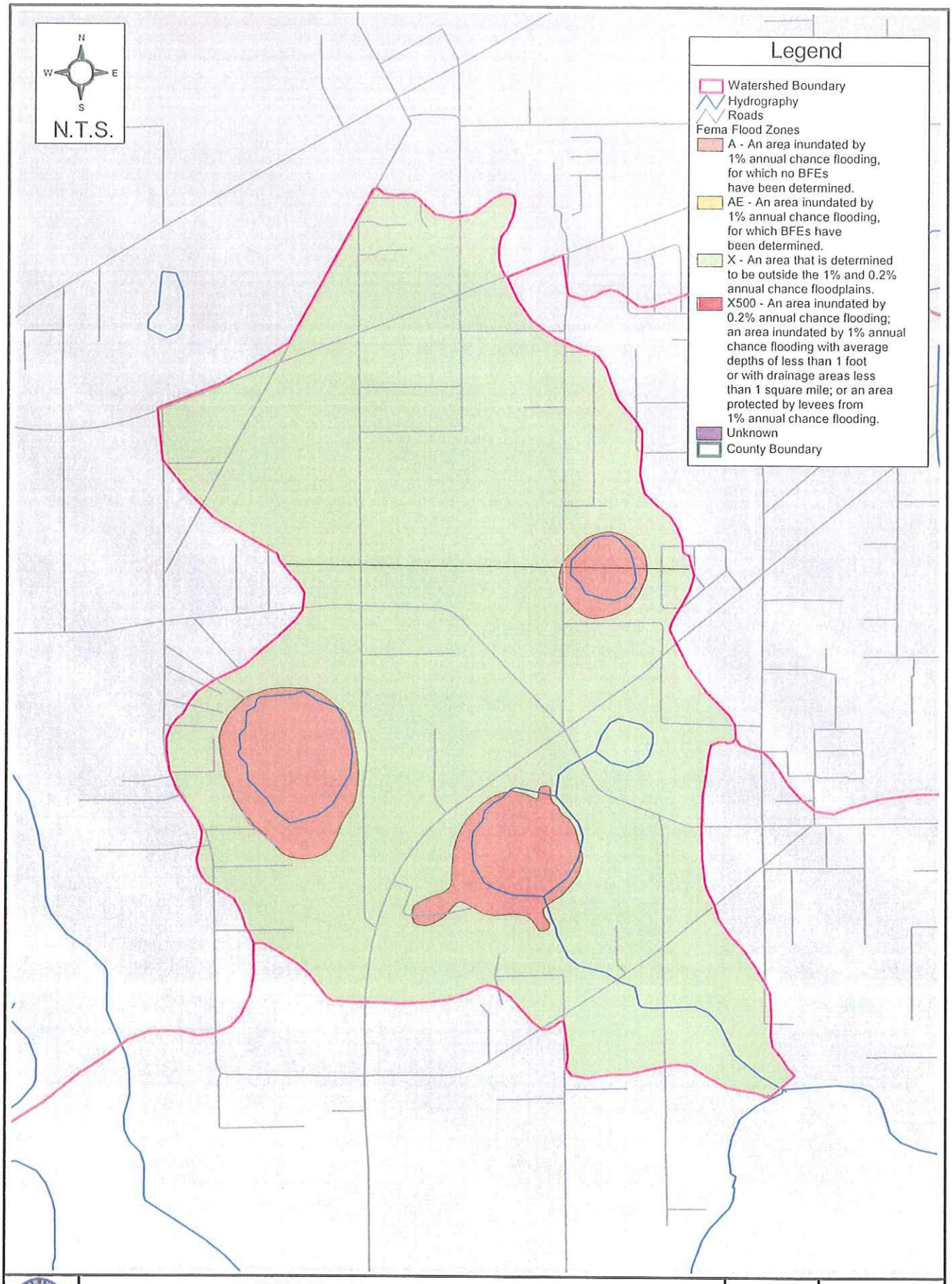


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Mudlake_outlet.apr

Location of the Mudlake Outlet Watershed
Putnam County Master Stormwater Plan

Figure
3.2.10-1

AYRES ASSOCIATES



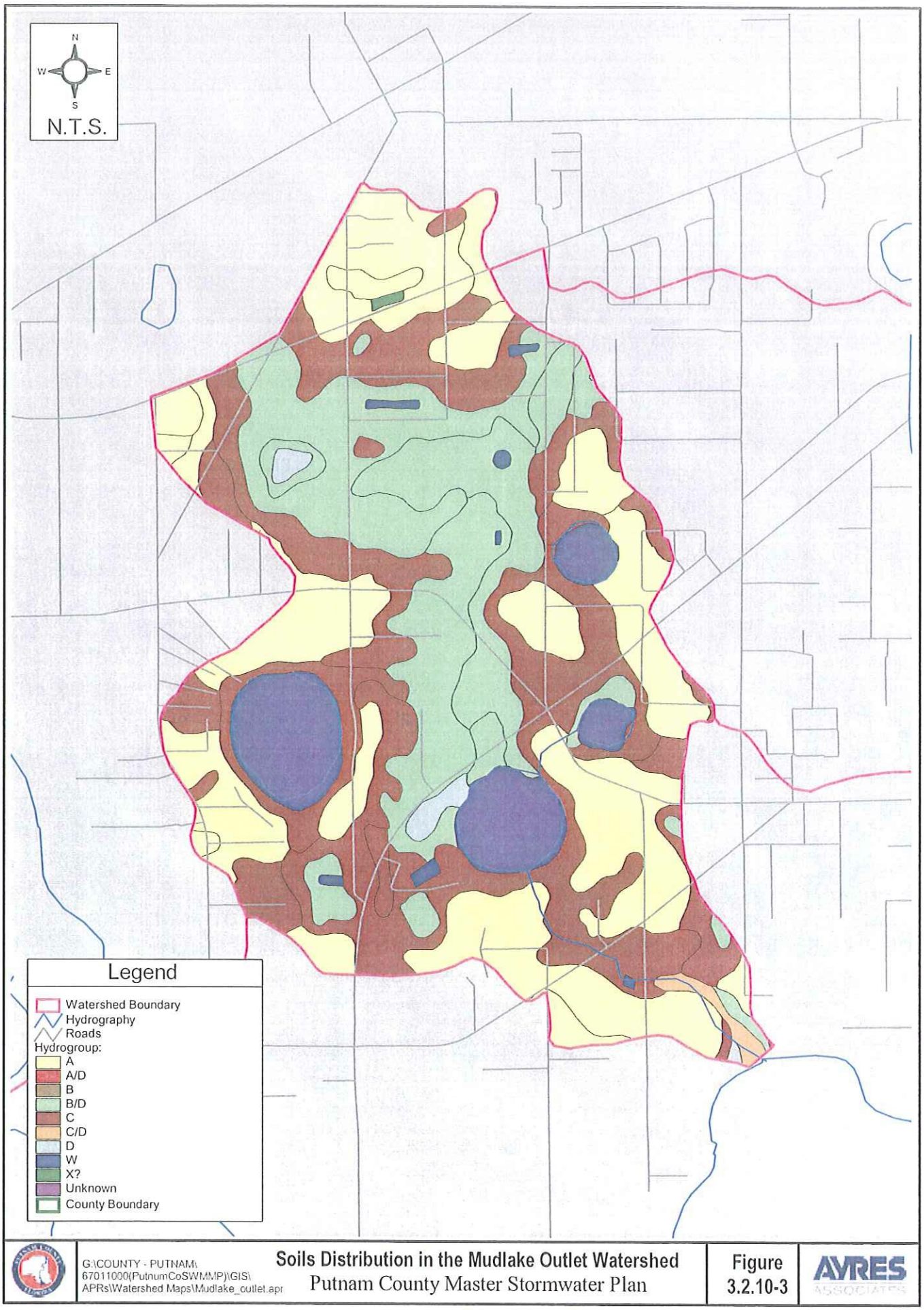
G:\COUNTY - PUTNAM\ 67011000(PutnumCoSWMMP)\GIS\ APRs\Watershed Maps\Mudlake_outlet.apr

FEMA Flood Zones in the Mudlake Outlet Watershed

Putnam County Master Stormwater Plan

Figure 3.2.10-2

AYRES ASSOCIATES

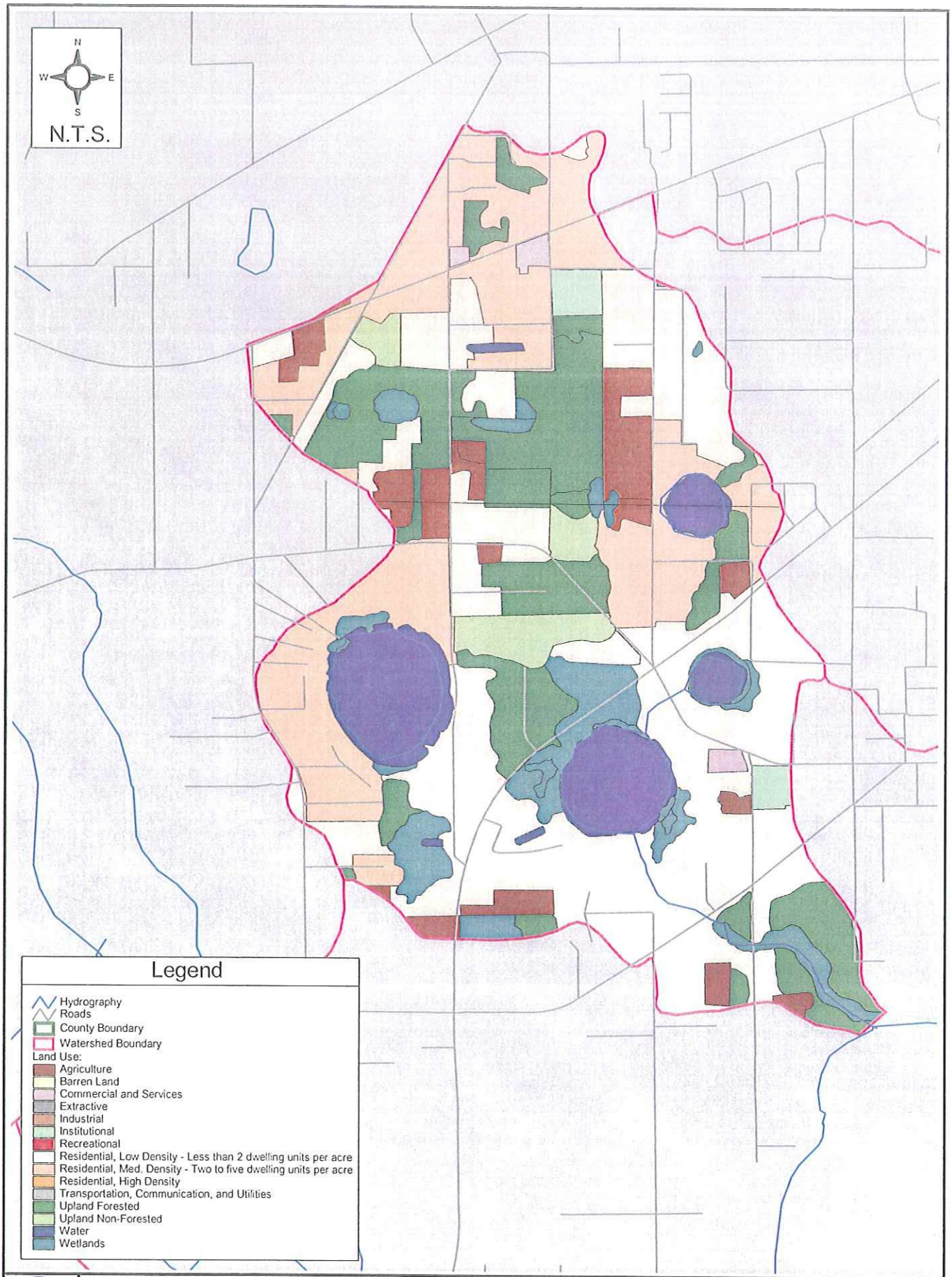


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Mudlake_outlet.apr

Soils Distribution in the Mudlake Outlet Watershed
Putnam County Master Stormwater Plan

Figure
3.2.10-3

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Mudlake_outlet.apr

Land Use Distribution in the Mudlake Outlet Watershed
Putnam County Master Stormwater Plan

Figure 3.2.10-4

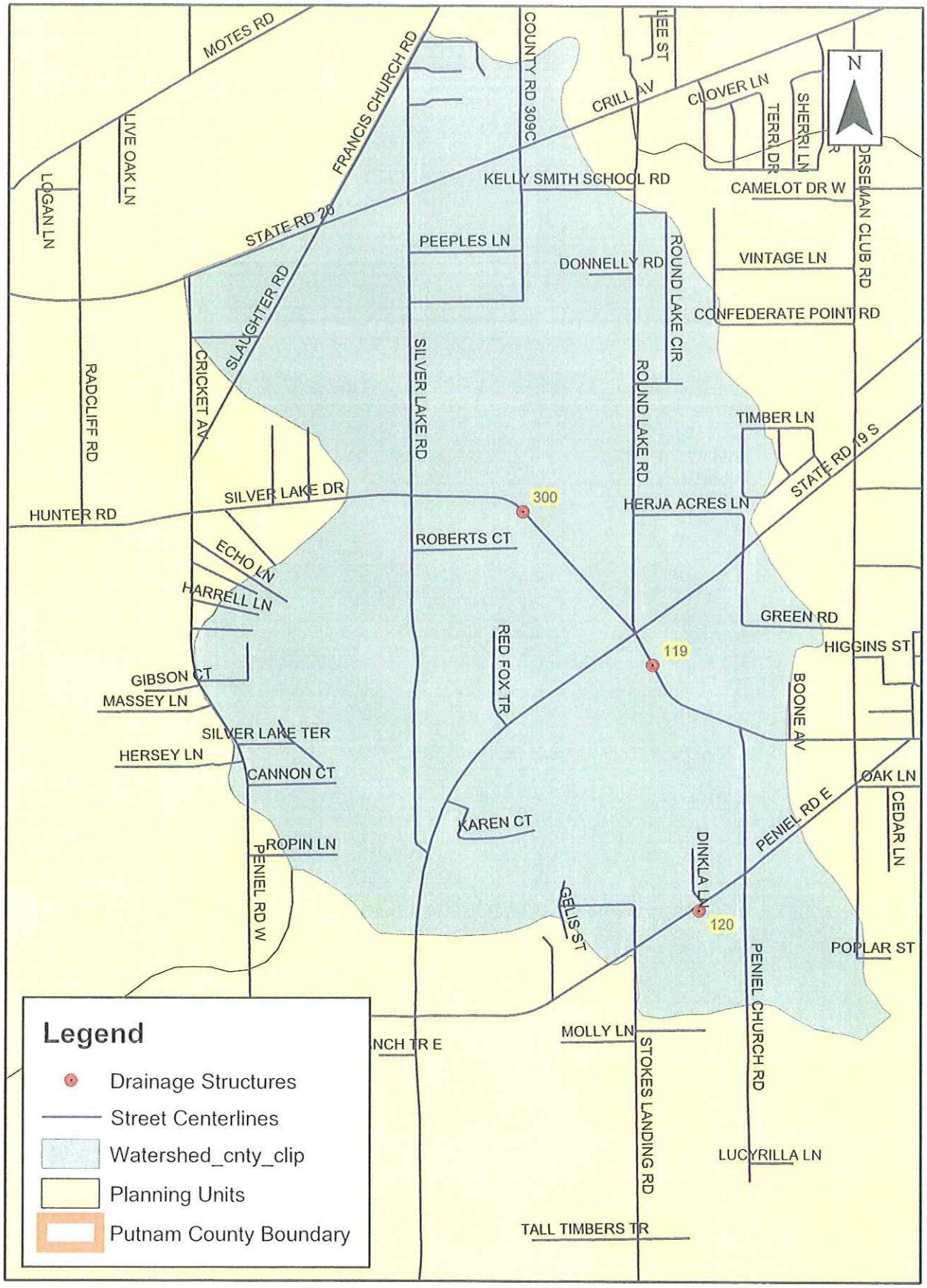
AYRES ASSOCIATES

3.2.10.5 Field investigations in Selected Subwatersheds

The field reconnaissance program described in Section 2.10 was performed for this watershed as illustrated on the following index figure. No modifications to basin delineations resulted from field investigations. Field reports for hydraulic structures and photo documentation from the investigation is presented in **Appendix 3-B**. These data have been incorporated into a GIS database for County use.

3.2.10.6 Sewer Network and Point Source Discharge

Sewer networks and point source discharges in this watershed have not been identified by the County. A search of FDEP permitted point source discharges and industrial stormwater dischargers was performed and no permitted point source discharges were found in the Mudlake Outlet Watershed.



Field Reconnaissance - Mudlake Outlet Watershed

3.2.11 ST. JOHNS RIVER WATERSHED

The South Mainstem DPU's St. Johns River Watershed is comprised of 220.2 square miles, located along the eastern side of Putnam County (**Figure 3.2.11-1**) and extending eastward and northward into St. Johns, Clay and Duval Counties. The Putnam County portion of this watershed covers 92.5 square miles and is dominated by the river channel and associated floodplain. It has not been divided by the USGS into smaller subwatersheds. Isolated portions of this watershed, specifically the Saratoga Harbor and Mondex flood problem areas, have been selected for more detailed study.

3.2.11.1 Physiography and Hydrology

The St. Johns River main stem runs northward through this Palatka-area watershed for a distance of roughly 39 river miles, commencing from the Ocklawaha River confluence to the northern border of Putnam County. The St. Johns River has about a 2-foot tidal range at low flow conditions. Significant tributaries along this reach include Dunn's Creek and Rice Creek, each of which is described in other sections of this report. The St. Johns River main stem in Putnam County is wide, averaging about one mile in width, and slow moving, with wetland floodplains predominantly on its west bank.

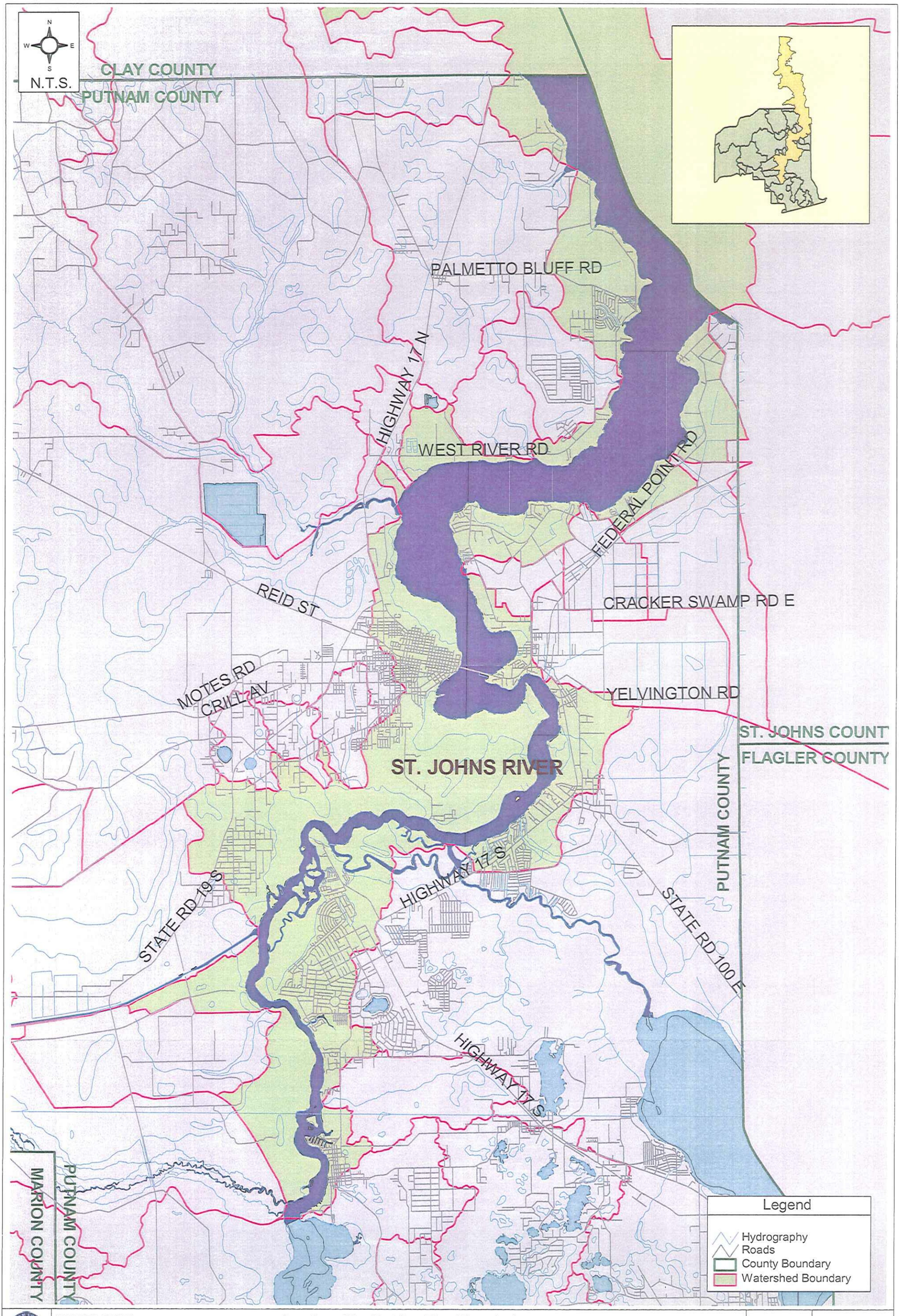
Bridge crossings within this reach include one railroad crossing located 2.5 miles downstream of the Cross Florida Barge Canal confluence, and the U.S Highway 17/State Highway 100 Bridge in Palatka. There is one USGS streamflow gage located within this watershed, Gage No. 02244040 "St. Johns River at Buffalo Bluff near Satsuma." The gage is located at the railroad crossing between the Mudlake Outlet and Devall Branch Watershed outfalls. The contributing drainage area at the gage is estimated by USGS to be 6,582 square miles. Monthly mean streamflow data collected from 1993 through 2003 reflect a range from -512 cfs (reversed flow direction) to 17,290 cfs. The average mean monthly streamflow for the period of record is 4,957 cfs. The highest mean monthly flows are typically seen in November. Lowest mean monthly flows are exhibited in May.

One NCDC rain gage is located within the boundary of this watershed. The "Federal Point, FL" co-op station (Site No. 82915) offers daily and monthly rainfall records from 1948 to the present. Several SJRWMD rain gages are also located in watersheds immediately adjacent to the St. Johns River watershed. These include Site Nos. 1697, 243, and 210. Another NCDC co-op station, "Palatka, FL" (Site No. 86753) is located in close proximity to this watershed.

3.2.11.2 FEMA Flood Zones

Because so much of this watershed consists of water surface and wetlands associated with the St. Johns River floodplain, the majority of the watershed is classified Zone AE, 100-year floodplain with base flood elevations determined. Significant portions of the watershed, primarily the municipalities which have developed on the higher ground along each bank, are designated as Zone X, or area determined to be outside the 500-year floodplain. FEMA floodplain mapping is depicted on **Figure 3.2.11-2**.

The Putnam County FIS and the City of Palatka FIS include flood profiles for the St. Johns River. These documents are provided in **Appendix 3-A** of this SMP.

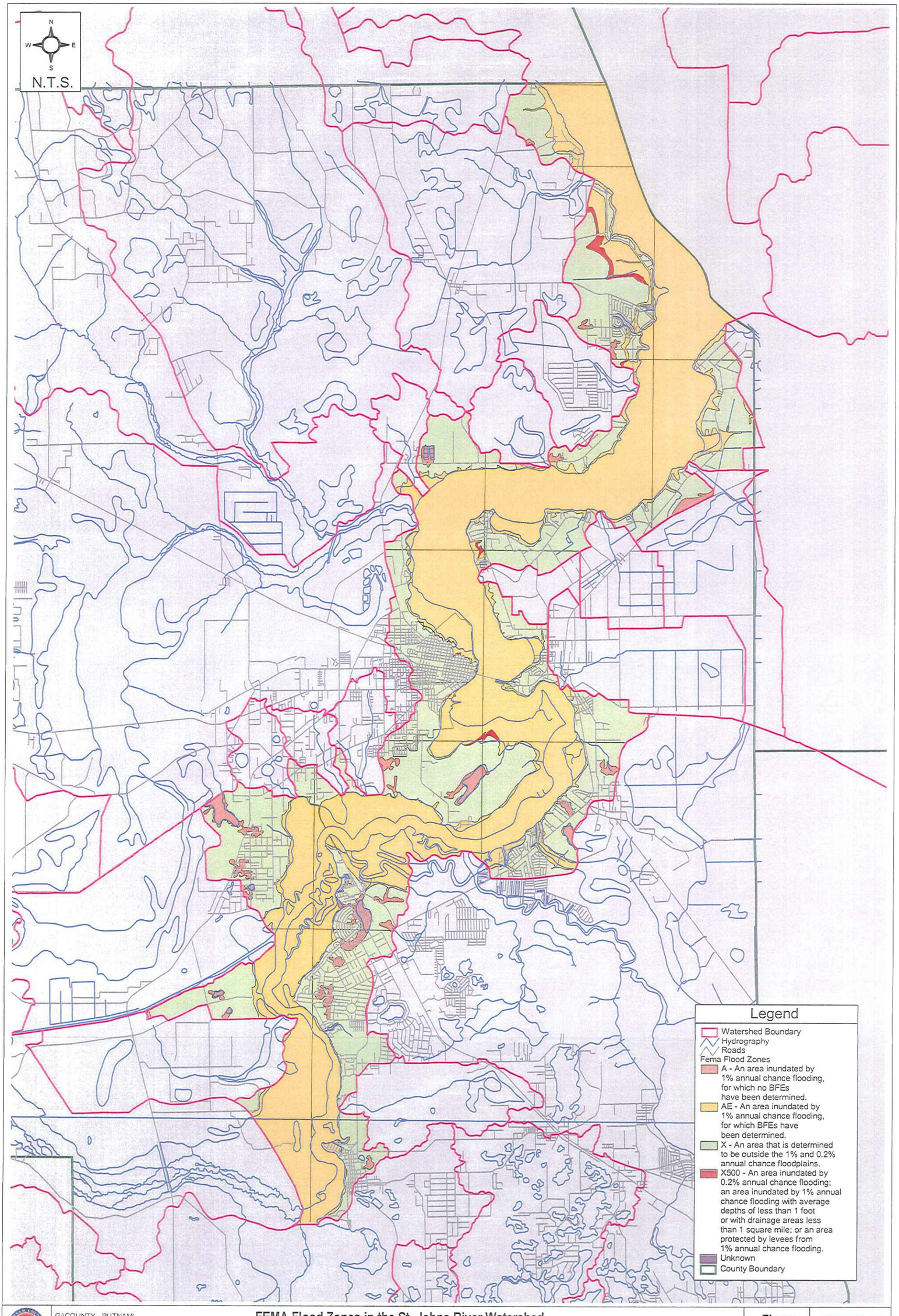


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\StJohns_River_n.apr

Location of the St. Johns River Watershed
Putnam County Master Stormwater Plan

Figure
3.2.11-1

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\StJohns_River_n.apr

FEMA Flood Zones in the St. Johns River Watershed
Putnam County Master Stormwater Plan

Figure
3.2.11-2

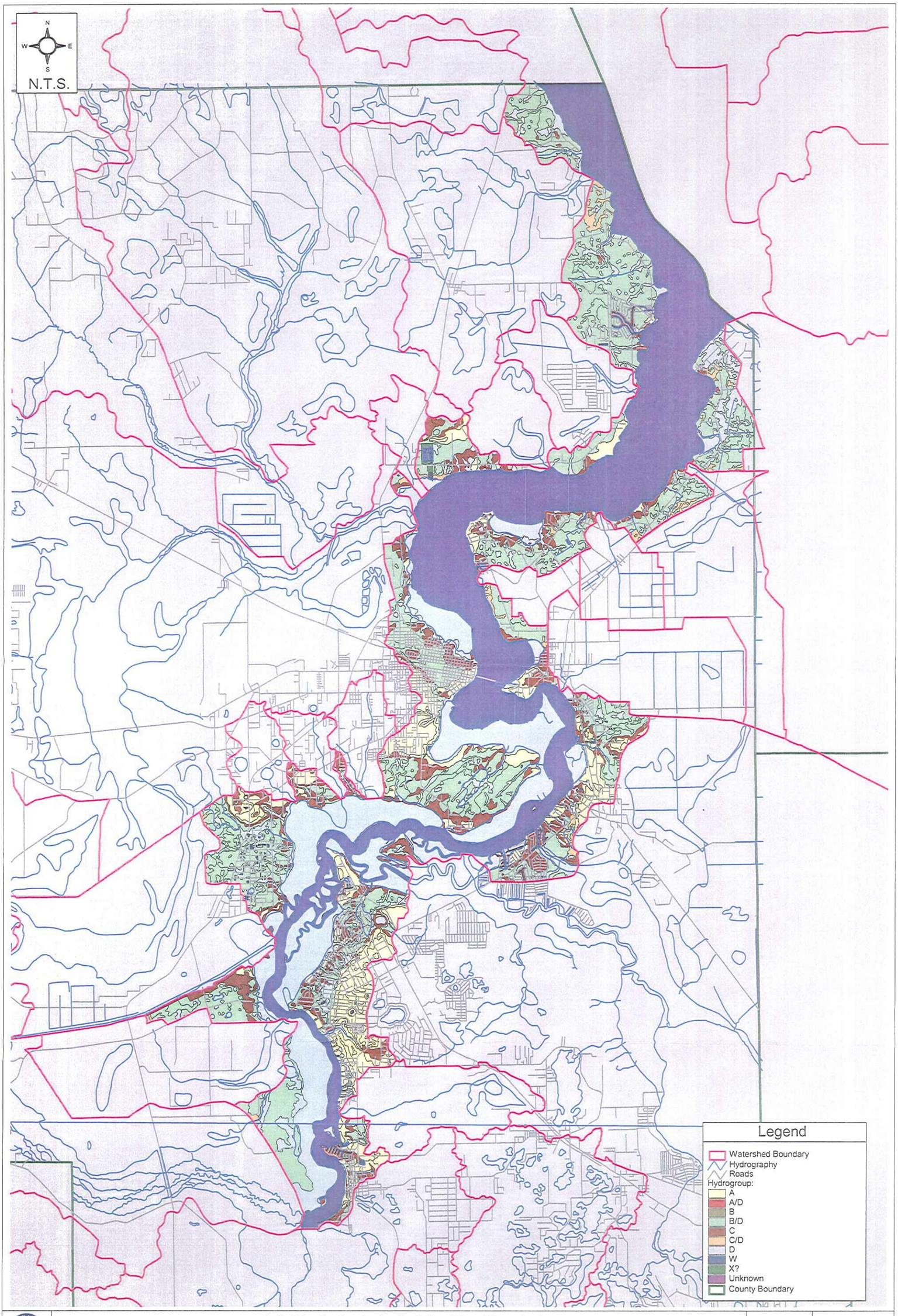
AYRES ASSOCIATES

3.2.11.3 Soils

Figure 3.2.11-3 depicts the current hydrologic soil groups in the Putnam County portion of the St. Johns River Watershed. While the majority of the Putnam County portion of the watershed has a W (water) soil classification, the next highest representation of soil groups is B/D at 27%, followed by D at 22% and A at 10%. HSG classification C and C/D soils are also present in this watershed in small proportions. Overall the runoff potential for this watershed is high.

3.2.11.4 Land Use/ Land Cover

Figure 3.2.11- 4 depicts the current land use in the Putnam County portion of the St. Johns River Watershed. Roughly 56% of the area is comprised of water surface and floodplain wetlands. Another 17% of the area is coded as "Upland Forested." Developed land uses are present in smaller percentage as follows; "Residential" at 14%, "Agriculture" at 6%, and "Transportaion/Communicaton/Utilities" and "Commercial" each at 1%.

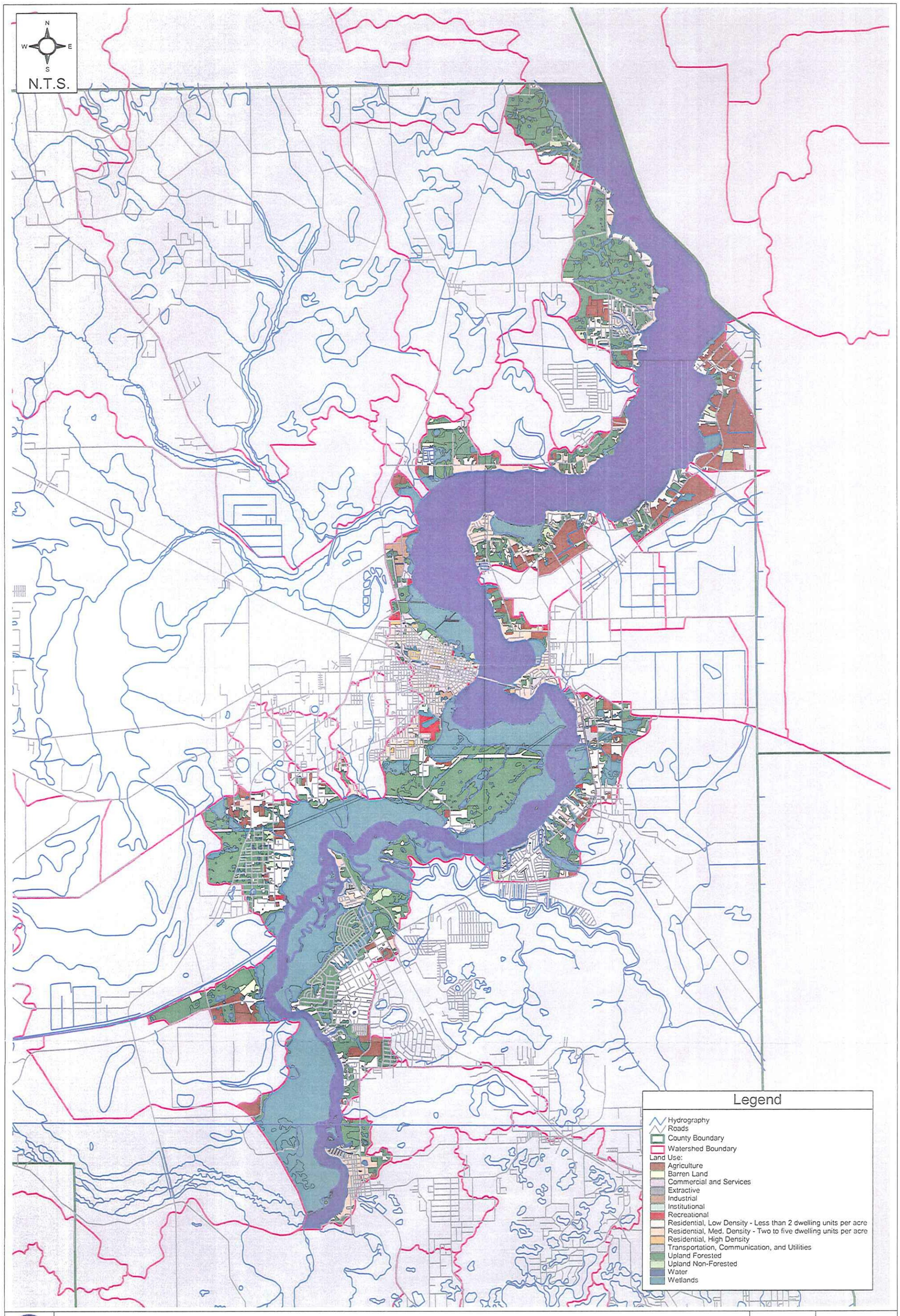


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\StJohns_River_n.apr

Soils Distribution in the St. Johns River Watershed
Putnam County Master Stormwater Plan

Figure
3.2.11-3

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\StJohns_River_n.apr

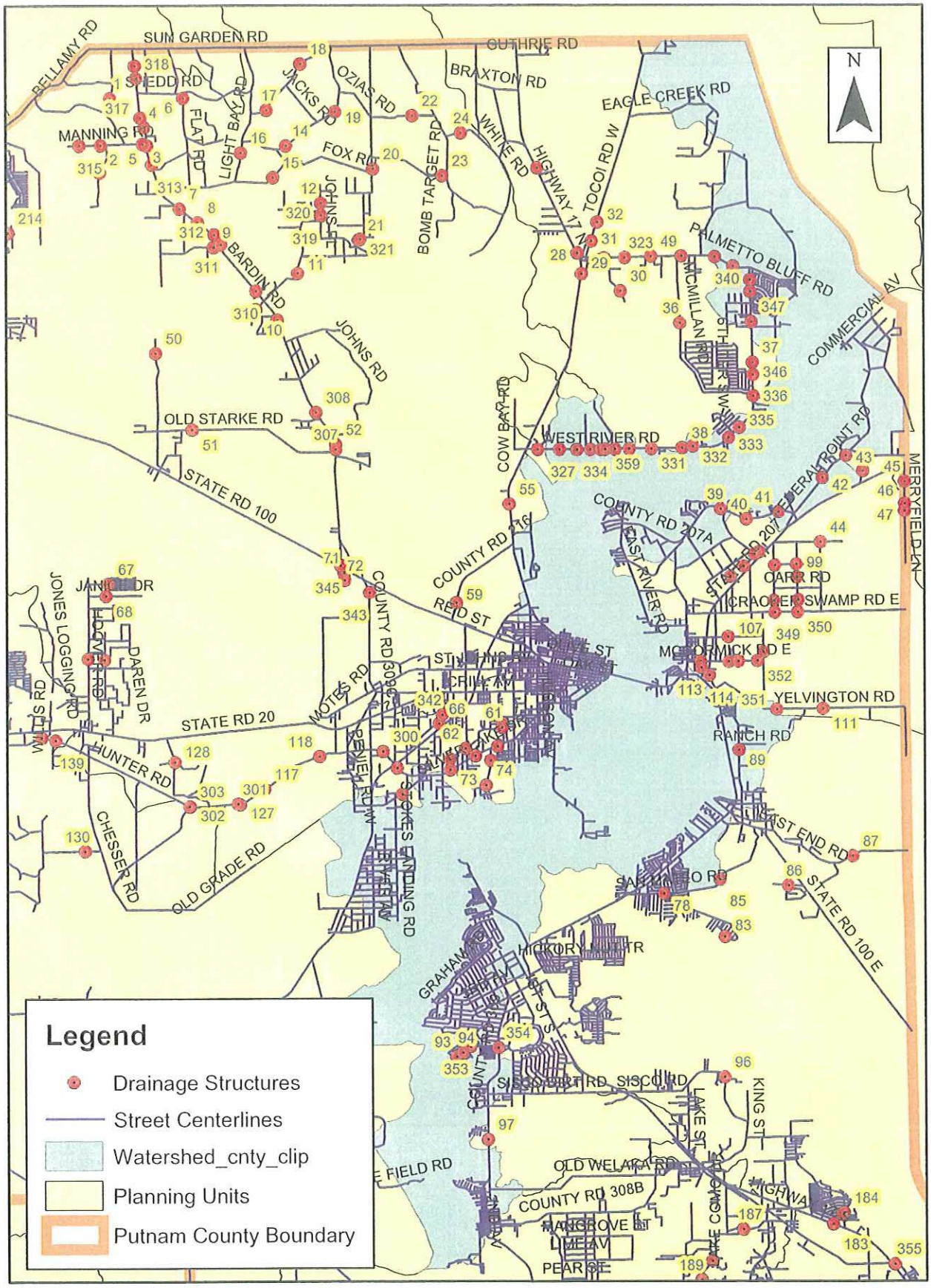
Land Use Distribution in the St. Johns River Watershed
Putnam County Master Stormwater Plan

Figure
3.2.11-4

AYRES ASSOCIATES

3.2.11.5 Field investigations in Selected Subwatersheds

The field reconnaissance program described in Section 2.10 was performed in the Saratoga Harbor subwatershed as illustrated on the following index figure. Field review and additional photo documentation in the Mondex and Saratoga Harbor areas was also performed as part of the capital improvement program reconnaissance presented in Section 7 of this Master Stormwater Plan. Basin delineations for the Saratoga Harbor and Mondex subwatersheds were based on field review and topographic data. Field reports for hydraulic structures and photo documentation from the field investigation is presented in **Appendix 3-B**. These data have been incorporated into a GIS database for County use.



Field Reconnaissance - St. Johns River Watershed

3.2.11.6 Sewer Network and Point Source Discharge

Sewer networks and point source discharges in this watershed have not been identified by the County. A search of FDEP permitted point source discharges and industrial stormwater dischargers was performed and yielded the following results:

WATER SHED	SUBWATER SHED	FACILITY ID	NAME	FACILITY TYPE	FACILITY ADDRESS	CITY	OWNER SHIP TYPE
St. Johns R.		FLR05F888	BOTTLING GROUP, LLC	Multi-Sector Stormwater GP	3840 REID STREET	PALATKA	Privately Owned
St. Johns R.		FLR05F794	CITY OF PALATKA WWTP	Multi-Sector Stormwater GP	3010 BROWNS LANDING RD.	PALATKA	Privately Owned
St. Johns R.		FLR05D001	GEORGIA-PACIFIC PALATKA CHIP-N-SAW	Multi-Sector Stormwater GP	230 COMFORT ROAD	PALATKA	Privately Owned
St. Johns R.		FLR05F741	JOHN'S METALS	Multi-Sector Stormwater GP	HN'S METALS	PALTKA	Privately Owned
St. Johns R.		FLR05B962	KAY LARKIN MUNICIPAL AIRPORT	Multi-Sector Stormwater GP	4015 REID ST	PALATKA	Privately Owned
St. Johns R.		FLR05G022	LAFARGE NORTH AMERICA	Multi-Sector Stormwater GP	886 n Us 17	Palatka	Privately Owned
St. Johns R.		FLR05F969	PDM BRIDGE, LLC	Multi-Sector Stormwater GP	211 COMFORT RD	PALATKA	Privately Owned
St. Johns R.		FLR05B869	SEMINOLES UNITS 1 & 2	Multi-Sector Stormwater GP	890 NORTH HIGHWAY 17	PALATKA	Privately Owned
St. Johns R.		FL0278076	ANGUILLA FISH FARM	Industrial Wastewater	181 SCHOOL ROAD	EAST PALATKA	Privately Owned
St. Johns R.		FLG110326	FLORIDA ROCK INDUSTRIES, PALATKA PLANT	Concrete Batch GP	COMFORT ROAD & HIGHWAY 17	PALATKA	Public Ownership
St. Johns R.		FL0032166	FPL PUTNAM STEAM PP PA74-01	Industrial Wastewater	US 17	EAST PALATKA	Privately Owned

WATER SHED	SUBWATER SHED	FACILITY ID	NAME	FACILITY TYPE	FACILITY ADDRESS	CITY	OWNERSHIP TYPE
St. Johns R.		FL0043389	HIAWATHA & HART POINT WWTF	Domestic WWTP	116 HIAWATHA COURT	E PALATKA	Privately Owned
St. Johns R.		FL0040061	PALATKA WWTF	Domestic WWTP	ROUTE 3, BOX 129	PALATKA	City Owned
St. Johns R.		FL0042617	PORT BUENA VISTA WWTF	Domestic WWTP	121 MARGARITA DRIVE	EAST PALATKA	County Owned
St. Johns R.		FL0041319	PRICE BROTHERS CO	Industrial Wastewater	245 COMFORT ROAD	PALATKA	Privately Owned
St. Johns R.		FL0117129	PUTNAM LANES WWTF	Domestic WWTP	SR-100	PALATKA	Privately Owned
St. Johns R.		FL0036498	SEMINOLE ELECTRIC COOP WWTF	Industrial Wastewater	US 17	PALATKA	Privately Owned

3.2.12 TWOMILE (DUVAL) CREEK WATERSHED

The Twomile Creek Watershed is comprised of 2.6 square miles, located near Palatka in central Putnam County, just west of the St. Johns River (**Figure 3.2.12-1**). It has not been divided into smaller subwatersheds and has been selected for more detailed study.

3.2.12.1 Physiography and Hydrology

The primary outfall, Twomile Creek (known locally as Duval Creek) flows southward from southern Palatka near State Highway 20 for a distance of roughly 2.3 miles before discharging to the St. Johns River. A smaller tributary running southeast from Old Peneil Road to Heidt Road joins the main channel just east of Heidt Road. The watershed slopes southward and inward toward the creek channel, dropping from a high elevation of roughly 80 feet NGVD at the northern boundary, to an elevation of 15 feet NGVD at the outlet.

There are no USGS streamflow gages or SJRWMD/NCDC rain gages located within this watershed. The NCDC "Palatka, FL" and the SJRWMD "District Headquarters" rain gages are both located near this watershed and would provide representative data.

3.2.12.2 FEMA Flood Zones

With the exception of the wetland area located between Ansley Lane and Barber Lane and the Twomile Creek outlet at the southern tip of the watershed, the entire watershed is classified Zone X, or area determined to be outside the 500-year floodplain. The wetland area is designated Zone A, lying in the 100-year floodplain for which no base flood elevations have been determined. Only the downstream-most portion of Twomile Creek is designated Zone AE, signifying that base flood elevations have been determined. FEMA floodplain mapping is depicted on **Figure 3.2.12-2**.

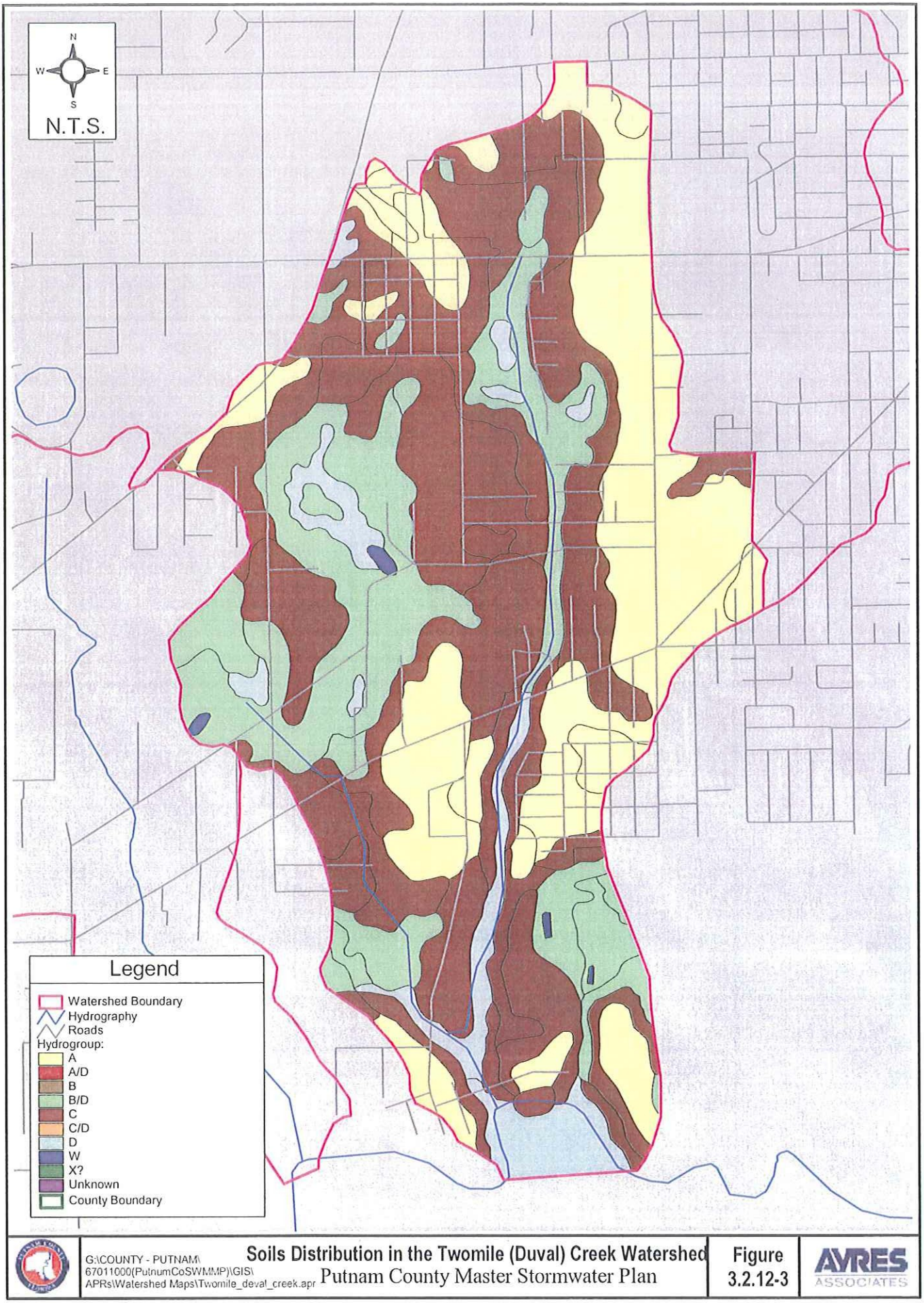
The Putnam County FIS does not include the Twomile Creek Watershed in its detailed study area. The base flood elevations that have been determined within the Twomile Creek Watershed are associated with the flood profiles generated from detailed study of the St. Johns River.

3.2.12.3 Soils

This watershed exhibits moderate runoff potential, with HSG C soil designations over 43% of the watershed area. Well drained, HSG A soils account for 28% of the watershed. HSG B/D is the next most prevalent soil group, covering 22% of the watershed. HSG D soils, primarily in the wetland area, cover 7% of the watershed. **Figure 3.2.12-3** depicts the current hydrologic soil groups in the Twomile (Duval) Creek Watershed.

3.2.12.4 Land Use/ Land Cover

Over half of the watershed area (51%) is designated as "Residential" with associated developed land uses such as "Commercial", "Transportation/Communication/Utilities" and "Institutional" accounting for an additional 10%. "Agriculture" represents 11% of the watershed area. **Figure 3.2.12- 4** depicts the current land use in the Twomile (Duval) Creek Watershed.

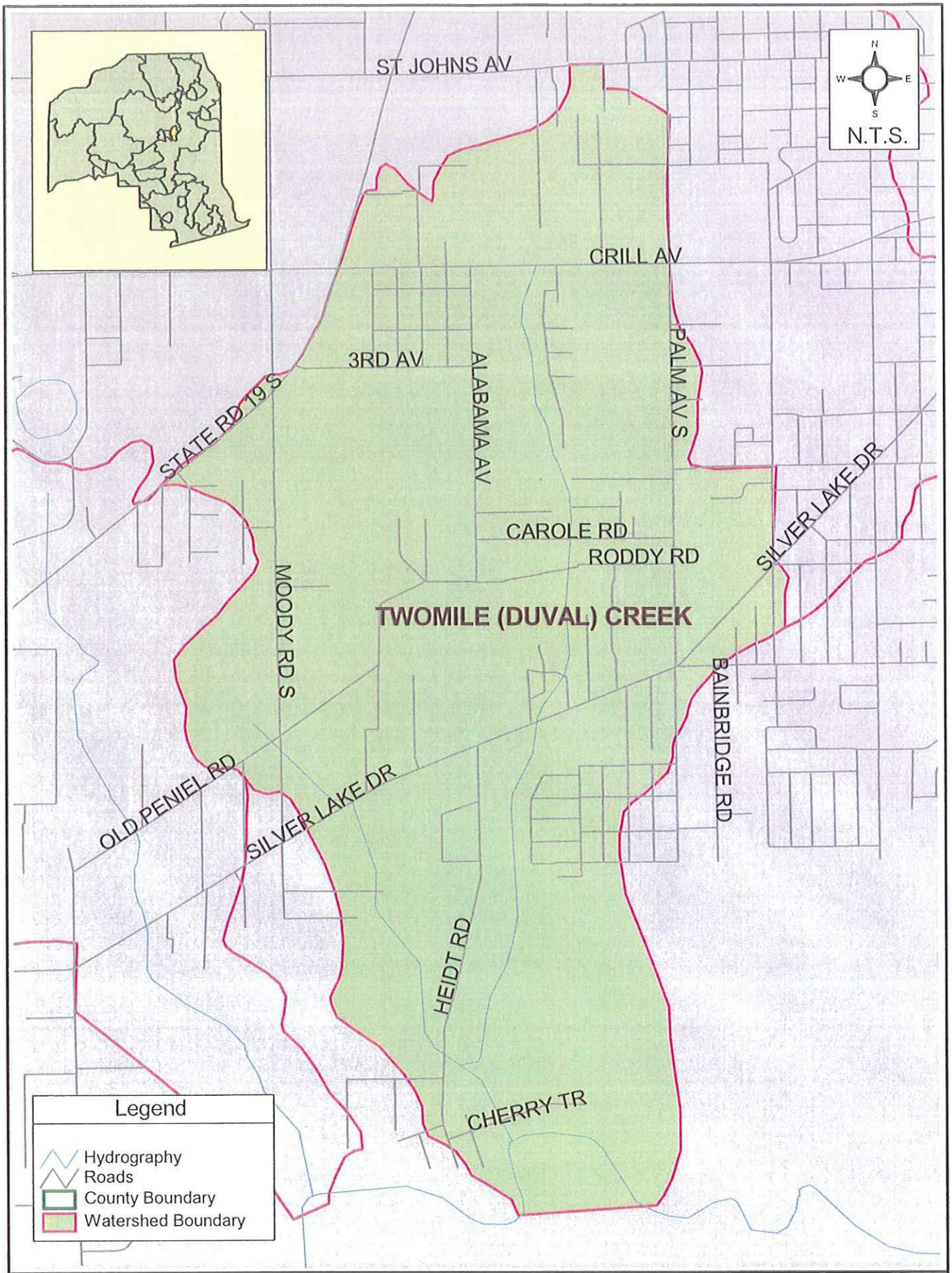


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Twomile_deval_creek.apr

Soils Distribution in the Twomile (Duval) Creek Watershed
Putnam County Master Stormwater Plan

Figure 3.2.12-3

AYRES ASSOCIATES



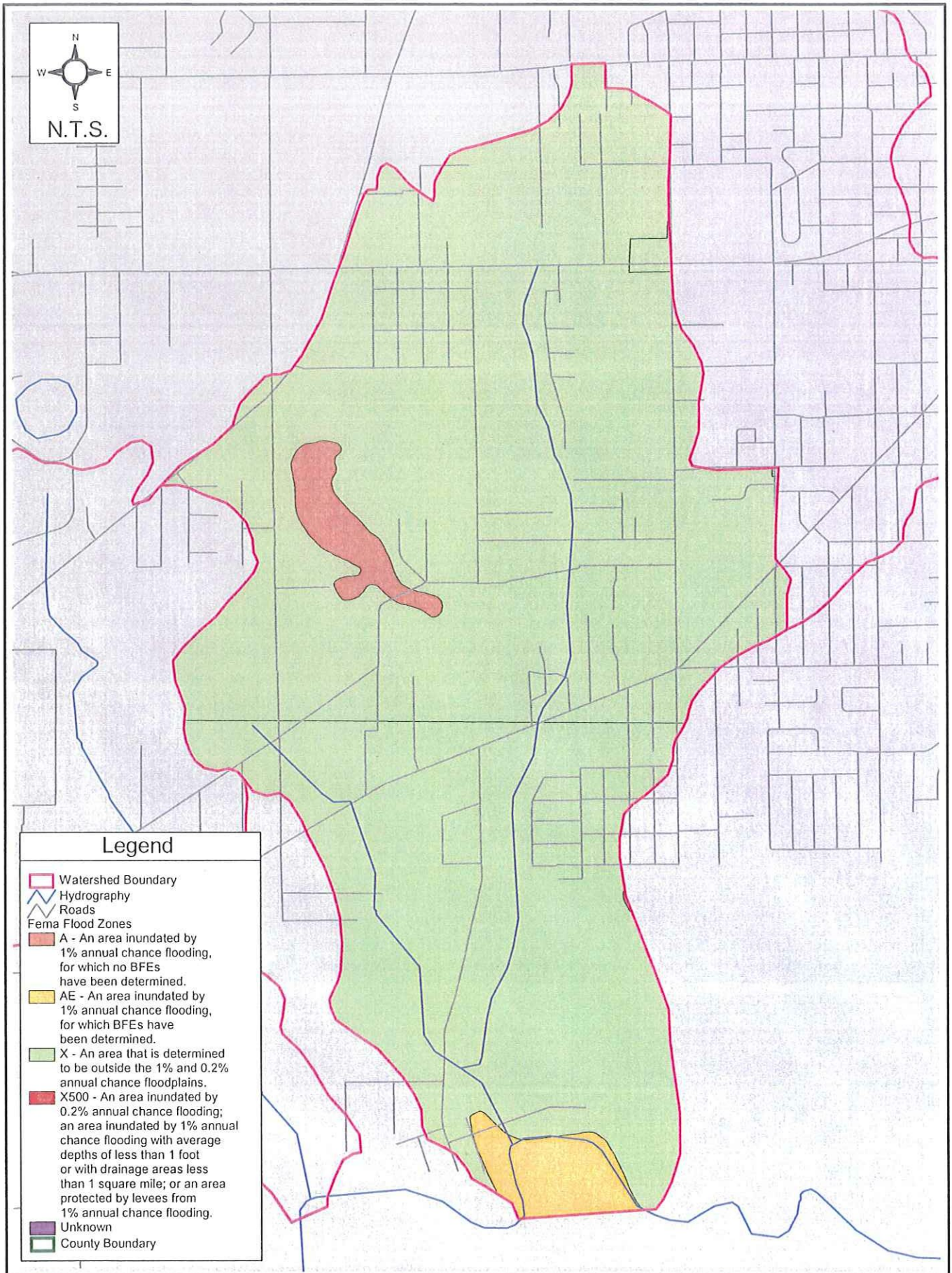
G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\Twomile_duval_creek.apr

Location of the Twomile (Duval) Creek Watershed

Putnam County Master Stormwater Plan

Figure 3.2.12-1

AYRES ASSOCIATES



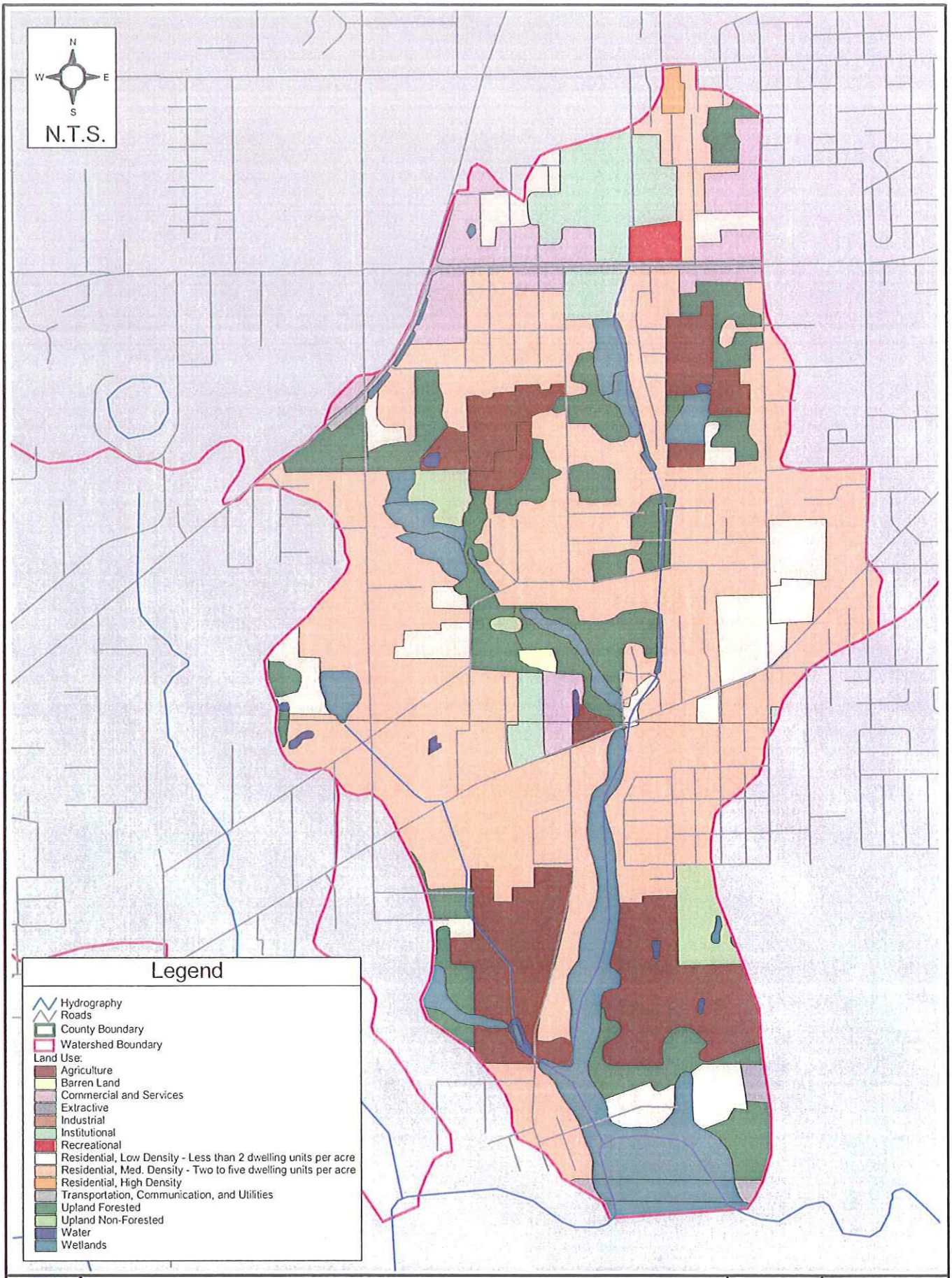
G:\COUNTY - PUTNAM\ 67011000(PutnumCoSWMMP)\GIS\ APRs\Watershed Maps\Twomile_deval_creek.apr

FEMA Flood Zones in the Twomile (Duval) Creek Watershed

Putnam County Master Stormwater Plan

Figure 3.2.12-2

AYRES ASSOCIATES



Land Use Distribution in the Twomile (Duval) Creek Watershed

Putnam County Master Stormwater Plan

G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\Twomile_Duval_creek.apr

Figure 3.2.12-4

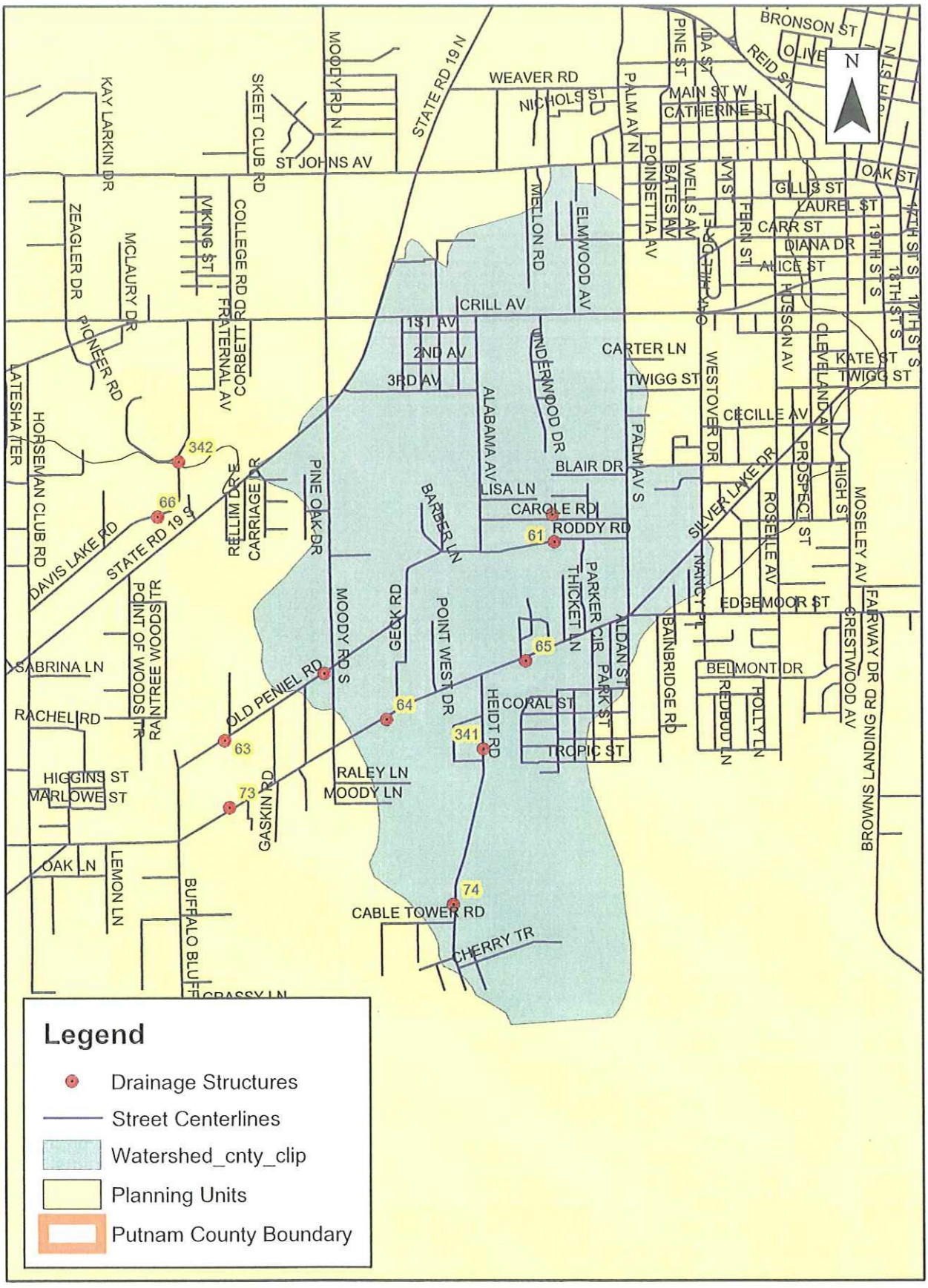
AYRES ASSOCIATES

3.2.12.5 Field investigations in Selected Subwatersheds

The field reconnaissance program described in Section 2.10 was performed for this watershed as illustrated on the following index figure. No modifications to basin delineations resulted from field investigations. Field reports for hydraulic structures and photo documentation from the investigation is presented in **Appendix 3-B**. These data have been incorporated into a GIS database for County use.

3.2.12.6 Sewer Network and Point Source Discharge

Sewer networks and point source discharges in this watershed have not been identified by the County. A search of FDEP permitted point source discharges and industrial stormwater dischargers was performed and no permitted point source discharges were found in the Twomile Creek Watershed.



Field Reconnaissance - Twomile Creek Watershed

3.2.13 WEST RUN INTERCEPTOR D WATERSHED

The West Run Interceptor D Watershed is comprised of 9.0 square miles, located at the eastern edge of Putnam County, just east of the St. Johns River (**Figure 3.2.13-1**). Portions of the watershed also lie in St. Johns County. The Putnam County watershed area covers 6.8 square miles. It has been divided by the USGS into the two (2) following subwatersheds:

1. West Run Interceptor D*
2. Unnamed Ditches-2*

Subwatersheds identified with an asterisk (*) have been selected for additional studies that are described in later subsections.

3.2.13.1 Physiography and Hydrology

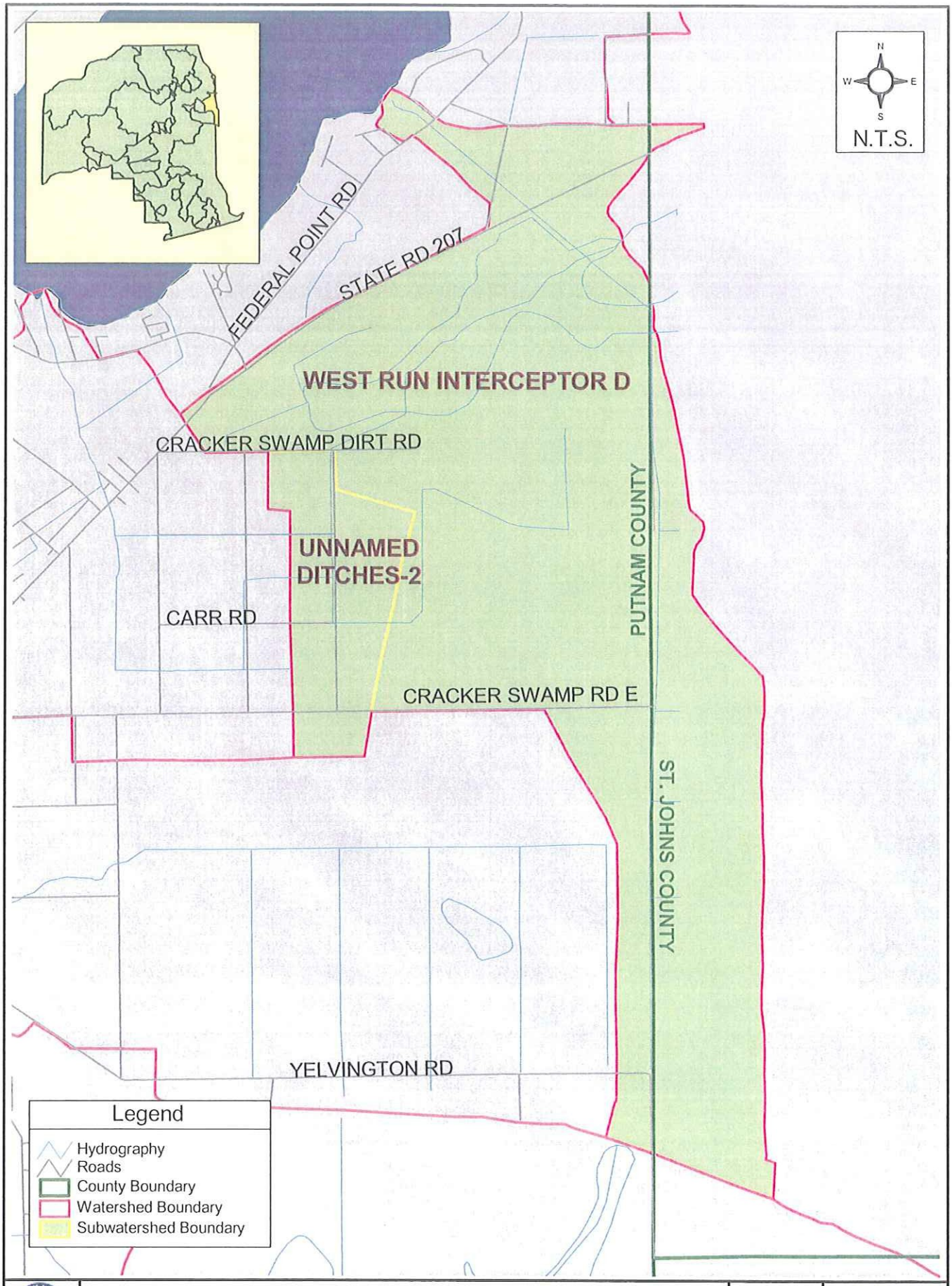
The primary outfall of the West Run Interceptor D watershed is a 6-mile collector channel flowing north along the Putnam-St. Johns County boundary and then turning northwest to discharge into the St. Johns River. Several ditches feed into the main channel along its northward run. The West Run tributary, which originally drained northeast to Cracker Branch - a tributary of Deep Creek to the north, is intercepted by the main channel at the north end of Cracker Swamp. A system of drainage ditches within the Unnamed Ditches-2 subwatershed ties into the upstream end of the West Run tributary, as well. Ditch systems within the Unnamed Ditches-2 subwatershed are hydraulically connected to the adjacent Dog Branch watershed. The topography is quite flat throughout the watershed

There are no USGS streamflow gages located within this watershed. No rain gages are located within the watershed boundaries, however representative rainfall records are available from one NCDC co-op station, Site 82915 "Federal Point, FL" located north of the West Run Interceptor D watershed and one SJRWMD rainfall recording site (No. 243) "Hell Cat Bay" located south of this watershed.

3.2.13.2 FEMA Flood Zones

The greatest majority of this watershed is classified Zone X, or area determined to be outside the 500-year floodplain. The wetland areas of the West Run, north of Cracker Swamp Dirt Road, are designated Zone A, lying in the 100-year floodplain for which no base flood elevations have been determined. Only the downstream-most portion of the watershed, at its outfall to the St. Johns River, and limited stretches of the interceptor channel itself are designated Zone AE, signifying that base flood elevations have been determined. FEMA floodplain mapping is depicted on **Figure 3.2.13-2**.

FEMA has not studied the West Run Interceptor D Watershed in detail.



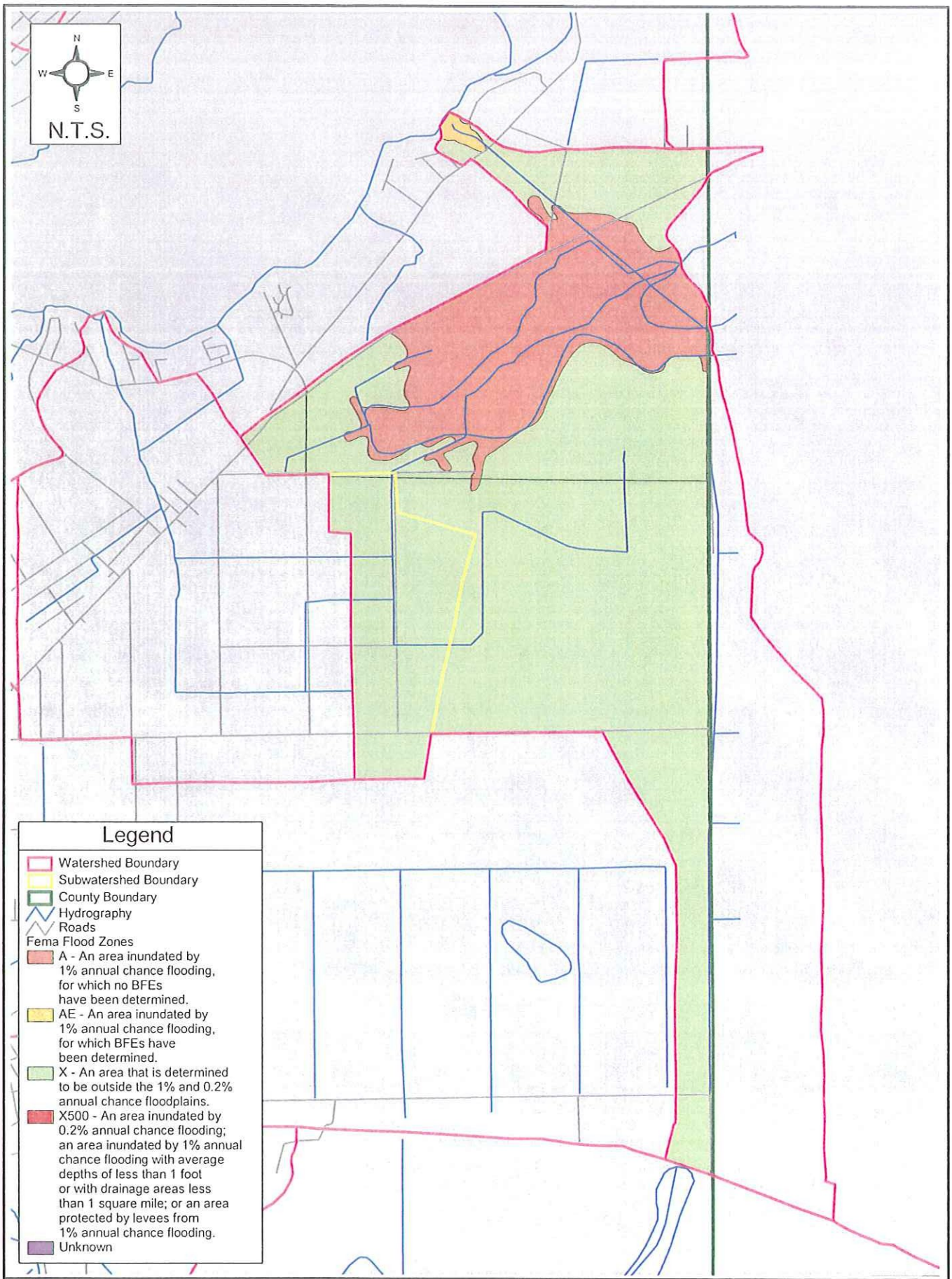
G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\WesRun_InterD.apr

Location of the West Run Interceptor D Watershed

Putnam County Master Stormwater Plan

Figure 3.2.13-1

AVIRES ASSOCIATES



G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\WestRun_InterD.apr

FEMA Flood Zones in the West Run Interceptor D Watershed

Putnam County Master Stormwater Plan

Figure 3.2.13-2

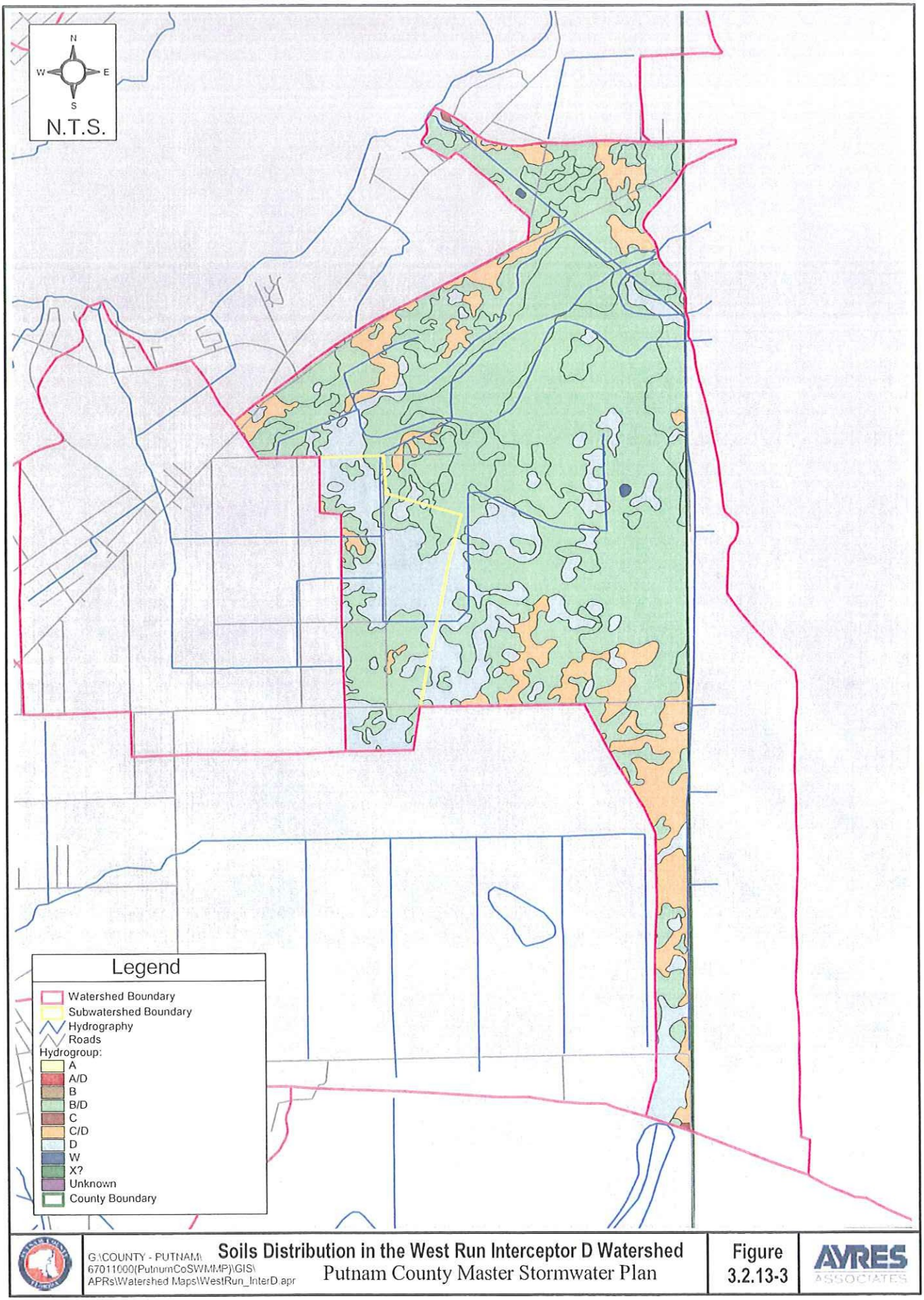
AYRES ASSOCIATES

3.2.13.3 Soils

High surficial water table in this watershed, for all or part of the year, results in high runoff potential over most of the watershed area not ditched and drained by agriculture. The highest representation, covering 69% of the Putnam County watershed area, is the B/D HSG classification. Hydric soils (HSG D) account for 19% of the Putnam County watershed. Roughly 12% of the area is represented by a HSG classification C/D. **Figure 3.2.13-3** depicts the current hydrologic soil groups in the West Run Interceptor D Watershed.

3.2.13.4 Land Use/ Land Cover

More than 70% of this watershed is represented by undeveloped land uses, as illustrated in **Figure 3.2.13- 4** depicting the current land use in the Putnam County portion of the West Run Interceptor D Watershed. "Agriculture" occupies approximately 26% of the Putnam County area. Only 1% of the Putnam County portion of this watershed is represented by "Residential" land use.

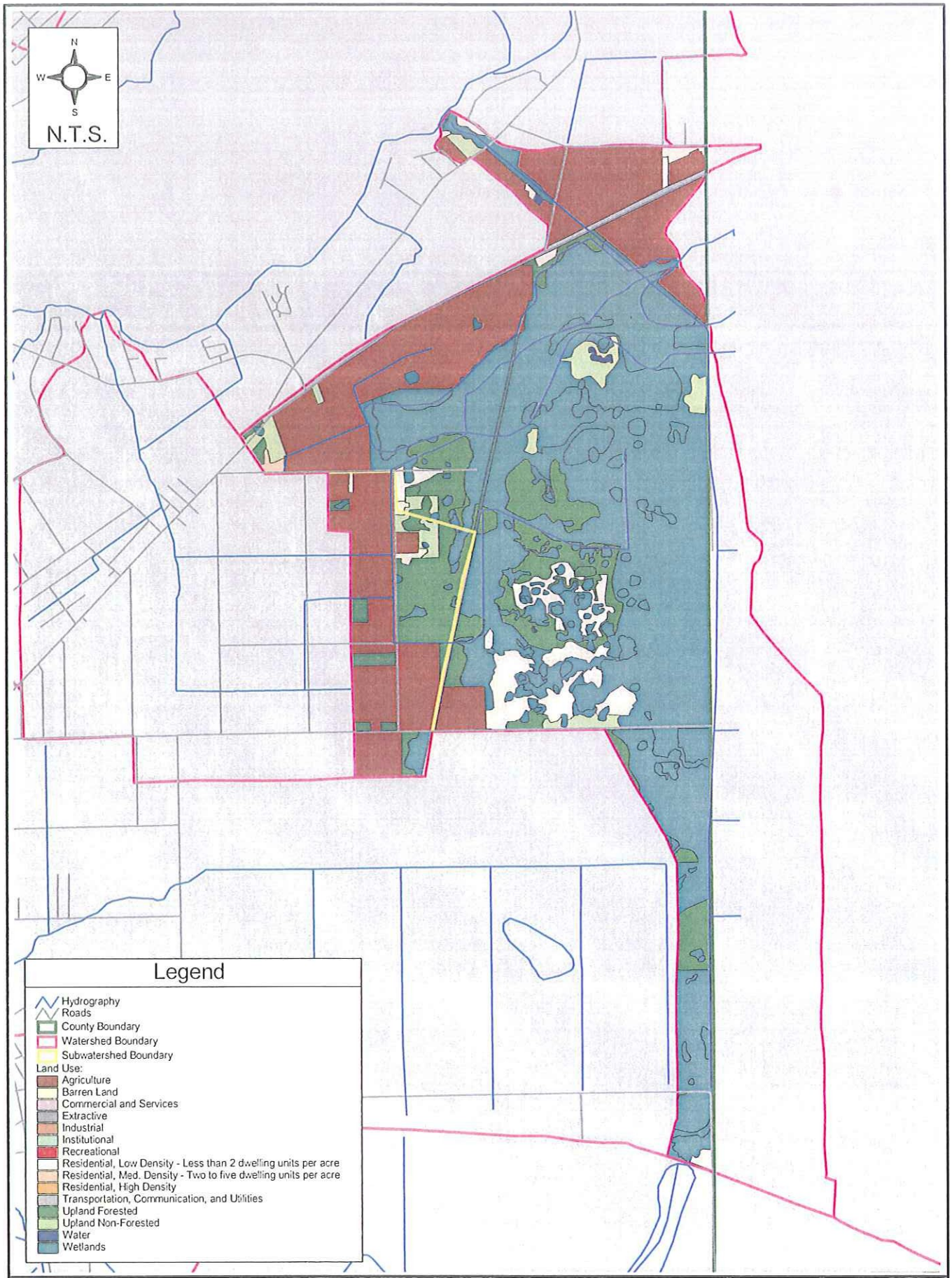


G:\COUNTY - PUTNAM\ 67011000(PutnumCoSWMMP)\GIS\ APRs\Watershed Maps\WestRun_InterD.apr

Soils Distribution in the West Run Interceptor D Watershed
Putnam County Master Stormwater Plan

Figure 3.2.13-3

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\WestRun_InterD.apr

Land Use Distribution in the West Run Interceptor D Watershed

Putnam County Master Stormwater Plan

Figure 3.2.13-4

AYRES ASSOCIATES

3.2.13.5 Field investigations in Selected Subwatersheds

The field reconnaissance program described in Section 2.10 was performed for this watershed as illustrated on the following index figure. No modifications to basin delineations resulted from field investigations. Field reports for hydraulic structures and photo documentation from the investigation is presented in **Appendix 3-B**. These data have been incorporated into a GIS database for County use.

3.2.13.6 Sewer Network and Point Source Discharge

Sewer networks and point source discharges in this watershed have not been identified by the County. A search of FDEP permitted point source discharges and industrial stormwater dischargers was performed and no permitted point source discharges were found in the West Run Interceptor D Watershed.

Field Reconnaissance - West Run Interceptor D Watershed

3.2.14 UNNAMED CREEK WATERSHED

The Unnamed Creek Watershed is comprised of 8.8 square miles in Clay and Putnam Counties. The southern 3.9 square miles are located in northeast Putnam County, just west of the St. Johns River (**Figure 3.2.14-1**). This watershed has not been divided into smaller subwatersheds and was not selected for field study.

3.2.14.1 Physiography and Hydrology

The primary outfall is located, for most of its length, in Putnam County and flows eastward for a distance of roughly 4.5 miles before discharging to the St. Johns River. High elevations for the Putnam County portion of this watershed are seen in the western extent at roughly 105 feet NGVD. The watershed slopes toward the St. Johns River, with low elevations of 5 feet NGVD at the outlet.

There are no USGS streamflow gages located within this watershed. Nor are there any NCDC/SJRWMD rain gages in proximity to this watershed.

3.2.14.2 FEMA Flood Zones

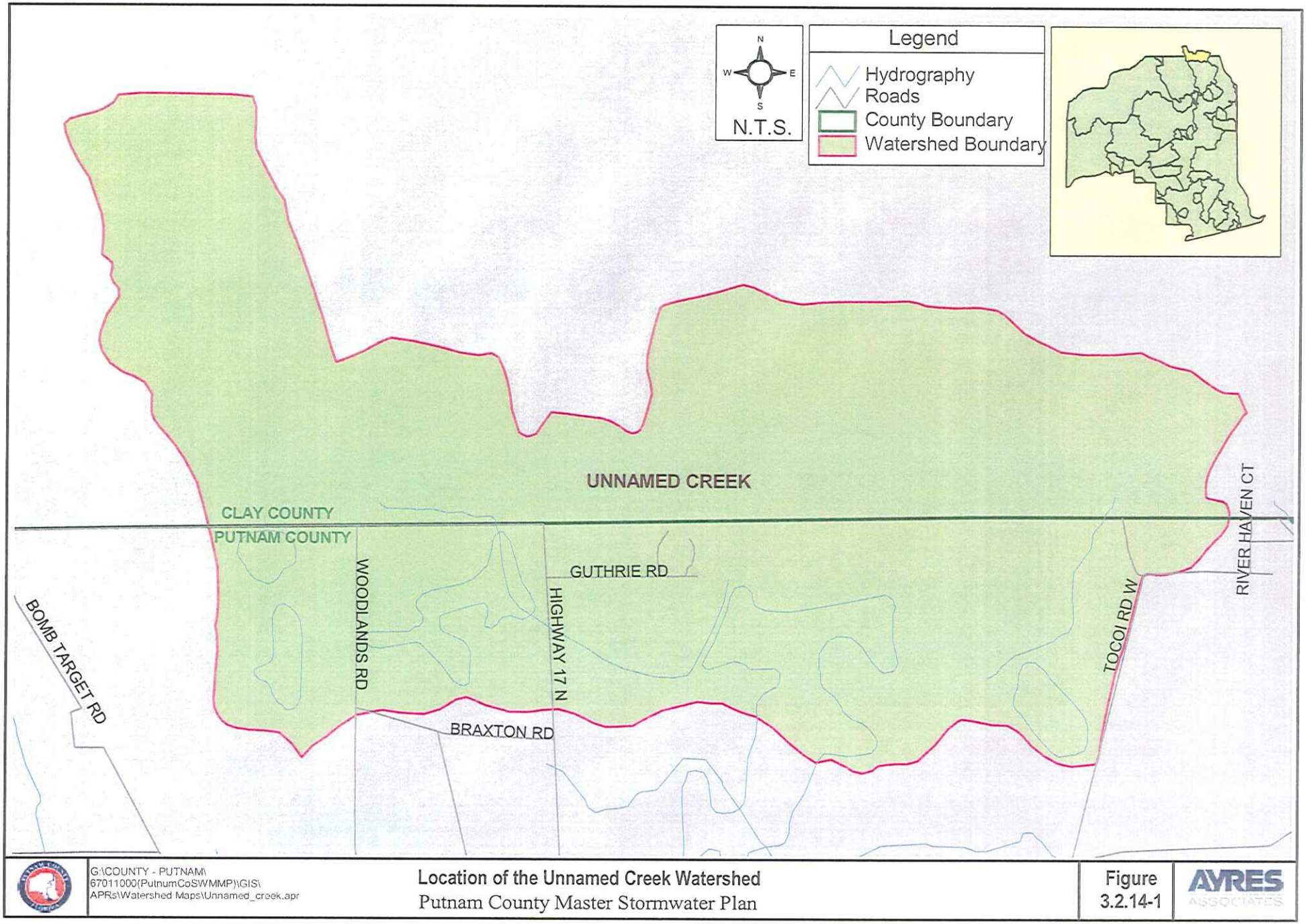
FEMA floodplain mapping for the Putnam County portion of the watershed is depicted on **Figure 3.2.14-2**. Flood zone designations are either Zone X (area determined to be outside the 500-year floodplain) or, for the wetland areas and along stream channels Zone A (lying in the 100-year floodplain for which no base flood elevations have been determined). No detailed FEMA studies have been performed for this watershed.

3.2.14.3 Soils

Within Putnam County, the dominant hydrologic soils groups indicate a high surficial water table and high runoff potential. Soils classified as B/D underlie 70% of the Putnam County portion of the watershed. Another 26% of the area is classified as HSG D (generally hydric soils). HSG C soil types represent the remaining 4% of the area. **Figure 3.2.14-3** depicts the current hydrologic soil groups in the Putnam County portion of the Unnamed Creek Watershed.

3.2.14.4 Land Use/ Land Cover

Figure 3.2.14- 4 depicts the current land use in the Putnam County portion of the Unnamed Creek Watershed. The Putnam County portion is almost entirely undeveloped, with 92% of its area represented by "Upland Forested," "Wetlands" and "Upland Non-Forested" land use codes. Just 4% of the area is comprised of "Agriculture" and 2% of "Residential." "Extractive, "Industrial" and "Transportation/Communication/Utilities" each occupy 1% of the Putnam County watershed area.

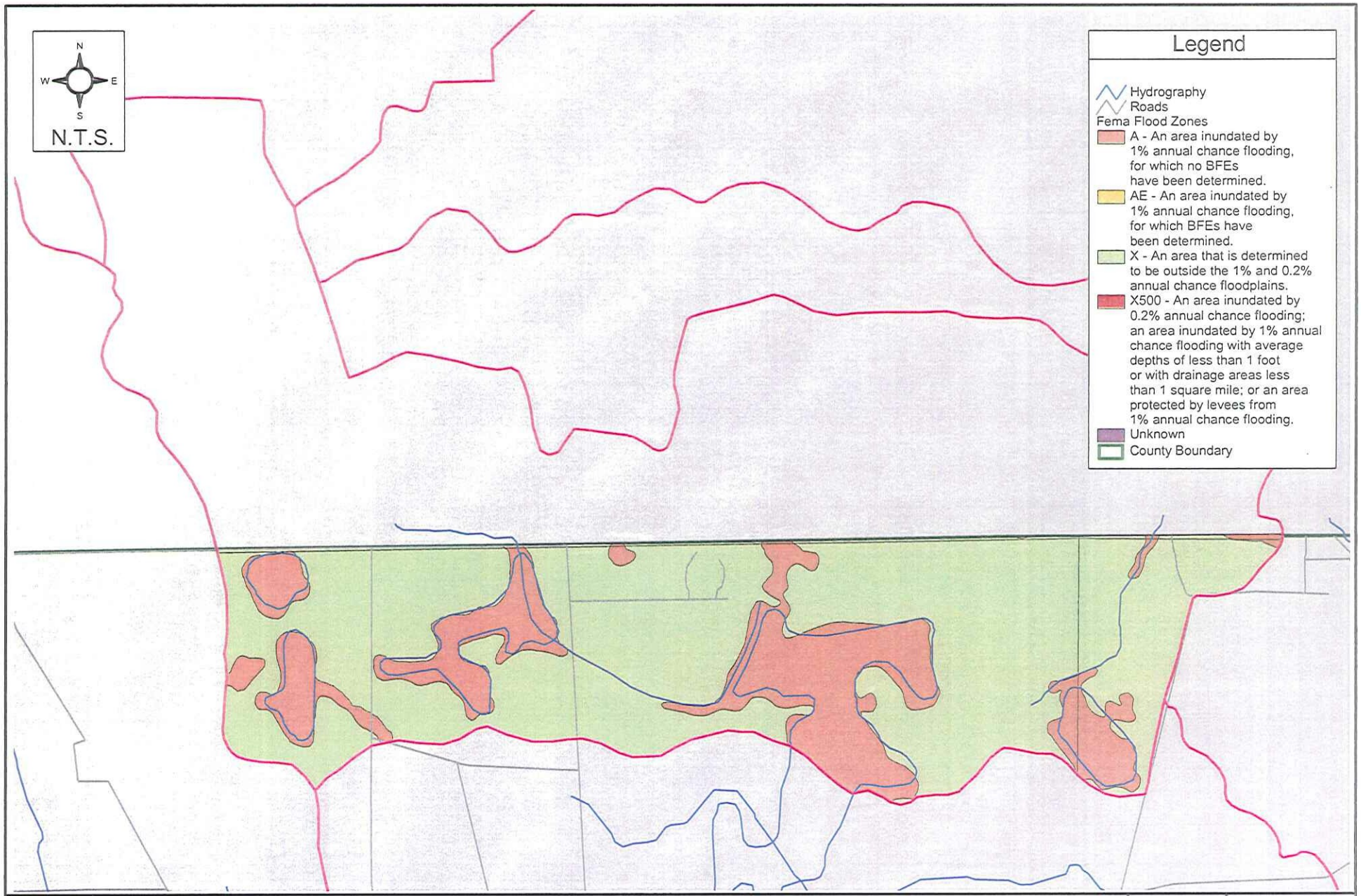


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Unnamed_creek.apr

Location of the Unnamed Creek Watershed
Putnam County Master Stormwater Plan

Figure
3.2.14-1

AYRES ASSOCIATES



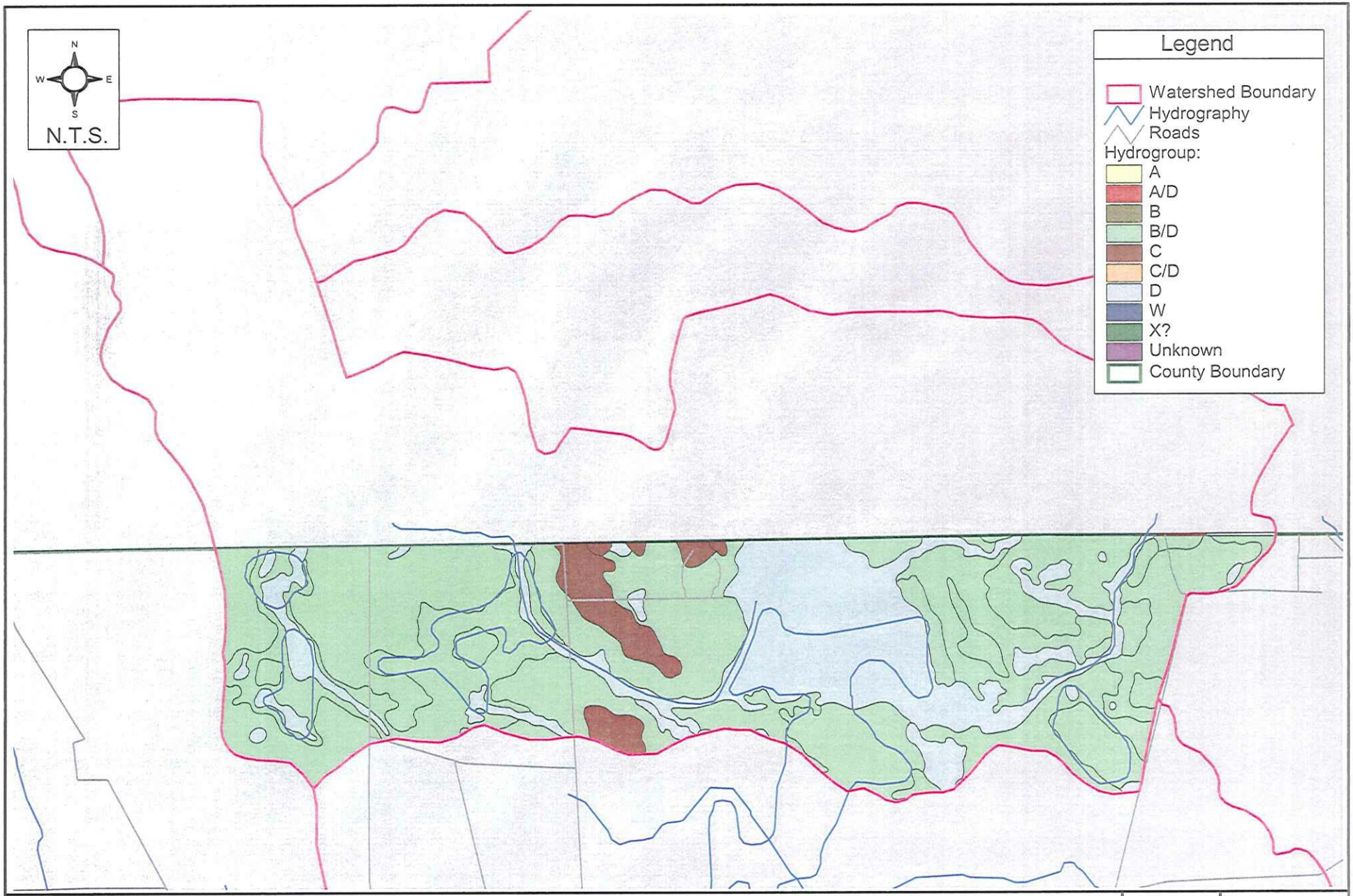
G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Unnamed_creek.apr

FEMA Flood Zones in the Unnamed Creek Watershed

Putnam County Master Stormwater Plan

Figure 3.2.14-2

AYRES ASSOCIATES

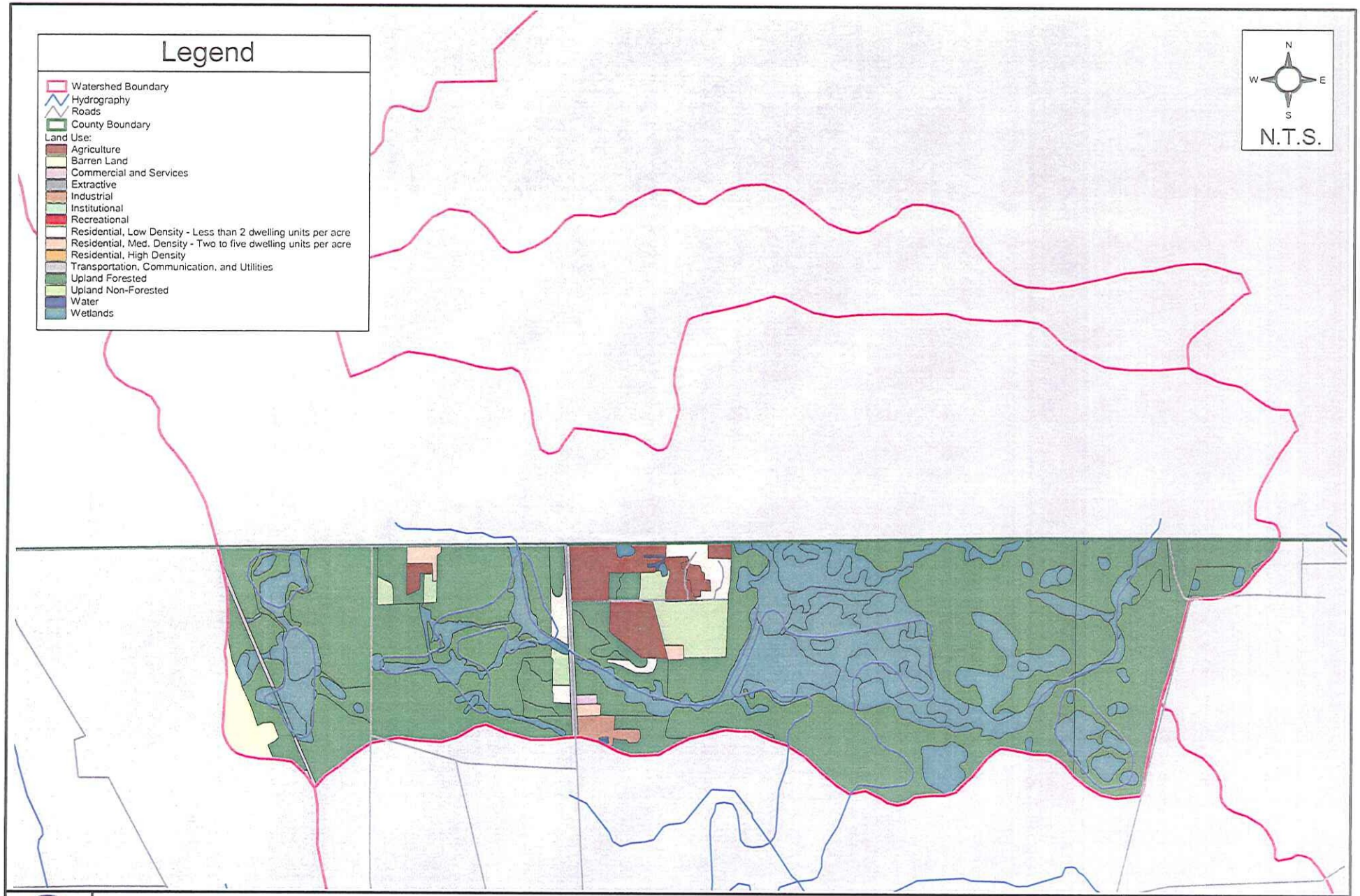


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Unnamed_creek.apr

Soils Distribution in the Unnamed Creek Watershed
Putnam County Master Stormwater Plan

Figure
3.2.14-3

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Unnamed_creek.apr

Land Use Distribution in the Unnamed Creek Watershed
Putnam County Master Stormwater Plan

Figure
3.2.14-4

AYRES ASSOCIATES

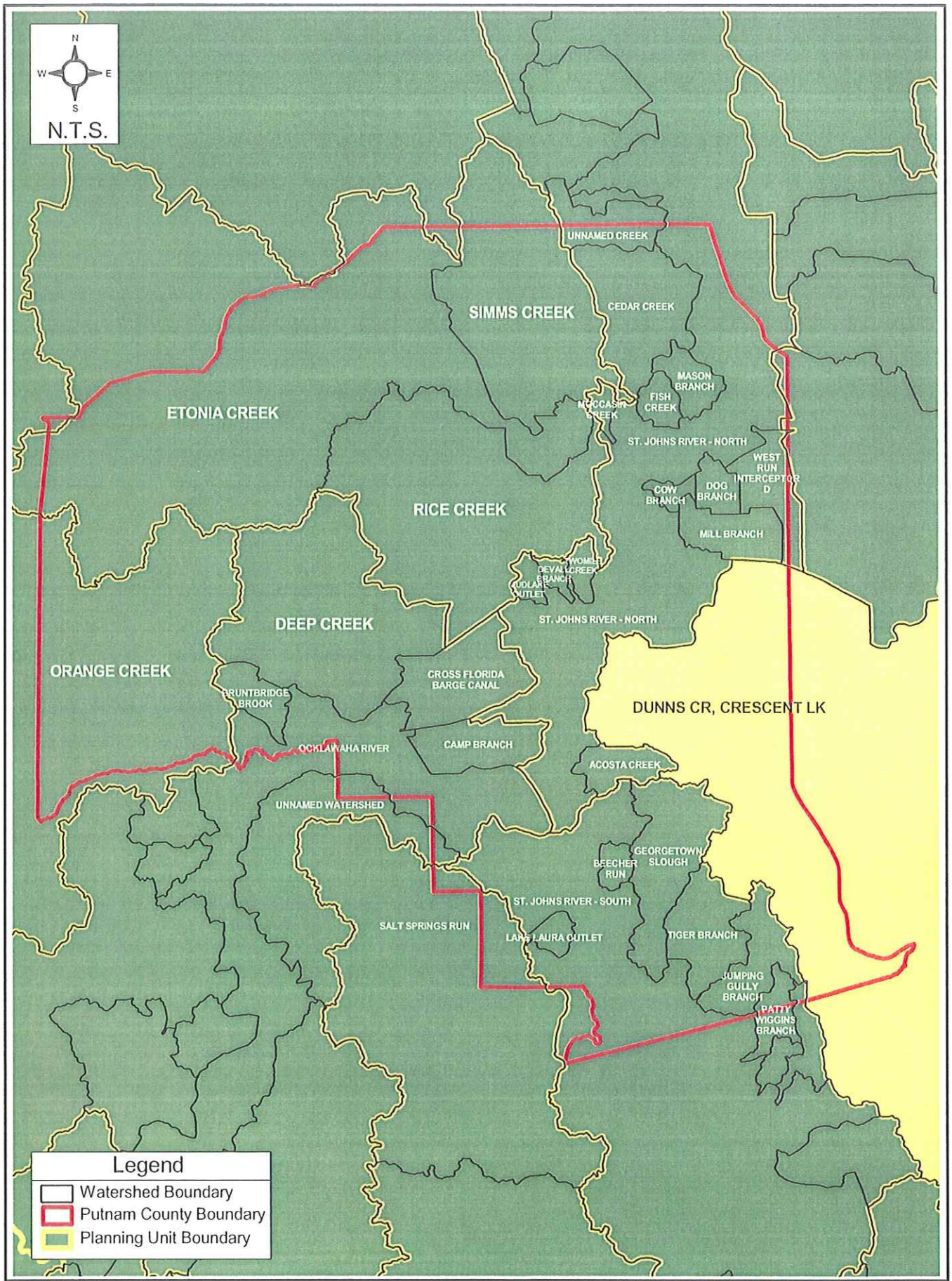
3.3 CRESCENT LAKE DRAINAGE PLANNING UNIT

The Crescent Lake Drainage Planning Unit (DPU) contains 614 square miles across Flagler, Volusia, St. Johns and Putnam Counties. Of the total land area, 90 square miles lie in southeast Putnam County. **Figure 3.3-1** depicts the Crescent Lake DPU and its only associated primary watershed. The Putnam County portion represents the downstream-most portion of the Crescent Lake outfall.

Table 3.3-1 presents a breakdown of existing land use and hydrologic soil group distribution for the Putnam County portion of the Crescent Lake DPU.

TABLE 3.3-1 LAND USE AND SOILS SUMMARY FOR CRESCENT LAKE DPU

Land Use	Distribution %	Hydrologic Soil Group	Distribution %
Agriculture	12%	A	22%
Barren Land	0%	A/D	0%
Commercial and Services	0%	B	0%
Extractive	0%	B/D	31%
Industrial	0%	C	7%
Institutional	0%	C/D	2%
Open Land	0%	D	15%
Recreational	0%	W (Water)	22%
Residential, High Density	0%	X (Arents)	0%
Residential, Low Density	9%		
Residential, Med. Density	1%		
Transportation, Communication, Utilities	0%		
Upland Forested	25%		
Upland Non-Forested	4%		
Water	21%		
Wetlands	26%		



G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\DPUs.apr

Location of the Crescent Lake DPU
Putnam County Master Stormwater Plan

Figure 3.3-1

AYRES ASSOCIATES

3.2.14 UNNAMED CREEK WATERSHED

The Unnamed Creek Watershed is comprised of 8.8 square miles in Clay and Putnam Counties. The southern 3.9 square miles are located in northeast Putnam County, just west of the St. Johns River (Figure 3.2.14-1). This watershed has not been divided into smaller subwatersheds and was not selected for field study.

3.2.14.1 Physiography and Hydrology

The primary outfall is located, for most of its length, in Putnam County and flows eastward for a distance of roughly 4.5 miles before discharging to the St. Johns River. High elevations for the Putnam County portion of this watershed are seen in the western extent at roughly 105 feet NGVD. The watershed slopes toward the St. Johns River, with low elevations of 5 feet NGVD at the outlet.

There are no USGS streamflow gages located within this watershed. Nor are there any NCDC/SJRWMD rain gages in proximity to this watershed.

3.2.14.2 FEMA Flood Zones

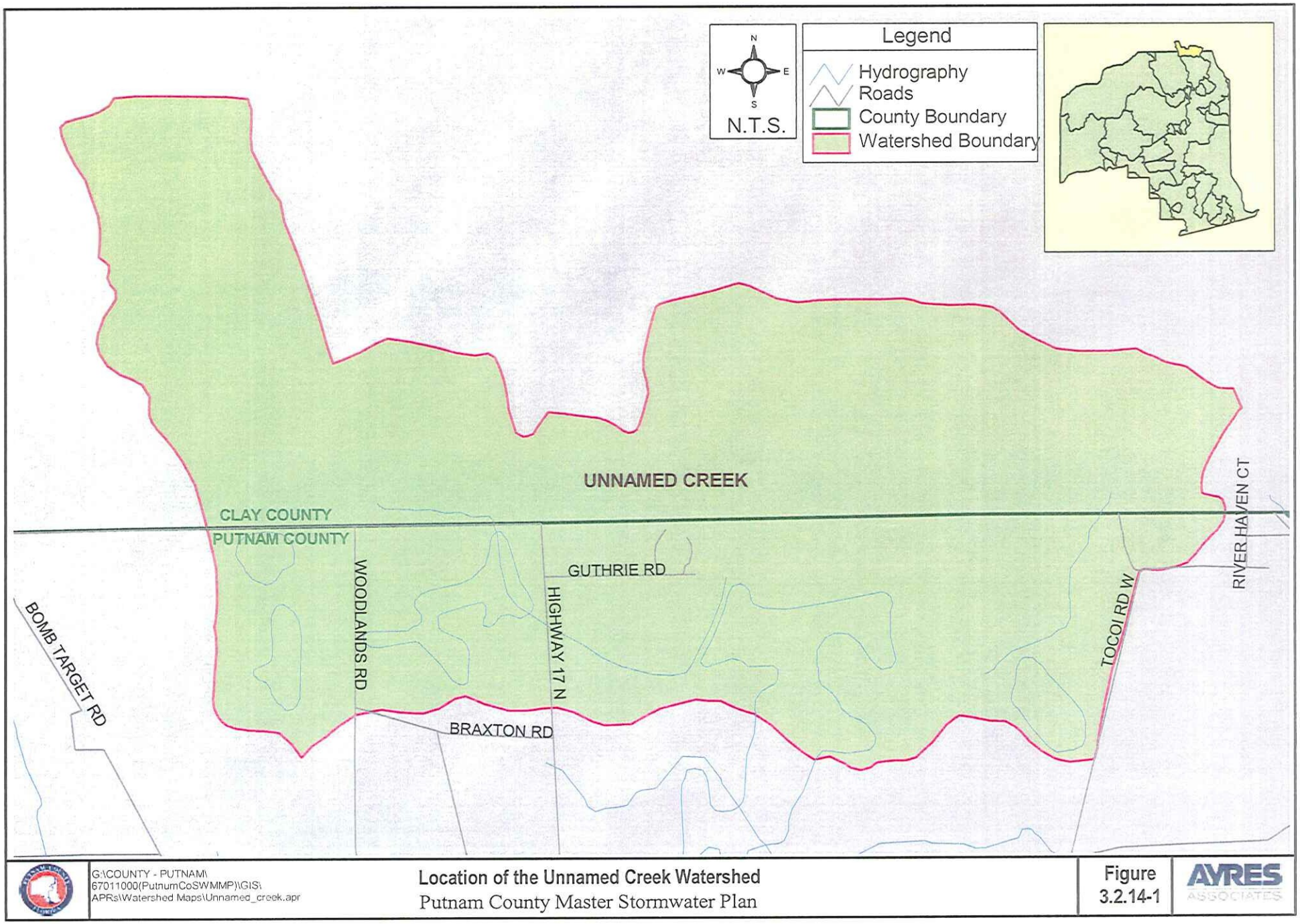
FEMA floodplain mapping for the Putnam County portion of the watershed is depicted on Figure 3.2.14-2. Flood zone designations are either Zone X (area determined to be outside the 500-year floodplain) or, for the wetland areas and along stream channels Zone A (lying in the 100-year floodplain for which no base flood elevations have been determined). No detailed FEMA studies have been performed for this watershed.

3.2.14.3 Soils

Within Putnam County, the dominant hydrologic soils groups indicate a high surficial water table and high runoff potential. Soils classified as B/D underlie 70% of the Putnam County portion of the watershed. Another 26% of the area is classified as HSG D (generally hydric soils). HSG C soil types represent the remaining 4% of the area. Figure 3.2.14-3 depicts the current hydrologic soil groups in the Putnam County portion of the Unnamed Creek Watershed.

3.2.14.4 Land Use/ Land Cover

Figure 3.2.14- 4 depicts the current land use in the Putnam County portion of the Unnamed Creek Watershed. The Putnam County portion is almost entirely undeveloped, with 92% of its area represented by "Upland Forested," "Wetlands" and "Upland Non-Forested" land use codes. Just 4% of the area is comprised of "Agriculture" and 2% of "Residential." "Extractive, "Industrial" and "Transportation/Communication/Utilities" each occupy 1% of the Putnam County watershed area.

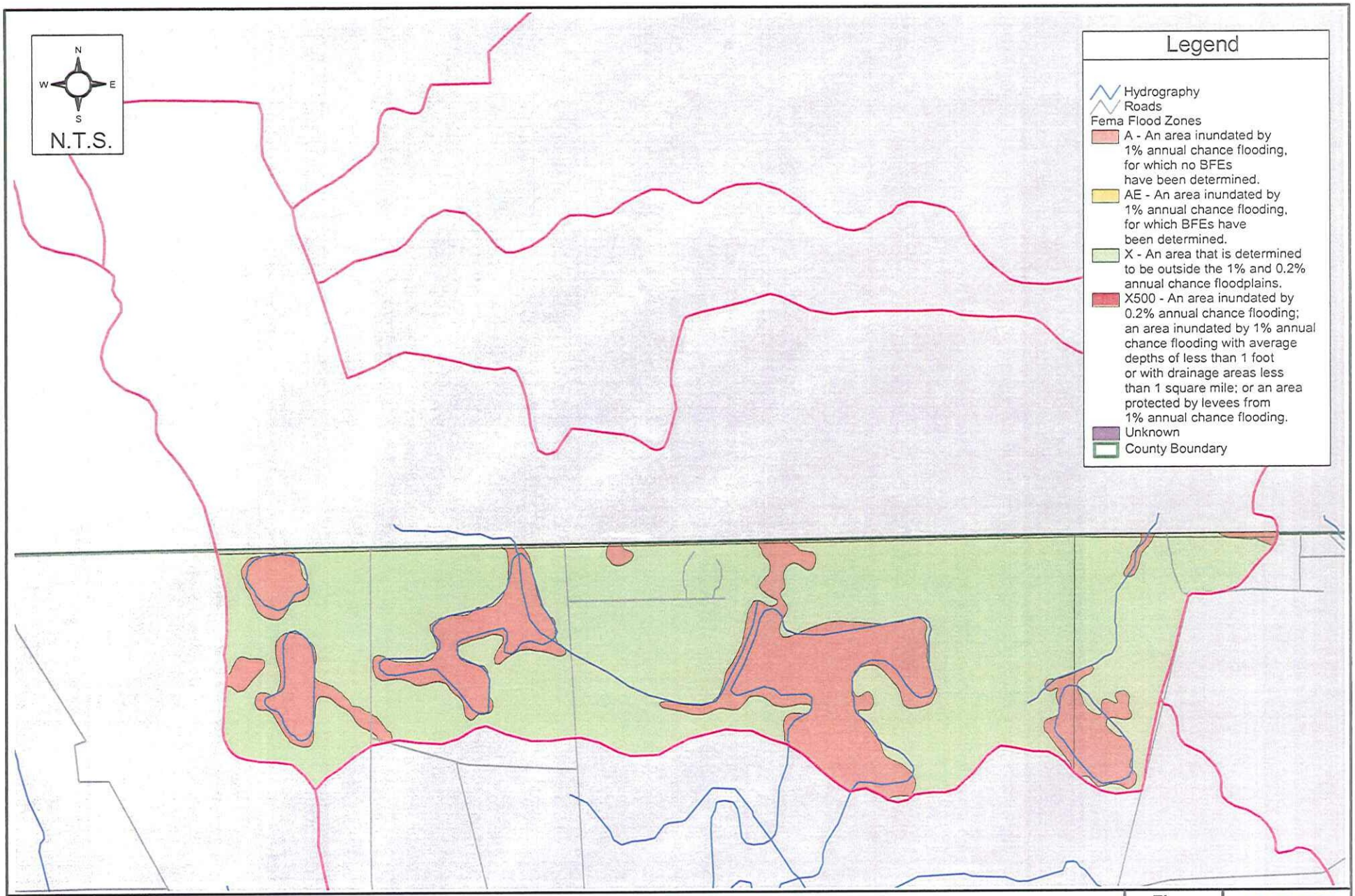


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Unnamed_creek.apr

Location of the Unnamed Creek Watershed
Putnam County Master Stormwater Plan

Figure
3.2.14-1

AYRES ASSOCIATES



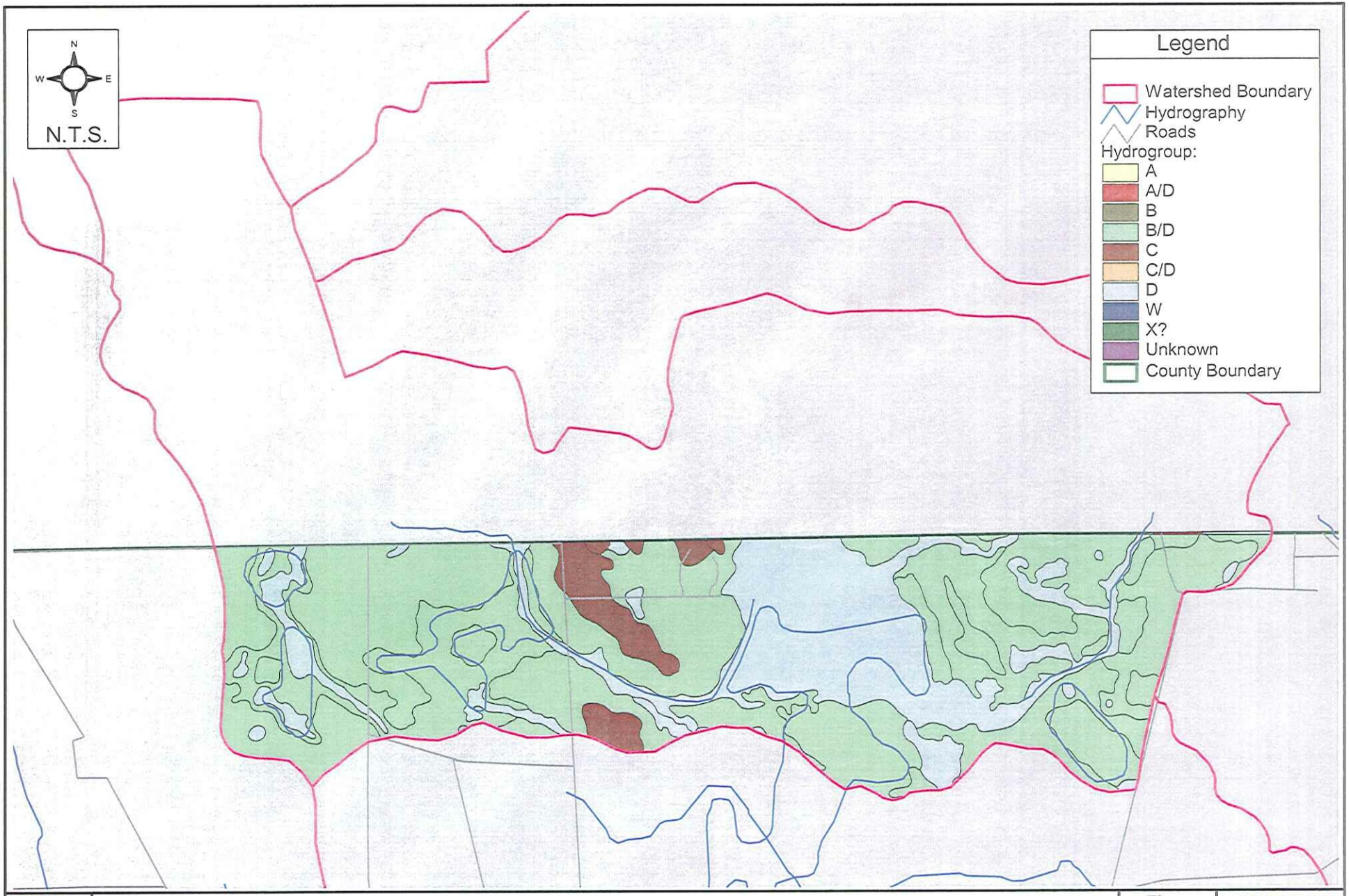
G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Unnamed_creek.apr

FEMA Flood Zones in the Unnamed Creek Watershed

Putnam County Master Stormwater Plan

Figure 3.2.14-2

AYRES ASSOCIATES

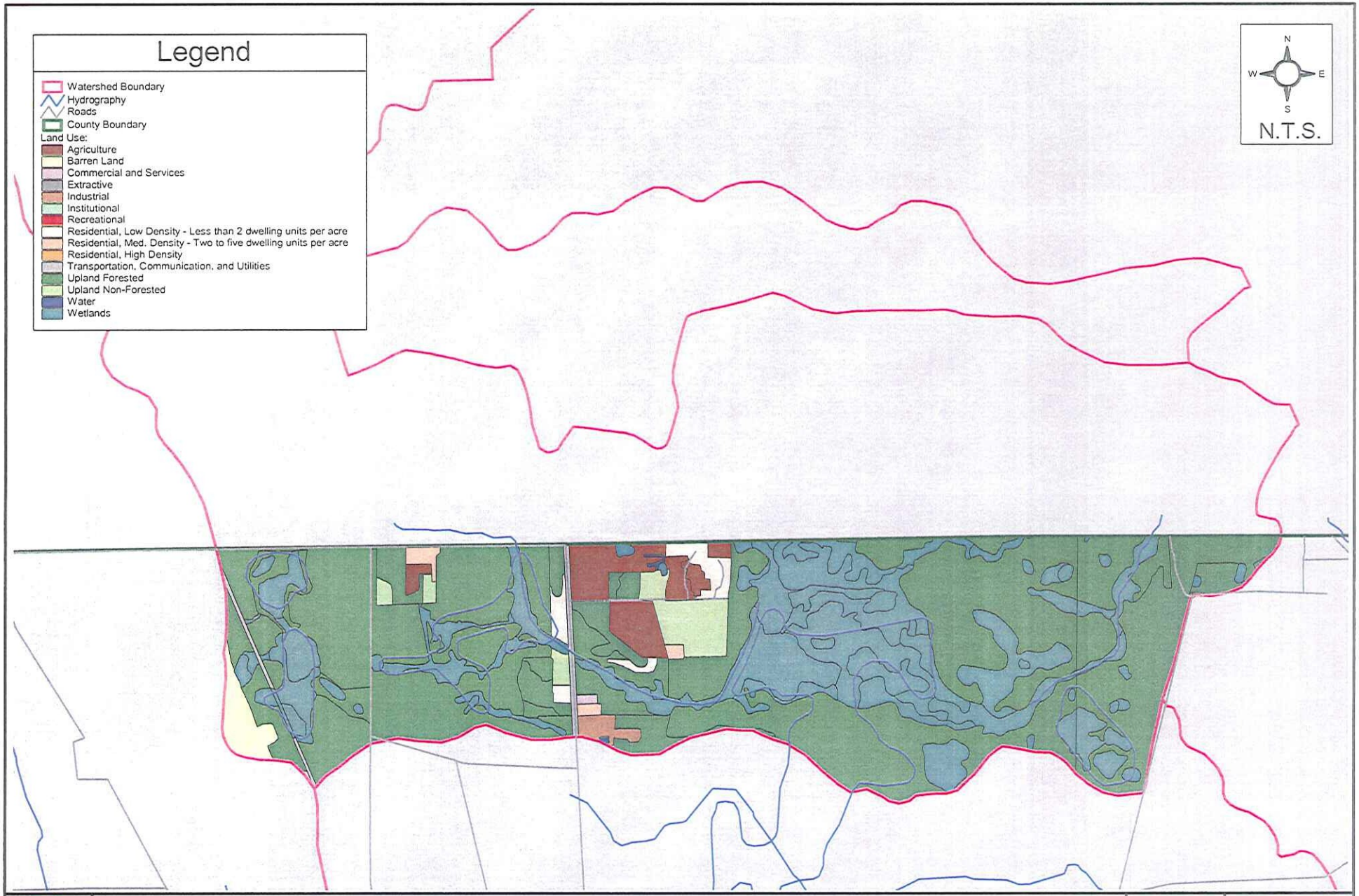


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Unnamed_creek.apr

Soils Distribution in the Unnamed Creek Watershed
Putnam County Master Stormwater Plan

Figure
3.2.14-3

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Unnamed_creek.apr

Land Use Distribution in the Unnamed Creek Watershed
Putnam County Master Stormwater Plan

Figure
3.2.14-4

AYRES ASSOCIATES

3.3.1 DUNNS CREEK, CRESCENT LAKE WATERSHED

The Dunns Creek, Crescent Lake Watershed is the only primary watershed within the Crescent Lake DPU. As stated previously, the downstream-most portion lies in southeast Putnam County, covering 90 square miles (**Figure 3.3.1-1**). The Putnam County portion includes all or part of the following nine (9) subwatersheds:

1. Crane Ponds Outlet
2. Dunns Creek, Crescent Lake*
3. Hammock Branch
4. Hell Cat Bay
5. Lake Broward Outlet
6. Lake Myra Outlet
7. Lake Stella Outlet*
8. Silver Lake Outlet*
9. Unnamed Ditches-1

Subwatersheds identified with an asterisk (*) have been selected for additional studies that are described in later subsections.

3.3.1.1 Physiography and Hydrology

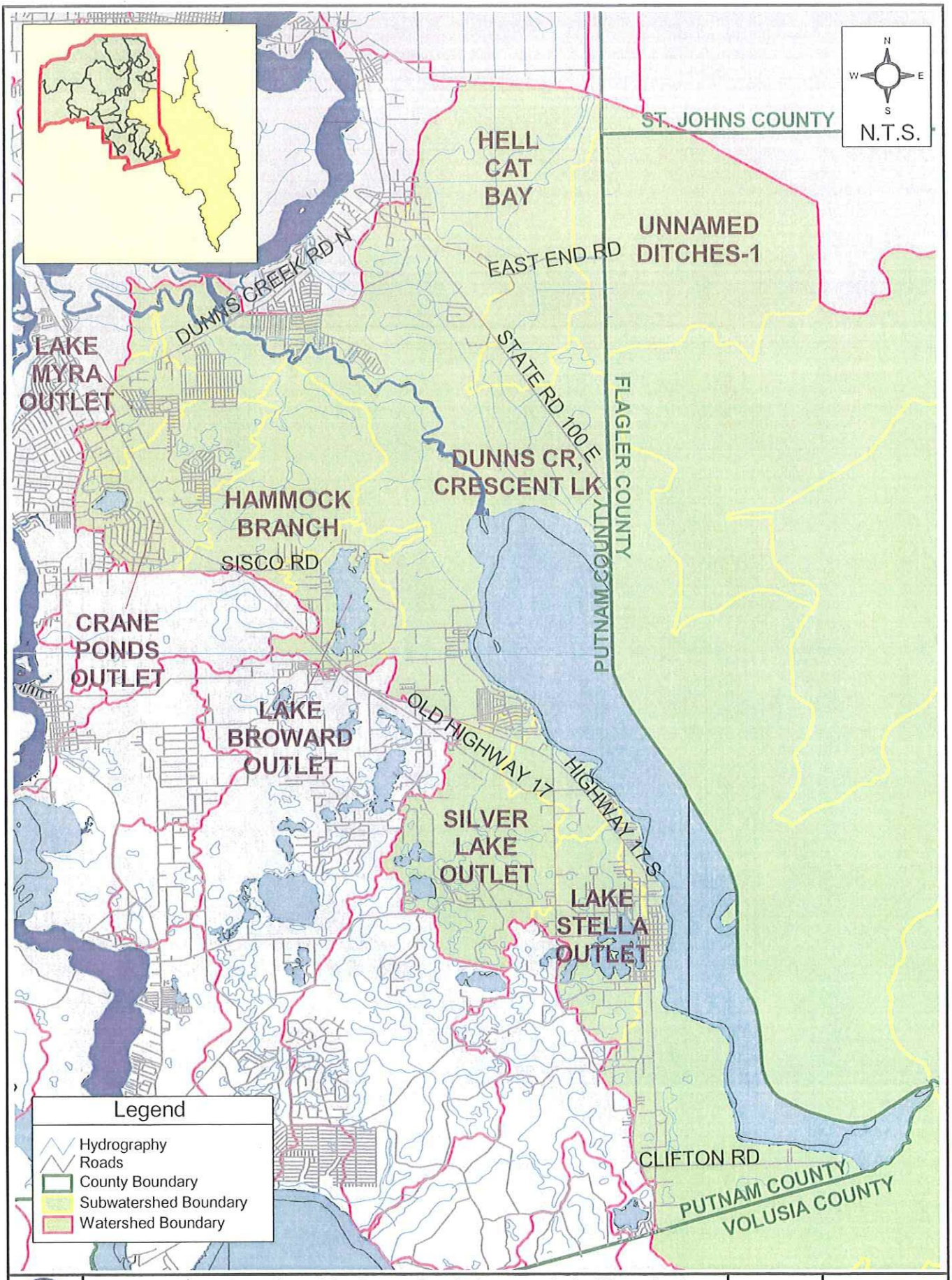
The primary outfall, Dunns Creek, flows northwest from the outlet of Crescent Lake, a 26.8 square-mile waterbody, for a distance of roughly 7.8 river miles before discharging to the St. Johns River. The Dunns Creek, Crescent Lake subwatershed is comprised of the Crescent Lake waterbody, Dunns Creek channel, and direct runoff area surrounding the two. Putnam County subwatersheds tributary to Crescent Lake include the southward-draining Unnamed Ditches-1 conveyance system; the north-draining Lake Stella Outlet; and the northeast-draining Silver Lake Outlet. Contributing subwatersheds which drain to Dunns Creek include the Lake Broward Outlet, discharging to Dunns Creek just downstream of the Crescent Lake outfall; the Hell Cat Bay, draining southward via ditches and a primary outfall canal; the northeast-draining Hammock Branch; the Crane Ponds Outlet which overflows to Hammock Branch before entering Dunns Creek; and the north-draining Lake Myra Outlet.

Topographic highs of roughly 70 feet NGVD are found along the northwest watershed boundary. High elevations for the central west and southwest portion are in the range of 50 feet NGVD and 35 feet NGVD, respectively. Bank elevations at Crescent Lake are roughly 5 feet NGVD.

There is one USGS streamflow gage located within this watershed, the "Dunns Creek near Satsuma" Gage 02244440. The gage is located at the US Highway 17 bridge, approximately 0.8 miles upstream from the St. Johns River confluence. The contributing drainage area at the gage is estimated by USGS to be 585 square miles. Monthly mean streamflow data collected from 1978 through 2003 is highly variable. Data reflect a minimum flow value of -749 cfs,

signifying that the St. Johns River was draining southward through Dunns Creek into Crescent Lake. The maximum monthly mean value is 4,431 cfs. Average mean monthly streamflow is 510 cfs. The highest mean monthly flows are seen in November, January and February. Lowest mean monthly flows, primarily reverse flows from St. Johns River, are exhibited in May.

There are two rain gages within the Dunns Creek, Crescent Lake Watershed. One is maintained by the SJRWMD, Gage 243 "Hell Cat Bay." This gage is located near the shared boundary of the Hell Cat Bay and the Unnamed Ditches-1 subwatersheds. It offers continuous rainfall records from 1994 to the present. The second rain gage is NCDC co-op station 81978, "Crescent City, FL," and is located on the south end of the Lake Stella Outlet subwatershed. This gage has daily and monthly rainfall records available from 1948 to the present.



Location of the Dunns Creek, Crescent Lake Watershed

G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\DunnsCr_CrescentLk.apr

Putnam County Master Stormwater Plan

Figure 3.3.1-1

AYRES ASSOCIATES

3.3.1.2 FEMA Flood Zones

The Putnam County portion of this watershed contains a significant portion of Crescent Lake, as well as wetlands and smaller lakes on the western end. These areas, along with the unns Creek channel and floodplain, are given Flood Zone designations of AE and A, indicating 100-year flood zones. Upland areas are generally designated as Zone X, or area determined to be outside the 500-year floodplain. FEMA floodplain mapping is depicted on **Figure 3.3.1-2**.

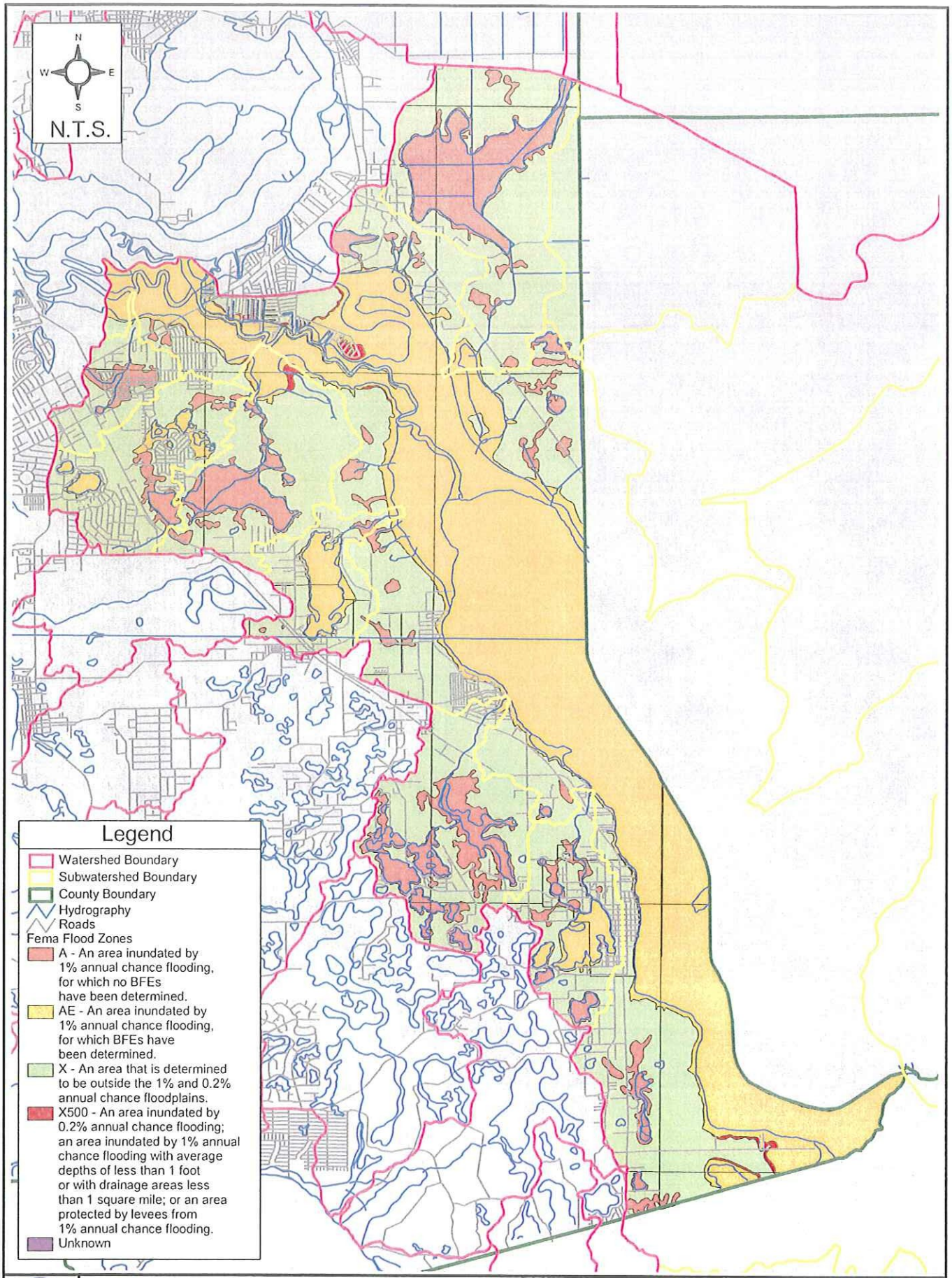
As part of the Putnam County FIS dated August 16, 1994, Dunns Creek has been studied in detail from the St. Johns River confluence, upstream to Crescent Lake. The FIS presents graphs of the flood profiles and defines the regulatory floodway for Dunns Creek. Stillwater flood elevations have been developed for Crescent Lake, Castle Lake, Crane Ponds, Saratoga Lake and Sugarbowl Lake, Lake Broward and Lake Stella. A copy of the Putnam County FIS is provided in **Appendix 3-A** of this SMP. The FIS for Crescent City, Florida (dated June 1979) is provided in **Appendix 3-A**. The Crescent City FIS presents flood stages for Crescent Lake and Lake Stella for various flood frequencies applicable to properties within the incorporated city limits. The FIS for the Town of Pomona Park, Florida (dated June 1979) is provided in **Appendix 3-A**. The Pomona Park FIS presents flood stages for Lake Broward for various flood frequencies applicable to properties within the town limits. Flood stages from Crescent City and Pomona Park FIS documents are consistent with the Putnam County FIS.

3.3.1.3 Soils

Figure 3.3.1-3 depicts the current hydrologic soil groups in the Dunns Creek, Crescent Lake Watershed. The Putnam County portion of the watershed is comprised predominantly of B/D, A and W (water) classifications. Roughly 15% of the area is underlain by D group soils.

3.3.1.4 Land Use/ Land Cover

A wide variety of land uses are represented within the Dunns Creek, Crescent Lake Watershed, although most in very small proportion. "Upland Forest, " "Water," and "Wetland" land use classifications each occupy from 21% to 26% of the Putnam County area within the Dunns Creek, Crescent Lake Watershed. "Agricultural" and "Residential" uses rank the next highest at 12.5% and 10%, respectively. **Figure 3.3.1- 4** depicts the current land use in the Dunns Creek, Crescent Lake Watershed.

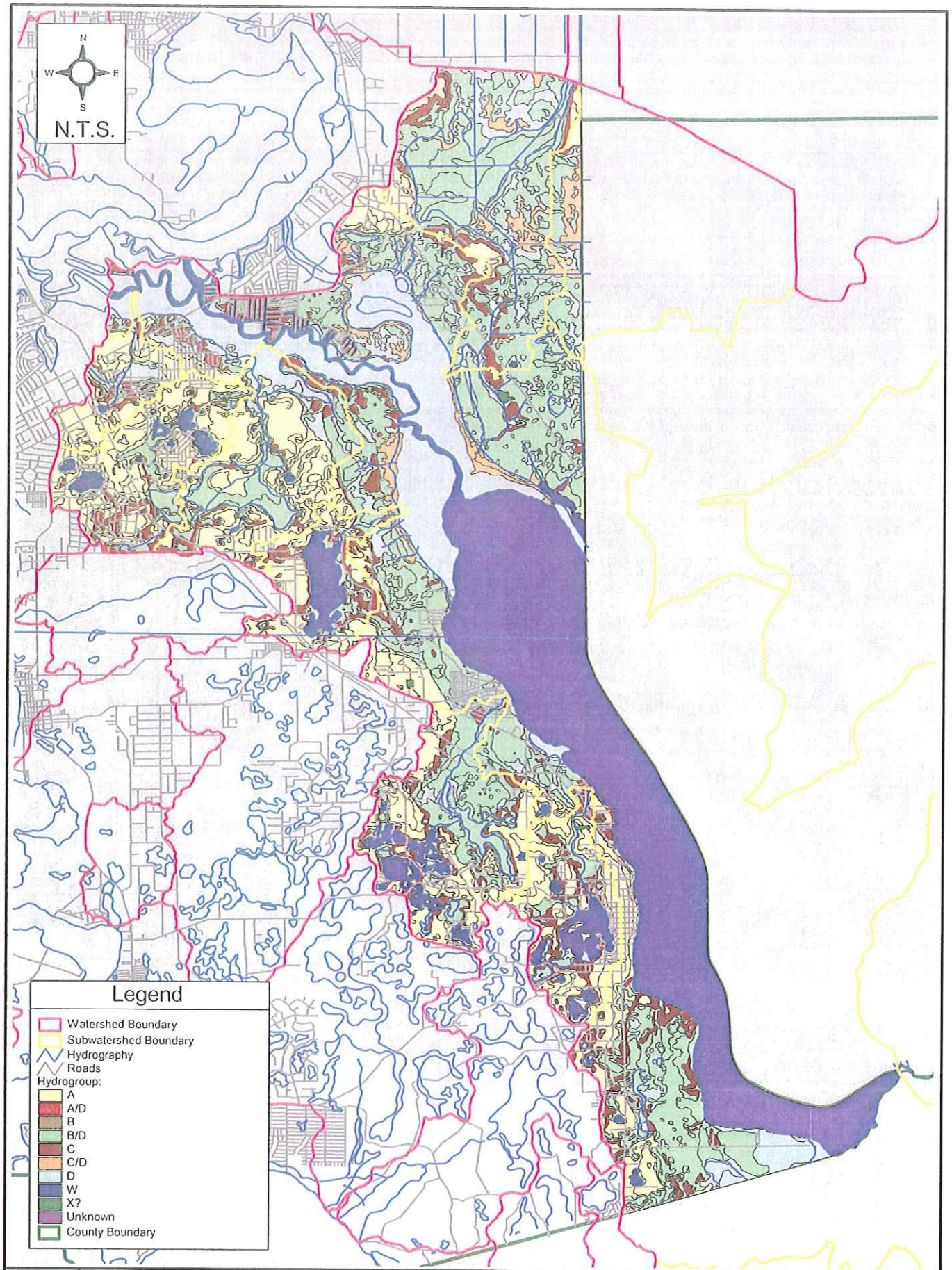


FEMA Flood Zones in the Dunns Creek, Crescent Lake Watershed
Putnam County Master Stormwater Plan

G:\COUNTY - PUTNAM\ 67011000(PutnumCoSWMMP)\GIS\ APRs\Watershed Maps\DunnsCr_CrescentLk.apr

Figure 3.3.1-2

AYRES ASSOCIATES

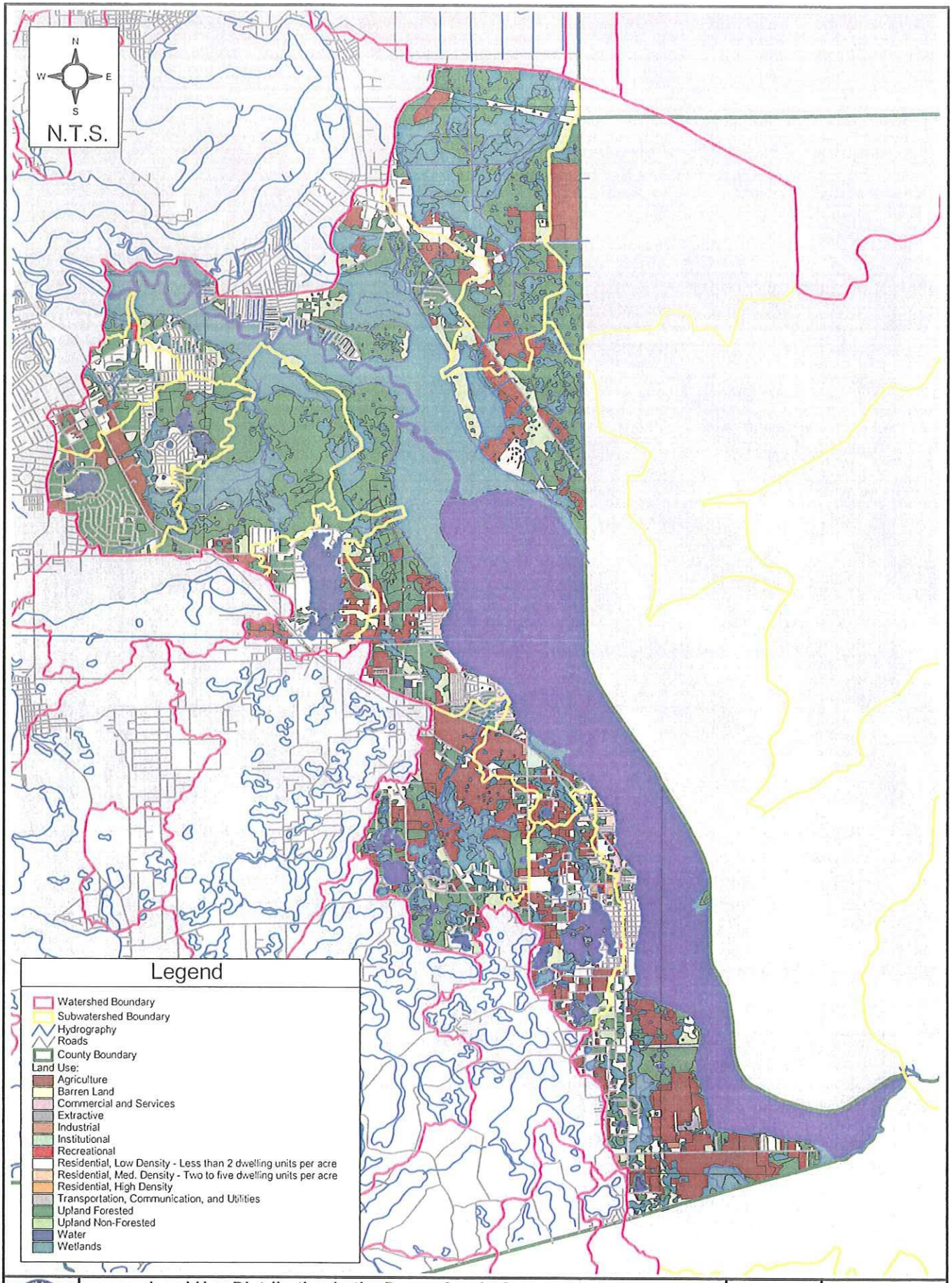


Soils Distribution in the Dunns Creek, Crescent Lake Watershed
Putnam County Master Stormwater Plan

G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\DunnsCr_CrescentLk.apr

Figure
3.3.1-3

AYRES ASSOCIATES



Land Use Distribution in the Dunns Creek, Crescent Lake Watershed

G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\DunnsCr_CrescentLk.apr

Putnam County Master Stormwater Plan

Figure 3.3.1-4

AYRES ASSOCIATES

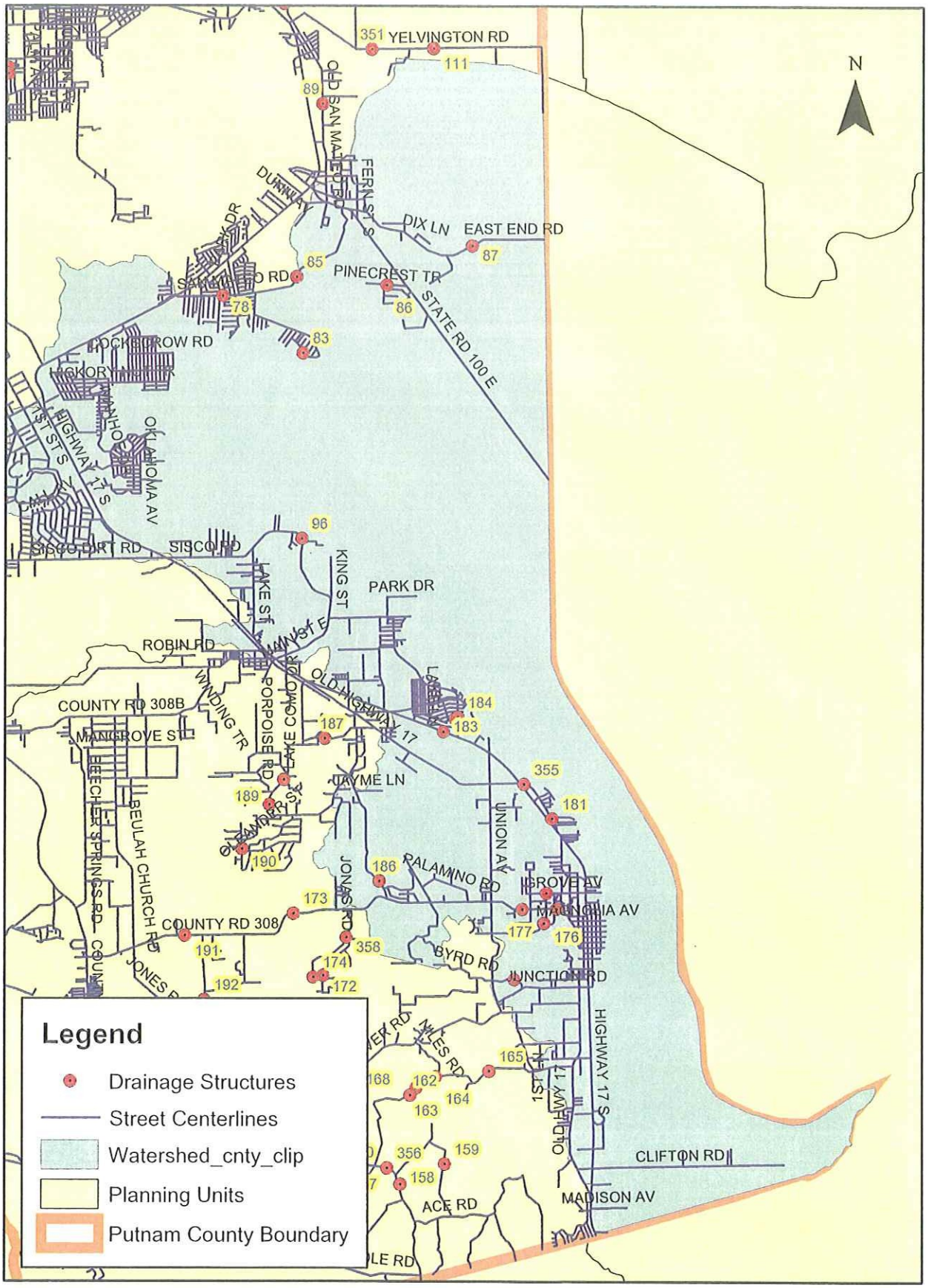
3.3.1.5 Field investigations in Selected Subwatersheds

The field reconnaissance program described in Section 2.10 was performed for three selected Dunns Creek, Crescent Lake subwatersheds as illustrated on the following index figure. No modifications to basin delineations resulted from field investigations. Field reports for hydraulic structures and photo documentation from the investigation is presented in **Appendix 3-B**. These data have been incorporated into a GIS database for County use.

3.3.1.6 Sewer Network and Point Source Discharge

Sewer networks and point source discharges in this watershed have not been identified by the County. A search of FDEP permitted point source discharges and industrial stormwater dischargers was performed and yielded the following results:

WATER SHED	SUBWATER SHED	FACILITY ID	NAME	FACILITY TYPE	FACILITY ADDRESS	CITY	**OWNER** SHIP TYPE
Dunns Creek, Crescent Lake	Dunns Creek, Crescent Lake	FL0043176	PARADISE POINT WWTF	Domestic WWTP	341 PARADISE POINT CIRCLE	PALATKA	County Owned
Dunns Creek, Crescent Lake	Lake Stella Outlet	FLR05C420	HUNTINGTON LANDFILL	Multi-Sector Stormwater GP	1551 CR 308	CRESCENT CITY	Public Ownership



Field Reconnaissance - Dunn's Creek & Crescent Lake Watershed

3.4.1 ORANGE CREEK WATERSHED

The Orange Creek Watershed is comprised of 601.7 square miles, located in west Putnam County as well as Alachua and Marion Counties (**Figure 3.4.1-1**). The Putnam County portion covers 79.9 square miles, although the flows through this region represent the entire contributing watershed. All or part of the following ten (10) subwatersheds are located in Putnam County:

1. Cabbage Creek
2. Cowpen Lake Outlet
3. Hewitt Lakes Outlet
4. Little Orange Creek
5. McCarthy Lake Outlet
6. McMeekin Drain
7. Orange Creek
8. Star Lake Outlet
9. Unnamed Branch-5
10. Unnamed Drain-4

No subwatersheds have been selected for additional field studies.

3.4.1.1 Physiography and Hydrology

The primary outfall, Orange Creek, flows east for a distance of roughly 9.2 miles along the southwestern border of Putnam County and outfalls to the Ocklawaha River upstream of Rodman Reservoir. The majority of the Putnam County portion of this watershed is drained southward and eastward through the Little Orange Creek and Cabbage Creek systems.

Watershed elevations range from highs of roughly 180 feet NGVD in the northern extent (north of Interlachen, Florida) to elevations of 30 feet NGVD or less along the Orange Creek floodplain.

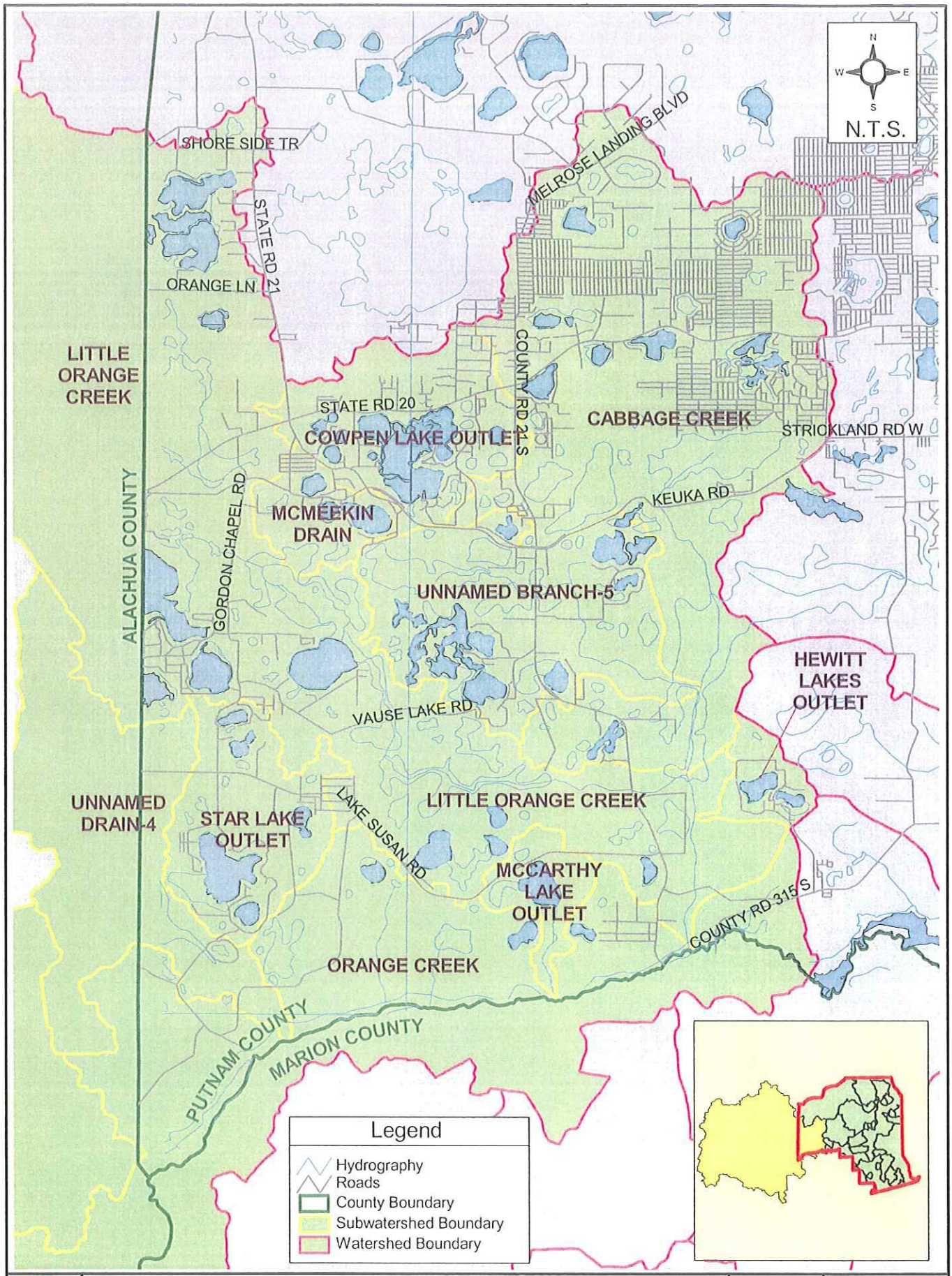
There is one USGS streamflow gage located within this watershed, near the outlet of the Little Orange Creek tributary. Gage No. 02243300 "Little Orange Creek near Johnson" is located at the State Route 21 crossing, approximately 0.75 miles upstream of the Cabbage Creek confluence. The contributing drainage area at the gage is estimated by USGS to be 42.6 square miles. Recorded data at this gage is available for only a short period of record, between 1995 and 1998. Monthly mean streamflow data reflect a minimum flow value of 3.1 cfs and a maximum monthly mean value of 112 cfs. Average mean monthly streamflow for this period is 16.6 cfs. The highest mean monthly flows are seen in February, March and April. Lowest mean monthly flows were recorded during summer months of June and July.

There are no NCDC or SJRWMD rain gages within the Orange Creek Watershed. However, the SJRWMD "Chesser Well" (Gage 7010) is located at the southern extent of the Etonia Creek Watershed and would be expected to provide representative data for the northern portion of this watershed. The "Chesser Well" gage offers continuous rainfall records from May 2002 to the present.

3.4.1.2 FEMA Flood Zones

The majority of this watershed is classified Zone X, or area determined to be outside the 500-year floodplain. However, around Orange Creek and its significant tributaries there are consistent strips of land designated Zone A. Areas in Zone A lie in a 100-year floodplain for which no base flood elevations have been determined. Other areas of Zone A surround the many lakes and wetlands scattered throughout the watershed. FEMA floodplain mapping is depicted on **Figure 3.4.1-2**.

The Orange Creek channel and floodplain, along with its Putnam County tributaries, have not been studied in detail as part of the Putnam County FIS. Two waterbodies within the Putnam County portion of the Orange Creek watershed, Redwater Lake in the Little Orange Creek subwatershed and Star Lake in the Star Lake Outlet subwatershed, have stillwater flood elevations reported in the Putnam County FIS provided in **Appendix 3-A** of this SMP.



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Orange_Creek.apr

Location of the Orange Creek Watershed
Putnam County Master Stormwater Plan

Figure
3.4.1-1

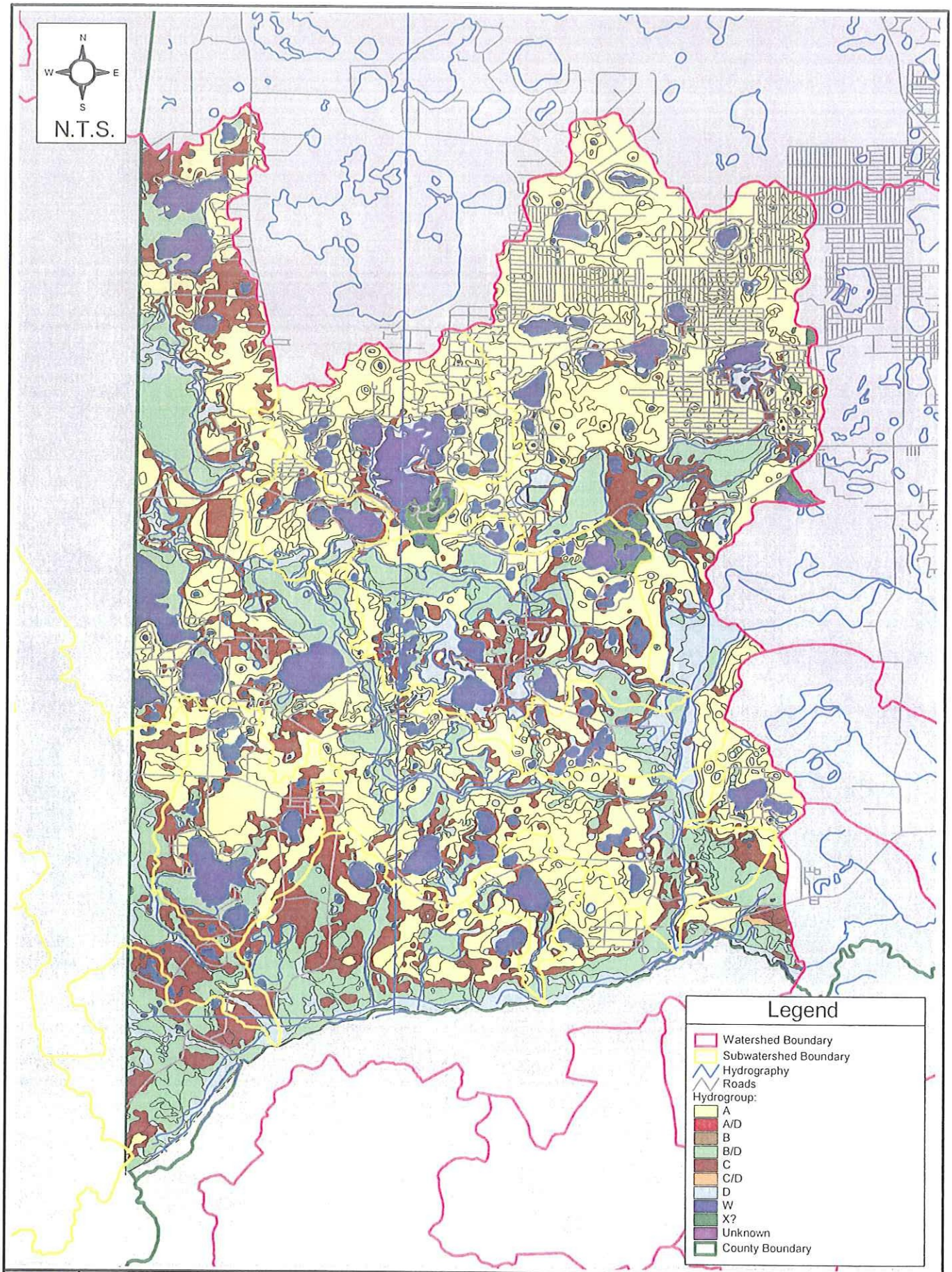
AYRES ASSOCIATES

3.4.1.3 Soils

Figure 3.4.1-3 depicts the current hydrologic soil groups in the Orange Creek Watershed. Nearly half of the Putnam County portion of the watershed is comprised of excessively well drained, HSG A, soil classifications. The B/D classification represents roughly 19% of the area, and D soil groups, common to hydric, wetland soils, or W (water) classifications occupy approximately 17%.

3.4.1.4 Land Use/ Land Cover

Within Putnam County, only 20% of this watershed is comprised of developed land uses (residential, agricultural). "Upland Forest, " "Wetland," and "Water" land use classifications occupy 44%, 18% and 9%, respectively. **Figure 3.4.1- 4** depicts the current land use in the Orange Creek Watershed.

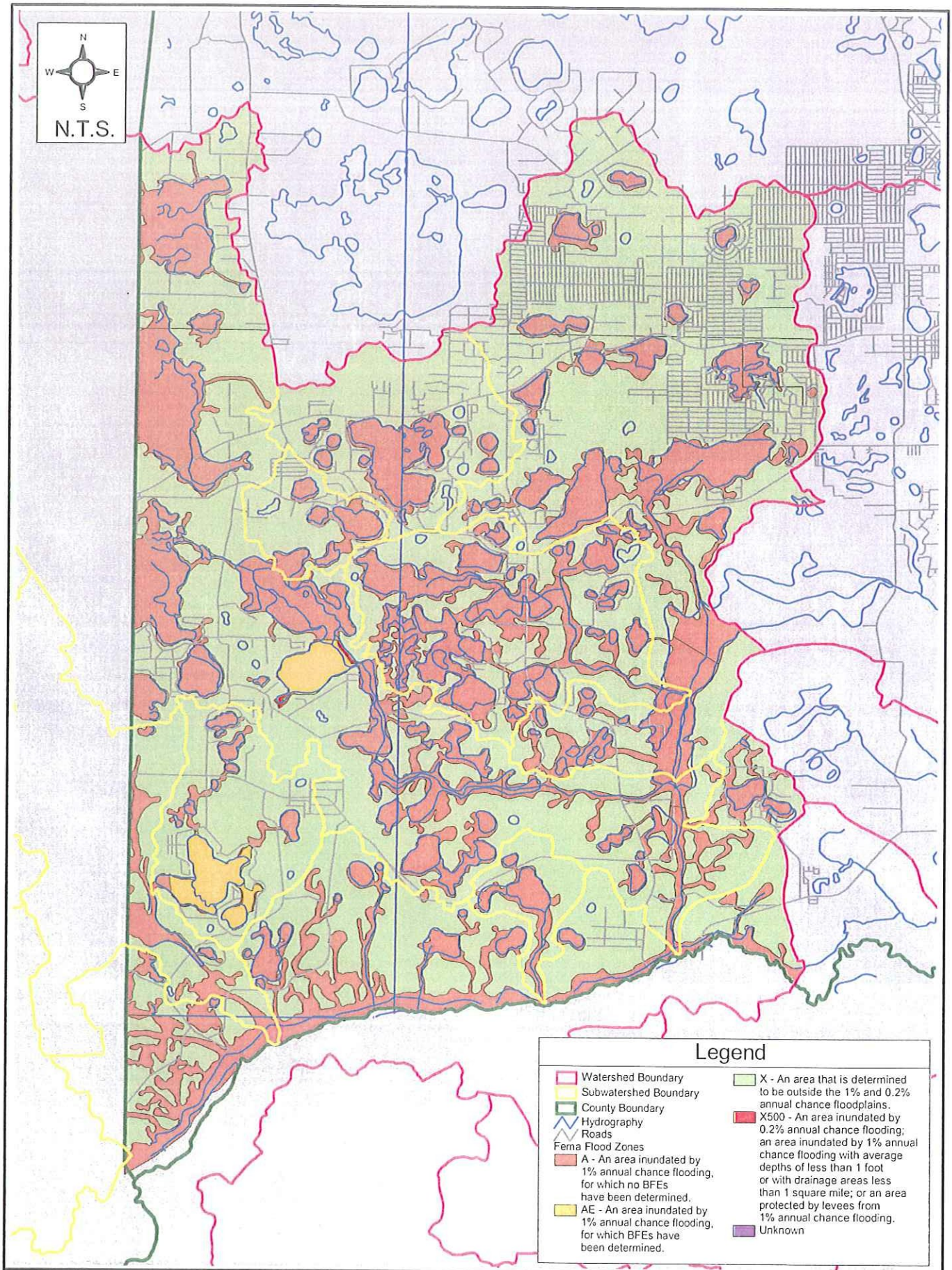


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\orange_creek.apr

Soils Distribution in the Orange Creek Watershed
Putnam County Master Stormwater Plan

Figure 3.4.1-3

AYRES ASSOCIATES



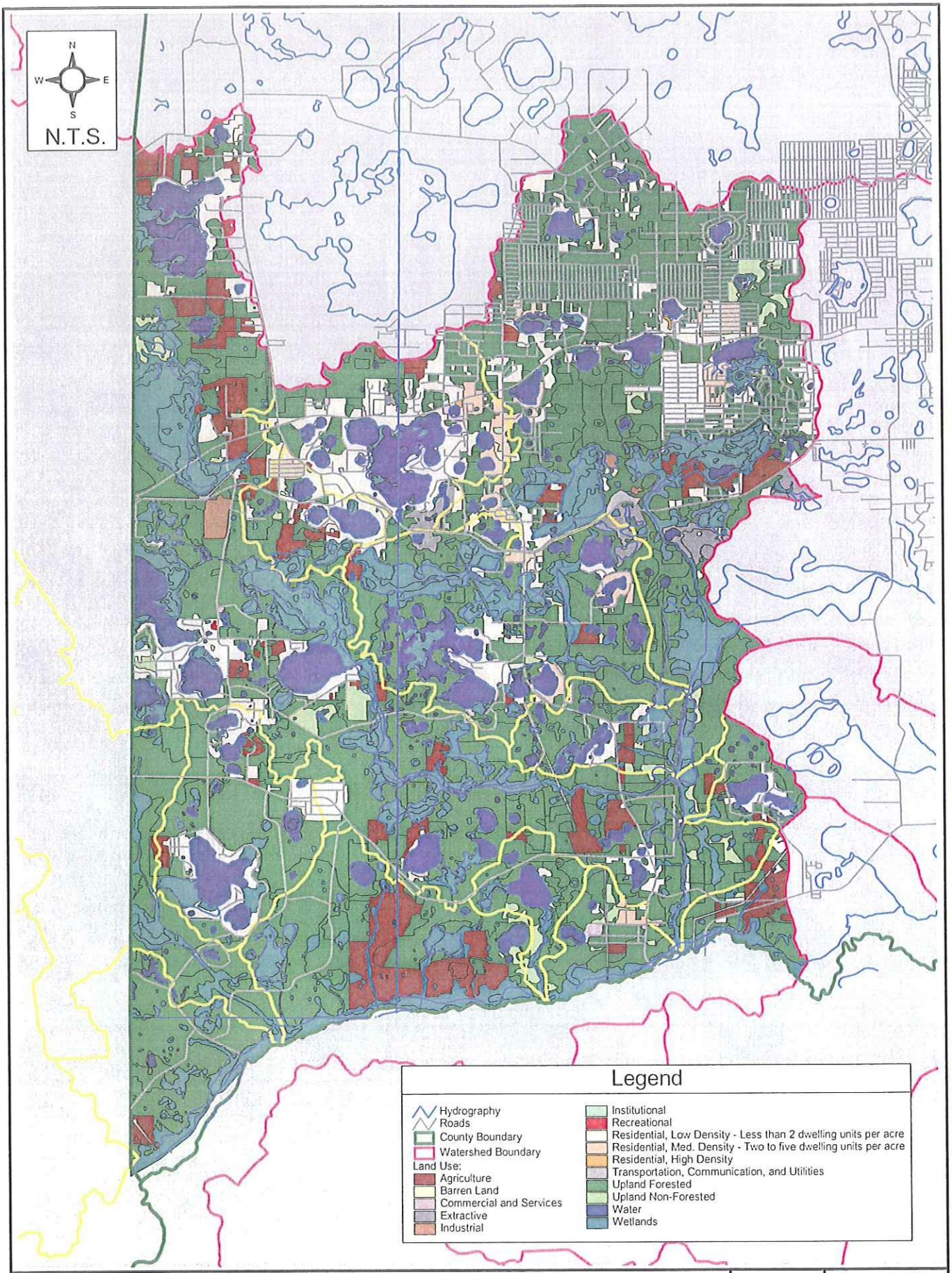
FEMA Flood Zones in the Orange Creek Watershed

Putnam County Master Stormwater Plan

G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\orange_creek.apr

Figure 3.4.1-2

AYRES ASSOCIATES



Land Use Distribution in the Orange Creek Watershed

Putnam County Master Stormwater Plan

G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\orange_creek.apr

Figure 3.4.1-4

AVIRES ASSOCIATES

3.5 RODMAN RESERVOIR DRAINAGE PLANNING UNIT

The Rodman Reservoir Drainage Planning Unit (DPU) contains 471.7 square miles across Marion and Putnam Counties. Of the total land area, 123.3 square miles lie in Putnam County. Figure 3.5-1 depicts the Rodman Reservoir DPU and its associated watersheds. According to the watershed designation developed by SJRWMD, the Rodman Reservoir DPU contains five (5) primary contributory watersheds that are located in whole or in part within Putnam County:

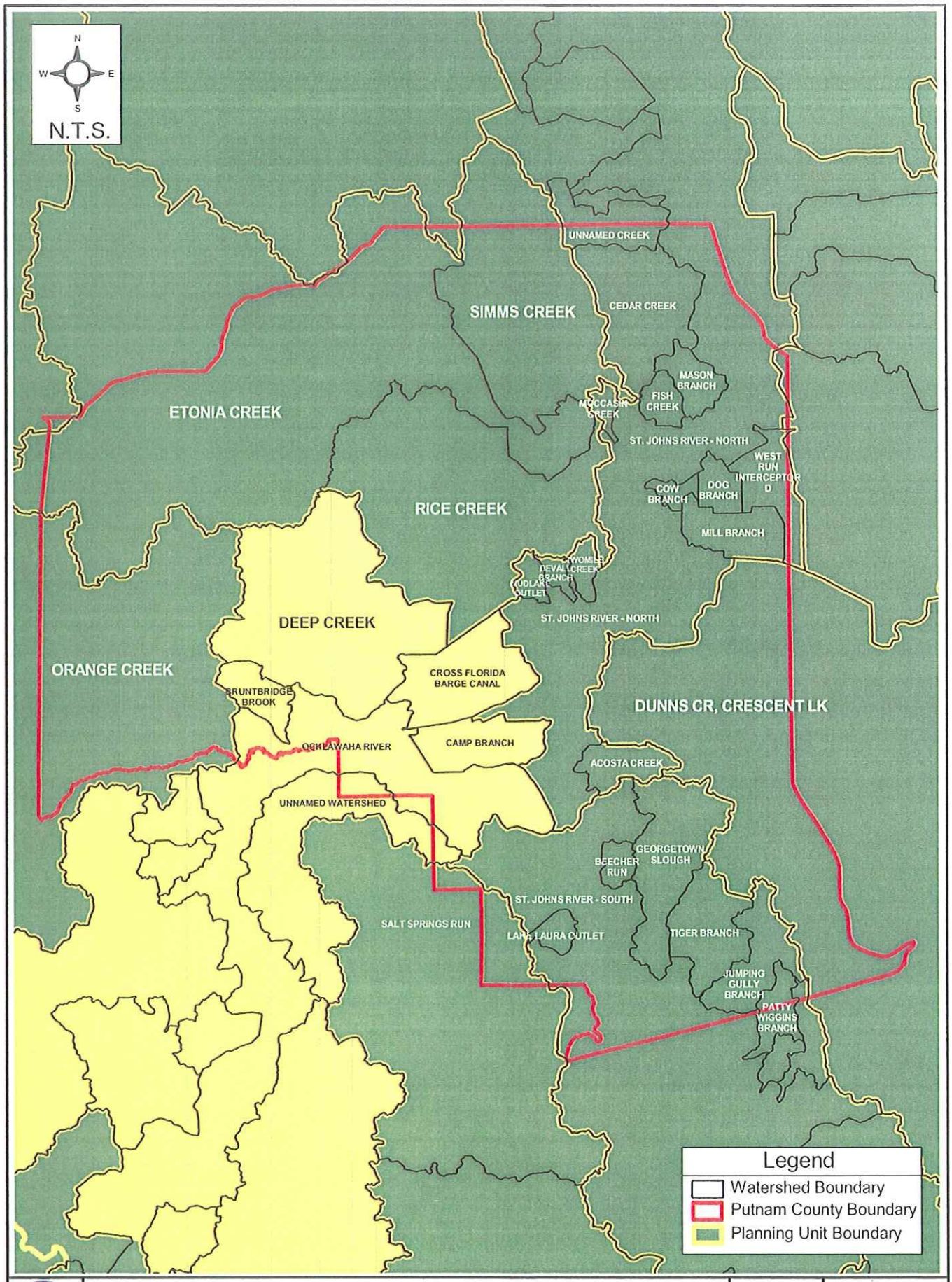
- Bruntbridge Brook
- Camp Branch
- Cross Florida Barge Canal
- Deep Creek
- Ocklawaha River

Note that one unnamed primary watershed is not included in the list above, although 2.9 square miles lie within the Putnam County borders. This horseshoe-shaped watershed is sandwiched between the Ocklawaha River primary watershed and the Lake Kerr DPU. The area has been designated by USGS as "non-contributing."

Table 3.5-1 presents a breakdown of existing land use and hydrologic soil group distribution for the Putnam County Portion of the Rodman Reservoir DPU.

TABLE 3.5-1 LAND USE AND SOILS SUMMARY FOR RODMAN RESERVOIR DPU

Land Use	Distribution %	Hydrologic Soil Group	Distribution %
Agriculture	6%	A	16%
Barren Land	1%	A/D	0%
Commercial and Services	0%	B	0%
Extractive	1%	B/D	42%
Industrial	0%	C	7%
Institutional	0%	C/D	3%
Open Land	2%	D	23%
Recreational	0%	W (Water)	8%
Residential, High Density	0%	X (Arents)	1%
Residential, Low Density	7%		
Residential, Med. Density	1%		
Transportation, Communication, Utilities	1%		
Upland Forested	40%		
Upland Non-Forested	5%		
Water	6%		
Wetlands	32%		



G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\DPUs.apr

Location of the Rodman Reservoir DPU
Putnam County Master Stormwater Plan

Figure 3.5-1

AYRES ASSOCIATES

3.5.1 BRUNTBRIDGE BROOK WATERSHED

The Bruntbridge Brook Watershed is comprised of 5.7 square miles located in southwest Putnam County (Figure 3.5.1-1). It has not been divided into smaller subwatersheds and has not been selected for additional field study.

3.5.1.1 Physiography and Hydrology

The primary outfall, Bruntbridge Brook, flows east and then south for a distance of roughly 2.8 miles to its outfall at Ocklawaha Lake (Rodman Reservoir). It has no named tributaries. Watershed elevations range from highs of roughly 80 feet NGVD in the northern extent to elevations of 25 feet NGVD or less along the floodplain of Ocklawaha Lake.

There are no USGS streamflow gages located within this watershed. Nor are there any SJRWMD or NCDC rain gages located within the Bruntbridge Brook Watershed.

3.5.1.2 FEMA Flood Zones

The watershed is classified Zone A, area in the 100-year floodplain for which no base flood elevations have been determined, along the stream channel and wetland headwaters. The remaining areas are designated as Zone X, or area determined to be outside the 500-year floodplain. FEMA floodplain mapping is depicted on Figure 3.5.1-2.

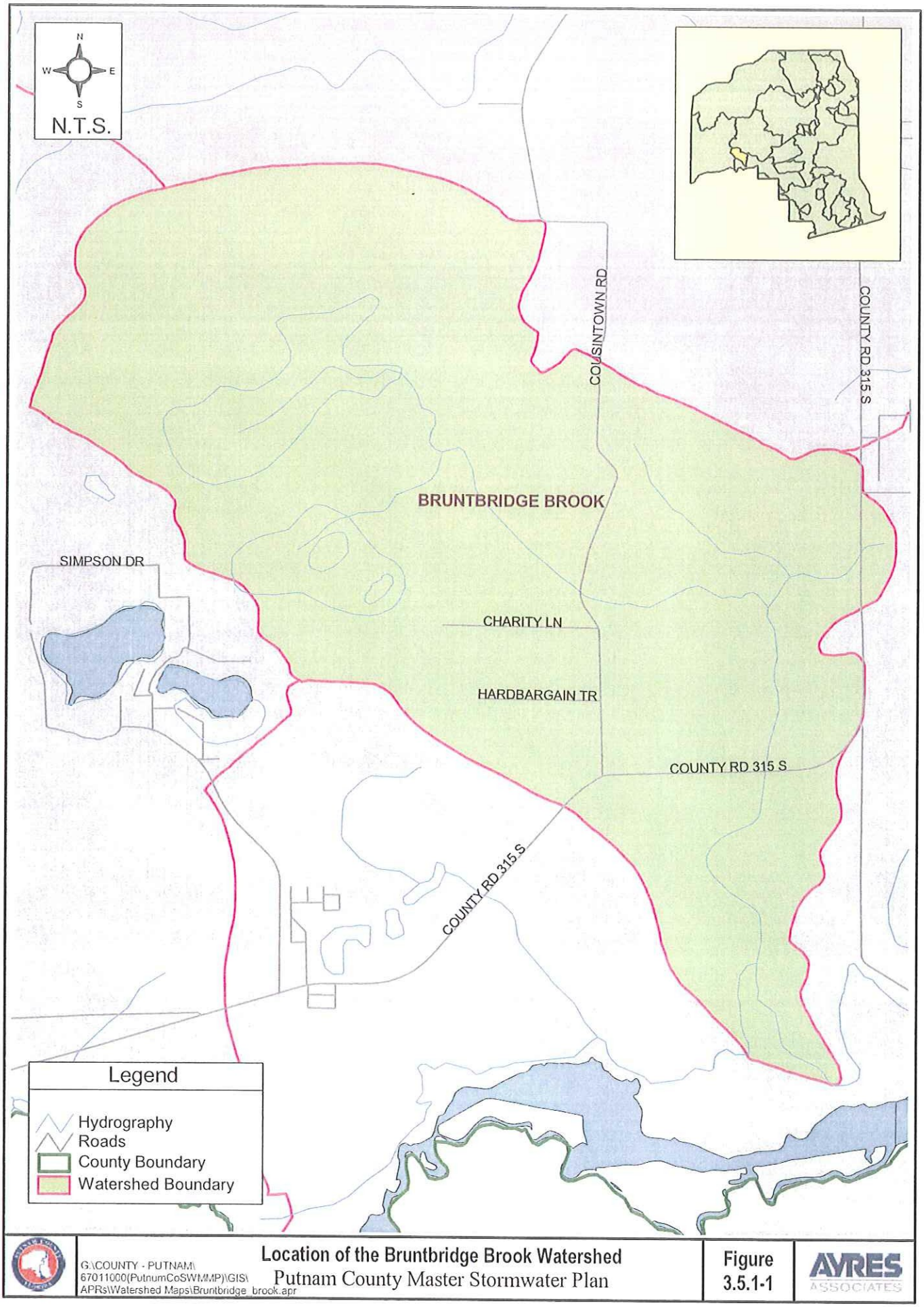
The area has not been studied in detail by FEMA. No channel flood profiles or stillwater flood elevations are reported for this watershed in the Putnam County FIS.

3.5.1.3 Soils

Figure 3.5.1-3 depicts the current hydrologic soil groups in the Bruntbridge Brook Watershed. Over half of the watershed is comprised of B/D classification soils. Roughly 22% of the watershed has excessively well drained (A classification) soils. Hydric wetland soils with D or W (water) classifications occupy approximately 19% of the watershed.

3.5.1.4 Land Use/ Land Cover

Only 6% of this watershed is comprised of developed land uses (agricultural, low-density residential, transportation). "Upland Forest, " "Wetland," and "Water" land use classifications occupy 66%, 24% and <2%, respectively. Figure 3.5.1- 4 depicts the current land use in the Bruntbridge Brook Watershed.

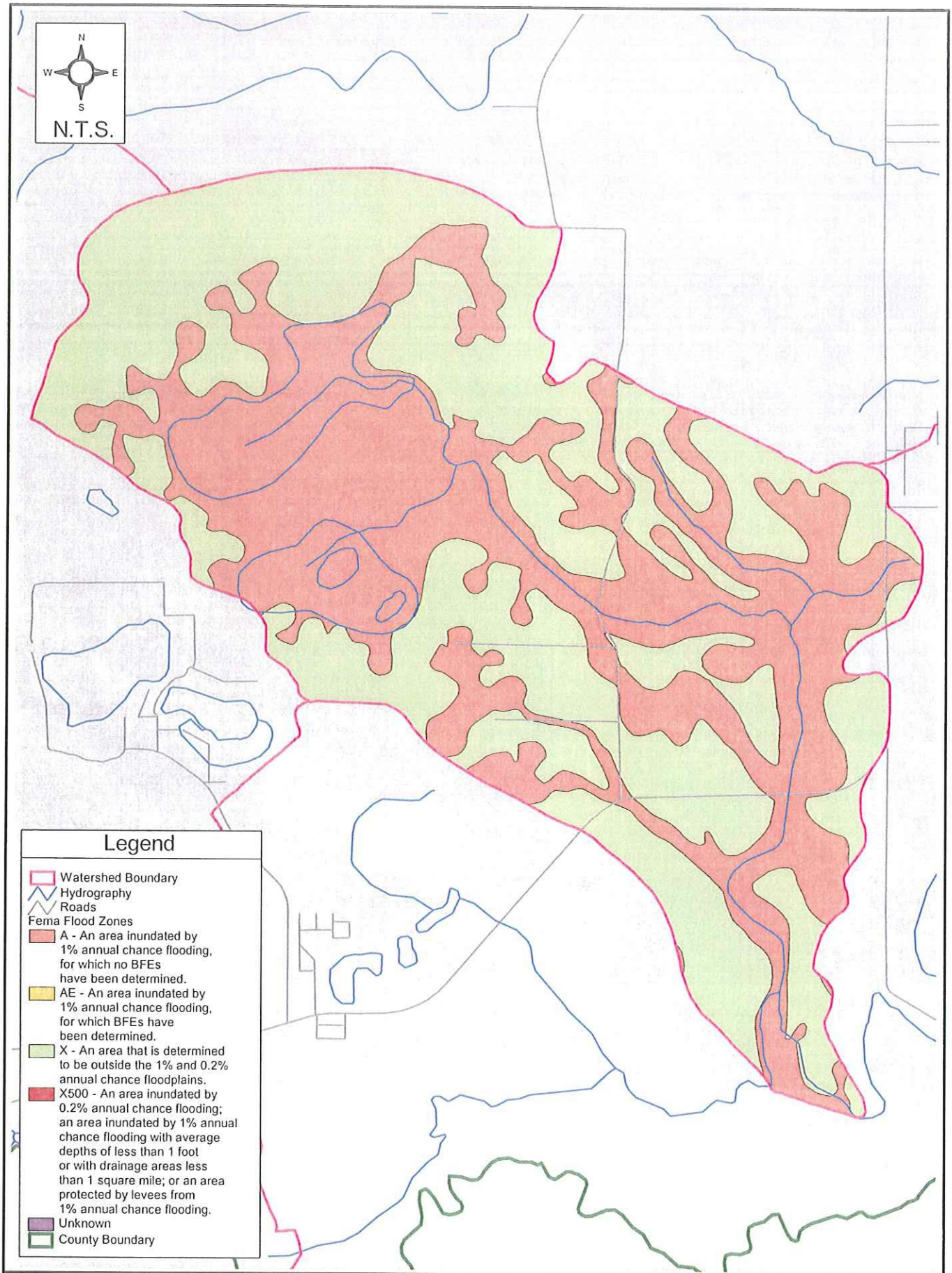


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Bruntbridge_brook.apr

Location of the Bruntbridge Brook Watershed
Putnam County Master Stormwater Plan

Figure 3.5.1-1

AYRES ASSOCIATES



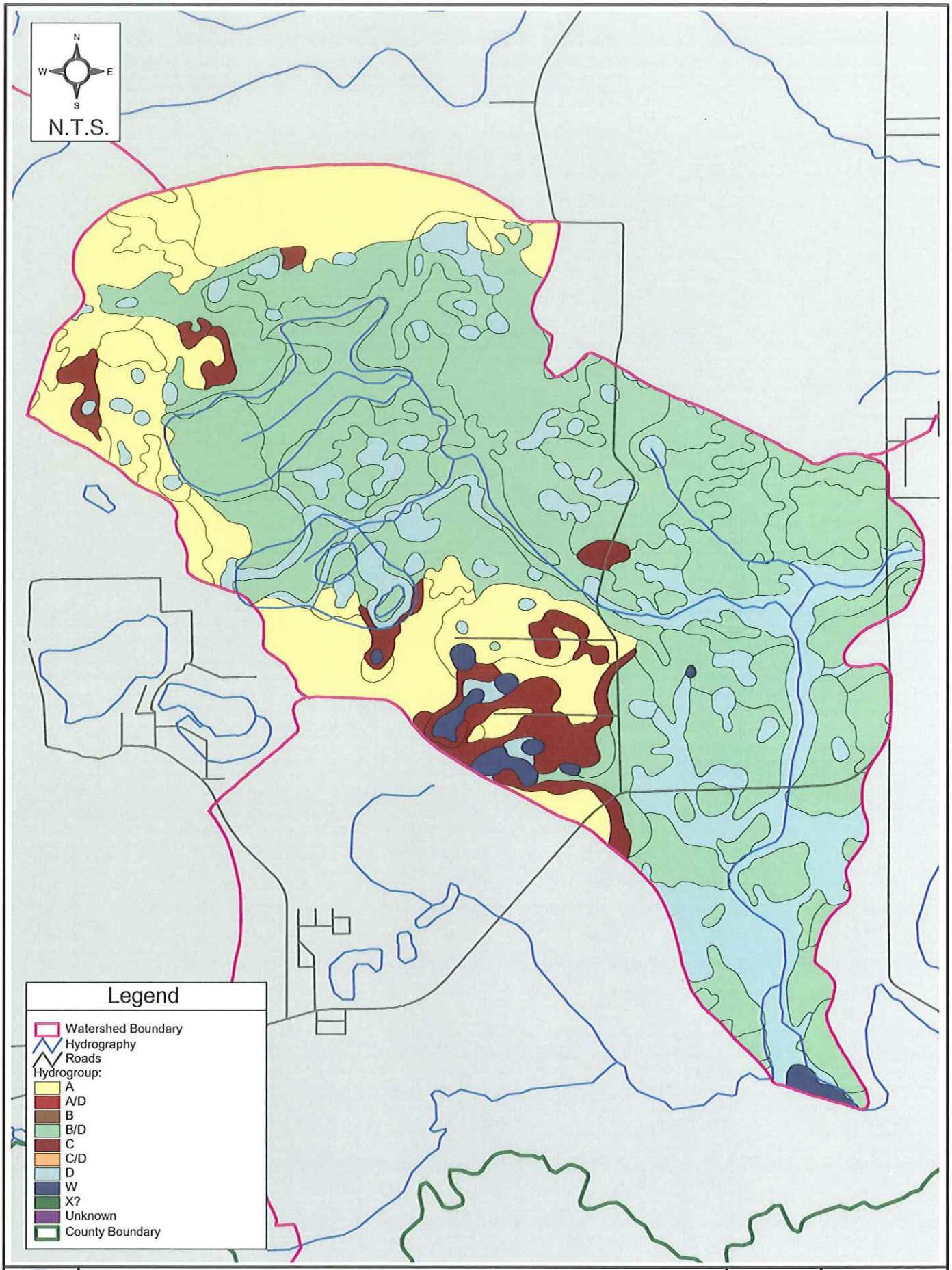
G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\Bruntbridge_brook.apr

FEMA Flood Zones in the Bruntbridge Brook Watershed

Putnam County Master Stormwater Plan

Figure 3.5.1-2

AYRES ASSOCIATES

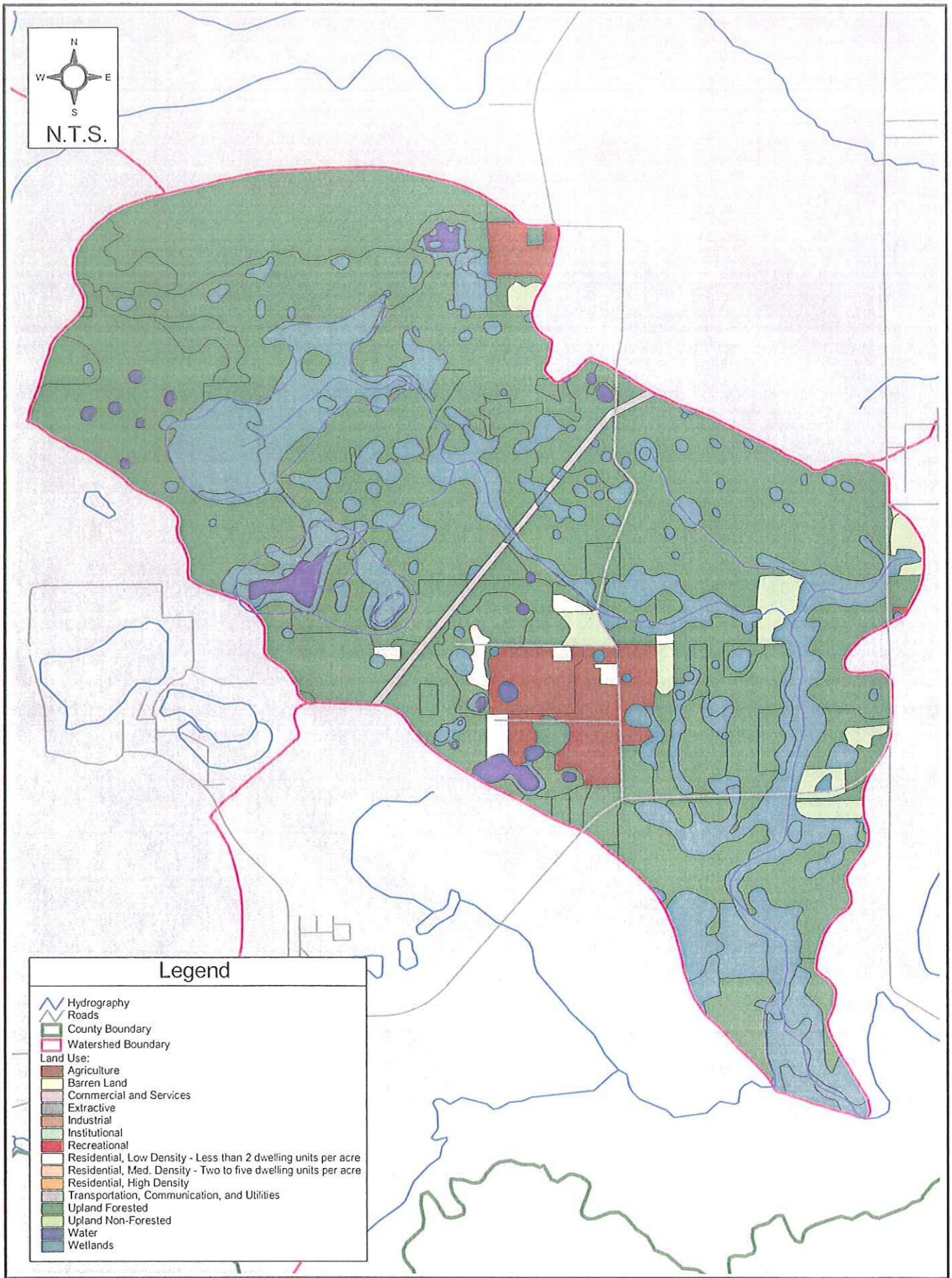


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Bruntbridge_brook.apr

Soils Distribution in the Bruntbridge Brook Watershed
Putnam County Master Stormwater Plan

Figure 3.5.1-3

AYRES ASSOCIATES



Land Use Distribution in the Bruntbridge Brook Watershed

G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\Bruntbridge_brook.apr

Putnam County Master Stormwater Plan

Figure 3.5.1-4

AYRES ASSOCIATES

3.5.2 CAMP BRANCH WATERSHED

The Camp Branch Watershed is comprised of 10.3 square miles, located in south-central Putnam County (Figure 3.5.2-1). It has not been divided into smaller subwatersheds and has not been selected for additional field study.

3.5.2.1 Physiography and Hydrology

This watershed is divided into a west and east portion by SR 19. The primary outfall, Camp Branch begins east of SR 19 and flows in a "U" pattern; first south, then east, and finally turning north for a total distance of roughly 4.7 miles to the St. Johns River. West of SR 19, roughly 168 acres of unnamed wetland drains southward via a small tributary through the U.S. Naval Bombing Range to the Ocklawaha River at Rodman Reservoir. Watershed elevations range from highs of roughly 30 feet NGVD in the north and western extent to elevations of less than 5 feet NGVD along the floodplain of the St. Johns River and Ocklawaha River.

There are no USGS streamflow gages located within this watershed. Nor are there any SJRWMD or NCDC rain gages located within the Camp Branch Watershed. One SJRWMD rain gage (Site 1697) is located nearby, in the adjacent Cross Florida Barge Canal Watershed.

3.5.2.2 FEMA Flood Zones

The western portion of the watershed (west of SR 19) is classified Zone A, area in the 100-year floodplain for which no base flood elevations have been determined, with some areas designated as Zone X, or area determined to be outside the 500-year floodplain. East of SR 19, the majority of the watershed is designated Zone X, with Zone A designations only along the stream channel and isolated depressions. Zone AE designations are found at the eastern end of the watershed, along the St. Johns River floodplain. Base flood elevations have been determined in these areas from St. Johns River flood stages. FEMA floodplain mapping for the Camp Branch Watershed is depicted on Figure 3.5.2-2.

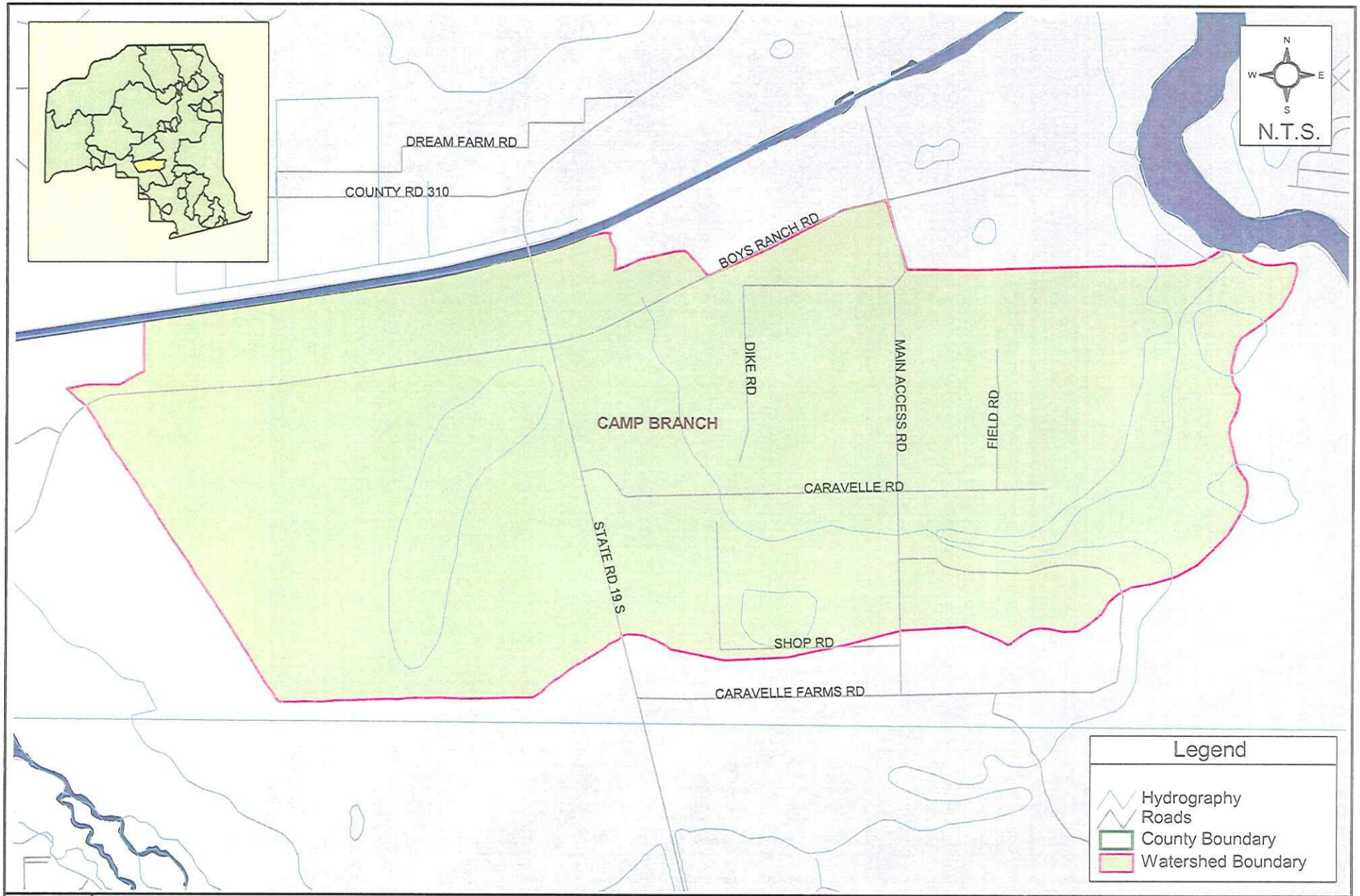
With the exception of the eastern portion associated with the St. Johns River floodplain, this area has not been studied in detail by FEMA. No channel flood profiles or stillwater flood elevations are reported for this watershed in the Putnam County FIS.

3.5.2.3 Soils

Figure 3.5.2-3 depicts the current hydrologic soil groups in the Camp Branch Watershed. The watershed is dominated by B/D and D soil classifications.

3.5.2.4 Land Use/ Land Cover

Figure 3.5.2- 4 depicts the current land use in the Camp Branch Watershed. The area is largely undeveloped with "Upland Forested" and "Upland Non-Forested" land uses occupying 58% of the total area. "Wetlands" occupy 26% of the watershed and "Agriculture" 13.5%.

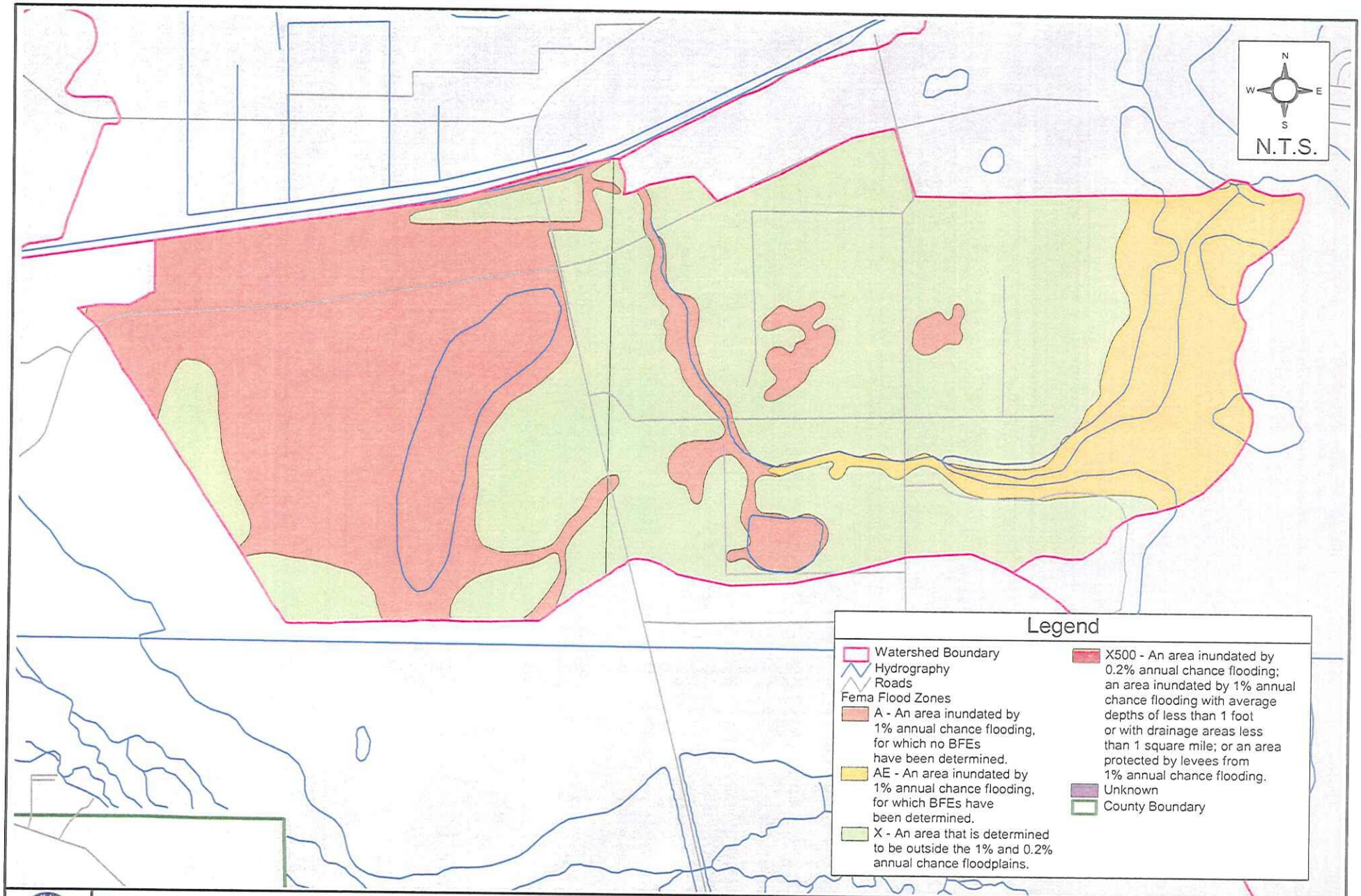


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Camp_Branch.apr

Location of the Camp Branch Watershed
Putnam County Master Stormwater Plan

Figure
3.5.2-1

AYRES ASSOCIATES



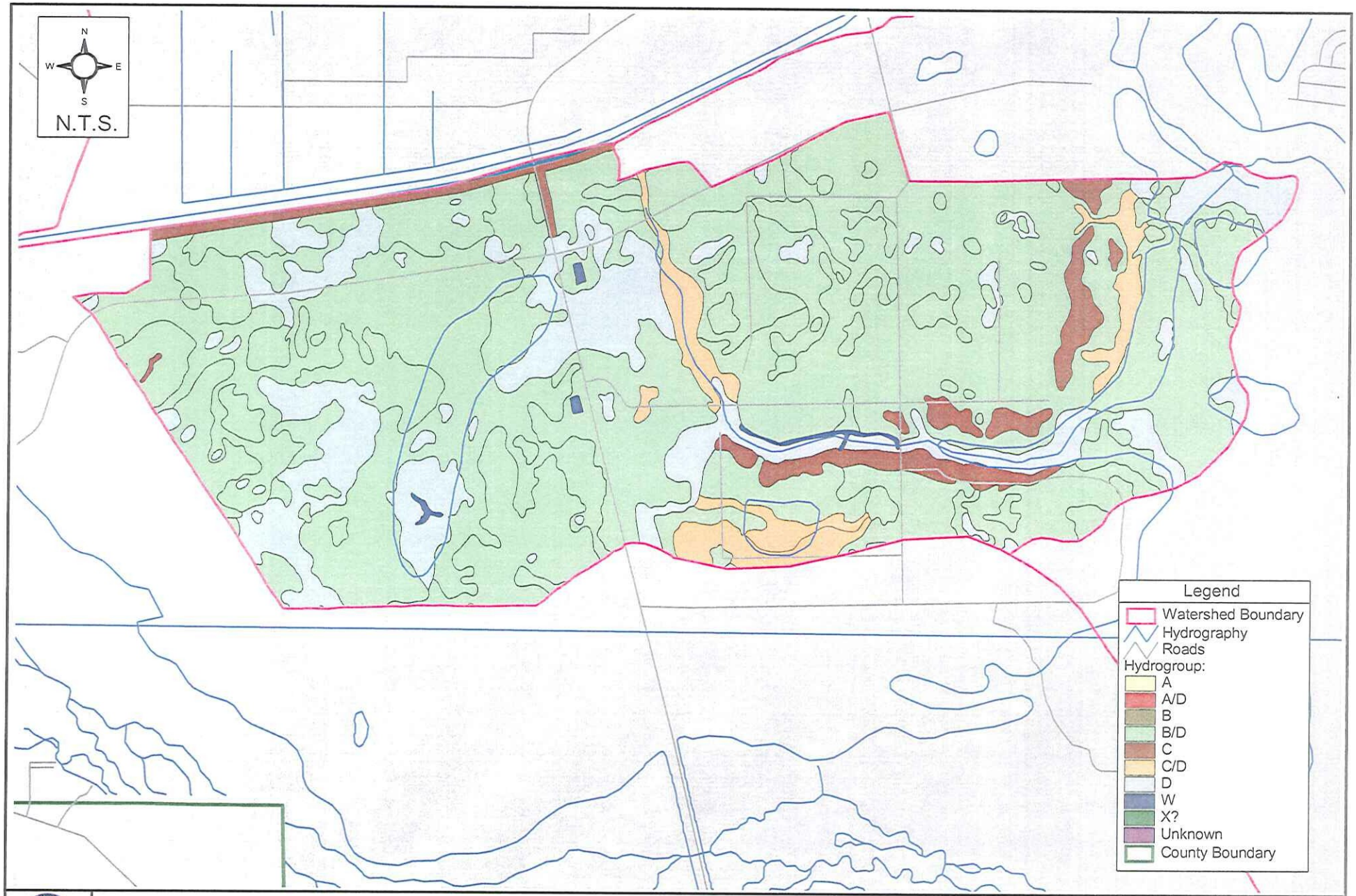
G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Camp_Branch.apr

FEMA Flood Zones in the Camp Branch Watershed

Putnam County Master Stormwater Plan

Figure 3.5.2-2

AYRES ASSOCIATES



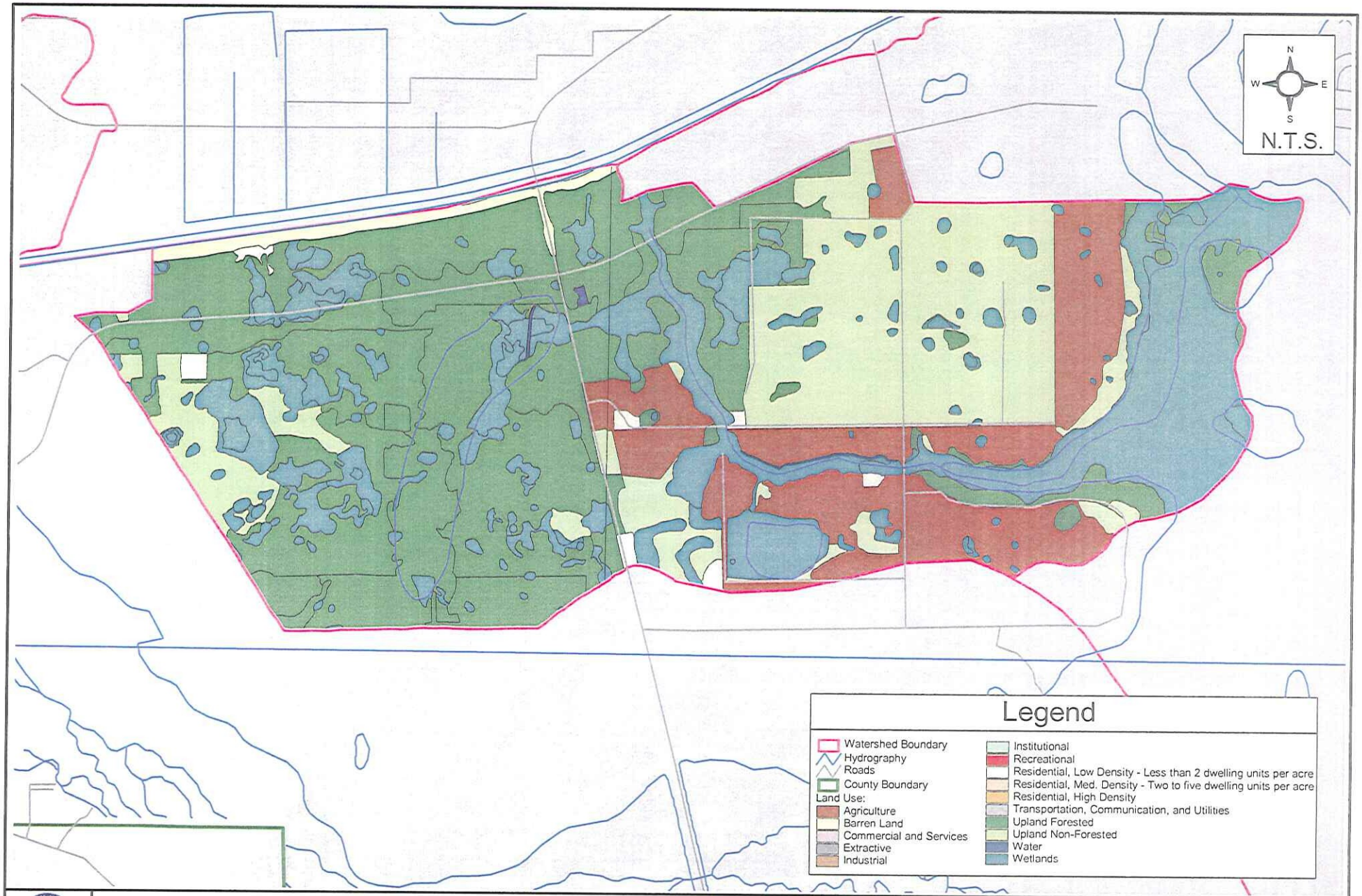
G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Camp_Branch.apr

Soils Distribution in the Camp Branch Watershed

Putnam County Master Stormwater Plan

Figure 3.5.2-3

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Camp_Branch.apr

Land Use Distribution in the Camp Branch Watershed
Putnam County Master Stormwater Plan

Figure
3.5.2-4

AYRES ASSOCIATES

3.5.3 CROSS FLORIDA BARGE CANAL WATERSHED

The Cross Florida Barge Canal Watershed is comprised of 17.2 square miles, located in south-central Putnam County (**Figure 3.5.3-1**). It has not been divided into smaller subwatersheds and has not been selected for additional field study.

3.5.3.1 Physiography and Hydrology

The primary water feature is the 6.3-mile segment of the Cross Florida Barge Canal which connects the Rodman Reservoir to the St. Johns River near Satsuma, Florida. The watershed itself, however is sloped to drain internally to the large wetland in its north and central region, Cow Heaven Bay. Cow Heaven Bay is hydraulically connected to the adjacent Deep Creek primary watershed through a tributary pop-off from Sweetwater Creek; and to the Etonia Creek DPU's Rice Creek Swamp by the Camp Branch tributary. Topography in this watershed is very mildly sloped with high elevations on the west and south boundaries of roughly 30 feet NGVD. Cow Heaven Bay is extremely flat at an elevation of 20+ to 21 feet NGVD. The outlet for the wetland is the SR 19 cross drain located in the southeast corner of the watershed. Overflow from Cow Heaven Bay would empty into the Cross Florida Barge Canal to the east of the SR 19 Bridge.

There is one USGS streamflow gage located within this watershed, "Cross Florida Barge Canal at Buckman Lock near Palatka," Gage No. 02244032. The contributing drainage area at the gage is not reported by USGS, as it is simply an engineered conveyance between two natural drainage systems. Recorded data at this gage is available from 1970 through 2002. Monthly mean streamflow data reflect a minimum flow value of 0 cfs (while the lock was out of use) and a maximum monthly mean value of 98.2 cfs. There is relatively little variation in this controlled system. Average mean monthly streamflow for this period is 37.8 cfs.

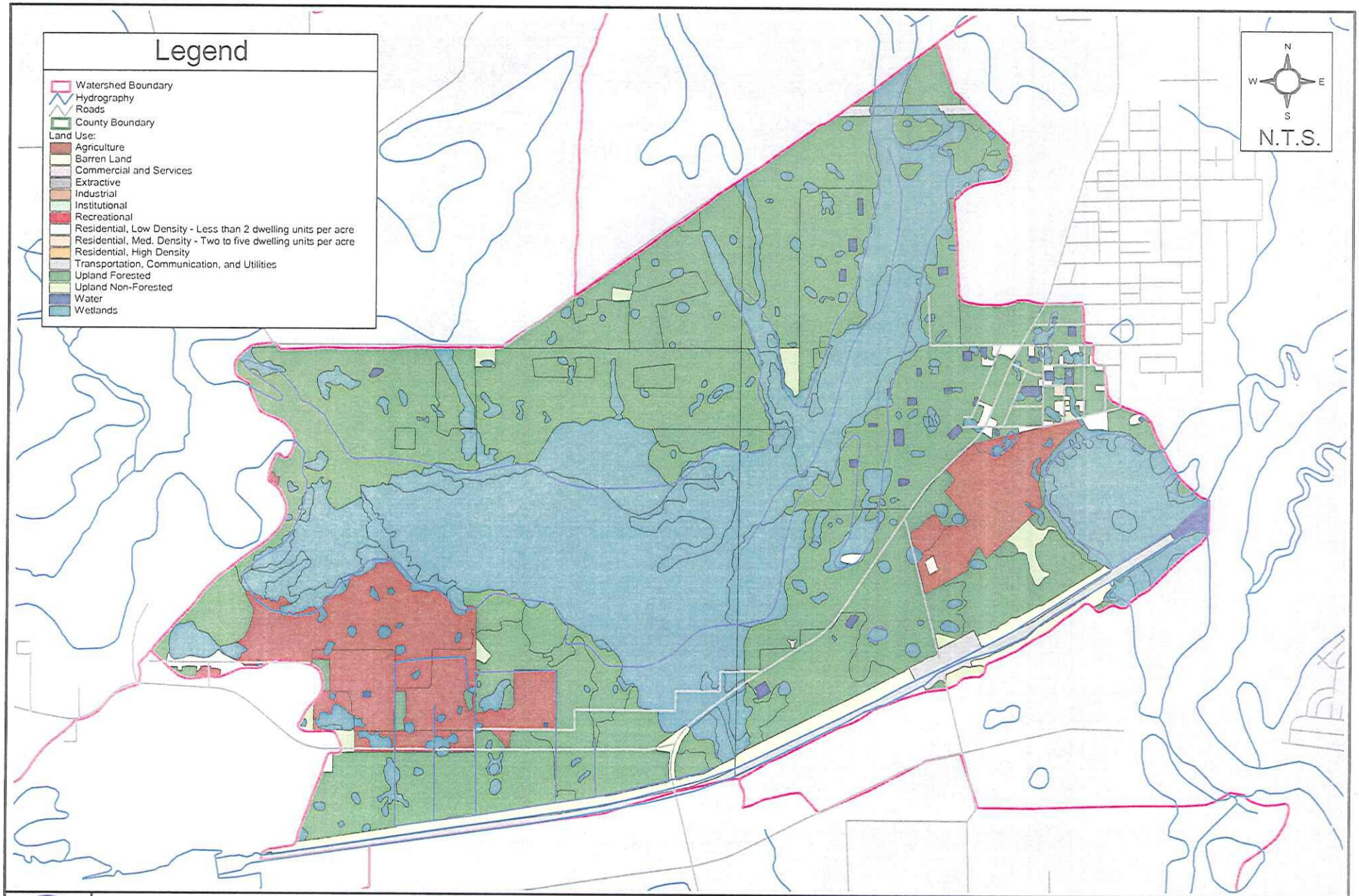
There is one SJRWMD rain gage within the Cross Florida Barge Canal Watershed, co-located with the USGS streamflow gage. The SJRWMD "Buckman Lock" (Gage 1697) offers continuous rainfall records from May 2002 to the present.

3.5.3.2 FEMA Flood Zones

The upland areas of the Cross Florida Barge Canal Watershed are classified Zone X, or area determined to be outside the 500-year floodplain. Cow Heaven Bay, the north bank of the western portion of the canal, and tributary stream channels are designated as Zone A, lying in the 100-year floodplain for which no base flood elevations have been determined. The proportion of Zone A and Zone X areas are nearly equal. FEMA floodplain mapping is depicted on **Figure 3.5.3-2**. None of the watershed has been studied by FEMA in detail.

3.5.3.3 Soils

Underlying soils are predominantly classified as B/D (54%) and D (28.5%) due to a high groundwater table. There are smaller pockets of C and A classification soils. **Figure 3.5.3-3** depicts the current hydrologic soil groups in the Cross Florida Barge Canal Watershed.



G:\COUNTY - PUTNAM\
67011000\PutnumCoSWMMP\\GIS\
APRs\Watershed Maps\XFL_BargeCanal.apr

Land Use Distribution in the Cross Florida Barge Canal Watershed
Putnam County Master Stormwater Plan

Figure
3.5.3-4

AYRES ASSOCIATES

3.5.4 DEEP CREEK WATERSHED

The Deep Creek Watershed is comprised of 55 square miles, located in west Putnam County (Figure 3.5.4-1). The Deep Creek Watershed includes the following ten (6) subwatersheds:

1. Alligator Creek
2. Deep Creek
3. Gum Creek
4. Poley Branch
5. Sweetwater Creek*
6. The Slash

Subwatersheds identified with an asterisk (*) have been selected for additional studies that are described in later subsections.

3.5.4.1 Physiography and Hydrology

The primary outfall, Deep Creek, flows southeast for a distance of roughly 7 miles, beginning at the shared headwaters of Cabbage Creek to the west, and outfalls to the Ocklawaha River on the north side of the Rodman Reservoir. The Gum Creek tributary drains 11.3 square miles, including portions of the City of Interlachen, and joins Deep Creek approximately 0.7 miles downstream of the County Road 315 Bridge. These two streams convey drainage from 43% of the Deep Creek Watershed.

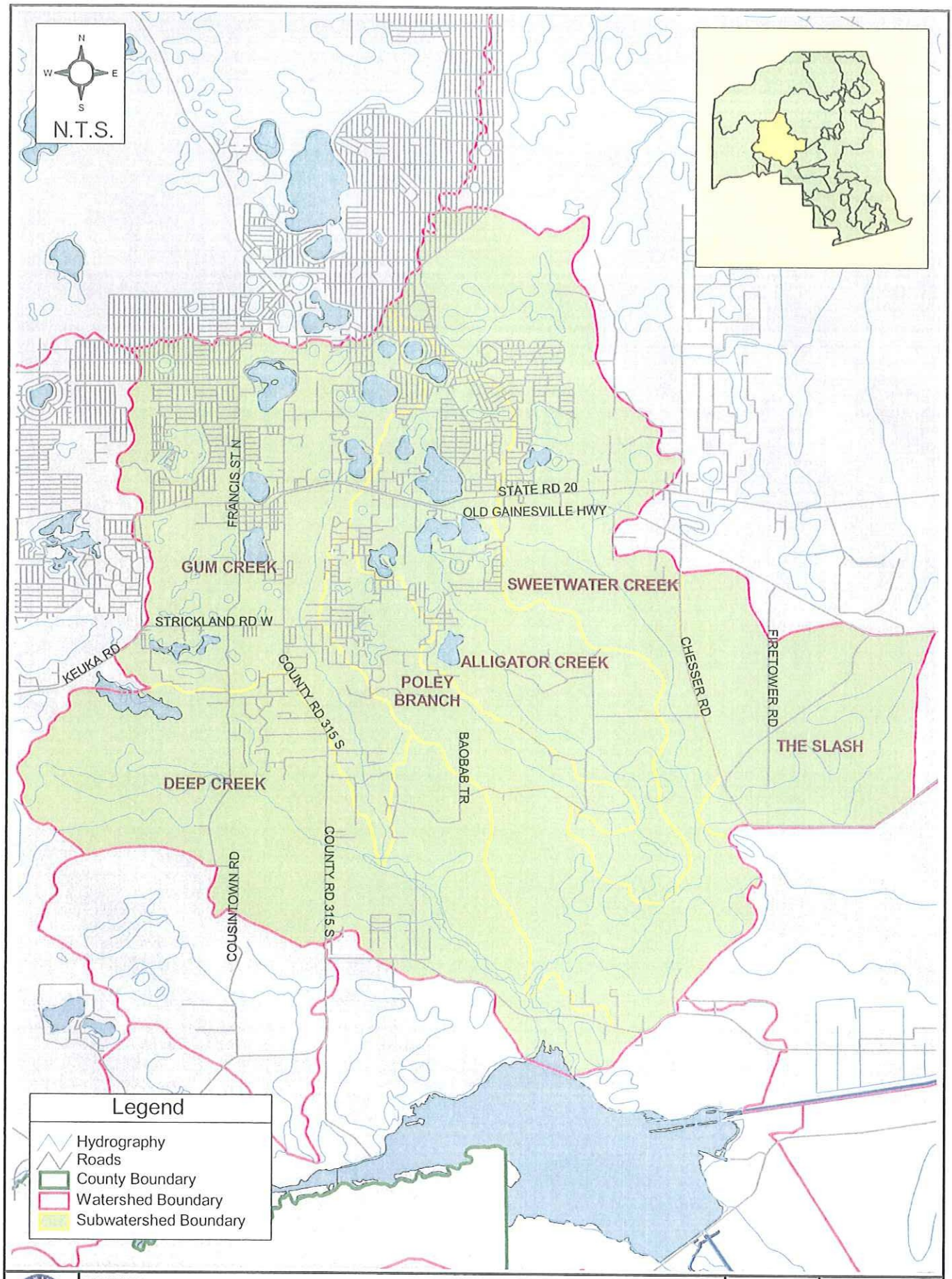
Sweetwater Creek drains roughly 57% of the Deep Creek Watershed and discharges to Deep Creek just one-half mile upstream of Ocklawaha Lake. Tributaries to the southward flowing Sweetwater Creek are Poley Branch, Alligator Creek and the Slash.

The watershed slopes from north to south, with high elevations along the northern boundary in Interlachen of 150 feet NGVD. At the Ocklawaha Lake (Rodman Reservoir) outfall, elevations are roughly 20 feet NGVD.

There are no USGS streamflow gages located within this watershed. Nor are there any SJRWMD or NCDC rain gages located within the Deep Creek Watershed.

3.5.4.2 FEMA Flood Zones

The majority of this watershed is classified Zone X, or area determined to be outside the 500-year floodplain. Along Deep Creek, Sweetwater Creek, and their significant tributaries there are consistent strips of land designated Zone A or AE. Areas in Zone A lie in the 100-year floodplain for which no base flood elevations have been determined. Areas in Zone AE lie in the 100-year floodplain where base flood elevations have been determined. Other areas of Zone A and AE surround the small lakes in the northwestern portion of the watershed. FEMA floodplain mapping is depicted on Figure 3.5.4-2.

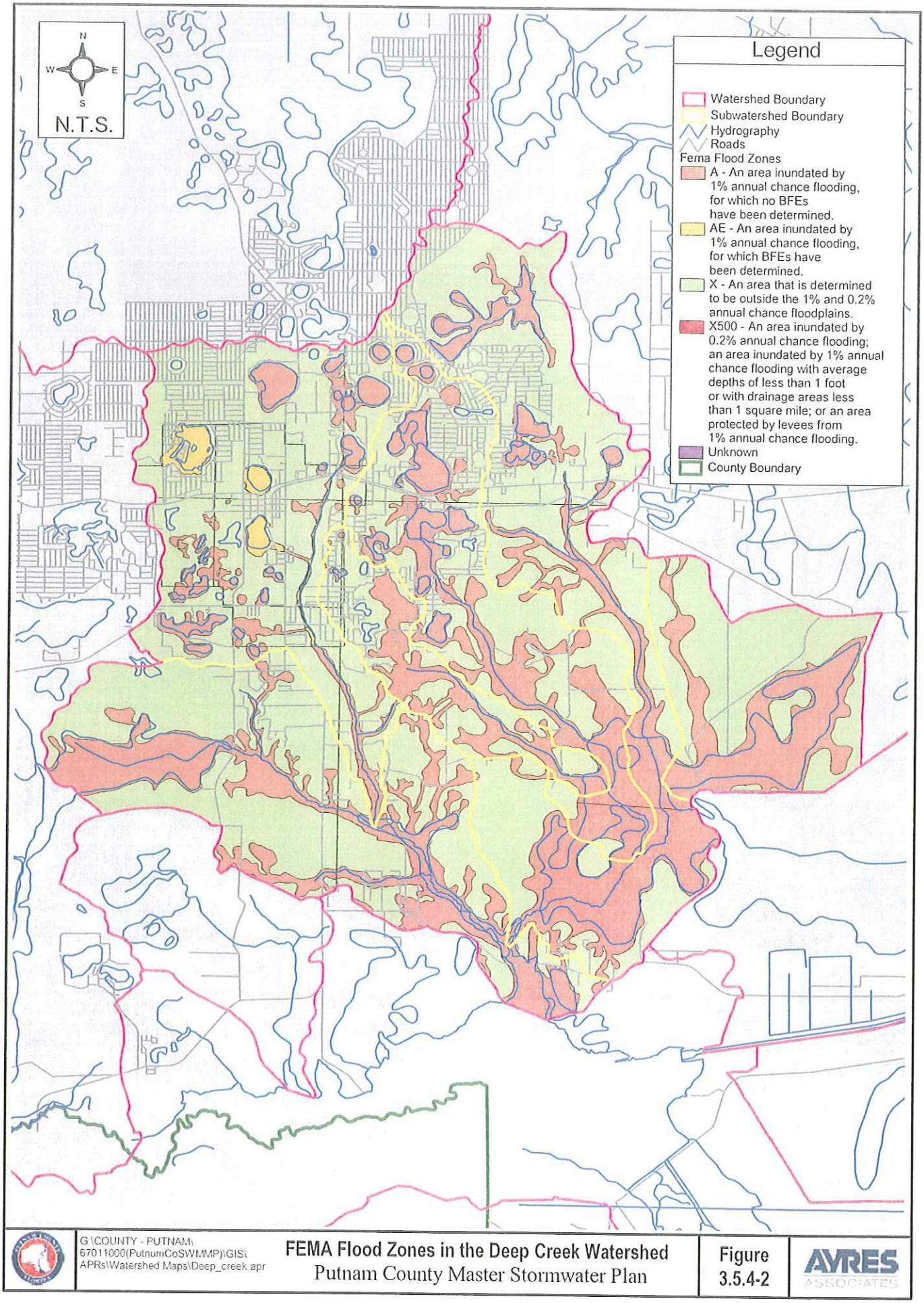


G:\COUNTY - PUTNAM\ 67011000(PutnumCoSWMMP)\GIS\ APRs\Watershed Maps\Deep_creek.apr

Location of the Deep Creek Watershed
Putnam County Master Stormwater Plan

Figure 3.5.4-1

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\Deep_creek.apr

FEMA Flood Zones in the Deep Creek Watershed
Putnam County Master Stormwater Plan

Figure 3.5.4-2

AYRES ASSOCIATES

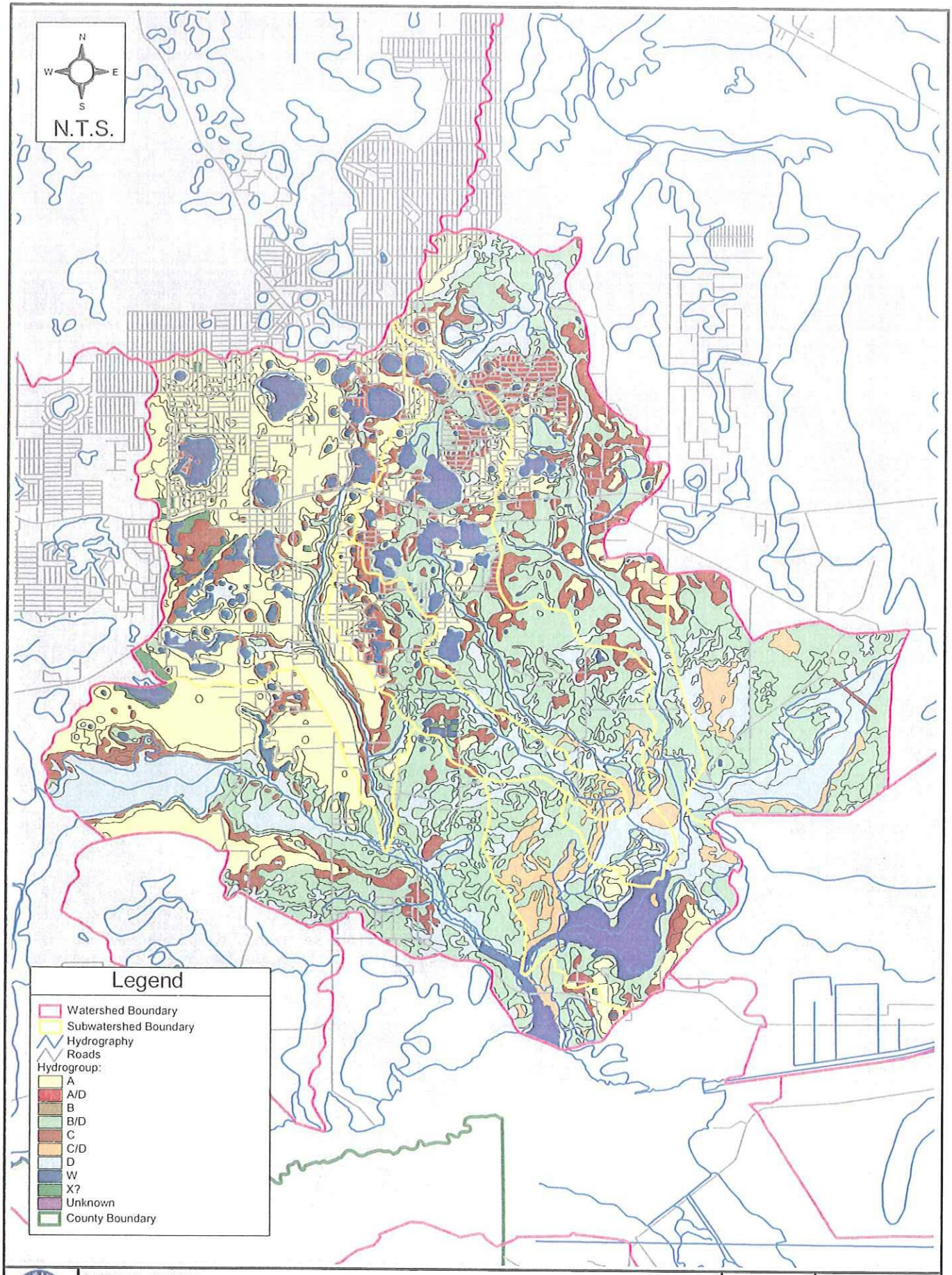
Additionally, as part of the Town of Interlachen, Florida FIS, Gum Creek has been studied in detail from the southernmost town limit (0.3 miles downstream of the Sleepy Hollow Road crossing) to the gas line crossing 1.75 miles upstream. Gum Creek stream profile graphs are located in the Town of Interlachen FIS provided in **Appendix 3-A** of this SMP. Stillwater flood elevations for various return frequencies are also provided in the Town of Interlachen FIS for Grassy Lake, Lake Chipco and Lake Lagonda.

3.5.4.3 Soils

Figure 3.5.4-3 depicts the current hydrologic soil groups in the Deep Creek Watershed. Although more varied in hydrologic soil classifications than many other Putnam County watersheds, the Deep Creek Watershed still exhibits a higher proportion of B/D soils compared to other HSG classifications. Within the watershed, B/D soils represent 34% of the area, with A, D and C classifications covering 27%, 19% and 10%, respectively.

3.5.4.4 Land Use/ Land Cover

Roughly 76% of the watershed is comprised of undeveloped land uses (water, wetland, forested or non-forested uplands, open lands). Significant "Residential" land use (16% of the area) is concentrated near the Town of Interlachen. "Agriculture" accounts for 5% of the Deep Creek Watershed development. **Figure 3.5.4- 4** depicts the current land use in the Deep Creek Watershed.

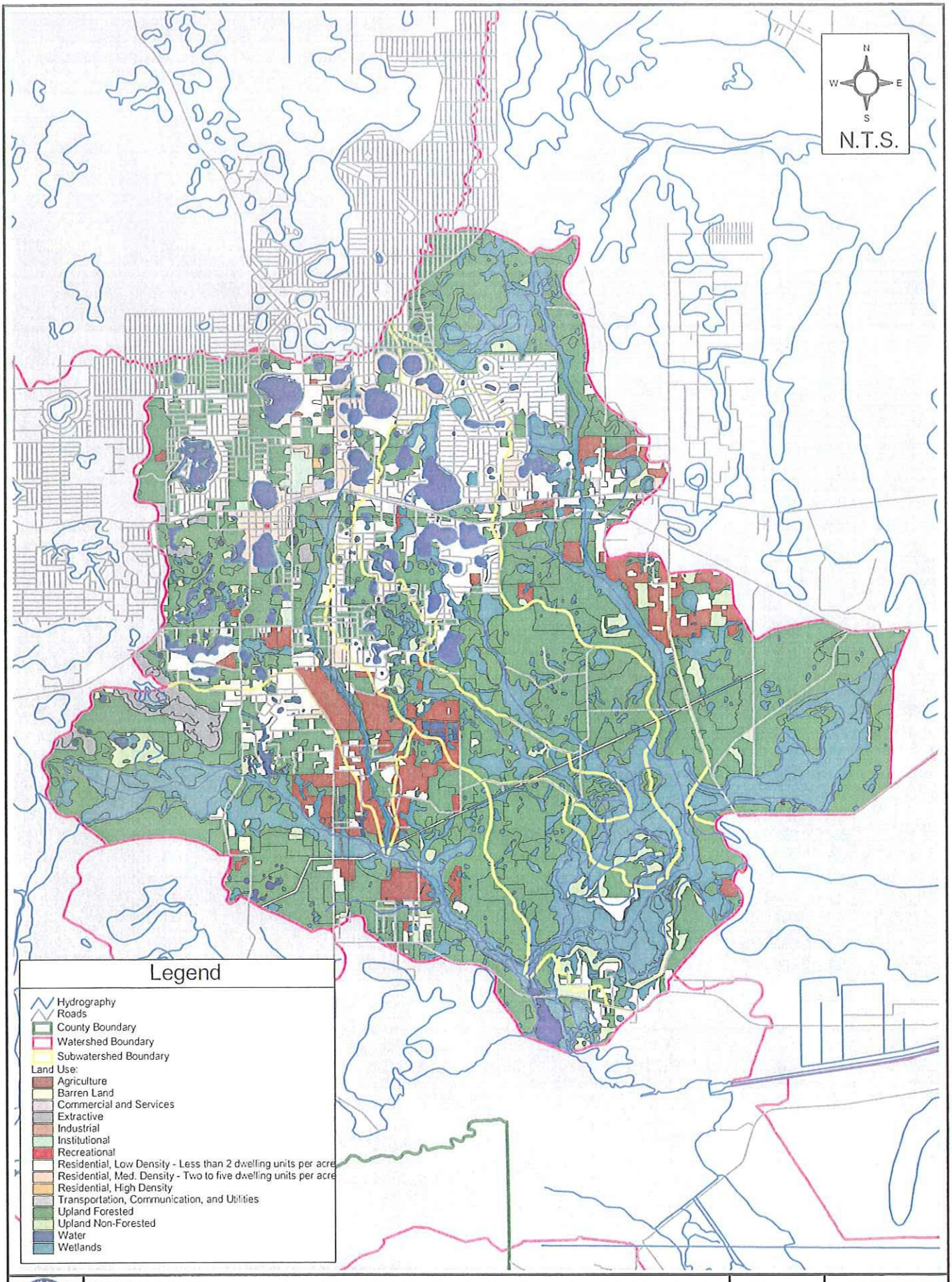


G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\Deep_creek.apr

Soils Distribution in the Deep Creek Watershed
Putnam County Master Stormwater Plan

Figure 3.5.4-3

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Deep_creek.apr

Land Use Distribution in the Deep Creek Watershed
Putnam County Master Stormwater Plan

Figure 3.5.4-4

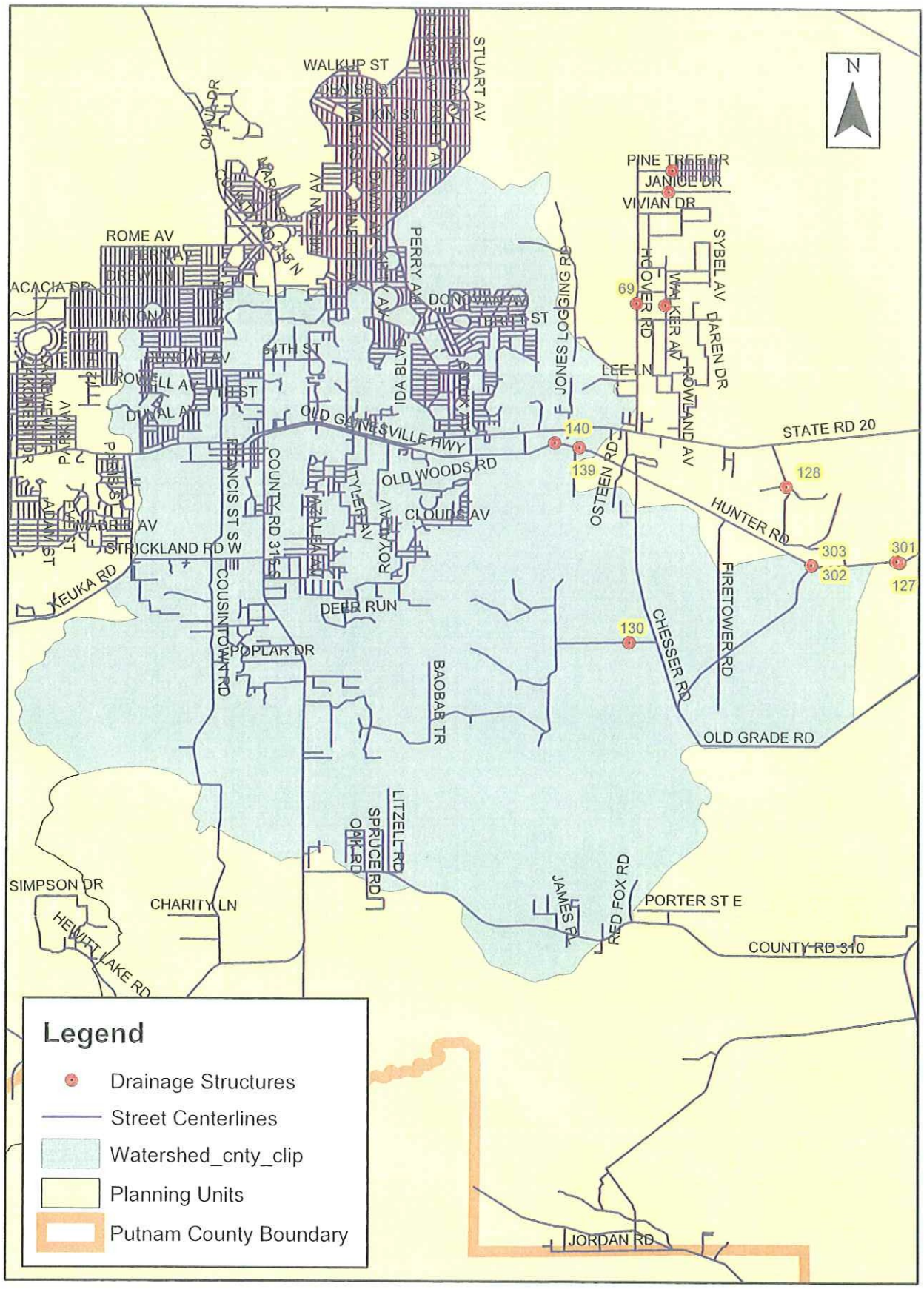
AYRES ASSOCIATES

3.5.4.5 Field investigations in Selected Subwatersheds

The field reconnaissance program described in Section 2.10 was performed for the selected Deep Creek subwatershed, Sweetwater Creek, as illustrated on the following index figure. No modifications to basin delineations resulted from field investigations. Field reports for hydraulic structures and photo documentation from the investigation is presented in **Appendix 3-B**. These data have been incorporated into a GIS database for County use.

3.5.4.6 Sewer Network and Point Source Discharge

Sewer networks and point source discharges in this watershed have not been identified by the County. A search of FDEP permitted point source discharges and industrial stormwater dischargers was performed and no permitted point source discharges were found in the Deep Creek Watershed.



Field Reconnaissance - Deep Creek Watershed

3.5.5 OCKLAWAHA RIVER WATERSHED

The Rodman Reservoir DPU's Ocklawaha River Watershed covers 97.3 square miles in Marion and Putnam Counties. The downstream-most portion, comprised of 32.1 square miles, is located in south Putnam County (Figure 3.5.5-1). It has not been divided into smaller subwatersheds as has not been selected for field investigation.

3.5.5.1 Physiography and Hydrology

The primary outfall of this watershed is the Ocklawaha River. The Rodman Reservoir DPU portion of this river begins in Marion County at State Highway 40 and flows northward for an approximate distance of 23 miles into Putnam County. The Putnam County portion of this watershed is primarily comprised of Ocklawaha Lake/Rodman Reservoir and the outfall reach from the Rodman Dam to the St. Johns River. The contributing watershed north of the Rodman reservoir has a moderate, southward slope from elevations of 50 feet NGVD to 20 feet NGVD. Much steeper watershed slope toward the north is seen on the south side of the reservoir, where topographic high elevations are roughly 150 feet NGVD and drop rapidly to elevations of 30 feet NGVD.

There is one USGS streamflow gage located within this watershed, 02243960 "Ocklawaha River at Rodman Dam near Orange Springs." The contributing drainage area at the gage is estimated by USGS to be 2,747 square miles. Monthly mean streamflow data collected from 1968 through 2003 reflect a range from 310 cfs to 5,432 cfs, with an average mean monthly streamflow 1,306 cfs. The highest mean monthly flows are typically seen in January to April (associated with frontal system rainfall) and September (associated with wet-season tropical and convective storms). Lowest mean monthly flows are exhibited in May, June and November.

There are no SJRWMD or NCDC rain gages located within the Putnam County portion of the Ocklawaha River Watershed.

3.5.5.2 FEMA Flood Zones

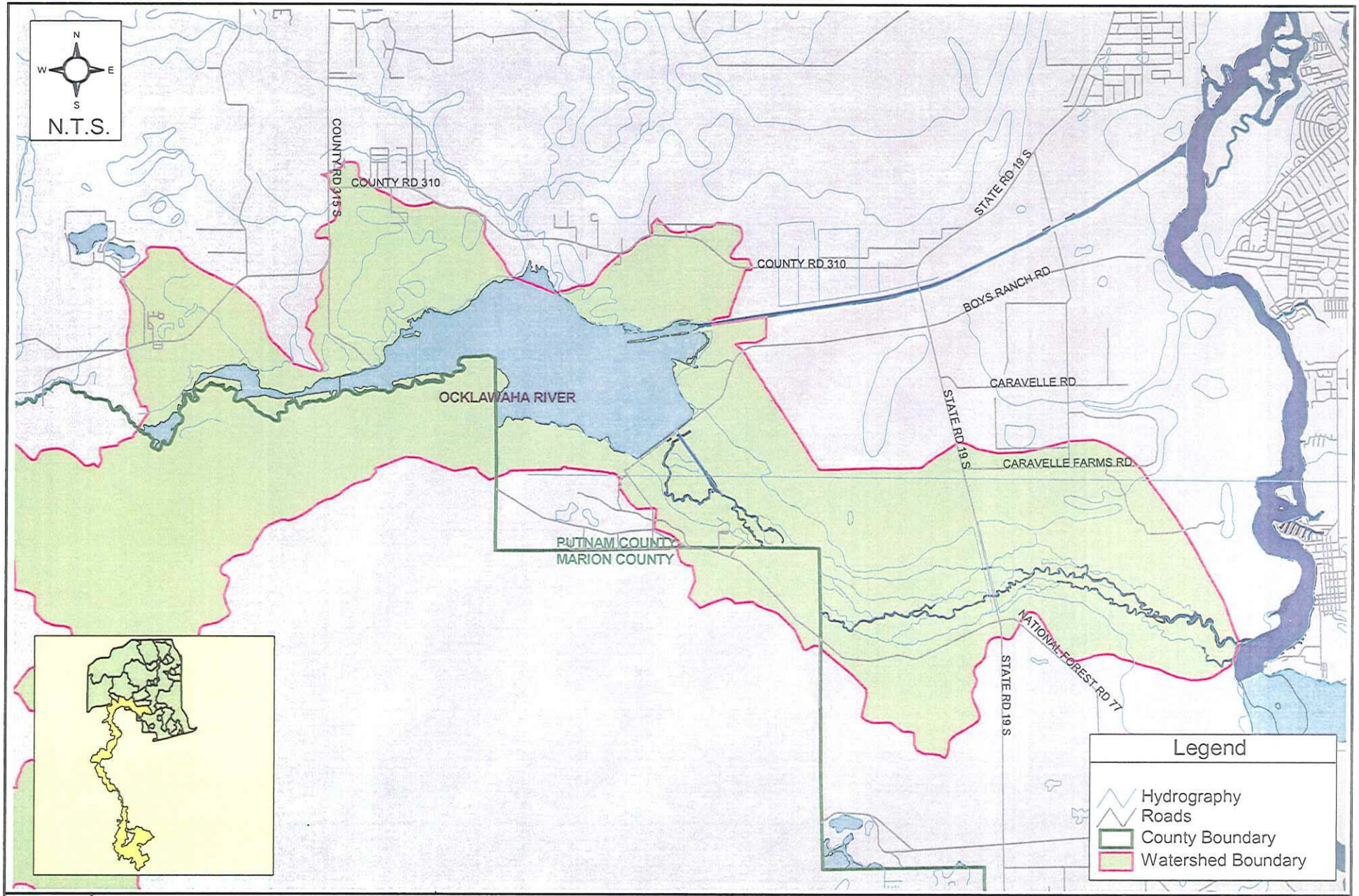
The majority of this watershed is classified Zone A, area that lies in the 100-year floodplain for which no base flood elevations have been determined. On the eastern end of the watershed, within the floodplain of the St. Johns River, areas are designated as Zone AE, lying in the 100-year floodplain where base flood elevations have been determined. In upland pockets and at near the upland watershed boundaries Zone X designations may be found, signifying area determined to be outside the 500-year floodplain. FEMA floodplain mapping is depicted on Figure 3.5.5-2.

3.5.5.3 Soils

Figure 3.5.5-3 depicts the current hydrologic soil groups in the Ocklawaha River Watershed. For the Putnam County portion, the B/D soil classification is most prevalent, followed by D (hydric) soils and W (water). Well drained, A soils comprise 9% of the Putnam County watershed area.

3.5.5.4 Land Use/ Land Cover

Less than 3% of the Putnam County watershed area is represented by developed land uses (agriculture, residential, commercial, etc). "Wetland" and "Water" land use designations cover 47% and 15% of the Putnam County watershed area, respectively. "Upland Forested" land use occupies 30.5% of the Ocklawaha River Watershed area within Putnam County. **Figure 3.5.5-4** depicts the current land use in the Ocklawaha River Watershed.

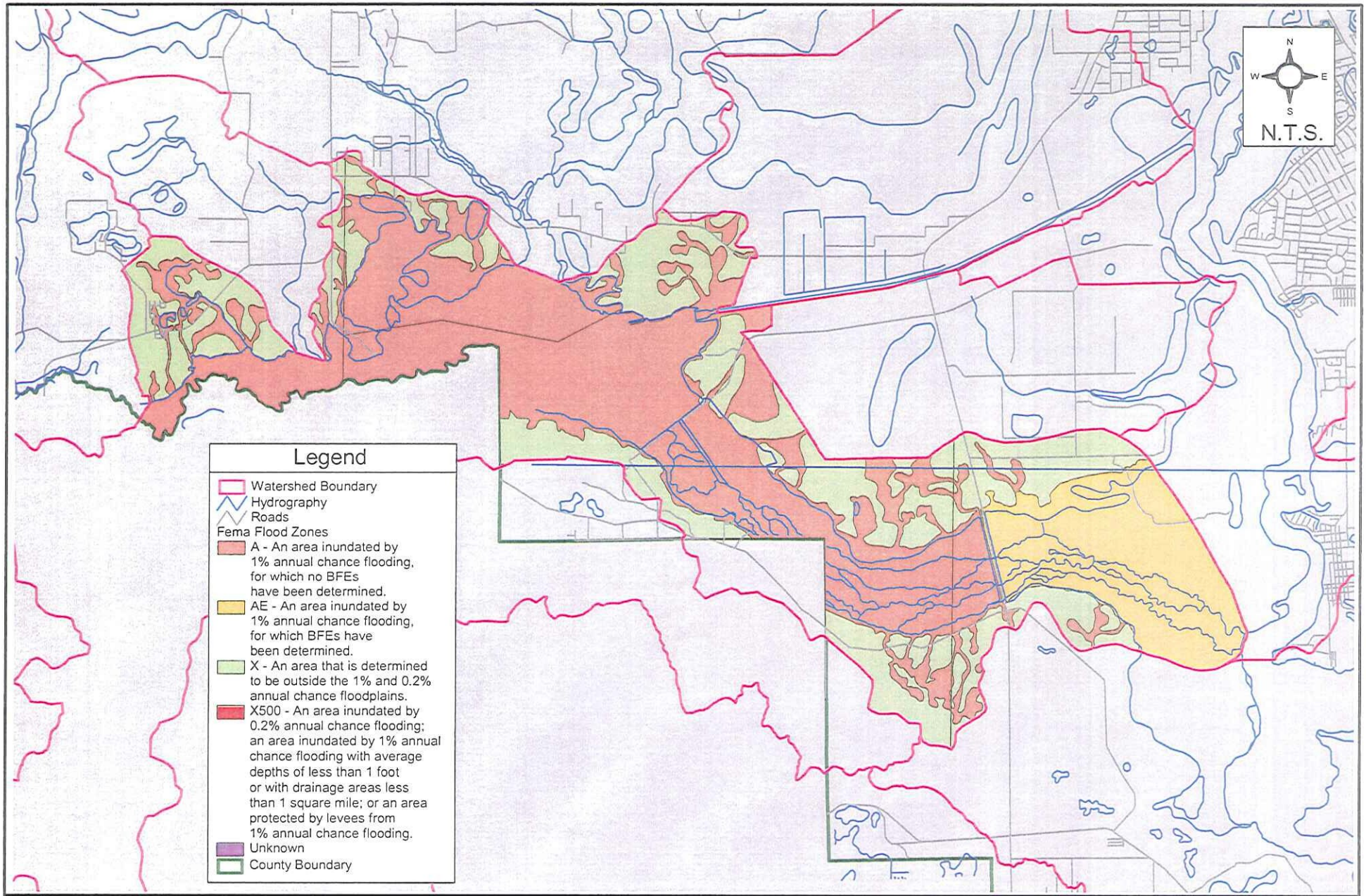


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Ocklawaha_River.apr

Location of the Ocklawaha River Watershed
Putnam County Master Stormwater Plan

Figure 3.5.5-1

AYRES ASSOCIATES



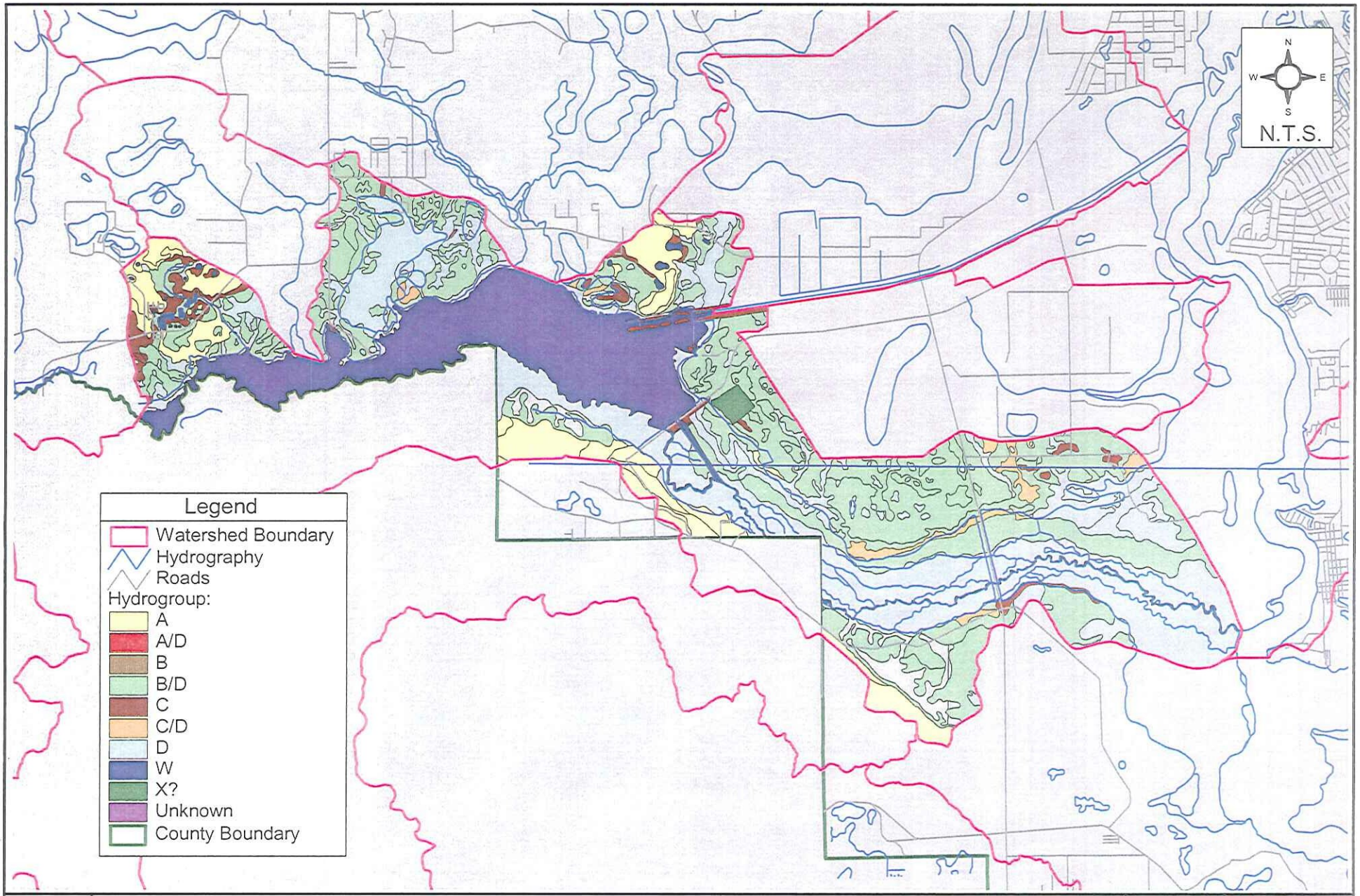
G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Ocklawaha _River.apr

FEMA Flood Zones in the Ocklawaha River Watershed

Putnam County Master Stormwater Plan

Figure
3.5.5-2

AYRES ASSOCIATES

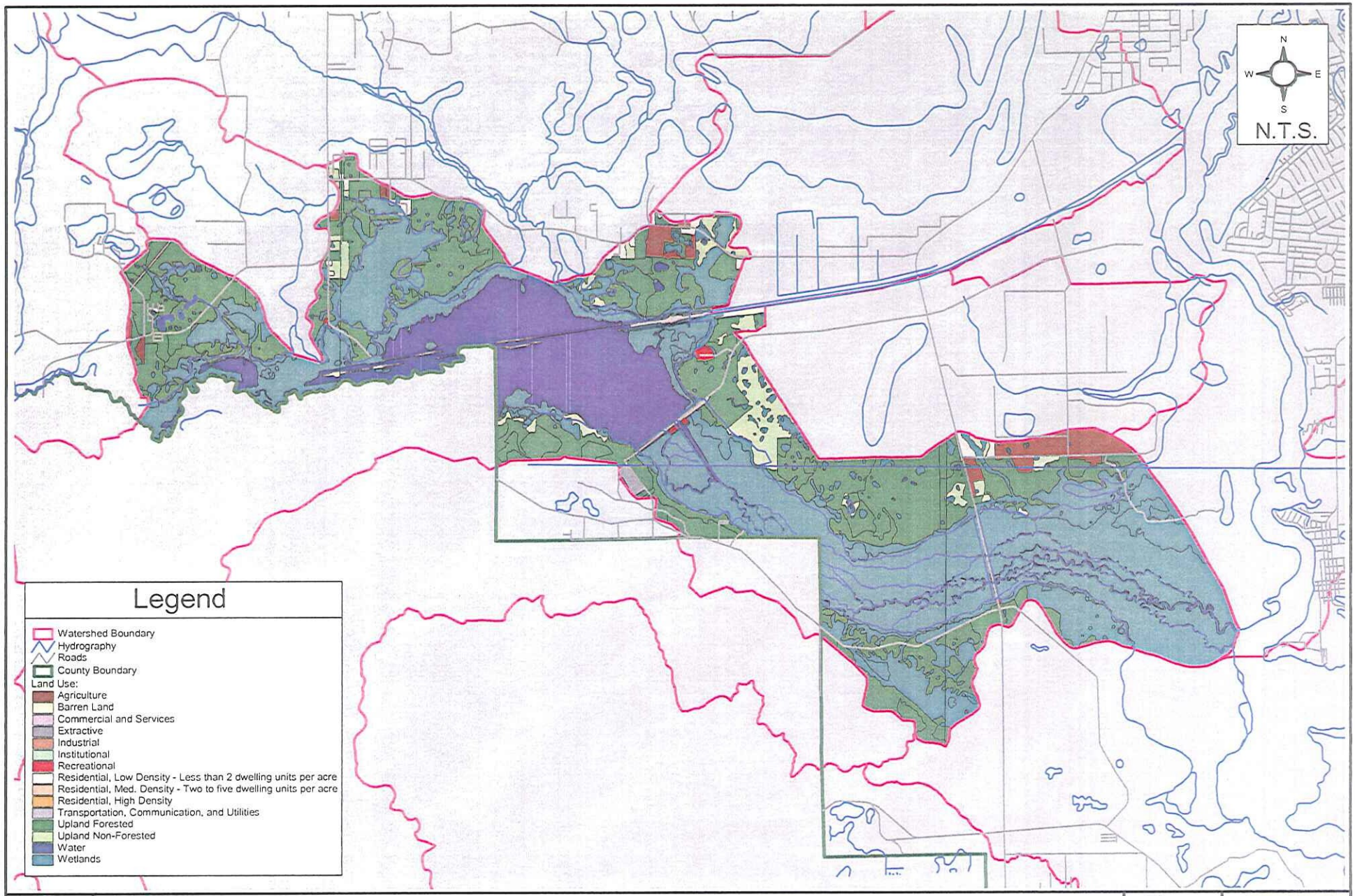


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Ocklawaha_River.apr

Soils Distribution in the Ocklawaha River Watershed
Putnam County Master Stormwater Plan

Figure
3.5.5-3

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Ocklawaha_River.apr

Land Use Distribution in the Ocklawaha River Watershed
Putnam County Master Stormwater Plan

Figure
3.5.5-4

AYRES ASSOCIATES

3.6 LAKE GEORGE DRAINAGE PLANNING UNIT

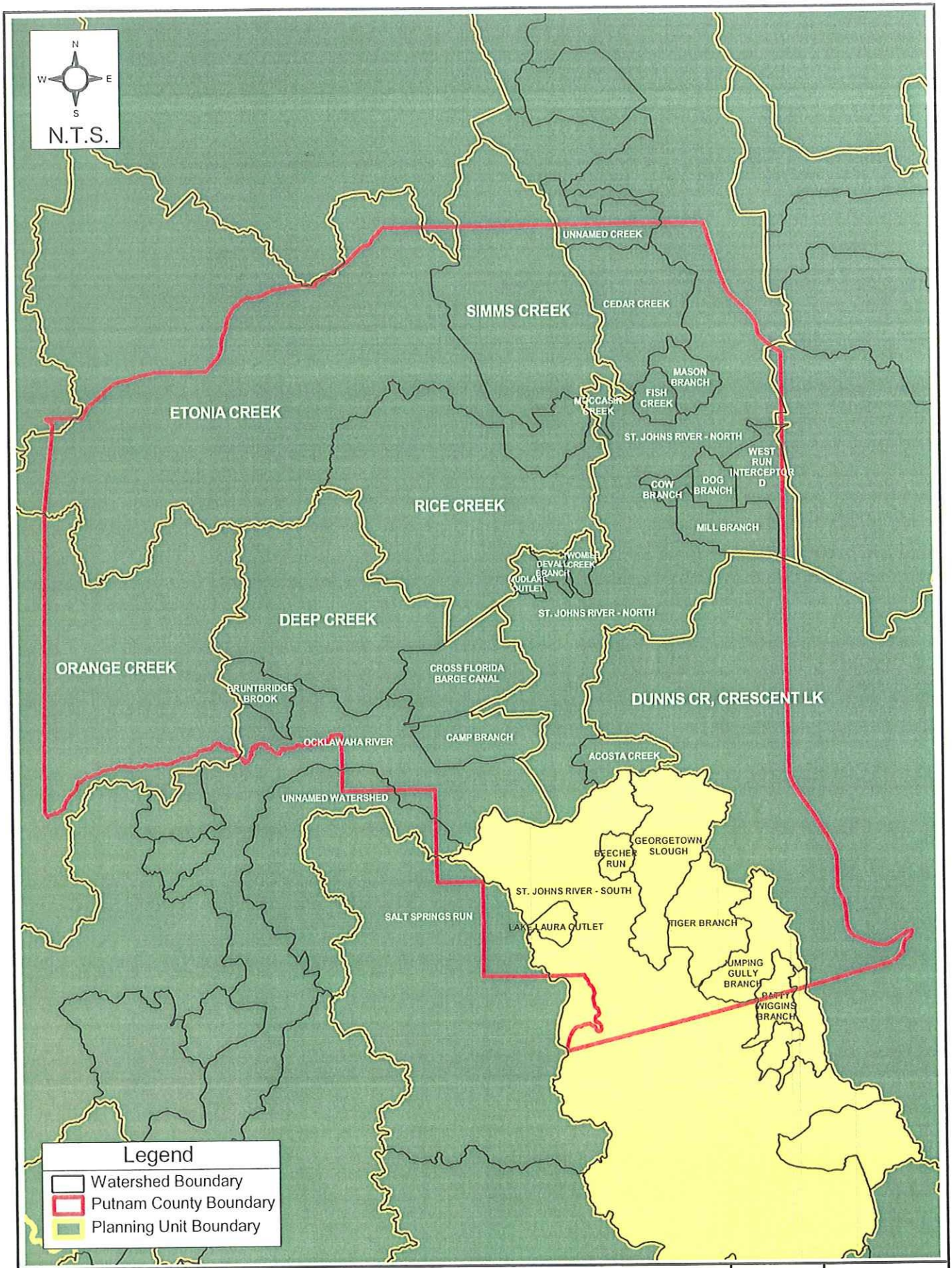
The Lake George Drainage Planning Unit (DPU) contains 251.8 square miles across Volusia and Putnam Counties, with small portions lying in Marion and Lake Counties. Of the total land area, 101.2 square miles lie in Putnam County. **Figure 3.6-1** depicts the Lake George DPU and its associated watersheds. According to the watershed designation developed by SJRWMD, the Lake George DPU contains seven (7) primary watersheds that are located in whole or in part within Putnam County:

- Beecher Run
- Georgetown Slough
- Jumping Gully Branch
- Lake Laura Outlet
- Patty Wiggins Branch
- St. Johns River
- Tiger Branch

Table 3.6-1 presents a breakdown of existing land use and hydrologic soil group distribution for the Putnam County Portion of the Lake George DPU.

TABLE 3.6-1 LAND USE AND SOILS SUMMARY FOR LAKE GEORGE DPU

Land Use	Distribution %	Hydrologic Soil Group	Distribution %
Agriculture	6%	A	26%
Barren Land	0%	A/D	0%
Commercial and Services	0%	B	0%
Extractive	0%	B/D	29%
Industrial	0%	C	9%
Institutional	0%	C/D	0%
Open Land	2%	D	14%
Recreational	0%	W (Water)	21%
Residential, High Density	0%	X (Arents)	0%
Residential, Low Density	9%		
Residential, Med. Density	1%		
Transportation, Communication, Utilities	0%		
Upland Forested	35%		
Upland Non-Forested	3%		
Water	21%		
Wetlands	23%		



G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\DPUs.apr

Location of the Lake George DPU
Putnam County Master Stormwater Plan

Figure 3.6-1

AYRES ASSOCIATES

3.6.2 GEORGETOWN SLOUGH WATERSHED

The Georgetown Slough Watershed is comprised of 19.7 square miles, located in southeast Putnam County (**Figure 3.6.2-1**). It has not been divided into smaller subwatersheds but has been selected for additional study.

3.6.2.1 Physiography and Hydrology

The primary means of surface water conveyance through the Georgetown Slough is through shallow, intermittent wetland flow originating near US Highway 17 and County Road 308B and making its way south through a wide swath of depression lakes, including Lake Como and Lake Margaret, and wetlands to the St. Johns River. There are no well-defined stream channels before the last mile of conveyance. The slough drains through a distance of roughly 8 miles.

Topography is mildly sloped and drainage is slow-moving. High elevations on the northwest boundary are generally in the range of 50 feet NGVD, although some isolated areas are as high as 100 feet NGVD. Low elevations in wetland areas run from 25 to 35 feet NGVD.

There are no USGS streamflow gages or NCDC/SJRWMD rain gages located within this watershed.

3.6.2.2 FEMA Flood Zones

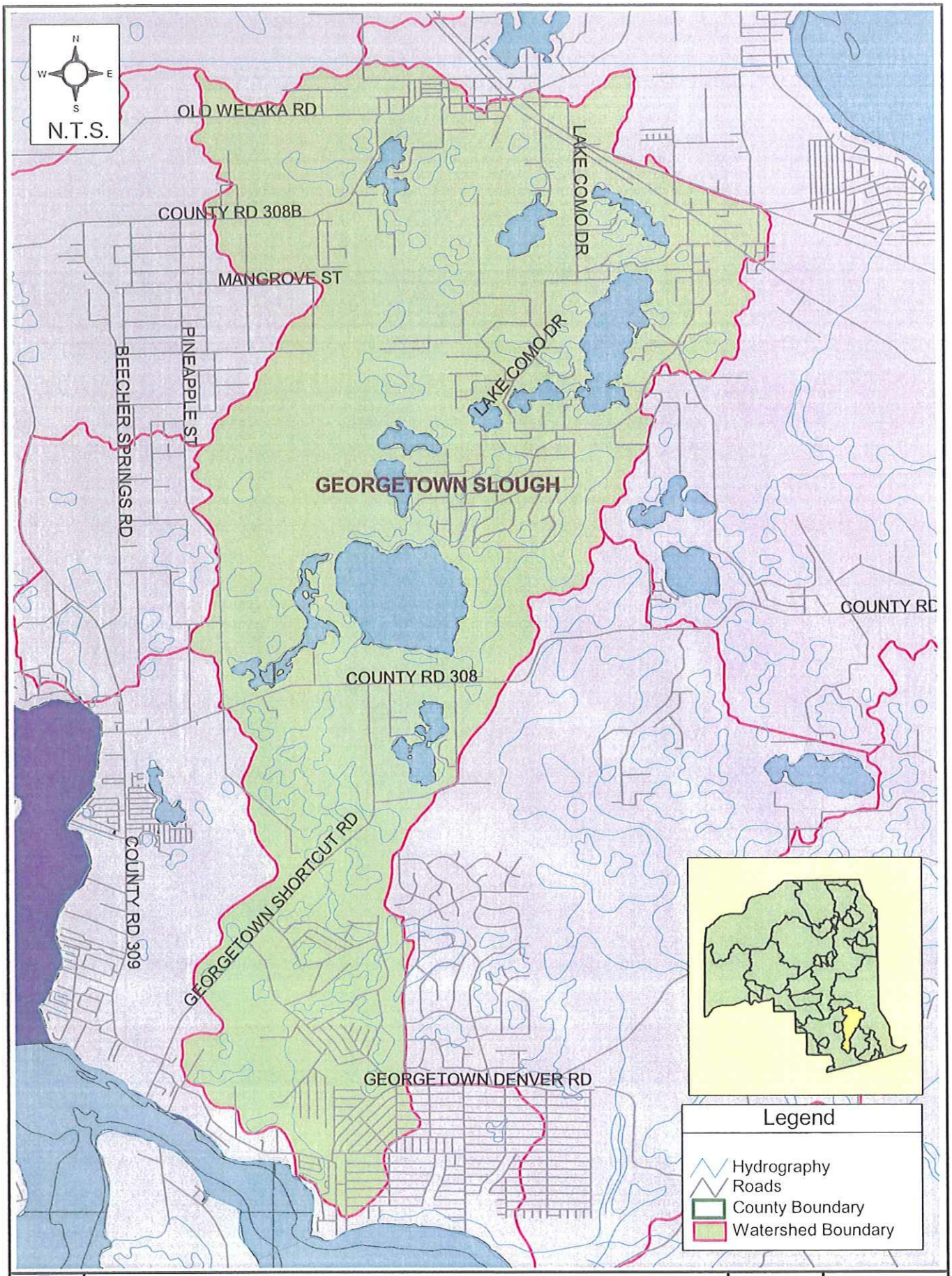
The majority of the northern portion of this watershed is classified Zone X, or area determined to be outside the 500-year floodplain. However, within the central and southern portion, significant areas around lakes, wetlands, and low-lying developed areas are designated Zone A. Areas in Zone A lie in the 100-year floodplain for which no base flood elevations have been determined. Most of the developed areas are designated Zone X. FEMA floodplain mapping is depicted on **Figure 3.6.2-2**. This watershed has not been studied in detail as part of the Putnam County FIS.

3.6.2.3 Soils

Nearly 50% of the Georgetown Slough Watershed area is comprised of soils classified as HSG A, well drained with low runoff potential. The type A soils are concentrated in the northern portion of the watershed as illustrated in **Figure 3.6.2-3,** which depicts the current hydrologic soil groups in the Georgetown Slough Watershed. In the central and southern portion of the watershed, B/D and C soil groups with higher runoff potential are more prevalent. HSG D classifications are represented in lesser proportion, primarily confined to the slough systems.

3.6.2.4 Land Use/ Land Cover

Land use analysis indicates that the Georgetown Slough watershed is comprised of 20% "Residential" and 17% "Agriculture" land use. The remainder of the watershed is dominated by forested uplands and wetlands/waterbodies. **Figure 3.6.2- 4** depicts the current land use in the Georgetown Slough Watershed.

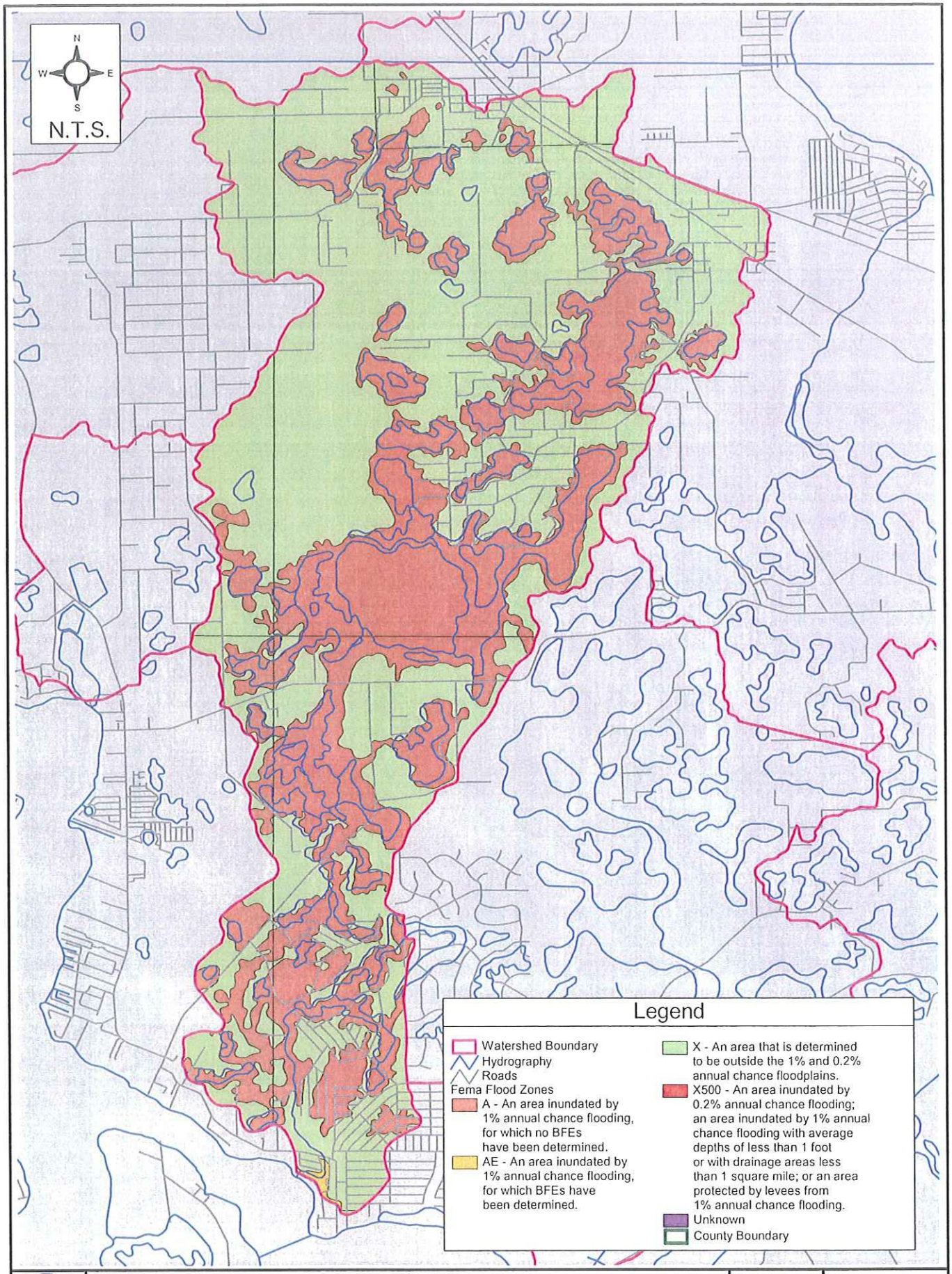


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Georgetown_slough.apr

Location of the Georgetown Slough Watershed
Putnam County Master Stormwater Plan

Figure 3.6.2-1

AYRES ASSOCIATES

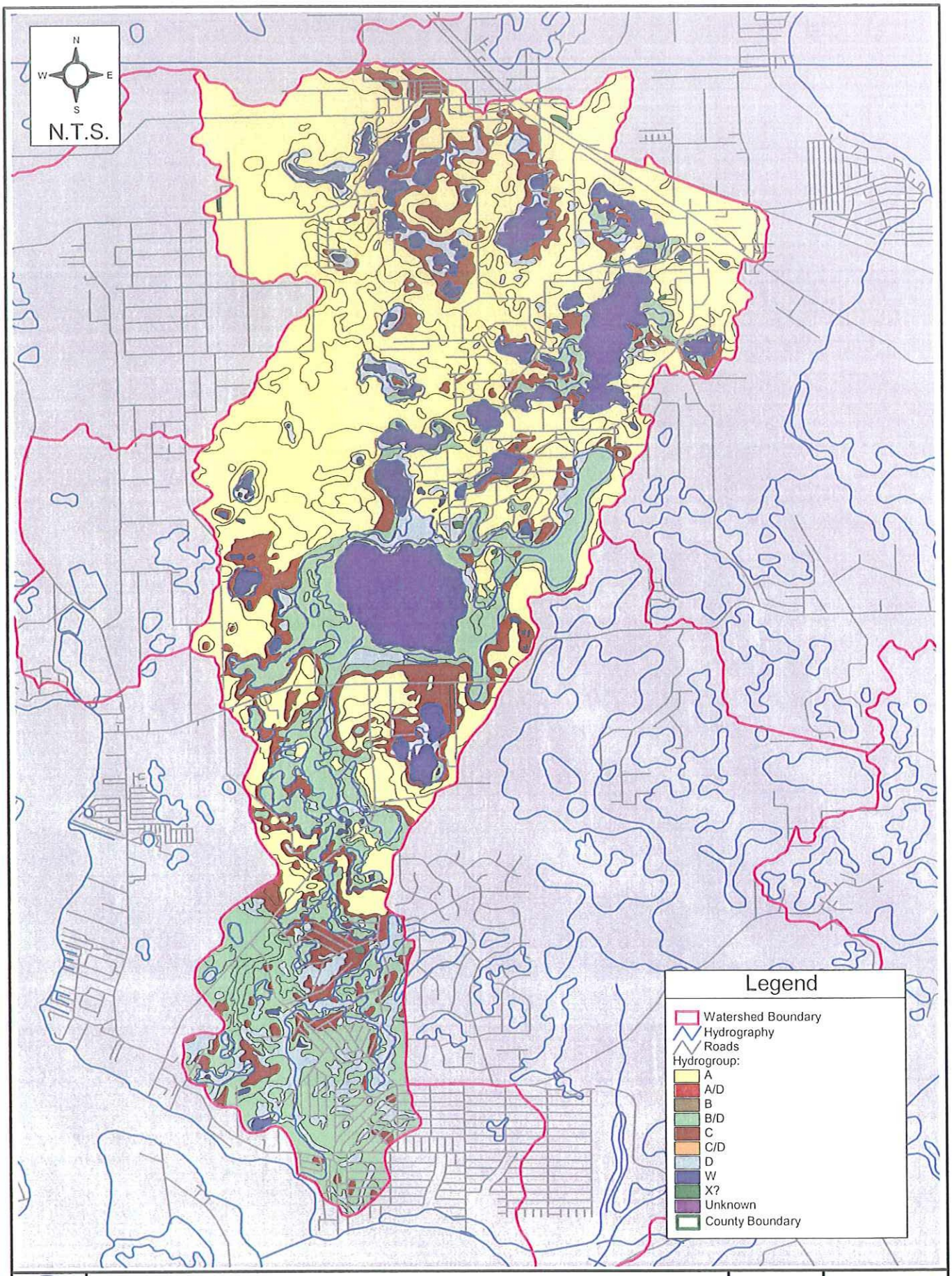


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Georgetown_Slough.apr

FEMA Flood Zones in the Georgetown Slough Watershed
Putnam County Master Stormwater Plan

Figure 3.6.2-2

AYRES ASSOCIATES



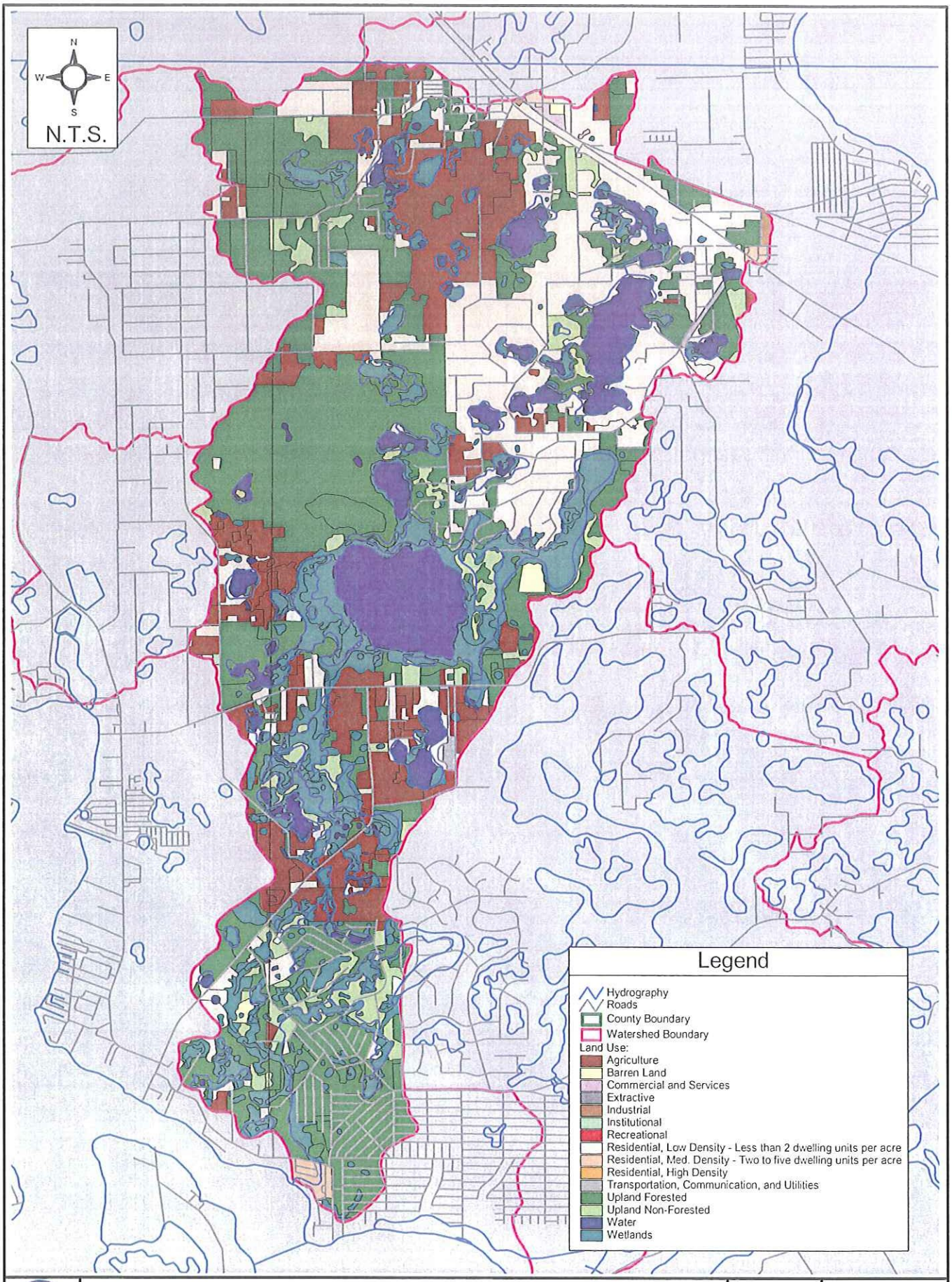
Soils Distribution in the Georgetown Slough Watershed

Putnam County Master Stormwater Plan

G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\Georgetown_Slough.apr

Figure 3.6.2-3

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\Georgetown_Slough.apr

Land Use Distribution in the Georgetown Slough Watershed

Putnam County Master Stormwater Plan

Figure 3.6.2-4

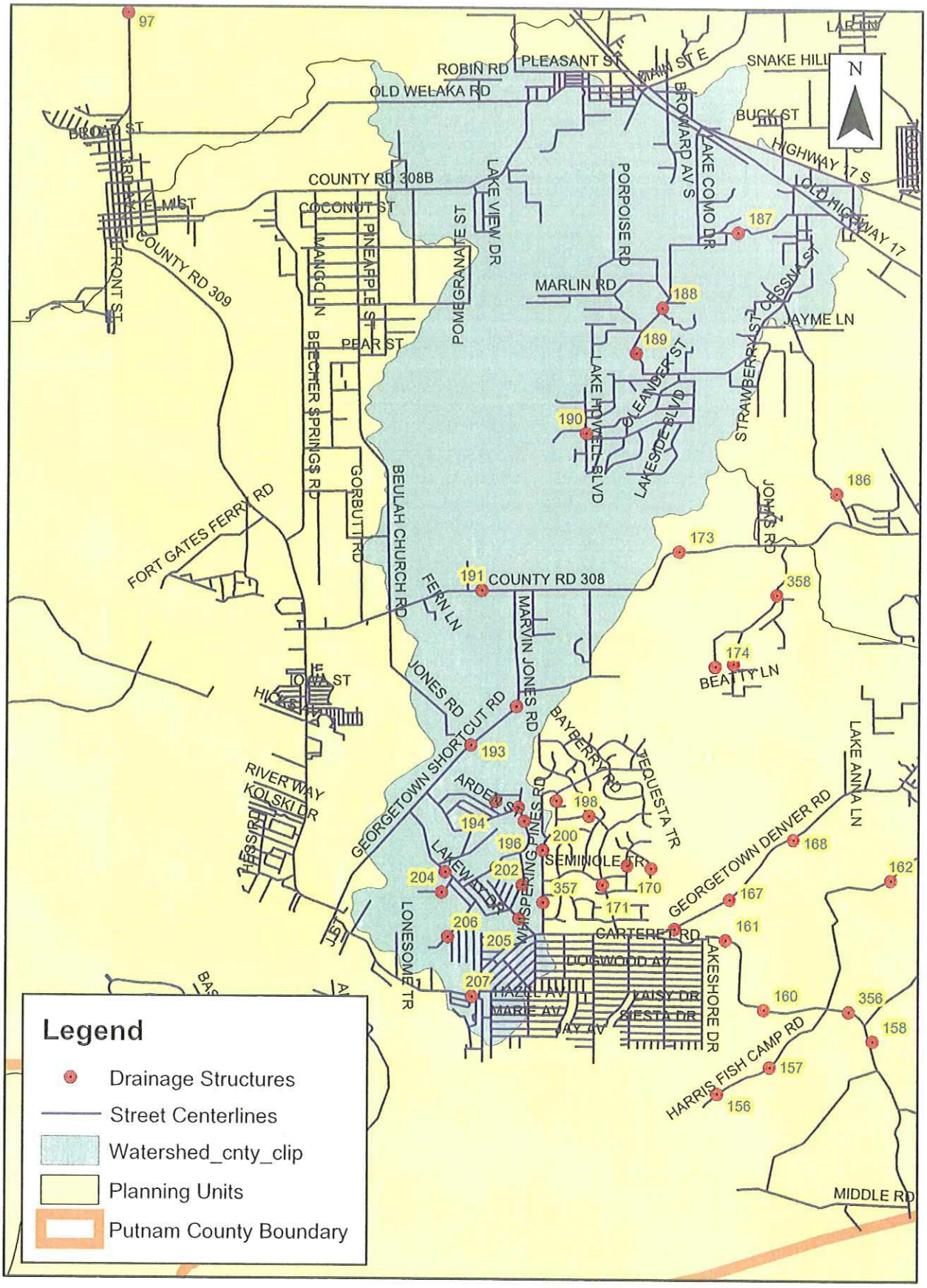
AYRES ASSOCIATES

3.6.2.5 Field investigations in Selected Subwatersheds

The field reconnaissance program described in Section 2.10 was performed for this watershed as illustrated on the following index figure. No modifications to basin delineations resulted from field investigations. Field reports for hydraulic structures and photo documentation from the investigation is presented in **Appendix 3-B**. These data have been incorporated into a GIS database for County use.

3.6.2.6 Sewer Network and Point Source Discharge

Sewer networks and point source discharges in this watershed have not been identified by the County. A search of FDEP permitted point source discharges and industrial stormwater dischargers was performed and no permitted point source discharges were found in the Georgetown Slough Watershed.



Field Reconnaissance - Georgetown Slough Watershed

3.6.3 JUMPING GULLY BRANCH WATERSHED

The Jumping Gully Branch Watershed is comprised of 10.6 square miles, located in southeast Putnam County (**Figure 3.6.3-1**). It has not been divided into smaller subwatersheds but has been selected for additional study.

3.6.3.1 Physiography and Hydrology

Jumping Gully Branch has its headwaters in a grouping of several small lakes west of Lake Stella, which pop-off southward to approximately 1.3 square miles of wetland area, thence draining southwest through the branch for a distance of roughly 2.8 miles to Lake George near Hendersons Landing.

With the exception of the northernmost extent of the watershed where topography drops fairly quickly from elevations of roughly 60 feet NGVD to 45 feet NGVD into numerous depression lakes, most of the watershed is mildly sloped toward the flat, central wetlands at elevation 35 feet NGVD. The Jumping Gully Branch conyeys flow from this region down to Lake George at elevation 5 feet NGVD.

There are no USGS streamflow gages or NCDC/SJRWMD rain gages located within this watershed. There is one representative SJRWMD rain gage within the adjacent Patty Wiggins Branch Watershed, Gage 232 "Silver Pond Wells," offering continuous rainfall records from July 1991 to the present.

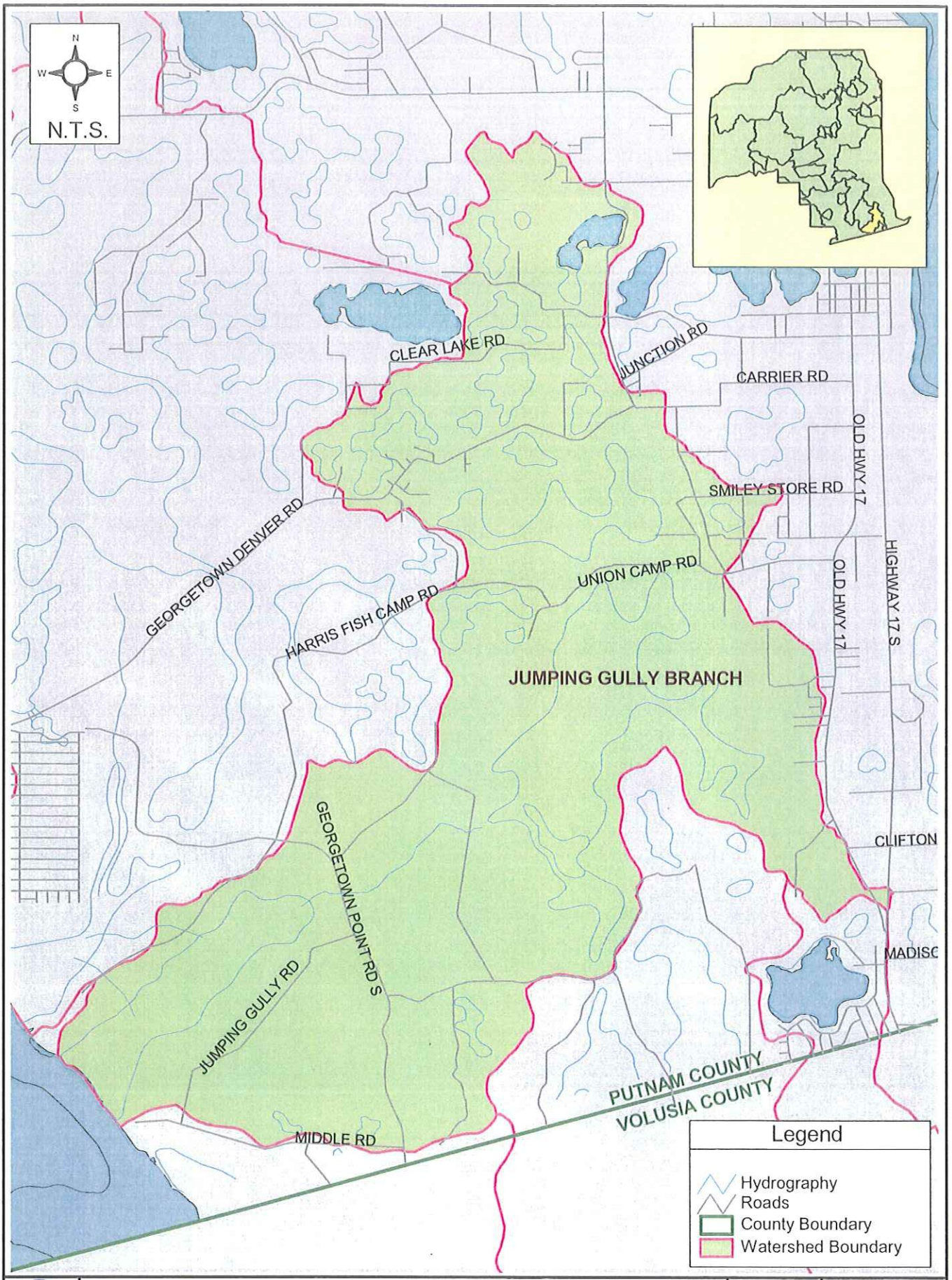
3.6.3.2 FEMA Flood Zones

The majority of this watershed is classified Zone X, or area determined to be outside the 500-year floodplain. However, a large proportion is designated Zone A, lying in the 100-year floodplain for which no base flood elevations have been determined. Zone AE designations, areas in the 100-year floodplain for which base flood elevations have been determined, are limited to the Jumping Gully Branch outlet at Lake George. FEMA floodplain mapping is depicted on **Figure 3.6.3-2**.

Jumping Gully Branch and the lakes in the northern region of the watershed have not been studied in detail as part of the Putnam County FIS, although base flood elevations for areas adjacent to Lake George have been determined by FEMA using the flood profiles developed for the St. Johns River.

3.6.3.3 Soils

Moderately well drained soils with a high water table (HSG B/D) dominate this watershed, representing 45% of the total area. Significant portions (21%) are comprised of well drained A soils with low runoff potential, or by poorly drained D soils and water (20%). HSG C soils represent about 13% of the watershed area. **Figure 3.6.3-3** depicts the current hydrologic soil groups in the Jumping Gully Branch Watershed.

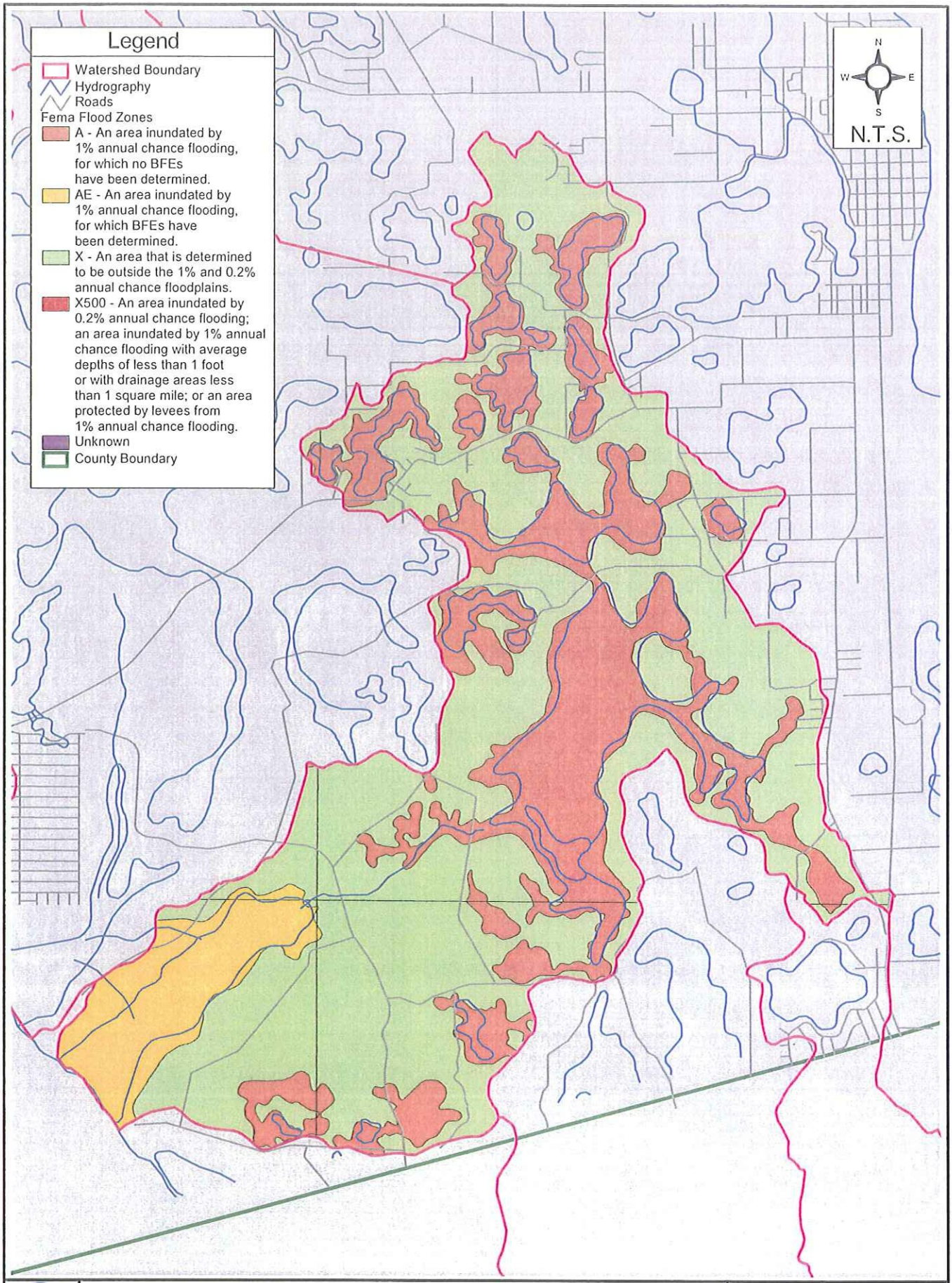


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\JumpingGully_Branch.apr

Location of the Jumping Gully Branch Watershed
Putnam County Master Stormwater Plan

Figure 3.6.3-1

AYRES ASSOCIATES



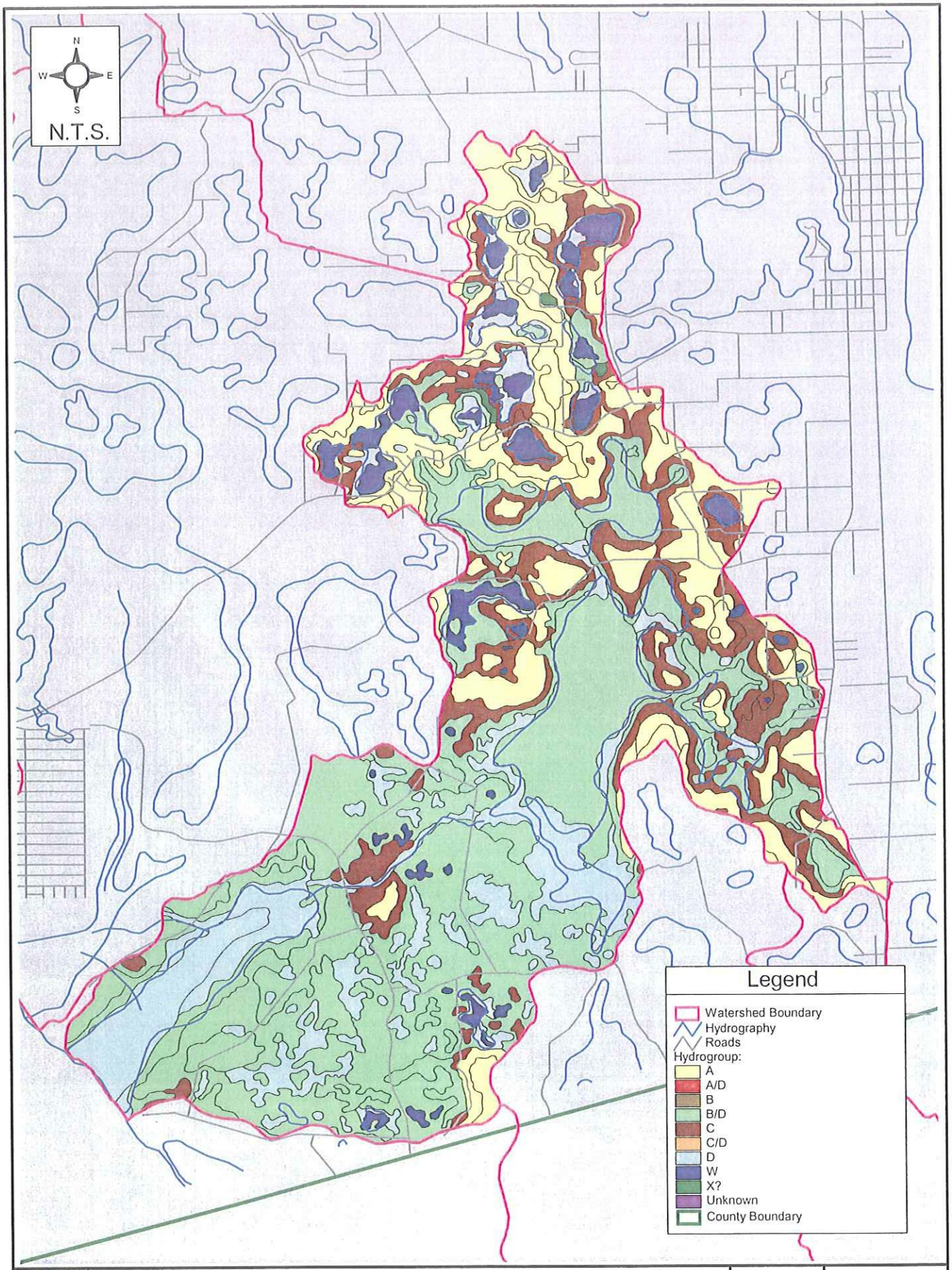
G:\COUNTY - PUTNAM\ 67011000(PutnumCoSWMP)\GIS\ APRs\Watershed Maps\JumpingGully_Branch.apr

FEMA Flood Zones in the Jumping Gully Branch Watershed

Putnam County Master Stormwater Plan

Figure 3.6.3-2

AVRES ASSOCIATES



Soils Distribution in the Jumping Gully Branch Watershed

Putnam County Master Stormwater Plan

G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\JumpingGully_Branch.apr

Figure 3.6.3-3

AYRES ASSOCIATES

3.6.3.4 Land Use/ Land Cover

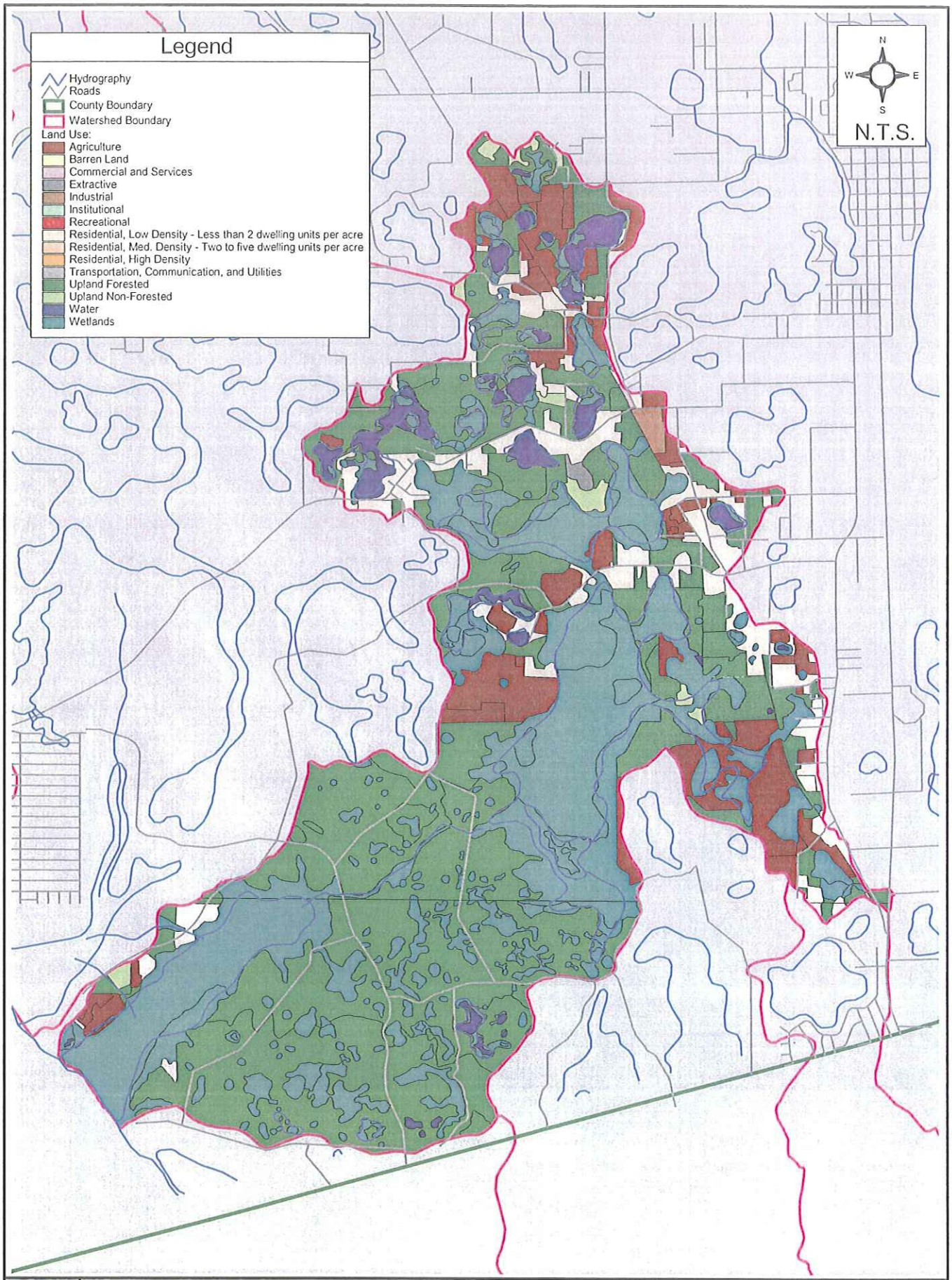
A full 83% of the Jumping Gully Branch Watershed is represented by undeveloped land uses such as forested/non-forested "Uplands", "Wetlands" and "Water." "Agriculture" accounts for roughly 10% of the land area and "Residential" lands occupy 6%. **Figure 3.6.3-4** depicts the current land use in the Jumping Gully Branch Watershed.

3.6.3.5 Field investigations in Selected Subwatersheds

The field reconnaissance program described in Section 2.10 was performed for this watershed as illustrated on the following index figure. No modifications to basin delineations resulted from field investigations. Field reports for hydraulic structures and photo documentation from the investigation is presented in **Appendix 3-B**. These data have been incorporated into a GIS database for County use.

3.6.3.6 Sewer Network and Point Source Discharge

Sewer networks and point source discharges in this watershed have not been identified by the County. A search of FDEP permitted point source discharges and industrial stormwater dischargers was performed and no permitted point source discharges were found in the Jumping Gully Branch Watershed.



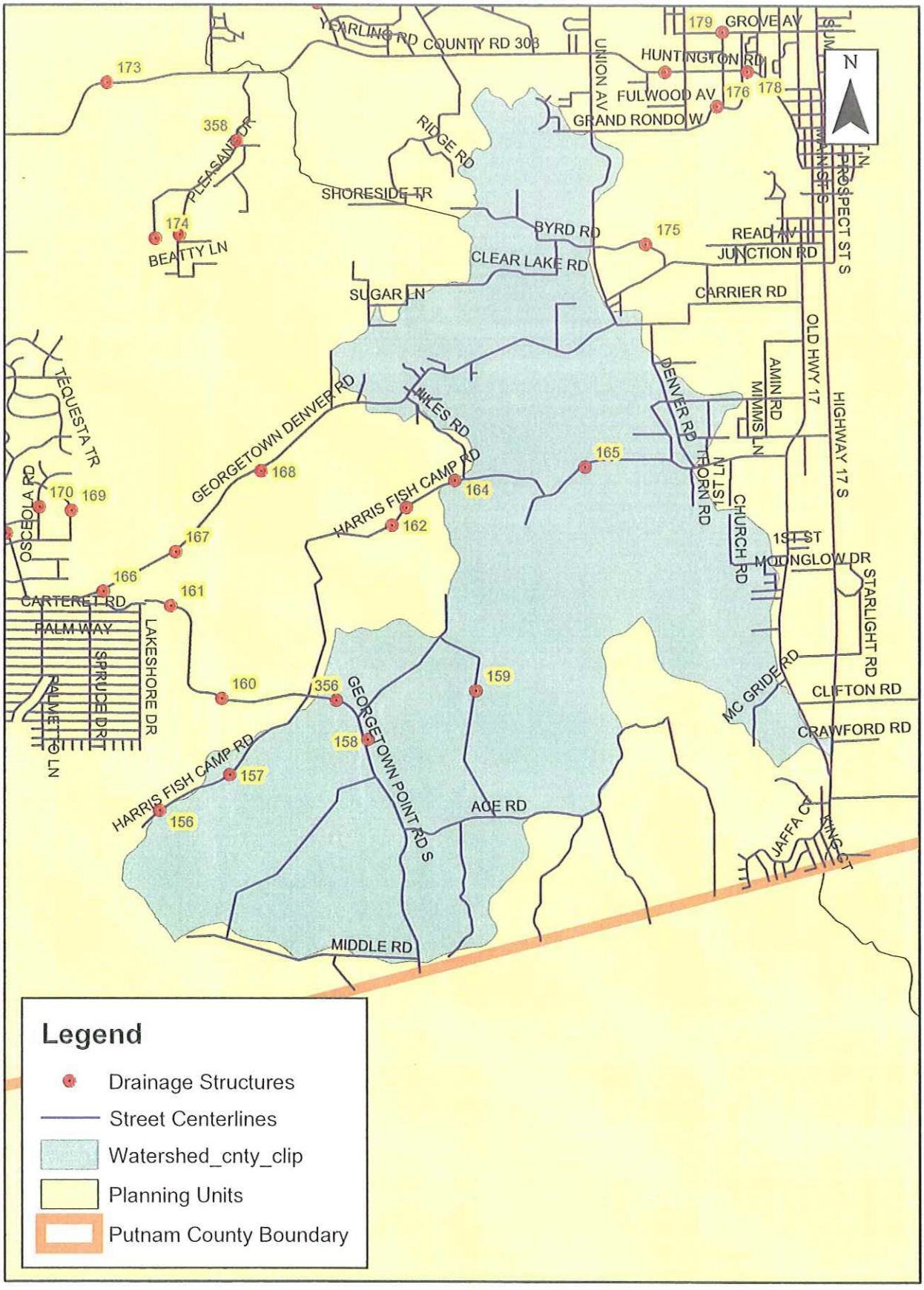
Land Use Distribution in the Jumping Gully Branch Watershed

Putnam County Master Stormwater Plan

G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\JumpingGully_Branch.apr

Figure 3.6.3-4

AYRES ASSOCIATES



Field Reconnaissance - Jumping Gully Branch Watershed

3.6.4 LAKE LAURA OUTLET WATERSHED

The Lake Laura Outlet Watershed is comprised of 2.4 square miles, located on the west side of the St. Johns River in south Putnam County (**Figure 3.6.4-1**). It has not been divided into smaller subwatersheds and has not been selected for field investigation.

3.6.4.1 Physiography and Hydrology

The primary conveyance is a 1.5-mile wetland slough that drains the watershed southward from 3.4-acre Lake Laura at the northern extent to Muddy Cove on the west bank of the St. Johns River along the Lake George outlet. National Forest Road 43 forms the upper boundary of the watershed at elevation 19-20 feet NGVD. The watershed slopes gently inward to the wetland slough with interior elevations of roughly 4 feet NGVD. The slough has almost no slope as it drains toward Muddy Cove.

There are no USGS streamflow gages or NCDC/SJRWMD rain gages located within this watershed.

3.6.4.2 FEMA Flood Zones

The watershed is almost evenly divided, proportionally, between Zone X and Zone A or AE classifications. Zone X represents areas determined to be outside the 500-year floodplain. Wetland areas and low-lying areas hydraulically connected to the St. Johns River at flood stages are designated Zone A or AE. Areas in Zone A lie in the 100-year floodplain for which no base flood elevations have been determined. Areas in Zone AE lie in the 100-year floodplain where base flood elevations have been determined using St. Johns River flood profiles. FEMA floodplain mapping is depicted on **Figure 3.6.4-2**.

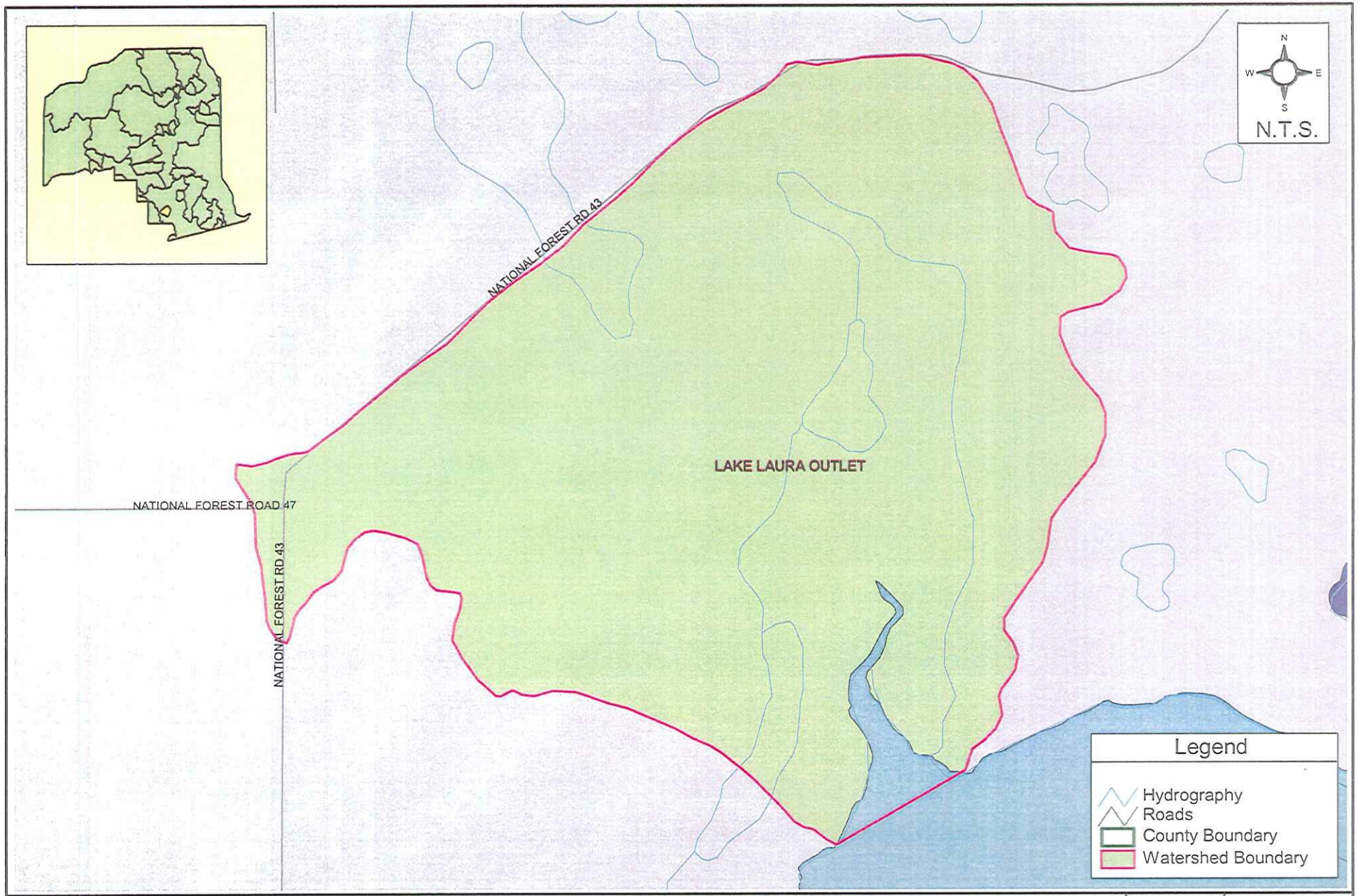
This watershed has not been studied in detail as part of the Putnam County FIS, except as part of the simulated floodplain for the detailed study of the St. Johns River; as reflected in the FEMA-determined base flood elevations.

3.6.4.3 Soils

Moderately well drained soils with a high water table (HSG B/D) dominate this watershed, representing 44% of the total area. Significant portions (34%) are comprised of poorly drained D soils or water, with a very high runoff potential. HSG A soils and C soils represent about 12% and 9% of the watershed area, respectively. **Figure 3.6.4-3** depicts the current hydrologic soil groups in the Lake Laura Outlet Watershed.

3.6.4.4 Land Use/ Land Cover

Figure 3.6.4- 4 depicts the current land use in the Lake Laura Outlet Watershed. Over half of the watershed is covered by water or wetlands. Most of the remaining area is occupied by forested uplands. Being part of the Ocala National Forest, there is no development in this watershed.

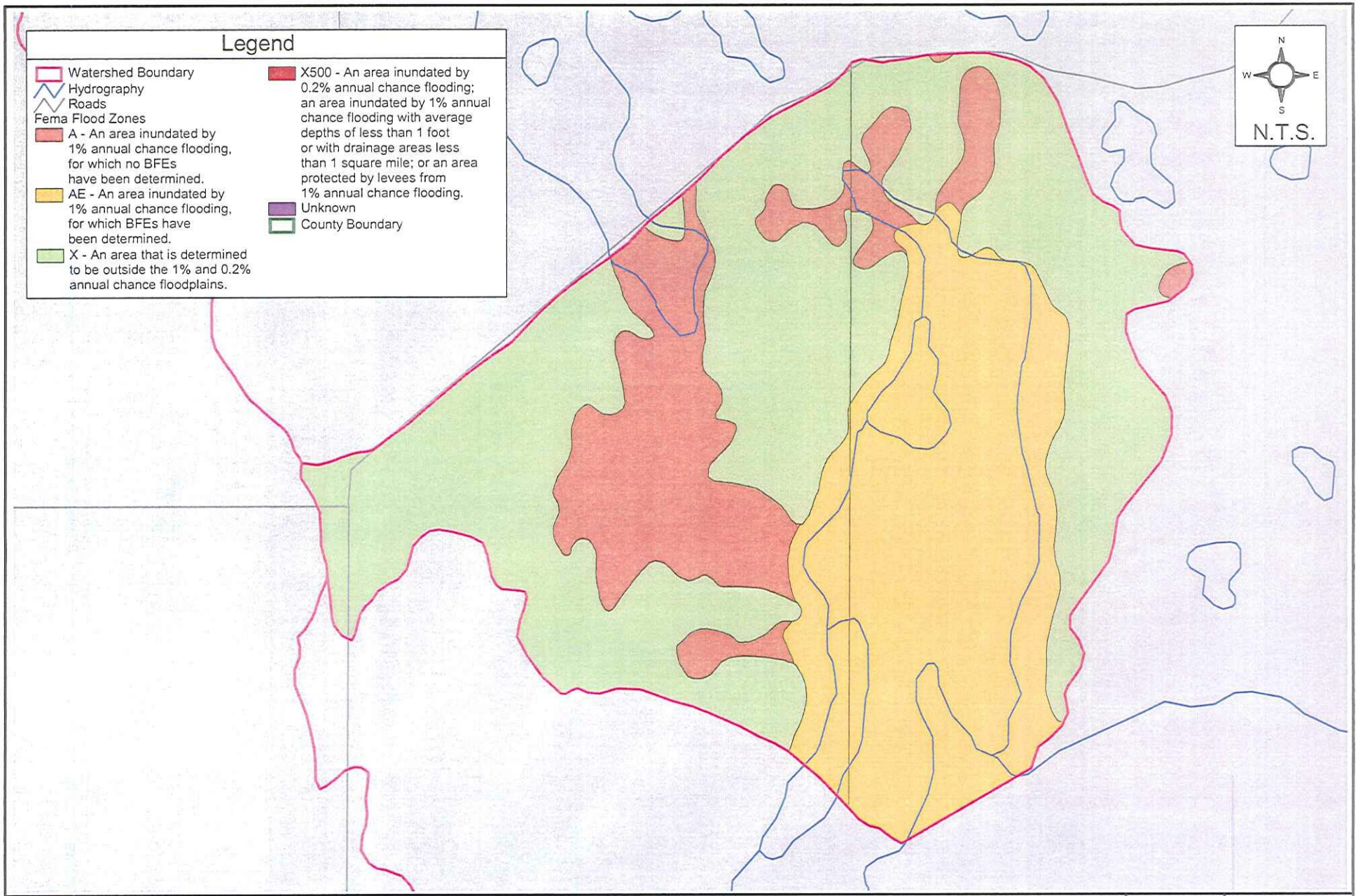


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Lake Laura Outlet.apr

Location of the Lake Laura Outlet Watershed
Putnam County Master Stormwater Plan

Figure
3.6.4-1

AYRES ASSOCIATES



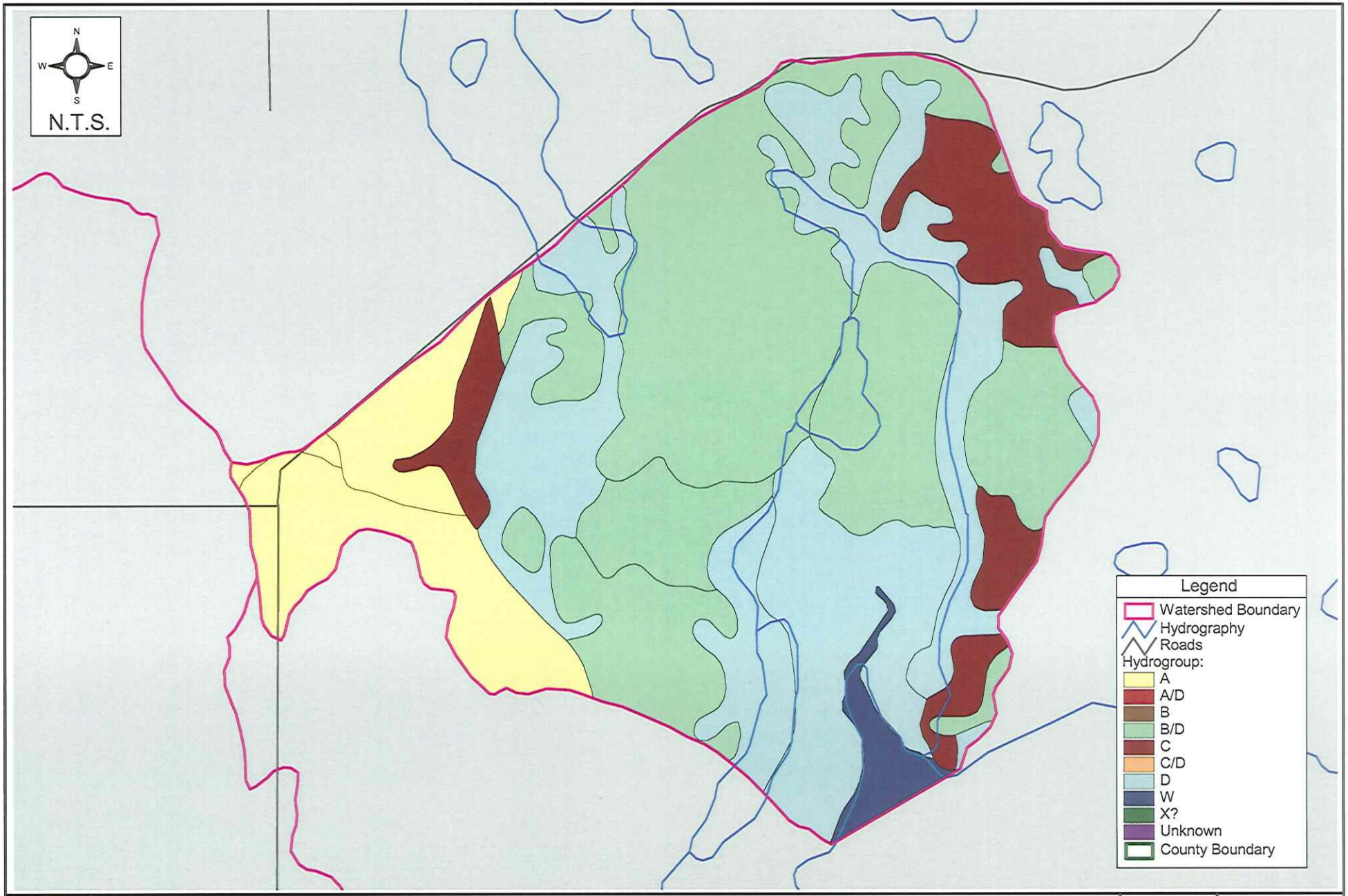
G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Lake Laura Outlet.apr

FEMA Flood Zones in the Lake Laura Outlet Watershed

Putnam County Master Stormwater Plan

Figure 3.6.4-2

AYRES ASSOCIATES

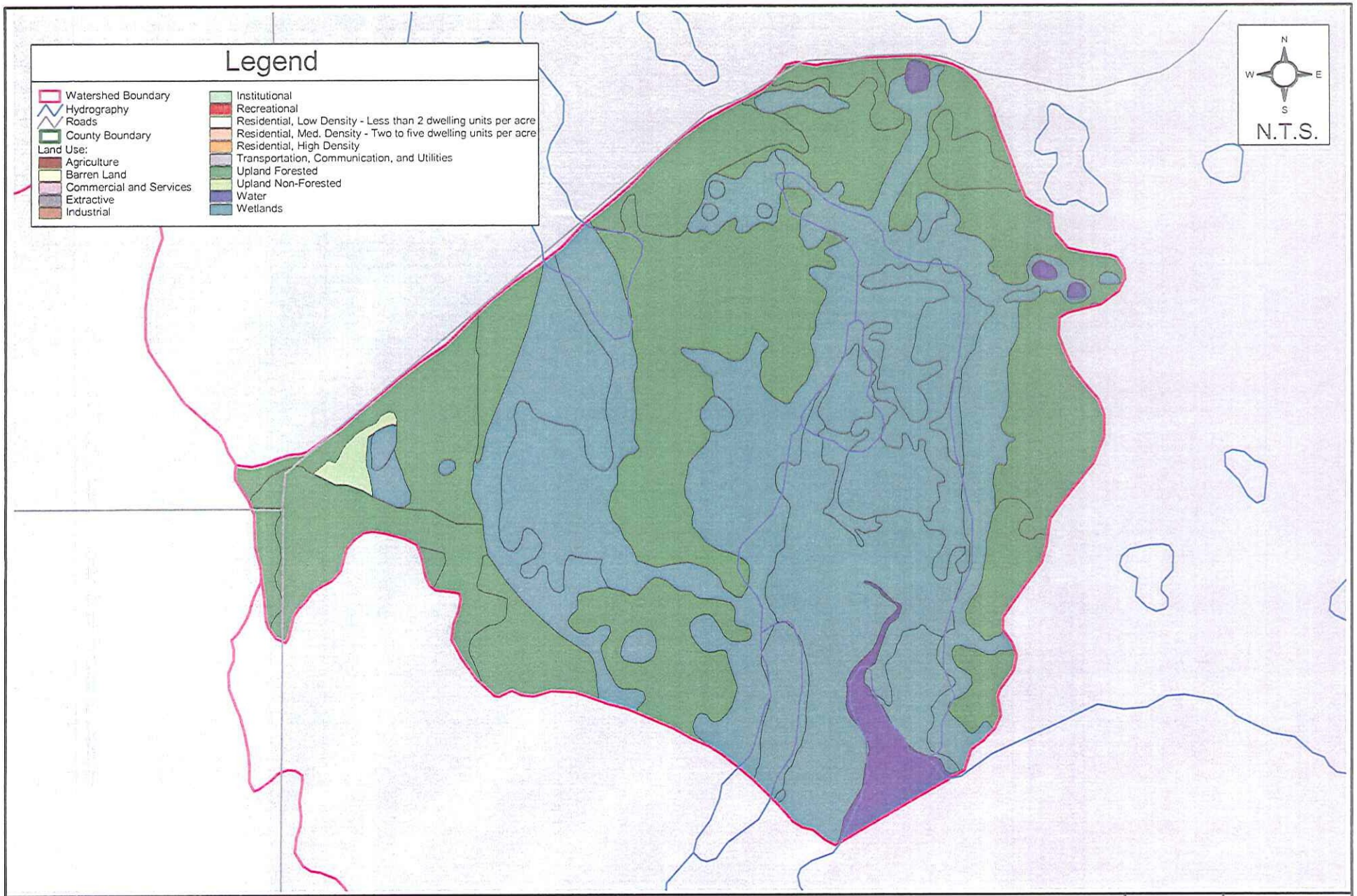


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Lake Laura Outlet.apr

Soils Distribution in the Lake Laura Outlet Watershed
Putnam County Master Stormwater Plan

Figure 3.6.4-3

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Lake Laura Outlet.apr

Land Use Distribution in the Lake Laura Outlet Watershed
Putnam County Master Stormwater Plan

Figure
3.6.4-4

AYRES ASSOCIATES

3.6.5 PATTY WIGGINS BRANCH WATERSHED

The Patty Wiggins Branch Watershed is comprised of 4.6 square miles, straddling Putnam County and Volusia County to the south. The upper 41%, 1.9 square miles, of the watershed is located in south Putnam County (**Figure 3.6.5-1**). It has not been divided into smaller subwatersheds and has not been selected for field investigation.

3.6.5.1 Physiography and Hydrology

The primary conveyance of this watershed, Patty Wiggins Branch, is located in Volusia County and drains southward to Lake George. The wetland headwaters of this system lie in Putnam County. High elevations of 58 to 65 feet NGVD are found at the northern watershed boundary. The vast majority of the Putnam County portion of the watershed lies at 30 to 35 feet NGVD and is very flat.

There are no USGS streamflow gages located within this watershed. There is one SJRWMD rain gage in the northern portion of the Patty Wiggins Branch Watershed, Gage 232 "Silver Pond Wells," offering continuous rainfall records from July 1991 to the present.

3.6.5.2 FEMA Flood Zones

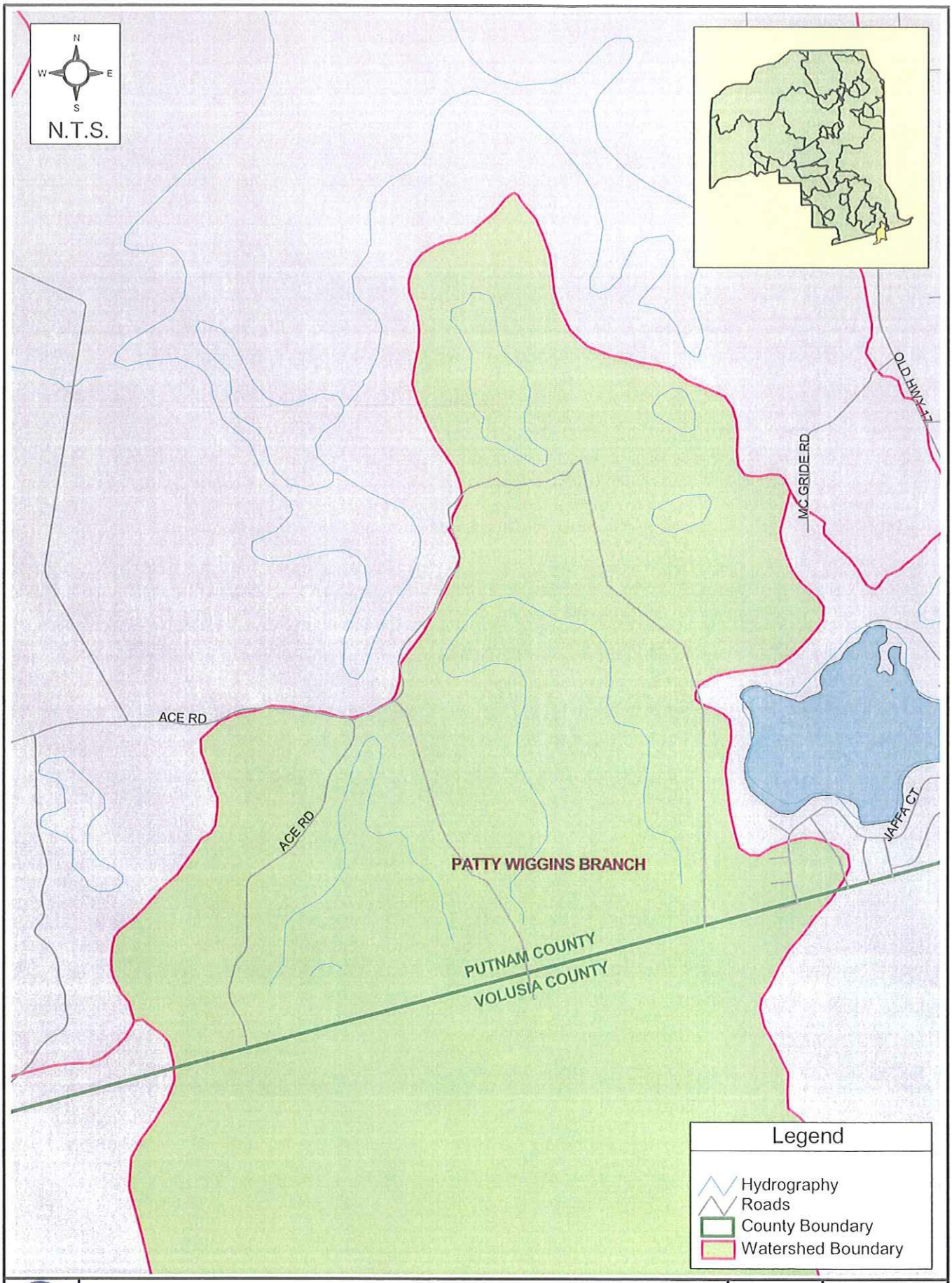
The Putnam County portion of the watershed is almost evenly divided, proportionally, between Zone X and Zone A classifications. Zone X represents areas determined to be outside the 500-year floodplain. Wetland areas and low-lying areas are designated Zone A. Areas in Zone A lie in the 100-year floodplain for which no base flood elevations have been determined. The Putnam County portion of this watershed has not been studied by FEMA in detail. FEMA floodplain mapping is depicted on **Figure 3.6.5-2**.

3.6.5.3 Soils

High water tables in this watershed result in a dominance of poorly drained soils with high or moderately high runoff potential. Within Putnam County, 41% of the watershed is comprised of D (hydric soils) or W (water) classifications. HSG B/D soils cover 30% of the Putnam County portion, while HSG A and C classifications represent 19% and 10% of the area, respectively. **Figure 3.6.5-3** depicts the current hydrologic soil groups in the Putnam County portion of the Patty Wiggins Branch Watershed.

3.6.5.4 Land Use/ Land Cover

Figure 3.6.5- 4 depicts the current land use in the Putnam County portion of the Patty Wiggins Branch Watershed. The Putnam County portion of the watershed is dominated by "Water" or "Wetlands" land use (38%) and "Upland Forested" land use (48%). "Agriculture" and "Residential" land uses occupy 13% and 2% of the Putnam County watershed area, respectively.

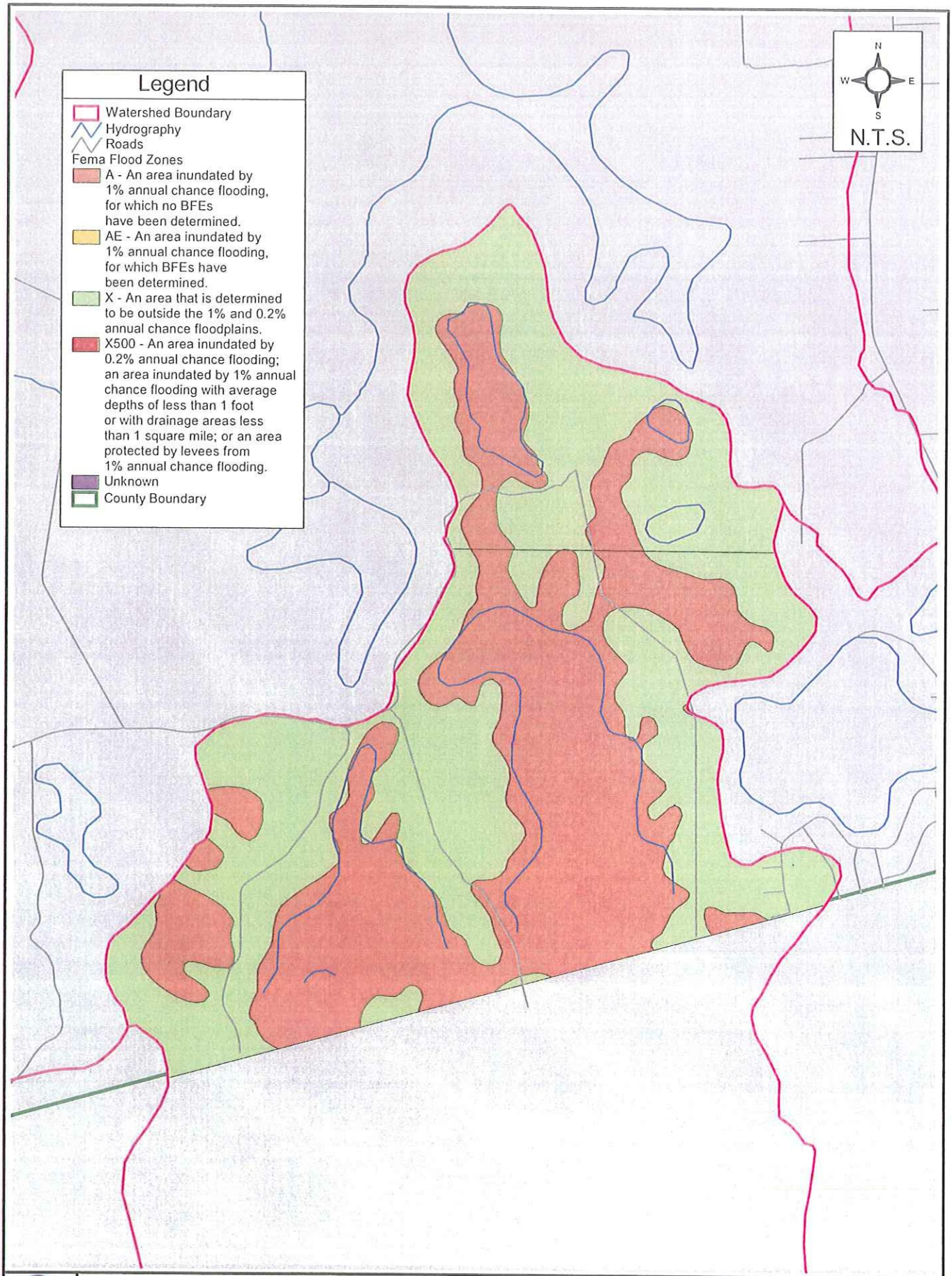


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Patty Wiggins Branch.apr

Location of the Patty Wiggins Branch Watershed
Putnam County Master Stormwater Plan

Figure 3.6.5-1

AYRES ASSOCIATES



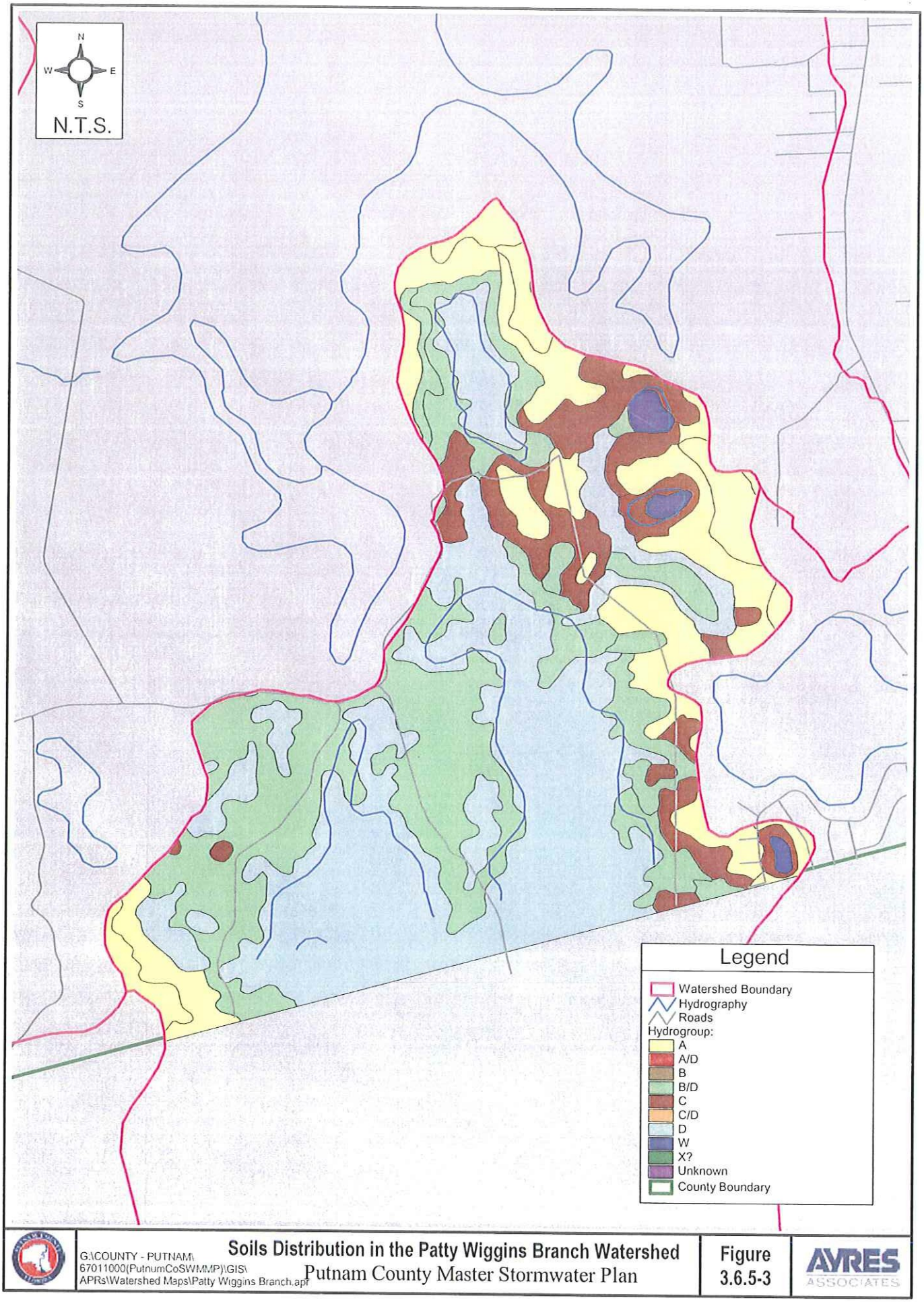
G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\Patty Wiggins Branch.apr

FEMA Flood Zones in the Patty Wiggins Branch Watershed

Putnam County Master Stormwater Plan

Figure 3.6.5-2

AYRES ASSOCIATES

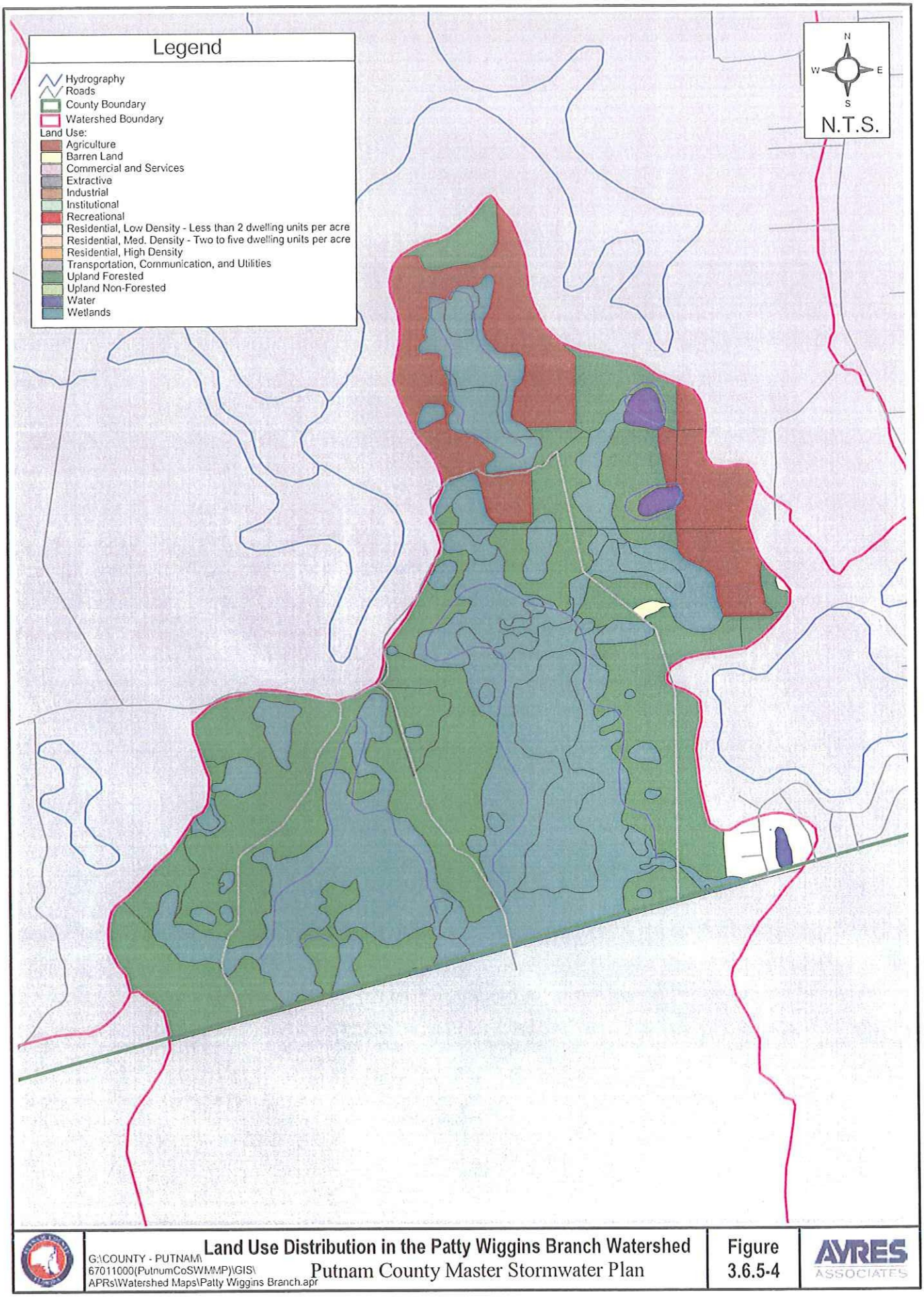


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Patty Wiggins Branch.apr

Soils Distribution in the Patty Wiggins Branch Watershed
Putnam County Master Stormwater Plan

Figure 3.6.5-3

AYRES ASSOCIATES



Land Use Distribution in the Patty Wiggins Branch Watershed

Putnam County Master Stormwater Plan

G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\Patty Wiggins Branch.apr

Figure 3.6.5-4

AYRES ASSOCIATES

3.6.6 ST. JOHNS RIVER WATERSHED

The St. Johns River Watershed (within the Lake George DPU) is comprised of 167.3 square miles in Volusia County and south Putnam County (**Figure 3.6.6-1**). It has not been divided by the SJRWMD into smaller subwatersheds although Welaka's County Road 308B flood problem area and the River Park subwatershed have been delineated and selected for further evaluation. The Putnam County portion of this watershed contains 51.7 square miles.

3.6.6.1 Physiography and Hydrology

The primary conveyance within Putnam County is the 11-mile stretch of the St. Johns River that serves as the outlet for Lake George in Volusia County, flowing northward to the Ocklawaha River confluence.

There are no USGS streamflow gages located within the Putnam County portion of this watershed. While there are no NCDC or SJRWMD rain gages located within the Putnam County portion of this watershed, two representative rain gages are located in nearby primary watersheds. The first is the SJRWMD "Silver Pond Wells" gage (232) offering continuous rainfall records from July 1991 to the present. The second is NCDC co-op station 81978, "Crescent City, FL," located on the south end of the Lake Stella Outlet subwatershed. This gage has daily and monthly rainfall records available from 1948 to the present.

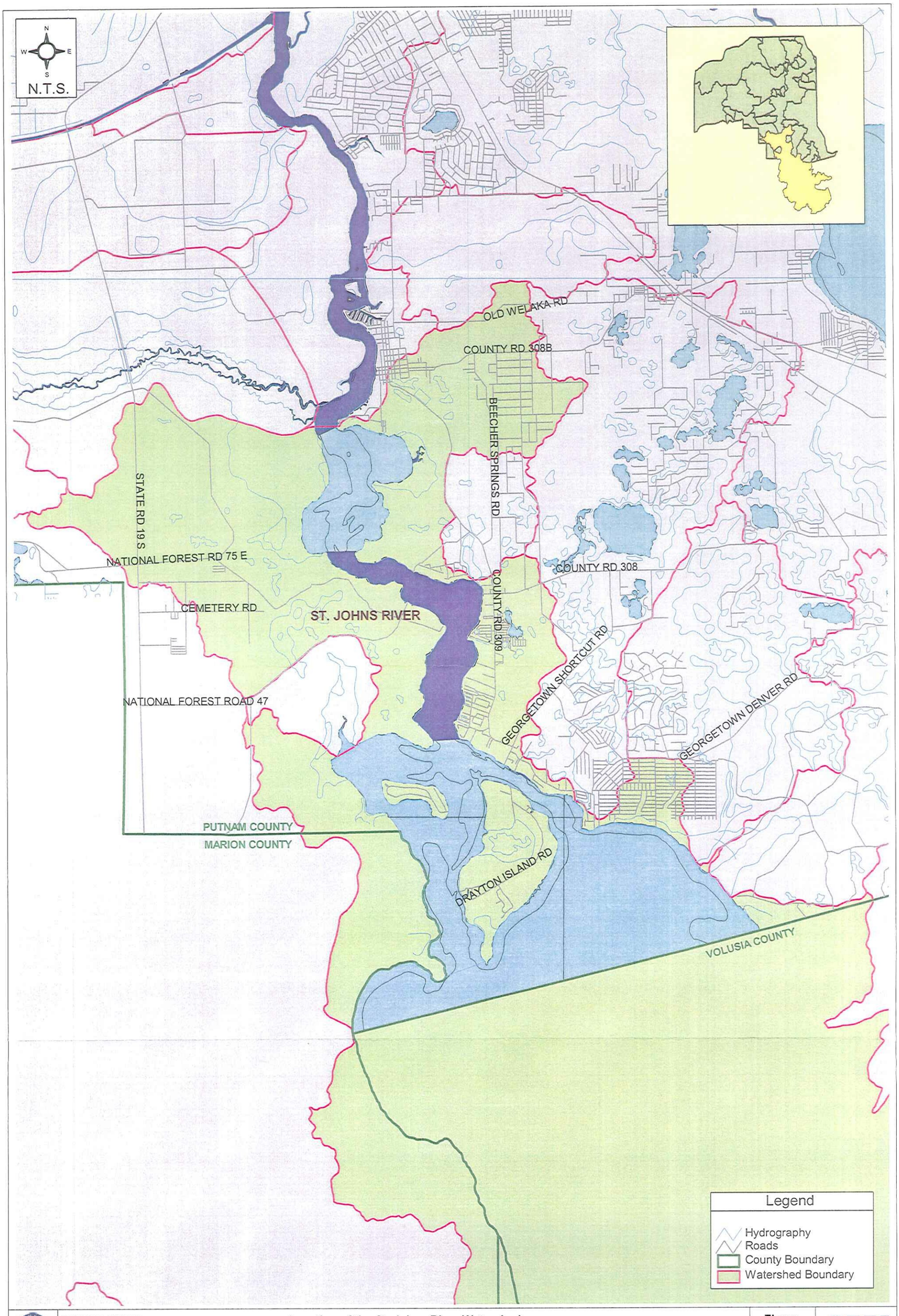
3.6.6.2 FEMA Flood Zones

The Putnam County portion of the watershed is almost evenly divided, proportionally, between Zone X and Zone A or AE classifications. Zone X represents areas determined to be outside the 500-year floodplain. Isolated wetland areas and low-lying areas are designated Zone A. Areas in Zone A lie in the 100-year floodplain for which no base flood elevations have been determined. Areas in Zone AE are primarily along the St. Johns River main channel and associated floodplain, which include Lake George and Little Lake George. These areas lie in the 100-year floodplain where base flood elevations have been determined. FEMA floodplain mapping is depicted on **Figure 3.6.6-2**.

As part of the Putnam County FIS, the St. Johns River has been studied in detail from the County's southern limit to its northern limit. Stream profile graphs are located in the Putnam County FIS provided in **Appendix 3-A** of this SMP.

3.6.6.3 Soils

Figure 3.6.6-3 depicts the current hydrologic soil groups in the Putnam County portion of the St. Johns River Watershed. While the majority of the Putnam County portion of the watershed has a W (water) soil classification, the next highest representation of soil groups is B/D at 24%, followed by A at 15%, and D at 15%.

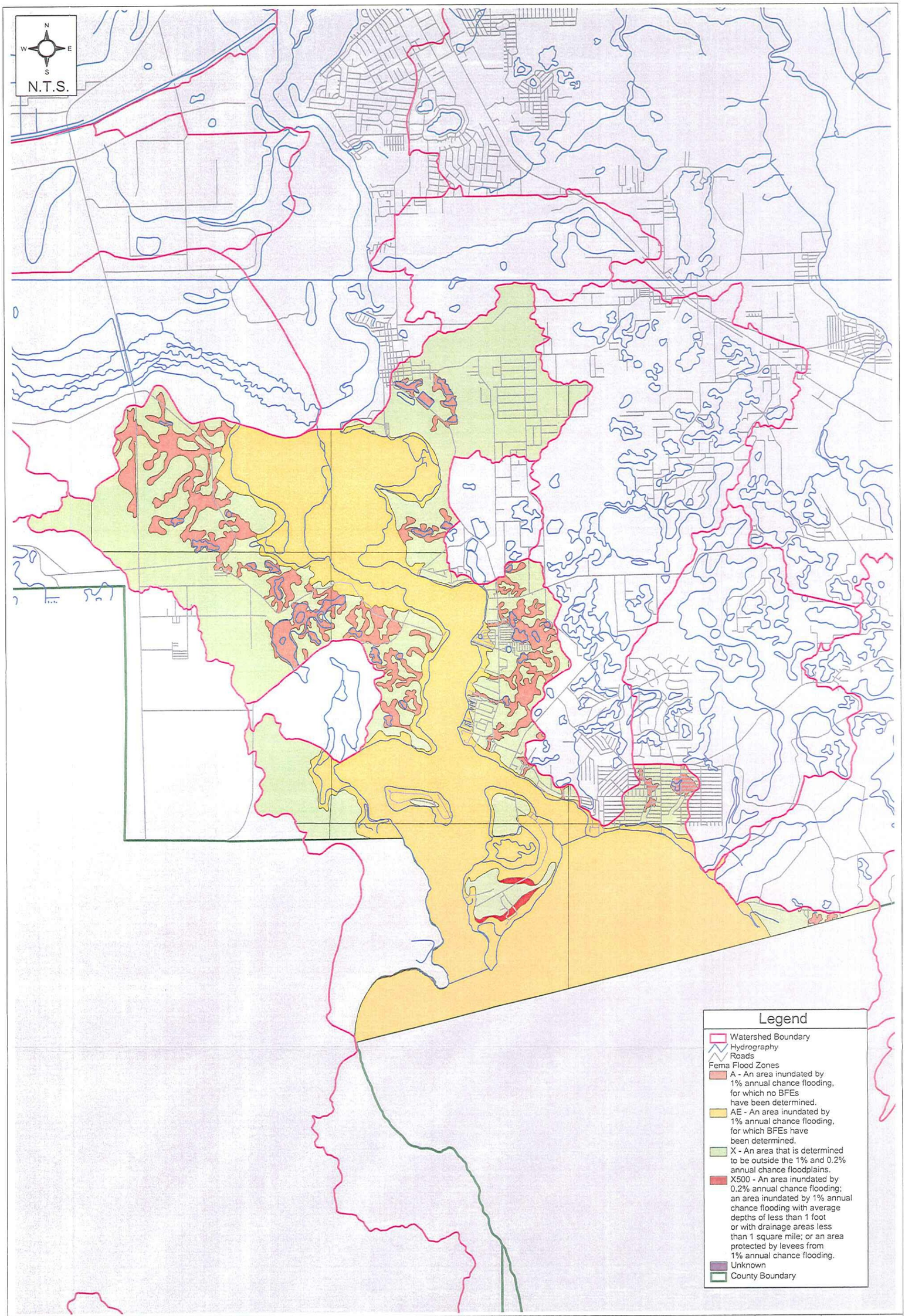


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\StJohns_River_s.apr

Location of the St. Johns River Watershed
Putnam County Master Stormwater Plan

Figure
3.6.6-1

AYRES ASSOCIATES

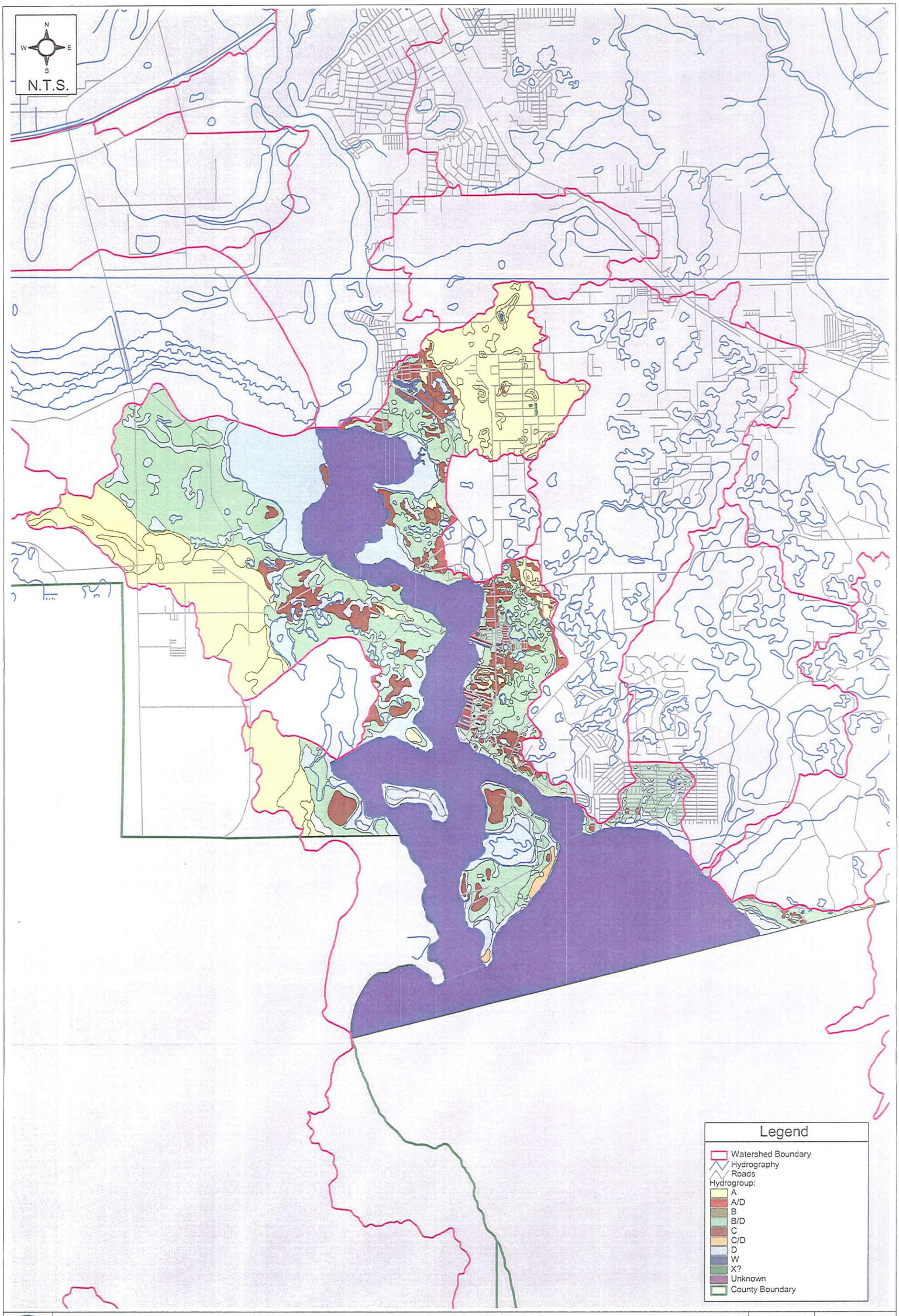


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\StJohns_River_s.apr

FEMA Flood Zones in the St. Johns River Watershed
Putnam County Master Stormwater Plan

Figure
3.6.6-2

AVRES ASSOCIATES



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\StJohns_River_s.apr

Soils Distribution in the St. Johns River Watershed
Putnam County Master Stormwater Plan

Figure
3.6.6-3

AYRES ASSOCIATES

3.6.6.4 Land Use/ Land Cover

The Putnam County portion of this watershed is comprised of a variety of land uses, both developed and undeveloped. The dominant land use is, of course, "Water" and "Wetlands," representing 55% of the Putnam County area. Other undeveloped land uses (forested/non-forested uplands and open land) constitute 37% of the Putnam County area. Residential developments comprise 7% of the area and agricultural use 1%.

Figure 3.6.6- 4 depicts the current land use in the Putnam County portion of the St. Johns River Watershed.

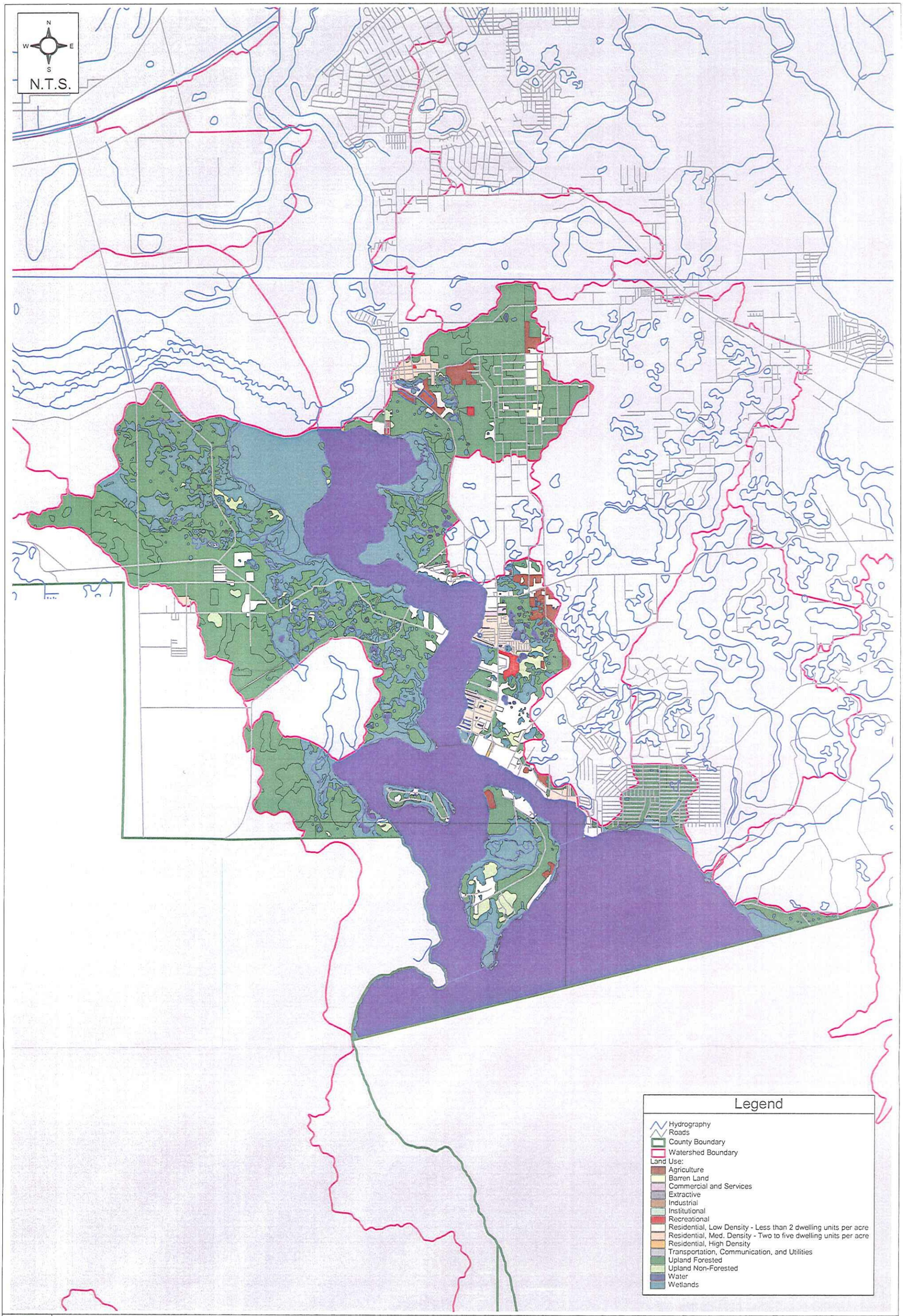
3.6.6.5 Field investigations in Selected Subwatersheds

Additional field reconnaissance was performed for the selected subwatershed areas, River Park (including portions of CR 309) and Welaka's CR 308B flood problem areas, described more fully in Section 7 of this Master Stormwater Plan. Basin delineations for these study areas were based on field review and topographic data.

3.6.6.6 Sewer Network and Point Source Discharge

Sewer networks and point source discharges in this watershed have not been identified by the County. A search of FDEP permitted point source discharges and industrial stormwater dischargers was performed and yielded the following results:

WATER SHED	SUBWATER SHED	FACILITY ID	NAME	FACILITY TYPE	FACILITY ADDRESS	CITY	OWNER SHIP TYPE
St. Johns River		FL0021610	CRESCENT CITY WWTF	Domestic WWTP	LAKE AND CYPRESS STREETS	CRESCENT CITY	City Owned



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\StJohns_River_s.apr

Land Use Distribution in the St. Johns River Watershed
Putnam County Master Stormwater Plan

Figure
3.6.6-4

AYRES ASSOCIATES

3.6.7 TIGER BRANCH WATERSHED

The Tiger Branch Watershed is comprised of 12.4 square miles, located in southeast Putnam County (**Figure 3.6.7-1**). It has not been divided into smaller subwatersheds but has been selected for additional study.

3.6.7.1 Physiography and Hydrology

The primary outfall, Tiger Branch, has its headwaters near County Road 308, in approximately 3 square miles of lakes and wetlands and drains southwest for a distance of roughly 2.5 miles to the outlet of Lake George. Topographic highs of 50 feet NGVD are observed at northern and eastern watershed boundaries. Overland slopes are mild.

There are no USGS streamflow gages or NCDC/SJRWMD rain gages located within this watershed. The nearest representative rain gages are the SJRWMD "Silver Pond Wells" gage (232) offering continuous rainfall records from July 1991 to the present; and the NCDC co-op station 81978, "Crescent City, FL" gage offering daily and monthly rainfall records from 1948 to the present.

3.6.7.2 FEMA Flood Zones

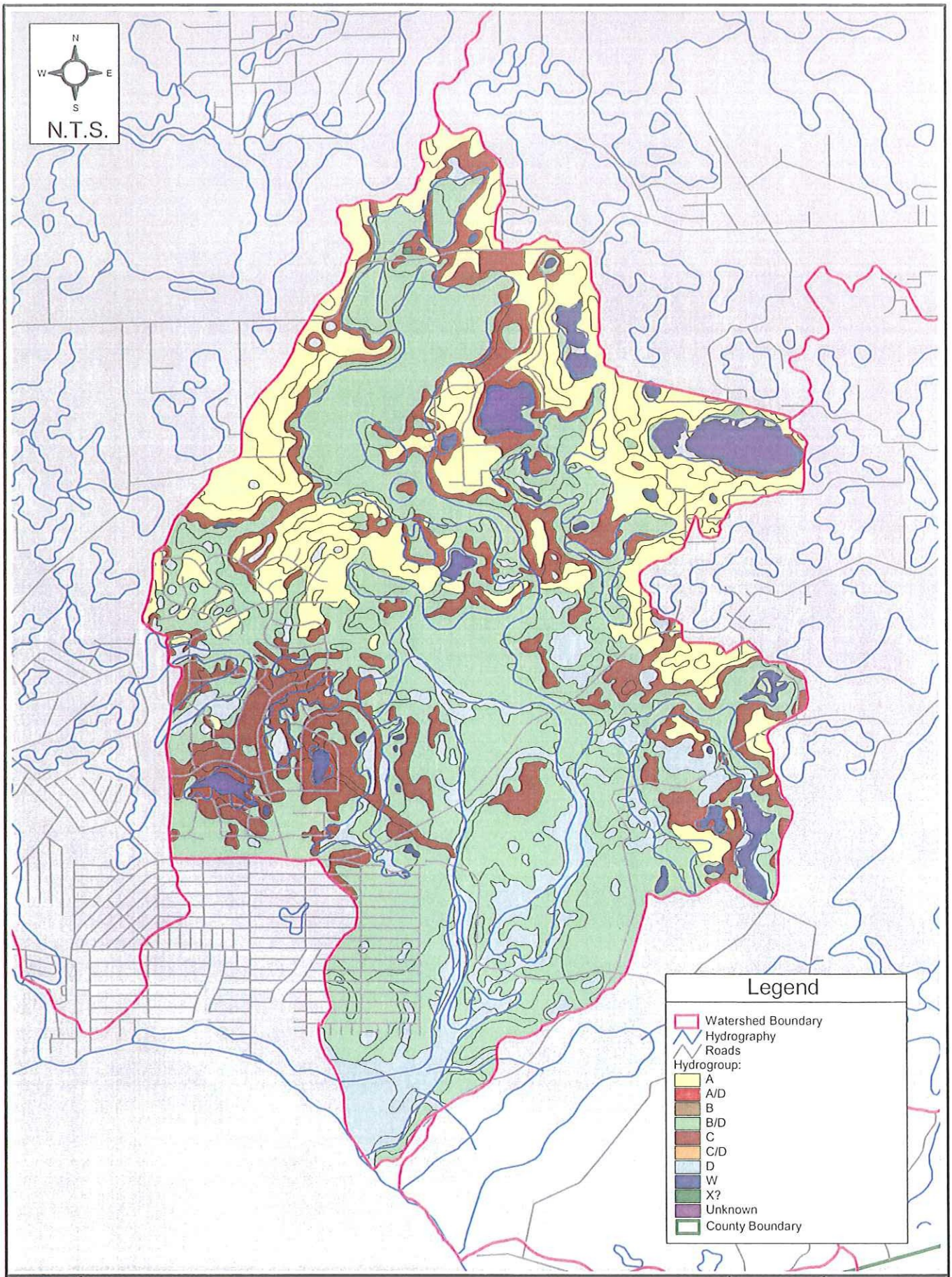
The majority of this watershed is classified Zone X, or area determined to be outside the 500-year floodplain. Around Tiger Branch and its tributaries, as well as the upper watershed wetlands and lakes there are corridors designated Zone A. Areas in Zone A lie in the 100-year floodplain for which no base flood elevations have been determined. Only at the downstream-most portion of this watershed are Zone AE designations found, where 100-year base flood elevations have been determined, based on detailed study of the St. Johns River. This watershed has not been subject to detailed study by FEMA. FEMA floodplain mapping is depicted on **Figure 3.6.7-2**.

3.6.7.3 Soils

This watershed exhibits a variety of hydrologic soil classifications, as shown in **Figure 3.6.7-3,** depicting the current hydrologic soil groups in the Tiger Branch Watershed. The most prevalent soil classification is B/D, representing nearly half of the watershed area. Other soil classifications represented in significant portions are well-drained A soils, somewhat poorly-drained C soils (moderately high runoff potential) and poorly-drained D soils with high runoff potential.

3.6.7.4 Land Use/ Land Cover

Figure 3.6.7- 4 depicts the current land use in the Tiger Branch Watershed. The vast majority of the watershed is undeveloped with 41% of the area represented by "Upland Forested" land use and 35% represented by "Water" and " Wetlands." "Residential" land use occupies 14% of the Tiger Branch Watershed.

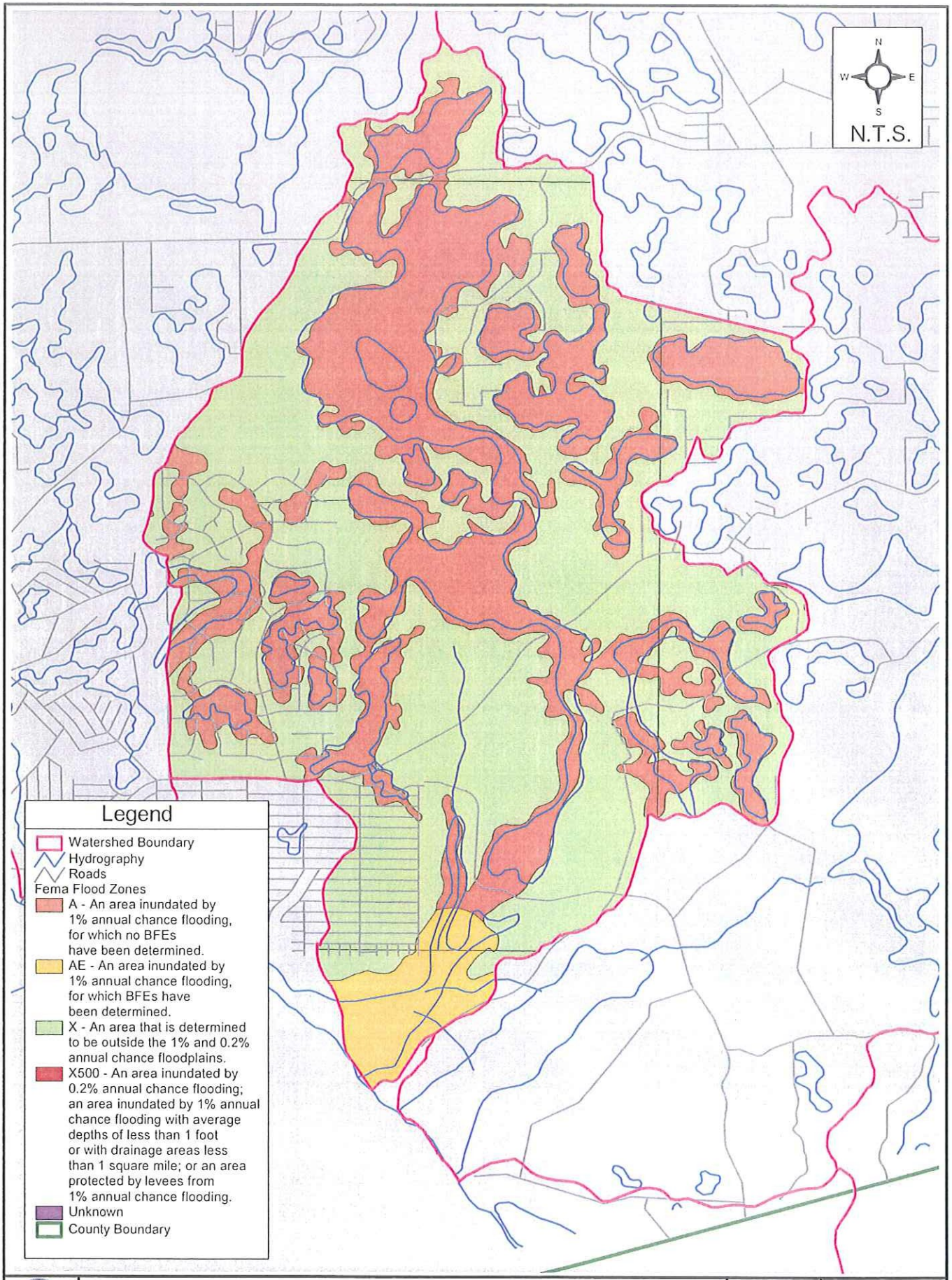


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\
APRs\Watershed Maps\Tiger_Branch.apr

Soils Distribution in the Tiger Branch Watershed
Putnam County Master Stormwater Plan

Figure
3.6.7-3

AYRES ASSOCIATES

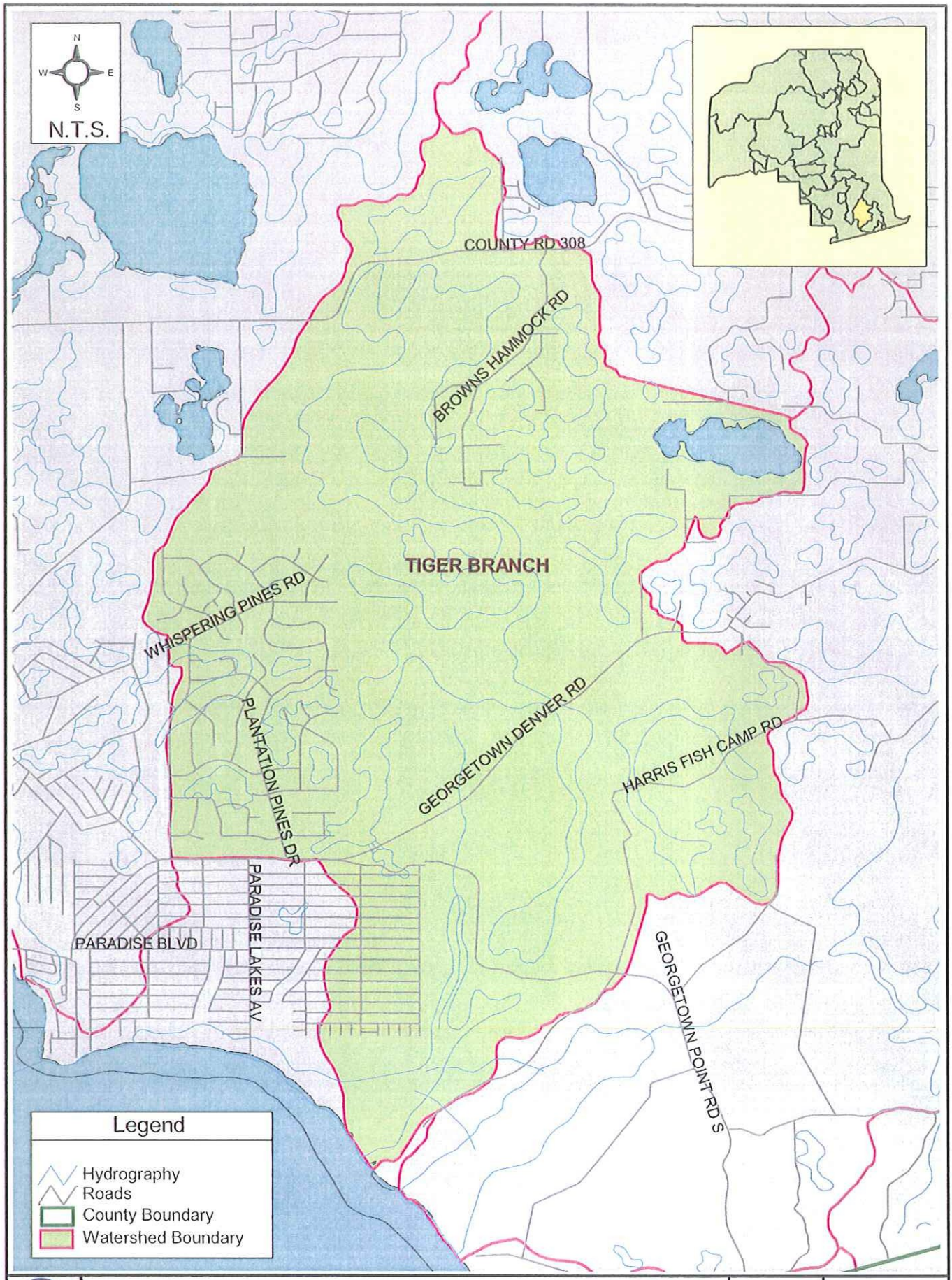


G:\COUNTY - PUTNAM\ 67011000(PutnumCoSWMMP)\GIS\ APRs\Watershed Maps\Tiger_Branch.apr

FEMA Flood Zones in the Tiger Branch Watershed
Putnam County Master Stormwater Plan

Figure 3.6.7-2

AYRES ASSOCIATES

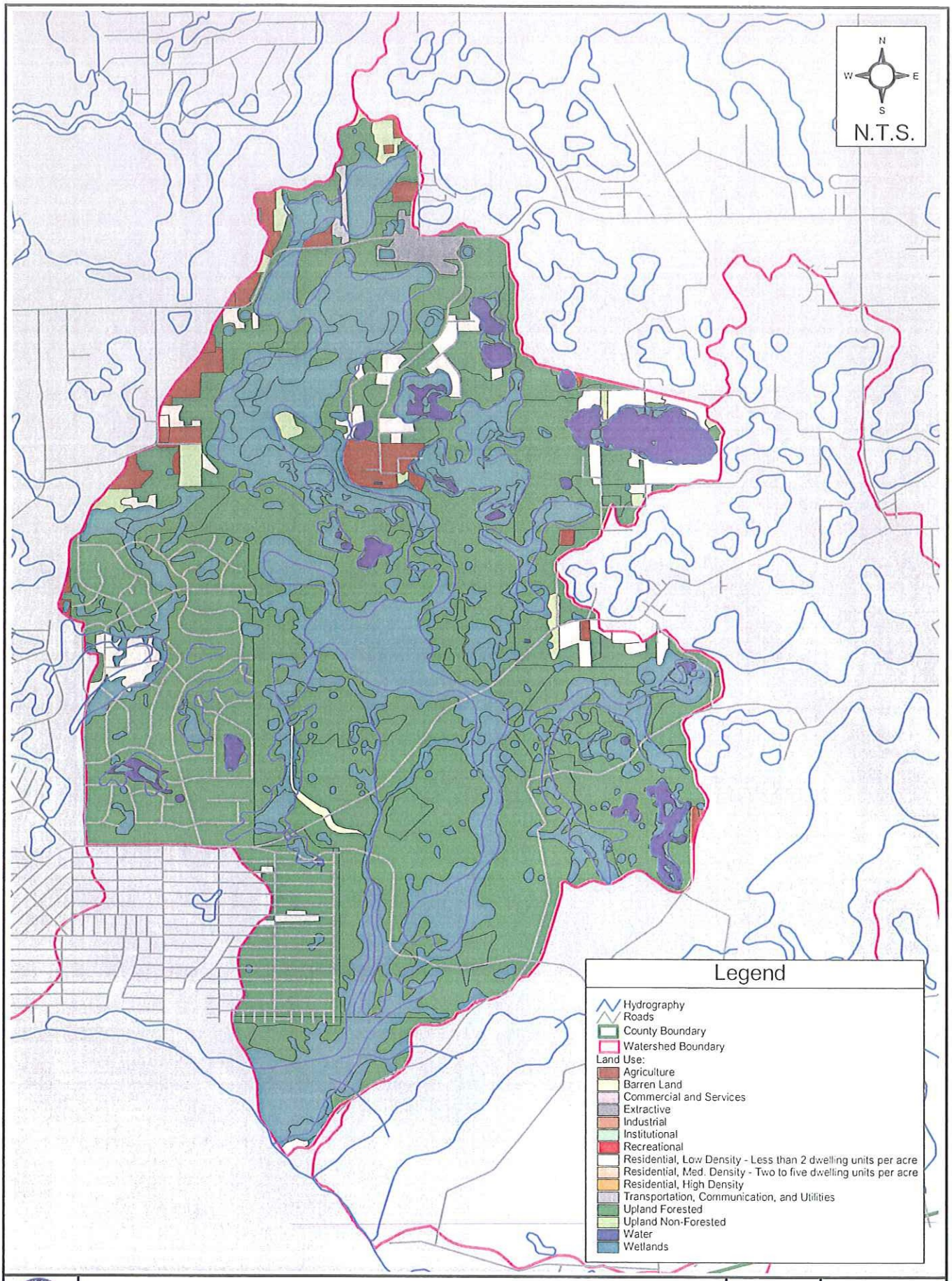


G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Watershed Maps\Tiger_Branch.apr

Location of the Tiger Branch Watershed
Putnam County Master Stormwater Plan

Figure 3.6.7-1

AVRES ASSOCIATES



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWM\P)\GIS\
APRs\Watershed Maps\Tiger_Branch.apr

Land Use Distribution in the Tiger Branch Watershed
Putnam County Master Stormwater Plan

Figure 3.6.7-4

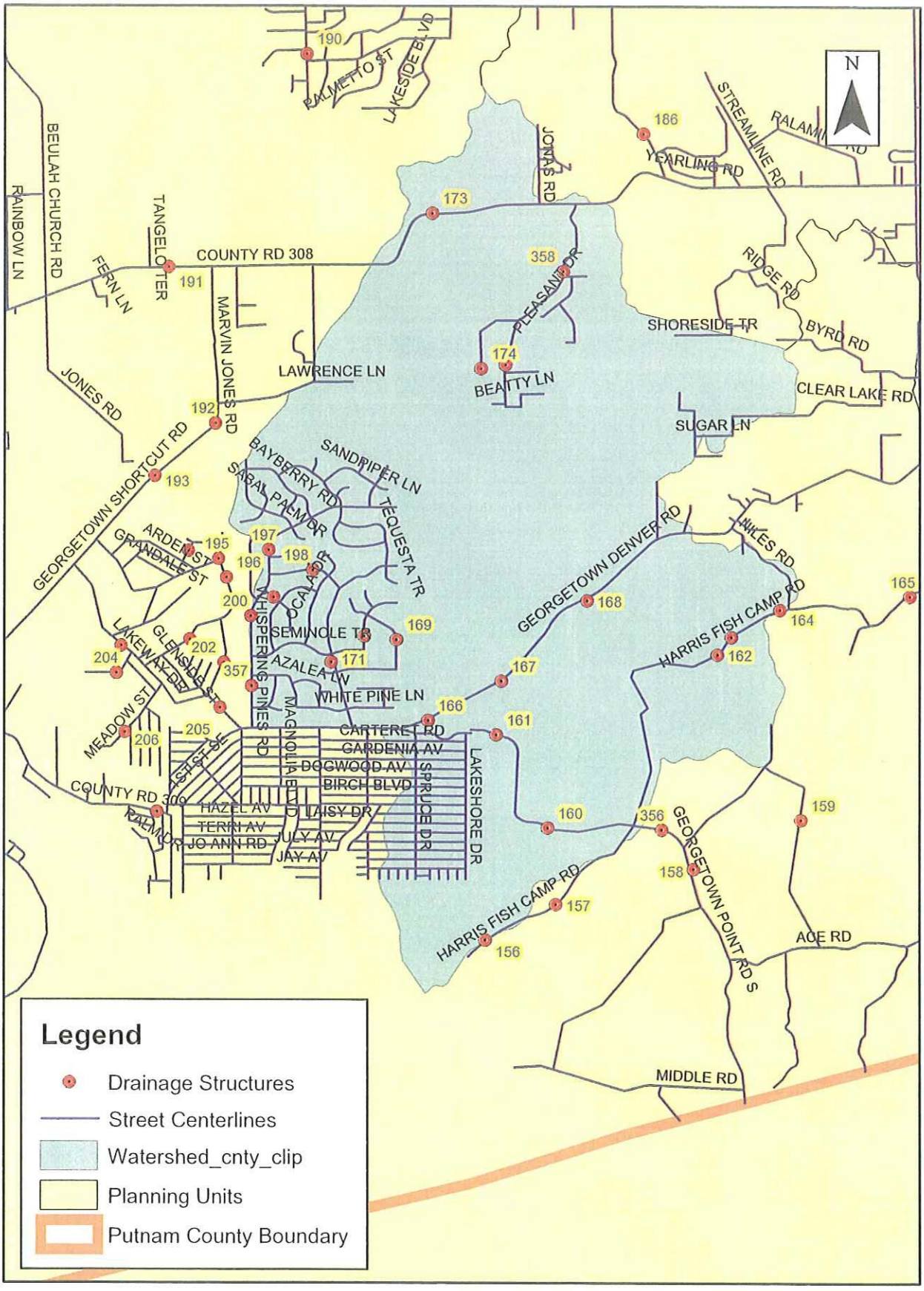
AYRES ASSOCIATES

3.6.7.5 Field investigations in Selected Subwatersheds

The field reconnaissance program described in Section 2.10 was performed for this watershed as illustrated on the following index figure. No modifications to basin delineations resulted from field investigations. Field reports for hydraulic structures and photo documentation from the investigation is presented in **Appendix 3-B**. These data have been incorporated into a GIS database for County use.

3.6.7.6 Sewer Network and Point Source Discharge

Sewer networks and point source discharges in this watershed have not been identified by the County. A search of FDEP permitted point source discharges and industrial stormwater dischargers was performed and no permitted point source discharges were found in the Tiger Branch Watershed.



Field Reconnaissance - Tiger Branch Watershed

Appendix 3-A
Putnam County Flood Insurance Studies (excerpts)

(Removed to a Separate Binder)

Appendix 3-B
Putnam County Field Investigation Data

(Removed to a Separate Binder)

TABLE OF CONTENTS

4.0 FUNDING AND ADMINISTRATION ALTERNATIVES....4-1
4.1 Current Funding Methods Review....4-1
4.1.1 Introduction....4-1
4.1.2 Making the System Work for the County....4-2
4.1.3 Grant and Funding Assistance Professionals....4-4
4.1.4 Federal and State Funding Assistance Programs....4-6
4.2 Comprehensive Plans Review....4-16
4.2.1 Element Review....4-16
4.2.2 Level of Service Evaluation....4-19
4.2.3 Other Municipal Comprehensive Plans....4-19
4.3 Land Development Codes Review....4-22
4.3.1 Article Review....4-22
4.3.2 Sufficiency Review....4-30
4.3.3 Other Municipal Codes....4-31
4.4 Prioritizing Future Flooding/WQ Problems....4-33

List of Tables

Table 4.1-1 Grant and Funding Assistance Professionals....4-5
Table 4.1-2 Federal and State Funding Assistance Programs....4-8
Table 4.3.3-1 Comparison of Municipal Land Development Codes with Putnam County .4-32

4.0 FUNDING AND ADMINISTRATION ALTERNATIVES

In addition to hydrologic and hydraulic engineering assessment of Putnam County stormwater management facilities, this Master Stormwater Plan provides evaluation and guidance for administrative and operational issues that are an integral part of stormwater management. Topics discussed in this section include:

- Stormwater Program Funding (current and potentially available)
- County and Municipal Levels of Service and Regulatory Frameworks (Comprehensive Plans/Land Development Codes)
- Prioritizing Future Flooding/Water Quality Problem Areas

These topics address the questions of how to finance the necessary maintenance and capital improvement tasks, as well as future studies; whether existing levels of service for public facilities are adequate and enforceable; how more detailed watershed assessments should best be approached technically; and what method of project prioritization will result in the highest and best use of available resources for the public's protection and welfare.

4.1 CURRENT FUNDING METHODS REVIEW

4.1.1 INTRODUCTION

Funding for staff, equipment, materials and engineering related to the maintenance and repair of existing stormwater facilities in Putnam County is primarily accomplished through the County's General Fund. Internal competition for General Funds each fiscal year is intense. There is one designated funding source set aside for infrastructure improvements called the "Better Places Fund," however it is insufficient for funding large capital improvement projects. There has been little success in obtaining cooperative funding or grants from Federal or State agencies for water resource projects to date.

The East Palatka and Hastings Drainage Districts' agriculture-related erosion and sediment transport issues are joined by an additional twenty-eight (28) significant flooding and sedimentation problems identified (Section 7) throughout the County. These problems will also require substantial maintenance and/or remediation in the form of Capital Improvement Projects (CIPs). The detailed evaluation of these CIPs will require development of 1-foot aerial contour mapping for, at a minimum, roughly half of the County. The current levels and methods of funding are not sufficient to support these "big ticket" items. As such, new funding sources will need to be explored.

A concept proven effective in funding drainage projects within many of Florida's local governments is Stormwater Utilities. Many cities in Florida have successfully implemented this funding mechanism. The noticing requirements for adding the proposed utility to ad-valorem taxes, however, make it much harder to pass in a County. Consequently, other sources of funding for County drainage projects are often preferred, such as cost sharing, acquisition of grants or funding assistance from Federal and State Agencies.

A more detailed discussion of funding assistance and cost sharing with state and federal agencies is presented in the following sections. Included are some comments on consultants specializing in local government grant assistance and cost sharing agreements with a list of

firms with experience in grant application writing; a summary of discussions held with several program managers; and a list of potential grant and funding assistance sources.

4.1.2 MAKING THE SYSTEM WORK FOR THE COUNTY

Obtaining funding assistance usually requires more than simply following the steps through the application process stipulated by the funding agency. Often characterized as a political process, the development of a reliable assisted-funding channel is surprisingly fluid. It requires the development of relationships with various agency contacts and/or the employment of an experienced consultant to act on the County's behalf. This commitment of resources is essential, as it is a stepwise process to acquire the "buy-in" of the funding Agency staff.

A funding application cycle is often a yearly process. For the successful applicant, the submittal of the application should be a formality, a final step in a process of discussions, meetings or series of meetings that began with the introduction of a project concept and ended with a general agreement on the project concept and as many of the individual components as possible. This is an iterative, and often time-consuming, process.

The evolutionary nature of the process can be illustrated by using the SJRWMD's cooperative funding process as an example. Note that a major emphasis for the Water Management District is pollutant load reduction goals (PLRGs) or total maximum daily load (TMDL) allocations for identified priority pollutants, which are not priorities shared by Putnam County as they tackle the twenty-eight (28) Problem Areas identified in Section 2.8 of this Master Stormwater Plan; or consider the fifteen (15) priority CIPs identified in Chapter 7 of this Master Stormwater Plan. However, a term often used among planners, "linkage", describes a process whereby certain components of a county project overlap, or are the same or similar, to components of a District project. The union of common components of the two projects can be cost-shared.

An example of this process follows.

Project: ***Hastings Drainage District***

Putnam County Components

-Aerial Mapping

-Culvert Replacement

-Expanding Maintenance Requirements

-Construct Sediment BMPs to Reduce Maintenance Requirements (all Watersheds, i.e. County Wide)

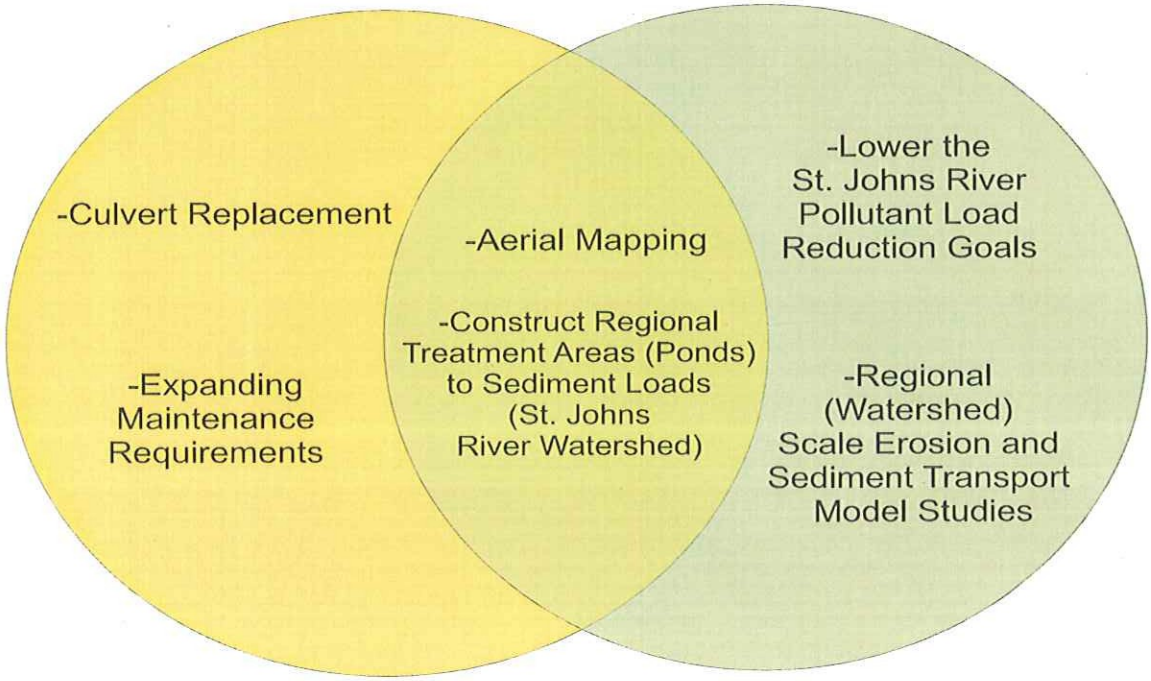
District Components

-Lower the St. Johns River Pollutant Load Reduction Goals

-Aerial Mapping

-Regional (Watershed) Scale Erosion and Sediment Transport Model Studies

-Construct Regional Treatment Areas (Ponds) to Sediment Loads (St. Johns River only)



In this scenario, aerial mapping and water quality (sediment load reduction) are the goals that the County and the District have in common. The water quality-related goal of the District is to remain at or below TMDL. The County's goal is the management of the sediment, more specifically the isolation of sediments into a limited number of locations to reduce the costs of maintenance. Coordination with District staff insures that the intersection of the two sets of project components is not only understood by both parties, but strongly supported by District staff. Although some components of a project may not be shared, such as the culvert replacement, others components are. On the other hand, if a water quality treatment area can be sited at or near the upstream end of the proposed replacement culverts, the replacement of the culverts can be tied in (linked) so that the costs can be distributed to both cooperating partners. In addition to "linkage", some funding agencies use the term "leverage" or "leveraging" of funds to describe this process of overlapping components to evaluate assisted funding potential.

4.1.3 GRANT AND FUNDING ASSISTANCE PROFESSIONALS

Use of consultants who specialize in development of grant and cost-sharing applications can reduce the burden of pursuing grants with limited County staff time. These consultants have a working knowledge of which programs are best funded, the amount of available funds, and what the realities are regarding types of projects likely to receive funding. In short, they have a good working knowledge of both funding sources and agency contacts. It is recommended that Putnam County utilize grant and funding assistance professionals to capitalize on often un-tapped state and federal funds and minimize the amount of County tax-based funding required for flood control and water quality improvements.

More complicated projects with intersecting components should also include an engineering consultant that understands the technical project components, the administrative and political nuances of linkages and of agency staff "buy-in," and the County and Agency goals as a major contributor to the project scope formulation and application process. A strong coordination effort, combining the two areas of expertise, forms the approach that will insure the strongest application (and assisted funding potential) possible.

A partial list of consultants providing grant and cost share-related services is provided in **Table 4.1-1**.

TABLE 4.1-1 GRANT AND FUNDING ASSISTANCE PROFESSIONALS

Ms. Rosemary Banks 114 North Madison Street Quincy, Florida 32351 Phone: 850/875-8601	**Jones-Phillips & Associates** **Mr. Bob Jones** 1829 Confederate Way Westville, Florida 32464 Phone: 850/956-5087 FAX: 850/956-5087 e-mail: rjones@wfeca.net	**North Central FL RPC** **Mr. Scott Koons** 2009 N.W. 67th Place, Suite A Gainesville, Florida 32653-1603 Phone: 352/955-2200 FAX: 352/955-2209 e-mail: koons@ncfrpc.org
Angie Brewer and Associates **Mr. Mark Brewer** 9104 58TH Drive East, Suite 101 Bradenton, Florida 34202 Phone: 941/756-5800 FAX: 941/756-0804 e-mail: angieb@abalc.com	**Jones-Phillips & Associates** **Ms. Robin Phillips** 2352 Arriviste Way Pensacola, Florida 32504 Phone: 850/433-4010 FAX: 850/433-4060 e-mail: robin.Phillips@cox.net	**North East Florida RPC, Inc.** 6850 Beelfort Oaks Place Jacksonville, Florida 32216 Phone: 904/279-0880 FAX: 904/279-0881 e-mail: info@nefrpc.org
Community Programs Consulting **Mr. Dick Edwards** 322 NW Houston Avenue Live Oak, Florida 32064 Phone: 386/364-6608 1-800/229-4210 FAX: 386/364-4828 e-mail: cpci@alltel.net	**Jordan and Associates** **Ms. Betty Jordan** 4611 U. S. Highway 17, Suite 3 Orange Park, Florida 32073 Phone: 386/264-6203 FAX: 386/278-0840 386/264-2190 (BJ desk) e-mail: jordangrants@aol.com	**Parrish and Associates** Mr. Jim Parrish 3041 Carlow Circle Tallahassee, Florida 32308 Phone: 850/668-3384 FAX: 850/893-8456 e-mail: jParr81243@aol.com
CRA Consulting, Inc. **Mr. Bud Clark** 305 South Andrews, Suite 710 Ft. Lauderdale, Florida 33301 Phone: 954/828-1370 FAX: 954/828-1334 e-mail: craprez@aol.com	**Key West Housing Authority** 1400 Kennedy Drive Key West, Florida 32040 Phone: 305/292-1221 FAX: 305/292-1162 e-mail: castillom@kwha.org	**Nancy Phillips & Associates** **Ms. Nancy Phillips** 7408 Edisto Drive Lake Worth, Florida 33467 Phone: 561/432-1524 FAX: 561/432-6734 e-mail: nsp920@aol.com
Andy Easton & Associates **Mr. Andy Easton** 1914 Fannie Drive Tallahassee, Florida 32303 Phone: 850/445-7829 FAX: 850/386-2605 e-mail: andyeaston2@msn.com	**David Melvin & Associates, Inc.** **Mr. Evan McAllister** Post Office Box 840 Marianna, Florida 32447-0840 Phone: 850/482-3045 FAX: 850/482-3957 e-mail: dhm@digitalexp.com	**Roumelis Planning & Dev. Serv.** **Ms. Deborah Belcher** 5378 Carisbrooke Lane Tallahassee, Florida 32309 Phone: 850/893-0694 FAX: 850/893-3503 e-mail: debroumelis@prodigy.com

TABLE 4.1-1 GRANT AND FUNDING ASSISTANCE PROFESSIONALS

Fred Fox Enterprises, Inc. Mr. Fred Fox Post Office Drawer 2017 Palatka, Florida 32178-2017 Phone: 386/328-3822 1-800/332-9369 FAX: 386/325-8484 e-mail: I_Fred@bellsouth.net	Curtis Minma 3706 North Ocean Blvd. Ft. Lauderdale, Florida 33308	Rural Resources Ms. Nan Wheeler 1207 Sandhurst Drive Tallahassee, Florida 32312 Phone: 850/386-3343 FAX: 850/385-4076
Government Funding Specialist Mr. Steve Weeks Post Office Box 3610 Sebring, Florida 33871 Phone: 941/471-2929 FAX: 941/471-0732 e-mail: z2804@ct.net	Meridian Comm. Ser. Group Ms. Lisa Blair Post Office Box 13408 Tallahassee, Florida 32317 Phone: 850/877-1908 toll-free: 800/877-1908 FAX: 850/878-8785 e-mail: meridianservicegroup@yahoo.com	Southern Research Center, Inc. Post Office Box 655 New Brockton, AL 36351 Phone: 334/347-6120 FAX: 334/347-2295 e-mail: herron100@hotmail.com
Hartman and Associates 201 East Pine Street, #100 Orlando, Florida 32801 Phone: 407/839-3955 FAX: 407/839-3790	Mittauer & Associates 4611-4 US Highway 17 Orange Park, Florida 32073 Phone: 904/278-0030 FAX: 904/278-0840 e-mail: mittauer@bellsouth.net	Summit Professional Services, Inc Ms. Marie Dingman Post Office Box 13356 Tallahassee, Florida 32317-3356 Phone: 850/309-1951 FAX: 850/309-1952 email: Marie.dingman@summitgrants.com

4.1.4 FEDERAL AND STATE FUNDING ASSISTANCE PROGRAMS

Table 4.1-2 provides a list of potential funding sources for Putnam County stormwater projects. Sources are divided into Federal and State agencies. As background in preparation of the table, program managers at several agencies were contacted, including the District, Natural Resource Conservation Service (NRCS), the Florida Department of Environmental Protection (FDEP), the United States Army Corps of Engineers (USACE), and the Department of Community Affairs (DCA).

The contacts interviewed at the District were Kraig McClain, Jeff Cole and Dennis Frazel. The largest pool of funds available from the Water Management Districts is through a special appropriation set aside by the state legislature. With few exceptions, this fund is targeted for construction projects to reduce TMDLs in the Lower St. Johns River, a designated Surface Water Improvement and Management (SWIM) program priority waterbody. Priority pollutant issues for this waterbody include sediment reduction and water quality improvement of agricultural non-point source input. A special Technical Advisory Committee (TAC) plays a significant role in coordination of projects and administration of funds. The District also appropriates funding for projects from its Stormwater Projects fund and out of its general fund. Feedback from the District indicated that, like the Lower St. Johns River TMDL fund, these latter two funding mechanisms are geared toward projects that address water quality.

The District has not historically provided funding assistance to the County, in large part due to an inability to find projects that have overlapping project components (linkage). Recent

applications from the County have been declined for this reason. This trend has potential for change if a greater investment of time is made toward strategically planning and building a consensus among District staff. Based on interviews with Mr. McClain, the District currently has a strong impetus to provide funding assistance to the County. With the formulation of this Master Stormwater Plan, linkages between several specific CIP projects and District water quality projects can be identified. Suitable projects include the East Palatka Drainage District and the Hastings Drainage District. The County Road 309 and 64th Street and the Palmetto Bluff Road projects also may have components that the District will be willing to share in. There may be additional opportunity in the future to leverage funds through District's designation as a Cooperating Technical Partner with FEMA, thereby opening a way toward new funds for flood studies and floodplain mapping.

The Florida Department of Environmental Protection offered grant funding (no matching funds required) in support of Putnam County's Comprehensive Stormwater Plan in July of 2005. An amount of $150,000 was offered under the State's Fiscal Year 2005-2006 General Appropriations Act for stormwater project funding. Project Work Plan forms were submitted by the County to begin watershed topographic mapping in support of future watershed modeling.

Inquiries were also made at the Department of Community Affairs. Jim Austin, a program manager in the Department, provided input. The emphasis from DCA was the same as that of the District. Like many other agencies, decisions are based, in part, on the recommendations of staff. Coordination with agency staff members helps to garner those recommendations.

DCA put the greatest emphasis on a special appropriation fund from FEMA for pre-disaster mitigation projects. The funds are for hurricane-related damage and mitigation. Though the program manager did not have all of the details readily available, he indicated that the fund's purpose was to assist with any past or future hurricane/flooding related projects. Moreover, FEMA funds will typically pay for any project-related item including County staff time, in-kind services, construction, and consulting fees. Consulting fees are not limited to design, and can even be used for grant writing consulting fees accrued while obtaining the hurricane disaster funds. Putnam County submitted an application to DCA in October 2005 requesting funding through the Hazard Mitigation Grant Program. The grant was requested to fund topographic mapping and watershed modeling studies to map floodplains and recommend flood control/flood protection projects and alternatives. Although the application was not denied, the grant program was subsequently placed in a "hold" status.

Discussion with the USACE and NRCS indicated that these programs are not as productive as other funding sources. All of the program managers commented that the annual funding amounts were on a downward trend, however funds are appropriated. As with the state agencies, the County will greatly increase its probability of obtaining funds by establishing a place as a stakeholder in both NRCS and USACE projects. Each of these agencies has a presence in the region and has programs that have eligibility requirements fitting those of Putnam County.

A summary of various federal and state programs is given in the table below. Several of these programs were discussed with the Program Managers in the above-mentioned interviews, although in-depth inquiries into each of these programs were beyond the scope of this task. The table does provide an indication of the extent and number of programs available to conduct water resource projects.

TABLE 4.1-2 FEDERAL AND STATE FUNDING ASSISTANCE PROGRAMS

FEDERAL FUNDS	
Agency	**Department of Defense (DOD), U.S. Army Corps of Engineers (USACE)**
Grant	**Aquatic Ecosystem Restoration**
Objective	Direct support for carrying out aquatic ecosystem restoration projects that will improve the quality of the environment.
Applicant Eligibility	
Local Office Contact	South Atlantic: (904) 232-2586
Web Site Address	None Provided
Agency	**Department of Interror (DOI), U.S. Geological Survey (USGS)**
Grant	**Streamgaging and Flood Monitoring Network**
Objective	Operation of a network of over 7,000 streamgaging stations that provide data on the flood characteristics of rivers.
Applicant Eligibility	
Local Office Contact	Chief, Office of Surface Water,USGS: (703) 648-5303
Web Site Address	
Agency	**Federal Emergency Management Agency (FEMA)**
Grant	**Flood Mitigation Assistance Program**
Objective	FMA provides funding to assist States and communities in implementing measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the National Flood Insurance Program (NFIP). There are three types of grants available under FMA: Planning, Project, and Technical Assistance Grants. FMA Planning Grants are available to States and communities to prepare Flood Mitigation Plans. NFIP-participating communities with approved Flood Mitigation Plans can apply for FMA Project Grants. FMA Project Grants are available to States and NFIP participating communities to implement measures to reduce flood losses. Ten percent of the Project Grant is made available to States as a Technical Assistance Grant.
Applicant Eligibility	Community/Watershed Group, Local Government, State/Territorial Agency, Tribal Agency
Local Office Contact	Region 4: Federal Emergency Management Agency 3003 Chamblee Tucker Road, Atlanta, GA 30341 Tel: 770-220-5200 Fax: 770-220-5230
Web Site Address	http://www.fema.gov/fima/fma.shtm
Agency	**Federal Emergency Management Agency (FEMA)**
Grant	**National Flood Insurance Program: Flood Mapping;**
Objective	Flood insurance rate maps and flood plain management maps for all NFIP communities;
Applicant Eligibility	Community/Watershed Group, Local Government, State/Territorial Agency, Tribal Agency
Local Office Contact	Region 4: Federal Emergency Management Agency 3003 Chamblee Tucker Road, Atlanta, GA 30341 Tel: 770-220-5200 Fax: 770-220-5230
Web Site Address	http://www.fema.gov/fima/fma.shtm
Agency	**Natural Resources Conservation Service (NRCS)**

TABLE 4.1-2 FEDERAL AND STATE FUNDING ASSISTANCE PROGRAMS

Grant	**Watershed Protection and Flood Prevention**
Objective	To provide technical and financial assistance in carrying out works of improvement to protect, develop, and utilize the land and water resources in small watersheds.
Applicant Eligibility	Any State agency, county or groups of counties, municipality, town or township, soil and water conservation district, flood prevention or flood control district, Indian tribe or tribal organization, or any other nonprofit agency with authority under State law to carry out, maintain, and operate watershed works of improvement may apply for assistance.
Local Office Contact	T. Niles Glasgow (904) 338-9500
Web Site Address	http://www.nrcs.usda.gov
Agency	**Natural Resources Conservation Service (NRCS)**
Grant	**Soil and Water Conservation**
Objective	To help people conserve, improve, and sustain our natural resources and environment.
Applicant Eligibility	Land users, Land owners, Community organizations, State governments and local governments.
Local Office Contact	T. Niles Glasgow (904) 338-9500
Web Site Address	http://www.nrcs.usda.gov
Agency	**Natural Resources Conservation Service (NRCS)**
Grant	**Watershed Protection & Flood Prevention**
Objective	To provide technical and financial assistance in carrying out works of improvement to protect, develop, and utilize the land and water resources in small watersheds.
Applicant Eligibility	Any State agency, county or groups of counties, municipality, town or township, soil and water conservation district, flood prevention or flood control district, Indian tribe or tribal organization, or any other nonprofit agency with authority under State law to carry out, maintain, and operate watershed works of improvement may apply for assistance. This program is available in Puerto Rico, the Virgin Islands, Guam, American Samoa, the Mariana Islands and the Trust Territories of the Pacific Islands.
Local Office Contact	Watersheds and Wetlands Division, Natural Resources Conservation Service, Department of Agriculture, P.O. Box 2890, Washington, DC 20013. Telephone: (202) 720-3534.
Web Site Address	http://www.nrcs.usda.gov
Agency	**Natural Resources Conservation Service (NRCS), Department of Agriculture (USDA)**
Grant	**Watershed Rehabilitation Program**
Objective	To provide technical and financial assistance to rehabilitate dams originally constructed with assistance of USDA Watershed Programs. Rehabilitation must extend the life of the dam and meet applicable safety and performance standards. Priority is given to dams that could result in loss of life if the dam should fail.

TABLE 4.1-2 FEDERAL AND STATE FUNDING ASSISTANCE PROGRAMS

Applicant Eligibility	Sponsoring local organizations for existing watershed projects that include dams that were originally constructed with assistance from one of the following water resource programs: Public Law 78-534, Section 13 of the Flood Control Act of 1944; Public Law 156-67, the pilot watershed program authorized under the heading Flood Prevention of the Department of Agriculture Appropriation Act of 1954; Public Law 83-566, the Watershed Protection and Flood Prevention Act of 1954; and Subtitle H of Title XV of the Agriculture and Flood Act of 1981, commonly known as the Resource Conservation and Development Program.
Local Office Contact	Watersheds and Wetlands Division, Natural Resources Conservation Service, Department of Agriculture, P.O. Box 2890, Washington, DC 20013. Telephone: (202) 720-3534. http://www.nrcs.usda.gov
Web Site Address	http://www.nrcs.usda.gov
Agency	**Natural Resource Conservation (NRCS)**
Grant	**Watershed Surveys and Planning**
Objective	Surveys and planning studies for appraising water and related resources, and formulating alternative plans for conservation use and development. Grants and advisory/counseling services to assist w/planning and implementation improvement.
Applicant Eligibility	States, political subdivisions of States or other responsible local agencies established under State law with full authority and ability to undertake necessary legal and financial responsibilities.
Local Office Contact	US Department of Agriculture (**USDA**) – National Resources Conservation Service (**NRCS**) Watersheds and Wetlands Division: (202) 720-4527 Deputy Chief for Programs: (202) 690-0848
Agency	**Natural Resource Conservation Service (NRCS)**
Grant	**Watershed Protection and Flood Prevention Program**
Objective	Technical and financial assistance for installing works of improvement to protect, develop, and utilize land or water resources in small watersheds under 250,000 acres.
Applicant Eligibility	Local Government, Community/Watershed Group, Nonprofit Groups, Conservation District
Local Office Contact	Director, Watersheds and Wetlands Division: (202) 720-3042 (202) 690-4614
Web Site Address	www.nrcs.usda.gov
Agency	**U.S. Army Corps of Engineers (USACE)**
Grant	**Flood Control Projects**
Objective	To reduce flood damages through projects not specifically authorized by Congress.
Applicant Eligibility	States, political subdivisions of States, or other responsible local agencies established under State law with full authority and ability to undertake necessary legal and financial responsibility.
Local Office Contact	Col. Bruce Malson (904) 791-2241
Agency	**U.S. Army Corps of Engineers (USACE)**
Grant	**Flood Plain Management Service**
Objective	To promote appropriate recognition of flood hazards in land and water use planning and development through the provision of flood and flood plain related data, technical services, and guidance.

TABLE 4.1-2 FEDERAL AND STATE FUNDING ASSISTANCE PROGRAMS

Applicant Eligibility	States, political subdivisions of States, other nonfederal public organizations and the public.
Local Office Contact	U.S. Army Corps of Engineers, Attn: CECW-PF, Washington, DC 20314-1000. Telephone: (202) 761-0169. FTS is not available.
Web Site Address	http://www.usace.army.mil/business.html
Agency	**U.S. Army Corps of Engineers (USACE)**
Grant	**Snagging and Clearing for Flood Control**
Objective	To reduce flood damages.
Applicant Eligibility	States, political subdivisions of States or other responsible local agencies established under State law with full authority and ability to undertake necessary legal and financial responsibilities.
Local Office Contact	U.S. Army Corps of Engineers, Attn: CECW-PM, Washington, DC 20314-1000. Telephone: (202) 761-1975. FTS is not available.
Web Site Address	http://www.usace.army.mil/business.html
Agency	**U.S. Army Corps of Engineers (USACE)**
Grant	**Flood Control Project**
Objective	To reduce flood damages through projects not specifically authorized by Congress.
Applicant Eligibility	States, political subdivisions of States, or other responsible local agencies established under State law with full authority and ability to undertake necessary legal and financial responsibility.
Local Office Contact	U.S. Army Corps of Engineers, Attn: CECW-PM, Washington, DC 20314-1000. Telephone: (202) 761-1975. FTS is not available.
Web Site Address	http://www.usace.army.mil/business.html
Agency	**U.S. Army Corps of Engineers (USACE)**
Grant	**Protection, Clearing And Straightening Channels**
Objective	To restore channels for purposes of navigation or flood control.
Applicant Eligibility	States, political subdivisions of States or other responsible local agencies established under State law with full authority and ability to undertake necessary legal and financial responsibilities.
Local Office Contact	Commander, U.S. Army Corps of Engineers, Attn: CECW-OD, Washington, DC 20314-1000. Telephone: (202) 272-8835. FTS is not available.
Web Site Address	http://www.usace.army.mil/business.html
Agency	**U.S. Army Corps of Engineers (USACE)**
Grant	**Floodplain Management Services**
Objective	Technical and planning assistance at the local, regional, or national level needed to support effective floodplain management.
Applicant Eligibility	
Local Office Contact	South Atlantic: (904) 232-2586
Web Site Address	None Provided
Web Site Address	http://www.usace.army.mil/business.html
Agency	**U.S. Department of Agriculture (USDA), Natural Resource Conservation Service (NRCS)**
Grant	**Emergency Watershed Protection Program**

TABLE 4.1-2 FEDERAL AND STATE FUNDING ASSISTANCE PROGRAMS

Objective	Provides technical and financial assistance for relief from imminent hazards in small watersheds, and to reduce vulnerability of life and property in small watershed areas damaged by severe natural hazard events.
Applicant Eligibility	Local Government, Community/Watershed Group, Nonprofit Groups, Conservation District
Local Office Contact	National Office – (202) 690-0848 Watersheds and Wetlands Division: (202) 720-3042
Web Site Address	None Provided
Agency	**U.S. Department of Agriculture (USDA), Rural Utilities Service**
Grant	**Water and Waste Disposal Systems for Rural Communities**
Objective	This USDA Rural Utilities Service program provides monies to provide basic human amenities, alleviate health hazards, and promote the orderly growth of the rural areas of the nation by meeting the need for new and improved rural water and waste disposal facilities. Funds may be used for the installation, repair, improvement, or expansion of a rural water facility including costs of distribution lines and well pumping facilities. Funds also support the installation, repair, improvement, or expansion of a rural waste disposal facility, including the collection and treatment of sanitary waste stream, stormwater, and solid wastes.
Applicant Eligibility	Local Government, Community/Watershed Group, Nonprofit Groups, Conservation District
Local Office Contact	Florida/Virgin Island Rural Development -Water and Environmental Programs Michael Langston (352) 338-3440 michael.langston@fl.usda.gov
Web Site Address	www.usda.gov/rus/water/programs.htm
Agency	**U.S. Environmental Protection Agency (EPA)**
	Targeted Watershed Grants
Objective	To support innovative, community-based watershed approaches aimed at preventing, reducing, or eliminating water pollution. The Watershed Initiative will provide resources in the form of grants, tools, training, and technical expertise and assistance to communities to bolster their efforts to expand and improve existing water protection measures. Funds will be awarded to assist watershed partnerships comprised of local, State, Indian Tribe, and interstate agencies and other public or nonprofit organizations in developing, implementing, and demonstrating on-the-ground projects to improve or maintain water quality.
Applicant Eligibility	State, local, public nonprofit institutions/organizations, federally recognized Indian tribal governments, U.S. territories or possessions, interstate organizations, colleges and universities, individuals, private nonprofit institutions/organizations.
Local Office Contact	Region 4: Florida - William Cox (404) 562-9351 cox.williaml@epa.gov.
Web Site Address	http://www.epa.gov/owow/watershed/initiative/
Agency	**U.S. Environmental Protection Agency (EPA)**
Grant	**Brownfields Grants**

TABLE 4.1-2 FEDERAL AND STATE FUNDING ASSISTANCE PROGRAMS

Objective	The U.S. Environmental Protection Agency's (EPA's) Brownfields Program is designed to empower states, communities, and other stakeholders in economic redevelopment to work together in a timely manner to prevent, assess, safely clean up, and sustainably reuse brownfields. EPA provides technical and financial assistance for brownfields activities through an approach based on four main goals: protecting human health and the environment, sustaining reuse, promoting partnerships, and strengthening the marketplace. Brownfields grants serve as the foundation of the Brownfields Program. These grants support revitalization efforts by funding environmental assessment, cleanup, and job training activities. Assessment Grants provide funding for brownfield inventories, planning, environmental assessments, and community outreach. Revolving Loan Fund Grants provide funding to capitalize a revolving loan fund and to provide subgrants to carry out cleanup activities at brownfield sites. Job Training Grants provide environmental training for residents of brownfields communities. Cleanup Grants provide direct funding for cleanup activities at specific sites.
Applicant Eligibility	Local Government, State/Territorial Agency, Tribal Agency
Local Office Contact	Region 4 - Florida State Coordinator Barbara Schuster schuster.barbara@epa.gov 404-562-8923
Web Site Address	www.epa.gov/brownfields/
State Funds	
Agency	**Florida Department of Community Affairs**
Grant	Community Development Block Grant Program
Objective	Provides funding for housing and community development. Examples of activities that are eligible include: rehabilitation and preservation of housing; water and sewer improvements; street improvements; economic development activities; downtown revitalization; parks and recreation; and drainage improvements.
Applicant Eligibility	Non-entitlement cities, or cities who opt out of an urban entitlement program, with a population less than 50,000 and counties having a population less than 200,000 are eligible to apply for Small Cities Community Development Block Grant funds.
Local Office Contact	Jim Austin 850-922-1882 email: jim.austin@dca.state.fl.us
Web Site Address	http://www.floridacommunitydevelopment.org/
Agency	**Florida Department of Community Affairs (Division of Emergency Management)**
Grant	**Pre-Disaster Mitigation project grants**
Objective	To assist communities to implement hazard mitigation programs designed to reduce overall risk to the population and structures before the next disaster occurs. Department of Emergency Management (DEM) is soliciting project applications and encourage your local government to identify and submit applications that address eligible mitigation activities that are designed to reduce your community's overall risk to hazards.

TABLE 4.1-2 FEDERAL AND STATE FUNDING ASSISTANCE PROGRAMS

Applicant Eligibility	Eligible applicants are State agencies; Federally recognized Indian Tribal governments, and local governments. Private non-profit organizations are not eligible, to apply; however, they may request a local government to submit an application for proposed activities on their behalf. Eligible activities include mitigation projects that primarily focus on natural hazards, but may also address hazards caused by non-natural forces. Funding is restricted to a maximum of $3.0 million federal share per project. Eligible projects include:· Property acquisition or relocation;· Structural and non-structural retrofitting (e.g. elevation, storm shutters and hurricane clips);· Minor structural hazard control on protection (e.g. culverts, floodgates, retention basins); and· Localized flood control projects that are designed to protect critical facilities and are not part of a larger flood control system.
Local Office Contact	Ara Nahapetian, Engineering Supervisor, (850)-922-5332 or E-mail: ara.nahapetian@dca.state.fl.us
Web Site Address	http://www.floridadisaster.org/brm/PDM/PDM_main.htm
Comments	application period will close March 4, 2005
Agency	**Florida Department of Environmental Protection (FDEP)**
Grant	**Statewide Surface Water Restoration and Wastewater Projects**
Objective	To provide funding for restoration and wastewater control efforts for statewide projects.
Applicant Eligibility	Local Government, Nonprofit, For-Profit
Local Office Contact	Department of Environmental Protection Division of Water Resource Management 2600 Blair Stone Road, Tallahassee, FL 32399-2400 Telephone: (850) 921-9459
Web Site Address	http://www.dep.state.fl.us/water/
Agency	**Florida Department of Environmental Protection (FDEP)**
Grant	**State Revolving Fund Loan Program for Water Pollution Control**
Objective	
Applicant Eligibility	Local governments and non-governmental entities
Local Office Contact	Bob Holmden (850) 245-8358
Web Site Address	http://www.dep.state.fl.us/water/wff/cwsrf
Agency	**Florida Department of Environmental Protection (FDEP)**
Grant	**Statewide Surface Water Restoration and Wastewater Projects**
Objective	To provide funding for restoration and wastewater control efforts for statewide projects.
Applicant Eligibility	Local Government, Nonprofit, For-Profit
Local Office Contact	Department of Environmental Protection Division of Water Resource Management 2600 Blair Stone Road, Tallahassee, FL 32399-2400 Telephone: (850) 921-9459
Web Site Address	http://www.dep.state.fl.us/water/
Agency	**Florida Department of Transportation (FDOT)**
Grant	**Small County Outreach Program**
Objective	To assist small county governments in resurfacing or reconstructing county roads or in constructing capacity or safety improvements to county roads.
Applicant Eligibility	Local Governments

TABLE 4.1-2 FEDERAL AND STATE FUNDING ASSISTANCE PROGRAMS

Local Office Contact	Department of Transportation Pavement Management Office 605 Suwannee Street, Mail Station 70, Tallahassee, FL 32399-0450 Telephone: (850) 414-4375
Web Site Address	http://www.dot.state.fl.us/programdevelopmentoffice/small_county_outreach_program.htm
Agency	**St. Johns River Water Management District**
Grant	**Stormwater Management Projects Cooperative Cost-Sharing Program**
Objective	To provide financial assistance to local governments in stormwater management related projects.
Applicant Eligibility	Qualified respondents include governmental agencies, municipalities, county governments, special districts and other public entities within SJRWMD's 18-county service area.
Local Office Contact	Denis Frazel (386) 329-4553, E-mail: dfrazel@sjrwmd.com
Web Site Address	http://www.sjrwmd.com/programs/cost_share.html
Agency	**St. Johns River Water Management District**
Grant	**Lower St. Johns River Basin Legislative TMDL Fund**
Objective	Lower TMDLs in the Lower St. Johns River through leglistative funding of multi-purpose construction projects designed to reduce TMDLs.
Applicant Eligibility	Qualified respondents with projects in the LSJR basin. Includes governmental agencies, municipalities, county governments,special districts and other public entities.
Local Office Contact	Kraig Mclane, (386) 999-9999, Email: kmclane@sjrwmd.com
Web Site Address	http://www.sjrwmd.com
Comments	This is principally a program to cost share construction projects
Other Funding Sources	
	www.ecivis.com - Grants Locator is the new standard for federal and state grant information that reduces the time local government employees spend researching funding opportunities.
	http://12.46.245.173/cfda/cfda.html - Catalog of Federal Domestic Assistance-This web site gives you access to a database of all Federal programs available to State and local governments.
	FloridaDisaster
	http://www.floridadisaster.org/brm/PDM/PDM_main.htm

4.2 COMPREHENSIVE PLANS REVIEW

The Comprehensive Plan for Putnam County was established by ordinance in 1991 and at the time of review, had last been revised in 2002. The overarching objective of the Comprehensive Plan is to:

> *"... control future land use, guide public facilities, and protect natural resources pursuant to the Local Government Comprehensive Planning and Land Development Regulation Act (Chapter 163, Part II, Florida Statutes), inlcuding a Future Land Use Element; Traffic Circulation Element; Housing Element; Sanitary Sewer, Solid Waste, Drainage, Potable Water and Natural Groundwater Aquifer Recharge Element; Conservation Element; Recreation and Open Space Element; Intergovernmental Coordination Element; and Capital Improvements Element; providing for severability; and providing for an effective date."*

Elements that are relevant to the Master Stormwater Plan are the:

- Future Land Use Element
- Sanitary Sewer, Solid Waste, Drainage and Natural Groundwater Aquifer Recharge (Infrastructure) Element
- Conservation Element
- Intergovernmental Cooperation Element
- Capital Improvements Element

These elements were reviewed and are discussed briefly, with emphasis on the Level of Service (LOS) standards. Comprehensive Plans from the municipalities within Putnam County have also been reviewed for consistency with the Putnam County Comprehensive Plan objectives.

4.2.1 ELEMENT REVIEW

Future Land Use Element

This element strives to set objectives and policies to maximize land utilization and reduce sprawl, while improving resource use by coordinating future land use with appropriate topography, adjacent land uses, soil conditions and public service facility availability. Related policies include limiting type and extent of development in areas identified by FEMA FIRM panels as areas of special flood hazard. The County's site plan review and permitting processes (laid out in the Land Development Code) are mandated in this element. The plan calls for the identification of interim measures for stormwater management and drainage issues until a County-wide Stormwater Master Drainage Plan is formally adopted and mandates the development of such a plan. The future land use element has specific policies protecting agricultural land uses and both public and residential water wells. Erosion control issues are addressed through policies that require paved roads for new subdivisions, construction BMPs, and agriculture/silviculture adherence to best management practice guidance documents. Policies also address the vegetative buffers and protective setbacks found in and enforced by Article 6 of the Land Development Code.

Sanitary Sewer, Solid Waste, Drainage and Natural Groundwater Aquifer Recharge (Infrastructure) Element

The stated goal of this element is to ensure that the County will meet existing and projected public service demands at the Level of Service (LOS) identified within the element and will protect and preserve the areas of high aquifer recharge capacity for the long-term benefit of those who draw water from this shared resource. Objectives include correcting existing deficiencies and coordinating the extension of facilities to meet future needs. A five-year schedule of capital improvement needs for public facilities is to be developed and maintained by Putnam County, maximizing the use of existing infrastructure. The review of this element focuses on the established LOS for drainage facilities.

Policy D.1.2.3 of the Comprehensive Plan applies the following level of service standards for drainage facilities, to be used as a basis of determining the availability of facility capacity and the demand generated by a development.

Stormwater management facilities shall be designed to accommodate the 25-year frequency, 24-hour duration design storm and to meet the subset of additional standards below:

- Peak post-development runoff rates shall not exceed pre-development peak runoff rates
- Stormwater treatment consistent with the Water Management District standards of 40C-42.025, F.A.C. shall be required for all new development and ambient water quality shall be maintained
- Wetland stormwater discharges shall be permitted in accordance with Rule 17-25.042 (now 62-25.042), F.A.C.
- Permits for construction of new stormwater discharge facilities shall follow Rule 17-25.040 (now 62-25.040), F.A.C.
- Level of Service for water quality consistent with Chapter 17-25 (now 62-25) stipulating the retention of the first one inch of runoff for drainage basins over 100 acres; the first one-half inch of runoff for drainage basins under 100 acres
- Closed conduits are to be designed for the 10-year, 24-hour storm based on IDF curves for Zone 5 (FDOT Drainage Manual)
- Open channels are to be designed for the 25-year, 24 hour storm based on IDF curves for Zone 5 (FDOT Drainage Manual)

Another stated objective in this element of the Comprehensive Plan is for the County to take specific flood protection measures which will protect all surface water bodies from pollutants. Policies that support this objective include the adoption of the level of service standards listed above as land development regulation, and the development, approval and enaction of a drainage master plan to be made part of the Public Facilities Element. A policy also calls for land development regulations which require on-site retention of runoff from new construction sites to permit "no greater runoff than existed prior to construction activities."

Conservation Element

The stated goal of this element is to conserve and protect the natural resources of Putnam County and maintain an acceptable quality of life for its citizens. The policies within this element include:

- Water quality protections such as prohibitions against the release of untreated or partially-treated sewage into water resources, stipulation of protective buffers between development and water or wetland resources, stormwater management and erosion control mandates, and identification of water quality impaired waters to Water Management Districts for SWIM program analysis
- Water conservation policies and recharge area/public wellhead protection setbacks and land use restrictions
- Limitations of development in areas of special flood hazard
- Setback and development limitations for wetland areas and other environmentally sensitive areas
- Protections for marine and wildlife habitat including potential establishment of wildlife corridors, a manatee protection plan for marinas, and greenways identification and enhancement

Intergovernmental Coordination Element

This element sets objectives and policies to improve coordination between Putnam County and the adjacent local governments, as well as local, regional and state agencies for the purpose of coordinating development activities and maximizing the use of available resources to preserve the quality of life. With respect to stormwater planning, the plan calls for adoption of coordination policies through plan review and/or significant development notification with the County School Board, Crescent City, Interlachen, Palatka, Pomona Park and Welaka. Coordinating relationships with municipalities are to be maintained to ensure compatibility of adjacent land uses and preservation of wildlife and plant habitats. The County Planning Building and Zoning Departments are to be responsible for coordination and municipality notification of changes in the Comprehensive Plan. The Regional Planning Council is to be used in resolution of conflict with neighboring jurisdictions regarding land uses and protection of natural resources

For coordination of state road construction and maintenance, and associated drainage facilities, Putnam County is to review adopted FDOT plans and programs and to participate in FDOT 5-year construction program workshops. Comparison of state regulations will be made to the LOS identified in the Comprehensive Plan's Drainage Sub-Element and Traffic Circulation Element.

Capital Improvements Element

This element strives to set objectives and policies to provide County residents with a financially feasible plan for the provision of public facilities, recreational facilities and roads concurrent with new development which meets or exceeds the adopted standards for LOS.

A five-year capital budget is to be maintained and updated annually, detailing necessary expenditures for new or renovated public facilities. Needs are to ranked and prioritized with estimated funds available for debt service. Criteria for identifying needs include protection of public health, welfare and safety, elimination of existing capacity deficits, facilities to serve new development, and facilities to serve future development. Coordination of land use decisions with projected new or improved public facilities should take place to ensure maintenance of required LOS. Future development is to pay fair share of the costs associated with providing necessary infrastructure improvements. Provisions and guidance for implementation,

monitoring and evaluation of the five-year capital improvements budget are included in this Element .

With respect to stormwater management, the Capital Improvements Element includes specific policies for drainage level of service standards to be used as a basis for determining available facility capacity and demand generated by development. The cited standards are identical to those previously summarized under the Drainage Sub-element. The Comprehensive Plan specifically states that the County shall not issue a building or other development order in any case where the drainage LOS standards are not met.

4.2.2 LEVEL OF SERVICE EVALUATION

The defined LOS standards of the Future Land Use Element and Drainage Sub-Element are consistent with state regulations and address FEMA 100-year flood hazard protections, water quality protection and the maintaining of historic/existing peak discharge rates to prevent adverse flood impacts to adjacent properties and natural water systems. The 100-year floodplain and floodway development and design assurances meet Federal floodway protection standards. The 10-year and 25-year design storm event return frequencies cited for drainage component design and capacity assessment reflect a reasonable public facility LOS expectation for protection of public health and safety as well as protection of properties against chronic flood damages. The County's adopted Land Development Code applies even stricter design standards to some components of roadway drainage facilities and stormwater management facilities for new development. The Conservation Element adequately provides for responsible use and conservation of natural resources and environmentally sensitive areas.

The only element missing from the Comprehensive Plan's drainage-related LOS standards are specific protections from increased runoff volume associated with new development in closed basins or watershed with limited outfall capacity. There is a policy that calls for land development regulations which require on-site retention of runoff from new construction sites to permit "no greater runoff than existed prior to construction activities." This might be interpreted in terms of volume and rate of runoff but is not as clear as it might be. It has been noted that specific runoff volume limits are included in the County's land development codes, discussed in Section 4.3 of this report, which are sufficiently stringent to accomplish this objective. It is recommended that Florida Administrative Code rule references for water regulation be updated from "Chapter 17-" references to the newer "Chapter 62-" references.

4.2.3 OTHER MUNICIPAL COMPREHENSIVE PLANS

There are five incorporated communities located within Putnam County, each with their own comprehensive plans, land development codes and/or zoning codes. The incorporated communities include:

- Crescent City
- Town of Interlachen
- City of Palatka
- Town of Pomona Park
- Town of Welaka

Comprehensive Plans were requested of and obtained from Interlachen, Palatka, Pomona Park and Welaka. Crescent City indicated that they do not currently have an adopted Comprehensive Plan although a Comprehensive Plan is referenced several times in the zoning ordinances provided by Crescent City. The stormwater management/drainage LOS standards for the supplied municipal Comprehensive Plans were reviewed in terms of general consistency with Putnam County's Comprehensive Plan LOS standards. A summary of noted similarities or significant differences follows.

Interlachen

The Interlachen Comprehensive Plan appears to have last been updated in 2002. The plan elements addressing topics relevant to stormwater management and master planning included the Future Land Use, Sanitary Sewer- Solid Waste- Drainage-Potable Water- Natural Groundwater Recharge (similar to Public Facilities), Conservation, and Capital Improvements elements. The goals and objectives for 100-year floodplain development, wetland and waterbody protection, water quality standards and drainage system LOS were specifically compared to those of Putnam County.

Development restrictions within the defined FEMA flood hazard areas are consistent with the County's policies, requiring adherence to Federal criteria for finished floor elevations, allowable uses and provision for floodway conveyance. Consistent with Putnam County's comprehensive plan, wetlands and waterbodies are to be protected from the impacts of direct runoff through the use of development setbacks, although there is inconsistency between different elements concerning the setback width (varies from 35 feet to 75 feet). Water quality standards reference retention of the first one-inch of runoff prior to discharge, which is consistent with Putnam County's comprehensive plan. The LOS for drainage is the 25-year, 24-hour event for all systems and the comprehensive plan includes reference to controlling runoff rates ands volumes (i.e., restricting post-development runoff rates/volumes to pre-development rates/volumes). The volume criterion appears in the Drainage portion of the various public facilities element. The rate criterion is cited under the capital Improvements element as a drainage standard for development.

Palatka

The City of Palatka Comprehensive Plan was provided on CD for review. The plan was last updated in 1998. The plan elements addressing topics relevant to stormwater management and master planning included the Future Land Use, Public Facilities, Conservation and Capital Improvements elements. The goals and objectives for 100-year floodplain development, wetland and waterbody protection, water quality standards and drainage system LOS were specifically compared to those of Putnam County.

Development restrictions within the defined FEMA flood hazard areas are consistent with the County's policies, requiring adherence to Federal criteria for finished floor elevations, allowable uses and provision for floodway conveyance. Wetlands and waterbodies are to be protected from the impacts of direct runoff through the use of development setbacks as they are in Putnam County; although the 50-foot setback cited in Palatka's comprehensive plan was noted to be reduced to 25 feet in their municipal codes. The drainage LOS standards were similar to those cited in Putnam County's comprehensive plan, and reference the Water Management District, ACE and FDEP regulations and permits regarding criteria for the management, storage and treatment of surface waters as well as dredge and fill activities. Reference to the need for

development of a Stormwater Master Plan for the City of Palatka is found in the Public Facilities and Capital Improvements elements.

Pomona Park

The Pomona Park Comprehensive Plan (dated 1991) is past due for updating. The plan elements addressing topics relevant to stormwater management and master planning included the Future Land Use, Public Facilities, Conservation and Capital Improvements elements. The goals and objectives for 100-year floodplain development, wetland and waterbody protection, water quality standards and drainage system LOS were specifically compared to those of Putnam County.

Development restrictions within the defined FEMA flood hazard areas are consistent with the County's policies, requiring adherence to Federal criteria for finished floor elevations, allowable uses and provision for floodway conveyance. Wetlands and waterbodies (with emphasis on Lake Broward) are to be protected from the impacts of direct runoff through the use of development setbacks in the range of 25 feet. This, too, is consistent with County policies.

Water quality standards and drainage LOS standards are nearly identical to those cited in Putnam County's comprehensive plan, with the only exception being that Pomona Park's LOS standards lack specific reference to controlling runoff rates or volumes (i.e., restricting post-development runoff rates/volumes to pre-development rates/volumes). The SJRWMD will regulate this aspect of stormwater management for all new development and qualifying redevelopment, in any case. Review of development plans and withholding of building permits until state and regional permit requirements are fulfilled are listed policies of the Comprehensive Plan.

Policies are also included to budget for drainage facility maintenance inspections. Reference to the necessity of developing a Stormwater Master Plan for the town of Pomona Park was found in several elements. As of June 2005, one has not been developed.

Welaka

The Town of Welaka 2015 Comprehensive Plan was adopted in 2004 to replace its 1991 plan. The plan elements addressing topics relevant to stormwater management and master planning included the Future Land Use, Infrastructure, Conservation and Capital Improvements elements. The goals and objectives for 100-year floodplain development, wetland and waterbody protection, water quality standards and drainage system LOS were specifically compared to those of Putnam County.

Development restrictions within the defined FEMA flood hazard areas are consistent with the County's policies, requiring adherence to Federal criteria for finished floor elevations, allowable uses and provision for floodway conveyance. Wetlands and waterbodies are to be protected from the impacts of direct runoff through the use of development setbacks of 25 to 50 feet. Specific waterbodies noted were Devil's Pond and the St. Johns River. This, too, is consistent with County policies. Water quality standards and drainage LOS standards for open and closed drainage systems are the same as those cited in Putnam County's comprehensive plan. LOS standards lack specific reference to controlling runoff rates or volumes for new development, either private or public, however the SJRWMD will regulate this aspect of stormwater management for all new development and qualifying redevelopment. Review of development

plans and withholding of building permits until state and regional permit requirements are fulfilled are listed policies of the Comprehensive Plan.

Although no Stormwater Master Plan currently exists for the town, reference to the necessity of developing a Stormwater Master Plan is found in several elements with a target date of 2006.

4.3 LAND DEVELOPMENT CODES REVIEW

The Land Development Code for Putnam County was obtained in 2005, consisting of 12 Articles with effective and/or amended dates by ordinance ranging from 2001 and 2004. Article 2 – Permitted Uses and Article 3 – Supplemental Use Regulations were noted to be in draft form, dated February 2005, and not yet formally adopted by ordinance. The Land Development Code has been approved by the County. The Land Development Code that was reviewed for this report was for a specific revision date; the most recent code should always be used for accuracy.

The stated intent of the Land Development Code is to:

> *"... provide for orderly growth, to decrease traffic congestion on public streets and highways, to provide adequate light and air, to promote civic amenities of historic, beauty and visual interest, to regulate density of population, and to facilitate the provision of adequate community facilities and services such as water, sewer, solid waste, roads, schools and parks, and to implement the Putnam County Comprehensive Plan"*

The Land Development Code contains all the land development regulations for the County. Of these regulations, several are of particular interest for the Master Stormwater Plan. These are:

- Article 5 – Facilities and Services: Concurrency and Development Exactions
- Article 6 – Resource Protection Standards
- Article 7 – Development Design and Improvement Standards
- Article 12 – Administration and Enforcement

4.3.1 ARTICLE REVIEW

Article 5 – Facilities and Services: Concurrency and Development Exactions

Drainage facilities are one of several listed public facilities addressed in this section of the Land Development Code. The purpose of the section is to ensure that:

1. Adequate public facilities are available to handle the impacts of development
2. The County's adopted Level of Service (LOS) standards are maintained as development progresses
3. Standards and procedures are established to make public facilities adequately available to serve new development (sometimes conditionally through development orders)
4. Adherence to the adopted LOS is monitored
5. Concurrency provisions for the Putnam County Comprehensive Plan are implemented

6. A means is provided to insure that any proposed development pays its fair share of the costs associated with providing and/or improving public facilities and services to that development

Stormwater management (drainage) facilities have defined LOS standards cross-referenced in this section to the Capital Improvement Element of the Putnam County Comprehensive Plan, Policy H.5.1.5. The specific standards contained therein will be reviewed as part of Section 4.3 of this Master Stormwater Plan. Concurrency is enforced under Article 5 by a development review and approval process that requires a developer to submit sufficient data demonstrating that either the necessary public facilities are already available to serve the development without causing a lapse of the LOS standards; or that adequate public facilities will be available prior to the construction of the proposed development. With respect to stormwater management facilities, an affidavit is required from the property owner or developer, acknowledging that all stormwater quality and quantity requirements of the county, and applicable regional (Water Management Districts) and state (FDEP) regulatory agencies will be met prior to issuance of a certificate of occupancy. Additionally, the term of concurrency certification is limited, and will expire if appropriate permits are not obtained in a timely fashion.

Article 6 – Resource Protection Standards

This portion of the Land Development Code is designed to implement the resource protection requirements of the Putnam County Comprehensive Plan. Resources identified as important to public health, safety and welfare are to be protected from harmful effects of development. Specific resources protected under this section include wetlands, water bodies, habitat of threatened or endangered species, flood hazard management and floodplain areas, potable water well fields and groundwater recharge areas. In most instances, the provision of special setbacks and buffers are the mechanism by which this protection is afforded.

Wetlands

County wetlands are mapped and presented in the Land Development Code. The following specific protections are afforded to wetlands:

- The required setback of site improvements is 25 feet
- All applicable state and federal regulations for permitting and mitigation must be met prior to issuance of County construction permits, and is enforced through the site plan review process conducted by Planning and Zoning staff

Some activities may be exempted from the setback requirements, such as:

- "Grandfathered" recorded lots with insufficient developable area to provide the setback
- Resource-based recreational facilities recreational facilities such as trails, boardwalks, piers, and boat ramps
- Water dependent commercial development components such as port facilities, marinas, fish camps, and commercial fishing and shell fishing operation
- General Agriculture, provided that the natural hydrology and function of the wetland areas are maintained in accordance with USDA NRCS guidelines and best management practices for non-point source management are applied
- Silviculture, conditional to following the "Silviculture Best Management Practices Manual" (Department of Agriculture and Consumer Services, 1993)
- Essential public services or emergency activities such as flood or hurricane-related search and rescue, or preventive/remedial activities related to large-scale contamination of streams or waterbodies

- Activities exempt from wetland impact permitting by FDEP, COE or the WMDs, except where those exemptions are based on acreage or size thresholds

Water Bodies

Specific protections afforded to natural water bodies (rivers, lakes, creeks, pond beds) and applied to all development within 500 feet of the Ordinary High Water Line (OHWL) are summarized below:

- Minimum frontage of 100 feet is required for post-1991 lots
- Stormwater management plans must be submitted for review and approval prior to building permit issuance
- On site sewage systems are subject to a 100-foot setback from OHWL and any effluent pond banks must be at least 3 feet above the mean high water elevation; no raw or treated sewage may be discharged directly to a water body or tributary
- Structure setbacks from a water body are a minimum of 50 feet; vegetated buffer strips must be in place to filter runoff from a water body
- No underground storage tanks are permitted within 100 feet of the OHWL and installation of aboveground/belowground storage tanks within 500 feet of the OHWL must be approved by the Department of Health
- Mining activities are prohibited within 500 feet of specifically listed water bodies of the State
- No more than 25 feet or 25% of a shoreline may be cleared by a property owner without proof of DEP or WMD authorization; and all other setback and buffering requirements must be met
- No development activity is allowed in the buffer areas except for the following uses (and in those cases only when unavoidable and in compliance with all other county laws and ordinances and federal/state regulations):
    - Resource-based recreational facilities such as trails, boardwalks, piers, and boat ramps
    - Water dependent commercial development components such as port facilities, marinas, fish camps, and commercial fishing and shell fishing operations
    - General Agriculture and Silviculture, subject to adherence to the best management practices cited for wetland protection
    - Essential public services

Habitat of Threatened or Endangered Species

Impacts to habitat of endangered or threatened species are avoided or minimized through a requirement that such habitats may not be disturbed where an otherwise permissible development can occur without impacting such habitat. A map indicating the recognized conservation, preservation and environmentally sensitive areas is provided in the land Development Code. The code also has provisions to allow transfer of densities and variances for setbacks to allow developers to avoid disturbing the habitat of threatened or endangered species. Development adjacent to the Ocala National Forest, Greenways and other wildlife or resource conservation/preservation areas will be assessed during site plan review for land use compatibility and may be required to provide additional buffering and setbacks. All future development of property in Putnam County known to serve as habitat for plant and animal species listed by the U.S. Fish and Wildlife Service (USFWS), Florida Fish and Wildlife Conservation Commission (FFWCC), FDEP or Florida Department of Agriculture as threatened, endangered or of special concern must comply with USFWS and FFWCC management criteria. The code requires Putnam County to post informational signage regarding manatees at all county-owned and maintained public boat ramps.

Areas of Special Flood Hazard and Floodplains

Flood hazard management and floodplain management is provided for in the Land Development Code for protection of human life and health, to minimize flood-related damages and associated public costs, to ensure that home buyers are notified that property is in a flood area, and to ensure that flood insurance is available to property owners through compliance with National Flood Insurance requirements. Flood hazard areas are delineated by FEMA on sets of Flood Insurance rate Mapping (FIRM). The objective of regulations is to require any new or expanded development to occur outside of the 100-year flood plain. Code requirements are extensive and will not be listed, however the general provisions are as follows:

- Development within areas of special flood hazard are to first be avoided by developing portions of the property outside the flood hazard area
- New and existing structures that are allowed in the 100-year floodplain are to be constructed of flood-resistant material and anchored to prevent floatation, collapse or lateral movement
- Service facilities (electrical, plumbing, heating, waste disposal/sewage) are to be designed to prevent flood waters from entering systems or infiltration/contamination of floodwaters
- New construction within special flood hazard areas must provide for the lowest floor (together with all mechanical and electrical equipment) to be at least 1-foot above the base flood elevation
- Storage, disposal or production of hazardous materials is prohibited within the 100-year floodplain
- The flood carrying capacity of a watercourse shall not be diminished by any relocation or alteration or bridge construction
- New or modified development and/or bridge structures must not increase the flood elevation more than 0.0000 inches at any point in the community
- Development is prohibited within defined floodways; in limited cases where sufficient technical support by a registered professional engineer demonstrates 0.0000 ft rise ("No-Rise") in base flood elevation, using FEMA-approved methodologies, a variance may be considered but is not guaranteed
- Streams without identified floodways, but with Base Flood Elevations determined, will have no encroachment within areas of special flood hazard unless a 'No-Rise" certification is provided by a registered professional engineer, accompanied by technical documentation
- Streams without identified floodways or Base Flood Elevations will have no encroachments within areas of special flood hazard within a distance from each stream bank equal to the greater of (a) five times the stream width at top of bank, or (b) 20 feet
- Areas of Shallow Flooding (AO Zones) shall have lowest floor elevations for new construction set at an elevation above the highest adjacent grade equal to the specified FIRM flood depth; where flood depth is unspecified, the height above highest adjacent grade will be at least 2 feet

Potable Water Well Fields

Potable water well fields are safeguarded by regulating the storage, handling, use or production of hazardous substances within defined well protection zones, consisting of a 500-foot fixed radius around all public water wellheads. Locations of all known public wellheads are mapped and included in the Land Development Code. The County is authorized to purchase property, through condemnation proceedings if need be, and set it aside for non-polluting uses. Land uses considered to be non-polluting are exempt from restrictions and include recreational,

conservation, and low density residential with no more than 1 dwelling unit per 5 acres Development restrictions apply to all other uses as summarized below:

- The underlying zoning in a well field protection zone shall not be up zoned to a land use more intense/dense than low-density residential through rezoning or Comprehensive Plan amendment
- New development within the well field protection zone is generally confined to residential use and must be connected to a municipal, county or investor-owned sewage system if one is available within ½-mile of the protection zone; individual sewage systems (septic systems) are not allowed in the protection zone for lots/parcels smaller than 1 acre
- Storage tanks within a well field protection zone are subject to special design requirements, including secondary containment
- Stormwater retention or storage and injection and drainage wells are prohibited within the well field protection zone
- Solid waste land fills and hazardous waste storage facilities are prohibited within the well field protection zone, except where hazardous waste/substance storage is necessary or incidental to the on-going operations and maintenance of an existing or otherwise permissible use; in such cases special provisions concerning product packaging, storage on impervious surfaces and secondary containment are applicable
- Fire, police, emergency medical services, governmental emergency management center facilities, public utilities, transportation corridors, and agricultural/silvicultural activities that comply with state pesticide application laws are exempted from the well field protection provisions (with the exception of the storage and treatment facilities of dairy farms or concentrated livestock feeding operations, which must be located at least 300 feet from the public well head)

Groundwater Recharge Areas

Groundwater recharge areas are regulated to protect both the quantity and quality of the groundwater supply as a potable water source. This is accomplished by prohibiting certain uses that threaten to pollute the Floridan aquifer and by limiting the amount of impervious area generated by development. In Putnam County, the top of the Floridan aquifer is considered to be the top of the continuous limestone unit of the Hawthorne Formation where present, or the top of the Ocala limestone unit of the Hawthorne formation is absent. Recharge areas presented on a reference map in the Land Development Code. Areas of high aquifer recharge (> 8 inches recharge per year) are protected through prohibition of auto salvage and junkyards, landfills, underground storage of toxic materials/locating of hazardous substances within such areas, and by additional development regulation. Development other than specifically prohibited uses within the recharge zone is discouraged; but is allowed provided that stormwater runoff is captured, retained and infiltrated on site or impervious surfaces are limited to less than 35% of the total area of the development site. The County provides for transfer of density from recharge areas to upland portions of the site to encourage development outside of the recharge areas.

Fire, police, emergency medical services, governmental emergency management center facilities, public utilities, transportation corridors, geotechnical boring activity, and agricultural/silvicultural activities that comply with state pesticide application laws are exempted from the recharge area protection provisions (with the exception of pig, poultry, cattle and dairy feedlots that require a waste disposal permit from FDEP).

Article 7 – Development Design and Improvement Standards

This portion of the Land Development Code is designed to ensure healthy, functional, safe and attractive development that takes into account the protection of natural resources. It is the intent of Putnam County to avoid unnecessary impervious surface cover; provide adequate access to lots and sites; and avoid adverse effects of shadow, glare, noise, odor, traffic, drainage and utilities on surrounding properties. General standards pertinent to drainage and general water management and protection are summarized below:

- Development is prohibited within proposed future County or State road right-of-way corridors. Subdivision and non-residential development contiguous to an existing County Collector Roadway must reserve or dedicate the right-of-way to Putnam County
- Dimensional requirements for development include maximum impervious surface area limits for various zoning districts; typical limits are 35% to 45% impervious surface area, where impervious surface means a surface that has been compacted of covered by material that is highly resistant to infiltration by water
- Landscaping and buffering requirements protect trees and native plant communities and promote water conservation and aquifer recharge while reducing soil erosion and stormwater runoff
- Specific stormwater design, construction and operation requirements are included for the control of runoff volume and treatment of stormwater runoff to protect the quality of receiving surface and groundwaters, and to prevent erosion, sedimentation and flooding
- Activities listed below (with a few specific exceptions) require a construction permit from the County Engineer:
    - construction, clearing, filling, excavating, grading, paving, dredging root raking, mining, drilling and other soil-disturbing activities
    - building, installing, enlarging, replacing or substantially restoring an impervious surface or water management system
    - converting agricultural lands to non-agricultural uses or subdivision of land where road improvements are required
    - land alteration or construction/expansion of structures or impervious surfaces
    - borrow areas or man-made ponds greater than 1/8-acre in size
- Standards for stormwater management system design/maintenance include:
    - prevention of downstream siltation or release of debris and encouragement of stormwater reuse
    - characterization of underlying soils for seasonal high water and permeability in accordance with the DOT drainage manual
    - computation of retention/detention volumes above the seasonal high water table and incorporation of engineering safety factors of 2 for soil permeability and filtration system design
    - treatment volume capacity recovery within 72 hours and full storage recovery within 14 days (except for wet detention systems)
    - maintaining historic watershed boundaries/drainage areas where possible, and accommodation of off-site contributing drainage
    - defined design events of 10-year/24-hour storm for minor components such as roadside swales; and 25-year/24-hour storm for major components such as collector ditches and storm sewers
- Supplemental standards including the FDOT drainage manual, regional water management district (WMD) rules and FDEP water management rules are incorporated by reference
- For projects that discharge to streams or open lakes, pre-development discharge rates are not to be exceeded for events up to and including the 25-year/24-hour storm event

- For projects that discharge to a closed lake, pre-development rates and discharge volumes must be maintained for events up to and including the 100-year/24-hour storm event
- For projects in closed basins (without a positive outfall), the stormwater management system must retain the total volume of stormwater generated from the 25-year/24-hour storm from the contributing watershed
- Special requirements for stormwater treatment are applied to development in karst areas of Putnam County which include; minimizing stormwater basin depth, provision of at least three feet of unconsolidated soil material between the limestone bedrock and the basin sides/bottom, fully vegetated side slopes and basin bottom
- Water quality criteria for stormwater treatment are consistent with WMD standards
- Erosion and sedimentation control plans are required to minimize adverse impacts of erosion and sediment transport during construction
- Stormwater management areas are required to be stabilized by grass or sand-based sod
- Subdivisions must establish a homeowners' association to provide routine maintenance of interior stormwater management facilities, unless opting to have the County implement a stormwater management benefit assessment; subdivision streets dedicated to the County will have associated stormwater systems maintained by the County
- Subdivision retention/detention basins are not to be located within platted building lots (unless lots are greater than one acre, with well drained soils and without confining layers)
- Reasonable maintenance access of 12-foot minimum width and 8:1 slope or flatter must be provided outside the limits of platted building lots
- The Land Development Code describes the contents of the preliminary development plan submittal and the professional certification required for drainage and pipe calculations

The standards of this section are enforced through plan review and approval by the Development Review Office, as well as inspections by the Public Works Department.

Article 7 also includes provisions and requirements for roadway drainage, consistent with FDOT design guidelines and the WMD standards. A summary of these standards is presented below:

- Open channels are to be designed to convey, at a minimum, the 25-year/24-hour design discharge and should be provided with a minimum positive slope of 0.1 percent
- Appropriate channel linings (grass, sod, rigid lining) are required to prevent erosion and downstream sediment transport due to in-channel velocities
- On-site of off-site treatment and retention for flow attenuation is required in accordance with WMD standards
- Cross-drains are to be constructed of reinforced concrete (unless otherwise approved by Putnam County) with minimum pipe cover of 12-inches (top-of-pipe to top-of-roadway base)
- Cross-drains and side-drains (driveway culverts) are to be sized to handle runoff from the 50-year/24-hour storm event with a minimum diameter of 15-inches; and County-approved end treatments
- Side drain inverts shall be set at elevations conforming with ditch grades
- Curb and gutter inlet maximum spacing is generally 500 feet and inlets must be designed to restrict the width of flow spread to one-half of the adjacent travel lane under rainfall intensities of 4 inches per hour

- Manholes, inlet, pipe end treatment and box culvert design and construction is expected to be consistent with the FDOT Roadway and Traffic Design Standards
- Bridges must be designed and constructed in accordance with FDOT Standards and Specifications, FDOT Structure design Guidelines and American Association of State Highway and Transportation Officials (AASHTO) Standards Specifications for Highway Bridges

Article 12 – Administration and Enforcement

This portion of the Land Development Code is provides the procedural requirements for obtaining development approvals and certain types of permits; and also defines the procedures for rezoning property, seeking special use permits, appealing decisions, seeking legislative action to amend the Land development Code or Comprehensive Plan, and for enforcing the Land Development Code. With respect to this Master Stormwater Plan, review of the following subsections has been conducted and summarized:

- Development Plan review process
- Plan review submittal requirements
- Procedure for obtaining surface and stormwater management permits
- Enforcement of development permits and orders

Development Plan Review

The Development Plan review process first requires classification of development activity into one of three classes. Class I covers development activity associated with previously approved development plans or development orders, very minor site alterations and construction of one single or two-family home on a lot or parcel in compliance with the code. Class III includes non-residential developments of 5 acres or more or with gross building area greater then 50,000 square feet and significant residential developments (> 100 acres or >100 dwelling units; > 5 acres developed at a density of 7 to 9 units/acre; or > 9 units/acre density). All other development is considered Class II development.

The basic elements of the Development Review include: pre-application conference, application submittal, sufficiency review (determination of whether necessary administrative and supporting documentation is present), preliminary development plan review, and final development plab review. Development plans are reviewed and commented on by the Department and then subject to approval at a regularly scheduled Development Review Committee meeting. Time clocks for both County review and applicant response are set forth in the code.

Development Review Submittal Requirements

Completed applications must be signed by all subject property owners (or agents thereof) and notarized. Administrative and legal information such as name/address/contact number(s) for owners, location map and legal description of the subject property, and location and linear dimensions of the parcel must accompany a general description of the intended use and proposed development activities. A scaled site plan showing existing and proposed structures, property lines, setbacks and proposed landscape and parking areas is required. Construction plans are required for Class I development activities.

Class III development submittals require a certified boundary survey, including existing and proposed easements, and various rights-of-way and accessways. Quality scaled site drawings are to indicate building locations, vehicular and pedestrian accessways, parking and

loading/service areas, dimensions of site features and setbacks, general landscaping and irrigation plans, locations of existing utilities, fire protection facilities (fire hydrant locations and proposed connections to the public water system, proposed water and wastewater facility locations, wetland protection setbacks, location of proposed stormwater management facilities and areas of special flood hazard. The total area of the site must be quantified with percentages allocated to buildings, paving, impervious area and open space.

The final development plan for Class II and lass III projects must include a drainage narrative and design calculations and technical support signed and sealed by a professional engineer. Drainage paving and grading plans with typical sections and details of all drainage facilities, construction specifications and construction notes must be included with the signature and seal of a professional engineer. A maintenance statement for the stormwater management facilities and a sedimentation control plan are also required.

Obtaining Surface and Stormwater Management Permits

Approval by the County of a surface water and stormwater management plan is required for all Class II, III and non-residential Class I development. Where FDEP, WMD or Army Corps of Engineers permits apply, the County is to be copied on permit submittal packages. The County will review surface water and stormwater management plans for sites which may not be regulated by the WMD. The submittal/approval process includes:

- Submittal of appropriate County forms with supporting documentation (aerial and topographic mapping, soils and land use data for the project area and contributing watershed, paving/ grading/ drainage/ building plans and details, erosion and sediment control plan, technical engineering report describing assumptions, calculations and procedures used to determine compliance with 25-year/24-hour design event requirements of the Comprehensive Plan)
- A 30-day sufficiency review by the Director of Public Works written determination of sufficiency or deficiency
- Permit posting for public notice prior to commencement of development activity

The duration of surface and stormwater plan approval is limited to 3 years or completion of construction of the project's permitted discharge structure. Extensions may be considered. Approval may be revoked if the approved schedule and permit conditions are violated without approval of plan modification.

Enforcement

The Code provides for enforcement of development permits and orders through County inspection and written notice of deficiencies or deviations. Minor deviations are generally handled by Department modification of the development order or plan to conform to the actual development. Major deviations or deficiencies require corrective action or justification by the developer in a timely manner. Enforcement tools that are available to the County through this Code include "Stop Work" orders, "Cease and Desist from Sale" orders, retaining of maintenance collateral, and revocation of the development order or permit.

4.3.2 SUFFICIENCY REVIEW

The Land Development Code articles summarized in the previous section address resource protection through development prohibitions, restrictions, setbacks and a specific development review and surface/stormwater management permitting procedures. Putnam County Code requirements are consistent with current Federal and State water management programs and in some cases apply even stricter criteria.

Exemptions provided in the Code for agricultural and silvicultural land uses may represent weak links, unless qualifying criteria such as adherence to scientifically-supported best management practices are enforced through inspection and legal action, as appropriate. Sediment transport is a significant maintenance issue for Putnam County, and total suspended solids (TSS) is an issue for the SJRWMD and the FDEP in terms of water quality within the St. Johns River and its tributaries.

Additionally, though the target LOS standard adopted by Putnam County provides an admirable level of flood protection for its citizens, modeling studies are necessary to determine where the County's established LOS standards are, or are not, being achieved for the existing drainage system. Responsible growth management would dictate that additional conveyance capacity or flood attenuation would be provided in areas not meeting the County LOS before new development may be allowed. Concurrency provisions cannot be evaluated for future development until the existing system's LOS has been determined.

4.3.3 OTHER MUNICIPAL CODES

The Land Development Code articles summarized in the previous section apply to unincorporated areas of Putnam County. There are five incorporated communities located within Putnam County, each with their own land development and/or zoning codes. The incorporated communities include:

- Crescent City
- Town of Interlachen
- City of Palatka
- Town of Pomona Park
- Town of Welaka

Three of these municipalities, Crescent City, Pomona Park and Interlachen, rely on Putnam County for review and issuance of their building permits although the issued permits are based on conformity to each municipality's regulations rather than Putnam County's. Palatka and Welaka review and issue their own building permits.

The land development codes were requested from each of the above-listed municipalities and were reviewed for general consistency with Putnam County's codes. Several municipalities supplied their zoning ordinances or land development standards as general equivalents, which may not contain all the elements of Putnam County's Land Development Code. Based upon references within the supplied ordinances, it is believed that some of the missing elements may be found in other city or town ordinances not provided.

Table 4.3.3-1 summarizes noted similarities and significant differences.

TABLE 4.3.3-1 COMPARISON OF MUNICIPAL LAND DEVELOPMENT CODES WITH PUTNAM COUNTY

Topic	Putnam County	Crescent City	Interlachen	Palatka	Pomona Park	Welaka
Ordinance/Code Last Updated	2005	1999	2003	2004	2001	2004
RESOURCE PROTECTION						
Wetland Setback/Buffers	25 feet	Not cited	35-75 feet [3] c	25 feet	25 feet	Not cited
Waterbody Setback/Buffers - structures - septic/storage tanks	 50 feet 100 feet	Not cited	 75 feet Not cited	Not cited 50 feet [3] Not cited	 25 feet Not cited	Not cited
- Adjacent Use Limits	Yes	Yes	Not cited	Yes	Yes	Not cited
Agriculture/Silviculture/Mining BMPs Required	Yes	Yes	Not cited	Yes	Yes	Not cited
Wellhead Protection Zone Radius	500 feet	Not cited	300 feet[3]	100 feet	Not cited	Not cited
- Adjacent Use Limits	Yes	Not cited	Not cited	Yes	Not cited	Not cited
FLOOD HAZARD AREAS						
Limits on Development in Floodplain	Yes	Not cited [1]	Not cied	Yes	Not cited	Not cited
Minimum Floor Elevations > BFE	Yes	Yes	Not cited	Yes	Not cited	Not cited
No Rise Criteria	Yes	Not cited [1]	Not cited	Yes	Not cited	Not cited
DEVELOPMENT STANDARDS						
Impervious Area Limits	Yes	Not cited	Not cited	Not cited	Yes	Not cited
Erosion Control	Yes	Not cited	Not cited	Yes	Not cited	Yes
Runoff Volume Control - closed lakes - closed basin	100-yr, 24-hr 25-yr, 24-hr	Not cited [2]	Not cited	Not cited [2]	Not cited [2]	Not cited
Runoff Rate Control	25-yr, 24-hr	Not cited [2]	Not cited	Not cited [2]	Not cited [2]	Not cited
WQ Criteria	WMD standards	Not cited [2]	Not cited	Not cited [2]	Not cited [2]	WMD reference
Plan Review	Yes	Yes	Yes	Yes	Yes	Yes
County/Municipal Permitting Process	Yes	Yes	Yes	Yes	Yes	Yes
WMD, DEP, ACOE Coordination	Yes	Not cited [2]	Not cited	Yes	Not cited [2]	Yes
PUBLIC FACILITIES						
Design Standards – Open Channels, Ponds Closed Stormsewers Roadway Cross-, Side-drains Minor swales	 25-yr/24-hr 25-yr/24-hr 50-yr/24-hr 10-yr/24-hr	Not cited [2]	Not cited 25-yr/24-hr[3]	Not cited [2] 25-yr/24-hr[3] 10-yr/24-hr[3]	Not cited [2]	min. pipe diameter-slope, max. pipe length, wet/dry basin dimensions
Maintenance Inspections	Yes	Not cited	Not cited	Not cited	Not cited	Not cited

1 – May be included in a referenced Floodplain Protection Ordinance 2- May be included in a referenced Concurrency Management Ordinance 3- Comprehensive Plan

4.4 PRIORITIZING FUTURE FLOODING/WQ PROBLEMS

The Putnam County Comprehensive Plan sets forth a policy to maintain and update a five-year capital improvement plan. Public drainage and roadway facilities of the County require capital improvements including the repair, replacement or provision of supplementary structures in order to meet currently adopted LOS standards and to serve new and future development. Stormwater management system improvement and resource protection projects must be prioritized and ranked as they compete with other public facility projects for available funds.

Consistent with the Capital Improvements Element of the County's Comprehensive Plan, the criteria for identifying facility needs must address:

- Facilities/projects needed for the protection of public health, welfare and safety
- Facility upgrades needed to eliminate existing capacity deficits
- Facilities required to serve development areas with vested development approval
- Facilities required to serve redevelopment areas identified in the comprehensive plan
- Facilities required to provide service to new development areas
- Facilities to serve anticipated needs identified in future plans of the Water Management Districts or other state agencies that may provide public facilities within the County

Other prioritizing factors must include potential for degradation to the environment and cost effectiveness.

These objectives have been applied to the identification of subwatersheds to be studied in greater detail as part of this Master Stormwater Plan as well as the prioritization of specific capital improvement projects for identified problem areas. Selected subwatersheds have been identified based upon existing deficiencies in system capacity which result in LOS standards not being met and in severe sedimentation problems for some areas. Prioritization of the identified flood problem and sedimentation areas includes the severity of the system deficiency, the areal extent impacted by the deficiency, the level of development or urbanization within the immediate subwatershed and the estimated project cost-to-benefit ratio for potential system upgrades.

Wherever possible, the design and implementation of capital improvements projects for stormwater management should incorporate projected needs of new development with vested development approval or targeted redevelopment areas identified in the Putnam County Comprehensive Plan by providing sufficient capacity for full projected build-out. Development of capital improvement projects for public drainage facilities for future development would be appropriately limited to cooperatively funded projects between the County and developers, municipalities or state agencies where significant mutual benefits can be demonstrated.

TABLE OF CONTENTS

5.0 OPERATION AND MAINTENANCE CONSIDERATIONS 5-1
5.1 Current Maintenance and Operation 5-1
5.1.1 Activities 5-1
5.1.2 Expenditures 5-3
5.1.3 Staffing 5-5
5.1.4 Equipment 5-8
5.2 Practices In Other Counties 5-8
5.3 Comparison With Putnam County 5-10
5.3.1 Organization 5-10
5.3.2 Activities 5-10
5.3.3 Staffing 5-11
5.3.4 Equipment/Resources 5-11
5.3.5 Expenditures 5-12
5.4 Proposed Maintenance Plan 5-12
5.4.1 Program Scope 5-13
5.4.2 Periodic Inspection Program 5-13
5.4.3 Routine Maintenance 5-14
5.4.4 Major Facilities Rehabilitation 5-15
5.4.5 Drainage Incident Response 5-16
5.4.6 Staffing And Equipment 5-16
5.5 Application Of Best Management Practices 5-17
5.5.1 Urban Areas 5-18
5.5.2 Unpaved Roads 5-18
5.5.3 Roadside Swales/Ditches 5-19

List of Figures

Figure 5-1 Roads and Bridges Map 5-2
Figure 5-2 Organization Chart - Road and Bridge-Dept. of Public Works 5-6
Figure 5-3 Work Area Divisions 5-7

List of Tables

Table 5-1 Drainage Activity Costs 5-4
Table 5-2 Costs Comparison 5-12
Table 5-3 Drainage Incident Priority Codes 5-16
Table 5-4 Additional Recommended Equipment 5-17

List of Appendices

Appendix 5-A Stormwater-Related Maintenance Issues for Putnam County
Appendix 5-B Putnam County Public Works Equipment List
Appendix 5-C Maintenance Plan Excerpts from the South Maintenance Unit of Hillsborough County
Appendix 5-D Maintenance Documents from Pinellas County
Appendix 5-E BMP Concept Sketches

5.0 OPERATION AND MAINTENANCE CONSIDERATIONS

The stormwater drainage system within Putnam County consists of over 700 miles of primary drainage canals and ditches that are tributary to the St. Johns River. Preserving a stormwater system as close as possible to its original design is necessary to allow adequate conveyance of periodic flood flows, and thereby avoid flooding within the County. The County does not have jurisdiction over all drainage systems within its boundaries, but does have responsibility for the drainage systems associated with County roads. Based on a GIS review, there are over 200 miles of County roads that intersect with streams at 65 locations (**Figure 5-1**). These stream crossings may be comprised of bridge structures or single/multiple culverts.

A critical component of this master stormwater plan is to document the current maintenance practices used in preserving the drainage ways associated with County roads and to recommend improvements where it is found to be deficient. Maintenance practices for the County were therefore assessed by:

- Reviewing current maintenance and operation
- Reviewing practices in other counties
- Comparing some other counties to Putnam County
- Proposing an operation and maintenance plan

5.1 CURRENT MAINTENANCE AND OPERATION

Putnam County has a well-documented maintenance program. Based on discussions with County staff, maintenance is not routine or scheduled, but is primarily performed based on citizen's complaints and available budget. Since the County has recently hired a second drainage crew, they are now beginning to perform scheduled maintenance activities.

In general, the Putnam County Public Works Department has responsibility for maintenance throughout the County. However, Putnam County has also devised an alternate method for paying for maintenance in certain areas of the County. These are known as Municipal Service Benefit Units, or MSBUs. MSBUs are known as "special assessments." They are a method by which the Board of County Commissioners can pay for certain specific projects by apportioning the costs to the property owners in a community or neighborhood that benefits from the projects. In Putnam County, County Commissioners have authorized twenty-nine (29) separate MSBU projects for road maintenance or road paving. Exhibits are provided at the end of this section which identify the location and areal extent of various MSBUs in Putnam County, as well as the MSBU status, "active" or "inactive."

5.1.1 ACTIVITIES

The County maintains a computerized database of all construction and maintenance activities and associated expenditures. From its database, the County provided data on maintenance for stormwater related activities for the years 2001, 2002, 2003, 2004, 2005, and 2006 year to date (January through August 31). Maintenance items in the database include activities for drainage ditches, culverts, storm sewers, and special construction projects consisting of culvert, ditch, and curb and gutter installation. The following activities are associated with each component.

DITCHES
Clean & reshape roadside ditches - No haul
Clean & reshape roadside ditches - Haul material
Remove blockage
Clean and reshape outfall ditches
Canal maintenance

CULVERTS
Clean cross culverts
Install/replace D/W culvert pipe
Install/replace 12" to 18" culvert pipe
Install/replace 24" to 30" culvert pipe
Install/replace 36" to 42" culvert pipe
Install/replace 48" to 54" culvert pipe
Install/replace 60" to 72" culvert pipe
Install/replace outfall culverts
Install/replace head-walls, mitered end
Clean driveway culvert

STORM SEWERS/CATCHBASIN
Catch basin cleaning
Catch basin const/replacement
Storm sewer cleaning
Storm sewer const/replacement
Junction box maintenance

BRIDGES
Remove blockage

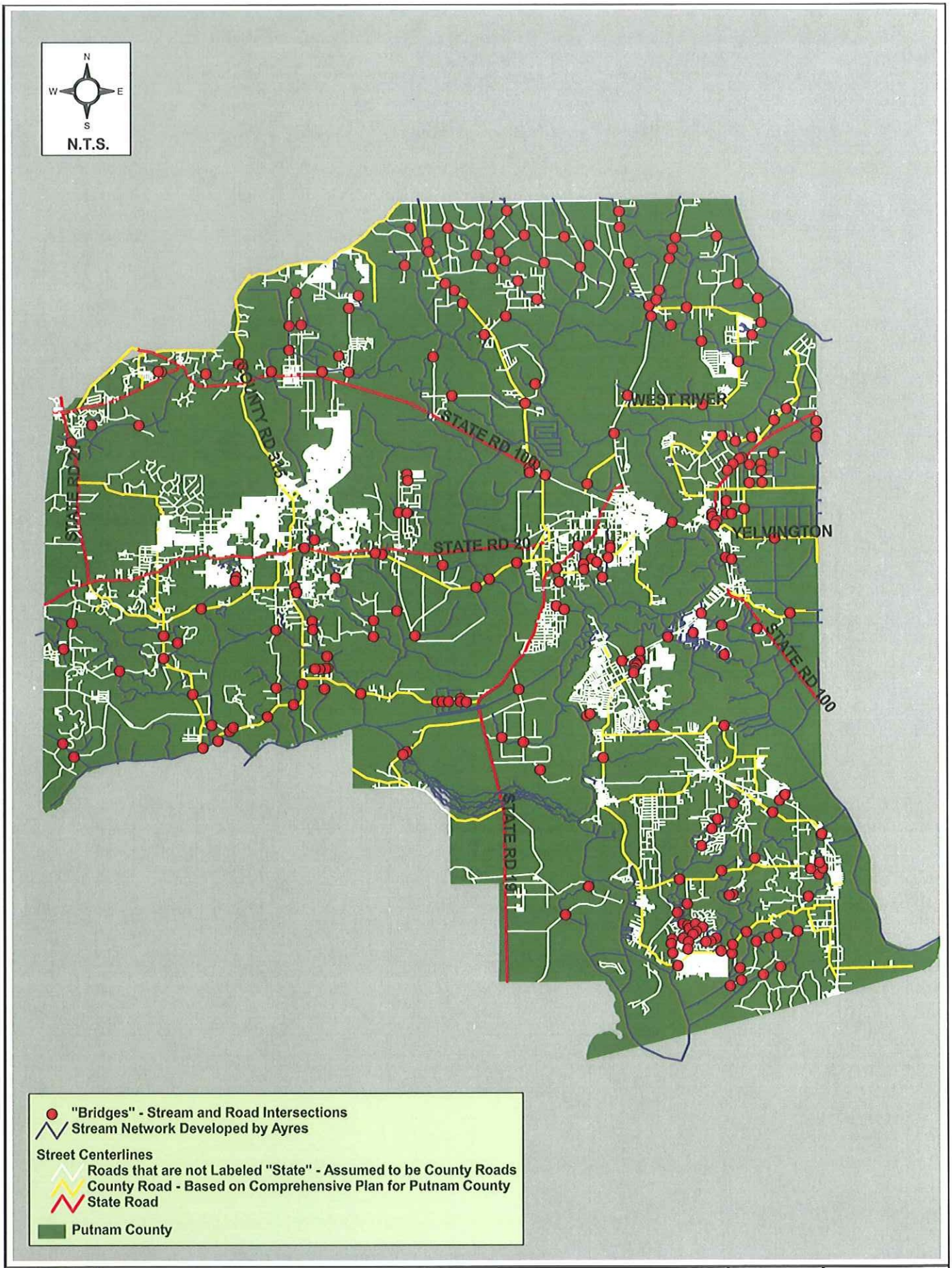
SPECIAL PROJECTS (CONSTRUCTION)
Excavate roadside ditch
Install driveway (d/w) culvert pipe
Install 12" to 18" culvert pipe
Install 24" to 30" culvert pipe
Install 36" to 42" culvert pipe
Install 48" to 54" culvert pipe
Install 60" to 72" culvert pipe
Excavate outfall ditch
Remove/ inst conc. curb & gutter
Remove/ install asphalt curb & gutter
Construct inlets & manholes
Install headwalls/mitered end sections

Maintenance activity data supplied by the County is presented in **Appendix 5-A**.

5.1.2 EXPENDITURES

Expenditures associated with maintaining the stormwater system for the period for which data were provided are:

- 2001 - $234,779
- 2002 - $344,970
- 2003 - $373,461
- 2004 - $264,327
- 2005 - $489,670
- 2006 - $347,954 (January through August 31)



	Roads and "Bridges" Map Putnam County Master Stormwater Plan	**Figure 5-1**	AYRES ASSOCIATES

Expenditures for the various components are shown in **Table 5-1** on the following page. Maintenance expenditures for each year were associated with the following metrics:

- 2001
  - Cleaning 82,600 linear feet of ditches
  - Removing 65 ditch blockages
  - Cleaning, installing, or repairing 2,959 linear feet of culverts
  - Cleaning or replacing 130 storm sewers / catch basins
- 2002
  - Cleaning 163,500 linear feet of ditches
  - Removing 259 ditch blockages
  - Cleaning, installing, or repairing 3,283 linear feet of culverts
  - Cleaning or replacing 169 storm sewers / catch basins
- 2003
  - Cleaning 113,300 linear feet of ditches
  - Removing 244 ditch blockages
  - Cleaning, installing, or repairing 4,530 linear feet of culverts
  - Cleaning or replacing 99 storm sewers / catch basins
- 2004
  - Cleaning 82,630 linear feet of ditches
  - Removing 554 ditch blockages
  - Cleaning, installing, or repairing 3,015 linear feet of culverts
  - Cleaning or replacing 98 storm sewers / catch basins
- 2005
  - Cleaning 39,604 linear feet of ditches
  - Removing 215 ditch blockages
  - Cleaning, installing, or repairing 3,891 linear feet of culverts
  - Cleaning or replacing 135 storm sewers / catch basins
- 2006 (January - August 31)
  - Cleaning 50,241 linear feet of ditches
  - Removing 60 ditch blockages
  - Cleaning, installing, or repairing 3,418 linear feet of culverts
  - Cleaning or replacing 109 storm sewers / catch basins

Crew hours associated with accomplishing the above work are as follows (updated values for 2005/2006 were unavailable):

- 2001
  - Ditch activities - 4,900 crew hours
  - Culvert activities - 4,025 crew hours
  - Storm sewer activities - 536 crew hours
- 2002
  - Ditch activities – 5,445 crew hours
  - Culvert activities – 6,888 crew hours
  - Storm sewer activities - 433 crew hours
- 2003
  - Ditch activities – 7,738 crew hours
  - Culvert activities – 7,295 crew hours
  - Storm sewer activities - 287 crew hours
- 2004
  - Ditch activities – 4,309 crew hours
  - Culvert activities – 5,034 crew hours
  - Storm sewer activities - 297 crew hours

TABLE 5-1 DRAINAGE ACTIVITY EXPENDITURES

ACTIVITY	EXPENDITURES					
	2001	2002	2003	2004	2005	2006*
05 DITCHES						
CLEAN&RESHAPE ROADSIDE DITCHES-NO HAUL	$6,484	$10,161	$23,587	$3,843	$19,089	$3,999
CLEAN&RESHAPE ROADSIDE DITCHES-HAUL MATL	$88,262	$77,123	$118,732	$86,892	$141,284	$59,537
REMOVE BLOCKAGE	$1,965	$7,083	$5,424	$9,097	$20,373	$5,300
CLEAN & RESHAPE OUTFALL DITCHES	$14,489	$17,842	$18,956	$3,831	$41,520	$1,700
CANAL MAINTENANCE	$498	$0	$0	$0	$97	$0
TOTAL DITCH MAINTENANCE EXPENDITURES	**$111,698**	**$112,209**	**$166,699**	**$103,663**	**$222,361**	**$70,536**
06 CULVERTS						
CLEAN CROSS CULVERTS	$4,909	$7,096	$7,510	$8,326	$8,638	$9,434
INSTALL/REPLACE D/W CULVERT PIPE	$7,265	$2,492	$16,585	$2,132	$14,806	$15,890
INSTALL/REPLACE 12" TO 18" CULVERT PIPE	$27,752	$66,518	$53,961	$42,202	$56,526	$47,052
INSTALL/REPLACE 24" TO 30" CULVERT PIPE	$38,286	$21,034	$33,647	$26,414	$59,213	$51,889
INSTALL/REPLACE 36" TO 42" CULVERT PIPE	$1,175	$7,378	$20,790	$18,637	$15,974	$56,038
INSTALL/REPLACE 48" TO 54" CULVERT PIPE	$0	$19,907	$0	$9,634	$0	$0
INSTALL/REPLACE 60" TO 72" CULVERT PIPE	$0	$59,480	$12,072	$508	$19,752	$0
INSTALL/REPLACE OUTFALL CULVERTS	$10,326	$0	$5,621	$4,249	$2,285	$1,780
INSTALL/REPLACE HD.WALLS.MITERED END	$22,204	$37,644	$44,610	$41,228	$71,992	$88,190
CLEAN DRIVEWAY CULVERT	$2,344	$4,924	$6,415	$1,977	$5,001	$3,429
TOTAL CULVERT MAINTENANCE EXPENDITURES	**$114,261**	**$226,472**	**$201,211**	**$155,308**	**$254,186**	**$273,701**
07 STORM SEWERS/CATCH BASINS						
CATCH BASIN CLEANING	$2,256	$3,209	$2,313	$1,527	$2,964	$2,382
CATCH BASIN CONST/REPLACEMENT	$2,026	$542	$2,244	$1,043	$1,585	$0
STORM SEWER CLEANING	$711	$1,302	$0	$0	$59	$84
STORM SEWER CONST/REPLACEMENT	$0	$0	$0	$0	$0	$0
JUNCTION BOX MAINTENANCE	$3,604	$528	$416	$2,742	$8,387	$1,250
TOTAL STORM SEWER MAINTENANCE EXPENDITURES	**$8,597**	**$5,581**	**$4,973**	**$5,311**	**$12,994**	**$3,716**
12 SPECIAL PROJECTS (CONSTRUCTION)						
EXCAVATE ROADSIDE DITCH	$122	$0	$0	$0	$0	$0
INSTALL D/W CULVERT PIPE	$102	$0	$459	$0	$0	$0
INSTALL 12" TO 18" CULVERT PIPE	$0	$0	$73	$0	$0	$0
INSTALL 24" TO 30" CULVERT PIPE	$0	$0	$0	$0	$0	$0
INSTALL 36" TO 42" CULVERT PIPE	$0	$0	$0	$0	$0	$0
INSTALL 48" TO 54" CULVERT PIPE	$0	$0	$0	$0	$0	$0
INSTALL 60" TO 72" CULVERT PIPE	$0	$0	$0	$0	$0	$0
EXCAVATE OUTFALL DITCH	$0	$0	$0	$0	$0	$0
REMOVE/INST. CONC. CURB & GUTTER	$0	$0	$0	$0	$0	$0
REMOVE/INST. ASPH. CURB & GUTTER	$0	$0	$0	$0	$0	$0
CONSTRUCT INLETS & MANHOLES	$0	$465	$44	$44	$129	$0
INSTALL HDWALLS/MITERED END SECTIONS	$0	$244	$0	$0	$0	$0
TOTAL SPECIAL PROJECTS EXPENDITURES	**$224**	**$709**	**$577**	**$44**	**$129**	**$0**
TOTAL MAINTENANCE EXPENDITURES	**$234,779**	**$344,970**	**$373,461**	**$264,327**	**$489,670**	**$347,954**

5.1.3 STAFFING

Maintenance activities are conducted under the direction of the Superintendent who reports directly to the Director for the Public Works Department. The Superintendent leads the Roads and Bridges Department (refer to **Figure 5-2**) with responsibility for stormwater (drainage), hauling, right of way, construction, and traffic engineering. Although the County is divided into four supervisory areas for roadway work, as shown in **Figure 5-3**, there are no area subdivisions for stormwater maintenance activities. The Superintendent's current staff for stormwater-related activities is comprised of seven members; one crew leader as part of a four-person crew, one excavator (Gradall) operator, and two truck drivers.

Organization Chart
Road & Bridge - Department of Public Works

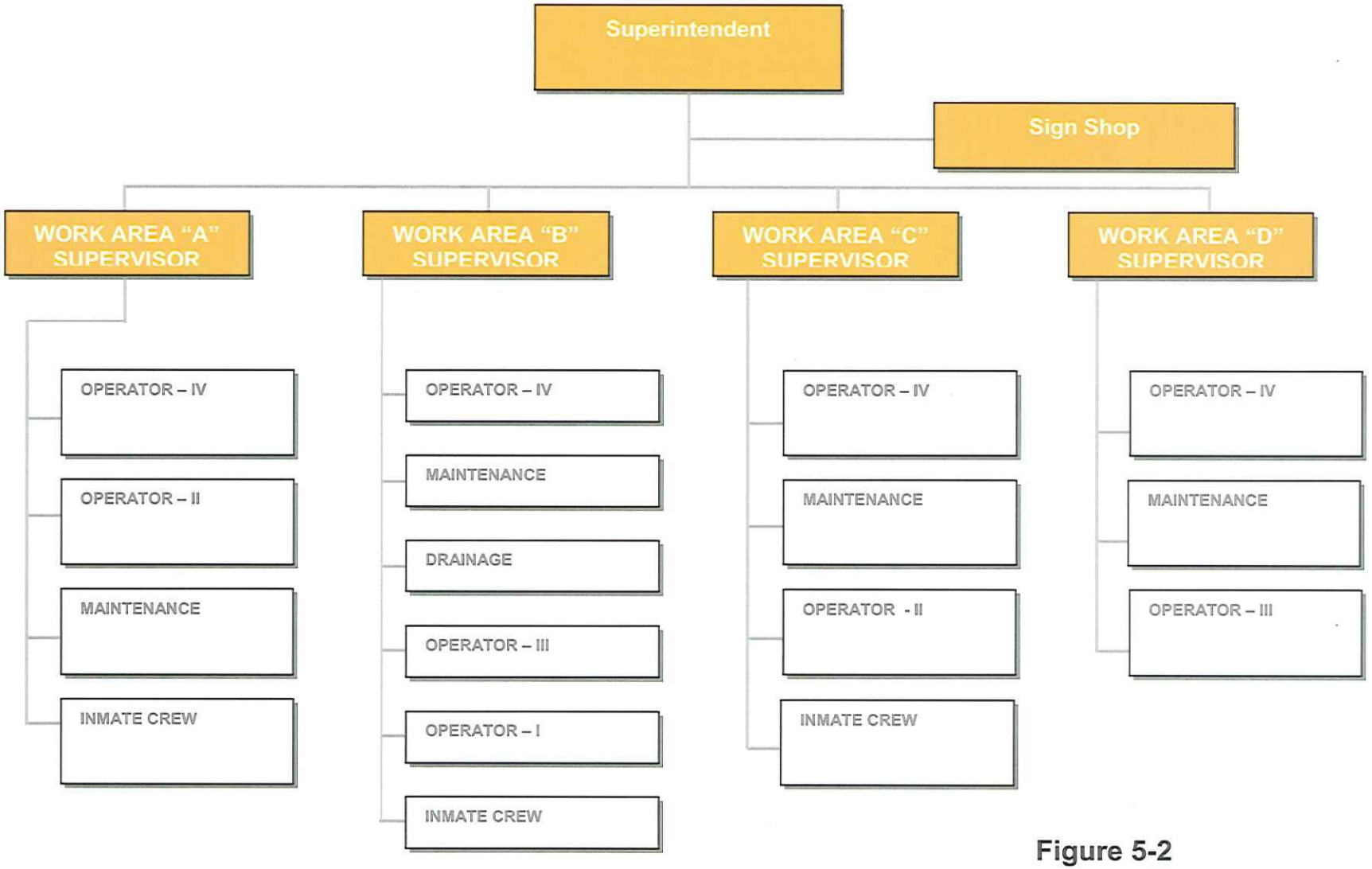
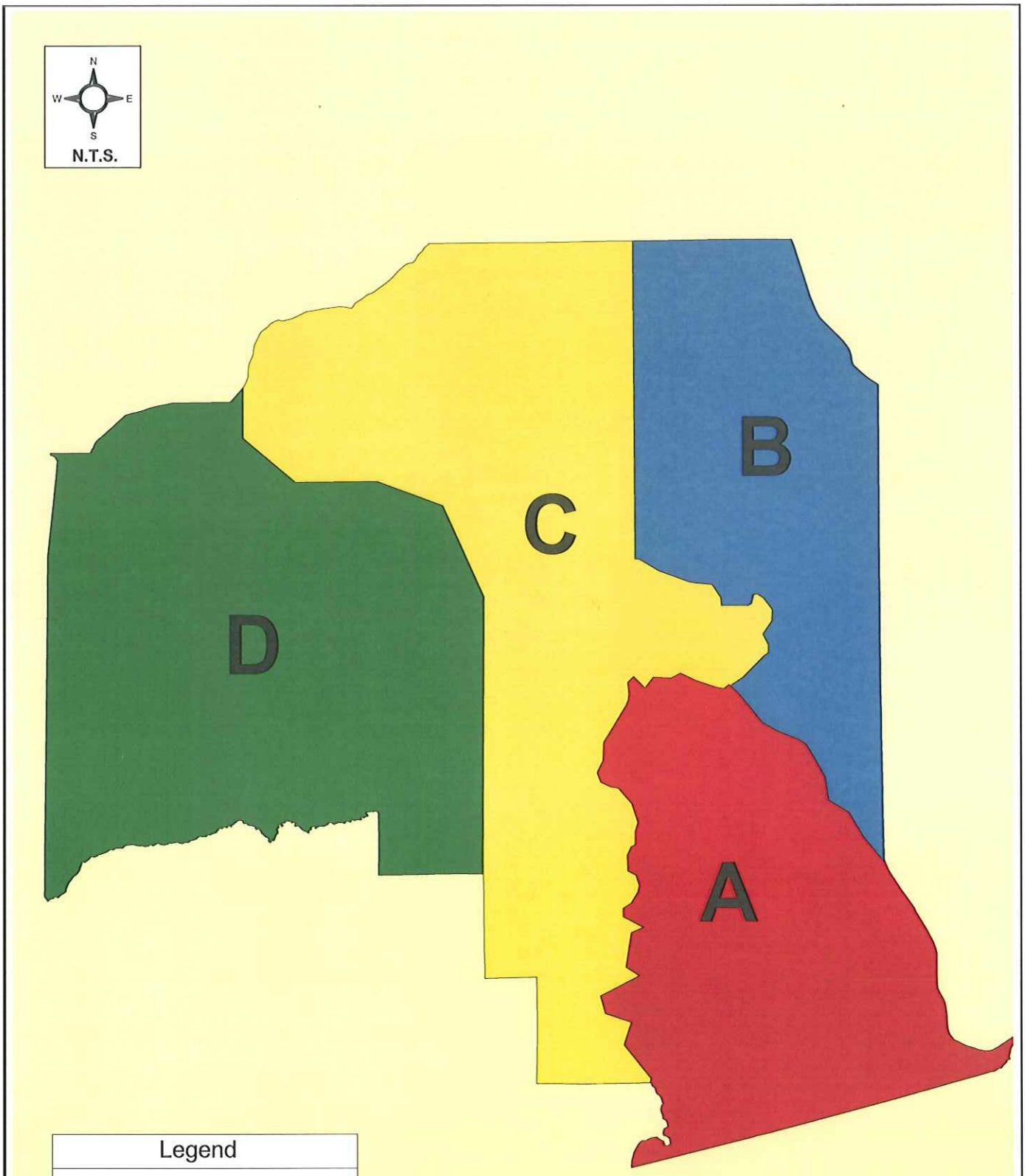


Figure 5-2



Putnam County Road Department Supervisor's Areas Boundary

G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\hydro_brdg_identification.apr

Putnam County Master Stormwater Plan

Figure 5-3

AYRES ASSOCIATES

5.1.4 EQUIPMENT

A list of equipment available to the Putnam County Public Works Department is presented in **Appendix 5-B**. The equipment list includes personnel vehicles, hauling vehicles, excavation and grading equipment, loaders and backhoes, concrete mixers, a compactor/rammer, chainsaws, tractors and trailers, weed-eaters, an edger and a blower.

Of this equipment, however, only two trucks and the Gradall are dedicated to stormwater related activities.

5.2 PRACTICES IN OTHER COUNTIES

Many counties do not have written maintenance practices available, but documents have been obtained for two Florida counties with well documented and fairly rigorous maintenance programs, Hillsborough County and Pinellas County. The first is similar in size to Putnam County and includes some very urban areas as well as large rural and agricultural regions. Hillsborough County anticipates significant residential and commercial growth in currently undeveloped areas. Pinellas County is primarily urban and almost fully built out. The documented practices of these two Counties were reviewed to provide a basis for assessing Putnam County's operation and maintenance resources against those of established programs.

The first maintenance document describes the practices of the South Maintenance Unit of Hillsborough County, responsible for the relatively rural watersheds located in southern Hillsborough County. The description of operations was provided in the Bullfrog Creek/Wolf Branch Watershed Management Plan (Dames & Moore, 2001). Excerpts from the maintenance plan are reproduced as **Appendix 5-C**. The following bullets summarize the Hillsborough County program:

- Organization
    - Stormwater Maintenance is a subset of the Road Maintenance Division
    - Stormwater Maintenance responsibility has been divided into four regional units (North Maintenance Unit, South Maintenance Unit, East Maintenance Unit and West Maintenance Unit)
    - The South Maintenance Unit (SMU) has divided its area of responsibility into 9 geographic zones
- Activities (SMU)
    - Scheduled routine maintenance through established maintenance schedules (mowing, sediment cleaning, vegetation clearing, debris removal, minor structural repair) with a goal of covering all nine zones at least once per year; activities tracked in a database
    - Post-storm inspection in identified problem areas after heavy rainfall
    - Incident/Complaint-related investigations and responses (estimated to represent nearly 80% of the staff and resource use); All reported incidents and complaints and resulting activities are logged in a database

  - Major system rehabilitation (repair/replacement of culverts and inlets, large-scale sediment removal, reconstruction of channel cross sections) as needed
- Staffing (SMU) – 50 authorized positions; not all filled
- Equipment/Resources (SMU) - full list unavailable
  - Vac Truck
  - Menzi Muck
  - Personnel Vehicles
  - Power tools, Hand tools
- Identified Needs
  - More dedicated equipment (possibly a leasing program) as County equipment is fully deployed and no back-ups exist
  - A stormwater system structure inventory identifying all drainage features in the Unit's area of responsibility
- Expenditures (SMU) - Reported annual expenditures for drainage-related activities varied from $939,000 to $1,021,000 between 1997 and 1999

In contrast, the relatively urban Pinellas County's maintenance practices were also reviewed. Maintenance documents for Pinellas County are presented in **Appendix 5-D**. The following bullets summarize the Pinellas County program:

- Organization
  - Drainage Maintenance is a subset of the Highway Division of the Pinellas County Public Works Department
  - Drainage Maintenance and Inspection responsibility has been divided into four geographic areas (North, Central, Southeast and Southwest)
  - Property owners are responsible for any ditches, streams or retention areas on their properties unless an easement has been designated to the County
- Activities
  - Inspection and maintenance (mowing, sediment cleaning, vegetation clearing, debris removal, minor structural repair) on a 6 month inspection cycle for each District
  - Inspection procedures and checklists are published for various stormwater management elements (ditches, channels, treatment ponds, exfiltration systems, mitigation areas, etc)
  - Routine mowing of ditches and embankments on a 6-week cycle for flat mowing and an 8 to 10-week cycle for slope mowing; hand and mechanical cleaning of ditches as needed
  - All County drainage sites inspected after major storm events
  - Incident/Complaint-related investigations handled by the District Supervisor or Assistant District Supervisor; All reported incidents and resulting activities are

recorded with task(s) performed, date completed, crew assigned, problem location and hours required to complete

- Three maintenance categories identified; Trash blockage, vegetative growth/intrusion, and major obstructions (fallen trees, large appliance/car, collapsed culvert)

- Staffing - Each District assigned a District Supervisor, Assistant District Supervisor, a construction crew, a mowing crew and maintenance operators
- Equipment/Resources - full list unavailable
  - Tractor and slope mowers
  - Hydraulic excavators
  - Backhoes
  - Front-end Loaders
  - Road sweepers
  - Dump trucks
  - Flat-bed trucks
  - Power/Hand Tools
  - Stormwater structure inventory (not as complete as County would like)
- Expenditures - No data received

5.3 COMPARISON WITH PUTNAM COUNTY

Comparison of the previously described county programs with Putnam County's program reveals some similarities and also directs attention to some deficiencies. These similarities and differences are presented by the following general topic; organization, activities, staffing, equipment/resources and expenditures.

5.3.1 ORGANIZATION

The organizational structure of Putnam County's Drainage Division, as a subset of the Road and Bridge department of Public Works, is similar to the other counties reviewed.

A noted difference is the absence of geographic region divisions for the drainage staff of Putnam County, although Work Area divisions have been assigned to other functions of the Road and Bridge Department (refer to **Figure 5-3**).

5.3.2 ACTIVITIES

The listed drainage-related activities for Hillsborough and Pinellas Counties were very similar. Primary components were incident/citizen complaint response; mowing and debris clearing for roadside ditches and stormwater retention/detention areas; pipe, inlet and channel sediment removal; scheduled and post-storm system inspections; and as-needed replacement/rehabilitation of pipes, inlets, control structures, channels and ditches. Based on staff interview, Putnam County maintenance activities are predominantly incident or citizen

complaint response activities. Pre-scheduled mowing, clearing and sediment clean-out for system components are not currently part of the drainage maintenance division's day-to-day operation. Work orders are reactive rather than preventive. It is clear that both the staff size and the available equipment/resources dedicated to the Putnam County drainage unit limits the scope of preventive maintenance activities.

Pinellas County appeared to have a more formal inspection program (printed checklists and objectives) and a proscribed mowing cycle; whereas the Hillsborough County SMU appears to rely on the regularity of the inspections to generate maintenance activity work orders. Putnam County does not currently have a program for regular inspection of system components.

All three counties document maintenance activities in a database of some kind to track man-hours and activity expenses, and to document citizen complaints, problem areas and County responses. Routine maintenance activity work orders are also generated by database management systems in Pinellas County and Hillsborough County.

5.3.3 STAFFING

Although a personnel count was provided only for the South Maintenance Unit of Hillsborough County (50 positions approved, although not all filled), the organizational structure described for Pinellas County's Drainage Maintenance group would require at least 12-15 persons per District (not including special equipment operators or administrative staff).

Putnam County staffing for Drainage Maintenance, with seven dedicated staff positions, is considerable smaller than that of either County reviewed. Putnam County is 4 to 5 times larger in area than Pinellas County whose drainage maintenance staff is estimated at 60 or more persons. Although roughly the same size as Putnam County, Hillsborough County employs 50 persons in just one of its four maintenance units.

5.3.4 EQUIPMENT/RESOURCES

A full listing of available equipment was not provided by Hillsborough or Pinellas County, nor were there listings of specifically dedicated drainage-related equipment provided. The Hillsborough County SMU did refer to full deployment of available equipment and a lack of back-up machinery. There was also reference to possible leasing of equipment due to inadequate resources.

Listed or referenced equipment was similar in type to the Putnam County equipment list presented in **Appendix 5-B**. It is noted that Vac Trucks or similar catchbasin cleanout equipment does not appear to be currently available to Putnam County's Drainage Maintenance crew. As noted earlier, only a limited amount of the Public Works Department equipment is dedicated to Drainage Maintenance group.

A stormwater infrastructure inventory was available as a resource for Pinellas County to clearly identify the system components under its responsibility. This type of resource was lacking in Hillsborough County and was listed as a future goal for their program. A drainage facility inventory does not currently exist in Putnam County. Development of a drainage facility inventory for selected subwatersheds, focusing on identified flooding and sedimentation problem areas, has been accomplished as part of this Master Stormwater Plan.

5.3.5 EXPENDITURES

The maintenance practices of Putnam County are not documented, however interview with staff indicate that it is accomplished primarily on a drainage incidence response basis. Routine inspection, preventive system maintenance and rehabilitation are not currently accomplished. Consequently, the expenditure for Putnam County is much lower than for Hillsborough County's SMU, even on a square mile basis as shown in **Table 5-2**. Cost figures were not provided by Pinellas County.

TABLE 5-2 COSTS COMPARISON

HILLSBOROUGH COUNTY SOUTH MAINTENANCE UNIT					
Area (square miles)	Year	Expenditures	Costs per square mile	Crew Hours	Crew Hours per square mile
186	1997	$939,187	$5,049	13,009	70
	1998	$1,020,710	$5,488	14,331	77
	1999	$959,904	$5,161	14,267	77
PUTNAM COUNTY					
Area (square miles)	Year	Expenditures	Costs per square mile	Crew Hours	Crew Hours per square mile
733	2001	$129,566	$177	9,461	13
	2002	$242,922	$331	12,766	17
	2003	$230,349	$314	15,320	21
	2004	$164,506	$224	9,640	13

5.4 Proposed Maintenance Plan

A proposed Maintenance Plan for Putnam County is described below, based upon the specific flooding and sedimentation problems reviewed during the Master Stormwater Plan Development, review of other county Maintenance Plans, and professional knowledge and experience concerning the design of stormwater management systems and their associated maintenance requirements. The proposed Maintenance Plan should include the following basic components:

- Defined program scope
- Periodic inspection program
- Routine maintenance program
- Drainage facilities rehabilitation program
- Drainage incident response program
- Staffing and equipment goals

5.4.1 PROGRAM SCOPE

The stormwater operation and maintenance program for Putnam County should be clearly defined in terms of what roadways and associated drainage conveyances are the County's responsibility, and what roadways and associated drainage features are considered privately owned and maintained. Property owners should be responsible for maintaining the ditches, streams and retention basins on their properties, unless a drainage maintenance easement has been granted to the County.

An inventory of County stormwater facilities is a valuable tool for identifying those areas with inherently higher operation and maintenance demands (generally more urbanized areas), allocating limited resources, and keeping track of which systems have been recently inspected or serviced. Facility inventories with the physical stormwater facility information in a database linked to spatially-referenced mapping are most useful. The County has a long-range goal of including roadside ditch slopes and driveway culverts in their GIS database, so that when private development occurs, developers can be asked to submit this information as well, allowing the County to properly assess proposed driveway culverts in comparison to overall system slopes. This, in turn, will assist in the maintenance and operation of roadside swales.

A more proactive inspection and preventive maintenance program, over time, will reduce the number of incident-driven and reactive work orders. A systematic operation and preventive maintenance program allows advanced scheduling of staff and equipment resources, rather than "emergency" deployment of whoever and whatever resources are currently available.

Inspection checklists and specific maintenance activity objectives should be developed to define the specific tasks to be performed and the frequency of implementation. These tasks and performance frequencies may vary with stormwater facility type or by specific regional characteristics. Some specific recommendations are made in the following sections.

Establishing regional divisions for drainage maintenance responsibilities will result in increased local knowledge of drainage systems on the part of those performing maintenance activities. It is recommended that drainage "Maintenance Units" be formed, consistent with the overall Work Area divisions (**Figure 5-3**) currently utilized by the Roadway and Bridge Department, as staffing resources are increased.

Additionally, an understanding between the County's incorporated towns and cities and Putnam County should exist concerning shared or divided responsibilities for drainage maintenance activities and incident response.

5.4.2 PERIODIC INSPECTION PROGRAM

In conjunction with the stormwater management facilities under Putnam County's jurisdiction becoming more clearly defined, a program should be implemented to enable visual inspection of all primary elements at least once per year. Identified problem areas (chronically flooded areas or facilities subject to rapid sedimentation) should be inspected after major storm events as a matter of course.

The purpose of these inspections is threefold, allowing:

1) Familiarity with all system components and their relative functionality

2) Assessment of the overall quality and effectiveness of routine maintenance activities
3) Rapid identification of areas with impaired or potentially impaired hydraulic performance

Identification of potential problems prior to the onset of heavy rains may significantly reduce the number of complaint-driven maintenance tasks generated.

An inspection checklist should be utilized which incorporates the following items:

- Inspector Name
- Date of Inspection; Date of Last Known Inspection
- Feature Location (nearest cross road/distance/direction) and Facility Type (stream channel, roadside ditch, cross-drain, side-drain, bridge, lake/pond, outfall control structure, catchbasin/inlet, etc.) or Facility/Feature ID if previously defined in a geo-database
- Condition Notations
    - Trash/Debris
    - Vegetative Growth
    - Obstruction
    - Erosion/Sedimentation
    - Bank Stabilization
    - Structural Integrity/Damage
- Action Items/Comments

A system will be needed for recording inspection dates, tracking noted action items and generating necessary work orders.

5.4.3 ROUTINE MAINTENANCE

Routine maintenance should be conducted proactively to maintain the stormwater system to its design condition. All maintenance activities, like inspection activities, should be recorded in a drainage database.

Routine activities for open conveyance systems and lakes/ponds that should be performed on a 6-10 week recurrence interval include:

- Removal of vegetation (mowing/harvesting)
- Revegetation/stabilization of eroded or exposed banks
- Limited access mowing using specialized equipment or hand labor
- Removal of trash/debris

Routine activities for open conveyance systems and lakes/ponds that should be performed at least once per year and after major storm events include:

- Clearance of blockages
- Removal of accumulated sediment in cross drains and side drains

Routine activities for open conveyance systems that should be performed on an as-needed basis (generated by inspection or incident report) include:

- Repair and replace cross drain and side drain culverts and headwalls (as needed)
- Roadside ditch cleaning/reshaping using Gradalls and similar equipment

Routine activities for closed conveyance systems (storm pipes and inlets) that should be performed on a 6-month recurrence interval, or as needed based upon inspection, include:

- Cleaning of closed culverts to remove obstruction and sediment
- Repair/replace damaged or inadequate catch basin inlets and manholes
- Clean and remove trash, rocks, silt and debris from catch basin inlets and manholes

5.4.4 MAJOR FACILITIES REHABILITATION

Rehabilitation should be conducted, as necessary, based upon inspections, incident reports, and citizen complaints. Major facilities rehabilitation includes, but is not limited to:

- Repair, rehabilitation and reconstruction of stormwater control structures (weirs, gates, pumps, etc.)
- Repair, rehabilitation and reconstruction of underground storm sewers
- Construction of new facilities
- Reconstruction of ditch cross sections and profiles
    - Dragline cleaning and reshaping of channels and off-system drainage ditches
    - Cleaning and reshaping channels and off-system drainage ditches using specialized equipment such as Menzi Muck

Facility rehabilitation activities generally require significant funding for equipment and man-power resources. Advanced planning for anticipated expenditures and shared-cost/shared-benefit opportunities are recommended.

5.4.5 DRAINAGE INCIDENT RESPONSE

Currently, the County maintenance program is based primarily on drainage incidence response. It is not known how reported incidents are prioritized, but it is suggested that a response code similar to that used in Hillsborough County's SMU should be adopted. Sample response codes are presented in **Table 5-3**.

TABLE 5-3 DRAINAGE INCIDENT PRIORITY CODES

Priority Code	Response Time Goal
00	No Priority (no action taken)
01	Immediate Response
02	2 Hours
03	5 Hours
04	24 Hours
05	1 Working Day
06	3 Working Days
07	5 Working Days
08	Within 1 Week
09	Within 2 Weeks
98	As per schedule
99	To be scheduled

At the time of each reported incident, a code should be assigned to prioritize the incident based on its importance. Importance should include factors such:

- Threat to life
- Blockage of major road
- Threat to critical facilities such as hospitals

5.4.6 STAFFING AND EQUIPMENT

As previously alluded to, the County would benefit from having staffed drainage maintenance units dedicated to specific areas in the County, particularly for routine maintenance. For emergency response situations, staff allocation should be based on priority status, and not necessarily restricted to specific areas. It is recommended that the four Work Areas currently used for roadway maintenance also be used for drainage maintenance. Each area should have an assigned drainage maintenance unit crew responsible for that specific region. Each crew leader would report to the Superintendent of the Road and Bridge Department. This level of staffing is significantly greater than the current level of staffing. The County should also hire a survey crew.

The County is in need of additional equipment for cleaning major channels, based on its current staffing and operations level. To achieve the proposed operation and maintenance levels, catch basin clean-out equipment should also be added. **Table 5-4** presents a list of additional

equipment needed to perform the proposed drainage maintenance activities. The equipment could be shared within the drainage maintenance section as a whole and scheduled for use. However, each drainage maintenance unit crew should have access to a gradall, four dump trucks, a crew pickup truck, hydraulic excavator, jet vac truck, flagging equipment including arrow board, cones, and variable information board, as well as communications equipment at its disposal. One possibility for obtaining equipment that is needed would be for the County to contract out certain equipment items, particularly expensive ones.

TABLE 5-4 ADDITIONAL RECOMMENDED EQUIPMENT

Item	Quantity
Small Dragline	1
Menzi Muck (or equiv.)	1
Vac Truck	1

5.5 APPLICATION OF BEST MANAGEMENT PRACTICES

The concept of "Best Management Practices" or BMP's refers to a method or combination of methods that have been determined to be effective and practicable in reducing or preventing nonpoint source pollution compatible with State and Federal water quality goals. BMP's may include structural methods such as sedimentation basins, infiltration basins, natural or man-made wetland impoundments or debris/grit-separating inlets to name a few. Non-structural BMP's such as street vacuuming, catch basin clean-out, fertilizer management, and litter-control programs can also be effective in pollution abatement. Approaches may vary on a regional and local basis depending on the nature of the pollution source, land use, soil types and various limiting physical characteristics. Non-point source management BMP's for various categories of activity have been studied and summarized in numerous federal and state guidance documents. The activity categories most relevant to Putnam County include:

- Urban
- Agricultural
- Construction
- Forestry

Structural BMP's are routinely required by the Suwanee River and St. Johns River Water Management Districts for new development and redevelopment, with the exception of singly developed residential lots and some agricultural exemptions. Additionally, the FDEP now issues a generic permit for construction activities that disturb one acre of land (or more) under the NPDES program. These permits require the development of a stormwater pollution prevention plan, design and construction of erosion control measures during construction activities (basins, silt fences, haybales), and in some cases inspection of BMP's during significant storm events to ensure proper functioning. County land development codes, site plan review and building permit inspections add another level of local protection against water quality degradation and deteriorating drainage system function from erosion, turbidity and high sediment loads. The water management district regulations focus predominantly on long-term water quality and flood control impacts of development, while the FDEP stormwater permits focus on the short-term construction activity impacts. Agricultural and Silvicultural activities are

required by Putnam County to utilize BMP's consistent with USDA NRCS guidelines and the "Silviculture Best Management Practices Manual" (Department of Agriculture and Consumer Services, 1993) although there does not appear to be a mechanism for the inspection and enforcement of these requirements.

Field investigations and communication with the drainage maintenance staff both point to sedimentation from the erosion of unpaved roads and culvert damage from crushing and corrosion as the primary drainage maintenance problems. Maintenance of unpaved roads and associated drainage systems comprises a large proportion of the maintenance costs incurred by Putnam County. County-maintained roadways and associated drainage systems include many unpaved roadways with compacted dirt surfaces. Most of the County-identified problem areas can be attributed more to maintenance needs than inadequate conveyance designs. As such, BMP's recommended for the County at this time are tailored to reduction and prevention of sediment transport. Prevention of the entry of sediment into surface water management systems will improve water quality and water clarity for water bodies and will also extend the life of existing conveyance systems. **Appendix 5-E** presents illustrations for selected BMP concepts.

5.5.1 URBAN AREAS

The following structural and non-structural BMP's are generally practicable in urban areas for the reduction of sediment, litter/debris, excessive nutrient and non-stormwater entry to County drainage systems and receiving wetlands and water bodies:

Non-Structural	Structural
Labeling Inlets ("No Dumping – Drains Directly to River/Lake")	Regional sedimentation basins (using County park lands)
"Adopt-a-Road"-style litter control programs	Baffle or Vortex-based separation inlets (off-line or on-line)
Landscape/Lawncare public workshops (proper fertilizer application)	Elevated grate inlets in grassed areas
Periodic street vacuuming (sweepers only move dirt)	Vegetated buffers and/or velocity dissipaters for steeper outfall slopes
Periodic catch basin clean-out	

5.5.2 UNPAVED ROADS

Although paving of all permanent public roads would be the long-term solution, the following BMP's are recommended for unpaved roads to reduce sediment wash off and preserve both roadway and drainage system integrity:

Non-Structural	Structural
Perform grading/blading operations in 1-Day project lengths (avoiding very wet and very dry conditions where possible)	Utilize culvert materials consistent with anticipated vehicle loads and maintain adequate top cover (2.0 ft minimum recommended)
"Adopt-a-Road"-style litter control programs	Provide retaining walls and headwalls for cross-drains
Maintain vegetation on shoulders	Vegetated buffers and/or velocity dissipaters for steeper embankment slopes
Repair/Reinforce failed slopes (grass, shrubs, rip rap, stakes)	Provide cross-drains at 500' (or less) intervals or design Turn-out discharge points with level spreaders to prevent standing water in roadside ditches
	Regional sedimentation basins (using County park lands)

5.5.3 ROADSIDE SWALES/DITCHES

BMP's for roadside swales and ditches focus on providing stable channel linings, preventing obstruction of cross-drains, reducing or controlling velocities and enhancing sediment settling prior to discharge. Some BMP's are common to the unpaved road BMP's.

Non-Structural	Structural
Remove man-made and natural debris after major storm-events (large limbs, tires, furniture)	Provide cross-drains at 500' (or less) intervals or design Turn-out discharge points
"Adopt-a-Road"-style litter control programs	Construct ditch blocks/check dams to encourage short-term ponding and sediment settling for everyday rain events (large events would bypass blocks)
Maintain vegetation in channels but avoid excessive growth (especially near culverts)	Incorporate velocity dissipaters to reduce scour at pipe inflow locations or along steep spillways
Repair/Reinforce failed channel slopes and dredge accumulated sediments as needed	

APPENDIX 5-A
STORMWATER-RELATED MAINTENANCE ISSUES FOR PUTNAM COUNTY

Tabel 5-A-1
Annual Performance

			Putnam County Public Works Annual Costs - Drainage Related Activities											
	Activity	Units	2001 Units	2001 Cost	2002 Units	2002 Cost	2003 Units	2003 Cost	2004 Units	2004 Cost	2005 Units	2005 Cost	2006 Units	2006 Cost
05 DITCHES													(Jan - Aug 31)	
	CLEAN&RESHAPE ROADSIDE DITCHES-NO HAUL	100 LF	28.8	6484.14	209.1	10160.94	248.5	23587.38	66.9	3842.79	227.1	19088.9	33.01	3999.4
	CLEAN&RESHAPE ROADSIDE DITCHES-HAUL MATL	100 LF	497.4	88261.79	137	77122.91	804	118732.3	646.7	86892.05	125.988	141283.8	455.4	59537.1
	REMOVE BLOCKAGE	EACH	65.5	1964.6	259.5	7082.56	244	5423.91	554	9097.48	215.1	20372.5	59.8	5300.3
	CLEAN & RESHAPE OUTFALL DITCHES	100 LF	299	14488.56	1288.6	17842.36	80.8	18955.51	112.7	3830.84	42.95	41519.5	14	1699.5
	CANAL MAINTENANCE	100 LF	0.8	498.41	0	0	0	0	0	0	0.5	96.7	0	0
	SUBTOTAL			111697.5		112208.77		166699.1		103663.16		222361.4		70536.3
06 CULVERTS														
	CLEAN CROSS CULVERTS	EACH	83	4909.07	266.5	7096.21	268	7510.08	150	8326.41	143	8637.6	201	9433.8
	INSTALL/REPLACE D/W CULVERT PIPE	L.F.	342	7265.22	78	2491.52	736	16585.15	129	2132.37	285	14805.5	270	15890.1
	INSTALL/REPLACE 12" TO 18" CULVERT PIPE	L.F.	1264.5	27751.7	1888	66517.68	1833	53960.9	1512	42202.19	1576	56525.7	1230	47052.2
	INSTALL/REPLACE 24" TO 30" CULVERT PIPE	L.F.	1002.4	38286.36	694.6	21034.25	1057	33646.89	693.5	26413.85	1535	59213.1	1054	51889.1
	INSTALL/REPLACE 36" TO 42" CULVERT PIPE	L.F.	30.3	1174.55	94	7377.76	420	20789.68	390	18636.98	255.2	15973.6	784	56037.7
	INSTALL/REPLACE 48" TO 54" CULVERT PIPE	L.F.	0	0	200	19906.75	0	0	167	9633.67	0	0	0	0
	INSTALL/REPLACE 60" TO 72" CULVERT PIPE	L.F.	0	0	328	59480.05	160	12071.95	7.7	508.32	150	19752.2	0	0
	INSTALL/REPLACE OUTFALL CULVERTS	L.F.	320	10326.02	0	0	324	5621.22	116	4249.39	90	2285	80	1779.5
	INSTALL/REPLACE HD.WALLS.MITERED END	EA.	142	22203.9	142	37643.51	167	44610.13	146	41227.8	161	71992.2	110.5	88189.7
	CLEAN DRIVEWAY CULVERT	EA.	100.5	2344.01	204	4924.04	333	6415.06	62	1977.15	145	5000.6	77	3428.8
	SUBTOTAL			114260.83		226471.77		201211.06		155308.13		254185.5		273700.9
07 STORM SEWERS/CATCH BASINS														
	CATCH BASIN CLEANING	EA.	103	2256.33	153	3208.99	85.2	2313	74	1526.81	106.3	2963.5	104.6	2382
	CATCH BASIN CONST/REPLACEMENT	EA.	7	2025.64	3	542.1	4	2244.35	5	1042.91	5	1584.8	0	0
	STORM SEWER CLEANING	100 LF	8.5	711.34	4.4	1301.79	0	0	0	0	1	58.6	3	84.3
	STORM SEWER CONST/REPLACEMENT	L.F.	0	0	0	0	0	0	0	0	0	0	0	0
	JUNCTION BOX MAINTENANCE	EA.	20	3603.67	13	527.71	10	415.92	19.5	2741.53	24	8387.3	4	1250
	SUBTOTAL			8596.98		5580.59		4973.27		5311.25		12994.2		3716.3
12 SPECIAL PROJECTS (CONSTRUCTION)														
	EXCAVATE ROADSIDE DITCH	L.F.	3.5	121.97	0	0	0	0	0	0	0	0	0	0
	INSTALL D/W CULVERT PIPE	L.F.	5.1	102.07	0	0	30	459.28	0	0	0	0	0	0
	INSTALL 12" TO 18" CULVERT PIPE	L.F.	0	0	0	0	0.2	73.35	0	0	0	0	0	0

Tabel 5-A-1
Annual Performance

			Putnam County Public Works Annual Costs - Drainage Related Activities											
	Activity	Units	2001 Units	2001 Cost	2002 Units	2002 Cost	2003 Units	2003 Cost	2004 Units	2004 Cost	2005 Units	2005 Cost	2006 Units	2006 Cost
	INSTALL 24" TO 30" CULVERT PIPE	L.F.	0	0	0	0	0	0	0	0	0	0	0	0
	INSTALL 36" TO 42" CULVERT PIPE	L.F.	0	0	0	0	0	0	0	0	0	0	0	0
	INSTALL 48" TO 54" CULVERT PIPE	L.F.	0	0	0	0	0	0	0	0	0	0	0	0
	INSTALL 60" TO 72" CULVERT PIPE	L.F.	0	0	0	0	0	0	0	0	0	0	0	0
	EXCAVATE OUTFALL DITCH	L.F.	0	0	0	0	0	0	0	0	0	0	0	0
	REMOVE/INST. CONC. CURB & GUTTER	L.F.	0	0	0	0	0	0	0	0	0	0	0	0
	REMOVE/INST. ASPH. CURB & GUTTER	L.F.	0	0	0	0	0	0	0	0	0	0	0	0
	CONSTRUCT INLETS & MANHOLES	EA.	0	0	1	465.01	0.1	44.44	0.6	44.14	1	128.7	0	0
	INSTALL HDWALLS/MITERED END SECTIONS	EA.	0	0	4	243.7	0	0	0	0	0	0	0	0
	SUBTOTAL			224.04		708.71		577.07		44.14		128.7		0
	TOTAL FOR ALL ITEMS			234779.35		344969.84		373460.5		264326.68		489669.8		347953.5

Table 5-A-2
Annual Costs

			Putnam County Public Works Annual Performance - Drainage Related Activities							
			2001		2002		2003		2004	
	Activity	Units	Crew Hours	Cost	Crew Hours	Cost	Crew Hours	Cost	Crew Hours	Cost
05 DITCHES										
	CLEAN&RESHAPE ROADSIDE DITCHES-NO HAUL	100 LF	246.5	2639.22	519.5	5193.56	801.5	9813.33	151	1901.41
	CLEAN&RESHAPE ROADSIDE DITCHES-HAUL MATL	100 LF	3393.5	40644.84	3165.5	37149.05	5099	61372.62	3414	42913.32
	REMOVE BLOCKAGE	EACH	116	1371.1	390	4511.49	381.5	4538.41	496.5	6365.48
	CLEAN & RESHAPE OUTFALL DITCHES	100 LF	1088.5	9328.04	1369.8	12004.2	1456	15164.03	247.5	2646.34
	CANAL MAINTENANCE	100 LF	55	443.41	0	0	0	0	0	0
06 CULVERTS										
	CLEAN CROSS CULVERTS	EACH	433.6	4116.07	588.5	5931.7	560	6562.37	468.5	5925.33
	INSTALL/REPLACE D/W CULVERT PIPE	L.F.	167	2028.19	78	938.84	377	4729.36	54	689.01
	INSTALL/REPLACE 12" TO 18" CULVERT PIPE	L.F.	781.5	9447.78	1325	16215.77	1584	20259.36	1024.8	13240.21
	INSTALL/REPLACE 24" TO 30" CULVERT PIPE	L.F.	662.5	8147.56	482	6088.88	911	11170.1	619	8125.97
	INSTALL/REPLACE 36" TO 42" CULVERT PIPE	L.F.	32.5	386.76	162	1955.51	547.2	7134.24	295	4357.84
	INSTALL/REPLACE 48" TO 54" CULVERT PIPE	L.F.	0	0	323	4186.26	0	0	85.1	1191.37
	INSTALL/REPLACE 60" TO 72" CULVERT PIPE	L.F.	0	0	831.5	12513.28	169.5	2484.3	28.5	355.04
	INSTALL/REPLACE OUTFALL CULVERTS	L.F.	174.5	2331.08	0	0	123.5	1368.96	82.5	1133.2
	INSTALL/REPLACE HD.WALLS.MITERED END	EA.	1564	14481.92	2664.9	25032.16	2500.5	29028.99	2244	25255.54
	CLEAN DRIVEWAY CULVERT	EA.	209	2053.01	433.5	4268.04	522	5731.56	133	1622.9
07 STORM SEWERS/CATCH BASINS										
	CATCH BASIN CLEANING	EA.	165	1958.83	243	2868.99	134.5	1672	98	1246.81
	CATCH BASIN CONST/REPLACEMENT	EA.	110.5	1159.31	34.5	406.84	124	1572.84	54	696.36
	STORM SEWER CLEANING	100 LF	78	628.84	117.5	947.29	0	0	0	0
	STORM SEWER CONST/REPLACEMENT	L.F.	0	0	0	0	0	0	0	0
	JUNCTION BOX MAINTENANCE	EA.	182	2153.73	37.5	430.21	28.5	350.76	145	1913.38
12 SPECIAL PROJECTS (CONSTRUCTION)										
	EXCAVATE ROADSIDE DITCH	L.F.	3.5	51.97	0	0	0	0	0	0
	INSTALL D/W CULVERT PIPE	L.F.	3	42.07	0	0	18	215.85	0	0
	INSTALL 12" TO 18" CULVERT PIPE	L.F.	0	0	0	0	4.5	51.6	0	0
	INSTALL 24" TO 30" CULVERT PIPE	L.F.	0	0	0	0	0	0	0	0
	INSTALL 36" TO 42" CULVERT PIPE	L.F.	0	0	0	0	0	0	0	0
	INSTALL 48" TO 54" CULVERT PIPE	L.F.	0	0	0	0	0	0	0	0
	INSTALL 60" TO 72" CULVERT PIPE	L.F.	0	0	0	0	0	0	0	0
	EXCAVATE OUTFALL DITCH	L.F.	0	0	0	0	0	0	0	0
	REMOVE/INST. CONC. CURB & GUTTER	L.F.	0	0	0	0	0	0	0	0
	REMOVE/INST. ASPH. CURB & GUTTER	L.F.	0	0	0	0	0	0	0	0
	CONSTRUCT INLETS & MANHOLES	EA.	0	0	40	425.01	1	14.44	1	14.14
	INSTALL HDWALLS/MITERED END SECTIONS	EA.	0	0	17.5	141.09	0	0	0	0

APPENDIX 5-B
PUITNAM COUNTY PUBLIC WORKS EQUIPMENT LIST

Table 5-B-1

Equipment

Putnam County Public Works

Unit No.	Equipment Description
2B1110	DUMP12 YARD
2C1113	DUMP12 YARD FORD STERLING
2C1117	DUMP12 YARD FORD STERLING
2F1128	DUMP12 YARD STERLING LT9500
2H1142	DUMP12 YARD STERLING LT9500
2H1143	DUMP12 YARD STERLING LT9500
2K1148	DUMP12 YARD STERLING LT9500 2007
2K1149	DUMP12 YARD STERLING LT9500 2007
2Y1104	DUMP12 YD
2V1089	DUMP12 YD
2X1097	DUMP12 YD
2X1099	DUMP5 YD
2Y1103	DUMP5 YD
2Q1114	DUMP5 YD
2Z1105	DUMP CREW CAB 2 1/2 TON
2D1118	DUMP CREW CAB 2 1/2 TON FREIGHTLINER
2D1121	DUMP CREW CAB 2 1/2 TON FREIGHTLINER
2H1135	DUMP CREW CAB 2 1/2 TON FREIGHTLINER M2
2H1134	DUMP CREW CAB 2 1/2 TON FREIGHTLINER M2
2H1133	DUMP CREW CAB 2 1/2 TON FREIGHTLINER M2
2G1129	DUMP CREW CAB 2 1/2 TON FREIGHTLINER M2
2D1120	DUMP CREW CAB 5 YARD
2D1119	DUMP CREW CAB 5 YARD
2T1079	DUMP CREW CAB 5 YD
2Y1100	FUEL TRUCK
2C1115	PICK UP
2W1092	PICK UP
2C2351	PICK UP
2C1116	PICK UP
2W1093	PICK UP
2X1098	PICK UP
2Y1102	PICK UP
2X2316	PICK UP
2C2352	PICK UP
2Z1106	PICK UP 1 TON FOR SIGN SHOP
2D1122	PICK UP 1/2 TON 2001 CHEVY SILVERADO
2D2361	PICK UP 1/2 TON 2001 CHEVY SILVERADO
2D1123	PICK UP 1/2 TON 4X4 F182 FORD
2T2362	PICK UP 1991
2W1130	PICK UP 1994 CHEVY MODEL CC10903
2H1138	PICK UP 2005 CHEVY SILVERADO 1500
2H1136	UP 2005 CHEVY SILVERADO 1500
2H1137	UP 2005 CHEVY SILVERADO 1500
2K1150	UP 2007 CHEVY MODEL CK 15703
2K2363	UP 2007 CHEVY MODEL CK 15703
2K1151	UP 2007 CHEVY MODEL CK 15703
2C2353	PICK UP 4 X 4
2R1076	TRACTOR 5TH WHEEL
2J1146	YUKON 1500 FULL SIZE UTILITY 4 X 4

Table 5-B-1 (cont) Equipment Putnam County Public Works	
Unit No.	**Equipment Description**
3Y1101	HYDRAULIC EXCAVATOR
3B1111	HYDRAULIC EXCAVATOR
3G1131	HYDRAULIC EXCAVATOR CAT 320CL
3H1147	HYDRAULIC EXCAVATOR GRADALL XL4100
3F1920	HYDRAULIC EXCAVATOR GRADALL XL4100
4H1145	DOZER D6N
4G1486	TRACTOR
4S1731	TRACTOR
4A1847	TRACTOR
4L1595	TRACTOR
4Y1832	TRACTOR
4J1785	TRACTOR 48 INCH BLADE
4Z1831	TRACTOR SIDE MOWER WITH BOOM ATTACHMENT
5T1755	LOADER
5V1797	LOADER BACKHOE
5G1928	LOADER IT28G CAT INTEGRATED TOOL CARRIER
5B1882	LOADER WHEEL 928G CATEPILLAR
5J1152	LOADER WHEEL CAT 928G YEAR 2006
5D1897	MIDLAND ROAD WIDENER GRADER ATTACHMENT
5G0415	MOTOR GRADER 2004 CAT 12H (LEASED)
5G0414	MOTOR GRADER 2004 CAT 12H (LEASED)
5G0417	MOTOR GRADER 2004 CAT 12H (LEASED)
5G0427	MOTOR GRADER 2004 CAT 12H (LEASED)
5G0418	MOTOR GRADER 2004 CAT 12H (LEASED)
5G0423	MOTOR GRADER 2004 CAT 12H (LEASED)
5G0426	MOTOR GRADER 2004 CAT 12H (LEASED)
5H0428	MOTOR GRADER 2005 CAT (LEASED) 10 FOOT
5H0429	MOTOR GRADER 2005 CAT 12H (LEASED)
5B1125	ROLLER VIBRATORY 1999 MODEL CS433C
5B1473	ROTOR MIXER
7J1976	BLOWER BG55 HAND HELD
7E1913	BLOWER STIHL 2G-85 HAND HELD
7G1945	BLOWER STIHL BG55
751732	BOOM AXE
751727	BOOM AXE 50 INCH
7J1986	CHAIN SAW 16 INCH STIHL MS210
7Y1822	CHAINSAW 16 INCH
7T1765	CHAINSAW 16 INCH
7Y1821	CHAINSAW 16 INCH
7G1954	CHAINSAW 16 INCH HUSQVARNA
7G1956	CHAINSAW 16 INCH HUSQVARNA
7G1955	CHAINSAW 16 INCH HUSQVARNA
7G1943	CHAINSAW 16 INCH STIHL
7G1946	CHAINSAW 16 INCH STIHL
7G1947	CHAINSAW 16 INCH STIHL
7A1853	CHAINSAW 16 INCH STIHL 021
7A1851	CHAINSAW 16 INCH STIHL 021
7J1983	CHAINSAW 16 INCH STIHL MS210
7G1930	CHAINSAW 16 INCH STIHL MS210
7G1931	CHAINSAW 16 INCH STIHL MS210
7J1982	CHAINSAW 16 INCH STIHL MS210
7J1981	CHAINSAW 16 INCH STIHL MS210

Table 5-B-1 (cont) Equipment Putnam County Public Works	
Unit No.	**Equipment Description**
7G1944	CHAINSAW 16 INCH STIHL MS210
7G1928	CHAINSAW 16 INCH STIHL MS210
7G1942	CHAINSAW 16 INCH STIHL MS210
7G1929	CHAINSAW 16 INCH STIHL MS210
7J1984	CHAINSAW 16 INCH STIHL MS210 EASY START
7J1985	CHAINSAW 16 INCH STIHL MS210 EASY START
7F1924	CHAINSAW 16 INCH STIHL MS29
7F1921	CHAINSAW 16 INCH STIHL MS29
7G1950	CHAINSAW 18 INCH HUSQVARNA
7G1948	CHAINSAW 18 INCH HUSQVARNA
7G1949	CHAINSAW 18 INCH HUSQVARNA
7D1885	CHAINSAW 18 INCH WOOD BOSS
7D1884	CHAINSAW 18 INCH WOOD BOSS
7D1883	CHAINSAW 18 INCH WOOD BOSS
7G1951	CHAINSAW 20 INCH HUSQVARNA
7J1488	CHAINSAW 24 INCH
7U1007	CHAINSAW 24 INCH
7Q1702	CHAINSAW 24 INCH
7Y1816	CHAINSAW 24 INCH
7E1901	CHAINSAW 24 INCH STIHL 044
7C1874	CHAINSAW 24 INCH STIHL 044
7E1902	CHAINSAW 24 INCH STIHL 044
7F1925	CHAINSAW 24 INCH STIHL MS440
7G1941	CHAINSAW 36 INCH STIHL
7G1940	CHAINSAW 36 INCH STIHL
7A1957	EDGER HUSQVARNA
7J1988	EDGER STIHL FC75 CURVED SHAFT
7E1914	MOWER STU 33" BRIGGS WALK BEHIND
7G1952	POLE SAW STIHL EXTENDIBLE
7E1899	POLE SAW STIHL EXTENDIBLE
7G1953	POLE SAW STIHL EXTENDIBLE
7C1877	POLE SAW STIHL EXTENDIBLE HT-75 W/12" BA
7C1876	POLE SAW STIHL EXTENDIBLE HT-75 W/12" BA
7J1980	POLE SAW STIHL EXTENDIBLE HT100 10 FOOT
7J1977	POLE SAW STIHL EXTENDIBLE HT100 10 FOOT
7J1979	POLE SAW STIHL EXTENDIBLE HT100 10 FOOT
7J1978	POLE SAW STIHL EXTENDIBLE HT100 10 FOOT
7G1932	POLE SAW STIHL EXTENDIBLE HT101
7G1939	ROAD SCRAPER THREE POINT BLADE SHOULDERS
7F1927	SEEDER SSP-6 W/CAT HITCH & ACRE METER
7P1648	SOD CUTTER WALK BEHIND
7Q1687	SPREADER SAND
7Q1698	SPREADER/FERTILIZER
7D1889	WEEDEATER STIHL FS-80
7D1891	WEEDEATER STIHL FS-80
7F1919	WEEDEATER STIHL FS110
7F1917	WEEDEATER STIHL FS110
7F1916	WEEDEATER STIHL FS110
7F1915	WEEDEATER STIHL FS110
7F1918	WEEDEATER STIHL FS110

Table 5-B-1 (cont) Equipment Putnam County Public Works	
Unit No.	**Equipment Description**
7J1973	WEEDEATER STIHL FS110 STRAIGHT SHAFT
7J1974	WEEDEATER STIHL FS110 STRAIGHT SHAFT
7J1975	WEEDEATER STIHL FS110 STRAIGHT SHAFT
7J1971	WEEDEATER STIHL FS110 STRAIGHT SHAFT
7J1970	WEEDEATER STIHL FS110 STRAIGHT SHAFT
7J1969	WEEDEATER STIHL FS110 STRAIGHT SHAFT
7J1972	WEEDEATER STIHL FS110 STRAIGHT SHAFT
7J1968	WEEDEATER STIHL FS110 STRAIGHT SHAFT
7J1966	WEEDEATER STIHL FS110 STRAIGHT SHAFT
7J1967	WEEDEATER STIHL FS110 STRAIGHT SHAFT
7G1934	WEEDEATER STIHL FS85 STRAIGHT SHAFT
7G1933	WEEDEATER STIHL FS85 STRAIGHT SHAFT
7G1938	WEEDEATER STIHL FS85 STRAIGHT SHAFT
7G1935	WEEDEATER STIHL FS85 STRAIGHT SHAFT
7G1937	WEEDEATER STIHL FS85 STRAIGHT SHAFT
7G1936	WEEDEATER STIHL FS85 STRAIGHT SHAFT
8J1139	BOARD ARROW
8J1140	BOARD MESSAGE
8J1144	BOARD MESSAGE
8S1085	TRAILER 28 FT 5TH WHEEL BOX
8E1124	TRAILER 6' X 10' FOR SIGN SHOP
8P1065	TRAILER 8 X 18
8T1084	TRAILER TRANSPORT LOWBOY
9B1867	CONCRETE MIXER
9B1868	CONCRETE MIXER
9T1776	CONCRETE MIXER
9P1660	GENERATOR
9P1667	MIXER CONCRETE
9S1830	MOWER ROTARY 30" CUT
9W1964	MOWER SNAPPER ZERO TURN 40 INCH CUT
9X1965	MOWER SNAPPER ZERO TURN 40 INCH CUT
9Z1835	SAW CONCRETE 14 INCH BLADE
9T1787	SAW CONCRETE 14 INCH BLADE
9C1878	SAW CONCRETE 14 INCH BLADE
9C1879	SAW CONCRETE 14 INCH BLADE
9J1987	SAW CONCRETE 14 INCH STIHL TS400 CUTQUIK
9S0269	TRIMMER 20 CC

APPENDIX 5-C
MAINTENANCE PLAN EXCERPTS FROM THE SOUTH MAINTENANCE UNIT OF HILLSBOROUGH COUNTY

HILLSBOROUGH COUNTY (DAMES & MOORE, 2000)
BULLFROG / WOLF BRANCH CREEK STORMWATER MAINTENANCE PLAN

INTRODUCTION

The Bullfrog Creek and Wolf Branch drainage systems include nearly 60 miles of primary drainage canals that receive and convey the discharge of numerous secondary and neighborhood/local stormwater systems to their respective receiving water bodies. The development of a clear understanding of the current maintenance level and ongoing maintenance program is an important aspect of evaluating the behavior and capability of the watershed's stormwater management system.

The performance of a drainage system is directly related to the maintenance level of the conduits and structures from which the system is composed. Failure to adequately maintain pipes, ditches and structures can frequently cause chronic local flooding during minor storm events. The effects of inadequate system maintenance are greatly magnified during larger, more significant storm events.

In Hillsborough County, the maintenance activities for stormwater structures are performed by the County's Road Maintenance Division, which has divided the County into four service areas: North, South, East and West. The Bullfrog Creek/ Wolf Branch Watershed falls entirely within the South Service Area. The South Maintenance Unit (SMU) of the Hillsborough County Roads and Streets Department is responsible for maintenance of stormwater facilities in this area.

SCOPE

The objective of this task is the preparation of a maintenance plan for the watershed based upon a series of activities:

- Review the County's documented maintenance inventory of facilities, maintenance frequencies and procedures as currently implemented in the watershed
- Evaluate the adequacy of the current maintenance program and minor reconstruction program relative to current hydraulic characteristics and properties of conveyances and structures
- Perform field inspections of representative and critical portions of the watershed to establish and document existing maintenance conditions for significant conveyance facilities within the watershed
- Prepare recommendations regarding potential enhancement areas and minor reconstruction projects that would benefit system hydraulics and potentially reduce flooding problems
- Meet with County maintenance personnel to discuss their documented maintenance conditions, review current maintenance frequencies and discuss the preliminary recommendations for maintenance program enhancements

CURRENT O&M PROGRAM COMPONENTS

The drainage maintenance program is driven by established maintenance schedules, incident driven inspections, routine inspections and requests generated from residents of the County. These activities are consolidated into four program components:

- Routine Maintenance
- Drainage Incident Response
- Drainage Conveyance System Maintenance
- Major Facilities Rehabilitation

The SMU is responsible for the maintenance of stormwater facilities and drainage conveyance systems throughout the Bullfrog Creek/Wolf Branch Watershed areas. The South Service Area is divided into a series of nine maintenance zones, identified as A through I, though only eight of these zones fall within the Bullfrog Creek/Wolf Branch drainage areas.

ROUTINE MAINTENANCE

The ongoing routine maintenance program is a proactive process that is responsible for the periodic maintenance of the existing stormwater management facilities throughout the South Service Area to assure that existing facilities meet their potential service capabilities. The SMU attempts to provide maintenance in all nine of its zones each year. In addition, known problem areas are inspected after heavy rain events.

Routine maintenance activities conducted by the SMU include:

- Slope mowing of roadside ditch and off system canals with steep slopes and other areas not accessible to other mowers
- Mowing of canal banks and retention ponds on County-owned property and drainage easements
- Repair of cross-drain and side-drain pipe culverts and box culverts
- Cleaning and removal of debris and silt from cross-drain and side-drain pipe culverts, storm sewers and box culverts as necessary to maintain conveyance
- Repair/replace damaged or inadequate catch basin inlets and manholes
- Clean and remove trash, rocks, silt and debris from catch basin inlets and manholes
- Replace and install pipe culverts
- Construct small drainage structures
- Dragline cleaning and reshaping of canals and off-system drainage ditches
- Cleaning and reshaping canals and off-system drainage ditches using specialized equipment such as Menzi Muck
- Roadside ditch cleaning and reshaping using Gradalls and similar equipment

- Limited access mowing using specialized equipment or hand labor

DRAINAGE INCIDENT RESPONSE

A substantial portion of the County's operation of the maintenance program is reactive in that maintenance actions are initiated in response to inspector observations, citizen complaints and extreme weather/flooding conditions. Reactive maintenance provides short-term response to reported drainage incidents or complaints, but generally at the expense of regularly scheduled maintenance activities.

Upon receipt of a complaint or observation of a problem, a County inspector investigates and prepares a work effort report. The inspector's report will identify whether or not the County is authorized to resolve the problem, provides an estimate of the level of effort required and assesses the safety factors involved, such as the roadway integrity. This report is reviewed and assessed by supervisory staff and a priority level is assigned. Table 1 lists the various priority codes in use and designates the time frame goal for completion of the work. The priority code sets the deadline for resolution by the SMU.

SMU staff has estimated that 80% of the Unit's available resources are utilized performing reactive maintenance work as the result of incident responses. This leaves only 20% of the Unit's resources available to perform the standard, scheduled maintenance activities.

Table 1
DRAINAGE INCIDENT PRIORITY CODES

Priority Code	Response Time Goal
00	No Priority (no action taken)
01	Immediate Response
02	2 Hours
03	5 Hours
04	24 Hours
05	1 Working Day
06	3 Working Days
07	5 Working Days
08	Within 1 Week
09	Within 2 Weeks
98	As per schedule
99	To be scheduled

DRAINAGE CONVEYANCE SYSTEM MAINTENANCE

The drainage conveyance system maintenance program includes the removal of weed and brush overgrowth, fallen trees, excessive silt accumulation and other debris materials from the

County's network of major drainage ditches and storm drains. This program is a proactive process that is responsible for scheduled maintenance. Key work activities in this program include:

- Removal of accumulated sediment
- Ditch reshaping and reconstruction
- Removal of vegetation
- Clearance of obstructions and blockages
- Repair of small structural failures of closed conduits and appurtenant structures
- Cleaning of closed culverts to remove obstructions and accumulated sediment

Major Facilities Rehabilitation

The stormwater facilities maintenance program involves retrofitting facilities to design conditions, slope stabilization, filter cleanup and reconstruction, and removal of accumulated silt. This program is a proactive process that is responsible for scheduled major maintenance of existing stormwater facilities on a prioritized basis. Key work activities in this program include:

- Sediment removal
- Reconstruction of ditch cross-sections and profiles
- Repair, rehabilitation and reconstruction of storm sewers
- Repair, rehabilitation and reconstruction of stormwater control structures

STAFFING AND PRODUCTIVITY

As stated previously, maintenance of County facilities within the Bullfrog Creek and Wolf Branch basins is performed entirely by the South Maintenance Unit (SMU). The supervisor of the SMU is Mr. James Pruitt.

Staffing

Interviews with the SMU staff indicated that the unit currently has approximately 50 approved positions. Discussions with staff during the interview process revealed that a number of approved positions have remained unfilled. The SMU is located in a somewhat remote area of the County and as a result, the availability of potential employees is limited.

Production Reporting/Levels of Effort

The Hillsborough County Road Maintenance Division currently uses a computer-based maintenance management system (Hansen Version 6) for tracking and assessing the productivity of the maintenance units activities. The system was queried for drainage related work activities at the SMU over the past three years, 1997, 1998 and 1999.

Assessment of the resulting data found that in 1999, there were inconsistencies in the units used by the system. The 1999 data was entered in a fashion that prevents it from being used to determine performance or unit costs. Table 2 provides a summary of the crew hours and production at the SMU for stormwater and drainage related activities.

From the available information, total levels of effort for the last three years appear to have remained fairly consistent at 7.5 man-years of reported field crew effort, based on 1850 hours per man-year.

Work Tracking System - Hansen Version 7

Hillsborough County Road Maintenance Division has recently implemented a new version of the work tracking system, the Hansen Version 7 Enterprise Solution from Hansen Information Technologies. Through the Hansen system's activity definition, users may describe work requirements for performing tasks at varying levels of detail. Each activity definition is used to describe the work requirements for the job at hand.

Table 2
ANNUAL PERFORMANCE - DRAINAGE RELATED ACTIVITIES

Activity	Units	FY 1997		FY 1998		FY 1999	
		Crew Hours	Quantity	Crew Hours	Quantity	Crew Hours	Quantity
CONSTRUCTION							
Install CB/IN/MH	Units	137	16	145.00	20.00	78	7
Install Cross Drains	Ft	190.5	641	175.50	864.00	57	324
Install Curbs & Gutters	Ft	30	45.75	No Data	No Data	No Data	No Data
Install Head-End Walls	Units	133	12	58.00	13.00	135	**
Install Mitered Ends	Units	216	73	115.50	66.00	186	**
Install Side Drains	Ft	236	1351	377.00	2,891.00	455.5	2068
Install SW/DW/SPW	Sq. Yds	24.5	2.5	No Data	No Data	7.5	68.3
Install Under Drains	Ft	No Data	No Data	28.00	385.00	13	40
Install Slip Liner	Ft	51	903	41.00	560.00	42.5	545
Repair CB/IN/MH	Units	141.4	26.25	107.00	28.00	143.5	36
Repair Cross Drains	Units	58	11	27.00	9.00	155.5	**
Repair Curb & Gutter	Ft	42	180	41.00	201.00	45.5	151
Repair Head-End Walls	Units	5	1	13.00	4.00	23	4
Repair Mitered Ends	Units	33.5	4.75	No Data	No Data	23	4
Repair Side Drains	Units	86.5	24	83.50	27.00	155.5	**
Repair SW/DW/SPW	Sq. Yds	87	195	70.50	121.00	317.5	**
Repair Under Drains	Units	33.95	7.25	28.00	7.00	45.5	**
DRAINAGE							
Limited Access Canal Cleaning	Acres	542.5	22805.95	561.00	**	638.5	18512.2
Longreach Canal Cleaning	Ft	111.5	2000	No Data	No Data	86	5000
Other Drainage Area Maint.	Hrs	1212.35	1789.1	2,578.60	6,873.25	1567	**
Roadside Ditch Cleaning/Reshape	Ft	1562.15	172486.9	1,412.00	201,721.00	1474.5	154265
JET-VAC							
Jetvac	Ft	249.5	38162.5	251.50	14,403.50	244	13944
MOWING							
Hand Mowing	Sq. Yds	184	73250	No Data	No Data	20	758186
Limited Access Mowing	Acres	230	35.45	145.00	13.90	228.5	38.7
Mow/Clean Curb/Gutter/Sidewalk	Ft	378.5	80139.1	166.00	7,730.00	235.5	70699.5
Mowing/Herbicide	Acres			241.95	309.41	544.15	837.5
Off System Mowing	Acres	57.5	22.8	134.00	59.60	135.5	130.5
Roadside Mowing	Acres	2997.15	8873.46	3,066.50	7,982.81	1847.8	4622.04
Slope Mowing	Acres	880.05	689.2	2,026.75	833.50	3356.25	3494.55
ROADSIDE							
Other Roadway Maintenance	Hrs	573.65	1149.2	316.35	916.20	316.3	916.5
Seeding/Fertilizer/Mulching	Acres	252.5	93.85	89.50	7.75	25	4.75
Sodding	Sq. Yds	120.5	2521.46	197.00	14,503.10	306	**
Stabilize Shoulders & Ditches	Miles	601.85	47.52	106.85	18.75	211	**
Stabilize Unpaved Road Surface	Miles	103.25	5.55	72.50	12.11	83.5	17.7
Stabilize Washouts & Driveways	Tons	942.65	2490.25	1,336.30	7,038.34	622.75	**
Trash Removal	Loads	301.35	161.8	313.25	195.68	441.1	**
SPRAY							
Off System Spraying	Gal	198.5	3397.99	No Data	No Data	No Data	No Data
Roadside Spraying	Acres	4	0.5	6.00	1.00	No Data	No Data

ANNUAL TOTALS	13008.8 Hours	14331.05 Hours	14266.85 Hours

** Quantity data entered in non-compliant units

Hansen uses an activity based costing system, which is more of a management tool than an accounting method. It essentially combines two different cost statements. The first cost statement reflects the basic cost groups per cost center. The second provides a deeper breakdown by activity minus non-productive time. Ultimately, the cost per quantity of activities performed can be determined. Organizations can use activity based costing methods to help determine and justify their budgetary requirements. The Hansen system allows organizations to maintain detailed costs per activity as well as down time for individuals and crews.

Preventive maintenance schedules may also be created for both asset groups and individual assets within the Hansen system. The system can then develop reports that summarize the costs associated with a specific group of work orders. The Hansen 7 system is still in the implementation stages, but once fully integrated into the County's operations it will provide the ability to generate detailed reports regarding the operation of the maintenance units. This information should prove invaluable in the development of efficient maintenance unit operation and determining the optimal distribution of staff, effort and equipment.

Maintenance Standards

The SMU is currently in the process of developing a set of maintenance standards, but this information was not available for review or summary here. Presumably, these standards will identify the typical work tasks performed by the Unit and establish unit quantities for equipment, staff, and production. This document will be essential for the development of annual budget projections. The successful implementation of the Hansen system should help provide valuable information in the development of this document.

VEHICLES AND OPERATING EQUIPMENT

A complete inventory report of vehicles and operating equipment was not available at the SMU. The current inventory was discussed with the SMU staff during the staff interview process, which resulted in the following key points being made:

- The SMU previously shared a Vac Truck with another maintenance unit until they recently acquired their own Vac Truck for their exclusive use. This should improve the staff's ability to perform maintenance activities. The staff also expressed a possible need for a second Vac Truck and crew.

- The successful implementation of the Hansen system should help assess and document the actual need for an additional truck and crew.

- The limited number of operational equipment currently in use at the Units results in a delay or stoppage of work progress in the event of a breakdown. Currently the existing equipment is generally fully deployed, with no replacement units available.

- Management staff at the Unit suggested the possibility of developing a lease program for the County that would stock additional equipment that could be

shared between the four County Maintenance Units. A County lease program would permit rapid deployment of backup equipment and help reduce the amount of downtime currently experienced at the Maintenance Units.

- The successful implementation of the Hansen system should help assess and document the types and quantities of additional equipment that a lease program would need.

The most heavily used piece of equipment at the SMU is the Menzi Muck All Terrain Excavator. The Unit has two of these pieces of equipment, however only one is functional. Due to the harsh conditions under which they operate, Menzi excavators typically have a relatively short functional life span of approximately five years. After that, they are generally unreliable and become increasingly expensive to maintain. As the most essential machinery in use at the Unit, the staff have expressed an interest in obtaining a second functional Menzi along with additional staff for its operation. The successful implementation of the Hansen system should help assess and document the actual need for this additional equipment and staff.

STAFF INTERVIEWS

Interviews were conducted with key personnel involved in the operation and maintenance of the County's stormwater management system in the South Service Area. Issues discussed in the interviews were system problems and needs, frequency and methods used to maintain the system and equipment, materials and manpower costs.

INTERVIEWS

The first staff interviews were conducted on December 14, 1999. SMU staff participating in the interviews included:

James Pruitt ..... Maintenance Unit Supervisor
Willie Lavandeira ..... Engineer II
Louie Bennett ..... Senior Crew Leader
Kevin Myers ..... Engineer Technician
Wanda Davis ..... Field Operations Supervisor

A second round of staff interviews were conducted on February 29, 2000. SMU staff interviewed at that time included:

James Pruitt ..... Maintenance Unit Supervisor
Willie Lavandeira ..... Engineer II
Louie Bennett ..... Senior Crew Leader
Wanda Davis ..... Field Operations Supervisor

OPERATIONAL CONCERNS

Interviews with the SMU staff disclosed the following operation issues and concerns:

- The fish farms located within the South Service Area frequently use the County's system of drainage facilities when draining their ponds. This results

in both a reduced conveyance capacity of the drainage system and substantially elevated levels of nutrients and organic wastes. This acts as a fertilizer and greatly increases the growth of vegetation in the County's open drainage conveyances. The response of the SMU has been to increase mowing and related maintenance in these areas.

- Pond maintenance that should fall to homeowners associations is generally not being performed. By policy, the County does not maintain private ponds, but will step in where situations are occurring that affect County-owned and maintained systems.

- The staff expressed a need for some additional equipment including a second Vac Truck and crew and a second operational Menzi Muck All Terrain Excavator (Menzi). The most heavily used piece of equipment at the SMU is the Menzi and although the SMU has two of these pieces of equipment, only one is functional. Due to the harsh conditions under which they operate, Menzi excavators typically have a life span of approximately five years. After that, they are generally unreliable and become increasingly expensive to maintain.

- The SMU has had trouble in filling open positions. The Unit is located in a somewhat remote area of the County and the availability of potential employees is limited.

INSTITUTIONAL ISSUES

In the first public meeting on January 13, 200, an assertion was made that the County was no longer maintaining ditches that it previously maintained and that this was resulting in frequent and exacerbated flooding conditions. Drainage facilities along the railroad tracks were identified as severely overgrown and neglected in terms of maintenance. SMU staff indicated that in the past railroad rights-of-way were indeed maintained by the County. When it was discovered that the County does not have legal access to these areas, maintenance by County forces was halted. The railroad does have its own maintenance resources and the County has had success in the past when requesting maintenance action by the railroad. The County does not intend to again perform maintenance on this area in the future, as it has no responsibility or legal right to do so.

In a similar fashion, the County previously maintained State road rights-of-way; a practice that was eliminated approximately seven years ago. In the past, the SMU has had trouble identifying County rights-of-way and easements. As a result, maintenance activities were often performed on non-County owned systems. The SMU staff now attempt to establish ownership before performing maintenance through coordination with the County's Real Estate Department.

The County's current policy is to only perform maintenance on County-owned facilities. This policy has become increasingly necessary, as cutbacks over the past five years have reduced the SMU's staffing by approximately 50%. Under current staffing levels, approximately 80% of the SMU's resources are utilized performing work as the result of incident responses, leaving only 20% of the Unit's resources to perform the standard, scheduled maintenance activities.

SMU staff indicated that an additional, unplanned workload frequently occurs when other County departments request assistance from the SMU in terms of both staff and equipment. This pulls the SMUs limited resources away from its regularly scheduled maintenance activities, further reducing the frequency at which those activities are conducted.

A suggestion was made concerning the possibility of developing a lease program for the County. The limited number of operational equipment currently in use at the Units results in a delay or stoppage of work progress in the event of a breakdown. Currently the existing equipment is generally fully deployed, with no replacement units available.

CURRENT PROGRAM BUDGET

A summary of the units annual operating budget was not available at the time of this report. The performance reports discussed earlier in Section 4.2 did include total costs associated with each of the activities tracked by the system. Table 3 presents this data for each drainage related activity over the 1997 through 1999 reporting periods. These numbers and data should not be assumed to be representative of the units comprehensive annual budget, but rather the expenses incurred and directly attributed to the specific maintenance items as listed.

CURRENT MAINTENANCE CONDITIONS ASSESSMENT

Field inspections were conducted from mid-1999 through early 2000. These field inspections were conducted as part of the system assessment and definition of the drainage patterns within both Bullfrog Creek and the Wolf Branch basins.

Table 3
ANNUAL COST DATA - DRAINAGE RELATED ACTIVITIES

Activity	1997 Cost	1998 Cost	1999 Cost
CONSTRUCTION			
Install CB/IN/MH	$ 17,536.52	$ 12,598.01	$ 5,352.66
Install Cross Drains	$ 30,623.87	$ 34,367.46	$ 9,282.57
Install Curbs & Gutters	$ 2,607.65	No Data	No Data
Install Head-End Walls	$ 20,173.05	$ 9,906.37	$ 21,391.82
Install Mitered Ends	$ 31,774.14	$ 21,668.24	$ 22,388.77
Install Side Drains	$ 35,335.60	$ 84,722.90	$ 65,545.00
Install SW/DW/SPW	$ 769.85	No Data	$ 1,696.83
Install Under Drains	No Data	$ 2,280.46	$ 1,525.55
Install Slip Liner	$ 22,117.43	$ 24,704.66	$ 15,734.69
Repair CB/IN/MH	$ 6,802.55	$ 7,157.05	$ 9,219.29
Repair Cross Drains	$ 4,047.06	$ 9,741.04	$ 18,513.32
Repair Curb & Gutter	$ 2,470.87	$ 2,427.32	$ 2,449.08
Repair Head-End Walls	$ 251.03	$ 783.44	$ 3,361.59
Repair Mitered Ends	$ 2,257.33	No Data	$ 2,534.23
Repair Side Drains	$ 12,349.34	$ 8,392.17	$ 18,372.92
Repair SW/DW/SPW	$ 4,385.34	$ 6,125.18	$ 21,606.24
Repair Under Drains	$ 1,467.09	$ 1,926.40	$ 3,131.45
DRAINAGE			
Limited Access Canal Cleaning	$ 28,600.71	$ 28,431.04	$ 25,774.80
Longreach Canal Cleaning	$ 6,054.13	No Data	$ 5,023.45
Other Drainage Area Maintenance	$ 92,784.12	$ 166,552.42	$ 110,049.48
Roadside Ditch Cleaning/Reshape	$ 158,848.16	$ 157,482.76	$ 183,449.43
JET-VAC			
Jetvac	$ 13,015.03	$ 12,489.99	$ 10,713.74
MOWING			
Hand Mowing	$ 11,496.30	No Data	$ 877.53
Limited Access Mowing	$ 7,579.75	$ 4,409.95	$ 7,657.16
Mow/Clean Curb/Gutter/Sidewalk	$ 30,400.34	$ 5,779.04	$ 19,124.91
Mowing/Herbicide	No Data	$ 7,157.74	$ 14,781.46
Off System Mowing	$ 1,938.73	$ 4,975.58	$ 3,672.01
Roadside Mowing	$ 98,272.84	$ 107,782.22	$ 66,285.60
Slope Mowing	$ 57,307.13	$ 75,706.47	$ 121,303.34
ROADSIDE			
Other Roadway Maintenance	$ 50,081.03	$ 23,750.48	$ 17,796.66
Seeding/Fertilizer/Mulching	$ 27,413.09	$ 5,676.46	$ 2,199.80
Sodding	$ 20,984.95	$ 17,772.68	$ 42,035.87
Stabilize Shoulders & Ditches	$ 65,899.70	$ 9,994.44	$ 26,112.20
Stabilize Unpaved Road Surface	$ 8,269.33	$ 8,790.28	$ 5,671.17
Stabilize Washouts & Driveways	$ 48,753.87	$ 143,741.68	$ 50,533.28
Trash Removal	$ 10,311.84	$ 13,083.07	$ 24,736.21
SPRAY			
Off System Spraying	$ 6,097.21	No Data	No Data
Roadside Spraying	$ 110.10	$ 333.30	No Data
TOTALS	$ 939,187.08	$ 1,020,710.30	$ 959,904.11

PROGRAM ASSESSMENT

The current maintenance program is approximately 80% reactive. The vast majority of the time and effort expended by the SMU is in response to complaints at the expense of planned maintenance activities.

The SMU does not have an accurate inventory of the facilities it is responsible for maintaining, nor does it have a published set of maintenance standards or any facility mapping. A maintenance management plan is under development. The current maintenance program is heavily reliant upon the knowledge and experience of its staff.

SUMMARY OF PROBLEMS

A detailed list of identified problems based on field inspections is included in Table G-4. Generic classification of these 113 noted problems include:

- Crushed culverts
- Blocked culverts
- Erosion problems
- Overgrown/wet conditions

In addition to this specific list of identified problems, the presence of a number of fish farms located within the South Service Area has resulted in some unique problems for the County. Some of these farms frequently use the County's system of drainage facilities when draining their fishponds. In addition to reducing the conveyance capacity of the drainage system by occupying a portion of the flow capacity, the water from these ponds often has substantially elevated levels of nutrients and organic wastes. This acts as a fertilizer and greatly enhances the growth of vegetation in the County's open drainage conveyances, further reducing the conveyance capacity. Currently the County's policy is to increase mowing and related maintenance in these areas to preserve the conveyance capacity of the system.

The discharge of aquaculture water into the County's drainage system is considered a point source. Such practices without the appropriate environmental permits and controls are violations of the Clean Water Act, and are regulated through Federal law and the County's MS4 NPDES Permit. Enforcement is difficult, however, as violators are generally in remote locations and can quickly shut off or move pumps.

APPENDIX 5-D
MAINTENANCE DOCUMENTS FROM PINELLAS COUNTY

PINELLAS COUNTY, FL
DRAINAGE MAINTENANCE AND INSPECTION
STANDARD OPERATING PROCEDURES

OBJECTIVE: To construct and maintain the waterways and drainage structures within the County's jurisdiction, including natural streams, canals, lakes, ditches and culverts to ensure their continued ability to accommodate the flow of storm water runoff.

RESPONSIBILITIES: The Highway Division of the Pinellas County Public Works Department maintains the countywide storm drainage program to curtail flooding problems. Currently, this entails the maintenance of approximately 2,500 miles of off-road drainage facilities and underground drainage structures.

The Director of the Highway Division is responsible for the administration of drainage maintenance and inspection standard operating procedures.

The Pinellas County Highway Department divides Pinellas County into four geographic areas: North, Central, Southeast, and Southwest. Each district has a district supervisor and an assistant district supervisor who inspect their respective areas to ensure that the drainage systems flow properly.

All work on State and County property and highway bridges shall be coordinated with appropriate state and county offices.

Property owners are responsible for maintaining the ditches, streams and retention basins on their properties. The County personnel shall not enter into private property unless an easement has been obtained or unless the problem is deemed an emergency and guidance has been provided by the County Attorney.

JURISDICTION: Of the 2,800-mile drainage system within unincorporated Pinellas County, the County drainage system inspection and maintenance standard operating procedures covers 2,500 miles of creeks, canals, outfalls, and ditches. These standard operating procedures also cover all future retention areas built and dedicated to the County and all existing retention areas that are maintained by the County by-right-of-maintenance.

AUTHORITY: The County has the legal authority to inspect and maintain all creeks, canals, outfalls, ditches, and retention basins on County property and properties which are the County's by-right-of-maintenance.

The County has been granted permission to enter onto state and water management district property to inspect maintenance.

Where the owner has dedicated a drainage maintenance easement to the County, the County has the legal authority to enter onto private property for the purposes of inspecting and maintaining creeks, canals, outfalls, ditches, and retention basins.

IDENTIFICATION OF PROBLEMS: Each district supervisor and their assistant district supervisor inspect their respective areas to ensure that the drainage systems flow properly. Each site, on average, is inspected at least once every six months. Regular patrolling of the drainage systems is done not only by the district supervisor and the assistant district supervisor but also by all construction crews, mowing crews, and maintenance operators.

After each major storm, the Public Works Department sends out staff to inspect all creeks, canals, outfalls, ditches and retention basins on County property and properties which are the County's by-right-of-maintenance for debris.

If a citizen calls with information regarding a blockage, this information is provided to the appropriate maintenance district and is inspected by the district supervisor or assistant district supervisor.

If an inspection identifies a problem, the inspector requests on a work order that the problem be corrected. The highway Division keeps records listing task completed, the date the task was completed, which crew completed the task, the location of the blockage or drainage problem, and the number of hours spent completing the task.

MAINTENANCE: Routine maintenance activities for the County's drainage systems include flat mowing and slop mowing of slopes and banks, hand cleaning and mechanical cleaning of ditches. Flat mowing is performed on a routine cycle which runs approximately six (6) weeks in length. Slope mowing is performed on a routine cycle which runs approximately 8-10 weeks in length. Ditch cleaning is performed on an as-needed basis. Equipment utilized to perform this maintenance and cleaning consists of tractor mowers, slope mowers, hydraulic excavators, back hoes, front-end loaders, road sweepers, tandem dump trucks, five (5) yard dump trucks, flat bed trucks, power hand tools, etc. There are three general types of maintenance problems:

- Trash: Man-made objects such as garbage, tires, lumber, furniture and appliances, and animal carcasses.

- Minor problem: Vegetative growth, tree limbs, and other naturally occurring debris.
- Obstructions: Fallen trees, culvert damage, large appliances and cars, etc; that, by itself, obstructs the flow of water.

On public property or where public water flows across private property and an easement has been granted, the blockage is immediately removed by a construction team.

On private property where no easement has been granted, the owner is responsible for the removal of trash, minor problems and obstructions. Should a Highway Division crew in the course of their maintenance activities come across littering on private property that causes blockage to the County drainage system, the County's Department of Environmental Management is notified of the situation.

NPDES MS4 PERMIT REQUIREMENTS

Stormwater Treatment Ponds (Dry Detention w/ Sand Filter System) (DE)

Inspect facility for evidence of damage and short-circuiting of the filter. Close attention should be given to the filter box, bed, trench or mound and appurtenant works. Signs of piping (erosion of filter sand) into underdrain pipes or (sink) holes next to junction box and/or discharge control structures or exposure of coarse aggregate or geotextile surrounding the underdrain pipe should be noted and scheduled for repair. Note any damage and schedule for repair.

Note any critically eroded areas on banks, pond bottom, or filter. Schedule for stabilization.

Note any undercutting (erosion) at the point of discharge (POD) and erosion in the vicinity of inflow pipes, flumes and diversion structures and schedule for repair.

Dead or dying grass on the pond bottom and/or standing water following 3 days or more of dry weather are indicative of filter "blinding." (Blinding occurs when fines or other materials physically inhibit the flow of stormwater through the filter material). When observed, the facility should be scheduled for major maintenance.

Note any signs of excessive petroleum hydrocarbon contamination and handle appropriately. (1)

When so equipped, check "clean out" ports at the end of each underdrain and the junction box or underdrain outlet for evidence of blockage, (i.e., standing water in underdrain lateral accompanied by little or no outflow.) Also inspect for damage to caps from mowing accidents or any breaks in seals to prevent short-circuiting of the filter.

Stormwater Treatment Ponds (Wet Detention w/Sand Filter System) (WE)

Inspect filtration component in accordance with type of system as per Dry Detention w/Sand Filter System requirements.

Inspect detention pond component as described in Wet Detention requirements.
Close attention should be given to the filtration component particularly evidence of short-circuiting associated with piping in the vicinity of underdrain junctions and the control structure.

NPDES MS4 PERMIT REQUIREMENTS

Stormwater Treatment Ponds (Dry Retention) (DP)

Inspect facility for signs of prolonged wetness and damage to structures including diversion devices and inflow and outflow structures and pipes. Note conditions that cannot be immediately corrected.

Dead or dying grass on the pond bottom are indications of potential clogging and reduced infiltration capacity. When observed, the facility should be checked to insure that it percolates completely within 3 days following storms. Scraping, discing or otherwise aerating pond bottom may be required to restore the infiltration capacity of the soil.

Note any critically eroded areas on banks and pond bottom. Schedule for stabilization.

Note any undercutting at the point of discharge and signs of piping in the vicinity of the control structure or inlets, flumes, diversion structures or pipes and schedule for repair.

Note any signs of excessive petroleum hydrocarbon contamination and handle appropriately. (1)

Grass Treatment Swales (Dry) (TS)

Inspect for and note any signs of prolonged wetness and damage to structures including diversion devices, inflow pipes, driveway culverts, and swale blocks. Note conditions that cannot be immediately corrected.

Dead or dying grass and saturation of the swale bottom are indications of potential clogging and reduced infiltration capacity. When observed, the facility should be checked to insure that it percolates completely within 3 days following storms. Scraping, discing or otherwise aerating the bottom may be required to restore the infiltration capacity of the soil.

Note any critically eroded areas on banks and front or back slope and swale bottom. Schedule for stabilization.

Note any undercutting at the point of discharge and paved flumes or pipes and culverts and schedule for repair.

Note any signs of excessive petroleum hydrocarbon contamination and handle appropriately. (1)

NPDES MS4 PERMIT REQUIREMENTS

Stormwater Treatment Ponds (Wet Detention) (WL & MWL)

Bleeder devices such as orifices as well as weirs, stand pipes, box drop inlets, grates, and screens should clean, free of debris and ready for service. Note conditions that cannot be immediately corrected.

Inspect control structure, inflow(s) and the point of discharge (POD) for proper operational condition and capacity. Note conditions that cannot be immediately corrected.

When present, all control gates should be checked for operational capacity by briefly opening and closing valve.

Detention facilities that include planted littoral shelf components will be monitored and managed to avoid invasive aquatic plant problems. Schedule removal of invasive species or chemical control when necessary to prevent excessive competition with beneficial or desired plants. (2)

Note those areas within the littoral zone where the spread or overcrowding of beneficial plants necessitates management and harvesting due to mosquito breeding problems or other detrimental conditions.

Note any undercutting at the POD and evidence of piping (erosion of soil into pipe junctions) and/or erosion in the vicinity of inflow pipes, the outlet control structure, or flumes and schedule for repair.

Forebays/sediment sumps are to be monitored for sediment accumulation. Monitor sediment accumulations within each sump by measuring from the flow line of the pipe to the top of the sediment level. The "Cleanout Level" is reached when 60% of storage volume is filled (Example: Bottom of sump is 1.5 ft. below flow line of pipe/sump dimension at bottom is 3'X3' with 1:1 side slopes = 33.75 cu. ft. – "Cleanout Level" is reached when the sump has accumulated 20.25 cu. ft. of sediment which is approximately 0.4 ft. below the flow line of pipe). Remove sediment from all sumps within the facility and restore the sump to dimensions shown on the plans or to the elevation that was later established due to high sediment loading. (3)

Note signs of excessive total petroleum hydrocarbon contamination and handle appropriately. (1)

NPDES MS4 PERMIT REQUIREMENTS

Pollution Control Boxes (Catch Basins with Oil, Grease & Grit Separation Chambers) (CDS)

Monitor facility sediment accumulation.

Inspect appurtenances such as grates, oil and grit separation chambers, overflow weirs, and discharge pipes. Overflow weirs and grated inlets should be free of debris and ready for service. Sedimentation and oil/grit separators should be scheduled for cleaning when sediment depth approaches cleanout level.

Cleanout level is not less than 1 foot below the control elevation of the chamber.

Exfiltration Systems (UE/US)

Monitor facility for sediment accumulation in the pipe (when used) and storage volume recovery (i.e., drawdown capacity). Observation wells and inspection ports should be checked following 3 days minimum dry weather. Failure to discharge stored runoff to the design treatment volume level within 72 hours may indicate a physical blockage preventing water from reaching the filter or may indicate blinding of filtration sand and/or clogging of geotextile liner with fine solids. Reductions in storage volume due to sediment in the distribution pipe also reduce efficiency. Minor maintenance measures may restore exfiltration rates to acceptable levels short term. Major maintenance (total rehabilitation) is required when recovery of the treatment volume no longer occurs within the permitted recovery period or when minor measures are no longer effective or cannot be performed due to design configuration.

Inspect appurtenances such as sedimentation and oil and grit separation chambers of the catch basins as well as diversion devices and overflow weirs when used. Diversion facilities and overflow weirs should be free of debris and ready for service.

Sedimentation and oil/grit separators should be scheduled for cleaning when sediment depth approaches "Cleanout Level". Cleanout levels shall not be less than 1 foot below the control elevation of the chamber.

NPDES MS4 PERMIT REQUIREMENTS

Notes:

(1) Excessive petroleum hydrocarbon contamination can present severe sediment disposal/cleanup problems. Evidence of such pollution includes very dark oily stains, particularly at inlet and outlet structures and strong odors of gasoline, etc. The source of such pollutant discharges to the MS4 should be determined and removed if possible. Otherwise, pretreatment practices should be used as necessary to insure that stormwater runoff is not contaminated beyond levels normally observed in runoff from highways and parking lots.

(2) Use only pesticides approved by USEPA and FDACS for aquatic sites to control weed pests in and around treatment facilities. Use of pesticides and chemicals for the control of invasive species and common undesirable aquatic plants should be minimized. Careful herbicide selection and application is essential to minimize harm to desirable plants and animals. If done on a routine basis physical removal can help control unwanted aquatics and minimize the use of chemicals. However, experienced trained applicators can selectively control many undesirable plants with minimum harm to desirable vegetation and possible downstream contamination. The DEP regional biologist, with the Bureau of Aquatic Plant Management and/or County Cooperative Extension Service, should be contacted for assistance.

Soil amendments (fertilizer) should be used as needed to establish and maintain healthy and vigorous cover on the banks of treatment facilities. However, normal rates of fertilization should be lowered in the immediate vicinity of treatment facilities to avoid over-enrichment of the soil and adjacent waters. Apply soil amendments only when grass shows signs of distress once ground cover is well established. Clippings should be removed periodically to prevent the buildup of nutrients in vegetation subject to periodic or frequent inundation.

Problem areas susceptible to chronic erosion require more intense measures for protection and establishment of permanent vegetative cover. These special considerations may include the use of sod in lieu of seeding and/or the use of higher rates of soil amendments and supplemental moisture during dry weather conditions to insure more rapid establishment or vigorous growth in bank vegetation. Experts in soil
conservation are available for assistance by contacting the Natural Resources Conservation Service with the USDA.

(3) Sediments associated with stormwater treatment devices may be regarded as contaminated. As such, if disposed of haphazardly, this material may become a source of pollution for substances like heavy metals, petroleum hydrocarbons, other organic compounds and pesticides, as well as infectious organisms, nutrient and oxygen demanding substances. However, absent the regular addition of refuse, paints, solvents cleaning agents, pesticide and fuel spills, etc., there is little probability that these materials would be concentrated to the extent so as to be considered "hazardous waste." Off-site disposal of sediments shall be pursuant to Department rules.

GENERAL MAINTENANCE GUIDELINES (ALL FACILITIES)
STORMWATER OPERATIONS

1. Inspect facility for damage including skimmers, diversion devices, filter beds, flumes, side slopes, berm, and inflow and outflow structures and pipes. Note any damage that cannot be immediately corrected.

2. Inspect and clear any obstructions from drainage structures and control devices to ensure free flow of water.

3. Fences, gates, locks and any other access features should be repaired as necessary. Locks should be oiled during each regular maintenance cycle.

4. Sediment sumps shall be established at all inflow pipes that enter at pond bottom. Dry ponds: The dimensions of the sump shall be established/maintained to capture all sediment that enters the facility between established maintenance cycles. At a minimum the "Cleanout Level" for dry ponds is reached when sediment levels are less than 3" below the flow line of the pipe.

5. Check to see if proper identification signs are present. Replace as needed.

6. Repair or replace rebar/pvc pipe as necessary for mowing delineation.

7. Remove and properly dispose of all visible trash, debris, etc. resulting from or encountered during maintenance activities.

8. Trim overhanging limbs (offsite trees) from fence lines to prevent interference with maintenance equipment. Vines that have potential to damage fencing shall also be removed.

WET DETENTION POND MAINTENANCE OBJECTIVES (WL)

STORMWATER OPERATIONS

1 Maintain a minimum of 35% vegetative littoral shelf concentrated at the outfall or as indicated on the plans. In general, any native vegetation will be acceptable to maintain permit compliance. Where ponds have been planted with or have recruited more desirable native vegetation, maintenance practices shall be conducted in a manner that encourages the spread of desirable vegetation using selective removal of less desirable vegetation.

2. If applicable, encourage tree health and growth by eliminating or minimizing stress factors. Vines should be removed if they are hindering tree growth or development. Removal should be done in such a way that the removal methods also do not hinder tree growth (collateral mechanical or chemical damage should be avoided).

3 Remove and properly dispose of all trash, debris, etc. resulting from or encountered during maintenance activities, including removal of obstructions from drainage structures and control devices.

4 Trees should be maintained in an upright growth pattern, with staking provided as necessary. Stakes and guying should be inspected regularly and adjusted as necessary. Removal of staking and guying shall be directed by the Senior Environmental Specialist and should occur when the tree is able to maintain itself in an upright position (generally six months to a year). Small trees should be freshly flagged and staked to aid in their recognition. Trees maintenance is only to be done under the direction of the Senior Environmental Specialist.

MULTI-PURPOSE FACILITIES:
MITIGATION & WET DETENTION (MWL)
MAINTENANCE OBJECTIVES

STORMWATER OPERATIONS

1. Ensure that the presence of undesirable vegetative species is contained at a ten percent (10%) level or less within the footprint of the facility (project limits). Undesirable Species shall mean vegetation, which is not conducive to, or which inhibits the successful establishment of the desired vegetative community. Species classified as undesirable include, but are not limited to those plants listed in the Florida Exotic Pest Plant Council's current List of Invasive Species. In general this should also include Cattails (*Typha* spp.), Primrose willow (*Ludwigia peruviana*), and *Sesbania* spp.

2. Maintain a minimum of 85% coverage by planted and/or desirable recruited plants. This should include the 35% vegetative littoral shelf concentrated at the outfall or as indicated on the plans.

3. If applicable, encourage tree health and growth by eliminating or minimizing stress factors. Vines should be removed if they are hindering tree growth or development. Removal should be done in such a way that the removal methods also do not hinder tree growth (collateral mechanical or chemical damage should be avoided).

4. Trees should be maintained in an upright growth pattern, with staking provided as necessary. Stakes and guying should be inspected regularly and adjusted as necessary. Removal of staking and guying shall be directed by the Senior Environmental Specialist and should occur when the tree is able to maintain itself in an upright position, generally within six months to a year. Small trees should be freshly flagged and staked to aid in their recognition. Tree maintenance to be done under the direction of the Senior Environmental Specialist.

5. Remove and properly dispose of all trash, debris, etc. resulting from or encountered during maintenance activities, including removal of obstructions from drainage structures and control devices, when present.

MITIGATION MAINTENANCE OBJECTIVES (M)

STORMWATER OPERATIONS

1. Ensure that the presence of undesirable vegetative species is contained at a ten percent (10%) level or less within the footprint of the facility (project limits). Undesirable Species shall mean vegetation, which is not conducive to, or which inhibits the successful establishment of the desired vegetative community. Species classified as undesirable include, but are not limited to those plants listed in the Florida Exotic Pest Plant Council's current List of Invasive Species. In general this should also include Cattails (*Typha* spp.), Primrose willow (*Ludwigia peruviana)*, and *Sesbania* spp.

2. Encourage tree health and growth by eliminating or minimizing stress factors. Vines should be removed if they are hindering tree growth or development. Removal should be done in such a way that the removal methods also do not hinder tree growth (collateral mechanical or chemical damage should be avoided).

3. Trees should be maintained in an upright growth pattern, with staking provided as necessary. Stakes and guying should be inspected regularly and adjusted as necessary. Removal of staking and guying shall be directed by the Senior Environmental Specialist and should occur when the tree is able to maintain itself in an upright position, generally within six months to a year. Small trees should be freshly flagged and staked to aid in their recognition. Tree maintenance to be done under the direction of the Senior Environmental Specialist.

NUISANCE VEGETATION MANAGEMENT

STORMWATER OPERATIONS

1. Brazilian Pepper
2. Sesbania
3. Primrose willow
4. Australian pine
5. Camphor
6. Castor bean
7. Chinese tallow
8. Carrotwood
9. Melaleuca
10. Lead tree
11. Chinaberry
12. Christmas senna
13. Tropical soda apple
14. Lantana
15. Air potato

These species can be managed through manual or mechanical (physical) removal. Note the approximate coverage on-site by species and the percentage removed.

Other FLEPPC Nuisance Species noted on site to be referred to Vegetation Management through the Senior Environmental Specialist.

Permitted Facilities: Inspection/Maintenance Underground Facilities: CDS-DE-UE-US-WE

General inspection and Maintenance Items (all systems)	
Task Item by Area	**Task Item by Area**
Pipes	**Miscellaneous**
Check for blockages	Facility ID / Dot signs are in place and correct
Inspect/clean sumps	
Clean sediment from storage pipes	
Note any significant damage affecting function	
Structures	**Filtration Systems**
Check for and clear any blockages	Inspect filtration system (DE & WE) for evidence of damage & short-circuiting (piping/sinkholes) of the filter.
Check weir(s) are clear/intact/functional	Prior to cleaning - Inspect upstream end of filtration system (UE) and note depth of water, if present. Inspect and note discharge characteristics at the downstream end of filtration system.
Check skimmer for damage – repair/adjust	Check for adequate filtration recovery time - within 72 hrs. (DE - look for dead/dying grass/signs of aquatic vegetation).
Check for downstream blockages	Inspect/repair/report any filter system component damage affecting function
Inspect/clean sumps	Check plugs are in place and watertight
Note any significant damage affecting function	

CONTINUOUS DEFLECTION SYSTEMS (CDS)	
Note level of sediment accumulation prior to removal – (Cleanout level is not less than 1 foot below control elevation of the chamber)	Inspect/clean discharge pipes
Inspect grates & overflow weirs – remove debris	Note any significant damage affecting function
Inspect oil/grit separation chambers - clean	

F:\Users\SWA_DOC\StormAdmin\Forms\Maintenance Forms\2004\Underground Maintenance Checklist CDS-DE-UE-US-WE Facilities.doc

APPENDIX 5-E
BMP CONCEPT SKETCHES

Source: "Recommended Practices Manual – A Guideline for Maintenance and Service of Unpaved Roads." Choctoawhatchee, PEA and Yellow Rivers Watershed Management Authority, February 2000.

Example of Debris-Sediment Separation Inlet (from CDS Technologies brochure)

DROP INLET UNIT

Although catch basins are readily used across the U.S., few are ideally designed for sediment and pollutant capture like the Drop Inlet Unit from CDS.

The Drop Inlet Unit, or Precast Manhole Insert Unit, removes suspended solids, sediments, trash, debris, oil and grease along with floatable materials from storm water flows. The Drop Inlet Unit provides the lowest cost per cfs processed when compared to other structural Best Management Practices. Its patented non-blocking screen and non-mechanical function make it a low maintenance storm water treatment solution for very small developments.

Process

Using patented continuous deflective separation (CDS) technology, the Drop Inlet Unit effectively and efficiently separates solids from liquids.

1. Storm water flow enters the inlet grate or curb inlet and is channeled into the separation chamber.
2. It passes over a specially perforated separation screen in a hydraulically balanced condition, creating vortex solid separation.
3. Solids are then captured and retained within the central chamber. The fluid dynamics along the surface of the screen and the deflective characteristics of the screen prevent blocking.
4. Fluid passes through the screen and beneath an oil baffle before it exits via the storm drain outlet pipe.
5. Suspended solids, sediments and other solid pollutants, including oil and grease, trash and debris, are retained in a centrally located solids catchment chamber. The heavier solids settle into the sump.

Advantages

The Drop Inlet Unit is an effective fine solid separator, and no other BMP comes close to its assured removal of gross solids and neutrally buoyant material.

Installed underground, the Drop Inlet Unit is ideal for new construction sites as well as urban retrofit situations where space is limited and the drainage area is small.

This unit, like all CDS units, is entirely gravity driven with no moving parts or power requirements.

Its non-blocking screen overcomes the clogging and reduced efficiency experienced by direct filtration systems.

Independent tests show that in addition to 80% suspended solids removal, the units trap virtually 100% of gross particulate material half the aperture size of the screen and more than 90% of the particulates one-third the aperture size.

A conventional oil baffle in the unit effectively controls oil and grease in the storm water flow. With the addition of sorbents, the permanent capture efficiency is increased to 80-90%.

The Drop Inlet Unit can be strategically located in small areas to serve as both a drain inlet and a curb inlet. (NOTE: All CDS Units can be configured with grated or curb inlets.)

Specifications

Footprint diameter: 4 ft.

Variable Sump Capacity: 0.5 to 1.5 cubic yards

Treatment Capacity Range: 0.7-2.8 cubic feet per second

Maintenance

With its corrosion-resistant stainless steel screens and inert fiberglass inlet, the Drop Inlet Unit requires very little maintenance. As a general rule, CDS recommends removing solids with a standard vactor truck one to four times a year, depending on each site's pollutant loading characteristics.

Drop Inlet Unit

05

Unpaved Road Maintenance
Blading BMPs

Blading and Dragging

Blading and dragging is a smoothing operation which pulls loose material from the side of the road or spreads wind-rowed aggregate to fill surface irregularities and restore the road crown. It is performed with the moldboard tilted forward with light down pressure on the motor grader blade as shown in figure 1-2. The angle of the moldboard is adjusted to between 30 and 45 degrees, and in most cases, the front wheels are tilted slightly 10 to 15 degrees toward the direction the aggregate should roll.

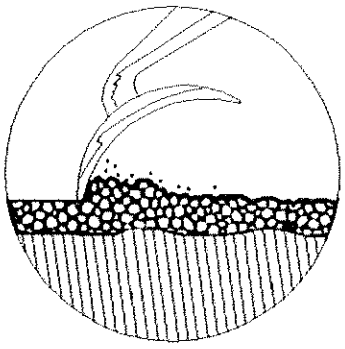


Figure 1-2. Blading

The following should be adhered to when blading:

a. Avoid blading during extended dry periods to minimize the loss of fine aggregates and minimize "washboarding".

b. Blading/dragging speed depends on the operator's skill, type and condition of machine (grader), tire pressure, and road surface condition. Normally, **three miles per hour in second gear is advised.**

c. Periodically blade the road surface against traffic flow to prevent aggregate from drifting onto ends of bridges, culverts, intersections, and railroad crossings. This is commonly referred to as "back dragging".

d. On hill crests, avoid cutting into the road surface, gradually adjusting the blade up as the front wheels pass over the crest and then down as the rear wheels follow (figure 1-3a).

e. In valleys or swags, gradually adjust the blade down as the front wheels pass the lowest point and then adjust the blade up as the rear wheels follow. This will prevent loose, easily erodible materials from piling up where runoff and concentrated flows frequently occur, thus preventing loss of valuable road fill, and preventing massive sedimentation to local streams and waterways (figure 1-3b).

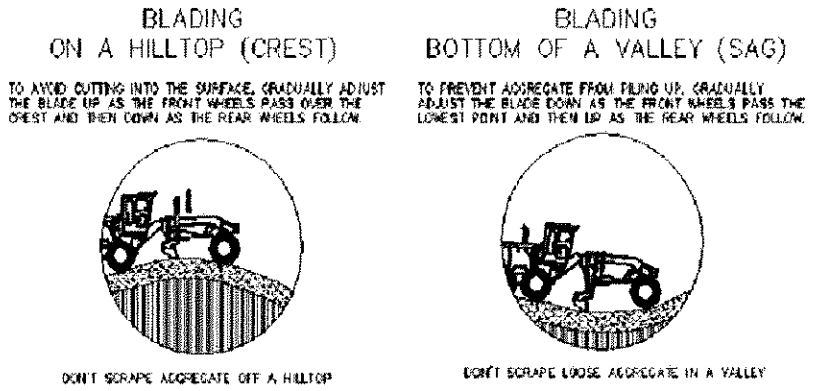


Figure 1-3. Blading on Hill Crests and in Valleys or Swags

Roadside Ditch BMPs

Efficient disposal of runoff from the road will help preserve the road bed and banks. Well vegetated ditches slow, control, and filter runoff providing an opportunity for sediments to be removed from the runoff water before it enters surface waters. In addition, a stable ditch will not become an erosion problem itself. Ideally, "turn-outs" (intermittent discharge points also called "tail ditches") will help maintain a stable velocity and the proper flow capacity within the road ditches by timely outleting water from them. This will help alleviate roadway flooding, reduce erosion, and thus reduce maintenance problems. In addition, properly placed "turn-outs" help distribute roadway runoff and sediments over a larger vegetative filtering area, helping to reduce the amount of road ditch maintenance required to remove caught-up sediment.

Ditch Profile and Grading

General

Roadway ditch location, profile, shape, lining and outlets effect how efficiently water will be removed from the roadway. Ideally ditches should resist erosion, be self cleaning, and discharge onto nearly level vegetated areas, thus maximizing the length of time between regrading, thereby reducing maintenance costs. As shown in figure 2-1, ditches should be located on the uphill side of the roadway to prevent runoff water from flowing onto and over the road surface.

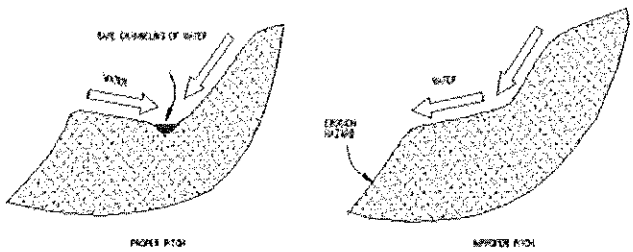


Figure 2-1. Hillside Pitch of Roadway and Proper Ditch Location

Turnouts or "Tail Ditches"

Excavate roadway ditches at a bottom elevation 1 to 2 feet below the road base. The ditch bottom should be rounded-V shaped (preferred), parabolic, or flat, as shown in figure 2-2, and at least 2 feet wide to disperse the flow and slow the velocity. Do not construct U-shaped ditches. U-shaped ditches actually have up to 30 percent less drainage capacity than other shapes and they tend to look messy. Their steep sides make maintenance difficult and the sides tend to cave in, compounding maintenance problems and adding to erosion and sedimentation.

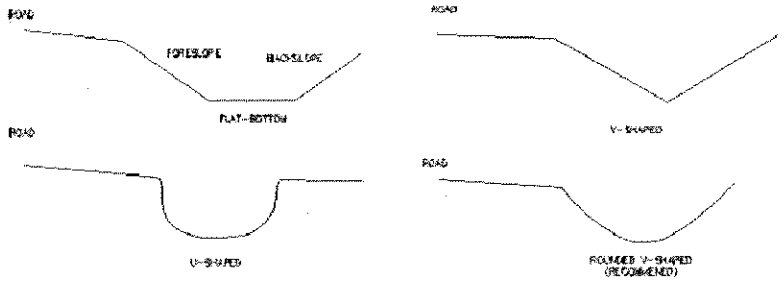


Figure 2-2. Common Ditch Shapes

Where possible, install "turn-outs" ("tail-ditches") to help maintain a stable velocity and the proper flow capacity within the road ditches by timely outleting water from them. See Figure 2-3 below. These structures are critical elements in establishing and maintaining a stable unpaved roadway drainage system. It is imperative that landowners adjacent to these roadways allow water to be discharged in this manner at crucial points. Correspondingly, these turn-out points must be stabilized to prevent creating worse erosion problems such as gullies. In many cases, the discharged runoff can be spread to reduce the erosive energy of concentrated flows.

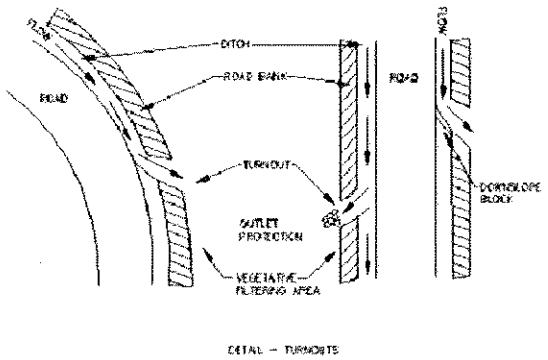


Figure 2-3. Typical Locations for "Turnouts" ("Tail Ditches")

Outlet Protection - Plunge Basins/Splash Aprons

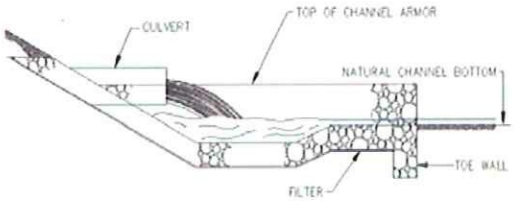


Figure 4-1. Depressed Type Plunge Basin Illustration

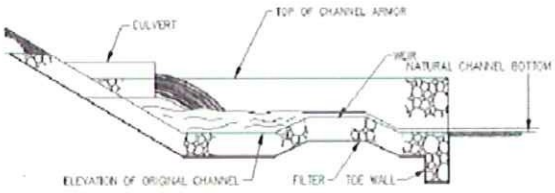


Figure 4-2. Weir-formed Plunge Basin Illustration

Splash Apron

A widened, flat, armored area, level to slightly sloping, located at the low-energy discharge point of conveyance structures and/or splash/plunge basins. Flow exiting this structure should enter a stream or vegetated outlet.

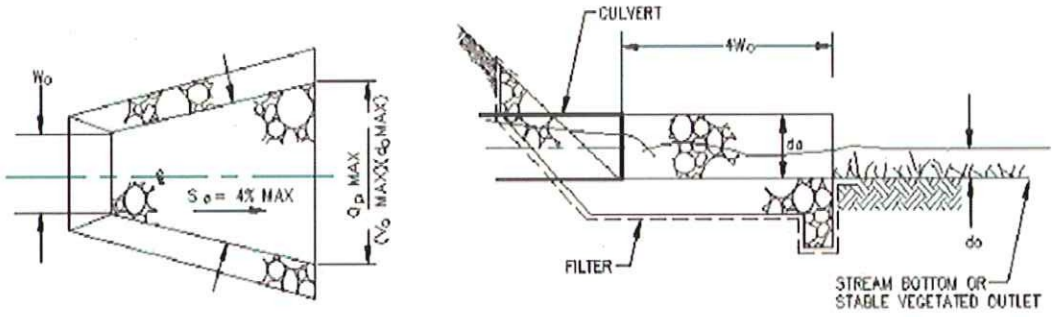


Figure 4-3. Splash Apron Illustration

As shown in figure 4-3, the structure's bottom dimensions taper from a narrow width at the conveyance structure discharge point to a wider dimension at the outlet some distance downstream. This spreads the water in a fanning action over the rough, armored surface reducing the velocity, and promoting sheet flow as the water exits into streams or onto vegetated

Bank Grading BMPs to Minimize Erosion

Construction and Grading/Re-Grading

Bank construction and maintenance procedures in relation to compaction (for fills), slope gradient, and surface grading is critical to establishing a long term, stable slope.

Fill slopes should be compacted to a density commonly stable for the soil material used. Loose fill should be placed on a relatively level, scarified surface (roughened one inch) in lifts not to exceed 12 inches, and thoroughly compacted before more material is added. Compaction equipment must cover the entire surface, preferably in a cris-cross pattern, sufficient enough times to achieve the desired compaction. Tests may be required to determine the level of compaction (density). With familiar soils, established, common, and proven methods may be routinely used for expediency and economy. Most fill slopes should be 3 feet horizontal to 1 foot vertical (3:1) or flatter for stability, however, some soils can be placed at steeper slopes to accommodate limited space. Evaluation of the soil material should be made by a professional engineer to determine whether slopes flatter or steeper than 3:1 should be used.

Smooth, and even grading of the slope surface will enhance aesthetics and will also improve the ability to establish a good vegetative cover and maintain it. Slope grades should be straight and true without humps, bellies, dips or ridges. This will reduce concentration of runoff on slopes and promote sheet flow which is less erosive and enhances infiltration of water needed for plant growth. Vertical tracking (up & down slope) with a dozer will also enhance infiltration.

Bank-Grading Techniques

Terracing

The construction of benches on long and/or excessively steep slopes to provide breaks and near level "troughed" areas in the slope which will intercept runoff. These troughs are back-sloped from the slope face to catch runoff and channel it to either end of the embankment. (See figure 5-1).

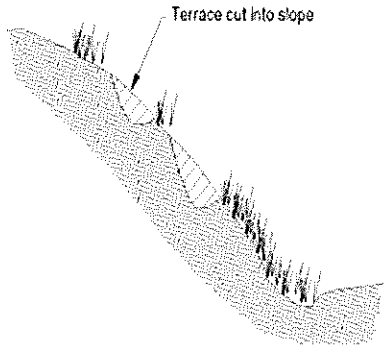


Figure 5-1. Slope Terracing

Vegetation by Trees & Shrubs

Trees and shrubs can be used to create a good vegetative filter strip and stabilize steep or wet slopes, stream banks, and/or other areas where stronger and/or larger vegetation than grass is needed for stabilization. Deep rooted species of trees and shrubs provide greater protection against soil slippage problems.

Use native plants of the area to ensure adaptability and reduce costs. Identify plants in the area which are proven to provide the protection and stabilization desired. Some plants common to the CPYRWMA area which are often used for stabilization are willows, alders, and dogwoods. Use the most effective, appropriate technique in planting and establishing trees and shrubs for bank stabilization.

Live stakes

Cuttings of live branches neatly pruned of limbs, usually 1/2 to 1-1/2 inches in diameter, and 2 to 3 feet long. This technique is inexpensive and can be used when time and/or resources are very limited and the site is not complicated. See figure 5-5 below.

1. The basal end should be cut at an angle to facilitate insertion into the ground.
2. Stakes are driven into the ground perpendicular to the slope, basal end first (buds oriented upward), until only 2" to 3" of the stake protrudes above the ground.
3. Stakes are planted in rows on the contour. Stakes in each successive row are staggered yielding an alternating grid pattern with two to four stakes per square yard.
4. Stakes should be cut during dormant seasons and installed the same day as cut, or temporarily stored (a few days) in a very moist, cool environment until use.

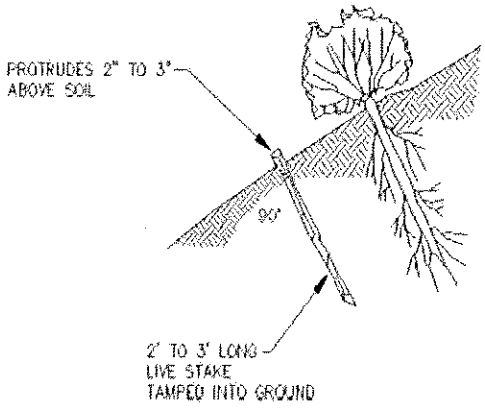


Figure 5-5. Live Stake Planting

Ditch Blocks/Check Dams

Rock Ditch Check/Check Dam

Semi-permanent to "permanent" structure composed of stone, as shown in figure 6-3, which will eddy water behind it, settle out sediment, and allow water to pass through and/or over its crest. Once sediment has filled in behind the structure the active function of collecting sediment will cease, however, it will continue to act as a stabilizing force for the ditch bottom grade.

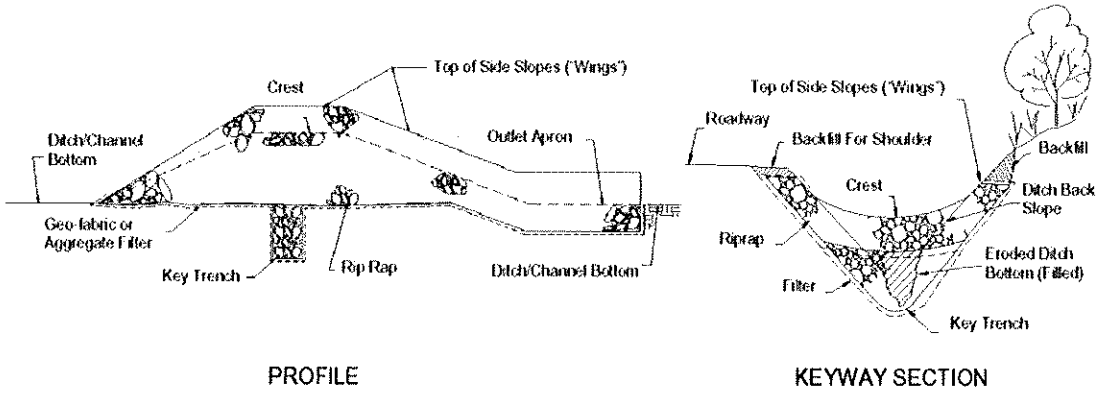


Figure 6-3. Rock Ditch Check/Check Dam Details

The roadway crown, shoulder, and ditch bottom elevations must be maintained constant for as long as possible to extend the life of these structures and make them cost effective. Unchecked roadway degradation renders these stationery structures useless and may allow them to become accelerants to erosion rather than aids against it.

For optimum performance, these structures must be designed by a professional engineer, meticulously installed, and rigorously maintained. Structures must be embedded into the side banks, toed into the channel bottom at the outlet, and have a flow channel deep enough to handle normal runoff to minimize the potential for over-flow scour around the edges. Also, there should be enough outlet apron to dissipate the energy of water overflowing the crest to protect the toe from the undermining scour which leads to failure. A toe-wall at the end of the apron is often necessary. Continual maintenance is critical until the structure has stabilized and "seated" itself.

Lateral runoff from adjacent roadway surfaces or back slopes must be directed safely into the ditch or structure to prevent washout along the edges of the structure. Construct the structure of stone large enough, or otherwise secured in place (ie. grouted, gabion, etc.), to resist expected velocities. A geotextile fabric or aggregate filter should lay between all stone to ground contact surfaces, with overlap at fabric seams, and fabric or aggregate overlapping the exposed edges at the surface as shown in figure 6-3.

Level Spreader for Velocity Dissipation

Level Spreader

Semi-permanent to permanent trench used to spread, and discharge water flow over a wide area. This structure reduces concentrated flow, increases infiltration, and allows for sediment to be removed by settling and filtering. Level spreaders are generally used at the toe of a slope, but can be used to intercept concentrated runoff and disperse it across the head (top) of a slope or grade. This application can be useful in protecting road banks from concentrated flow entering from upland drainage areas.

As shown in figure 6-4, it is constructed as a water impounding channel or trench, cut on a level contour into a slope or grade. The front (downslope) edge allows shallow discharge over its entire length when the impoundment is full. The impoundment should be shallow, but deep and wide enough to reduce surface turbulence from the runoff inflow allowing the water to evenly fill the impoundment and then flow smoothly over the discharge point along the front edge no deeper than 1/2" at peak design flow. The impoundment will catch sediment and will require periodic clean-out maintenance.

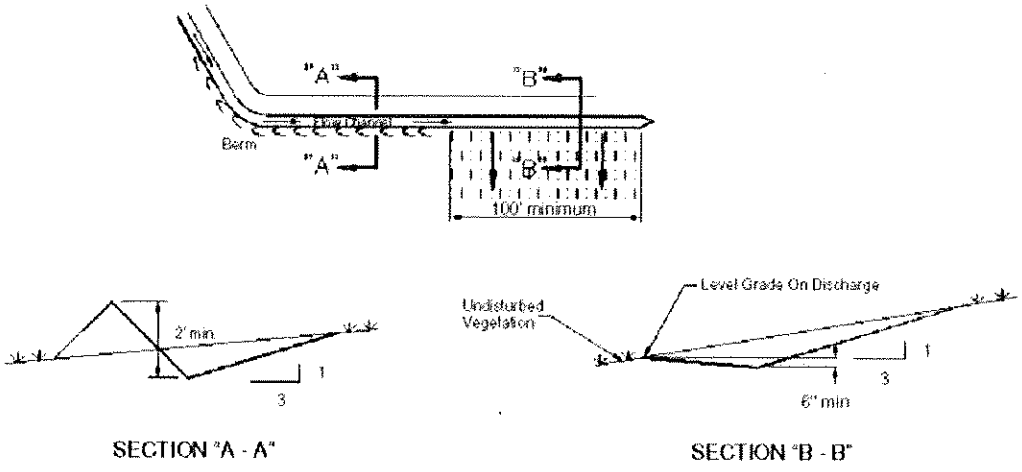


Figure 6-4. Level Spreader Details

Vegetated (Riparian) Buffer

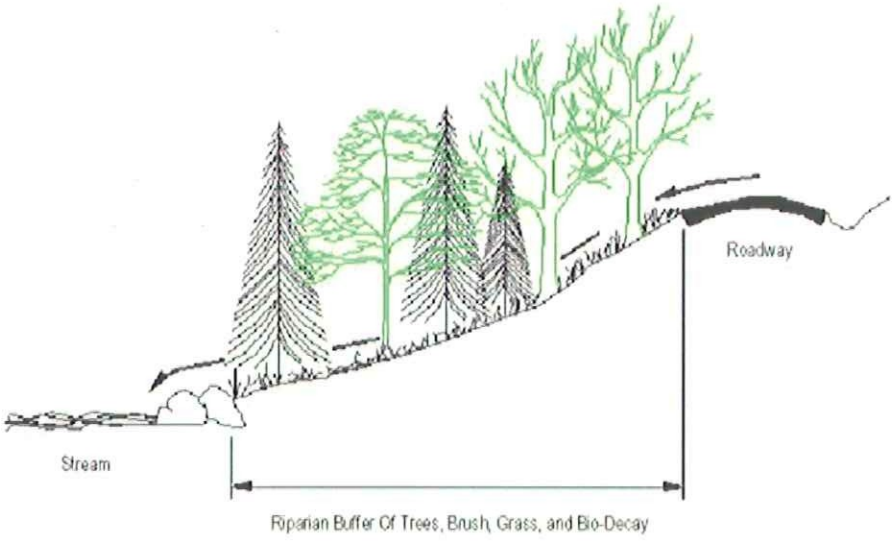


Figure 6-7. Riparian Buffer Illustration

Road ditches, turn-outs, and other water disposal systems from roadways should empty into a riparian buffer, whenever possible, before entering sensitive areas. The discharge from these disposal systems should be fanned (spread out) as much as possible as it transitions from the concentrated channel to the riparian buffer (see Figure 6-4, Level Spreader Details). The distance from concentrated discharge to sensitive areas should be adequate to allow vegetation to grow through and stabilize deposited sediments. The minimum distance should be fifty feet.

Riparian buffers may become filled and damaged from excessive sedimentation. This may require additional spreading of the runoff or delicate removal of sediment from the buffer. In either case, a need for additional upland sediment control is indicated.

TABLE OF CONTENTS

6.0 REPAIR AND REPLACEMENT PROJECTS 6-1

List of Figures

Figure 6-1 Repair and Replacement Project Locations 6-4

List of Tables

Table 6-1 Repair and Replacement Projects 6-1

6.0 REPAIR AND REPLACEMENT PROJECTS

Existing drainage system components in need of repair or replacement have been identified through coordination with Putnam County drainage maintenance staff, field review of identified flood problem and sedimentation areas, and additional field investigations performed in selected subwatersheds as part of GIS stormwater facilities inventory and database development. The Florida Department of Transportation (FDOT) District 2 office performs bridge inspections for the County's bridges along with State-owned bridges within its jurisdiction. FDOT Bridge Inspection Reports and recommendations were also reviewed to compile the repair and replacement projects list. **Table 6-1** lists existing systems or components in need of repair or replacement and includes brief descriptions of the identified problems.

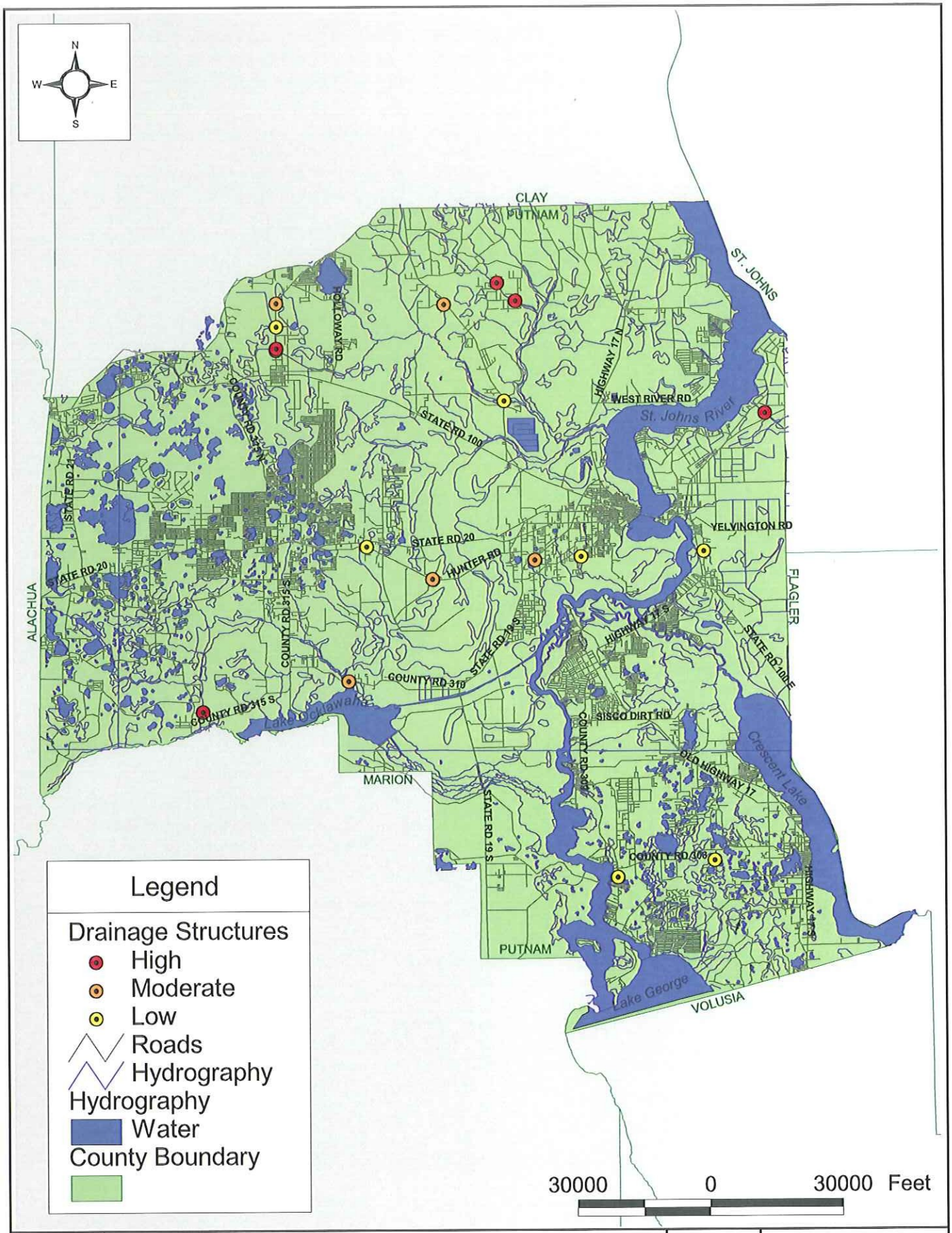
Project areas are listed in order of perceived priority and include bridge replacements, headwall or wingwall repairs, channel/abutment armoring and replacement of severely crushed, corroded or silted culverts. Repair and replacement projects have been prioritized based upon public safety, severity of component disrepair, and potential flooding impacts of the compromised function of the component. Some of these projects will be referenced again in this Master Stormwater Plan, and recommended for capital improvement program projects. **Figure 6-1** presents the locations of listed projects.

TABLE 6-1 REPAIR AND REPLACEMENT PROJECTS

Location	Hydraulic Feature ID or Table 2.8-1 Problem Area No.	Description	DPU Watershed *Subwatershed*
HIGH PRIORITY			
Silver Lake Drive over Twomile (Duval) Creek	Problem Area 9 Hyd ID 348	Deteriorated culvert in need of repair or replacement. Primary creek conveyance.	**SOUTH MAINSTEM** Twomile (Duval) Creek
Orange Springs Shortcut Road over Little Orange Creek	Problem Area 5	Timber bridge with insufficient flood clearance, timber damage and unprotected abutments. Unsafe for traffic during moderate to heavy rains.	**ORANGE CREEK** Orange Creek *Little Orange Creek*
Rector Road at State Road 207	Problem Area 17 Hyd ID 348	Corroded and sediment-blocked culvert of significant size. Traffic safety concern. Culvert collapsed in 2006 and road was closed.	**SOUTH MAINSTEM** West Run Interceptor D *West Run* *Interceptor D*

Location	Hydraulic Feature ID or Table 2.8-1 Problem Area No.	Description	DPU Watershed *Subwatershed*
Coral Farms Road over Etonia Creek canal tributary	Hyd ID 213, 305	Corrugated metal culverts (14 to 15 ft diameter) approx. 1 mile north of SR 100. Requires evaluation due to roadway settling.	ETONIA CREEK Etonia Creek *Etonia Creek*
John's Place over Unnamed Branch-1	Hyd ID 12 Florahome Drainage District	Timber bridge (# 764042) needs replacement. Transfer of ownership to County is complete.	ETONIA CREEK Simms Creek *Unnamed Branch - 1*
Songbird Road over Simms Creek	Hyd ID 21 Florahome Drainage District	Timber bridge (# 764031) needs replacement. Bank protection failed. Structural and scour risk.	ETONIA CREEK Simms Creek *Unnamed Branch - 1*
MODERATE PRIORITY			
County Road 310 over Deep Creek	FDOT Bridge No. 764014	Pile and abutment protection deterioration, heavy channel vegetation restricting flow and significant scour noted at several locations. This structure is rated Scour Critical and needs scour countermeasures implemented.	RODMAN RESERVOIR Deep Creek *Deep Creek*
Providence Church Road over Etonia Creek tributary	Hyd ID 9 Florahome Drainage District	Double 32-inch culvert cross-drain rusted through and choked with sediment	ETONIA CREEK Etonia Creek *Etonia Creek*
Hunter Road roughly 1.2 miles east of Fire Tower Road	Hyd ID 302, 303	Two 24-inch co-located cross-drains severely silted and squashed.	ETONIA CREEK Rice Creek *Rice Creek*

Location	Hydraulic Feature ID or Table 2.8-1 Problem Area No.	Description	DPU Watershed *Subwatershed*
Silver Lake Drive over Pine Lake outlet channel	Hyd ID 119	Single 24-inch culvert providing connection between Pine lake and Mud lake is severely silted and squashed.	SOUTH MAINSTEM Mudlake Outlet
River Park Subdivision drainage outlet at County Road 309	Problem Area 13	Outlet cross-drain is undersized causing property flooding.	LAKE GEORGE St Johns River *River Park Subdivision*
Coral Farms Road north of Thornton Lane	Hyd ID 306 NW Florahome Drainage District	Single 24-inch culvert severely silted with almost no remaining hydraulic function.	ETONIA CREEK Etonia Creek *Etonia Creek*
LOWER PRIORITY			
Coral Farms Road over tributary near Haast Road	Hyd ID 211 NW Florahome Drainage District	Collapsing wingwall at 48-inch cross-drain culvert.	ETONIA CREEK Etonia Creek *Etonia Creek*
Bardin Road (CR 309) over Etonia Creek	Hyd ID 52	Bridge No 764007 End Bent undermining and significant scour noted during last bridge inspection. Replace riprap protection	ETONIA CREEK Etonia Creek *Etonia Creek*
Heidt Road near Heidt Loop Road	Hyd ID 341	Severely silted and squashed 16-inch cross-drain.	SOUTH MAINSTEM Twomile (Duval) Creek
Hunter Road over Sweetwater Creek	Hyd ID 139	Sand-cement headwall needs repair at 48-inch cross-drain.	RODMAN RESERVOIR Deep Creek *Sweetwater Creek*
Old San Mateo Road over unnamed tributary	Hyd ID 89	Structure cover eroding at headwall of 72-inch cross-drain.	SOUTH MAINSTEM St Johns River
Browns Hammock Road near Gem Lake Drive	Hyd ID 358	Road washout causing severe siltation and crushing of 16-inch cross-drain.	LAKE GEORGE Tiger Branch



Repair and Replacement Project Locations
Putnam County Master Stormwater Plan

G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\drainagestructures.apr

Figure 6-1

AYRES ASSOCIATES

TABLE OF CONTENTS

7.0 CAPITAL IMPROVEMENT PROGRAM FOR LOCALIZED FLOODING .....
7.1 Capital Improvement Program Development .....
7.2 Localized Flooding And Sedimentation Areas .....
7.2.1 Price Road .....
7.2.2 Bellamy Woods Road .....
7.2.3 Roops Ditch .....
7.2.4 Florahome Drainage District .....
7.2.5 Orange Springs Shortcut .....
7.2.6 Hunter Road (Old Gainesville Highway) .....
7.2.7 Mondex .....
7.2.8. Devall Branch .....
7.2.9 Twomile (Duval) Creek .....
7.2.10 West Tocoi Road .....
7.2.11 Palmetto Bluff Road .....
7.2.12 Millican Road .....
7.2.13 River Park Subdivision .....
7.2.14 Lakeway Drive Drainage .....
7.2.15 San Mateo Road To Dunns Creek .....
7.2.16 East Palatka Drainage District .....
7.2.17 Rector Road .....
7.2.18 East River Road .....
7.2.19 County Road 315 at 64th Street .....
7.2.20 Whispering Pines .....
7.2.21 Saratoga Harbor: Saratoga Harbor Estates .....
7.2.22 County Road 308 B .....
7.2.23 County Road 309 (South) .....
7.2.24 Harris Fish Camp Road .....
7.2.25 Junction Road .....
7.2.26 Mud Lake/Monroe Mill Creek .....
7.2.27 Sisco Dirt Road .....
7.2.28 Foxwood Outfall .....
7.3 Priority Ranking .....
7.4 Potential Stormwater Strategies .....

7.4.1 Devall Branch (Rank No. 1) 7-87
7.4.2 Twomile (Duval) Creek (Rank No. 2) 7-88
7.4.3 Palmetto Bluff Road (Rank No. 3) 7-88
7.4.4 Millican Road (Rank No. 4) 7-88
7.4.5 River Park Subdivision (Rank No. 5) 7-88
7.4.6 Mud Lake / Monroe Mill Creek Watershed (Rank No. 6) 7-88
7.4.7 Orange Springs Shortcut (Rank No. 7) 7-88
7.4.8 Rector Road (Rank No. 8) 7-88
7.4.9 East Palatka Drainage District (Rank No. 9) 7-88
7.4.10 Whispering Pines (Rank No. 10) 7-88
7.4.11 County Road 315 at 64th Street (Rank No. 11) 7-88
7.4.12 Florahome Drainage District (Rank No. 12) 7-88
7.4.13 East River Road (Rank No. 13) 7-88
7.4.14 Saratoga Harbor (Rank No. 27) 7-88
7.4.15 Mondex (Rank No. 28) 7-88
7.5 Benefit - Cost Analysis 7-88
7.5.1 Description of FEMA Benefit-Cost Analysis 7-88
7.5.2 Results 7-88

List of Figures

Figure 7.2-1 Price Road Problem Area 7-3
Figure 7.2-2 Bellamy Woods Road Problem Area 7-6
Figure 7.2-3 Roops Ditch Problem Area 7-9
Figure 7.2-4 Florahome Drainage Problem Area 7-12
Figure 7.2-5 Orange Springs Shortcut Problem Area 7-15
Figure 7.2-6 Old Gainesville Highway Problem Area 7-18
Figure 7.2-7 Mondex Problem Area 7-22
Figure 7.2-8 Devall Branch Problem Area 7-25
Figure 7.2-9 Twomile (Duval) Creek Problem Area 7-27
Figure 7.2-10 West Tocoi Problem Area 7-32
Figure 7.2-11 Palmetto Bluff Problem Area 7-35
Figure 7.2-12 Millican Road Problem Area 7-38
Figure 7.2-13 River Park Subdivision Problem Area 7-40
Figure 7.2-14 Lakeway Drive Problem Area 7-43
Figure 7.2-15 San Mateo Road - Dunns Creek Problem Area 7-46
Figure 7.2-16 East Palatka Drainage District Problem Area 7-48

Figure 7.2-17 Rector Road Problem Area 7-50
Figure 7.2-18 East River Road (at Camp Road) Problem Area 7-53
Figure 7.2-19 County Road 315 at 64th Street Problem Area 7-57
Figure 7.2-20 Whispering Pines Problem Area 7-60
Figure 7.2-21 Saratoga Harbor Problem Area 7-63
Figure 7.2-22 County Road 308 B Problem Area 7-67
Figure 7.2-23 County Road 309 Problem Area 7-70
Figure 7.2-24 Harris Fish Camp Road Problem Area 7-72
Figure 7.2-25 Junction Road Problem Area 7-75
Figure 7.2-26 Mud Lake Problem Area 7-78
Figure 7.2-27 Sisco Road Problem Area 7-81
Figure 7.4.1-1 Devall Branch Location Map 7-89
Figure 7.4.1-2 Devall Branch Location and Basin Delineation by HNTB 7-90
Figure 7.4.1-3 HEC-RAS Representation of the CMP 7-91
Figure 7.4.1-4 12-foot Conspan Drawing 7-92
Figure 7.4.2-1 Twomile Creek Location Map 7-97
Figure 7.4.3-1 Palmetto Bluff Road Location Map 7-99
Figure 7.4.3-2 Rural Turnout Construction 7-101
Figure 7.4.3-3 Palmetto Bluff Road Maintenance Easement Corridors 7-103
Figure 7.4.4-1 Millican Road Location Map 7-107
Figure 7.4.4-2 Drainage Improvements 7-108
Figure 7.4.5-1 River Park Subdivision Location Map 7-112
Figure 7.4.5-2 Integrated Model Cross-Section and Components 7-115
Figure 7.4.5-3 Existing and Proposed Hydrographs for a Lake 7-116
Figure 7.4.6-1 Mud Lake/Monroe Creek Location Map 7-119
Figure 7.4.7-1 Orange Springs Shortcut Location Map 7-122
Figure 7.4.7-2 16-Foot Conspan Drawing 7-125
Figure 7.4.8-1 Rector Road Location Map 7-127
Figure 7.4.8-2 28-Foot Conspan Drawing 7-130
Figure 7.4.8-3 HEC-RAS Model – Arch Pipes 7-133
Figure 7.4.8-4 HEC-RAS Model - Conspan 7-134
Figure 7.4.9-1 East Palatka Drainage District Location Map 7-136
Figure 7.4.9-2 East Palatka Drainage District Location Map (Detailed) 7-137
Figure 7.4.10-1 Whispering Pines Location Map 7-139
Figure 7.4.11-1 County Road 315 at 64th Street Location Map 7-141
Figure 7.4.12-1 Florahome Drainage District Location Map 7-144
Figure 7.4.12-2 Florahome Drainage District Location Map (Detailed) 7-145
Figure 7.4.12-3 12-Foot Conspan Drawing 7-150
Figure 7.4.13-1 East River Road (at Camp Road) Location Map 7-152
Figure 7.4.14-1 Saratoga Harbor Location Map 7-157
Figure 7.4.14-2 HEC - HMS Model Schematic 7-159
Figure 7.4.14-3 HEC - HMS Summary of Results 7-160
Figure 7.4.14-4 Lake Overflow Slope Stabilization 7-161

Figure 7.4.15-1 Mondex Location Map 7-164
Figure 7.4.15-2 Mondex Location Map (Detailed) 7-165
Figure 7.4.15-3 Mondex FEMA Flood Zones 7-166
Figure 7.4.15-4 SCS Soils Classifications 7-168

List of Tables

Table 7.3-1 15 Top-Ranked Projects for Putnam County 7-86
Table 7.4.1-1 HEC-Ras Output: Devall Branch 7-93
Table 7.4.1-2 Devall Branch Summary of Activities, Timeline, and Budget 7-95
Table 7.4.3-1 Cost Estimate for Palmetto Bluff Rd/Millican Rd Intersection 7-100
Table 7.4.3-2 List of Owners / Assessed Value 360 Ft Millican 7-102
Table 7.4.3-3 List of Owners / Assessed Value 3000 Ft Crossing 7-104
Table 7.4.3-4 List of Owners / Assessed Value 6000 Ft Crossing 7-104
Table 7.4.3-5 Cost Estimate and Timetable for a Modeling Analysis 7-105
Table 7.4.4-1 Cost Estimate for Millican Road 7-106
Table 7.4.4-2 Costs for Millican Road 7-109
Table 7.4.4-3 Parcel Numbers and Per-Acre Values of ROW 7-109
Table 7.4.5-1 River Park Area Summary of Activities, Timeline, and Budget 7-117
Table 7.4.6-1 Mud Lake Summary of Activities, Schedule & Budget 7-120
Table 7.4.8-1 HEC-Ras Output - Arch Pipes 7-131
Table 7.4.8-2 HEC-Ras Output - Conspan 7-131
Table 7.4.11-1 Cost Estimate for CR 315 at 64th Street 7-142
Table 7.4.13-1 County Complex Elevations 7-154
Table 7.4.14-1 Cost Estimate for Saratoga Harbor 7-158
Table 7.5.1 Projects Evaluated for BCR Analysis 7-171

7.0 CAPITAL IMPROVEMENT PROGRAM FOR LOCALIZED FLOODING

Based on the scope of services, the Capital Improvement Program (CIP) should:

- Identify capital improvement needs; including cost estimates for engineering, construction, contingency, operation and maintenance costs, time requirements, cost/benefit ratio and a priority ranking
- Provide engineering design and administration services, if required
- Support the Master Stormwater Management Plan

The following sections describe the CIP development strategy and project prioritization; provide preliminary engineering designs for priority projects; and present a Master Stormwater Management Plan.

7.1 CAPITAL IMPROVEMENT PROGRAM DEVELOPMENT

Development of the Capital Improvement Program centered on the historic flooding and sedimentation problem areas listed in Section 2.8. These areas were field-visited and analyzed to allow project prioritization and to note any limiting factors which might impact potential stormwater strategies. Section 7.2 describes each of the identified flooding/sedimentation areas, including photos and notes from the field review. Section 7.3 presents the project priority ranking.

The 15 top-ranked flooding/sedimentation areas were selected for stormwater strategy analysis. Section 7.4 presents potential stormwater strategies and evaluation of effectiveness in alleviating flood and water quality problems for each of the 15 priority project areas. Preliminary cost assessments for proposed alternatives are also developed. Section 7.5 presents a simplistic cost/benefit ratio assessment for each alternative.

7.2 LOCALIZED FLOODING AND SEDIMENTATION AREAS

Putnam County has identified twenty-eight (28) specific flooding and sedimentation areas. In a meeting on April 16, 2004, the County provided Ayres Associates a list and description of the areas, which is presented, along with a map of locations, in Section 2.8 of this Master Stormwater Plan.

Both the "Localized Flooding Areas" and "Significant Sediment Contribution" tasks required joint field visits by Ayres Associates and the County maintenance staff. Ayres Associates was responsible for interviewing the maintenance staff, photographing problem areas, collecting data and developing narratives based on the field work and other background data.
The following process was used to investigate the sites:

1. Conduct an assessment by visiting the sites with Area Maintenance Supervisors
2. Take appropriate preliminary measurements (culvert diameters, lengths, channel widths/slopes)
3. Photograph key features

4. Record the history of the site as recalled by the Area Maintenance Supervisor

To the extent possible, these investigations were verified and refined by discussions with other appropriate County personnel including the County Engineer. In all, as directed by the County, 28 sites were investigated.

7.2.1 PRICE ROAD

Location and General Description

Price Road is shown on **Figure 7.2-1**. It is unpaved and is located in the Etonia Creek watershed, which is within the Etonia Creek Planning Unit. It intersects with SR 21 south of the town of Melrose near the Alachua / Putnam County line. Topography ranges from a high elevation of approximately 150 feet NGVD along the southern portions of this road to elevations of 110 feet NGVD near the wetlands located in the northern portion of this project area. Land use consists primarily of agriculture and forested uplands. A small portion of the area is wetlands that discharge across Price Road toward Lake Melrose.

Problem Description

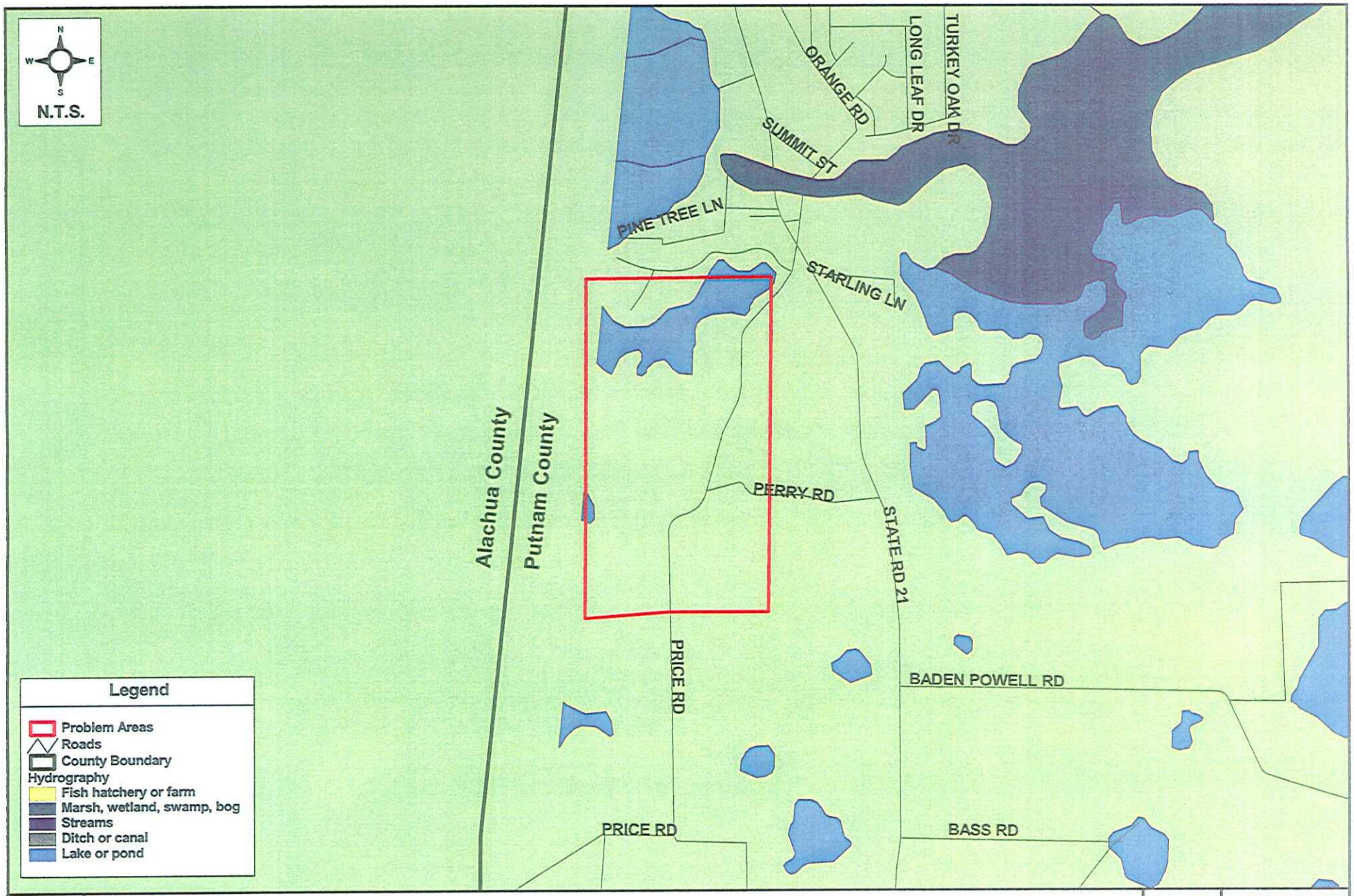
Price road floods in three locations during moderate and greater rainfall events. In two of the locations, flooding occurs where the surrounding grade is higher than the road grade and there is no roadside drainage. Standing water remains for 2-3 days. Approximately 500 feet of road in each of these locations is flooded. In the third location, approximately 250 feet of the road floods. Two 18-inch CMPs drain from southeast to northwest across private property toward Lake Melrose. The two 18-inch CMP culverts are stacked vertically (set on top of each other) and provide the outfall for the wetland on the east side of the road.

During the field visit it was noted that the natural drain that crosses private property was overgrown. The County has made numerous attempts to acquire a drainage easement but without success. Flooding may be eliminated with regular maintenance.

Problem Summary

In this case the purpose of the field investigation was to document the nature of the Price Road problem area. Ultimately, the County is in the process of paving Price Road, thus the issues discussed herein should be remedied through the paving. Accordingly, this problem area will not be ranked. A summary of the Price Road problem area is provided in the table below.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd		Low	X	Safety Issue		High		LT 100k		Good	X
Sub-watshd		Medium		Obstr. Travel	X	Medium	X	100-400K		Average	
Local	X	High		Nuisance		Low		GT 400k	X	Poor	



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 1through7.apr

Price Road Problem Area
Putnam County Master Stormwater Plan

Figure 7.2-1

AYRES ASSOCIATES

Photo 1.1: First of three locations that flood on Price

Photo 1.2: Second of three locations that flood on Price Road.

7.2.2 BELLAMY WOODS ROAD

Location and General Description

Bellamy Woods Road is shown on **Figure 7.2-2**. It is east of Price Road near the intersection of Price Road and SR 21, south of the town of Melrose. The surrounding land use is agricultural and forested uplands. A large wetland contiguous with Lake Melrose runs along the south side of the road. The road does not lie in the FIRM map's A or AE (100-year) flood zones.

Problem Description

The road floods in one location, where it passes through a topographic depression. Generally, the direction of runoff is from the north where the shoulder and adjacent lands are above the road, into a roadside swale, through a 12-inch cross drain south, and then into a wetland to the south. Ayres Associates was advised that the cross drain and swale provide adequate drainage when maintained. However, at the time of the field visit and routinely the cross-drain and the swale are completely filled with sediment. Consequently, stormwater fills the swale and comes out onto the road where it remains until percolating/evaporating.

The drainage area supervisor for this region commented that the County does not have the manpower to remove the sediment build-up in the ditch after every storm event, the frequency required to maintain adequate site drainage.

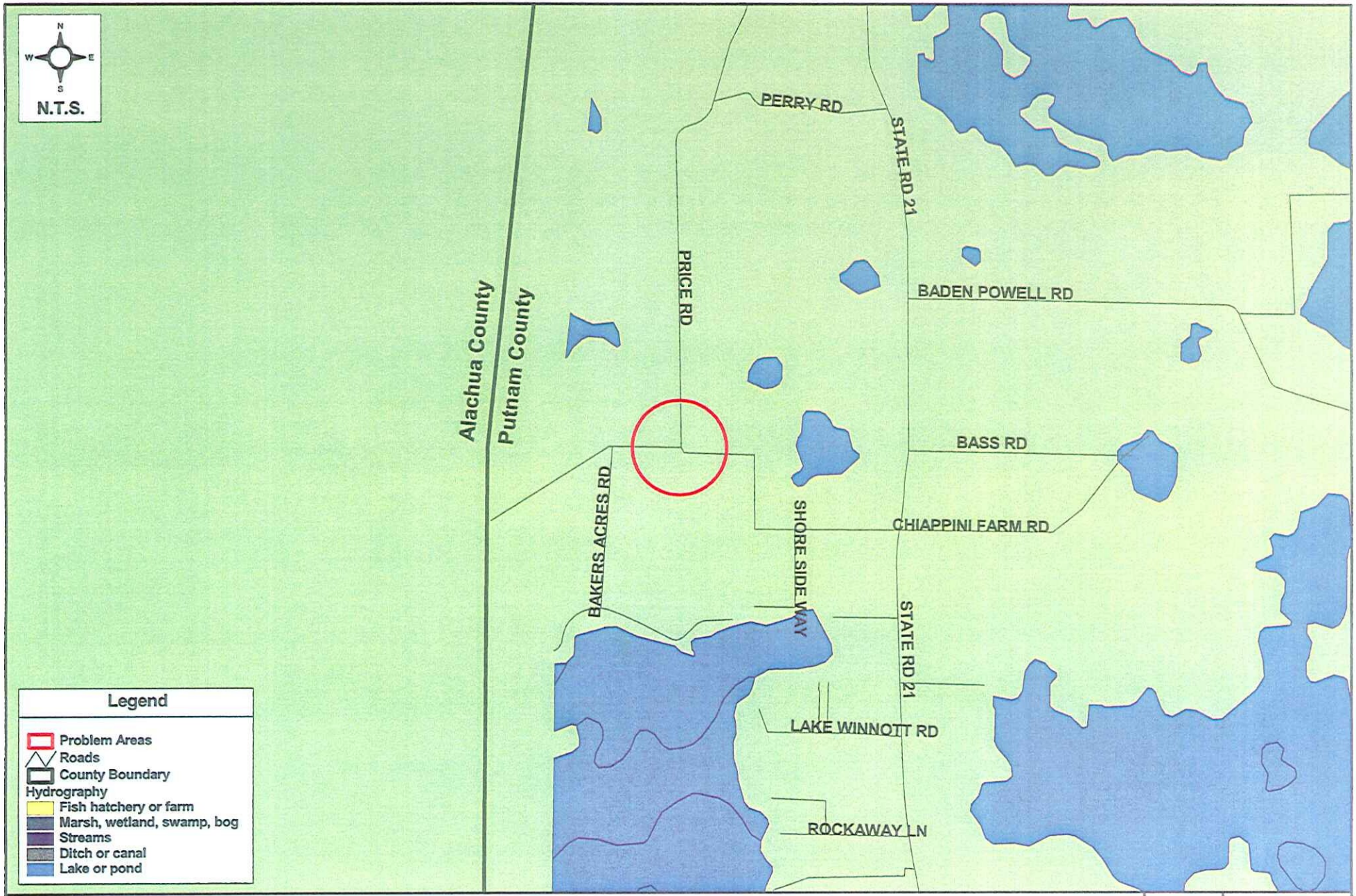
Problem Summary

If this project is within the top 15, further analysis will be conducted. From the history of the project, the field investigations and discussions with County staff, potential solutions are:

- Construct ditch blocks to concentrate the deposition in specific and limited locations.
- Pave the road and include roadway drainage (swales and treatment ponds).

A summary of this problem area is provided in the table below.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd		Low	X	Safety Issue		High		LT 100k		Good	
Sub-watshd		Medium		Obstr. Travel	X	Medium	X	100-400K	X	Average	X
Local	X	High		Nuisance		Low		GT 400k		Fair	



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 1through7.apr

Bellamy Woods Road Problem Area
Putnam County Master Stormwater Plan

Figure
7.2-2

AYRES ASSOCIATES

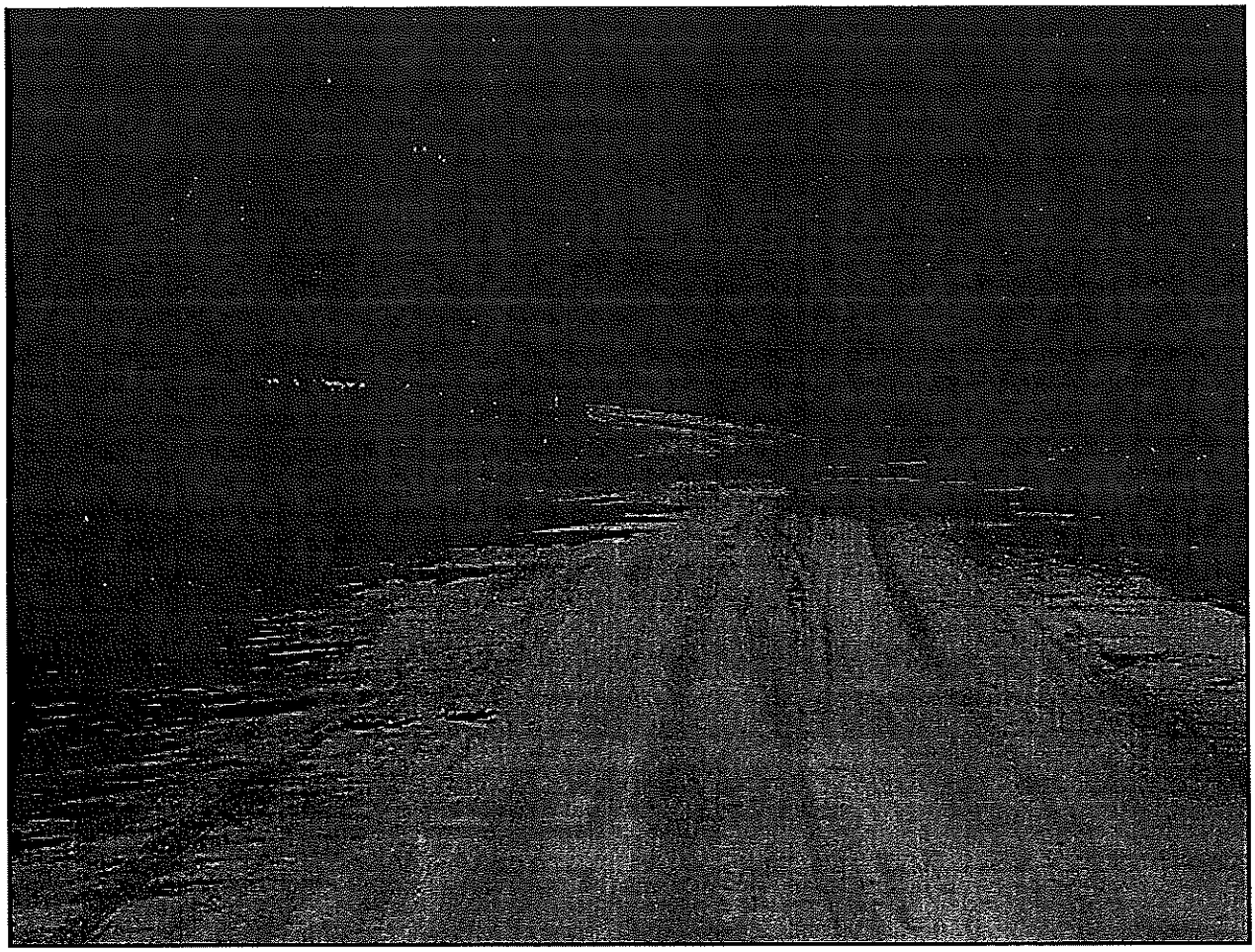


Photo 2.1: Depressional area that overtops.

7.2.3 ROOPS DITCH

Location and General Description

Roops Ditch is a natural drain for a chain of lakes south of the Town of Johnson in the western region of the County. The ditch is maintained by the County and carries overflow from Gillis Pond in the northwest, through a wetland to the southeast, continuing under SR 21, into Lake Higginbotham, with an eventual outfall into Cabbage Creek. This problem is wholly contained in the Cabbage Creek watershed, which is in the Orange Creek Planning Unit. The location is presented in **Figure 7.2-3**.

Current land use surrounding the project is predominantly open land with some medium density residential parcels. A small portion of the area is wetlands. The wetlands drain across SR-21 toward Lake Higginbotham and eventually into Cabbage Creek.

Gillis Pond, Roops Ditch, the downstream wetland, and the area around Lake Higginbotham are in Zone A on the FIRM. All other nearby areas are zoned C.

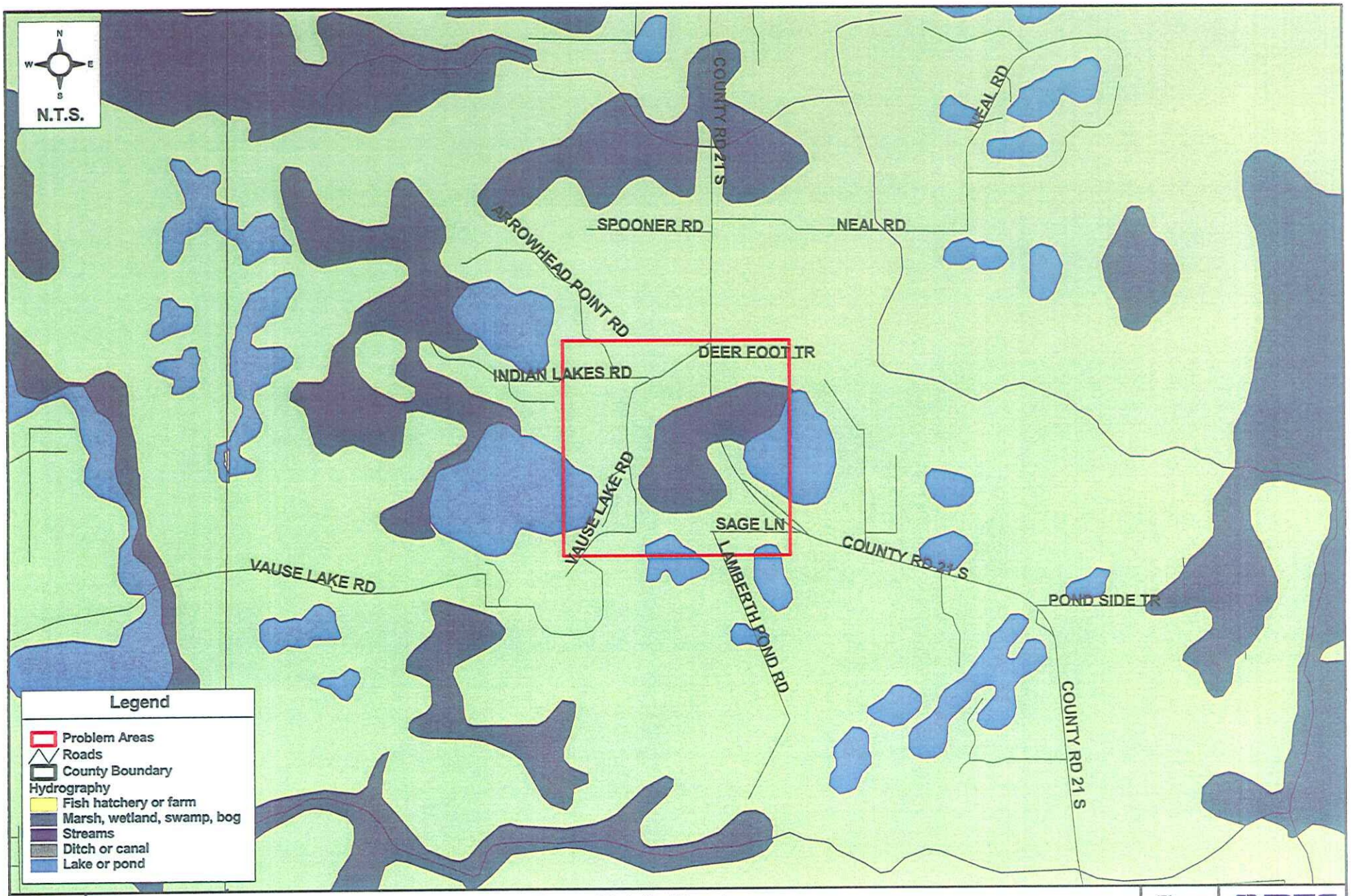
Problem Description

At the time of the field inspection in June 2004, the ditch appeared to be well maintained by the County. During rainfall events, downstream lakes and wetlands flood and tailwater conditions prevent sufficient discharge capacity from Gillis Pond and one residence on the Pond floods. The resident was present during part of the field visit and stated that his home does not flood when the ditch is properly maintained.

Problem Summary

Beyond routine maintenance, no meaningful recommendations can be formulated with the limited nature and amount of information. The ditch being privately owned precludes County action being taken at this time. Due to the very low topographic relief and the scope of the system hydraulics, a detailed model of this watershed may be required to formulate any improvement project. A summary of the Roops Ditch problem area is provided in the table below.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd		Low		Safety Issue		High		LT 100k	X	Good	
Sub-watshd	X	Medium	X	Obstr. Travel		Medium		100-400K		Average	X
Local		High		Nuisance	X	Low	X	GT 400k		Poor	



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 1through7.apr

Roops Ditch Problem Area
Putnam County Master Stormwater Plan

Figure
7.2-3

AYRES ASSOCIATES

Photo 3.1: Looking down-stream from Indian Lake Road

Photo 3.2: Looking upstream from Indian Lake Road

7.2.4 FLORAHOME DRAINAGE DISTRICT

Location and General Description

Florahome Drainage District is shown on **Figure 7.2-4**. The Drainage District defined the borders within which a special assessment was collected. The special assessment funded the maintenance of the network of canals that comprises and drains the District. It is within Rice Creek, the largest watershed in the County. Apparently, three major branches were maintained. The main branch begins at Coral Farms Road and ran west for approximately 3.3 miles before bending south and running approximately one mile to Lake Grandin Outlet. A north tributary begins 1,500 feet south of Hunt Road and goes north for approximately one mile before turning west for 3,600 feet into an unnamed lake. The north branch continues north for 8,200 feet before turning west for 6,400 feet and ending. Apparently the final 8,200 and 6,400 feet were not maintained, but this is not confirmed.

Problem Description:

A resident of the area was not aware of any flooding or overtopping of the canal system. A dragline maintained the system approximately every 3 years when the Drainage District collected the necessary funds. This area has been identified for evaluation because it has not been maintained since the Drainage District was dissolved over 15 years ago. Excessive vegetation growth is evident throughout the canal system. Overgrowth creates an increased flood risk. Photos 4.1 and 4.2 are typical of the system's current condition.

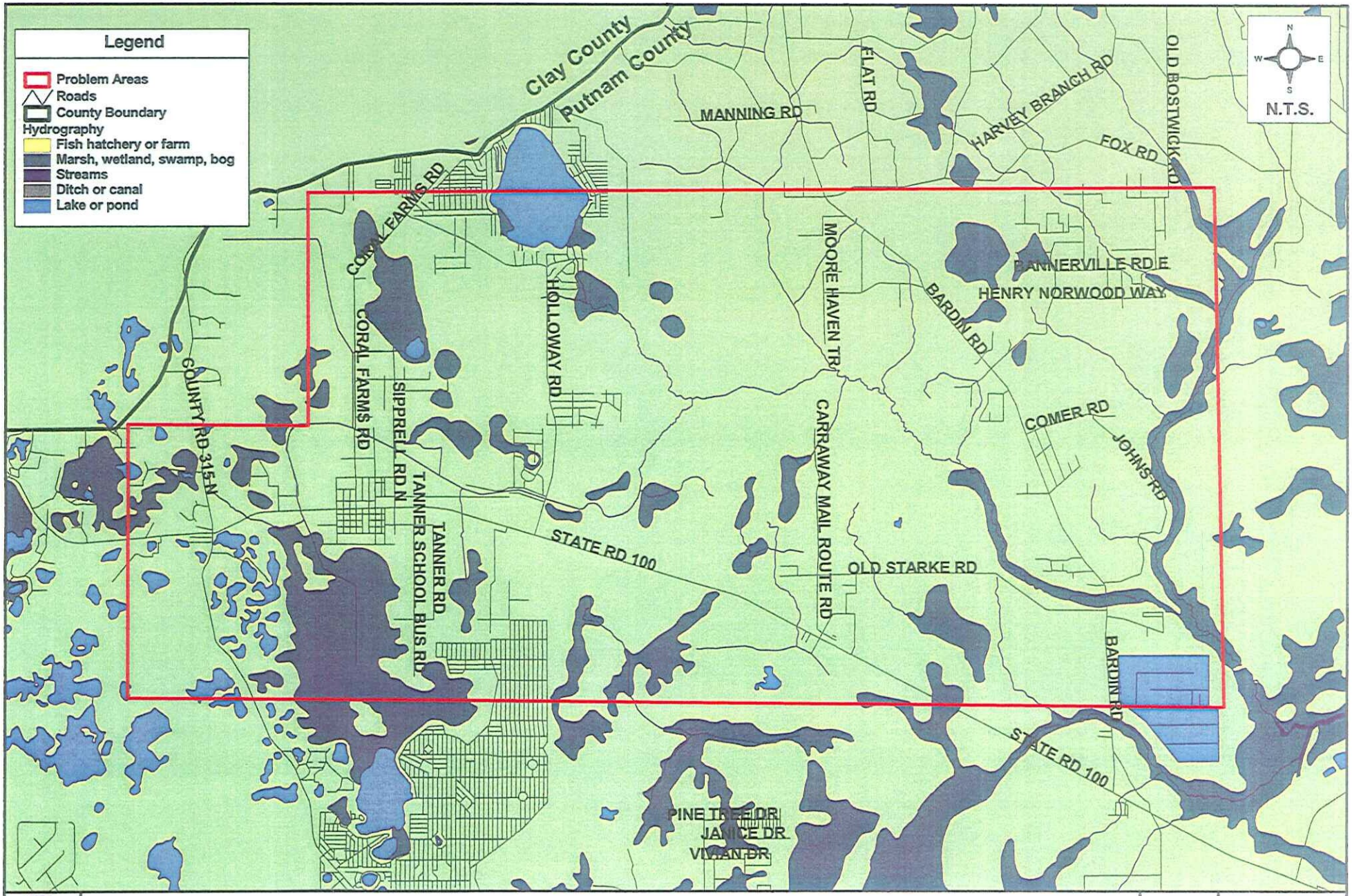
The County does not budget for dragline operations in the Florahome area and it is believed that lack of maintenance could trigger flooding in a large portion of the District.

The Florahome Drainage District also includes Bardin Estate Circle. This is a dirt road that was visited on January 13, 2005 after the 2004 hurricane activity and evidenced severe erosion. High rates of runoff moving over a dirt road and roadside ditches resulted in the erosion. This problem could be remedied with paving the road and installing curbside ditches to convey the runoff. However, the road is a "non-public right-of-way" and the County does not have authority, although emergency maintenance has been conducted. Bardin Estate Circle was therefore not further considered.

Problem Summary

If and when maintenance within the area resumes, Ayres Associates recommends a detailed hydraulic analysis of the system, to determine a cost-effective maintenance schedule. Pending the outcome of the ranking procedure, the type and scope of this hydraulic analysis will be described. Details for costs and disposal of any sediment removed from the canal(s) will also be provided. A summary of this problem area is provided in the table below.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd	X	Low		Safety Issue		High		LT 100k		Good	X
Sub-watshd		Medium		Obstr. Travel	X	Medium		100-400K		Average	
Local		High	X	Nuisance		Low	X	GT 400k	X	Poor	



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 1through7.apr

Florahome Drainage Problem Area
Putnam County Master Stormwater Plan

Figure 7.2-4

AYRES ASSOCIATES

Photo 4.1: Canal in May 2004 west side running parallel to Coral Farms Road

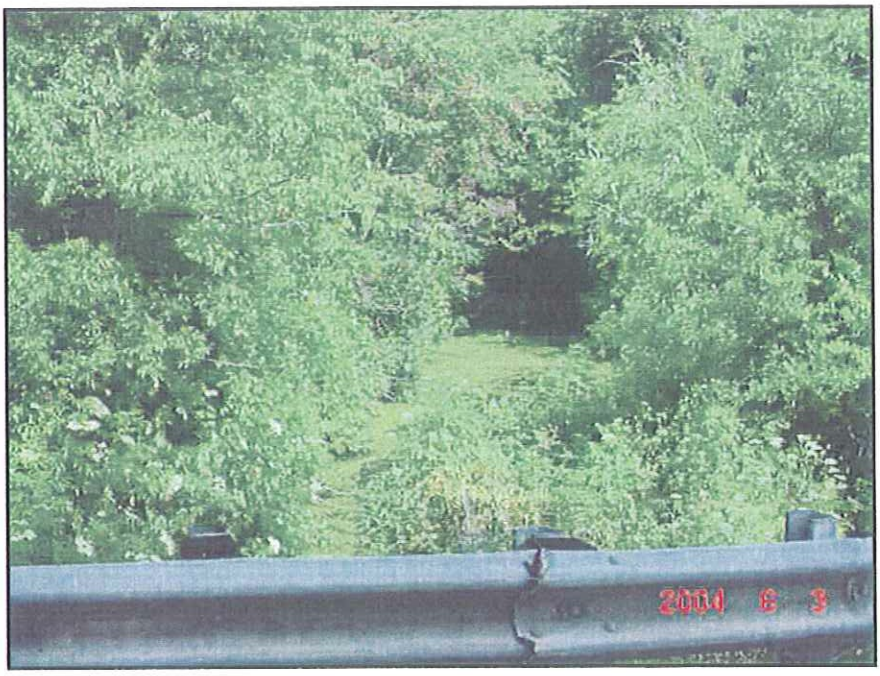


Photo 4.2: Canal in May 2004 at crossing of Coral Farms Road.

7.2.5 ORANGE SPRINGS SHORTCUT

Location and General Description

The Orange Springs Shortcut project consists of evaluation of a bridge that has been impacted by scour and regularly overtops. Orange Springs Shortcut is unpaved and is located in the southwest part of the County near the Putnam / Marion County line. It services local travel, tractor-trailers during logging operations, and school busses. The bridge spans Cabbage Creek and is constructed from wood. It is also posted with weight limits. The approximate bridge location is shown in **Figure 7.2-5**.

Current land use on either side of the road consists of upland forests, pasture lands with some medium density residential, and wetlands along the banks of Cabbage Creek. The wetlands drain toward the south and eventually discharge into Orange Creek.

Problem Description

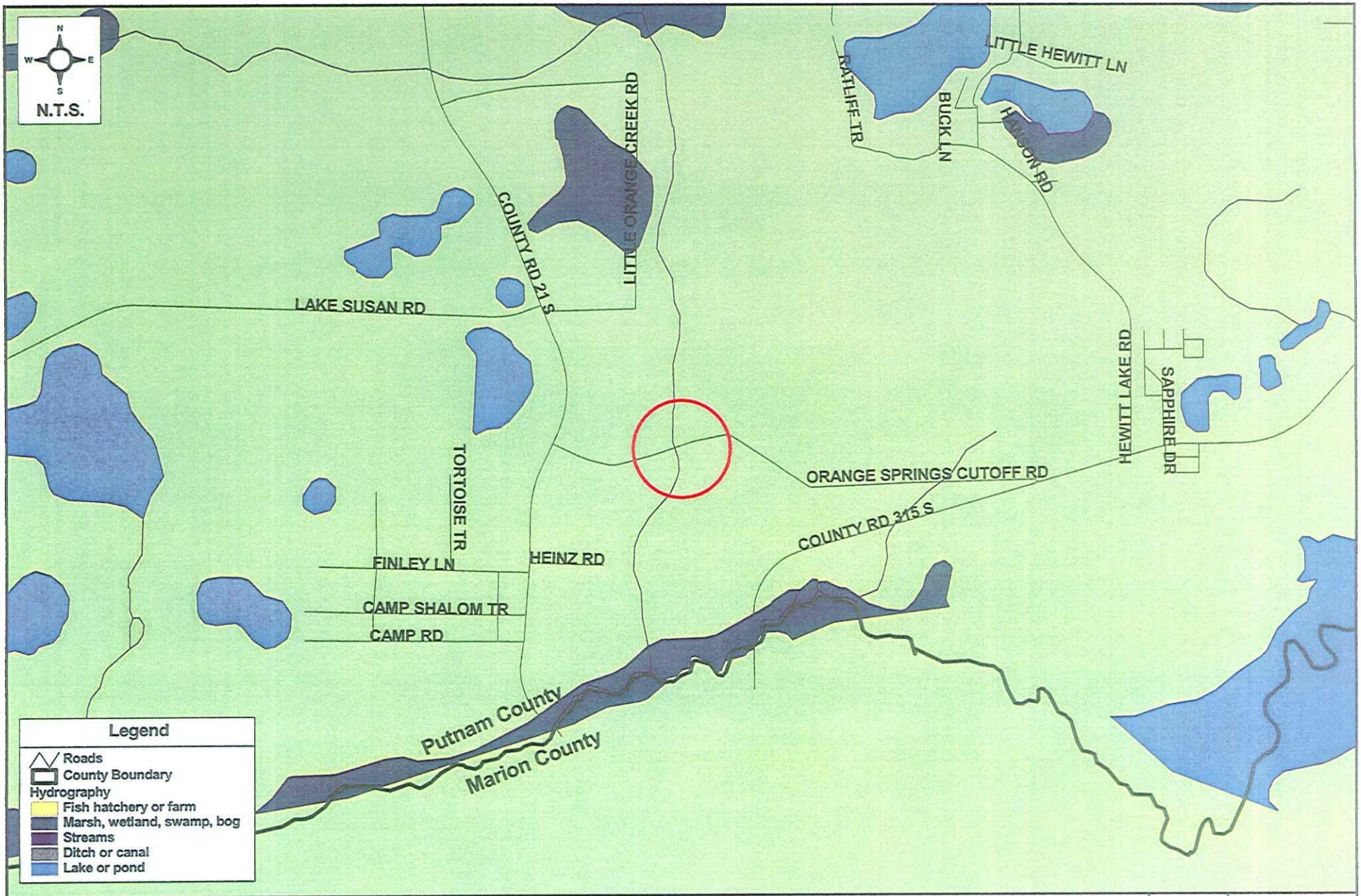
This bridge has no guard rails and overtops one to four times a year during high intensity storm events. The low cord is routinely reached. For safety reasons the bridge has been repetitively closed off by public works; the last time during Hurricane Charlie in the summer of 2004. For safety reasons, school buses are routed around the bridge and into Marion County. School board staff have stated that travel outside of Putnam County creates logistical and administrative issues.

This bridge was replaced several years ago after a scour event resulted in pile failure and 6 to 12 inches of settlement. There was also flooding approximately 250-feet to the east and west of the bridge structure. From field observations, the SR 21 crossing upstream has considerably greater conveyance capacity, causing increased head losses and scour susceptibility at this bridge.

Problem Summary

Pending the score of this problem from the ranking procedure, a preliminary CIP evaluation and cost estimate will be developed for this problem area. At a minimum, due to the safety concerns, the County will be required to regularly inspect and maintain the bridge. Additional inspections should be conducted after storm events. A summary of this problem area is provided in the table below.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watershed	X	Low		Safety Issue	X	High		LT 100k		Good	X
Sub-watershed		Medium	X	Obstr. Travel		Medium		100-400K	X	Average	
Local		High		Nuisance		Low	X	GT 400k		Poor	



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 1through7.apr

Orange Springs Shortcut Problem Area
Putnam County Master Stormwater Plan

Figure
7.2-5

AYRES ASSOCIATES

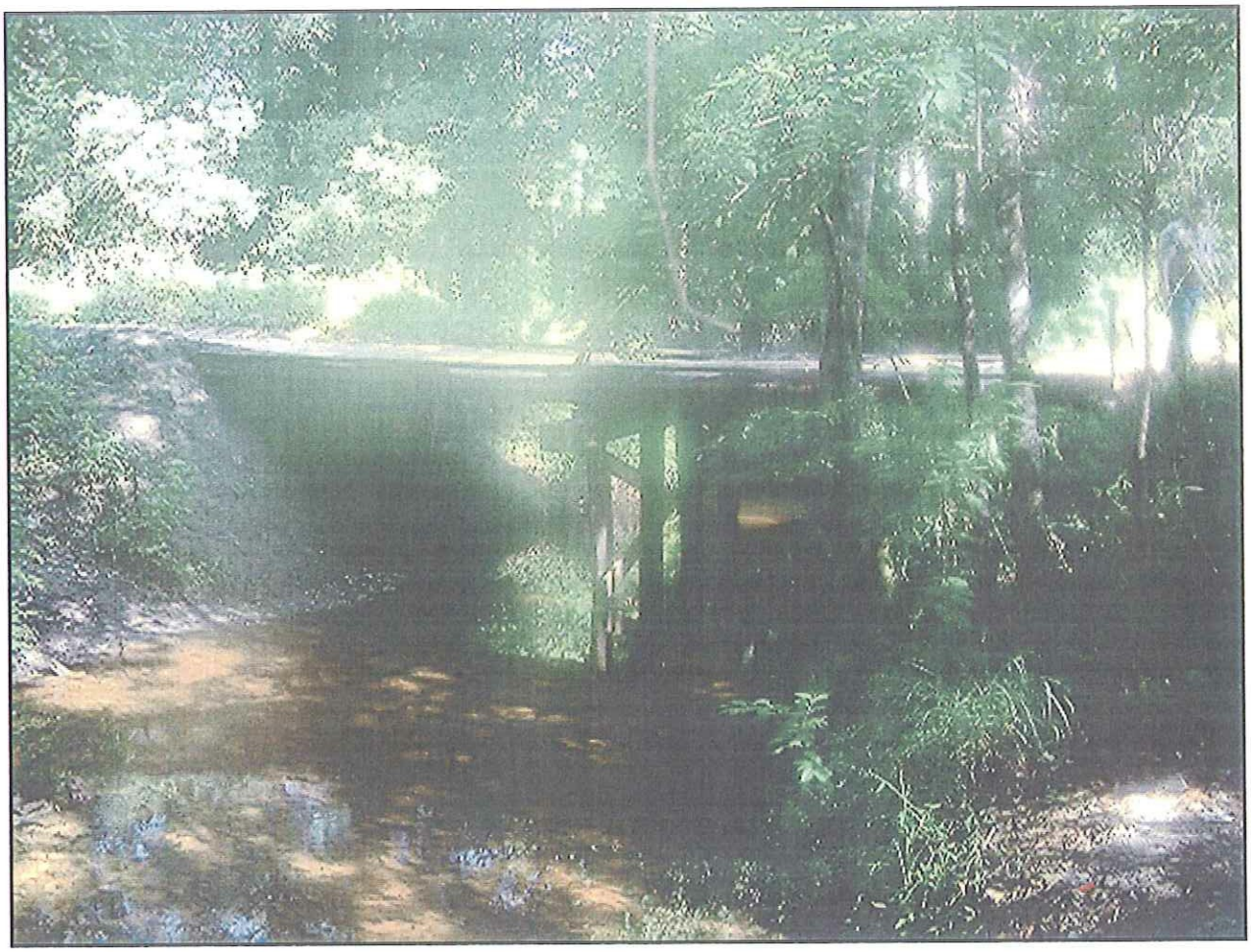


Photo 5.1: From Creek looking upstream at wooden bridge

7.2.6 HUNTER ROAD (OLD GAINESVILLE HIGHWAY)

Location and General Description

Hunter Road (Old Gainesville Highway) is shown in **Figure 7.2-6**. It is a dirt road that historically was the route between Palatka and Gainesville prior to the construction of SR 20. Hunter Road parallels SR 20 to the south between the Cities of Palatka and Interlachen. The problem areas are located in two watersheds, Rice Creek on the east and Sweetwater Creek on the west. The Rice Creek watershed is within the Etonia Creek Planning Unit and the Sweetwater Creek watershed is within the Rodman Reservoir Planning Unit. Figure 6 shows the project location map. Current land use on either side of this road is comprised of upland forests, mainly planted pines, along with several branches of wetlands that cross the road.

Problem Description

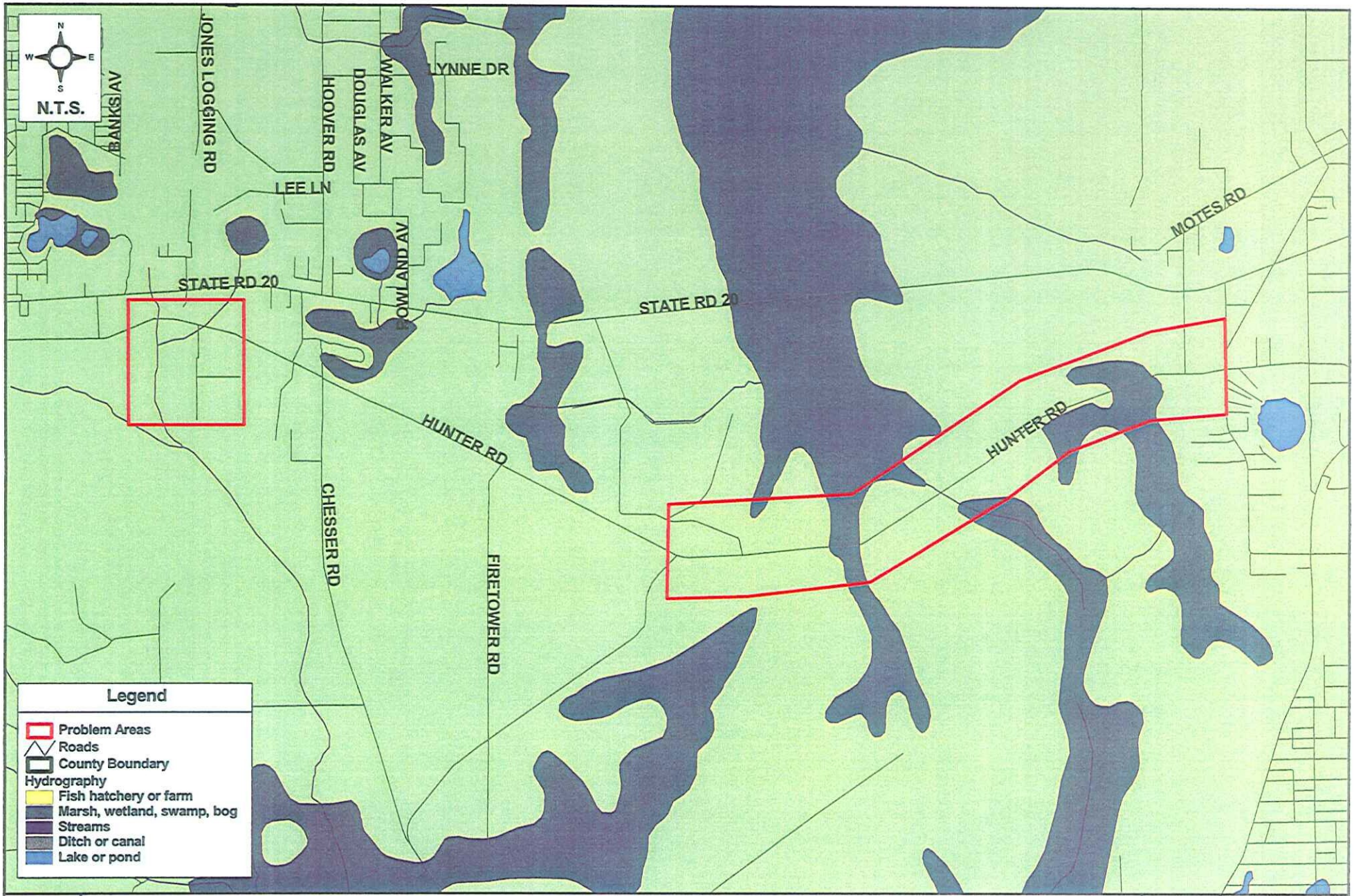
This dirt road currently floods in two locations during moderate rainfall events and washes out during heavy rainfall events because some sections of road are lower than the surrounding grade. Land use consists mainly of planted pine pulpwood. In these two locations stormwater from adjacent lands is directed into the roadside ditches. The adjacent lands have recently been logged which effectively increases the amount of runoff to the roadside ditches and in turn floods the road for several hundred feet in either direction from these locations. During heavy rainfall events, stormwater overtops the road, frequently resulting in washouts.

During the June 2004 field visit, it was noted that the adjacent lands contain excavated ditches that convey stormwater from off-site to the roadway. The practice is intended to prevent over hydration of seedlings. The County has ordinances prohibiting this type of management activity, but enforcement over such a large geographic area is formidable.

Problem Summary

Hunter Road is principally a roadway paving and drainage project. As a matter of policy, the County does not purchase right-of-way for roadway paving and this factor will influence its final score in the ranking matrix. A summary of this problem area is provided in the table below.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd	X	Low	X	Safety Issue		High	X	LT 100k		Good	X
Sub-watshd		Medium		Obstr. Travel	X	Medium		100-400K		Average	
Local		High		Nuisance		Low		GT 400k	X	Poor	



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 1through7.apr

Old Gainsville Highway Problem Areas
Putnam County Master Stormwater Plan

Figure 7.2-6

AYRES ASSOCIATES

Photo 6.1: Existing roadside swales

Photo 6.2: Management of seedling by excavating trenches to roadside

7.2.7 MONDEX

Location and General Description

Mondex is located approximately 6 miles southwest of Palatka, directly adjacent to the St. Johns River. **Figure 7.2-7** shows the Mondex area. West Peniel Road, Pinellas Street, SR 19, and the St. Johns River bound Mondex and the to the north, south, east and west respectively. Mondex drains through four unnamed creeks that discharge to the St. Johns River.

The infrastructure within Mondex consists of below and above ground septic tanks, wells, and both block masonry homes (many of which are on-grade) and manufactured (mobile) homes. The existing grade is natural in some parts of the area, but is filled in others. The source of the fill is borrow areas within the community. A typical area can be seen in Photo 7.1. Roads in the area are mostly unpaved. The condition of the roadway drainage varies but most roads have swales (Photo 7.2). The County currently maintains Stokes Landing Road, Park Avenue, East Pinellas Road, and Royal Palm Road. The remaining roads require maintenance.

Problem Description

Roads, yards, and some structure flooding is said to occur in Mondex on an annual or semi-annual basis. This observation is not consistent with the FIRM maps for the area, which show less severe flooding; however, in the absence of any other data, or predictions determined through a floodplain modeling analysis, the conflict is not resolvable. Short of an immediate County ordinance or a Letter of Map Revision (that must be based on an analytical or engineering analysis procedure) to the contrary, the floodplains published in the FIRMS will stand as the basis for regulating first floor elevations.

There are four SCS soils classifications within the area: Palmetto, Pomona, Immokalee, Holopaw and Myakka Sands. All of these soil types are rated as poor for infrastructure (homes, commercial buildings, local roads, etc.) The groundcover in Mondex is characterized by wetland and hammock vegetation. Photo 7.2 below shows the water table in the dry season (May 2004) within 1 to 1½ feet of the ground surface. Topographically, Mondex lies below and is completely within a 25-foot contour that rims the area and separates it from the St. Johns River. Mondex, in effect, is in the bottom of a bowl with minimal positive drainage capacity. In summary, all of the conditions in Mondex are unfavorable and unsuitable for land development and residential land use.

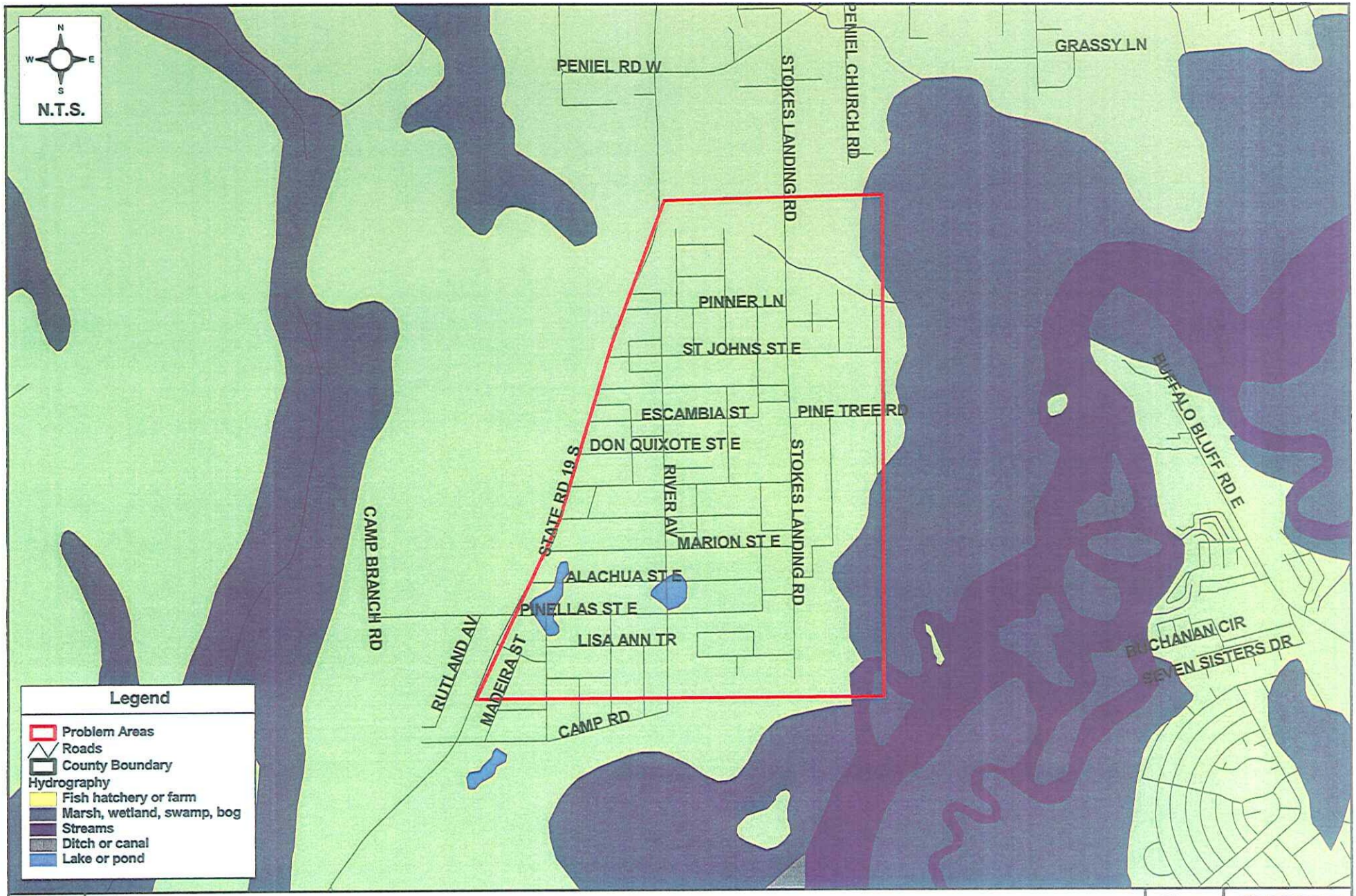
Problem Summary

There is no data on which to base recommendations for improvements in Mondex. In addition, the County does not own or have easements over any of the four systems that drain the area. Therefore, even maintenance on these systems to improve conveyance and limit, at a minimum, the duration of future flooding is not possible. The first steps toward a feasible cost effective solution in Mondex are as follows:

- Developing 1-foot contour topographic mapping.
- Complete a 100-year floodplain and integrated hydrologic/hydraulic modeling study
- As a part of the study, use the model to develop a final design and obtain a conceptual permit from the SJRWMD.
- Obtain rights-of-way, easements and ownership of lands based on the conceptual design.

A systematic step-wise procedure including schedule and budget will be developed if Mondex ranks in the top 15 of the ranking matrix. A summary of the impacts in Mondex is in the table below.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd	X	Low		Safety Issue		High		LT 100k		Good	
Sub-watshd		Medium	X	Obstr. Travel	X	Medium	X	100-400K		Average	
Local		High		Nuisance		Low		GT 400k	X	Poor	X



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 1through7.apr

Mondex Problem Area

Putnam County Master Stormwater Plan

Figure 7.2-7

AYRES ASSOCIATES

Photo 7.1: Unpaved roads and roadside swales.

Photo 7.2: Typical borrow area and water table less then two feet below ground

7.2.8. DEVALL BRANCH

Location and General Description:

Devall Branch is an urbanized watershed within the City of Palatka. It is shown in **Figure 7.2-8**. It begins at Davis Lake approximately one half mile north of SR 19 and runs almost due south for approximately three miles to its confluence with the St. Johns River. The creek is relatively steep ranging in elevation from 60 feet NGVD at Davis Lake to 5 feet NGVD at the St. Johns River. The slope of the creek over its two mile distance is 0.5%.

There are four road crossings and a railroad crossing. Grades from the surrounding watershed sloping toward the creek are noticeably steep thus water levels are highly transient making it characteristically "flashy."

Problem Description:

There were some inconsistencies in the initial summary provided by the County and the information obtained during the field visit. The summary contained in this description is based on the field visit, a drainage report and County staff knowledge of the area.

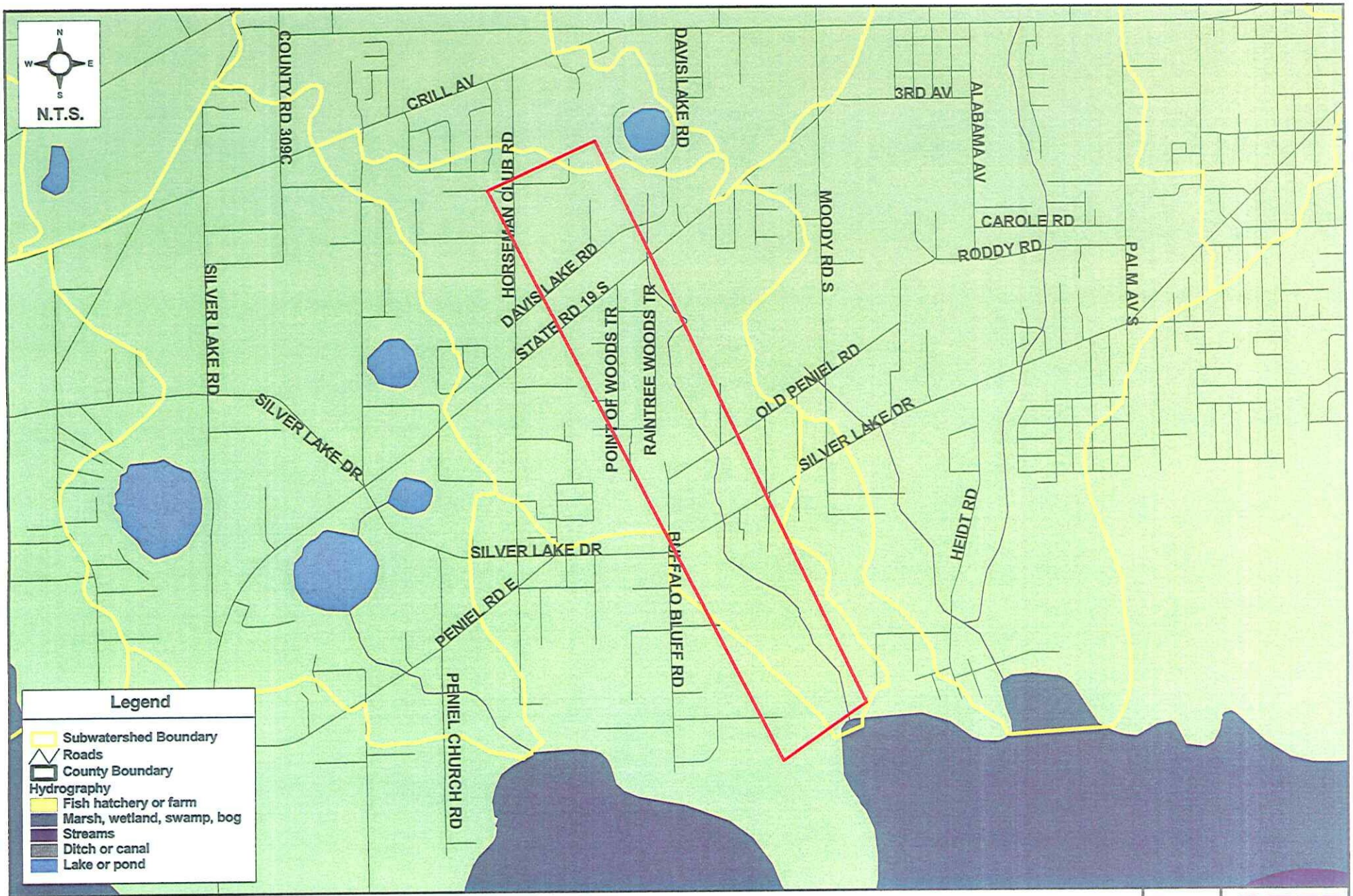
There are no instances of flooding in the creek or surrounding watershed. Concerns in the Devall Branch watershed consist of trends in erosion in the creek bed most notably between SR 19 and Silver Lake Drive. The bottom width of the creek once ranged from two to three feet, compared to the existing 8 to 12-foot bottom widths.

The field visit was rapid and limited to two crossings, consistent with County personnel's limited knowledge of the problems in the watershed. No sediment deposits were evident at the locations visited during the field visit. Maintenance staff noted the need to acquire easements over the creek. Significant vegetation growth was noted as compared to Twomile Creek. Ayres Associates were advised during follow-up discussions with other County personnel that in the Devall Branch and Twomile Creek watersheds, erosion and sedimentation issues are very similar in nature, scope and magnitude. A summary of this problem area is provided in the table below.

Problem Summary

Follow-up with the County was performed to determine the scope, magnitude and nature of the issues in this watershed before assigning a final ranking. Earlier drainage studies provided by the County, although outdated (1970 and 1988), contain some relevant information that may be useable for a CIP project if this problem area falls within the top 15 projects.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd	X	Low		Safety Issue		High	X	LT 100k		Good	X
Sub-watshd		Medium		Obstr. Travel		Medium		100-400K	X	Average	
Local		High	X	Nuisance	X	Low		GT 400k		Poor	



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 8 through14.apr

Devall Branch Problem Area
Putnam County Master Stormwater Plan

Figure 7.2-8

AYRES ASSOCIATES

7.2.9 TWOMILE (DUVAL) CREEK

Location and General Description:

Twomile Creek is shown in **Figure 7.2-9**. It is an urbanized watershed within the City of Palatka that begins just north of SR 20 (Grill Avenue), and runs almost due south for approximately two miles to its confluence with the St. Johns River. The creek is relatively steep ranging in elevation from 55 feet NGVD at SR 20 to 5 feet NGVD at the St. Johns River. The slope of the creek over its distance of slightly more then two miles is 0.44%.

There are six roadway and one railroad crossings of the creek. Two within the City have been recently upgraded with 60-inch diameter HDPE culverts with mitered end sections. The most downstream crossing is poorly maintained and requires repair. Grades from the surrounding watershed sloping toward the creek are noticeably steep thus it is a characteristically "flashy" system.

Problem Description

There are no instances of flooding in the creek or surrounding watershed. Concerns in the Twomile Creek watershed consist of trends in erosion in the creek bed most notably between Carole Road and CR 310. The bottom width of the creek once ranged from two to three feet, compared to the existing 8 to 12-foot bottom widths.

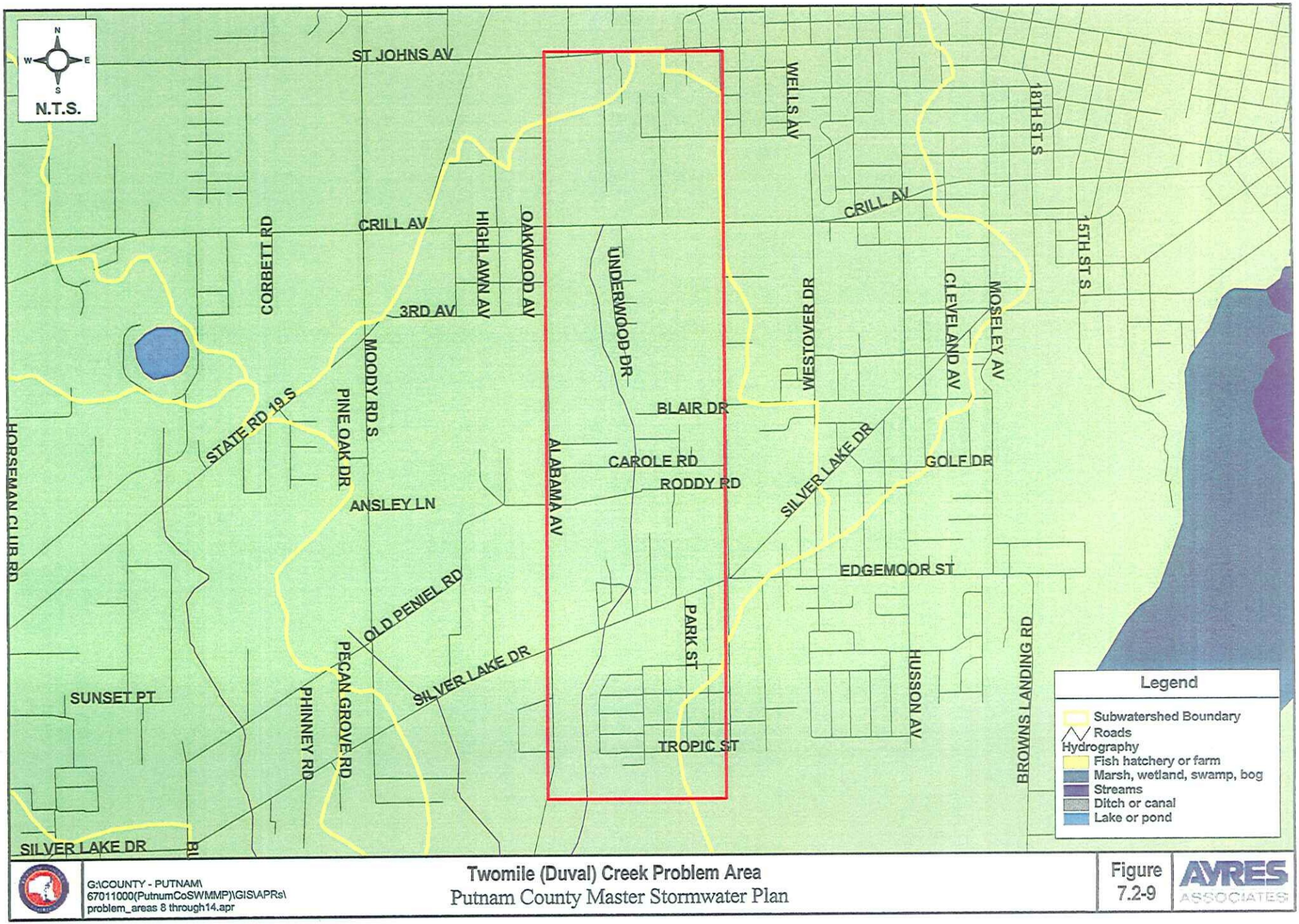
No sediment deposits were evident upstream or downstream of the culvert crossing at Carole or Roddy Road. Maintenance staff noted the need to acquire easements over the creek beginning approximately 300 feet south of the Roddy Road crossing and continuing to CR 310. Within this reach of the creek significant vegetation growth was noted as compared to the reach upstream of Carole Road. A summary of this problem area is provided in the table below.

Problem Summary

Follow-up with County will be required to determine scope, magnitude and nature of the issues in this watershed before assigning it a final ranking.

A summary of this problem area is provided in the table below.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd	X	Low		Safety Issue		High	X	LT 100k		Good	X
Sub-watshd		Medium		Obstr. Travel		Medium		100-400K	X	Average	
Local		High	X	Nuisance	X	Low		GT 400k		Poor	



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 8 through14.apr

Twomile (Duval) Creek Problem Area
Putnam County Master Stormwater Plan

Figure 7.2-9

AYRES ASSOCIATES

Photo 9.1: Looking East at Carole Road Crossing

7.2.10 WEST TOCOI ROAD

Location and General Description:

West Tocoi Road is a dirt road that parallels U.S. Highway 17 and CSX railroad tracks on the east side approximately two miles west of the St. Johns River. This project is approximately three miles in length and is located across several unnamed watersheds within the South Mainstream Planning Unit. Drainage along this road is toward the St. Johns River to the east. **Figure 7.2-10** depicts the project location map. Topography ranges from a high elevation of approximately 30 feet NGVD along the western boundary of the road to elevations of 20 feet NGVD along the eastern boundary. Due to the length of this project there are several types of soils encountered in the area. Major portions of this road are located in Pomona, Palmetto, and Riveria Series soils that are poorly drained and moderately permeable. Other soils along this road include Cassia, Holopaw, and Malabar Series that are all fine sand types with poor drainage and moderate to slow permeability.

Current land use surrounding the project is predominantly comprised of agricultural and forested uplands. The FIRM for the area shows that all areas along the road to be in Zone C - outside of the 500-year floodplain.

Problem Description

The portion of West Tocoi Road inspected for this study was from Palmetto Bluff Road on the south to Eagle Creek Road on the north. Along this portion of the road there are five cross drains of various sizes that are used to convey stormwater from west to east. The basic problem is that the road is flooded and, in extreme cases, washed out. Road flooding is predominantly around these culvert crossings. There are roadside swales, on both sides of the road, along a major portion of this project. The problems for each of the five culvert crossings are described separately below. The culverts are described in order starting from the south and moving north along the road.

Culvert Crossing 1:

This crossing is by far the largest one encountered on this road. It consists of a 9 X 15 foot elliptical CMP culvert with fabriform end treatments to prevent bank erosion on the upstream and downstream sides. This culvert was replaced within the last year due to a washout that occurred during a heavy rainfall event. At the time of the washout, the flood water was observed to be at the crown of the upstream elliptical CMP culvert (under the railroad) that measured 10.5 X 16 feet. During a recent inspection, it was estimated that the crown of the upstream culvert was approximately the same elevation as the crown of the road, and the elevation of the railroad tracks were estimated to be approximately five feet above the crown of the road. The channel upstream and downstream appeared to be relatively well defined with some moderate trash and debris. However, there was some vegetation and sedimentation build-up between the railroad tracks and the road. The downstream channel lies on private property, which the County is unable to maintain.

Culvert Crossing 2:

The cross drain in this location consists of two 54-inch RCP culverts under the railroad tracks, and one 48-inch CMP and one 42-inch CMP under the road. Neither of the two crossings have any type of end treatment. One of the upstream culverts was half-filled with sediment and the channel between the railroad and road is severely clogged with vegetation, trash, and debris. A fence along the property line crosses the downstream channel and, as was the case with the first culvert crossing, the downstream channel runs across private property and cannot be

maintained by the County. Road flooding in this location occurs at depths of one to two feet in places. The railroad tracks were estimated to be approximately four to six feet above the road elevation.

Culvert Crossing 3:
The flooding extents in this location are approximately 1,000 feet to the south and to the north between this location and the next crossing. The cross drain in this location consists of one opening under the railroad tracks that measures 18 X 5 feet and two 36-inch HDPE culverts under the road. The opening under the railroad tracks has a major constriction caused by the aggregate base on the railroad tracks spilling over and blocking the channel. A photograph documenting this condition is presented at the end of this section. There is no end treatment for the crossing under the railroad tracks; however, the crossing under the road has a sandbag type headwall on both sides of the culvert. The channel between the two cross drains is not properly aligned, although it is relatively well defined. The downstream channel had some moderate vegetation and, as was noted for the previous crossing, a fence along the property line crosses this channel. As was the case with the two previous crossings, the railroad track elevation is higher than the road elevation.

Culvert Crossing 4:
The cross drains in this location consist of one 20 X 5 foot concrete trestle under the railroad and two 60-inch HDPE culverts under the road. The railroad crossing contains no end treatment while the crossing under the road includes sandbag headwalls on both sides. The same restriction conditions noted for Crossing 3 also occur at this crossing, where the railroad aggregate base is providing a constriction at the cross drain under the railroad. (The photographs provided show these conditions.) Flooding is predominantly between Crossing 3 and this location. The channel between the railroad and the road is well defined with moderate to heavy trash and debris. The conditions of the downstream channel are essentially the same as the previous crossings where it travels across private property and cannot be maintained by the County. During the inspection of this crossing, it was noted that lands upstream had recently been logged and since that time flooding conditions have become more frequent.

Culvert Crossing 5:
This location is the northernmost boundary where the road flooding persists. Just to the north of this crossing is the entrance to the Eagle Creek subdivision. The railroad has built a wood piling trestle to provide the crossing over this channel. The trestle is approximately 83 feet in length and 8 feet above the bottom of the channel. The cross drain under the road consists of three 60-inch RCP, and two of the three are 50% filled with sediment. The channel between the railroad and road is severely overgrown with vegetation and is not well defined. The downstream channel is relatively well defined with moderate vegetation and debris in the channel. The roadside ditch on the east side of the road is a major contributor of sediment to the channel and cross drains. There is no end treatment on the cross drains under the road.

Additional problems of note are the fact that the St. Johns River in this area is tidal and can have some effect on upstream flooding problems. Discussions with County personnel during site inspection indicate that the contributing area for these cross drains is a relatively large forested area and, when harvested, flows in the creeks increase significantly and road flooding increases.

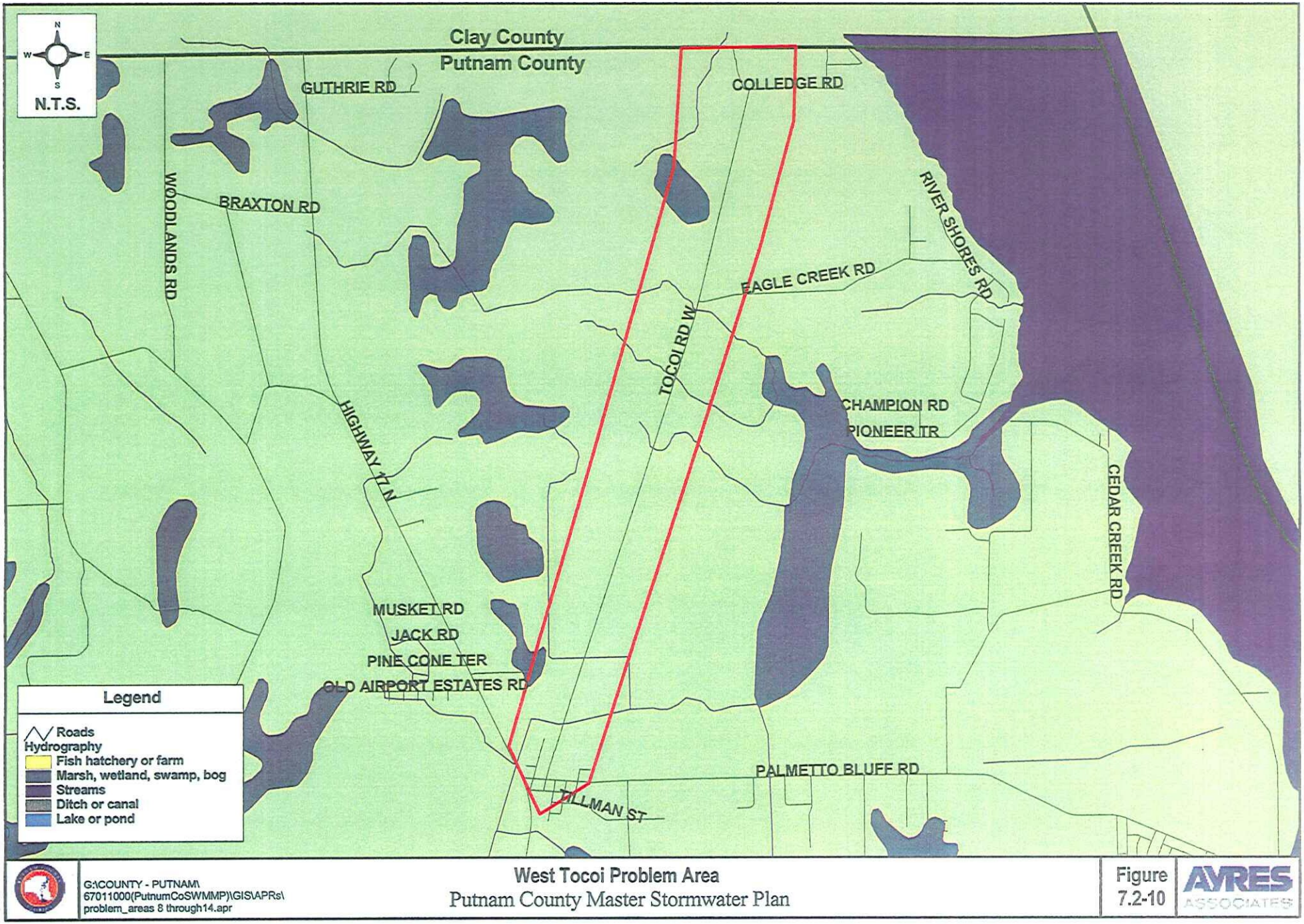
It is not practical to raise the road elevation to the elevation of the railroad tracks. However, it is anticipated that the road will be paved.

Recommendation

The purpose of the field investigation was to document the nature of the West Tocoi Road problems in this masterplan. The West Tocoi Road has been in the design phase of a paving project, thus the issues discussed herein should be remedied. The County will be bidding West Tocoi in the next several months. Accordingly, a preliminary recommendation has not been developed and this problem area will not be ranked. A summary of the West Tocoi Road problem area is provided in the table below.

To assist in the design phase (at a minimum), the roadway design should include a step-backwater analysis to determine the 100-year flood elevations at the road crossings. A summary of this problem area is provided in the table below.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd	X	Low		Safety Issue		High		LT 100k		Good	
Sub-watshd		Medium	X	Obstr. Travel	X	Medium	X	100-400K		Average	X
Local		High		Nuisance		Low		GT 400k	X	Poor	



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 8 through14.apr

West Tocoi Problem Area
Putnam County Master Stormwater Plan

Figure 7.2-10

AYRES ASSOCIATES

Photo 10.1: New cross-drain at crossing #1. Elevated railroad embankment in background.

7.2.11 PALMETTO BLUFF ROAD

Location and General Description

Palmetto Bluff Road is the main access road for the Cedar Creek community, a densely populated residential area on the St. Johns River. The road is shown in **Figure 7.2-11**.

Problem Description

Palmetto Bluff Road floods in three locations between its intersection with Millican Road and the town of Bostwick. The flooding occurs three to four times per year with typical weather patterns, but more often if tropical storms/hurricanes occur.

The Millican Road intersection floods to a depth of approximately 6 inches. Photo 11.1 shows the intersection. The flooding occurs when the capacity of the culvert under Millican Road (parallel to Palmetto Bluff Road) is exceeded. Flows overtop Millican and continue east toward a north-south drainage canal but still flood the intersection. Flooding in the intersection extends to both edges of pavement on Palmetto Bluff. The County recently upsized the culvert when the flow east across Millican cut through the limerock base and severed access to the intersection by northbound traffic onto Palmetto Bluff and Southbound traffic onto Millican. High flows are also reported in the north-south drainage canal east of the intersection. Flow capacity in the canal is exceeded and water backs to roadside ditch parallel to Palmetto Bluff to the Millican Road culvert.

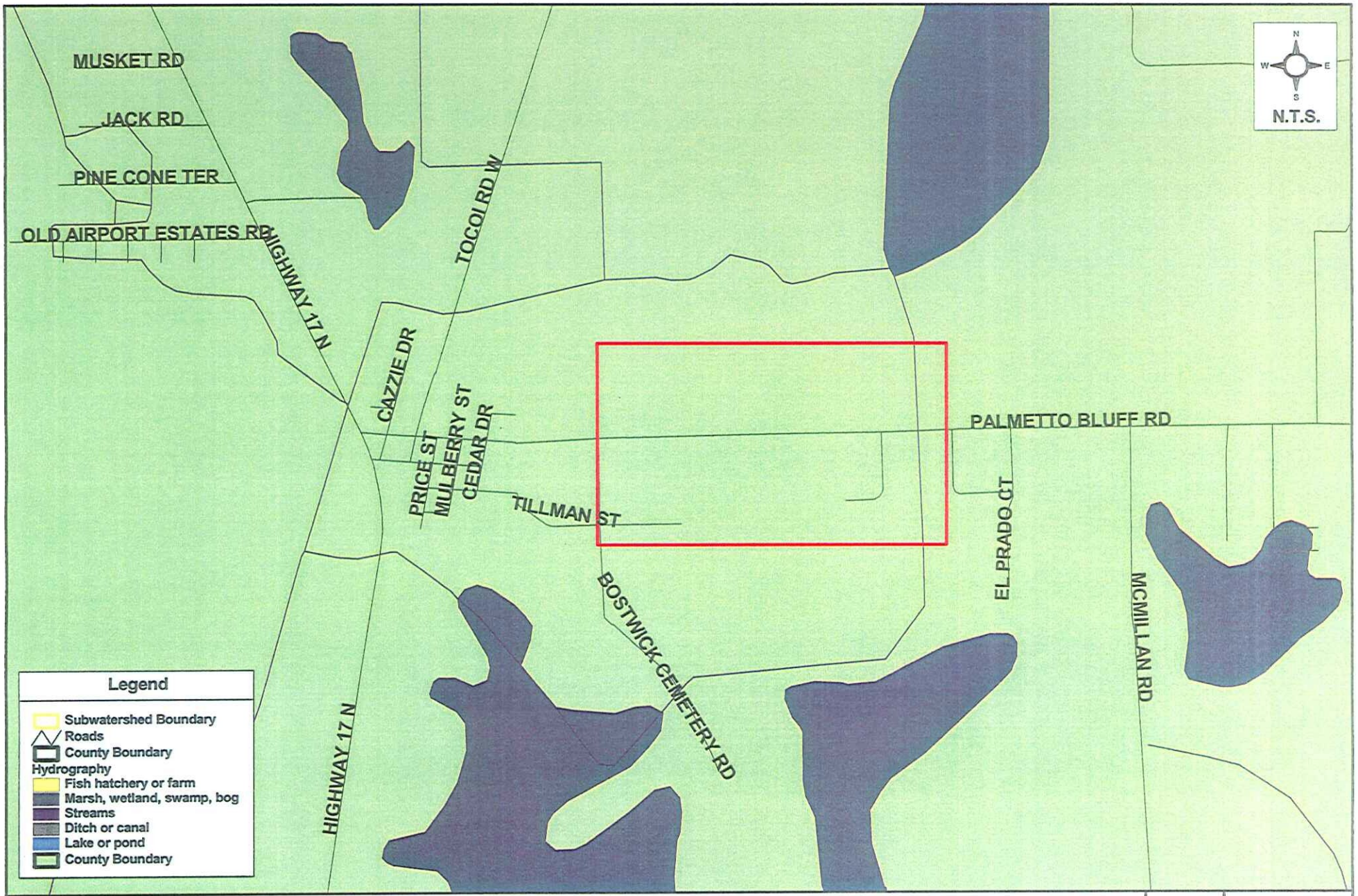
The second and third locations that flood are a mile east of the Millican Road intersection and one-half mile east of the town of Bostwick, respectively, at unnamed drainage canal crossings. The canals are five to six feet deep and 12 -13 feet wide. Photo 11.2 shows the first un-maintained canal downstream of Palmetto Bluff Road. The culverts are standard 5-foot X 8-foot concrete boxes.

Problem Summary

Palmetto Bluff Road is an arterial road and repetitive flooding has significant negative impacts on the local population. Based on the information gathered, it appears that flow capacity in the canals is inadequate due to lack of maintenance and Palmetto Bluff overtops when capacity in the canal downstream of the crossing is exceeded.

Should the ranking procedure place this problem area within the 15 problem areas for development of a preliminary CIP evaluation and cost estimate, it may be possible to perform a simple inlet controlled hydraulic analysis to estimate. An estimate would indicate whether maintenance or a more structural approach is required to increase conveyance in the channels. This problem area may require detailed study before a preliminary CIP evaluation can be performed. A summary of this problem area is provided in the table below.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd	X	Low		Safety Issue		High		LT 100k		Good	
Sub-watshd		Medium		Obstr. Travel	X	Medium	X	100-400K	X	Average	X
Local		High	X	Nuisance		Low		GT 400k		Poor	



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 8 through14.apr

Palmetto Bluff Problem Area
Putnam County Master Stormwater Plan

Figure
7.2-11

AYRES ASSOCIATES

Photo 11.1: Palmetto Bluff & Millican Road intersection - up to 6-inch depth of flooding

Photo 11.2: From Palmetto Bluff Road looking North at un-maintained canal

7.2.12 MILLICAN ROAD

Location and General Description:

From east to west, Millican Road begins at its intersection with West River Road and runs west for approximately one mile before slowly turning north for three miles until its intersection with Palmetto Bluff Road. The location where Millican Road floods is shown in **Figure 7.2-12**. It is a two-lane dirt road that is generally at or below grade with the shoulder and surrounding lands. It passes through hammocks, swampy areas and pine groves. The pine groves at the northern end of the roadway are well above the road grade. Roadside drainage does not exist in some areas, and varies between small swales to relatively well maintained ditches, particularly in the northern portions.

Problem Description

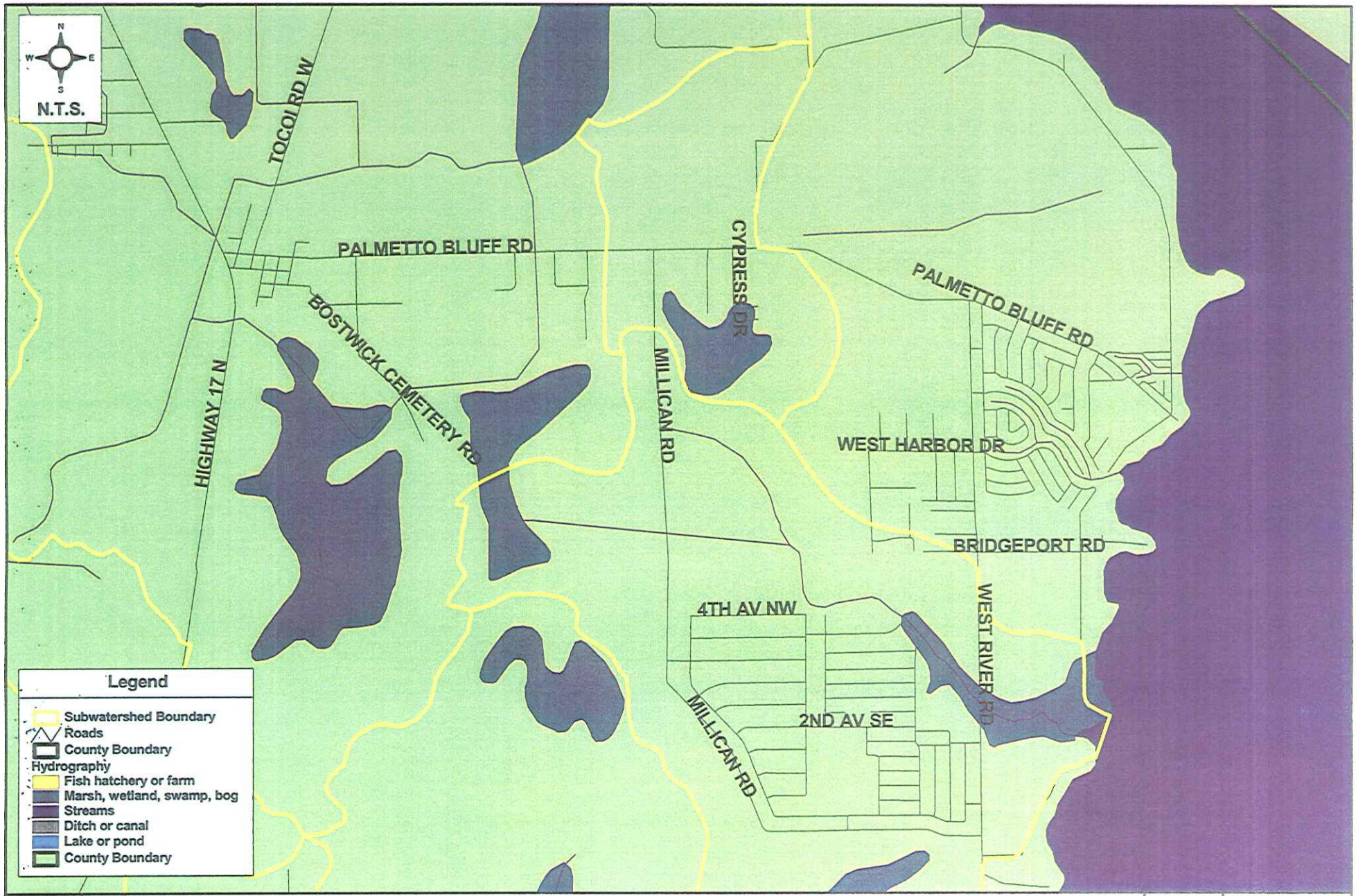
Millican Road flooding begins one-half mile south of its intersection with Palmetto Bluff Road, and extends south for approximately one-half mile. Flooding is approximately one foot deep. A summary of the Palmetto Bluff Road problem area is provided below.

Problem Summary

Subsequent to the May 2004 field visit, the County Engineer advised Ayres Associates that the County has scheduled Millican Road to be paved. The preliminary recommendation is to follow up with the County project manager so that observations from the investigation of this problem area can be adequately noted.

The County is in the process of planning a paving project for Millican Road however paving without roadway drainage will not eliminate overtopping. A paving project for Millican Road will likely require an expanded drainage study, beyond the customary roadway drainage design. This problem area will be ranked, however formulation of a preliminary CIP project may not be possible without topographic mapping and a watershed study. A summary of the Millican Road problem area is provided in the table below.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd		Low	X	Safety Issue		High		LT 100k		Good	X
Sub-watshd	X	Medium		Obstr. Travel	X	Medium	X	100-400K	X	Average	
Local		High		Nuisance		Low		GT 400k		Poor	



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 8 through14.apr

Millican Road Problem Area
Putnam County Master Stormwater Plan

Figure
7.2-12

AYRES ASSOCIATES

7.2.13 RIVER PARK SUBDIVISION

Location and General Description

The River Park Subdivision is shown in **Figure 7.2-13**. It is located on the east and west side of CR 309, approximately 0.5 miles south of the intersection of CR 309 and CR 308 in the town of Fruitland. The St. Johns River lies less than one mile to the west.

Problem Description

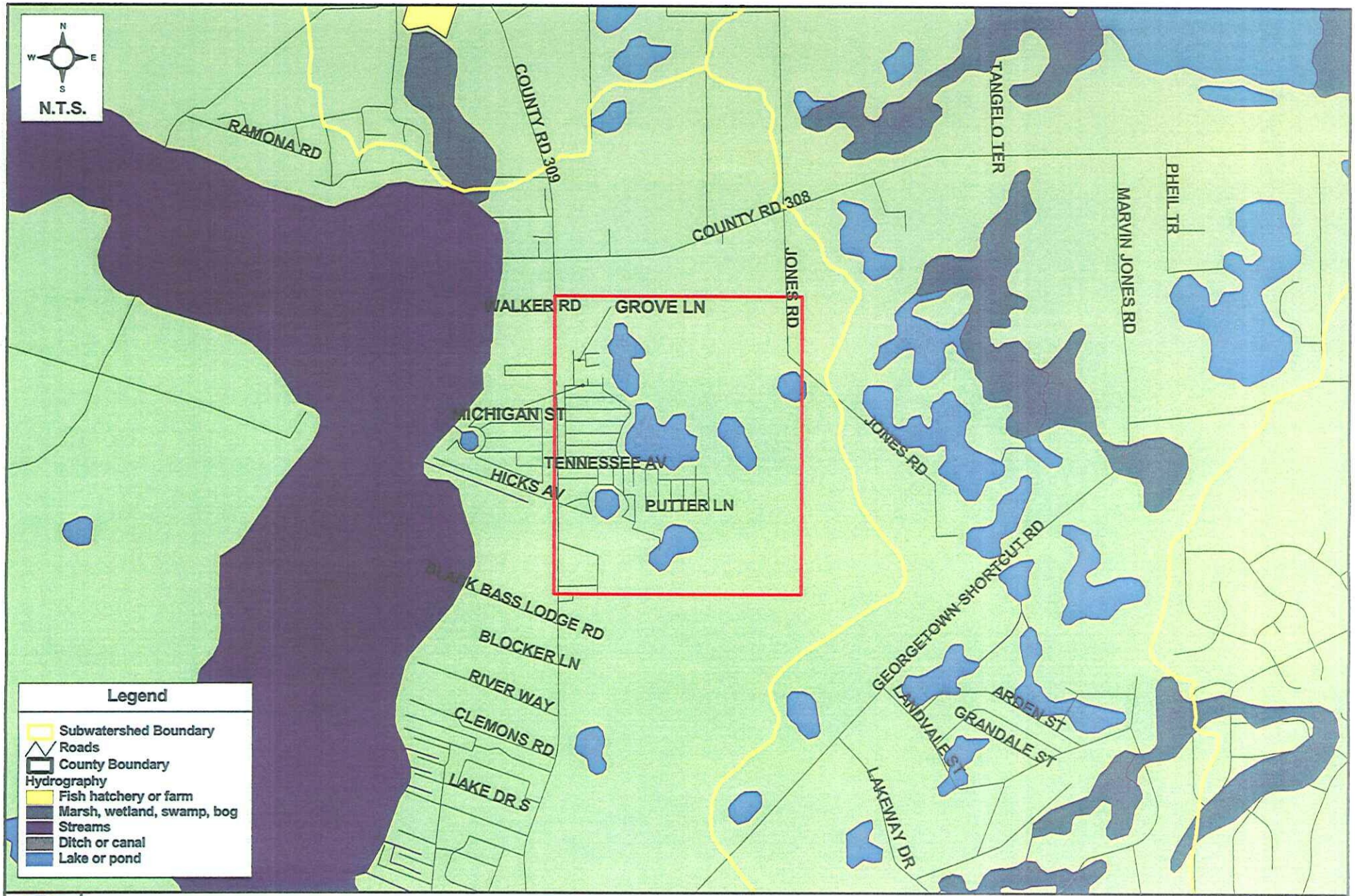
Flooding in River Park occurs when Lake Laverne, Lake Maxine and a third unnamed lake overtop and flow west through an undersized conveyance system under CR 309 toward the St. Johns River. Photo 13.1 shows the west side of Lake Laverne and Photo 13.2 shows the outlet conveyance system. It is significantly undersized in proportion to the area of the two lakes and the surrounding drainage basin size.

At the time of the latter of two field visits, the lakes were receding, however evidence of recent yard and street flooding remained. A resident reported regular yard, garage and utility room flooding.

Problem Summary

The remedy for River Park consists of conveyance improvements to the outlet system. Because the improvements could alter the lake hydroperiods, environmental resource permitting may be a challenge. The preliminary CIP evaluation and cost estimate will include estimates for the environmental permitting and potential mitigation costs, if the problem falls within the 15 highest ranked projects. A summary of this problem area is provided in the table below.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd		Low		Safety Issue	X	High		LT 100k		Good	X
Sub-watshd	X	Medium		Obstr. Travel		Medium		100-400K	X	Average	
Local		High	X	Nuisance		Low	X	GT 400k		Poor	



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 8 through14.apr

River Park Subdivision Problem Area
Putnam County Master Stormwater Plan

Figure
7.2.13

AYRES ASSOCIATES

Photo 13.1: Lake Laverne

Photo 13.2 Outlet Conveyance System

7.2.14 LAKEWAY DRIVE DRAINAGE

Location and General Description:

Lakeway Drive is a dirt road that intersects with Georgetown Shortcut Road in the southern part of the County. **Figure 7.2-14** shows the location.

Problem Description

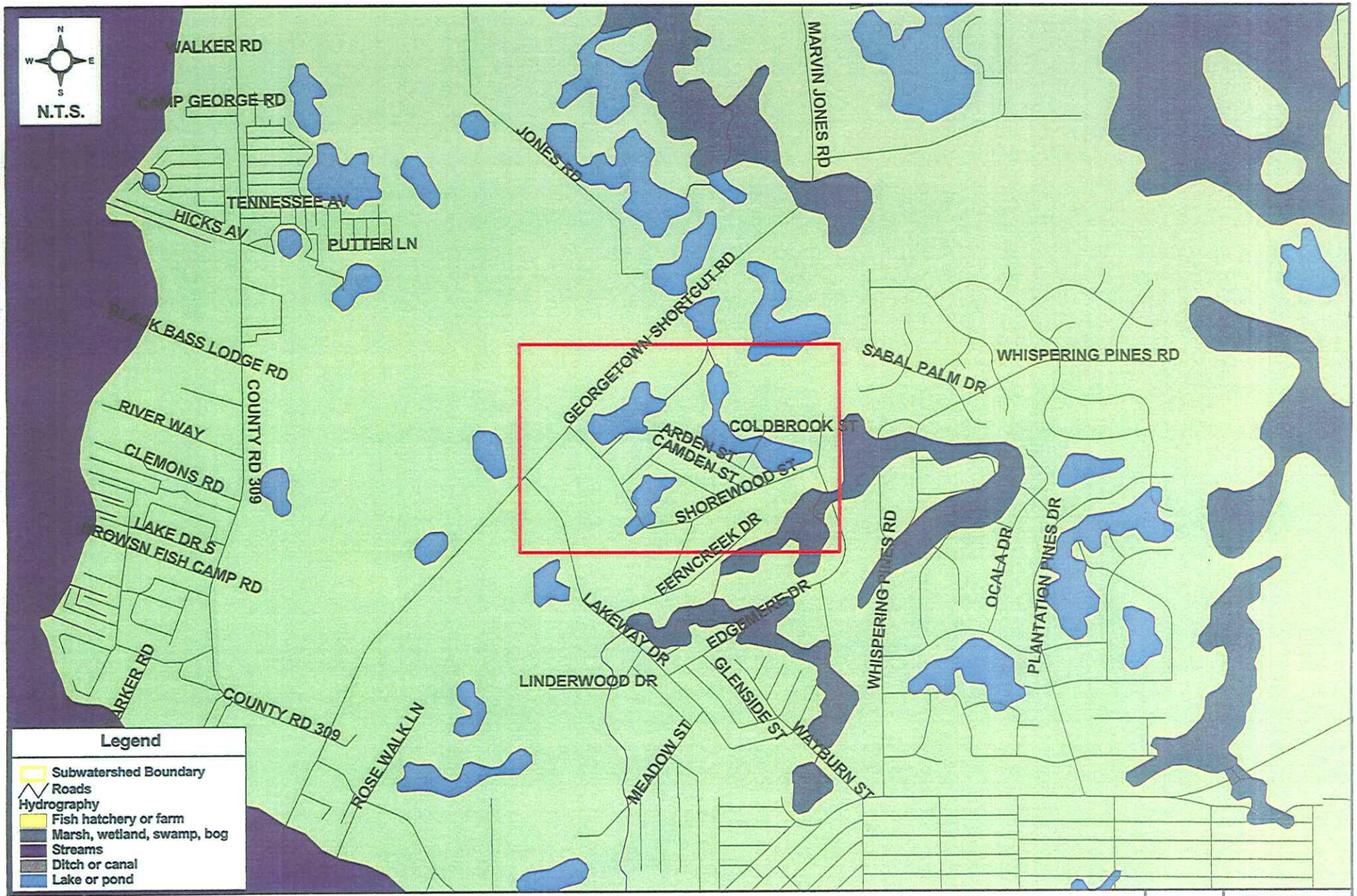
Approximately 200 feet of the road, within a depression, becomes inundated during average rainfall events. Presumably the swales on both sides provide some positive conveyance to a natural outfall to the south. However, the roadside system is severely clogged with vegetation and flows are restricted.

This road was used as part of a detour while the bridge on CR 309 was being replaced. During the time of the detour this road experienced heavy traffic and complaints escalated. Subsequent to the reopening of CR 309, the volume of complaints has decreased significantly.

Problem Summary

Lakeway Drive is primarily a roadway paving project. It may be further evaluated pending its score in the ranking procedure. It appears that at a minimum, flooding at this location can be managed with routine maintenance. Additional comments and an analysis will be performed, pending its score in the ranking procedure. A summary of this problem area is provided in the table below.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd		Low	X	Safety Issue		High		LT 100k		Good	
Sub-watshd		Medium		Obstr. Travel	X	Medium	X	100-400K		Average	X
Local	X	High		Nuisance		Low		GT 400k	X	Poor	



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 8 through14.apr

Lakeway Drive Drainage Problem Area
Putnam County Master Stormwater Plan

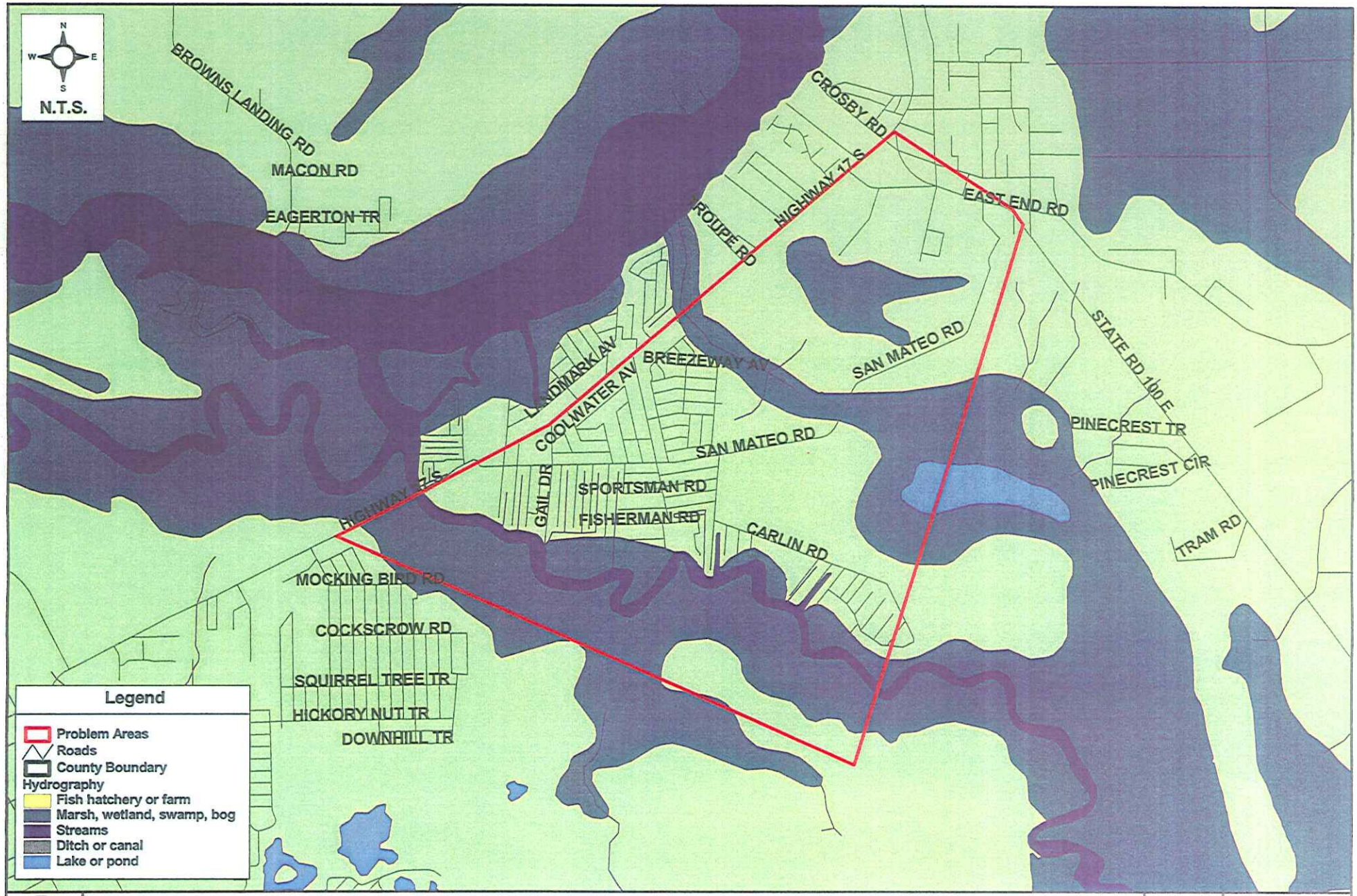
Figure
7.2-14

AYRES ASSOCIATES

Photo 14.1

7.2.15 SAN MATEO ROAD TO DUNNS CREEK

This problem area was not investigated by Ayres Associates. An engineering analysis for this problem is currently being performed by Jones Edmunds & Associates. The location is shown in **Figure 7.2-15**.



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 15through21.apr

San Mateo Road Dunns Creek Problem Area
Putnam County Master Stormwater Plan

Figure
7.2-15

AVRES ASSOCIATES

7.2.16 EAST PALATKA DRAINAGE DISTRICT

Location and General Description

The site visit for this area consisted of observations at the Dog Branch crossing of SR 207. The crossing consists of a 5 x 12 foot double box culvert and the upstream approaches have been recently maintained and cleared of large quantities of sediment deposits. **Figure 7.2-16** shows the problem area location.

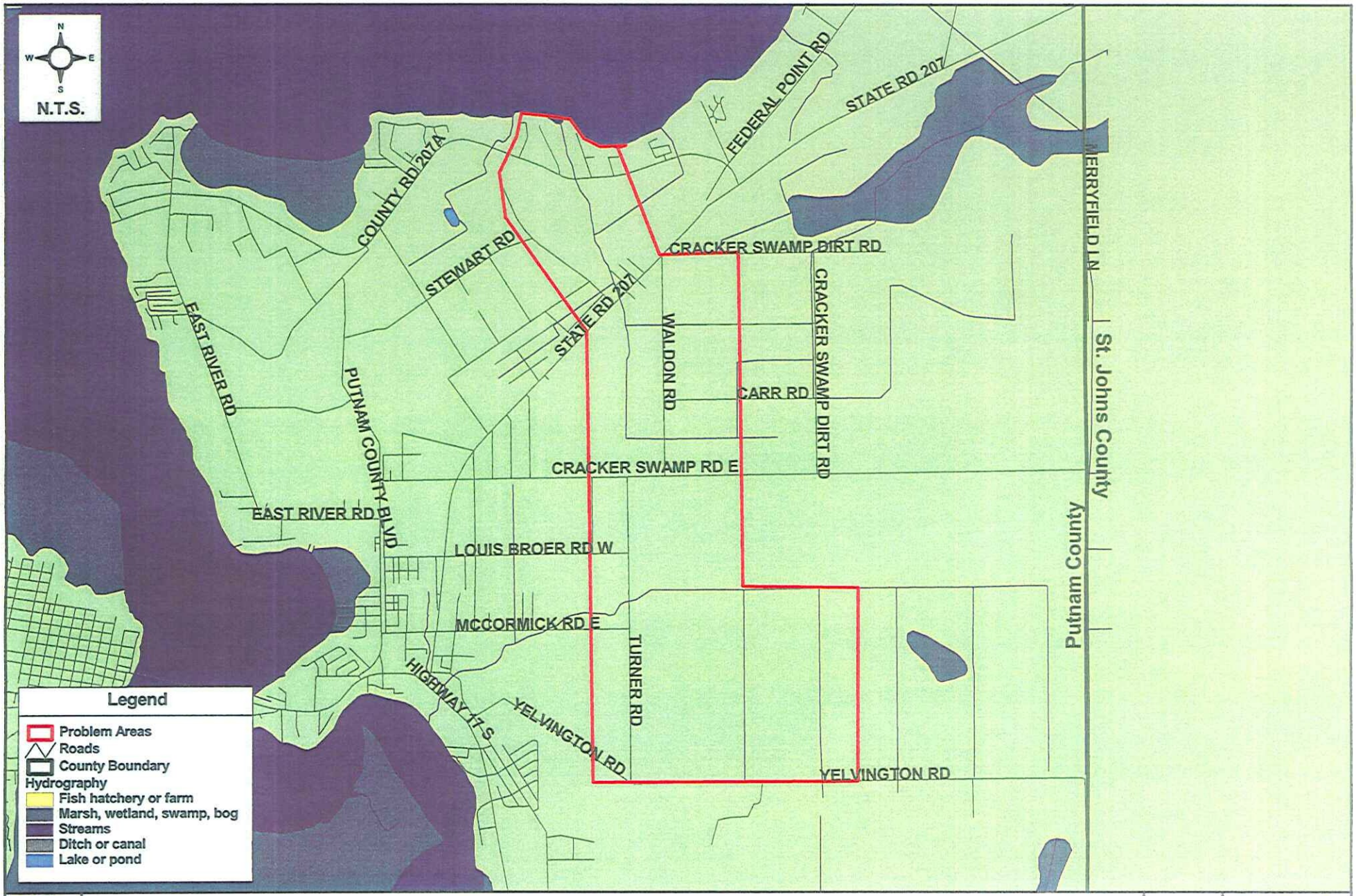
Problem Description

At the SR 207 crossing, large deposits of sediment accumulate. The accumulation causes a severe loss of conveyance such that water has been seen at the edge of the highway pavement. The change in velocity head at the SR 207 crossing (causing the sediment deposition) is a result of overgrowth of vegetation in the downstream reaches that the County has no ingress/egress rights to maintain. This location is indicative of the sedimentation issue throughout the East Palatka area and many conveyance systems throughout Putnam County in general.

Problem Summary

The St. Johns River Water Management District is constructing a large sediment removal and water quality treatment facility downstream of the crossing. However, failure to address the channel maintenance problem above will not result in any improvements at this location. Pending the score of this problem from the ranking procedure, a preliminary CIP evaluation and cost estimate will be developed for this problem area. At a minimum, the CIP will include contact with the Water Management District to discuss the channel maintenance issue.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd	X	Low		Safety Issue		High	X	LT 100k		Good	X
Sub-watshd		Medium		Obstr. Travel	X	Medium		100-400K		Average	
Local		High	X	Nuisance		Low		GT 400k	X	Poor	



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 15through21.apr

East Palatka Drainage District Problem Area
Putnam County Master Stormwater Plan

Figure
7.2-16

AYRES ASSOCIATES

7.2.17 RECTOR ROAD

Location and General Description

The Rector Road problem area is immediately north of the intersection of Rector Road and SR 207 near Hastings, at a triple barrel 8 x 12 foot ECMP crossing of a drainage canal. The pipe sizes were measured in the field. The canal is approximately 12 feet deep with a 40-foot wide bottom width and approximately 1.5:1 side slopes. **Figure 7.2-17** shows the location.

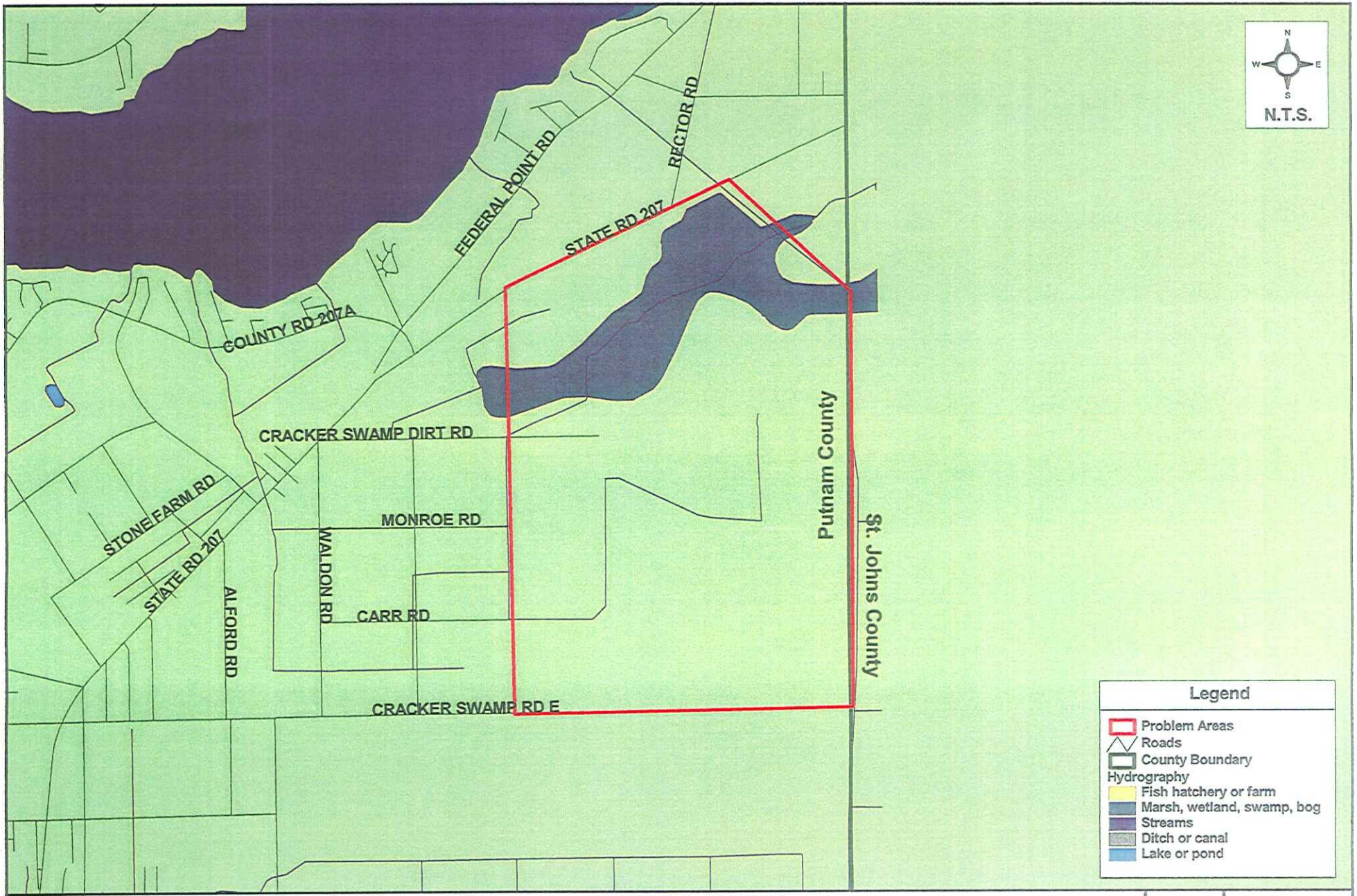
Problem Description

The approaches to the culverts are relatively clear of debris and sediment; however, two culverts are partially constricted with sediments and one is completely blocked. In addition, the culverts are severely corroded (rusted) and pose a safety hazard, and the DOT has advised replacement on a priority basis.

Problem Summary

Sedimentation is an impediment to proper flow rate and hydraulic performance in the canal, although corrosion is the principal factor that has led to the deterioration of the culverts. The loss of structural integrity now poses a safety hazard. Should the ranking process place this problem area within the 15 priority areas, the preliminary CIP evaluation will include cost estimates for bridge/culvert shapes (CONSPAN, RCP's, etc) made from materials with a 100 + year service life. A summary is provided in the table below.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd	X	Low		Safety Issue	X	High		LT 100k		Good	X
Sub-watshd		Medium	X	Obstr. Travel		Medium		100-400K	X	Average	
Local		High		Nuisance		Low	X	GT 400k		Poor	



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 15through21.apr

Rector Road Problem Area
Putnam County Master Stormwater Plan

Figure 7.2-17

AYRES ASSOCIATES

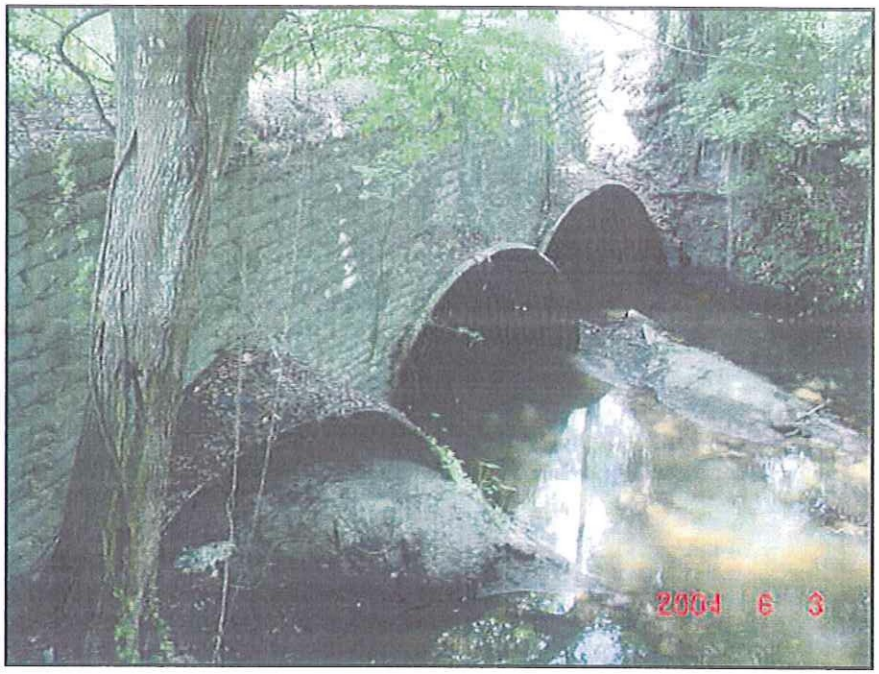


Photo 17.1: West side of Road looking south at Culverts. Flow was in NW direction.

Photo 17.2: E side of Road looking S at Culverts. Flow was in NW direction.

7.2.18 EAST RIVER ROAD

Location and General Description:

The Camp/East River Road problem area is shown on **Figure 7.2-18**. For the most part, the problem impacts the Putnam County Public Works Facility on the northeastern side of Palatka. It is bounded on west by Putnam County Boulevard, on the north by Fulwood Road, and on the south and east by East River Road. There are three principal land uses within the area: the County Public works facilities on Putnam County Boulevard, agriculture, and medium and low density residential area. The County facilities consist of the offices for the Public Works and Maintenance Departments, parking lots, stockpile areas, and the maintenance garage. The GIS land use table specifically described the agriculture as potato and cabbage crops which was confirmed by the field inspection. The residential areas primarily consist of individual parcels (versus subdivided plats) along the main roads.

Problem Description

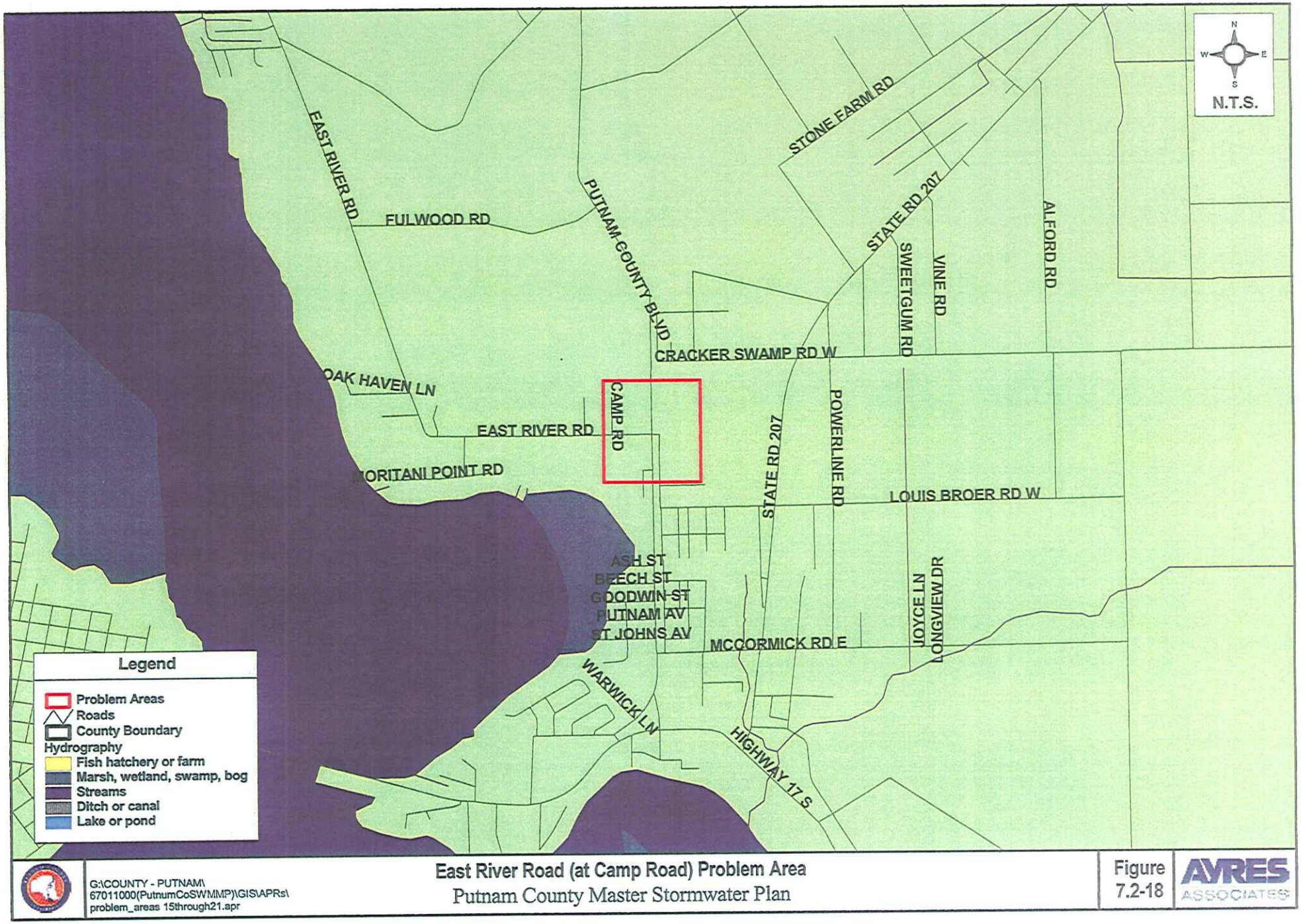
The flooding in this area consists of site flooding in the County Public Works facilities on Putnam County Boulevard, and inundation of various topographically low areas within the watershed. According to County, the parking lots, the clay and limerock stockpile area and the maintenance garage are all inundated an average of twice a year. Incidents of flooding in the office spaces are limited to one event. No residential flooding is known to occur.

A relatively large watershed which discharges through an undersized and poorly maintained outlet under East River Road causes the flooding within the County facilities. The most downstream segment of the drainage system is shown in Photo 1. It runs parallel to Camp Road and surcharges into the County facilitates. The ditch is connected to a box culvert under East River Road. Downstream of the box culvert under East River Road, flow is conveyed through a somewhat irregular shaped trapezoidal ditch. The spoil from the past ditch excavation(s) was left on the banks. Photos 18.2, 18.3, and 18.4 show a left-to-right cross-section of the ditch at a location approximately 300 feet South of East River Road. There has been no apparent channel maintenance in recent years

Problem Summary

The watershed size, land use, soil type, and the size and condition of the outlet all combine to increase flood potential within the basin. Should the ranking process place this problem area in the top 15 priority areas, costs estimates and rights-of-way requirements will be included in the preliminary CIP evaluation. A summary of this problem area is contained in the table below.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd	X	Low	X	Safety Issue		High		LT 100k		Good	X
Sub-watshd		Medium		Obstr. Travel	X	Medium	X	100-400K	X	Average	
Local		High		Nuisance		Low		GT 400k		Poor	



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 15through21.apr

East River Road (at Camp Road) Problem Area
Putnam County Master Stormwater Plan

Figure 7.2-18

AYRES ASSOCIATES

Photo 18.1: Segment of downstream drainage system along Camp Road.

Photo 18.2, 18.3, and 18.4: Looking downstream in ditch 300 feet South of River Road.

7.2.19 COUNTY ROAD 315 AT 64TH STREET

Location and General Description

This problem area is located approximately one mile north of the Town of Interlachen on CR 315 near the intersection with 64th Street. **Figure 7.2-19** depicts the problem area location. Topography ranges from a high elevation of approximately 130 feet NGVD along the rim of Mariner Lake in the southern portions of this problem area to elevations of 100 feet NGVD near the low area of the road where the problem is located.

Current land use surrounding the problem area is predominantly comprised of low density residential along with a small section of forested uplands. The land on the east side of Mariner Lake is defined as low density residential and the land on the west side of the lake is defined as forested upland.

The FIRM for the area shows that a 100-year flood would inundate the area around Mariner Lake including a section of CR 315 along the western edge of the lake. These areas are zoned A, with flood elevations undetermined. All other areas are zoned X, with areas determined to be outside the 500-year floodplain.

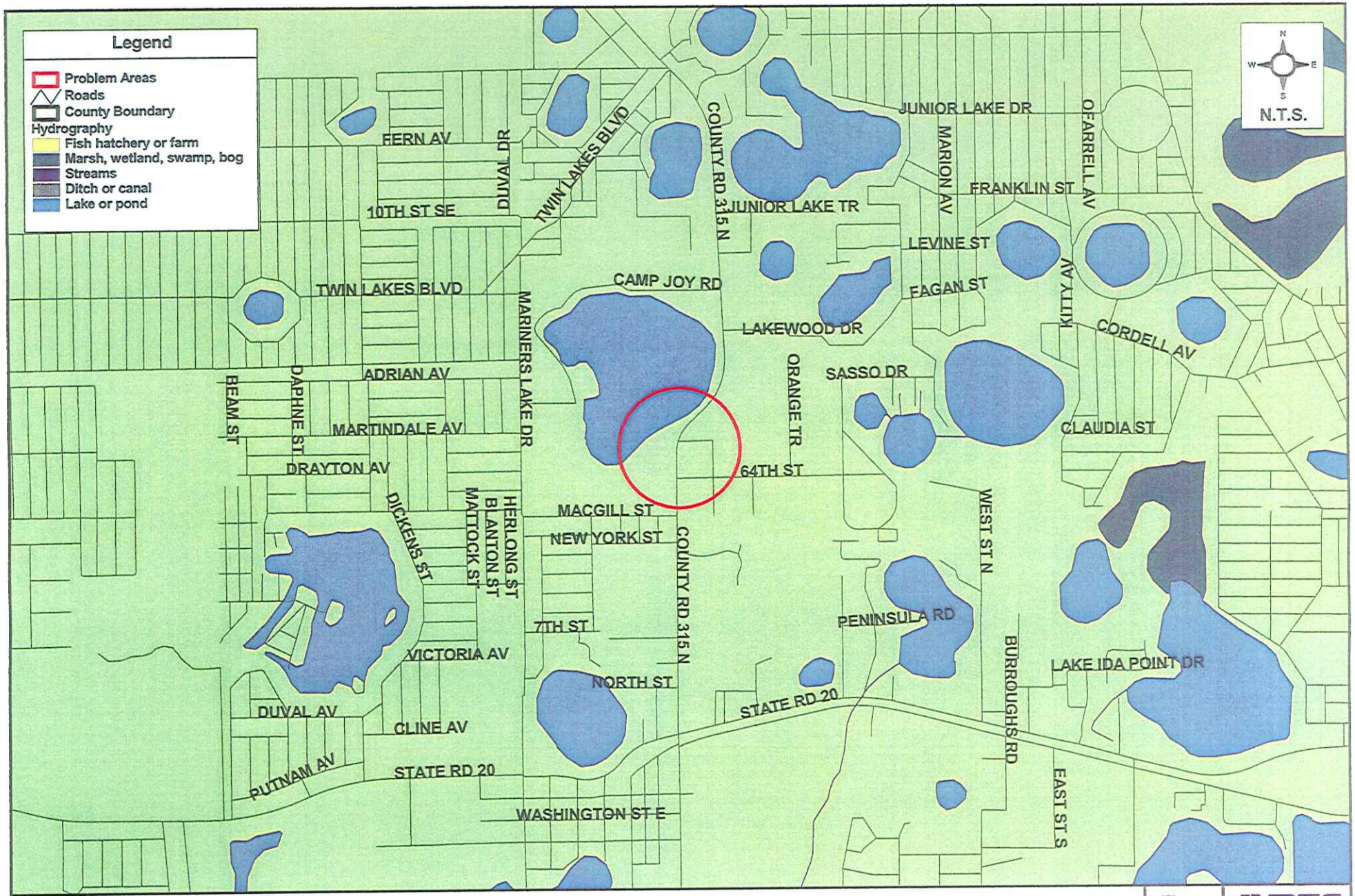
Problem Description

This road elevation drops from approximately 130 feet NGVD near its intersection with 64th Street to approximately 100 feet NGVD where the road curves to the right around Mariner Lake. The road floods along the curve as there are no cross drains. Beginning with moderate rains, water ponds up to approximately the centerline of the road. A portion of 2nd Lane (a dirt road east of CR 315), drains toward CR 315 and carries sediment into the roadside swale along its eastern side, causing them to become clogged and flood.

Problem Summary

Sediment from 2nd Lane is a major cause of flooding at this location. East-west cross drains to Mariner Lake are not permissible due to water quality treatment requirements. Several practical solutions are available for this problem area. Paving the portion of 2nd Lane that drains toward CR 315 would significantly decrease sedimentation in the roadside swale. Routine maintenance after paving would also be necessary to prevent subsequent flooding. Pending the ranking score of this problem area, a preliminary CIP evaluation and cost estimate will be developed and these concepts will be further developed. A summary of this problem area is provided in the table below.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd		Low		Safety Issue		High	X	LT 100k	X	Good	
Sub-watshd		Medium		Obstr. Travel	X	Medium		100-400K		Average	X
Local	X	High	X	Nuisance		Low		GT 400k		Poor	



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 15through21.apr

County Road 315 at 64th Street Problem Area
Putnam County Master Stormwater Plan

Figure 7.2-19

AYRES ASSOCIATES

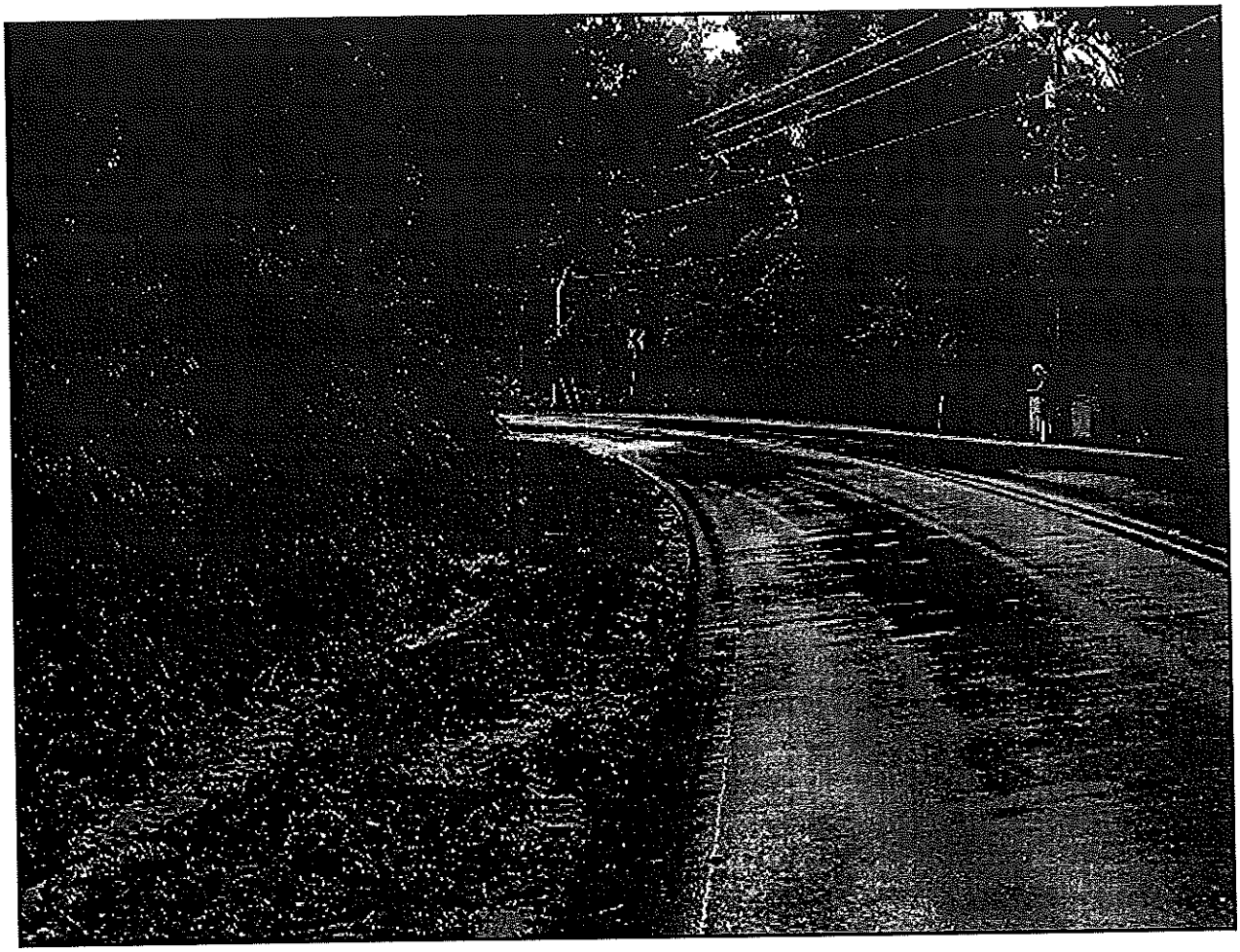


Photo 19.1 Location of flooding on CR 315

7.2.20 WHISPERING PINES

Location and General Description

The Whispering Pines Subdivision is located on the north side of Georgetown-Denver Road approximately one mile north of Lake George. **Figure 7.2-20** is a general location map showing the Whispering Pines subdivision.

Problem Description

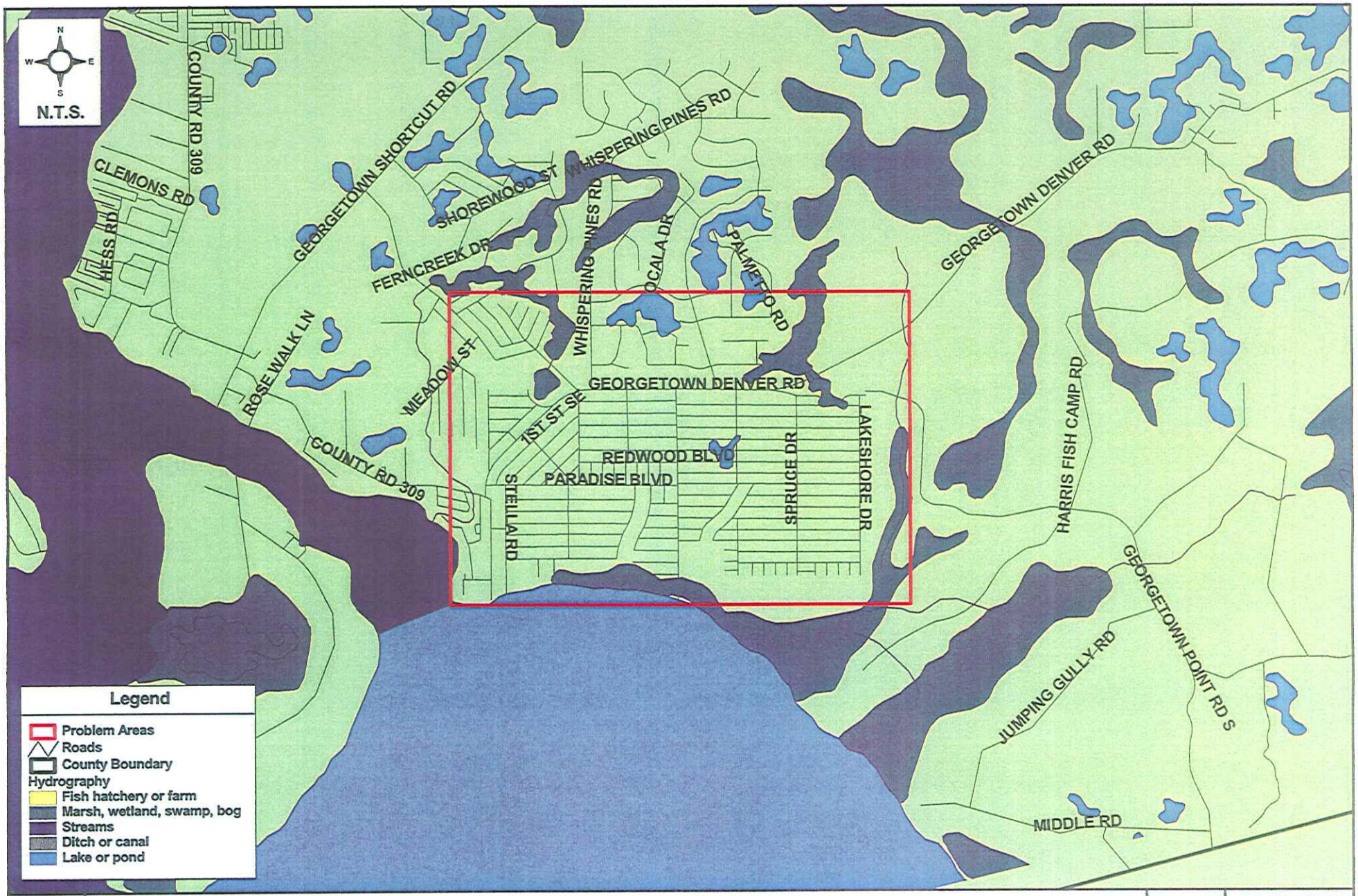
Local flooding is reported in this subdivision; predominantly sediment-laden road flooding from the dirt road. Road and occasional yard flooding is said to occur beginning with moderate rainfall.

During the recent field visit to this area the majority of the roadside ditches were filled with sediment. The County maintains some of the drainage systems and roads in this subdivision.

Problem Summary

There are several ditches systems that convey stormwater through the neighborhood that are maintained by the County. The majority of the flooding problems can be alleviated through grading of the road and the roadside swales. Pending the ranking score of this problem area, a preliminary CIP evaluation and cost estimate will be developed and these concepts will be further studied. A summary of this problem area is provided in the table below.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd		Low		Safety Issue		High		LT 100k		Good	X
Sub-watshd	X	Medium	X	Obstr. Travel	X	Medium	X	100-400K	X	Average	
Local		High		Nuisance		Low		GT 400k		Poor	



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 15through21.apr

Whispering Pines Problem Area
Putnam County Master Stormwater Plan

Figure
7.2-20

AYRES ASSOCIATES

Photo 20.1 Dirt road providing source of sediments

Photo 20.2 Dirt road providing source of sediments

7.2.21 SARATOGA HARBOR: SARATOGA HARBOR ESTATES

Location and General Description

The Saratoga Harbor area is east of CR 309 and immediately east of the St. Johns River as shown in **Figure 7.2-21**. Some of the homes in Saratoga Estates are on the river. Saratoga is a medium density residential community with dirt roads, septic tanks, wells, and both block masonry homes and manufactured (mobile) homes. It is characterized by well-drained soils, and relatively steep grades with a range of topographic elevations from 95 feet to 5 feet NGVD. The homeowners group for Saratoga Harbor is the primary forum for local government representation to the community residents. Much of the subdivision is built around two ponds that are connected by a 24-inch CMP and grated overflow structure culverts under a roadway embankment. A second roadway embankment (Gibbs Avenue) separates the second pond from a 500-foot long canal off the St. Johns River. Flow through this second embankment is conveyed through three drop- board risers. All three risers utilize 18-inch diameter CMPs. Drop boards were in place at the time of the field visit on June 1, 2004. There is also an overflow consisting of two 24-inch diameter CMPs running parallel to the drop-board risers. The culverts under Gibbs Avenue can be seen in Photo 21.1. Photo 21.2 shows the canal. All five of the conduits described above are approximately 100 feet long. The three CMP risers were recently sleeved with HDPE. The width of the canal is roughly 110 feet. One side is populated by single family residences with individually owned docks and boat lifts, and the other side with relatively new boat slips that are owned by Saratoga Harbor's homeowner association.

Problem Description

The Saratoga Harbor problem can be characterized as a sedimentation/dredging issue within the 500- foot canal directly connected to the St. Johns River.

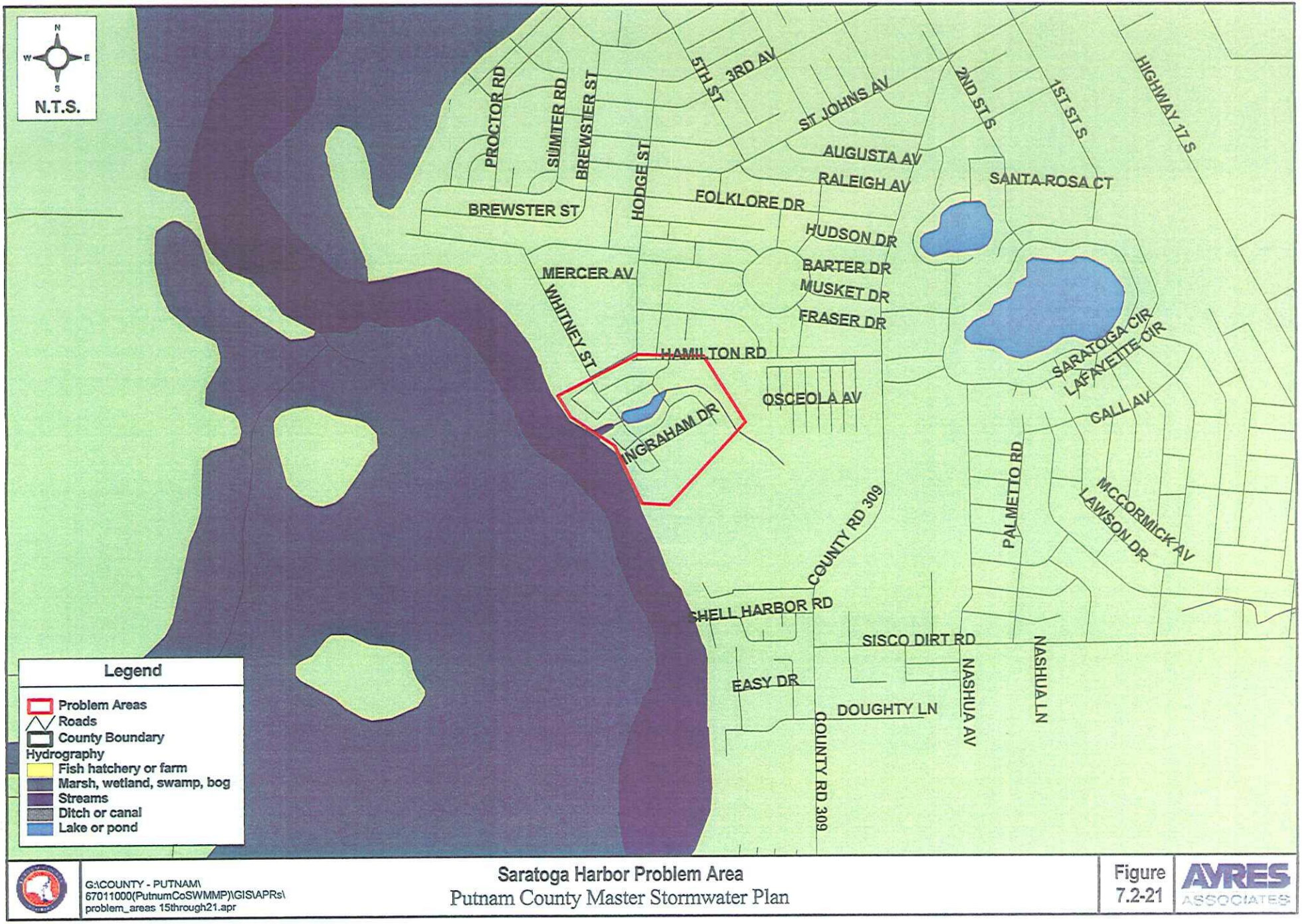
A resident stated that depths in the canal have gone from 3.5 feet to 1.8 feet. The homeowners assert that the sedimentation is the result of erosion that began with piping failure at the drop-board structures that eventually eroded a large volume of material from the embankment. The County generally agrees that the sediment in the canal is from the embankment (Gibbs Avenue), and plans to fund dredging of the canal.

In addition to the embankment failure, sediments suspended in tidal flows appear to be falling out around the pilings that support the docks, filling in the boat slips. Photo 21.3 shows sediment buildup at the most western end of the boat slips where velocities are first affected by the pilings. The amount of sediment in the canal does not appear to be consistent with the amount of material that would have eroded and filled in the canal. There is no visual evidence that dirt roads in Saratoga Harbor are contributing to the sedimentation deposits in the canal.

Problem Summary

Pending the outcome of the ranking procedure, this problem area will be further evaluated. A summary of this problem area is given in the table below.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd		Low		Safety Issue		High	X	LT 100k		Good	
Sub-watshd	X	Medium	X	Obstr. Travel	X	Medium		100-400K	X	Average	X
Local		High		Nuisance		Low		GT 400k		Poor	



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 15through21.apr

Saratoga Harbor Problem Area
Putnam County Master Stormwater Plan

Figure
7.2-21

AYRES ASSOCIATES

Photo 21.1: East side of Gibbs Avenue showing road embankment 18" risers and 24" CMP overflows.

Photo 21.2: Looking west showing canal and homeowners boat slips

Photo 21.3: Standing at west end of dock facility where sedimentation begins

7.2.22 COUNTY ROAD 308 B

Location and General Description:

The CR 308 B problem area begins at its intersection with CR 309 and continues approximately three miles until its intersection with Orange Blossom Street. The 1.5 miles passes through the City of Welaka and the next 1.5 miles lies in unincorporated Putnam County (**Figure 7.2-22**).

Problem Description

Within the City of Welaka, the problems consist of road flooding that includes overtopping and inundation of both travel lanes. The flooding occurs after moderate rainfall events in numerous locations between the intersection of 308 B with 7th Street and Pineapple Street. Water also collects in the ruts of both travel lanes and the shoulders. Both lanes are inundated with up to six (6) inches of standing water in two locations between 7th and 11th Avenue, and at one location immediately west of Beecher Springs Road. Photo 22.1 shows the location that inundates immediately west of 11th Avenue and Photo 22.2 shows the Beecher Springs Road location that inundates. The City of Welaka has installed and interconnected a system of five ditch-bottom inlets (DBI)s and pipes east and west of 6th Avenue in an attempt to provide some drainage relief. The DBI system was designed to drain south to an abandoned borrow pit. However, during the field visit it was noted that the cross drain at the intersection of Oak Street and 6th Avenue is plugged and positive drainage is not possible.

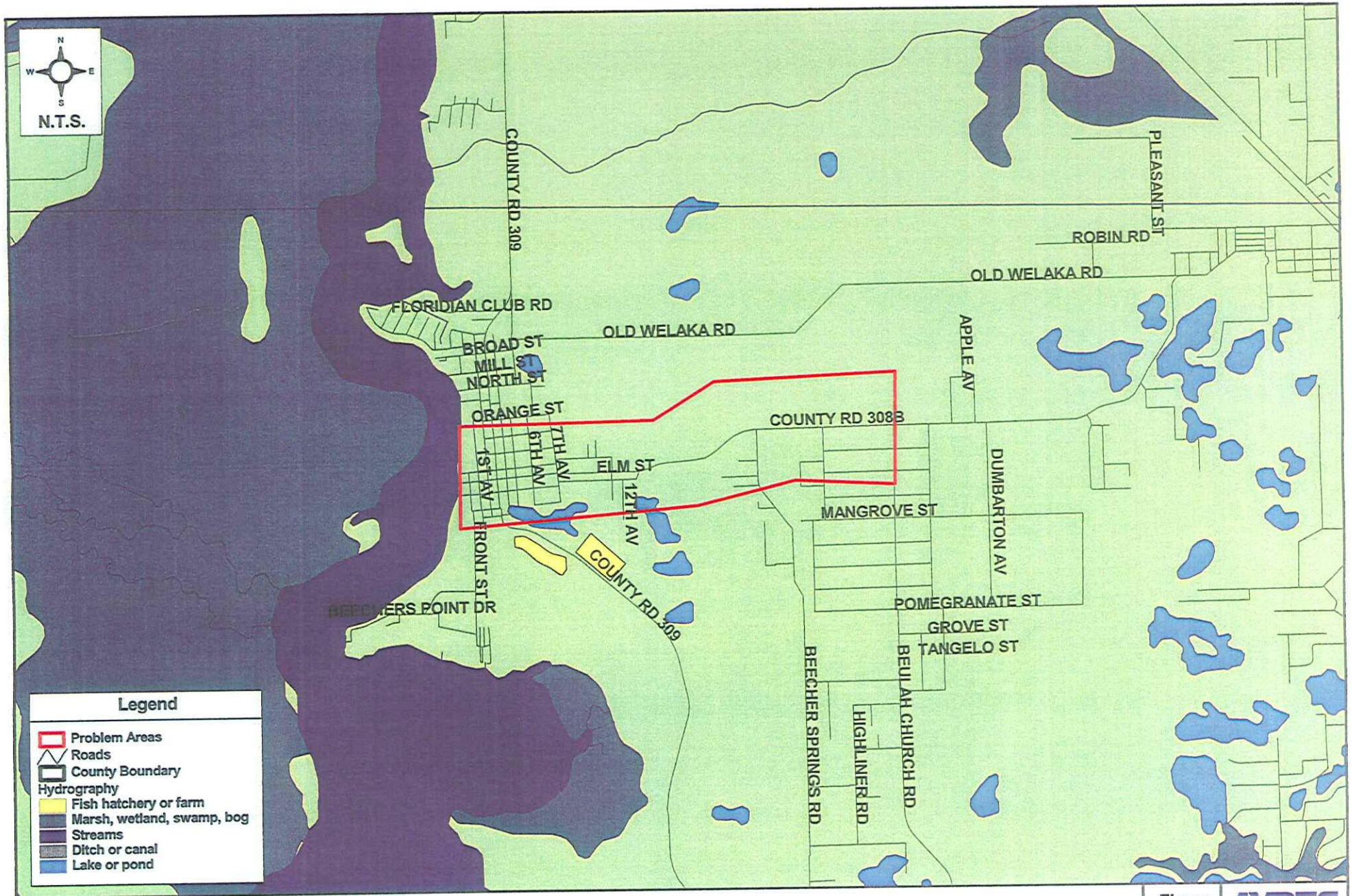
The sedimentation consists of deposits in both travel lanes on CR 308 B at the intersection of CR 308 B and Beecher Springs Road in unincorporated Putnam County. The source of the sediment is Beecher Springs Road which is a county-maintained road constructed from clayey sand. The sediments are suspended in runoff from a segment of Beecher Springs Road that slopes steeply toward the intersection with CR 308 B. Photo 22.1 shows this intersection and the sediment deposits.

The County has recently been awarded a grant to widen and pave the road between CR 309 and Old Welaka Road. However, no roadside drainage will be incorporated into the paving. In addition, the County does not plan to apply for an ERP to treat the additional stormwater runoff that will be generated by the street widening.

Problem Summary

To address the drainage issues, a drainage component developed separately, or with the paving project, will be required. Sufficient outfall capacity and treatment is available in borrow pits immediately to the south. The concept may be further refined pending the final ranking. Because the County does not purchase right-of-way for drainage projects, this project may not be ranked. A summary of this problem area is given in the table below.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd		Low		Safety Issue	X	High		LT 100k		Good	X
Sub-watshd	X	Medium		Obstr. Travel		Medium	X	100-400K	X	Average	
Local		High	X	Nuisance		Low		GT 400k		Poor	



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 22through28.apr

County Road 308 B Problem Area

Putnam County Master Stormwater Plan

Figure 7.2-22

AYRES ASSOCIATES

Photo 22.1: Looking east from CR 308 B at location west of 11th Av. where both travel lanes inundate

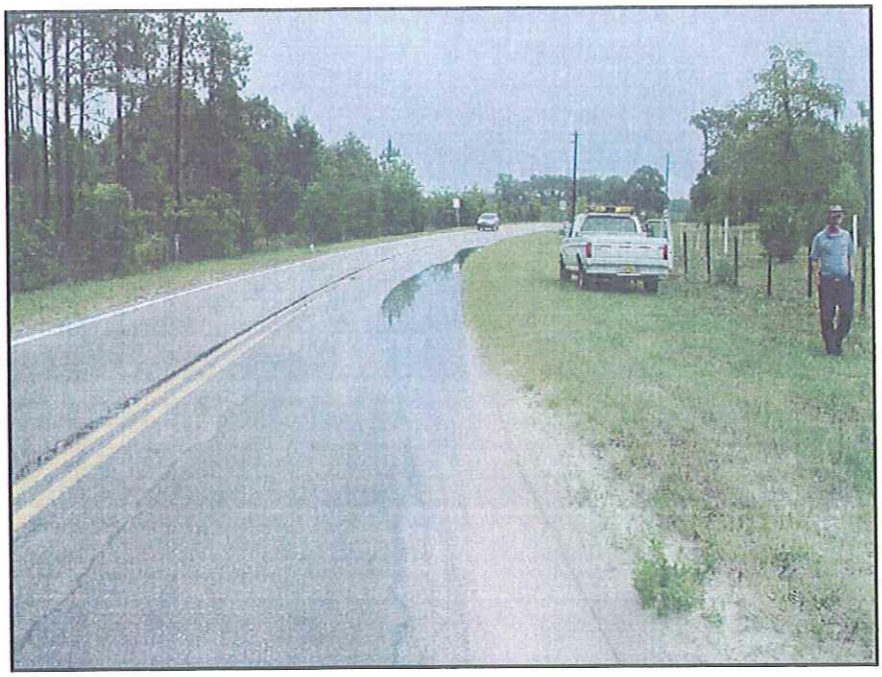


Photo 22.2: Looking east from CR 308 B at location west of Beecher Springs Rd. that inundates.

7.2.23 COUNTY ROAD 309 (South)

Location and General Description

CR 309 intersects with U.S. Highway 17 near Satsuma and runs north and south paralleling Highway 1 to the west. The problem area location is shown in **Figure 7.2-23.**

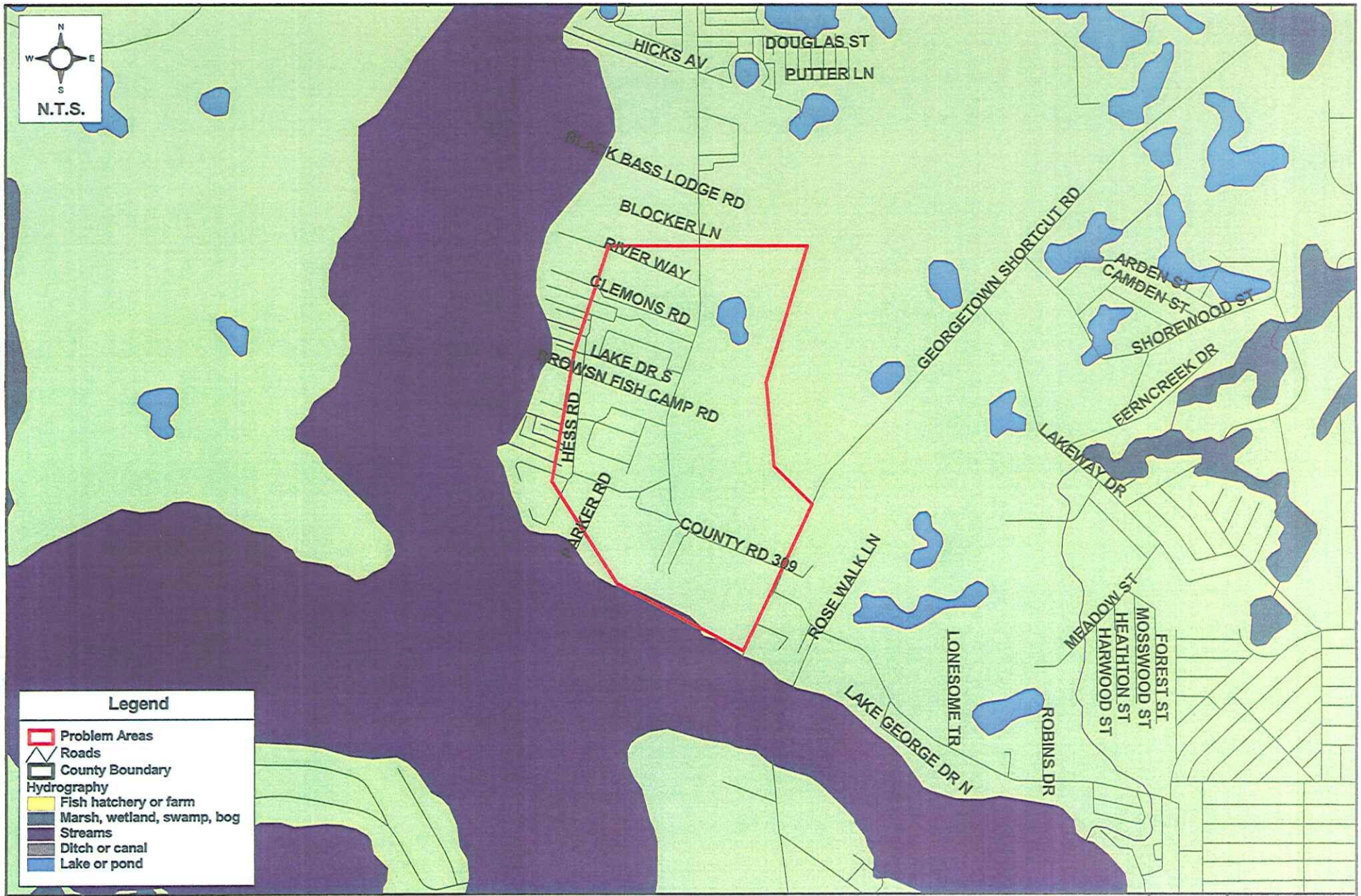
Problem Description

The majority of the problems occur on the south end of this road beginning at the Town of Georgetown. Beginning with moderate rains, water ponds in the ruts of the road. A summary of this problem area is given in the table below.

Problem Summary

The purpose of the field investigation was to document the nature of the CR 309 problems. The County has advised Ayres Associates that the road is scheduled for resurfacing, which should eliminate the problem. Accordingly, a preliminary recommendation has not been developed and this problem area will not be ranked. A summary of the CR 309 problem area is provided in the table below.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd		Low		Safety Issue	X	High		LT 100k		Good	X
Sub-watshd	X	Medium		Obstr. Travel		Medium	X	100-400K	X	Average	
Local		High	X	Nuisance		Low		GT 400k		Poor	



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 22through28.apr

County Road 309 Problem Area
Putnam County Master Stormwater Plan

Figure
7.2-23

AYRES ASSOCIATES

7.2.24 HARRIS FISH CAMP ROAD

Location and General Description

Harris Fish Camp Road is a dirt road through the Lake George Wildlife Management Area. The lands on either side of the road are owned by the St. Johns River Water Management District, and Harris Fish Camp Road provides service to Harris Fish Camp located on the northeast side of Lake George. The location can be seen on **Figure 7.2-24**.

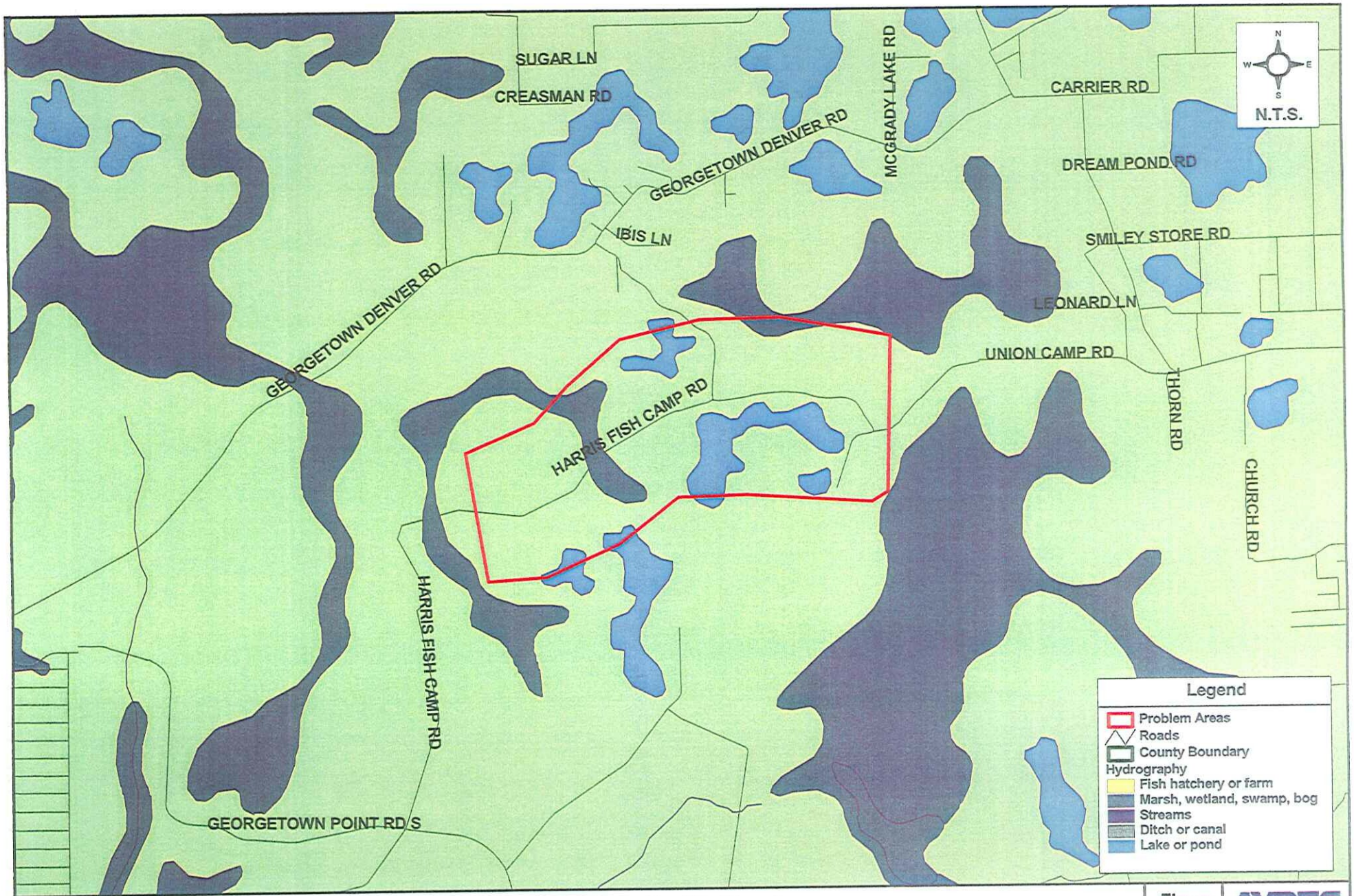
Problem Description

The area where the flooding occurs is at an S-curve in the road. Stormwater flows down the east side of the road in a swale until it reaches an elevated transition point and then begins to flow across the road, causing washouts. The outfall for an upstream wetland appears to be this ditch, which exacerbates the problem. Because the land on either side of the road is owned by SJRWMD and currently there are no cross drains, SJRWMD would not allow the installation of any new drainage improvements. On one part of the S-curve, there does not appear to be a distinct outfall (i.e. creek, stream, wetland). On the other part of the S-curve, there appears to be sufficient elevation change to allow for a proper outfall. There is one cross drain that is approximately 75 feet south of this area. However, the invert is higher than the road elevation at the flooded S-curve.

Problem Summary

There are several possible remedial measures for this area including installation of a cross drain. Compensatory treatment at a nearby location may be required. The problem may be further investigated pending the ranking procedure. A table summarizing this problem area follows.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd		Low	X	Safety Issue		High		LT 100k		Good	
Sub-watshd		Medium		Obstr. Travel	X	Medium		100-400K	X	Average	
Local	X	High		Nuisance		Low	X	GT 400k		Poor	X



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 22through28.apr

Harris Fish Camp Road Problem Area
Putnam County Master Stormwater Plan

Figure 7.2-24

AYRES ASSOCIATES

Photo 24.1: Location of Road Flooding and Washout.

7.2.25 JUNCTION ROAD

Location and General Description

Junction Road is a paved road with curb and gutter drainage that intersects with U.S. Highway 17 south of Crescent City at its east end, and Union Avenue at its west end. Figure 7.2-25 shows the problem area location.

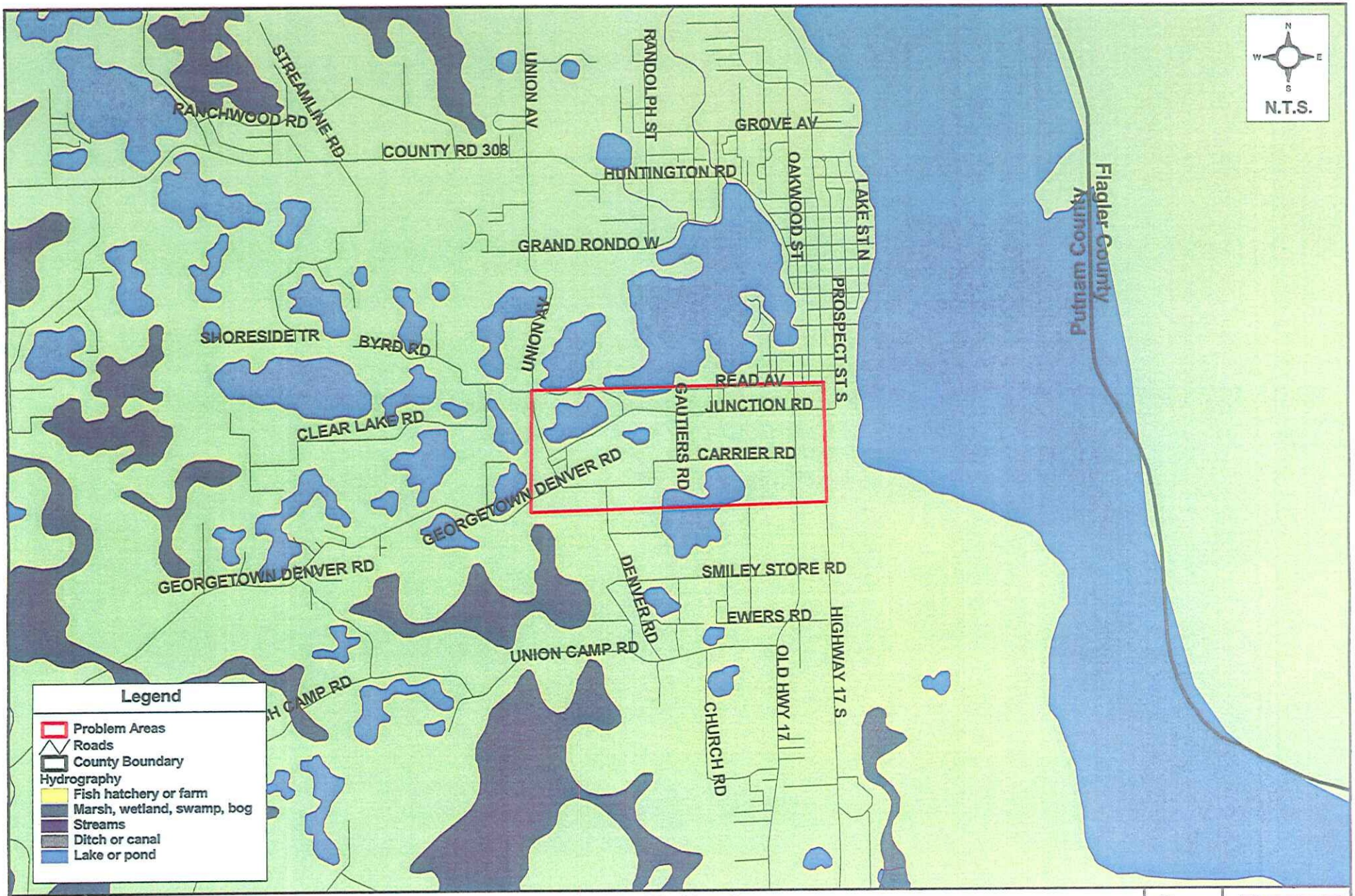
Problem Description

The road floods beginning with moderate rainfall due to what appears to be insufficient curb inlet spacing. At one location, the inlet spacing exceeds 1,000 feet. Pipe invert data was not available to determine pipe grades. The right-of-way is the back of curb. The shoulder to the south of the road is higher than the road. Along the section that floods, a ditch is located on the south side. The ditch had standing water during inspection. When the capacity of the curb and gutter is exceeded, water overtops the road, flows to the north side, and over the curb and gutter. Both sides have heavy vegetation just behind the curb and gutter. Where water overtops the curb and gutter on the north side, erosion of the bank has caused the curb and gutter to slough off and crack. At one time, backfill was used to help prevent the curb and gutter from deteriorating further. Local residents do not favor expansion of the limited right-of-way the County now holds.

Problem Summary

Any of a number of factors such as inlet capacity, limited conveyance, poor maintenance, etc., may contribute to the deficiency at this location. Pending the ranking of this problem area as one of the 15 selected for CIP alternatives development, measurements taken in the field may be used to estimate runoff, curb inlet and swale flow capacity, etc., to better assess the cause of this deficiency. A summary of this problem area is provided in the table below.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd		Low	X	Safety Issue		High		LT 100k		Good	
Sub-watshd		Medium		Obstr. Travel	X	Medium		100-400K	X	Average	X
Local	X	High		Nuisance		Low	X	GT 400k		Poor	



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 22through28.apr

Junction Road Problem Area
Putnam County Master Stormwater Plan

Figure
7.2-25

AYRES ASSOCIATES

Photo 25.1 Roadway

7.2.26 MUD LAKE/MONROE MILL CREEK

Location and General Description

The Mud Lake/Monroe Mill Creek system begins near the intersection of Silver Lake Drive and SR 20 and flows south, crossing SR 19 into Mud Lake, then Southeast through Monroe Mill Creek. Monroe Mill Creek flows into the St. Johns River. Figure 7.2-26 shows the location. The area will hereafter be referred to as Mud Lake.

Problem Description

The Mud Lake area was identified as a problem area due to structure/residential flooding on Red Fox Trail immediately north of SR 19 (Photo 26.1) and on Karen Place and Karen Court South of SR 19. A number of the homes in this subdivision are built around Mud Lake. At least one home on Red Fox Trail flooded during the hurricanes of the summer of 2004, and the remainder experienced yard flooding. Red Fox Trail was also flooded. Several of the homes in the subdivision flooded, including some that are built around Mud Lake and at least one that was not. The County is also concerned that widening on SR 20 near the City of Palatka will increase runoff within the upper part of the watershed and exacerbate the flooding described above.

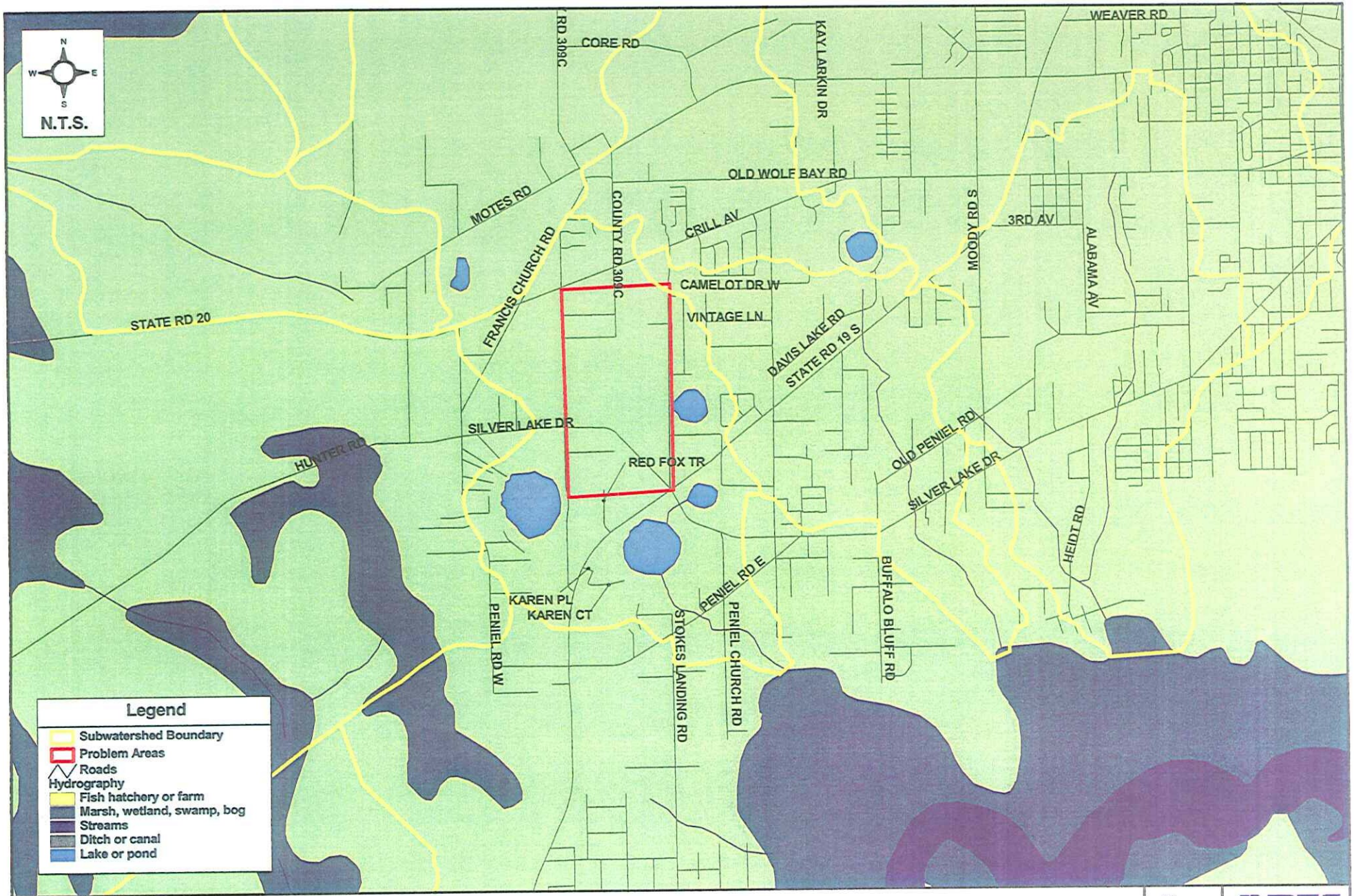
Problem Summary

The pre/post discharge analysis necessary to permit the construction will, in theory, prevent increased flooding. Like any other part of the County, it must be assumed that adherence to the St. Johns River Water Management District stormwater permitting criteria will attenuate additional runoff and that water levels and flow rates in the area described above will not be adversely affected.

Addressing flooding on Red Fox Trail and Mud Lake will create difficult engineering and environmental problems. With respect to engineering, increasing conveyance is costly, as additional land is usually required to attenuate flows and prevent offsite impacts. With respect to environmental issues, an environmental resource permit to alter anything related to the hydroperiod of a lake is one of the most difficult environmental permits to acquire. Acquisition of a permit to alter any component of a lake requires an extensive amount of ecological field work and numerical modeling to forecast the lake's hydraulic performance with the conveyance system modifications.

The hydraulic/civil design engineering and environmental analysis required to obtain a permit to construct the modifications that would be necessary to reduce the flooding observed at this problem area will be further described pending the ranking procedure. A table summarizing this problem area follows.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd	X	Low		Safety Issue		High	X	LT 100k		Good	X
Sub-watshd		Medium		Obstr. Travel	X	Medium		100-400K	X	Average	
Local		High	X	Nuisance		Low		GT 400k		Poor	



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 22through28.apr

Mud Lake Problem Area
Putnam County Master Stormwater Plan

Figure
7.2-26

AYRES ASSOCIATES

Photo 26.1: W. Peniel Road - Outlet of Mud Lake

7.2.27 SISCO DIRT ROAD

Location and General Description:

Sisco Dirt Road is located in east-central Putnam County east of the CSX Railroad system running parallel to U.S. Highway 17. From east to west, Sisco Dirt Road begins at its intersection with CR 309 and ends at its intersection with U.S. Highway 17 and the CSX Railroad. The location is shown in **Figure 7.2-27**.

Problem Description:

According to County, Sisco Dirt Road inundates in approximately 10 locations between its east and west intersections. Photos 27.1 and 27.2 show a typical section of the road. Most of Sisco Dirt Road is lower then the surrounding grade. According to County personnel, flooding is the result of inadequate roadside drainage. They do not report substantial runoff from the surrounding lands or overtopping in the form of sheet flow from one side of the road to the other.

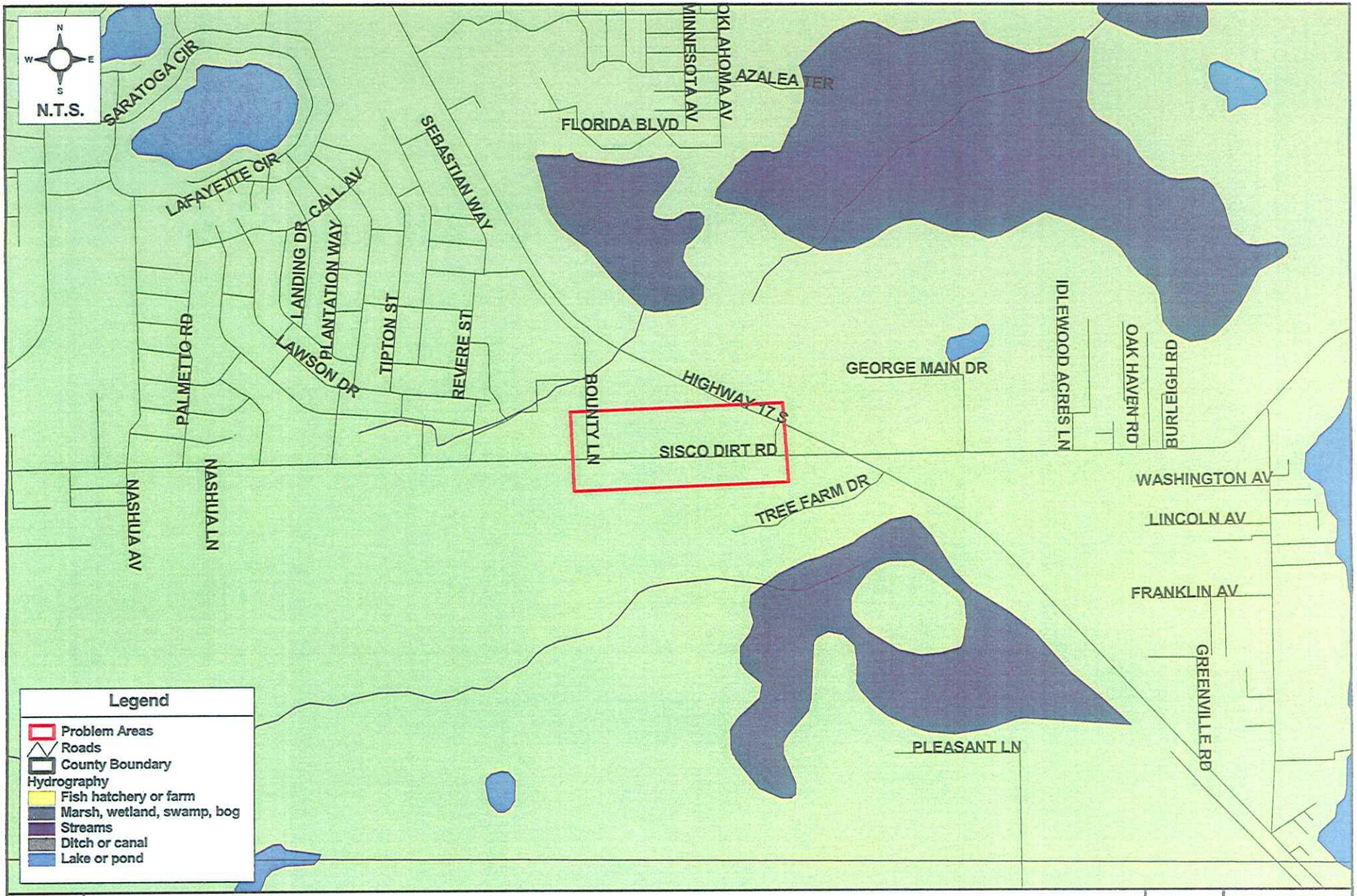
Discussion

A pavement project must address adequate edge of pavement elevations, adequate right-of-way for drainage, water quality treatment, and changes in pre-post runoff rates.

Problem Summary

Sisco Dirt Road is principally a roadway paving project and will require right-of-way for drainage. The County does not purchase right-of-way for drainage thus this project will not be scored in the matrix evaluation.

Scale		Population Density Affected		Degree of Flooding		Water Quality Benefits		Cost		Acceptability/ Permitability	
Watshd		Low	X	Safety Issue		High	X	LT 100k		Good	
Sub-watshd		Medium		Obstr. Travel	X	Medium		100-400K		Average	
Local	X	High		Nuisance		Low		GT 400k	X	Poor	X



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 22through28.apr

Sisco Road Problem Area
Putnam County Master Stormwater Plan

Figure
7.2-27

AYRES ASSOCIATES

Photo 27.1: Looking west at typical section

Photo 27.2: Looking south at surrounding lands, ROW limits and existing roadside swale.

7.2.28 FOXWOOD OUTFALL

Because the County has recently completed construction of a solution to this problem, it was not investigated.

7.3 PRIORITY RANKING

Identified problem areas in the County were prioritized for this CIP by ranking based on factors such as:

- Population density affected
- Degree of flooding
- Water quality benefits
- Cost
- Public Acceptance
- Permitability (potential to be issued an Environmental Resource Permit)

The ranking basis was divided into the following defined categories: maintainability, flood impacts, public benefit, water quality impact, cost, and permitability/constructability. Each of these categories had an assigned point range, where higher point values are associated with a more favorable status.

However, not all the project categories under consideration were considered of equal importance. For instance, water quality benefits may not be valued as highly as eliminating flooding on an evacuation route. Therefore, weighting factors were also assigned to each category. A summary of the point scales and weighting factors for each category is presented below.

Category	Weighting Factor	Point Scale
Manage w/ Continued Maintenance	1	(1-2)
Impacts from Flooding	2	(1-7)
Public Benefit	1	(1-3)
Impacts on Water Quality	1	(1-3)
Estimated Cost	2	(1-3)
Permitability / Constructability	0.5	(1-3)

To the greatest extent possible, data gathered in the field, GIS land use coverages, Department of Transportation (DOT) costs, and professional judgment were used to assign the appropriate number of points to each category. The ranking equation is presented below:

$$\frac{MG + Flood\ Imp \times 2 + PB + WQ\ Imp + Cost \times 2 + P/C \times 0.5}{7.5}$$

where

MG = Manage w/ Continued Maintenance: Cannot be [2]; Can be [1]

Flood Imp = Flood Impact in Priority Order:
public safety [7]; structural flooding [6]; evacuation route [5]; collector road [4]; local / neighborhood road [3]; low density neighborhood [2]; nuisance yard flooding [1]

PB = Public Benefit: High [3]; Average [2]; Low [1]

WQ Imp = Water Quality Benefits in Priority Order:
pond [3]; other minor attenuation (ditch etc.) [2]; no pond/direct runoff [1]

Cost = Cost < $0.1 million [4]; $0.1 million < Cost ≤ $0.4 Million [3];
$0.4 million < Cost ≤ $1.0 Million [2]; Cost > $1.0 million [1]

P/C = Permitability/Constructability: Good [3]; Moderate [2]; Poor [1]

The ranking system is neither purely objective nor purely analytical; rather it is a screening and decision making tool to assist managers in organizing a diverse range of projects with differing levels and types of merit and liabilities. It is a flexible way to prioritize practical constraints (fiscal/political etc.).

The original assessment produced a list of 15 top-ranked projects. These projects were selected for analysis of specific potential stormwater strategies to alleviate the local flooding/sedimentation issues. Prior to finalization of this report, but subsequent to field review and engineering analyses, two areas (Saratoga Harbor and Mondex) were re-ranked. As such, the subsequent discussion of stormwater strategies in Section 7.4 will include those projects **Table 7.3-1** presents the final project ranking.

TABLE 7.3-1 15 TOP-RANKED PROJECTS FOR PUTNAM COUNTY

Rank	Project	Planning Unit Subwatershed
1	Devall Branch	South Mainstem Devall Branch, Davis Lake Outlet
2	Twomile (Duval) Creek	South Mainstem Twomile (Duval) Creek
3	Palmetto Bluff	South Mainstem Cedar Creek
4	Millican Road	South Mainstem Cedar Creek, Mason Branch
5	River Park Subdivision	Lake George St Johns River-River Park
6	Mud Lake/Monroe Creek	South Mainstem Mudlake Outlet
7	Orange Springs Shortcut	Orange Creek Little Orange Creek
8	Hasting's Drainage District (Rector Road)	South Mainstem West Run Interceptor D
9	East Palatka Drainage District (SR 207)	South Mainstem Mill Branch, Dog Branch
10	Whispering Pines	Lake George Tiger Branch and St Johns River
11	County Road 315 at 64th Street	Rodman Reservoir Gum Creek
12	Florahome Drainage	Etonia Creek Beecher Run, Blocker Lake Outlet, Clearwater Lake Outlet, Etonia Creek, Falling Branch, etc.[1]
13	East River Road (at Camp Road)	South Mainstem Cow Branch
14	County Road 309	Lake George St Johns River
15	County Road 308B - Welaka	Lake George St Johns River

[1] Lake Grandin Outlet, Lake Suggs Outlet, Long Pond Outlet, Oldtown Branch, Palmetto Branch, Rice Creek, Simms Creek, Unnamed Branch-1,2 and 3, Unnamed Drain 1,5 and 6, Unnamed Run 1 and 2.

7.4 POTENTIAL STORMWATER STRATEGIES

Many of the sites presented above in Table 7.3-1 did not have adequate information available to develop an engineering design. However, the available information was utilized along with engineering judgment to develop conceptual projects and make cost estimates. The following subsections present the potential stormwater strategies developed for 15 projects.

7.4.1 DEVALL BRANCH (RANK NO. 1)

Location and General Description

The Devall Branch Watershed lies in the central portion of the County, approximately two miles southwest of the City of Palatka. It is approximately 1,050 acres (1.64 mi^2), and has mixed land uses including agricultural, single family residential, improved open space and undeveloped area. The watershed basin boundary, as delineated by the USGS, is shown over a digital orthographic quad in **Figure 7.4.1-1**. Howard, Needles, Tammen and Bergendorff (HNTB), conducted a watershed study of Devall Branch in 1988, and the basin delineation illustrated in the final report is captioned in **Figure 7.4.1-2**. The HNTB delineation is on a USGS quadrangle. Although the USGS and HNTB are based on the same 5-foot contours, they vary slightly from the USGS delineation, but the differences do not precipitate any fundamental differences. Additionally, the HNTB report provides other detailed information, and will be discussed at some length.

In all, HNTB found seven subbasins within the watershed. The watershed begins at Davis Lake approximately one half mile north of SR 19 and runs almost due south for approximately three miles to its confluence with the St. Johns River. The creek is relatively steep, ranging in elevation from 60 feet NGVD at Davis Lake to 5 feet NGVD at the St. Johns River. Over its two-mile distance, the slope is relatively steep (0.005 or 0.5%), and is thus a fairly transient system. Structures in the creek consist of four road crossings and one railroad crossing.

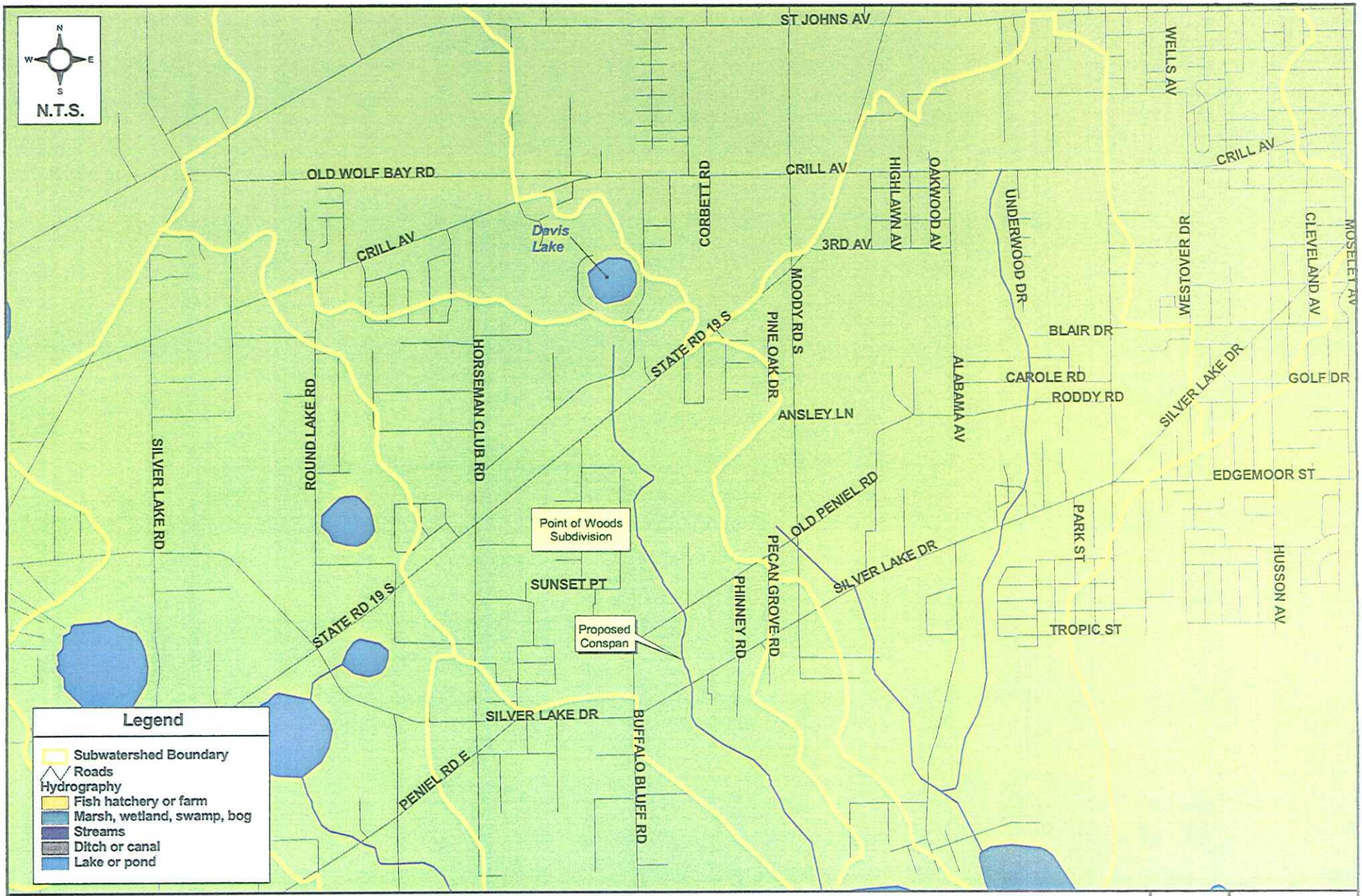
There are specific problems throughout the watershed including flooding at Davis Lake and Point of Woods Subdivision and structural failure of a CMP crossing at Silver Lake Drive. The County is also concerned about an increase in velocities and erosion as the basin develops. During field visits, the main channel was observed to be choked with vegetation, up- and downstream at the Old Peniel Drive and Silver Lake Drive Crossings. The County does not have easements or ROW over the creek to perform maintenance.

Along with the personal computer, the evolution of hydrologic and hydraulic modeling software has advanced in quantum leaps since 1988, thus the HNTB study is outdated in many respects. For example, most H & H studies today are based on 1-foot contour topographic mapping, and thus have far greater detail. Coincidently however, the topographic relief in Devall Branch is uncharacteristically steep, thus the seven individual sub-basins could be delineated from the 5-foot USGS contours, providing enough detail for a reasonable estimation of peak flows in creek. Combined with the "tried and true" step-backwater method for determining peak water surface elevations, the HNTB study provides more information than the other 14 CIP projects being evaluated.

Silver Lake Drive Crossing

The structural integrity of the CMP is compromised at the Silver Lake Drive crossing and imposes a safety issue. The County has expressed a sense of urgency about a suitable replacement for the CMP thus a preliminary estimate of a Conspan crossing has been developed. Conspan is a trademark name and there are other manufacturers that supply the same configurations and shapes. Like many other products, the patent name Conspan has become synonymous with the shape of the conduit.

With the peak flows from the HNTB study, a simple HEC-RAS step-backwater model was used to develop an approximate Conspan pipe size to replace the CMP at the Silver Lake Drive Crossing. The graphical user interface in HEC-RAS provides representations of the culvert, shown in **Figure 7.4.1-3**.



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 8 through14.apr

Devall Branch Location Map
Putnam County Master Stormwater Plan

Figure 7.4.1-1

AYRES ASSOCIATES

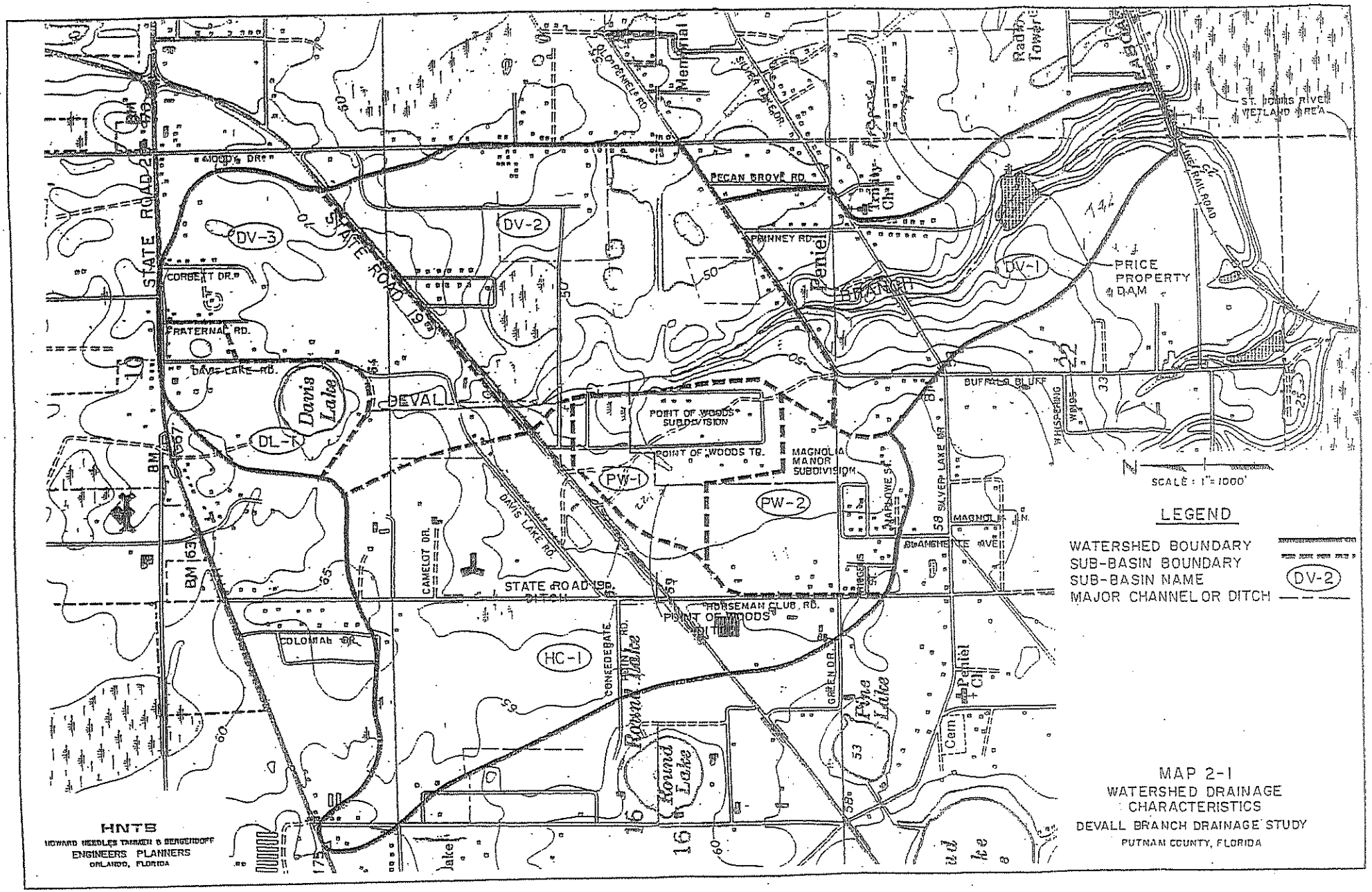

DV-3
DV-2
DV-1
DL-1
PW-1
PW-2
HC-1
STATE ROAD 19
DEVALL BRANCH
Davis Lake
Round Lake
Pine Lake
Peniel
PECAN GROVE RD.
PINNEY RD.
CORBETT DR.
FRATERNAL RD.
DAVIS LAKE RD.
STATE ROAD 19A
HORSEMAN CLUB RD.
COLONIAL DR.
CAMELOT DR.
POINT OF WOODS SUBDIVISION
POINT OF WOODS TR.
MAGNOLIA MANOR SUBDIVISION
BUFFALO BLUFF
PRICE PROPERTY DAM
ST. JOHNS RIVER WETLAND AREA
SCALE : 1"=1000'
LEGEND
WATERSHED BOUNDARY
SUB-BASIN BOUNDARY
SUB-BASIN NAME
MAJOR CHANNEL OR DITCH
HNTB
HOWARD NEEDLES TAMMEN & BERGENDOFF
ENGINEERS PLANNERS
ORLANDO, FLORIDA
MAP 2-1
WATERSHED DRAINAGE CHARACTERISTICS
DEVALL BRANCH DRAINAGE STUDY
PUTNAM COUNTY, FLORIDA

Figure 7.4.1-2

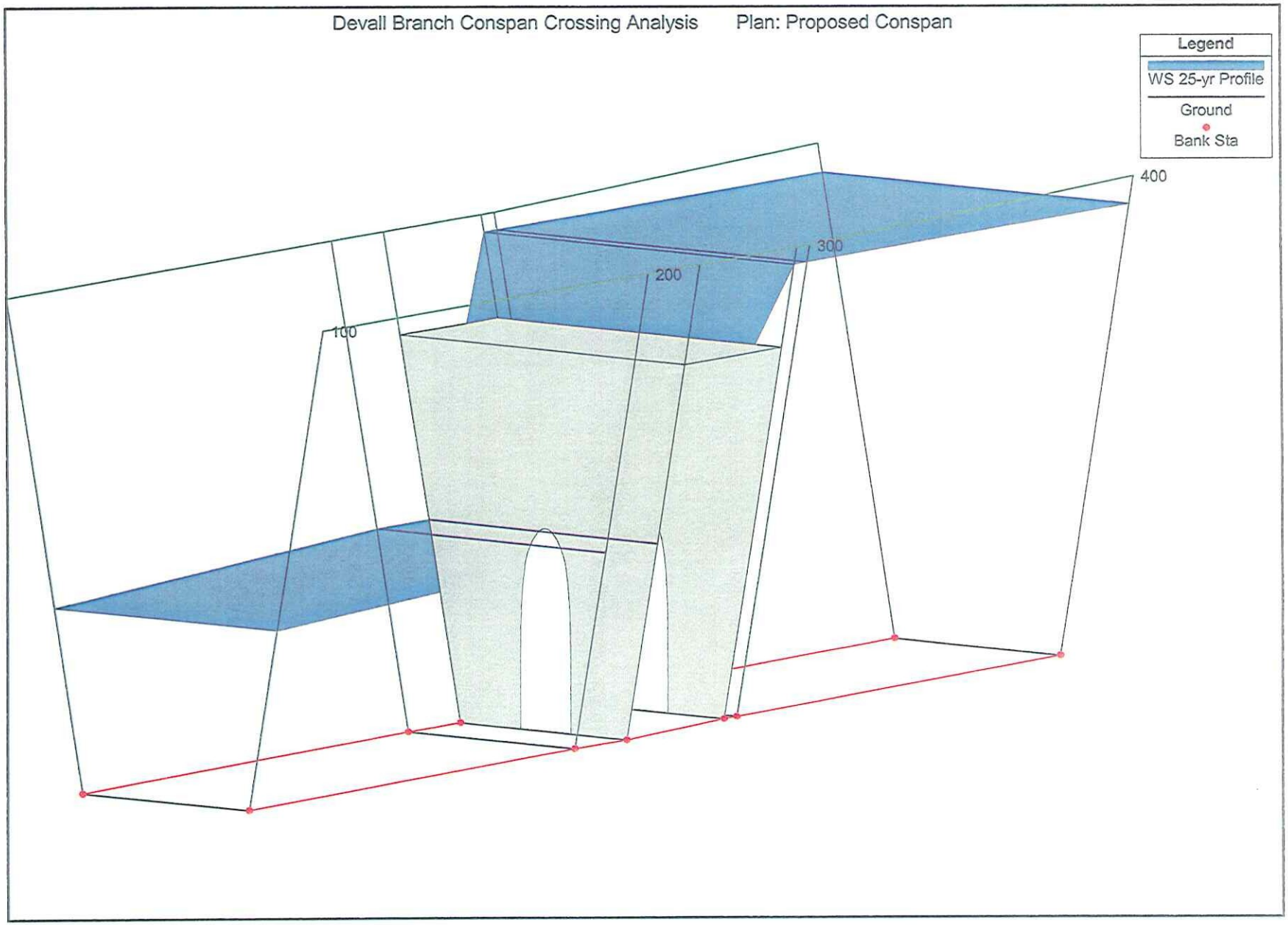
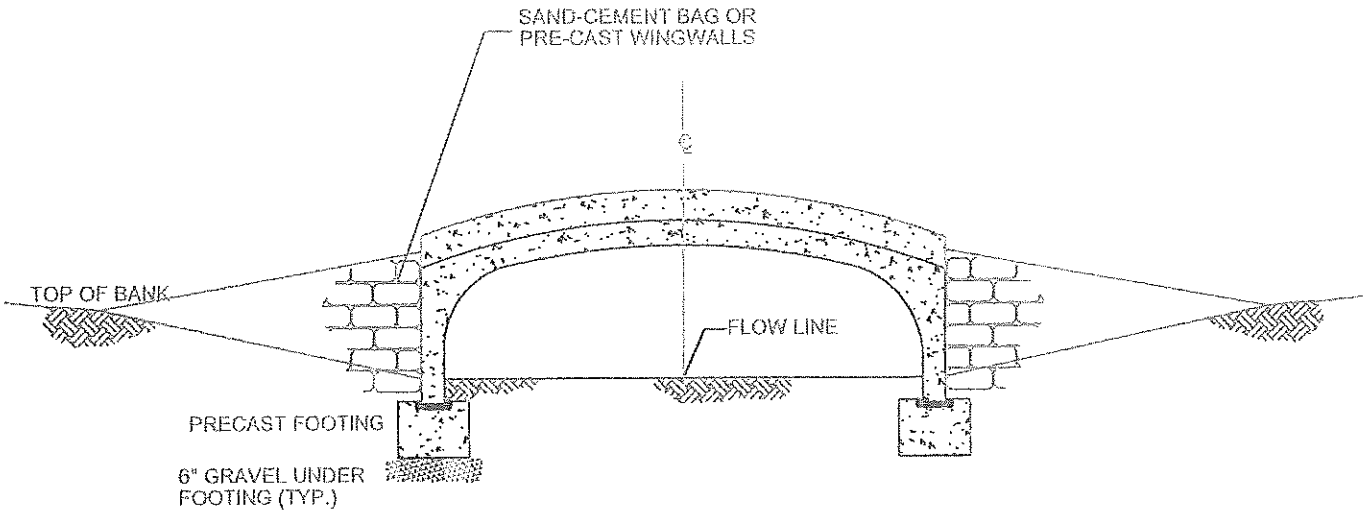
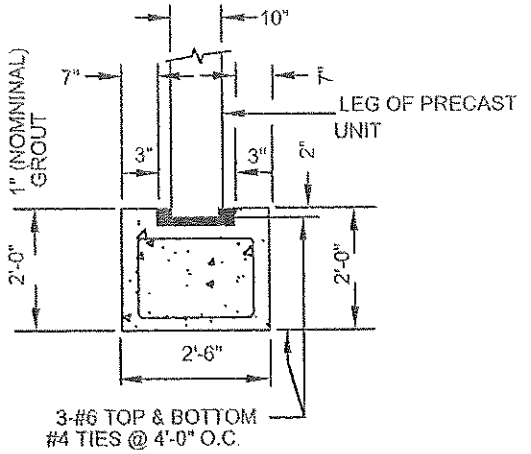
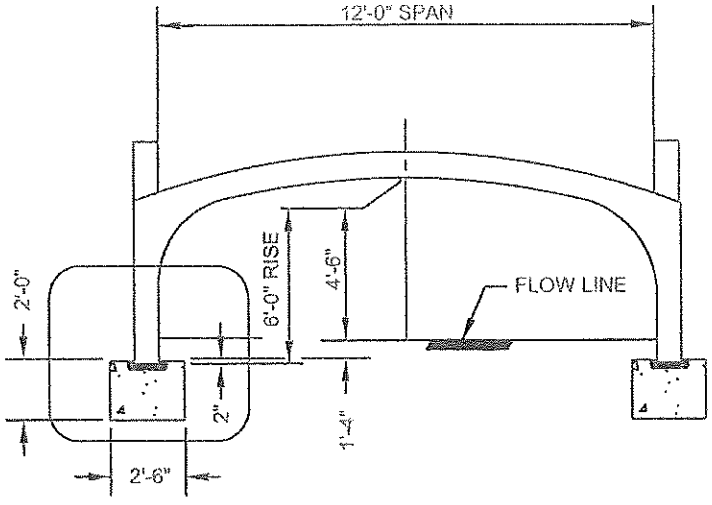

Devall Branch Conspan Crossing Analysis
Plan: Proposed Conspan
Legend
WS 25-yr Profile
Ground
Bank Sta
400
300
200
100

Figure 7.4.1-3



CULVERT SECTION





CULVERT SPAN DETAILS

J:\08\PUTNUMCOS\WIP\2\CTR\DEVALLBRANCH\CONSPAN.DWG

The surveyed up- and downstream cross-sections from the model were not available; therefore, HEC-RAS does not contain ineffective flow areas and other parameters necessary for final design of the Conspan. On a relative scale however, estimating the water levels with the existing culvert and matching them with the Conspan is adequate for this evaluation.

An existing conditions model was developed using a culvert size, tail water and flow rate from information from the HNTB report. Different size Conspan's were then tested in the model until upstream elevations were close to matching the elevations computed with the CMP arch pipe. The output from the HEC-RAS model is with the existing Arch Pipe and a 12' x 6' Conspan is provided in Table 7.4.1-1. **Figure 7.4.1-4** shows a drawing of the Conspan.

TABLE 7.4.1-1 HEC-RAS OUTPUT: DEVALL BRANCH

Plan: Arch Pipes Profile: 25-yr Profile							
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)
Devall Branch	400	25-yr Profile	1037	0.3	10.96		11
Devall Branch	300	25-yr Profile	1037	0.2	10.93	2.82	10.97
Devall Branch	250		Culvert				
Devall Branch	200	25-yr Profile	1037	0.1	5.04		5.32
Devall Branch	100	25-yr Profile	1037	0	4.5	2.63	4.85
Plan: Conspan							
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)
Devall Branch	400	25-yr Profile	1037	0.3	10.89		10.94
Devall Branch	300	25-yr Profile	1037	0.2	10.86	2.88	10.92
Devall Branch	250		Culvert				
Devall Branch	200	25-yr Profile	1037	0.1	5.03		5.38
Devall Branch	100	25-yr Profile	1037	0	4.5	2.69	4.92

A more detailed hydraulic analysis with stream cross-sections, to match the existing WSE of the CMP, will be required for final sizing of the Conspan. However, there are no other hydraulic criteria requirements and this analysis provides a "ballpark" estimate. The estimate of the cost to replace the CMP is shown below.

Cost of Pre-cast Concrete Arch (12 foot span)

Item	Cost
Arches	$12,800
Footers	$1800
Headwalls	$3,250
Wingwalls	$10,00[est]
Construction	$26,725
Total Cost	$44,625

Point of Woods Subdivision

The Point of Woods Subdivision is shown on **Figure 7.4.1-2**. Flooding problems at this location were mentioned in the HNTB report, but no specifics were given regarding number of structures, yards, or streets. Numerous yards and two homes were flooded during the hurricanes in 2004. The HNTB report recommends channelization, regrading, and reshaping of the Point of Woods ditch to a hardened trapezoid. From a hydraulics point of view, the solution may be effective. However, the current Water Management District rules and general philosophy of the agency, as compared to 1988, would discourage or not permit hardening of the channel bottom. In addition, SJRWMD requires evidence of no impacts (increase in WSE) downstream. Step-backwater simulations do not provide this information, as they only compute water surface elevations in any respective upstream reach with respect to flow and the immediate downstream WSE.

Davis Lake

Davis Lake is the site of residential flooding at two locations. Davis Lake discharges through a 24-inch PVC culvert under Lakeshore Drive, and eventually to a dredged trapezoidal shaped creek.

Davis Lake was neglected in the HNTB analysis on the basis that by the time Davis Lake began to discharge, the peaks in the watershed area south would have passed, making it unnecessary to consider it. The assumption was probably valid for a step-backwater analysis. However, given the high density of vegetation in the channel (and the resulting attenuation), a dynamic simulation based on time varying runoff hydrographs and routing with the full momentum and continuity may show that Davis Lake contributes to the peak WSE in all or parts of the Devall Branch conveyance system.

Due to lack of topographic and survey data, it is not possible to estimate a solution within the scope of this analysis. Any meaningful preliminary engineering would require development of a watershed model and a detailed evaluation of the effects of changing the outlet of the lake, on the lake hydroperiod.

Recommendations

Devall Branch and the Point of Woods drainage ditch are overrun with vegetation. Acquisition of the necessary easements/ROW to perform immediate maintenance and remove the vegetation in the creek is highly recommended as a first step to holistically address all of the issues in Devall Branch. Routine maintenance is permitted under an exemption from SJRWMD and consists of cutting back exotics, removal of stumps, fallen limbs, and dead or fallen trees. At a minimum, if the main conveyance of Devall Branch is maintained, it will greatly reduce the flood potential of the creek and may eliminate the Point of Woods problem all together.

A Conspan replacement at Silver Lake Drive is also recommended to address the safety concerns. The cost for a Conspan is provided in the previous table.

Temporary load testing to determine if replacement can be delayed however, is recommended. If based on load testing or a certified inspection the replacement can be delayed, an alternative to performing the above two recommendations piecemeal, is to fund a cursory hydrologic and hydraulic investigation of the watershed. A cursory investigation would consist of a spot check of the 1988 cross-sections for applicability, some additional survey, some refinements to the basin delineations, and potentially, depending the scope of the required improvements to the outlet, development of a simple integrated model to evaluate Davis Lake. Reasons why an integrated model may be required are given in discussion in Section 7.4.5.

Results from a cursory analysis will allow a comprehensive assessment of improvements to the Davis Lake outfall, and if immediate maintenance can achieve the desired level of protection in Point of Woods. A substantial advantage also lies in the opportunity to forecast flow at the Silver Lake Crossing before it is replaced. If structural improvements to improve conveyance in the upper reaches of the creek are necessary, the increased flow would have to be accommodated for all the way downstream to Devall Branch's confluence with the St. Johns River. Thus, if the existing arch pipe is not replaced immediately, a sufficiently large Conspan can be selected to accommodate increased flows caused by potential structural improvements that may be recommended to address Point of Woods and Davis Lake.

An opinion of costs and a schedule for a detailed study is given below. Accordingly, acquisition of the necessary easements and right-of-ways to perform maintenance is recommended. Concurrently, an update of the HNTB model (assuming the old model input can be found) should begin to determine if maintenance will resolve the flooding problems or at a minimum, provide an acceptable level of service. New channel cross-sections will be required if not. Development of structural solutions may be desirable if an updated model shows necessity.

Silver Lake Drive Conspan

Assuming the cross-section information can be obtained from HNTB and the stream has not changed considerably, an alternative is to fund a cursory hydrologic and hydraulic investigation of the creek. A cursory investigation would consist of a spot check of the 1988 cross-sections for applicability and some refinements to the basin delineations to provide more resolution to the aerial and temporal distribution of runoff, and dynamic routing of the runoff through the system. Results from a cursory analysis will determine if the width dimension alone can sufficiently increase capacity of the Davis Lake outfall, if immediate maintenance can achieve the desired level of protection, and what alternatives are available for Point of Woods.

If the results from a cursory investigation are inadequate, a detailed study will be necessary. A detailed analysis will require 1-foot contour topographic mapping. A detailed study of Davis Lake using and integrated model may also be required. An opinion of costs and a schedule for a detailed study is given in **Table 7.4.1-2**.

Table 7.4.1-2 Devall Branch Summary of Activities, Timeline, and Budget

Task	Schedule (Months)	Opinion of Cost
Topographic Mapping, bathymetry, and channel cross-sections[1]	4	$20,000
Data collection	6	$16,406
Model development and calibration	9	$9,840
Integrated model and conceptual design and public involvement	12	$20,000[2]
Final site survey, design and permitting	15	$75,000
Total (Consulting and topographic survey total) & project closeout	18	$141,246
Acquire easements/ROW and construct	TBD	TBD

1 - May not be required depending on HNTB report data

2- $15,000 for integrated may not be required

7.4.2 TWOMILE (DUVAL) CREEK (RANK NO. 2)

Location and General Description

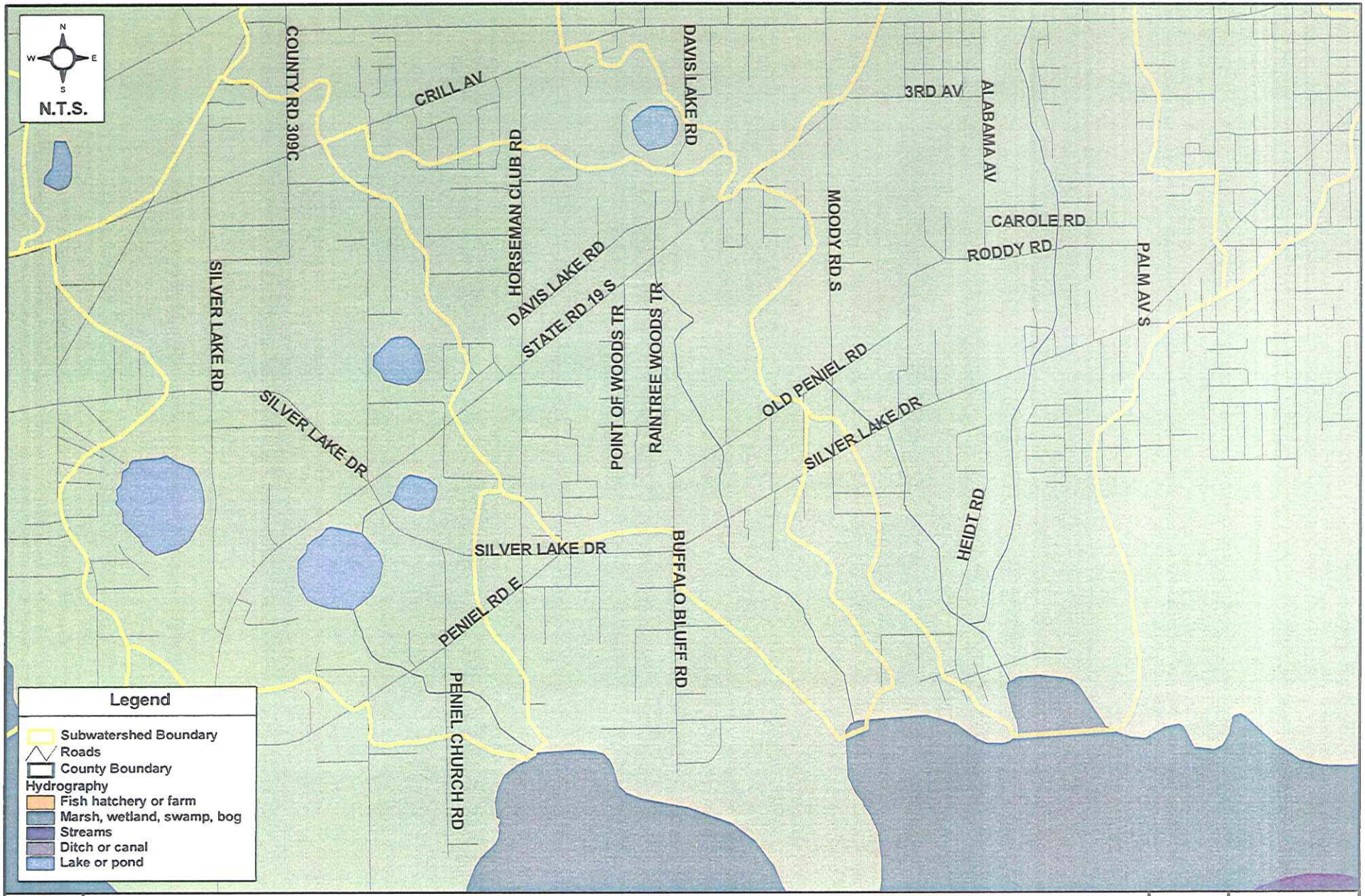
Twomile Creek is shown in Figure 7.4.2-1. It is an urbanized watershed within the City of Palatka that begins just north of SR 20, and runs almost due south for approximately two miles to its confluence with the St. Johns River. The creek is relatively steep ranging in elevation from 55 feet NGVD at SR 20 to five feet NGVD at the St. Johns River. The slope of the creek over its distance of slightly more than two miles is 0.44%.

There are six roadway and one railroad crossings of the creek. Two within the City have been recently upgraded with 60-inch diameter HDPE culverts with mitered end sections. The most downstream crossing is poorly maintained and requires repair. Grades from the surrounding watershed sloping toward the creek are noticeably steep thus it is a characteristically "flashy" system.

Problem Description

There are no instances of flooding in the creek or surrounding watershed. Concerns in the Twomile Creek watershed consist of trends in erosion in the creek bed most notably between Carole Road and CR 310. The bottom width of the creek once ranged from two to three feet, compared to the existing 8 to 12-foot bottom widths.

No sediment deposits were evident upstream or downstream of the culvert crossing at Carole or Roddy Road. Maintenance noted the need to acquire easements over the creek beginning approximately 300 feet south of the Roddy Road crossing and continuing to CR 310. Within this reach of the creek, significant vegetation growth was noted as compared to the reach upstream of Carole Road.



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 8 through14.apr

Twomile Creek - Location Map
Putnam County Master Stormwater Plan

Figure
7.4.2-1

AVRES ASSOCIATES

7.4.3 PALMETTO BLUFF ROAD (RANK NO. 3)

Location and General Description

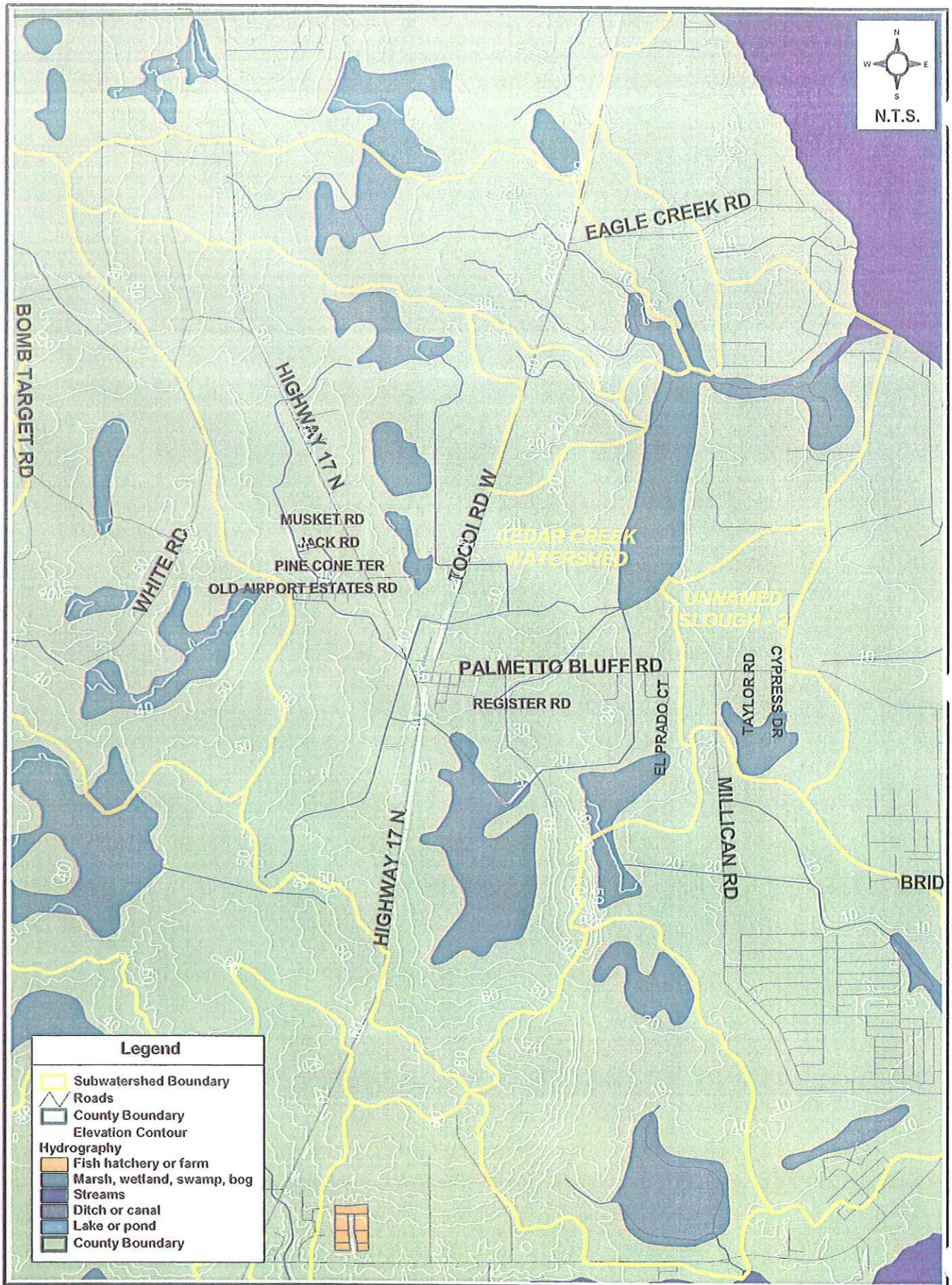
Palmetto Bluff Road is the main access road for the Cedar Creek community, a densely populated residential area on the St. Johns River. The road and the drainage basins are shown in **Figure 7.4.3-1**. Palmetto Bluff Road is a hydraulic divide in the subwatershed with four box culverts that carry flow to a slough system between the Palmetto Bluff Road to the south and the St. Johns River to the north. These four culverts are located between the intersections of Palmetto Bluff Road and Millican Road to the east and the intersection of Palmetto Bluff Road and U.S. Highway 17 to the west.

Palmetto Bluff Road floods in three locations between its intersection with Millican Road and the town of Bostwick. The flooding occurs three to four times per year with typical weather patterns, but more often if tropical storms/hurricanes occur. The contributing basin area is 15.1 mi^2, with land uses mixed between agriculture, monoculture, and individual residential.

The Millican Road intersection floods to a depth of approximately 6 inches. Photo 7.4.3-1 shows the intersection.

Photo 7.4.3-1. Palmetto Bluff & Millican Road intersection - up to 6-inch depth of flooding

The flooding occurs when the capacity of the culvert under Millican Road (parallel to Palmetto Bluff Road) is exceeded. Flow overtops Millican and continues east toward a north-south drainage canal but also floods the intersection. Flooding in the intersection extends to both edges of pavement on Palmetto Bluff Road. The County recently upsized the culvert when the flow east across Millican cut through the limerock base and severed access to the intersection by northbound traffic onto Palmetto Bluff and southbound traffic onto Millican Road. Downstream or east of Millican Road, flow is in the roadside ditch, to a 5' x 8' RCBC cross-drain. The cross drain is at a ninety degree bend to the roadside ditch approximately 360' east. The cross-drain flows to a ditch that flows northwest then north to the St. Johns River.



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 8 through14.apr

Palmetto Bluff Road - General Location and Cedar Creek Watershed Boundary
Putnam County Master Stormwater Plan

Figure 7.4.3-1

AYRES ASSOCIATES

The second location is approximately 3,000 feet west of the Palmetto Bluff/Millican Road intersection. The canals are five to six feet deep and 12 to 13 feet wide. Photo 7.4.3-2 shows the first unmaintained canal downstream of Palmetto Bluff Road. The culverts are standard 5' x 8' concrete boxes.

Photo 7.4.3-2.
Unmaintained canal

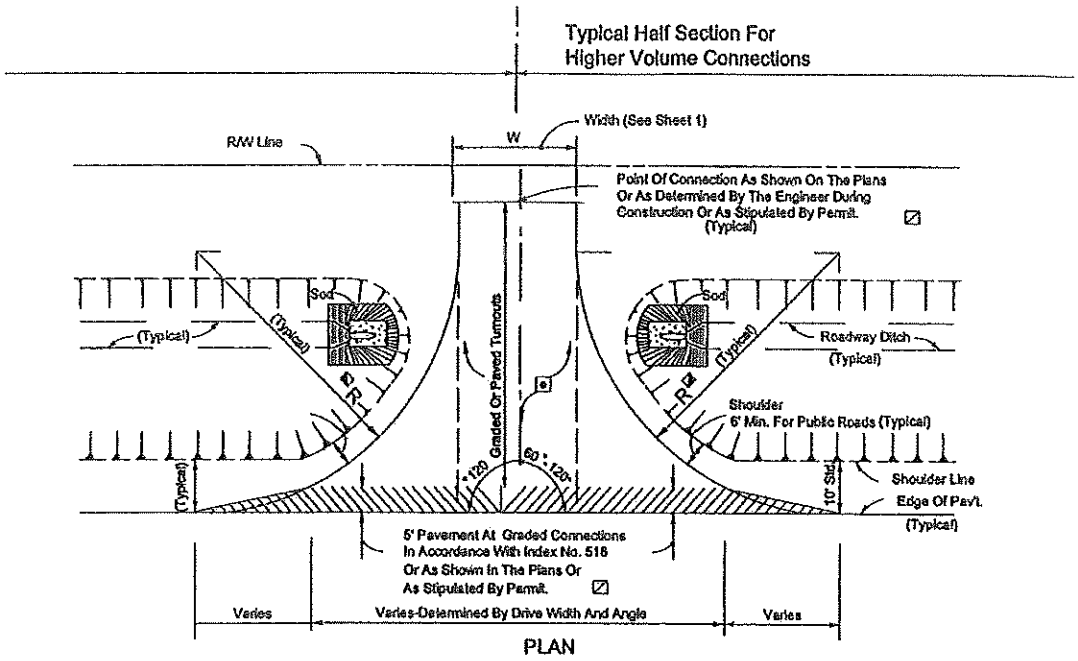
The third location is approximately 6,000 feet West of the Palmetto Bluff Road and Millican Road intersection. Like the crossing 3,000 feet to the east, it appears to be a standard 5' x 8' RCBC, and the approach and exit channels are approximately 12 feet wide.

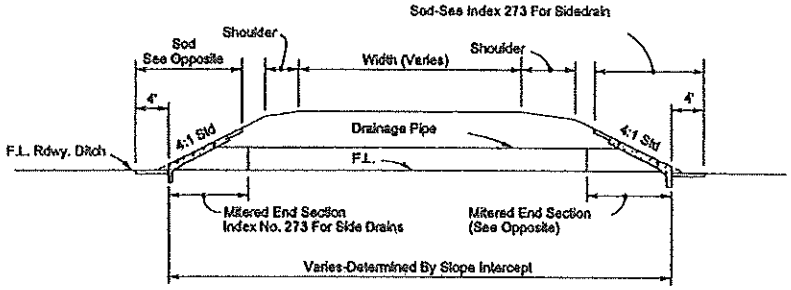
CIP Evaluation and Cost Estimate

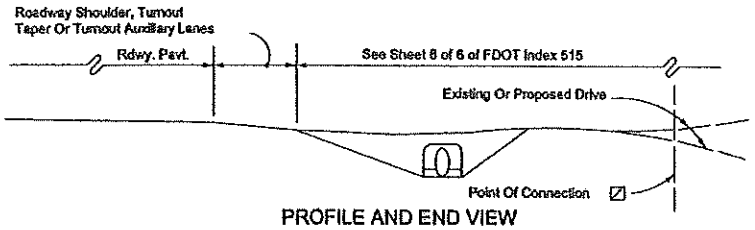
To address future erosion of Millican Road at the turnout onto Palmetto Bluff Road, an asphalt apron should be carried back a minimum of 100 feet south down Millican Road. The apron will not decrease flooding; its function is to harden the surface of Millican Road above the culvert, so that future overtopping does not cut through the road and create a safety hazard or prevent access. **Figure 7.4.3-2** is a typical rural turnout and provides a guideline for final design. A cost estimate to pave the turnout and eliminate the flooding is provided in **Table 7.4.3-1**. The estimate includes end treatments of the side drain under Millican Road.

TABLE 7.4.3-1 COST ESTIMATE FOR PALMETTO BLUFF ROAD/MILLICAN ROAD INTERSECTION

Index No.	Pay Item Description	Units	Quantity	Cost Per Unit	Total Cost
104-10-1	Hay or Straw Bale (18" x 18" x 36")	EA	2.00	$6.00	$12.00
104-13	Staked Silt Fence	LF	200.00	$1.50	$300
285-701	Asphalt (Optional Group 1)	SY	266.00	$7.61	$2,024
430-984-129	Mitered End Section (Conc. Pipe Round) (30" SD)	EA	2.00	$752.00	$1,504
575-1-1	Sodding (Bahia)	SY	100.00	$1.19	$119
285-703	Optional Base 3	SY	266	$5.90	$1569
Total					$5,528







☆ Drainage pipe size and length shall be that shown on the plans, or as stipulated by permit, or, as determined by the Engineer during construction. The size shall be at least that established by the FDOT District, but not less than 15" diameter or equivalent. For minimum cover over drainage pipe see Index No. 205. Pipe arch or elliptical pipe may be required to obtain necessary cover. At minimal cover applications a modified pavement apron is permitted. See 'PERMISSIBLE PAVEMENT MODIFICATION' Index No. 273. For spacing between adjacent pipe end treatments see Index No. 273.

[6] Stable material may be required for graded turnouts to private property as directed by the Engineer in accordance with Section 102-6 of the Standard Specifications.

[5] The 5' pavement at graded connections is not required where there is paved shoulder 4' or more in width. The 5' pavement requirement may be waived for connections serving one or two homes or field entrances with less than 20 trips per day, or 5 trips per hour as approved by permit or by the Engineer, or when not itemized in the plans.

Paved turnouts are to be constructed for all paved connecting facilities. The connecting point will be determined by the Engineer.

[4] See "Summary Of Geometric Requirements For Turnouts" chart for return radii lengths and supplemental information.

RURAL TURNOUT CONSTRUCTION

J:\PUTNAM\CIDS\WMP\CIPS\PALMETTOBLUFF\RDX\TURNOUT_DRAWING.DWG
G:\COUNTY - PU

Due to the absence of contour and/or survey data, it is not possible to develop definitive solutions for the remaining two crossings to the west. Referring again to **Figure 7.4.3-1** that includes the USGS 10-foot contour interval topography, essentially there are only two contours in the drainage basin, for elevations 10 and 20 feet. Without contour information to develop drainage basins or runoff parameters and storage characteristics for a hydrologic and hydraulic modeling analysis, it is impractical to formulate any meaningful structural recommendations (e.g. larger capacity culverts) to address overtopping on Palmetto Bluff Road.

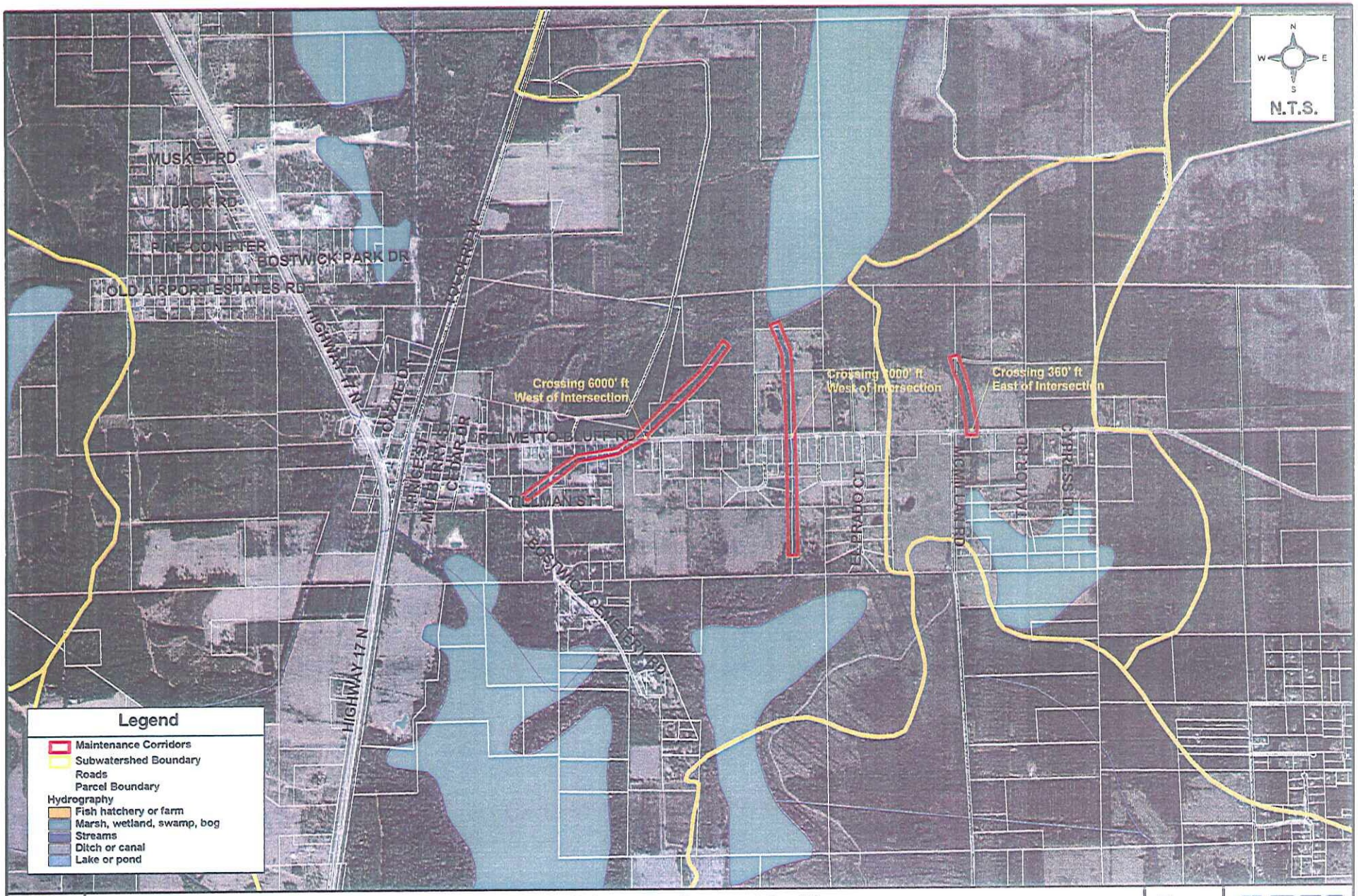
For different reasons, reliable recommendations for non-structural solutions are equally formidable as structural solutions. Generally, non-structural solutions are limited to removal of nuisance vegetation in the main channel and overbanks. If implemented, the result will be lower peak water surface elevations for the higher frequency storm events at all of the channel/culvert systems crossing Palmetto Bluff Road.

Non-structural improvements will require acquisition of easements over the drainage systems. **Figure 7.4.3-3** shows the approximate easements necessary to maintain the drainage systems. They run from the upstream sides where the channels form from wetlands to the downstream sides where the channels transition into sloughs that drain to the St. Johns River.

Tables 7.4.3-2 through **7.4.3-4** provide a list of owners and the assessed value of the land. These data are provided for the purpose of indicating how many owners would have to donate/sell easements to make routine maintenance possible. The costs provided in the tables should not be construed as the actual costs to purchase the land. These data are available and thus included, but actual costs will vary depending on a number of variables including County policies.

TABLE 7.4.3-2 LIST OF OWNERS / ASSESSED VALUE 360 FT MILLICAN

PARCEL NUMBER	T-R-S	LANDVALUE/ACRE
6428-08-27-0000-0030-0020	082728	$1,973.84
6428-08-27-0000-0030-0030	082728	$2,442.69
6428-08-27-0000-0030-0050	082728	$2,393.92
6428-08-27-0000-0030-0051	082728	$2,804.27
6428-08-27-0000-0030-0052	082728	$416.67
6428-08-27-0000-0050-0050	082728	$4,255.32
6428-08-27-0000-0050-0060	082728	$4,031.83



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 8 through14.apr

Palmetto Bluff Road - Maintenance Easement Corridors

Putnam County Master Stormwater Plan

Figure 7.4.3-3

AYRES ASSOCIATES

TABLE 7.4.3-3 LIST OF OWNERS / ASSESSED VALUE 3000 FT CROSSING

PARCEL NUMBER	T-R-S	LANDVALUE/ACRE
6429-08-27-0000-0010-0000	082729	$4,013.49
6429-08-27-0000-0010-0010	082729	$1,327.78
6429-08-27-0000-0010-0020	082729	$3,995.33
6429-08-27-0000-0010-0030	082729	$2,458.25
6429-08-27-0000-0070-0030	082729	$2,477.29
6429-08-27-0000-0080-0000	082729	$2,329.51
6429-08-27-0740-0000-0090	082729	$2,776.86
6429-08-27-0740-0000-0100	082729	$4,542.02
6429-08-27-0740-0000-0110	082729	$4,700.00
6429-08-27-0740-0000-0140	082729	$4,510.10
6429-08-27-0740-0000-0150	082729	$4,700.00
6429-08-27-0740-0000-0180	082729	$4,536.68
6429-08-27-0740-0000-0190	082729	$4,625.98
6429-08-27-0740-0000-0200	082729	$4,677.73

TABLE 7.4.3-4 LIST OF OWNERS / ASSESSED VALUE 6000 FT CROSSING

PARCEL NUMBER	T-R-S	LANDVALUE/ACRE
6428-08-27-0000-0030-0020	082728	$1,973.84
6428-08-27-0000-0030-0030	082728	$2,442.69
6428-08-27-0000-0030-0050	082728	$2,393.92
6428-08-27-0000-0030-0051	082728	$2,804.27
6428-08-27-0000-0030-0052	082728	$416.67
6428-08-27-0000-0050-0050	082728	$4,255.32
6428-08-27-0000-0050-0060	082728	$4,031.83

Recommendations

Though the County has tentative plans to pave Millican Road, it is recommended to proceed with paving 100 feet of Millican Road and constructing mitered end sections for the cross-drain the Palmetto Bluff Road/Millican Road intersection.

To address repetitive flooding over Palmetto Bluff Road, it is not possible to make recommendations, structural, non-structural or both, without a watershed modeling analysis. Any potential solution, structural or non-structural, must be tested using a watershed model that accounts for tailwater form the St. Johns River, vegetation in the channels, etc.

Based on a 21 square mile drainage area for Cedar Creek, a cost estimate and timetable for a modeling analysis, including 1-foot contour interval mapping is provided in **Table 7.4.3-5**.

TABLE 7.4.3-5 COST ESTIMATE AND TIMETABLE FOR A MODELING ANALYSIS

Task	Schedule (months)	Cost
Topographic mapping (1-foot Contour Interval)	6	$30,200
Cross-section and bridge/culvert surveys	6	$15,000
Watershed Data Collection	12	$97,500
Watershed Modeling/100-year Floodplain Determination	18	$52,500
Preliminary Engineering/Conceptual Design/ERP pre-application	24	$10,000
Site Survey/Final Design	38	$20,000
ERP Permitting	42	$5,000
Total (Watershed Analysis and Final Design)		$230,200
Construction	TBD	TBD
Easement Acquisition	TBD	TBD

7.4.4 MILLICAN ROAD (RANK NO. 4)

Location and General Description

From east to west, Millican Road begins at its intersection with West River Road and runs west for approximately one mile before slowly turning north for three miles until its intersection with Palmetto Bluff Road. A general location map is shown in **Figure 7.4.4-1**. Millican Road is two lanes and is generally at or below grade of the dirt shoulder and surrounding lands. It passes through hammocks, swampy areas, and planted pines. The pines in the northern end of the road are well above the road grade. Roadside drainage does not exist in some areas, and varies between small swales to relatively well-maintained ditches, beginning approximately 1½ miles from its intersection with Palmetto Bluff Road. The locations where Millican Road floods are shown on the location map **Figure 7.4.4-1**. Beginning one half mile south of its intersection with Palmetto Bluff Road, then south for approximately one half mile. Flooding is approximately one foot deep. Millican Road also floods in various locations between SW 6th Terrace and NW 2nd Avenue. These two streets are shown on the location map also.

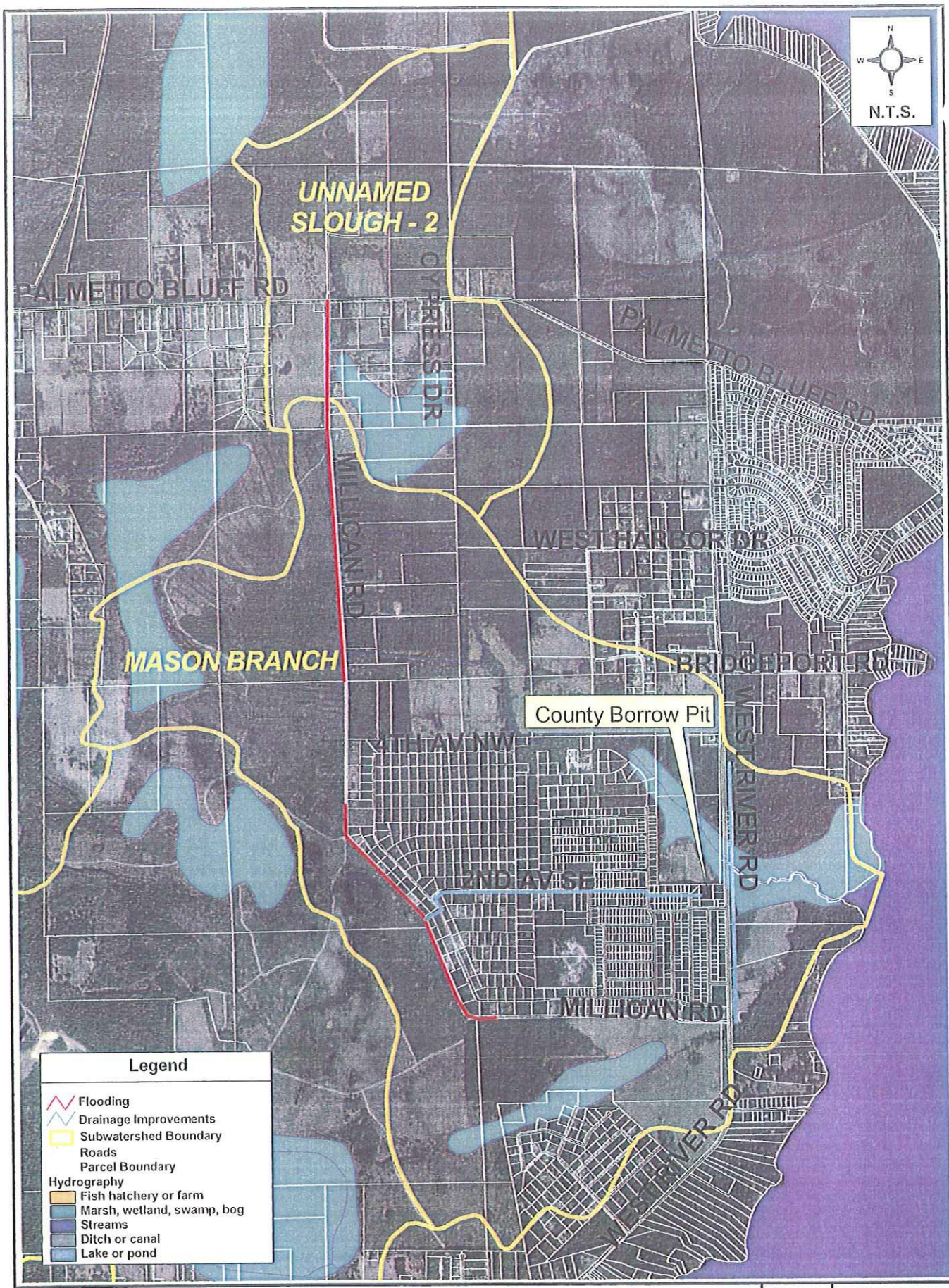
CIP Evaluation and Preliminary Cost Estimate

Millican Road is on the County's list of paving projects; however, no work is scheduled in the immediate future. It would be somewhat impractical to implement drainage improvements of the scope necessary to resolve the flooding on and around Millican Road without paving first. The most cost effective approach is to construct the paving and drainage improvements within the same project.

Table 7.4.4-1 provides cost estimates for paving and drainage for a two-lane roadway with drainage improvements. The source of the Unit Costs was FDOTs Long Range Estimates Handbook. The quantities are for the entire length of Millican Road. Drainage improvements over and above those that would be incorporated in the paving project are shown in **Figure 7.4.4-2** and the costs are shown in **Table 7.4.4-2**. The additional improvements are conceptual and were chosen to minimize ROW requirements and utilize a borrow pit under the ownership of the County. The figure shows the improvements running east west from Millican Road to the County borrow pit will require ROW. **Table 7.4.4-3** shows parcel numbers and per acre values of the ROW requirements.

TABLE 7.4.4-1 COST ESTIMATE FOR MILLICAN ROAD

Index No.	Pay Item Des.	Units	Qty.	Unit Cost	Total Cost
Pg. 1-17	Drainage	MI	4.1	$180,000	$738,000
Pg 1-23	Signing	MI	4.1	$4,000	$16,400
Pg. 1-31	Pavement	TN	4,762	$62.21	$735,554
710-23-61	6" Yellow Stripe	LF	21,650	$0.26	$5,629
575-1-1	Sodding (Bahia)	SY	48,117	1.26	$60,627
Pg. 1-31	Base Group	SY	57,728	$761	$439,310
110-1-1	Clearing and Grubbing	AC	50	$7,501	$37,505
Pg 1-17	Maintenance of Traffic (10%)	NA	NA	NA	$203,302
Pg. 1-16	Mobilization (10%)	NA	NA	N/A	$223,632
Project Total					$2,459,959

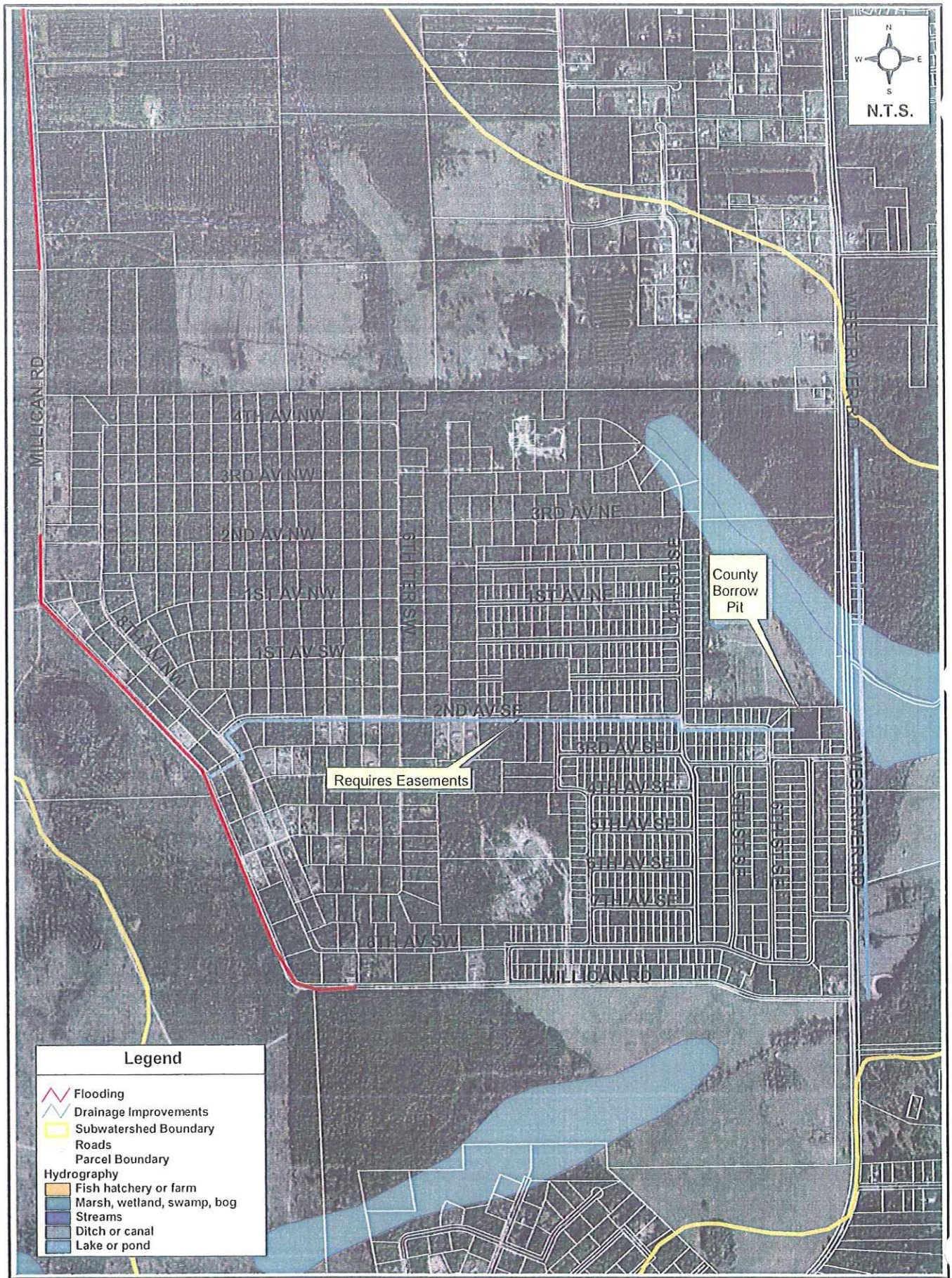


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 8 through14.apr

Millican Road - Location Map
Putnam County Master Stormwater Plan

Figure
7.4.4-1

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 8 through14.apr

Millican Road - Drainage Improvements
Putnam County Master Stormwater Plan

Figure 7.4.4-2

AVRES ASSOCIATES

TABLE 7.4.4-2 COSTS FOR MILLICAN ROAD

Pay Item	Pay Item Description	Units	Qty.	Unit Cost	Total Cost
104-10-1	Hay or straw bale (18"x18"x36")	Ea.	25	$6.00	$150
104-13-1	Staked silt fence	LF	19,350	$1.50	$29,025
430-984-125	Mitered end section (Conc. pipe round, 18" SD)	Ea.	45	$583.26	$26,246
575	Sodding (Bahia)	SY	35,480	$1.19	$42,221
430-172-125	Pipe Culvert Round (18" CD)	FT	1,080	$43.82	$47,325
120-1	Excavation - Regular	CY	24,765	$2.91	$72,066
Project Total					$217,033

TABLE 7.4.4-3 PARCEL NUMBERS AND PER ACRE VALUES OF ROW

PARCEL NUMBER	T-R-S	LANDVALUE/ACRE
6403-09-27-0000-0070-0000	092703	$1,592.26
6403-09-27-0000-0071-0000	092703	$1,788.82
6403-09-27-0000-0071-0080	092703	$1,777.78
6403-09-27-0000-0073-0030	092703	$1,824.32
6403-09-27-0000-0073-0040	092703	$1,277.03
6403-09-27-0000-0073-0101	092703	$1,788.82
6403-09-27-0000-0073-0381	092703	$1,591.84
6403-09-27-0000-0073-0391	092703	$1,756.10
6403-09-27-0000-0073-0401	092703	$1,053.66
6403-09-27-0000-0073-0411	092703	$4,585.37
6403-09-27-0000-0073-0420	092703	$4,585.37
6403-09-27-0000-0073-0431	092703	$1,760.87
6403-09-27-7730-0000-0001	092703	$170.05
6403-09-27-7730-0020-0140	092703	$3,939.39
6403-09-27-7730-0020-0150	092703	$2,280.70
6403-09-27-7730-0240-0010	092703	$4,642.86
6403-09-27-7730-0240-0030	092703	$4,642.86
6403-09-27-7730-0240-0040	092703	$4,642.86
6403-09-27-7730-0240-0050	092703	$4,642.86
6403-09-27-7730-0240-0060	092703	$4,642.86
6403-09-27-7730-0240-0070	092703	$4,642.86
6403-09-27-7730-0240-0080	092703	$4,642.86
6403-09-27-7730-0240-0090	092703	$4,642.86
6403-09-27-7730-0240-0100	092703	$4,193.55
6403-09-27-7732-0230-0010	092703	$3,103.45
6403-09-27-7732-0230-0020	092703	$3,214.29
6403-09-27-7732-0230-0030	092703	$3,214.29
6403-09-27-7732-0230-0040	092703	$3,214.29
6403-09-27-7732-0230-0050	092703	$3,214.29
6403-09-27-7732-0230-0060	092703	$3,214.29

PARCEL NUMBER	T-R-S	LANDVALUE/ACRE
6403-09-27-7732-0230-0070	092703	$3,214.29
6403-09-27-7732-0230-0080	092703	$3,214.29
6403-09-27-7732-0230-0090	092703	$321.43
6403-09-27-7732-0230-0100	092703	$321.43
6403-09-27-7732-0230-0110	092703	$3,214.29
6403-09-27-7732-0230-0120	092703	$3,214.29
6403-09-27-7732-0230-0130	092703	$3,214.29
6403-09-27-7732-0230-0140	092703	$3,214.29
6403-09-27-7732-0230-0150	092703	$3,214.29
6404-09-27-0000-0020-0016	092704	$906.47
6404-09-27-0000-0021-0017	092704	$2,571.43
6404-09-27-0000-0021-0470	092704	$2,629.41
6404-09-27-0000-0021-0910	092704	$2,516.23
6404-09-27-0000-0021-0930	092704	$3,500.00

Recommendation

The design and permitting of drainage improvements must be based on a modeling analysis of the Mason Branch subwatershed. The Mason Branch subwatershed covers 3,200 acres. The analysis would include aerial mapping, modeling, and an analysis and conceptual design to correct the flooding issues. However, the estimates for the roadway design include consulting fees and the drainage improvements would be a component of the roadway design.

The recommendation for the area is to schedule the projects in accordance with the priority from the ranking.

7.4.5 RIVER PARK SUBDIVISION (RANK NO. 5)

Location and General Description

The River Park Subdivision is shown in Figure 7.4.5-1. It is located on the east side of CR 309, approximately 0.5 miles south of the intersection of CR 309 and CR 308 in the town of Fruitland. The St. Johns River lies less than one mile to the west.

The River Park Subdivision is ranked number four in the matrix evaluation. Frequent flooding in River Park occurs when Lake Laverne, Lake Maxine, and a third unnamed lake stage up and flow west through an undersized ditch and culvert crossing at Lake Drive. The ditch is shown on the location map, running between Michigan Street and Grove Lane. The outlet for River Park is a double-barrel 48" RCP under CR 309, draining towards the St. Johns River. This CR 309 crossing is shown in Photo 7.4.5-1. Photos 7.4.5-2 through 7.4.5-4 show the outlet system in a west to east progression. The lake shown in Photo 7.4.5-4 is Lake Laverne. With the exception of the CR 309 crossing, the outlet system is significantly undersized in proportion to the area of the two lakes and the surrounding drainage basin size. As a result, the banks overtop and site flooding (yards, carports and sheds) occurs. During excessively wet periods, the lakes overtop much of their shoreline perimeter and sheet flow into the River Park's streets and drainage swales.

In addition to the field visit made during the site evaluation, a follow up-visit was made after the third hurricane event in the summer of 2004. A resident reported that in addition to the hurricane flooding, there has been regular yard, garage, and utility room flooding. During the last Ayres field visit (10/13/04), roadside swales had standing water and yards were saturated with shallow standing water.

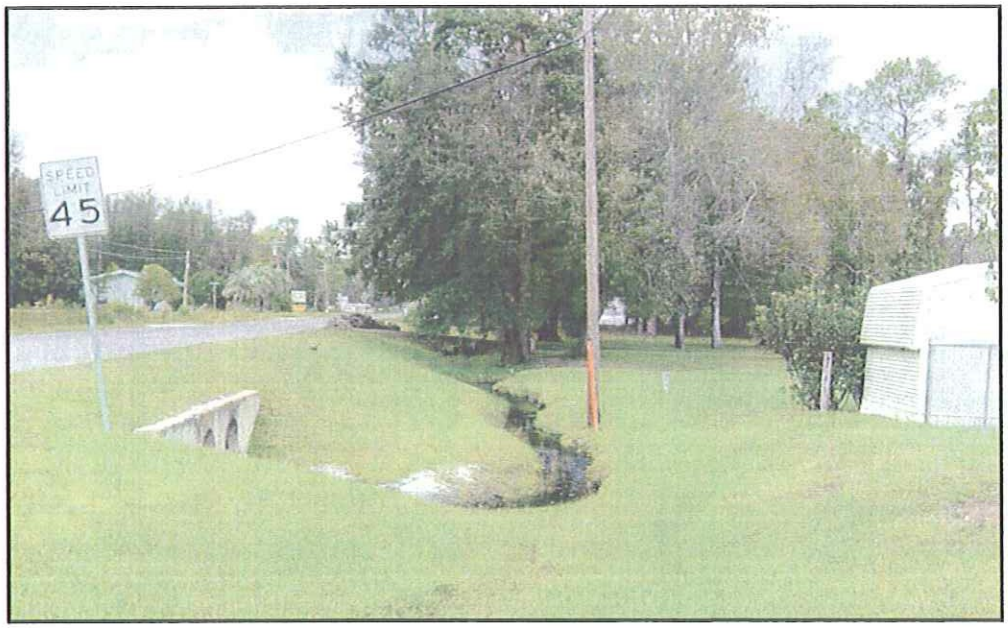
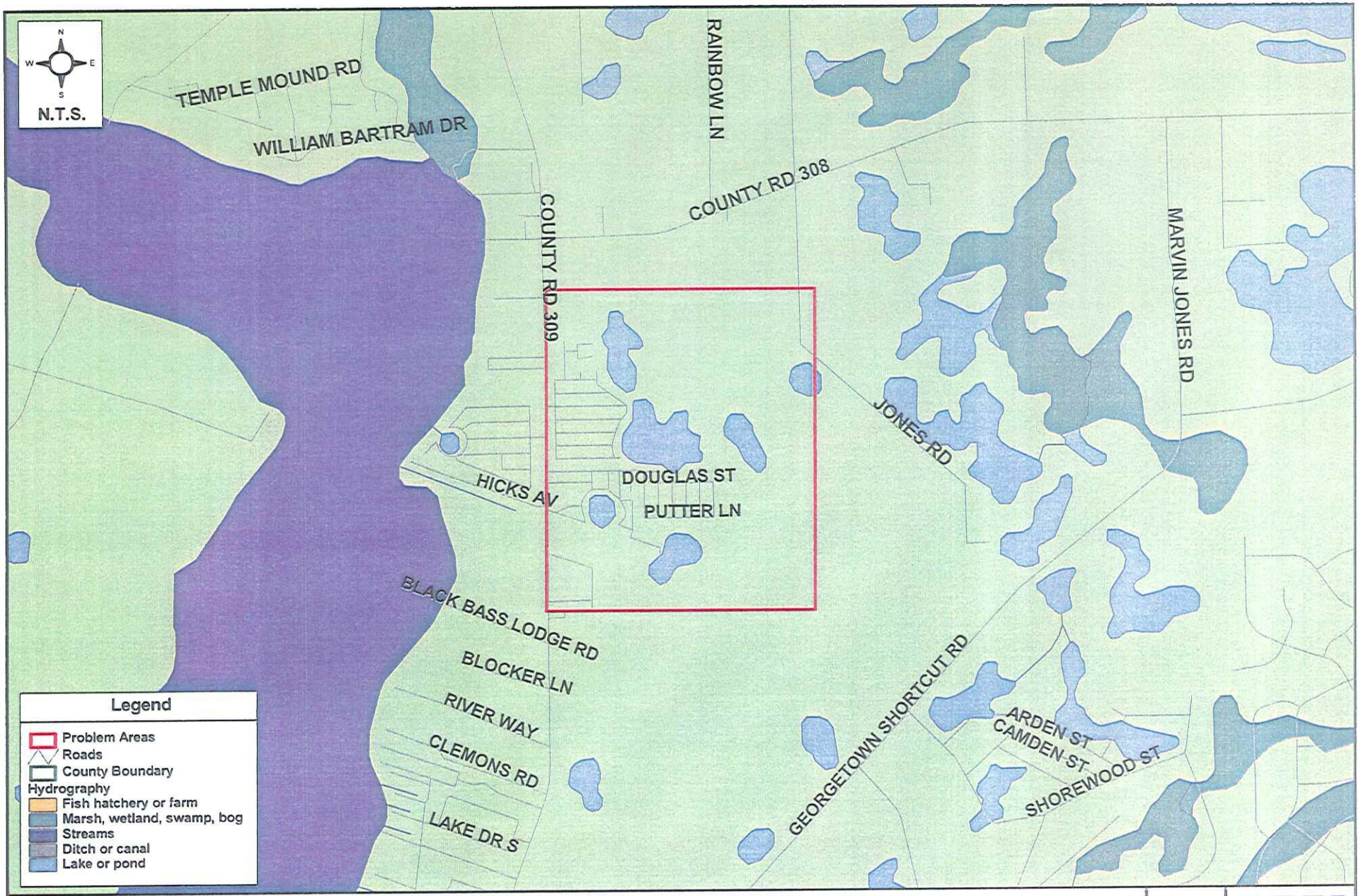


Photo 7.4.5-1
CR 309
Crossing



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 22through28.apr

River Park Subdivision - Location Map
Putnam County Master Stormwater Plan

Figure
7.4.5-1

AYRES ASSOCIATES

Photo 7.4.5-2 Outlet system in a west to east progress-sion

Photo 7.4.5-3 Outlet system in a west to east progression

Photo 7.4.5-4 Lake Laverne

CIP Evaluation and Cost Estimate

Environmental Resource Permitting (ERP) - General

The only practical way to reduce flooding in River Park is to permanently lower the lake and/or increase the size of the outlet capacity. Residential flooding from nearby lakes is a common occurrence in Florida, but modification of a lake system to reduce the flooding is something that environmental permitting agencies steadfastly resist and consequently, acquiring a permit to lower a lake or lake system is one of the most difficult ERPs to acquire in Florida. Modifying a lake outlet can have a significant effect on a lake's hydroperiod and the ecology that depends on it. Regulatory agencies review applications that propose this type of change with great caution. Other stakeholders such as lake residents, also have strong opinions about an alteration of "their" lake and Individual ERPs often cannot be granted if there is public opposition.

Design and Permitting Approach

If the right-of-way along the outlet system was not limited by adjacent properties the most cost-effective and constructable solution would be to leave the flowline invert at the existing elevation and significantly increase the peak flow capacity. However, right-of-way may be nearly or completely impossible to acquire; thus, a modification to Lake Laverne's outlet will likely incorporate operating a structure or designing a variable crest device (e.g., a notched weir). Two examples, a fixed crest and operable gate structure are provided in **Figures 7.4.5-2** and **7.4.5-3**. The reluctance permitting agencies have to modifying a lake by installing a structure or lowering the invert is a problem that can be overcome, as long as the right technical information is provided to the public, reviewers, and the stakeholders in general. Essentially a "before and after" representation of the lake's hydroperiod predicted with an integrated numerical model is required. The function of an integrated model is to simulate the ground and surface water components of a lake just as they are coupled in the natural environment.

The model is then used to develop outlet configurations that permit higher lake discharge during excessively wet periods or storm events, but do not have a residual effect of dehydrating the lake or affecting its daily average levels during "normal" or dry periods.

This is possible by simulation of a lake over a relatively long period (multiple years) for the full cycle of natural processes including rainfall, tree canopy interception, evaporation/ evapotranspiration, infiltration, unsaturated and saturated groundwater flow, overland flow, and baseflow and free surface or hydraulic flow into and out of the lake **Figure 7.4.5-2** illustrates a cross-section of an integrated lake model of a lake system.

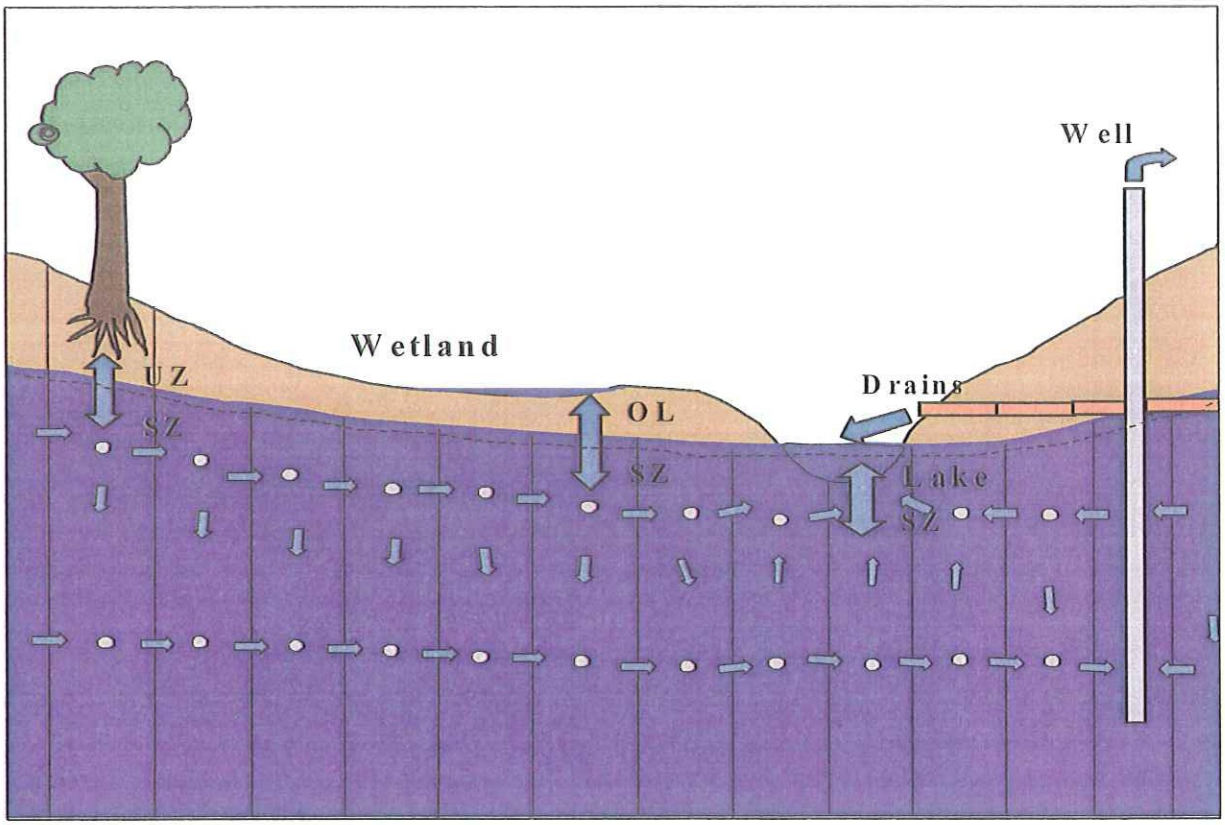


Figure 7.4.5-2 Integrated Model Cross-Section and Components

Once the "existing lake" system is represented in the model, the lake is simulated over a period of time, which establishes a basis for comparison. After the existing lake stages and adjacent water table is simulated with the model, the model is run repetitively thereafter, to simulate the effects of "proposed" or "alternative" system modifications. In this case, model simulations with different configurations of a control structure at the outlet of the lake, to compare to existing system simulations.

Figure 7.4.5-3, existing and proposed hydrographs for a lake, illustrates the results of this procedure.

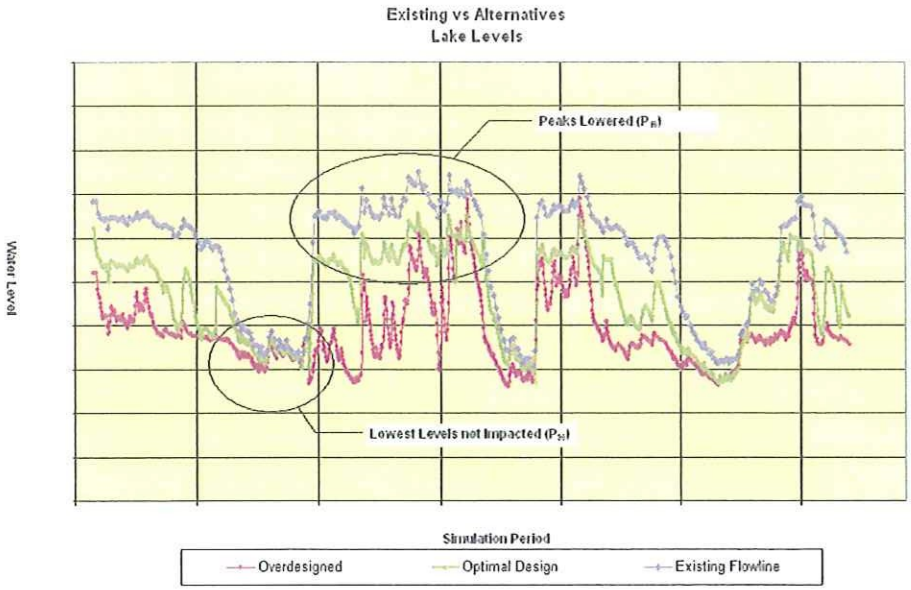


Figure 7.4.5-3 Existing and Proposed Hydrographs for a Lake

Note that the peak water level for the optimal design is lowered thus abating flood conditions but the lower elevations in the hydrographs typically attained in the dry months of the year (the statistical P90) are not extended or prolonged. This contrasts with the over-designed hydrograph where the peaks and the midrange of the hydrograph is significantly lower thus decreasing shoreline and over exposing the lake bed near the shoreline and negatively impacting on the lake's ecology. Most outlet modifications include changes to both parameters, flowline and flow capacity, thus the integrated model is used to optimize the design until there is a balance.

In summary, the utility of an integrated analysis is that speculation or overly conservative deductive reasoning by regulatory agencies cannot be used as a basis to deny a permit for an otherwise worthy and beneficial CIP project. The results are generally accepted because they are based on a real world representation of the whole natural system. Each hydrologic and hydraulic process is represented directly in the model, and presuming a suitable outlet configuration can be engineered, its long-term effects can be analyzed by inspecting the model's output data and water budgets.

Recommendation

It is Ayres' opinion (based on over 20 years of conducting lake management projects), that a permit to reduce flooding in River Park by altering the outlets of lakes Laverne and/or Maxine would be difficult to be obtained without a well developed approach to permitting that includes the involvement of stakeholders and an integrated modeling analysis of the lake. The specific steps in sequence, to develop lake study are given immediately below.

Given the state of the art of GIS preprocessors, costs to develop a "local" model of the lake and surrounding basin, would be between $15,000 and $20,000. This amount includes early coordination with permitting agency(s), an essential component as regulatory "buy-in" is critical.

The stepwise procedure for design of a lake outlet structures is as follows:

1. Develop 1-foot contour interval topographic mapping for the lake watershed.
2. Begin coordination with the St. Johns River Water Management District and begin informing the pubic about the proposed changes to the lake outlet.
3. Collect instantaneous water table depths and install two shallow wells using hand augers.
4. Develop and calibrate the integrated model hydrologic/hydraulic model.
5. Complete the modeling and develop a conceptual design.
6. Submit a Conceptual permit application to the SJRWMD.
7. Pending approval of the permit application, availability of rights-of-way, easements and ownership of lands, begin final design of the drainage improvements.
8. Complete final design and obtain an ERP.

TABLE 7.4.5-1 RIVER PARK AREA SUMMARY OF ACTIVITIES, TIMELINE, AND BUDGET

Task	Schedule (Months)	Opinion of Cost
Topographic Mapping, bathymetry, and channel cross-sections	4	$10,000
Data collection and creek/ditch survey	6	$2,000
Model development and calibration	9	$15,000
Conceptual design and public involvement	12	$5,000
Final site survey, design and permitting	15	$40,000
Total (Consulting and topographic survey total) & project closeout	18	$72,000
Acquire easements/ROW and construct	TBD	TBD

The recommendation is to include the project in the County's budget. If more then one budgeting year is necessary to fund the project, topographic mapping is the first essential step. Other milestones in a project of this nature are conceptual design and public involvement, followed by final design and permitting.

7.4.6 MUD LAKE / MONROE MILL CREEK WATERSHED (RANK NO. 6)

Location and General Description

The creek begins near the intersection of Silver Lake Drive and SR 20 and flows south, crossing SR 19 into Mud Lake, then southeast through Monroe Mill Creek. Monroe Mill Creek flows into the St. Johns River. **Figure 7.4.6-1** shows the watershed area. The CIP project described here will be referred to as Mud Lake.

Mud Lake ranked fifth in the matrix. A CIP project is necessary for Mud Lake due to street and house flooding on Red Fox Trail immediately north of SR 19 and on Karen Place and Karen Court, south of SR 19. Karen Place and Karen Court are in the Fox Trail subdivision. A number of the homes in Fox Trail are built on Mud Lake. A least one home on Red Fox Trail flooded during the hurricanes in the summer of 2004, and numerous others experienced yard flooding. Red Fox Trail was also flooded. There was more than six inches of standing water over the road. Several of the homes in Heritage Heights flooded, both those that are built on Mud Lake and at least one other home.

Further upstream in the watershed, the County has expressed concern that widening on SR 20 near the City of Palatka will increase runoff within the upper part of the watershed and exacerbate the flooding described above. Mud Lake is located in the lower or southern third of the watershed. The total contributing watershed area is approximately 1,400 acres (2.19 mi^2). Given the issues in the upper part of the watershed and the fact that the Mud Lake is the outlet for the watershed before discharging to the St. Johns River, an analysis of the hydrologic/hydraulic system of Mud Lake requires analysis of the whole watershed.

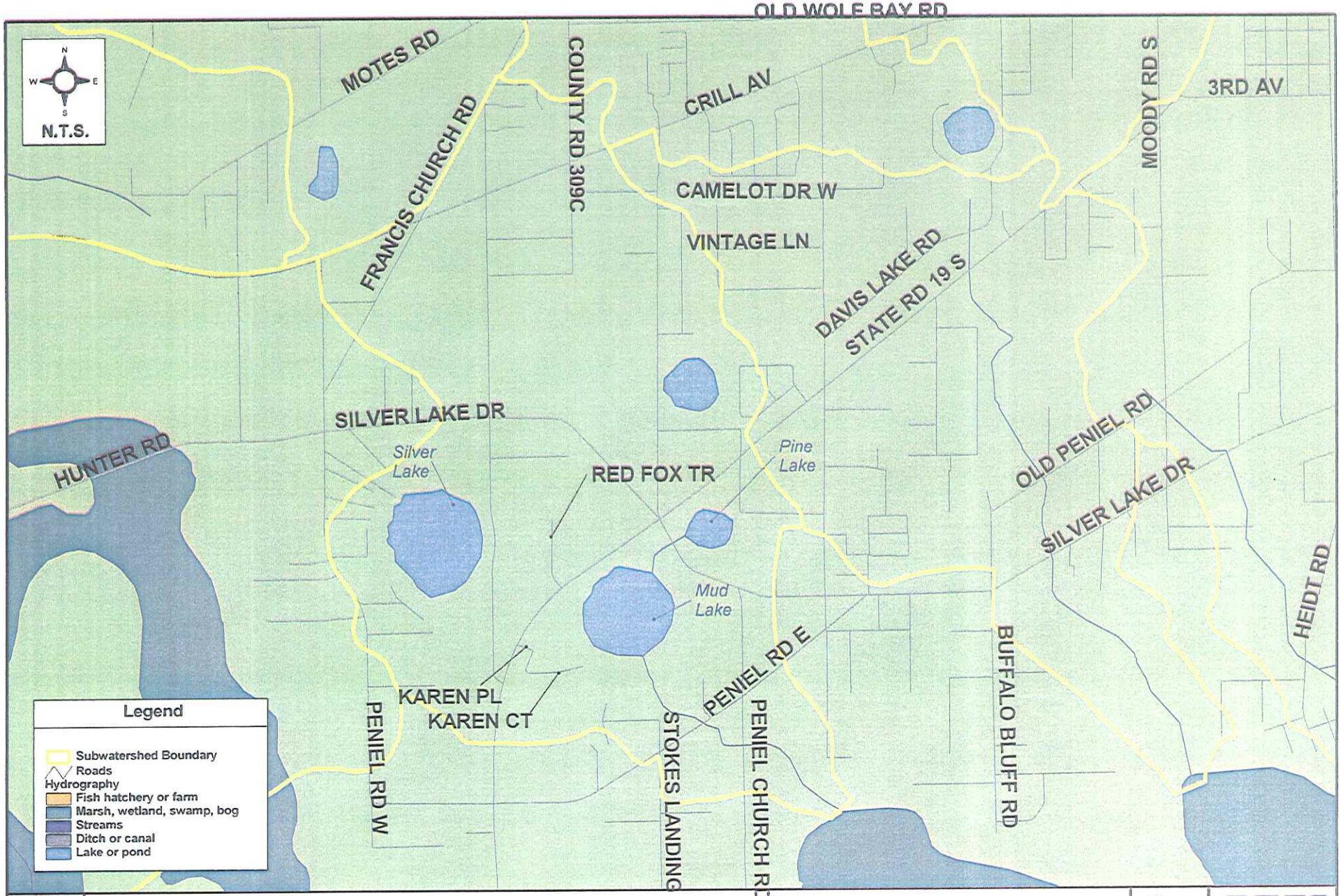
CIP Evaluation and Cost Estimate

There are two possible approaches to flood protection for Red Fox Trail, reduction of flow from upstream or an increase in discharge under SR 19 to Mud Lake. The latter must be offset by improvements to Mud Lake's outlet. The County has specified that improvements to Mud Lake's outlet, which is named Monroe Creek, must be adequate to provide flood protection for Heritage Heights.

The only practical way to reduce flooding in River Park is to permanently lower the lake and/or increase the size of the outlet capacity. To address the flooding near Mud Lake, for the same reasons the approach described for the River Park Subdivision in the previous section (7.4.5), will be necessary. Residential flooding from nearby lakes is a common occurrence in Florida, but modification of a lake system to reduce the flooding is one of the most difficult ERPs in Florida to acquire.

Development of conceptual design(s) to address flooding on Fox Trail or Mud Lake will require most of the components within all four major tasks of a Watershed Management Plan. These major tasks are Digital Topographic Information, Watershed Evaluation, and a Watershed Management Plan (including modeling and conceptual design). An integrated model of Mud Lake like that required for River Park will also be required.

Typically, determining the most appropriate modeling software for any given Watershed Management Plan is made during the study period. However, in this case, because modification of a lake outlet is required, it is critical to choose a model before the project begins so that the efforts for the 100-year floodplain analysis and the integrated modeling analysis can be combined.



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 22through28.apr

Mud Lake / Monroe Creek - Location Map
Putnam County Master Stormwater Plan

Figure 7.4.6-1

AYRES ASSOCIATES

Currently the Mike SHE/Mike 11 suite of models will permit the County to conduct the 100-year floodplain analysis and also the integrated modeling analysis seamlessly. MIKE 11 is a hydrodynamic model approved by FEMA, a general requirement for acceptance of 100-year floodplain studies submitted to FEMA. Upon completion of the floodplain analysis, Mike 11 integrates with MIKE SHE, thus development of the CIP project to address the flooding on and around Mud Lake is not a separate stand-alone effort.

A schedule and cost estimate for an analysis and design to address the flooding is provided in Table 7.4.6-1.

TABLE 7.4.6-1 MUD LAKE EVALUATION SUMMARY OF ACTIVITIES, SCHEDULE & BUDGET

Task	Schedule (months)	Cost
Topographic mapping (1-foot Contour Interval)	4	$6,562
Cross-section, Bridge/culvert, and Bathymetic surveys	4	$10,000
Watershed Data Collection	4	$21,600
Watershed Modeling/100-year Floodplain Determination	18	$12,960
Integrated model/Conceptual Design/ERP pre-application	22	$25,000
Public Involvement/Meetings	24	$2,500
Site Survey	26	$5,000
Final Design & ERP (all improvements in watershed)	32	$70,000
Total	NA	$153,622
Construction	TBD	TBD

Recommendation

The recommendation is to budget the project over a two-year period. Completion of the 100-year floodplain determination phase would constitute the first year and completion of the Final Design and ERP phase would complete the second year.

7.4.7 ORANGE SPRINGS SHORTCUT (RANK NO. 7)

Location and General Description

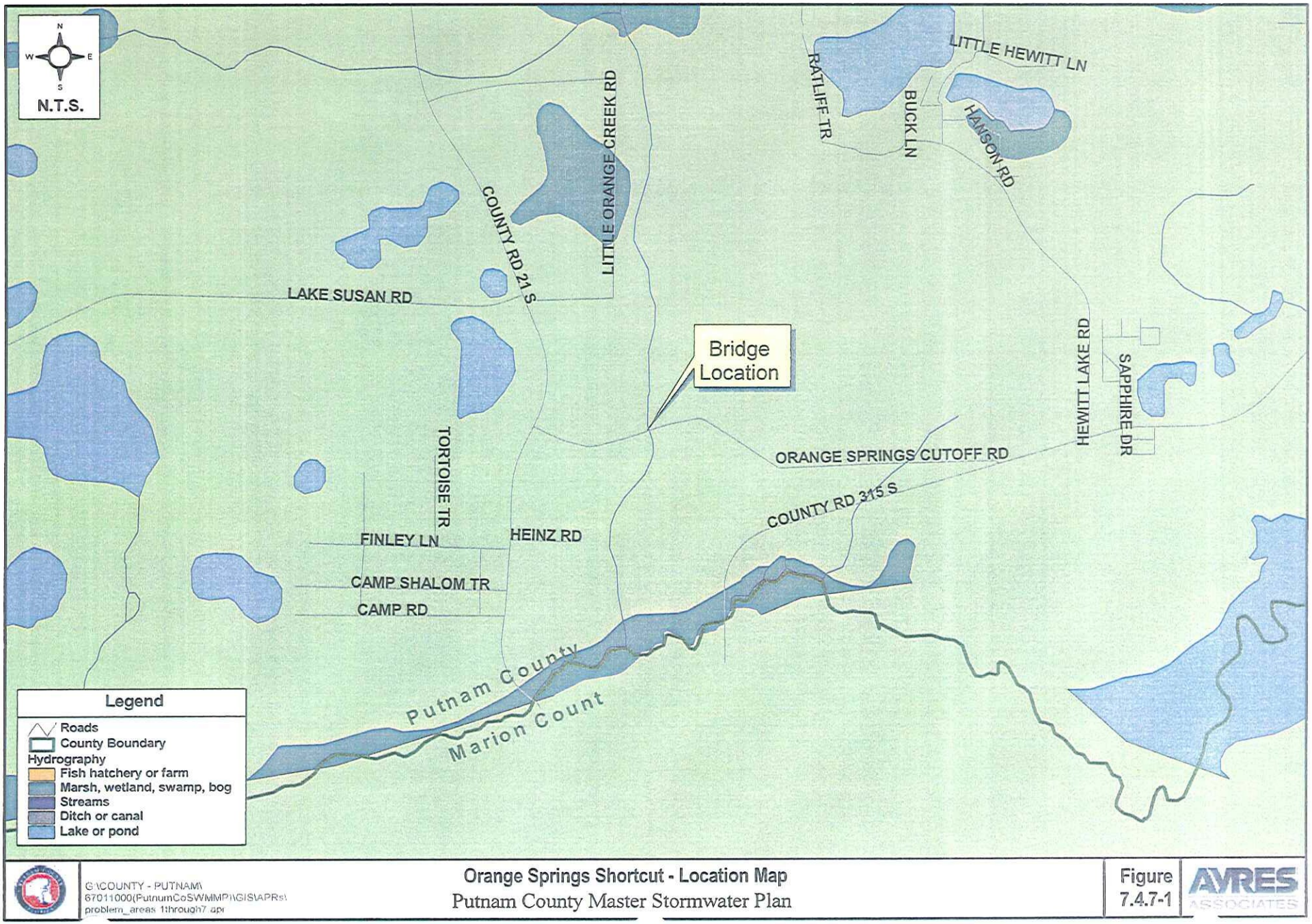
Orange Springs Shortcut is unpaved and located in the southwestern part of the County near the Putnam/Marion County line. The CIP project must address a bridge that has been impacted by scour, and regularly overtops. The bridge services local travel, tractor-trailers during logging operations, and school buses. The bridge spans Cabbage Creek and is constructed from wood (Photo 7.4.7-1). The approximate bridge location is shown in **Figure 7.4.7-1**.

Photo 7.4.7-1. Looking Upstream at Wooden Bridge

Due to safety issues, this bridge was ranked number two in the preliminary point-based matrix evaluation. The bridge is not equipped with guardrails and overtops between one and four times a year during high intensity storm events.

The bridge was replaced several years ago after a scour event resulted in pile failure and six to 12 inches of settlement. The DOT inspection report obtained from the PONTIS database (the national bridge safety tracking database) lists the bridge with two spans in the main unit, and a total structure length of 30.98 feet. The inspection report referred to above gives a National Bridge Inventory (NBI) conditions rating as "Structurally Deficient", rates the bridge as "Medium" for scour susceptibility, and recommends a Phase II scour analysis. The weight limit posting is 14.8 tons. A copy of the PONTIS report is contained at the end of this section.

The Public Works Department has repeatedly closed the bridge. The last closing was during hurricanes in the summer of 2004. For safety reasons, during floods, school buses are routed around the bridge and into Marion County.



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP\GIS\APRs\
problem_areas 1through7.apr

Orange Springs Shortcut - Location Map
Putnam County Master Stormwater Plan

Figure
7.4.7-1

AYRES ASSOCIATES

The School Board has stated that travel outside of Putnam County creates problematic logistical and administrative issues and would prefer in-county travel. As a result, there is some impetus from the School Board to improve or replace the bridge.

CIP Evaluation and Cost Estimate

Construction of a new crossing is the only option that will address the concerns at this location. In estimating a lower size limit (thus optimizing costs) and due to the scarcity of data, it was necessary to follow a somewhat circuitous method to estimate the lower size limit of the replacement bridge/culvert. The first step was to test the adequacy of the upstream structure, a double-barrel 6' x 6' RCBC.

The flow rate was determined by a simple estimate using the USGS regression equations in Volume 2A of the DOT drainage manual. DOT requires the minimum deck elevation to be no less then that obtained from a 50-year peak flow rate. The regression equation for that rate was therefore used. The peak 50-year flow is as follows:

$$Q_{50} = 609DA^{0.69}\,SL^{0.227}(LK+3)^{-0.695}$$

where:
DA=drainage area (square miles)
SL=slope (feet/mile)
LK= percent lake area in watershed

Using the USGS drainage basin delineations obtained from the SJRWMD, and assuming the watershed area that drains to Little Orange Creek includes Cabbage Creek, the parameters for the regression are as follows:

DA = 42 mi^2
SL = 0.15 ft/mi
LK = 50%

Substituting into the regression equation:

$$Q100_{100} = 609(42)^{0.69}\,(0.15)^{0.227}(50+3)^{-0.695} = 324\ ft^3/s$$

The upstream box culverts were then modeled in HEC-RAS to determine if they had adequate capacity and did not overtop. If not, then it could be assumed that an opening for the replacement bridge could be approximately the same size. A river slope of 0.001 was assumed for the normal depth option in HEC-RAS and a flow of 260 CFS was used as a peak flow rate. HEC-RAS showed no overtopping; thus, it is assumed that a cross-section for the proposed crossing equal to the upstream cross-section would be adequate and provide a lower limit for a replacement bridge.

Costs for three different crossing types were estimated and the totals are shown below. A reinforced concrete box culvert was not considered because it has a hardened bottom and eliminates the possibility of retaining a natural channel bottom. Hardened bottom typically results in environmental permitting issues that would be costly to address. The first of the three considered was a 24-foot wide prefabricated truss bridge. Steadfast Bridges in Mobile, Alabama provided a preliminary verbal estimate. It is in effect an in-kind replacement. The 24-foot width does not provide any shoulder width and the trusses act as guardrails. The second was a cast-in-place in-kind replacement (with guardrails). The section for a two lane rural highway was carried over the bridge. The third was an arched concrete span (known by the original trade

mark name as a Conspan). The lower limit of a span would be 14 feet wide and 8 feet high. A 28-foot wide span was also estimated so that as it would not encroach into the channel, and would avoid environmental permitting issues. A drawing for an arched pipe is shown in **Figure 7.4.7-2**.

The costs for the three bridge types are as follows:

Prefabricated Truss Bridge

Item	Cost
Bridge (delivered to site)	$80,000
Headwalls/Deck/Installation	$60,000
Total Cost	$140,000

Cast in Place Single Pile

Item	Cost
Bridge (Deck/Headwalls/Single Pile)	$80 ft^2
Total Area (ft^2)	1440 ft^2
Total Cost	$115,200

Pre-cast Concrete Arch (20-foot span)

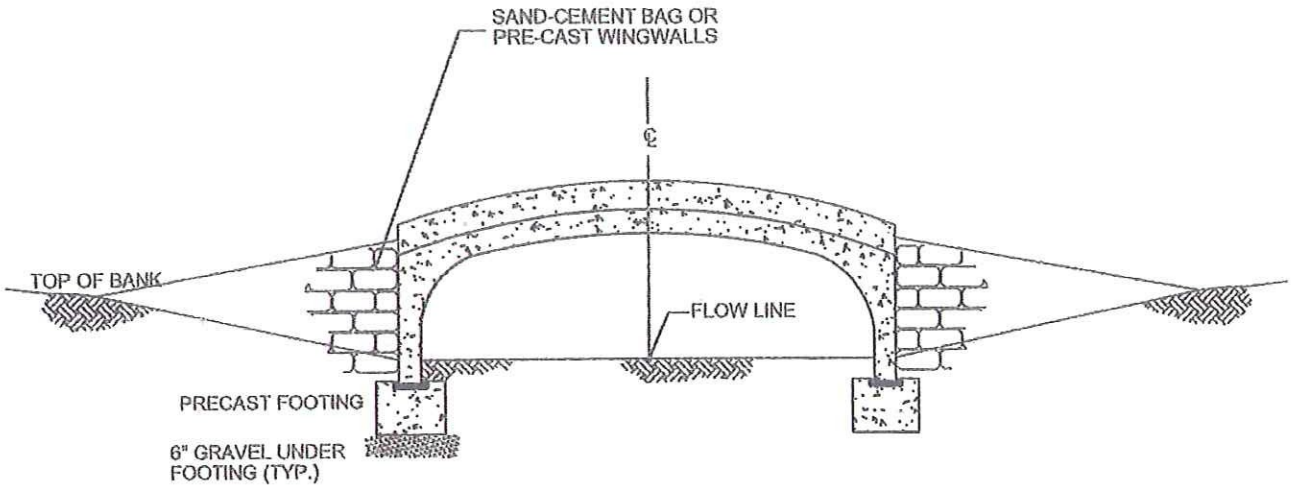
Item	Cost
Arches	$24,230
Footers	$1,800
Headwalls	$3,250
Wingwalls	$14,200
Total Structure	$43,480.00
Construction (Structure x 1.5)	$86,940
Total Cost	$108,700

Pre-cast Concrete Arch (14 foot span)

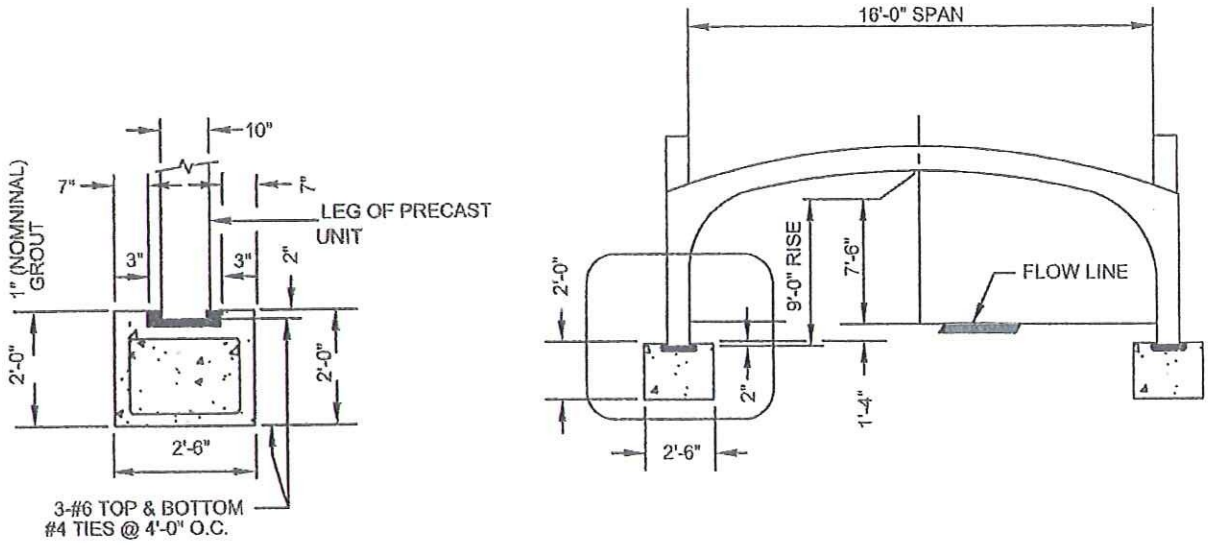
Item	Cost
Arches	$17,035
Footers	$ 900
Headwalls	$1,400
Wingwalls	$12,200
Total Structure	$31,535.00
Construction (Structure x 1.5)	$47,302
Total Cost	$78,837

Recommendation

Based on cost, Environmental Resource Permitting issues, and service life, an arched concrete span is preferable for Orange Springs Shortcut.



CULVERT SECTION



CULVERT SPAN DETAILS

D00(PUTNUMDOS\WRP)\CIPS\ORANGE_SPRINGS_CUTOFF_ORANGESPRINGSCONSPAN.DWG

G:\COUNTY - PU

16-Foot Conspan
Orange Springs Cutoff Road
Evaluation & Preliminary Cost Estimate
Putman County Stormwater Management Plan

Figure 7.4.7-2

AYRES ASSOCIATES

7.4.8 RECTOR ROAD (RANK NO. 8)

Location and General Description

Rector Road is immediately north of the intersection of Rector Road and SR 207 near Hastings. The concern at this location is a triple barrel 9' x 14' ECMP crossing of a drainage canal. The crossing location is shown in **Figure 7.4.8-1** and the photos below (Photos 7.4.8-1 and 7.4.8-2). There are no guardrails on either side of the crossings. The canal is named Cracker Canal in the DOT inspection report. The report also provides a pipe span of 14 feet, and a length of 50.2 feet. The 9' x 14' dimension was estimated during a field visit. The canal dimensions were also estimated in the field; the width, depth and side slopes are approximately 40 feet, 12 feet, and 1.5:1 respectively.

Due to safety issues related to structural deficiencies, this bridge ranked number three in the matrix evaluation.

Photo 7.4.8-1: West side of road looking south at culverts, flow in NW direction.

Photo 7.4.8-2: East side of road looking south at culverts, flow in NW direction.

G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\CIP_areas 15through21.apr

Rector Road - Location Map
Putnam County Master Stormwater Plan

Figure 7.4.8-1

AYRES ASSOCIATES

The approaches to the culverts are relatively clear of debris and sediment; however, two culverts are partially constricted with sediments and one is completely blocked. In addition, the culverts are severely corroded (rusted) and pose a safety hazard. An excerpt from the DOT inspection report is as follows:

> *The pipes and connecting hardware gave a 2' wide band of heavy corrosion with up to 95% to 100% section loss along the spring lines. A hammer can easily penetrate the pipes where the corrosion exists. The connecting hardware for the steel plates is missing in random areas. The floors in Pipes 1 and 2 are buckled upward up to *"high in random locations. The south side of Pipe 2 at the west end has a tear 1' x 8" x ½" deep. Also Pipe 2 has an area of 100% section loss 4' above the floor on the south side at the west end. These conditions show no change since the previous inspection.*

The underside in Pipe 1 has a downward deformation along the north bolted seam 21' from the west end. There is a 6"downward deformation 10' from the east end along the same seam. These conditions have increased since the previous inspection.

The recommendation in the inspection report is as follows:

> *Repair or replace all pipes. Install advance warning signs in accordance with FDOT Standard index #12357 guidelines. Install a guardrail system in accordance with current FDOT standards.*

The existing headwall is constructed of sand cement riprap. Some deficiencies were noted but replacement of the culverts will require demolition of the headwalls, thus repair of the headwalls is superfluous.

CIP Evaluation and Cost Estimate

Optional Structures

Construction of a new crossing is the only practical option at this location. Due to the corrosive properties in the water, the replacement crossing will have to be constructed from materials that are corrosion resistant, or if conventional materials are used (concrete for example), have a coating.

Below is a summary of features contained in culvert/prefabricated bridge types suitable for the Rector Road Crossing for both conventional materials and alternative materials such as High Density Polyethylene pipe.

Type/Shape	Made From Corrosion Resistant Material	Available w/ Corrosion Resistant Coating	Available Size	Use Will Decrease Sedimentation
Conspan	No	Yes	Yes	Yes
Pre-fab. Bridge	No[1]	No	Yes	Yes
HDPE Pipe	Yes	N/A	No	No
Hardie Pipe	Yes	Yes	No	No
CMP	No	Yes	Yes	No

1-Refers to headwall

The available size limitation of the Hardie and HDPE pipe eliminate them from further consideration. While coatings (typically a tar like material) are available for CMPs that will

provide a significant amount of service life, deterioration of the tar will eventually occur thus exposing the culvert to corrosion and structural failure. Theoretically, the exposed concrete headwalls required for a prefabricated bridge could be spray coated in the field. However, the spread footer or piles on which the headwalls would be sited could not be coated.

The option that is recommended is a coated prefabricated arch or Conspan. Unlike the cast in-place headwalls required with a pre-fabricated steel bridge, the footers can be pre-cast and protected with a coating and all joints (e.g., between the arches and footers) can be sealed in the field. Some of the basic components of a Conspan structure are shown in **Figure 7.4.8-2**. Additional benefits are that sedimentation would be reduced in proportion to the reduction in entrance losses and roughness of a single prefabricated arch versus multiple CMPs.

Because the entrance losses and roughness of a single concrete arch are significantly less than three CMPs, the same conveyance can be maintained with a smaller cross-sectional area. A smaller cross-section converts to a smaller arch structure and thus lower costs. The lower limit of the size is governed by the prohibition against increasing upstream water surface elevations as a result of additional constrictions in the conveyance system.

Determination of Crossing Size

A simple HEC-RAS model using the steady flow option was used to estimate the size of the concrete arch (Conspan) that would provide the same conveyance as the existing CMPs. An estimate for flow at this crossing was determined using the USGS regression equations in Volume 2A of the DOT drainage manual. The equation is as follows:

$$Q_p = 609DA^{0.685}\,SL^{0.227}(LK+3)^{-0.685}$$

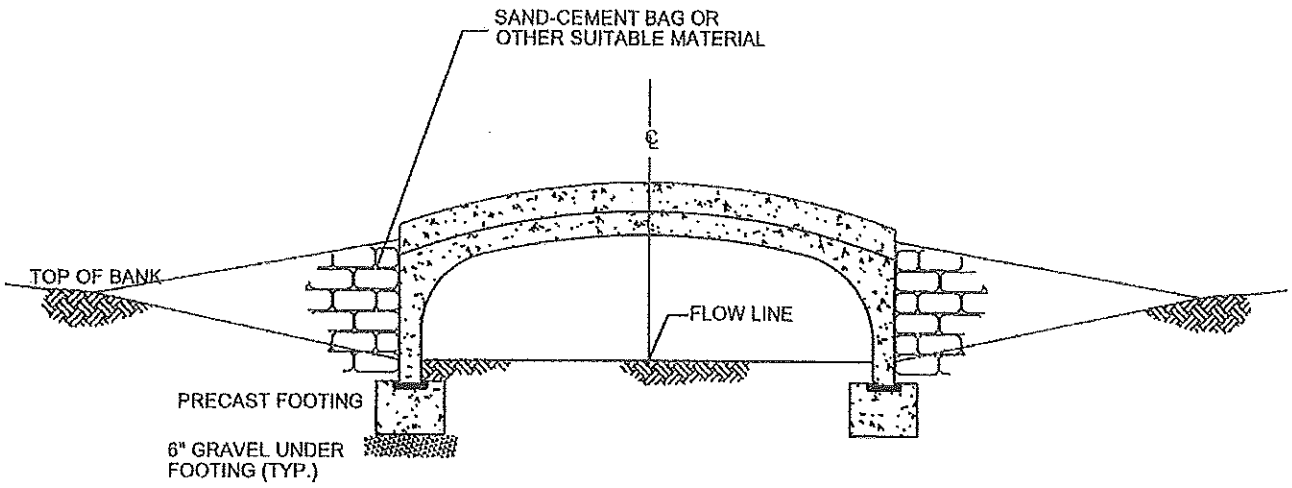
where:

DA=drainage area = 5776 acres = 9.02 mi^2
SL=slope= 2.87 ft/mi
LK= percent lake area in watershed = 8.8 % (Wetlands)

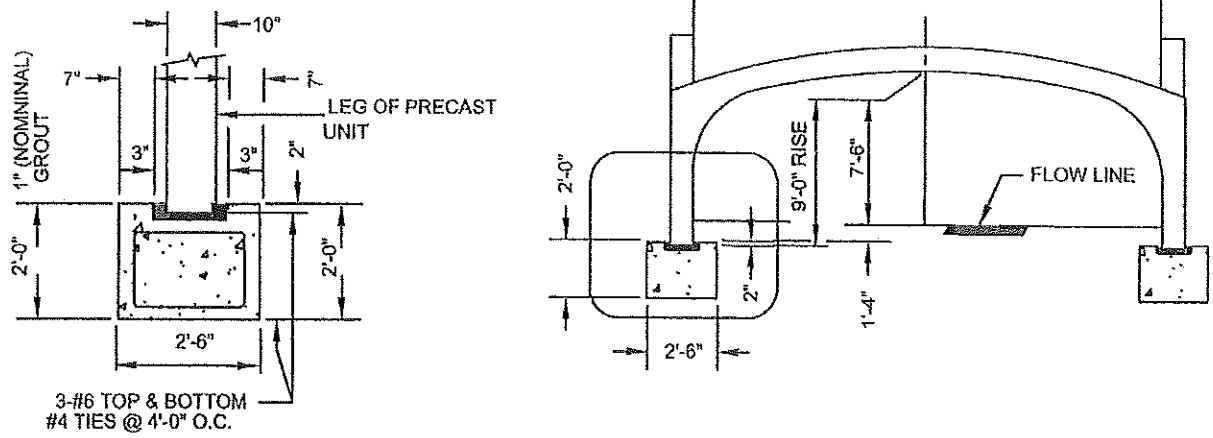
Using the USGS drainage basin delineations obtained from the SJRWMD, and assuming the watershed area that drains to Cracker Canal:

$$Q_{100} = 609(0.84)^{0.685}\,(6.99)^{0.227}(8.8+3)^{-0.695} = 632.5\ ft^3/s$$

A river slope of 0.00054 was assumed for the normal depth option and a flow of 632.5 cfs computed with the equation above was used as a peak flow rate. No overtopping was computed by the model; thus, it is assumed that a cross-section for the proposed crossing equal to the upstream cross-section is adequate.



CULVERT SECTION



CULVERT SPAN DETAILS

J:\000CPUTNUM\CDS\WHP\CIPS\HASTINGS\RAINDIST\RECTOR_CONSPAN.DWG

G:\COUNTY ... \

28-Foot Conspan
Rector Road
Evaluation & Preliminary Cost Estimate
Putnam County Stormwater Management Plan

Figure 7.4.8-2

AYRES ASSOCIATES

Several Conspan sizes were entered in HEC-RAS until one that was found that did not cause upstream a rise in depth upstream of the structure. **Tables 7.4.8-1** and **7.4.8-2** show the model results for the existing 9' x 14' arch pipes and a 9' x 28' Conspan.

TABLE 7.4.8-1 HEC-RAS OUTPUT - ARCH PIPES

HEC-RAS Plan: Arch Pipes River: Cracker Canal Reach: 100 Profile: 100-yr Profile							
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)
100	400	100-yr Profile	632.5	0.3	6.8		6.87
100	300	100-yr Profile	632.5	0.2	6.75	2.15	6.82
100	250		Culvert				
100	200	100-yr Profile	632.5	0.1	6.61		6.68
100	100	100-yr Profile	632.5	0	6.55	1.94	6.62

TABLE 7.4.8-2 HEC-RAS OUTPUT - CONSPAN

HEC-RAS Plan: Conspan River: Cracker Canal Reach: 100 Profile: 100-yr Profile							
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)
100	400	100-yr Profile	632.5	0.3	6.83		6.9
100	300	100-yr Profile	632.5	0.2	6.78	2.15	6.85
100	250		Culvert				
100	200	100-yr Profile	632.5	0.1	6.61		6.68
100	100	100-yr Profile	632.5	0	6.55	1.94	6.62

The column titled "W.S Elev" provides the water surface elevations for both structures. The differences from the 9' x 28' Conspan are negligible and thus for an approximate level of analysis performed, the two water surfaces are adequately close. **Figures 7.4.8-3** and **7.4.8-4** shows the HEC-RAS model with the Arch Pipe and Conspan, respectively.

Recommendation

Replace the existing structure with a 9' x 28' Conspan. Two options for coating the concrete to resist corrosion are provided in the back of this section. The hydraulic analysis in this section was preliminary. The final design and size of the structure requires results from a more detailed modeling analysis.

Costs

The costs for a Conspan is shown below. The costs do not include any design services.

Pre-cast concrete arch (28 foot span)

Item	Cost
Arches[1]	$19,384
Footers	$1,800
Headwalls	$3,250
Total Structure	$24,434
Construction (Structure x 1.5)	$36,651
Total Cost	**$61,085**

1: 4-8' sections

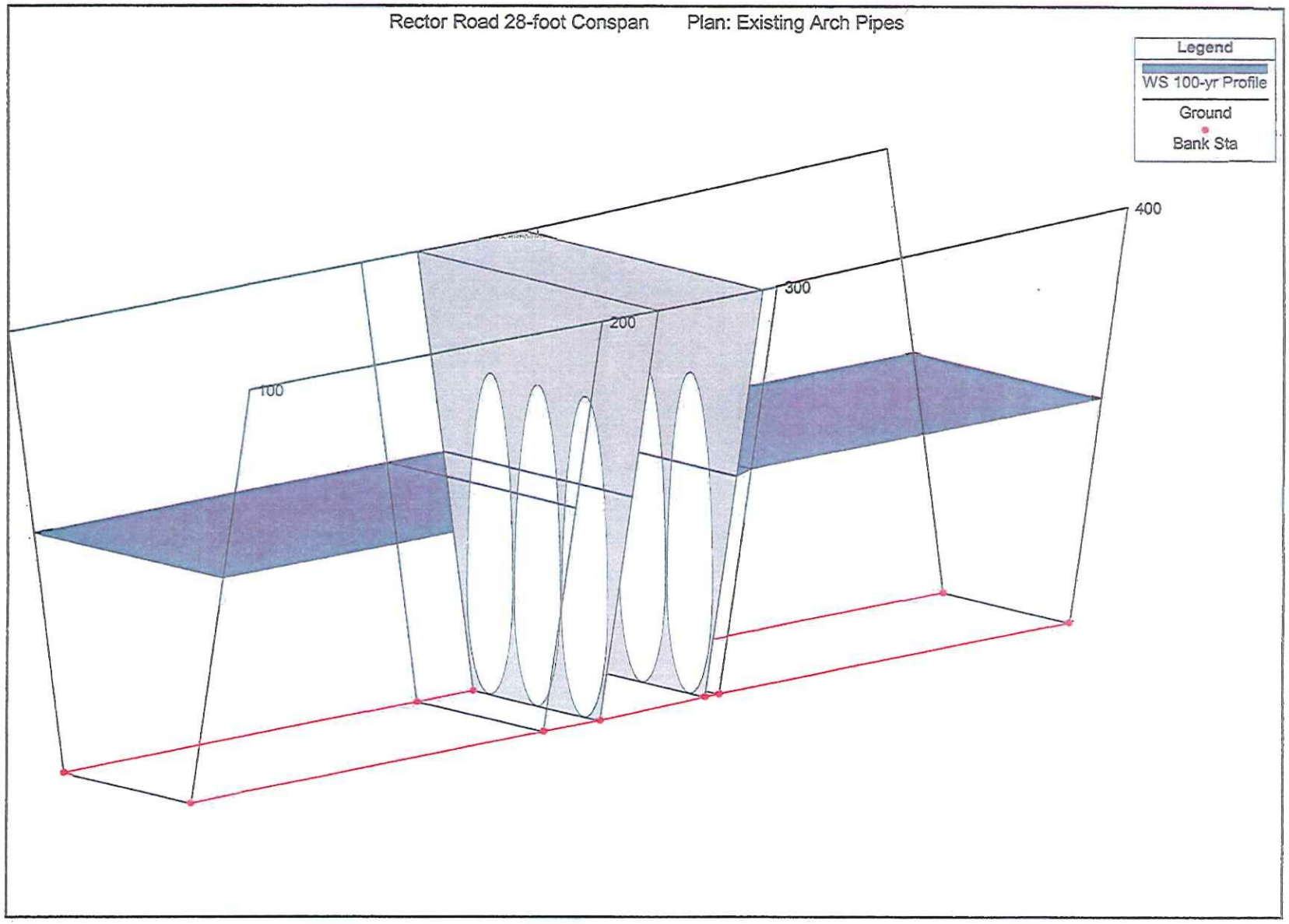

Rector Road 28-foot Conspan
Plan: Existing Arch Pipes
Legend
WS 100-yr Profile
Ground
Bank Sta
100
200
300
400

Figure 7.4.8-3

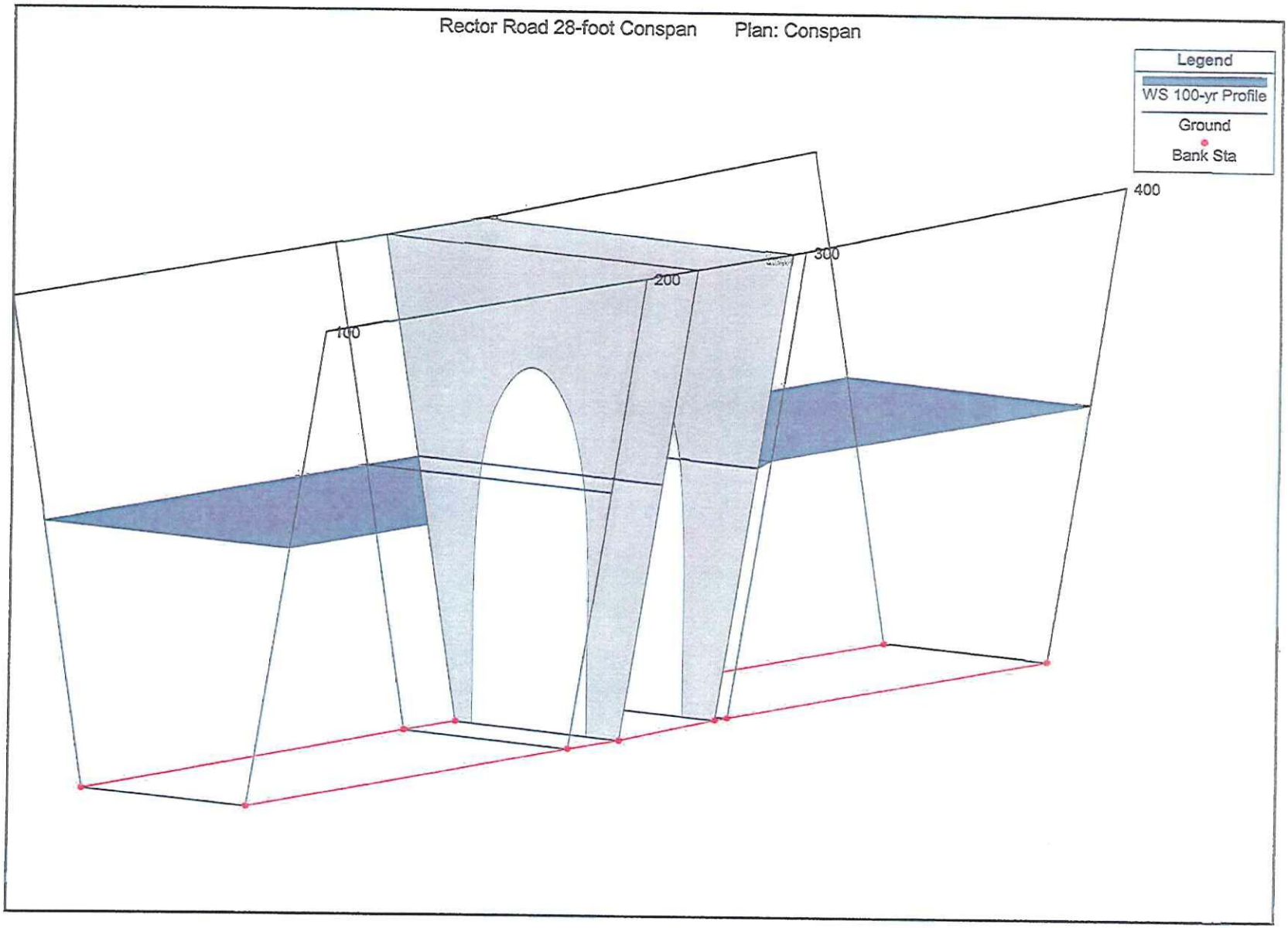

Rector Road 28-foot Conspan Plan: Conspan
Legend
WS 100-yr Profile
Ground
Bank Sta
400
300
200
100

Figure 7.4.8-4

7.4.9 EAST PALATKA DRAINAGE DISTRICT (RANK NO. 9)

Location and General Description

The site is located at the SR 207 crossing of Dog Branch between Palatka and Hastings. This is a four-lane crossing with double 5' x 12' box culverts. The contributing subwatershed area to Dog Branch is 2,375 acres. The subwatershed boundary is shown in **Figure 7.4.9-1**. The crossings and some of the surrounding area features are shown in **Figure 7.4.9-2**. The St. Johns River Water Management District is constructing a large sediment removal and water quality treatment facility downstream of the crossing. The District refers to the project as Edgefield. The location of the pond is also shown in **Figure 7.4.9-2**.

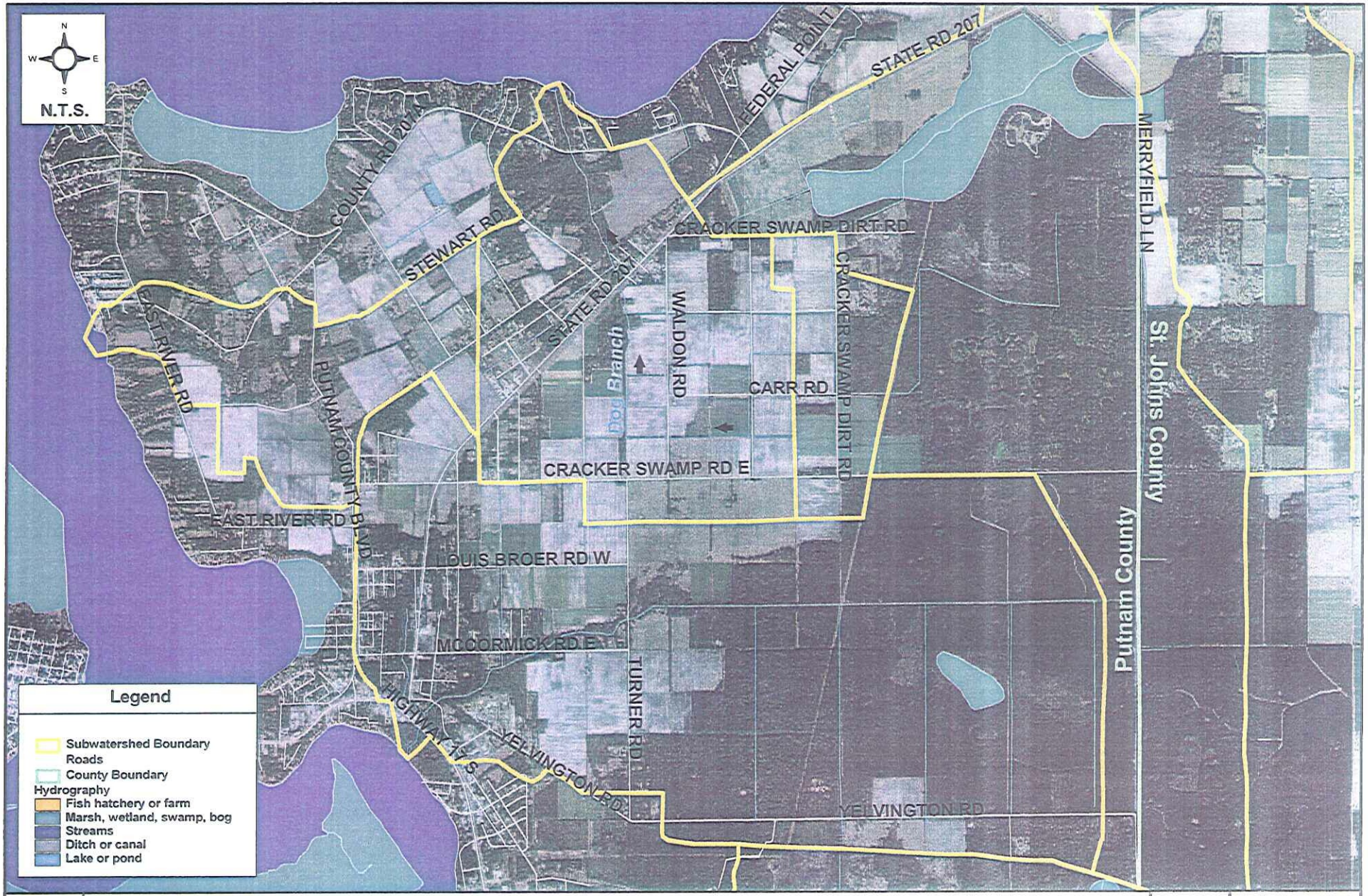
At the SR 207 crossing, large deposits of sediment accumulate. The County regularly maintains both sides. The most recent maintenance was prior to the May 2004 field visit when they removed sediment from the upstream side. Failure to maintain the crossing constricts flow to the extent that water has been seen at the edge of the highway pavement.

Neither channel cross-sections nor any other data were available to perform an analysis but enough anecdotal evidence is available to make the necessary engineering judgment. The depositions appear to result from vegetation growth in the downstream reaches that the County has no ingress/egress rights to maintain. The District's Edgefield Project Manager commented that fallen and floating vegetation accumulation during the Hurricanes in 2004 have further decreased channel conveyance. This location is indicative of the sedimentation issue throughout the East Palatka area and many conveyance systems throughout Putnam County in general.

CIP Evaluation and Preliminary Cost Estimate

The deposition of sediments is acute at this location as a result of velocities that dramatically decrease due to the constriction caused by vegetation and debris in the channel. The only practical and appropriate step for a permanent solution is maintenance of the downstream channel from SR 207 to the Edgefield project. Two recommendations are possible. The first possible solution is defer maintenance responsibilities to DOT. The County may have not done so up to now for specific reasons but if not, SR 207 is a state road and maintenance of the crossing is DOT's responsibility.

The permanent solution and one that reduces or eliminates the flood hazard, is acquisition of the necessary easements so that routine maintenance can be performed. Though the assumption is that the channel is in private ownership, the parcel lines in **Figure 7.4.9-2** show that the centerline of the channel is not privately held. If not and the centerline is privately held, the parcel number are shown on the figure. It is assumed that County staff will maintain the system; thus, a no cost estimate is provided.



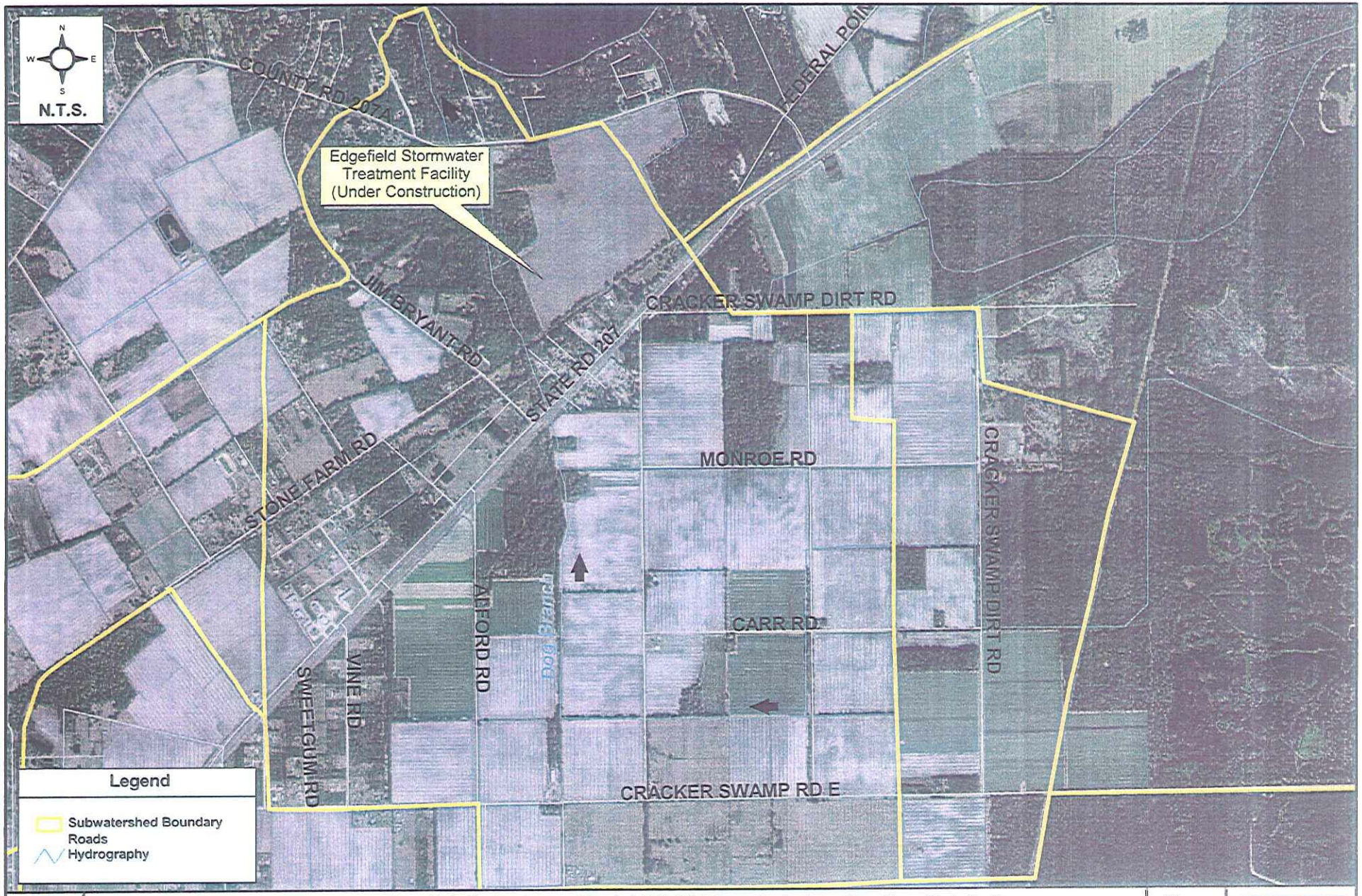
G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
cip 15through21.apr

East Palatka Drainage District (SR 207 Crossing) - Location Map

Putnam County Master Stormwater Plan

Figure 7.4.9-1

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP\GIS\APRs\cip15through21.apr

East Palatka Drainage District (SR 207 Crossing) - Location Map (Detailed)

Putnam County Master Stormwater Plan

Figure 7.4.9-2

AYRES ASSOCIATES

7.4.10 WHISPERING PINES (RANK NO. 10)

Location and Description

The Whispering Pines Subdivision is located on the north side of Georgetown-Denver Road approximately one mile north of Lake George. **Figure 7.4.10-1** is a general location map showing the Whispering Pines subdivision.

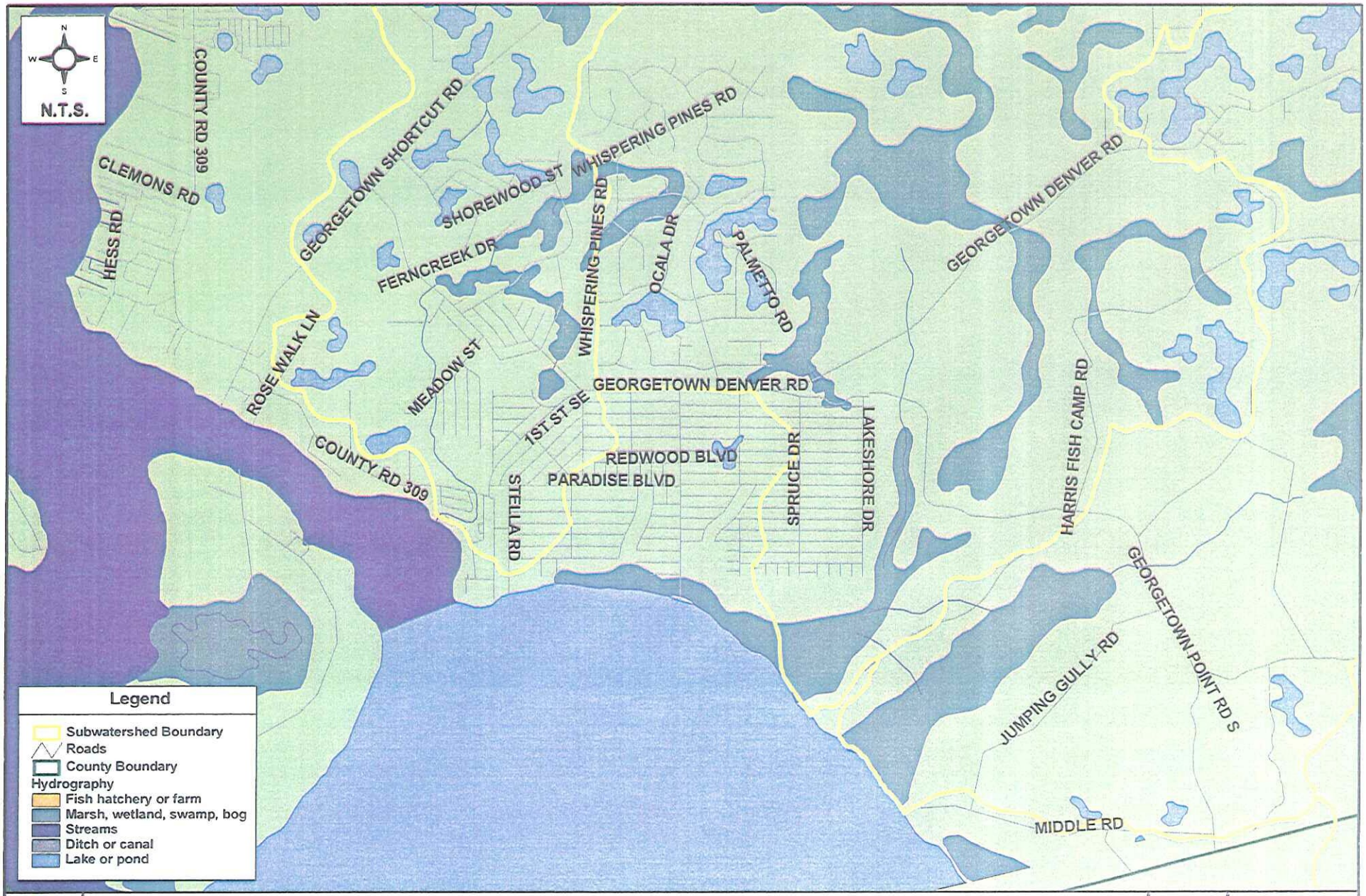
Problem Description

Local flooding is reported in this subdivision; predominantly sediment-laden road flooding from the dirt road. Road and occasional yard flooding is said to occur beginning with moderate rainfall.

During the recent field visit to this area, the majority of the roadside ditches were filled with sediment. The County maintains some of the drainage systems and roads in this subdivision.

Problem Summary

There are several ditches systems that convey stormwater through the neighborhood that are maintained by the County. The majority of the flooding problems can be alleviated through grading of the road and the roadside swales.



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP\GIS\APRs\
cip15through21.apr

Whispering Pines - Location Map
Putnam County Master Stormwater Plan

Figure 7.4.10-1

AVRES ASSOCIATES

7.4.11 COUNTY ROAD 315 AT 64TH STREET (RANK NO. 11)

Location and General Description

This problem area is located approximately one mile north of the Town of Interlachen on CR 315 near the intersection with 64th Street. **Figure 7.4.11-1** shows the problem area location.

Current land use surrounding the problem area is mostly low density residential along with a small section of forested uplands.

A small CIP project is required at this location to evacuate standing water on CR 315 that collects after storm events. Water collects north of the intersection of CR 315 and 2nd Lane, where the road curves to the east around Mariner Lake. Estimating from the USGS 10-foot contours, the drop in elevation is between 20 and 25 feet. Direct runoff on the road originates at the intersection of CR 315 and 64th Street and runs north, down gradient, past 2nd Avenue approximately 500 feet where it collects. A portion of 2nd Lane drains onto CR 315, and also runs along the down-gradient to the collection point. 2nd Lane is noticeably eroded, and the sediments have accumulated on the edge of the northbound lane of CR 315.

No accidents have been reported as a result of the standing water but there is a safety issue at this location. Photo 7.4.11-1 shows the location where the water collects and the curvature in the road. From a field observation, visibility of standing water would be poor for northbound traffic.

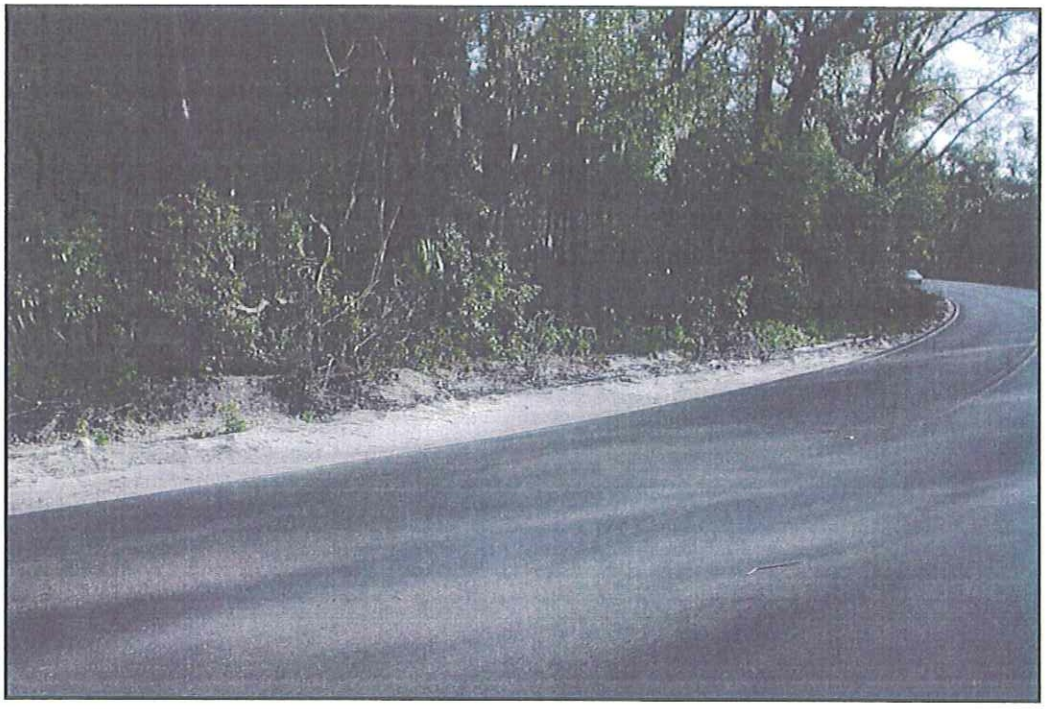
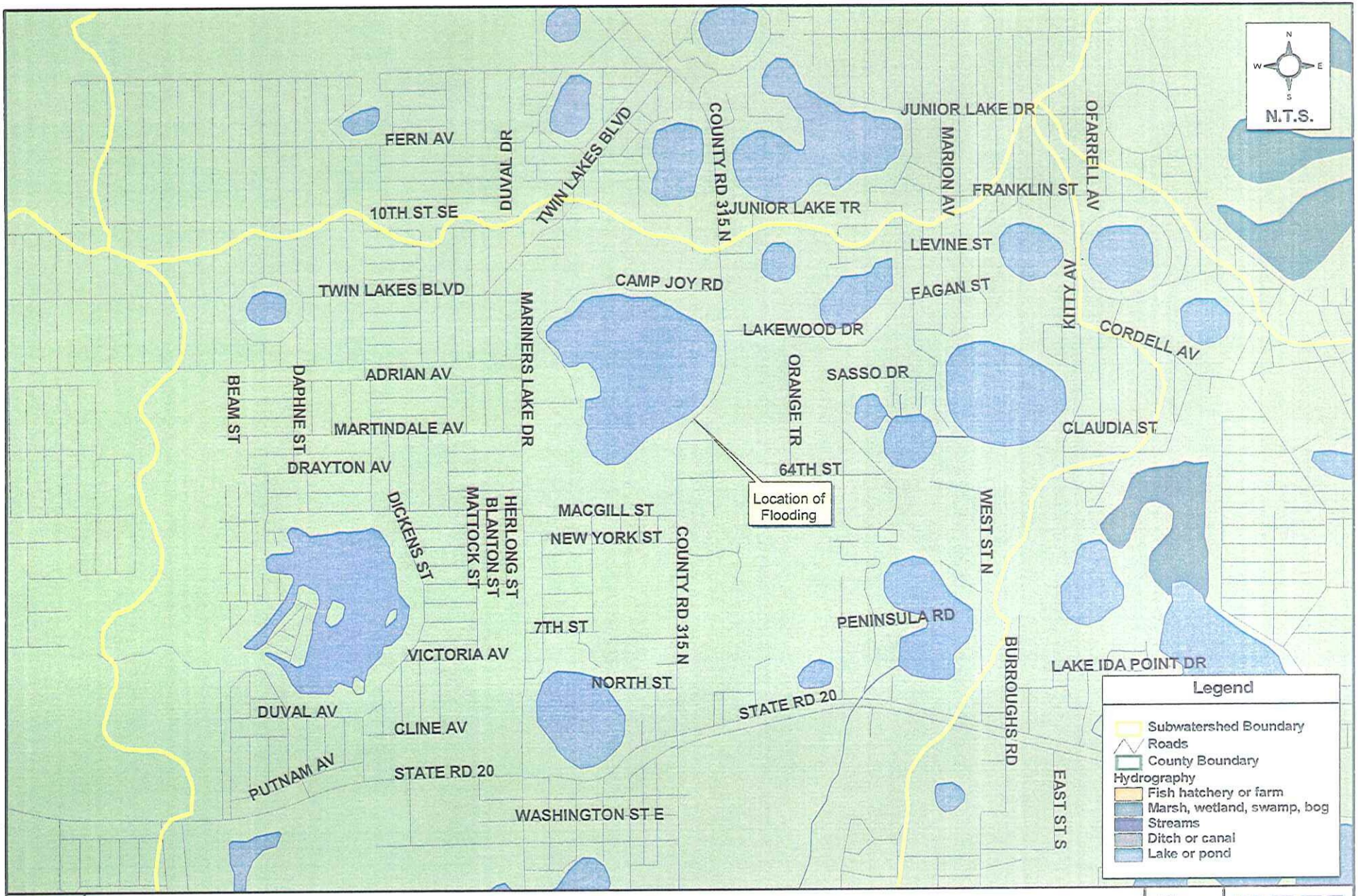


Photo 7.4.11-1 Curvature in Road on CR 315



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
cip 15through21.apr

County Road 315 at 64th - Location Map
Putnam County Master Stormwater Plan

Figure 7.4.11-1

AYRES ASSOCIATES

CIP Evaluation and Preliminary Cost Estimate

Figure 7.4.11-1 shows the runoff collection point on CR 315. This CIP area ranked eighth, and the solution is constructible, cost-effective and can be addressed on a priority basis.

Discharge is toward Mariner Lake. Due to the sediment content of the runoff from 2nd Lane, asphalting approximately 500 feet from the intersection of CR 315 and 2nd Lane east is required. The current accumulation of sediments on CR 315 and the location where the water ponds is evidence that omission of the paving component will cause frequent plugging of the DBI.

Due to the scale of the project and because some water quality treatment can be built into the design, the permitting requirements of the SJRWMD cannot be anticipated until an application is submitted. The proposed improvements will create a direct discharge into Mariner Lake, but flow from the culvert will pass over vegetated ground before entering the lake. Paving 2nd Lane will eliminate sediments. Creation of a shallow grassed swale on the east shoulder of CR 315 will also provide treatment and therefore adequate good faith efforts to minimize water quality impacts.

Recommendation

Obtain an ERP and construct the proposed improvements. An estimate of costs for the proposed CIP project is provided in the Table 7.4.11-1. Consulting fees for survey, design, CADD, and permitting are not included as it is assumed that these items will be performed by County design staff.

TABLE 7.4.11-1 COST ESTIMATE FOR CR 315 AT 64TH STREET

Index No.	Pay Item Des.	Units	Qty.	Unit Cost	Total Cost
104-10-1	Hay or straw bale (18"x18"x36")	Ea.	6	$6.00	$36
104-13-1	Staked silt fence	LF	500	$1.50	$750
430-982-625	Mitered end section (Conc. pipe round, 18" CD)	Ea.	1.00	$657.74	$657
575	Sodding (Bahia)	SY	444	$1.19	$528
425	Type-C DBI	Ea.	1	$2015.55	$2015
430-172-125	Pipe Culvert Round (18" CD)	FT	38	$43.82	$1665
120-1	Excavation - Regular	CY	296	$2.91	$861
285-703	Optional Base 3	SY	611	$5.90	$3604
377-7-20	Asph Conc.	TN	48.9	$57.02	$2789
101-1	Mobilization	LS		N/A	$2000
Project Total					$14,905

7.4.12 FLORAHOME DRAINAGE DISTRICT (RANK NO. 12)

Location and General Description

The Florahome Drainage District is a geographical subdivision within Putnam County. Generally, the District funded the maintenance of a network of drainage canals that discharged to Etonia Creek. No records establishing the District or describing its boundaries were found so more about the District can be established. The canal network and total contributing watershed boundary is shown in **Figure 7.4.12-1**. Three major branches are said to comprise the Florahome Drainage District, which are also shown on **Figure 7.4.12-1**. Beginning at the most upstream location, the main branch begins at Lake Grandin Outlet which is immediately south of State Highway 100, runs north for approximately one mile, then bends west and runs for approximately 3.3 miles where it intersects with Holloway Road. From its confluence with the main branch, the north tributary runs parallel west of Coral Farms Road for approximately 4,000 feet where it divides. At the divide where Hunt Road intersects Coral Farms Road, one branch bends due east for approximately 3,400 feet where it ends in a slough. The other branch continues north for approximately one and a half miles, then bends due west and runs for 1.2 miles (6,400 feet) where it ends. To provide a sense of the land uses they provide drainage for, the Florahome canal network is shown with 2004 color aerial photographs in **Figure 7.4.12-2**.

In recent the past none of the canals described above were maintained. According to a longtime resident, a dragline was formerly used for ditch maintenance approximately every 3 years. The County first identified it as one of the 28 Problem Areas. Maintenance was said to have lapsed since the Drainage District was dissolved over 15 years ago, and no funds or manpower had been available to maintain the system. The concern was that excessive vegetation growth, evident throughout the canal system, would reduce conveyance capacity during flood events and the system will overtop its banks and flood adjacent properties and roads. It should be noted that there was no reported out of bank or overtopping of the system during the hurricanes in the summer of 2004.

The County was able to perform ditch maintenance for a substantial portion of the ditch system in 2005, just before finalization of this Plan.

CIP Evaluation and Cost Estimate

This CIP evaluation includes a screening level comparison of the conveyance and resulting flow depths in the canal in the maintained and un-maintained condition using Manning's equation and flows for the 2.33-, 25-, 50-, and 100-year return frequencies. Issues related to Environmental Resource Permitting are also addressed in the section below.

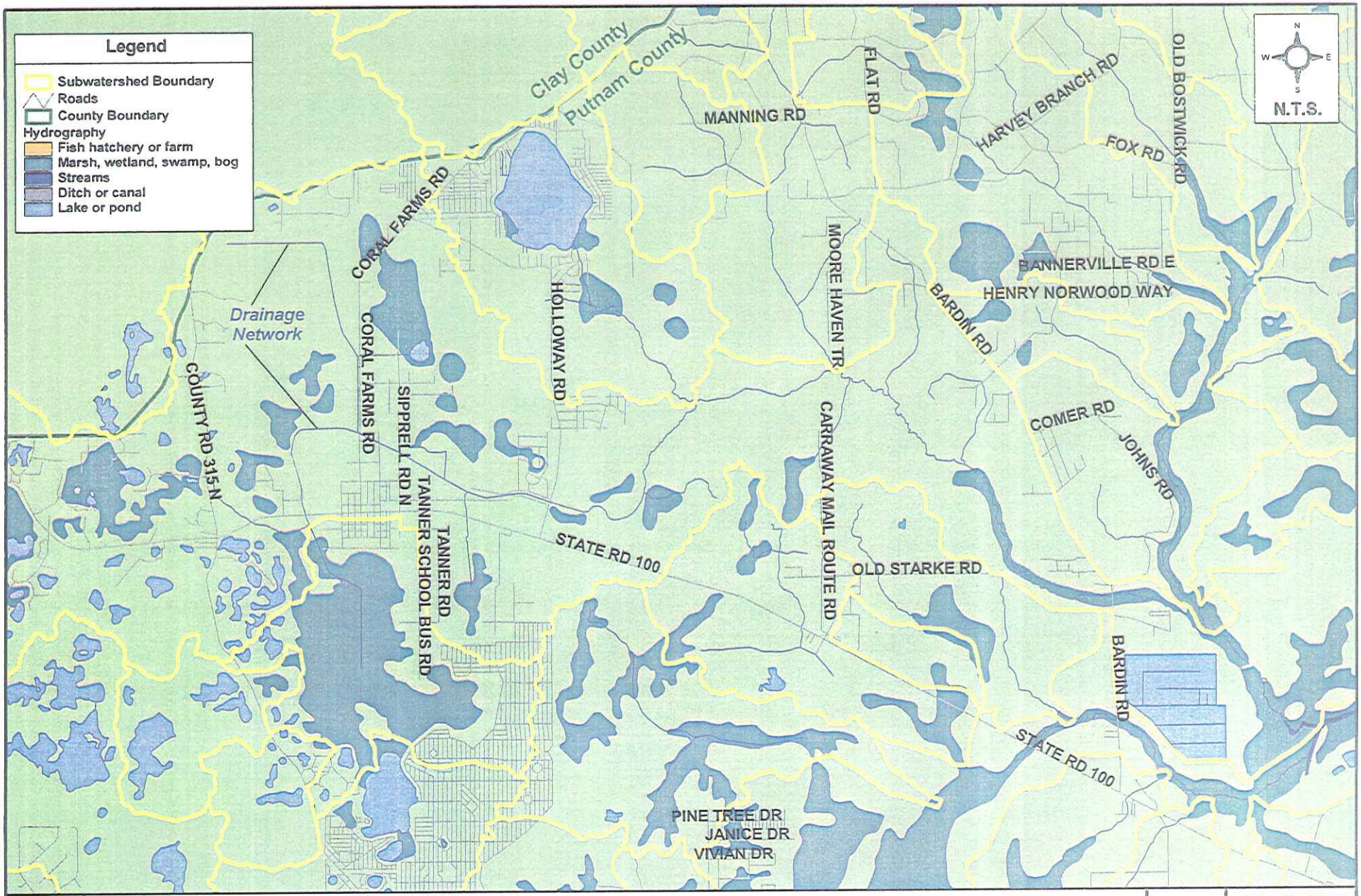
Conveyance/Depths

Manning's equation in its typical form is given below:

$$Q = \frac{1.49}{n} AR^{2/3}S^{1/2}$$

where:

A = Area
R= Hydraulic Radius
S= channel slope
n= roughness



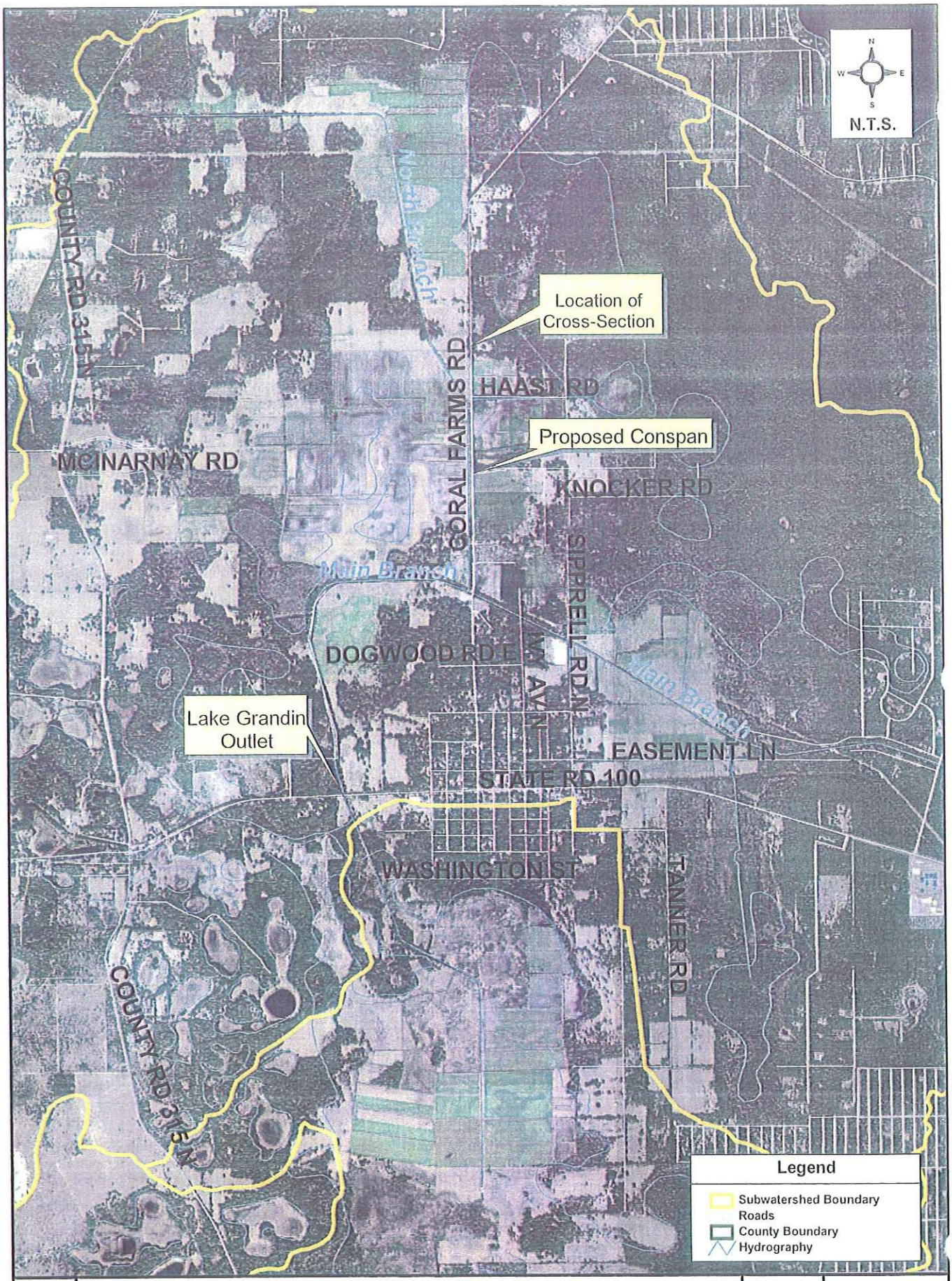
G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP\\GIS\APRs\cp_1through7.apr

Florahome Drainage - Location Map

Putnam County Master Stormwater Plan

Figure 7.4.12-1

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\
GIS\APRs\cip_1through7.apr

Florahome Drainage District - Location Map (Detailed)
Putnam County Master Stormwater Plan

Figure 7.4.12-2

AYRES ASSOCIATES

Field measurements to estimate cross-section dimensions were performed at the location shown in **Figure 7.4.12-2**. The bottom width was estimated as 14 feet, the top width as 52 feet, and the depth as 14 feet. Based on the USGS contours with 10-foot intervals available for the region, the assumptions for Manning's equation were as follows:

Basin/Canal Slope = 0.00044
Channel Side Slopes = 1.5
$n_{maintained} = 0.10$
$n_{unmaintained} = 0.04$

The location for which the flows are computed is also shown in **Figure 7.4.12-2**. The estimates for flow, calculated for the cross-section locations were taken were estimated with the Federal Highway Administration (FHWA) Regression Equations (DOT, 1987).

The FHWA regression equation is of the form:

$$Q_p = 0.0214 DA^{0.44} RL^{1.64} dZ^{0.785}$$

where:

DA = Drainage area =0.9 mi^2
dZ = Difference in Elevation from top of Watershed to point of Flow = 5 ft
R = USLE Rainfall Factor as taken from the Figure in the Appendix = 500
$Q_p = 0.0214(0.9)^{0.44} (500)^{1.64} (5)^{0.785}$

The flows computed from the regression equation are contained in the table below as are the corresponding flow depths in the Florahome Canal system using Manning's equation.

Manning's n	2.33-yr (787 cfs)	10-yr (1919 cfs)	50-yr (3335 cfs)	100-yr (3920 cfs)
0.1	16.0	23.5[1]	30.0[1]	32.5[1]
0.045	11.1	16.6	21.2[1]	23.1[1]

1- Out of bank

Manning's equation in this case can provide only an estimate of flow depth within the Florahome network. As a check, a four cross-section HEC-RAS model of the culvert crossing under Coral Farms Road to determine if the 9' x 15' pipe arches controlled was developed, and ran for all of the flows in the table. Depths computed by Manning's equation and the HEC-RAS model were reasonably close to one another. In addition, without topographic contours, it was impossible to estimate overbank storage. Because the canal is approximately 14 feet deep at the top-of-bank, all depths in the table above 14 feet are not realistic. The purpose of reporting the values in the table is to provide an indication of the degree the system will respond to maintenance and to provide an indication of the level of service the canal may provide. After accounting for the approximate nature of the analysis, the canal likely provides between a 10- and 25 year level of service in the maintained condition.

Permitting

The Florahome drainage system network fits all the definitions of a system that is exempt from permitting provided the activity is limited in scope to routine maintenance. However, paragraph 3. 4.1(e) in the Applicant's Handbook: Management and Storage of Surface Waters, November 11, 2003, St. Johns River Water Management District, states the following:

(e) Exemptions for certain maintenance activities are provided in paragraphs 403.813(2)(f) and (g), F.S." The exemption in 403.813(2)(f), F.S. addresses the maintenance dredging of

existing manmade canals and channels, which include navigation basins and ship's berths; intake and discharge structures; and previously dredged portions of natural water bodies within recorded drainage rights-of-way or drainage easements. The exemption in 403.813(2)(g), F.S., addresses the maintenance of existing insect control structures, dikes, and irrigation and drainage ditches. These exemptions have a number of limitations or conditions, which are further described below. 1. Routine custodial maintenance. The maintenance exemptions in paragraphs 403.813(2)(f) and (g), F.S., allow only routine custodial maintenance having no more than a minimal adverse environmental impact. In order to be considered routine custodial maintenance that has no more than a minimal adverse impact on the environment, the maintenance must occur on a frequent enough basis to ensure that the system continues to function as originally designed. The District recognizes that a partial loss of function will occur over a period of time prior to routine custodial maintenance. However, should a system be allowed to deteriorate over a period of time to the extent that it no longer functions, then restoring the system to its original design is not exempt from the requirements to obtain a permit. A system is considered to no longer function when it no longer fulfills its originally intended purpose or the repairs needed to restore the system to original design are so extensive that they would cause more than a minimal adverse environmental impact. Examples of originally intended purposes of systems include:

a. dikes - preventing flooding to enable specific agricultural, urban or recreational land uses;
b. irrigation ditches - conveying water from a water source to a water use area;
c. drainage ditches - draining lands to enable specific agricultural, residential, commercial or recreational landuse;
d. drainage ditches - draining lands to enable harvesting, site preparation, and regeneration of silvicultural lands during timber rotations;
e. canals - conveying water for flood control or draining lands to enable specific land uses or navigational uses; and
f. channels – specific navigational uses. (This list of examples is provided to assist maintenance entities and is not all-inclusive). The only instance when repair of a non-functioning system would be routine custodial maintenance is when the system has lost functionality due to a sudden event such as a large storm. In such a case the repair must be conducted as soon as practicable after the damage occurs, but in no case later than June 1 of the next calendar year. This serves to ensure a continuity of function during the wet season, which generally occurs between June and October in the District. If the June 1 deadline would result in a substantial hardship or would violate principles of fairness, the maintenance entity may seek a variance from the requirement pursuant to section 120.542, F.S. The evaluation of environmental impacts will compare the environmental conditions prior to conducting the proposed maintenance activity with the expected environmental conditions that would result from the proposed maintenance activity.

Environmental impacts that are considered to be more than minimal include: increasing or decreasing water levels in wetlands or other surface waters in a manner that adversely impacts fish and wildlife or their habitat as described in sections 12 through 12.2.8; increasing water levels off-site in a manner which causes flood damage as described in paragraph 40C3- 11 (MSSW - 7/8/01)

Because the canal has not been maintained in many years, it may be considered to have "deteriorated over a period to the extent that it no longer functions" and is not exempt from requiring a permit to maintain The issues in the permit may address conveyance, but the emphasis will be on the ecology and natural systems. Consulting fees to complete a Noticed ERP are included in the cost estimate below.

Maintenance must also be limited to removal of vegetation. Regulations now state that unless demonstrated otherwise, sediments and muck removed from drainage systems are considered hazardous waste. To remove muck, extensive testing and evaluation is required to demonstrate

that the muck contains no hazardous materials. Also, stockpiling any muck removed from the system will require an approved storage facility.

Culvert Arch - Coral Springs Road
In addition to the issues related to the maintenance of the system, it is necessary to make a rough initial assessment of the 14' x 9' single span, steel arch plate corrugated metal culvert for Coral Farms Road approximately 1,000 feet south of Hunt Road. The culvert is seriously deteriorated along the springlines with significant section loss, with the south end appearing to have settlement due to underlying scour.

Bridge structures are typically inspected and rated according to the National Bridge Inspection Standards (23 CFR 650.3). Qualifying structures that are 20' or longer are inspected every 2 years or less under Florida Department of Transportation Bridge Inspection Program in accordance to FHWA, FDOT, ASSHTO guidelines. Non-qualifying structures are recommended to be inspected under the County's bridge inspection program.

With the limited information available, a NBI Rating of 3 would be suggested for the culvert with a 6-month interim inspection cycle. This is a very low rating and is encroaching on closing the roadway. The PONTIS Condition State for the culvert element, Element 240, would most likely be rated low at a 4 and the channel element, Element 290, would also be rated low at a 4 due to the settlement of the culvert and the possibility of scour and piping. Evidently, backfill is leaking through the holes in the culvert at the springline and roadway maintenance is ongoing.

Recommendations

Routine Maintenance
Maintenance should be conducted at regular intervals as described in Section 5 of this Master Stormwater Plan.

Coral Springs Road Crossing (Culvert)
Pending sufficient budget availability, the recommendation is to replace the existing culvert. Following is a cost estimate for a 16 foot wide Conspan to replace the existing 14' x 9' Arch. **Figure 7.4.12-3** is a drawing of the recommended Conspan (not to scale).

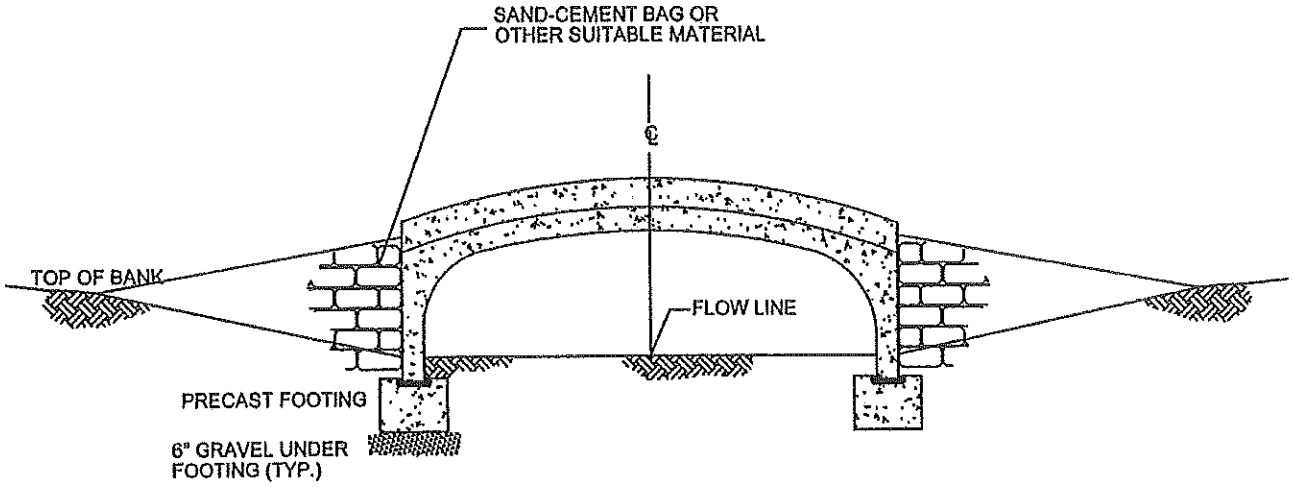
Pre-cast concrete arch (16 foot span)

Item	Cost
Arches	$12,400
Footers	$1,800
Headwalls	$3,250
Wingwalls	$5,000
Subtotal	$22,450.00
Construction (Structure x 1.5)	$33,675
Total Cost	$56,125

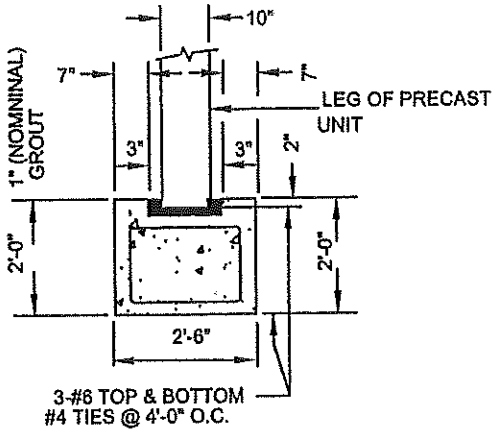
If a replacement date in 2006 cannot be established, some preliminary recommendations with respect to monitoring are as follows:

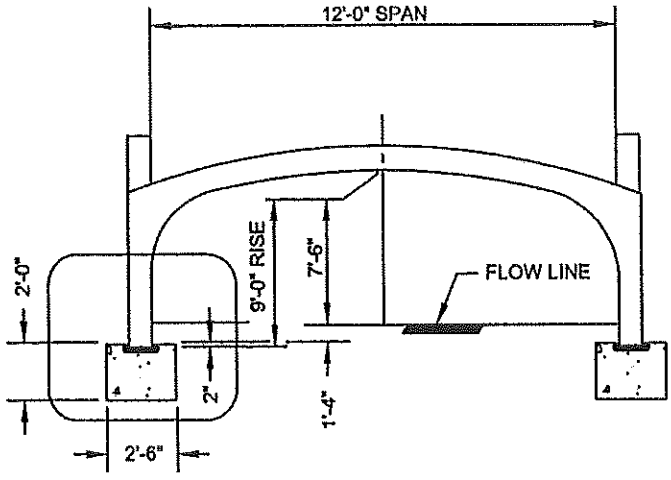
- Have and in-depth inspection performed, if not already in a program, to determine the extent of the existing culvert conditions
- Have a load rating analysis performed to determine the capacity of the existing culvert

- Determine if Coral Farms Road is posted and update accordingly, or close the location, if necessary
- Perform repairs or replacement, if necessary



CULVERT SECTION





CULVERT SPAN DETAILS

G:\COUNTY - PUTN\PUTNUMCDSWMP\CIPS\FLORAHOMEDRAIN\FLORAHOMEDRAINAGEDISTRICT.DWG

7.4.13 EAST RIVER ROAD (RANK NO. 13)

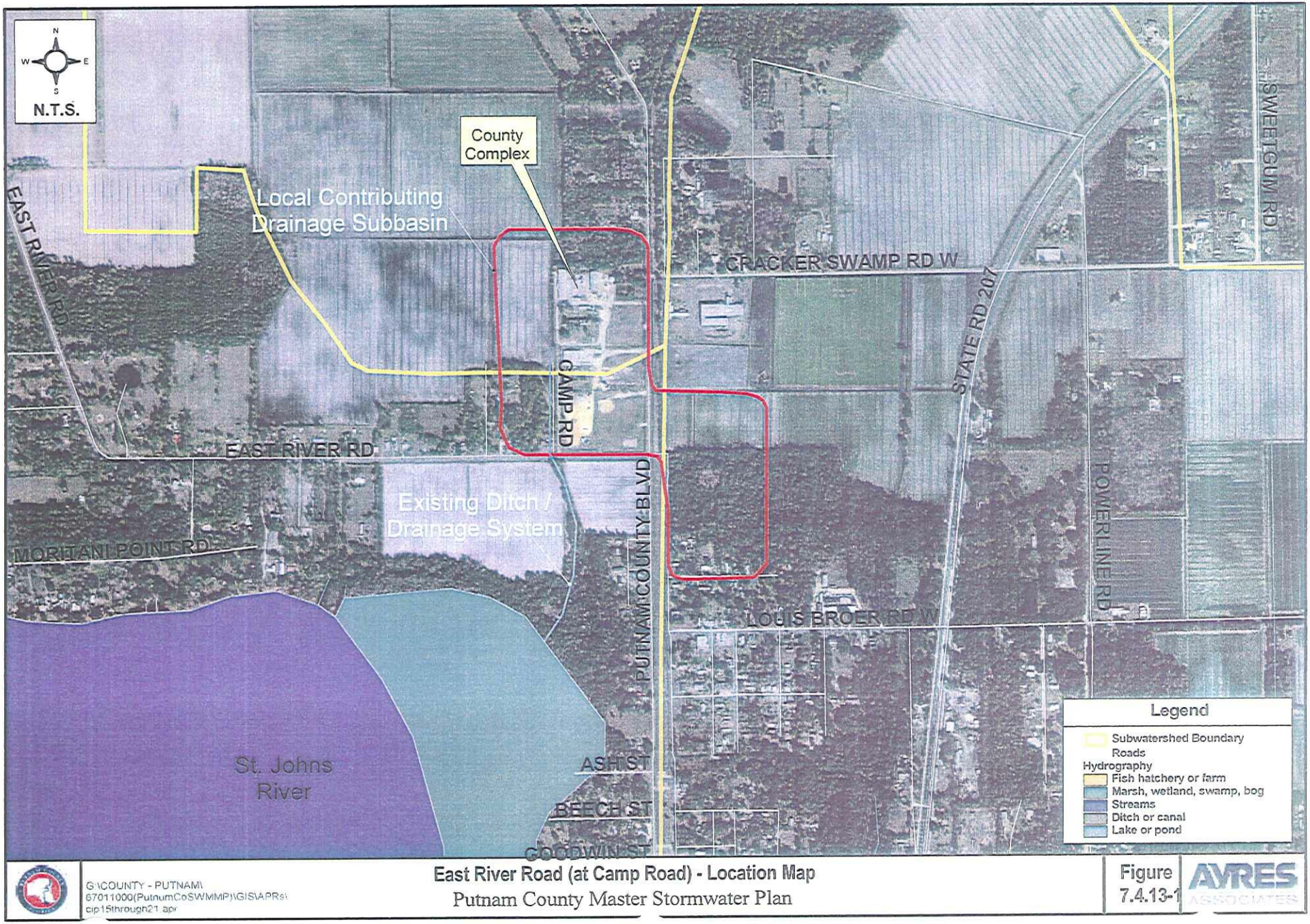
Location and General Description

A generalized view of Camp/East River Road area is shown on **Figure 7.4.13-1**. For the most part the area of concern and the area that the CIP project was developed for is the Putnam County Public Works Facility. It is on the northeastern side of Palatka. It is bounded on the west by Putnam County Boulevard, the north by Fulwood Road, and the south and east by East River Road. There are three principle land uses, the County Public Works facilities on Putnam County Boulevard, agriculture, and medium and low density residential. The County facilities consist of the offices for the public works and maintenance departments, parking lots, stockpile areas, and the maintenance garage. The GIS land use attribute table specifically describes the agriculture as potato and cabbage crops, which was confirmed by County staff. Generally, the residential areas consist of individual parcels (versus subdivided plats) along the main roads but some of the residential uses are adjacent to or interspersed with staging areas and garages ancillary to the agricultural operations.

The flooding in this area consists of site flooding in the County Public Works facilities on Putnam County Boulevard, and inundation of various topographically low areas within the drainage basin. According to County staff the parking lots, the clay and limerock stockpile area, and the maintenance garage are all inundated an average of twice a year. Incidents of flooding in the office spaces are limited to one event. No residential flooding is known to occur.

The flooding within the County facilities is caused by a relatively large drainage basin which discharges through an undersized and poorly maintained outlet under East River Road. Using the USGS 5-foot topographic quads, interpretation of digital ortho photo quads, and observations in the field, the contributing drainage basin is approximately 30 acres. **Figure 7.4.13-1** also shows the drainage basin. The most downstream segment of the drainage system for the basin is also shown in **Figure 7.4.13-1** and in Photo 7.4.13-1.

Photo 7.4.13-1. Downstream segment of the drainage system



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
cip15through21.apr

East River Road (at Camp Road) - Location Map

Putnam County Master Stormwater Plan

Figure 7.4.13-1

AVRES ASSOCIATES

The segment runs parallel to Camp Road and surcharges into the County facilities. The bottom width is approximately 3 feet with 2:1 side slopes. The ditch is connected to a 3' x 6' box culvert under East River Road. In addition to requiring maintenance, the system appears to be undersized relative to the drainage basin. Flooding is further exacerbated by artificially high antecedent soil moisture and water levels in the surrounding farmlands. At the time of the field inspection, the area immediately adjacent to and north of the County complex was being irrigated. The drop inlet structures were closed off and water was backed into the furrows. Essentially, no storage capacity was available in either the soil or the drainage system and system overtopping would likely have occurred from a marginal event. Downstream of the box culvert under East River Road, flow is conveyed through a somewhat irregular shaped trapezoidal ditch, having a depth measured during the field visit of between five and eight feet, a bottom width of 10 feet, and 1:1 or 1.5:1 side slopes. The ditch outfalls to the St. Johns River. The spoil from the past ditch excavation(s) was left on the banks. There has been no apparent channel maintenance in recent years.

The soil types within the basin are Riveria, Pomona, Wabasso, Wauchula, and Winder. All of these soils are classified as Hydrologic Soil Group D (the highest of the four classifications for runoff potential), and not favorable for dwellings, commercial buildings, local roads, or landscaping.

CIP Project Development

Analysis Approach

The drainage basin size, land use, soil type, and the size and condition of the outlet all combine to increase flood potential within the basin. To estimate what improvements to the existing system would be required to provide a minimal level of service, a simple hydraulic capacity analysis or screening analysis was performed by using the Rational Method for runoff and the steady state option of the Army Corps of Engineers HEC-RAS modeling software to compute water surface elevations. The intensity term in the Rational Equation was taken from the IDF curves in the FDOT Drainage Manual (FDOT, 1987). This was a screening level analysis only, and should not be considered suitable for application as a final design. The first model run approximated existing conditions; the second approximated the improvements that would result from simple maintenance of the ditch between East River Road and Camp Road; and the third, the improvement that would result from increasing the conveyance in the ditch from a 2-foot to a 3-foot bottom width. The 2-,10-,25- and 100-year return frequency events were simulated.

Analysis Results

Table 7.4.13-1 summarizes elevations at the upstream end of the ditch and the upstream side the box culvert at East River Road.

TABLE 7.4.13-1 COUNTY COMPLEX ELEVATIONS

Cross-section Location	Unmaintained 3' x 6' Box Culvert	Maintained 3' x 6' Box Culvert	Incr. Convey. 3' x 6' Box Culvert
Upstream End			
2-yr	16.53	14.76	14.38
10-yr	17.03	15.07	14.67
25-yr	17.43	15.28	14.90
100-yr	17.93	15.54	15.17
East River Road & Camp Street			
2-yr	13.98	12.99	12.67
10-yr	14.26	13.21	12.91
25-yr	14.45	13.34	13.16
100-yr	14.68	13.58	13.49

Routine Maintenance Alternative

To simulate routine maintenance, the Manning's roughness value for the cross-sections upstream of East River Road was set to 0.045. In an effort to minimize future maintenance commitments, the simulation assumed that the cross-sections roughness values downstream of East River Road would not be reduced.

The simulation showed a reduction of 2 feet in the WSE at the upstream side of the ditch and approximately 1 foot at the box culvert for all the return frequencies. All of the WSE hovered around 15 feet, the TOB of the ditch, although the 2-year frequency was below the TOB.

A 2-foot reduction in WSE is a considerable improvement even when accounting for uncertainties of the data, and the model on which the data are based. Most noteworthy is the close proximity of the water surface to the TOB. The 100-year return frequency for example, at the upstream end of the ditch, is 0.54 feet above the TOB, too close to definitely state that maintenance will, or will not provide a drop in peak water levels necessary to eliminate the flooding at the County facilities/complex. More discussion on the uncertainties is provided below in the Recommendations section.

Ditch Improvements

Ditch improvements were simulated by increasing the cross-section to 2:1 side slopes and a 3-foot bottom. As with the routine maintenance simulation, the Manning roughness value was set to 0.045 to represent a maintained condition.

The response of the model was a decrease of approximately 0.30 in the water surface elevations for the all of the return frequencies, with only the peak WSE for 100-year frequency exceeding the TOB. These small differences are however within the uncertainty of the model, thus it is not possible to predict if improvements to existing cross-section is necessary, or adequate to remedy the flooding problem at this location.

Recommendation and Preliminary Cost Estimate

The model results do not indicate that the box culvert under East River Road requires replacement, and that improvements can be limited to work in the ditch. The recommendation, given the uncertainties in the model, is to perform maintenance on the system and rely on monitoring to determine if the maintenance is an adequate to solution to the flooding problems.

If after maintenance the flooding does not abate, a small local scale routing model and design may be required.

Because this is a relatively simple maintenance activity that would likely be performed by County staff, no costs were estimated.

7.4.14 SARATOGA HARBOR (RANK NO. 27)

Location and General Description

The Saratoga Harbor area is east of CR 309 and immediately east of the St. Johns River. Figure 7.4.14-1 shows the general location. Some of the homes in Saratoga Estates are on the river. Saratoga is a medium density residential community with dirt roads, below grade septic tanks, wells, and both block masonry homes and manufactured (mobile) homes. It is characterized by well-drained soils and relatively steep grades with uncharacteristically high topographic relief, ranging from 95 feet to 5 feet NGVD.

This area was formerly ranked as 11th, however the County is currently implementing improvements and no longer requires further study of this system. Original evaluations are supplied in the following paragraphs.

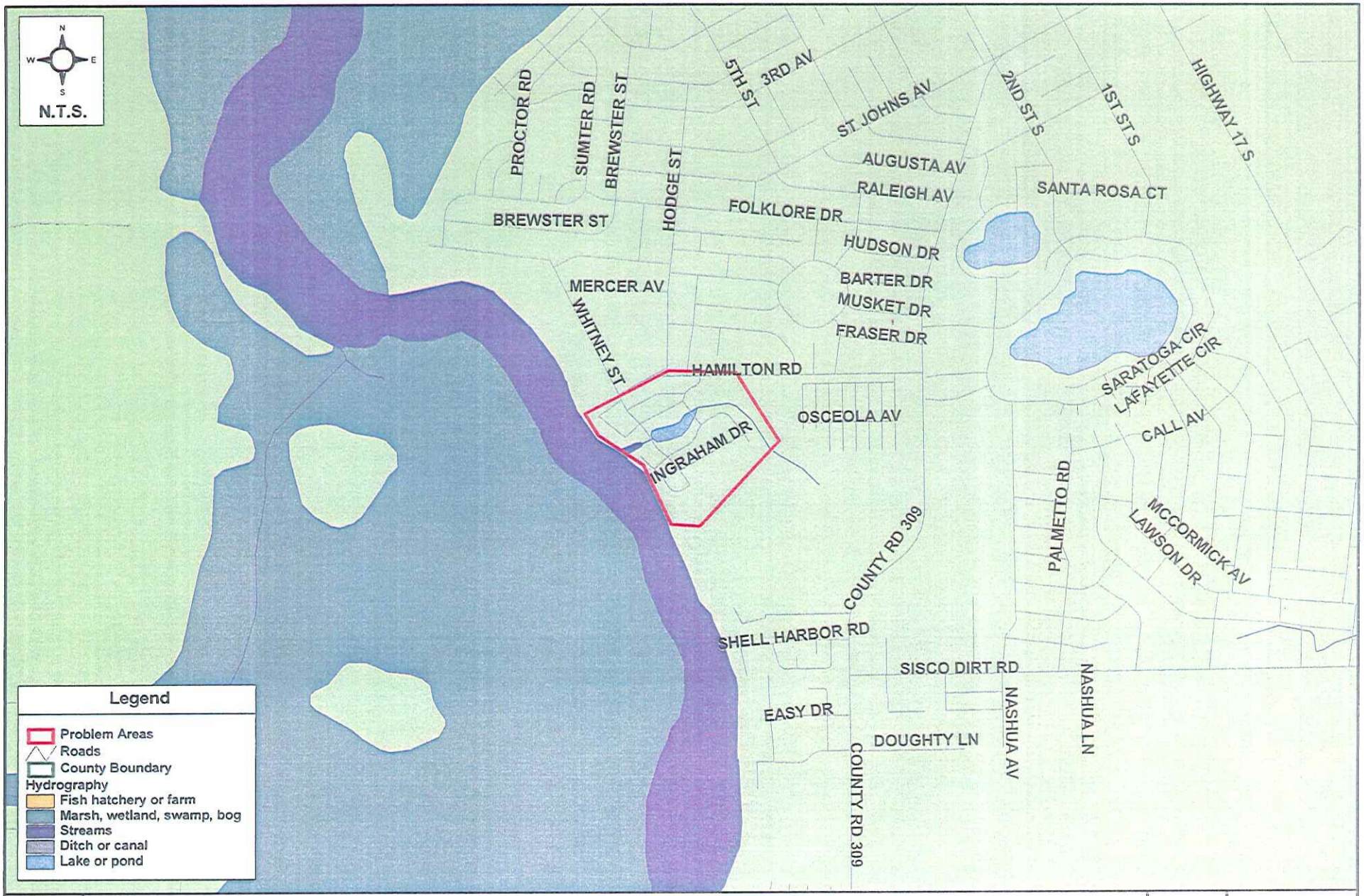
The area of Saratoga that is of concern is the most downstream of the two ponds formed by roadway embankments. USGS contours show that the ponds were once a short tributary to the St. Johns River. The construction of two embankments across this tributary created ponds. A third pond, immediately north of Hamilton Road appears to be natural. The Hamilton Road pond is connected to the most upstream of the manmade ponds by a 24-inch CMP. This upstream manmade pond is connected to the downstream manmade pond by a 24-inch CMP and a grated overflow structure under one of the roadway embankments named Ketter Place. A second roadway embankment (Gibbs Avenue) separates the second manmade pond from what remains of the tributary, essentially a 500-foot long boat canal off the St. Johns River. Flow through this second embankment is through three drop board risers. All three risers are 18-inch diameter CMPs. Drop boards were in place at the time of the field visit on June 1, 2004. There is also an overflow consisting of two 24-inch inch diameter CMPs running parallel to the drop board risers. All five of the conduits described above are approximately 100 feet long. The three CMP risers were recently sleeved with HDPE. The width of the boat canal is approximately 110 feet. One side is populated by single family residences with individually owned docks and boat lifts, and the other side with relatively new boat slips that are owned by Saratoga Harbor's homeowner association.

Problem Description

On the surface the Saratoga Harbor problem can be characterized as a sedimentation/dredging issue within the 500-foot canal directly connected to the St. Johns River.

A resident stated that depths in the canal have gone from 3.5 feet to 1.8 feet. The homeowners assert that the sedimentation is the result of erosion that began with piping at the drop board structures that eventually eroded a large volume of material from the embankment. The County generally agreed that the sediment in the canal is from the embankment (Gibbs Avenue), and plans to fund dredging of the canal. Assuming the source of the sediments is the road, an alternate explanation for the culvert failure, developed using a simple HEC-HMS model is provided below.

In addition to the embankment failure, sediments suspended in tidal flows appear to be falling out around the pilings that support the docks, filling in the boat slips. Photo 7.4.14-1 shows sediment buildup at the most western end of the boat slips where velocities are first affected by the pilings. The amount of sediment in the canal does not appear to be consistent with the amount of material that would have eroded and filled in the canal. There is also no visual evidence that dirt roads in Saratoga Harbor are contributing to the sedimentation deposits in the canal.



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
problem_areas 15through21.apr

Saratoga Harbor Problem Area
Putnam County Master Stormwater Plan

Figure
7.4.14-1

AYRES ASSOCIATES

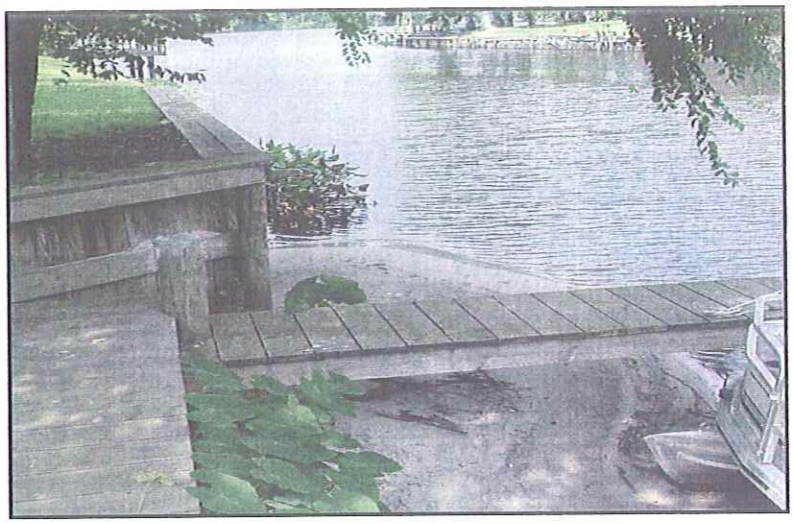


Photo 7.4.14-1 Standing at west end of dock facility where sedimentation begins

CIP Evaluation and Cost Estimate

The County has tentatively decided to dredge the canal. To assess the risk of another failure of Gibbs Avenue, a runoff model was developed with HEC-HMS. The high slopes around the lake make accurate delineation of the drainage basin with USGS 5-foot interval contours possible. A drainage basin, Tc, and CN were developed with existing shape files. Stage-area relationships were also developed along with the basin parameters, and were placed into HEC-HMS for hydrologic modeling.

A schematic of the model is provided in **Figure 7.4.14-2**. All three lakes were modeled as reservoirs with orifices and weirs representing the culverts under Gibbs Avenue, Ketter Place, and Hamilton Road. Some survey data exist for the road crossings but was not available for the scheduled submission of this report. Revisons to this report will incorporate the survey data; the existing model input elevations had to be approximated.

The model output is shown in **Figure 7.4.14-3**. The reservoir overtopped during the 10-year flood indicating, approximately, that it will overtop every 10 years. Based on this frequency it is recommended that the embankment be stabilized with Geoweb. A Plan and Profile drawing is provided as **Figure 7.4.14-4**. Essentially the Geoweb will be placed from shoulder of pavement to waters edge on both sides. Stability of the Geoweb is achieved with a sod covering. A cost estimate is provided in **Table 7.4.14-1**.

TABLE 7.4.14-1 COST ESTIMATE FOR SARATOGA HARBOR

Index No.	Pay Item Des.	Units	Quantity	Unit Cost	Total
104	Staked silt fence	LF	510	$1.50	$765
145-71	Geogrid	SY	680	$10.83	$7,364
575	Sodding (Bahia)	SY	700	$1.19	$833
	Dredging	SY	600	$45.00	$27,000
	Project Subtotal				$35,962
101-1	Mobilization @5%	LS			1,798
	Project Total				$37760

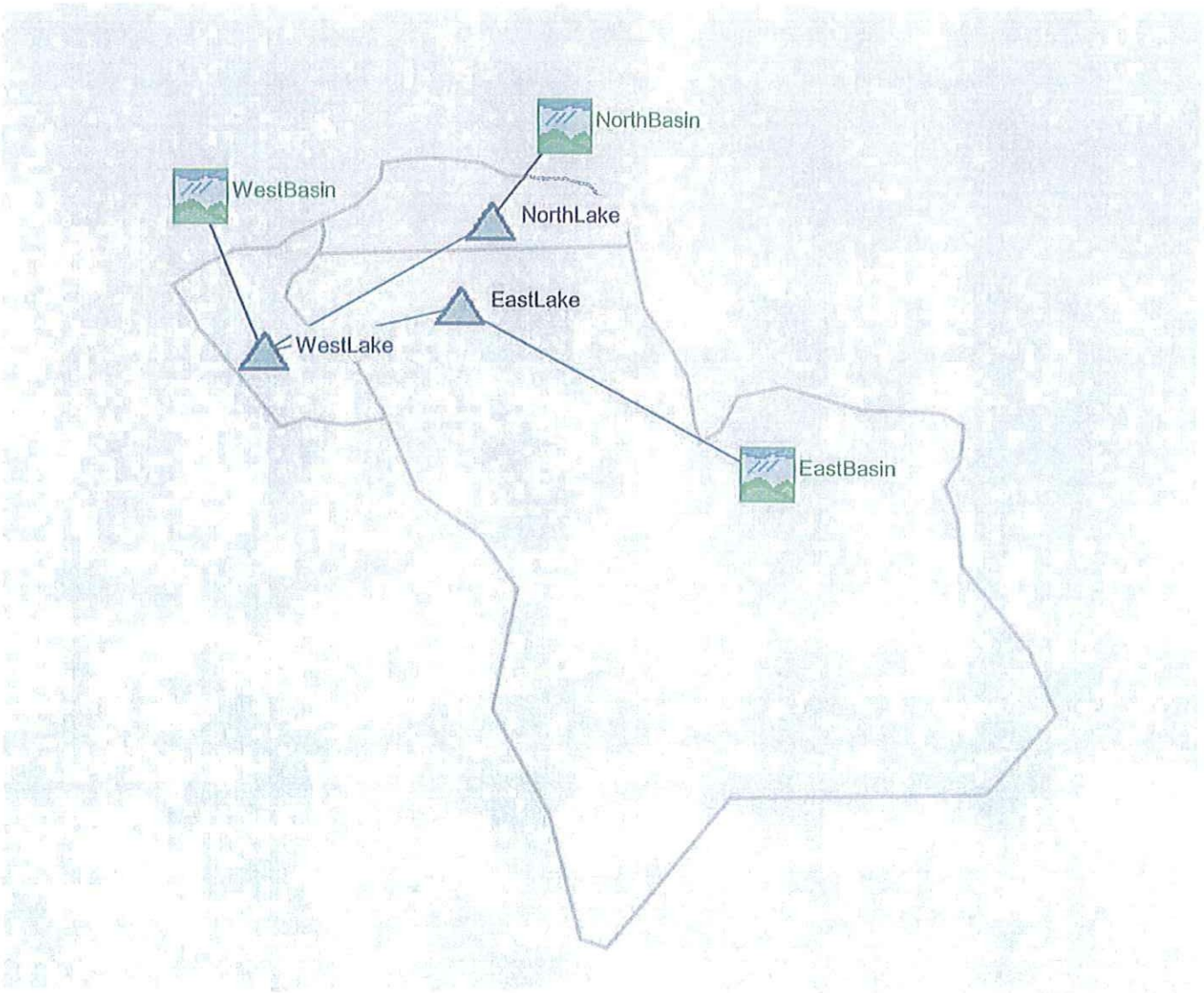


Figure 7.4.14-2

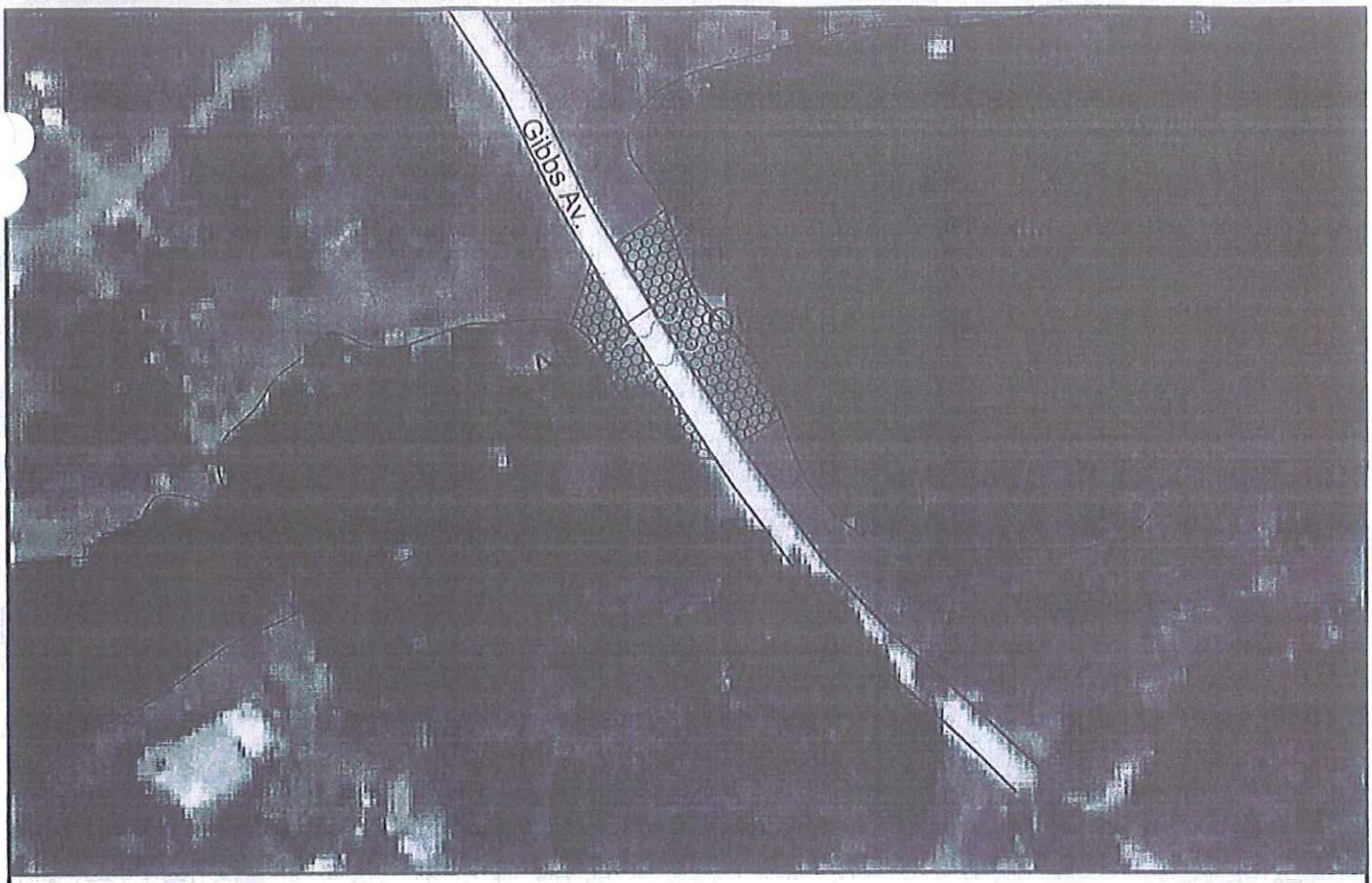
HMS * Summary of Results

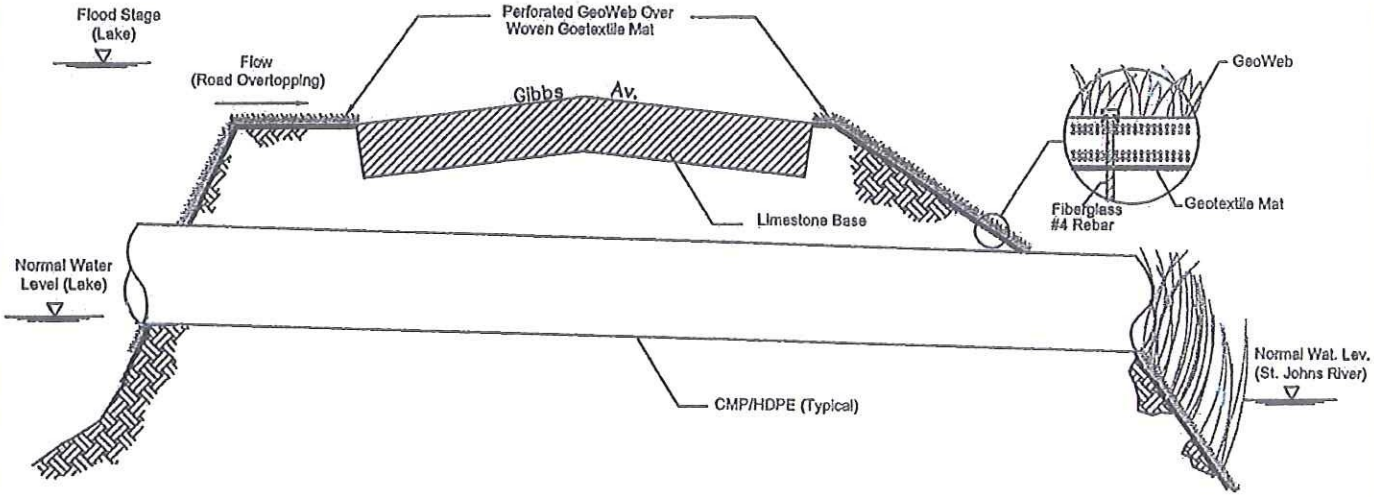
Project : Saratoga Harbor Run Name : 25-yr

Start of Run : 10Dec04 0000 Basin Model : Saratoga Drain Basin
End of Run : 11Dec04 2400 Met. Model : 25-yr
Execution Time : 31Jan05 1509 Control Specs : 25-yr

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
EastBasin	1051.9	10 Dec 04 1240	195.04	0.910
EastLake	928.63	10 Dec 04 1255	182.33	0.910
NorthBasin	229.26	10 Dec 04 1218	27.402	0.072
NorthLake	191.07	10 Dec 04 1229	25.805	0.072
WestBasin	341.04	10 Dec 04 1203	24.540	0.060
WestLake	979.50	10 Dec 04 1307	227.76	1.042

Figure 7.4.14-3





Section A-A'

Typical Cross-section Slope Stabilization Detail

N.T.S.

I:\GIS\PUTNUMGIS\MAPS\CIPS\SARATOGA\SARATOGA_GEOWEB_REV2.DWG

G:\COUNTY - PL

Lake Overflow Slope Stabilization
Saratoga Harbor CIP
Evaluation & Preliminary Cost Estimate
Putnam County Stormwater Management Plan

Figure 7.4.14-4

AYRES ASSOCIATES

Recommendation

Perform dredging as discussed with Saratoga Harbor Homeowners Association and place Geoweb as shown.

7.4.15 MONDEX (RANK NO. 28)

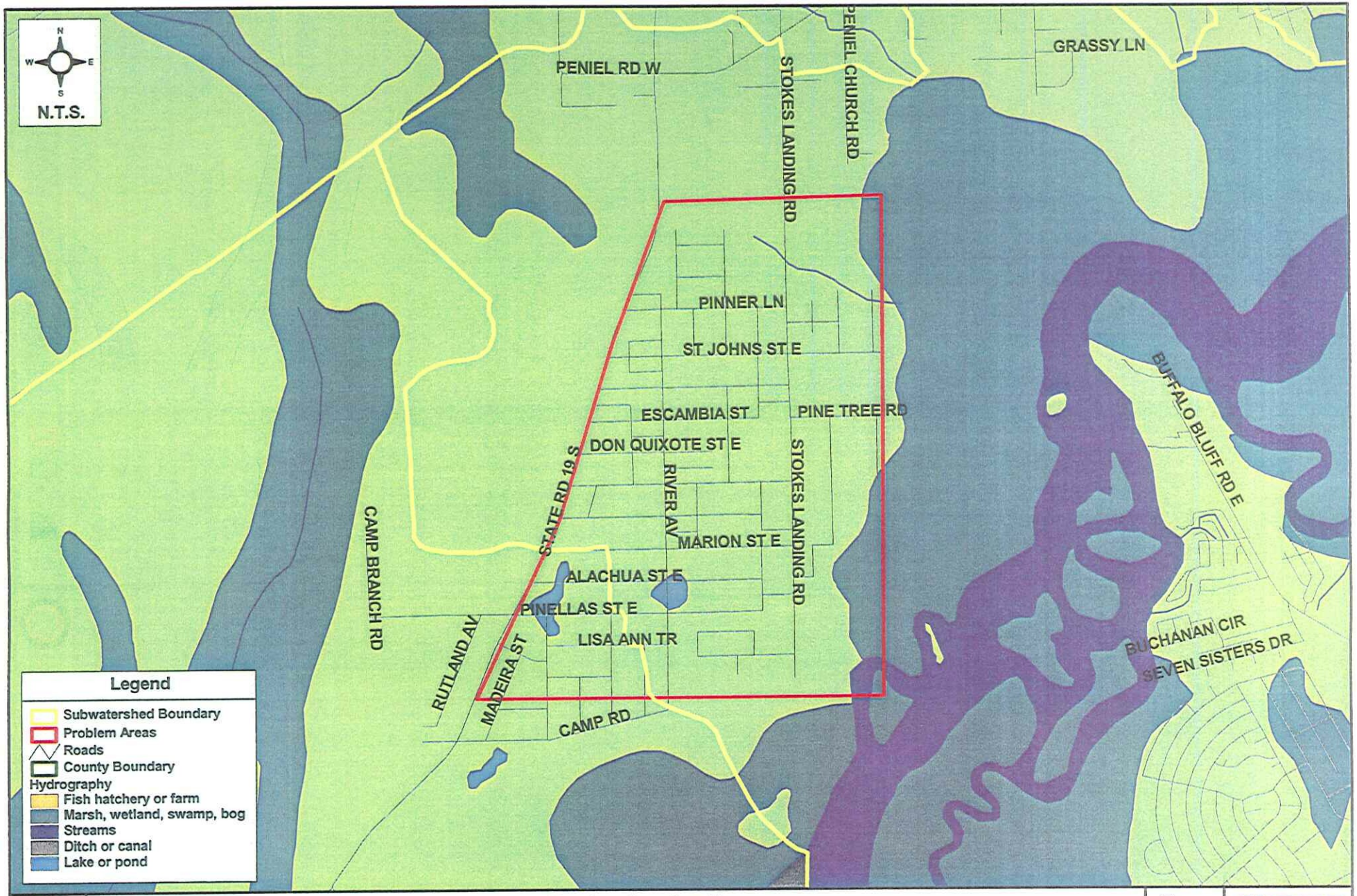
Location and General Description

Mondex is located approximately 6 miles southwest of Palatka, directly adjacent to the St. Johns River. **Figure 7.4.15-1** is a generalized location map showing the Mondex area. **Figure 7.4.15-2** is a smaller scale, digital ortho-photo quad that shows some of the features of the area, including West Peniel Road, Pinellas Street, and SR 19, which bound Mondex to the north, south, and west respectively. The drainage basin for Mondex is also shown in **Figure 7.4.15-2**, beginning just under a mile west of SR 19 and draining east toward the St. Johns River through four unnamed creeks. The creeks lose definition as they intersect with the river's floodplain forest, seen in the eastern most part of the graphic.

Infrastructure in Mondex primarily consists of mounded and below-grade septic tanks, wells, and both block masonry homes (many of which are on-grade) and manufactured (mobile) homes. The existing grade is natural in some parts, but is filled in others. According to County staff the source of the fill is typically borrow areas that are visible in **Figure 7.4.15-2**. There are approximately 37 of these areas in the Mondex subbasin; a typical borrow area is seen in Photo 7.4.15-1.

Roads in the area are mostly unpaved. The County currently maintains Stokes Landing Road, Park Avenue, East Pinellas Road, and Royal Palm Road. The remainder of the roads require maintenance. Some of the manufactured homes are elevated to County code, but many are elevated several additional feet, presumably for flood protection. County personnel commented that the area was originally developed in the 50' and 60's. FEMA flood zones are shown in **Figure 7.4.15-3**. There are two principal zones within Mondex, A (area within a 100-year flood) and X, an area outside of the 100-year flood but within a 500-year flood.

Photo 7.4.15-1 Mondex borrow areas

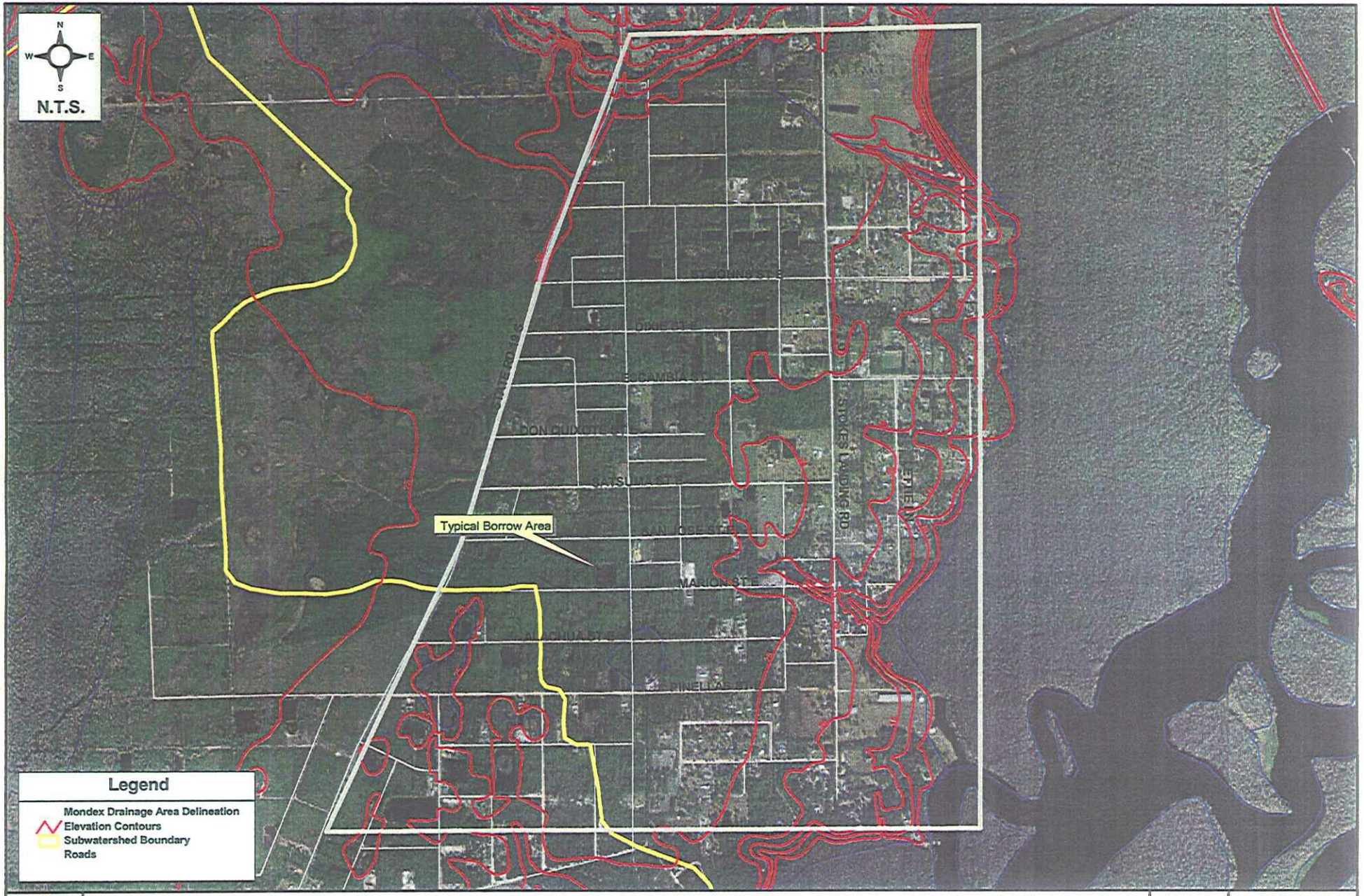


G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
cip_1through7.apr

Mondex - Location Map
Putnam County Master Stormwater Plan

Figure
7.4.15-1

AYRES ASSOCIATES



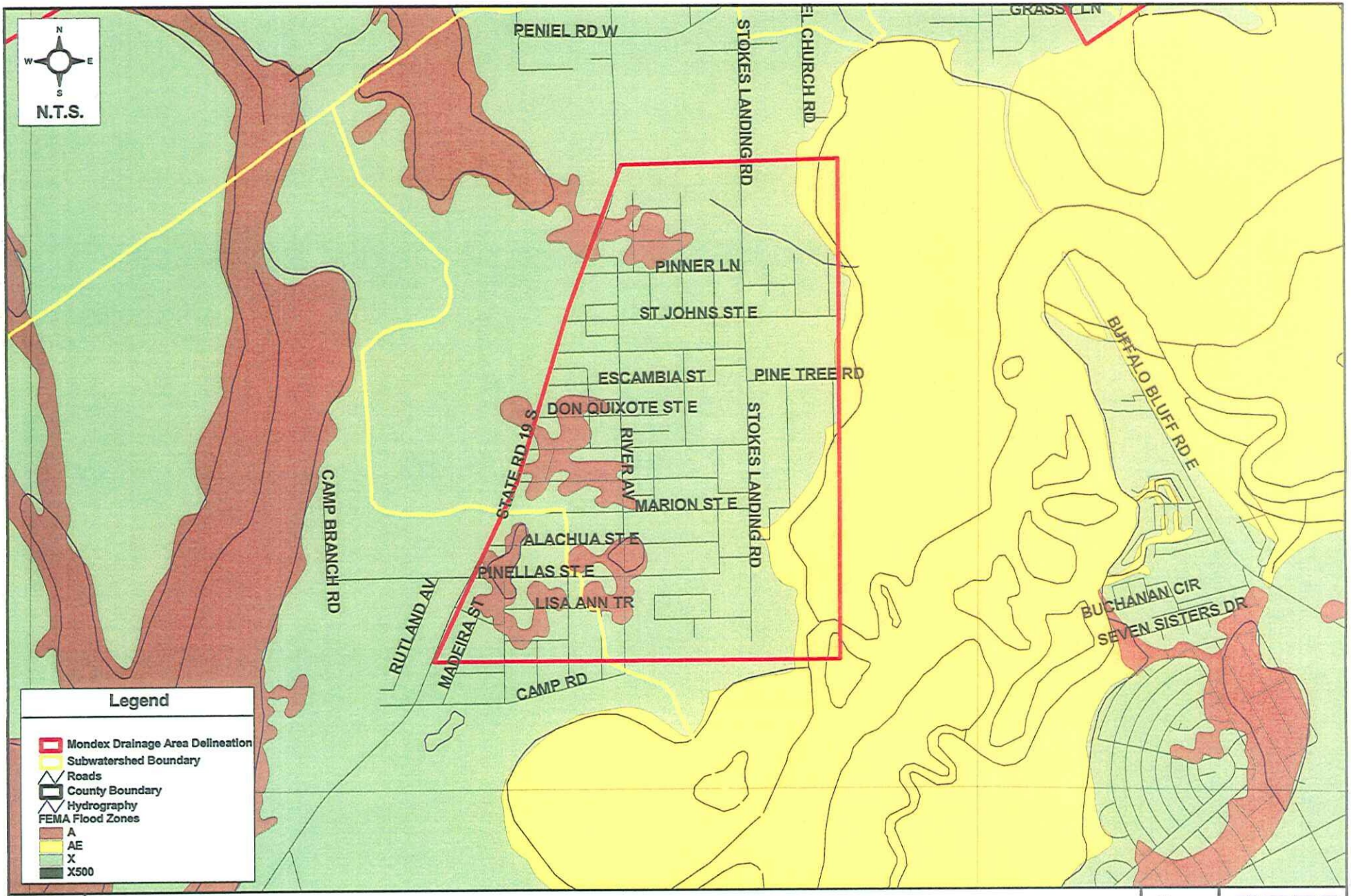
G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
cip_1through7.apr

Mondex - Location Map (Detailed)

Putnam County Master Stormwater Plan

Figure 7.4.15-2

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
cip_1through7.apr

Mondex - FEMA Flood Zones
Putnam County Master Stormwater Plan

Figure
7.4.15-3

AYRES ASSOCIATES

Problem Description

County staff report widespread flooding within Mondex. Roads, yards, and some structure flooding is said to occur on annual or semi-annual basis. This observation is not consistent with the FIRM panels provided in **Figure 7.4.15-3**. However, in the absence of any other data or predictions determined through a numerical modeling analysis, the conflict is not resolvable. The floodplains published in the FIRMS will stand as the basis for regulating first floor elevations or setting insurance premium rates due to the lack of any other credible or superceding information. The unnumbered A zones on the FIRM panels, are the direct descendents of the Flood Hazard Boundary Maps also published by FEMA in the late 1960's. They were approximations of a 100-year flood delineated by hand, using judgment of where the 100-year flood elevation would be based on wetland boundaries interpreted from an aerial photograph.

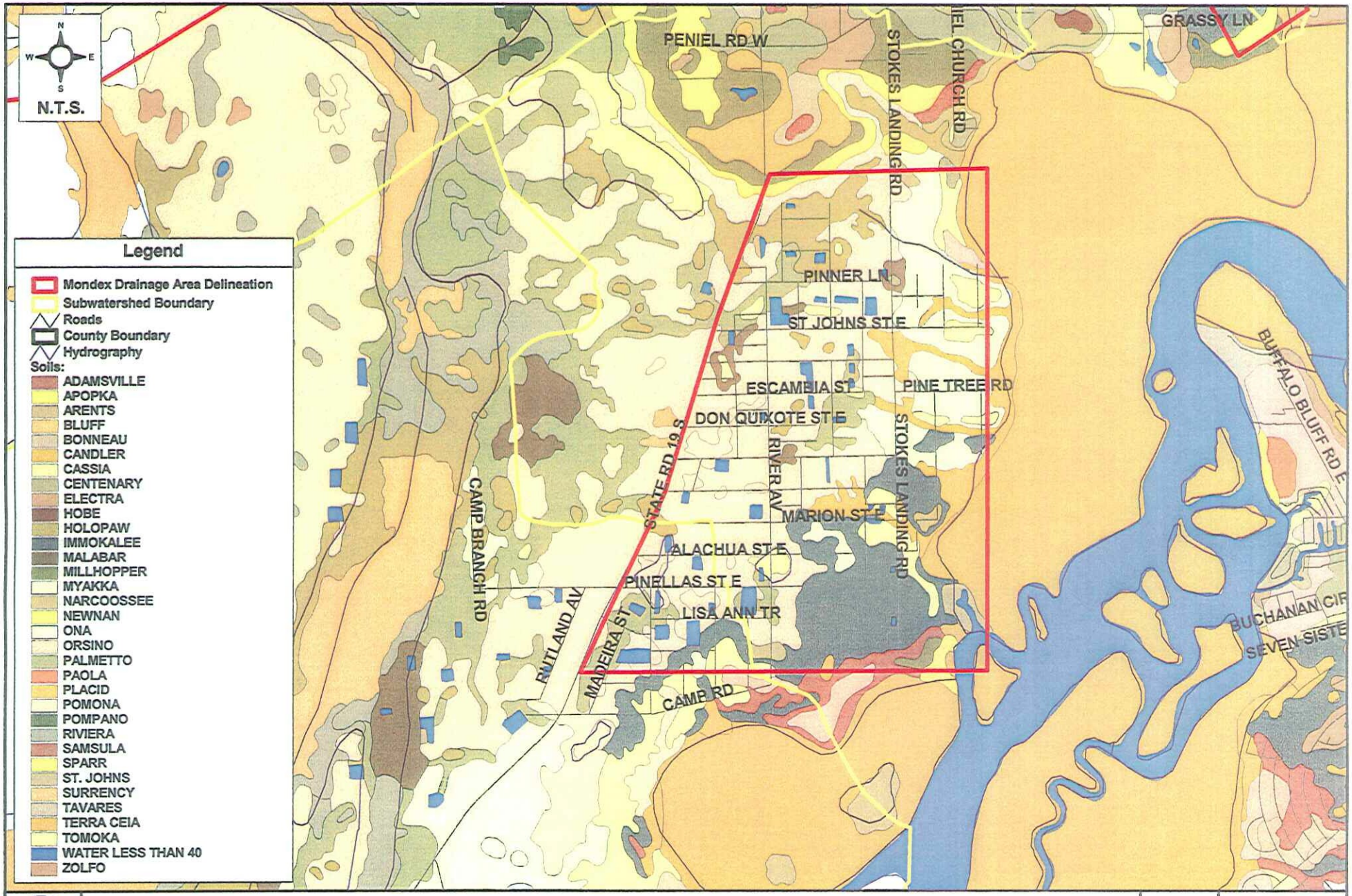
The topography, soils, and ground cover vegetation all provide insight into the area's flood prone nature. Each of these characteristics work in conjunction and add to both the magnitude (severity) and frequency of the flooding. Topographically, Mondex lies below and is completely within a 25-foot contour that rims the area and separates it from the St. Johns River. Mondex in effect, is in the bottom of a bowl a shallow bowl with minimal positive drainage capacity. The USGS 5-,10-,15-,20- and 25-foot contours on **Figure 7.4.15-2** help to illustrate this point. Note that the 25-foot contour forms a perimeter around the outside of the Mondex area.

Figure 7.4.15-4 provides the SCS soils classifications within the area. The four soil types that occur are Palmetto, Pomona, Immokalee, Holopaw and Myakka Sands. SCS rates all of these soil types as poor for dwellings, commercial buildings, local roads, lawns and landscapes, and septic tank absorption fields. The natural groundcover in Modex is characterized by wetland and hammock vegetation. Joint-Tail Grass (Manisuris spp.), Leather Fern (acrostichum spp.), and Bay trees (Persea spp.) were seen at the top of bank of many drainage ditches and in the front lawns of some residences.

A consistently high water table that is within one to two feet of the ground surface is directly related to the vegetation cover. During a field visit on May 26, the water table was approximately one and a half feet below the ground surface. Relative to the low/dry regional antecedent moisture conditions, a very shallow water table depth strongly indicates the water table is at or near ground surface during most of the year. Shallow water table conditions of this magnitude contribute and exacerbate flood conditions by occupying the soil storage, and when at ground surface, creating a transient impermeable condition and produce greater runoff volumes. During the field visit, standing water was observed in some of the roadside ditches and in three of the four unnamed creeks, which was an unexpected condition given the antecedent conditions.

Discussion

There is no data on which to base recommendations for improvements in Mondex. In addition, the County does not own or have easements over any of the four systems that drain the area.



G:\COUNTY - PUTNAM\
67011000(PutnumCoSWMMP)\GIS\APRs\
cip_1through7.apr

Mondex - Soil Distribution
Putnam County Master Stormwater Plan

Figure
7.4.15-4

AYRES ASSOCIATES

If the County had ownership or easements over the unnamed creeks, permitting issues would also provide challenges to any CIP alternative aimed at reducing flood levels in the area. Due to the extremely high water table, attenuation basins or storage areas will provide very limited capacity, leaving improvements to the four outlet systems as essentially the only alternative. In effect, Mondex will have to be dewatered on a permanent basis by well-maintained drainage along the roadsides, and more significantly, alterations to at least three of the four unnamed creeks that drain to the east.

Alterations to these systems will have significant impacts on wetlands and water table levels and ERP criteria can, if not appropriately addressed, make the project impractical. Improvements to a drainage system like that in the Mondex system for flood control is not impossible, if approached properly, with a environmentally sensitive plan developed in partnership of stakeholders including all of the jurisdictional permitting agencies. In this case, the agency may be limited to the SJRWMD. By involving the agencies in the evaluation and solution process, they are able to acquaint themselves with the issues and limitations of the analysis and the constraints governing any solution. Often, if a permit reviewer is included in as a stakeholder and agrees on the design concept as it is developed, the permit application is, barring an outside challenge, a formality.

Recommendation

Two immediate issues that are evident in Mondex are to determine an accurate 100-year flood level so that future first floors can be better regulated, and reduce the magnitude and duration of future flooding.

The specific steps in sequence, to address these issues are provided below.

1. Develop 1-foot contour interval topographic mapping for the drainage basin defined on **Figure 7.4.15-2**. This is the basis for any detailed analysis and is required before proceeding with any other steps.
2. Collect data and conduct detailed field surveys in the watershed in preparation for development of a detailed hydrologic/hydraulic. The purpose of the model is to determine the level and magnitude of flooding and to determine the 100-year floodplain.
3. Develop a hydrologic/hydraulic model. The complexity of the area's hydrology requires a more complex approach using a hydraulic model that can be uncoupled and coupled to a distributed model that can compute levels in the surficial aquifer. The distributed model will be used to determine antecedent moisture conditions prior to a 100-year event. The 100-year event can then be simulated with single event hydrology using the hydraulic model that is uncoupled from the distributed model.
4. Map the 100-year flood level and submit a Letter of Map Revision to FEMA that documents the determination of the revised 100-year flood level. Pending the response to the LOMR, regulate first floors in Mondex with the revised flood elevation.
5. Organize stakeholders in the Mondex area and conduct an analysis to reduce flooding. The hydraulic model will be recoupled to the distributed hydrologic model so that the effects of the proposed drainage improvements can be evaluated for impacts and refined in accordance with Environmental Resource Permitting regulations. No specific level of service should be targeted.
6. Submit a Conceptual permit application to the SJRWMD

7. Pending approval of the permit application, availability of rights-of-way, easements and ownership of lands, begin final design of the drainage improvements.

8. Complete final design and obtain an ERP.

9. Begin construction in phases, from downstream to upstream, in accordance with funding and the priorities in the County.

Mondex Area Summary of Activities, Timeline, and Budget

Time-line	Activity	Budget
Year 1	Topographic Mapping	$20,000
Year 2	Data Collection and detailed survey	$12,000
Year 3	Model development, 100-year floodplain determination	$45,000
Year 4	Flood protection alternatives development & conceptual permitting	$24,500
	Analysis Phase Subtotal	$101,500
Year 5	Final Design and Permitting	TBD pending results of study

7.5 BENEFIT - COST ANALYSIS

The Capital Improvement Program includes the development of a quasi-Benefit-Cost Ratio (BCR) for each CIP alternative, if that is possible without the development of watershed models. The 15 top-ranked CIP project areas and concept-level project alternatives have been described in Section 7.4. Where adequate data were lacking in some CIP areas, additional data collection or studies were recommended. Consequently, the BCRs were not calculated for all projects. Table 7.5-1 presents the 15 project sites and indicates whether adequate information was available for the development of a BCR.

TABLE 7.5-1 PROJECTS EVALUATED FOR BCR ANALYSIS

Rank	Project Name	Planning Unit	Description	Adequate Information for Benefit-Costs?
1	Devall Branch	South Mainstem	Safety issue. Rusted culvert with potential for complete road collapse.	Yes
2	Twomile (Duval) Creek	South Mainstem	Pending discussions with County	No
3	Palmetto Bluff	South Mainstem	Inadequate data. Study recommended	No
4	Millican Road	South Mainstem	Road blockage during flooding	No
5	River Park Subdivision	Lake George	Inadequate data. Study recommended	No
6	Mud Lake/Monroe Mill Creek	South Mainstem	Inadequate data. Study recommended	No
7	Orange Springs Shortcut	Orange Creek	Safety issue. Bridge in danger of collapse. Overtopped by mean annual flood.	Yes
8	Hasting's Drainage District (Rector Road)	South Mainstem	Culverts rusted. Not functioning to design capacity. Potential hazard.	Yes
9	East Palatka Drainage District (SR 207)	South Mainstem	DOT to rectify problem.	No
10	Whispering Pines	Lake George	Pending discussions with County	No
11	County Road 315 at 64th Street	Rodman Reservoir	Frequent road flooding.	Yes
12	Florahome Drainage	Etonia Creek	Culvert hazardous to traffic. Maintenance also recommended, consistent with proposed maintenance plan.	Yes
13	East River Road (at Camp Road)	South Mainstem	Maintenance recommended. No construction required.	No
27 (former 10)	Saratoga Harbor	South Mainstem	Road flooding and damage during flooding	Yes
28 (former 15)	Mondex	South Mainstem	Inadequate data. Study recommended	No

Benefit-Cost analysis was performed using FEMA computer programs. Available information was input to the riverine flood version of the Very Limited Data (VLD) module of FEMA's Benefit-Cost Analysis of Hazard Mitigation Projects software. Descriptions shown below in italics were extracted directly from the FEMA Technical Manual/Guidance Manual.

7.5.1 DESCRIPTION OF FEMA BENEFIT-COST ANALYSIS

There are four key elements to all benefit-cost analyses of hazard mitigation projects:

1. *an estimate of damages and losses before mitigation*
2. *an estimate of damages and losses after mitigation*
3. *an estimate of the frequency and severity of the hazard causing damages (e.g. floods), and*
4. *the economic factors of the analysis (i.e. discount rate and mitigation project useful lifetime)*

The key elements shown above serve as program input to various modules as described below.

Benefit-Cost Modules

Benefit-cost modules are individual computer programs that perform the three types of benefit-cost analyses (lower-bound, upper-bound, best- estimate) to calculate a BCR. Four modules evaluate project cost-effectiveness: riverine flooding, coastal flooding, earthquakes, and hurricane winds. This guide deals only with riverine and earthquake modules. There are three types of modules used with flood projects: Very Limited Data (VLD), Limited Data (LD), and Full Data. When the benefit-cost software was first developed, only the Full Data module was available for analysts. This module uses the most data of the three and determines, with a high degree of accuracy, the cost-effectiveness of a project. But, as we've mentioned, data are sometimes unavailable or not easily obtained. This creates a bottleneck in processing project applications and underscores the need for an accurate but flexible approach.

Often, only one or two pieces of key information are needed to determine a project's BCR. The Limited Data and Very Limited Data modules were developed to determine cost-effectiveness with less information than the Full Data module. With these new modules, project cost-effectiveness is often determined before additional data are sought. Whereas the Full Data module performs an analysis in detail, the Limited Data module looks at a project in less detail, and the Very Limited Data module analyzes only the most basic characteristics of a project.

Of the three modules, the Very Limited Data module has the "largest-holed" screen, because it evaluates cost-effectiveness using only basic data. For projects that are cost-effective using this module (remember, sometimes only one or two key data are needed), the benefit-cost analysis is complete and no further analysis is required. Those that are not cost-effective are reviewed with the Limited Data module. This "medium-holed" screen requires more data than the Very Limited Data module. The Full Data module is the "smallest-holed" screen, using quantitative, site-specific hazard data.

The following table illustrates which type of analysis is used with which type of module.

Matrix of Analysis and Modules

Module	Lower Bound	Upper Bound	Best Estimate
Very Limited Data	X	*Rarely*	*Never*
Limited Data	X	X	X
Full Data	X	X	X

Lower-Bound Analysis

Lower-bound analysis is a powerful tool that can often demonstrate that projects are cost-effective — in many cases regardless of whether the available data are complete or not. This is an important point, because a project's cost-effectiveness can sometimes be determined by using only one or two key pieces of data. The lower-bound analysis was developed with this in mind. This is because the lower-bound analysis considers only some of a project's benefits — those that are the most important or those for which data exist — and ignores other benefits that may be difficult to estimate or for which data may not be available. In other words, this analysis purposely uses only a few data to determine the project's cost-effectiveness and undercounts, or ignores, other benefits that will be gained by funding the project. If these few data indicate that a project is cost-effective, then no further analysis is needed. No additional data has to be collected. .

The module used for Putnam County CIP is the very limited data module as described below.

Very Limited Data (VLD) Module

This module is designed to quickly screen projects for cost-effectiveness with a minimum of data entries. Analyses conducted with this module tend to be lower-bound analyses for this reason, as well as the fact that damages are assumed to be constant (at the level of the declared event) even in more severe floods. In addition, the module does not rely on quantitative, site-specific data for flood recurrence intervals, as the Full Data module does.

This module uses limited data to analyze projects in areas where flooding has a known occurrence (e.g. 10-year flood). To make estimates about future damages, the VLD uses data obtained from Damage Survey Reports, the FEMA documents that summarize in detail the damages from a declared flood event, and/or other historical flood damage data. The following table summarizes this module.

VLD Module at a Glance

Use	*A quick screening tool for flood mitigation projects with incomplete data.*
Type of Analysis	*Lower-bound*
Minimum Data Requirements	• *Project Cost* • *Frequency of declared event* • *Observed damages of declared event* • *Useful life of project* • *Flood protection level (i.e. 50-year, 100-year, etc.)*
Assumptions	• *No flood damages occur at flood frequencies less than the declared event (e.g., if the declared event is a 25-year flood, we may not know if damages will occur in smaller floods such as a 5- or 10-year flood. For a lower-bound analysis, we assume that such damages in smaller floods are zero.)* • *Flood damages from flood frequencies more than the declared event are the same as the declared event (e.g., assumes a 50-year flood will cause only as much damage as a 35-year flood. Since this is not typically true, the damages in a 50-year flood will generally be greater and, therefore, the benefits of avoiding these damages will also be larger).* • *Project is 100% effective up to and including the level of protection suggested by the application.*
Use of Results	• *BCR $\geq$ 1.0 – Project is cost-effective; no further analysis is needed.* • *BCR < 1.0 – Cost-effectiveness cannot be determined; limited data or full data module analysis required.*

7.5.2 RESULTS

All of the analyzed projects had a computed BCR that exceeded one. Results for each analyzed project are shown on the computer printouts on the following pages. A BCR was not developed for Millican Road because the project is a large roadway improvement project, and drainage is only a small component.

Federal Emergency Management Agency
Benefit-Cost Analysis of Hazard Mitigation Projects
Riverine Flood: Very Limited Data Module
Flood Mitigation Projects
Version 5.2.2
December 31, 1998

Project Description	Putnam County, Florida Devall Branch
Analyst	Michael Walters
Date	4/13/2005
Mitigation Project Cost	$40,000
Project Useful Lifetime (years)	30
Discount Rate	7.00%
Present Value Coefficient	12.41

Observed Damages At This Site in Declared Flood Event Are at Least	Frequency of Declared Flood Event (years)	Mitigation Project 100% Effective to Flood Event (years)	Project Cost-Effective If Cost is Less Than
$10,000	1	25	$119,127

Project Benefit Cost Ratio is Greater Than: 2.98 This is a Lower Bound Analysis.

Data Sources and Documentation:

Section 7 of Draft Stormwater Management Plan.
Discount rate of 7% from FEMA.
Value of damage prevented substituted for Observed damages.

This is a lower bound analysis.
Projects with BCRs greater than 1.0 are cost effective.
Projects with BCRs less than 1.0 require further analysis and may be cost effective.
Benefit-cost analysis is based on current data and is subject to revision if project costs or project design change significantly.

Federal Emergency Management Agency
Benefit-Cost Analysis of Hazard Mitigation Projects
Riverine Flood: Very Limited Data Module
Flood Mitigation Projects
Version 5.2.2
December 31, 1998

Project Description	Putnam County, Florida Orange Springs Shortcut
Analyst	Michael Walters
Date	4/13/2005
Mitigation Project Cost	$48,000
Project Useful Lifetime (years)	30
Discount Rate	7.00%
Present Value Coefficient	12.41

Observed Damages At This Site in Declared Flood Event Are at Least	Frequency of Declared Flood Event (years)	Mitigation Project 100% Effective to Flood Event (years)	Project Cost-Effective If Cost is Less Than
$48,000	5	100	$113,170

Project Benefit Cost Ratio is Greater Than: 2.36 **This is a Lower Bound Analysis.**

Data Sources and Documentation:

Section 7 of Draft Stormwater Management Plan.
Discount rate of 7% from FEMA.
Value of damages prevented substituted for observed Damages.
Value of damages prevented assumed to be at least the cost of replacement.

This is a lower bound analysis.
Projects with BCRs greater than 1.0 are cost effective.
Projects with BCRs less than 1.0 require further analysis and may be cost effective.
Benefit-cost analysis is based on current data and is subject to revision if project costs or project design change significantly.

Federal Emergency Management Agency

Benefit-Cost Analysis of Hazard Mitigation Projects

Riverine Flood: Very Limited Data Module

Flood Mitigation Projects

Version 5.2.2

December 31, 1998

Project Description	Putnam County, Florida Hasting's Drainage District (Rector Road)
Analyst	Michael Walters
Date	4/13/2005
Mitigation Project Cost	$61,000
Project Useful Lifetime (years)	30
Discount Rate	7.00%
Present Value Coefficient	12.41

Observed Damages At This Site in Declared Flood Event Are at Least	Frequency of Declared Flood Event (years)	Mitigation Project 100% Effective to Flood Event (years)	Project Cost-Effective if Cost is Less Than
$61,000	5	100	$143,821

Project Benefit Cost Ratio is Greater Than: 2.36 This is a Lower Bound Analysis.

Data Sources and Documentation:

Section 7 of Draft Stormwater Management Plan.
Discount rate of 7% from FEMA.
Value of damages prevented substitued for observed damages
Value of damages prevented assumed to be at least the cost of replacement

This is a lower bound analysis.
Projects with BCRs greater than 1.0 are cost effective.
Projects with BCRs less than 1.0 require further analysis and may be cost effective.

Benefit-cost analysis is based on current data and is subject to revision
If project costs or project design change significantly.

Federal Emergency Management Agency

Benefit-Cost Analysis of Hazard Mitigation Projects

Riverine Flood: Very Limited Data Module

Flood Mitigation Projects

Version 5.2.2

December 31, 1998

Project Description	Putnam County, Florida County Road 315 at 64th Steet
Analyst	Michael Walters
Date	4/13/2005
Mitigation Project Cost	$14,000
Project Useful Lifetime (years)	30
Discount Rate	7.00%
Present Value Coefficient	12.41

Observed Damages At This Site in Declared Flood Event Are at Least	Frequency of Declared Flood Event (years)	Mitigation Project 100% Effective to Flood Event (years)	Project Cost-Effective If Cost is Less Than
$2,000	1	25	$23,825

Project Benefit Cost Ratio is Greater Than: 1.70 **This is a Lower Bound Analysis.**

Data Sources and Documentation:

Section 7 of Draft Stormwater Management Plan.
Discount rate of 7% from FEMA.
Each annual flooding event is assumed to cost at least $2,000, including economic costs of traffic diversions, loss of time, county flagging, etc.

This is a lower bound analysis.
Projects with BCRs greater than 1.0 are cost effective.
Projects with BCRs less than 1.0 require further analysis and may be cost effective.

Benefit-cost analysis is based on current data and is subject to revision if project costs or project design change significantly.

Federal Emergency Management Agency

Benefit-Cost Analysis of Hazard Mitigation Projects

Riverine Flood: Very Limited Data Module

Flood Mitigation Projects

Version 5.2.2

December 31, 1998

Project Description	Putnam County, Florida Saratoga Harbor
Analyst	Michael Walters
Date	4/13/2005
Mitigation Project Cost	$37,760
Project Useful Lifetime (years)	30
Discount Rate	7.00%
Present Value Coefficient	12.41

Observed Damages At This Site in Declared Flood Event Are at Least	Frequency of Declared Flood Event (years)	Mitigation Project 100% Effective to Flood Event (years)	Project Cost-Effective If Cost is Less Than
$10,000	2.33	25	$48,294

Project Benefit Cost Ratio is Greater Than: 1.28 **This is a Lower Bound Analysis.**

Data Sources and Documentation:

Section 7 of Draft Stormwater Management Plan.
Discount rate of 7% from FEMA.
Road damage and ecomimic loos during floods assumed to be at least $10,000.

This is a lower bound analysis.
Projects with BCRs greater than 1.0 are cost effective.
Projects with BCRs less than 1.0 require further analysis and may be cost effective.
Benefit-cost analysis is based on current data and is subject to revision if project costs or project design change significantly.

Federal Emergency Management Agency
Benefit-Cost Analysis of Hazard Mitigation Projects
Riverine Flood: Very Limited Data Module
Flood Mitigation Projects
Version 5.2.2
December 31, 1998

Project Description	Putnam County, Florida Florahome Drainage District
Analyst	Michael Walters
Date	4/13/2005
Mitigation Project Cost	$42,200
Project Useful Lifetime (years)	30
Discount Rate	7.00%
Present Value Coefficient	12.41

Observed Damages At This Site in Declared Flood Event Are at Least	Frequency of Declared Flood Event (years)	Mitigation Project 100% Effective to Flood Event (years)	Project Cost-Effective if Cost is Less Than
$42,200	5	50	$94,259

Project Benefit Cost Ratio is Greater Than: 2.23 This is a Lower Bound Analysis.

Data Sources and Documentation:

Section 7 of Draft Stormwater Management Plan.
Discount rate of 7% from FEMA.
Value of damages prevented substituted for observed damages
Value of damages prevented assumed to be at least the cost of replacement

This is a lower bound analysis.
Projects with BCRs greater than 1.0 are cost effective.
Projects with BCRs less than 1.0 require further analysis and may be cost effective.
Benefit-cost analysis is based on current data and is subject to revision if project costs or project design change significantly.

TABLE OF CONTENTS

8.0 PHASED WATERSHED PLAN DEVELOPMENT 8-1

8.1 Flood Model Development for Selected Subwatersheds 8-1
8.2 Stormwater Models Review 8-4
8.2.1 Simple / Empirical Models 8-4
8.2.2 Single Event Models 8-5
8.2.3 Continuous Simulation Models 8-6
8.2.4 Selection of Numerical Model(s) for Current and Future Watershed Modeling Applications 8-6
8.3 Data Collection Sites 8-18
8.3.1 Rainfall 8-18
8.3.2 Streamflow 8-18
8.3.3 Weather 8-18
8.4 Monitoring Protocol 8-21
8.5 Topographic Mapping Recommendations 8-22
8.5.1 Mapping Specifications 8-22
8.5.2 Comparing Quality and Costs 8-23

List of Figures

Figure 8.2-1 Example of Continuous Simulation and/or Distributed Integrated Models ... 8-10
Figure 8.3-1 SJRWMD/NCDC Rainfall Gages 8-19
Figure 8.3-2 Proposed Site for Weather Station 8-20

List of Tables

Table 8.1-1 Prioritized Ranking for Modeling Selected Subwatersheds 8-1
Table 8.2-1 Hydrologic Models Meeting the Minimum Requirement of NFIP 8-11
Table 8.2-2 Hydraulic Models Meeting the Minimum Requirement of NFIP 8-14

List of Appendices

Appendix 8-A Copies of Portions of EPA Meteorological Monitoring Guidance for Regulatory Modeling Applications

8.0 PHASED WATERSHED PLAN DEVELOPMENT

A phased watershed plan has been developed to be consistent with the County's needs and budgetary constraints. The plan consists of:

- Flood Model Development for Selected Subwatersheds
- Proposed Data Collection Sites
- Monitoring Protocol

8.1 FLOOD MODEL DEVELOPMENT FOR SELECTED SUBWATERSHEDS

The section addresses the development of a phased plan to develop watershed models of the County for prediction of 100-year flood elevations for submittal to the Federal Emergency Management Agency (FEMA). The said flood levels will translate to community rating points for reduction of flood insurance rates and also provide first floor information for new development.

Section 7 (Capital Improvement Program) identifies areas where model development is required for flood level prediction. Section 2 shows a ranking of watersheds. These rankings should also be used for prioritizing topographic mapping and survey to support subsequent flood modeling. The rankings are reproduced below in **Table 8.1-1**. Although these rankings show the priorities in the selected basins, flood models should be developed for the entire county.

TABLE 8.1-1 PRIORITIZED RANKING FOR MODELING SELECTED SUBWATERSHEDS

Watershed/ (Problem Area)	Prioritized Rank	*Estimated Costs
DEVALL BRANCH - (Devall Branch)	1	$23,963
DAVIS LAKE OUTLET (Devall Branch, Foxwood Outfall)	2	$25,734
TWOMILE CREEK (Twomile Creek)	3	$38,296
CEDAR CREEK (Palmetto Bluff, Millican, W. Tocoi)	4	$235,768
MASON BRANCH (Millican Road)	5	$77,576
ST JOHNS R.,Lk.GEORGE– RIVER PARK (River Park , Whispering Pines, CR 309)	6	$39,767
MUDLAKE OUTLET (Monroe-Mill Cr)	7	$31,972
WEST RUN INTERCEPTER D (Rector Rd)	8	$90,310
DOG BRANCH (E. Palatka Drainage)	9	$55,751

Watershed/ (Problem Area)	Prioritized Rank	*Estimated Costs
MILL BRANCH (E. Palatka Drainage)	10	$134,495
TIGER BRANCH (Whispering Pines, Harris Fish Camp)	11	$190,923
BEECHER RUN (Florahome)	12	$38,629
CLEARWATER LAKE OUTLET (Florahome)	13	$75,600
ETONIA CREEK (Florahome, Bellamy Woods, Price Rd)	14	$1,024,641
RICE CREEK, ETONIA (Florahome)	15	$609,744
FALLING BRANCH (Florahome)	16	$137,921
UNNAMED DRAIN-5 (Florahome)	17	$70,897
LAKE SUGGS OUTLET (Florahome)	18	$108,460
LAKE GRANDIN OUTLET (Florahome)	19	$117,217
UNNAMED BRANCH-1 (Florahome)	20	$162,154
UNNAMED RUN-1 (Florahome)	21	$59,268
SIMMS CREEK (Florahome)	22	$209,246
PALMETTO BRANCH (Florahome)	23	$110,249
UNNAMED BRANCH-2 (Florahome)	24	$36,297
LONG POND OUTLET (Florahome)	25	$34,386
UNNAMED DRAIN-1 (Florahome)	26	$38,349
OLDTOWN BRANCH (Florahome)	27	$138,843
BLOCKER LAKE OUTLET (Florahome)	28	$52,104
UNNAMED RUN-2 (Florahome)	29	$36,977
UNNAMED DRAIN-6 (Florahome)	30	$95,501
UNNAMED BRANCH-3 (Florahome)	31	$80,179
COW BRANCH (East River Rd)	32	$27,270
ST JOHNS R., Lk.GEORGE – (Welaka CR 308B)	33	$16,753

Watershed/ (Problem Area)	Prioritized Rank	*Estimated Costs
JUMPING GULLY BRANCH (Harris Fish Camp)	34	$165,443
LAKE STELLA OUTLET (Juncton Rd)	35	$65,963
GEORGETOWN SLOUGH (Lakeway Dr)	36	$301,132
RICE CREEK, RICE CR (Hunter Road)	37	$609,744
SWEETWATER CREEK (Hunter Road)	38	$214,531
DUNNS CR, CRESCENT LK (San Mateo)	39	$502,769
UNNAMED DITCH-2 (Foxwood Outfall)	40	$87,782
ST JOHNS R. – SARATOGA (Saratoga Harbor)	41	$3,009
ST JOHNS R. –MONDEX (Mondex)	42	$29,270
SILVER LAKE OUTLET	43	$113,141
UNNAMED DITCHES-2	44	$14,008
UNNAMED SLOUGH-5	45	$52,654
UNNAMED DITCH-3	46	$21,943
UNNAMED DITCH-1	47	$61,994

* Costs include aerial photographs, surveying, mapping, modeling, flood plain delineation. Please note that costs can be significantly reduced if many contiguous watersheds are modeled simultaneously.

8.2 STORMWATER MODELS REVIEW

Stormwater models in the context of this report are simply mathematical representations of the hydrologic response to rainfall events and the hydraulic capacity of conveyance features (streams, ditches, pipes, etc) that exist within the County. Models are generally developed at a subwatershed level. An equation for runoff may use typical hydrologic watershed parameters (watershed area, soil infiltration rates/capacity, amount of water caught in the tree canopy and ground cover, etc.) to simulate the flow over land to a storage area (pond, lake, reservoir) or to a conveyance system (creek, river, etc.). Another set of equations simulate storage utilization and use hydraulic parameters (channel geometry, channel slope, roughness due to vegetation, etc.) to simulate flow in a conveyance system. Ideally, when all the processes - rainfall, runoff, storage and flow in the conveyance system - are combined and computed simultaneously, realistic water surface elevations and flows can be obtained at any discrete location in the watershed. The simulated values can be used to set first floor elevations, road crown elevations and also, in locations that flood, to determine the degree and amount, and principal origin(s) or source of the flooding. Stormwater models may include water quality components or may be limited to water quantity estimations such as flood flow rates, volumes, stages.

Mathematical models for surface waters are generally of the following types, with each type requiring various amounts and types of input data:

- Simple/Empirical
- Single Event (dynamic or steady state)
- Continuous Simulation

The following sections describe the use and limitations of each model type, including examples of appropriate applications for management of stormwater in Putnam County. Models currently used by the County are evaluated for adequacy. Additionally, specific recommendations are offered for future stormwater management system modeling with respect to level of service determination, land management planning, and the design of flood control/flood relief systems.

8.2.1 SIMPLE / EMPIRICAL MODELS

Empirical models are generally derived from direct statistical relationships between basin parameters and water quantity, and are often considered "rule-of-thumb" approaches requiring engineering experience and judgment. They generate peak flow estimates at a single location. An example of a widely-used empirical model for computing runoff excess is the "Rational Method;" **R=cP** where runoff volume, R, is estimated as a fraction of precipitation depth, P. The applied rational coefficient, c, is determined from land cover and soil characteristics.

A related empirical method used extensively in roadway drainage design and described in the Florida Department of Transportation (FDOT) Drainage Manual, is the rational formula, **Q=ciA**, for estimating peak runoff discharge rate, Q, as a function of rainfall intensity, i; drainage area, A; and the same land cover-based rational coefficient, c. Tables are published by many sources to assist in the selection of appropriate "c" values and "i" values for various regions and rainfall return frequencies.

Empirical models like these rational methods are popular among designers because of their straightforward application and credible results for small subbasins. Subbasin size is the most critical limiting factor. Rational methods are not recommended for use in subbasins larger than

100 acres and are best applied to local cross drain or side drain culvert sizing or sizing of minor collection ditches. They do not produce reliable results for tailwater-controlled systems.

A slightly more complex empirical method for estimation of runoff excess is presented in the Natural Resource Conservation Service Technical Release No. 55 (TR-55). TR-55 presents procedures to calculate storm runoff volume, peak rate of discharge, simple hydrographs, and attenuation storage volumes required for small urbanizing watersheds. Specific method components from TR-55 are often used in developing input for more complex models. It is popular because it is a desktop design method not requiring computer simulation or entailing iterative solutions. The physical data required as input is often readily available.

Another empirical model type used in stream analysis is the regression equation. The USGS has developed many simple equations known as regression equations for various regions, including many Florida regions, to estimate streamflow in ungaged areas, where contributing watershed area, mean channel slope, and general land use and land cover have been determined. Often, adjustment factors are included for significant surface storage (lakes and wetlands) in the contributing watershed. USGS publications include descriptions of equation development and inherent assumptions and limitations. Directions for proper application of equations and coefficient/exponent tables are generally presented for various regions and flood return frequencies.

Regression models are useful for establishing design flows at specific locations in ungaged rural areas, which may then be applied to more complex hydraulic models, typically step backwater profile models, for generating flood profiles along a length of river. USGS regression equations were used to develop conceptual project alternatives for some of the Putnam County flood problem areas described in Section 7 of this Master Stormwater Plan.

8.2.2 SINGLE EVENT MODELS

Single event models may include dynamic and steady state hydraulic routing models. The "single event" classification refers to simulation of a watershed or riverine response to a particular design event (rainfall or flood flow). Dynamic models are commonly used for stormwater management planning, design and permitting, especially for large inter-connected systems and for urban systems. Steady state models are most often used to assess open channel conveyances (riverine systems) and bridge crossings for particular flood return frequencies.

The hydrologic model component utilizes mathematical equations to simulate a time-dependent rainfall-runoff relationship known as a runoff hydrograph that predicts the watershed response for a discrete storm event. Unit hydrograph methods such as the SCS Unit Hydrograph or the Santa Barbara Unit Hydrograph methods are often the basis for simulated rainfall-runoff responses. Another runoff simulation method common to many surface water models is the kinematic wave method for overland flow.

Event simulation may be based on an historic rainfall event gleaned from rainfall records, but is often based on a design storm distribution where rainfall is simulated with a synthetic or "design storm event". The synthetic storms are determined by statistical procedures and are worst-case scenarios. Hydrologic model components are coupled with hydraulic routing models to produce dynamic flood profiles throughout the length of a simple or complex network. Required input data for such models can range from minimal to extensive, depending on the size and complexity of the network and the scope of the application.

Examples of dynamic (unsteady state) stormwater models with single event hydrograph generation and hydraulic routing capability are EPA's Stormwater Management Model (SWMM), the U.S. Army Corps of Engineers HEC-RAS model (version 3.0+) and UNET model, the Inter-Connected Pond Routing (ICPR™) model, and XPSWMM™.

Steady state hydraulic models such as the Federal Highway Administration's WSPRO model, the HEC-2 model and HEC-RAS model allow prediction of flood stage that varies along a length of channel (a flood profile) for user-defined flood flows. Here flood stages are predicted at numerous locations, but without a time-varying response. The peak flood flows may be generated by empirical methods or by using the maximum runoff hydrograph flow generated by event-driven hydrologic models described above.

8.2.3 CONTINUOUS SIMULATION MODELS

Continuous simulation models offer time varying hydrologic responses for extended simulation periods (months or years) using historic precipitation records to determine average, minimum and maximum flow conditions for a particular system, or using synthesized records for stochastic predictions. They are most commonly used for determining watershed-specific flood flow frequencies, for ecological and water quality studies, and for water resource use allocation, management and planning.

Continuous simulation models require large input datasets, substantial computational resources, and careful calibration to produce credible results. Examples of models with continuous simulation capabilities are EPA's SWMM, HSPF, the USGS DBRM, and MIKE 11 (RR Module).

8.2.4 SELECTION OF NUMERICAL MODEL(S) FOR CURRENT AND FUTURE WATERSHED MODELING APPLICATIONS

Selection of numerical models for current and future watershed modeling applications must be guided by an understanding of the different models' limitations, the intended scope and complexity of the problem being studied, the availability and reliability of input data, and the financial resources available for the study. A discussion of practical guidelines for model selection is provided in the following subsections.

Watershed modeling in general, and modeling projects for Putnam County, will be driven by three issues:

- The proper type of model to apply, given the hydrology and hydraulics of the system under analysis
- The intended model use
- The scope of the study or design (often budget-dependent)

These issues will determine the level of detail or resolution required to adequately represent all of the features (individual sub-basins, channel geometry, wetlands, lakes, etc.) within the watershed. It may also determine which model is most suitable.

The SJRWMD has developed guidelines and criteria for the design and construction of surface water management systems. These guidelines and criteria are published in the Applicants Handbook: Management and Storage of Surface Waters (February 2005). Use of these

guidelines is recommended as a consistent methodology for both flood control and water quality improvement project design. They are applicable to both local and watershed-scale modeling projects (including floodplain determinations) and to support Capital Improvement Program projects where it will be necessary to demonstrate the absence of significant upstream or downstream hydraulic impacts. The guidelines do not dictate or disallow specific modeling programs.

The primary criteria for selection of model type (empirical, single event steady or unsteady state, or continuous) is the project's hydrologic or hydraulic characteristics, such as:

- Basin size
- Freely draining versus closed or internally-drained basin
- Simple linear hydraulic network versus complex or looped hydraulic network
- Significant channel storage or contributing basin storage
- Tailwater influences and/or flow reversals

Another significant factor is the project application, such as:

- Locally-drained (small drainage area) culvert or channel installation/replacement
- Bridge installation/replacement or major channel modifications for major conveyances
- Design of sedimentation basins or water quality enhancement ponds
- Regional flood control projects
- Floodplain determination
- Pollutant loading assessment
- Hydroperiod/ecological assessment
- Water resource allocation/management studies (reservoir or lake level management)
-

And finally, the scope/level of detail of the modeling study, whether the model is intended to provide support for:

- Concept designs for capital improvement budget planning or feasibility studies
- Ecologic/resource management planning
- Repair or replacement projects (Design-level)
- New surface water management systems serving existing development
- New surface water management systems serving new development
- FEMA DFIRM, FIRM revision, LOMA, or LOMR

General Recommendations

Ultimately, the selection of model type or method should be based on reasonable scientific judgment. Calibration of simulation models should be based on as many of the following indicators as possible: water elevation (stage) records, streamflow records, hydrologic indicators, and anecdotal/eyewitness accounts of peak stages.

When modeling major conveyances, use a model approved by the Federal Emergency Management Agency (FEMA) so that the County can submit the floodplain elevations to FEMA for incorporation into the next DFIRM, FIRM revision, LOMA, or LOMR.

The following discussion provides recommendations for the application of various stormwater models under the different scenarios outlined above. A listing of FEMA-approved hydrologic and hydraulic models is provided in **Tables 8.2-1** and **8.2-2**.

Simple/Empirical Models

The use of simple models such as the Rational Formula, TR-55, FDOT Stormtabs and the like should be limited to the following applications:

- In-kind culvert replacement and channel restoration (as a maintenance repair activity) on minor systems
- Design of side drains or driveway culverts, cross drains and roadside ditches on stormwater systems with small contributing drainage areas serving existing development, and with no known capacity-related flood problems
- Runoff volume generation for planning-level pollutant loading studies

Also, USGS regression equations are appropriate for estimating riverine flood flows for various return frequencies to be used in bridge replacement or major culvert designs at the concept level, where gaged streamflow data are unavailable. For final design, however, it is recommended that flood flows be generated using more sophisticated models tied to routing programs.

These simple models are not appropriate for simulating runoff rates from large basins, from basins with significant depressional storage, or from systems that are largely tailwater-controlled.

Single Event Models

The majority of County design work for stormwater management systems will be best supported by single event, dynamic models able to general runoff hydrographs from real or synthetic rainfall input and to route runoff through complex networks of pipes, channels, storage areas and control structures. A wide selection of proprietary and non-proprietary models is available, including but not limited to, HEC-HMS, HEC-RAS, SWMM, XP-SWMM™, ICPR™, MIKE 11™. Recommended applications include conceptual and engineering design for:

- New or modified channel cross sections with large contributing areas or in identified flood areas
- Culvert and/or bridge installation/replacement on major conveyances or in identified flood areas

- Stormwater management systems serving new development (altered land use/land cover)
- Regional flood control facilities
- Floodplain delineations for FEMA DFIRM, FIRM revision, LOMA, or LOMR

In cases where modeled reaches are generally linear, without significant branching or looping in the study area, and where control structures (dams, gates, etc,) would not interfere with the flow, it would be acceptable for the following applications;

- Floodplain delineation
- Bridge hydraulic assessment

to couple USGS regression analysis for flow rate determination in ungaged areas; or flood frequency analysis from gaged areas to determine peak flow rates for various return frequencies, rather than generating a synthetic design storm hydrograph as described above. These flows may then be applied to steady or unsteady state, FEMA-approved models such as WSPRO or HEC-RAS for flow routing and flood stage determination.

Continuous Simulation Models

The most common applications for continuous simulation models in Putnam County would be for long-range planning and evaluation of water and ecological resources. Continuous simulation models are often used for:

- Frequency analysis of rainfall and/or streamflow data to establish typical “wet,” “dry” or “average” hydrologic conditions
- Water quality assessments for pollutant loading, sediment transport, and pollutant decay
- Assessment of hydroperiod for lakes and wetlands

For hydroperiod assessments, and in flood studies where there is significant water table influence, integrated surface and groundwater models should be considered. A conceptualization of a model of this type is seen in **Figure 8.2-1**.

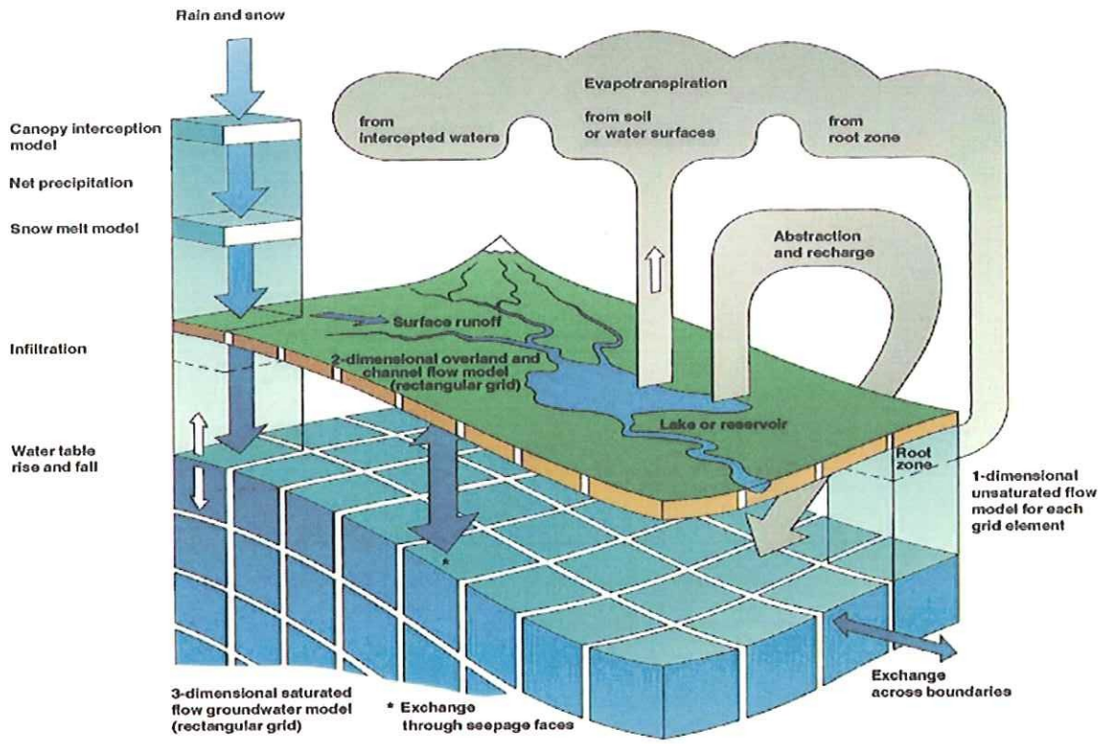


Figure 8.2-1 Example of Continuous Simulation and/or Distributed Integrated Models

TABLE 8.2-1 HYDROLOGIC MODELS MEETING THE MINIMUM REQUIREMENT OF NFIP (Nationally Accepted Models- May 2004)

Hydrologic Models: Determination of Flood Hydrographs

TYPE	PROGRAM	DEVELOPED BY	AVAILABLE FROM	COMMENTS	PUBLIC DOMAIN
Single Event	HEC-1 4.0.1 and up[2] (May 1991)	U.S. Army Corps of Engineers	Water Resources Support Center[3] Corps of Engineers Hydrologic Engineering Center (HEC) 609 Second Street Davis, CA 95616-4687	Flood hydrographs at different locations along streams. Calibration runs preferred to determine model parameters.	Yes
	HEC-HMS 1.1 and up (March 1998)	U.S. Army Corps of Engineers	U.S. Army Corps of Engineers Hydrologic Engineering Center 609 Second Street Davis, CA 95616-4687 http://www.hec.usace.army.mil/	The Hydrologic Modeling System provides a variety of options for simulating precipitation-runoff processes. It has a capability to use gridded rainfall data to simulate runoff. It does not provide snowmelt and snowfall functions; it cannot be used for areas where snowmelt is an important flood hazard source and must be considered in estimation of flood discharges.	Yes
	TR-20 (February 1992)	U.S. Department of Agriculture, Natural Resources Conservation Service	U.S. Department of Commerce National Technical Information Service 5285 Port Royal Road Springfield, VA 22161	Flood hydrographs at different locations along streams. Calibration runs preferred to determine model parameters.	Yes
	TR-55 (June 1986)	U.S. Department of Agriculture, Natural Resources Conservation Service	U.S. Department of Commerce National Technical Information Service 5285 Port Royal Road Springfield, VA 22161 http://www.wcc.nrcs.usda.gov/hydro/hydro-tools-models-tr55.html	Peak discharges and flood hydrographs at a single location.	Yes
	SWMM (RUNOFF) 4.30 (May 1994), and 4.31 (January 1997)	U.S. Environmental Protection Agency and Oregon State University	Center for Exposure Assessment Modeling U.S. Environmental Protection Agency Office of Research and Development Environmental Research Laboratory 960 College Station Road Athens, GA 30605-2720 http://www.epa.gov/ceampubl/swater/ Department of Civil, Construction, and Environmental Engineering Oregon State University 202 Apperson Hall Corvallis, OR 97331-2302 http://ccee.oregonstate.edu/swmm/ ftp://ftp.engr.orst.edu/pub/swmm/pc/	Calibration or verification to the actual flood events highly recommended.	Yes
	MIKE 11 UHM (June 1999 and 2002 D)	DHI Water and Environment	DHI Inc. 301 South State Street Newton, PA 18940	Simulates flood hydrographs at different locations along streams using unit hydrograph techniques. Three methods are available for calculating infiltration losses and three methods for converting rainfall excess to runoff, including SCS Unit hydrograph method. The web page is at: http://www.dhisoftware.com/mike11/Description/RR_module.htm	No

TYPE	PROGRAM	DEVELOPED BY	AVAILABLE FROM	COMMENTS	PUBLIC DOMAIN
	DBRM 3.0 (1993)	Bernard L. Golding, P.E. Consulting Water Resources Engineer Orlando, FL	Center for Microcomputers in Transportation (McTrans) University of Florida 512 Weil Hall Gainesville, FL 32611-6585	Flood hydrographs at different locations along streams. Calibration runs preferred to determine model parameters.	No
	HYMO	U.S. Department of Agriculture, Natural Resources Conservation Service	U.S. Department of Commerce National Technical Information Service 5285 Port Royal Road Springfield, VA 22161	Flood hydrographs at different locations along streams. Calibration runs preferred to determine model parameters.	Yes
	PondPack v.8 (May 2002)	Haestad Methods, Inc.	Haestad Methods, Inc. 37 Brookside Road Waterbury, CT 06708-1499 http://www.haestad.com	The program is for analyzing watershed networks and aiding in sizing detention or retention ponds. Only the NRCS Unit Hydrograph method and NRCS Tc calculation formulas are acceptable. Other hydrograph generation methods or Tc formulas approved by State agencies in charge of flood control or floodplain management are acceptable for use within the subject State.	No
	XP-SWMM 8.52 and up	XP Software	XP-Software 2000 NE 42nd Ave. #214 Portland, OR 97213-1305 http://www.xpsoftware.com	Model must be calibrated to observed flows, or discharge per unit area must be shown to be reasonable in comparison to nearby gage data, regression equations, or other accepted standards for 1% annual chance events.	No
Continuous Event	DR3M (October 1993)	U.S. Geological Survey	U.S. Geological Survey National Center 12201 Sunrise Valley Drive Reston, VA 22092	Calibration to actual flood events required. The web page is at: http://water.usgs.gov/software/surface_water.html	Yes
	HSPF 10.10 and up (December 1993)	U.S. Environmental Protection Agency, U.S. Geological Survey	Center for Exposure Assessment Modeling U.S. Environmental Protection Agency Office of Research and Development Environmental Research Laboratory 960 College Station Road Athens, GA 30605-2720	Calibration to actual flood events required. The web page is at: http://water.usgs.gov/software/surface_water.html	Yes
	MIKE 11 RR (June 1999 and 2002 D)	DHI Water and Environment	DHI Inc. 301 South State Street Newton, PA 18940	The Rainfall-Runoff Module (RR, formerly NAM) is a lumped-parameter hydrologic model capable of continuously accounting for water storage in surface and sub-surface zones. Flood hydrographs are estimated at different locations along streams. Calibration to actual flood events is required. The web page is at: http://www.dhisoftware.com/mike11/Description/RR_module.htm	No
	PRMS Version 2.1 (January 1996)	U.S. Geological Survey	U.S. Geological Survey 12201 Sunshine Valley Drive Reston, VA 22092 http://water.usgs.gov/software/surface_water.html U.S. Geological Survey P.O. Box 25046, Mail Stop 412 Denver Federal Center Lakewood, CO 80225-0046 http://wwwbrr.cr.usgs.gov/mms/	PRMS is a modular-designed, deterministic, distributed-parameter modeling system that can be used to estimate flood peaks and volumes for floodplain mapping studies. Calibration to actual flood events required. The program can be implemented within the Modular Modeling System (MMS) that facilitates the user interface with PRMS, input and output of data, graphical display of the data, and an interface with GIS.	Yes

TYPE	PROGRAM	DEVELOPED BY	AVAILABLE FROM	COMMENTS	PUBLIC DOMAIN
Interior Drainage Analysis	HEC-IFH 1.03 and up	U.S. Army Corps of Engineers	U.S. Army Corps of Engineers Hydrologic Engineering Center 609 Second Street Davis, CA 95616-4687	Provides both continuous simulation and hypothetical event analyses. Coincidence frequency analysis (not included in the model) may be needed for some cases. Supporting documentation is available at: http://www.fema.gov/fhm/dl_ifh.shtm	Yes

[2]The enhancement of these programs in editing and graphical presentation can be obtained from several private companies.
[3]Program is typically distributed by vendors and may not be available through HEC. A list of vendors may be obtained through HEC.

TABLE 8.2-2 HYDRAULIC MODELS MEETING THE MINIMUM REQUIREMENT OF NFIP (Nationally Accepted Models- May 2004)

Hydraulic Models: Determination of Water-Surface Elevations for Riverine Analysis

TYPE	PROGRAM	DEVELOPED BY	AVAILABLE FROM	COMMENTS	PUBLIC DOMAIN
One-dimensional Steady Flow Models					
	HEC-RAS 3.0 and 3.1	U.S. Army Corps of Engineers	Water Resources Support Center Corps of Engineers Hydrologic Engineering Center 609 Second Street Davis, CA 95616-4687	Under rare circumstances, for bridges with low flow, and weir flow on the overbanks, HEC-RAS 3.0 may not be able to balance the flow using weir flow equation and low flow bridge analysis methods. HEC-RAS 3.0 will then use the energy method, and the computed energy grade elevations and water-surface elevations may be on the high side.	Yes
	HEC-2 4.6.2[1] (May 1991)	US Army Corps of Engineers	Water Resources Support Center[2] Corps of Engineers Hydrologic Engineering Center 609 Second Street Davis, CA 95616-4687	Includes culvert analysis and floodway options.	Yes
	WSPRO (June 1988 and up)	US Geological Survey, Federal Highway Administration (FHWA)	Federal Highway Administration (FHWA) web page at: http://www.fhwa.dot.gov/bridge/hyddescr.htm	Floodway option is available in June 1998 version. 1988 version is available on the USGS web page at: http://water.usgs.gov/software/surface_water.html	Yes
	QUICK-2 1.0 and up (January 1995)	FEMA	Federal Emergency Management Agency Hazard Identification Branch Mitigation Directorate 500 C Street, SW Washington, DC 20472	Intended for use in areas studied by approximate methods (Zone A) only. May be used to develop water-surface elevations at one cross section or a series of cross sections. May not be used to develop a floodway.	Yes
	HY8 4.1 and up (November 1992)	US Department of Transportation, Federal Highway Administration (FHWA)	Federal Highway Administration (FHWA) web page at: http://www.fhwa.dot.gov/bridge/hyddescr.htm	Computes water-surface elevations for flow through multiple parallel culverts and over the road embankment. Software and related publication are available from Center for Microcomputers in Transportation (McTrans), University of Florida, 512 Weil Hall, Gainesville, FL 32611-6585; and on the web at: http://www-mctrans.ce.ufl.edu/	Yes
	WSPGW 12.96 (October 2000)	Los Angeles Flood Control District and Joseph E. Bonadiman & Associates, Inc.	Joseph E. Bonadiman & Associates, Inc. 588 West 6th Street San Bernardino, CA 92410 http://www.bonadiman.com	Windows version of WSPG. Computes water-surface profiles and pressure gradients for open channels and closed conduits. Can analyze multiple parallel pipes. Road overtopping cannot be computed. Open channels are analyzed using the standard step method but roughness coefficient can not vary across the channel. Overbank analyses cannot be done. Multiple parallel pipe analysis assumes equal distribution between pipes so pipes must be of similar material, geometry, slope, and inlet configuration. Floodway function is not available. Demo version available from: http://www.civildesign.com	No
	StormCAD v.4 (June 2002) and v.5 (Jan. 2003)	Haestad Methods, Inc.	Haestad Methods, Inc. 37 Brookside Road Waterbury, CT 06708-1499 http://www.haestad.com	Perform backwater calculations. Should not be used for systems with more than two steep pipes (e.g. supercritical conditions). Inflow is computed by using the Rational Method; the program is only applicable to watershed which has the drainage area to each inlet less than 300 acres.	No

TYPE	PROGRAM	DEVELOPED BY	AVAILABLE FROM	COMMENTS	PUBLIC DOMAIN
	PondPack v.8 (May 2002)	Haestad Methods, Inc.	Haestad Methods, Inc. 37 Brookside Road Waterbury, CT 06708-1499 http://www.haestad.com	Cannot model ineffective flow areas. HEC-RAS or an equivalent program must be used to model tail water conditions when ineffective flow areas must be considered.	No
	Culvert Master v.2.0 (September 2000)	Haestad Methods, Inc.	Haestad Methods, Inc. 37 Brookside Road Waterbury, CT 06708-1499 http://www.haestad.com	Compute headwater elevations for circular concrete and RCB culverts for various flow conditions.	No
	XP-SWMM 8.52 and up	XP Software	XP-Software 2000 NE 42nd Ave. #214 Portland, OR 97213-1305 http://www.xpsoftware.com	XP-SWMM cannot represent more than three Manning's n values per channel section. Where more than this number of values per section are required, the user must demonstrate that the three n values used accurately depict the composite n value for the entire section at various depth.	No
One-dimensional Unsteady Flow Models	HEC-RAS 3.0 and Up	US Army Corps of Engineers	Water Resources Support Center Corps of Engineers Hydrologic Engineering Center (HEC) 609 Second Street Davis, CA 95616-4687 http://www.hec.usace.army.mil	Calibration or verification to the actual flood events highly recommended. Floodway concept formulation unavailable. Version 3.1 cannot create detailed output for multiple profiles in the report file. CHECK-RAS cannot extract data.	Yes
	FEQ 8.92 and FEQUTL 4.68 (1997, both)	Delbert D. Franz, Linsley, Kraeger Associates; and Charles S. Melching, USGS	US Geological Survey 221 North Broadway Avenue Urbana, IL 61801 http://water.usgs.gov/software/surface_water.html and technical support available at http://il.water.usgs.gov/proj/feq/	The FEQ model is a computer program for the solution of full, dynamic equations of motion for one-dimensional unsteady flow in open channels and control structures. The hydraulic characteristics for the floodplain (including the channel, overbanks, and all control structures affecting the movement of flow) are computed by its companion program FEQUTL and used by the FEQ program. Calibration or verification to the actual flood events highly recommended. Type 5 culvert flow computations of FEQUTL need verification with results obtained using methodology or models accepted for NFIP use. Floodway concept formulation is unavailable.	Yes
	ICPR 2.20 (October 2000) and 3.02 (November 2002)	Streamline Technologies, Inc.	Streamline Technologies, Inc. 6961 University Boulevard Winter Park, FL 32792 http://www.streamnologies.com	Calibration or verification to the actual flood events highly recommended. Floodway concept formulation unavailable; however, version 3 allows user to specify encroachment stations to cut off the cross section.	No

TYPE	PROGRAM	DEVELOPED BY	AVAILABLE FROM	COMMENTS	PUBLIC DOMAIN
	SWMM 4.30 (May 1994), and 4.31 (January 1997)	US Environmental Protection Agency and Oregon State University	Center for Exposure Assessment Modeling US Environmental Protection Agency Office of Research and Development Environmental Research Laboratory 960 College Station Road Athens, GA 30605-2720 http://www.epa.gov/ceampubl/swater/ Department of Civil, Construction, and Environmental Engineering Oregon State University 202 Apperson Hall Corvallis, OR 97331-2302 http://ccee.oregonstate.edu/swmm/ ftp://ftp.engr.orst.edu/pub/swmm/pc/	Calibration or verification to the actual flood events highly recommended. Structural loss calculations unavailable and must be accommodated via roughness factor manipulation. Floodway concept formulation unavailable. Preferably, for NFIP purposes, head losses at bridges should be verified using WSPRO; losses at culverts should be verified using the US Geological Survey's six equations for culvert analysis. Losses at storm sewer junctions should also be verified with separate calculations; contact FEMA for guidance with these calculations. Supporting documentation for floodway calculations is available at: http://www.fema.gov/fhm/dl_swmm.shtm.	Yes
	UNET 4.0 (April 2001)	US Army Corps of Engineers	Water Resources Support Center Corps of Engineers Hydrologic Engineering Center (HEC) 609 Second Street Davis, CA 95616-4687	Calibration or verification to the actual flood events highly recommended. Comparison of bridge and culvert modeling to other numerical models reveals significant differences in results; these differences may be investigated in the near future. Floodway option currently under review, not accepted for NFIP usage.	Yes
	FLDWAV (November 1998)	National Weather Service	Hydrologic Research Laboratory Office of Hydrology National Weather Service, NOAA 1345 East-West Highway Silver Spring, MD 20910	Includes all the features of DAMBRK and DWOPER plus additional capabilities. It is a computer program for the solution of the fully dynamic equations of motion for one-dimensional flow in open channels and control structures. Floodway concept formulation is unavailable. Calibration to actual flood events required. This model has the capability to model sediment transport. Program is supported by NWS. Supporting documentation is available at: http://www.fema.gov/fhm/dl_fdwv.shtm	Yes
	MIKE 11 HD (2002D)	DHI Water and Environment	DHI Inc. 301 South State Street Newton, PA 18940	Hydrodynamic model for the solution of the fully dynamic equations of motion for one-dimensional flow in open channels and control structures. The floodplain can be modeled separately from the main channel. Calibration to actual flood events highly recommended. Floodway concept formulation is available for steady flow conditions. This model has the capability to model sediment transport. The web page is at: http://www.dhisoftware.com/mike11/	No
	FLO-2D v. 2000.11 (December 2000)	Jimmy S. O'Brien, Ph.D., P.E.	FLO-2D Software, Inc. Tetra Tech, ISG P.O. Box 66 Nutrioso, AZ 85932	Hydrodynamic model for the solution of the fully dynamic equations of motion for one-dimensional flow in open channels and two-dimensional flow in the floodplain. Bridge or culvert computations must be accomplished external to FLO-2D using methodologies or models accepted for NFIP usage. Calibration to actual flood events required. Floodway computation is unavailable.	Yes
	XP-SWMM 8.52 and up	XP Software	XP-Software 2000 NE 42nd Ave. #214 Portland, OR 97213-1305 http://www.xpsoftware.com	XP-SWMM cannot represent more than three Manning's n values per channel section. Where more than this number of values per section are required, the user must demonstrate that the three n values used accurately depict the composite n value for the entire section at various depth. Calibration to actual flood events required. The floodway procedures are for steady flow purposes only. Use the procedure posted on the FEMA website at http://www.fema.gov/fhm/en_modl.shtm for unsteady flow floodway calculation.	No

TYPE	PROGRAM	DEVELOPED BY	AVAILABLE FROM	COMMENTS	PUBLIC DOMAIN
Two-dimensional Steady/Unsteady Flow Models	TABS RMA2 v. 4.3 (October 1996) RMA4 v. 4.5 (July 2000)	US Army Corps of Engineers	Coastal Engineering Research Center Department of the Army Waterways Experiment Station Corps of Engineers 3909 Halls Ferry Road Vicksburg, MS 39180-6199	Limitations on split flows. Floodway concept formulation unavailable. More review anticipated for treatment of structures.	Yes
	FESWMS 2DH 1.1 and up (June 1995)	US Geological Survey	US Geological Survey National Center 12201 Sunrise Valley Drive Reston, VA 22092 http://water.usgs.gov/software/surface_water.html	Region 10 has conducted study in Oregon. Floodway concept formulation unavailable. This model has the capability to model sediment transport.	Yes
	FLO-2D v. 2000.11 (December 2000)	Jimmy S. O'Brien, Ph.D., P.E.	FLO-2D Software, Inc. Tetra Tech, ISG P.O. Box 66 Nutrioso, AZ 85932	Hydrodynamic model that has the capabilities of modeling unconfined flows, complex channels, sediment transport, and mud and debris flows. It can be used for alluvial fan modeling.	No
	MIKE Flood HD (2002 B and 2002 D)	DHI Water and Environment	DHI Inc. 301 South State Street Newton, PA 18940	A package that facilitates the dynamic coupling of MIKE 11 (one dimensional) and MIKE 21 (two-dimensional) hydrodynamic models. Solves the fully dynamic equations of motion for one- and two-dimensional flow in open channels, riverine flood plains, alluvial fans and in coastal zones. Control structures are modeled with one-dimensional flow using bridge and culvert routines in MIKE 11 HD. This combination allows users to model some areas in 2D detail, while other areas can be modeled in 1D. Calibration for actual flood events is highly recommended. The model has the capability to model sediment transport. The web page is at http://www.dhisoftware.com/mikeflood/	No
Floodway Analysis	SFD	US Army Corps of Engineers/FEMA	Federal Emergency Management Agency Hazard Identification Branch Mitigation Directorate 500 C Street, SW Washington, DC 20472	Simplified floodway procedure for streams with no regulatory floodway limits.	Yes
	PSUPRO	Pennsylvania State University/ US Army Corps of Engineers/FEMA	Federal Emergency Management Agency Hazard Identification Branch Mitigation Directorate 500 C Street, SW Washington, DC 20472	Encroachment analysis for streams with no regulatory floodway limits.	Yes

[1]The enhancement of these programs in editing and graphical presentation can be obtained from several private companies.
[2]Program is typically distributed by vendors and may not be available through HEC. A list of vendors may be obtained through HEC

8.3 DATA COLLECTION SITES

A hydrometerological monitoring program is required for establishing a network of stations to monitor water levels, water quality, weather data such as air temperature, relative humidity, atmospheric pressure, and pan evaporation. Hydrometeorological data are desirable for model calibration and verification, prior to the models use for predicting flood flows and stages. Section 2 identifies the existing hydrometerological data network. This section identifies other sites to supplement the program.

8.3.1 RAINFALL

Figure 2.3.2-1 and **Table 2.3.2-1** identifies the existing rainfall data network. The spatial variation of the rainfall stations are good but could be enhanced by adding four more stations as shown in **Figure 8.3-1**. For stormwater modeling purposes incremental rainfall for short time increments (e.g., 15 minutes, 1-hour) are desirable. Of the eight raingages shown in **Table 2.3.2.1**, only three do not have short time-incremental data. It is recommended that these stations should be converted to short time-incremental data stations and the new recommended stations should also be short time-incremental data stations.

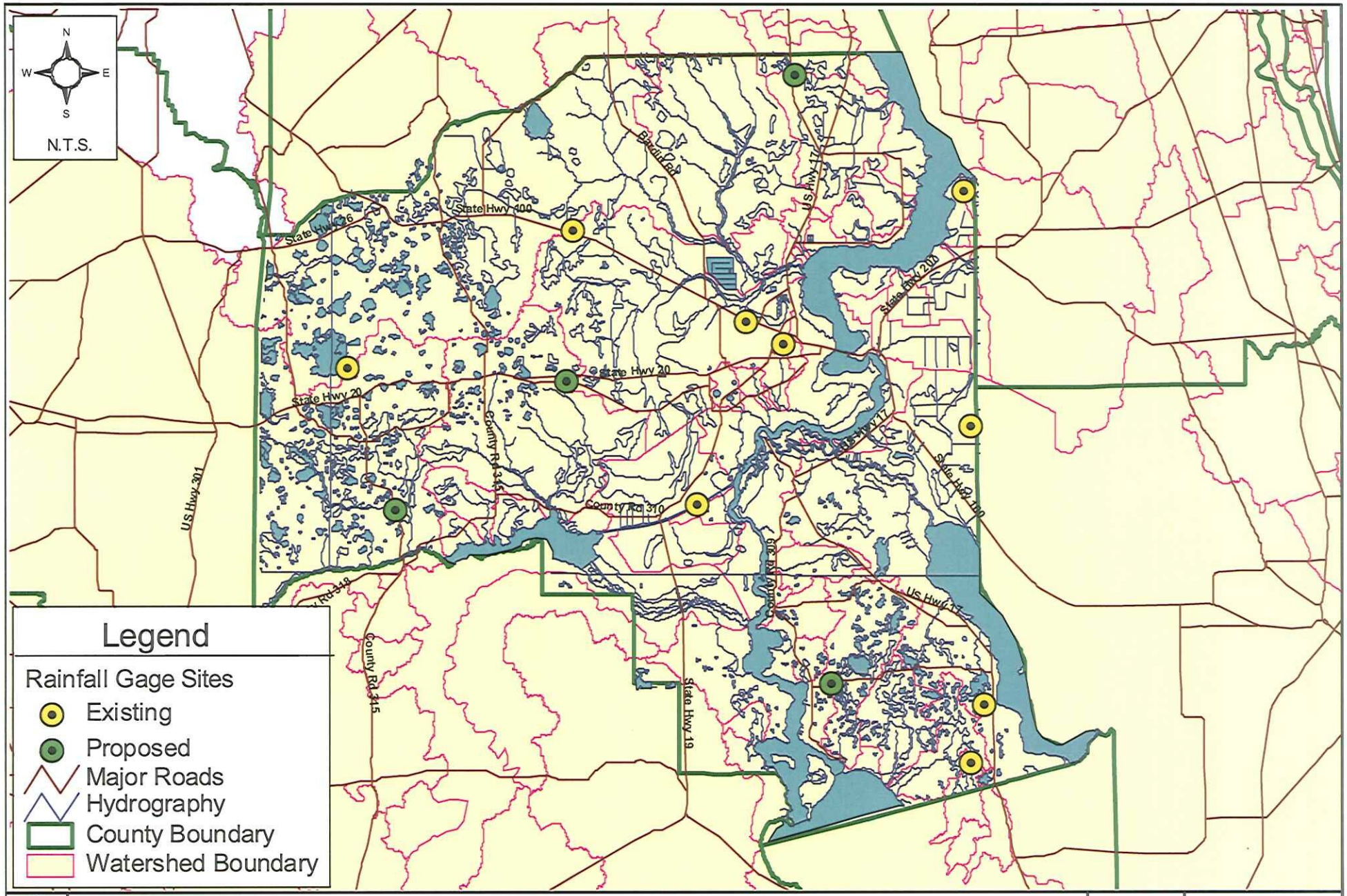
8.3.2 STREAMFLOW

Figure 2.3.2-1 and **Table 2.3.2-2** identifies the existing streamflow data network. The major conveyance systems already have streamflow monitoring stations and new stations are not recommended. For minor tributaries where information is required (See Section 7) it is recommended that stormwater modeling techniques should be used for design purposes.

Water quality data are being assessed by others for TMDL purposes. There is no requirement for Putnam County to collect additional data except if mandated for NPDES purposes. Although this stormwater management plan has identified sedimentation as a problem, sedimentation will be assessed by empirical methods.

8.3.3 WEATHER

Currently, there are no known full weather stations in Putnam County. Although not central to the County, it is recommended that a weather station should be installed in Palatka, preferably at District's headquarters (there is currently a precipitation station with wind data but no evaporation, humidity, temperature, solar radiation, etc). The District is preferred to the County's offices because it is believed that the District's staff would be better trained and equipped to maintain the station and collect the data. The site should be equipped to monitor rainfall, evaporation, humidity, wind speed and direction, and air temperature. Other recommended weather station sites include a southern County site west of Crescent City and a station near or in the City of Interlachen. The location of the proposed sites is shown in **Figure 8.3-2**.



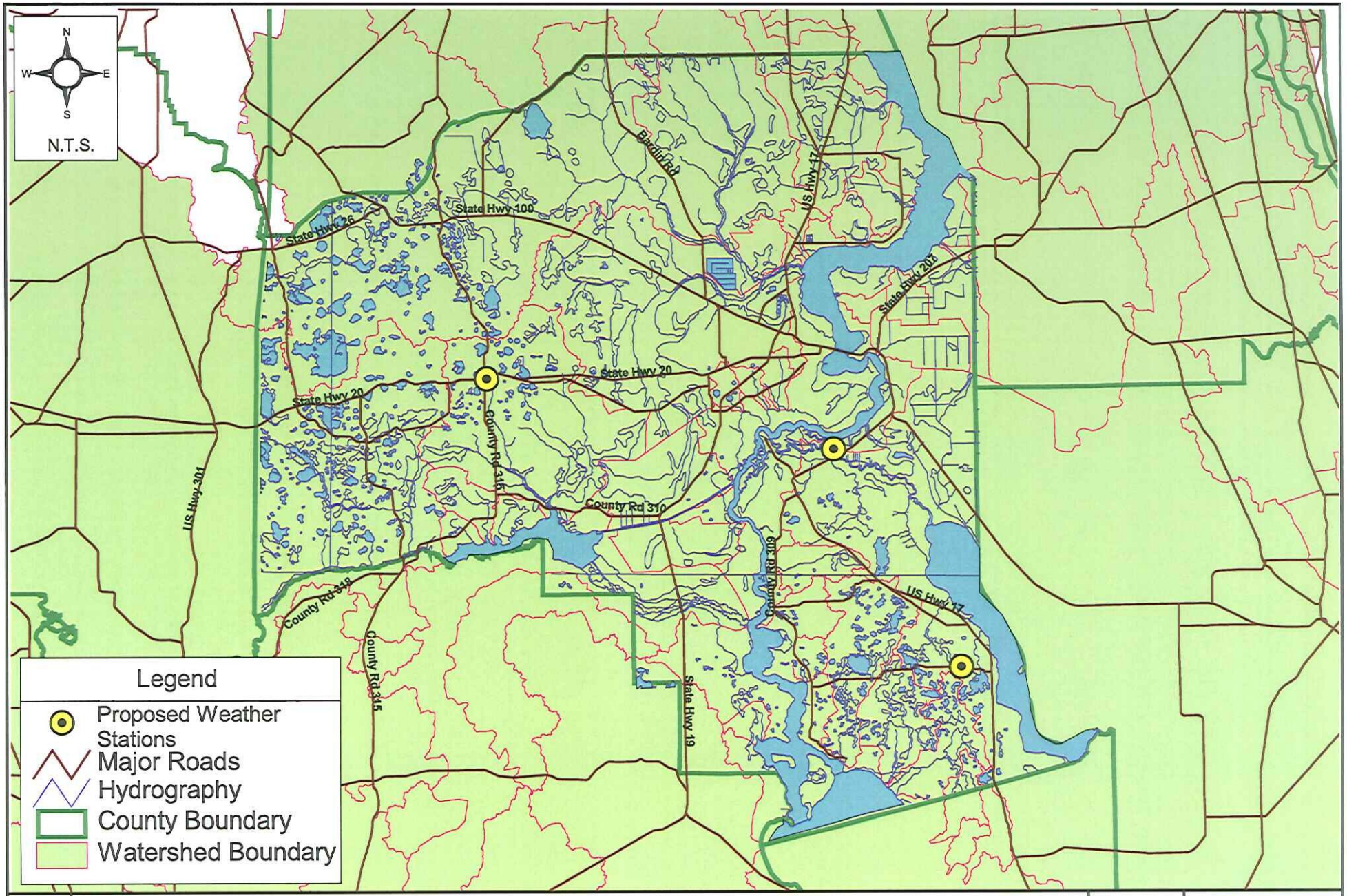
G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Location_Big.apr

SJRWMD/NCDC Rainfall Gages

Putnam County Master Stormwater Plan

Figure 8.3-1

AYRES ASSOCIATES



G:\COUNTY - PUTNAM\67011000(PutnumCoSWMMP)\GIS\APRs\Location_Big2.apr

Proposed Weather Stations
Putnam County Master Stormwater Plan

Figure 8.3-2

AYRES ASSOCIATES

8.4 MONITORING PROTOCOL

Four (4) additional proposed rainfall monitoring sites and three (3) weather station sites are shown in Section 8.3 figures. This section identifies the protocol for data collection. No streamflow or water quality monitoring sites have been proposed. For the monitoring protocol for the rainfall and weather station (meteorological instruments) guidance published by the EPA (EPA, 2000, Meteorological Monitoring Guidance for Regulatory Modeling Applications) is standard protocol and has been adopted for Putnam County. The complete document can be found on the Internet at:

http://www.epa.gov/scram001/guidance/met/mmgrma.pdf

The document contains information on:

- Primary Meteorological Variables
- Siting and Exposure
- Meteorological Data Recording
- System Performance
- Meteorological Data Processing
- Data Reporting and Archiving
- Quality Assurance and Quality Control

The cover pages, table of contents, and relevant sections of the report are shown in **Appendix 8-A.**

8.5 TOPOGRAPHIC MAPPING RECOMMENDATIONS

Most aspects of stormwater management involve the use of aerial photogrammetry and mapping. Accordingly, development of aerial mapping is the foundation of any strategic and long range plan within the County that is aimed at proactively managing its stormwater issues. Mapping is useful for many applications; during ad-hoc field investigations, determination of flow boundaries and paths, and is essential for any type of modeling study or capital improvement project that includes a modeling task. To save on costs, aerial mapping projects can be part of a cost sharing agreement between nearby counties or districts.

The Water Management Districts and some local governments, including St. Johns County, have aerial mapping coverage across parts or, in some cases, all of their jurisdictional or political boundaries. Due to the low topographic relief in Florida, one (1) foot contours have become somewhat of a standard specification throughout Florida, i.e. all of the local governments and agencies that purchase aerial mapping issue the one-foot standard. One of the Water Management Districts for example, stipulates the following in their aerial mapping project contracts:

> *"Photogrammetrically-derived digital terrain models: The required accuracy of the terrain models will vary depending on the project, but the Consultants should be able to create terrain models capable of supporting one-foot contours in accordance with National Mapping Standards and 61G17 F.A.C."*

Essentially the standard above requires 1-foot contours with an accuracy tolerance of +/- 0.5 feet. Contours maps with this level of accuracy provide the detail necessary to make reliable determinations in the field during field reviews, to make determinations related to basin boundaries and surface water flow paths for modeling studies, and to extend the overbank portion of channel cross-sections, etc., for flood plain studies without shifting liability for accuracy of the modeling results from the engineer to the owner of the mapping and/or the mapping consultant.

FEMA guidelines require only 2-foot contour intervals. However FEMA's specification is based on the nature of FEMA's jurisdictional boundaries, i.e. the entire United States. Two-foot intervals are more than adequate in many parts of the country; however, the standard is inadequate in Florida, and Putnam County in particular, given the low topographic relief.

8.5.1 MAPPING SPECIFICATIONS

The technology and trends today are almost exclusively toward development of 1-foot contours using Light Detection and Ranging (LiDAR) technology, in large part due to its relatively low cost. Neighboring St. Johns County is in the process of mapping their entire County using LiDAR. However, the National Mapping Standard captioned above, and the one necessary to obtain the 1-foot contour accuracy standards, is not obtainable with LiDAR technology. In ideal conditions, such as bare ground cover, LiDAR is accurate up to +/-15 centimeters (5.9 inches) which is just inside the +/- 0.5 feet accuracy standard. However, given the amount of ground cover in Putnam County, especially in the sivilculture areas, the 15 centimeter standard will not likely be met and in some cases contours developed from the LiDAR technology may not be accurate enough to base watershed modeling results on. Consequently, there is potential for the Engineer of Record on CIPs and floodplain studies that included complex modeling tasks, to have to caveat signed and sealed work products. Alternatively, additional field survey may be

required to confirm the topographic data provided by the LiDAR mapping, particularly with regard to ditch and stream profiles and to confirm drainage divides.

8.5.2 COMPARING QUALITY AND COSTS

Ayres has had recent experience with comparing aerial topographic mapping based on LiDAR to that based on traditional stereoscope produced methods. In our opinion, the conventionally produced mapping was more accurate and consistent. In some cases the LiDAR produced maps that were off by well over a foot and in many cases lacked sufficient detail. For example, contours defining man-made ditches and swales that have geometric symmetry could not be defined by the LiDAR, as compared to the conventional maps.

The choice for the County will likely come down to cost. On a cost basis there is no comparison. LiDAR mapping may be generated at a cost between $1,100 and $1,500 per square mile versus conventional methods costing approximately $7,500 per square mile to produce.

Ayres recommends development of 1-foot contour interval mapping, beginning with all of the selected subwatershed, and later expanding coverage over the other areas of the county on a timetable consistent with funding and the subwatershed studies described in Section 8.

Appendix 8-A

COPIES OF PORTIONS OF EPA METEOROLOGICAL MONITORING GUIDANCE FOR REGULATORY MODELING APPLICATIONS

United States Environmental Protection Agency | Office of Air Quality Planning and Standards Research Triangle Park, NC 27711 | EPA-454/R-99-005 February 2000

Air

EPA

Meteorological Monitoring Guidance for Regulatory Modeling Applications

EPA-454/R-99-005

Meteorological Monitoring Guidance for Regulatory Modeling Applications

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, NC 27711

February 2000

DISCLAIMER

This report has been reviewed by the U.S. Environmental Protection Agency (EPA) and has been approved for publication as an EPA document. Any mention of trade names or commercial products does not constitute endorsement or recommendation for use.

PREFACE

This document updates the June 1987 EPA document, "On-Site Meteorological Program Guidance for Regulatory Modeling Applications", EPA-450/4-87-013. The most significant change is the replacement of Section 9 with more comprehensive guidance on remote sensing and conventional radiosonde technologies for use in upper-air meteorological monitoring; previously this section provided guidance on the use of sodar technology. The other significant change is the addition to Section 8 (Quality Assurance) of material covering data validation for upper-air meteorological measurements. These changes incorporate guidance developed during the workshop on upper-air meteorological monitoring in July 1998.

Editorial changes include the deletion of the "on-site" qualifier from the title and its selective replacement in the text with "site specific"; this provides consistency with recent changes in Appendix W to 40 CFR Part 51. In addition, Section 6 has been updated to consolidate and provide necessary context for guidance in support of air quality dispersion models which incorporate boundary layer scaling techniques.

The updated document (like the June 1987 document) provides guidance on the collection of meteorological data for use in regulatory modeling applications. It is intended to guide the EPA Regional Offices and States in reviewing proposed meteorological monitoring plans, and as the basis for advice and direction given to applicants by the Regional Offices and States. To facilitate this process, recommendations applicable to regulatory modeling applications are summarized at the end of each section. Alternate approaches, if these recommendations can not be met, should be developed on a case-by-case basis in conjunction with the Regional Office.

ACKNOWLEDGMENTS

The original (June 1987) document was prepared by the On-site Meteorological Data Work Group, formed in December 1985 and chaired by Roger Brode, EPA-OAQPS. Its members and their contributions are as follows: Edward Bennett, NY State DEC, Section 6.6; Roger Brode, EPA-OAQPS, Sections 1.0, 2.0 and 4.0; James Dicke, EPA-OAQPS, Section 5.2; Robert Eskridge, EPA-ASRL, Sections 6.2 and 6.3; Mark Garrison, EPA-Region III, Sections 3.2 and 9.0; John Irwin, EPA-ASRL, Sections 6.1 and 6.4; Michael Koerber, EPA-Region V, Sections 3.1 and 3.3; Thomas Lockhart, Meteorological Standards Institute, Section 8.0; Timothy Method, EPA-Region V, Section 3.4; Stephen Perkins, EPA-Region I, Sections 6.5 and 7.0; and Robert Wilson, EPA-Region 10, Sections 5.1 and 8.6, and parts of Sections 8.1, 8.2, and 8.5. Through their internal reviews and discussions, all of the work group members contributed to shaping the document as a whole. The work group wishes to acknowledge the time and effort of those, both within and outside of EPA, who provided technical review comments on the document. The work group also acknowledges the support and helpful guidance of Joseph A. Tikvart, EPA-OAQPS.

The June 1995 reissue of the document was prepared by Desmond T. Bailey with secretarial assistance from Ms. Brenda Cannady. Technical advice and guidance was provided by John Irwin.

The February 1999 reissue of the document provides updated material for Sections 8 (Quality Assurance) and 9 (Upper-Air Meteorological Monitoring). This material is the product of a workshop conducted at EPA facilities in Research Triangle Park, NC in July 1998. The workshop was conducted for EPA by Sharon Douglas of Systems Applications Inc. and three expert chairpersons: Ken Schere (U.S. EPA); Charles (Lin) Lindsey (Northwest Research Associates, Inc.); and Thomas Lockhart (Meteorological Standards Institute). Participants to the workshop were selected based on their expertise in atmospheric boundary layer measurements and/or the use of such data in modeling. Workshop participants were provided copies of the mock-up for review prior to the workshop, and were tasked to finalize the document during the workshop. The mock-up was prepared by Desmond Bailey (U.S. EPA) based on a draft report prepared under contract to EPA by Sonoma Technology, Inc. (SAI) entitled, "Guidance for Quality Assurance and Management of PAMS Upper-Air Meteorological Data". The latter report was written by Charles Lindsey and Timothy Dye (SAI) and Robert Baxter (Parsons Engineering Science Inc).

The two dozen participants to the workshop represented various interest groups including: remote sensing equipment vendors; local, state, and federal regulatory staff; the NOAA laboratories; university staff; and private consultants. Participants to the workshop were as follows: Desmond T. Bailey (Host), Alex Barnett (AVES), Mike Barth (NOAA Forecast Systems Lab), Bob Baxter (Parsons Engineering Science, Inc.), William B. Bendel (Radian International, LLC), Jerry Crescenti (U.S. Department of Commerce/NOAA), Sharon Douglas (Systems Applications Intl., Inc, Workshop Coordinator), Tim Dye (Sonoma Technology, Inc.), Leo Gendron (ENSR), Gerry Guay (Alaska Dept. of Environmental Conservation), Mark Huncik (CP&L), John Higuchi (SCAQMD), John Irwin (U.S. Environmental Protection Agency. Host),

David Katz (Climatronics), Shawn Kendall (Phelps Dodge Corporation), Don Lehrman (T & B Systems), Charles (Lin) Lindsey (Northwest Research Associates, Inc., Chairperson), Thomas Lockhart (Meteorological Standards Institute, Chairperson), Louis Militana (Roy F. Weston, Inc), Bill B. Murphey (Georgia Dept. of Natural Resources), Kenneth L. Schere (U.S. Environmental Protection Agency ORD, Chairperson), Nelson Seaman (Pennsylvania State University), Dr. Volker Thiermann (SCINTEC Atmospharemesstechnik AG), Stan Vasa (Southern Company Services), John White (North Carolina Division of Air Quality), Dr. J. Allen Zak (NASA Langley Research Center/VIGYAN, Inc.).

Peer review of the an April 1999 draft of this document was provided by Rob Wilson (U.S. EPA, Region 10) and Larry Truppi (U.S. EPA, NERL).

TABLE OF CONTENTS

Page

PREFACE iii

ACKNOWLEDGMENTS iv

TABLE OF CONTENTS vi

LIST OF FIGURES xi

LIST OF TABLES xii

1. INTRODUCTION 1-1
   - 1.1 Background 1-1
   - 1.2 Organization of Document 1-2

2. PRIMARY METEOROLOGICAL VARIABLES 2-1
   - 2.1 Wind Speed 2-1
     - 2.1.1 Cup Anemometers 2-2
     - 2.1.2 Vane-oriented and Fixed-mount Propeller Anemometers 2-2
     - 2.1.3 Wind Speed Transducers 2-3
   - 2.2 Wind Direction 2-3
     - 2.2.1 Wind Vanes 2-4
     - 2.2.2 U-V and UVW Systems 2-4
     - 2.2.3 Wind Direction Transducers 2-4
     - 2.2.4 Standard Deviation and Turbulence Data 2-5
   - 2.3 Temperature and Temperature Difference 2-5
     - 2.3.1 Classes of Temperature Sensors 2-5
     - 2.3.2 Response Characteristics 2-6
     - 2.3.3 Temperature Difference 2-6
     - 2.3.4 Sources of Error 2-6
   - 2.4 Humidity 2-7
     - 2.4.1 Humidity Variables 2-7
     - 2.4.2 Types of Instrumentation 2-7
   - 2.5 Precipitation 2-8
   - 2.6 Pressure 2-8
   - 2.7 Radiation 2-9
   - 2.8 Recommendations 2-10

3. SITING AND EXPOSURE 3-1
3.1 Representativeness 3-1
3.1.1 Objectives for Siting 3-1
3.1.2 Factors to Consider 3-2
3.2 Simple Terrain Locations 3-3
3.2.1 Wind Speed and Wind Direction 3-4
3.2.2 Temperature, Temperature Difference, and Humidity 3-6
3.2.3 Precipitation 3-7
3.2.4 Pressure 3-8
3.2.5 Radiation 3-8
3.3 Complex Terrain Locations 3-9
3.3.1 Wind Speed 3-10
3.3.2 Wind Direction 3-10
3.3.3 Temperature Difference 3-11
3.4 Coastal Locations 3-12
3.5 Urban Locations 3-12
3.6 Recommendations 3-13

4. METEOROLOGICAL DATA RECORDING 4-1
4.1 Signal Conditioning 4-1
4.2 Recording Mechanisms 4-1
4.3 Analog-to-Digital Conversion 4-1
4.4 Data Communication 4-2
4.5 Sampling Rates 4-2
4.6 Recommendations 4-2

5. SYSTEM PERFORMANCE 5-1
5.1 System Accuracies 5-1
5.2 Response Characteristics of Meteorological Sensors 5-2
5.3 Data Recovery 5-4
5.3.1 Length of Record 5-4
5.3.2 Completeness Requirement 5-4
5.4 Recommendations 5-5

6. METEOROLOGICAL DATA PROCESSING 6-1
6.1 Averaging and Sampling Strategies 6-1
6.2 Wind Direction and Wind Speed 6-1
6.2.1 Scalar Computations 6-3
6.2.2 Vector Computations 6-5
6.2.3 Treatment of Calms 6-7
6.2.4 Turbulence 6-8
6.2.5 Wind Speed Profiles 6-8
6.3 Temperature 6-11

6.3.1 Use in Plume-Rise Estimates 6-11
6.3.2 Vertical Temperature Gradient 6-11
6.4 Stability 6-11
6.4.1 Turner's method 6-12
6.4.2 Solar radiation/delta-T (SRDT) method 6-15
6.4.3 σ_E method 6-16
6.4.4 σ_A method 6-18
6.4.5 Accuracy of stability category estimates 6-21
6.5 Mixing Height 6-23
6.5.1 The Holzworth Method 6-23
6.6 Boundary Layer Parameters 6-24
6.6.1 The Profile Method 6-25
6.6.2 The Energy Budget Method 6-26
6.6.3 Surface Roughness Length 6-27
6.6.4 Guidance for Measurements in the Surface Layer 6-29
6.7 Use of Airport Data 6-30
6.8 Treatment of Missing Data 6-30
6.8.1 Substitution Procedures 6-31
6.9 Recommendations 6-32

7. DATA REPORTING AND ARCHIVING 7-1
7.1 Data Reports 7-1
7.2 Data Archives 7-2
7.3 Recommendations 7-2

8. QUALITY ASSURANCE AND QUALITY CONTROL 8-1
8.1 Instrument Procurement 8-2
8.1.1 Wind Speed 8-2
8.1.2 Wind Direction 8-3
8.1.3 Temperature and Temperature Difference 8-4
8.1.4 Dew Point Temperature 8-5
8.1.5 Precipitation 8-5
8.1.6 Pressure 8-5
8.1.7 Radiation 8-5
8.2 Installation and Acceptance Testing 8-6
8.2.1 Wind Speed 8-6
8.2.2 Wind Direction 8-7
8.2.3 Temperature and Temperature Difference 8-7
8.2.4 Dew Point Temperature 8-7
8.2.5 Precipitation 8-8
8.2.6 Pressure 8-8
8.2.7 Radiation 8-8
8.3 Routine Calibrations 8-8

8.3.1 Sensor Check 8-9
8.3.2 Signal Conditioner and Recorder Check 8-12
8.3.3 Calibration Data Logs 8-13
8.3.4 Calibration Report 8-14
8.3.5 Calibration Schedule/Frequency 8-14
8.3.6 Data Correction Based on Calibration Results 8-14
8.4 Audits 8-15
8.4.1 Audit Schedule and Frequency 8-15
8.4.2 Audit Procedure 8-15
8.4.3 Corrective Action and Reporting 8-16
8.5 Routine and Preventive Maintenance 8-16
8.5.1 Standard Operating Procedures 8-17
8.5.2 Preventive Maintenance 8-17
8.6 Data Validation and Reporting 8-20
8.6.1 Preparatory Steps 8-20
8.6.2 Levels of Validation 8-21
8.6.3 Validation Procedures 8-21
8.6.4 Schedule and Reporting 8-25
8.7 Recommendations 8-25

9. UPPER-AIR MONITORING 9-1
9.1 Fundamentals 9-1
9.1.1 Upper-Air Meteorological Variables 9-1
9.1.2 Radiosonde Sounding System 9-7
9.1.3 Doppler Sodar 9-9
9.1.4 Radar Wind Profiler 9-11
9.1.5 RASS 9-14
9.2 Performance Characteristics 9-15
9.2.1 Definition of Performance Specifications 9-15
9.2.2 Performance Characteristics of Radiosonde Sounding Systems 9-17
9.2.3 Performance Characteristics of Remote Sensing Systems 9-18
9.3 Monitoring Objectives and Goals 9-18
9.3.1 Data Quality Objectives 9-19
9.4 Siting and Exposure 9-20
9.5 Installation and Acceptance Testing 9-22
9.6 Quality Assurance and Quality Control 9-25
9.6.1 Calibration Methods 9-27
9.6.2 System and Performance Audits 9-28
9.6.3 Standard Operating Procedures 9-33
9.6.4 Operational Checks and Preventive Maintenance 9-33
9.6.5 Corrective Action and Reporting 9-35
9.6.6 Common Problems Encountered in Upper-Air Data Collection 9-35
9.7 Data Processing and Management (DP&M) 9-38

9.7.1 Overview of Data Products 9-38
9.7.2 Steps in DP&M 9-38
9.7.3 Data Archiving 9-40
9.8 Recommendations for Upper-Air Data Collection 9-41

10. REFERENCES 10-1

3. SITING AND EXPOSURE

This section provides guidance on siting and exposure of meteorological towers and sensors for the in situ measurement of the primary meteorological variables. Specific guidance is provided for siting in simple terrain (Section 3.2), in complex terrain (Section 3.3), in coastal locations (Section 3.4), and in urban locations (Section 3.5). The issue of representativness is addressed in Section 3.1.

As a general rule, meteorological sensors should be sited at a distance which is beyond the influence of obstructions such as buildings and trees; this distance depends upon the variable being measured as well as the type of obstruction. The other general rule is that the measurements should be representative of meteorological conditions in the area of interest; the latter depends on the application. Secondary considerations such as accessibility and security must be taken into account, but should not be allowed to compromise the quality of the data. In addition to routine quality assurance activities (see Section 8), annual site inspections should be made to verify the siting and exposure of the sensors. Approval for a particular site selection should be obtained from the permit granting agency prior to any site preparation activities or installation of any equipment.

3.1 Representativeness

One of the most important decisions in preparing for an air quality modeling analysis involves the selection of the meteorological data base; this is the case whether one is selecting a site for monitoring, or selecting an existing data base. These decisions almost always lead to similar questions: "Is the site (are the data) representative?" Examples eliciting a negative response abound; e.g., meteorological data collected at a coastal location affected by a land/sea breeze circulation would generally not be appropriate for modeling air quality at an inland site located beyond the penetration of the sea breeze. One would hope that such examples could be used in formulating objective criteria for use in evaluating representativeness in general. Though this remains a possibility, it is not a straight forward task - this is due in part to the fact that representativeness is an exact condition; a meteorological observation, data base, or monitoring site, either is, or is not representative within the context of whatever criteria are prescribed. It follows that, a quantitative method does not exist for determining representativeness absolutely. Given the above, it should not be surprising that there are no generally accepted analytical or statistical techniques to determine representativeness of meteorological data or monitoring sites.

3.1.1 Objectives for Siting

Representativeness has been defined as "the extent to which a set of measurements taken in a space-time domain reflects the actual conditions in the same or different space-time domain taken on a scale appropriate for a specific application" [10]. The space-time and application aspects of the definition as relates to site selection are discussed in the following.

In general, for use in air quality modeling applications, meteorological data should be representative of conditions affecting the transport and dispersion of pollutants in the "area of interest" as determined by the locations of the sources and receptors being modeled. In many instances, e.g. in complex terrain, multiple monitoring sites may be required to adequately represent spatial variations in meteorological conditions affecting transport and/or dispersion.

In steady-state modeling applications, one typically focuses on the meteorological conditions at the release height of the source or sources, or the plume height in the case of buoyant sources. Representativeness for steady-state modeling applications must necessarily be assessed in concert with the steady-state assumption that meteorological conditions are constant within the space-time domain of the application; as typically applied, measurements for a single location, somewhere near the source, are assumed to apply, without change, at all points in the modeling domain. Consistency would call for site selection criteria consistent with the steady-state assumption; i.e., to the extent possible, sites should perhaps be selected such that factors which cause spatial variations in meteorological conditions, are invariant over the spatial domain of the application, whatever that might be. Such factors would include surface characteristics such as ground cover, surface roughness, the presence or absence of water bodies, etc. Similarly, the representativeness of existing third-party data bases should be judged, in part, by comparing the surface characteristics in the vicinity of the meteorological monitoring site with the surface characteristics that generally describe the analysis domain.

Representativeness has an entirely different interpretation for non-steady-state modeling applications which commonly employ three dimensional gridded meteorological fields based on measurements at multiple sites. The meteorological processors which support these applications are designed to appropriately blend available NWS data, local site-specific data, and prognostic mesoscale data; empirical relationships are then used to diagnostically adjust the wind fields for mesoscale and local-scale effects **[11]**, **[12]** . These diagnostic adjustments can be improved through the use of strategically placed site-specific meteorological observations. Support for such applications is provided to the extent that this guidance can be used for selecting sites to monitor the significant meteorological regimes that may need to be represented in these applications. Site selection for such applications (often more than one location is needed) falls in the category of network design and is beyond the scope of this document. Model user's guides should be consulted for meteorological data requirements and guidance on network design for these applications.

3.1.2 Factors to Consider

Issues of representativeness will always involve case-by-case subjective judgements; consequently, experts knowledgeable in meteorological monitoring and air quality modeling should be included in the site selection process. The following information is provided for consideration in such decisions. Readers are referred to a 1982 workshop report **[10]** on representativeness for further information on this topic.

- It is important to recognize that, although certain meteorological variables may be considered unrepresentative of another site (for instance, wind direction or wind speed), other variables may be representative (such as temperature, dew point, cloud cover). Exclusion of one variable does not necessarily exclude all. For instance, one can argue that weather observations made at different locations are likely to be similar if the observers at each location are within sight of one another - a stronger argument can be made for some types of observations (e.g., cloud cover) than others. Although, by no means a sufficient condition, the fact that two observers can "see" one another supports a conclusion that they would observe similar weather conditions.
- In general, the representativeness of the meteorological data used in an air quality modeling analysis is dependent on the proximity of the meteorological monitoring site to the "area-of-interest".
- Spatial representativeness of the data will almost always be adversely affected (degraded) by increasing the distance between the sources and receptors (increasing the size of the area-of-interest).
- Although proximity of the meteorological monitoring site is an important factor, representativeness is not simply a function of distance. In some instances, even though meteorological data are acquired at the location of the pollutant source, they may not correctly characterize the important atmospheric dispersion conditions; e.g., dispersion conditions affecting sources located on the coast are strongly affected by off-shore air/sea boundary conditions - data collected at the source would not always reflect these conditions.
- Representativeness is a function of the height of the measurement. For example, one can expect more site-to-site variability in measurements taken close to the surface compared to measurements taken aloft. As a consequence, upper-air measurements are generally representative of much larger spatial domains then are surface measurements.
- Where appropriate, data representativeness should be viewed in terms of the appropriateness of the data for constructing realistic boundary layer profiles and three dimensional meteorological fields.
- Factors that should be considered in selecting a monitoring site in complex terrain include: the aspect ratio and slope of the terrain, the ratios of terrain height to stack height and plume height, the distance of the source from the terrain feature, and the effects of terrain features on meteorological conditions, especially wind speed and wind direction.

3.2 Simple Terrain Locations

For the purposes of this guidance, the term "simple terrain" is intended to mean any site where terrain effects on meteorological measurements are non-significant. The definition of significance depends on the application; for regulatory dispersion modeling applications,

significance is determined by comparing stack-top height to terrain height - terrain which is below stack-top is classified as simple terrain [1]

3.2.1 Wind Speed and Wind Direction

3.2.1.1 Probe placement

The standard exposure height of wind instruments over level, open terrain is 10 m above the ground [9]. Open terrain is defined as an area where the distance between the instrument and any obstruction is at least ten times the height of that obstruction [2, 4, 9]. The slope of the terrain in the vicinity of the site should be taken into account when determining the relative height of the obstruction [2]. An obstruction may be man-made (such as a building or stack) or natural (such as a hill or a tree). The sensor height, its height above obstructions, and the height/character of nearby obstructions should be documented. Where such an exposure cannot be obtained, the anemometer should be installed at such a height that it is reasonably unaffected by local obstructions and represents the approximate wind values that would occur at 10 m in the absence of the obstructions. This height, which depends on the extent, height, and distance of obstructions and on site availability, should be determined on a case-by-case basis. Additional guidance on the evaluation of vertical profiles (Section 6.1.3) and surface roughness (Section 6.4.2) may be helpful in determining the appropriate height.

If the source emission point is substantially above 10 m, then additional wind measurements should be made at stack top or 100 m, whichever is lower [1]. In cases with stack heights of 200 m or above, the appropriate measurement height should be determined by the Regional Office on a case-by-case basis. Because maximum practical tower heights are on the order of 100 m, wind data at heights greater than 100 m will most likely be determined by some other means. Elevated wind measurements can be obtained via remote sensing (see Section 9.0). Indirect values can be estimated by using a logarithmic wind-speed profile relationship. For this purpose, instruments should be located at multiple heights (at least three) so that site-specific wind profiles can be developed.

3.2.1.2 Obstructions

Buildings. Aerodynamic effects due to buildings and other major structures, such as cooling towers, should be avoided to the extent possible in the siting of wind sensors; such effects are significant, not only in the vicinity of the structures themselves, but at considerable distances downwind. Procedures for assessing aerodynamic effects have been developed from observing such effects in wind tunnels [13], [14]. Wind sensors should only be located on building rooftops as a last resort; in such cases, the sensors should be located at a sufficient height above the rooftop to avoid the aerodynamic wake. This height can be determined from on-site measurements (e.g., smoke releases) or wind tunnel studies. As a rule of thumb, the total depth of the building wake is estimated to be approximately 2.5 times the height of the building [1].

Trees. In addition to the general rules concerning obstructions noted above, additional considerations may be important for vegetative features (e.g., growth rates). Seasonal effects should also be considered for sites near deciduous trees. For dense, continuous forests where an open exposure cannot be obtained, measurements should be taken at 10m above the height of the general vegetative canopy.

Towers. Sensors mounted on towers are frequently used to collect wind speed measurements at more than one height. To avoid the influence of the structure itself, closed towers, stacks, cooling towers, and similar solid structures should not be used to support wind instruments. Open-lattice towers are preferred. Towers should be located at or close to plant elevation in an open area representative of the area of interest.

Wind instruments should be mounted on booms at a distance of at least twice the diameter/diagonal of the tower (from the nearest point on the tower) into the prevailing wind direction or wind direction of interest [2]. Where the wind distribution is strongly bimodal from opposite directions, such as in the case of up-valley and down-valley flows, then the booms should be at right angles to the predominant wind directions. The booms must be strong enough so that they will not sway or vibrate sufficiently to influence standard deviation values in strong winds. Folding or collapsible towers are not recommended since they may not provide sufficient support to prevent such vibrations, and also may not be rigid enough to ensure proper instrument orientation. The wind sensors should be located at heights of minimum tower density (i.e., minimum number of diagonal cross-members) and above/below horizontal cross-members [2]. Since practical considerations may limit the maximum boom length, wind sensors on large towers (e.g., TV towers and fire look-out towers) may only provide accurate measurements over a certain arc. In such cases, two systems on opposite sides of the tower may be needed to provide accurate measurements over the entire 360°. If such a dual system is used, the method of switching from one system to the other should be carefully specified. A wind instrument mounted on top of a tower should be mounted at least one tower diameter/diagonal above the top of the tower structure.

Surface roughness. The surface roughness over a given area reflects man-made and natural obstructions, and general surface features. These roughness elements effect the horizontal and vertical wind patterns. Differences in the surface roughness over the area of interest can create differences in the wind pattern that may necessitate additional measurement sites. A method of estimating surface roughness length, z_o, is presented in Section 6.4.2. If an area has a surface roughness length greater than 0.5 m, then there may be a need for special siting considerations (see discussion in Sections 3.3 and 3.5).

3.2.1.3 Siting considerations

A single well-located measurement site can be used to provide representative wind measurements for non-coastal, flat terrain, rural situations. Wind instruments should be placed taking into account the purpose of the measurements. The instruments should be located over level, open terrain at a height of 10 m above the ground, and at a distance of at least ten times the

height of any nearby obstruction. For elevated releases, additional measurements should be made at stack top or 100 m, whichever is lower [1]. In cases with stack heights of 200 m or above, the appropriate measurement height should be determined by the Regional Office on a case-by-case basis.

3.2.2 Temperature, Temperature Difference, and Humidity

The siting and exposure criteria for temperature, temperature difference and humidity are similar. Consequently, these variables are discussed as a group in the following; exceptions are noted as necessary.

3.2.2.1 Probe placement

Ambient temperature and humidity should be measured at 2 m, consistent with the World Meteorological Organization (WMO) standards for ambient measurements [9]. Probe placement for temperature difference measurements depend on the application.. For use in estimating surface layer scaling parameters (Section 6.6.4), the temperature difference should be measured between $20z_0$ and $100z_0$; the same recommendation applies to temperature difference measurements for use in estimating the P-G stability category using the solar radiation delta-T method (Section 6.4.4.2). For use in estimating stable plume rise, temperature difference measurements should be made across the plume rise layer, a minimum separation of 50 m is recommended. For sites that experience large amounts of snow, adjustments to the temperature measurement height may be necessary, however, the ambient temperature measurement should not extend above 10 m. For analysis of cooling tower impacts, measurements of temperature and humidity should also be obtained at source height and within the range of final plume height. The measurement of temperature difference for analysis of critical dividing streamline height, H_{crit}, a parameter used in complex terrain modeling, is discussed in Section 3.3.3.

Temperature and humidity sensors should be located over an open, level area at least 9 m in diameter. The surface should be covered by short grass, or, where grass does not grow, the natural earth surface [2, 9]. Instruments should be protected from thermal radiation (from the earth, sun, sky, and any surrounding objects) and adequately ventilated using aspirated shields. Forced aspiration velocity should exceed 3 m/s, except for lithium chloride dew cells which operate best in still air [2]. If louvered shelters are used instead for protection (at ground level only), then they should be oriented with the door facing north (in the Northern Hemisphere). Temperature and humidity data obtained from naturally-ventilated shelters will be subject to large errors when wind speeds are light (less than about 3 m/s).

Temperature and humidity sensors on towers should be mounted on booms at a distance of about one diameter/diagonal of the tower (from the nearest point on the tower) [2]. In this case, downward facing aspiration shields are necessary.

3.2.2.2 Obstructions

Temperature and humidity sensors should be located at a distance of at least four times the height of any nearby obstruction and at least 30 m from large paved areas [2], [15]. Other situations to avoid include: large industrial heat sources, rooftops, steep slopes, sheltered hollows, high vegetation, shaded areas, swamps, areas where frequent snow drifts occur, low places that hold standing water after rains, and the vicinity of air exhausts (e.g., from a tunnel or subway) [2, 9].

3.2.2.3 Siting considerations

In siting temperature sensors, care must be taken to preserve the characteristics of the local environment, especially the surface. Protection from thermal radiation (with aspirated radiation shields) and significant heat sources and sinks is critical. Siting recommendations are similar for humidity measurements, which may be used for modeling input in situations involving moist releases, such as cooling towers. For temperature difference measurements, sensors should be housed in identical aspirated radiation shields with equal exposure.

3.2.3 Precipitation

3.2.3.1 Probe placement

A rain gauge should be sited on level ground so the mouth is horizontal and open to the sky [2]. The underlying surface should be covered with short grass or gravel. The height of the opening should be as low as possible (minimum: 30 cm), but should be high enough to avoid splashing in from the ground.

Rain gauges mounted on towers should be located above the average level of snow accumulation [15]. In addition, collectors should be heated if necessary to properly measure frozen precipitation [4].

3.2.3.2 Obstructions

Nearby obstructions can create adverse effects on precipitation measurements (e.g., funneling, reflection, and turbulence) which should be avoided. On the other hand, precipitation measurements may be highly sensitive to wind speed, especially where snowfall contributes a significant fraction of the total annual precipitation. Thus, some sheltering is desirable. The need to balance these two opposite effects requires some subjective judgment.

The best exposure may be found in orchards, openings in a grove of trees, bushes, or shrubbery, or where fences or other objects act together to serve as an effective wind-break. As a general rule, in sheltered areas where the height of the objects and their distance to the instrument is uniform, their height (above the instrument) should not exceed twice the distance (from the instrument) [15]. In open areas, the distance to obstructions should be at least two, and

preferably four, times the height of the obstruction. It is also desirable in open areas which experience significant snowfall to use wind shields such as those used by the National Weather Service [2, 9, 15].

3.2.3.3 Siting considerations

In view of the sensitivity to wind speed, every effort should be made to minimize the wind speed at the mouth opening of a precipitation gauge. This can be done by using wind shields. Where snow is not expected to occur in significant amounts or with significant frequency, use of wind shields is less important. However, the catch of either frozen or liquid precipitation is influenced by turbulent flow at the collector, and this can be minimized by the use of a wind shield.

3.2.4 Pressure

Although atmospheric pressure may be used in some modeling applications, it is not a required input variable for steady-state modeling applications. Moreover, the standard atmospheric pressure for the station elevation may often be sufficient for those applications which require station pressure; the model user's guide should be checked for specific model requirements.

3.2.5 Radiation

3.2.5.1 Probe placement

Pyranometers used for measuring incoming (solar) radiation should be located with an unrestricted view of the sky in all directions during all seasons, with the lowest solar elevation angle possible. Sensor height is not critical for pyranometers. A tall platform or rooftop is a desirable location [2]. Net radiometers should be mounted about 1 m above the ground [2].

3.2.5.2 Obstructions

Pyranometers should be located to avoid obstructions casting a shadow on the sensor at any time. Also, light colored walls and artificial sources of radiation should be avoided [2]. Net radiometers should also be located to avoid obstructions to the field of view both upward and downward [2].

3.2.5.3 Siting considerations

Solar radiation measurements should be taken in open areas free of obstructions. The ground cover under a net radiometer should be representative of the general site area. The given application will govern the collection of solar or net radiation data.

3.3 Complex Terrain Locations

For the purposes of this guidance, the term "complex terrain" is intended to mean any site where terrain effects on meteorological measurements may be significant. Terrain effects include aerodynamic wakes, density-driven slope flows, channeling, flow accelerations over the crest of terrain features, etc.; these flows primarily affect wind speed and wind direction measurements, however, temperature and humidity measurements may also be affected. The definition of significance depends on the application; for regulatory dispersion modeling applications, significance is determined by comparing stack-top height and/or an estimated plume height to terrain height - terrain which is below stack-top is classified as simple terrain (see Section 3.2), terrain between stack-top height and plume height is classified as intermediate terrain, and terrain which is above plume height is classified as complex terrain **[1]**.

Vertical gradients and/or discontinuities in the vertical profiles of meteorological variables are often significant in complex terrain. Consequently, measurements of the meteorological variables affecting transport and dispersion of a plume (wind direction, wind speed, and σ_θ) should be made at multiple levels in order to ensure that data used for modeling are representative of conditions at plume level. The ideal arrangement in complex terrain involves siting a tall tower between the source and the terrain feature of concern. The tower should be tall enough to provide measurements at plume level. Other terrain in the area should not significantly affect plume transport in a different manner than that measured by the tower. Since there are not many situations where this ideal can be achieved, a siting decision in complex terrain will almost always be a compromise. Monitoring options in complex terrain range from a single tall tower to multiple tall towers supplemented by data from one or more remote sensing platforms. Other components of the siting decision include determining tower locations, deciding whether or not a tower should be sited on a nearby terrain feature, and determining levels (heights) for monitoring. Careful planning is essential in any siting decision. Since each complex terrain situation has unique features to consider, no specific recommendations can be given to cover all cases. However, the siting process should be essentially the same in all complex terrain situations. Recommended steps in the siting process are as follows:

- Define the variables that are needed for a particular application.
- Develop as much information as possible to define what terrain influences are likely to be important. This should include examination of topographic maps of the area with terrain above physical stack height outlined. Preliminary estimates of plume rise should be made to determine a range of expected plume heights. If any site specific meteorological data are available, they should be analyzed to see what can be learned about the specific

terrain effects on air flow patterns. An evaluation by a meteorologist based on a site visit would also be desirable.

- Examine alternative measurement locations and techniques for required variables. Advantages and disadvantages of each technique/location should be considered, utilizing as a starting point the discussions presented above and elsewhere in this document.
- Optimize network design by balancing advantages and disadvantages.

It is particularly important in complex terrain to consider the end use of each variable separately. Guidance and concerns specific to the measurement of wind speed, wind direction, and temperature difference in complex terrain are discussed in the following sections.

3.3.1 Wind Speed

For use in plume rise calculations, wind speed should be measured at stack top or 100 m, whichever is lower. Ideally, the wind speed sensor should be mounted on a tower located near stack base elevation; however, a tower located on nearby elevated terrain may be used in some circumstances. In this latter case, the higher the tower above terrain the better (i.e. less compression effect); a 10-meter tower generally will not be sufficient. The measurement location should be evaluated for representativeness of both the dilution process and plume rise.

Great care should be taken to ensure that the tower is not sheltered in a closed valley (this would tend to over-estimate the occurrence of stable conditions) or placed in a location that is subject to streamline compression effects (this would tend to underestimate the occurrence of stable conditions). It is not possible to completely avoid both of these concerns. If a single suitable location cannot be found, then alternative approaches, such as multiple towers or a single tall tower supplemented by one or more remote sensing platforms should be considered in consultation with the Regional Office.

3.3.2 Wind Direction

The most important consideration in siting a wind direction sensor in complex terrain is that the measured direction should not be biased in a particular direction that is not experienced by the pollutant plume. For example, instruments on a meteorological tower located at the bottom of a well-defined valley may measure directions that are influenced by channeling or density-driven up-slope or down-slope flows. If the pollutant plume will be affected by the same flows, then the tower site is adequate. Even if the tower is as high as the source's stack, however, appreciable plume rise may take the plume out of the valley influence and the tower's measured wind direction may not be appropriate for the source (i.e., biased away from the source's area of critical impact).

The determination of potential bias in a proposed wind direction measurement is not an easy judgement to make. Quite often the situation is complicated by multiple flow regimes, and the existence of bias is not evident. This potential must be considered, however, and a rationale

developed for the choice of measurement location. Research has indicated that a single wind measurement location/site may not be adequate to define plume transport direction in some situations. While the guidance in this document is concerned primarily with means to obtain a single hourly averaged value of each variable, it may be appropriate to utilize more than one measurement of wind direction to calculate an "effective" plume transport direction for each hour.

3.3.3 Temperature Difference

The requirements of a particular application should be used as a guide in determining how to make measurements of vertical temperature difference in complex terrain. Stable plume rise and the critical dividing streamline height (H_{crit}), which separates flow that tends to move around a hill (below H_{crit}) from flow that tends to pass over a hill (above H_{crit}), are both sensitive to the vertical temperature gradient. The height ranges of interest are from stack top to plume height for the former and from plume height to the top of the terrain feature for the latter. The direct measurement of the complete temperature profile is often desirable but not always practical. The following discussion presents several alternatives for measuring the vertical temperature gradient along with some pros and cons.

Tower measurement: A tower measurement of temperature difference can be used as a representation of the temperature profile. The measurement should be taken between two elevated levels on the tower (e.g. 50 and 100 meters) and should meet the specifications for temperature difference discussed in Section 5.0. A separation of 50 m between the two sensors is preferred. The tower itself could be located at stack base elevation or on elevated terrain: optimum location depends on the height of the plume. Both locations may be subject to radiation effects that may not be experienced by the plume if it is significantly higher than the tower.

The vertical extent of the temperature probe may be partially in and partially out of the surface boundary layer, or may in some situations be entirely contained in the surface boundary layer while the plume may be above the surface boundary layer.

Balloon-based temperature measurements: Temperature profiles taken by balloon-based systems can provide the necessary information but are often not practical for developing a long-term data base. One possible use of balloon-based temperature soundings is in developing better "default" values of the potential temperature gradient on a site-specific basis. A possible approach would be to schedule several periods of intensive soundings during the course of a year and then derive appropriate default values keyed to stability category and wind speed and/or other appropriate variables. The number and scheduling of these intensive periods should be established as part of a sampling protocol.

Deep-layer absolute temperature measurements: If the vertical scale of the situation being modeled is large enough (200 meters or more), it may be acceptable to take the difference between two independent measurements of absolute temperature (i.e., temperature measurements would be taken on two different towers, one at plant site and one on terrain) to serve as a surrogate measurement of the temperature profile. This approach must be justified on a case-by-

case basis, and should be taken only with caution. Its application should be subject to the following limitations:

- Depth of the layer should be 200 meters at a minimum;
- The measurement height on each tower should be at least 60 meters;
- Horizontal separation of the towers should not exceed 2 kilometers;
- No internal boundary layers should be present, such as near shorelines; and
- Temperature profiles developed with the two-tower system should be verified with a program of balloon-based temperature profile measurements.

3.4 Coastal Locations

The unique meteorological conditions associated with local scale land-sea breeze circulations necessitate special considerations. For example, a stably stratified air mass over water can become unstable over land due to changes in roughness and heating encountered during daytime conditions and onshore flow. An unstable thermal internal boundary layer (TIBL) can develop, which can cause rapid downward fumigation of a plume initially released into the stable onshore flow. To provide representative measurements for the entire area of interest, multiple sites would be needed: one site at a shoreline location (to provide 10 m and stack height/plume height wind speed), and additional inland sites perpendicular to the orientation of the shoreline to provide wind speed within the TIBL, and estimates of the TIBL height. Where terrain in the vicinity of the shoreline is complex, measurements at additional locations, such as bluff tops, may also be necessary. Further specific measurement requirements will be dictated by the data input needs of a particular model. A report prepared for the Nuclear Regulatory Commission [**16**] provides a detailed discussion of considerations for conducting meteorological measurement programs at coastal sites.

3.5 Urban Locations

Urban areas are characterized by increased heat flux and surface roughness. These effects, which vary horizontally and vertically within the urban area, alter the wind pattern relative to the outlying rural areas (e.g., average wind speeds are decreased). The close proximity of buildings in downtown urban areas often precludes strict compliance with the previous sensor exposure guidance. For example, it may be necessary to locate instruments on the roof of the tallest available building. In such cases, the measurement height should take into account the proximity of nearby tall buildings and the difference in height between the building (on which the instruments are located) and the other nearby tall buildings.

In general, multiple sites are needed to provide representative measurements in a large urban area. This is especially true for ground-level sources, where low-level, local influences, such as street canyon effects, are important, and for multiple elevated sources scattered over an

urban area. However, due to the limitations of the recommended steady-state guideline models (i.e. they recognize only a single value for each input variable on an hourly basis), and resource and practical constraints, the use of a single site is necessary. At the very least, the single site should be located as close as possible to the source in question.

3.6 Recommendations

Recommendations for siting and exposure of in situ meteorological sensors in simple terrain are as follows:

Sensors for wind speed and wind direction should be located over level, open terrain at a height of 10 m above ground level and at a distance at least ten times the height of nearby obstructions. For elevated releases, additional measurements should be made at stack top or 100 m, whichever is lower. Monitoring requirements for stacks 200 m and above should be determined in consultation with the appropriate EPA Regional Office.

Temperature sensors should be located at 2 m. Probe placement for temperature difference measurements depend on the application. For use in estimating surface layer stability, the measurement should be made between $20z_0$ and $100z_0$; the same recommendation applies to temperature difference measurements for use in estimating the P-G stability category using the solar radiation delta-T method. For use in estimating stable plume rise, temperature difference measurements should be made across the plume rise layer, a minimum separation of 50 m is recommended for this application. Temperature sensors should be shielded to protect them from thermal radiation and any significant heat sources or sinks.

Pyranometers used for measuring incoming (solar) radiation should be located with an unrestricted view of the sky in all directions during all seasons. Sensor height is not critical for pyranometers; a tall platform or rooftop is an acceptable location. Net radiometers should be mounted about 1 m above ground level.

Specific recommendations applicable to siting and exposure of meteorological instruments in complex terrain are not possible. Generally, one should begin the process by conducting a screening analysis to determine, among other things, what terrain features are likely to be important; the screening analysis should also identify potential worse case meteorological conditions. This information should then be used to design a monitoring plan for the specific application.

Special siting considerations also apply to coastal and urban sites. Multiple sites, though often desirable, may not always be possible in these situations. In general, site selection for meteorological monitoring in support of regulatory modeling applications in coastal and urban locations should be conducted in consultation with the appropriate EPA Regional Office.

If the recommendations in this section cannot be achieved, then alternate approaches should be developed in consultation with the appropriate EPA Regional Office. Approval of site

TABLE OF CONTENTS

9.0 MASTER STORMWATER PLAN RECOMMENDATIONS 9-1

9.1 Administrative and Funding Recommendations 9-1
9.2 Operation and Maintenance Recommendations 9-2
9.3 GIS Database and Mapping Recommendations 9-3
9.4 Topographic Mapping and Survey 9-3
9.5 Watershed Modeling for Engineering Design and Floodplain Delineation 9-3
9.6 Plan of Action 9-5

9.0 MASTER STORMWATER PLAN RECOMMENDATIONS

The objective of this Master Stormwater Plan is to provide Putnam County with a planning tool to guide the decision process for project prioritization, budgetary planning, and implementation of improvements for publicly managed drainage systems. Improved flood protection for the citizens of Putnam County may be achieved through a combination of refinement and enforcement of regulatory standards, a program of preventive system maintenance and timely repair, an expanded hydraulic structure inventory and GIS database, specific structural improvements, and critical mapping and hydrologic data monitoring endeavors to support engineering and flood studies.

A summary of recommendations is presented herein, followed by a Plan of Action

9.1 ADMINISTRATIVE AND FUNDING RECOMMENDATIONS

Administrative

Putnam County's Comprehensive Plan and Land Development Codes provide an LOS standard for public drainage facilities and design standards for new development which are strict enough to prevent adverse flooding and water quality impacts from future development, so long as the codes are enforced. The following recommendations are put forth for County consideration.

1. Exemptions for agriculture and silviculture in the land development codes for erosion control and drainage standards, with a proviso that Best Management Practices (BMPs) are adhered to, creates a potential "weak link." These land uses have high potential for sediment contribution to both natural and man-made conveyances, which has been noted during field reconnaissance. Sediment transport has been identified as a major maintenance issue for Putnam County's stormwater maintenance staff. A concentrated effort must be made to enforce the use of scientifically-supported BMPs through inspection and legal action, as appropriate.

2. Concurrency provisions cannot be evaluated until the existing system's LOS has been determined. Modeling studies are necessary to determine where the County's established LOS standards are not being achieved for the existing drainage system. Responsible growth management would dictate that additional conveyance capacity or flood attenuation would be provided in those areas before new development may be allowed.

3. The framework for assessing Development Impact Fees to share the cost of providing infrastructure to new developments has been laid in the Comprehensive Plan. These fees were once assessed but are reportedly no longer collected by Putnam County. Bearing the full financial burden of providing infrastructure for future development is an unnecessary undertaking for a rural County with limited funds. It is strongly recommended that assessment of Development Impact Fees be reinstated.

4. The County should begin organizing its drainage issues and projects by DPU and Watershed as well, so that in years to come, as additional studies are implemented and drainage improvements are made in individual watersheds, the pertinent information may be added to the file for the specific DPU and watershed.

5. New developments must provide the County right-of-way and drainage easements sufficient for the County to adequately maintain systems.

6. Require property owners to grant the County drainage easement if they have a waterbody, ditches, streams, etc. that crosses through, or is included in, their property in order for the County to provide flood protection through adequate conveyance.

Funding

A variety of funding sources are potentially available to financially support the objectives of the Master Stormwater Plan, and have been described in Section 4. A combination of funding sources are recommended for various components of the Plan.

1. A Stormwater Utility Study is recommended to assess the feasibility of funding ongoing maintenance and repair of the existing public stormwater facilities. Upon establishing where the adopted LOS has been achieved for the existing system, the Utility may also be a viable supplemental funding mechanism for capital improvements to upgrade deficient portions of the system.
2. The County should actively pursue cooperative funding through grant applications to those agencies identified in Section 4.1 of this Master Stormwater Plan. Two applications have been completed for agency grants listed in Table 4.1-2, using priority project areas identified in this Master Stormwater Plan. The existence of an adopted Master Stormwater Plan will increase Putnam County's potential for winning these funds, as it represents a good faith effort to systematically address current water resource needs and provide protection of public resources for the future.
3. The County should engage grant assistance professionals to assist in identifying and pursuing funding sources that align with County stormwater planning needs and objectives

9.2 OPERATION AND MAINTENANCE RECOMMENDATIONS

Staffing and equipment shortages limit the effectiveness of current stormwater operations and maintenance activities of Putnam County. The current operations are predominantly reactive or incident-driven and fail to maintain the existing system of ditches, channels and cross drains in fully functioning condition. The following recommendations, though badly needed, will require a significant ongoing financial commitment.

1. The Proposed Maintenance Plan described in Section 5.4 should be adopted and implemented; including scheduled preventive inspection and maintenance of a fully-inventoried network of drainage components, rehabilitation of compromised system components, development of a formal incident response and documentation program, and acquisition of additional dedicated and shared equipment.
2. The current 7-person stormwater maintenance crew is considered adequate for providing the outlined Maintenance Program for one of the four Roads and Bridges service areas within the County. Three additional crews are recommended to provide the necessary man-power for adequate system maintenance. A staffing increase of this level, and the generation of funds to support it, requires time. A stormwater utility or similar fee assessment is recommended as the most effective vehicle for generating necessary funds.

9.3 GIS DATABASE AND MAPPING RECOMMENDATIONS

An inventory of maps, topography, hydrologic and hydraulic coverages (including FEMA flood zones), and the first stage of the County's hydraulic structure inventory have been assimilated and integrated into ArcMap projects compatible with the County's GIS system. All files have been translated to a common mapping projection. The following recommendations apply to GIS database and mapping resources:

1. Conveyance system data currently available for Putnam County is too course. Additional data collection in the form of field survey, aerial contour mapping and channel cross section determination is needed throughout the County. Priority subwatersheds (Devall Branch, Twomile Creek, Mudlake Outlet, Cedar Creek, River Park and Mondex) should be targeted first, to support engineering designs for the construction of the highest priority CIP projects.
2. The hydraulic structure inventory should be expanded to include all County-maintained channel and ditch conveyances; first for the selected subwatersheds and later for the remaining subwatersheds. Customized database templates should be developed for use in the operation and maintenance database as well as for future watershed studies.
3. FEMA flood zone coverages reflect base flood elevations for water bodies and conveyances available from existing Flood Insurance Rate Studies. Many tributaries and water bodies have not yet been studied in detail. As the County is able to complete detailed watershed studies and to generate base flood profiles and flood stages for water bodies, the GIS database and mapped coverages should be revised and updated.
4. The County land use coverage contains numerous blank polygons, primarily in roadway and waterbody areas. These attribute tables should be populated with appropriate land use categories. It has been noted that a "Rivers, Lakes and Streams" land use category is defined but is not frequently utilized.

9.4 TOPOGRAPHIC MAPPING AND SURVEY

Development of aerial mapping is the foundation of any strategic and long-range plan within the County that is aimed at proactively managing its stormwater issues. Ayres recommends development of 1-foot contour interval mapping, for all selected subwatersheds, beginning with the Devall Branch, Twomile Creek, Mudlake Outlet, Cedar Creek, River Park and Mondex subwatersheds; and later expanding coverage to the other areas of the county on a timetable consistent with available funding and the subwatershed study ranking described in Section 8.

9.5 WATERSHED MODELING FOR ENGINEERING DESIGN AND FLOODPLAIN DELINEATION

The selection of model type or method must be based on reasonable scientific judgment and is influenced by the intended use of model results. The following specific recommendations are made concerning project design modeling and watershed-scale modeling (especially for the purpose of flood plain delineation) in Putnam County.

1. The use of simple models such as the Rational Formula, TR-55, FDOT Stormtabs and the like should be limited to the following applications:

- In-kind culvert replacement and channel restoration (as a maintenance repair activity) on minor systems
- Design of side drains or driveway culverts, cross drains and roadside ditches on stormwater systems with small contributing drainage areas serving existing development, and with no known capacity-related flood problems
- Runoff volume generation for planning-level pollutant loading studies

2. USGS regression equations are appropriate for estimating riverine flood flows for various return frequencies to be used in bridge replacement or major culvert designs at the concept level, where gaged streamflow data are unavailable. For final design it is recommended that flood flows be generated using more sophisticated models tied to routing programs.
3. The majority of County design work for stormwater management is best supported by single event, dynamic models able to general runoff hydrographs from real or synthetic rainfall input and to route runoff through complex networks of pipes, channels, storage areas and control structures. Recommended applications include conceptual and engineering design for:

   - New or modified channel cross sections with large contributing areas or in identified flood areas
   - Culvert and/or bridge installation/replacement on major conveyances or in identified flood areas
   - Stormwater management systems serving new development (altered land use/land cover)
   - Regional flood control facilities
   - Floodplain delineations for FEMA DFIRM, FIRM revision, LOMA, or LOMR

4. When modeling major conveyances, use a model approved by the Federal Emergency Management Agency (FEMA) so that the County can submit the floodplain elevations to FEMA for incorporation into the next DFIRM, FIRM revision, LOMA, or LOMR. Calibration of simulation models should be based on as many of the following indicators as possible: water elevation (stage) records, streamflow records, hydrologic indicators, and anecdotal/eyewitness accounts of peak stages.
5. Continuous simulation models are recommended for:

   - Frequency analysis of rainfall and/or streamflow data to establish typical "wet," "dry" or "average" hydrologic conditions
   - Water quality assessments for pollutant loading, sediment transport, and pollutant decay
   - Assessment of hydroperiod for lakes and wetlands. For hydroperiod assessments, and in flood studies where there is significant water table influence, integrated surface and groundwater models should be considered.

9.6 PLAN OF ACTION

The culmination of this phase of Putnam County's Master Stormwater Plan is the Plan of Action. Although the Plan of Action described below references a ten year horizon, a three to five year schedule for updating of the Putnam County Master Stormwater Plan should result in a reasonably current narrative and will afford opportunity for re-evaluation of flooding and water quality priorities as well as funding levels and maintenance staffing levels. Based upon the data collection, review of chronic flooding and sedimentation areas, characterization of watersheds and their inter-relation, LOS goals, prioritization assessment, conceptual solution generation and cost estimates the following action items are recommended.

Short Term (Year 1 - 2):

- Address "High Priority " repair and replacement projects
  Complete engineering designs and construct designed solutions for
  - Johns Place Bridge
  - Orange Creek Shortcut Bridge
  - Songbird Road Bridge
  - Rector Road at SR 207
- Complete engineering designs already in progress and construct designed solutions for identified problem areas
  - West Tocoi
  - Sarasota Harbor
  - Mud Lake
- Aggressively pursue teaming/cost sharing opportunities for LiDAR mapping
- Begin the FDEP-funded watershed studies and alternatives analysis for Devall Branch, Mudlake Outlet & Twomile Creek
- Actively track DCA matching grant status and engage grant assistant professionals (refer to Section 4) to identify other funding sources
- Construct additional precipitation and streamflow monitoring stations
- Budget for needed Maintenance staffing and equipment

Long Term (Year 2 – 10):

- Develop a schedule for "Medium" and "Low" priority repair and replacement projects
- Budget for remaining watershed mapping and modeling studies in order of priority ranking
- Determine the existing LOS for the County's existing stormwater management facilities Compare to the target LOS Identify critical areas of concern Prioritize next set of projects for the Capital Improvement Program
- Perform feasibility studies for alternative/supplemental stormwater improvement funding through Development Impact fees and/or Stormwater Utility fees
- Continue to expand the stormwater feature inventory database
- number of elements documented drainage structure invert elevations adjacent ground/roadway elevations
- Monitor and record precipitation and streamflow at new monitoring station locations
- Periodically update the Master Stormwater Plan