

NORTHWEST FLORIDA CHOCTAWHATCHEE-PEA BASIN ROAD-STREAM CROSSINGS ASSESSMENT

2008


Mike Rainer

NORTHWEST FLORIDA CHOCTAWHATCHEE-PEA BASIN ROAD-STREAM CROSSINGS ASSESSMENT

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GLOSSARY

DEFINITIONS

Blackwater stream: A blackwater stream is a natural perennial, intermittent, or ephemeral stream that originates from the slow release of water from lowland swamp and bog wetlands. The resulting stream flows are laden with tannins, particulates, dissolved organic matter, and iron-creating, tea-colored waters.

Canal (C1): A C1 canal is a minor- or moderate-capacity artificial urban or agricultural drainage channel.

Canal (C2): A C2 canal is a major artificial urban or agricultural drainage channel.

Clearwater stream: A clearwater stream is a natural perennial, intermittent, or ephemeral seepage stream originating from shallow groundwaters that have percolated through deep, sandy, upland soils.

Crossover site: A crossover site is a culvert or bridge water conveyance structure that moves roadside drainage from one side of an unpaved road to a point of discharge on the other side of the road that directly or indirectly intersects an off-site water body.

False ditch: A false ditch is an in-road drain created by stormwater runoff.

Outlet: An outlet is the overflow discharge stream from a constructed impoundment such as a lake or pond.

Perched pond: A perched pond is a naturally occurring marsh, bog, or swamp wetland that isolated within terrestrial landscapes and is not directly connected to streams.

Proximity site: A proximity site is a nonstructural conveyance of unpaved road stormwater runoff to a discharge point that directly or indirectly intersects an off-site water body.

Riparian zone: A riparian zone is the wetlands, floodplains, terraces, and/or terrestrial drainage slopes that occur along waterbodies at variable widths.

Slough: A slough is a natural surface-water feature that has discernable flow regimes but without a defined stream channel configuration.

Stream (S1): An S1 stream is a natural surface feature with flow in a defined channel.

Stream (S2): An S2 stream is a natural surface feature with flow in a defined channel that has undergone minor or moderate alteration by stream cleanouts, dredging, and/or channelization.

Stream (S3): An S3 stream is a natural surface feature with flow in a defined channel that has undergone extensive alteration by stream cleanouts, dredging, and/or channelization.

Stream crossing cleanout: A stream crossing cleanout is a water crossing maintenance operation whereby soil excavation equipment is used to remove sediments and reestablish channel configurations.

Thalweg crossing: These crossings generally have relatively steep road approach slopes with little or no area of gradient transition prior to the crossing as typically occurs with crossings that have stream floodplains. The road approach slope toe is generally at or near the crossing structure.

Water crossing: A water crossing is the intersection and crossing of a waterway by an unpaved road and a bridge, culvert, or low-water crossing structure.

Wetland drain (D1): A D1 wetland drain is a small stream within a confined channel that typically accepts overflow from a swamp, shrub/scrub wetland, beaver impoundment, depression, or other natural water residence feature. ,

Wetland drain (D2): A D2 wetland drain is a D1 drain that has been partly altered by stream crossing cleanout operations; the extent of alteration is limited to sections of the channel near the crossing.

Wetland drain (D3): A D3 wetland drain is a D1 drain that has been altered by extensive dredging and/or channelization.

ACRONYMS

AM	adaptive management	**LCS**	Lower Choctawhatchee Subbasin
AMSL	average mean sea level	**LRMG**	Landscape Recovery and Management Group
BP	botanical project	**NED**	National Elevation Dataset
CBA	cost-benefit analysis	**NMFS**	National Marine Fisheries Service
CCC	Civilian Conservation Corps	**NPS**	nonpoint source
CFR	Code of Federal Regulations	**NRCS**	National Resource Conservation Service
CKSS	Crossing Knowledge Support System	**ORM**	operational roads maintenance
CPB	Choctawhatchee-Pea Basin	**OTTED**	Office of Trade Tourism and Economic Development
CS	crossover site	**PDA**	personal digital assistant
CWA	Clean Water Act	**PS**	proximity site
DEM	digital elevation model	**RCD**	road cross drain
DOI	Department of Interior	**ROI**	region of influence
EPT	Ephemeroptera, Plecoptera, and Trichoptera	**RZ**	riparian zone
ESA	Endangered Species Act	**SA**	surficial aquifer
FA	Floridan Aquifer	**SAIC**	Science Applications International Corporation
FAC	Florida Administrative Code	**SB**	Stream Bioassessment
FDEP	Florida Department of Environmental Protection	**SCI**	Stream Condition Index
FNAI	Florida Natural Areas Inventory	**SSM**	StreamX Synoptic Method
FoRDS	Field Reconnaissance Design Survey	**STATSGO**	State Soil Geographic Database
FR	Field Reconnaissance	**SWCD**	Soil and Water Conservation District
FRC	flood relief culvert	**TMDL**	total maximum daily load
FSWS	Florida Surface Waters of the State	**USACE**	United States Army Corps of Engineers
FWCC	Florida Fish and Wildlife Conservation Commission	**USEPA**	U.S. Environmental Protection Agency
FWRA	Florida Watershed Restoration Act	**USFWS**	United States Fish and Wildlife Service
GIS	geographic information system	**USGS**	United States Geological Survey
GPS	Global Positioning System	**WBID**	waterbody identification
HC	hydrologic crest	**WC**	water crossing
HUC	Hydrologic Unit Code	**WQ**	water quality
IS	intermediate system	**WQA**	Water Quality Act

CHAPTER ONE

INTRODUCTION


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This chapter presents background information concerning the development and implementation of the Choctawhatchee-Pea Basin Road-Stream Crossings Assessment Project. Emphasis is placed on stating the problem, describing the project, defining the study area, describing the Crossing Knowledge Support System technical processes, and acknowledging the project sponsors, technical service provider, and cooperating organizations.


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ACRONYMS

CKSS	Crossing Knowledge Support System
CPB	Choctawhatchee-Pea Basin
FDEP	Florida Department of Environmental Protection
FoRDS	Field Reconnaissance Design Survey
FR	field reconnaissance
GIS	geographic information system
GPS	Global Positioning System
HUC	Hydrologic Unit Code
LRMG	Landscape Recovery and Management Group
NPS	nonpoint source
PDA	personal digital assistant
SAIC	Science Applications International Corporation
SSM	StreamX Synoptic Method
USEPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey
WBID	waterbody identification


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1. INTRODUCTION

1.1 PROBLEM OVERVIEW

Of all human activities that disturb the land, few cause more long-term effects on social, economic, and ecological environments than roads. Roads create corridors that both connect and fragment environmental components. Although road networks occupy a relatively small portion of the landscape, their significant effects on water quality and terrestrial, wetland, and aquatic ecosystems have been well documented (Reid and Dunne, 1984; Swift, 1984; Forman and Alexander, 1998; DeMaynadier and Hunter, 2000; Gucinski et al., 2000; Trombulak and Frissel, 2000).

Unpaved roads in particular, pose harm to water resources. Northwest Florida, as is the case for much of the United States, is crisscrossed by unpaved roads that inevitably interact with aquatic environments. Unpaved road-stream crossings primarily affect water resources through soil erosion and waterway sedimentation. More than 100 years of crossing-induced sedimentation has altered the natural dynamics of streams and wetlands, creating significant instabilities. Experts generally agree that crossing-induced sediment impacts are prevalent and, in some cases, catastrophic to aquatic ecosystems.


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Unfortunately, efforts to minimize these impacts have been relatively ineffective. The primary reasons for these failures are a lack of information upon which to base decision-making; an adherence to historical road maintenance methods; improperly designed, installed, and/or maintained crossing structures; and lack of funding. Long-term solutions must account for the diversity of crossing environmental impact variables, targeting funds to high-priority crossing treatment sites, and producing viable treatment options. Also required are changes that must also embrace a shift in road maintenance and road trafficability requirements. Given the thousands of potentially problematic unpaved road-stream crossings in Northwest Florida, a systematic program is critical for developing technologies, managing information, addressing issues, formulating solutions, and monitoring results.

1.2 PROJECT DESCRIPTION

The *Northwest Florida Choctawhatchee-Pea Basin Road-Stream Crossings Assessment* was developed and implemented by the Florida Department of Environmental Protection (FDEP), Nonpoint Source Management Section, Tallahassee, Florida; Three Rivers Resource Conservation and Development Council, Inc. (Three Rivers), Milton, Florida; and Science Applications International Corporation (SAIC), Shalimar, Florida. This project involved investigating the impacts of county-maintained unpaved road-stream crossings on Choctawhatchee-Pea Basin (CPB) aquatic ecosystems and prioritizing crossings for treatment. The CPB includes the Northwest Florida Lower Choctawhatchee, Pea River, and Choctawhatchee Bay Subbasins. This study excluded paved road crossings and crossings on private, state, or federal lands not maintained by CPB counties.

Investigations included collecting and analyzing field data gathered at crossing sites and prioritizing crossings for treatment. The result was an accessible library of information that decision-makers can use to design and implement on-the-ground projects to effectively reduce the sedimentation impacts from road-stream crossings and promote the recovery of CPB aquatic ecosystems. The project was funded in part by a Section 319 Nonpoint Source Management Program Implementation grant from the U.S. Environmental Protection Agency (USPEA) through an agreement with the Nonpoint Source Management Section of FDEP.

This project required the design of innovative field reconnaissance tools, analysis processes, and information delivery systems to achieve cost-effective data collection, interpretation, management, and delivery solutions. The *Crossing Knowledge Support System* (CKSS) technologies, developed by SAIC, to identify crossing issues and prioritize treatment opportunities were used in the performance of this project. The CKSS technical approach adopted for this study is detailed in Section 1.5.

The project involved two studies conducted from 2006 to 2008. The first study was a demonstration of the CKSS field data collection, analysis, and prioritization technologies within the Northwest Florida Lower Choctawhatchee Subbasin. The second study applied CKSS lessons learned and technology improvements to an evaluation of the crossings within the entire CPB. Data was also collected for noncrossing, county-maintained unpaved road culverts.

In addition to collecting crossing site data, over 8,000 photographs were taken to document crossing site characteristics. These photos show current conditions as well as how adverse crossing conditions, such as erosion and sediment delivery, subsequently impact waterway water quality, species habitats, and recreation values. These photographs tell the story of CPB crossings and can be used to evaluate change over time. A summary report for each of the 759 CPB crossings surveyed during this project was developed. Summary reports and associated photos are available at the *Northwest Florida Road-Stream Crossings* website (https://www.gcsaic.com/streamx2) developed for this project and hosted by Three Rivers Resource Conservation and Development Council, Inc.


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1.3 DRAINAGE BASINS

A *drainage basin* is the topographic region from which a stream receives runoff, throughflow, and groundwater flow. A *basin* or *watershed* is a hydrologically defined drainage area with a single drainage discharge point. It represents the land area within which surface runoff and groundwater seepage collects and drains into a central feature — usually a wetland, lake, river, or stream. A watershed can be a relatively large area of up to 200 square miles that drains a major river system or a swimming hole on a small tributary stream. Watersheds are hierarchical, in that smaller watersheds nest within larger ones.

The components of a watershed include tributaries and interfluves; main stem trunk; mouth or receiving basin; and zones of sediment production, transportation, and deposition. Watershed patterns are primarily a function of basin geology (structure, lithology, overburden), climate, developmental history, and slope. Watersheds are generally described by their size, shape, arrangement of tributaries (drainage basin pattern), and drainage density (total stream length/unit area). Factors that influence watershed drainage density include permeability, soil erodibility, vegetative cover, slope, and time. The topographical and geographical form that constitutes a watershed landscape functions to concentrate runoff, whether within the realm of the surface waters or subsurface groundwater.

The United States Geological Survey (USGS) developed the standardized Hydrologic Unit Code (HUC) system in the 1970s. An HUC is the numerical identifier of a specific hydrologic unit containing a two-digit sequence for each specific level within the delineation hierarchy. The underlying concept is a topographically defined set of drainage areas organized in a nested hierarchy by size. HUC terms for describing drainage areas from largest to smallest are: *region*, *subregion*, *river basin*, *subbasin*, *watershed*, and *subwatershed* (Table 1-1). This system divides the United States into 21 regions, 222 subregions, 352 basins, and 2,149 subbasins based on surface features.

Table 1-1. Hydrologic Unit Levels

Hydrologic Unit Level	Name	Digits	Size (square miles)	Units
1	Region	2	177,560 average	21
2	Subregion	4	16,800 average	222
3	Basin	6	10,596 average	352
4	Subbasin	8	703	2,149
5	Watershed	10	63-391	22,000
6	Subwatershed	12	16-63	160,000

Source: http://www.fpc.org/Metadata/FPC_HUC_Metadata.html

A waterbody identification (WBID) system developed by FDEP for the 6,243 identified Florida waterbodies is also used in this report. Each unique WBID designates the waterbody type (river, stream, lake, estuary, or coastal water) and the hydrologic watershed extent of waterbody segments. Generally, WBID polygons follow HUC watershed delineations; however, in some cases a relatively large HUC may be divided into multiple WBIDs based on topographic factors or to delineate the spatial extent of anticipated changes in water quality. WBID identifiers are used by FDEP as assessments units for Clean Water Act, Section 303(d) impaired waters reports submitted biannually to USEPA.

1.4 CHOCTAWHATCHEE-PEA BASIN STUDY AREA

The Choctawhatchee-Pea Basin (HUC 031402) lies within Alabama and Florida and drains approximately 2,975,563 acres or 4,649 square miles; 31 percent (1,441 square miles) of the basin drainage area is in Florida and 69 percent (3,208 square miles) is in Alabama. The basin includes the Upper Choctawhatchee Subbasin (HUC 03140201), Lower Choctawhatchee Subbasin (HUC 03140203), Pea River Subbasin (HUC 03140202), and Choctawhatchee Bay Subbasin (HUC 03140102) (Figure 1-1).

The approximately 1,084,422-acre project study area is bounded by the Lower Choctawhatchee, Pea River, and Choctawhatchee Bay Subbasins that constitute the Florida portion of the basin and occupy parts of Bay, Jackson, Walton, and Washington Counties and all of Holmes County. The portion of Choctawhatchee Bay Subbasin within Eglin Air Force Base was excluded from the study (Figure 1-2). Identification, size, and location data for the 163 CPB study area subbasin watershed WBIDs is summarized in Table 1-2.

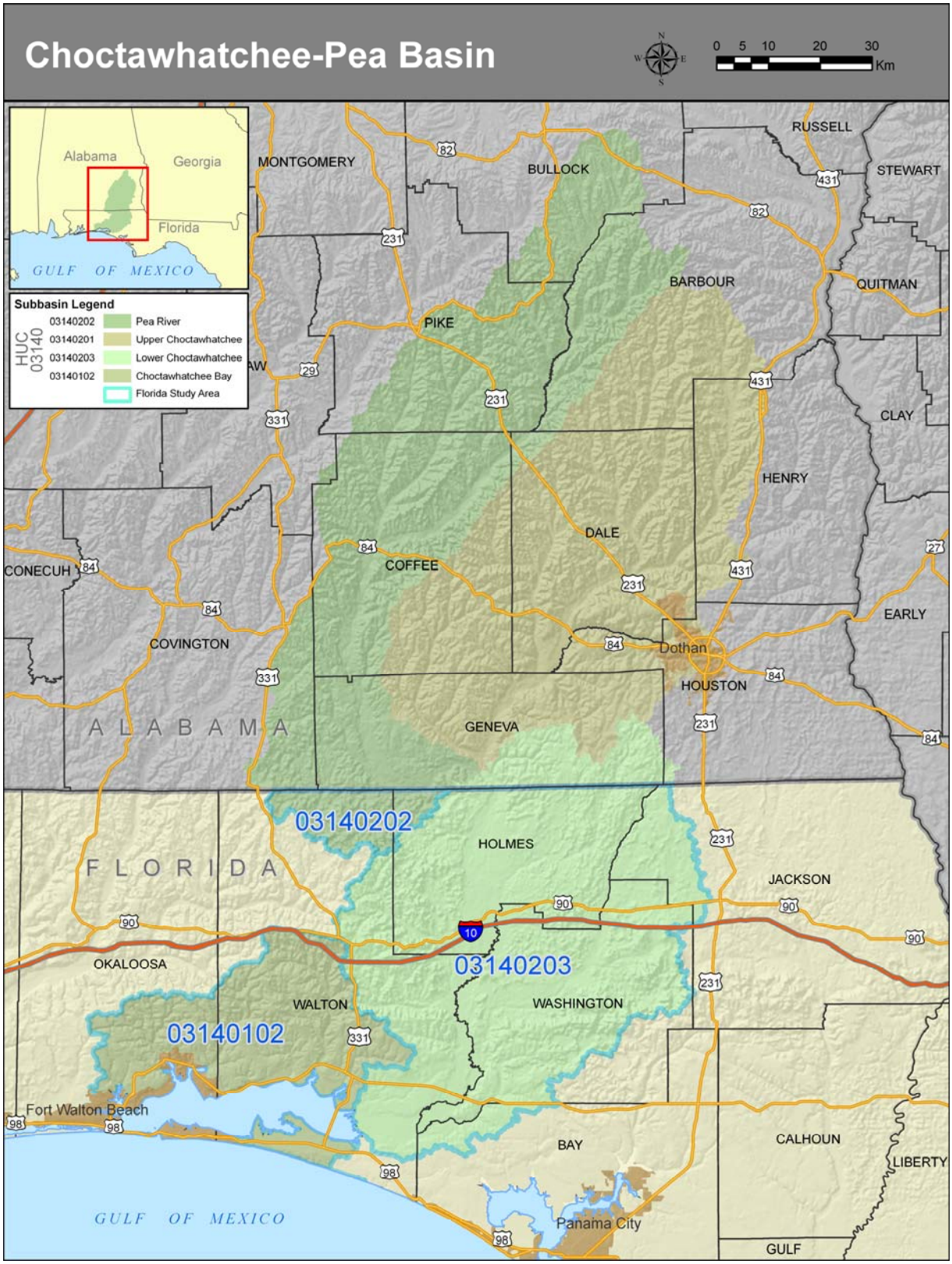


Figure 1-1. Choctawhatchee-Pea Basin (HUC 03140) (David Rubino)



Figure 1-2. Choctawhatchee-Pea Basin (HUC 03140) Study Area (David Rubino)

Table 1-2. Choctawhatchee-Pea Basin Subbasins and Watersheds

WBID	Watershed Name	County/Size (Acres)					
		Bay	Holmes	Jackson	Walton	Washington	Total
Choctawhatchee Bay Subbasin, HUC 03140102							
1029	Direct runoff to gulf	—	—	—	282	—	282
323	Bear Creek	—	—	—	4,313	—	4,313
332	Cosson Mill Creek	—	—	—	4,164	—	4,164
340	Kiser Branch	—	—	—	3,308	—	3,308
351A	Alaqua Creek	—	—	—	5,835	—	5,835
369	Sconiers Mill Creek	—	—	—	4,581	—	4581
436	Blount Creek	—	—	—	3,758	—	3,758
491	Alice Creek	—	—	—	3,746	—	3,746
544	White Branch	—	—	—	1,964	—	1,964
557	Magnolia Creek	—	—	—	5,409	—	5,409
567	Four Mile Creek	—	—	—	9,986	—	9,986
621	Wolf Creek	—	—	—	3,829	—	3,829
646	Lafayette Creek	—	—	—	12,467	—	12,467
731	Alaqua Bayou	—	—	—	2,604	—	2,604
772	Little Trout Creek	—	—	—	161	—	161
774	Bear Creek	—	—	—	2,082	—	2,082
778C	Choctawhatchee Bay	—	—	—	697	—	697
778D	Choctawhatchee Bay	—	—	—	239	—	239
789	Lagrange Bayou	—	—	—	4,657	—	4,657
803	Direct runoff to bay	—	—	—	787	—	787
851	Direct runoff to bay	—	—	—	1,761	—	1,761
881	Direct runoff to bay	—	—	—	9,322	—	9,322
897	Direct runoff to bay	—	—	—	3,687	—	3,687
937	Mack Bayou	—	—	—	1,065	—	1,065
938	Direct runoff to bay	—	—	—	120	—	120
943	Direct runoff to bay	—	—	—	565	—	565
944	Hewett Bayou	—	—	—	1,405	—	1,405
957	Mussett Bayou	—	—	—	1,193	—	1,193
959	Morris Lake	—	—	—	70	—	70
959A	Campbell Lake	—	—	—	95	—	95
959B	Stalworth Lake	—	—	—	13	—	13
959C	Oyster Lake	—	—	—	20	—	20
959D	Draper Lake	—	—	—	33	—	33
959E	Alligator Lake	—	—	—	11	—	11
959F	Morris Lake Drain	—	—	—	6,212	—	6,212
972	Bowman Bayou	—	—	—	1,565	—	1,565
976	Direct runoff to bay	—	—	—	245	—	245
978	Little Bayou	—	—	—	895	—	895
980	McQuage Bayou	—	—	—	1,379	—	1,379
981	Direct runoff to bay	—	—	—	1,135	—	1,135
	Subbasin Total	—	—	—	**105,660**	—	**105,660**

Table 1-2. Choctawhatchee-Pea Basin Subbasins and Watersheds Cont'd

WBID	Watershed Name	County/Size (Acres)					
		Bay	Holmes	Jackson	Walton	Washington	Total
Lower Choctawhatchee Subbasin, HUC 03140203							
103	Corbett Branch	—	944	—	—	—	944
108	Bee Branch	—	768	—	—	—	768
109	Fowler Branch	—	3,419	—	—	—	3,419
112	Angelico Branch	—	1,494	—	—	—	1,494
113	Register Branch	—	1,947	—	—	—	1,947
115	Crooked Run	—	989	—	—	—	989
119	Windmill Branch	—	1,358	—	—	—	1,358
120	Unnamed Branch	—	1,353	—	—	—	1,353
121	Little Creek	—	3,262	—	—	—	3,262
123	Alligator Creek	—	1	13,587	—	13,263	26,851
126	Dada Branch	—	1,038	—	—	—	1,038
130	Fish Branch	—	—	10,008	—	—	10,008
133	Ginhouse Branch	—	2,154	—	—	—	2,154
136	Pine Log Creek	—	5,611	—	—	—	5,611
139	Jackson Branch	—	1,803	—	—	—	1,803
142	Sikes Creek	—	10,825	—	—	—	10,825
143	Limestone Branch	—	2,226	—	—	—	2,226
146	West Pittman Creek	—	12,169	—	4	—	12,173
147	Gum Creek	—	—	8,377	—	2,167	10,544
150	Kelley Branch	—	1,063	—	—	—	1,063
157	Little Alligator Creek	—	—	3,159	—	—	3,159
163	Bay Branch	—	4,093	—	—	—	4,093
164	Timber Branch	—	2,404	—	—	—	2,404
165	Mill Branch	—	2,335	—	—	—	2,335
178	Sandy Creek	—	9,933	—	12,272	—	22,205
178z	Ponce De Leon Spring	—	6	—	—	—	6
183	Catfish Branch	—	1,744	—	—	—	1,744
185	Bay Branch	—	—	—	1,277	—	1,277
195	Scurlock Creek	—	—	3,231	—	—	3,231
204	Blue Pond Drain	—	612	—	896	—	1,508
204a	Blue Pond	—	13	—	38	—	51
205	Bay Drain	—	3,763	—	—	—	3,763
206	Gum Branch	—	4,639	—	—	—	4,639
210	Otter Creek	—	11,077	—	—	—	11,077
210a	Double Pond	—	29	—	—	—	29
212	Reedy Creek	—	13,812	—	2,822	—	16,634
212z	Morrison Spring	—	—	—	23	—	23
219	Camp Creek	—	—	—	941	—	941
226	Cassidy Lake	—	340	—	1	—	341
226a	Cassidy Lake Drain	—	615	—	1,540	—	2,155
227	Hood Lake	—	206	—	—	—	206
227a	Hood Lake Drain	—	2,693	—	—	—	2,693
230	Big Branch	—	—	—	1,507	—	1,507
232	Unnamed drain	—	2,427	—	—	—	2,427
233	Unnamed creek	—	—	5,115	—	2,185	7,300
234	Long Drain	—	—	—	586	—	586

Table 1-2. Choctawhatchee-Pea Basin Subbasins and Watersheds Cont'd

WBID	Watershed Name	County/Size (Acres)					
		Bay	Holmes	Jackson	Walton	Washington	Total
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd							
235	Pine Barn Creek	—	—	901	—	—	901
239	Gum Creek	—	8,963	—	—	13,528	22491
239a	Pate Lake	—	—	—	—	391	391
240	Hathaway Mill Creek	—	4,325	—	—	—	4,325
246	Huckleberry Creek	—	—	—	2,314	—	2,314
249	Padgett Creek	—	3,279	—	41	—	3,320
251	Camp Branch	—	4,925	—	—	—	4,925
253	Helms Branch	—	—	—	—	6,434	6,434
261	Dram Branch	—	1,561	—	—	8,094	9,655
262	Gilberts Mill Creek	—	—	3849	—	2,902	6,751
263	Andrews Mill Creek	—	—	—	1,761	—	1,761
269	West Sandy Creek	—	—	—	7,600	—	7,600
269a	Lake Stanley	—	—	—	112	—	112
270	Goose Branch	—	1,721	—		—	1,721
273	Parrish Creek	—	662	—	3	—	665
283	Lake Juniper	—	—	—	566	—	566
283a	Lake Juniper Drain	—	—	—	3,331	—	3,331
286	Open Creek	—	5,677	—	—	5,582	11,259
289	Black Branch	—	1,280	—	—	—	1,280
293	Poly Branch	—		—	738	—	738
298	Cow Branch	—	1,287	—	—	—	1,287
302	Spring Lake	—	—	—	148	—	148
302a	Spring Lake Outlet	—	—	—	395	—	395
304	Bridge Creek	—	1,248	—	3,623	—	4,871
337	Flat Creek	—	—	—	—	13,132	13,132
343	Bruce Creek	—	88	—	25,154	—	25,242
343a	Lake Defuniak	—	—	—	47	—	47
346	Little Hard Labor Creek	—	—	—	—	8,425	8,425
348	Gully Creek	—	—	—	—	12,832	12,832
348z	Cypress Springs	—	—	—	—	18	18
349	Mill Creek	—	3,077	—	1,529	—	4,606
350	Bay Branch	—	—	—	2,875	—	2,875
362	Yates Mill Creek	—	—	—		5,649	5,649
366	Oak Grove Branch	—	54	—	2,290	—	2,344
371	Panther Creek	—	—	—	4,361	—	4,361
373	White Creek	—	—	—	1,681	—	1,681
382	White Creek	—	—	—	6,607	—	6,607
388	Indian Creek	—	—	—	1,150	—	1,150
391	Potter Branch	—	—	—	—	1,700	1,700
399	Hughes Ditch	—	—	—	2,744	—	2,744
401	Hard Labor Creek	—	—	—	—	20,024	20,024
404	Crooked Creek	—	—	—	2,828	—	2,828
414	Folks Creek	—	—	—	1,113	—	1,113
416	Gainer Lake Outlet	—	—	—	—	910	910
416a	Gainer Lake	—	—	—	—	56	56

Table 1-2. Choctawhatchee-Pea Basin Subbasins and Watersheds Cont'd

WBID	Watershed Name	County/Size (Acres)					
		Bay	Holmes	Jackson	Walton	Washington	Total
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd							
423	Chapel Branch	—	—	—	—	9,763	9,763
441	Peavy Creek	—	—	—	1,027	—	1,027
450	Shaky Joe Branch	—	—	—	—	2,915	2,915
455	Davis Branch	—	—	—	—	886	886
456	Reedy Creek	—	—	—	—	7,235	7,235
457	Spears Branch	—	—	—	899	—	899
47	Parrot Creek	—	9,819	—	—	—	9,819
48	Whitewater Branch	—	2,603	—	—	—	2,603
486	Mill Creek	—	—	—	4,288	—	4,288
49	Choctawhatchee River	—	13,178	—	3,130	7,683	23,991
490	Poley Creek	—	—	57	—	4,652	4,709
498	Bonnet Pond Slue	—	—	—	—	1,962	1,962
49a	Choctawhatchee River	—	—	—	15,458	—	15,458
49b	Choctawhatchee River	—	—	—	7,794	7,883	15,677
49c	Choctawhatchee River	—	—	—	3,059	1,366	4,425
49d	Choctawhatchee River	—	—	—	4,288	4,118	8,406
49e	Choctawhatchee River	—	—	—	632	4,122	4,754
49f	Choctawhatchee River	—	23,416	—	—	—	23,416
501	Pippin Mill Creek	—	—	—	—	5,131	5,131
508	Hunter Branch	—	—	—	586	—	586
521	Hays Maltsby Drain	—	—	—	—	699	699
526	Pine Log Creek	5,503	—	—	—	45,974	51,477
526a	Dunford Lake	—	—	—	—	214	214
526b	Major Lake	—	—	—	—	117	117
526c	Open Lake	—	—	—	—	207	207
529	McKinnon Branch	—	—	—	753	—	753
53	Clark Mill Creek	—	1,044	—	—	—	1,044
536	McCallum Branch	—	—	—	816	—	816
54	Wrights Creek	—	39,677	—	—	—	39,677
545	Reedy Branch	—	—	—	—	2,718	2,718
549	Fanning Branch	—	—	—	—	1,773	1,773
55	East Pittman Creek	—	6,962	—	—	—	6,962
550	Williams Branch	—	—	—	—	1,003	1,003
56	Tenmile Creek	—	11,614	—	—	—	11,614
565	Palmeto Branch	—	—	—	1,160	—	1,160
570	Seven Runs	—	—	—	11,140	—	11,140
572	McKinnon Branch	—	—	—	1,197	—	1,197
575	Sugar Mill	—	—	—	1,373	—	1,373
578	Mill Branch	—	—	—	1,804	—	1,804
58	Mill Branch	—	1,060	—	—	—	1,060
59	Holmes Creek	—	19,707	8,653	—	57,229	85,589
594	Unnamed Branch	—	—	—	602	—	602
596	Mill Creek	—	—	—	—	507	507
59a	Blue Lake	—	—	—	—	27	27
59y	Beckton Spring	—	—	—	—	18	18
608	Bear Bay Creek	—	—	—	—	13,426	13,426

Table 1-2. Choctawhatchee-Pea Basin Subbasins and Watersheds Cont'd

WBID	Watershed Name	County/Size (Acres)					
		Bay	Holmes	Jackson	Walton	Washington	Total
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd							
61	Texas Branch	—	2,177	—	—	—	2,177
61a	Sand Hammock Pond	—	51	—	—	—	51
651	Spring Run	—	—	—	—	3,603	3,603
660	Grape Head	—	—	—	481	—	481
667	Carter Branch	—	—	—	977	—	977
679	Black Creek	—	—	—	17,144	—	17,144
688	Big Head Branch	—	—	—	632	—	632
69	Unnamed branch	—	970	—	—	—	970
708	Battle Ground Fork	—	—	—	3,865	—	3,865
715	Big Cypress Creek	—	—	—	3,389	—	3,389
719	Little Black Creek	—	—	—	1,823	—	1,823
739	Pate Branch	—	—	—	1,730	—	1,730
741	Unnamed run	—	—	—	1,854	—	1,854
747	Unnamed creek	—	—	—	1,407	—	1,407
748	Camp Creek	—	—	—	3,606	—	3,606
753	Dismal Creek	—	—	—	5,059	—	5,059
764	Mciver Branch	—	—	—	1,224	—	1,224
77	Little Creek	—	8,829	—	—	—	8,829
783	Botheration Creek	2,411	—	—	—	10,338	12,749
783a	Big Blue Lake	—	—	—	—	751	751
80	Little Creek	—	0	4,670	—	—	4,670
86	Bell Branch	—	1,548	—	—	—	1,548
869	East River	2,244	—	—	355	3,066	5,665
875	Ditch Branch	2,342	—	—	—	—	2,342
907	Little Crooked Creek	6,142	—	—	—	—	6,142
94	Limestone Branch	—	2,614	—	—	—	2,614
950	Otter Creek	6,592	—	—	—	—	6,592
951	Sister River	—	—	—	2,692	—	2,692
97	Clouin Bay	—	1,567	—	—	—	1,567
982	Roaring Creek	—	—	—	2,805	—	2,805
983	Tenmile Branch	1,412	—	—	1,467	—	2,879
	Subbasin Total	**26,646**	**298,148**	**61,607**	**205,434**	**316,678**	**908,513**
Pea River Subbasin , HUC 03140202							
125	Dry Branch	—	360	—	2,275	—	2,635
40	Limestone Branch	—	—	—	7,822	—	7,822
40A	Natural Bridge Creek	—	—	—	1,419	—	1,419
42	Eighteen Mile Creek	—	—	—	17,621	—	17,621
43	Limestone Creek	—	129	—	6,784	—	6,913
44	Pea River	—	111	—	—	—	111
45	Camp Creek	—	3,755	—	1,195	—	4,950
46	Pea River	—	1,480	—	—	—	1,480
63	Hurricane Creek	—	7,198	—	462	—	7,660
66	Spring Branch	—	—	—	5,212	—	5,212
68	Chestnut Creek	—	6	—	13,094	—	13,100
81	Mack Bay Branch	—	1,326	—	—	—	1,326
	Subbasin Total	**—**	**14,365**	**—**	**55,884**	**—**	**70,249**

The approximately 174-mile-long Choctawhatchee River originates in southeastern Alabama and discharges at its 3-mile-wide mouth into Choctawhatchee Bay, Florida. Approximately 100 miles of the river is in Florida (Figure 1-3). The U.S Army Corps of Engineers abandoned maintenance of the river for commercial navigation in the 1940s. Agriculture and forestry are the major land uses in undeveloped portions of the river basin. Major Florida cities within the CPB include Bonifay, Chipley, and DeFuniak Springs. The river is designated as an Outstanding Florida Water and as such is protected under Florida statutes (Section 3.7).



Figure 1-3. Choctawhatchee River (Mike Rainer)

The Pea River is the largest tributary of the Choctawhatchee River. It begins in Bullock County, Alabama, and generally flows southwest for approximately 128 miles, where it joins the Choctawhatchee River in Geneva County, Alabama, just north of the Florida state line.

Choctawhatchee Bay is located east of Pensacola Bay and is the discharge for the CPB. The bay is a sandy, shallow, tannic-stained, brackish estuary surrounded by marshes and oyster beds. It is over 27 miles long, ranges from 1 to 6 miles wide, varies from 10 to 43 feet deep, and discharges into the Gulf of Mexico at Destin Pass. Salt concentrations are highly variable and fluctuate with tide events.

1.5 CROSSING KNOWLEDGE SUPPORT SYSTEM

The CKSS was developed by the SAIC Landscape Recovery and Management Group (LRMG) to strategically inventory, analyze, prioritize, and disseminate relevant crossing information to decision-makers and other interested parties. This systematic process is based on the integration of field data and complementary geographic information system (GIS) data resources to create a baseline of specialized knowledge from which to develop site-specific solutions and comprehensive resource management strategies. The CKSS technical approach utilizes state-of-the-art tools, techniques, and real-time crossing site data to create comprehensive crossing databases, transparent audit trails, analytical procedures, and customized deliverables that translate into practical information for decision-making. The CKSS process is conceptually based on the premise that targeted projects to reduce crossing sedimentation will promote measurable recovery and conservation of water quality and aquatic species habitat within the CPB.

The fundamental framework in developing the CKSS was to implement information management processes that were comprehensive and efficient for information gathering and processing while simultaneously focusing, pinpointing, culling, and repackaging crossing site information. The result is a "funneling" process that scrutinizes bulk information and effects a transition of diverse information into manageable datasets. This process is critical, considering the extent and diversity of crossing types and conditions exhibited within the CPB.

Based on previous experience and a review of previous studies, it was determined that it would be unnecessary and impractical to treat all CPB county-maintained, unpaved road crossings equally. The CKSS is designed to identify potential crossing-induced impacts on aquatic resources and discriminate the impact significance for individual crossing sites. This approach allows dramatic accomplishments, by maximizing the effectiveness and value of resource allocations and initiating measurable progress in the conservation and recovery of damaged aquatic ecosystems. The four phases of the CKSS process include:

- Phase I – Crossing StreamX Field Reconnaissance
- Phase II – Crossing Data Analysis and Prioritization
- Phase III – Crossing Project Design
- Phase IV – Crossing Project Monitoring

This project involved Phases I and II, which are detailed in the following subsections.

1.5.1 Phase I – StreamX Crossing Site Field Reconnaissance

Field reconnaissance (FR) is a survey procedure used to collect and record crossing data. The purpose of FR is to record point-in-time crossing information and establish a quantitative baseline of crossing features and conditions. Level I FR used for this project was restricted to objective on-site observations; no crossing feature measurements or condition metrics were collected. The Level I visual observations and condition interpretation records were used to categorize, isolate, and prioritize crossing parameters and treatment needs during Phase II. During Phase I, GIS datasets were also acquired to use in exhibiting CPB natural and socioeconomic resource attributes during Phase II.

In response to recent advances in GIS and Global Positioning System (GPS) software and personal digital assistant (PDA) hardware technologies, SAIC developed the mobile StreamX Field Reconnaissance Design Survey (FoRDS) field tool. The FoRDS application uses ArcPad software and the PocketPC platform to provide a dynamic, interactive, data entry platform to consistently capture crossing environmental, anthropogenic, and photo point attributes for crossings in real-time.


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In addition to feature (Chapter 4) and condition attributes (Chapter 5), interpretive (not measured) data was also collected for soil erosion, sediment discharge, hydrologic connectivity, sediment production, and other water quality and aquatic habitat impact indicators. The FR data acquisition process was guided by standardized protocols that determine what is to be surveyed and the extent and sequence of information gathering. The use of standard protocols minimizes bias and supports the post-processing

of field data. StreamX crossing site data was integrated into a local database for reporting, analysis, prioritization, or incorporation into GIS systems.

In addition to collecting crossing data, FoRDS also supports crossing photopoint documentation. Photographs serve as visual records of current crossing features and conditions. During FR surveys, GPS coordinate photo points are established to record the geographic location and ground orientation for all crossing photos. In addition to substantiating crossing observations, the photographs can also be stored in a temporal database to monitor site changes. Over the course of this project, 8,582 spatially and temporally referenced crossing site photo point photographs were taken at CPB crossing sites. These crossing photo point photographs are available for viewing on the project website at (https://www.gcsaic.com/streamx2).

1.5.2 Phase II – Crossing Data Analysis and Prioritization

The purpose of Phase II was to utilize StreamX field data collected during Phase I and applicable GIS data to characterize the interactions of county-maintained unpaved road crossings and aquatic resources, discriminate the type and importance of water resource impact potentials, and prioritize crossing treatment opportunities. The objective was to develop a variable scale-based prioritization index from which crossing treatment opportunities can be defined. The methodology selected for this analysis is the StreamX Synoptic Method (SSM).


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The SSM is a rapid, flexible, systematic process developed by the LRMG to quantify the interactions of crossings with aquatic ecosystems at multiple spatial and temporal scales, as well as identify site treatment opportunities to restore aquatic resource water quality and habitat attributes. The SSM analysis and prioritization process primarily relies on the information generated during Phase I to define, compartmentalize, index, and selectively combine StreamX and GIS datasets.

The quality assurance, processing, data mining, scoring, and presentation software tools were developed to facilitate flexibility in orchestrating multilevel crossing site data analysis and prioritization of sites for treatment while meeting diverse goals and objectives. The prioritization models calculate score and ranking values used to indicate significance and basis for comparative analysis. The steps utilized in the process include 1) identifying synoptic indices, 2) selecting index indicators, 3) defining rules of combination, 4) conducting the analysis, and 5) producing deliverables. The SSM indexing and prioritization process is discussed in Chapter 7, Analysis and Site Prioritization.

1.5.3 CKSS Information Management

The intensity of field data collection and analysis generated by this project presented an opportunity to build a suite of innovative deliverables that convey information along with complementary text, photographs, graphics, databases, and maps. The project deliverables include the *Choctawhatchee-Pea Basin Road-Stream Crossings Assessment* report and the *Northwest Florida Road-Stream Crossings* website (https://www.gcsaic.com/streamx2). The report provides information on the process, technique, and results and the website accommodates quick access to project data at various levels of detail, from an overview of the entire basin to site-specific information for each project crossing.

The *Choctawhatchee-Pea Basin Road-Stream Crossings Index* map (Appendix A) is enclosed to assist users in quickly locating crossings of interest. The map subdivides the basin by county, HUC, and WBID (Section 1.3) and provides the crossing site identification number, type (Section 4.1), and treatment priority score (Section 7.4). It provides a quick reference to pinpoint crossing conditions presented in Chapter 5 and crossing analysis and prioritization results from Chapter 7. The index map may also be viewed or downloaded from the website *Choctawhatchee-Pea Basin Road-Stream Crossings Assessment*, Resources, Map Library section (https://www.gcsaic.com/streamx2).

Achieving measurable success in facilitating knowledgeable decision-making depends on developing, packaging, and optimizing access to crossing information. Although often overlooked, access to targeted site-specific data is often the missing variable in transitioning from a broad consensus that change is needed in crossings maintenance to the implementation of on-the-ground project solutions that effect such change. To maximize user access to the diversity of data generated by this study, a project website was developed. The website's viewing platforms and navigation tools provide options in selecting the desired level and/or scale of data access and the extent of data evaluation. To complement potential end user information needs, website project data reports are presented in basin, county, watershed/WBID, and crossing site scale formats. Each web report represents a different level of data analysis and scale of presentation.

1.6 ACKNOWLEDGEMENTS

This project was funded through Clean Water Act Section 319(h) grant, administered by the FDEP Nonpoint Source Management Section, Tallahassee, Florida, and managed by the grantee, Three Rivers. Technical services employed in the completion of this project were provided by SAIC. Additional organizations that provided project support included Northwest Florida Soil and Water Conservation Districts, Chipola River Partnership, Holmes County, West Florida Resource Conservation and Development Council, Inc., Florida Fish and Wildlife Conservation Commission, Natural Resource Conservation Service, and U.S. Fish and Wildlife Service. The project administrator, grantee, and technical services provider are described below.


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FDEP is a state agency charged with the management, stewardship, and protection of Florida's air, water, and land resources. Agency priorities include restoring the Everglades, improving air quality, restoring and protecting water quality, conserving environmentally sensitive lands, and providing the public with recreational opportunities. The Nonpoint Source Management Section administers Section 319(h) grant funds it receives from the USEPA to implement projects and programs within the state's nonpoint source (NPS) priority watersheds to reduce sources of NPS pollution. Examples of fundable projects include demonstration and evaluation of best management practices, NPS pollution reduction in priority watersheds, groundwater protection from NPS sources, public education regarding NPS source management, and other activities.

Three Rivers is a 501(c) 3 nonprofit organization headquartered in Milton, Florida, incorporated and commissioned by local civic leaders to provide technical support to rural and urban individuals and organizations that encourage community socioeconomic improvements and the wise management of natural resources. The 19 members of the Three Rivers council have represented the interests of Escambia, Santa Rosa, Okaloosa, Walton, Washington, Holmes, and Bay Counties for over 30 years. Three Rivers has extensive experience in funding acquisition and administration, as well as contractual distribution, project implementation, and monitoring. Through years of involvement at local, state, and federal levels, Three Rivers has established a reliable network of contacts and long-term relationships with local communities that have proven to be indispensable in accomplishing resource management goals and objectives.

As the technical services provider, SAIC's Landscape Recovery and Management Group (LRMG) headquartered in Shalimar, Florida, conducted the technical aspects of the project, including project design, research, crossing field surveys, data analysis and management, and reporting. The LRMG specializes in natural landscape planning, inventory, assessment, recovery, and management. The LRMG principals include Mr. Mike Rainer, SAIC Soil Scientist, Mr. David Rubino, SAIC Systems Engineer, and Mr. Bill Brown, SAIC GIS Analyst/Hydrologic Engineer.

A special thanks to Mr. Donald Ray, FDEP Stream Biologist, for his significant contribution to this project. Mr. Ray and his staff conducted stream biology surveys at crossings assessed during the 2006 *Lower Choctawhatchee Subbasin Road-Stream Crossings Assessment*. His work was instrumental in validating correlations between CPB crossing-induced sedimentation and aquatic ecosystem impairment (Section 5.4.7). For this project, he provided technical assistance, photo documentation, and information on Northwest Florida streams and aquatic insects that was essential to this assessment.

Other cooperating organizations that were instrumental in this project include the Northwest Florida Soil and Water Conservation Districts, Chipola River Partnership, Florida Fish and Wildlife Conservation Commission, Holmes County, National Resource Conservation Service, U.S. Fish and Wildlife Service, and West Florida Resource Conservation and Development Council, Inc.

1.7 LITERATURE CITED

DeMaynadier, P. G. and M. L. Hunter. 2000. Road effects on amphibian movements in a forested landscape. *Natural Areas Journal*, 20(1):56-65.

Forman, R. T. T. and L. E. Alexander. 1998. Roads and their Major Ecological Effects. *Annual Reviews of Ecology and Systematics*, 29:207-231.

Gucinski, H., J. J. Furniss, R. R. Ziemer, and M. H. Brookes (eds.). 2000. *Forest Roads: A Synthesis of Scientific Information*. USDA Forest Service.

Reid, L.M. and Dunne, T. 1984. Sediment Production from Forest Road Surfaces. *Water Resources Research*, 20(11): 1753-1761.

Swift, L.W. 1984. Soil Losses from Roadbeds and Cut and Fill Slopes in the Southern Appalachian Mountains. *Southern Journal of Applied Forestry* 8(4):209-216.

Trombulak, S. C. and C. A. Frissel. 2000. Review of Ecological Effects of Roads on Terrestrial and Aquatic Communities. Conservation Biology, 14(1):18-30.


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CHAPTER TWO

HISTORICAL REVIEW





Florida State Archives

This chapter discusses the settlement and development of Northwest Florida. Topics include early settlement patterns and transportation, the development of roads and crossings, and the general effects of habitation and land use changes on Choctawhatchee-Pea Basin landscapes. All historical photographs presented in this chapter were used with permission from the Florida State Archives.


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ACRONYMS

CPB	Choctawhatchee-Pea Basin
NRCS	Natural Resources Conservation Service


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2. HISTORICAL REVIEW

The lands of the Choctawhatchee-Pea Basin (CPB) have undergone significant changes since pioneer settlement; some human activities had relatively minor effects, whereas others have permanently altered the form and function of its ecosystems. The consequences of over 100 years of population growth, natural resource depletion, alteration of waterways, and exponential increases in miles of roads throughout Northwest Florida has detrimentally affected impacted environments. A review of CPB history establishes a cultural context for identifying and analyzing the significance of mans interactions with the environment. CPB environmental conditions are not confined to the obvious impacts of recent human activities but are cumulative, in that the current condition is evidence of the diversity of effects on ecosystems brought about by decades of human intervention. The following sections review settlement, transportation, and land uses that were instrumental in shaping the CPB.

2.1 SETTLEMENT

Many pioneers of the 1800s had heard reports of Florida, the land of sunshine and flowers, with towering virgin pines and spreading oaks, its green pastures, its great bays, lakes, swamps, and rivers, its abounding fish and game. They saw Northwest Florida as a new and better country where they could build homes, have more elbow room, drink pure water, and breathe clean air. The early 19th century settlement of the relatively unexplored Northwest Florida territory depended on facilities for transportation, which were generally erratic and inadequate; in much of this territory, there were no roads and few Native American trails. The north-south orientation of most major waterways governed early settlement patterns. As pioneers gained access to new lands, they built homes, cleared land, and established the infrastructure and social networks to sustain themselves (Figure 2-1).



Figure 2-1. Early Northwest Florida Homesteads (Florida State Archives; Mike Rainer)

In 1845, approximately 66,500 people lived in Florida. Of these, 16,624 (25 percent) lived in the scattered settlements of Northwest Florida at a density of approximately 2 people per square mile. The economy was primarily based on staple agriculture and timber, there were few if any public schools, and communication and trade were primarily by water routes or rough overland routes (Dodd, 1945). The location of early settlements were primarily governed by environmental factors, cultural alliances, and farming suitability.

Nineteenth century improvements in water, rail, and road transportation networks (Figure 2-2) not only increased communication but, more significantly, stimulated commerce, industry, and the development of natural resources. Better transportation opened vast stretches of Northwest Florida to settlement and promoted connectivity and unity among scattered inhabitants. Lands were cleared for agriculture, trees were harvested for timber, and waterways were snagged and dredged to establish dependable routes for steamboats.



Figure 2-2. CPB Steamboat, Rail, and Road Transportation Circa 1890s to 1900s
(Florida State Archives)

Throughout the 20th century, availability of abundant Northwest Florida natural resources and the advent of the tourist industry led to more population growth and development. The growing population, the increasing volume of transported goods, and the introduction of the automobile required improvements in road and stream crossing construction and maintenance techniques. During the first three years of the 21st century, the population of Florida

increased by 6.8 percent to approximately 17.1 million, which makes it the fourth most populous state in the United States. Within the counties that comprise the Choctawhatchee-Pea Basin, population densities generally range from 8 to over 1,000 inhabitants per square mile.

2.2 EARLY ROADS AND CROSSINGS

Roads are distinctive signatures of human occupation. Roads have a major influence on the land and its development; as road densities increase, so do the capacities of people to alter the cover and uses of the land. The following discussion examines the historical trends in CPB road system developments that have directly affected current land cover and uses, as well as potential impacts on aquatic resources, and outlines current unpaved road conditions.

Over thousands of years of occupation, Native Americans established trails that generally met their transportation requirements. When natural obstacles were encountered, the location of the trail likely represented a preferred route of least resistance. Early military route surveys generally followed Native American trails; however, new routes were established as necessary to meet specific destination needs or other logistical requirements (Whitman, 1938).

Because of the predominant topography, many narrow north-south roads were constructed on higher ground, avoiding many of the wetlands and waterbodies along the coast. Early builders of east-west roads were challenged by the diversity of swamps, bogs, natural ponds, creeks, and bayous along the Northwest Florida coast (Womack, 1999).

The only major road in existence at the time of Florida's admission to the United States was the King's Road constructed from a Native American trail in 1763, which led from New Smyrna to St. Augustine, up into Georgia. The first attempt to improve transportation in the Florida territory was the construction of the Pensacola-St. Augustine Road in 1824 to 1826 (Whitman, 1938).

Federal soldiers stationed at Pensacola constructed a 16-foot-wide road from Pensacola to Tallahassee. At the same time, John Bellamy, a planter in Leon County, built the eastern section of the road that ran between Tallahassee and St. Augustine. The western portion of the road became known as the Federal Road and the eastern section was the Bellamy Road. Overall, river ferry service was poor and numerous washouts were reported (Womack, 1999). Following completion, much of the Federal Road was little used, and it was abandoned after several years (Whitman, 1938).

In 1828, the United States Congress appropriated $2,000 to reopen portions of the old King's Road. An additional $7,000 in 1835 was used to repair roads between St. Augustine and Pensacola and between Bayard and Newmansville. In 1838, a highway was completed from St. Joseph to Marianna into Georgia. Each road construction and/or repair project brought with it an increased influx of settlers that cleared the land and built communication network roads and trails. Tourists also came to north Florida as early as the 1820s, for health reasons, and later became Florida residents. The increased movement and settlement of people in the area attracted economic projects, investors, taverns, salesmen, ministers, missionaries, and other interests (Whitman, 1938). The growing demands for transportation and communication required the development of public travel corridors to accommodate the needs of the growing population.

The next major road construction project was completed with the opening of the east-west U.S. Highway 90, known as the Old Spanish Trail in Northwest Florida, in 1929. It paralleled the Louisville & Nashville Railroad built in 1883 between Pensacola and Chattahoochee (Womack, 1999).

Means of travel have a direct bearing on the form and function of the transportation corridors. Throughout the 1800s and into the early 1900s, foot travel, bicycles, horses, and animal-drawn carts, wagons, and buggies were the primary forms of road travel in the Florida territory (Figure 2-3). With the advent of the automobile, the load-bearing capacity, widths, and general frequency of use requirements for roads increased. Roads required more frequent maintenance, proper drainage, and road surfacing materials that provided a harder surface.



Figure 2-3. Bicycle and Wagon Transportation Circa 1890s (Florida State Archives)

The advent, in the 1910s and 1920s, of large, heavy-duty trucks to transport people, commercial goods and services, and timber produced significant increases on the wheeled stress applied to county roads. Even on the highest quality sand-clay roads, the road degradation created by the repetitive trips of fully loaded logging trucks was significant (Figure 2-4).



Figure 2-4. Company Transport Truck 1914 and Loaded Logging Truck Circa 1920s (Florida State Archives)

Road networks and other means of transportation grew at an accelerated rate throughout the late 19th and early 20th centuries. By 1910, there were over 2,000 miles of unpaved roads within the counties that comprise the Choctawhatchee-Pea Basin.

2.2.1 Unimproved Roads

Since most early travelers only required roads wide enough to accommodate walkers, horsemen, or relatively small wagons, straight, wide roads were not necessary. In reality, most trails converted to roads were only slightly widened to allow passage of wagons. As necessary, the road would weave in and out of the timber to avoid tree cutting. As unimproved, the surfaces of these roads were generally not modified; in some instances, the stumps of cut hardwoods may have been removed to prevent interference from sprouts growing from the stumps (Figure 2-5). Over time, the increased use of the roads would create wheel furrows that further defined the road footprint.



Figure 2-5. Unimproved Sand Roads Washington County Circa 1910s (Florida State Archives)

2.2.2 Improved Roads

Based on surveys of the road network in 1908, 1909, and 1910, it was determined that there were approximately 17,954 total miles of public roads in Florida. The total miles of improved roads in Florida, exclusive of graded dirt roads, were 2,070. These improved roads included:

- 1,000 miles of sand-clay roads
- 611.3 miles of marl or crushed stone roads
- 277 miles of pine straw roads
- 146.1 miles of shell roads
- 22.5 miles of gravel roads
- 8.5 miles of brick roads
- 5.2 miles of cement roads
- 0.4 miles of asphalt roads

County governments were responsible for road construction, repair, and expenditure of funds to maintain county roads; in some counties, county commissioners supervised the roads in their districts. In 1910, the Northwest Florida counties of Escambia, Santa Rosa, and Washington used county prisoners to build and maintain roads. Some counties had their own resources for road surfacing while other counties purchased needed materials, utilized existing right-of-way resources, or relied on the contributions of citizens. The total expenditure of funds on Florida public roads in 1910 for the 44 reporting counties was approximately $1,080,949 (Sellards et al., 1911).

Pine straw was used in the late 1800s and early 1900s as a covering for unimproved and improved sand roads (Figure 2-6). In 1910, there were approximately 277 miles of pine straw roads in Florida, and the average cost for strawing was approximately $40 per mile (Sellards et al., 1911). Since this resource was readily available from the longleaf pine forests adjacent to most Northwest Florida roads, it proved to be a cheap upgrade for some lightly traveled roads. Under light-to-moderate use, strawing was an effective road improvement option. The development of the unimproved pine straw roads were limited to the removal of stumps from the roadway, localized road leveling, and application of pine straw to the surface.



Figure 2-6. Sand Roads Surfaced with Pine Straw Circa 1900s (Florida State Archives)

Sand-clay materials surfaced the majority of improved roads in Northwest Florida (Figure 2-7). This material was used extensively because it was cost-effective to mine and apply and was readily available in the counties of the Panhandle. Clay and sand-clay materials were mined by removing overburden and excavating the material or locating hillslopes where geologic clay layers had been exposed by erosion.

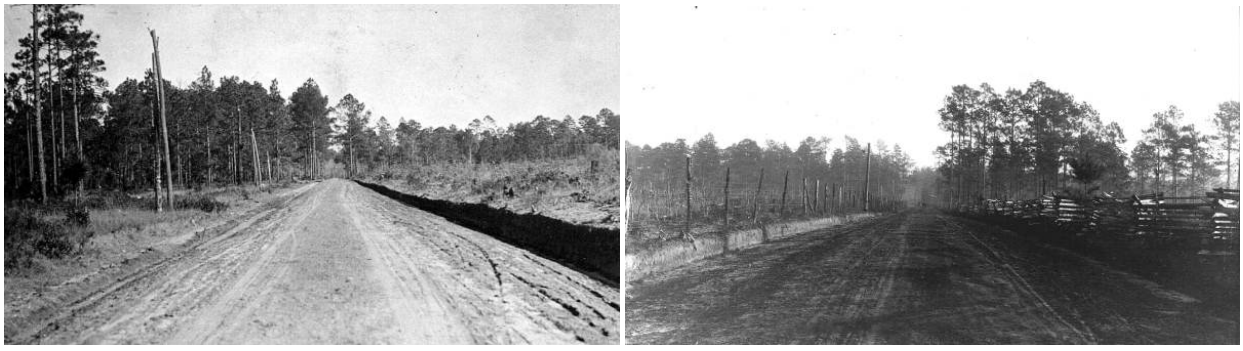


Figure 2-7. Improved Sand-Clay Road, Washington County 1911 (Florida State Archives)

Fine clays mixed in proper proportion with coarse sand were often a preferred road surfacing material where cost-effectiveness and light traffic were primary considerations. Road clays were identified by a red or yellowish brown color, indicating a high content of iron compounds that likely assisted in the bonding of road materials. In

texture, the clays are generally rather coarse and tend to break up easily. The sand-clay mixing ratio for roads often required adjustment to ensure that the fine clays filled the voids between the sand grains. Too much sand or too much clay in the mixture restricts the bonding of soil particles necessary to maintain a solid, cohesive roadbed. Some counties in Northwest Florida, notably Leon, Jefferson, Gadsden, Jackson, and parts of other counties, have naturally occurring sand-clay foundations for roads (Sellards et al., 1911).

The width of sand-clay roads in the late 1800s and early 1900s varied from 9 to 30 feet, and thickness of road surfacing material was generally between 6 and 14 inches at the center of the road and 2 to 10 inches at the road edges. By the end of 1910, there were approximately 1,000 miles of improved sand-clay roads in Florida constructed at a cost of $731,600. The miles of public sand-clay roads and all public roads within reporting counties during the road surveys of 1908, 1909, and 1910 are presented in Table 2-1.

Table 2-1. Historical Northwest Florida Public Roads

County	Estimated Road Miles		Road Specifications
	Sand-Clay Roads	All Public Roads*	
Calhoun	NA	250	Extensive areas of natural near-surface clays that only require grading and proper drainage to create good roads; roads worked by citizens; county convicts leased out; total expenditure on public roads and bridges during 1910 was $3,967
Escambia	115**	1,000	Sand-clay roads built 20 to 25 feet wide; 14 inches thick at the middle and 4 inches thick at the edges; constructed at a cost of $1,000 per mile; total expenditure on public roads during 1910 was $40,355
Franklin	NA	30	No improved sand-clay roads reported; 25 miles of shell roads; roads worked by citizens; total expenditure on public roads during 1910 was $4,406
Gadsden	31	500	Principally natural sand-clay roads graded, drained, and built 30 feet wide; county convicts used on the roads; cost to construct a road averaged $350 per mile; total expenditure on public roads during 1910 was $16,000
Holmes	NA	1,000	Some natural sand-clay roads; roads worked by citizens under the 8-day system; total expenditure on public roads during 1910 was $4,588
Jackson	NA	400	Extensive areas of natural near-surface clays that only require grading and proper drainage to create good roads; citizens worked roads under the 8-day system; total expenditure on public roads during 1910 was $3,000
Jefferson	NA	350	With exception of the southern extremity, there are extensive areas of natural near surface clays that only require grading and proper drainage to create good roads; citizens worked roads under the 8-day system; county convicts and laborers hired by the county; total expenditure on public roads during 1910 was $2,326
Leon	150	450	Roads in the north half of the county have natural near surface clays that only require grading and proper drainage; cost for sand-clay roads ranged from $100 and $500 per mile; total expenditure on public roads during 1910 was $12,227
Liberty	NA	236	Road materials included sand-clay and limestone; work on roads outsourced through county contracts; total expenditure on public roads during 1909 was $4,879
Santa Rosa	50	250	Road materials included sand-clay and shell marl; roads worked by citizens, convicts, and laborers; total expenditure on public roads during 1910 was $15,000
Wakulla	NA	100	No hard surfaced roads reported in the county; roads worked by citizens under the 8-day system; total expenditure on public roads during 1910 was $600
Walton	3	200	Road materials included sand-clay and shell marl; roads worked by citizens; total expenditure on public roads and bridges during 1910 was $8,000
Washington	4***	500	Principal costs of road construction included right-of-way clearing, bridging streams, and road drainage; roads worked by citizens under the 8-day system; total expenditure on public roads and bridges during 1910 was $10,000
Totals	353	5,266	

Source: Sellards et al., 1911; NA = Not available; * = Includes unimproved and improved public roads; ** = Exclusive of sand-clay roads within the cities; *** = Four miles of a 16 mile sand-clay road between Vernon and Chipley were completed at the time of the survey in 1910

2.2.3 Upside Down Roads

With the advent of timber management through controlled burning by timber companies and state and federal forest landowners, improved and unimproved dirt roads were required to function as firebreaks as well as travel corridors. Since roads defined the boundaries of many forest stands, their presence presented an access route and barrier for prescribed burning and barrier against the spread of wildfires. In the 1930s, the Civilian Conservation Corps was used in Northwest Florida to construct new roads and/or modify existing roads with exaggerated roadside berms that would deflect the movement of ground fires across roads. The grading employed to build berms at the edges of the road usually resulted in the flattening of the road profile by taking material from the normally higher middle portion of the road and moving it to the road edges (Figure 2-8). Because of their U-shape configuration, they became known as "upside down roads."



Figure 2-8. CPB Upside Down Roads, Bay County 1934 (Florida State Archives)

2.2.4 Road Construction and Repair

The principal road construction and repair equipment used by Northwest Florida counties in the 1910s could have included mules, traction engines, wagons, road graders, road compactors, steam rollers, scrapers, water tanks, camp outfits, and general hand tools (e.g., shovels, axes, and picks). In many instances, only hand tools were available for county road construction and repair. Principal expenses of road construction included clearing rights-of-way, bridging streams, and providing for drainage (Sellards et al., 1911). Convicts, citizens, and/or hired laborers performed roadwork.

Improved roads were constructed to shed water off the roadway and collect water in roadside ditches and/or disperse runoff into vegetated areas adjacent to the roadway. Compacting was also used by early road workers to stabilize the surface soils of roads. Heavy rollers were moved across newly constructed or repaired roads to maximize the stability of the road surface by increasing the bonding of sand or sand-clay materials. Examples of historical road construction and repair equipment and activities are presented in Figure 2-9.

2.2.5 Stream Crossings

Until the early 1900s, the ferry was a primary means of crossing large streams and rivers. Smaller streams and swampy areas were crossed by unimproved low-water crossings or wooden bridges. In locations where it was applicable, the dirt road transitioned directly through the stream. Because of the absence of a stabilized crossing structure, travel at this type of crossing was generally limited to low-to-normal water flow conditions.

Continued 19th century investments in road construction and improvements created an urgent need for ferries and stream crossings; in the 1840s, the Florida territorial legislative council passed nearly 100 acts granting individuals the right to operate stream ferries, and bridges were built with public and private funds to move people and goods across smaller streams (Whitman, 1938). Examples of ferry operations and wooden bridge crossings are presented in Figures 2-10 and 2-11.



Figure 2-9. Early 20th Century Road Construction and Maintenance (Florida State Archives)



Figure 2-10. Northwest Florida Ferry Crossing Circa 1890s (Florida State Archives)



Figure 2-11. Northwest Florida Wooden Bridge Crossings, 1918 and 1935 (Florida State Archives)

2.3 LANDSCAPE CONVERSIONS

Human occupation and farming operations have profoundly impacted the CPB landscape. Native Americans were the first farmers to reside in the area; however, it was the introduction of large-scale land clearing by European settlers in the early to mid-1800s that resulted in the replacement of virgin forest with row crop agriculture operations (Figures 2-12 and 2-13). Early subsistence and commercial farming operations took advantage of the natural fertility of virgin soils and produced crops without incorporating practices to conserve soil fertility and prevent human-induced soil erosion. As a result, there were high rates of soil erosion that far exceeded natural background erosion and significant loss of topsoil within the CPB and much of the southeast United States. In some portions of the CPB, relatively steep slopes, highly erodible soils, and intensive rainfall patterns created landscapes highly susceptible to human-induced soil erosion.



Figure 2-12. Land Cleared for Farming, Okaloosa County 1920 (Florida State Archives)



Figure 2-13. Plowing Recently Cleared Farmland Circa 1910s (Florida State Archives)

Land use by nonnative Americans is characterized by three major eras: agricultural exploitation, timber exploitation, and recovery. Agriculture reached it peak during the late 19th century with the cotton production boom. The introduction of the boll weevil dramatically altered the cotton production capacity of many farmers, and cotton was supplanted by other crops. The disposal of large public land areas following the Civil War and depletion of Great Lakes states timber resources created a timber industry boom in the southern United States that peaked in the early part of the 20th century. Over several decades, nearly all stands of virgin timber were clearcut. By the 1930s, the intensity of agricultural and timber production had seriously degraded many land areas in the CPB and other parts of the South (Wear and Greis, 2002).

Land clearing, depletion, and abandonment was common in much of the southeast United States until the 1930s. Cotton farmers would often crop the land for several years until the soil was exhausted and then abandon the land; in this abused condition, the land was most susceptible to soil loss by erosion. As erosion-induced declines in soil fertility increased, lands of marginal farming productivity potential and high erosion potential were cleared and planted, with disastrous effects to terrestrial and aquatic environments. Significant gully systems and gross amounts of erosion and sedimentation were common on many early farming operations (Figure 2-14). In the southeast United States, land abandonment was most often attributed to excessive soil erosion (Trimble, 1974).



Figure 2-14. Farming-Induces Soil Erosion and Sedimentation Circa 1920 (Florida State Archives)

Historically, ditches and canals within the CPB were constructed to drain low lands for agriculture, improve soil water conditions for silviculture, or to control low land flooding (Figures 2-15 and 2-16). Many of the drainage features constructed over 100 years ago are still in use (Section 3.5.8). Generally, agricultural drainage networks consisted of small lateral ditches that drained into larger canals, which discharged runoff and groundwater seepage to receiving streams or wetland areas. Floodplain and wetland areas that contained fertile soils but were too wet to farm often experienced extensive drainage modification to accommodate the tillage and harvesting of row crops. However, the expense and labor needed to install and maintain complex drainage networks generally limited them to areas where discernable economic gains could be achieved.

Based on research by Trimble (1974), it is estimated that the highest rates of human-induced soil erosion and sedimentation in the southern United States occurred between 1870 and 1930. Extensive amounts of soil loss and delivery of sediment into waterways resulted in the choking of stream channels and filling in of wetland areas that severely restricted their sediment transport capabilities. Investigations of 10 southern Piedmont river basins found that, of the soils eroded from uplands since European settlement, only about 5 percent has been exported to areas outside the basins. It was concluded that human-induced sedimentation so overloaded impacted waterways that a majority of the soil material has remained within the system. Since streams of the Piedmont and the CPB are relatively analogous, it is further asserted that a stream steady state, wherein the solid materials transported from stream basins are approximately equal to that eroded from upland slopes, cannot be assumed for the CPB.

Sediment-laden waterways were less navigable and suffered from an increased frequency and intensity of flood events. As land development and farming demands further increased, it became necessary to mechanically restore water flows and flood retention capacities by channelizing and dredging streams and constructing drainage canals and ditches. Although short-term flood and drainage relief were realized, long-term effects on natural hydrology were disastrous.



Figure 2-15. Canal Construction Circa 1890s and Post Construction Surveying, 1920 (Florida State Archives)



Figure 2-16. Canal Construction, 1930
(Florida State Archives)

Strong economic growth following World War II resulted in increased population and urbanization. Changing markets, legislation, and conservation initiatives supported increased allocation of lands to more stable agriculture and timber production. Over the following decades, silviculture (managed forestry) returned at a higher rate than agriculture. The southern United States has become the dominant timber-producing region of the county. It is forecasted that between 1992 and 2040, approximately 25 million acres of the southern United States could be converted from agriculture to timber production (Wear and Greis, 2002).

Declines in agriculture, conversion of cropland to pasture and silviculture, and widespread implementation of soil conservation practices have significantly reduced the rates of soil erosion and stream sedimentation. The United States Department of Agriculture, Soil Conservation Service, now known as the Natural Resources Conservation Service (NRCS), was established in the 1930s to reduce topsoil loss by advocating the incorporation of farmland conservation practices. The adoption of soil conservation practices by farmers resulted in significant reductions in soil erosion and stream sedimentation rates. Many of the beneficial effects of terraces and contour plowing can still be seen today on CPB hillside pastures. Many of the farmland drainage gully systems were also stabilized and rehabilitated. The NRCS continues to provide landowners with technical and financial assistance in selecting, designing, and implementing farming conservation practices that minimize soil erosion and sedimentation.

As sediment delivery to waterways began to decline, unstable stream channels worked to reestablish stable channel grades by downcutting through the sediment deposits. Sediments were slowly eroded from upstream areas and deposited within lower stream reaches. One effect of this degradation (erosion) and aggradation (sediment deposition) process is a disconnect of upper stream reaches from adjacent floodplain areas, as the channels become entrenched and widening of floodplains and midstream and downstream reach flood retention capacities are diminished.

The sediments that eroded into CPB streams over the last century continue to be resuspended, relocated, and redeposited within the subbasin drainage areas. This means that the soil erosion legacies of generations past as well as current conditions are affecting the existing characteristics of CPB aquatic ecosystems. Based on a review of historical records and existing trends, Trimble (1974) estimated that the distribution of sediments in streams would continue to change at an increasing rate. Shifts in the channel stabilities of upper reaches will likely create accelerated rates of channel degradation in the lower reaches of the river basins. Unstable channel conditions reduce the quality and quantity of aquatic habitat, promote poor water quality, and increase catastrophic flood potentials.

2.4 LITERATURE CITED

Dodd, D. Florida in 1845. 1945. *Florida Historical Quarterly*, XXIV, Issue 1.

Sellards, E.H., Gunter, H., and Cox, N.H. 1911. *Roads and Road Materials of Florida*. Bulletin No. 2, Florida State Geological Survey.

Trimble, S.W. 1974. *Man-Induced Soil Erosion on the Southern Peadmon 1700 to 1970*. Soil Conservation Society of America.

Wear, D.N. and Greis, J.G. 2002. Southern Forest Resource Assessment: Summary Report. Gen. Tech. Rep. SRS-54. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station.

Whitman, A. 1938. Transportation in Territorial Florida. *The Florida Historical Quarterly*, 17(1):25-53.

Womack, M. 1999. *Design, Building of Panhandle Roads Have Winding History*. Data retrieved from the Internet on June 29, 2006 at: http://www.newsherald.com/archive/local99/li050299.htm.


Mike Rainer

CHAPTER THREE

ENVIRONMENTAL BASELINE


Mike Rainer

Environmental baselining is a data collection and characterization process that inventories and describes the natural and anthropogenic components of the Choctawhatchee-Pea Basin. It also establishes a basis to characterize associative relationships and interactions between crossings and affected environments. Topics of discussion include environmental data, geology and soils, landscape relief, hydrology, land use and land cover, land conservation, water quality, rare and imperiled aquatic species, stream bioassessments, and socioeconomics. This baseline of environmental data, in combination with site-specific crossing conditions and environmental effects summarized in Chapters 5 and 6 provides the basis for crossing analysis and treatment prioritization presented in Chapter 7.


Donald Ray

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ACRONYMS

AMSL	above mean sea level
BP	botanical project
CPB	Choctawhatchee-Pea Basin
CS	Crossover Site
CWA	Clean Water Act
EEL	Environmentally Endangered Lands
EPT	Ephemeroptera, Plecoptera, and Trichoptera
FA	Floridan Aquifer
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FNAI	Florida Natural Areas Inventory
FWCC	Florida Wildlife Conservation Commission
GIS	geographic information system
IS	Intermediate System
LCS	Lower Choctawhatchee Subbasin
NED	National Elevation Dataset
NPS	nonpoint source
NRCS	National Resource Conservation Service
OTTED	Office of Trade Tourism and Economic Development
ROI	region of influence
RZ	riparian zone
SA	Surficial Aquifer
USGS	U.S. Geological Survey
WBID	waterbody identification
WQ	water quality

3. ENVIRONMENTAL BASELINE

3.1 ENVIRONMENTAL DATA

The natural and socioeconomic data presented in this chapter is primarily based on public geographic information system (GIS) sources. Although products such as maps and tables derived from GIS data serve many purposes well, they may not contain the perceived degree of perfection conveyed by the precise line work, colors, finishing, and point features of professionally produced maps. It is the completeness and precision of the data behind the map product that defines its confidence and acceptable use.

Misuse of GIS data occurs when the decision parameters and data quality assumptions of the user are misaligned with the precision and/or accuracy constraints and transferability of the data; continuing to infer greater detail often leads to inherent errors that produce misleading information, erroneous results, and poor and costly decisions. Just because a particular GIS dataset is easily accessible, is available on the Internet, or comes from a renowned institution does not mean it meets the required quality standards and is fit for all uses. Data are only of high quality if they are fit for their intended use, beyond which there is a degree of uncertainty and error.

These issues tend to be exacerbated as multiple data layers are combined into integrated solutions with each dataset contributing errors that affect overall data quality. Data misuse can also occur with the combination of datasets in order to establish conditions or relations using data of varying delineation, quality, and intent. Often, it is the scale of a particular geological feature that drives the granularity, or precision, of the GIS layers. As an example, drawing conclusions from combining highly precise and accurate field data with that which has been greatly generalized may result in an inaccurate representation of true conditions.

For this project, which seeks to characterize Choctawhatchee-Pea Basin (CPB) road-stream crossings, it would be a misuse of small- to regional-scale GIS data to quantify crossing site-specific features, conditions, and environment interactions. The level of scrutiny required to quantify and analyze potential interactions between crossings and resources can only be achieved using data from on-site field surveys. The processes employed to collect and analyze real-time crossing site data are described in Section 1.5.

For this project, natural resource and aquatic species GIS datasets were assessed for accuracy, precision, and completeness to determine their fitness for use. Datasets with gaps in coverage, incompleteness, attribute inconsistencies, or incompatible scales were excluded from the analysis. The geo-referenced and attribute polygon-based datasets used to produce the resource maps contained in the following sections are presented in Table 3-1.

Table 3-1. Choctawhatchee-Pea Basin Environmental Baseline GIS Maps

GIS Maps	Source	Date	Type	Description
Soil Orders	USDA	2006	shapefiles	Identification of CPB soil orders was derived from USDA, Natural Resources Conservation Service, Publication_Date: 2006 Soil Survey Geographic (SSURGO) Database for the CPB counties
Hypsography	USGS	1999	raster coverage	Coverage was derived from the USGS National Elevation Dataset (NED) for the state of Florida, 1999

Table 3-1. Choctawhatchee-Pea Basin Environmental Baseline GIS Maps Cont'd

GIS Maps	Source	Date	Type	Description
Springs	FDEP	Various after 2002	coordinate lists	Statewide coverage of springs in Florida. The spring location coverage began as an Excel field of Florida Springs information compiled prior to 2002 and collected from several published sources. CPB spring coordinates were compiled from *Choctawhatchee River Springs Inventory Holmes, Walton, and Washington Counties, Florida* (Barrios 2005).
Surface Drainage	NHD/FDEP	2004	shapefiles	Identification of CPB surface hydrology was derived from the National Hydrography Dataset – Hydrographic Waterbody Features (1:24,000 scale, NHD.Florida_NHD 2004)
Land Use	NFWMD	1994/1995	shapefiles	Estimated CPB land use cover was derived from coverage produced by the NFWMD Land Use, Cover, and Forms Classification System (FLUCCS) 1994/1995 land use/cover maps
Land Cover	FFWCC	3/17/2004	raster coverage	Estimated CPB land cover was derived from coverage produced by the FFWCC Office of Environmental Services, March 17, 2004 (2003 Landsat Imagery)
Conservation Lands	FDEP	2006	shapefiles	Outstanding Florida Waters, 1:24,000 scale
	FNAI	2002		Florida Aquatic Preserve Boundaries, 1:24,000 scale. This dataset contains the boundaries for Outstanding Florida Waters that are designated as aquatic preserves
		2007		Florida Managed Areas (layer name FLMA). This is a polygon data layer for public and some private lands that the FNAI has identified as having natural resource value and that area being managed for conservation purposes. *Managed Area* refers to a managed conservation land.
		2008		Florida Forever Board of Trustees (BOT) Projects (layer name FFBOT). This is a ploygon data layer for Florida Forever BOT projects formally known as CARL projects.
	FFWCC	2002		Fish and Wildlife Conserveration Commission Management Areas. This dataset contains the management areas of the FFWCC.
Water Quality	FDEP	2005	Excel spreadsheet	WBID water quality parameters identified under the Impaired Waters Rule, G3 Choctawhatchee Master List
Rare and Imperiled Species	FFWCC	2004	shapefiles and coordinate list compilations	Identification of CPB WBIDs where listed fish species were verified to occur was derived from FFWCC, Florida Imperiled Fishes Species Investigations Database, 2004
	USFWS	2006		Identification of CPB WBIDs where candidate mussel species were verified to occur was derived from data provided by the USFWS, Panama City Office
Crossing Bioassessments	FDEP	2007	Excel spreadsheet	The CPB crossing stream bioassessments were conducted by Mr. Donald Ray, FDEP Stream Biologist in 2007. Tabular CPB bioassessment GPS point data was geocoded into a data layer and processed spatially to establish associations between StreamX crossing survey and bioassessment survey points. The data was presented in a thematic map to portray the StreamX crossing locations with the classification information stored in each BioAssessment data record.
Population Density	TeleAtlas	2006	shapefiles	CPB Population densities per square mile data were derived from TeleAtlas North America, Inc., ESRI, 2006.

CPB = Choctawhatchee-Pea Basin; FDEP = Florida Department of Environmental Protection; WBID = waterbody identification

The information that populates the selected GIS screening data layers used in this report may not be verified in the field and may have been confined to *interpretations* of existing conditions or status; at best, it is an estimation of potentials. The GIS maps presented in the chapter can be viewed or downloaded from the *Northwest Florida Road-Stream Crossings* website (https://www.gcsaic.com/streamx2) located in the *Northwest Florida Choctawhatchee-Pea Basin Road-Stream Crossings Assessment*, Resources, Map Library section.

3.2 GEOLOGY AND SOILS

The landforms that constitute the CPB resulted from erosion, deposition, and solution-related processes that have extended over geologic time. The geology of Florida differs from other parts of North America, in that it was originally connected to the continent of Africa, rather than the North American continent. The regional geology is generally characterized by marine deposited sands over clastic materials over carbonate bedrock.

The CPB is located along the southern portion of the Chattahoochee Anticline tertiary geologic formation that upwarps in Jackson County and dips away toward the south, southeast, and southwest. The numerous changes in gradational down dip formation created shallow off-shore depositional environments that were strongly influenced by sediment fluxes and changing marine currents. As a result, there are numerous examples of various shallow water depositional environments in Northwest Florida moving toward the Gulf of Mexico along the Chattahoochee Anticline.

The late Eocene Ocala Group is the oldest limestone rock outcrop in the CPB region. It is typically composed of light yellow to cream to white colored, granular, permeable, high fossiliferous limestone that contains prolific fossil fauna. This unit is found near the surface along the northern portion of Jackson County. Localized surface exposures are often hardened by recrystallization of silicification.

The Oligocene Series, which is the next younger formation, consists of Marianna and Suwannee Limestones. The Marianna Limestone lies on the Ocala Group and outcrops in a narrow band through central Jackson County. Generally, the limestone is soft, massive, and less permeable than the Ocala and tends to harden when exposed. The Suwannee Limestone, which overlies the Marianna, is composed of porous fossiliferous, dolomitic limestone and generally outcrops in a narrow band that parallels the Marianna to the north.

The CPB Oligocene Series is overlaid by the Miocene Series, which consists of the older Tampa Stage, the Alum Bluff, and the younger Choctawhatchee Stage. The Tampa Stage is characterized by fine quartz sand within limestone in Jackson County and almost pure limestone in Holmes and Washington Counties. The similar Alum Bluff and Choctawhatchee Stage are typically composed of sandy clays and clayey sands with abundant mollusk shell fossil remains. Orange coloring of materials is most often a result of iron oxide leached from overlying sands. Thin layers of sand that originated from ancient sea level fluctuations blanket the Miocene Series and all CPB lithologic outcrops. In addition, stream valley and terrace erosion and deposition processes have created accumulations of clean sandy materials (Schmidt and Coe, 1978).

Alluvial and fluvial stream terrace formations, at locations well above existing floodplains, occur along all major streams within the CPB. Geological surveys have identified four definite terrace levels that represent geologic periods of stream valley downcutting caused by alluvial flooding events. These terraced remnants of previous floodplains occur at elevations of 10 to 20, 30 to 50, 60 to 100, and 145 to 165 feet above mean sea level (AMSL), are generally arranged parallel to each other, are separated by escarpments, and have slopes of approximately 1.3 feet per mile. Viewed in a cross section of the stream valley, the older, wider terraces are at the higher elevations and the younger narrower terraces are at the lower elevations. Older terraces were generally occupied by shallow, wide valleys, whereas the younger stream valleys are deeper and narrower. CPB stream terrace information is summarized in Table 3-2.

Table 3-2. Choctawhatchee-Pea Basin Stream Terrace Features

Stream Terrace	Deposition Thickness (feet)	Surface Features
145 to 165 feet (oldest)	110+	Original surface is rarely seen; heavily dissected with excellent drainage; flat topped hills in northeast Holmes and Northwest Jackson counties reach elevations near the original terrace surface
60 to 100 feet	60 to 100	Original surface poorly preserved, dissected, and well drained; Holmes and Ten Mile Creeks in Holmes County are flanked by wide remnants of this surface
30 to 50 feet	40 to 80	Original surface and alluviation patterns well preserved; natural levees are well developed; drainage poorly defined, developed primarily in Holmes County
10 to 20 feet (youngest)	20 to 40	Original surface and alluviation patterns well preserved; drainage poorly developed; in southeastern Washington County all previous fluvial terraces except the 10 to 20 foot have been removed;
0 Feet (floodplain)	0 to 30	Surface and alluviation patterns being developed; drainage lines are rarely present

Source: Vernon, 1942

The geologic formations that constitute the CPB are the parent materials from which soils were formed. Soil is a natural material composed of solids, liquid, and gasses that occurs on the land surface; it is characterized by horizons or layers that are distinguishable from the parent material either as a result of additions, losses, transfers, and/or transformations of energy and matter or the ability to support rooted plants in a natural environment. The CPB is home to a diversity of soil types with unique physical and chemical characteristics that, in combination with a subtropical climate, partly determine the structure and function of ecosystems. A preeminent characteristic of upland CPB soils that is responsible for many of its unique attributes is the broad distribution and, in most cases, dominance of quartz sand.

Of the seven soil orders in Florida, six occur within the CPB, including Entisols, Histosols, Inceptisols, Spodosols, Ultisols, and Vertisols (Figure 3-1). Approximately 88 percent of the CPB land area is composed of Ultisol and Entisol soils (Table 3-3).

Table 3-3. Choctawhatchee-Pea Basin Soil Orders

Soil Order	Acres*	Percent
Entisols	464,287	36.37
Histosols	30,015	2.35
Inceptisols	88,245	6.91
Spodosols	33,791	2.65
Ultisols	659,940	51.69
Vertisols	387	0.03
Total	**1,276,665**	**100.00**

* Total acreage does not include clay pits, water, urban lands, aquents, gullied lands, and Lynchburg and Lynchburg variants.

The CPB Entisols formed in the deep sands of upland and alluvial terraces and silty clays of coastal marine terraces. Drainage ranges from dry, excessively drained uplands to very poorly drained, permanently flooded, salt marsh areas. Predominant texture classes include sand, sandy loam, sandy clay loam, and silty clay loam. Entisols may occur on relatively level areas or steep slopes where soil erosion exceeds soil formation rates (Buol, 1973). The properties unique to the Entisol soil order of northwest Florida are a dominance of mineral (inorganic) sandy constituents throughout the soil profile, no active soil-forming processes, and the general absence of soil horizon differentiation above 80 inches (most soils lack a subsoil) (Figure 3-2).



Figure 3-1. Choctawhatchee-Pea Basin Soil Orders (David Rubino)

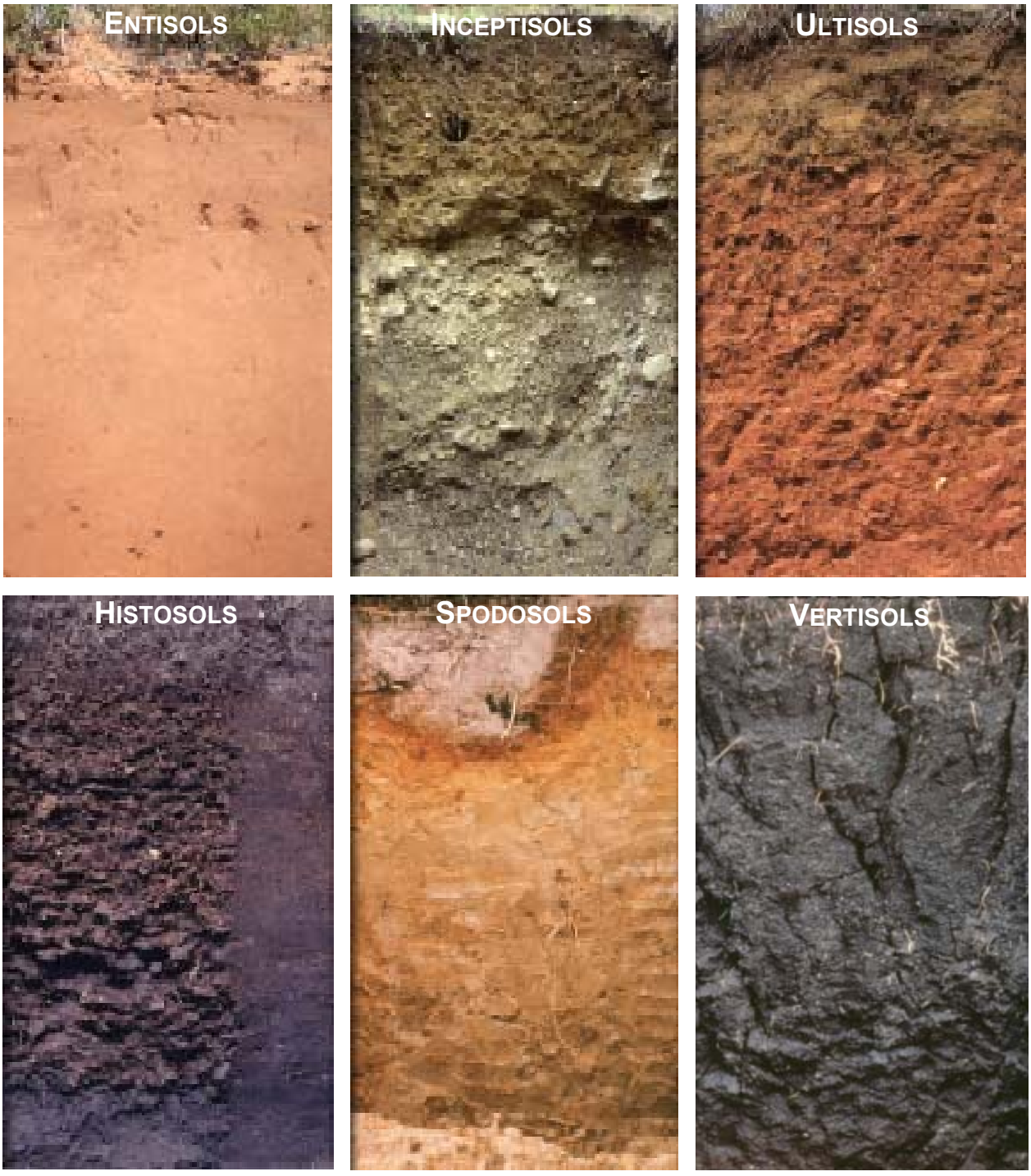


Figure 3-2. CPB Soil Orders (NRCS, 2006)

Soils that belong to the Histosol orders have a high content of organic matter and are frequently referred to as mucks or peat soils (Figure 3-2). The primary source of organic matter is the decomposed plant materials that accumulate in water. These soils occur in floodplains, hardwood swamps, flatwoods depressions, and coastal bays and marshes. The poorly drained Histosols occur on level to nearly level slopes of less than 1 percent (Buol, 1973).

Inceptisols are soils that have experienced some change in parent materials resulting in the leaching and accumulation of materials in subsurface layers or horizons (Figure 3-2). Inceptisols form mainly in loamy and clayey parent materials, whereas Entisols and Spodosols form in sandy materials. This soil order includes a wide variety of soil types. Inceptisols also include soils that have failed to meet the criteria of other soil orders. These soils range from poorly to excessively drained and frequently occur on level to gently undulating floodplain and marsh areas. Soil textures range from sandy loams to silty clays (Buol, 1973).

Spodosols are poorly drained, naturally infertile soils in which materials such as organic matter, aluminum, and/or iron have leached through the soil profile and accumulated in a lower layer in the soil profile called a spodic horizon (Figure 3-2). The soil texture class of these soils is mostly sandy, sandy-skeletal, coarse-loamy, loamy-skeletal, or coarse silty and is black or red in appearance. In Northwest Florida, they primarily occur in quartz-rich sands of acidic marine sediments with fluctuating groundwater levels, which typically include flatwoods, depressions, stream terraces, and tidal areas. Slopes typically range from 0 to 5 percent (Buol, 1973).

Ultisols are highly developed and leached soils in which clay has accumulated in a lower soil layer called the argillic horizon (Figure 3-2). Most surface layers have a sandy or loamy soil texture, and subsurface horizons typically have a loamy or clayey texture. The native vegetation of this soil order is forest. These excessively to poorly drained soils formed in loamy marine and alluvial deposits that occur on upland terraces, flats, ridges, hillslopes, drainways, depressions, and interstream divides that range from nearly level to slopes of 30 percent or greater (Buol, 1973).

Vertisols are clayey soils characterized by high soil shrink-swell potentials, a dark color ranging from very dark gray through brown, and difficult engineering properties (Figure 3-2). During dry periods, these soils become hard and may produce deep, wide cracks through the soil profile. When moistened, these soils swell and become sticky. Clay is dominant, composing 50 to 70 percent of the soil horizons. Parent materials are predominately thick, clayey marine deposits; some are developed over indurated limestone. A relatively large proportion of the clay fraction is classified as fine, montmorillonitic clay. In Northwest Florida, these soils generally formed under grasslands. These soils generally have gentle slopes of less than 2 percent (Buol, 1973).

The susceptibility of the soil to erosion (erodibility) is primarily dependent on factors such as soil texture, moisture content, pH, and ionic strength of the eroding water. Soil erodibility generally decreases with increasing clay and organic matter content, whereas uniform silts and sands tend to have high soil erodibility (Gray and Leiser, 1982). The potentially high sand and low organic matter content of some Entisols, Spodosols, and Ultisols associated with CPB crossings may present conditions that are particularly prone to soil erosion.

3.3 LANDSCAPE RELIEF

Landscape relief development, as illustrated by geologic and soil formation processes, directly affects the form and function of surface and subsurface environments. Changes in landscape matrix materials composition and surface elevations, whether a few inches or tens of feet, can dramatically influence hydrology (surface), geohydrology (subsurface), soil development, vegetative community composition, and other ecosystem variables.

A representation of the CPB surface relief was developed using the United States Geologic Survey (USGS) National Elevation Dataset (NED). The 1:24,000 scale NEDs were created on a national scale by merging the highest resolution, best quality elevation data into a seamless raster format. The shaded relief of the NEDs was derived from hillshade techniques and displayed using 315 degrees azimuth, 45 degrees elevation, and 0.00003 vertical exaggerations. A shaded NED map of the CPB work area is presented in Figure 3-3.



Figure 3-3. Choctawhatchee-Pea Basin Landscape Relief (David Rubino)

Slopes are generally defined by slope angle or gradient, slope length, and slope width. Under natural, undisturbed conditions, slopes do not tend to exist as straight featureless gradients but exhibit variability in terms of form and configuration. Based on the geologic history, parent materials, and environmental setting in which they develop, slope profiles are configured in a manner that promotes the stability of slope materials. The CPB surface elevations generally range from 3 feet (1 meter) (near the coast) to 344 feet (105 meters) AMSL.

3.4 GEOHYDROLOGY

The disposition of rainfall on the lands of the CPB is generally characterized by collection in surface water impoundments, discharge into streams that flow toward the Gulf of Mexico, return to the atmosphere through evaporation and plant transpiration, and infiltration into the soil and replenishment of subsurface aquifer systems that serve as the area's primary source of freshwater. This examination of subsurface hydrology is focused on characterizing the CPB Surficial Aquifer, Intermediate System, and the Floridan Aquifer.

3.4.1 Aquifers

The Surficial Aquifer (SA) or water table aquifer includes the uppermost subsurface layers that contain groundwater in unconfined conditions (water table) and semiconfined conditions (under pressure) in the lower portion of the aquifer. Water tables are recharged locally, and the height of the water table fluctuates in direct response to rainfall; a small amount of recharge from the Floridan Aquifer (FA) occurs in areas where the FA is higher than the SA system. Conversely, the SA may act as a recharge source in areas where the SA is higher than the FA system. The shape of SA surface generally follows the profile contours of the land surface and continually moves downgradient from areas of recharge to discharge. Water discharges in the form of a seep or spring.

The SA system is in direct contact with surface waters such as streams and wetlands. Because of the confining nature of the underlying Intermediate System (IS), recharge of the SA tends to flow laterally in a down gradient direction towards the entrenched valleys and steephead slope stream systems that are characteristic of some portions of the CPB. Discharge of groundwater constitutes the baseflow for most CPB rivers and streams (Vecchioli et al., 1990; Rosenau, 1977).

The IS below the SA is primarily composed of Alum Bluff and Intracoastal Formation sand, clay, and shell materials that generally thicken from west to south. The IS effectively retards the exchange of water between the SA and FA systems. The IS within the CPB generally occurs as a thin layer with minimal SA water-bearing capacity or limited confined water conditions. At times, the IS is comparable chemically to the FA because of the similar water carbonate composition (Schmidt, 1984).

Underlying the IS is the FA system. Within the CPB, the relatively thin, semiconfined FA is primarily composed of the Chattahootchee, Marianna/Suwannee Limestone, and Ocala Limestone Formations. The FA thickness ranges from approximately 150 feet of Ocala Limestone near the Alabama border to 700 feet of Marianna, Suwannee, and Chattahootchee Formations as the aquifer plunges southward. Along the Choctawhatchee River, the top of the FA is about 100 feet AMSL and thinly confined. In areas of aquifer recharge, particularly within the vicinity of the Ocala Uplift and along the Choctawhatchee River, the FA may exit under groundwater conditions near or at the ground surface. The semiconfined condition of the aquifer creates extensive areas of recharge and corresponding potential exposures to surface contamination. The FA serves as the primary source of consumptive-use water (Campbell, 1993; Scott, 1993; Moore, 1955; and Vernon, 1942).

3.4.2 Springs

In contrast to groundwater seepage, springs are classified as localized points of subsurface water discharge through fissure-type vents or diffuse upward percolation of water into pools and spring runs. There are 12 springs that have been identified within the CPB (Figure 3-4 and Table 3-4). The springs are classified based on the magnitude of water discharge measured in cubic feet per second. Examples of CPB springs are shown in Figures 3-5 and 3-6.

CPB springs are distinct points of exposure of the FA system, which makes them highly susceptible to impact from anthropogenic activities. Land use disturbances or water drawdowns in proximity to springs can directly impact hydrologic parameters of the spring and expose the FA to potential chemical contamination. The water quality of spring discharge is directly related to the water quality of the FA system (Barrios, 2005).

Table 3-4. Choctawhatchee-Pea Basin Springs

Name	Magnitude	County	Description
Morrison Spring	2nd	Walton	The broad spring run vent is located 0.7 mile west of the Choctawhatchee River near a county-managed recreation area.
Natural Bridge Rise	2nd		The spring discharges from a broad vent opening in Bridgeboro/Marianna limestone formation. The spring pool diameter is approximately 20 feet. A 30-foot-wide karst window is located on the west side of Natural Bridge Road and discharges flow to the east as Natural Bridge Creek.
Pleasant Ridge Seep Spring	*		This seep spring is located approximately 2.6 miles southwest of De Funiak Springs and emerges from the base of a 25-foot bluff in the Citronelle Formation just below the grade for Hewitt Road.
Vortex Spring	2nd	Holmes	This is a privately operated recreation area; the 0.4-mile spring run discharge into Blue Creek.
Ponce de Leon Spring	2nd		The spring is located on the grounds of the Ponce de Leon Springs State Recreation Area; the 660-foot spring run, into Sandy Creek (Figure 4-5).
Jackson Spring	*		It is located below Ponce de Leon Springs south of Interstate 10 and is surrounded by the floodplain of Sandy Creek.
Thundering Spring	6th		It is located on the west bank of Windmill Branch 0.7 mile north of West Pittman Creek and consists of sand boils in a shallow 6-foot-wide pool.
Pate Spring	4th		The spring run has been impounded to create a small private pond; the spillway waters flow 0.25 mile into Little Creek.
Holmes Blue Spring	2nd		This spring is located a few hundred feet from the Choctawhatchee River and discharges from an opening in the limestone into a 40-foot-wide pool (Figure 3-6).
Wrights Blue Spring	*		The spring vent is located adjacent to private property at the southern end of a 200-foot-wide pool on the north side of Wrights Creek 0.6 mile from its confluence with the Choctawhatchee River; it is frequently flooded by Wrights Creek.
Hidden Spring	*		This spring is located in a karst outcrop of the Ocala Limestone on the east bank of Wrights Creek. The discharge vent is in proximity to two sinkholes along the streambank.
Potter Spring	2nd	Washington	This limestone spring vent is located on Mill Branch north of Mill Lake; located on private property (Figure 3-6).
Washington Blue Spring	2nd		The spring is located 0.8 mile south of the confluence of the Choctawhatchee River and Holmes Creek; spring discharges from a 10-foot-wide vent beneath a limestone ledge; located adjacent to private property.
Blue Run Spring	*		The spring vent discharge is located north of Washington Blue Spring.

Source: Barrios, 2005
2nd Magnitude = >10 to 100 cubic feet per second; 4th Magnitude = >0.22 to 1 cubic foot per second; 6th Magnitude = 1 to 10 gallons per minute
* Discharge could not be measured during the survey.

In addition to the major springs described above, numerous low-order discharge springs were identified as the headwaters for many small perennial streams within the CPB watersheds. These tributary branches provide relatively constant water flows that feed many of the CPB stream systems. During the watershed field surveys, there were several instances where unpaved roads crossed spring tributaries within tens to hundreds of feet of the spring ground discharge point. The impacts of waterway crossings on the geomorphology and water quality of these relatively low energy streams can be significant. Examples of these spring systems are presented in Figure 3-7.



Figure 3-4. Choctawhatchee-Pea Basin Springs (David Rubino)



Figure 3-5. Ponce de Leon Spring and Natural Bridge Rise (Mike Rainer)



Figure 3-6. Potter Spring and Holmes Blue Spring (Northwest Florida Water Management District)



Figure 3-7. CPB Culvert Crossing Spring Discharge and Stream Run (Mike Rainer)

3.5 SURFACE HYDROLOGY

Surface water resources provide crucial functions such as wildlife habitat, water quality, floodwater retention, and recreation that are important to the diversity and integrity of the overall environment and society as a whole. Maintaining biodiversity requires protecting, restoring, and managing habitats, reducing threats, and assisting in the recovery of endangered and threatened species. The fact that 9 out of 10 registered voters in the United States believe that aquatic resources are important to their future speaks to the importance of understanding and conserving the diversity of unique hydrologic features in Northwest Florida (Sosin, Snell, Perry, and Associates, 1998). The following subsections discuss alluvial streams, wetland drains and outlets, steephead streams, wetlands, beaver ponds, riparian zones, and anthropogenic features. CPB hydrology is illustrated in Figure 3-8.

3.5.1 Alluvial Streams

Streams are collection corridors where water discharges from surface and/or groundwater sources and drains into defined channels. Streams include natural channels created by the erosive energy of concentrated water flows and artificial channels constructed by dredging natural streams or excavating new channels. Stream corridors are complex, biologically productive ecosystems that provide a diversity of functions, including modulating stream flow, storing water, removing harmful materials from water, and providing habitat for flora and fauna. Because of the extensive interaction with adjacent lands, streams are also susceptible to impacts caused by changes in land use and introduction of sediments and other pollutants. Streams within the CPB are generally classified as alluvial streams, which are waterways composed of sandy clays and clayey-silty sands that originate in upland areas.

Alluvial streams may become turbid due to relatively high content of soil, detritus, and organic particulates. As a result, water quality generally fluctuates with seasonal rainfall. Because of the diverse range of flow rates and sediment loads, alluvial channel water depths vary considerably between low and high/flood flow stages. Some alluvial streams have extensive floodplains that are inundated during flood events. The highly productive wetland floodplain communities nourished by floodwaters support a diversity of flora and fauna, including rare and imperiled species.

The alluvial valleys of primary Choctawhatchee River tributary streams such as Holmes, Sandy, and Pine Log Creeks have evolved as a result of the solution of underlying beds of limestone. Since many of these streams are fed by spring seepage, they naturally carry little sediment except during periods of heavy rainfall. Stream channels are generally characterized by channel outcrops of Tertiary sediments and streambanks topped with alluvial veneers overlying Tertiary sediments. Natural levee systems are generally limited to small streambank ridge formations adjacent to narrow swampy flats.

In the lower portions of the Choctawhatchee River, the gradient is 1.4 feet per mile; the gradient increases to approximately 2.5 feet per mile toward the headwaters in Alabama. Typically, floodplain deposits in the lower sections of the river are up to 30 feet thick, whereas, deposits near the Alabama line are characterized as relatively thin sediment veneers. The more rapid alluviation of the river creates natural dam features that decrease the gradients of some inflowing tributaries and results in the formation of numerous swamps, ponds, and lakes. In some areas, the Choctawhatchee River floodplain is 15 feet higher that the floodplains of its tributaries (Vernon, 1942).

CPB alluvial streams are generally classified as blackwater or clearwater streams, based on water clarity. These stream types are discussed in the following sections.



Figure 3-8. Choctawhatchee-Pea Basin Surface Drainage (David Rubino)

3.5.1.1 Blackwater Streams

These waterways originate from the slow release of waters from sandy lowland swamp and bog wetlands areas. The resulting stream flows are laden with tannins, particulates, dissolved organic matter, and iron-creating, tea-colored waters from which this type of stream gets its name (Figure 3-9). Typically, these streams have an acidic pH (3.8 to 6.0) but can become slightly alkaline during low flows. They are naturally low-nutrient systems that are vulnerable to increases in nutrient loading. Emergent and floating vegetation occur along shallower and slower-flowing stream segments. Streambank heights range from high to low. The high, steep streambanks that characterize some blackwater streams confine water flows except during flooding (Wolfe et al., 1988; FNAI, 1990).



Figure 3-9. CPB Blackwater Streams (Mike Rainer)

3.5.1.2 Clearwater Streams

Clearwater seepage streams are perennial, intermittent, or ephemeral waterways originating from shallow groundwaters that have percolated through deep, sandy, upland soils. These streams generally occur in portions of Northwest Florida where topographic relief is pronounced and most often occur as the headwaters for many alluvial stream systems. These streams normally exhibit perennial flow regimes, relatively shallow and narrow sandy bottoms, and clear to slightly colored waters that remain at a fairly constant temperature of 70ºF (Figure 3-10). The introduction of large sediment loads or development of extensive swamps and marshes that diminish water clarity and alter flow regimes initiates reclassification of the seepage stream as a blackwater stream. Other unique ecosystems associated with clearwater streams include seepage slope bogs and steepheads (Wolfe et al., 1988).



Figure 3-10. CPB Clearwater Streams (Mike Rainer)

3.5.2 Wetland Drains

A wetland drain is a small stream within a confined channel that typically accepts overflow from a swamp, shrub/scrub wetland, beaver impoundment, depression, or other water residence feature. These streams generally have a relatively shallow channel configuration and serve as primary conduits for moving water between wetlands and other stream networks (Figures 3-11). Water flow regimes are highly dependent on rainfall cycles; during drought periods, these streams may function as ephemeral channels or contain reaches of ponded water.



Figure 3-11. CPB Crossing Wetland Drains (Mike Rainer)

Because of their prominent occurrence in bottomlands and low-relief areas, drains often exhibit low water flow energies, which make them highly susceptible to stream crossing sedimentation. An exception to this characteristic is the wetland drain outburst flooding that may occur during the catastrophic failure of an impounding beaver dam or constructed pond earthen dam. These events can result in significant changes in stream channel profiles through aggradation and degradation of the streambed.

3.5.3 Steephead Streams

Steepheads are self-sustaining ecosystems created from the bottom up by a process known as spring sapping. These unique natural formations are a product of valley-head erosion caused by headwall slumping. Their formation begins with soil erosion at the point of groundwater discharge. The sandy clays near the surface remain vertical while the underlying softer sands near the spring wash away; undermining causes overburden to slump. As headwater stream channels develop, new groundwater discharge points are created. Since the groundwater medium is not homogenous, zones of higher discharge concentrate outflow and increase the rates of erosion. Steephead spring elevations generally range from 20 to 210 feet AMSL. It is estimated that active steepheads migrate at a rate of 1 to 2 inches per century (Wolfe et al., 1988).

The headcutting and slumping of overburden by the action of the deep, lateral spring headcuts creates semicircular box canyon bluffs with steep sideslopes; in many cases, steephead slope gradients exceed 50 percent (Figure 3-12). The depth of the steephead from the plateau ranges from 20 to 100 feet (normally between 50 and 70 feet) depending on the depth at which the springs emerge (Schmidt, 1984; Wolfe et al., 1988).



Figure 3-12. CPB Steephead Box Canyon Slope and Stream (Mike Rainer)

The spring-fed sand bottom steephead streams support wetland ecosystems (Figure 3-12) between the stream and the outward slopes that may be occupied by state-listed plant species such as Alabama spiny-pod (*Matelea alabamensis*), Baltzell's sedge (*Carex baltzellii*), Florida anise (*Illicium floridanum*), sweet pitcher-plant (*Sarracenia rubra*), spoon-flower (*Peltandra sagittifolia*), and panhandle lily (*Lilium iridollae*) (FNAI, 1990). The microclimates within these box canyons support vegetation similar to the ravines of the southern Appalachians (Wolfe et al., 1988).

Steepheads within the CPB are typically between 100 and 200 feet wide and primarily occur at the confluence of recent drainage with relatively high land areas having thick deposits of terrace sands. Vernon (1942) reported that in Washington County, steephead gradients range from steep sloped gullies to typical vegetated steephead slopes and that the overall amphitheater configuration of steephead features was generally governed by the positions of the

springs that produce the steephead feature. Because of their steep sideslopes, steephead features are highly susceptible to human-induced surface erosion (Figure 3-13). An inventory of CPB steephead features was unavailable at the time of this study.



Figure 3-13. Eroded Steephead Slopes, Santa Rosa County, Florida, 1930 (Florida State Archives) **and Recent Steephead Gully Created by Road Runoff** (Mike Rainer)

3.5.4 Wetlands

Wetlands are vital to the quality of life in Northwest Florida; they store floodwaters, recharge the aquifer, filter pollutants, and provide wildlife habitats. The CPB contains an abundant diversity of wetland systems that also serve as the first stopping point for migratory birds coming from the Southern Hemisphere. CPB wetlands typically occur at lower elevations within stream and river floodplains and along mid- to lower portions of slopes. Primary wetland types include riverine, lacustrine, and palustrine. Riverine systems are wetlands and deep-water habitats contained within channels, with the exception of wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens and habitats with water containing ocean-derived salts. Channels include natural (streams and rivers) and human-constructed conduits (large ditches and channels) that exhibit ephemeral, intermittent, or perennial flow that are bounded by uplands, channel banks, or other wetlands.

Lacustrine systems are tidal or nontidal wetlands and deepwater habitats including depressions or dammed river channels as well as wetlands lacking trees, shrubs, persistent emergents, emergent mosses, or lichens but with 30 percent areal coverage and greater than 20 acres in size. Lacustrine systems, such as permanently flooded lakes and reservoirs, are bounded by uplands or other wetland systems.

Palustrine systems are typically nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens; in some cases, tidal wetlands may be included in the classification (Figure 3-14). Examples of palustrine wetlands include bogs, floodplain swamps, and marshes (Cowardin et al., 1979).

Notable geomorphic features of Northwest Florida and the CPB are the flat-surfaced marshes, bogs, and swamps called perched ponds (Figures 3-15). Many of these wetland systems are isolated and are not directly connected with waters of the state. These natural features can range from less than 1 acre to over 1 square mile in size. Perched ponds are normally relatively shallow and may exhibit circular or irregular configurations. Because of their position on the landscape, small streams (wetland drains) often interconnect these systems. These features primarily formed as a result of dissolution of subsurface calcium carbonate depositions that lowered the surface (Schmidt,

1984). The hydrology of perched ponds may fluctuate with wet and dry seasons; during drought periods, the system may be void of surface waters. Alterations in hydrology could adversely affect the value and use of this unique habitat type. These ponds also provide valuable habitats for rare and imperiled plants and animals.



Figure 3-14. CPB Palustrine Wetlands (Mike Rainer)



Figure 3-15. CPB Perched Pond Wetlands (Mike Rainer)

One of the rarest assemblages of plants, and particularly carnivorous plants, occurs within the seepage slopes of the southeastern United States. These wetlands are generally confined to the Lower Gulf Coast Plain from the Apalachicola River in the east to the Tangipahoa River in the west and up to 100 kilometers inland. While more than 100 plant species have been identified in these environments, the plant species diversity in Northwest Florida seepage slopes has been as high as 300 species, which makes Florida seepage slope bogs one of the most unique ecosystems in the world. The abundance and diversity of many state listed threatened pitcher plants (*Sarracenia purpurea*, *S. psittacina*, and *S. rubra*) are highest within these seepage slopes. It is estimated that 97 percent of Northwest Florida seepage slopes have been lost (Wolfe et al., 1988).

A seepage slope bog or pitcher plant bog is a small, grass/sedge/forb dominated wetland occurring along a gentle slope intersection of the horizontal water table over a broad area (Figure 3-16). Seepage slopes primarily form along hillsides or in bowl shaped depressions. They occur on slopes with constant seepage from a perched water table

where the ground is saturated but rarely inundated. Subsurface clay layers restrict downward percolation and create lateral groundwater flows that emerge at mid- to lower slope positions and create saturated soil conditions. The water produced by hillside seeps flow gently downslope over the surface. Seepage slopes communities normally occur on slopes of less that 20 percent and, in some instances, the slope is barely discernable.



Figure 3-16. CPB Seepage Slope Bog (Mike Rainer)

Although defined as wetlands, seepage slope bogs can experience soil moisture gradient extremes. During periods of wet weather, seepage is normally continuous, which keeps the soil saturated; however, during droughts the soil may become quite dry. Typically, soils are nutrient poor, acidic, loamy sands with high organic content. The organic layers that accumulate on the surface vary from a few inches to several feet thick. Seepage slopes are characterized by high acidic pH that generally ranges from 3.5 to 5.0. Species that persist in seepage slope habitats exhibit adaptations to low nutrient soils and drastic changes in soil moisture that give them a competitive edge over other species. Seepage slopes frequently contain a diversity of wetland plants, including a number of carnivorous species such as pitcher plants (Wolfe et al., 1988).

Historically, land development, agriculture, and silviculture have contributed to the direct loss of wetlands. The effects of urbanization and road construction have also affected wetland hydrology and the spatial extent and configuration of wetlands. In 2001, a U.S. Supreme Court ruling resulted in the rolling back of federal regulations that protected isolated wetlands. In response, the U.S. Army Corps of Engineers limited its wetland permit jurisdiction to nonisolated wetlands that touched navigable waters (Ziewitz and Wiaz, 2004).

3.5.5 Sloughs and Bayous

As a consequence of relatively low gradients, some areas of the CPB support a diversity of slough wetlands. These waterways are defined as natural surface-water features that have discernable flow regimes but do not have a defined stream channel configuration (Figure 3-17). Over the course of geologic time, these features have transitioned between active stream channels and backwater wetlands. Sloughs may experience water drawdown periods during droughts, which can lead to the development of extensive bottomland hardwood forests. Bayous are also low-gradient wetland features that are geomorphologically similar to sloughs, except bayous have a discernable channel with flow generated by tide, spring, or stream discharge.



Figure 3-17. CPB Wetland Sloughs (Mike Rainer)

3.5.6 Beaver Ponds

Beaver dams are naturally engineered features that impound water. These dams often create small ponds that can cover several acres. Within the CPB, extensive beaver activity was identified in all the surveyed watersheds; dam features were identified at culvert as well as bridge water crossings. Changes in stream gradients created by culvert structures or heavy siltation that characterize many CPB crossings provide conditions favorable for building dams. Some culvert structures are also easily plugged by beavers, which provide a backup system to manage water flow in case of a blowout of the main upstream dam.

Depending on prevailing conditions, beaver dams may be less than 1 foot to several feet high and a few hundred feet long. A relatively small dam structure made of logs, sticks, grass, and mud may be sufficient to create a large impoundment in relatively level landscapes with low water flow gradients. Beavers often build a system of tiered dams that work collectively to build and maintain the largest pond possible. Although beaver dams are purposely constructed to gently leak and survive limited overtopping, catastrophic dam failures can occur and damage roads and crossing structures. Examples of CPB beaver dams and impoundments are presented in Figure 3-18.



Figure 3-18. CPB Crossing Beaver Dams (Mike Rainer)

3.5.7 Riparian Zones

Derived from the Latin word *riparious* meaning "streambank" or "life on a streambank," riparian zones (RZs) generally refer to lands that are adjacent to waterbodies. Federal and state agencies often use a minimum width to designate riparian management areas as exemplified by Streamside Management Zone buffers used in forestry. The definitions of a riparian area are as broad and diverse as are its users (Ilhardt et al., 2000). For the purposes of this review, RZs are defined as the wetlands, floodplains, terraces, and/or terrestrial drainage slopes that occur along waterbodies at variable widths. RZ buffers generally occupy ecosystem transitional areas adjacent to streams, rivers, and lakes, including related tributaries, feeder streams, and wetlands (Figure 3-19).



Figure 3-19. CPB Stream Riparian Zones (Mike Rainer)

The width of an RZ is primarily a function of stream and terrestrial geomorphology (Gregory and Ashkenas, 1990). For waterways with extensive floodplains, RZs can be quite broad, extending several hundred feet from the channel, whereas narrow, deeply incised channels with limited floodplain areas may have RZs tens of feet wide. As an example, alluvial headwater seepage streams generally have less extensive RZs compared to larger alluvial blackwater streams. RZ vegetation is usually dependent on floodwater inundation characteristics and soil moisture conditions.

RZs are important landscape connectivity features that link various types of terrestrial, wetland, and aquatic ecosystems. They are often arranged in branching networks that extend through forest and grassland ecosystems and contain repeating patterns of flora, fauna, and habitats. RZs provide important seasonal habitats and migration routes for wildlife; routes of plant dispersal also tend to follow RZs because of seed transport by animals and flowing water. These corridor features frequently survive wildfire and windstorm disasters because of their wet and biologically diverse characteristics, yet host some of the most fragile forest ecosystem types. RZs also filter and assimilate nutrients for surface and groundwater flows before they reach the waterway (Gregory and Ashkenas, 1990; Ilhardt et al., 2000). Other RZ attributes include water flow dispersion and energy dissipation, sediment and toxic material retention, and groundwater discharge and recharge (Roads/Riparian Restoration Team, 2002).

3.5.8 Anthropogenic Drainage Features

Human management of surface drainage is generally characterized by two important principles: water conveyance and storage. In natural systems, if conveyance is limiting, then storage capacity adjusts to establish a relative equilibrium with available conveyance. In contrast, man-made drainage systems are designed to minimize storage and maximize conveyance (Hey, 2001). Over the last 100 years, the forms, functions, and integrity of CPB water storage and conveyance features have been significantly altered by human intervention.

To accommodate land use requirements for agriculture, silviculture, urbanization, industrial, or other uses, water management features were frequently constructed or mechanically altered to store water in designated locations or expedite the removal of surface and subsurface water. Historically, water storage ponds and lakes were constructed to not only provide water for livestock and recreation but to reduce downstream flood potentials. Ditch and canal systems were designed to collect as much water as possible and move it quickly off-site to a wetland or stream discharge point. A common by-product of constructed drainage systems is accelerated erosion and sedimentation. Channels were typically configured as straight-line features with little or no sinuosity to reduce the erosive energy of water flows, and the channel banks were relatively steep and frequently unvegetated, which made them highly prone to erosion. CPB anthropogenic water management features discussed in this subsection include private ponds, ditches and canals, stream crossing cleanouts, and gully systems.

Ponds have been constructed on numerous private land holdings primarily as a source of water for cattle or crop irrigation and/or recreational purposes. These artificial impoundments were generally established by constructing an earthen dam across a stream channel and reworking stream slopes to increase storage capacity and access. Various types of spillway structures were installed to allow for water overflows without compromising the integrity of the dam. Streams below pond dams crossed by roads require a culvert or bridge structure to facilitate passage of waterflows. Depending on the source of water, streamflows may exhibit perennial or ephemeral characteristics. In some cases, dam and spillway structures have exceeded their life cycles or exhibit evidence of damage or disrepair. Blast water flows that occur during dam failures can extensively damage crossing structures and stream channels. Private pond locations, features, or condition data was not available for this assessment.

Land use and flood control drainage is typically achieved through the construction of new open channels or the modification of existing streams through channelization (mechanical straightening of existing streams) or channel dredging (Figures 3-20 to 3-24). Channel straightening reduces total channel length over a set change in elevation and results in an increase in channel slope. As channel slopes increase so do the potentials for upstream channel erosion.

Ditch systems most often occur in low, relatively flat areas where there is a convergence of surface runoff or near-surface groundwater. These drainage features are primarily designed to create channels with high water-carrying capacity that minimize surface and groundwater saturated conditions by expediting the removal of water following prolonged or intense rainfall (Vaughan, 2005). Some ditches that do not intercept groundwater may be classified as ephemeral or intermittent channels.

Constructed drainage features within the CPB also include channels within urban or high-density residential areas that function to minimize flood damage during intense storms. The increased use of impervious concrete and asphalt that often accompanies development increases surface runoff and the potential for flooding. Flood control channels typically have high bankfull capacities to accommodate flash flow events.



Figure 3-20. CPB Channelized Stream Reaches (Mike Rainer)



Figure 3-21. CPB Residential Area Flood Control Canals (Mike Rainer)



Figure 3-22. CPB Constructed Drainage Ditches (Mike Rainer)



Figure 3-23. Historic and Recently Constructed CPB Agricultural Drainage Ditches (Mike Rainer)



Figure 3-24. CPB Channelized Streams Within CPB Silviculture Areas (Mike Rainer)

3.6 LAND USE AND LAND COVER

Anthropogenic influences on the composition and patterns of vegetative communities are inherently linked with the density of occupying human populations and their use of technology. The term *land use* designates features of the human-built environments that include transportation, residential, commercial, and other developed land areas whereas, *land cover* defines vegetative and hydrologic features such as forests, grasslands, and waterbodies. As discussed in Section 2.3, the patterns of CPB land use/land cover are a result of cultural and natural influences. The most significant changes occurred with the development of road networks, establishment of communities, clearing of forests, draining of wetlands, and establishment of urban areas. The type, magnitude, and distribution of land use practices are critical factors influencing natural resource management (Turner, 1990). The water quality, hydrology, and stability and character of regional ecological systems largely depend on land use and the types and proportions of land cover (Gosselink et al., 1989).

Since European settlement, the CPB has transitioned from a landscape influenced by natural disturbance such as fire, succession, and geologic erosion to varying levels of human-induced disturbances such as vegetation removal, introduction of invasive species, wildfires, soil excavations and plowing, soil compaction, accelerated erosion, stream channelization and dredging, construction of impervious surfaces, and other variables. Modifications of terrestrial and aquatic ecosystems have direct and potentially long-term effects on the environment and its capacity to recover from disturbances. The current land uses and land cover vegetation of the CPB are shown in Figures 3-25 and 3-26 and listed in Table 3-5.

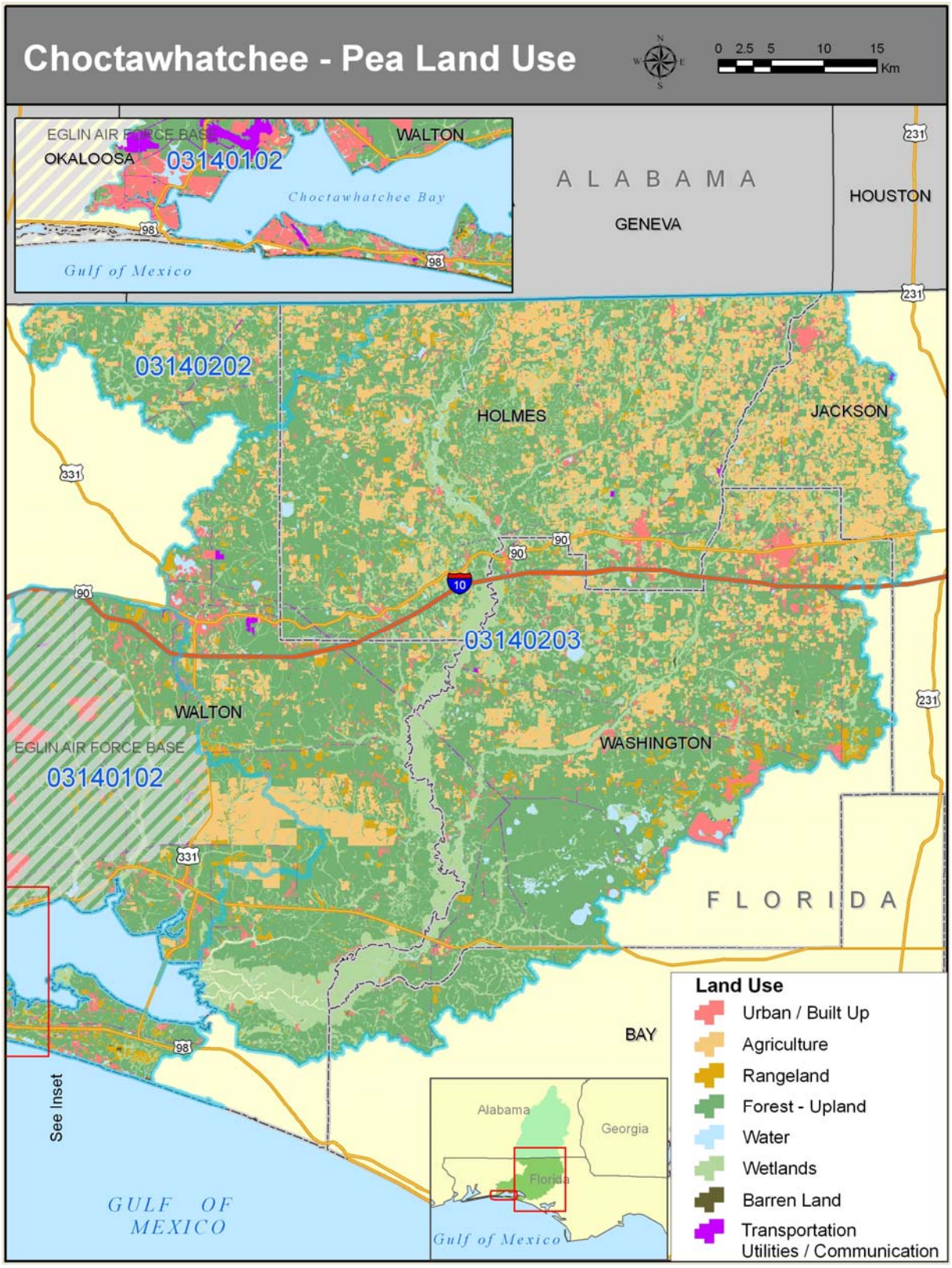


Figure 3-25. Choctawhatchee-Pea Basin Land Use (David Rubino)

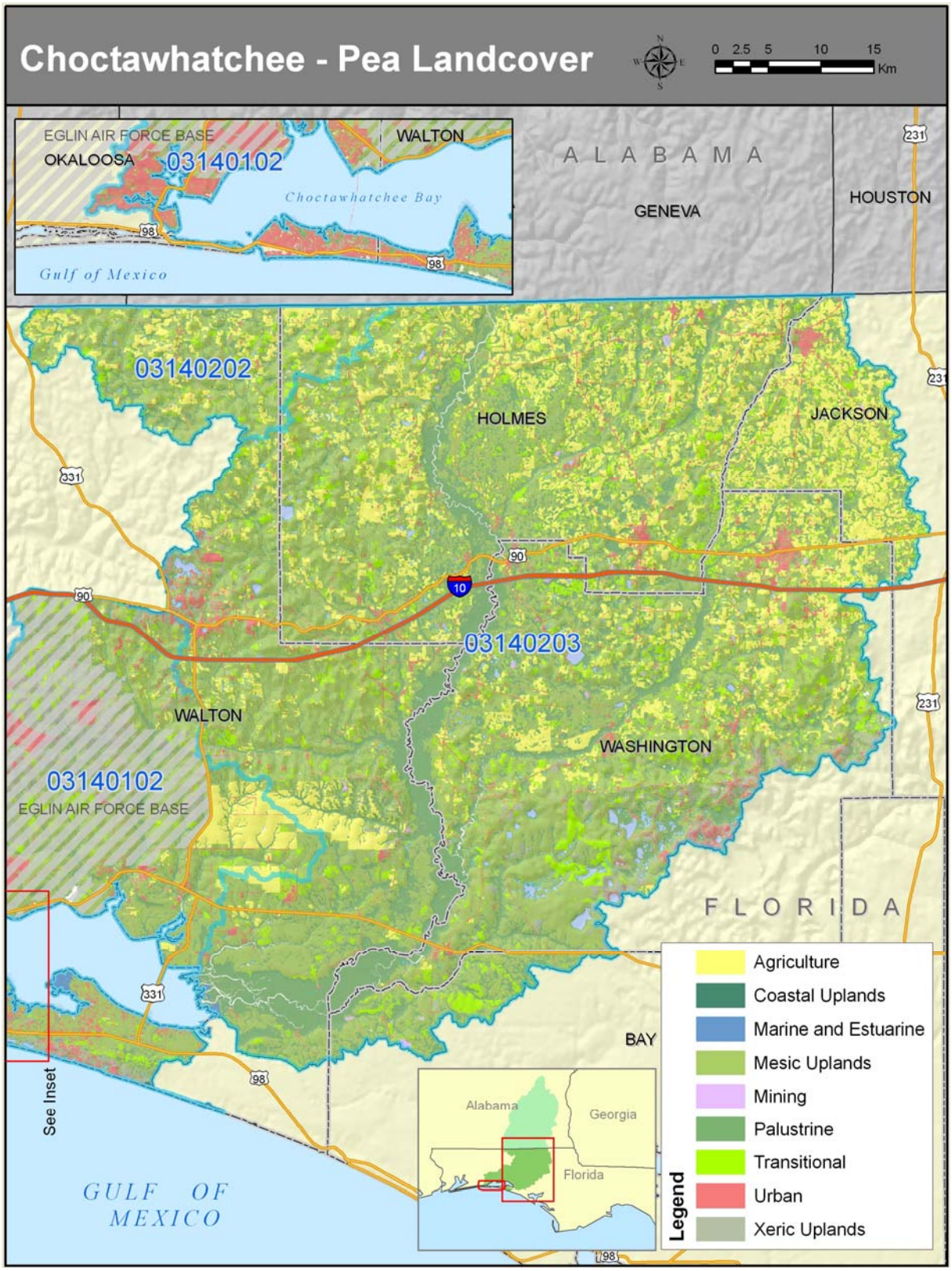


Figure 3-26. Choctawhatchee-Pea Basin Land Cover (David Rubino)

Table 3-5. Choctawhatchee-Pea Basin Land Use Summary

Classification	CPB Land Area	
	Acres	Percent
Land Use		
1000 – Urban and built-up	83,302	6.25
2000 – Agriculture	197,249	14.79
3000 – Rangeland	35,199	2.64
4000 – Upland forests	775,409	58.13
5000 – Water	19,896	1.49
6000 – Wetlands	206,676	15.50
7000 – Barren land	1,905	0.14
8000 – Transportation, communications, and utilities	14,186	1.06
Total	**1,333,824**	**100.00**
Land Cover		
Beach/Sand	1,527	1.26
Coastal Stand	447	0.37
Mixed Hardwood-Pine Forests	26,706	22.06
Sand Pine Scrub	1,655	1.37
Pine Sandhill	89,660	74.08
Xeric Oak Scrub	1,045	0.86
Total	**121,039**	**100.00**

As shown in Table 3-5, upland forests (58 percent), wetlands (16 percent), and agriculture (15 percent) land uses and longleaf pine sandhills (74 percent) and mixed hardwood-pine forests (22 percent) land cover are predominate within the CPB. Generally, CPB native wetland and upland vegetation community types include:

- Herb (*Drosera* spp., *Sarracenia* spp., *Pinguicula* spp.) and shrub (*Cyrilla racemiflora*, *Myrica* spp., *Ilex* spp., *Clethra alnifolia*, *Lyonia lucida*, *Leucothoe racemosa*) seepage bog wetlands
- Savannah wetlands (*Verbesina* spp., or *Pleea tenuiflora*, or *Pinus elliottii*, *Cyrilla* spp. *Taxodium distichum*, *Magnolia virginiana*, *Myrica cerifera Ilex* spp.)
- Black Titi (*Cliftonia monophylla*), swamp Titi (*Cyrilla racemiflora*), and bay (*Magnolia virginiana, Persea borbonia, Gordonia lasianthus, Quercus* spp*., Liquidambar styraciflua, Acer rubrum, Chamaecyparis thyoides*) swamp wetlands
- Bottomland hardwood (*Nyssa* spp., *Taxodium distichum*, *Fraxinus caroliniana*, *Liquidambar styraciflua*, *Quercus lyrata*) forest wetlands
- Longleaf pine (*Pinus palustris*) clayhill and sandhill forest uplands
- Mixed hardwood (*Quercus* spp., *Fagus grandifolia*, *Magnolia grandiflora*)-pine (*Pinus* spp.) climax forest uplands
- Sand pine (*Pinus elliottii*) and xeric oak (*Quercus* spp.) scrub uplands (Wolfe et al., 1988).

Changes to landscape hydrologic systems include altered surface drainage patterns and water flows, reduced water infiltration and percolation through the soil, increased impervious land surfaces, lowering of the water table, increased flooding, shifts in vegetative succession, accelerated rates of soil erosion and waterway sedimentation, and introduction of chemical pollutants. Long-term hydrologic impacts are generally determined by the runoff from small, low-frequency storms. The scale and character of ecosystem impacts are dependent on the form and scale of land use change (Bhaduri et al., 2000). The lowering of groundwater associated with long-term land use changes was apparent during recent CPB crossings field reconnaissance surveys. Many streams and wetland systems exhibited evidence of altered flow regimes and extended dry conditions that promoted extensive in-stream vegetation growth and development. These waterway conditions were most apparent in agricultural landscapes.

As a consequence of drastic increases in population, extreme pressures are being exerted on the uses of urban and suburban lands throughout Florida, including the counties within the CPB. One potentially significant impact of land development is the inevitable increase in impervious surfaces, which can directly impact watershed hydrology (Exum et al., 2005). Urban sprawl into suburban areas can have dramatic effects on ecosystems and place increased demands and pressures on transportation networks and other infrastructure components.

3.7 LAND CONSERVATION

The CPB contains private, state, and federal lands that are managed to protect and conserve valued natural resources. These areas comprise approximately 25 percent (274,314 acres) of the CPB. The majority of study area conservation lands are adjacent to the Choctawhatchee River. Waters of the state identified by the Florida Environmental Regulation Commission as worthy of special protection are designated as Outstanding Florida Waters (OFWs). This designation signifies waters that have exceptional ecological and/or recreational significance requiring maintenance of water quality standards as defined by the federal Clean Water Act.

Over the past 40 years, Florida has invested approximately $7.1 billion to protect about 3.7 million acres of land. Programs instrumental in the success included the Environmentally Endangered Lands (EEL), Outdoor Recreation, Save Our Coasts, Save Our Rivers, Conservation and Recreation Lands, and Preservation 2000. Most recently, the Florida Forever Program is being used to greatly expand environmental and cultural resource preservation, conservation, and restoration.

Florida Forever, as implemented by the Florida Legislature in 2000, invests $3 billion over 10 years to actively protect and conserve Florida's natural and cultural heritage, improve water resource development and supply, increase public access to public lands, provide open urban spaces, increase land protection through the acquisition of conservation easements, and improve the management and maintenance of acquired state lands. The state's land acquisition program works in cooperative partnerships with local, city, county, and federal governments and organizations to acquire and properly manage lands to meet natural and/or cultural resource protection and conservation goals. A summary of CPB study area natural resource protection and conservation lands is listed in Table 3-6 and shown in Figure 3-27.

OFWs, as defined in the Florida Administrative Code (62-302.700 F.A.C), include surface waters that have been classified by the state as having natural attributes and/or good water quality that is worthy of special protection. Examples include special waters (waterbodies that exhibit exceptional recreation or ecological significance), aquatic preserves, waters within state and national parks, EEL purchases, estuarine reserves, and other park and recreation types. Most OFWs are managed by federal or state agencies as parks, refuges, preserves, sanctuaries, memorials, wilderness areas, or research reserves. Figure 3-27 shows OFWs within the CPB.

Table 3-6. Choctawhatchee-Pea Basin Natural Resource Protection and Conservation Lands

Type	Identification	Subbasin HUC (Acres)	
		03140102	03140203
Bay County			
Florida Special Waters	Choctawhatchee River	–	1,910
Florida Natural Areas Inventory (FNAI) Managed Areas	Choctawhatchee River Water Management Area		1,162
	Pine Log State Forest		5,258
FWCC (Florida Wildlife Conservation Commission) Areas	Not Designated		316
	Wildlife Management Area (Hunting And Land)		22,118
		Bay Total	**30,764**

Table 3-6. Choctawhatchee-Pea Basin Natural Resource Protection and Conservation Lands Cont'd

Type	Identification	Subbasin HUC (Acres) 03140102	03140203
Holmes County			
Florida Special Waters	Choctawhatchee River	—	24,544
Outstanding Florida Waters	Ponce De Leon Springs State Recreation Area		314
FNAI Managed Areas	Choctawhatchee River Water Management Area		13,420
	Ponce De Leon Springs State Park		262
	Holmes Total		**38,540**
Walton County			
Florida Special Waters	Choctawhatchee River	58	29934
Outstanding Florida Waters	Eden State Gardens	1	—
	Grayton Beach State Recreation Area	740	
	Point Washington	11,230	5,774
	Ponce De Leon Springs State Recreation Area	—	112
	Topsail (Designation Undetermined)	1478	—
	Topsail Hill	255	
FNAI Botanical Areas	Florida's First Magnitude Springs Florida Forever Botanical Project (BP)	—	214
	North Nokuse Plantation Florida Forever BP	5,527	6369
	South Walton County Ecosystem Florida Forever BP	13,171	—
FNAI Managed Areas	Choctawhatchee River Delta Preserve	49	3135
	Choctawhatchee River Tract	—	3
	Choctawhatchee River Water Management Area	3533	25518
	Coffeen Nature Preserve	218	—
	Eden Gardens State Park	85	
	Grayton Beach State Park	747	
	M. C. Davis Conservation Easement	439	1,253
	Morrison Springs Recreational Facility	—	159
	Nokuse Plantation Conservation Easements		18,838
	Point Washington State Forest	8,522	—
	Ponce De Leon Springs State Park	—	121
	Stallworth Lake Preserve	2	—
	Topsail Hill Preserve State Park	1,599	
FWCC Areas	Not Designated	215	
	Wildlife Management Area (Hunting and Land)	9174	6,280
	Walton Total	**57,043**	**97,710**
	Walton Grand Total	**154,753**	
Washington County			
Florida Special Waters	Choctawhatchee River	—	23,076
Outstanding Florida Waters	Falling Waters State Recreation Area		157
FNAI Botanical Areas	Florida's First Magnitude Springs Florida Forever BP		38
	Sand Mountain Florida Forever BP		46
FNAI Managed Areas	Bruner Bay Tract		44
	Choctawhatchee River Tract		215
	Choctawhatchee River Water Management Area		18,623
	Dogwood Acres Camp And Retreat Center		516
	Econfina Creek Water Management Area		2,226
	Falling Waters State Park		166
	Glover Conservation Easement		1,137
	Haddock Conservation Easement		342
	Holmes Creek Tract		39
	Laidlaw Sanctuary		81
	Loblolly Tract		43
	Nokuse Plantation Conservation Easements		46
	Pine Log State Forest		1,528
	Rock Hill Preserve		336
	Tupelo Tract		34
FWCC Areas	Not Designated		17
	Wildlife Management Area (Hunting And Land)		1,547
	Washington Total		**50,257**
	CPB Total	**57,043**	**217,271**
	CPB Grand Total	**274,314**	



Figure 3-27. Choctawhatchee-Pea Basin Conservation Lands and Outstanding Florida Waters (David Rubino)

3.8 WATER QUALITY

Water quality (WQ) is a measure of the physical, chemical, and/or biological characteristics of water in relation to set standards. Water quality standards are the standards composed of designated present and future most beneficial uses and numerical and narrative criteria applied to the specific water uses or classification [Chapter 62-302.200(30), Florida Administrative Code (FAC)]. WQ standards are generally based on waterbody types, location, and designated uses such as drinking, human contact safety, and ecosystem health. Chapter 62-302.200(20) FAC, defines water pollution as the presence in water of the state any substance or contaminant or man-induced alteration of the chemical, physical, or biological integrity of water at levels that are or are potentially harmful to human health or welfare, animal or plant life, or property, including outdoor recreation. Water pollution sources are classified as point and nonpoint sources.

Point source water pollution is the discharge of contaminants from a single, identifiable point such as industrial plant effluent pipe, whereas, nonpoint source (NPS) pollution is the introduction of contaminants at dispersed locations from stormwater runoff and/or subsurface water infiltration. NPS stormwater runoff may contain contaminants such as sediment, heavy metals, bacteria and viruses, invasive species, fertilizer nutrients, and other materials. Examples of NPSs include agriculture, silviculture, urban runoff, and development.

Chapter 62-303, FAC, *Identification of Impaired Surface Waters,* was adopted by rule on 3 May 2001 by the Florida Department of Environmental Protection (FDEP) as a new scientific approach for guiding the identification and prioritizing of Florida's impaired surface waters. The rule evaluates whether waters meet their designated uses, which include aquatic life, primary contact and recreation, fish and shellfish consumption, and drinking water. Waters verified as not meeting one or more of their designated uses are placed on the state's 303(d) list. The rule also lowers thresholds for defining potential impairment so as not to miss marginally impaired waters. For waters with insufficient data to meet the requirements of the verified list, additional monitoring would be conducted as required.

Based on the 303(d) list approved by the U.S. Environmental Protection Agency in 2005, 20 of the 163 CPB waterbody identification (WIBD) segments (12 percent) have been listed as impaired (Table 3-7 and Figure 3-28). The Choctawhatchee River and Bay System Surface Water Improvement Plan (2002) presents an approach to reduce CPB water quality impairment from point and nonpoint pollution sources, including unpaved roads and crossings. Soil erosion and sedimentation (Section 6.1) are processes that have significantly altered the water quality and aquatic habitat (Section 6.2) attributes of CPB aquatic ecosystems. They represent the mechanics by which soil particles and other associated pollutants are delivered to receiving wetlands and waterways.

Table 3-7. Choctawhatchee-Pea Basin 303(d) Listed Impaired WIBD Segments

WIBD	Watershed Name	Water Quality Parameters	Category	County/Area (acres)				Total
				Holmes	Jackson	Walton	Washington	
Lower Choctawhatchee Subbasin, HUC 03140203								
123	Alligator Creek	BOD, DO,NU	Planning List	1	13,587	—	13,263	**26,851**
130	Fish Branch	DO, FC, TSS, TU		—	10,008	—	—	**10,008**
142	Sikes Creek	B, DO, FC, TC, TSS, TU		10,825	—	—	—	**10,825**
210	Otter Creek	B		11,077	—	—	—	**11,077**
232	Unnamed branch	B		2,427	—	—	—	**2,427**
251	Camp Branch	B, FC, NU		4,925	—	—	—	**4,925**

Table 3-7. Choctawhatchee-Pea Basin 303(d) Listed Impaired WIBD Segments Cont'd

WIBD	Watershed Name	Water Quality Parameters	Category	County/Area (acres)				Total
				Holmes	Jackson	Walton	Washington	
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd								
337	Flat Creek	B, DO, FC	Planning List	—	—	—	13,132	**13,132**
49	Choctawhatchee River	B, FC, M, TSS, TU	Planning List	13,178	—	3,130	7,683	**23,991**
		ME	Verified Impaired					
49A		ME	Verified Impaired	—	—	15,458	—	**15,458**
49B		B	Planning List	—	—	7,794	7,883	**15,677**
		ME	Verified Impaired					
49C		ME	Verified Impaired	—	—	3,059	1,366	**4,425**
49D		ME	Verified Impaired	—	—	4,288	4,118	**8,406**
49E		FC, TSS, TU	Planning List	—	—	632	4,122	**4,754**
		ME	Verified Impaired					
49F		FC, TC, TSS	Planning List	23,416	—	—	—	**23,416**
		ME	Verified Impaired					
55	East Pittman Creek	FC, TU	Planning List	6,962	—	—	—	**6,962**
56	Tenmile Creek	B		11,614	—	—	—	**11,614**
59	Holmes Creek	B, DO		19,707	8,653	—	57,229	**85,589**
80	Little Creek	FC			4,670	—	—	**4,670**
Choctawhatchee Bay Subbasin, HUC 03140102								
646	Lafayette Creek	B, FC, TC	Planning List	—	—	12,467	—	**12,467**
789	Lagrange Bayou	B		—	—	4,657	—	**4,657**
			Grand Total	**317,738**	**102,769**	**98,629**	**269,796**	**788,932**

Source: FDEP G3 Choctawhatchee Master List 20050923JRZ
Parameters: B = Biology, BOD = Biological Oxygen Demand, DO = Dissolved Oxygen, FC = Fecal Coliform, ME = Mercury (based on elevated levels of mercury in fish tissue that have resulted in limited consumption advisories), NU = Nutrients, TC = Total Coliform, TSS = Total Suspended Solids, TU = Turbidity
Planning List – potentially impaired and more data needed to verify

3.9 RARE AND IMPERILED AQUATIC SPECIES

Northwest Florida has abundant rivers, streams, tributaries, and wetlands that support a rich and diverse assemblage of aquatic species (Means, 1977; Yerger 1977; Swift et al., 1977). These aquatic ecosystems are critical to the conservation of aquatic species, particularly rare and imperiled freshwater mussel and fish species (Masters et al., 1998). Several species of state and federally listed fish, freshwater mussels, and aquatic insects have been identified in the rivers and streams of Northwest Florida. In many cases, habitat degradation, fragmentation, and/or loss associated with sedimentation are directly related to aquatic species declines and listing status. The CPB supports a diversity of aquatic flora and fauna. Species of particular concern to this study include fish, freshwater mussels, and aquatic insects.

3.9.1 Fish

Of the 119 fish taxa in Florida, 8 percent are considered imperiled (Benz and Collins, 1997). Bass (1999) documented greater than 176 species of fish collected from the Perdido, Escambia, Blackwater, Yellow, Choctawhatchee, Chipola, and Apalachicola Rivers in Northwest Florida. Of the species found, 28 are rare or imperiled as outlined in Hoehn (1998). Two species in particular, the Gulf sturgeon (*Acipenser oxyrinchus desotoi*) and Okaloosa darter (*Etheostoma okaloosa*), are federally listed as threatened and endangered, respectively.

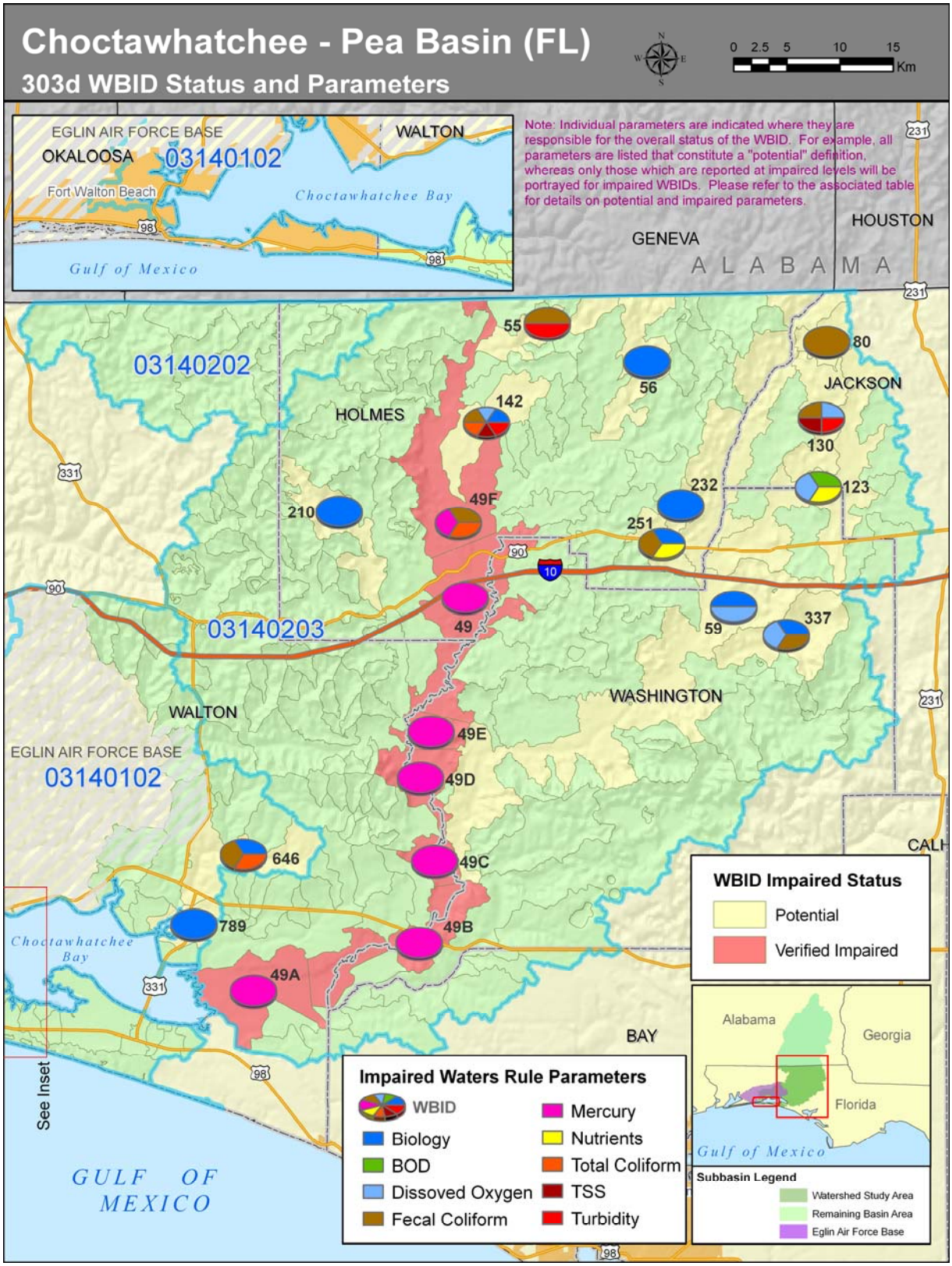


Figure 3-28. CPB 303(d) Listed WIBD Stream Segments (David Rubino)

In some instances, freshwater fish such as the redeye chub (*Notropis harperi*) and bluefin killifish (*Lucania goodei*) are known almost exclusively to spring-fed streams within Northwest Florida. These and other fish species found in Northwest Florida's rivers and streams are documented to be especially sensitive to changes in water quality and habitat alteration (Gilbert, 1992). Decreasing habitat area and increasing habitat fragmentation are strongly associated with the loss of fish diversity. Reductions in range, extreme isolation of extant populations, and extirpation of fish from entire drainages occur as consequential cumulative effects associated with aquatic degradation. Listed fish species known to occur within the CPB study area are listed in Table 3-8 and shown in Figures 3-29 and 3-30.

Table 3-8. Choctawhatchee-Pea Basin Rare and Imperiled Fish and Mussel Species

Common Name	Scientific Name	Conservation Status
Fish		
Bluenose shiner	*Pteronotropis welaka*	SC
Cypress darter	*Etheostoma proeliare*	R
Dusky shiner	*Notropis cummingsae*	R
Florida chub	*Macrhybopsis sp 2*	R
Goldstripe darter	*Etheostoma parvipinne*	R
Gulf sturgeon	*Acipenser oxyrinchus desotoi*	T
Ironcolor shiner	*Notropis chalybaeus*	R
Southern logperch	*Percina austroperca*	R
Spotted bullhead	*Ameiurus serracanthus*	R
Freshwater Mussels		
Alabama moccasinshell	*Medionidus acutissimus*	IT
Choctaw bean	*Villosa choctawensis*	SC
Downy rainbow	*Villosa villosa*	I
Florida floater	*Utterbackia peggyae*	I
Fluted elephant-ear	*Elliptio mcmichaeli*	SC
Fuzzy pigtoe	*Pleurobema strodeanum*	R
Giant floater	*Pygandodon grandis*	SC
Gulf lilliput	*Toxolasma sp.*	SC
Little spectaclecase	*Villosa lienosa*	CS
Paper pondshell	*Utterbackia imbecillis*	CS
Pondhorn	*Unionmerus tetralasmus*	CS
Purple pigtoe	*Fusconaia succissa*	CS
Round pearlshell	*Glebula rotundata*	R
Southern fatmucket	*Lampsilis straminea claibornensis*	CS
Southern kidneyshell	*Ptychobranchus jonesi*	I
Southern rainbow	*Villosa vibex*	CS
Tapered pigtoe	*Quincuncina burkei*	I
Threeridge	*Amblema plicata*	IT
Variable spike	*Elliptio icterina*	CS
Yellow sandshell	*Lampsilis teres*	CS

T = Threatened; CS = Currently Stable; SC = Special Concern; IT = Imperiled, Possibly Extirpated; I = Imperiled; R = Rare

3.9.2 Freshwater Mussels

The United States harbors the greatest diversity of freshwater mussels (*Unionidae* and *Margaritiferidae*) in the world, with 297 taxa recognized (Williams et al., 1993). An overwhelming 91 percent of these species are found in the southeastern United States (Neves et al., 1997). The Northeast Gulf watersheds of the Escambia, Yellow, Choctawhatchee, Apalachicola, and Ochlockonee Rivers drainages of Alabama, Florida, and Georgia support at least 52 species of freshwater mussels, of which 27 species are found nowhere else in the world (Brim-Box and Williams, 2000; Blalock-Herod and Williams, 2001; Bulter et al., 2002). Many of these species are considered imperiled, and seven are federally designated as endangered or threatened. The causes of freshwater mussel decline have been attributed to habitat loss and degradation, subsequent loss of host fish, and introduction of nonindigenous species (Neves et al., 1997). Listed freshwater mussels in the rivers and streams of the CPB study areas are listed in Table 3-8 and shown in Figures 3-29 and 3-31.

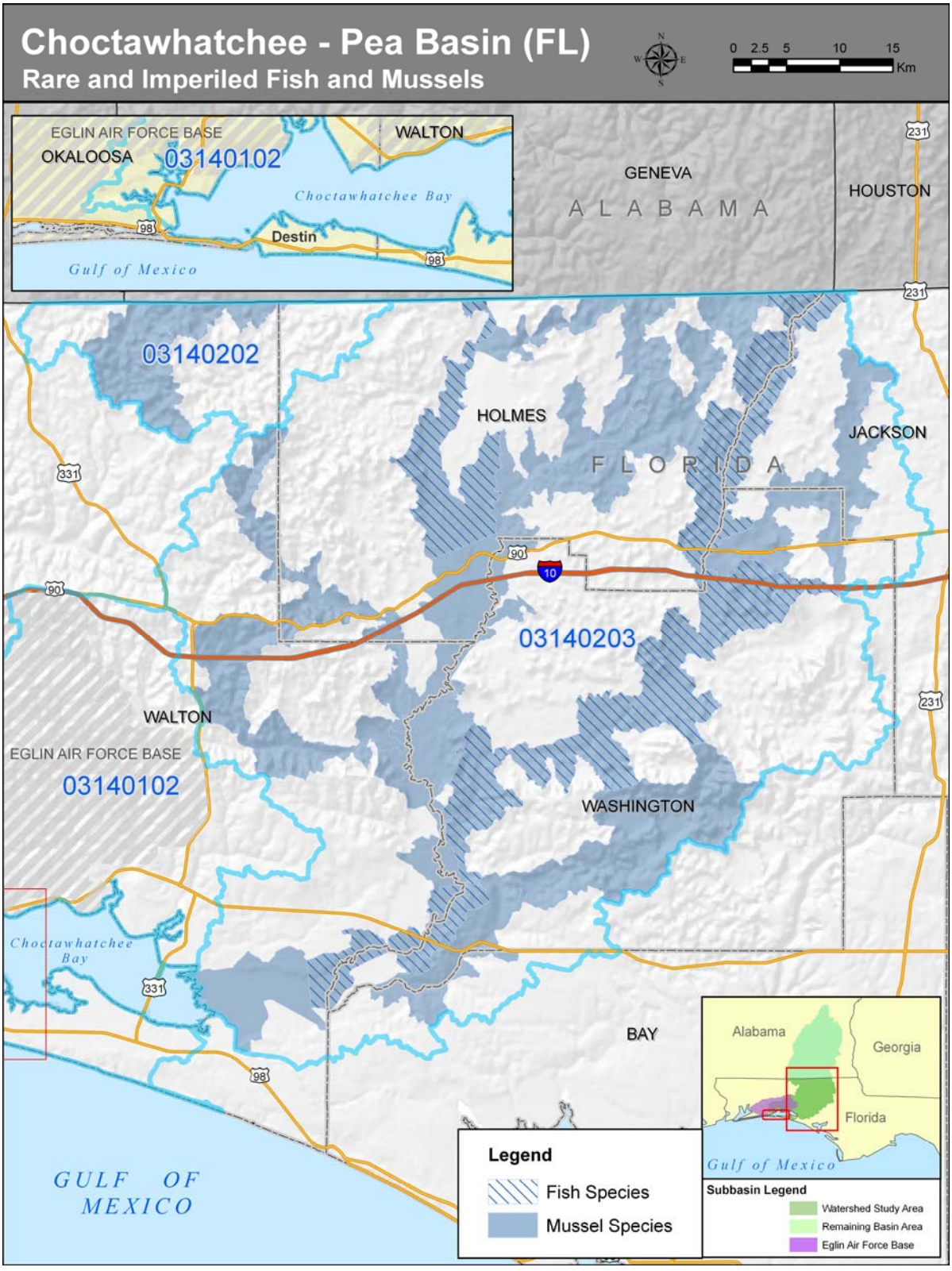


Figure 3-29. Choctawhatchee-Pea Basin Rare and Imperiled Fish and Freshwater Mussel Species

(David Rubino)



Bluenose Shiner (*Pteronotropis welaka*)
Species of Concern



Gulf Sturgeon (*Acipenser oxyrinchus desotoi*)
Threatened



Dusky Shiner (*Notropis cummingsae*)
Rare



Ironcolor Shiner (*Notropis chalybaeus*)
Rare



Cypress Darter (*Etheostoma proeliare*)
Rare



Southern Logperch (*Percina austroperca*)
Rare



Florida Chub (*Macrhybopsis sp 2*)
Rare

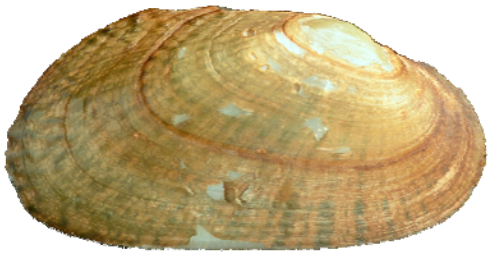


Spotted Bullhead (*Ameiurus serracanthus*)
Rare



Goldstripe Darter (*Etheostoma parvipinne*)
Rare

Figure 3-30. Choctawhatchee-Pea Basin Rare and Imperiled Fish
(Florida Fish and Wildlife Conservation Commission)



Alabama Moccasinshell (*Medionidus acutissimus*)
Imperiled, Possibly Extirpated



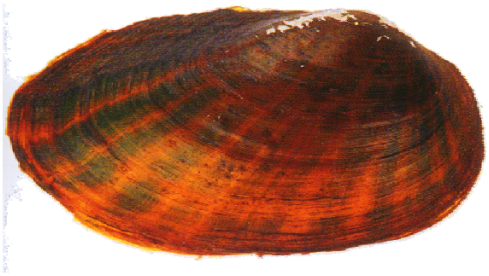
Fluted Elephantear (*Elliptio mcmichaeli*)
Special Concern



Choctaw Bean (*Villosa choctawensis*)
Special Concern



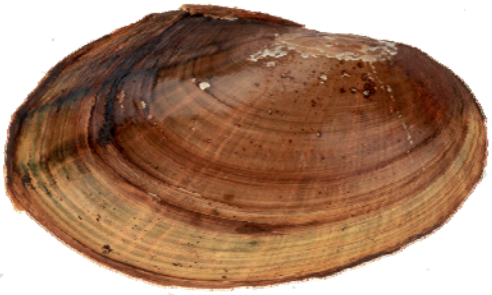
Fuzzy Pigtoe (*Pleurobema strodeanum*)
Rare



Downy Rainbow (*Villosa villosa*)
Imperiled



Giant Floater (*Pygandodon grandis*)
Special **Concern**



Florida Floater (*Utterbackia peggyae*)
Imperiled

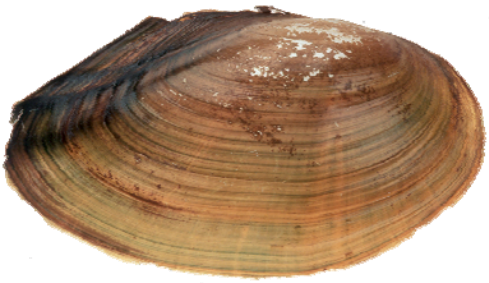


Lilliput (*Toxolasma sp.*)
Special Concern

Figure 3-31. CPB Rare and Imperiled Freshwater Mussels (U.S. Fish and Wildlife Service)



Little Spectalclecase (*Villosa lienosa*)
Currently Stable



Paper Pondshell (*Utterbackia imbecillis*)
Currently Stable



Pondhorn (*Uniomerus tetralasmus*)
Currently Stable



Purple Pigtoe (*Fusconaia succissa*)
Currently Stable



Round Pearlshell (*Glebula rotundata*)
Rare



Southern Fatmucket (*Lampsilis straminea claibornensis*)
Currently Stable



Southern Kidneyshell (*Ptychobranchus jonesi*)
Imperiled



Southern Rainbow (*Villosa vibex*)
Currently Stable

Figure 3-31. CPB Rare and Imperiled Freshwater Mussels (Cont'd) (U.S. Fish and Wildlife Service)

3.9.3 Aquatic Insects

In the United States, there are approximately 11,053 species of aquatic insects. The aquatic insects found in Northwest Florida are highly diverse. Species considered especially sensitive to and intolerant of pollution and disturbance include mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) (abbreviated as EPT) (Benz and Collins, 1997). For these stream insects, the time between generations may be less than, equal to, or greater than one year. EPTs require constant stream flows and other essential habitat attributes throughout the year to complete their life cycles (Fore, 2004).

As with most stream insects, mayflies spend most of their lives underwater as larvae and emerge as adults for only a few hours to breed and lay eggs. They primarily feed by collecting algae and organic materials from rock, gravel, and other substrates. Some species burrow in stream sand, silt, or clay bottoms (Benz and Collins, 1997). Rare and threatened Florida EPT aquatic insects that occur within the CPB are shown in Figure 3-32. Aquatic insect location data for the CPB study area was not available.

Caddisflies are most commonly found in the sediments, organic substrates, and backwater pools of gravelly to rocky, second to fourth order headwater streams. They are primarily bottom feeders that collect detritus and algae from solid substrates and prey on other smaller organisms. Caddisflies emerge as adults and live for several days to weeks to breed and lay eggs. Some species have higher tolerances to pollution than other insects; others are highly sensitive (Benz and Collins, 1997).

There are 189 stonefly species endemic to southeast United States. This species most often occurs in the gravelly to rocky headwaters of second and third order streams. As with mayflies, they spend most of their lives as larvae and emerge as adults for short periods to breed and lay eggs. Like other aquatic insects, stoneflies are dependent on clean, unsilted, gravel or rock stream bottoms to survive (Benz and Collins, 1997).

Hydroperta phormidia (Ray and Stark, 1981) and *Helopicus bogaloosa* (Stark and Ray, 1983) are new species of stoneflies discovered by Mr. Donald Ray, FDEP Stream Biologist, and are known to occur within the CPB. These are separate species from *Helopicus subbarians*, which was found by Mr. Ray in the Choctawhatchee River. *Hydroperta phormidia* is particularly sensitive to sedimentation and organic pollution. Chloroperlidae is the family for *Alloperla* and *Haploperla* stoneflies, which are rarely found in Northwest Florida. These rare species are known to only occur in a few locations within spring runs and seepage streams with pea-size gravel (Ray, 2008).

As with the previously discussed fish and mussel species, the capability of ecosystems to support viable populations of aquatic insects and other biota is dependent on the characteristics of the habitat, such as streambed composition temperatures, juxtaposition and depth of pools, and instream cover. Rather than measuring stream habitat attributes, methods have been developed to estimate stream health using stream invertebrates as indicators of stream conditions. The EPT richness biomonitoring method measures the number of mayflies, stoneflies, and caddisflies taxa for a stream segment. These invertebrate indicators are found in most streams, are less mobile than fish, and are intolerant of stream sedimentation and water quality degradation. FDEP stream bioassessment processes used to measure invertebrate taxa and assess stream conditions are presented in Section 5.4.7.



Caddisfly (*Agarodes ziczac*)
Threatened



Stonefly (*Hydroperla phormidia*)
Rare



Stonefly (*Alloperla prognoides*)
New to Florida, Listed as Rare in Alabama (as *A. furcula*)



Mayfly (*Pseudiron centralis*)
Threatened



Mayfly (*Homoeoneuria dolani*)
Threatened

Figure 3-32. Rare and Imperiled Aquatic Insects (Donald Ray)

3.10 SOCIOECONOMICS

A review of socioeconomic conditions and trends facilitates an understanding of the interactions of the population with the landscape and anticipation of future human-land relationships. This section provides a county-based socioeconomic summary for the CPB area that is referred to as the region of influence (ROI).

3.10.1 Labor Force

The unemployment rate during 2006 in the counties that comprise the ROI has a mean value of 3.0 percent, which is below the mean unemployment rate of 3.3 percent for the state of Florida (U.S. Bureau of Labor Statistics, 2007). The number of persons in the ROI that were unemployed during 2006 totaled over 4,600 (Table 3-9).

Table 3-9. Employment Statistics for the ROI (2006)

County	Unemployment Rate, (percent)	Number Employed	Labor Force
Bay	3.1	82,180	84,810
Holmes	3.0	8,428	8,689
Jackson	3.5	20,749	21,502
Walton	2.1	30,851	31,513
Washington	3.3	9,287	9,604
Total	Mean: 3.0	151,497	156,118

Source: U.S. Bureau of Labor Statistics, 2007

3.10.2 Economic Activity

Data on employment by industry in the ROI during 2006 reveals that the trade/transportation/utilities sector is the most prominent sector of employment, with an average of 17.9 percent. The trade/transportation/utilities industry also commands the third lowest annual wage earnings, with an average of $24,457 in the ROI. The leisure and hospitality industry is the sector with the lowest annual wage earnings but is also the third largest sector in the ROI, representing nearly 12 percent of employment during 2006. Other leading industries in the ROI include public administration, education and health services, and construction. Table 3-10 presents the detailed employment statistics by sector for these counties. The major private employers in the ROI for each county are listed below (Enterprise Florida, 2008a, b, c, d, and e):

- Bay County: Sallie Mae, Smufit/Stone Container, Trane Company, People's First Community Bank, Paradise Found Resorts & Hotels, Eastern Shipbuilding, WEllstream, Inc., C&C Manufacturing, Marriott Bay Point Resort, Nextel Partners
- Holmes County: Mariner Health Care of Bonifay, Doctor's Memorial Hospital, and Bonifay Manufacturing Company
- Jackson County: Alliance Laundry Systems, Family Dollar Distribution Center, and Louisiana Pacific, Inc.
- Walton County: Sandestin Golf & Beach Resort, Hilton Sandestin Beach Resort, resortQuest International/Abbott Resorts, Perdue Farms, Wal-Mart, Arvida/St. Joe Company, HealthMark Regional Medical Center, Sacred Heart Hospital on the Emerald Coast, Seaside Development Corporation, Professional Products, Inc
- Washington County: WestPoint Stevens Company, Inc., Trawick Construction, and Northwest Florida Community Hospital

Table 3-10. Employment by Industry in the ROI (2006)

Industry	Average Annual Employment (percent)	Average Annual Wage (dollars)
Bay		
Natural Resources and Mining	0.2	37,795
Construction	9.9	33,700
Manufacturing	5.1	44,755
Trade, Transportation, and Utilities	19.2	27,697
Information	1.9	46,717
Financial Activities	7.2	38,028
Professional & Business Services	10.7	42,037
Education & Health Services	10.4	38,236
Leisure & Hospitality	14.8	16,233
Other Services	3.5	27,490
Public Administration	7.5	48,419
Unclassified	0.0	23,271
Holmes		
Natural Resources and Mining	N/D	N/D
Construction	7.5	22,969
Manufacturing	4.2	29,555
Trade, Transportation, and Utilities	14.3	21,886
Information	0.4	39,730
Financial Activities	5.1	32,231
Professional & Business Services	4.7	22,287
Education & Health Services	N/D	N,/D
Leisure & Hospitality	6.7	10,706
Other Services	2.4	28,779
Public Administration	18.9	29,936
Unclassified	0.1	7,800
Jackson		
Natural Resources and Mining	N/D	N/D
Construction	5.8	26,395
Manufacturing	4.1	36,931
Trade, Transportation, and Utilities	22.4	25,178
Information	0.8	41,001
Financial Activities	3.2	29,750
Professional & Business Services	1.9	31,616
Education & Health Services	N/D	N/D
Leisure & Hospitality	7.7	11,980
Other Services	2.0	28,051
Public Administration	19.4	35,768
Unclassified	0.0	12,367
Walton		
Natural Resources and Mining	N/D	N/D
Construction	14.9	34,078
Manufacturing	3.3	32,884
Trade, Transportation, and Utilities	19.8	25,708
Information	0.6	38,937
Financial Activities	7.3	47,622
Professional & Business Services	6.6	32,961
Education & Health Services	8.2	29,080
Leisure & Hospitality	21.7	21,969
Other Services	3.4	23,572
Public Administration	8.4	35,078
Unclassified	0.1	19,393

Table 3-10. Employment by Industry in the ROI (2006) Cont'd

Industry	Average Annual Employment (percent)	Average Annual Wage (dollars)
Washington		
Natural Resources and Mining	N/D	N/D
Construction	8.8	29,798
Manufacturing	N/D	N/D
Trade, Transportation, and Utilities	13.8	21,815
Information	0.7	50,872
Financial Activities	2.1	30,275
Professional & Business Services	1.3	24,722
Education & Health Services	N/D	N/D
Leisure & Hospitality	9.1	12,707
Other Services	2.4	24,675
Public Administration	13.0	32,609
Unclassified	0.0	14,520
ROI		
Natural Resources and Mining	0.2	37,795
Construction	9.4	29,388
Manufacturing	4.2	36,031
Trade, Transportation, and Utilities	17.9	24,457
Information	0.9	43,451
Financial Activities	5.0	35,581
Professional & Business Services	5.0	30,725
Education & Health Services	9.3	33,658
Leisure & Hospitality	12.0	14,719
Other Services	2.8	26,513
Public Administration	13.4	36,362
Unclassified	0.0	15,470

Source: Enterprise Florida, 2008a,b,c,d, and e
*N/D – no data

3.10.3 Income

The poverty estimates for 2004 reveal that, on average, 14.4 percent of the individuals within these counties were impoverished, which was greater than the average poverty rate for the state of Florida during that time. Bay County had the highest per capita income of the counties in the ROI during 2003 to 2005. Washington County shows the lowest per capita income throughout the same period. On average, the counties in the ROI had a higher percentage of individuals facing poverty than the average for the state of Florida during 2004. All counties in the ROI had lower per capita income than the state of Florida during 2003 through 2005 (Table 3-11).

Table 3-11. Income Statistics and Percent Impoverished in the ROI Counties

County	Per Capita Income, (dollars)			Poverty, Total (percent)
	2003	2004	2005	2004
Bay	26,623	28,836	30,298	11.9
Holmes	18,858	20,501	21,500	17.6
Jackson	20,904	20,709	21,837	15.7
Walton	21,312	23,574	24,412	11.5
Washington	18,742	19,929	21,297	15.5
Average	21,288	22,710	23,869	14.4
FLORIDA	30,290	32,534	34,001	11.9

Source: Enterprise Florida, 2008a,b,c,d, and e

3.10.4 Demographics

Population estimates from the 1990, 2000, and 2007 Census reveal population growth over that decade. In Table 3-12, total population for each county in the ROI is defined. Total percent change in population from 1990 through 2007 illuminates potential growth trends in each county. Quick and marked growth in a geographical area often results in increased traffic with puts additional stress on area road networks.

Table 3-12. Population Census Totals

County	1990	2000	2007
Bay	126,994	148,217	163,984
Holmes	15,778	18,564	19,245
Jackson	41,375	46,755	49,287
Walton	27,760	40,601	52,881
Washington	16,919	20,973	22,886
Total	228,826	275,110	308,283

Source: U.S. Census Bureau, 2008a,b,c,d,and e

3.10.4.1 Population

The demographic and population dynamics in the ROI reveal an overall total population change of approximately 26 percent from 1990 to 2007 (Table 3-13). Current population estimates reveal that Walton County, the largest in total land area of the five counties, has grown the largest in population size over the past seven years, by 30 percent, to reach nearly 53,000 residents. Bay County was the second fastest-growing county in terms of population size between 2000 and 2007, with a 10 percent increase. The smallest county in the ROI, which also grew the least during the same period, was Holmes County, with an approximate 3.6 percent population growth. Jackson and Washington County populations grew by 5.4 and 9.1 percent, respectively, for an average population growth in the ROI of 12 percent between 2000 and 2007. In Figure 3-33, color denotes a snapshot of the current density (people per square mile) of CPB human residency based on 2005 federal census data. Population density calculations are based on established federal census block polygons.

Table 3-13. Age Composition Analysis for the ROI (2000)

County	Median Age, Total Population	Total, Percent Age 18+	Total, Percent Age 65+
Bay	37.4	75.6	13.4
Holmes	37.5	77.0	14.8
Jackson	37.6	77.7	14.6
Walton	40.5	78.3	15.8
Washington	38.8	76.6	15.7
Total	Mean: 38.4	Mean: 77.1	Mean: 14.9

Source: U.S. Census Bureau, 2008f,g,h,I,and j

3.10.4.2 Age Composition

The age composition analysis (Table 3-14) for the ROI reveals the average median age for the counties in this analysis unit to be 38.4 years. More than 77 percent of the population is over 18, and nearly 15 percent are 65 years and older.

3.10.4.3 Racial/Ethnic Composition

Analysis shows that over 80 percent of the population in the ROI is white. This uniformity may bring special attention to environmental justice concerns for any action that brings a disproportionate impact on the small minority populations in these counties. Table 3-15 presents the details of the racial and ethnic statistics in this analysis unit.

3.10.5 Organizational Capacity

Panama City is the county seat of Bay County. Much of the population in Bay County resides in Panama City along the Gulf and in nearby communities (Florida Netlink, 2008a). The most populous city in Holmes County is Bonifay, which is also the county seat, along with Esto, Noma, Ponce de Leon, and Westville (Florida Netlink, 2008b). Marianna is the county seat of Jackson County, which also includes Alford, Bascom, Campbellton, Cottondale, Graceville, Grand Ridge, Greenwood, Jacob, Malone, and Sneads. More than half of the residents in Jackson, Walton, and Washington Counties reside in the unincorporated areas (Florida Netlink, 2008c, d, and e). Walton County includes the cities of Defuniak Springs, Freeport, and Paxton. Washington County includes the county seat of Chipley, as well as Caryville, Ebro, Sunnyville, Vernon, and Wausau.

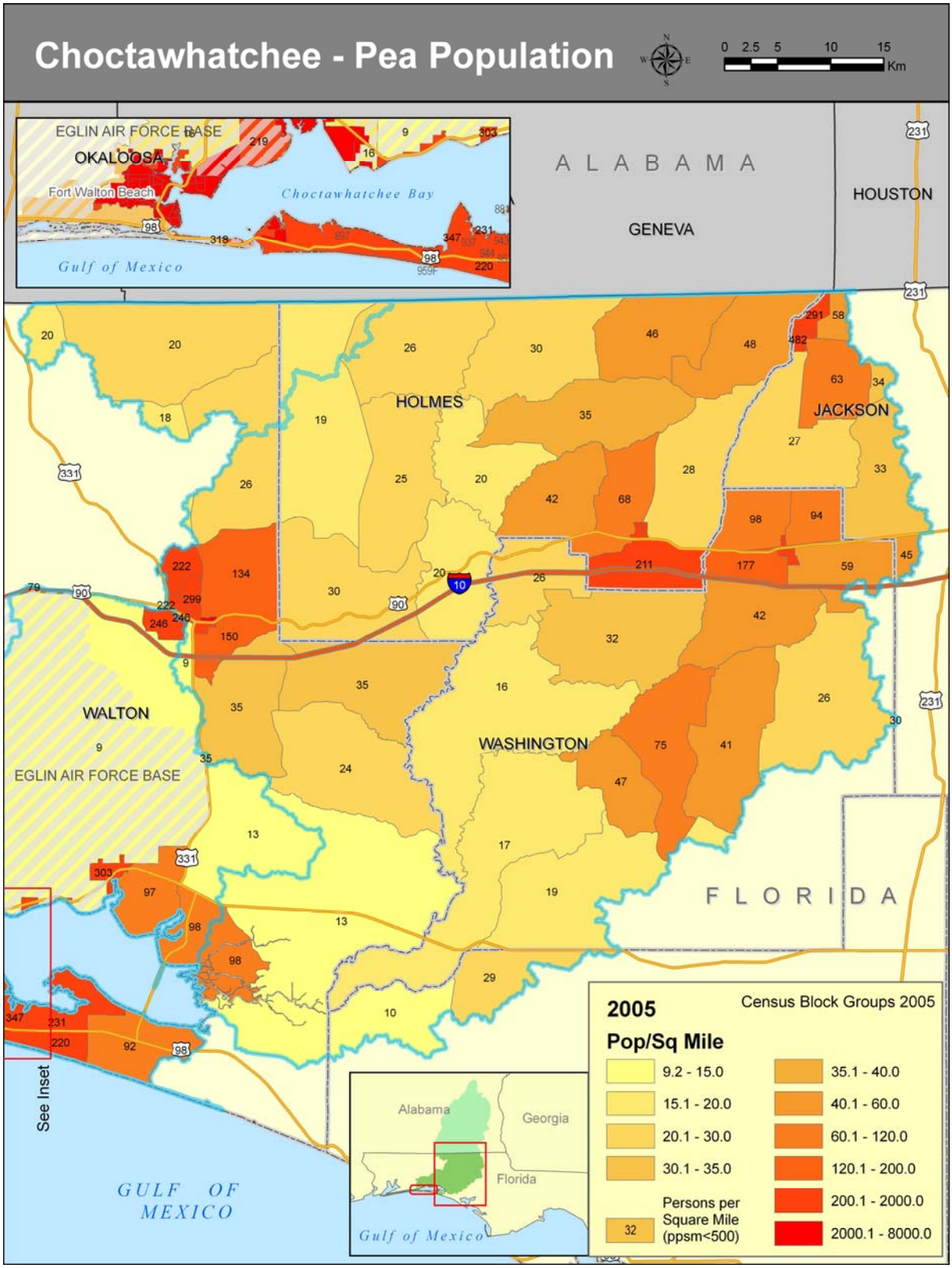


Figure 3-33. Choctawhatchee-Pea Basin Population Density (David Rubino)

Table 3-14. Racial and Ethnic Composition in the ROI (2000)

County	Population	Percent (Average)
Bay		
White	124,761	84.2
Black or African American	15,772	10.6
Native American and Alaska Native	1,159	0.8
Asian	2,561	1.7
Other	980	0.7
Two or More Races	2,869	1.9
Holmes		
White	16,669	89.8
Black or African American	1,208	6.5
Native American and Alaska Native	188	1.0
Asian	72	0.4
Other	147	0.8
Two or More Races	274	1.5
Jackson		
White	32,811	70.2
Black or African American	12,418	26.6
Native American and Alaska Native	311	0.7
Asian	168	0.4
Other	381	0.8
Two or More Races	653	1.4
Walton		
White	35,896	88.4
Black or African American	2,832	7.0
Native American and Alaska Native	520	1.3
Asian	183	0.5
Other	305	0.8
Two or More Races	847	2.1
Washington County		
White	17,140	81.7
Black or African American	2,872	13.7
Native American and Alaska Native	322	1.5
Asian	76	0.4
Other	121	0.6
Two or More Races	429	2.0
ROI		
White	227,277	82.86
Black or African American	35,102	12.88
Native American and Alaska Native	2,500	1.06
Asian	3,060	0.68
Other	1,934	0.74
Two or More Races	5,072	1.78

Source: U.S. Census Bureau, 2008f,g,h,i, and j

3.10.6 Historical Trends and Fluctuations

ROI historical data reveals a growth rate of nearly 12 individuals per square mile between 1990 and 2000 (Table 3-15).

Table 3-15. Density per Square Mile in the ROI Counties

County	Density per Square Mile, 2000[a]	Density per Square Mile, 1990	Percent Change 1990 to 2000
Bay	194.1	166.3	16.7
Holmes	38.5	32.7	17.7
Jackson	51.1	45.2	13.1
Walton	38.4	26.2	46.6
Washington	36.2	29.2	24.0
ROI Average	71.7	60.0	23.7
Florida	296.4	239.6	23.7

[a]U.S. Census Bureau, 2008k

3.10.7 Northwest Florida Development Trends

Florida's population is growing rapidly particularly in the northwest region. The influx of people into the area is partly due to the low cost of living, high quality of life, and the natural environment. There are 16 counties in Northwest Florida, of which 10 are considered rural. Most state and local efforts focus on development in rural areas in order to avoid overcrowding and congestion, which in turn affect land use and development in these areas. There are several predominant factors that drive changes in land use and development, including population growth or decline, economic growth, demographics, agricultural and forest prices, and regional and local planning and policies. In order to effectively manage and guide future growth and development, the Florida legislature adopted the Florida Growth Management Act in 1985, requiring all 67 Florida counties and 410 municipalities to adopt Local Government Comprehensive Plans.

3.10.7.1 Population Growth

Over the first three years of this century, the population of Florida has increased by 6.8 percent to approximately 17.1 million, which makes it the fourth most populous state in the United States. Approximately 10.8 percent of this growth was attributed to natural increases, while 89.2 percent of the growth was a result of net migration. Florida is also the only state in the southeast with a metropolitan population greater than the average for the United States. The population of Florida is expected to grow to 20.7 million by the year 2025.

Between 2000 and 2005, Washington County realized the largest percentage increase in growth of the three counties that constitute the CPB study area and is expected to realize the largest percentage change over the next five years (Table 3-16). Jackson County is expected to grow the slowest over the next five years. In the period from 2000 to 2005, in Northwest Florida, Walton County experienced the largest percentage change in population, followed by Santa Rosa. Washington, Jackson, and Holmes Counties ranked as 9th, 14th, and 16th fastest-growing counties, respectively, between 2000 through 2005. Holmes and Washington Counties are expected to increase in rank by three and four counties, respectively, while Jackson County will remain as the 14th fastest-growing county in Northwest Florida (Office of Economic and Demographic Research, 2006).

Table 3-16. Population Growth Projections

	Population					
County	**1990**	**2000**	**2005**	**Rank**	**2010**	**Rank**
Holmes	15,778	18,564	19,264	16	19,867	13
Jackson	41,375	46,755	48,985	14	51,062	14
Washington	16,919	20,973	22,299	9	25,759	5
Northwest Florida	998,964	1,199,629	1,318,632	NA	1,423,927	NA

Source: U.S. Census Bureau, 2000b, c, e
NA = not available

Most of the population growth in each county is expected to follow previous trends and be located near industrial and employment areas. In Jackson County, much of the growth is expected to occur more rapidly in the unincorporated areas, particularly the urban areas surrounding the city of Marianna rather than the municipalities. Future development in Jackson County is also limited by the availability of areas that can be accommodated by septic systems. To support the future populations, Jackson County will experience a shift from the predominant land use of agricultural and undeveloped land to residential and commercial land uses.

In 2001, approximately 62 percent of the land was devoted to agricultural use while residential use only composed about 5 percent of land use (Jackson County Comprehensive Plan, 2001). However, more new residential subdivisions were built between January 2005 and June 2006 than any other time in Jackson County's history for a period of that length (Cole-Sweazy, 2006). The number of new residential subdivisions since November 2004 equals

17, with a total of 707 residential lots. Most of the new lots being created are over half an acre, with the cost of new home construction from $100 to $125 per square foot. Most of the new homes are high-end homes with over, 1,800 square feet. The majority of residents purchasing homes in Jackson County are from southern Florida (south of Ocala) and northeastern United States, north of New Jersey (Cole-Sweazy, 2006). Also in Jackson County, a 30-townhouse project and separate commercial center are planned for development (Business Florida, 2006).

The same is expected to occur in Washington County where the most notable shift of land use in Washington County is the projected 12.5 percent decrease in agriculture/silviculture and or vacant/undeveloped areas. In contrast, total acreage land use devoted to commercial and conservation will increase, while land devoted to residential use will remain fairly stable (Table 3-17) (Parker, 1998).

Table 3-17. Generalized Acreage of Land Use in Washington County; Unincorporated Area (1998)

Land Use Category	Average Dwelling Units per Acre (DUPA)	Average 1998	Average 2010	Percent of Total 1998	Percent of Total 2010
Residential		14,934.72	14918.17	3.92	3.90
Low Density	0 < 1.0	13,280.00	13259.45	3.48	3.47
Low/Medium Density	1.0 < 3.57	1,647.05	1651.05	0.43	0.43
High/Medium Density	3.57 > 10	6.00	6.00	<0.01	<0.01
High Density	10+	1.67	1.67	<0.01	<0.01
Mixed Use	Up to 20	16,896.00	16896.00	4.43	4.43
Commercial	None	5,20.49	2075.32	0.14	0.54
Neighborhood Commercial	None	4.53	11.33	< 0.01	< 0.01
Industrial	None	72.54	157.84	0.01	0.04
Conservation	None	66,131.7	99519.80	17.33	26.07
Historic/Archeological	None	144.0	144.0	0.03	0.03
Recreation	None	1,301.5	1301.5	0.34	0.34
Public & Semipublic Facilities and Grounds	None	460.21	460.21	0.12	0.12
Agriculture/Silviculture and/or Vacant/Undeveloped	0.1	281,182.16	246,163.68	73.68	64.50
	Total	381,647.85	381,647.85	100.00	100.00

Source: Parker, 1998
Note: Total county land area excludes land located within municipalities (including Chipley, which consists of 2,267.26 acres)

3.10.7.2 Economic Growth

The state of Florida has created the Enterprise Zone Program that offers tax incentives and benefits to economically distressed areas in order to encourage economic growth and investments. There are currently a total of 55 state enterprise zones composed of both rural and urban zones. Jackson, Washington, and Holmes Counties are 3 out of 27 rural enterprise zones. Each county in the ROI has also been identified by the Governor's Office of Trade, Tourism and Economic Development (OTTED) as a "first rural area of critical economic concern." As stated in Florida Statute 288.0636, an area of critical economic concern must either be a rural community, a region adversely affected by an extraordinary economic or natural event, or a region that presents a substantial opportunity for development that would stimulate the creation of 1,000 jobs over five years. Those areas that have been assigned as first rural areas of critical economic concern are placed as high-priority assignments for the Rural Economic Development Initiative. Defining these areas also grants the governor the right to waive certain criteria and requirements of economic development incentives. Incentives and benefits of the zoning to qualified companies includes, but is not limited to, qualified target industry tax refunds, economic development transportation funds, rural job tax credits, various employee training funds, community development revolving loan programs, property tax credits, and business equipment and materials sales tax refund.

An example of a specific benefit that has arisen in part to stimulate commercial development in rural communities is a $100,000 grant awarded to Northwest Region's Opportunity Florida, Inc. to promote counties in the ROI and also in Calhoun, Franklin, Gadsden, Gulf, Liberty, and the city of Freeport. Another example is the state-level effort to assist WestPoint Stevens, a textile company in Washington County, to expand into Jackson County (Business Florida, 2006). As a result, a total of 150 new jobs were created in the area.

Other economic initiatives and programs have been implemented to create and retain employment in rural communities that are largely affected by unemployment and slow growth opportunities. The ROI counties are no exception. While Northwest Florida has low unemployment rates, the ROI counties are among the counties with the highest unemployment rates.

According to the 2001 Washington County Comprehensive Plan, the total acreage devoted to the industrial sector will more than triple by 2010. Currently, in the city of Chipley, there is an industrial park that offers full-service sites for certain manufacturers and industries. Another 220 acres in the county has already been designated and is under development for a second industrial park site (Washington County Homepage, 2006).

Holmes County is experiencing shifts to more commercial land uses. A three-phase development plan is being implemented, with phase one consisting of a 790-acre animal park near Bonifay, a city 10 miles west of Chipley and near Interstate 10. Groundbreaking work on the safari-type park is expected to start in 2008. The second phase of the plan includes a large-scale celebrity theme park that will be built next to the animal park and is scheduled for completion in the year 2011. The third phase will be the addition of an amphitheatre to the same general area (Mitchell, 2006).

Jackson County also has its share of rapid expansion. For instance, near Marianna on Interstate 10, a new 907,000-square-foot Family Dollar distribution center opened last year as part of a multimillion-dollar incentive package issued by the government. The distribution center draws employees from many surrounding counties, including Holmes and Washington. Another 178 acres nearby were bought by county and city officials and sold to Arizona Chemical (Business Florida, 2006).

3.11 LITERATURE CITED

Barrios, K. 2005. *Choctawhatchee River Springs Inventory Holmes, Walton, and Washington Counties, Florida*. Northwest Florida Water Management District, Havana, Florida, Water Resources Special Report 05-02.

Bass, G. 1999. *Checklist of Fishes Recorded from Inland Waters of Florida*. Florida Game and Freshwater Fish Commission, Fisheries Resources Bureau, Blackwater Fisheries Research and Development Center, Holt, Florida.

Benz, G.W. and Collins, D.E. (Eds.). 1997. Aquatic Fauna in Peril: The Southeastern Perspective. Southeast Aquatic Research Institute, Special Publication 1; Lenz Design & Communications; Decatur, Georgia.

Bhaduri, B., Harbor, J., Engel, B., and Grove, M. 2000. Assessing Watershed-Scale, Long-Term Hydrologic Impact of Land-Use Change Using a GIS-NPS Model. Environmental Management, 26:643-658.

Blalock-Herod, H.N. and Williams, J.D. 2001. Ouarterly Report II, Status Survey for the Suwannee Moccasinshell, Medionidus walderi, and Assessment of Historical Habitat for the Federally Endangered Oval Pigtoe, Plaurobema pyriforme, in the Suwannee River Drainage, Florida. Technical Report to the U.S. Fish and Wildlife Service, Jacksonville, Florida.

Brim-Box, J. and Williams, J.D. 2000. Unionid Mollusks in the Apalachicola Basin in Alabama, Florida, and Georgia. Bulletin of the Alabama Museum of Natural History, 21:1-143.

Bulter, R.S., Alam, S.A., and C.A. Ziewitz. 2002. Draft Recovery Plan for Endangered Fat Threeridge (Amblema neislerii), Shinyrayed Pocketbook (Lampsilis subangulata), Gulf Moccasinshell (Medionidus penicillatus), Ochlockonee Moccasinshell (Medionidus simpsonianus), Oval Pigtoe (Pleurobema pyriforme), and Threatened Chipola Slabshell (Elliptio chipolaensis), and Purple Bankclimber (Elliptoideus sloatianus). U.S. Fish and Wildlife Service, Panama City, Florida.

Bunnell, P., Rautio, S., Fletcher, C., and van Woudenberg, A. 1995. Problem Analysis of Integrated Resource Management of Riparian Areas in British Columbia. B.C. Ministry of Forestry and B.C. Ministry of Environment, Lands and Parks, Victoria, B.C.

Buol, S.W. 1973. Soils of the Southern States and Puerto Rico. U.S. Department of Agriculture, Soil Conservation Service.

Business Florida. 2006. Homepage, Northwest. "Northwest Expansion." Data retrieved from the Internet on June 28, 2006 at: http://www.businessflorida.com/regions/reg-nw.asp

Campbell, K. 1993. Geologic Map of Calhoun County. Florida Geological Survey, Open File Map Series No. 20.

Castro, J. 2003. Geomorphologic Impacts of Culvert Replacement and Removal: Avoiding Channel Incision. U.S. Fish and Wildlife Service, Oregon Fish and Wildlife Office, Portland, Oregon.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe, 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service, Biological Services Program. FWS/OBS-79/31. December 1979.

Cole-Sweazy. 2006. Personal Contact between Kim Cole-Sweazy, Senior Planner for Jackson County, and Pam Safford, SAIC. June 28, 2006. Question and answers about residential housing.

Doll, B.A., Grabow, G.L., Hall, K.R., Halley, J., Harman, W.A., Jennings, G.D. and Wise, D.E. Date Unknown, Stream Restoration: A Natural Channel Design Handbook. Prepared by the North Carolina Stream Restoration Institute and North Carolina Sea Grant.

Dunne, T. and Leopold, L.B. 1978. Water and Environmental Planning. W.H Freeman Company, San Francisco, CA.

Enterprise Florida. 2008a. Florida's County Profiles: Bay County. Available at: http://www.enterpriseflorida.com/floridasregionsSubpage.aspx?id=5440. Accessed on 1 April, 2008.

Enterprise Florida. 2008b. Florida's County Profiles: Holmes County. Available at: http://www.enterpriseflorida.com/floridasregionsSubpage.aspx?id=5440. Accessed on 1 April, 2008.

Enterprise Florida. 2008c. Florida's County Profiles: Jackson County. Available at: http://www.enterpriseflorida.com/floridasregionsSubpage.aspx?id=5440. Accessed on 1 April, 2008.

Enterprise Florida. 2008d. Florida's County Profiles: Walton County. Available at: http://www.enterpriseflorida.com/floridasregionsSubpage.aspx?id=5440. Accessed on 1 April, 2008.

Enterprise Florida. 2008e. Florida's County Profiles: Washington County. Available at: http://www.enterpriseflorida.com/floridasregionsSubpage.aspx?id=5440. Accessed on 1 April, 2008.

Enterprise Florida. 2008f. Fastest Growing Florida Counties. Available at: http://www.eflorida.com/FloridasRegionsSubpage.aspx?id=2630. Accessed on 31 March, 2008.

Exum, L.R., Bird, S.L., Harrison, J., and Perkins, C.A. 2005. Estimating and Projecting Impervious Cover in the Southeastern United States. U.S. Environmental Protection Agency, Region 4, Atlanta, Georgia, EPA/600/R-05/061.

Federal Interagency Stream Restoration Working Group. 2001. Stream Corridor Restoration: Principles, Processes, and Practices. GPO Item No. 0120-A, SuDocs No. A 57.6/2:EN3/PT.653, ISBN-0-934213-59-3, http://www.usda.gov/stream_restoration.

Florida Center for Instructional Technology. Exploring Florida: A Social Studies Resource for Students and Teachers. College of Education, Special Collections Department, University of South Florida, Tampa, Florida. http://fcit.usf.edu/florida/default.htm.

Florida Natural Areas Inventory (FNAI), 1990. Guide to the Natural Communities of Florida. Prepared by Florida Natural Areas Inventory and Department of Natural Resources.

Florida Netlink. 2008a. Florida Counties: Bay County. Available at: http://www.floridanetlink.com/bay.php. Accessed on 2 April, 2008.

Florida Netlink. 2008b. Florida Counties: Holmes County. Available at: http://www.floridanetlink.com/holmes.php. Accessed on 2 April, 2008.

Florida Netlink. 2008c. Florida Counties: Jackson County. Available at: http://www.floridanetlink.com/jackson.php. Accessed on 2 April, 2008.

Florida Netlink. 2008d. Florida Counties: Walton County. Available at: http://www.floridanetlink.com/walton.php. Accessed on 2 April, 2008.

Florida Netlink. 2008e. Florida Counties: Washington County. Available at: http://www.floridanetlink.com/washington.php. Accessed on 2 April, 2008.

Florida State Archives. Florida Memory Project: Florida Photographic Collection. Florida Department of State, Division of Library and Information Services, Bureau of Archives and Records, Management, Tallahassee, Florida. http://fpc.dos.state.fl.us/memory/PhotographicCollection/.

Fore, L.S. 2004. Development and Testing of Biomonitoring Tools for Macroinvertebrates in Florida Streams. Florida Environmental Protection Agency, Tallahassee, Florida.

Gray, D. H. and A. T. Leiser. 1982. Biotechnical Slope Protection and Erosion Control. Van Nostrand Reinhold, New York.

Gregory, S. and Ashkenas, L. 1990. Riparian Management Guide – Willamette National Forest. USDA, Forest Service, Willamette National Forest, Eugene, Oregon.

Gossellink, J.G. Shaffer, G.P., Lee, L.C., Burdick, D.M., Childers, D.L., Taylor, N., Hamilton, S., Boumans, R., Cushman, D., Fields, S., Loch, M., and Visser, J. 1989. Cumulative Impact Assessment and Management in A Forested Wetland Watershed in the Mississippi River Flood Plain. Marine Science Department, Louisiana State University, Baton Rouge. LSU-CEI-89-02.

Grissinger, E.H., and Little, W.C. 1986. Similarity of Bank Problems on Dissimilar Streams. In: Proceedings of the Fourth Federal Interagency Sedimentation Conference, 24-27 March 1986, Las Vegas, Nevada, pp. 5-51 - 5-60.

Gilbert, C.R. 1992. Rare and Endangered Biota of Florida. Volume II. Fishes. University Press of Florida, Gainesville, Florida.

Hey, D.L. 2001. Modern Drainage Design: The Pros, the Cons, and the Future. Hydrologic Science: Challenges for the 21st Century, Presentation at the Annual Meeting of the American Institute of Hydrology, October 14-17, 2001, Bloomington, Minnesota.

Hoehn, T.S. 1998. Rare and Imperiled Fish Species in Florida: A Watershed Perspective. Office of Environmental Services, Game and Freshwater Fish Commission. Tallahassee, Florida.

Horner, R., May C., Liningston, E., Blaha, D., Scoggins, M., Tims, J., and Maxted, J. Date Unknown. Structural and Non-Structural BMPs for Protecting Streams. Watershed Management Institute, Crawfordville, Florida.

Ilhardt, B.L., Verry, E.S., and Palik, B.J. 2000. Defining Riparian Areas. In: Wagner, R.G., and Hagan, J.M. (Eds.). Forestry and the Riparian Zone: Conference Proceedings. Wells Conference Center, Cooperative Forestry Research Unit, University of Maine, Orono, Maine.

Institute of Science and Public Affairs, Florida State University. Florida History Through Its Places. http://www.freac.fsu.edu/HistoricPlaces/Atlas.html.

Jackson County Comprehensive Plan. 2001. Adopted June 19. Data retrieved from the Internet on June 29, 2006 at: http://www.jacksoncountyfl.com/Comp%20Plan.pdf

Little, W.C., Throne, C.R., and Murphey, J.B. 1982. Mass Bank Failure Analysis of Selected Yazoo Basin Streams. Transactions of the American Society of Agricultural Engineers, 25(5):1321-1328.

Masters, L.L, Stephanie, R.F., and Stein B.A. (Eds.). 1998. Rivers of Life: Critical Watersheds for Protecting Freshwater Biodiversity. The Nature Conservancy, Arlington, Virginia.

McCutcheon, S. C. and J. C. Hayes, 1993. Effects of Excess Sediment. In: Proceedings of the Technical Workshop of Sediments; February 3-7, 1992, Corvallis, OR, sponsored by the U.S. Environmental Protection Agency and U.S. Department of Agriculture, page 29-31.

Means, D.B. 1977. Aspects of the Significance to Terrestrial Vertebrates of the Apalachicola River Drainage Basin, Florida. Florida Marine Research Publications, 37:67.

Mitchell, C. 2006. "Theme Park and Animal Kingdom Planned for Bonifay." News 13 On Your Side. Tuesday, May 23, 2006. Retrieved on June 26, 2006 at: http://www.wmbb.com/servlet/Satellite?pagename=WMBB/MGArticle/MBB_BasicArticle&c=MGArticle&cid=1137836278274&path

Moore, W.E., 1955. Geology of Jackson County. Florida Geological Survey, Bulletin 37, 1955.

Neves, R.J., Bogan, A.E., Williams, J.D., Ahlstedt, S.A., and Hartfield, P.W. 1997. Status of Aquatic Mollusks in the Southeastern United States: A Downward Spiral of Diversity. Pp. 43-85. In: Benz, G.W. and Collins, D.E. (Eds.). Aquatic Fauna in Peril: The Southeastern Perspective. Special Publication 1, Southeastern Aquatic Research Institute, Lenz Design and Communications, Decatur, Georgia.

Office of Economic & Demographic Research: 2006. The Florida Legislature. "Florida Population." Data retrieved from the Internet on June 29, 2006 at: http://edr.state.fl.us/population.htm

Parker, R.M. 1998. Washington County Comprehensive Plan – Future Land Use Element. West Florida Regional Planning Council, Pensacola, Florida.

RAND Florida, 2004a. Personal and Per Capita Personal Income Statistics (by SIC). RAND Florida, An Online Source for Florida and U.S. Statistics. Data retrieved from the Internet on June 29, 2006 at: http://fl.rand.org/stats/economics/persincUS.html.

RAND Florida, 2004b. RAND Florida Population Density in Florida Counties and Cities. RAND Florida, An Online Source for Florida and U.S. Statistics. Data retrieved from the Internet on June 29, 2006 at: http://fl.rand.org/stats/community/popdensity.html.

Ray, D.H and Stark, B.P. 1981. The Nearctic Species of Hydroperla (Plecoptera: Perlodidae). The Florida Entomologist, 64(3):385-395.

Roads/Riparian Restoration Team. 2002. Management and Techniques for Riparian Restorations: Roads Field Guide Volume I. United States Department of Agriculture, Forest Service, Rocky Mountain Research Station, General Technical Report RMRS-GTR-102.

Rosenau, J.C. 1977. Springs of Florida. Bureau of Geology, Florida Department of Natural Resources, Tallahassee, Florida.

Scott, T.M. 1993. Geologic Map of Jackson County. Florida Geological Survey, Open File Map Series No. 25.

Schmidt, W. 1984. Notes on the Geology of Walton County. Florida Geological Survey, Open File Report 3.

Schmidt, W. and Coe, C.. 1978. Regional Structure and Stratigraphy of the Limestone Outcrop Belt in the Florida Panhandle. Report of Investigations No. 86, State of Florida Department of Natural Resources, Division of Resource Management, Bureau of Geology

Sosin, Snell, Perry, and Associates. 1998. Findings of a Nationwide Survey of Registered Voters. January, 1998

Stark, B.P. and Ray, D.H. 1983. A Revision of the Genus Helopicus (Plecoptera: Perlodidae). Freshwat. Inverteb. Biol., 2(1)16-27.

Statutes & Constitution: View Statutes: flsentate.gov. "The 2005 Florida Statutes 288.0656." Data retrieved from the Internet on June 26, 2006 at:. http://www.flsenate.gov/Statutes/index.cfm?p=2&App_mode=Display_Statute&Search_St...

Swift, C., Yerger, R.W., and Parrish, P.R. 1977. Distribution and Natural History of the Fresh and Brackish Water Fishes of the Ochlochonee River, Florida and Georgia. Bulletin of the Tall Timbers Research Station, 20:1-111.

The Nature Conservancy. "Northwest Florida Greenway." Data retrieved from the Internet on June 26, 2006 at: http://www.nature.org/wherewework/northamerica/states/florida/preserves/art12820.html

Trimble, S.W. 1974. Man-Induced Soil Erosion on the Southern Peadmon 1700 to 1970. Soil Conservation Society of America.

Turner, B.L. 1990. The Earth As Transformed by Human Action. Cambridge University Press, Cambridge, MA.

University of Florida (UFL), 2006. Florida Electronic Federal Depository Library, County Pages. University of Florida George A. Smathers Libraries. Data retrieved from the Internet on June 29, 2006 at: http://www.uflib.ufl.edu/fefdl/counties/counties.html.

United States Bureau of Labor Statistics (BLS). 2007. Local Area Unemployment Statistics Information and Analysis. Available at: http://www.bls.gov/lau/. Accessed on 2 April, 2008.

United States Census Bureau. 2008a. Population Finder: Bay County, Florida. Available at: http://www.census.gov/. Accessed on 31 March, 2008.

United States Census Bureau. 2008b. Population Finder: Holmes County, Florida. Available at: http://www.census.gov/. Accessed on 31 March, 2008.

United States Census Bureau. 2008c. Population Finder: Jackson County, Florida. Available at: http://www.census.gov/. Accessed on 31 March, 2008.

United States Census Bureau. 2008d. Population Finder: Walton County, Florida. Available at: http://www.census.gov/. Accessed on 31 March, 2008.

United States Census Bureau. 2008e. Population Finder: Washington County, Florida. Available at: http://www.census.gov/. Accessed on 31 March, 2008.

United States Census Bureau. 2008f. Factfinder: Bay County, Florida. Available at: http://www.census.gov/. Accessed on 31 March, 2008

United States Census Bureau. 2008g. Factfinder: Holmes County, Florida. Available at: http://www.census.gov/. Accessed on 31 March, 2008

United States Census Bureau. 2008h. Factfinder: Jackson County, Florida. Available at: http://www.census.gov/. Accessed on 31 March, 2008

United States Census Bureau. 2008i. Factfinder: Walton County, Florida. Available at: http://www.census.gov/. Accessed on 31 March, 2008

United States Census Bureau. 2008j. Factfinder: Washington County, Florida. Available at: http://www.census.gov/. Accessed on 31 March, 2008

United States Census Bureau. 2008k. Density Using Land Area For States, Counties, Metropolitan Areas, and Places. Available at: http://www.census.gov/population/www/censusdata/density.html. Accessed on 2 April, 2008.United States Bureau of Labor Statistics. "Local Area Unemployment Statistics." March 2005. Data retrieved from the Internet on June 2, 2006 at: http://www.bls.gov

United States Department of Agriculture (USDA), Natural Resources Conservation Service. 2000. Stream Corridor and Riparian Buffer Zone. Technical Note, Biology-49, Albuquerque, New Mexico.

Vaughan, R.E. 2005. Agricultural Drainage Ditches: Soils and Implications for Phosphorus Transport and Retention. Thesis submitted to the Faculty of the Graduate School of the University of Maryland, College Park.

Vecchioli, J., C. H. Tibbals, A. D. Fuerr, and D. B. Hutchinson, 1990. Ground Water Recharge in Florida – A Pilot Study in the Apalachicola-Chattahoochee-Flint River Basin, Southeastern Alabama, Northwestern Florida, and Southwestern Georgia. U.S. Geological Survey, Water Supply Paper 2460.

Vernon, R.O. 1942. Geology of Holmes and Washington Counties, Florida. State of Florida Department of Conservation, Florida Geological Survey, Tallahassee, Florida.

Warren, M. L. and M. G. Pardew, 1998. Road Crossings as Barriers to Small-Stream Fish Movement. Transactions of the American Fisheries Society, 127:637-644.

Washington County Homepage. 2006. Planning Department. "City/Town Future Land Use Maps." Data retrieved from the Internet on June 28, 2006 at: http://www.washingtonfl.com/planning.htm

Williams, J.D., Warren, M.L., Cummings, K.S., Harris, J.L., and Neves, R.J. 1993. Conservation Status of Freshwater Mussels of the United States and Canada. Fisheries 18(9):6-22.

Wolfe, S. H., J. A. Reidenauer, and D. B. Means, 1988. Ecological Characterization of the Florida Panhandle. U.S. Fish and Wildlife Service Biological Report 88(12). Minerals Management Service 88-0063. Washington, D.C. New Orleans.

Yerger, R.W. 1977. Fishes of the Apalachicola River. In: R.J. Livingston and E.A Joyce, Jr. (Eds.) Proceedings of the Conference on the Apalachicola Drainage System. 22-23 April 1976, Gainesville, Florida. Florida Marine Research Publication 26. pp. 22-33.

Ziewitz, K. and Wiaz, J. 2004. Green Empire: The St. Joe Company and the Remaking of Florida's Panhandle. University Press of Florida, Gainesville, Florida.

CHAPTER FOUR

CROSSINGS



This chapter defines Choctawhatchee-Pea Basin crossings and their interactive components. Described are CPB county-maintained crossing types, crossing components, noncrossing road culverts, and unpaved roads. The intent is to provide an understanding of what constitutes a crossing and recognition of its interactive features.


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ACRONYMS

CS	crossover site
CPB	Choctawhatchee-Pea Basin
FRC	flood relief culvert
HC	hydrologic crest
ORM	operational roads maintenance
PS	proximity site
RD	road drain
WC	water crossing


Mike Rainer

4. CROSSINGS

Crossings represent human imprinting on the landscape and the resulting impacts on natural resources. Roads are inevitably positioned at points of intersect or proximity to water resources. The ensuing hydrologic relationships between these anthropogenic (man-made) features and aquatic resources were the operational framework for this assessment. This chapter describes county-maintained unpaved roads and defines crossings within the Choctawhatchee-Pea Basin (CPB) landscape.

4.1 UNPAVED ROADS

The current CPB unpaved road system is a product of historical and recent activities designed to provide access and meet requirements of the public. Many of the roads in use today have been in place for well over 100 years (Section 2.2). Although road paving technologies have vastly improved the overall infrastructure and traffic support capabilities of the area, there is still an extensive labyrinth of unpaved roads within the CPB, particularly in Holmes County. In nearly all cases, crossings and unpaved road approaches maintained by the CPB counties are on private lands, and the potential environmental effects associated with WCs also occur on private lands. Typically, counties are granted easements to conduct road and crossing maintenance activities on private land holdings. CPB roads metadata is presented in Table 4-1 and a map of the CPB roads network is presented in Figure 4-1.

Table 4-1. CPB Roads Network Metadata

GIS Map	Source	Date	Type	Description
Roads Network	FDEP	1998	shp files	This coverage contains the digital line graphs (DLG) for the state of Florida as compiled by the Earth Science Information Center of the U.S. Geological Survey. The RDS24 coverage is a subset of all transportation data from the DLG data fields derived from the 1:24,000-scale and other large scale maps.

Data on the location and miles of CPB unpaved roads fit for use by this project was unavailable.

4.1.1 Road Configurations

To accommodate water removal, safety, and maintenance concerns, the roadway surface must uniformly slope toward one edge or have a center section that is higher than either edge. The three surface shape designs include crowned, insloped, and outsloped roads (Figure 4-2). A crowned road, the most common road configuration encountered during the CPB crossing survey, has a high point in the center of the road. Drainage ditches are used on one or both sides of the road to transport runoff to a receiving outlet. The primary attribute of the crown is the splitting of stormwater runoff, which reduces erosion potentials compared to other surface shapes. The volume of water per unit length of road flowing over fill slopes and in ditches is less than that for insloped or outsloped roads.

Unpaved road surfacing materials include sand, clay, gravel, and crushed rock (Figure 4-3). Of these, gravel and crushed rock aggregate provide the best road surface for traffic and erosion control. An aggregate surfaced road is an unpaved road that is primarily surfaced with materials from stone, such as gravel or crushed rocks. Aggregate surfacing of unpaved roads constructed of native or clay pit soils greatly increases the stability, traffic support capability, and resistance of roads to erosion. The optimum condition for encouraging surface material cohesion and durability is a well-balanced mixture of sand, clay, and gravel or crushed rock aggregates.



Figure 4-1. Choctawhatchee-Pea Basin Roads Network (David Rubino)

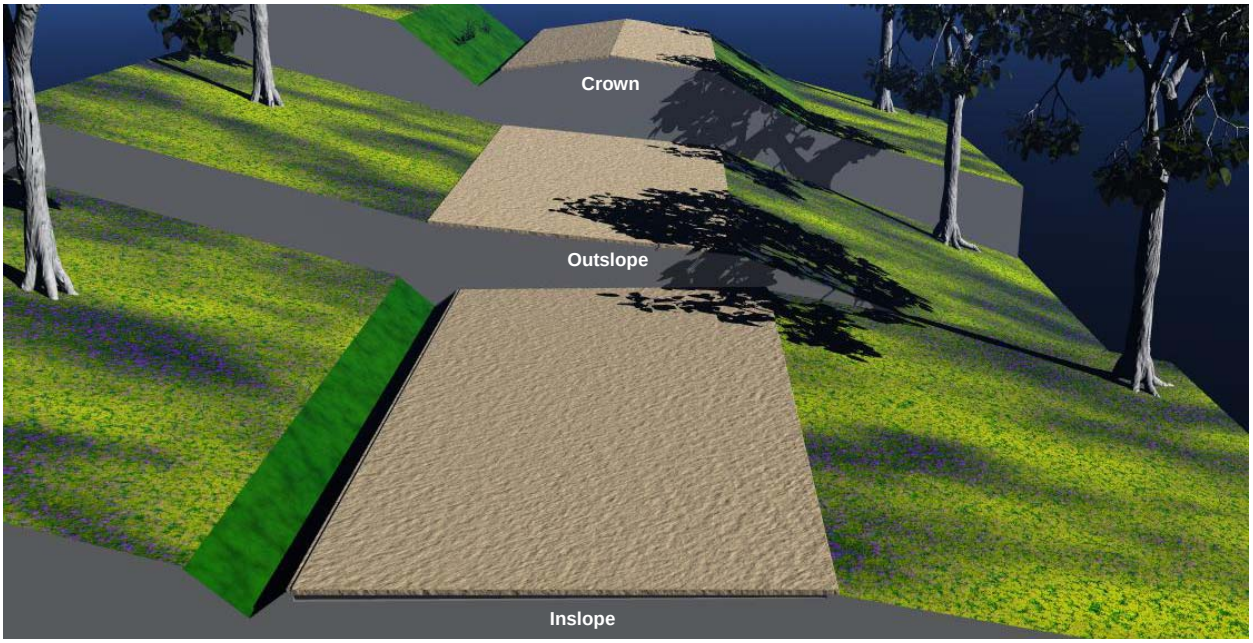


Figure 4-2. Insloped, Outsloped, and Crowned Road Surface Configurations (David Rubino)



Figure 4-3. CPB Road Surfaced Using Sand, Clay, Gravel, and Crushed Rock (Mike Rainer)

Soil materials, particularly fines (clay and silt sized soil particles), bind the road fill together, creating a dense, relatively stable road surface. Generally, aggregate surface roads will have longer maintenance cycles compared to roads constructed with native soil or imported clay fill. However, the proper mixture of soil and aggregate material must be maintained; otherwise, the road materials will separate by particle size, which will result in the failure of the road. Typically an aggregate road is constructed in three layers:

- *Surface Course* – A uniformly graded gravel or crushed stone layer 4 to 8 inches thick that is placed on top of the geotextile.
- *Base Course* – A 10- to 12-inch-thick layer composed of free draining, easily compacted gravel and crushed stone and a low amount of fines that produces a strong, stable matrix. In some cases, a base coarse may not be required if a naturally stable subgrade is present.
- *Subgrade* – The bottom layer roadbed made up of the native soil materials found along the road or imported fill (Figure 4-4).

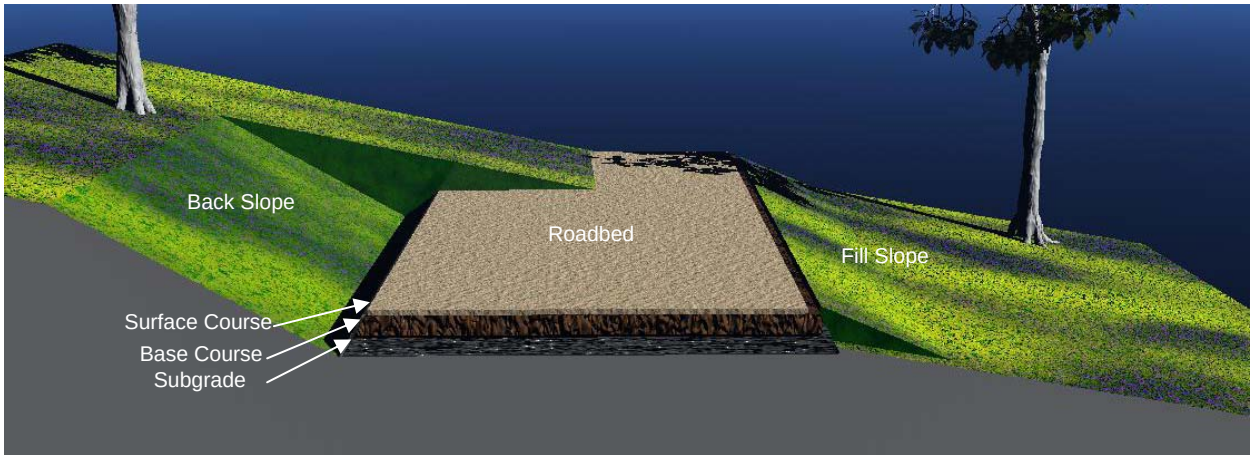


Figure 4-4. Aggregate Road Cross Section (David Rubino)

The absence of the aggregate base layer can compromise the function, durability, and life span of an aggregate road. In practice, many CPB aggregate roads only have subgrade and surface layers.

4.1.2 Operational Roads Maintenance

Road maintenance is generally defined as keeping roads in a stable and safe condition so that they continue to provide the needed design traffic service level and life expectancy. For purposes of this discussion, "operational roads maintenance (ORM)" is the maintenance level currently assigned to a county-maintained unpaved road, considering existing needs, road condition, budget constraints, and environmental concerns. It defines the level to which the road is currently being maintained.

ORM includes road preventative maintenance, minor restoration, and upkeep repairs; it excludes upgrade activities that significantly expand the capacity or change the original purpose of road assets. Road maintenance also includes activities required to meet applicable codes and regulations. Roads are considered fully maintained when road conditions meet the road management objectives. Replacement of existing structures, including culverts and bridges, is considered maintenance, while increasing culvert size or improving a bridge is considered improvement. ORM procedures discussed in the following subsections include road reconstruction, spot repairs, and roadside drainage.

4.1.2.1 Road Reconstruction

Road reconstruction refers to the mechanical rebuilding of existing road segments. Road reconstruction is the raising and reshaping of current degraded roads to an elevation and contour that will result in quick movement of runoff into established roadside drainage systems and provision of a cohesive road surface that will safely meet traffic requirements (Figure 4-5). Road improvement activities result in an increase in an existing road's traffic service level, expands its capacity, or changes its original design function.



Figure 4-5. CPB Road Reconstruction (Mike Rainer)

Reconstructive grading redistributes and recompacts the degraded road template and/or adds new road fill to create road elevations that are in compliance with the county ORM standards and specifications. This practice may also be used when repair of major surface deformations is necessary. Reconstruction generally involves rebuilding the roadway surface and/or subgrade. Heavy equipment may be used to rip the sub-grade and reestablish the road template. Typically a motor grader (or dozer) is used to reshape the road surface. Compaction is achieved by operating the construction equipment (crawlers, trucks, etc.) over the width of the road. Compaction of added surface fill material or redistribution of existing material ensures that the road surface removes runoff, which protects the road from degradation.

The primary source of road reconstruction and maintenance soil fill materials is clay or borrow pits (Figure 4-6). Frequently, clay pits are mined at locations where appropriate geologic layers were already exposed or in locations that required minimal excavation to reveal subsurface clay layers. Generally the slopes and terraces developed by stream systems provide areas of least resistance for accessing clay deposits. For this reason, some clay pits are adjacent or relatively close to streams and may be hydraulically linked to aquatic systems.



Figure 4-6. CPB County-Maintained Clay Pits (Mike Rainer)

4.1.2.2 Spot Road Repair

Spot road repair and maintenance is the use of surface deformation corrective measures on roads that are deemed hazardous to safety and road surface integrity. The purpose of spot road repair and maintenance is to focus resources and road repair activities on only the road segments that require attention. Spot road repair does not disturb road segments that do not require repair of surface deformations or reconstitution of a degraded surface. Surface deformations are primarily the result of inadequate road surface drainage, creating excessive moisture conditions in the road surface fill. Types of road surface deformations and repair techniques include the following:

- *Rutting* – Ruts are longitudinal depressions that weaken the road subgrade by channeling runoff and allowing standing water. These miniature channels collectively interrupt, collect, and redirect runoff. Even small ruts can dominate surface drainage. As the channelized water flows longitudinally, it increases in volume and velocity, which can result in road surface erosion. Rutting is corrected by road grading, surface compaction, and/or adding imported fill material.
- *Corrugating* – Road surface corrugation is the creation of ridges and depressions across the road surface caused by a lack of surface cohesion. Reduced surface material cohesion typically results from very dry conditions within the road surface that have caused the loss of fine road surface materials. Corrugations are generally repaired by road grading and surface compaction.
- *Depressions* – These are low areas in the road caused by settlement, excessive moisture content, and improper drainage. Depressions are repaired by road grading and surface compaction.
- *Potholes* – Potholes are voids in the road caused by excessive moisture, poor drainage, and/or poorly graded aggregate. Potholes are repaired by patching with fill, compacting, and/or spot grading. Road culverts (Section 4.4) may be required for low areas with chronic poor drainage.
- *Softspots* – Softspots are portions of the road weakened by poor drainage. Repair is achieved by improving drainage and/or adding better-draining fill material. Road culverts may be required for low area drainage.

Unpaved road grading and roadside ditching activities are the most common types of recurring road disturbances. ORM disturbances are often most frequent on CPB roads constructed on sandy soils, which lack the required strength and cohesiveness to support a stable roadway. Because these soils lack cohesiveness, washouts occur frequently on slopes and at stream crossings.

During scheduled unpaved road grading operations, one to two graders dress the road surface by redistributing road materials. As the grader blade scrapes the road, a thin layer of powdered sand-clay material is created over the roadway hardpack. Since grading operations are not followed by vibratory compactors or other stabilizing activities, the loose surface material that remains is readily suspended and transported by subsequent stormwater flows. Road maintenance grading operations then become a potential source of road material erosion and sediment generation. As unpaved road materials are graded to the sides of the roads and/or eroded by stormwater runoff, new sand-clay materials are added to rebuild the road elevation. Examples of CPB road grading operations are presented in Figures 4-7 and 4-8.



Figure 4-7. CPB Unpaved Road Grading (Mike Rainer)



Figure 4-8. CPB Freshly Graded Unpaved Roads (Mike Rainer)

4.1.2.3 Road Drainage

The construction and maintenance of a permanent roadside drainage system is a critical component of any road system. Proper drainage requires preventing the uncontrolled concentration of water and fostering the dispersal of water into stabilized land areas or protected stream channels. Failure or impairment of road drainage facilities is usually a factor in road-associated damage.

Road drainage should, if possible, discharge into natural drainage areas and/or stream discharge points only in nonconcentrated conditions. The greater infiltration rates of native soils, compared to compacted roads, and the soil binding and water transpiration rates of native woody and herbaceous vegetation make the use of native land drainways a preferred system of water disposal. The vegetated area that typically adjoins the right-of-way along a road can provide an effective natural attenuation area for dispersing and treating runoff.

Roadside drainage systems within the CPB watershed work areas generally fit into three categories: natural drainways, constructed roadside ditch systems, and false ditch systems. Natural drainways are used to promote the sheet flow dispersion of water into areas of standing grasses, forbs, shrubs, and trees and overground litter layers that subsequently act as effective infiltration sinks and filtering buffers. These zones are intended to be featureless,

in that the flow of water is allowed to move unencumbered off the road and into the natural, undisturbed drainage system of the adjoining lands. A drainway may be a relatively flat or gently sloping stand of timber, a wetland, a meadow, or a sloped stream riparian zone. Typically, a drainway system requires a road prism constructed to an elevation higher than adjacent natural ground. The construction of roadside natural drainways within the CPB is rare; in most cases they occur in areas where roads intersect river floodplains or other wetland landscapes. There are opportunities to reestablish natural drainways along roads where roadside grading berms are obstructing runoff discharge and on roads that incise the landscape insignificantly or sporadically (Section 7.5.11).

In areas not amenable to the use of native land as drainways, the construction and maintenance of water conveyance or ditch systems may be required. A road ditch is an excavated channel that intercepts and collects nonstream flow water that runs off a sloped road surface, as well as runoff contributions from the adjacent watershed (Figure 4-9). As important as it is to get water off the road as quickly and nonerosively as possible, it is equally important to provide for the transport and disposal of runoff. The purpose of a roadside ditch is twofold: 1) prevent water ponding alongside the road by moving runoff water to a designated discharge point, and 2) remove suspended sediments from the channelized runoff to the degree possible.



Figure 4-9. CPB Natural Drainway Roadside Drainage Systems (Mike Rainer)

Under certain conditions, ponded water can create a saturated road subgrade that results in severe road rutting, sedimentation, and/or movement of the road prism. It is, therefore, mandatory that road drainage ditches are constructed with a carrying capacity adequate for the intended water flows and that the channel surface is stabilized to the extent that it serves as a potential sediment sink and not a sediment source. Proper ditch function is based on the application of good hydraulic channel design and installation of in-channel erosion and runoff control features.

In contrast, constructed ditch systems within the CPB primarily serve as sediment sources and sinks. Ditches are typically cut into the roadside in a V shape without a shoulder buffer between the road prism and the ditch and are inadequately designed to accommodate water flows (Figure 4-10). Most often, these ditches have bare-ground bottoms with little or no vegetation to protect the integrity of the ditch system. Because of unabated erosion, these ditches require frequent maintenance and are often reestablished at the time of scheduled road grading activities, which removes any existing protective vegetation (Figure 4-11).



Figure 4-10. CPB Constructed Roadside Ditches (Mike Rainer)

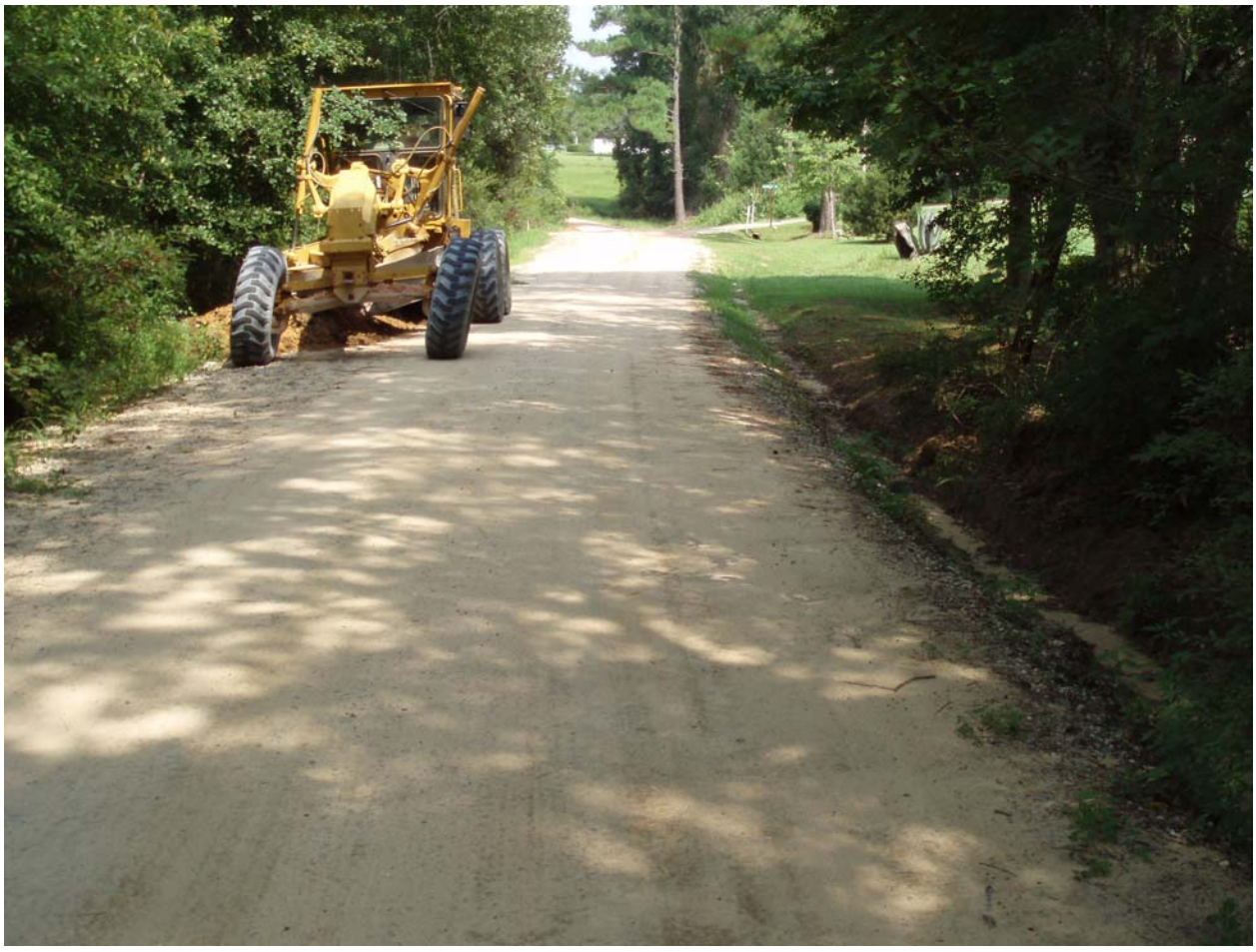


Figure 4-11. CPB Constructed Roadside Ditch Cleanout (Mike Rainer)

4.2 CROSSINGS TYPES

The CPB field surveys conducted for this assessment documented interaction between roads and waterways that require definition and clarification as to the human-induced connectivity between unpaved roads and impacted water resources. The traditional concept of a *crossing* is a road that encounters a flowing stream that is crossed by a bridge or culvert. Although this is a common road-stream interaction, there are other unpaved road network situations and water resource variables that do not fit this traditional scenario, yet can be equally significant in terms of potential impacts on aquatic resources.

Of particular importance to this assessment was quantifying the mechanics and potential waterway endpoint impacts of hydrology altered by unpaved road construction and maintenance. This includes the physical impacts of locating crossing structures within water courses; soil erosion from rain; and the interception, concentration, and directed discharge of stormwater runoff. Comprehensive analysis of the road-water resource interface required grouping road-water resource interactions into crossing types according to form and function. The crossing types identified within the CPB include water crossings, crossover sites, and proximity sites. CPB crossing types are discussed in the following subsections.

4.2.1 Water Crossing

A water crossing (WC) is the intersection and crossing of a waterway by an unpaved road either with or without paved road approaches. Sources of WC perennial, intermittent, or ephemeral water flows originate off-site and are not defined by road drainage features or conditions. The features that constitute a WC are the crossing structure, roadscape, and waterway. These components are discussed in Section 4.3.

The primary types of water crossings include bridges, culverts, and low-water crossings or fords (Figure 4-12). Bridges are typically the preferred WC for relatively large channels that experience frequent flooding and/or small streams that are sensitive fisheries habitats. Pipe culvert crossings are one of the most commonly used types of stream crossing structures that are easy to install and can provide long-term service if properly designed and maintained. Low-water crossings or fords allow vehicles to drive through the watercourse. The use of fords is applicable to small, low-water flow perennial or intermittent streams, particularly if road use is limited to the dry season when little or no water is flowing through the channel. Examples of CPB bridge and culvert water crossings are presented in Figure 4-13.

4.2.2 Crossover Site

A crossover site (CS) is a culvert that moves on-site stormwater runoff from one side of an unpaved road to a point of discharge on the other side of the road; CSs may be proximate to, but do not cross, waterways (Figure 4-14). These sites are characterized by sediment-laden runoff from both sides of the road that discharges into nearby waterways. The discharge point often evolves into gullies that create another source of sediment. As with other types of crossings, the volume and velocity of water flows and susceptibility of the roadway and adjacent roadside areas to erosion are directly related to the sediment impact potentials of CSs. Depending on the distance of CS discharge conveyance, off-site investigations may be required to determine the extent of hydrologic connectivity with aquatic resources and define associated environmental impacts. Examples of CPB crossover sites are presented in Figure 4-15.

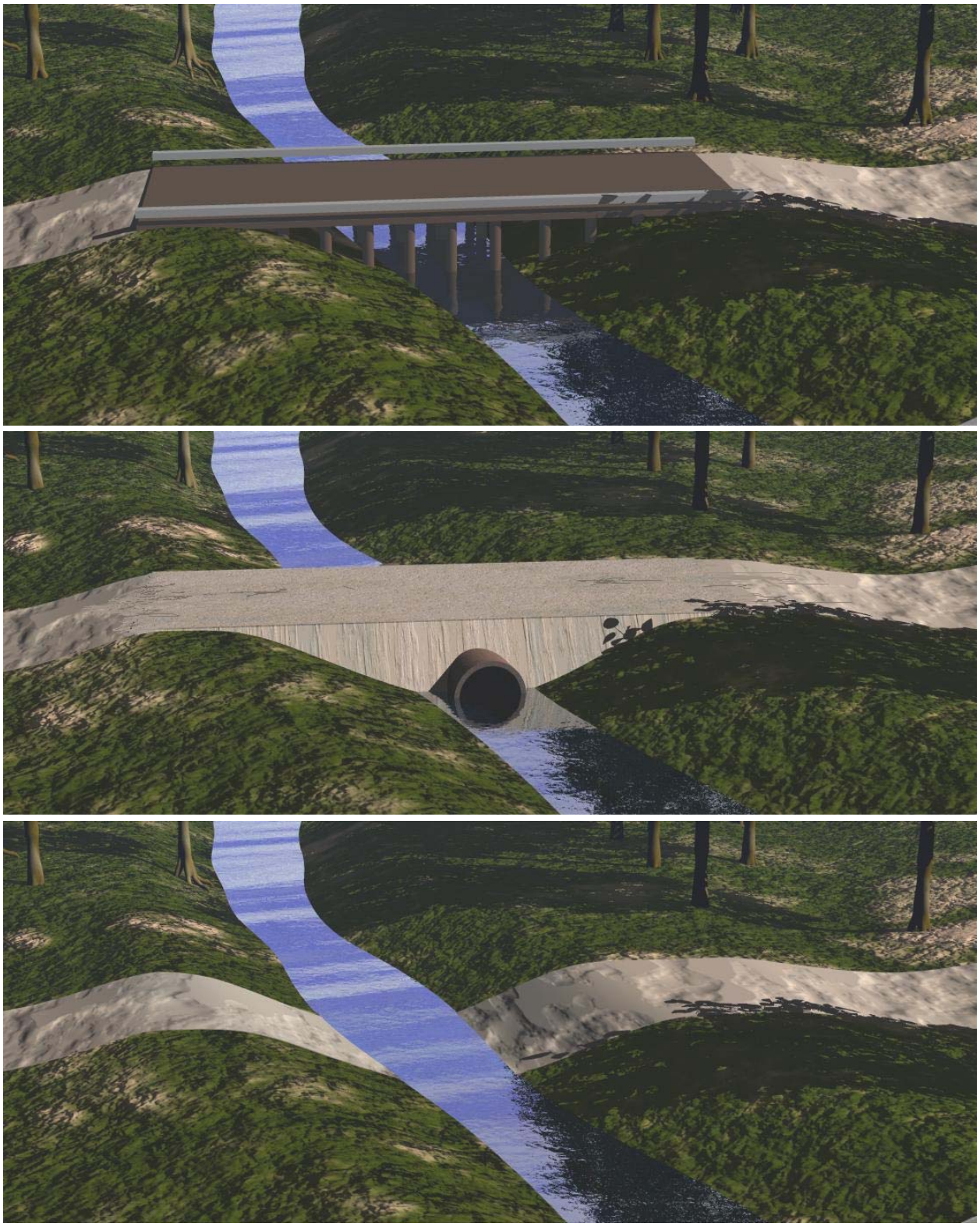


Figure 4-12. Bridge, Culvert, and Low-Water Crossings (David Rubino)



Figure 4-13. CPB Bridge and Culvert Water Crossings (Mike Rainer)

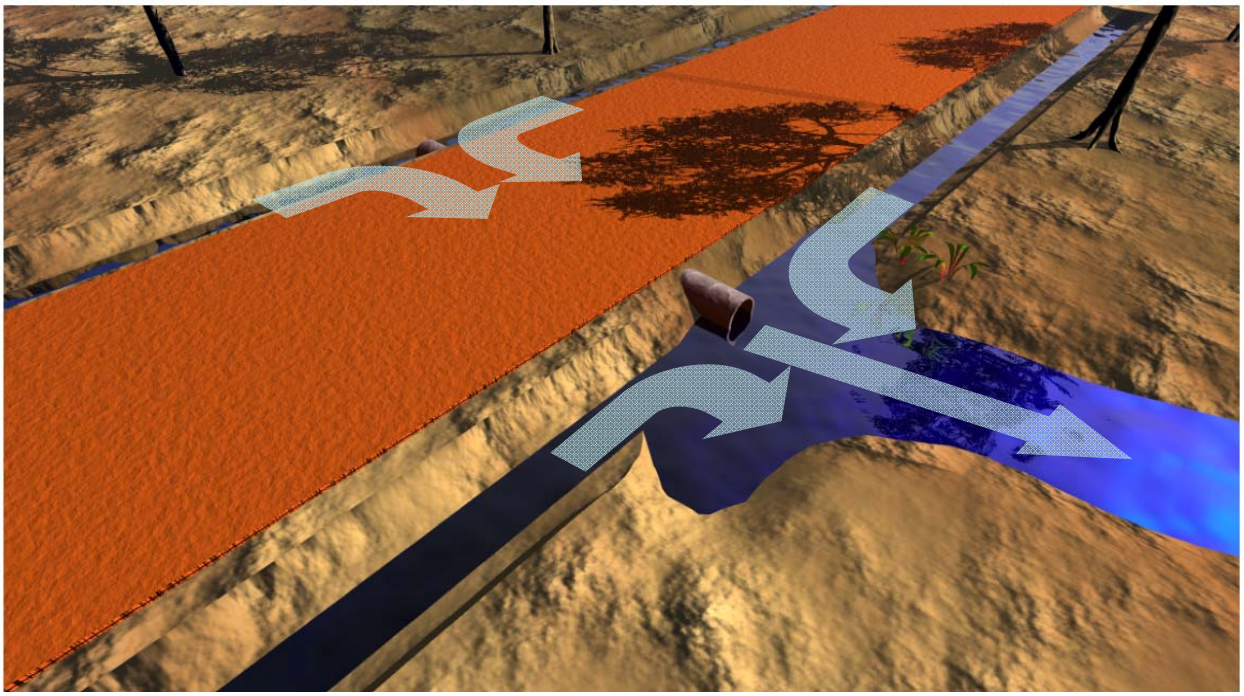


Figure 4-14. Crossover Site (David Rubino)



Figure 4-15. CPB Crossover Site Discharge Gullies (Mike Rainer)

4.2.3 Proximity Site

A proximity site (PS) is a nonstructural conveyance of unpaved road runoff to a discharge point that directly or indirectly intersects an off-site water body. PSs are proximate to, but do not cross, waterways (Figure 4-16). PSs often develop where roads intersect naturally occurring drainage patterns; however, in some cases, roadside discharge points are constructed to release ditch-confined water flows. The primary source of water flow is on-site stormwater runoff that is collected and transported downgradient by roadside drainage features. The source of runoff is typically generated by one or both roadside ditches (Figure 4-17). High-energy ditch runoff, when directed into improperly designed and located turnouts, may evolve into gullies. Depending on the distance of PS discharge conveyance, off-site investigations may be required to determine 1) the extent of hydrologic connectivity with aquatic resources and 2) define associated ecosystem impacts.

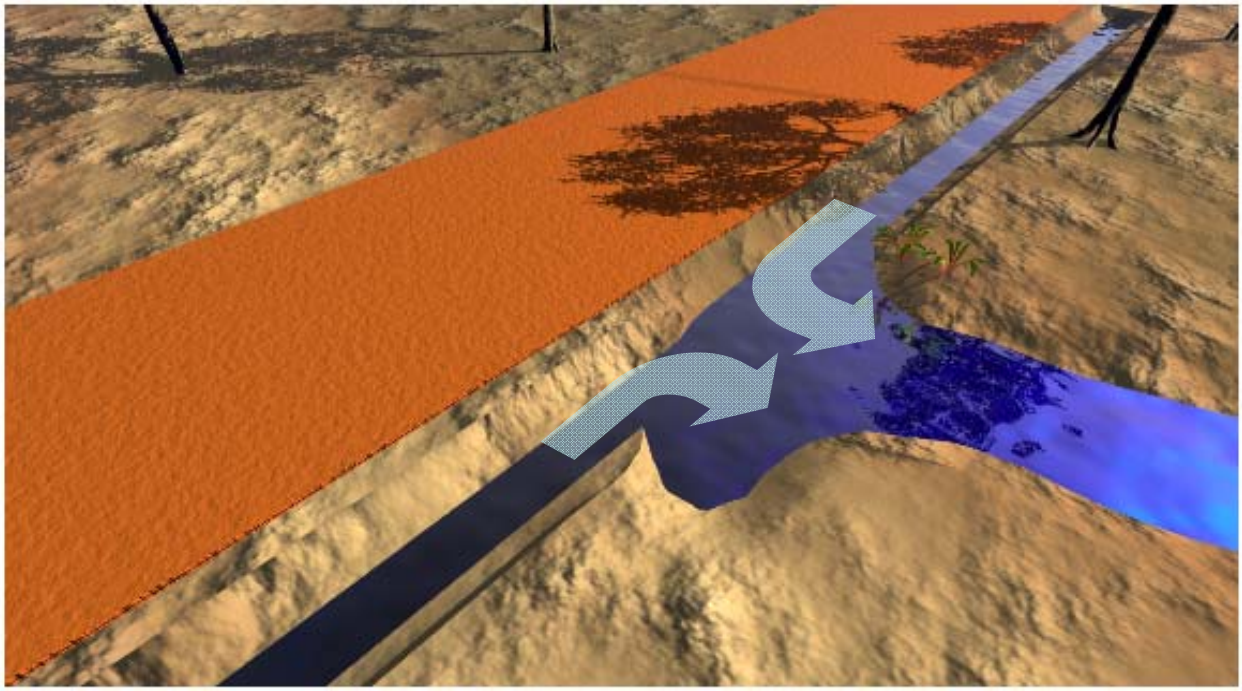


Figure 4-16. Proximity Site (David Rubino)



Figure 4-17. CPB Proximity Site Discharge Gullies (Mike Rainer)

4.3 CROSSING COMPONENTS

Crossing components are the man-made and natural features of the crossing. These features include the crossing structure, roadscape, and waterway. It is the connectivity and interactions of these crossing components that define prevailing environmental and maintenance conditions and issues. These components apply to WCs, CSs, and PSs.

4.3.1 Crossing Structure

The crossing structure includes the physical features that connect opposing unpaved road approaches and facilitate the movement of wheeled vehicles across intersected waterways. The primary types of WC structures include bridges, culverts, and low-water crossings or fords (Figures 4-12 and 4-13). Of these, culvert crossings are the most common, least expensive, and relatively easy to install and can have the greatest impact on waterway hydrology; a culvert crossing is essentially a dam with a hole in it. Low-water crossings allow vehicles to drive directly through the stream and are generally not considered for crossings that are used extensively. No CPB county-maintained ford crossings were identified.

4.3.2 Roadscape

The roadscape includes the crossing road approaches and the adjacent rights-of-way. The road approaches are maintained by the CPB counties as travelways for vehicles; roadsides may or may not be maintained by the counties.

4.3.2.1 Road Approaches

For purposes of this study, "road approaches" were considered to be county-maintained, unpaved road segments on each side of the crossing (Figure 4-18). The extent of each road approach was determined by the location of the hydrologic crest (HC), which identifies the upslope location where there is a break in water flows that move away from the crossing. The HC has a direct bearing on the magnitude of stormwater runoff that a crossing can generate. A road approach may be less than 100 feet or greater than a 1 mile in length. This hilltop-to-hilltop profile generally defines the physical extent of crossing maintenance activities (Figure 4-19). Road approaches may or may not have constructed roadside ditch systems to manage runoff.



Figure 4-18. Examples of CPB Bridge Crossing Road Approaches (Mike Rainer)

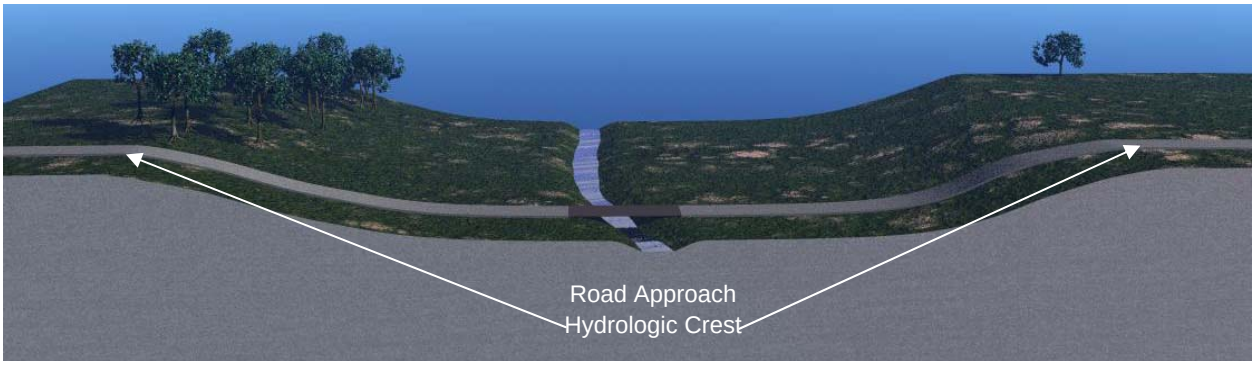


Figure 4-19. Illustration of a Crossing Profile (David Rubino)

4.3.2.2 Roadsides

Roadsides include the adjoining terrestrial and/or aquatic ecosystems that contribute runoff to or are potentially affected by crossing road approach features. In most instances, CPB unpaved roads are framed by right-of-way corridors. As applicable, the vegetation and surface configurations of these areas are often managed by county agencies to support drainage requirements and utilities. Roadsides may occur as natural, relatively undisturbed lands or areas that have been highly altered by agriculture, development, silviculture, and/or other land uses (Figure 4-20).



Figure 4-20. CPB Crossing Roadside Environments (Mike Rainer)

4.3.3 Waterways

Waterways include natural, modified, and constructed water confinement and conveyance features that may or may not have a defined channel and discernable water flows, as well as associated flora, fauna, and habitats. These features are generally classified as streams, wetlands, natural and artificial impoundments (ponds and lakes), and constructed drainage canals and ditches.

Crossing waterways are more than corridors that move water or impoundments that store water. They are as diverse as the purposes they serve; some water resource features remain relatively undisturbed by human activities, whereas others have been extensively altered from dredging and channelization activities. In most cases, human alteration of waterways was driven by changes in land uses for agriculture, silviculture, or development that required the

expedient removal of water. These CPB aquatic resources are interconnected, diverse, and valuable ecosystems that are innately linked to human well-being and the overall integrity of the environment. Examples of CPB waterways are presented in Figure 4-21.



Figure 4-21. CPB Crossing Waterways (Mike Rainer)

4.4 ROAD CULVERTS

In addition to road crossings, location data was also collected for road culverts identified during project field surveys. CPB road culverts are generally categorized as road drains, road flood relief culverts, and road wetland connectivity culverts. They differ from crossings in that these structures typically lack the road approach drainage and stream connectivity features that exemplify crossings.

4.4.1 Road Drains

Road drains (RDs) are pipe culverts buried under the road to transfer road drainage between roadside ditches (Figure 4-22); these pipes are for road system drainage and not stream water conveyance. Their purpose is to reduce stormwater runoff energy, reduce localized flooding, and prevent ditch flows from reaching erosive velocities. RDs are often used at road intersections and along road segments where the drainage overflows the ditch (Figure 4-23). An RD that discharges ditch runoff would be categorized as a CS crossing (Section 4.2.2).

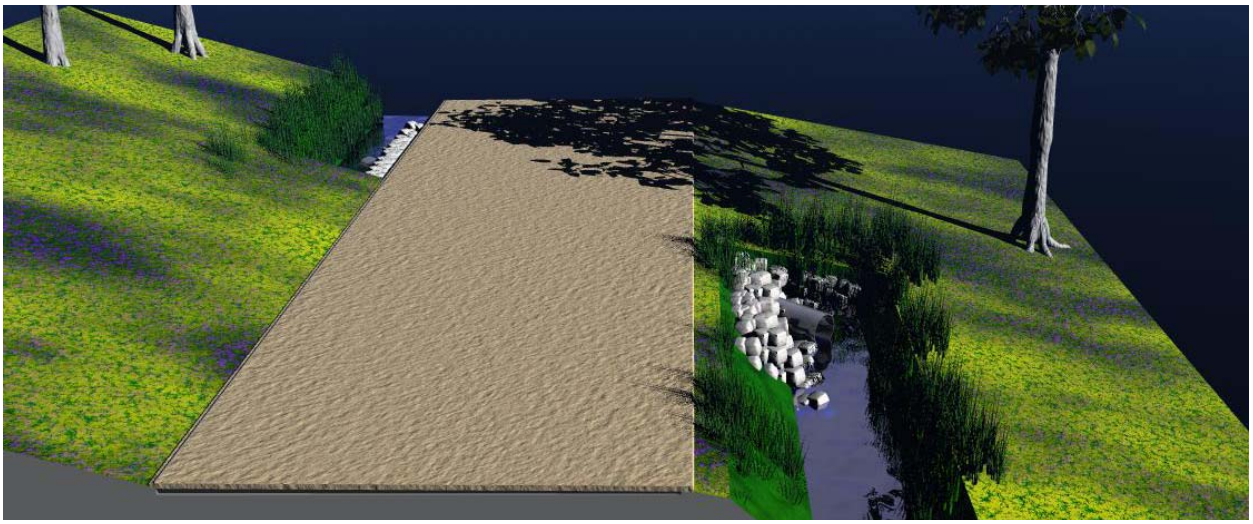


Figure 4-22. Ditch-to-Ditch Road Drain (David Rubino)



Figure 4-23. CPB Road Drain Culverts (Mike Rainer)

4.4.2 Road Flood Relief Culverts

Road flood relief culverts (FRCs) are installed in natural depression areas to minimize water impoundment during major flood events. Generally, these sites have no observed channel or wetland characteristics. FRCs may also occur at small legacy streams that have been significantly impacted by sedimentation and/or receding water tables. These sites no longer exhibit perennial water flows or well-defined channels and frequently exhibit dominant terrestrial vegetation. FRCs are frequently found near residential areas but may occur in any location where occasional flooding occurs (Figure 4-24).

4.4.3 Road Wetland Connectivity Culverts

Occasionally, CPB unpaved roads dissect wetlands and create physical barriers that impede the natural hydrology of the site. Culverts are placed under the roads to reestablish connectivity and permit water movement. Generally, the structures are intended to prevent road blowouts, reduce the effects of standing water on the roadbed, and/or minimize road overtopping during floods (Figure 4-25). For larger wetlands or crossings with broad floodplains, multiple culverts may be used to assist in relieving floodwater pressures on the road and crossing.



Figure 4-24. Opposing Landscape Views at a Road Flood Relief Culvert (Mike Rainer)



Figure 4-25. Opposing Landscape Views at Properly Functioning Wetland Connectivity Culverts (Mike Rainer)


Mike Rainer

CHAPTER FIVE

CROSSING CONDITIONS



This chapter describes and illustrates prominent Choctawhatchee-Pea Basin crossing conditions. These conditions represent the culmination of the historical and current human disturbances of unpaved road crossings on natural landscapes. The presence of these conditions can profoundly affect the forms and functions of aquatic and terrestrial ecosystems. A summary of potential environmental effects associated with these conditions is presented in Chapter 6.


Mike Rainer

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ACRONYMS

CKSS	Crossing Knowledge Support System
CPB	Choctawhatchee-Pea Basin
EPT	mayfly (Ephemeroptera), stonefly (Plecoptera) and caddisfly (Trichoptera)
FDEP	Florida Department of Environmental Protection
FI	Florida Index, listed clean water indicator
RCD	road cross drain
RZ	riparian zone
SB	Stream Bioassessment
SCI	Stream Condition Index



5. CROSSING CONDITIONS

5.1 INTRODUCTION

Each crossing within the Choctawhatchee-Pea Basin (CPB) differs in how it relates to surrounding environments. A number of variables determine the overall conditions of each crossing. Thus, presenting all possible crossing conditions is not practical. However, during the course of the project, a series of crossing structure, roadscape, and waterway conditions were identified as strongly influencing the relationships of crossings with CPB environments. CPB crossings are most often characterized by multiple combinations of these interactive conditions that collectively define the character and environmental issues for each crossing. The presence of a single condition or multiple conditions for a given crossing can have environmental repercussions ranging from minor to catastrophic. The economic impacts on county maintenance and traffic utility and safety can also be dramatic. The 26 CPB crossing conditions discussed in this chapter are listed in Table 5-1.

Table 5-1. Choctawhatchee-Pea Basin Crossing Conditions Summary

Crossing Condition	Section	Page Number
Crossing Structure		
Unstable Culvert Crossing Fill	5.2.1	5-2
Fish Barriers	5.2.2	5-6
Crossing Culvert Skew	5.2.3	5-9
Thalweg Crossing	5.2.4	5-11
Crossing Roadscape		
Road Approach Conditions	5.3.1	5-13
Loose Surface Roads	5.3.1.1	5-13
Flat Road Profile	5.3.1.2	5-15
Incised Roads	5.3.1.3	5-18
Steeply Sloped Roads	5.3.1.4	5-23
Inroad Erosion	5.3.1.5	5-26
Road Edge Erosion	5.3.1.6	5-31
Constructed Ditch Erosion	5.3.1.7	5-35
Road Drain Outlet Erosion	5.3.1.8	5-38
False Ditch Erosion	5.3.1.9	5-42
Roadside Grading Berms	5.3.1.10	5-46
Road Cross Drain Erosion – Crossover Site Crossing	5.3.1.11	5-50
Ditch Turnout Erosion – Proximity Site Crossing	5.3.1.12	5-55
Roadside Conditions	5.3.2	5-59
Roadside Erosion	5.3.2.1	5-59
Groundwater Seepage	5.3.2.2	5-62
Invasive Species	5.3.2.3	5-64
Crossing Waterway		
Sediment Plugs and Islands	5.4.1	5-66
Streambed Smothering	5.4.2	5-71
Crossing Cleanouts	5.4.3	5-73
Beaver Activity	5.4.4	5-80
Wetland Hydrology Disconnects	5.4.5	5-84
Disturbed Riparian Zones	5.4.6	5-87
Impaired Aquatic Ecosystems	5.4.7	5-90

The sources of crossing conditions data include the Crossing Knowledge Support System (CKSS) Phase I Crossing StreamX Field Reconnaissance (Section 1.5) and the Florida Department of Environmental Protection (FDEP) crossing stream bioassessments (Section 5.4.7).

Many of the crossing conditions presented herein, such as road approach conditions, may be temporal and transitory in nature – the point-in-time field observation may change with subsequent site visits. Intervening road maintenance activities may temporally mask or remove the visual indicators of the condition. However, the construction variables of the crossing structure and roadscape components provide clues as to the form and function of the crossing. For example, a road approach without a constructed roadside ditch system will be prone to false ditch and/or inroad erosion conditions; a crowned unpaved road approach without vegetative shoulders and relatively steep roadside ditch slopes will likely develop road edge rill and/or gully erosion features. Road maintenance grading may temporarily mask these conditions that will begin to redevelop with the first rain event.

The *Northwest Florida Road-Stream Crossings* website (https://www.gcsaic.com/streamx2) and *Choctawhatchee-Pea Basin Road-Stream Crossings Index* map (Appendix A) are provided to facilitate web access to detailed crossing site condition information and to quickly identify crossing condition locations and evaluate spatial juxtaposition at basin, subbasin, and watershed scales using the enclosed hardcopy reference map (see pocket insert).

5.2 CROSSING STRUCTURE CONDITIONS

The crossing structure, whether a bridge, culvert, or low-water crossing, and the condition of the structure can profoundly affect soil erosion and sedimentation potentials; this is especially evident with culvert crossings. The type and configuration of the crossing structure determines how it interacts with associated waterways. In contrast to the relatively benign interaction of bridges with waterways, crossing culvert structures are in constant contact with aquatic ecosystems. Upstream water flows are transported through crossing fill materials using fixed single or multiple pipe configurations. CPB crossing structure conditions of particular concern include unstable culvert crossing fill, fish barriers, and culvert skew.

5.2.1 Unstable Culvert Crossing Fill

Crossing fill instability occurs when the soil materials that cover crossing culverts are left exposed and unprotected against erosion and traffic. The near-vertical side slopes of many culvert fill structures increase susceptibility to sloughing and erosion from runoff and stream flows. Culvert installations generally include tens to hundreds of cubic yards of soil fill materials. Fill instability near the crossing culvert inlet and outlet are most common where crossing endwalls are not used. These hard structures provide added protection to the areas near the culvert that are most prone to disturbance by stream flows. Unprotected culvert fills are susceptible to runoff-induced erosion (Figure 5-1), and catastrophic culvert blowouts during floods can result in a 100 percent deposition of fill materials into receiving waterways. The 145 CPB culvert crossings with unstable fill conditions are listed in Table 5-2 and presented in Figure 5-2.



Figure 5-1. Choctawhatchee-Pea Basin Unstable Culvert Crossing Fill (Mike Rainer)

Table 5-2. Choctawhatchee-Pea Basin Culvert Crossings With Unstable Crossing Fill

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12131_585620_3402440	283A	Lake Juniper Drain	Walton	B2
12131_585653_3402149	269	West Sandy Creek		
12131_587694_3373832	741	Unnamed run		B4
12131_588597_3373858	739	Pate Branch		
12059_603513_3425625	47	Parrot Creek	Holmes	C1
12059_606105_3426458				
12059_600205_3421948	109	Fowler Branch		
12059_606026_3424697	94	Limestone Branch		
12059_599642_3405100	210	Otter Creek		C2
12059_596942_3408843				
12059_595677_3410137				
12059_594768_3410680				
12059_595243_3411442				
12059_606923_3411670	49F	Choctawhatchee River		
12059_593915_3415962	146	West Pittman Creek		
12059_597409_3417399	164	Timber Branch		
12059_592936_3404304	273	Parrish Creek		
12059_599227_3402110	298	Cow Branch		
12059_599918_3405410	270	Goose Branch		
12059_602102_3408645	212	Reedy Creek		
12059_605393_3398698				C3
12131_589556_3387946	343	Bruce Creek	Walton	
12131_594230_3388124				
12131_603917_3388406	49E	Choctawhatchee River		
12131_604086_3387915				
12005_599121_3361813	950	Otter Creek	Bay	C5
12059_620534_3419184	54	Wrights Creek	Holmes	D1
12059_615312_3424152	55	East Pittman Creek		
12059_619077_3427196				
12059_616641_3426004				
12059_610676_3428692	49F	Choctawhatchee River		
12059_623492_3419197	56	Tenmile Creek		
12059_616556_3427853	69	Unnamed branch		
12059_616749_3424615	108	Bee Branch		
12059_607182_3424350	94	Limestone Branch		
12059_622215_3403141	239	Gum Creek		D2
12059_630729_3419945	54	Wrights Creek		
12059_613793_3412809				
12059_612738_3415817	49F	Choctawhatchee River		
12059_622848_3418245	56	Tenmile Creek		
12059_617677_3408660	240	Hathaway Mill Creek		
12059_618673_3407170	261	Dram Branch		
12059_618284_3407130				
12133_618173_3404328			Washington	
12059_624966_3414933	206	Gum Branch	Holmes	
12133_614556_3400848	49	Choctawhatchee River	Washington	D3
12133_624733_3401517	286	Open Creek		
12133_608895_3371613	49B	Choctawhatchee River		D4
12133_609783_3382380	59	Holmes Creek		
12133_609327_3383958				
12059_631373_3425390	54	Wrights Creek	Holmes	E1
12059_633265_3428625				
12059_636401_3428218				
12059_624944_3426115	56	Tenmile Creek		
12059_625607_3427827				
12059_625131_3429532				
12059_625048_3419399				
12059_626736_3424561				
12059_627138_3424782				
12059_625102_3424144				
12059_627493_3422139				
12059_627131_3428070				
12059_631093_3427099	58	Mill Branch		
12059_635376_3420591	59	Holmes Creek		
12059_635621_3421345				
12059_637103_3421585				
12059_635966_3421964				

Table 5-2. Choctawhatchee-Pea Basin Culvert Crossings With Unstable Crossing Fill Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12059_635924_3422889	59	Holmes Creek	Holmes	E1
12059_639892_3429040				
12059_639280_3424444				
12059_637554_3421906				
12059_638102_3424551				
12059_637109_3424203				
12059_637141_3425027				
12059_637320_3425437				
12059_638749_3425969				
12063_638723_3421488			Jackson	
12059_637934_3427072	86	Bell Branch	Holmes	
12059_606356_3422560	119	Windmill Branch		
12063_641318_3423413	130	Fish Branch	Jackson	
12063_642168_3422706				
12063_642456_3421386				
12059_633958_3420481	139	Jackson Branch	Holmes	
12059_634725_3419557				
12063_639229_3418951	147	Gum Creek	Jackson	
12059_599786_3408536	205	Bay Drain	Holmes	
12059_601244_3399095	349	Mill Creek		
12059_626787_3415716	54	Wrights Creek		E2
12059_630541_3408083	59	Holmes Creek		
12059_632326_3409458				
12059_633049_3412290				
12059_630721_3406621				
12059_632870_3408534				
12059_633585_3415689				
12059_634528_3416459				
12059_632475_3418231				
12063_636081_3418138			Jackson	
12063_635313_3413275				
12063_641200_3414909	130	Fish Branch		
12063_641043_3413302				
12063_640949_3413184				
12063_637804_3415298	147	Gum Creek		
12059_628312_3407385	251	Camp Branch	Holmes	
12059_628565_3407554				
12059_627943_3408659				
12059_627555_3404690				
12059_627939_3404435				
12133_629502_3398783	59	Holmes Creek	Washington	E3
12133_630035_3399203				
12133_627090_3394392				
12133_627465_3394656				
12133_635561_3401290				
12133_633961_3399573				
12133_627510_3401084	286	Open Creek		
12133_642008_3397707	337	Flat Creek		
12133_641030_3396310				
12133_639810_3397108				
12133_635580_3396336				
12133_633249_3394653	401	Hard Labor Creek		
12133_639341_3387976				
12133_641691_3387683				
12133_635494_3387474	456	Reedy Creek		
12133_636881_3386512				
12133_636843_3386378				
12133_625875_3387015	501	Pippin Mill Creek		
12133_635833_3385174	456	Reedy Creek		E4
12133_632519_3384737	526	Pine Log Creek		
12133_633767_3384797				
12063_642760_3418963	130	Fish Branch	Jackson	F1
12063_644135_3419774				
12063_643582_3416447				F2
12063_642985_3417493				
12063_648745_3414522	195	Scurlock Creek		
12133_643054_3393049	346	Little Hard Labor Cr	Washington	F3

Table 5-2. Choctawhatchee-Pea Basin Culvert Crossings With Unstable Crossing Fill Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12133_643171_3387949	401	Hard Labor Creek	Washington	F3
12133_644049_3389298				
12133_642899_3388588				
12133_646316_3387889	490	Poley Creek		
Pea River Subbasin, HUC 03140202				
12131_575631_3428399	40A	Natural Bridge Creek	Walton	B1
12131_584738_3426399	43	Limestone Creek		
12131_585933_3428376				
12131_584945_3424329	66	Spring Branch		
12059_598029_3426302	63	Hurricane Creek	Holmes	C1
12059_598215_3426316				
12059_595068_3423954				

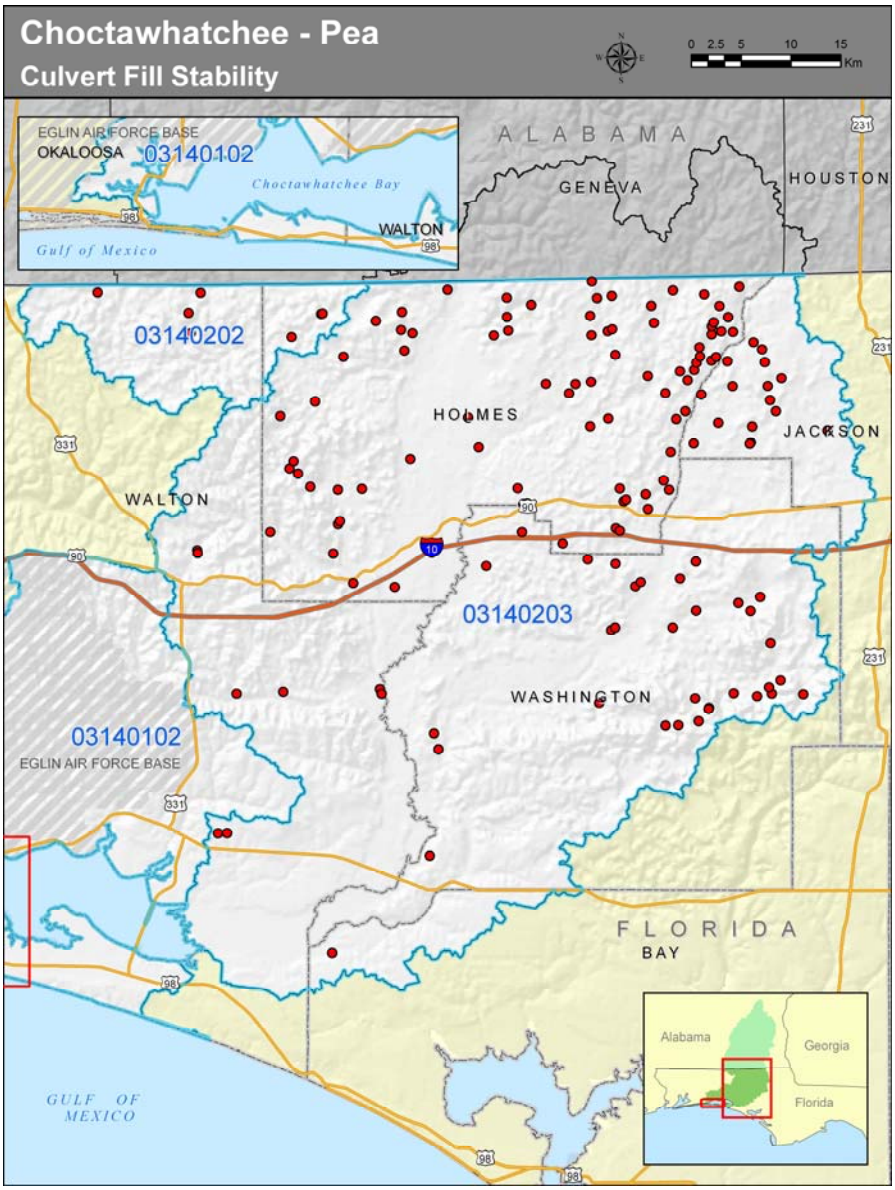


Figure 5-2. Choctawhatchee-Pea Basin Culvert Crossings With Unstable Fill Conditions (David Rubino)

5.2.2 Fish Barriers

Culvert crossings can function as physical barriers preventing movement of fish and other aquatic species between habitats. Culvert structures primarily impede movements because of their susceptibility to debris plugging during high flow periods and the potential for culvert misalignments with the stream channel. Substantial culvert outfall conditions can effectively exclude certain species from habitat areas (Figure 5-3). For rare and imperiled species, migration exclusion(s) from essential upstream habitat variables could be significant to species viability. In many fish, the burst swimming speed of individuals may be insufficient to overcome the elevation disparity of the bottom of the culvert and the stream water column below and/or the faster flow velocities within closed culvert pipes (Figure 5-4). Barriers to species movements may be temporary, partial, or complete.



Figure 5-3. Crossing Culvert Outlet Outfall



Figure 5-4. Choctawhatchee-Pea Basin Potential Fish Barriers (Mike Rainer)

Under temporary conditions, access to species habitat may be restricted to certain stream flow conditions; partial habitat access restriction impacts some species' movements within the watershed during part or all of the species life stages. At the extreme, complete habitat access restriction excludes all species movements within the watershed during all life stages and flow regimes. Primary characteristics of culvert crossings with poor fish passage characteristics include 1) a constricting natural channel width, 2) smothered or hardened streambeds that lack diverse substrates, 3) misaligned culverts, 4) culverts in poor physical condition, and 5) projecting inlets. Optimal culvert design for fish passage requires the magnitude, duration, frequency, and seasonal relationship of the flow and the timing of fish movements. In some cases, culverts are intentionally perched to create upstream impoundments on private lands. The 56 CPB potential culvert crossing fish barriers are listed in Table 5-3 and shown in Figure 5-5.

Table 5-3. Choctawhatchee-Pea Basin Culvert Crossing Potential Fish Barriers

Crossing Identification	WBID	WBID Name	County	Culvert Drop (feet)	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203					
12131_585620_3402440	283A	Lake Juniper Drain	Walton	>1	B2
12131_585614_3404688	269	West Sandy Creek		0.5	
12131_584870_3388458	486	Mill Creek			B3
12131_587694_3373832	741	Unnamed run			B4
12059_603513_3425625	47	Parrot Creek	Holmes		C1
12059_602167_3419934	146	West Pittman Creek			
12059_606111_3408200	49F	Choctawhatchee River			C2
12059_606923_3411670					
12059_595243_3411442	210	Otter Creek		>1	
12059_597988_3414206	146	West Pittman Creek		0.5	
12131_603548_3388701	49E	Choctawhatchee River	Walton		C3
12131_601129_3390936	399	Hughes Ditch			
12131_597017_3391508	441	Peavy Creek			
12131_598977_3390609	457	Spears Branch			
12131_590344_3373860	747	Unnamed creek		1	C4
12005_600965_3360125	950	Otter Creek	Bay	0.5	C5
12059_624597_3429579	56	Tenmile Creek	Holmes		D1
12059_622519_3419867	77	Little Creek		>1	
12059_607182_3424350	94	Limestone Branch		0.5	
12059_623019_3408453	239	Gum Creek			D2
12133_614556_3400848	49	Choctawhatchee River	Washington		D3
12133_612247_3396364	362	Yates Mill Creek		>1	
12133_611570_3380601	59	Holmes Creek		0.5	D4
12133_614218_3385675	545	Reedy Branch			
12059_631373_3425390	54	Wrights Creek	Holmes		E1
12059_625048_3419399	56	Tenmile Creek		>1	
12059_627138_3424782				0.5	
12059_631093_3427099	58	Mill Branch			
12059_635621_3421345	59	Holmes Creek			
12059_606356_3422560	119	Windmill Branch		>1	
12063_642168_3422706	130	Fish Branch	Jackson	0.5	E2
12059_619399_3419998	54	Wrights Creek	Holmes		
12133_629502_3398783	59	Holmes Creek	Washington		E3
12133_627465_3394656				>1	
12133_637101_3402004				0.5	
12133_641030_3396310	337	Flat Creek			
12133_639810_3397108				>1	
12133_639341_3387976	401	Hard Labor Creek		0.5	
12133_641691_3387683				1	
12133_635494_3387474	456	Reedy Creek		0.5	
12133_626142_3374258	526	Pine Log Creek			E4
12063_646364_3422088	123	Alligator Creek	Jackson	>1	F1
12063_643514_3419772	130	Fish Branch		0.5	
12133_644180_3408431	123	Alligator Creek	Washington	>1	F2
12063_643582_3416447	130	Fish Branch	Jackson		
12133_642967_3390542	346	Little Hard Labor Creek	Washington	0.5	F3
12133_644049_3389298	401	Hard Labor Creek		>1	
12133_646584_3388217	490	Poley Creek		0.5	

Table 5-3. Choctawhatchee-Pea Basin Culvert Crossing Potential Fish Barriers Cont'd

Crossing Identification	WBID	WBID Name	County	Culvert Drop (feet)	Index Map Grid
Pea River Subbasin, HUC 03140202					
12131_573354_3425249	40	Limestone Branch	Walton	0.5	B1
12131_579149_3425387	42	Eighteen Mile Creek			
12131_584186_3426376	43	Limestone Creek			
12059_598541_3424859	63	Hurricane Creek	Holmes		C1
12059_595068_3423954				>1	
Choctawhatchee Bay Subbasin, HUC 03140102					
12131_577085_3396991	332	Cosson Mill Creek	Walton	0.5	B3
12131_579859_3394231	369	Sconiers Mill Creek			
12131_574146_3364860	881	Direct runoff to bay			B5

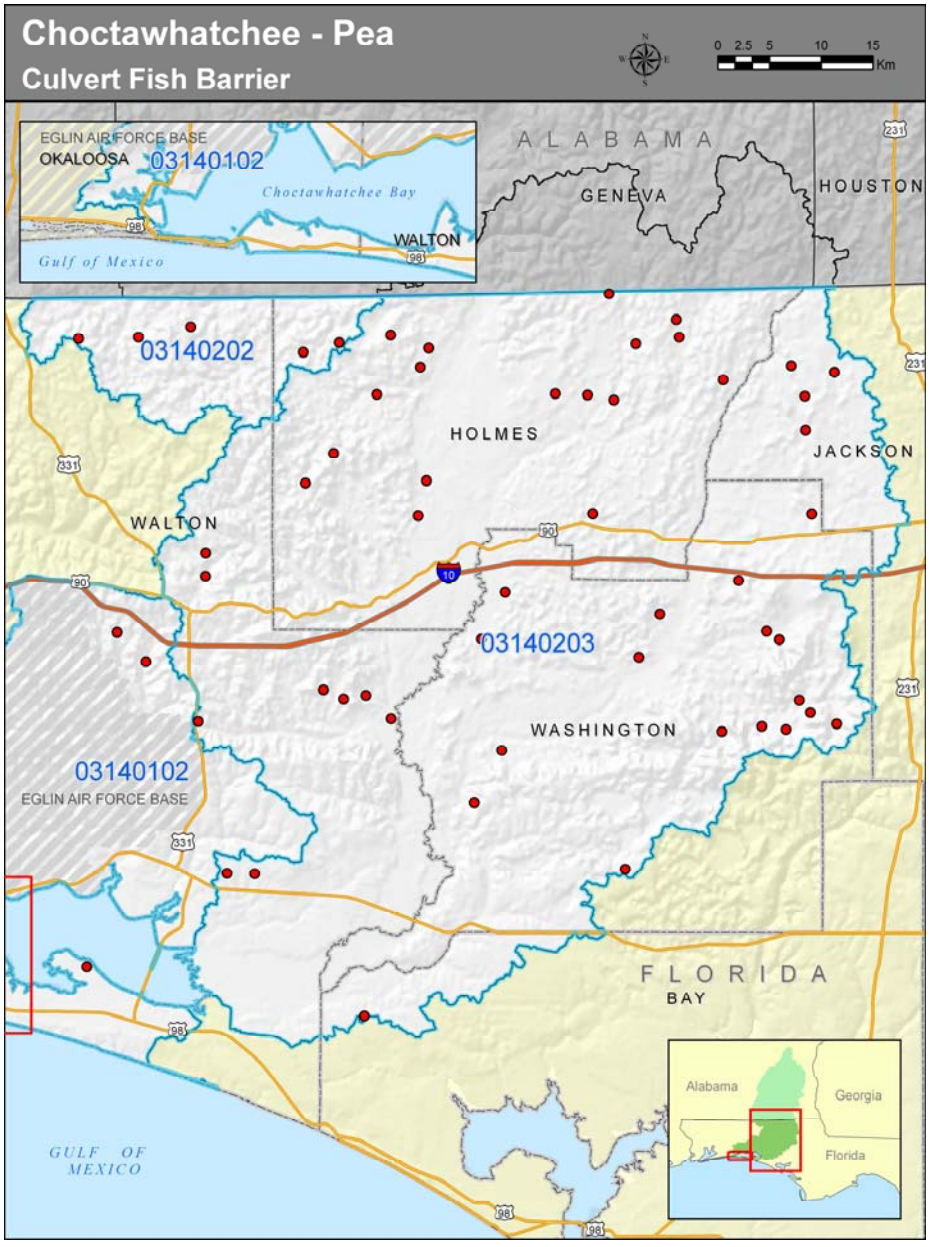


Figure 5-5. Choctawhatchee-Pea Basin Potential Culvert Crossings Fish Barriers

(David Rubino)

5.2.3 Crossing Culvert Skew

Crossing culverts may also be horizontally misaligned in relation to the water course. *Culvert skew* is the angle of the culvert inlet in relation to the centerline of the stream. Considering that flowing water does not like to turn angles, as the abrupt angle of culvert skew increases, so does the potential for water turbulence and damage. Depending on the interactions of other crossing variables, consequences may include increased stream flow velocities, streambank and crossing fill erosion, streambed scouring or sediment buildups, and/or culvert inlet plugging by woody debris. Inlet debris plugs can impound water, which could cause crossing structure overtopping and catastrophic blowout failure during floods. Generally, skews of 0 to 10 degrees are likely to have minor impacts; however, skews of 30 degrees or more are particularly vulnerable to damage (Figure 5-6). The 24 CPB crossings with culvert inlet skews of 30 degrees or more are listed in Table 5-4 and presented in Figure 5-7.



Figure 5-6. Choctawhatchee-Pea Basin Moderate and Severe Crossing Culvert Inlet Skew (Mike Rainer)

Table 5-4. Choctawhatchee-Pea Basin Culvert Crossings With Inlet Skews of 30 Percent or More

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12131_585644_3400896	269	West Sandy Creek	Walton	B3
12059_606111_3408200	49F	Choctawhatchee River	Holmes	C2
12059_595243_3411442	210	Otter Creek		
12131_592169_3387913	343	Bruce Creek	Walton	C3
12131_600477_3395891	366	Oak Grove Branch		
12131_597017_3391508	441	Peavy Creek		
12059_615312_3424152	55	East Pittman Creek	Holmes	D1
12059_623492_3419197	56	Tenmile Creek		
12133_615819_3402419	261	Dram Branch	Washington	D2
12133_611570_3380601	59	Holmes Creek		D4
12133_609849_3378843	651	Spring Run		
12059_627138_3424782	56	Tenmile Creek	Holmes	E1
12063_642456_3421386	130	Fish Branch	Jackson	
12059_632475_3418231	59	Holmes Creek	Holmes	E2
12063_640949_3413184	130	Fish Branch	Jackson	
12059_627555_3404690	251	Camp Branch	Holmes	
12133_630414_3397868	59	Holmes Creek	Washington	E3
12133_629502_3398783				
12133_630035_3399203				
12133_636881_3386512	456	Reedy Creek		
12133_631902_3387482	526	Pine Log Creek		
12063_642926_3422175	130	Fish Branch	Jackson	F1
Pea River Subbasin, HUC 03140202				
12131_571101_3428871	40	Limestone Branch	Walton	A1
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_577085_3396991	332	Cosson Mill Creek	Walton	B3

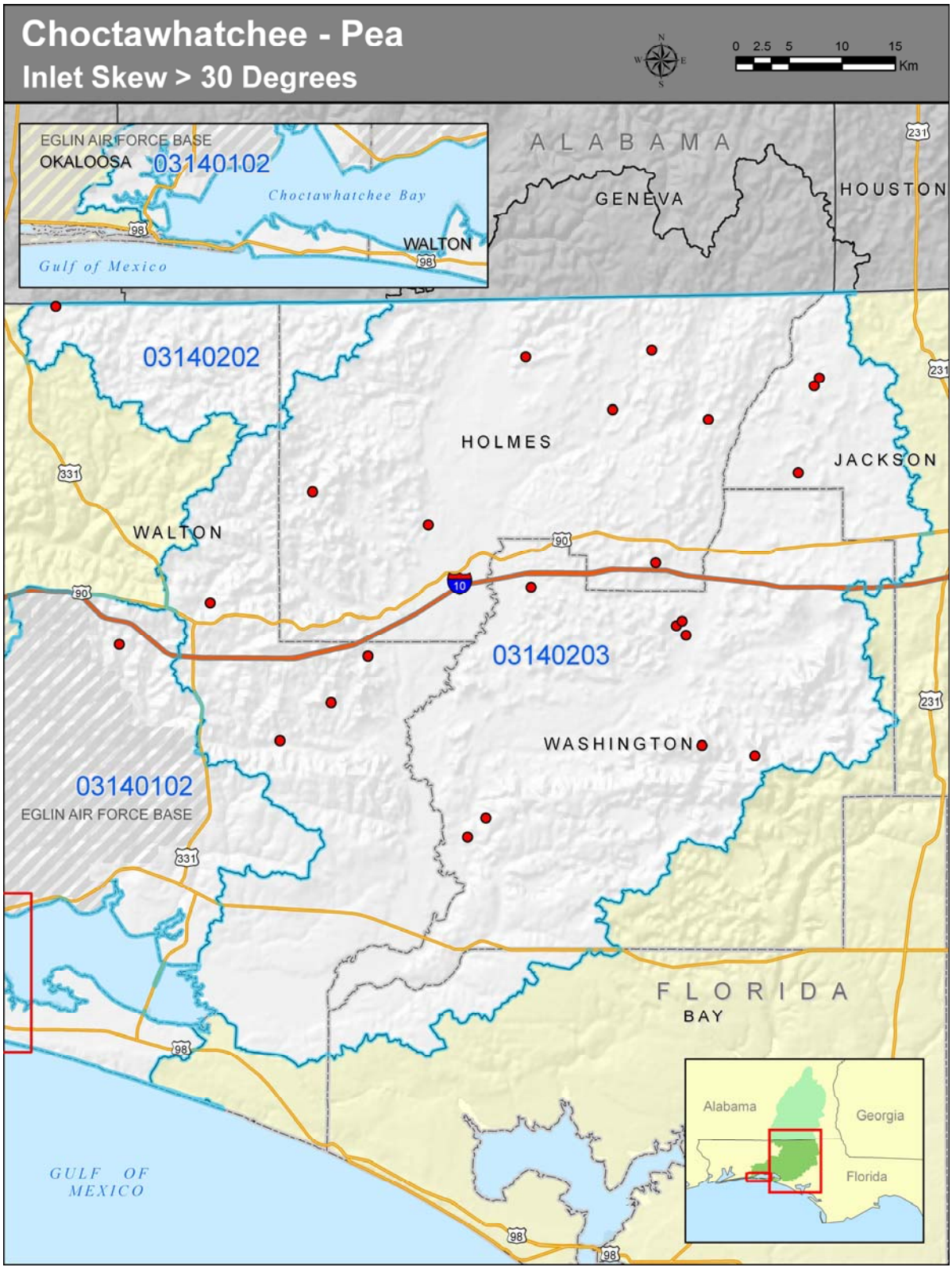


Figure 5-7. Choctawhatchee-Pea Basin Crossings With Estimated Culvert Inlet Skews of 30 Degrees or Greater (David Rubino)

5.2.4 Thalweg Crossing

For a given landscape area, stream and wetland drainage features generally occur at the lower elevations of the watershed. Transitions between slope gradients are less evident for terrain with relatively mild slopes, whereas hill and valley terrain of uplands can be dramatic. Since crossings occur at the intersections of roads and watercourses, they frequently occupy low points of the landscape. The position of crossing structures at the bottom of relatively steep slopes presents a number of problems. As illustrated in Figure 5-8, runoff and sediments flow directly to the crossing and are discharged over the crossing structure. In extreme cases, the structure becomes a repository for eroded road fill that eventually ends up in the stream. Road fill is also frequently deposited over thalweg crossing structures during road maintenance grading. These issues often require the use of elevated crossing structures.

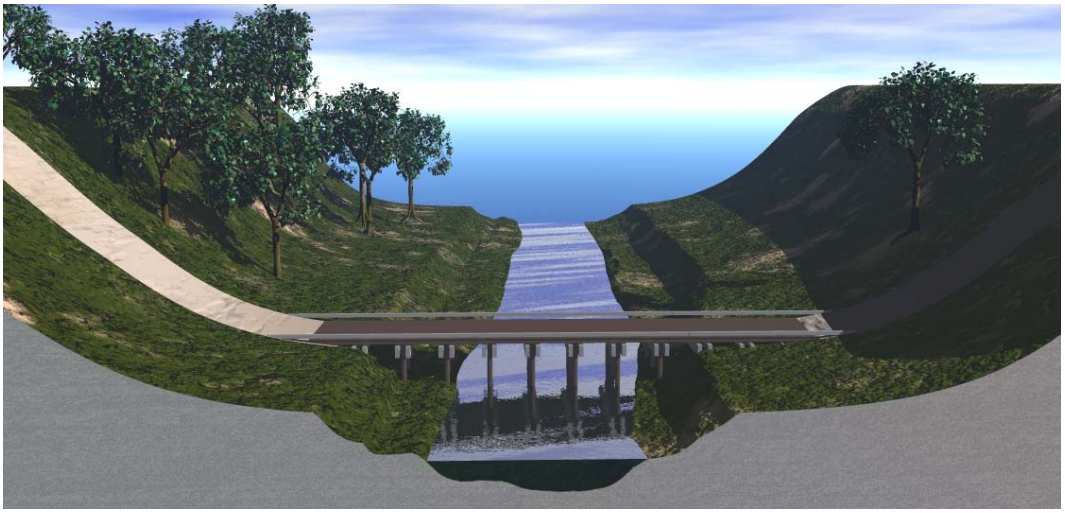


Figure 5-8. Thalweg Crossing Profile (David Rubino)

Crossing elevation raises the driving surface of the bridge or culvert so that the road approaches slope away from the structure, thereby preventing runoff from discharging at the crossing (Figure 5-9). This practice creates an elevated, level driving surface over the crossing that extends away from the crossing on both sides. The practice extends the life of the crossing structure and reduces sediment deposition over the structure. The 26 CPB water crossings with thalweg characteristics are listed in Table 5-5 and shown in Figure 5-10.



Figure 5-9. Crossing Elevation (David Rubino)

Table 5-5. Choctawhatchee-Pea Basin Thalweg Crossings

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12131_585614_3404688	269	West Sandy Creek	Walton	B2
12131_585644_3400896	269	West Sandy Creek		B3
12131_583070_3393990	350	Bay Branch		
12131_588901_3373806	739	Pate Branch		B4
12131_588597_3373858				
12059_603459_3420893	112	Angelico Branch	Holmes	C1
12059_606032_3421506	119	Windmill Branch		
12059_597409_3417399	164	Timber Branch		C2
12131_592387_3387504	343	Bruce Creek	Walton	C3
12131_594230_3388124				
12131_596073_3387582				
12005_600965_3360125	950	Otter Creek	Bay	C5
12059_621827_3422702	77	Little Creek	Holmes	D1
12059_619790_3417892	54	Wrights Creek		D2
12059_614624_3409574	240	Hathaway Mill Creek		
12063_641663_3417689	147	Gum Creek	Jackson	E2
12133_646259_3388743	490	Poley Creek	Washington	F3
Pea River Subbasin, HUC 03140202				
12131_573354_3425249	40	Limestone Branch	Walton	B1
12131_580828_3425985	42	Eighteen Mile Creek		
12131_580805_3428008	43	Limestone Creek		
12131_584945_3424329	66	Spring Branch		
12059_601030_3428689	46	Pea River	Holmes	C1
12059_596747_3427352	81	Mack Bay Branch		
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_580649_3395756	340	Kiser Branch	Walton	B3
12131_581412_3395702	369	Sconiers Mill Creek		
12131_580921_3395729				

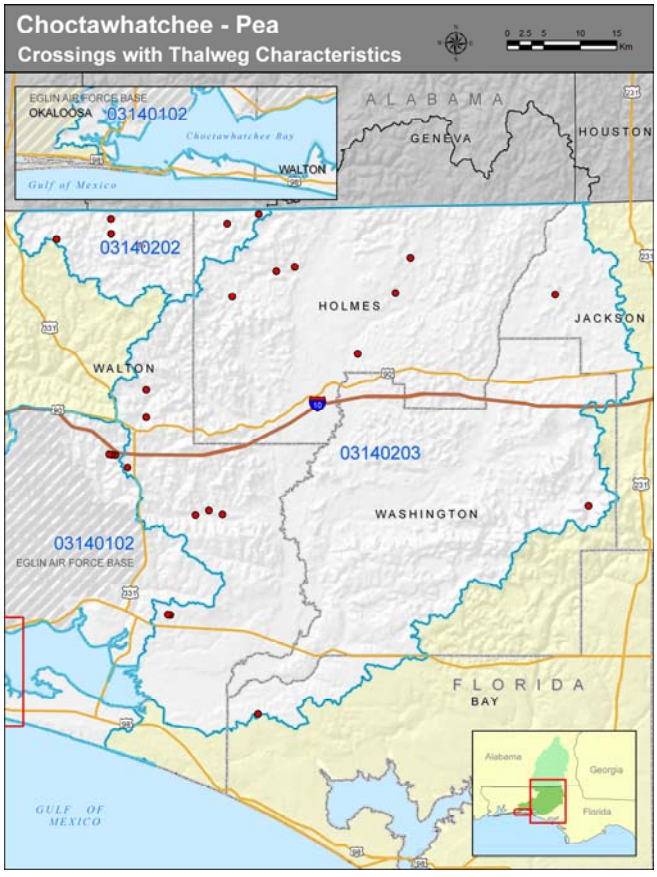


Figure 5-10. Choctawhatchee-Pea Basin Water Crossings With Thalweg Characteristics (David Rubino)

5.3 CROSSING ROADSCAPE CONDITIONS

Most county-maintained roadscapes for unpaved road crossings are active disturbance regimes that are in a constant state of flux from roadway and roadside maintenance. Generally, the extent of disturbance associated with a crossing will vary with its uses, road maintenance requirements, length of the road approaches, and width of roadside maintenance. The roadscape area tied to a particular crossing can extend linearly from a few hundred feet to over 1 mile over an area less than 1 acre to tens of acres in size. Considering the potential extent of disturbed area and its direct connectivity with waterway crossings, roadscapes can dramatically affect crossing conditions. Prominent CPB roadscape conditions are discussed in the following sections.

5.3.1 Road Approach Conditions

The crossing road approach includes the unpaved roadway used by vehicles and the extent of the road drainage system adjacent to the roadway. CPB crossing road approaches are generally characterized by stormwater and road maintenance regimes that continually alter the physical conditions of the road. These include loose surface roads, flat road profile, incised roads, steeply sloped roads, inroad erosion, road edge erosion, constructed ditch erosion, road drain outlet erosion, false ditch erosion, roadside grading berms, and ditch turnout erosion. All these road approach conditions can result in soil erosion and sedimentation.

5.3.1.1 Loose Surface Roads

Loose surface roads are characterized by noncompacted surface materials (Figure 5-11). Contributing factors include road location, construction, use, and/or maintenance. Roads constructed with native sandy soils or sandy/clay fill are inherently incohesive and frequently are incapable of sustaining a stable road matrix. Based on the surface type and maintenance requirements, roads may experience numerous grading operations over the course of a year to repair road damage. As a general rule, unpaved road surface soils are not compacted using specialized compaction equipment following maintenance grading; any road compaction occurs from the road grader and vehicle traffic. Roads with loose surfaces are highly prone to water erosion and deformation such as washboarding, rutting, and potholes. Nearly all CPB crossing road approaches surfaced with soil materials exhibited loose soil conditions. The 97 CPB crossings where very loose road surface conditions were observed are listed in Table 5-6 and shown in Figure 5-12.



Figure 5-11. Choctawhatchee-Pea Basin Loose Surface Roads (Mike Rainer)

Table 5-6. Choctawhatchee-Pea Basin Crossing With Very Loose Surface Roads

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12131_585614_3404688	269	West Sandy Creek	Walton	B2
12131_588901_3373806	739	Pate Branch		B4
12131_588597_3373858				
12131_587694_3373832	741	Unnamed run		
12131_594023_3392453	382	White Creek		C3
12131_598012_3391393	404	Crooked Creek		
12131_590344_3373860	747	Unnamed creek		C4
12131_590457_3373824				
12005_599121_3361813	950	Otter Creek	Bay	C5
12133_620666_3399722	239	Gum Creek	Washington	D3
12133_623909_3375974	526	Pine Log Creek		D4
12059_629231_3426838	61	Texas Branch	Holmes	E2
Pea River Subbasin, HUC 03140202				
12131_570318_3428215	40	Limestone Branch	Walton	A1
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_580186_3394422	369	Sconiers Mill Creek	Walton	B3



Figure 5-12. Choctawhatchee-Pea Basin Crossings With Estimated Very Loose Road Approach Surface Conditions (David Rubino)

5.3.1.2 Flat Road Profile

Although crowned roads are the most common type of CPB road surface design, some unpaved roads have flat surfaces, particularly in the southern portion of the CPB where soils that are sandy throughout their profile are most common (Figure 5-13). The incohesive nature of the sands makes the development and maintenance of a stable crowned road profile difficult. Roads with flat profiles are frequently bordered by roadside grading berms (Section 5.3.1.10) and lack a road drainage system. Under these conditions, the road becomes a large drainage ditch that often exhibits false ditches (Section 5.3.1.9) and severe inroad erosion (Section 5.3.1.5). The 102 CPB crossings where one or both road approaches had predominantly flat surface profiles are listed in Table 5-7 and shown in Figure 5-14.



Figure 5-13. Choctawhatchee-Pea Basin Roads With Graded Flat Profiles (Mike Rainer)

Table 5-7. Choctawhatchee-Pea Basin Crossings With Flat Road Profiles

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12131_585614_3404688	269	West Sandy Creek	Walton	B2
12131_585653_3402149				
12131_585620_3402440	283A	Lake Juniper Drain		
12131_585644_3400896	269	West Sandy Creek		B3
12131_588846_3392706	343	Bruce Creek		
12131_588597_3373858	739	Pate Branch		B4
12131_588901_3373806				
12131_587694_3373832	741	Unnamed run		
12059_602307_3426910	47	Parrot Creek	Holmes	C1
12059_606105_3426458				
12059_605717_3429264				
12059_605805_3428211				
12059_600205_3421948	109	Fowler Branch		
12059_606032_3421506	119	Windmill Branch		
12059_606703_3421024	126	Dada Branch		
12059_598568_3418405	146	West Pittman Creek		
12059_598113_3416255				C2
12059_598980_3417165				
12059_594768_3410680	210	Otter Creek		
12059_595243_3411442				
12059_601908_3413431	212	Reedy Creek		
12131_603917_3388406	49E	Choctawhatchee River	Walton	C3
12131_604086_3387915				
12131_603548_3388701				
12131_602720_3391759	178	Sandy Creek		
12131_592169_3387913	343	Bruce Creek		
12131_592407_3387439				
12131_590198_3391114	371	Panther Creek		
12131_596880_3388321	382	White Creek		
12131_598012_3391393	404	Crooked Creek		
12131_597017_3391508	441	Peavy Creek		

Table 5-7. Choctawhatchee-Pea Basin Crossings With Flat Road Profiles Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12131_590457_3373824	747	Unnamed creek	Walton	C4
12133_604043_3366921	49B	Choctawhatchee River	Washington	C5
12005_601942_3362462	950	Otter Creek	Bay	
12005_600965_3360125				
12005_599121_3361813				
12005_599190_3361962				
12059_609588_3426163	47	Parrot Creek	Holmes	D1
12059_608364_3427017				
12059_610676_3428692	49F	Choctawhatchee River		
12059_620534_3419184	54	Wrights Creek		
12059_632432_3427383				
12059_622519_3419867	77	Little Creek		
12059_607182_3424350	94	Limestone Branch		
12059_607716_3410489	49F	Choctawhatchee River		D2
12059_623817_3413615	54	Wrights Creek		
12059_622848_3418245	56	Tenmile Creek		
12059_628994_3407640	232	Unnamed drain		
12059_619270_3409939	240	Hathaway Mill Creek		
12133_616501_3396220	239	Gum Creek	Washington	D3
12133_608657_3371568	49B	Choctawhatchee River		D4
12133_608963_3371801				
12133_609327_3383958	59	Holmes Creek		
12133_623909_3375974	526	Pine Log Creek		
12059_625607_3427827	56	Tenmile Creek	Holmes	E1
12059_635376_3420591	59	Holmes Creek		
12059_638798_3423643				
12063_638723_3421488			Jackson	
12059_637934_3427072	86	Bell Branch	Holmes	
12059_634725_3419557	139	Jackson Branch		
12059_599786_3408536	205	Bay Drain		
12059_624250_3414951	54	Wrights Creek		E2
12133_634872_3410545	59	Holmes Creek	Washington	
12133_634790_3411395				
12063_641200_3414909	130	Fish Branch	Jackson	
12133_635561_3401290	59	Holmes Creek	Washington	E3
12133_641030_3396310	337	Flat Creek		
12133_640400_3396919				
12133_639437_3389888	401	Hard Labor Creek		
12133_641691_3387683				
12133_642465_3390661	455	Davis Branch		
12133_626142_3374258	526	Pine Log Creek		E4
12133_630809_3381381				
12063_646364_3422088	123	Alligator Creek	Jackson	F1
12063_643514_3419772	130	Fish Branch		
12063_644237_3419882				
12063_646228_3417776	123	Alligator Creek		F2
12063_642985_3417493	130	Fish Branch		
12063_647255_3409221	233	Unnamed creek		
12063_650607_3404144	262	Gilberts Mill Creek		
12063_649215_3408107				
12133_643054_3393049	346	Little Hard Labor Creek	Washington	F3
12133_642967_3390542				
12133_643171_3387949	401	Hard Labor Creek		
12133_644049_3389298				
12133_642899_3388588				
12133_647019_3392581				
12133_646259_3388743	490	Poley Creek		
Pea River Subbasin, HUC 03140202				
12059_601754_3428790	46	Pea River	Holmes	C1
12059_598029_3426302	63	Hurricane Creek		
12059_598541_3424859				
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_577085_3396991	332	Cosson Mill Creek	Walton	B3
12131_578634_3396546				
12131_580649_3395756	340	Kiser Branch		
12131_580186_3394422	369	Sconiers Mill Creek		
12131_579859_3394231				
12131_579533_3394149				

Table 5-7. Choctawhatchee-Pea Basin Crossings With Flat Road Profiles Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Choctawhatchee Bay Subbasin, HUC 03140102 Cont'd				
12131_576836_3375767	351A	Alaqua Creek	Walton	B4
12131_578852_3375630				
12131_571853_3360706	881	Direct runoff to bay		B5
12131_573913_3362924				
12131_574146_3364860				

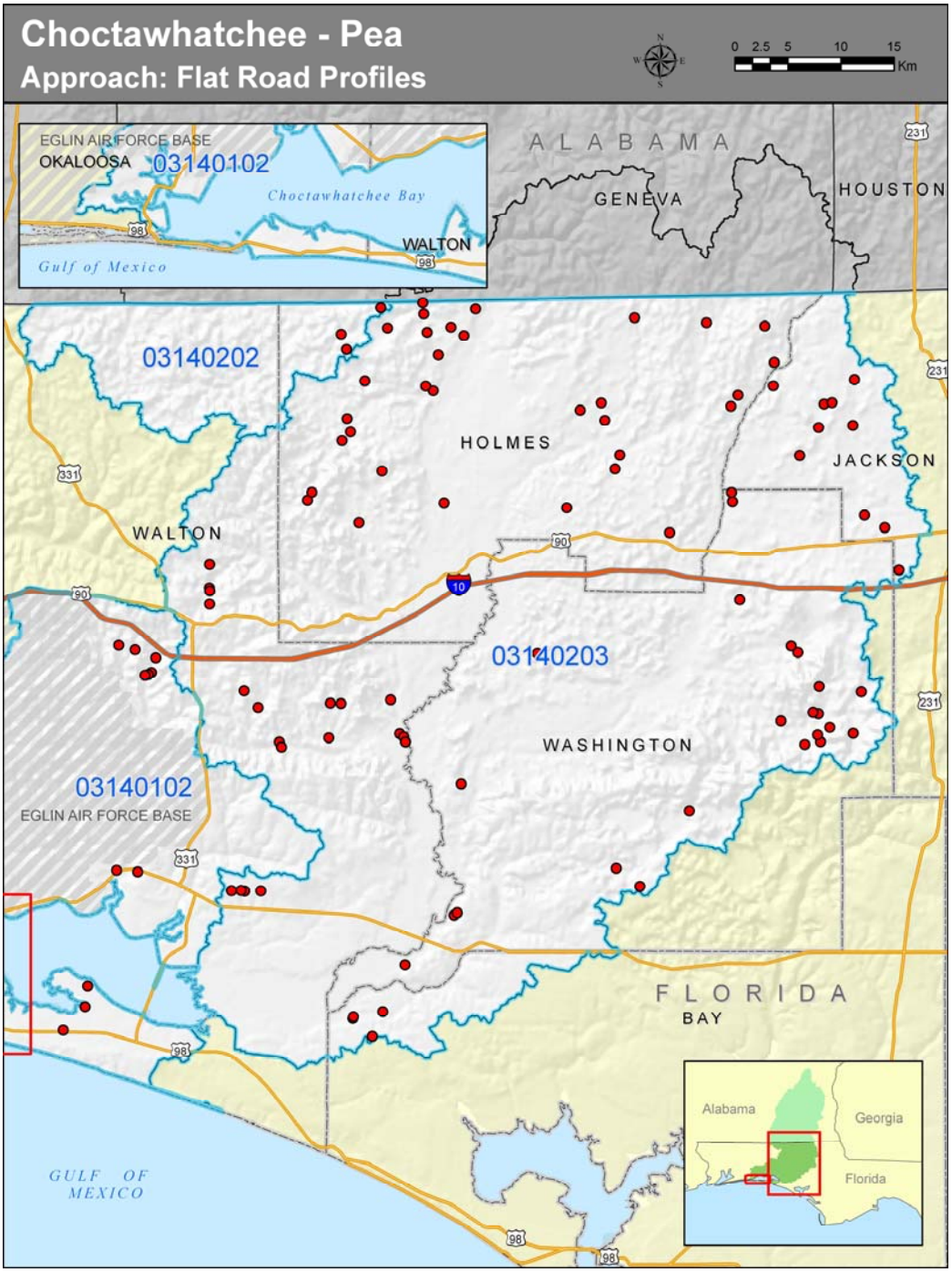


Figure 5-14. Choctawhatchee-Pea Basin Crossings With Flat Road Profiles (David Rubino)

5.3.1.3 Incised Roads

Road incision is a condition in which the elevation of the roadway is below the elevation of adjacent natural ground; the depth of incision can range from less than 1 foot to tens of feet. This condition is generally the result of decades of erosion that has lowered the road elevation. As the road becomes entrenched, stormwater runoff that enters the road becomes trapped, converting the road into a ditch. Historical roads, roads constructed on steep slopes, and improperly maintained roads often evolve into incised roads. Incised roads usually have vertical cutbanks bordering each side of the road and exhibit extensive water flows within the traveled portion of the roadway.

The depth of road incision can range from a minor difference of 1 foot or less to significant incisions that are often characterized by nearly vertical roadside cutbanks and elevation differentiations of tens of feet between the top of the road prism and the surface of natural ground (Figures 5-15 and 5-16). The character of the road incision may vary dramatically along the crossing road approach. Near the stream crossing the road may be at, above, or only slightly below natural ground, whereas the depth of incision as the road intersects upland slope contours moving away from the crossing may exhibit an exaggerated pattern of broken depths by several feet. The pattern of road approach incision is therefore directly related to the slope variables of the impacted landscape(s).



Figure 5-15. Choctawhatchee-Pea Basin Moderately Incised Roads With Unstable Cutbanks (Mike Rainer)



Figure 5-16. Choctawhatchee-Pea Basin Deeply Incised Roads with Unstable Cutbanks (Mike Rainer)

The transition between the surface of the incised road and the adjoining landscapes can vary from mild side slopes to vertical cutbanks. Generally, as the depth of incision increases, so does the trend towards roadside cutbank features. Depending on site disturbance and geomorphological parameters, these features may become stabilized or continue to degrade. Stabilized cutbanks typically exhibit vegetation and various types of moss and fungi that hold

the soil in place (Figure 5-17). In contrast, unstable cutbanks are void of vegetation and show signs of mass soil sloughing and erosion. Road cutbanks impacted by groundwater seepage, spring discharge, or roadside ditch water flows are normally unable to maintain stable slope profiles (Figure 5-18).



Figure 5-17. Choctawhatchee-Pea Basin Incised Roads With Stabilized Cutbanks (Mike Rainer)



Figure 5-18. Unstable Choctawhatchee-Pea Basin Roadside Cutbanks (Mike Rainer)

Frequently, road incision prevents the use of practices such as turnouts, crossover pipes, and other drainage features to manage the collection and discharge of stormwater runoff. Without accommodations for discharging runoff into adjacent areas, water flows become concentrated, with the road resulting in further erosion and sediment generation.

The 131 CPB water crossings with an average road approach incision of 3 to 5 feet and 12 crossings with an average incision of greater than 5 feet are listed in Table 5-8 and presented in Figure 5-19. For CPB water crossings, the overall average road approach incision was 2 feet below natural ground.

Table 5-8. Choctawhatchee-Pea Basin Crossing Incision

Crossing Identification	WBID	WBID Name	County	Incision (feet)	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203					
12131_587566_3412505	178	Sandy Creek	Walton	3-5	B2
12131_587757_3390255	343	Bruce Creek			B3
12131_588111_3390200					
12131_585279_3388430	486	Mill Creek			
12059_606105_3426458	47	Parrot Creek	Holmes		C1
12059_606026_3424697	94	Limestone Branch			
12059_606032_3421506	119	Windmill Branch		>5	

Table 5-8. Choctawhatchee-Pea Basin Crossing Incision Cont'd

Crossing Identification	WBID	WBID Name	County	Incision (feet)	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd					
12059_603459_3420893	112	Angelico Branch	Holmes	3-5	C1
12059_598885_3420183	136	Pine Log Creek			
12059_606243_3410154	49F	Choctawhatchee River			C2
12059_593553_3415873	146	West Pittman Creek			
12059_593915_3415962					
12059_598113_3416255					
12059_597988_3414206					
12059_598980_3417165					
12059_597409_3417399	164	Timber Branch			
12059_596942_3408843	210	Otter Creek		>5	
12059_595677_3410137				3-5	
12059_594768_3410680					
12059_601172_3408729	212	Reedy Creek			
12059_593982_3404088	249	Padgett Creek		>5	
12059_596249_3404471	289	Black Branch		3-5	
12059_596707_3404240					
12059_599227_3402110	298	Cow Branch			
12131_602720_3391759	178	Sandy Creek	Walton		C3
12059_605393_3398698	212	Reedy Creek	Holmes		
12059_602867_3405332				>5	
12131_600312_3387259	343	Bruce Creek	Walton	3-5	
12131_589556_3387946					
12131_592169_3387913					
12131_592387_3387504					
12131_592407_3387439					
12131_596073_3387582					
12059_601141_3398948	349	Mill Creek	Holmes		
12131_595137_3393850	373	White Creek	Walton		
12131_596880_3388321	382	White Creek			
12131_595982_3394340					
12131_598012_3391393	404	Crooked Creek			
12131_598977_3390609	457	Spears Branch			
12131_598106_3388730					
12005_599121_3361813	950	Otter Creek	Bay		C5
12059_608751_3428168	47	Parrot Creek	Holmes		D1
12059_615788_3428702	48	Whitewater Branch		>5	
12059_615206_3428824				3-5	
12059_614478_3428556					
12059_610676_3428692	49F	Choctawhatchee River			
12059_615312_3424152	55	East Pittman Creek			
12059_619077_3427196					
12059_616641_3426004					
12059_620441_3428234					
12059_620977_3426932					
12059_615802_3425995	69	Unnamed branch			
12059_616556_3427853				>5	
12059_608330_3424331	94	Limestone Branch		3-5	
12059_607182_3424350					
12059_616749_3424615	108	Bee Branch			
12059_615200_3423100	121	Little Creek		>5	
12059_607716_3410489	49F	Choctawhatchee River		3-5	D2
12059_619470_3412825	54	Wrights Creek			
12059_619790_3417892					
12059_623817_3413615					
12059_624157_3414952					
12059_623019_3408453	239	Gum Creek			
12133_620568_3404818			Washington		
12059_619270_3409939	240	Hathaway Mill Creek	Holmes		
12059_614624_3409574					
12133_618173_3404328	261	Dram Branch	Washington		
12133_615537_3402016				>5	
12133_615819_3402419				3-5	
12059_624503_3405170	286	Open Creek	Holmes		
12133_614932_3398772	239	Gum Creek	Washington		D3
12133_620666_3399722				>5	
12133_620956_3401344				3-5	
12133_616501_3396220					

Table 5-8. Choctawhatchee-Pea Basin Crossing Incision Cont'd

Crossing Identification	WBID	WBID Name	County	Incision (feet)	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd					
12133_624814_3395782	348	Gully Creek	Washington	3-5	D3
12133_608657_3371568	49B	Choctawhatchee River			D4
12133_611506_3381437	59	Holmes Creek		>5	
12059_619565_3428353	53	Clark Mill Creek	Holmes	3-5	E1
12059_625115_3419525	54	Wrights Creek			
12059_631373_3425390					
12059_631786_3422866					
12059_633090_3429287					
12059_636667_3429703					
12059_626690_3419538					
12059_627131_3428070	56	Tenmile Creek			
12059_625607_3427827					
12059_625131_3429532					
12059_624895_3419454					
12059_626549_3422359					
12059_626736_3424561					
12059_635376_3420591	59	Holmes Creek			
12059_635621_3421345					
12059_640825_3429170					
12059_641905_3429936					
12059_637554_3421906					
12059_637934_3427072	86	Bell Branch			
12059_633525_3425328	103	Corbett Branch			
12059_630038_3423411	113	Register Branch			
12063_641318_3423413	130	Fish Branch	Jackson		
12063_642456_3421386					
12059_633958_3420481	139	Jackson Branch	Holmes		
12059_634725_3419557					
12063_640089_3420588	147	Gum Creek	Jackson		
12059_631631_3417650	54	Wrights Creek	Holmes		E2
12059_630721_3406621	59	Holmes Creek			
12059_633585_3415689					
12059_629231_3426838	61	Texas Branch			
12063_641200_3414909	130	Fish Branch	Jackson		
12063_641663_3417689	147	Gum Creek			
12133_633961_3399573	59	Holmes Creek	Washington		E3
12133_635580_3396336	337	Flat Creek			
12133_635494_3387474	456	Reedy Creek			
12133_636843_3386378					
12133_625875_3387015	501	Pippin Mill Creek			
12133_631902_3387482	526	Pine Log Creek			
12133_635833_3385174	456	Reedy Creek			E4
12133_632519_3384737	526	Pine Log Creek			
12133_633767_3384797					
12063_646844_3416549	157	Little Alligator Creek	Jackson		F2
12133_644049_3389298	401	Hard Labor Creek	Washington		F3
12133_647019_3392581					
Pea River Subbasin, HUC 03140202					
12131_571101_3428871	40	Limestone Branch	Walton	3-5	A1
12131_573354_3425249					B1
12131_574345_3425295	42	Eighteen Mile Creek			
12131_579195_3426192					
12131_580828_3425985					
12131_585703_3428652	43	Limestone Creek			
12131_584945_3424329	66	Spring Branch			
12131_591261_3428489	43	Limestone Creek			C1
12059_601030_3428689	46	Pea River	Holmes		
=12059_599869_3428008	63	Hurricane Creek			
12059_598029_3426302					
12059_598215_3426316					
12059_598541_3424859					
12059_595068_3423954					
12059_596747_3427352	81	Mack Bay Branch			

Table 5-8. Choctawhatchee-Pea Basin Crossing Incision Cont'd

Crossing Identification	WBID	WBID Name	County	Incision (feet)	Index Map Grid
Choctawhatchee Bay Subbasin, HUC 03140102					
12131_578634_3396546	332	Cosson Mill Creek	Walton	3-5	B3
12131_578062_3396628					
12131_580649_3395756	340	Kiser Branch		>5	
12131_581412_3395702	369	Sconiers Mill Creek		3-5	
12131_580921_3395729				>5	
12131_580773_3395720				3-5	
12131_578852_3375630	351A	Alaqua Creek			B4

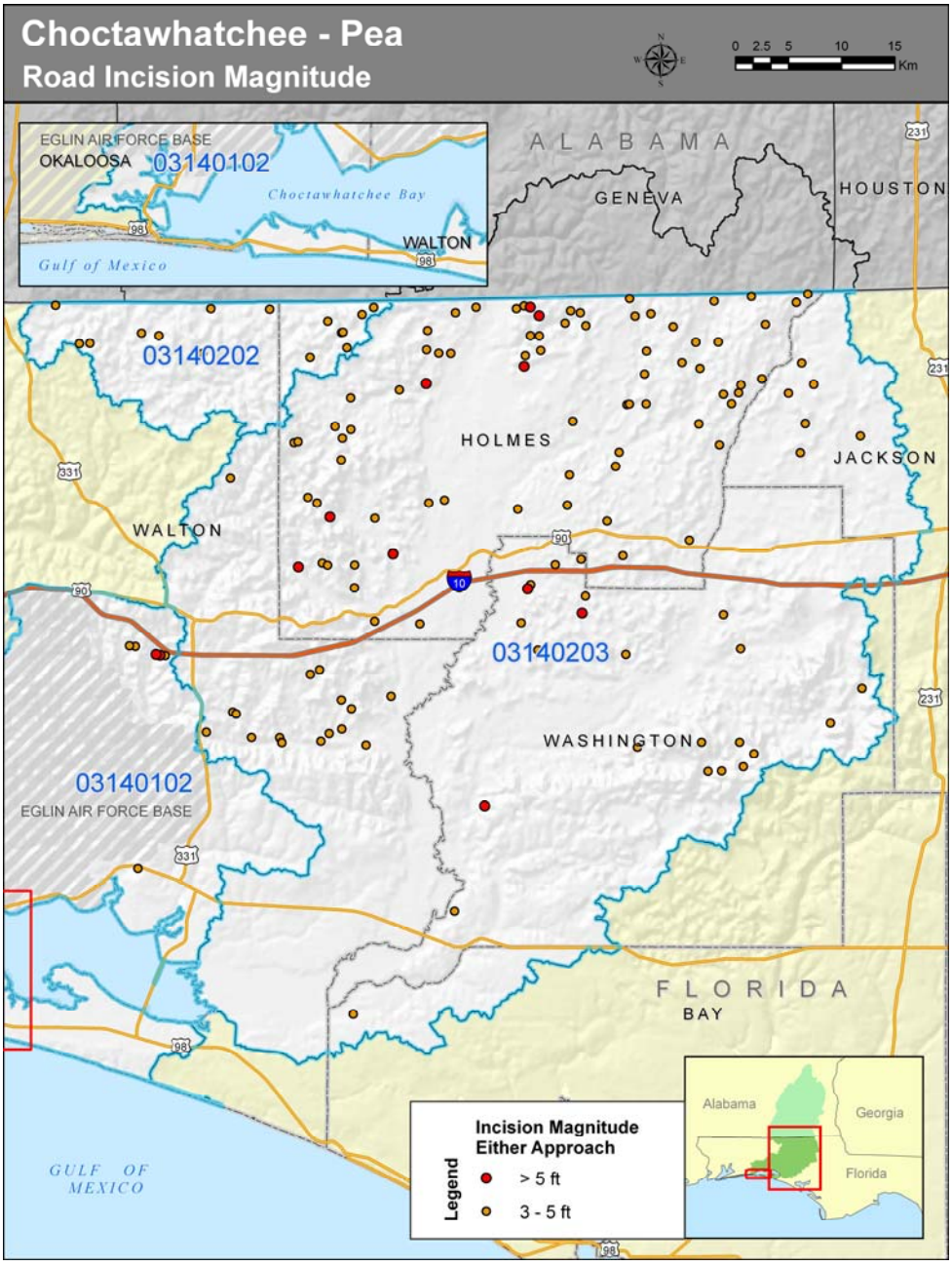


Figure 5-19. Choctawhatchee-Pea Basin Water Crossings With Estimated Averaged Road Incision of 3 to 5 Feet and Greater Than 5 Feet David Rubino)

5.3.1.4 Steeply Sloped Roads

As would be expected, increases in unpaved road slope gradients and length can significantly affect soil erosion and sedimentation potentials. It has been observed that CPB road approach slopes greater than 5 percent, coupled with slope lengths greater that 500 feet, frequently produce highly erosive roadway conditions. Although most CPB crossing road approach slopes have gradients of 5 percent or less, the density of roads within the CPB landscape ensures that unpaved roads with critically steep slopes do occur. Historically, some roads were constructed in straight lines following township and range line boundaries, regardless of the landscape features encountered, which often resulted in roads that were constructed over steep slopes (Figure 5-20).



Figure 5-20. Choctawhatchee-Pea Basin Steep (>10 percent) Crossing Road Approaches (Mike Rainer)

Note that the steepness of a crossing road approach cannot be used as an exclusive indicator of road erosion susceptibility. Some locations where steep roads occur have become incised, which often exposes geologic layers with clayey soils or cemented sands that tend to bind into a cohesive matrix. Under the right conditions, these soil layers may inherently resist erosion, and the soils may provide a more cohesive road base than imported soils with high sand/silt content.

Thus, an unpaved road approach at a location with a naturally occurring, very sandy soil on a relatively mild slope may be just as susceptible to sediment generation and transport as a road approach on a clayey steep slope. These conditions highlight the fact that crossings are a dynamic interaction of diverse variables, the combination of which can produce atypical conditions. There were 55 CPB water crossings with estimated road approach slope gradients averaging 5 to 10 percent and 3 crossings with road approach gradients averaging greater than 10 percent (Table 5-9 and Figure 5-21).

Table 5-9. Choctawhatchee-Pea Basin Crossing Road Gradients

Crossing Identification	WBID	WBID Name	County	Slope (Percent)	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203					
12131_587566_3412505	178	Sandy Creek	Walton	5-10	B2
12131_585614_3404688	269	West Sandy Creek			
12131_585644_3400896					B3
12131_588111_3390200	343	Bruce Creek			
12131_585279_3388430	486	Mill Creek			
12131_588901_3373806	739	Pate Branch			B4
12059_606026_3424697	94	Limestone Branch	Holmes		C1
12059_606032_3421506	119	Windmill Branch			
12059_593982_3404088	249	Padgett Creek			C2
12059_596707_3404240	289	Black Branch			
12131_589556_3387946	343	Bruce Creek	Walton		C3
12131_592407_3387439					
12131_598977_3390609	457	Spears Branch			
12131_595982_3394340	382	White Creek			
12131_590344_3373860	747	Unnamed creek			C4
12131_590457_3373824					
12059_615788_3428702	48	Whitewater Branch	Holmes		D1
12059_615206_3428824					
12059_614478_3428556				>10	
12059_616556_3427853	69	Unnamed branch		5-10	
12059_607182_3424350	94	Limestone Branch			
12059_616749_3424615	108	Bee Branch			
12059_615200_3423100	121	Little Creek			
12059_623817_3413615	54	Wrights Creek			D2
12059_624157_3414952					
12059_619470_3412825					
12059_623019_3408453	239	Gum Creek			
12059_614624_3409574	240	Hathaway Mill Creek			
12133_618173_3404328	261	Dram Branch	Washington		
12133_615537_3402016					
12133_615819_3402419					
12133_620666_3399722	239	Gum Creek		>10	D3
12059_619565_3428353	53	Clark Mill Creek	Holmes	5-10	E1
12059_626690_3419538	54	Wrights Creek			
12059_636667_3429703					
12059_631786_3422866					
12059_637934_3427072	86	Bell Branch			
12059_633525_3425328	103	Corbett Branch			
12059_633958_3420481	139	Jackson Branch			
12059_634725_3419557					
12059_635539_3419224					
12059_629231_3426838	61	Texas Branch			E2
12133_639437_3389888	401	Hard Labor Creek	Washington		E3
12133_625875_3387015	501	Pippin Mill Creek			
12133_633767_3384797	526	Pine Log Creek			E4
12133_632519_3384737					
12133_646584_3388217	490	Poley Creek			F3
12133_646259_3388743				>10	
Pea River Subbasin, HUC 03140202					
12059_596747_3427352	81	Mack Bay Branch	Holmes	5-10	C1
12059_601754_3428790	46	Pea River			
Choctawhatchee Bay Subbasin, HUC 03140102					
12131_578634_3396546	332	Cosson Mill Creek	Walton	5-10	B3
12131_578062_3396628					
12131_579533_3394149	369	Sconiers Mill Creek			
12131_580921_3395729					
12131_578852_3375630	351A	Alaqua Creek			B4

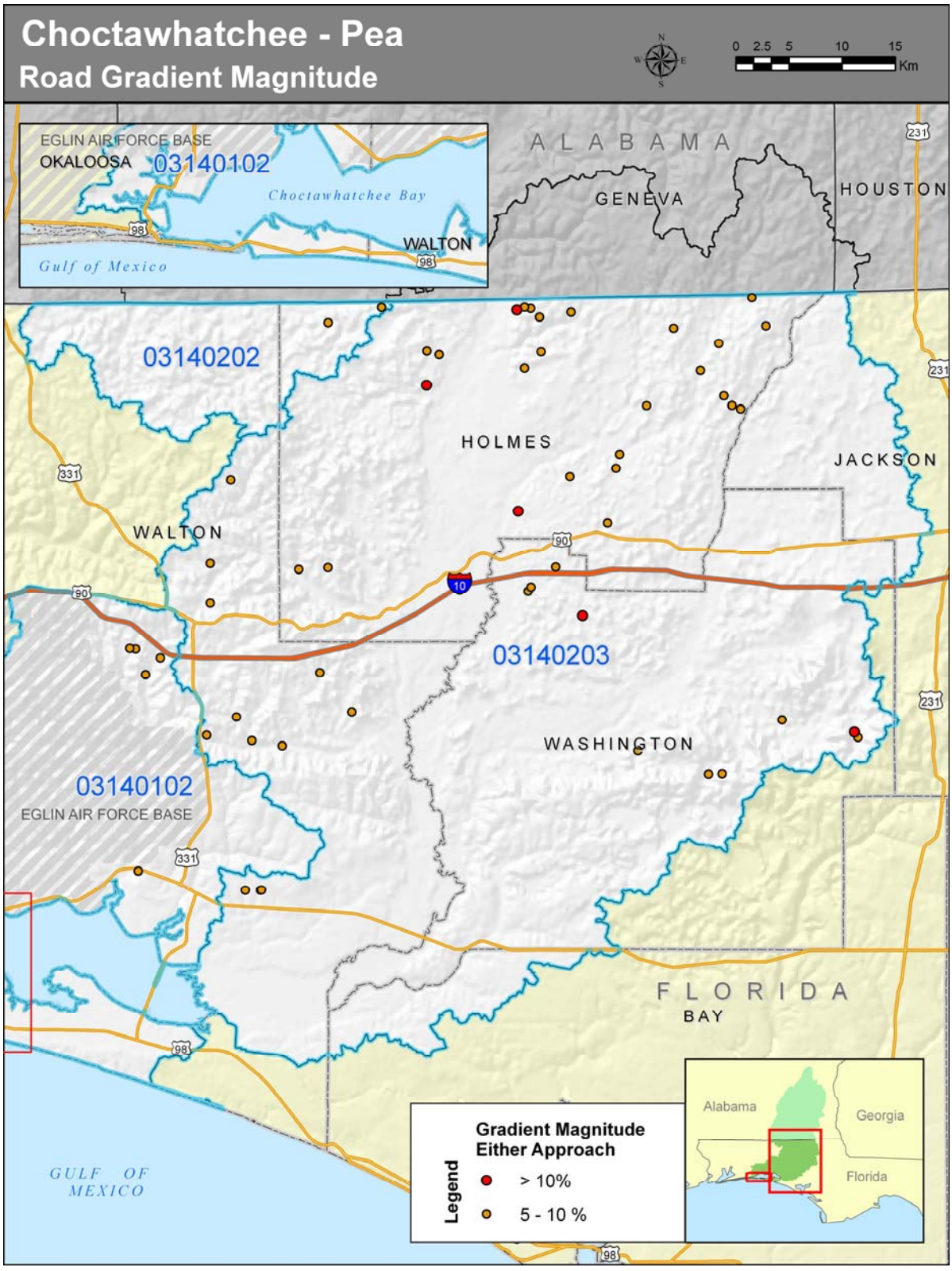


Figure 5-21. Choctawhatchee-Pea Basin Water Crossings With Estimated Averaged Road Approach Gradients of 5 to 10 Percent and Greater Than 10 Percent (David Rubino)

5.3.1.5 Inroad Erosion

Inroad erosion occurs when runoff is concentrated across or down the road, resulting in the development of erosion rills and/or gullies. This process can result in gross amounts of soil loss, degradation of the road profile, and unsafe driving conditions. Roads with ditch systems may exhibit extensive road gully development as the gully headcuts into the road to stabilize its grade with that of the roadside ditch bottom (Figure 5-22).



Figure 5-22. Choctawhatchee-Pea Basin Inroad Rill and Gully Erosion (Mike Rainer)

The 179 CPB water crossings that exhibited inroad erosion rill and/or gully conditions are listed in Table 5-10 and shown in Figure 5-23.

Table 5-10. Choctawhatchee-Pea Basin Crossings With Inroad Erosion

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12131_587757_3390255	343	Bruce Creek	Walton	B3
12131_588901_3373806	739	Pate Branch		B4
12131_588597_3373858				
12131_587694_3373832	741	Unnamed run		
12059_604871_3428774	47	Parrot Creek	Holmes	C1
12059_605805_3428211				
12059_602307_3426910				
12059_606105_3426458				
12059_606026_3424697	94	Limestone Branch		

Table 5-10. Choctawhatchee-Pea Basin Crossings With Inroad Erosion Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12059_606032_3421506	119	Windmill Branch	Holmes	C1
12059_602167_3419934	146	West Pittman Creek		
12059_606111_3408200	49F	Choctawhatchee River		C2
12059_606243_3410154				
12059_598980_3417165	146	West Pittman Creek		
12059_593915_3415962				
12059_598113_3416255				
12059_597988_3414206				
12059_593553_3415873				
12059_599642_3405100	210	Otter Creek		
12059_597857_3408906				
12059_596942_3408843				
12059_595677_3410137				
12059_594768_3410680				
12059_595243_3411442				
12059_600902_3403815				
12059_605393_3398698	212	Reedy Creek		C3
12059_605137_3402312				
12133_604043_3366921	49B	Choctawhatchee River	Washington	C5
12005_599121_3361813	950	Otter Creek	Bay	
12131_596726_3358868	983	Tenmile Branch	Walton	
12059_609588_3426163	47	Parrot Creek	Holmes	D1
12059_608751_3428168				
12059_615788_3428702	48	Whitewater Branch		
12059_615206_3428824				
12059_610676_3428692	49F	Choctawhatchee River		
12059_615312_3424152	55	East Pittman Creek		
12059_619077_3427196				
12059_616641_3426004				
12059_615306_3425537				
12059_620441_3428234				
12059_624597_3429579	56	Tenmile Creek		
12059_624460_3424379				
12059_623492_3419197				
12059_626640_3425941	61	Texas Branch		
12059_615802_3425995	69	Unnamed branch		
12059_616556_3427853				
12059_615200_3423100	121	Little Creek		
12059_612738_3415817	49F	Choctawhatchee River		D2
12059_607716_3410489				
12059_630729_3419945	54	Wrights Creek		
12059_624157_3414952				
12059_613793_3412809				
12059_622848_3418245	56	Tenmile Creek		
12059_614889_3413732	183	Catfish Branch		
12059_624966_3414933	206	Gum Branch		
12059_628994_3407640	232	Unnamed drain		
12133_615537_3402016	261	Dram Branch	Washington	
12059_624503_3405170	286	Open Creek	Holmes	
12133_620956_3401344	239	Gum Creek	Washington	D3
12133_624733_3401517	286	Open Creek		
12133_624814_3395782	348	Gully Creek		
12133_617534_3393617				
12133_610428_3378697	651	Spring Run		D4
12133_611506_3380992	59	Holmes Creek		
12133_611506_3381437				
12133_623909_3375974	526	Pine Log Creek		
12059_624944_3426115	56	Tenmile Creek	Holmes	E1
12059_625607_3427827				
12059_625131_3429532				
12059_624895_3419454				
12059_625048_3419399				
12059_626549_3422359				
12059_626736_3424561				
12059_627138_3424782				
12059_627468_3425739				
12059_627493_3422139				

Table 5-10. Choctawhatchee-Pea Basin Crossings With Inroad Erosion Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12059_619565_3428353	53	Clark Mill Creek	Holmes	E1
12059_626690_3419538	54	Wrights Creek		
12059_627131_3428070	56	Tenmile Creek		
12059_635398_3418338	59	Holmes Creek		
12059_635376_3420591				
12059_635621_3421345				
12059_637103_3421585				
12059_635924_3422889				
12059_640506_3429418				
12059_640656_3430055				
12059_640825_3429170				
12059_641905_3429936				
12059_642412_3429094				
12059_639280_3424444				
12059_637554_3421906				
12059_638798_3423643				
12059_638102_3424551				
12059_637109_3424203				
12059_638749_3425969				
12059_640289_3424608				
12059_637934_3427072	86	Bell Branch		
12059_633525_3425328	103	Corbett Branch		
12059_630038_3423411	113	Register Branch		
12059_633958_3420481	139	Jackson Branch		
12063_641318_3423413	130	Fish Branch	Jackson	
12063_642168_3422706				
12063_642456_3421386				
12059_634725_3419557	139	Jackson Branch	Holmes	
12059_635539_3419224				
12063_640089_3420588	147	Gum Creek	Jackson	
12059_624250_3414951	54	Wrights Creek	Holmes	E2
12059_626787_3415716				
12059_630541_3408083	59	Holmes Creek		
12059_632340_3409137				
12059_632326_3409458				
12059_633049_3412290				
12059_633419_3413576				
12059_633917_3414927				
12059_631164_3405247				
12059_630721_3406621				
12059_632870_3408534				
12059_632035_3414226				
12059_633585_3415689				
12059_634528_3416459				
12059_632975_3417285				
12059_632475_3418231				
12063_636081_3418138			Jackson	
12063_635313_3413275				
12133_634872_3410545			Washington	
12059_629231_3426838	61	Texas Branch	Holmes	
12063_641043_3413302	130	Fish Branch	Jackson	
12063_640949_3413184				
12063_641200_3414909				
12063_641925_3414701				
12059_627943_3408659	251	Camp Branch	Holmes	
12059_627939_3404435				
12133_630414_3397868	59	Holmes Creek	Washington	E3
12133_630035_3399203				
12133_627465_3394656				
12133_628817_3395596				
12133_635561_3401290				
12133_636388_3399583				
12133_633961_3399573				
12133_627510_3401084	286	Open Creek		
12133_638794_3396780	337	Flat Creek		
12133_635580_3396336				

Table 5-10. Choctawhatchee-Pea Basin Crossings With Inroad Erosion Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12133_639437_3389888	401	Hard Labor Creek	Washington	E3
12133_637868_3392298				
12133_633249_3394653				
12133_639341_3387976				
12133_636881_3386512	456	Reedy Creek		
12133_636843_3386378				
12133_635833_3385174				E4
12133_630809_3381381	526	Pine Log Creek		
12133_632519_3384737				
12133_633767_3384797				
12063_642760_3418963	130	Fish Branch	Jackson	F1
12063_644135_3419774				
12063_642926_3422175				
12063_645738_3413309	123	Alligator Creek		F2
12063_645775_3413975				
12063_643582_3416447	130	Fish Branch		
12063_642985_3417493				
12133_643054_3393049	346	Little Hard Labor Creek	Washington	F3
12133_642967_3390542				
12133_643171_3387949	401	Hard Labor Creek		
12133_644049_3389298				
12133_642465_3390661	455	Davis Branch		
12133_646259_3388743	490	Poley Creek		
12133_646316_3387889				
12133_646584_3388217				
Pea River Subbasin, HUC 03140202				
12131_579195_3426192	42	Eighteen Mile Creek	Walton	B1
12131_584991_3420465	68	Chestnut Creek		
12131_585542_3420465				
12059_601030_3428689	46	Pea River	Holmes	C1
12059_599869_3428008	63	Hurricane Creek		
12059_598029_3426302				
12059_598215_3426316				
12059_595068_3423954				
12059_594827_3424131				
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_576836_3375767	351A	Alaqua Creek	Walton	B4
12131_578852_3375630				
12131_574146_3364860	881	Direct runoff to bay		B5

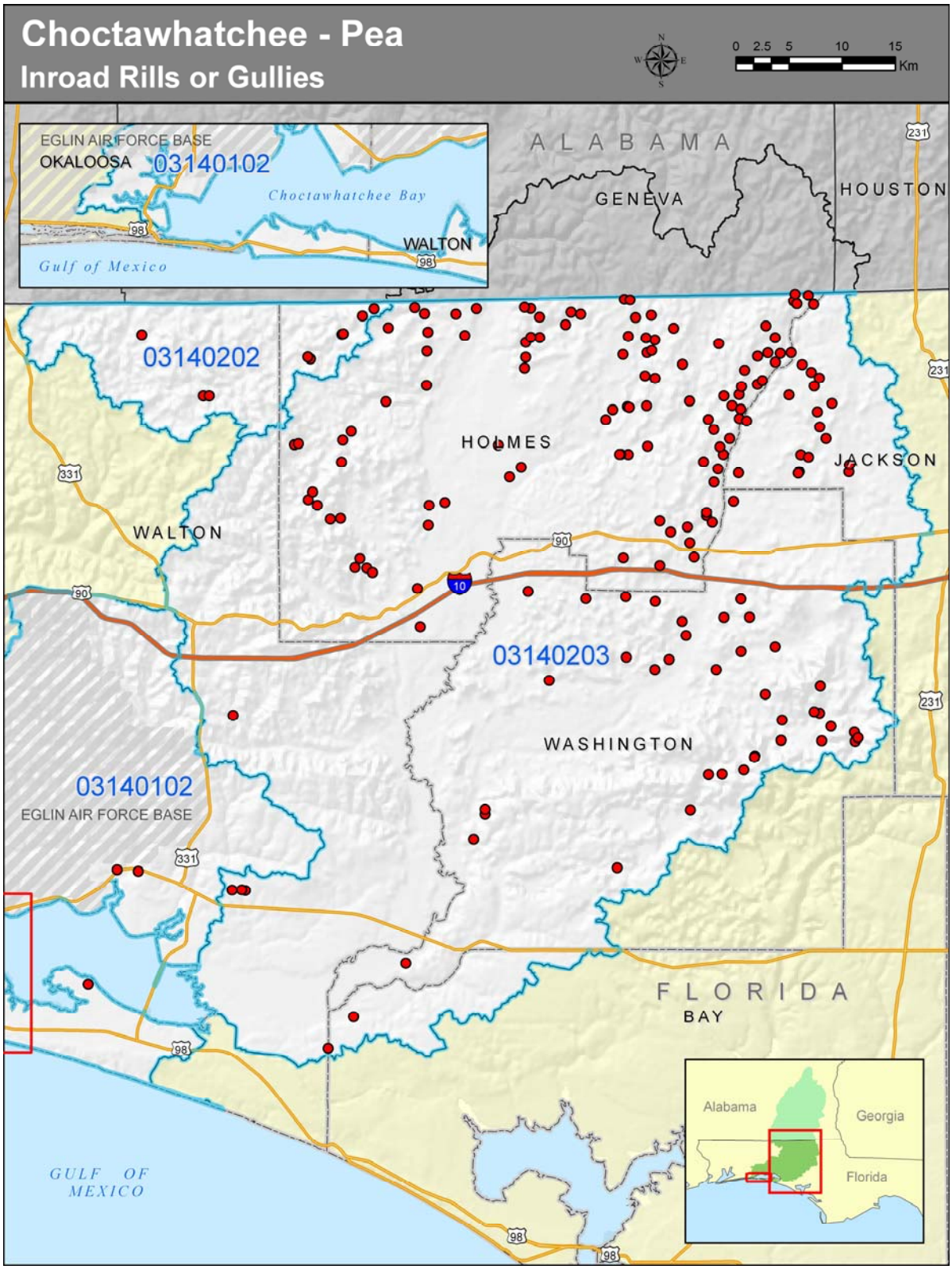


Figure 5-23. Choctawhatchee-Pea Basin Water Crossings Exhibiting Inroad Rill and/or Gully Erosion

(David Rubino)

5.3.1.6 Road Edge Erosion

Road edge erosion occurs when water flows off the road prism toward roadside ditches. Erosion rills or gullies form when there is an absence of a buffering road shoulder to stabilize the sloped area between the road and ditch (Figure 5-24). Left unchecked, road edge erosion can evolve into inroad rill and gully features (Section 5.3.1.5). Road shoulders are the vegetative buffers that connect the road prism with roadside ditches. These narrow corridors provide a grade break transition from disturbed unpaved road surfaces to the undisturbed surfaces of constructed drains. The road edge of the shoulder provides a line-of-sight for road maintenance grading that prevents extending surface disturbances into roadside ditches and also prevents the breakdown of the road edge. The visual break between the road and roadside area defined by the shoulder also provides motorists with defined boundaries of the travelway and reduces the potential for vehicle damage to stabilized roadsides (Figure 5-25). Vegetated shoulders are a rare occurrence on CPB roads surfaced with soil materials and fitted with constructed roadside ditches.



Figure 5-24. Choctawhatchee-Pea Basin Road Edge Erosion (Mike Rainer)



Figure 5-25. Road Shouldered Drainage System (David Rubino)

Although the evidence of road edge erosion will be removed during road maintenance, these features will frequently reappear following the next rainfall event. The 152 CPB water crossings that exhibited severe road approach road edge erosion are listed in Table 5-11 and presented in Figure 5-26.

Table 5-11. Choctawhatchee-Pea Basin Crossings With Road Edge Erosion

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12131_587566_3412505	178	Sandy Creek	Walton	B2
12131_587757_3390255	343	Bruce Creek		B3
12131_588846_3392706				
12131_583070_3393990	350	Bay Branch		
12131_584870_3388458	486	Mill Creek		
12131_585279_3388430				
12131_587694_3373832	741	Unnamed run		B4
12131_588597_3373858	739	Pate Branch		
12059_606026_3424697	94	Limestone Branch	Holmes	C1
12059_606032_3421506	119	Windmill Branch		
12059_605456_3422790				
12059_606703_3421024	126	Dada Branch		
12059_598885_3420183	136	Pine Log Creek		
12059_595428_3402370	178	Sandy Creek		C2
12059_605172_3406628	212	Reedy Creek		
12059_601866_3408469				
12059_601172_3408729				
12059_599918_3405410	270	Goose Branch		
12059_596249_3404471	289	Black Branch		
12059_596707_3404240				
12059_599227_3402110	298	Cow Branch		
12059_605393_3398698	212	Reedy Creek		C3
12059_605137_3402312				
12131_589556_3387946	343	Bruce Creek	Walton	
12131_594230_3388124				
12059_601141_3398948	349	Mill Creek	Holmes	
12131_600477_3395891	366	Oak Grove Branch	Walton	
12131_590198_3391114	371	Panther Creek		
12131_595137_3393850	373	White Creek		
12131_594023_3392453	382	White Creek		
12131_595982_3394340				
12131_598012_3391393	404	Crooked Creek		
12131_597017_3391508	441	Peavy Creek		
12131_598977_3390609	457	Spears Branch		
12133_604043_3366921	49B	Choctawhatchee River	Washington	C5
12131_596726_3358868	983	Tenmile Branch	Walton	
12059_615788_3428702	48	Whitewater Branch	Holmes	D1
12059_615206_3428824				
12059_614478_3428556				
12059_626640_3425941	61	Texas Branch		
12059_616556_3427853	69	Unnamed branch		
12059_623336_3423834	77	Little Creek		
12059_616749_3424615	108	Bee Branch		
12059_615200_3423100	121	Little Creek		
12059_610508_3420337	133	Ginhouse Branch		
12059_626096_3413298	206	Gum Branch		
12059_613008_3410302	54	Wrights Creek		D2
12059_619790_3417892				
12059_623817_3413615				
12059_630729_3419945				
12059_624157_3414952				
12059_613793_3412809				
12059_627229_3420965				
12059_621864_3414904				
12059_621668_3414077				
12059_619470_3412825				
12059_622291_3422114	77	Little Creek		
12059_618628_3415535	143	Limestone Branch		
12059_614889_3413732	183	Catfish Branch		
12059_624966_3414933	206	Gum Branch		
12059_628994_3407640	232	Unnamed drain		
12133_620568_3404818	239	Gum Creek	Washington	
12059_622215_3403141			Holmes	
12059_623019_3408453				
12059_614624_3409574	240	Hathaway Mill Creek		
12059_617677_3408660				
12059_619270_3409939				

Table 5-11. Choctawhatchee-Pea Basin Crossings with Road Edge Erosion Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12133_615537_3402016	261	Dram Branch	Washington	D2
12133_615819_3402419				
12059_618673_3407170			Holmes	
12059_618284_3407130				
12059_624503_3405170	286	Open Creek		
12133_614932_3398772	239	Gum Creek	Washington	D3
12133_620956_3401344				
12133_620666_3399722				
12133_616501_3396220				
12133_624766_3401446	286	Open Creek		
12133_624733_3401517				
12133_617534_3393617	348	Gully Creek		
12133_624814_3395782				
12133_612247_3396364	362	Yates Mill Creek		
12133_623909_3375974	526	Pine Log Creek		D4
12133_610428_3378697	651	Spring Run		
12133_609849_3378843				
12059_619565_3428353	53	Clark Mill Creek	Holmes	E1
12059_633265_3428625	54	Wrights Creek		
12059_626690_3419538				
12059_636667_3429703				
12059_631786_3422866				
12059_632080_3429420				
12059_631373_3425390				
12059_632634_3429053				
12059_633090_3429287				
12059_636401_3428218				
12063_638723_3421488	59	Holmes Creek	Jackson	
12059_627639_3426295	61	Texas Branch	Holmes	
12059_637934_3427072	86	Bell Branch		
12059_633525_3425328	103	Corbett Branch		
12059_630038_3423411	113	Register Branch		
12059_629531_3424126				
12059_606356_3422560	119	Windmill Branch		
12059_633958_3420481	139	Jackson Branch		
12059_634725_3419557				
12059_635539_3419224				
12063_640335_3419074	147	Gum Creek	Jackson	
12063_640089_3420588				
12063_640517_3421167				
12059_624250_3414951	54	Wrights Creek	Holmes	E2
12059_626787_3415716				
12059_625263_3415772				
12059_630621_3416764				
12059_631631_3417650				
12059_629231_3426838	61	Texas Branch		
12133_638927_3410070	123	Alligator Creek	Washington	
12063_641663_3417689	147	Gum Creek	Jackson	
12059_628864_3413520	206	Gum Branch	Holmes	
12059_628909_3413769				
12133_627510_3401084	286	Open Creek	Washington	E3
12133_639437_3389888	401	Hard Labor Creek		
12133_642465_3390661	455	Davis Branch		
12133_625875_3387015	501	Pippin Mill Creek		
12133_631902_3387482	526	Pine Log Creek		
12133_632519_3384737				E4
12133_633767_3384797				
12063_645366_3413300	123	Alligator Creek	Jackson	F2
12063_647888_3417781	157	Little Alligator Cr		
12063_648636_3414126	195	Scurlock Creek		
12063_648745_3414522				
12133_648715_3403157	262	Gilberts Mill Creek	Washington	
12063_649215_3408107			Jackson	
12133_643054_3393049	346	Little Hard Labor Creek	Washington	F3
12133_646316_3387889	490	Poley Creek		
12133_646584_3388217				
12133_646259_3388743				

Table 5-11. Choctawhatchee-Pea Basin Crossings With Road Edge Erosion Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Pea River Subbasin, HUC 03140202				
12131_569997_3427554	40	Limestone Branch	Walton	A1
12131_571101_3428871				
12131_575631_3428399	40A	Natural Bridge Creek		B1
12131_577263_3424973	42	Eighteen Mile Creek		
12131_579195_3426192				
12131_577907_3426307				
12131_580828_3425985				
12131_585703_3428652	43	Limestone Creek		
12131_584991_3420465	68	Chestnut Creek		
12131_585542_3420465				
12131_591261_3428489	43	Limestone Creek		C1
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_578634_3396546	332	Cosson Mill Creek	Walton	B3
12131_577085_3396991				
12131_578062_3396628				
12131_579533_3394149	369	Sconiers Mill Creek		
12131_576836_3375767	351A	Alaqua Creek		B4
12131_578852_3375630				
12131_574146_3364860	881	Direct runoff to bay		B5

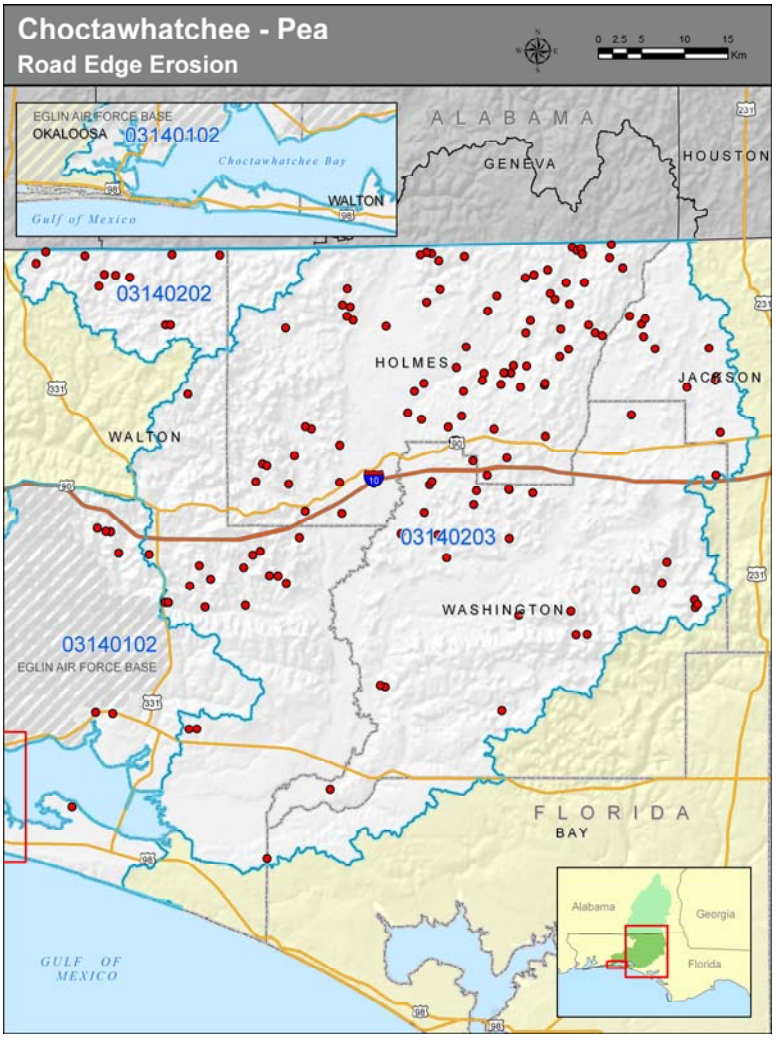


Figure 5-26. Choctawhatchee-Pea Basin Water Crossings Exhibiting Road Approach Road Edge Erosion (David Rubino)

5.3.1.7 Constructed Ditch Erosion

CPB roadside ditches are constructed drains that are typically maintained with unvegetated native soil bottoms and side slopes. Ditch cleanout operations are used to periodically remove sediment fill and vegetation. In nearly all cases, bare ground ditches are incapable of resisting water-induced erosion (Figure 5-27). Over time, eroding ditches evolve into gullies that can generate gross amounts of erosion and soil loss. The 97 CPB water crossings with vegetated road approach ditches that are generally less susceptible to ditch erosion are listed in Table 5-12 and shown in Figure 5-28.



Figure 5-27. Choctawhatchee-Pea Basin Constructed Road Ditch Erosion (Mike Rainer)

Table 5-12. Choctawhatchee-Pea Basin Crossings With Vegetated Roadside Ditches

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12131_587594_3390119	343	Bruce Creek	Walton	B3
12059_605717_3429264	47	Parrot Creek	Holmes	C1
12059_600205_3421948	109	Fowler Branch		
12059_605456_3422790	119	Windmill Branch		
12059_599136_3418265	146	West Pittman Creek		
12059_601760_3419857				
12059_593553_3415873				C2
12059_599137_3418171				
12059_597409_3417399	164	Timber Branch		
12059_595428_3402370	178	Sandy Creek		
12059_600382_3411724	205	Bay Drain		
12059_597857_3408906	210	Otter Creek		
12059_600562_3405537				
12059_605172_3406628	212	Reedy Creek		
12059_602102_3408645				
12059_601908_3413431				
12059_601866_3408469				
12059_593982_3404088	249	Padgett Creek		
12131_602720_3391759	178	Sandy Creek	Walton	C3
12059_602867_3405332	212	Reedy Creek	Holmes	
12131_592387_3387504	343	Bruce Creek	Walton	
12131_600312_3387259				
12131_592407_3387439				
12131_596073_3387582				
12059_601141_3398948	349	Mill Creek	Holmes	
12131_595137_3393850	373	White Creek	Walton	
12131_596880_3388321	382	White Creek		
12059_610676_3428692	49F	Choctawhatchee River	Holmes	D1
12059_632432_3427383	54	Wrights Creek		
12059_620534_3419184				

Table 5-12. Choctawhatchee-Pea Basin Crossings With Vegetated Roadside Ditches Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12059_615312_3424152	55	East Pittman Creek	Holmes	D1
12059_620977_3426932				
12059_623492_3419197	56	Tenmile Creek		
12059_623336_3423834	77	Little Creek		
12059_622519_3419867				
12059_608330_3424331	94	Limestone Branch		
12059_607182_3424350				
12059_612706_3413958	49F	Choctawhatchee River		D2
12059_627229_3420965	54	Wrights Creek		
12059_622291_3422114	77	Little Creek		
12133_624766_3401446	286	Open Creek	Washington	D3
12133_624733_3401517				
12133_612247_3396364	362	Yates Mill Creek		
12133_608963_3371801	49B	Choctawhatchee River		D4
12133_609327_3383958	59	Holmes Creek		
12133_611506_3381437				
12133_617731_3385316	550	Williams Branch		
12059_632405_3427941	54	Wrights Creek	Holmes	E1
12059_632280_3428832				
12059_633823_3428214				
12059_636401_3428218				
12059_625115_3419525				
12059_625048_3419399	56	Tenmile Creek		
12059_625102_3424144				
12059_631093_3427099	58	Mill Branch		
12059_635621_3421345	59	Holmes Creek		
12059_637103_3421585				
12059_635966_3421964				
12059_639892_3429040				
12059_639577_3426066				
12059_638692_3424359				
12059_599786_3408536	205	Bay Drain		
12059_627159_3416907	54	Wrights Creek		E2
12059_619399_3419998				
12059_633585_3415689	59	Holmes Creek		
12059_633419_3413576				
12063_635313_3413275			Jackson	
12059_633587_3408266			Holmes	
12059_629231_3426838	61	Texas Branch		
12059_627555_3404690	251	Camp Branch		
12059_627939_3404435				
12133_632556_3392055	59	Holmes Creek	Washington	E3
12133_636843_3386378	456	Reedy Creek		
12133_626142_3374258	526	Pine Log Creek		E4
12063_646733_3414135	123	Alligator Creek	Jackson	F2
12063_646050_3416437				
12063_646228_3417776				
12063_647888_3417781	157	Little Alligator Creek		
12063_646844_3416549				
12063_648745_3414522	195	Scurlock Creek		
12063_647819_3409694	233	Unnamed creek		
12063_647147_3409117				
12063_650607_3404144	262	Gilberts Mill Creek		
Pea River Subbasin, HUC 03140202				
12131_574345_3425295	42	Eighteen Mile Creek	Walton	B1
12131_579149_3425387				
12131_580805_3428008	43	Limestone Creek		
12131_585703_3428652				
12131_584186_3426376				
12131_584738_3426399				
12131_584991_3420465	68	Chestnut Creek		
12059_598215_3426316	63	Hurricane Creek	Holmes	C1
12059_596747_3427352	81	Mack Bay Branch		

Table 5-12. Choctawhatchee-Pea Basin Crossings With Vegetated Roadside Ditches Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_581412_3395702	369	Sconiers Mill Creek	Walton	B3
12131_580186_3394422				
12131_576836_3375767	351A	Alaqua Creek		B4
12131_571853_3360706	881	Direct runoff to bay		B5
12131_573913_3362924				

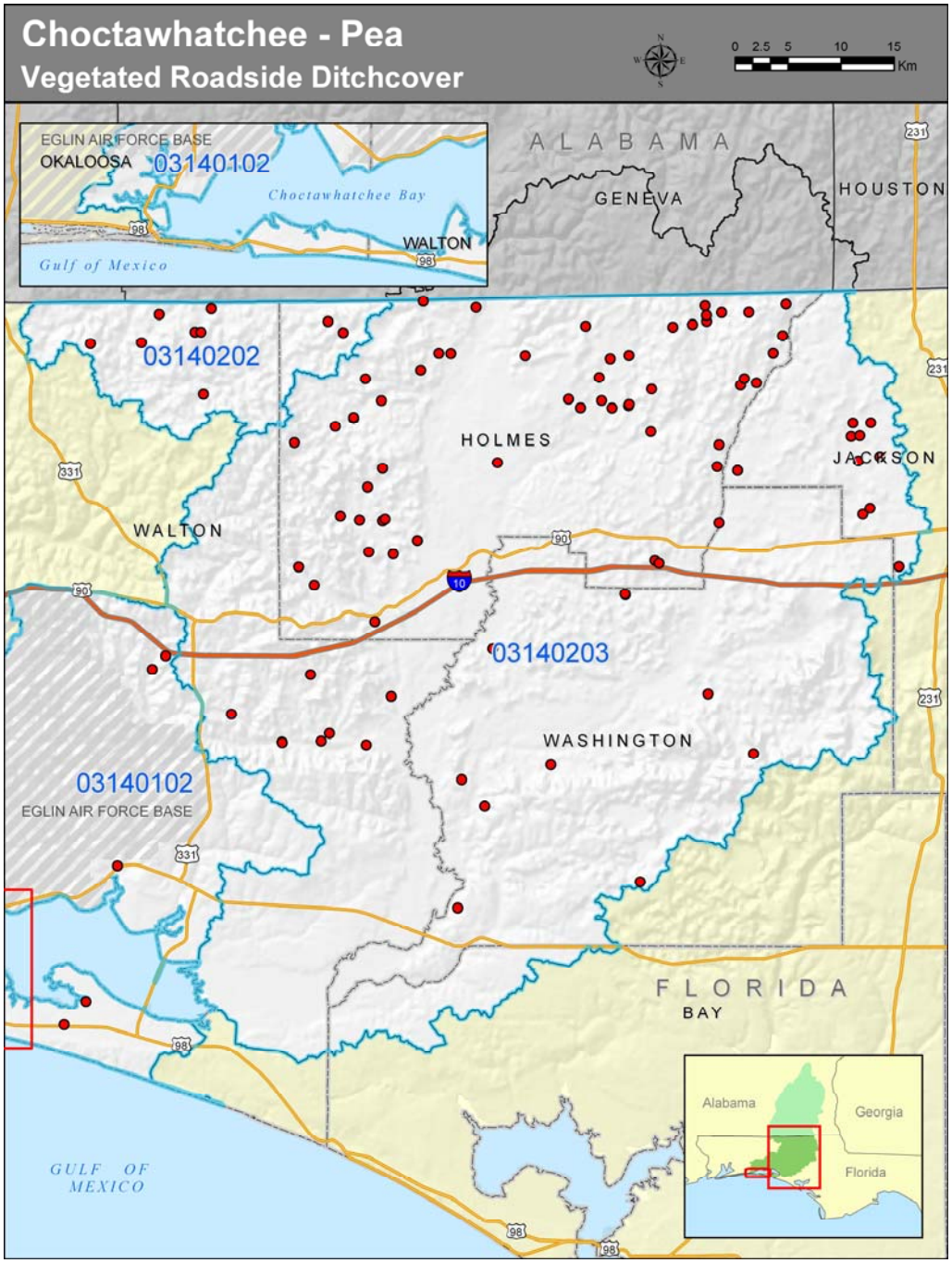


Figure 5-28. Choctawhatchee-Pea Basin Water Crossings With Vegetated Roadside Ditch Cover (David Rubino)

5.3.1.8 Road Drain Outlet Erosion

Drain outlets are the discharge points of roadside ditches. Typically, runoff is delivered into waterways in unlined channels that are highly susceptible to erosion and gully formation. Generally, no action is taken to reinforce the discharge point by vegetative or structural means. These features become a sediment source as well a conduit for sediment delivery.

In addition to design and maintenance concerns, a pervasive problem with current CPB roadside ditch systems is the high frequency of unprotected ditch discharge points, contributing to sedimentation. At almost every water crossing surveyed during this assessment, road approach ditches released water directly into receiving streams with no provisions made to manage runoff velocities, abate the delivery of suspended sediments, or protect the discharge point from erosion (Figure 5-29).

Frequently the volume and velocities of concentrated runoff within these observed ditches created gullies at their discharge points that were headcutting up the ditch. Gully headcutting is relentless in that, left unabated, runoff will continue to erode gross amounts of soil until it establishes a stable, nonerosive slope gradient; this may occur with a few feet or hundreds of feet, depending on the elevation disparity. The 135 CPB crossings with unimproved drain outlet gullies are listed in Table 5-13 and shown in Figure 5-30.



Figure 5-29. Choctawhatchee-Pea Basin Crossing Unimproved Drain Outlet Erosion (Mike Rainer)

Table 5-13. Choctawhatchee-Pea Basin Crossings With Unimproved Drain Outlet Gullies

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12131_585614_3404688	269	West Sandy Creek	Walton	B2
12131_585620_3402440	283A	Lake Juniper Drain		
12131_587757_3390255	343	Bruce Creek		B3
12131_583070_3393990	350	Bay Branch		
12131_585279_3388430	486	Mill Creek		
12131_588901_3373806	739	Pate Branch		B4
12131_587694_3373832	741	Unnamed run		
12059_602307_3426910	47	Parrot Creek	Holmes	C1
12059_604871_3428774				
12059_605805_3428211				
12059_603513_3425625				
12059_606105_3426458				
12059_606026_3424697	94	Limestone Branch		
12059_606032_3421506	119	Windmill Branch		
12059_602167_3419934	146	West Pittman Creek		
12059_600415_3419219				
12059_606111_3408200	49F	Choctawhatchee River		C2
12059_593915_3415962	146	West Pittman Creek		
12059_598113_3416255				
12059_597988_3414206				
12059_599137_3418171				
12059_596942_3408843	210	Otter Creek	Holmes	
12059_595677_3410137				
12059_595243_3411442				
12059_601908_3413431	212	Reedy Creek		
12059_601866_3408469				
12059_593982_3404088	249	Padgett Creek		
12059_599918_3405410	270	Goose Branch		
12131_604086_3387915	49E	Choctawhatchee River	Walton	C3
12059_605137_3402312	212	Reedy Creek	Holmes	
12131_595137_3393850	373	White Creek	Walton	
12131_598012_3391393	404	Crooked Creek		
12059_609588_3426163	47	Parrot Creek	Holmes	D1
12059_608751_3428168				
12059_615788_3428702	48	Whitewater Branch		
12059_614478_3428556				
12059_610676_3428692	49F	Choctawhatchee River		
12059_615306_3425537	55	East Pittman Creek		
12059_619077_3427196				
12059_616641_3426004				
12059_616556_3427853	69	Unnamed branch		
12059_615200_3423100	121	Little Creek		
12059_614393_3421453	142	Sikes Creek		
12059_615210_3420390				
12059_607716_3410489	49F	Choctawhatchee River		D2
12059_610765_3414346				
12059_630729_3419945	54	Wrights Creek		
12059_624157_3414952				
12059_622848_3418245	56	Tenmile Creek		
12133_618173_3404328	261	Dram Branch	Washington	
12059_624503_3405170	286	Open Creek	Holmes	
12133_620666_3399722	239	Gum Creek	Washington	D3
12133_624766_3401446	286	Open Creek		
12133_624814_3395782	348	Gully Creek		
12133_612247_3396364	362	Yates Mill Creek		
12133_608657_3371568	49B	Choctawhatchee River		D4
12133_608895_3371613				
12133_609327_3383958	59	Holmes Creek		
12059_626690_3419538	54	Wrights Creek	Holmes	E1
12059_625115_3419525				
12059_627468_3425739	56	Tenmile Creek		
12059_627131_3428070				
12059_624944_3426115				
12059_625607_3427827				
12059_625131_3429532				
12059_628150_3424588				

Table 5-13. Choctawhatchee-Pea Basin Crossings With Unimproved Drain Outlet Gullies Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12063_638723_3421488	59	Holmes Creek	Jackson	E1
12059_635621_3421345			Holmes	
12059_640656_3430055				
12059_641905_3429936				
12059_639280_3424444				
12059_637554_3421906				
12059_638102_3424551				
12059_637109_3424203				
12059_637934_3427072	86	Bell Branch		
12059_633525_3425328	103	Corbett Branch		
12059_633958_3420481	139	Jackson Branch		
12059_634725_3419557				
12059_635539_3419224				
12059_625263_3415772	54	Wrights Creek		E2
12059_630541_3408083	59	Holmes Creek		
12059_632340_3409137				
12059_633917_3414927				
12059_630721_3406621				
12059_632870_3408534				
12059_632475_3418231				
12063_640949_3413184	130	Fish Branch	Jackson	
12059_628565_3407554	251	Camp Branch	Holmes	
12059_627943_3408659				
12059_627555_3404690				
12133_632556_3392055	59	Holmes Creek	Washington	E3
12133_630414_3397868				
12133_629502_3398783				
12133_630035_3399203				
12133_635561_3401290				
12133_635587_3399509				
12133_636388_3399583				
12133_633961_3399573				
12133_627510_3401084	286	Open Creek		
12133_642008_3397707	337	Flat Creek		
12133_635580_3396336				
12133_638794_3396780				
12133_637868_3392298	401	Hard Labor Creek		
12133_639341_3387976				
12133_635494_3387474	456	Reedy Creek		
12133_636843_3386378				
12133_631902_3387482	526	Pine Log Creek		
12133_635833_3385174	456	Reedy Creek		E4
12133_632519_3384737	526	Pine Log Creek		
12063_642743_3419649	130	Fish Branch	Jackson	F1
12063_644135_3419774				
12063_642926_3422175				
12063_645738_3413309	123	Alligator Creek		F2
12063_645775_3413975				
12063_643582_3416447	130	Fish Branch		
12063_642985_3417493				
12133_643171_3387949	401	Hard Labor Creek	Washington	F3
12133_644049_3389298				
12133_642899_3388588				
12133_647019_3392581				
12133_646584_3388217	490	Poley Creek		
12133_646259_3388743				
Pea River Subbasin, HUC 03140202				
12131_575631_3428399	40A	Natural Bridge Creek	Walton	B1
12131_577263_3424973	42	Eighteen Mile Creek		
12131_574345_3425295				
12131_577907_3426307				
12131_585703_3428652	43	Limestone Creek		
12059_599869_3428008	63	Hurricane Creek	Holmes	C1
12059_598029_3426302				
12059_595068_3423954				
12059_594827_3424131				

Table 5-13. Choctawhatchee-Pea Basin Crossings With Unimproved Drain Outlet Gullies Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_578634_3396546	332	Cosson Mill Creek	Walton	B3
12131_579859_3394231	369	Sconiers Mill Creek		
12131_579533_3394149				
12131_578852_3375630	351A	Alaqua Creek		B4

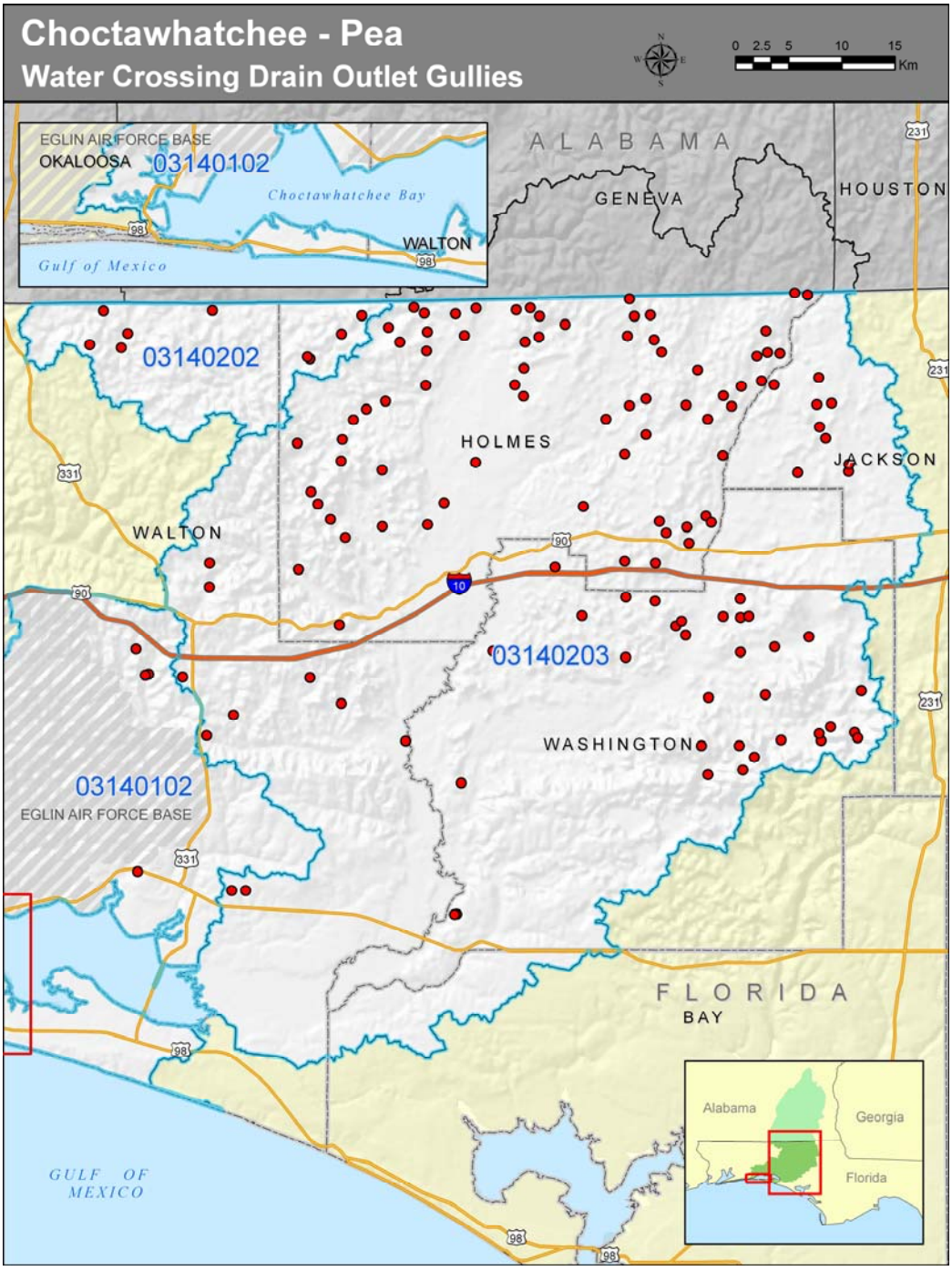


Figure 5-30. Choctawhatchee-Pea Basin Water Crossings With Unimproved Crossing Drain Outlet Gully Erosion (David Rubino)

5.3.1.9 False Ditch Erosion

False ditches are roadside drainage systems manufactured by stormwater runoff on mild to steep road slopes. These drainage features are generally the result of improper road drainage design and/or maintenance, road incision (Section 5.3.1.3), and/or road grading berms (Section 5.3.1.10). These drainage channels frequently evolve into gullies that can degrade the roadway and generate and transport vast amounts of sediment to waterbodies at crossings (Figure 5-31). Ditch down cutting may intercept groundwater seepage flows, which can further destabilize side slopes and the roadway. It is impossible to stabilize soils and prevent soil erosion and sedimentation as long as false ditches exist.



Figure 5-31. Choctawhatchee-Pea Basin False Ditch Erosion (Mike Rainer)

The 124 CPB water crossings that exhibited road approach false ditch features are listed in Table 5-14 and presented in Figure 5-32.

Table 5-14. Choctawhatchee-Pea Basin Crossings With False Ditches

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12131_583070_3393990	350	Bay Branch	Walton	B3
12131_588597_3373858	739	Pate Branch		B4
12131_588901_3373806				
12131_587694_3373832	741	Unnamed run		
12059_605805_3428211	47	Parrot Creek	Holmes	C1
12059_602307_3426910				
12059_606243_3410154	49F	Choctawhatchee River		C2
12059_593915_3415962	146	West Pittman Creek		
12059_599926_3411751	205	Bay Drain		
12059_595677_3410137	210	Otter Creek		
12059_594768_3410680				
12059_595243_3411442				
12059_601172_3408729	212	Reedy Creek		
12059_601908_3413431				
12131_603548_3388701	49E	Choctawhatchee River	Walton	C3
12131_603917_3388406				
12131_604086_3387915				
12059_605137_3402312	212	Reedy Creek	Holmes	
12059_605393_3398698				
12131_590198_3391114	371	Panther Creek	Walton	
12131_595982_3394340	382	White Creek		
12131_598012_3391393	404	Crooked Creek		
12131_597017_3391508	441	Peavy Creek		
12131_598977_3390609	457	Spears Branch		
12131_590344_3373860	747	Unnamed creek		C4
12131_590457_3373824				
12133_604043_3366921	49B	Choctawhatchee River	Washington	C5
12005_601942_3362462	950	Otter Creek	Bay	
12005_600965_3360125				
12005_599121_3361813				
12005_599190_3361962				
12131_596726_3358868	983	Tenmile Branch	Walton	
12059_609588_3426163	47	Parrot Creek	Holmes	D1
12059_608364_3427017				
12059_608751_3428168				
12059_614478_3428556	48	Whitewater Branch		
12059_610676_3428692	49F	Choctawhatchee River		
12059_619077_3427196	55	East Pittman Creek		
12059_616641_3426004				
12059_607182_3424350	94	Limestone Branch		
12059_616749_3424615	108	Bee Branch		
12059_615200_3423100	121	Little Creek		
12059_607716_3410489	49F	Choctawhatchee River		D2
12059_630729_3419945	54	Wrights Creek		
12059_622725_3416486	56	Tenmile Creek		
12059_622652_3417035				
12059_618628_3415535	143	Limestone Branch		
12059_623019_3408453	239	Gum Creek		
12059_619270_3409939	240	Hathaway Mill Creek		
12133_615342_3404831	261	Dram Branch	Washington	D3
12133_614556_3400848	49	Choctawhatchee River		
12133_616501_3396220	239	Gum Creek		
12133_624766_3401446	286	Open Creek		
12133_624733_3401517				
12133_608657_3371568	49B	Choctawhatchee River		D4
12133_608895_3371613				
12133_608963_3371801				
12133_611570_3380601	59	Holmes Creek		
12133_609783_3382380				
12133_611506_3380992				
12133_623909_3375974	526	Pine Log Creek		
12133_614218_3385675	545	Reedy Branch		
12133_617731_3385316	550	Williams Branch		

Table 5-14. Choctawhatchee-Pea Basin Crossings With False Ditches Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12059_626690_3419538	54	Wrights Creek	Holmes	E1
12059_625115_3419525				
12059_625607_3427827	56	Tenmile Creek		
12059_625131_3429532				
12059_625048_3419399				
12059_626736_3424561				
12059_640825_3429170	59	Holmes Creek		
12059_642412_3429094				
12059_639280_3424444				
12063_642168_3422706	130	Fish Branch	Jackson	
12059_635539_3419224	139	Jackson Branch	Holmes	
12063_640089_3420588	147	Gum Creek	Jackson	
12059_601244_3399095	349	Mill Creek	Holmes	
12059_624250_3414951	54	Wrights Creek		E2
12059_633049_3412290	59	Holmes Creek		
12059_633917_3414927				
12059_630721_3406621				
12059_632870_3408534				
12059_632475_3418231				
12063_641043_3413302	130	Fish Branch	Jackson	
12063_640949_3413184				
12063_641200_3414909				
12133_630035_3399203	59	Holmes Creek	Washington	E3
12133_627465_3394656				
12133_633961_3399573				
12133_627510_3401084	286	Open Creek		
12133_637868_3392298	401	Hard Labor Creek		
12133_639437_3389888				
12133_641691_3387683				
12133_639341_3387976				
12133_642465_3390661	455	Davis Branch		
12133_636881_3386512	456	Reedy Creek		
12133_636843_3386378				
12133_625875_3387015	501	Pippin Mill Creek		
12133_635833_3385174	456	Reedy Creek		E4
12133_633767_3384797	526	Pine Log Creek		
12133_630809_3381381				
12063_647255_3409221	233	Unnamed creek	Jackson	F2
12063_649215_3408107	262	Gilberts Mill Creek		
12133_643054_3393049	346	Little Hard Labor Cr	Washington	F3
12133_643171_3387949	401	Hard Labor Creek		
12133_644049_3389298				
12133_642899_3388588				
12133_647019_3392581				
12133_646316_3387889	490	Poley Creek		
12133_646584_3388217				
12133_646259_3388743				
Pea River Subbasin, HUC 03140202				
12131_569997_3427554	40	Limestone Branch	Walton	A1
12131_580828_3425985	42	Eighteen Mile Creek		B1
12131_585542_3420465	68	Chestnut Creek		
12059_601754_3428790	46	Pea River	Holmes	C1
12059_599869_3428008	63	Hurricane Creek		
12059_594827_3424131				
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_577085_3396991	332	Cosson Mill Creek	Walton	B3
12131_576673_3397336				
12131_581412_3395702	369	Sconiers Mill Creek		
12131_580186_3394422				
12131_579859_3394231				
12131_579533_3394149				
12131_576836_3375767	351A	Alaqua Creek		B4
12131_578852_3375630				

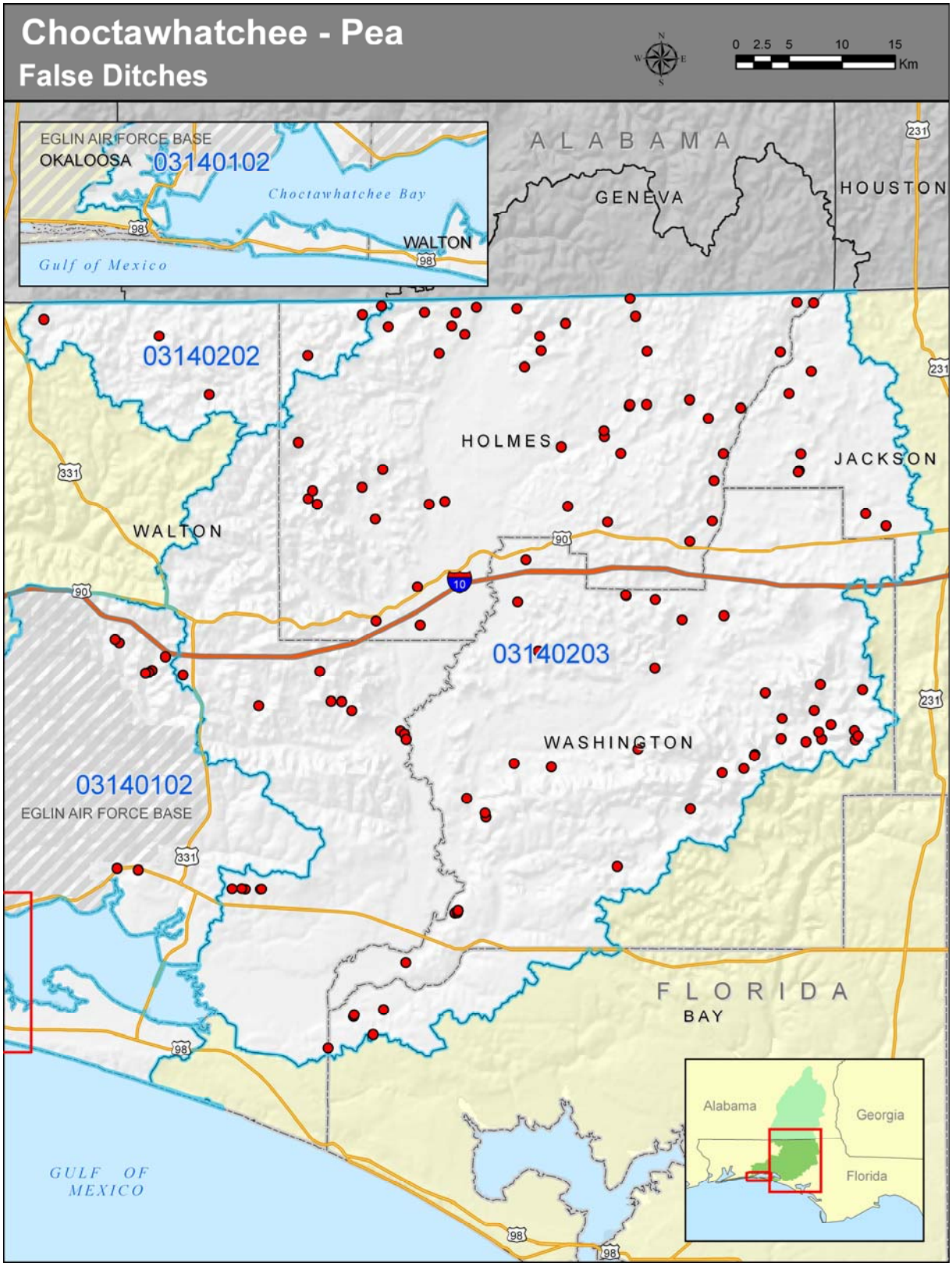


Figure 5-32. Choctawhatchee-Pea Basin Water Crossings With False Ditches (David Rubino)

5.3.1.10 Roadside Grading Berms

The practice of grading roads to a near-flat surface profile and depositing graded soils into roadside berms that expand over time results in U-shaped roads that function within the same space as stormwater runoff ditches and travel corridors. Roadside berms prevent runoff from efficiently exiting the road and foster concentrated, high-velocity downgradient water flows that easily erode unprotected road soils that, in turn, discharge directly into receiving waterways at crossings (Figure 5-33). The 143 CPB water crossings with observed roadside grading berms are listed in Table 5-15 and shown in Figure 5-34.



Figure 5-33. Choctawhatchee-Pea Basin Road Grading Berms (Mike Rainer)

Table 5-15. Choctawhatchee-Pea Basin Crossings With Roadside Grading Berms

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12131_585614_3404688	269	West Sandy Creek	Walton	B2
12131_585653_3402149				
12131_585620_3402440	283A	Lake Juniper Drain		
12131_585644_3400896	269	West Sandy Creek		B3
12131_588111_3390200	343	Bruce Creek		
12131_588846_3392706				
12131_583070_3393990	350	Bay Branch		
12131_584870_3388458	486	Mill Creek		
12131_585279_3388430				
12131_588901_3373806	739	Pate Branch		B4
12131_588597_3373858				
12131_587694_3373832	741	Unnamed run		
12059_605805_3428211	47	Parrot Creek	Holmes	C1
12059_602307_3426910				
12059_606703_3421024	126	Dada Branch		
12059_606923_3411670	49F	Choctawhatchee River		C2
12059_599926_3411751	205	Bay Drain		
12059_599642_3405100	210	Otter Creek		
12059_600562_3405537				
12059_594768_3410680				
12059_595243_3411442				
12131_603548_3388701	49E	Choctawhatchee River	Walton	C3
12131_603917_3388406				
12131_604086_3387915				
12059_605137_3402312	212	Reedy Creek	Holmes	
12059_601172_3408729				
12131_589556_3387946	343	Bruce Creek	Walton	
12131_600312_3387259				
12131_592169_3387913				
12131_592387_3387504				

Table 5-15. Choctawhatchee-Pea Basin Crossings With Roadside Grading Berms Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12131_590198_3391114	371	Panther Creek	Walton	C3
12131_595137_3393850	373	White Creek		
12131_595982_3394340	382	White Creek		
12131_596880_3388321				
12131_601129_3390936	399	Hughes Ditch		
12131_598012_3391393	404	Crooked Creek		
12131_598977_3390609	457	Spears Branch		
12131_590344_3373860	747	Unnamed creek		C4
12131_590457_3373824				
12133_604043_3366921	49B	Choctawhatchee River	Washington	C5
12005_601942_3362462	950	Otter Creek	Bay	
12005_600965_3360125				
12005_599121_3361813				
12005_599190_3361962				
12131_596726_3358868	983	Tenmile Branch	Walton	
12059_609588_3426163	47	Parrot Creek	Holmes	D1
12059_608364_3427017				
12059_610676_3428692	49F	Choctawhatchee River		
12059_619077_3427196	55	East Pittman Creek		
12059_616641_3426004				
12059_626640_3425941	61	Texas Branch		
12059_622687_3419761	77	Little Creek		
12059_607182_3424350	94	Limestone Branch		
12059_607716_3410489	49F	Choctawhatchee River		D2
12059_622725_3416486	56	Tenmile Creek		
12059_622848_3418245				
12059_622270_3417030	77	Little Creek		
12059_619270_3409939	240	Hathaway Mill Creek		
12133_616501_3396220	239	Gum Creek	Washington	D3
12133_608657_3371568	49B	Choctawhatchee River		D4
12133_608895_3371613				
12133_608963_3371801				
12133_611570_3380601	59	Holmes Creek		
12133_611506_3381437				
12133_611989_3382356				
12133_623909_3375974	526	Pine Log Creek		
12133_614218_3385675	545	Reedy Branch		
12133_617731_3385316	550	Williams Branch		
12059_632634_3429053	54	Wrights Creek	Holmes	E1
12059_633090_3429287				
12059_626549_3422359	56	Tenmile Creek		
12059_625607_3427827				
12059_626736_3424561				
12059_627138_3424782				
12059_637103_3421585	59	Holmes Creek		
12059_640506_3429418				
12059_640825_3429170				
12059_642412_3429094				
12059_638798_3423643				
12059_638692_3424359				
12059_627639_3426295	61	Texas Branch		
12063_642092_3422971	130	Fish Branch	Jackson	
12063_642168_3422706				
12063_640089_3420588	147	Gum Creek		
12059_601244_3399095	349	Mill Creek	Holmes	
12059_624250_3414951	54	Wrights Creek		E2
12059_619399_3419998				
12063_636081_3418138	59	Holmes Creek	Jackson	
12133_634790_3411395			Washington	
12059_632475_3418231			Holmes	
12063_635313_3413275			Jackson	
12063_641043_3413302	130	Fish Branch		
12063_640949_3413184				
12063_640904_3414891				
12063_641200_3414909				
12063_641925_3414701				

Table 5-15. Choctawhatchee-Pea Basin Crossings With Roadside Grading Berms Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12133_627465_3394656	59	Holmes Creek	Washington	E3
12133_637101_3402004				
12133_635561_3401290				
12133_641030_3396310	337	Flat Creek		
12133_639810_3397108				
12133_638794_3396780				
12133_639437_3389888	401	Hard Labor Creek		
12133_641691_3387683				
12133_639341_3387976				
12133_642465_3390661	455	Davis Branch		
12133_636881_3386512	456	Reedy Creek		
12133_636843_3386378				
12133_633767_3384797	526	Pine Log Creek		E4
12133_630809_3381381				
12133_626142_3374258				
12063_646364_3422088	123	Alligator Creek	Jackson	F1
12063_645738_3413309				F2
12063_642627_3414509	130	Fish Branch		
12063_647819_3409694	233	Unnamed creek		
12063_647255_3409221				
12133_648715_3403157	262	Gilberts Mill Creek	Washington	F3
12133_643054_3393049	346	Little Hard Labor Creek		
12133_642967_3390542				
12133_643171_3387949	401	Hard Labor Creek		
12133_644049_3389298				
12133_642899_3388588				
12133_647019_3392581				
12133_646259_3388743	490	Poley Creek		
Pea River Subbasin, HUC 03140202				
12131_569835_3427686	40	Limestone Branch	Walton	A1
12131_580828_3425985	42	Eighteen Mile Creek		B1
12131_585933_3428376	43	Limestone Creek		
12131_584991_3420465	68	Chestnut Creek		
12131_585542_3420465				
12059_598541_3424859	63	Hurricane Creek	Holmes	C1
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_577085_3396991	332	Cosson Mill Creek	Walton	B3
12131_578062_3396628				
12131_576673_3397336				
12131_580649_3395756	340	Kiser Branch		
12131_581412_3395702	369	Sconiers Mill Creek		
12131_580921_3395729				
12131_580773_3395720				
12131_580186_3394422				
12131_579859_3394231				
12131_579533_3394149				
12131_576836_3375767	351A	Alaqua Creek		B4
12131_578852_3375630				
12131_576454_3374724	731	Alaqua Bayou		

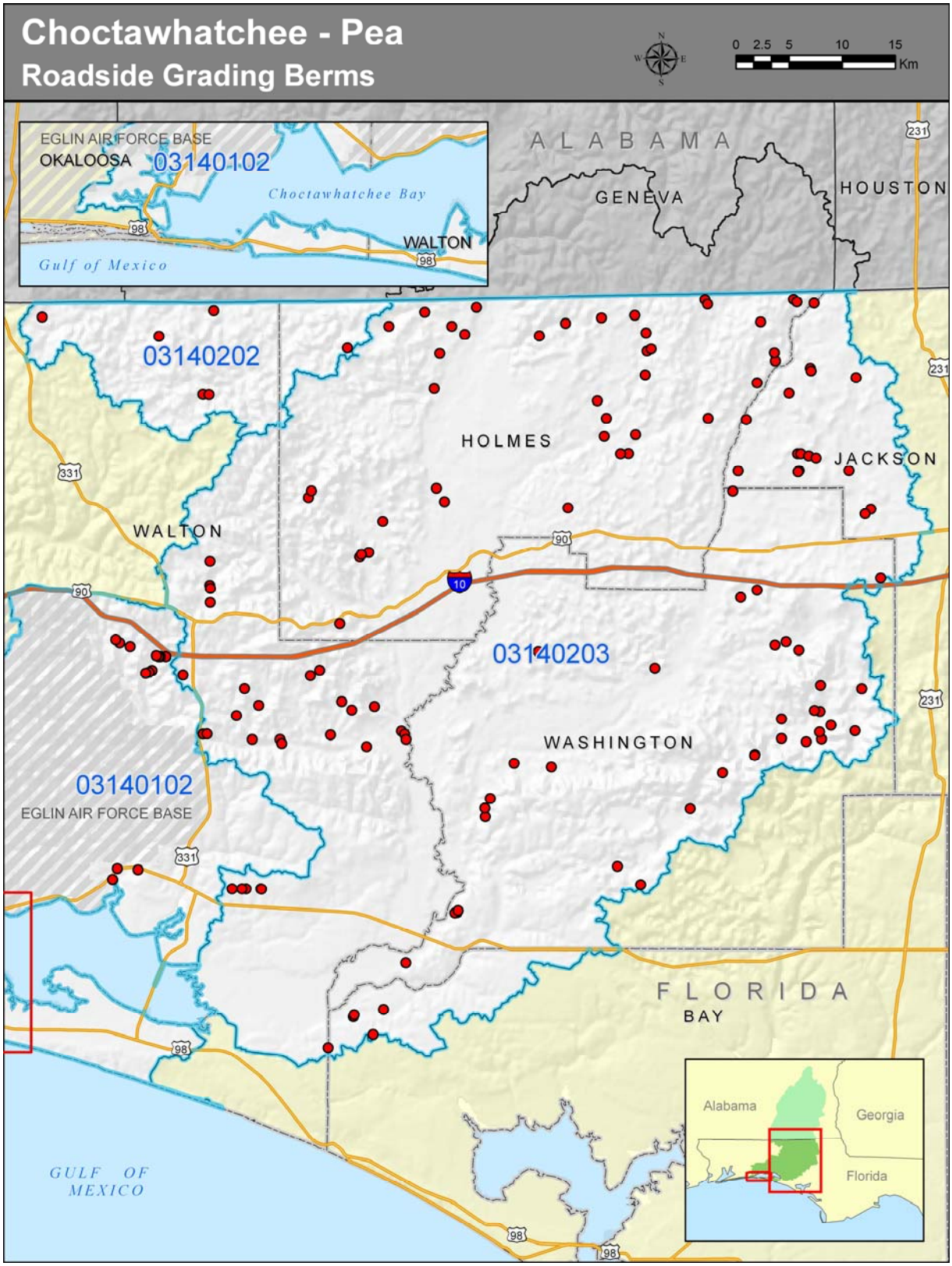


Figure 5-34. Choctawhatchee-Pea Basin Water Crossings With Roadside Grading Berms (David Rubino)

5.3.1.11 Road Cross Drain Erosion – Crossover Site Crossing

Road cross drains (RCDs) are culvert structures used to control roadside drainage. Typically, these culverts are used to manage the volume and velocity of roadside ditch drainage by transferring water under the road to a receiving ditch. However, in some cases RCDs are used to discharge road drainage. The results frequently include the development of discharge gullies and transport of sediment off-site (Figure 5-35). Depending on the proximity of water resources, RCDs may function as conduits between sediment sources and aquatic ecosystems. In addition to sediment inputs from the road approaches, sites with relatively steep discharge slopes may generate gross amounts of gully erosion.



Figure 5-35. Choctawhatchee-Pea Basin Crossover Sites (Mike Rainer)

During StreamX field data collection, problematic road crossing drains were collected as crossover sites. The 267 CPB crossover site crossings (Section 4.2.2) are listed in Table 5-16 and presented in Figure 5-36. There were 59 sites that were observed to have direct connectivity to water resources, 3 that were indirectly connected, and 205 sites that had undetermined connectivity.

Table 5-16. Choctawhatchee-Pea Basin Crossover Site Crossings

Crossing Identification	WBID	WBID Name	County	Index Map Cross Reference	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203					
12131_587015_3413516	178	Sandy Creek	Walton	58-168	B2
12131_588834_3391961	343	Bruce Creek		58-175	B3
12059_600987_3423652	109	Fowler Branch	Holmes	60-30	C1
12059_600336_3421083				60-29	
12059_598435_3422393				59-53	
12059_600929_3423802				60-31	
12059_600367_3424409				60-32	
12059_602634_3423915	112	Angelico Branch		60-33	
12059_597702_3420478	136	Pine Log Creek		59-28	
12059_595995_3419869				59-36	
12059_596711_3419976				59-37	
12059_605814_3421310	146	West Pittman Creek		60-52	
12059_597060_3419372	164	Timber Branch		59-38	
12059_603943_3413394	49f	Choctawhatchee River		60-45	C2
12059_612904_3410056	54	Wrights Creek		61-153	
12059_593176_3415248	146	West Pittman Creek		59-23	
12059_597934_3414791				59-24	
12059_598377_3416501				59-26	
12059_597633_3413261				59-25	
12059_592508_3415886				59-22	
12059_602642_3416374	163	Bay Branch		60-35	
12059_602963_3415209				60-34	
12059_595419_3404520	178	Sandy Creek		59-39	
12059_599252_3404259	210	Otter Creek		59-8	
12059_593636_3410562				59-12	
12059_603124_3413428	212	Reedy Creek		60-44	
12059_602883_3413427				60-43	
12059_602557_3413429				60-42	
12059_602093_3413429				60-41	
12059_601858_3407775				60-100	
12059_603281_3413293				60-46	
12059_601879_3408170				60-101	
12059_602813_3405722				60-97	
12059_604296_3398989				60-98	
12059_604939_3402611				60-48	
12059_603177_3403735				60-49	
12059_604975_3402459				60-47	
12059_602579_3408018	227a	Hood Lake Drain		60-50	
12059_595336_3408291	249	Padgett Creek		59-40	
12059_619403_3407392	261	Dram Branch		61-103	
12059_598379_3407127	270	Goose Branch		59-102	
12059_597755_3407367				59-9	
12059_598116_3404029	298	Cow Branch		59-11	
12059_607785_3399633	49	Choctawhatchee River		60-99	C3
12131_589669_3388007	343	Bruce Creek	Walton	58-169	
12059_597786_3398851	349	Mill Creek	Holmes	59-79	
12131_593100_3394734	414	Folks Creek	Walton	59-176	
12133_605247_3366456	49b	Choctawhatchee River	Washington	60-223	C5
12133_604021_3366648				60-222	
12005_603244_3364095	526	Pine Log Creek	Bay	60-0	
12005_603243_3364599				60-1	
12133_603447_3366053	869	East River	Washington	60-224	
12005_598997_3358866	983	Tenmile Branch	Bay	59-2	
12005_598732_3358912				59-3	
12005_598176_3359127				59-4	
12005_597689_3359106				59-5	
12005_597232_3358998				59-6	
12005_596991_3358959				59-7	

Table 5-16. Choctawhatchee-Pea Basin Crossover Site Crossings Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Cross Reference	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd					
12059_615972_3429210	48	Whitewater Branch	Holmes	61-57	D1
12059_616292_3429243				61-58	
12059_614473_3429628				61-59	
12059_614470_3429177				61-60	
12059_614941_3428816				61-61	
12059_614485_3427824				61-62	
12059_614558_3427670				61-63	
12059_614078_3427612				61-64	
12059_622533_3414594	54	Wrights Creek		62-123	
12059_624268_3429261	56	Tenmile Creek		62-13	
12059_616339_3426883	69	Unnamed branch		61-54	
12059_616594_3427680				61-55	
12059_616184_3427755				61-56	
12059_615685_3427615				61-163	
12059_620988_3425504	77	Little Creek		62-72	
12059_620980_3426123				62-73	
12059_620981_3426392				62-74	
12059_622428_3427716				62-75	
12059_608692_3424863	94	Limestone Branch		60-51	
12059_611831_3422423	120	Unnamed branch		61-65	
12059_610500_3421627				61-66	
12059_610277_3421477				61-67	
12059_610025_3421118	133	Ginhouse Branch		61-68	
12059_610805_3420143				61-69	
12059_610873_3420041				61-70	
12059_611286_3419473				61-71	
12059_622725_3406217	239	Gum Creek		62-80	
12059_613879_3407094	49	Choctawhatchee River		61-10	D2
12133_615784_3407022			Washington	61-185	
12059_623702_3410926	54	Wrights Creek	Holmes	62-82	
12059_623723_3411677				62-83	
12059_622766_3414973				62-84	
12059_620380_3414123				62-85	
12059_619867_3413439				61-86	
12059_617502_3410765				61-87	
12059_615794_3410112				61-89	
12059_615310_3410366				61-90	
12059_617403_3411516				61-93	
12059_617368_3411642				61-94	
12059_622267_3410858				62-95	
12059_621869_3414626				62-96	
12059_623484_3412059				62-116	
12059_613465_3408632				61-117	
12059_614779_3409982				61-118	
12059_613738_3412344				61-119	
12059_613154_3411401				61-120	
12059_616346_3414731				61-122	
12059_622809_3414620				62-124	
12059_622831_3414496				62-125	
12059_623124_3414190				62-126	
12059_624130_3413727				62-127	
12059_624617_3413740				62-128	
12059_623620_3414973				62-129	
12059_622952_3414872				62-130	
12059_624251_3414917				62-131	
12059_615121_3415916	183	Catfish Branch		61-121	

Table 5-16. Choctawhatchee-Pea Basin Crossover Site Crossings Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Cross Reference	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd					
12059_623591_3410293	239	Gum Creek	Holmes	62-81	D2
12059_621059_3408650				62-111	
12059_625097_3410720				62-112	
12059_624250_3406851				62-159	
12059_617186_3410384	240	Hathaway Mill Creek		61-88	
12059_619289_3409479				61-91	
12059_619928_3411163				61-92	
12059_619335_3408638				61-108	
12059_619810_3408643				61-109	
12059_620725_3408657				62-110	
12059_620393_3409911				62-143	
12059_620240_3410751				62-144	
12059_620887_3410399				62-145	
12059_620773_3410072				62-146	
12059_624489_3405231	286	Open Creek		62-142	
12059_619068_3407251	261	Dram Branch		61-104	
12059_617792_3407166				61-105	
12059_616943_3407387				61-106	
12059_618986_3408465				61-107	
12059_623340_3403021	286	Open Creek		62-140	
12059_622809_3402724				62-141	
12133_614942_3399917	49	Choctawhatchee River	Washington	61-225	D3
12133_608972_3388027	49e			60-214	
12133_611282_3389283	59	Holmes Creek		61-213	
12133_611574_3389202				61-234	
12133_619913_3400487	239	Gum Creek		61-200	
12133_619896_3400250				61-201	
12133_617756_3400317				61-202	
12133_622595_3396421				62-203	
12133_622412_3397065				62-207	
12133_620328_3397742				62-208	
12133_621774_3399044				62-209	
12133_615694_3396819				61-210	
12133_615690_3397409				61-211	
12133_614790_3398393				61-226	
12133_613824_3397285				61-227	
12133_616718_3395822				61-237	
12133_617274_3395498				61-238	
12133_617547_3395355				61-239	
12133_618227_3394944				61-240	
12133_618518_3395018				61-241	
12133_622248_3394420				62-242	
12133_621653_3395028				62-243	
12133_624296_3395777	348	Gully Creek		62-204	
12133_624580_3395876				62-205	
12133_612947_3396903	362	Yates Mill Creek		61-228	
12133_612556_3396685				61-229	
12133_611621_3395767				61-230	
12133_611392_3395721				61-231	
12133_611149_3395571				61-232	
12133_610475_3393618				61-233	
12133_611426_3390649	450	Shaky Joe Branch		61-212	
12133_612208_3388397				61-235	
12133_611087_3391716				61-236	
12133_608803_3381960	59	Holmes Creek		60-215	D4
12133_608862_3381962				60-216	
12133_623927_3375377	526	Pine Log Creek		62-248	

Table 5-16. Choctawhatchee-Pea Basin Crossover Site Crossings Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Cross Reference	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd					
12133_607848_3369303	49b	Choctawhatchee River	Washington	60-220	D5
12133_607046_3368875				60-221	
12059_635753_3428207	54	Wrights Creek	Holmes	63-77	E1
12059_626036_3417359				62-132	
12059_626663_3420234				62-138	
12059_636820_3429626				63-150	
12059_626594_3422636	56	Tenmile Creek		62-15	
12059_626619_3422890				62-16	
12059_627817_3424956				62-17	
12059_635601_3418555	59	Holmes Creek		63-18	
12059_638651_3423856				63-20	
12059_638693_3424258				63-21	
12059_628016_3426809	61	Texas Branch		62-76	
12059_637344_3427333	86	Bell Branch		63-78	
12059_637149_3427162				63-149	
12059_633491_3426309	103	Corbett Branch		63-148	
12059_633522_3426152				63-147	
12059_629716_3422620	113	Register Branch		62-151	
12059_629895_3423310				62-152	
12063_642572_3421208	130	Fish Branch	Jackson	64-164	
12063_641176_3418543	147	Gum Creek		64-156	
12059_632120_3419016	150	Kelley Branch	Holmes	63-136	
12059_632296_3419206				63-137	
12059_623355_3403374	286	Open Creek		62-139	
12059_624814_3412196	54	Wrights Creek		62-114	E2
12059_624530_3412403				62-115	
12059_625650_3416662				62-133	
12059_628184_3415403				62-161	
12059_627498_3417049				62-162	
12059_633103_3416915	59	Holmes Creek		63-19	
12063_642392_3416997	130	Fish Branch		64-165	
12063_641436_3417966	147	Gum Creek		64-154	
12063_641397_3418044				64-155	
12059_631911_3418579	150	Kelley Branch		63-135	
12059_625001_3412010	206	Gum Branch		62-113	
12059_626980_3413290				62-134	
12059_629321_3407685	232	Unnamed drain		62-160	
12059_627694_3407512	251	Camp Branch		62-14	
12133_632345_3390264	59	Holmes Creek	Washington	63-178	E3
12133_632270_3391315				63-179	
12133_629484_3398966				62-180	
12133_630298_3399349				63-181	
12133_630364_3399373				63-182	
12133_635931_3400790				63-183	
12133_627049_3397420				62-206	
12133_627268_3389388				62-253	
12133_635567_3397721	337	Flat Creek		63-184	
12133_640200_3397929				64-187	
12133_638826_3388225	401	Hard Labor Creek		63-191	
12133_639550_3387536				63-192	
12133_641510_3387835				64-194	
12133_641984_3387850				64-195	
12133_642302_3388135				64-196	
12133_633496_3392882				63-197	
12133_633637_3393333				63-198	
12133_632706_3393942				63-199	
12133_637565_3388948				63-244	

Table 5-16. Choctawhatchee-Pea Basin Crossover Site Crossings Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Cross Reference	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd					
12133_635798_3387457	456	Reedy Creek	Washington	63-188	E3
12133_635979_3387574				63-189	
12133_636234_3389144				63-190	
12133_627555_3384000	501	Pippin Mill Creek		62-250	E4
12133_625837_3373913	526	Pine Log Creek		62-247	
12133_626864_3379463				62-249	
12133_632307_3384895				63-251	
12133_633484_3384274				63-252	
12063_642706_3428487	59	Holmes Creek	Jackson	64-166	F1
12063_648543_3420751	157	Little Alligator Cr		64-158	
12133_644599_3403200	123	Alligator Creek	Washington	64-218	F2
12133_645203_3403971				64-219	
12133_643996_3409017				64-246	
12063_648344_3412436	235	Pine Barn Creek	Jackson	64-157	
12133_646968_3403239	262	Gilberts Mill Creek	Washington	64-217	
12133_643224_3396626	337	Flat Creek		64-186	F3
12133_642804_3390660	346	Little Hard Labor Creek		64-259	
12133_644687_3396782				64-255	
12133_644725_3395642				64-256	
12133_642836_3392014				64-258	
12133_644840_3393109				64-260	
12133_643326_3393321				64-257	
12133_645534_3393096				64-261	
12133_643164_3388355	401	Hard Labor Creek		64-193	
12133_646894_3393920				64-254	
12133_645543_3391573				64-262	
12133_645831_3387877	490	Poley Creek		64-245	
12133_649404_3390547				64-263	
12133_649651_3390054				64-264	
12133_645986_3388700				64-266	
12133_645903_3388692				64-265	
Pea River Subbasin, HUC 03140202					
12131_579218_3428629	42	Eighteen Mile Creek	Walton	57-167	B1
12059_596965_3426519	81	Mack Bay Branch	Holmes	59-27	C1
Choctawhatchee Bay Subbasin, HUC 03140102					
12131_578328_3398500	332	Cosson Mill Creek	Walton	57-170	B3
12131_576727_3396682				57-173	
12131_580772_3390406	436	Blount Creek		58-172	
12131_582491_3392217				58-174	
12131_580775_3390689				58-171	
12131_576168_3374311	731	Alaqua Bayou		57-177	B4

5.3.1.12 Ditch Turnout Erosion – Proximity Site Crossing

The use of best management practices designed to prevent erosion can often have the opposite effect. One of the most common instances involves roadside ditch turnouts. Although an effective practice to discharge road runoff, turnouts are often improperly located and constructed. Rather than dissipating and discharging runoff in a nonerosive manner, many turnouts create roadside gullies that discharge directly into waterways (Section 4.2.3 and Figure 5-37). The installation of crossing BMPs that control a problem, to the exclusion of other interactive issues affecting a crossing, may simply relocate and further disperse the stresses of runoff on other sensitive areas, thereby minimizing the effectiveness of the practice and increasing overall soil erosion. During StreamX field data collection, problematic ditch turnouts were collected as proximity sites.

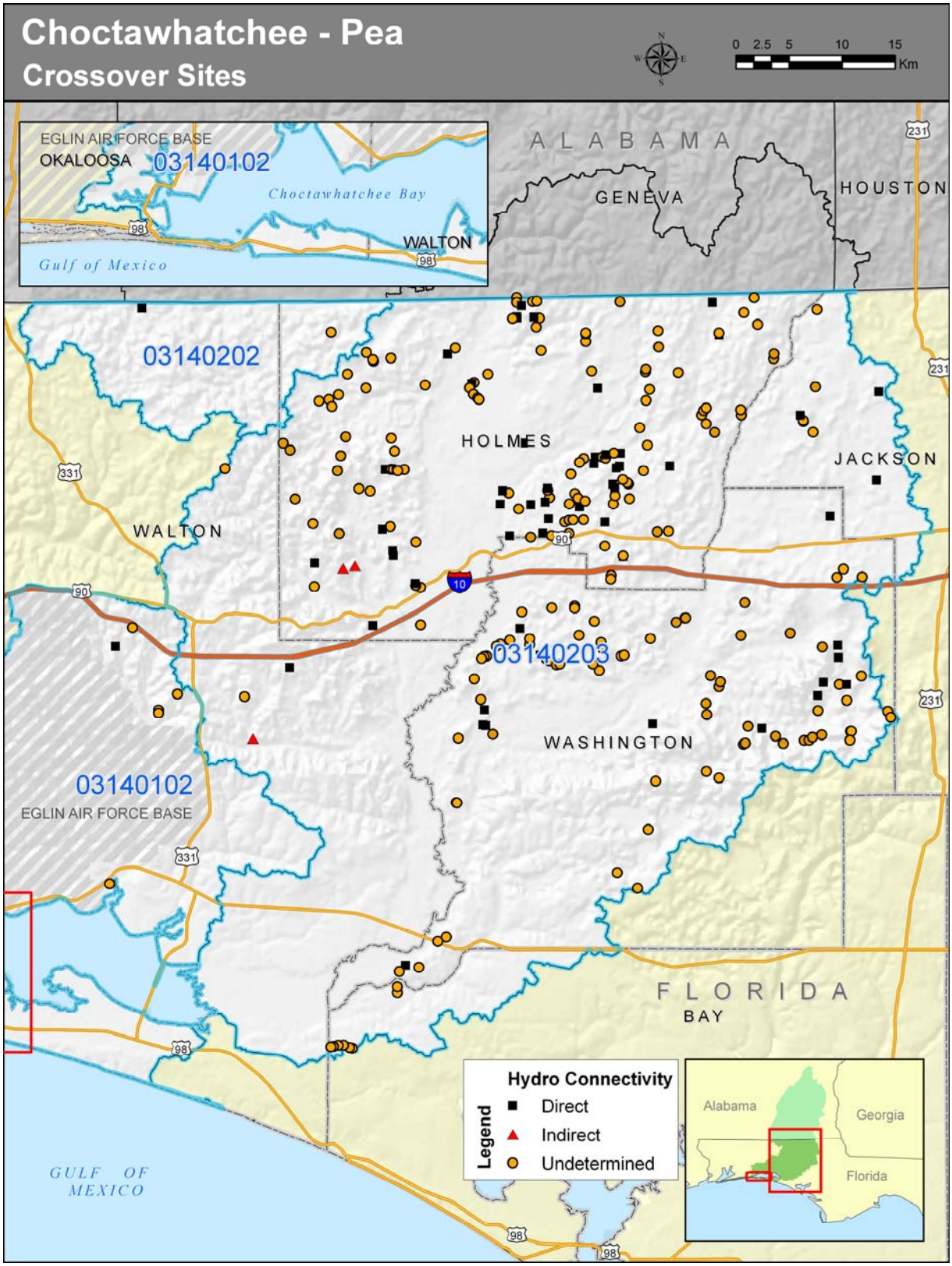


Figure 5-36. Choctawhatchee-Pea Basin Crossover Site Crossings (David Rubino)



Figure 5-37. Choctawhatchee-Pea Basin Roadside Ditch Turnout Erosion (Mike Rainer)

The 46 CPB turnout proximity site crossings (Section 4.2.3) are listed in Table 5-17 and presented in Figure 5-38. There were 10 sites that were observed to have direct connectivity to water resources, 1 that was indirectly connected, and 35 sites that had undetermined connectivity.

Table 5-17. Choctawhatchee-Pea Basin Proximity Site Crossings

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12131_588295_3373840	739	Pate Branch	Walton	B4
12059_600358_3404206	210	Otter Creek	Holmes	C2
12059_598972_3404228				
12059_596136_3410952				
12059_598589_3409073				
12059_603487_3411827	227a	Hood Lake Drain		
12059_604613_3411972				
12131_602813_3388256	343	Bruce Creek	Walton	C3
12131_596564_3387504				
12131_598788_3396430	349	Mill Creek		
12131_593153_3394700	414	Folks Creek		
12131_599727_3390188	457	Spears Branch		
12059_607972_3424275	94	Limestone Branch	Holmes	D1
12059_620757_3414454	54	Wrights Creek		D2
12059_614944_3410617				
12059_615284_3410375				
12059_619284_3409785	240	Hathaway Mill Creek		
12059_624670_3404872	286	Open Creek		
12133_609211_3388028	49e	Choctawhatchee River	Washington	D3
12133_608401_3387993				
12133_609139_3388312				
12059_601939_3401887	212	Reedy Creek	Holmes	
12133_618911_3394452	348	Gully Creek	Washington	D4
12133_609460_3378858	59	Holmes Creek		
12133_624640_3384304				
12133_611940_3380042				
12133_623387_3381901	526	Pine Log Creek		
12133_623320_3381982				
12133_620011_3383005	549	Fanning Branch		
12059_636193_3421360	59	Holmes Creek	Holmes	E1
12059_637573_3421899				
12059_632330_3411446				E2
12133_625045_3400811	286	Open Creek	Washington	E3
12133_633394_3395122	337	Flat Creek		
12133_640707_3387929	401	Hard Labor Creek		
12133_633309_3394975				

Table 5-17. Choctawhatchee-Pea Basin Proximity Site Crossings Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12133_630854_3380694	526	Pine Log Creek	Washington	E4
12133_630518_3380886				
12133_630318_3381300				
12133_630058_3381700				
12063_642643_3422166	130	Fish Branch	Jackson	F1
12063_647799_3414127	195	Scurlock Creek		F2
12133_645763_3387764	490	Poley Creek	Washington	F3
12133_644826_3397035	346	Little Hard Labor Creek		
Pea River Subbasin, HUC 03140202				
12059_594100_3424486	63	Hurricane Creek	Holmes	C1
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_581151_3390866	436	Blount Creek	Walton	B3

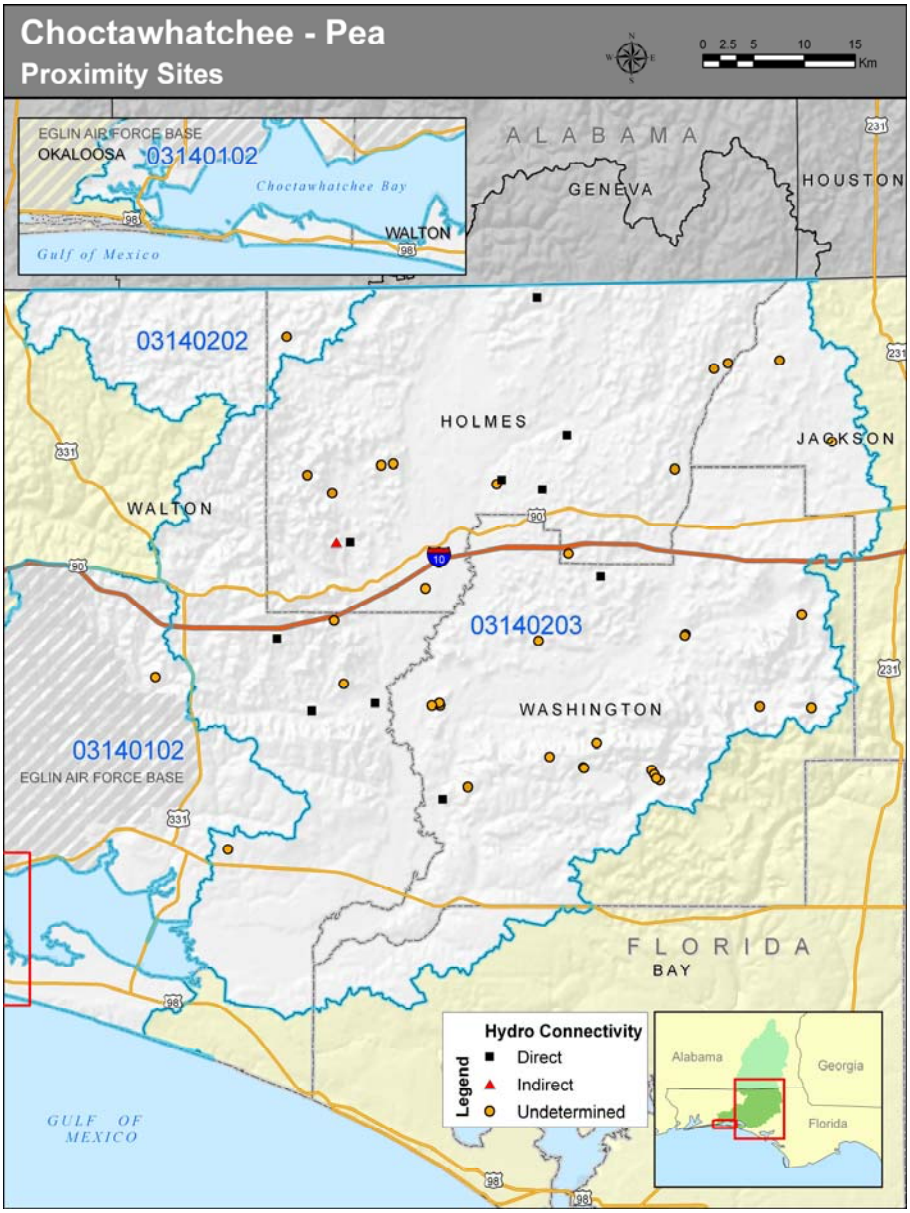


Figure 5-38. Choctawhatchee-Pea Basin Proximity Site Crossings (David Rubino)

5.3.2 Roadside Conditions

Crossing roadside conditions are associated with the roadside areas hydrologically connected to the road approach. The extent of the roadside area can extend away from the road a few feet or hundreds of feet. Roadside areas are potential contributors of sediment, surface runoff, and groundwater seepage and provide potential habitat for nonnative invasive plant species. Roadside conditions of concern discussed in this section include roadside erosion, groundwater seepage, and invasive species.

5.3.2.1 Roadside Erosion

Roadside erosion includes areas that have been physically disturbed to the point that the land surface is unable to maintain its structural integrity. Typically, these areas are denuded of vegetation and are scarred by sheet, rill, and gully erosion-induced soil loss (Figure 5-39). Generally, these conditions are created by equipment operations, material excavations, undercutting and sloughing of slopes by ditches, and/or other disturbances. The 90 CPB crossings that exhibited roadside erosion are listed in Table 5-18 and presented in Figure 5-40.



Figure 5-39. Choctawhatchee-Pea Basin Crossing Roadside Erosion (Mike Rainer)

Table 5-18. Choctawhatchee-Pea Basin Crossings With Roadside Erosion

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12131_585614_3404688	269	West Sandy Creek	Walton	B2
12131_585620_3402440	283a	Lake Juniper Drain		
12131_583070_3393990	350	Bay Branch		B3
12131_585279_3388430	486	Mill Creek		
12059_602307_3426910	47	Parrot Creek	Holmes	C1
12059_604871_3428774				
12059_603513_3425625				
12059_606105_3426458				
12059_606026_3424697	94	Limestone Branch		
12059_606032_3421506	119	Windmill Branch		
12059_602167_3419934	146	West Pittman Creek		
12059_600415_3419219				
12059_606111_3408200	49f	Choctawhatchee River		C2
12059_593915_3415962	146	West Pittman Creek		
12059_598113_3416255				
12059_597988_3414206				
12059_599137_3418171				
12059_596942_3408843	210	Otter Creek		
12059_595243_3411442				
12059_601908_3413431	212	Reedy Creek		
12059_601866_3408469				
12059_593982_3404088	249	Padgett Creek		
12059_599918_3405410	270	Goose Branch		
12131_604086_3387915	49e	Choctawhatchee River	Walton	C3
12059_605137_3402312	212	Reedy Creek	Holmes	
12131_595137_3393850	373	White Creek	Walton	

Table 5-18. Choctawhatchee-Pea Basin Crossings With Roadside Erosion Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12059_609588_3426163	47	Parrot Creek	Holmes	D1
12059_615788_3428702	48	Whitewater Branch		
12059_614478_3428556				
12059_619077_3427196	55	East Pittman Creek		
12059_616641_3426004				
12059_615200_3423100	121	Little Creek		
12059_607716_3410489	49f	Choctawhatchee River		D2
12059_630729_3419945	54	Wrights Creek		
12059_624157_3414952				
12059_622848_3418245	56	Tenmile Creek		
12133_618173_3404328	261	Dram Branch	Washington	
12059_624503_3405170	286	Open Creek	Holmes	
12133_620666_3399722	239	Gum Creek	Washington	D3
12133_624766_3401446	286	Open Creek		
12133_612247_3396364	362	Yates Mill Creek		
12133_608657_3371568	49b	Choctawhatchee River		D4
12133_608895_3371613				
12133_609327_3383958	59	Holmes Creek		
12059_625115_3419525	54	Wrights Creek	Holmes	E1
12059_626690_3419538				
12059_628150_3424588	56	Tenmile Creek		
12059_625607_3427827				
12059_635621_3421345	59	Holmes Creek		
12063_638723_3421488			Jackson	
12059_641905_3429936			Holmes	
12059_633958_3420481	139	Jackson Branch		
12059_634725_3419557				
12059_635539_3419224				
12059_633917_3414927	59	Holmes Creek		E2
12059_632870_3408534				
12059_628565_3407554	251	Camp Branch		
12059_627555_3404690				
12133_632556_3392055	59	Holmes Creek	Washington	E3
12133_629502_3398783				
12133_635587_3399509				
12133_636388_3399583				
12133_627510_3401084	286	Open Creek		
12133_642008_3397707	337	Flat Creek		
12133_638794_3396780				
12133_639341_3387976	401	Hard Labor Creek		
12133_635494_3387474	456	Reedy Creek		
12133_636843_3386378				
12133_631902_3387482	526	Pine Log Creek		
12133_635833_3385174	456	Reedy Creek		E4
12133_632519_3384737	526	Pine Log Creek		
12063_644135_3419774	130	Fish Branch	Jackson	F1
12063_642926_3422175				
12063_645738_3413309	123	Alligator Creek		F2
12063_643582_3416447	130	Fish Branch		
12133_643171_3387949	401	Hard Labor Creek	Washington	F3
12133_644049_3389298				
12133_642899_3388588				
12133_647019_3392581				
12133_646584_3388217	490	Poley Creek		
12133_646259_3388743				
Pea River Subbasin, HUC 03140202				
12131_574345_3425295	42	Eighteen Mile Creek	Walton	B1
12131_577263_3424973				
12131_577907_3426307				
12131_585703_3428652	43	Limestone Creek		
12059_601754_3428790	46	Pea River	Holmes	C1
12059_598029_3426302	63	Hurricane Creek		
12059_594827_3424131				
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_578634_3396546	332	Cosson Mill Creek	Walton	B3
12131_579533_3394149	369	Sconiers Mill Creek		

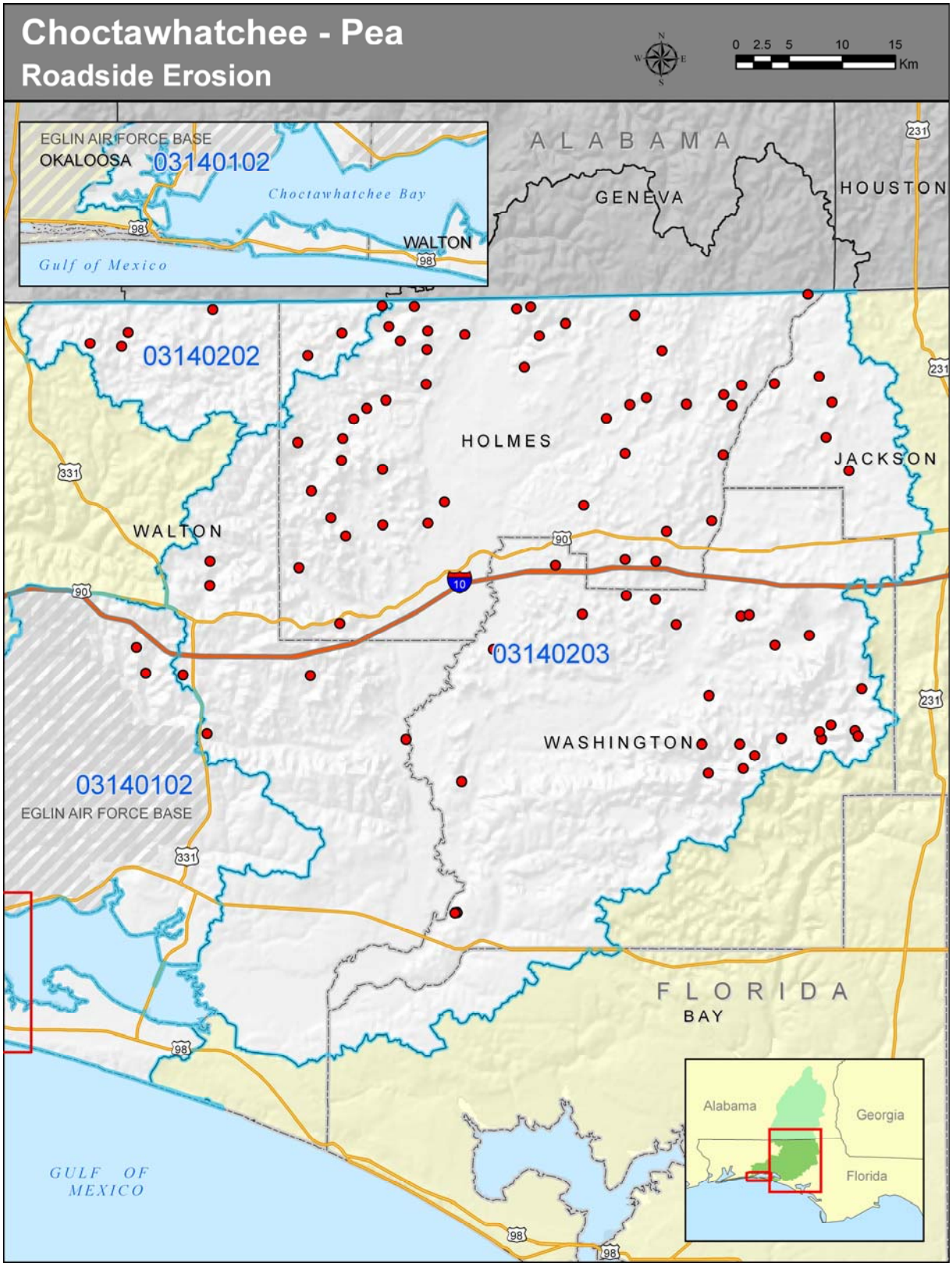


Figure 5-40. Choctawhatchee-Pea Basin Water Crossing Roadside Erosion (David Rubino)

5.3.2.2 Groundwater Seepage

Groundwater discharged from the soil media through diffuse percolation is termed "seepage." Seepage frequently occurs where road incision and/or roadside ditch excavations have intersected near-surface groundwater flows. Depending on the amount of road cut and prevailing roadside groundwater conditions, seepage may persist as ephemeral or perennial flow regimes. The extended presence of water can compromise the integrity of the road matrix and prevent the establishment of vegetation and other erosion control measures within roadside ditches and rights-of-way (Figure 5-41). Road maintenance costs associated with minor to severe seepage conditions can be significant.



Figure 5-41. CPB Roadside Groundwater Seepage (Mike Rainer)

The presence of groundwater seepage is directly linked to site geomorphology and the weather. Seepage may only occur at some sites in very wet years, while other sites may produce seepage for extended periods following each storm event. The 10 CPB water crossings that exhibited roadside groundwater seepage conditions are listed in Table 5-19 and shown in Figure 5-42. It should be noted, the study area was experiencing severe drought conditions during the 2007 StreamX field reconnaissance surveys. It is likely, that during normal weather conditions more crossing road approach seepage conditions would have been observed. However, the presence of seepage during drought conditions is an indicator of locations where the impacts of chronic soil saturation are most likely to be expressed.

Table 5-19. Choctawhatchee-Pea Basin Crossings With Groundwater Seepage

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12131_587566_3412505	178	Sandy Creek	Walton	B2
12131_585279_3388430	486	Mill Creek		B3
12059_602867_3405332	212	Reedy Creek	Holmes	C3
12059_616749_3424615	108	Bee Branch		D1
12059_621450_3421119	77	Little Creek		D2
Pea River Subbasin, HUC 03140202				
12131_574345_3425295	42	Eighteen Mile Creek	Walton	B1
12131_579195_3426192				
12059_596747_3427352	81	Mack Bay Branch	Holmes	C1
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_580921_3395729	369	Sconiers Mill Creek	Walton	B3
12131_574146_3364860	881	Direct runoff to bay		B5

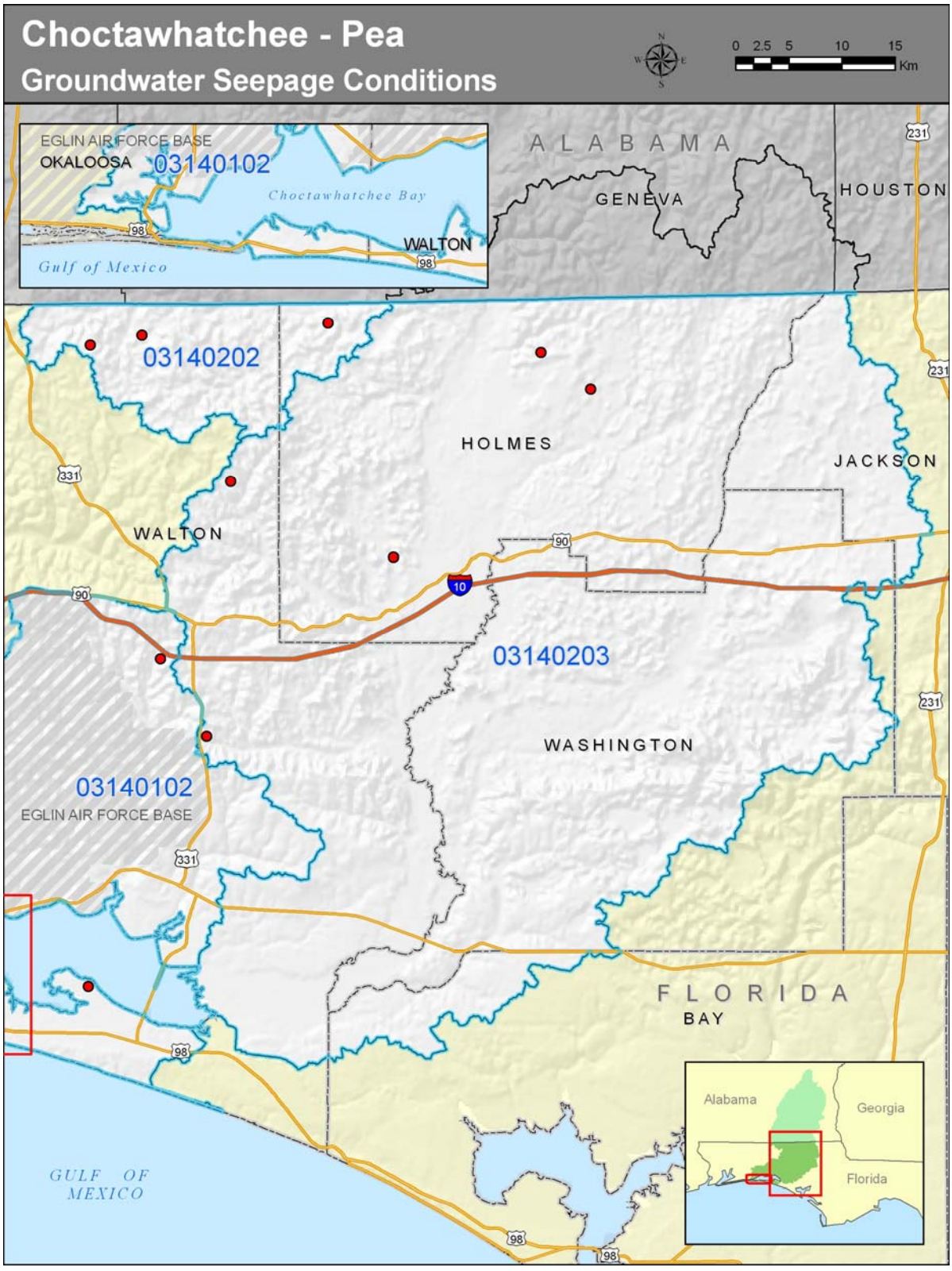


Figure 5-42. Choctawhatchee-Pea Basin Water Crossings With Roadside Groundwater Seepage Conditions (David Rubino)

5.3.2.3 Invasive Species

The introduction of nonnative, invasive species reduces the integrity and biodiversity of natural plant communities and subsequent wildlife habitats, as well as spreads diseases and alters ecosystem processes. In some instances, invasive species threaten federally listed species. Invasive plant species may become established by intentional plantings or distributed by vehicles, machinery, and illegal dumping. As vehicles drive through areas infested with invasive species, seeds, spores, and vegetative materials become lodged in tire treads, undercarriages, door jams, and other areas and can travel for miles before being dislodged.

Roads and crossings may serve as avenues for introducing nonnative, invasive species into natural communities. The ground disturbances associated with crossing maintenance provides habitats that may promote colonization by invasive plants. Many invasive plants are early seral (pioneer) species that are well adapted to the less-than-optimal seed germination and plant-growth conditions of disturbed roadside areas (Cousens and Mortimer, 1995; Walters, 1996). The removal of vegetation or disturbance of roadside soils may create a microenvironment to which nonnative species are best adapted. Once established, nonnative species could potentially encroach into native communities. The rise of invasive species to levels of abundance greater than indigenous species is likely related to the mechanics of disturbance that remove vegetative, biomass, climate, soil condition, or other barriers to its proliferation (Schowalter and Means, 1989).

Two nonnative invasive plant species observed to be widely distributed among CPB crossings include cogan grass (*Imperata cylindrica*) and kudzu (*Pueraria lobata*). Populations have become established through accidental infestation and intentional plantings to stabilize soils and control erosion (Figure 5-43). The five CPB crossings with observed infestations of cogan grass and/or kudzu are listed in Table 5-20 and presented in Figure 5-44.



Figure 5-43. CPB Roadside Cogan Grass and Kudzu (Mike Rainer)

Table 5-20. Choctawhatchee-Pea Basin Crossings With Roadside Cogan Grass and Kudzu Infestations

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12133_624733_3401517	286	Open Creek	Washington	D3
12059_631786_3422866	54	Wrights Creek	Holmes	E1
12059_619399_3419998				E2
12133_639437_3389888	401	Hard Labor Creek	Washington	E3
12063_646364_3422088	123	Alligator Creek	Jackson	F1

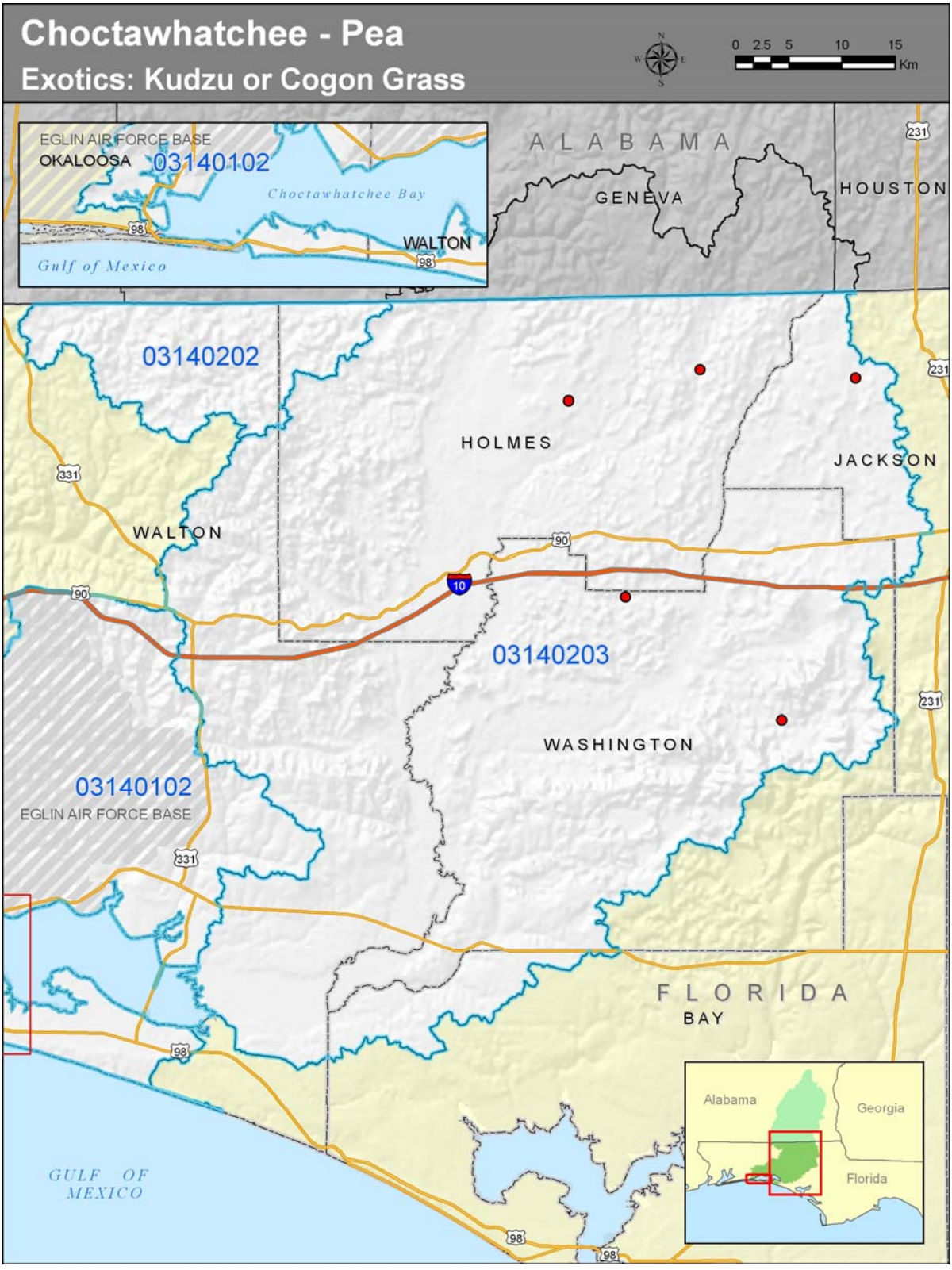


Figure 5-44. Choctawhatchee-Pea Basin Water Crossing With Cogan Grass and/or Kudzu Infestations

(David Rubino)

5.4 CROSSING WATERWAY CONDITIONS

Crossing waterways are the endpoint for stormwater runoff and pollutants generated by crossing road approaches, roadsides, and crossing structure components. Depending on site conditions the consequences of crossing inputs may be relatively benign or result in catastrophic ecosystem changes. The waterway conditions of concern discussed in this section include sediment plugs and islands, streambed smoothing, crossing cleanouts, beaver activity, and wetland hydrology disconnects.

5.4.1 Sediment Plugs and Islands

Crossing upstream and downstream sediment plugs and islands are indicators of crossing-induced sedimentation. These instream features signify that significant amounts of soil materials are being exported and deposited within the water course. Plugs and islands are primarily composed of fine to coarse sand materials that quickly fall out of suspension within the channel. These crossing features frequently occur at the points where road drains discharge into streams (Figure 5-45). Their prominence generally relates to the frequency and extent of sediment discharge and the sediment transport capacity of the stream. Headwater low order streams may exhibit extensive plug and island development whereas the stream power of higher order streams tend to more readily move sediments downstream. In some cases, the islands and plugs support the development of instream vegetation. The extent and juxtaposition of these transitory features may change during high flow periods following storm events; materials are constantly being resuspended, relocated, and redeposited in different locations. The 158 CPB water crossings with instream sediment plugs and/or sediment island features are listed in Table 5-21 and presented in Figure 5-46.



Figure 5-45. CPB Instream Sediment Plugs and Islands (Mike Rainer)

Table 5-21. Choctawhatchee-Pea Basin Crossings With Instream Sediment Plugs and Islands

Crossing Identification	WBID	WBID Name	County	Location at Crossing	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203					
12131_587566_3412505	178	Sandy Creek	Walton	Both	B2
12131_585614_3404688	269	West Sandy Creek		Downstream	
12131_585620_3402440	283a	Lake Juniper Drain			
12131_587757_3390255	343	Bruce Creek		Both	B3
12131_588846_3392706				Downstream	
12131_583070_3393990	350	Bay Branch			
12131_584870_3388458	486	Mill Creek		Downstream	
12131_585279_3388430				Upstream	
12131_588597_3373858	739	Pate Branch		Both	B4
12131_588901_3373806				Downstream	
12131_587694_3373832	741	Unnamed run		Both	
12059_606026_3424697	94	Limestone Branch	Holmes		C1
12059_603459_3420893	112	Angelico Branch		Downstream	
12059_606032_3421506	119	Windmill Branch		Both	
12059_605456_3422790					
12059_606703_3421024	126	Dada Branch			
12059_597554_3420415	136	Pine Log Creek		Upstream	
12059_595428_3402370	178	Sandy Creek		Both	C2
12059_599926_3411751	205	Bay Drain		Upstream	
12059_601866_3408469	212	Reedy Creek		Downstream	
12059_601908_3413431					
12059_602102_3408645				Both	
12059_601172_3408729				Upstream	
12059_593982_3404088	249	Padgett Creek		Both	
12059_599918_3405410	270	Goose Branch		Downstream	
12059_596707_3404240	289	Black Branch			
12059_596249_3404471					
12059_599227_3402110	298	Cow Branch			
12059_605137_3402312	212	Reedy Creek		Both	C3
12059_605393_3398698				Upstream	
12131_592169_3387913	343	Bruce Creek	Walton	Downstream	
12131_596073_3387582					
12059_601141_3398948	349	Mill Creek	Holmes		
12131_595137_3393850	373	White Creek	Walton	Both	
12131_594023_3392453	382	White Creek		Downstream	
12131_596880_3388321				Upstream	
12131_601102_3391372	399	Hughes Ditch		Downstream	
12131_598012_3391393	404	Crooked Creek		Both	
12131_598977_3390609	457	Spears Branch			
12131_590344_3373860	747	Unnamed creek		Downstream	C4
12133_604043_3366921	49b	Choctawhatchee River	Washington		C5
12005_599121_3361813	950	Otter Creek	Bay	Both	
12005_599190_3361962					
12059_615788_3428702	48	Whitewater Branch	Holmes		D1
12059_615206_3428824				Downstream	
12059_614478_3428556				Both	
12059_632432_3427383	54	Wrights Creek		Downstream	
12059_620534_3419184					
12059_626640_3425941	61	Texas Branch			
12059_616556_3427853	69	Unnamed branch		Both	
12059_622687_3419761	77	Little Creek		Downstream	
12059_622410_3421121					
12059_608330_3424331	94	Limestone Branch			
12059_607182_3424350				Both	
12059_616749_3424615	108	Bee Branch			
12059_615200_3423100	121	Little Creek			
12059_610508_3420337	133	Ginhouse Branch			
12059_626096_3413298	206	Gum Branch			
12059_628994_3407640	232	Unnamed drain		Downstream	D2
12059_623019_3408453	239	Gum Creek		Both	
12133_620568_3404818			Washington	Downstream	
12059_617677_3408660	240	Hathaway Mill Creek	Holmes	Both	
12059_619270_3409939				Downstream	

Table 5-21. Choctawhatchee-Pea Basin Crossings With Instream Sediment Plugs and Islands Cont'd

Crossing Identification	WBID	WBID Name	County	Location at Crossing	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd					
12059_619790_3417892	54	Wrights Creek	Holmes	Upstream	D2
12059_613793_3412809				Both	
12059_624157_3414952					
12059_623817_3413615					
12059_613008_3410302					
12059_630729_3419945				Downstream	
12059_622270_3417030	77	Little Creek		Both	
12059_618628_3415535	143	Limestone Branch		Downstream	
12059_614889_3413732	183	Catfish Branch			
12059_624966_3414933	206	Gum Branch		Both	
12059_622215_3403141	239	Gum Creek		Downstream	
12059_614624_3409574	240	Hathaway Mill Creek		Both	
12059_618673_3407170	261	Dram Branch		Downstream	
12133_615342_3404831			Washington	Both	
12133_618173_3404328					
12133_615537_3402016					
12133_615819_3402419					
12059_618284_3407130			Holmes		
12059_624503_3405170	286	Open Creek			
12133_616501_3396220	239	Gum Creek	Washington		D3
12133_620666_3399722				Upstream	
12133_624766_3401446	286	Open Creek		Both	
12133_617534_3393617	348	Gully Creek			
12133_624814_3395782					
12133_612247_3396364	362	Yates Mill Creek		Downstream	
12133_623909_3375974	526	Pine Log Creek			D4
12133_617731_3385316	550	Williams Branch		Both	
12133_610428_3378697	651	Spring Run		Downstream	
12133_609849_3378843				Both	
12059_619565_3428353	53	Clark Mill Creek	Holmes		E1
12059_631786_3422866	54	Wrights Creek		Upstream	
12059_633265_3428625				Downstream	
12059_631373_3425390					
12059_636667_3429703					
12059_636401_3428218					
12059_626690_3419538				Both	
12059_633823_3428214					
12059_632634_3429053					
12059_631093_3427099	58	Mill Branch		Downstream	
12059_631790_3427338					
12063_638723_3421488	59	Holmes Creek	Jackson		
12059_627639_3426295	61	Texas Branch	Holmes	Both	
12059_637934_3427072	86	Bell Branch			
12059_633525_3425328	103	Corbett Branch			
12059_630038_3423411	113	Register Branch		Upstream	
12059_629531_3424126				Downstream	
12059_633958_3420481	139	Jackson Branch		Both	
12059_634725_3419557				Downstream	
12059_635539_3419224					
12063_639229_3418951	147	Gum Creek	Jackson	Both	
12063_640335_3419074					
12063_640089_3420588				Downstream	
12063_640517_3421167				Both	
12059_601244_3399095	349	Mill Creek	Holmes	Downstream	E2
12059_630621_3416764	54	Wrights Creek			
12059_627159_3416907					
12059_631631_3417650					
12059_624250_3414951				Both	
12059_626787_3415716					
12059_625263_3415772					
12133_638927_3410070	123	Alligator Creek	Washington	Downstream	
12063_637804_3415298	147	Gum Creek	Jackson		
12063_641663_3417689					

Table 5-21. Choctawhatchee-Pea Basin Crossings With Instream Sediment Plugs and Islands Cont'd

Crossing Identification	WBID	WBID Name	County	Location at Crossing	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd					
12133_627510_3401084	286	Open Creek	Washington	Downstream	E3
12133_639437_3389888	401	Hard Labor Creek			
12133_642465_3390661	455	Davis Branch		Both	
12133_631902_3387482	526	Pine Log Creek			E4
12133_632519_3384737					
12133_633767_3384797				Downstream	
12063_645366_3413300	123	Alligator Creek	Jackson		F2
12133_644180_3408431			Washington	Both	
12063_648745_3414522	195	Scurlock Creek	Jackson		
12063_648636_3414126				Downstream	
12063_647147_3409117	233	Unnamed creek		Upstream	
12063_650607_3404144	262	Gilberts Mill Creek		Downstream	
12133_643054_3393049	346	Little Hard Labor Cr	Washington		F3
12133_646316_3387889	490	Poley Creek			
12133_646584_3388217					
12133_646259_3388743				Upstream	
Pea River Subbasin, HUC 03140202					
12131_570318_3428215	40	Limestone Branch	Walton	Upstream	A1
12131_571101_3428871				Downstream	
12131_575631_3428399	40a	Natural Bridge Creek		Both	B1
12131_574345_3425295	42	Eighteen Mile Creek		Upstream	
12131_577263_3424973				Downstream	
12131_585933_3428376	43	Limestone Creek		Both	
12131_584945_3424329	66	Spring Branch		Downstream	
12131_585542_3420465	68	Chestnut Creek			
12059_596747_3427352	81	Mack Bay Branch	Holmes		C1
Choctawhatchee Bay Subbasin, HUC 03140102					
12131_577085_3396991	332	Cosson Mill Creek	Walton	Downstream	B3
12131_576673_3397336					
12131_578634_3396546				Both	
12131_578062_3396628				Downstream	
12131_580186_3394422	369	Sconiers Mill Creek		Both	
12131_578852_3375630	351a	Alaqua Creek			B4
12131_574146_3364860	881	Direct runoff to bay			B5

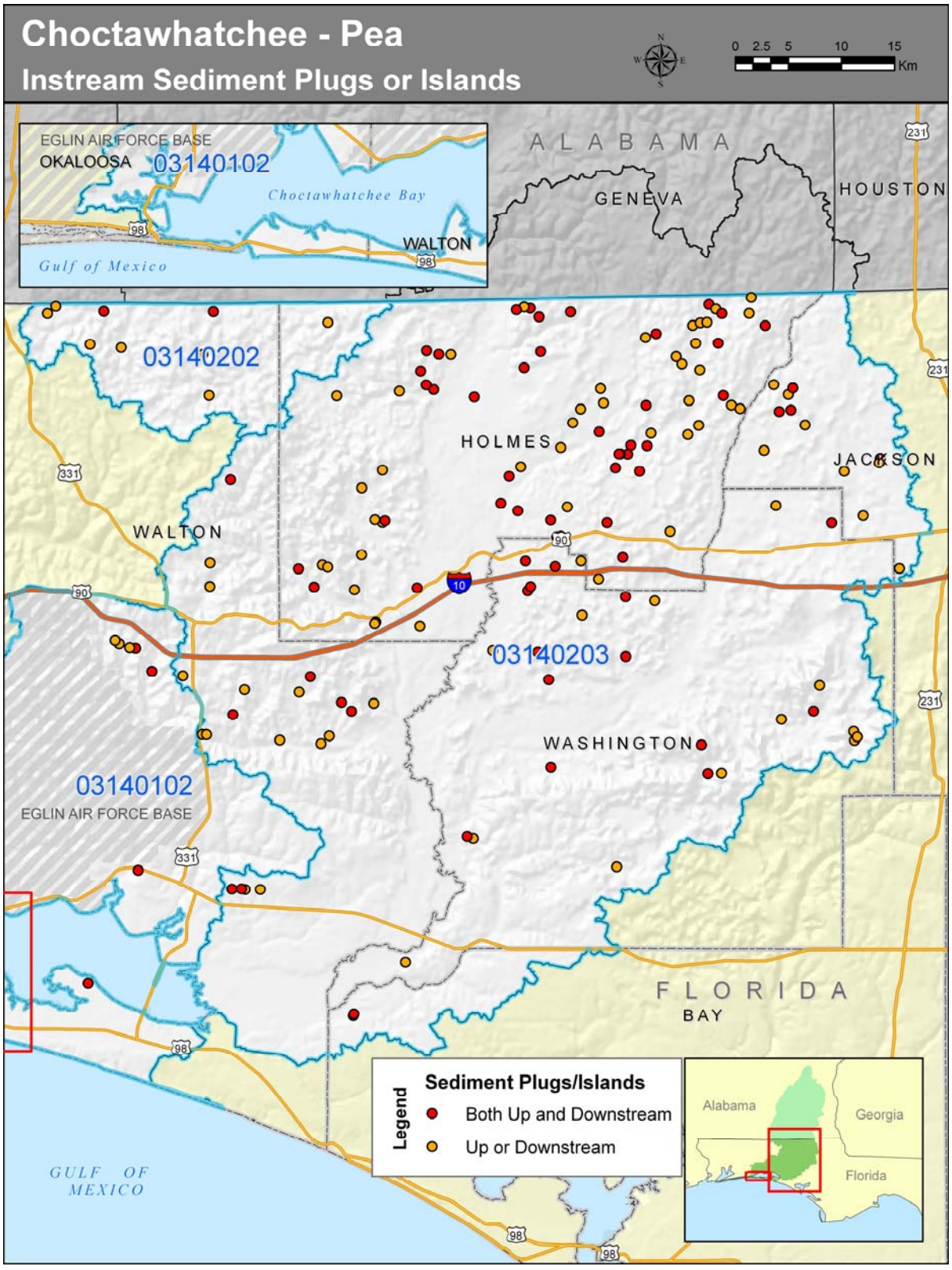


Figure 5-46. Choctawhatchee-Pea Basin Water Crossings With Instream Sediment Plugs and/or Sediment Islands (David Rubino)

5.4.2 Streambed Smothering

Extensive crossing sedimentation often results in smothering of streambed environments. As sediment inputs exceed stream transport capacity, fine to coarse soil materials are deposited over the streambed, which smothers habitats and spawning sites, fills in stream pool features, and/or increases channel scouring (Figure 5-47). These conditions may severely diminish the availability of rare and imperiled fish, mussel, and invertebrate species habitats or result in the direct mortality of incubating eggs or juveniles. The 26 CPB water crossings that exhibited severe streambed smothering are listed in Table 5-22 and presented in Figure 5-48.



Figure 5-47. CPB Streambed Habitats Smothered by Crossing-Induced Sedimentation (Mike Rainer)

Table 5-22. Choctawhatchee-Pea Basin Crossings With Severe Streambed Smothering

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12131_587566_3412505	178	Sandy Creek	Walton	B2
12131_583070_3393990	350	Bay Branch		B3
12059_595428_3402370	178	Sandy Creek	Holmes	C2
12059_599918_3405410	270	Goose Branch		
12059_599227_3402110	298	Cow Branch		
12005_599190_3361962	950	Otter Creek	Bay	C5
12059_616556_3427853	69	Unnamed branch	Holmes	D1
12059_624157_3414952	54	Wrights Creek		D2
12059_630729_3419945				
12059_617677_3408660	240	Hathaway Mill Creek		
12133_624814_3395782	348	Gully Creek	Washington	D3
12133_623909_3375974	526	Pine Log Creek		D4

Table 5-22. Choctawhatchee-Pea Basin Crossings With Severe Streambed Smothering Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12059_631373_3425390	54	Wrights Creek	Holmes	E1
12059_636401_3428218				
12063_638723_3421488	59	Holmes Creek	Jackson	
12059_637934_3427072	86	Bell Branch	Holmes	
12059_633958_3420481	139	Jackson Branch		
12059_626787_3415716	54	Wrights Creek		E2
12133_627510_3401084	286	Open Creek	Washington	E3
12133_632519_3384737	526	Pine Log Creek		E4
12133_633767_3384797				
12133_643054_3393049	346	Little Hard Labor Creek		F3
Pea River Subbasin, HUC 03140202				
12131_585933_3428376	43	Limestone Creek	Walton	B1
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_578634_3396546	332	Cosson Mill Creek	Walton	B3
12131_577085_3396991				
12131_576673_3397336				

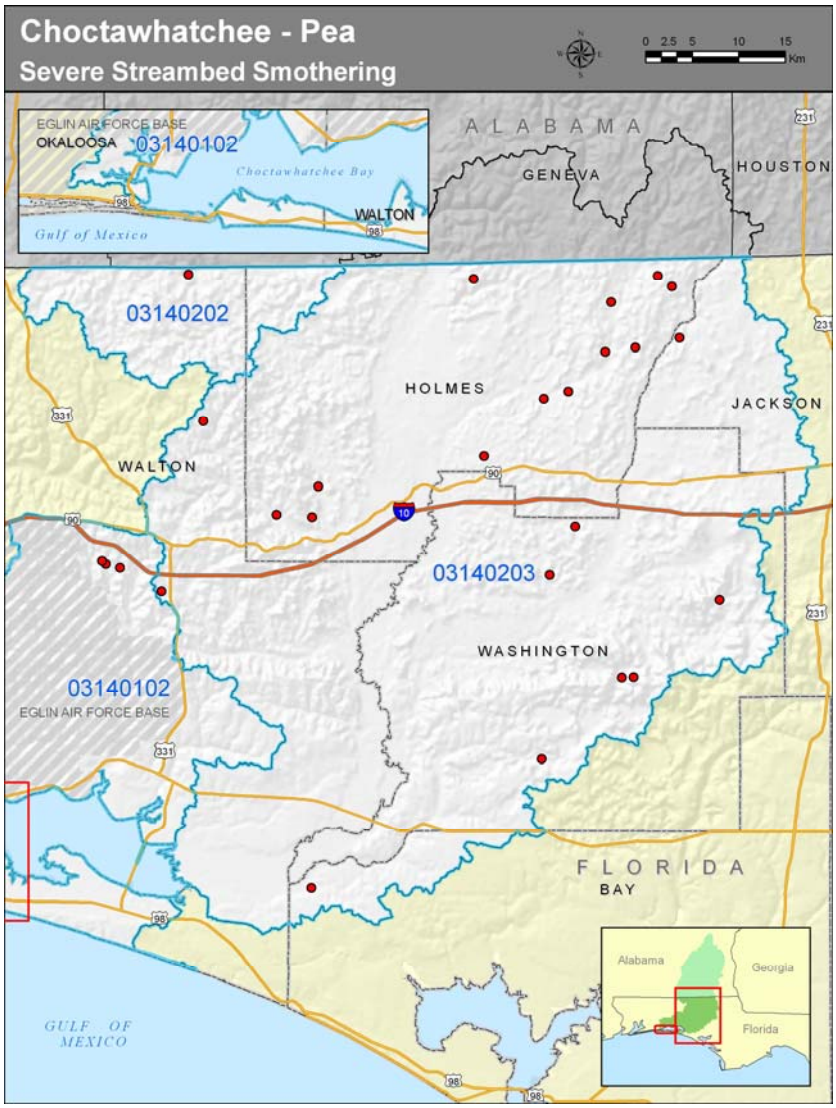


Figure 5-48. Choctawhatchee-Pea Basin Water Crossings Exhibiting Severe Streambed Smothering Conditions (David Rubino)

5.4.3 Crossing Cleanouts

Crossing cleanouts are mechanical excavations of channels adjacent to crossings that have been obstructed by sediment. Crossing cleanouts are invasive procedures whereby stream channels are mechanically dredged to remove sediment accumulations that are impeding flow. Although channel cleanouts may occur at any type of crossing, they are most often performed at culvert crossings. Gauging the extent of material to be removed is not based on a hydrologic design but is generally based on an estimate of what looks appropriate (Figures 5-49). All CPB unpaved road-stream crossings have experienced some degree of historical or periodic cleanout that ranges from minor material removal to extensive channel straightening and dredging.



Figure 5-49. CPB Stream Crossing Cleanouts

Dredged spoil materials are deposited on one or both streambanks or trucked to an alternative disposal location. Freshly deposited spoil materials are highly susceptible to erosion and often wash right back into the channel. The cleanout processes also result in disturbance of streambanks and removal of stabilizing vegetative cover that may increase stream sediment loading and turbidity. Crossings with a history of chronic erosion and sedimentation frequently exhibit extensive spoil banks along the stream. In some instances, these areas are vegetated to facilitate expedient recovery and site stabilization. The 354 CPB water crossings impacted by crossing cleanouts are listed in Table 5-23 and shown in Figure 5-50.

Table 5-23. Choctawhatchee-Pea Basin Crossings Impacted by Crossing Cleanouts

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12131_585614_3404688	269	West Sandy Creek	Walton	B2
12131_585653_3402149				
12131_585620_3402440	283a	Lake Juniper Drain		
12131_587594_3390119	343	Bruce Creek		B3
12131_587757_3390255				
12131_588111_3390200				
12131_588846_3392706				
12131_583070_3393990	350	Bay Branch		
12131_584870_3388458	486	Mill Creek		
12131_585279_3388430				
12131_588901_3373806	739	Pate Branch		B4
12131_588597_3373858				
12131_587694_3373832	741	Unnamed run		

Table 5-23. Choctawhatchee-Pea Basin Crossings Impacted by Crossing Cleanouts Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12059_602307_3426910	47	Parrot Creek	Holmes	C1
12059_604871_3428774				
12059_605717_3429264				
12059_605805_3428211				
12059_603513_3425625				
12059_606105_3426458				
12059_606026_3424697	94	Limestone Branch		
12059_600205_3421948	109	Fowler Branch		
12059_602721_3423728	112	Angelico Branch		
12059_603459_3420893				
12059_606032_3421506	119	Windmill Branch		
12059_605456_3422790				
12059_606703_3421024	126	Dada Branch		
12059_597554_3420415	136	Pine Log Creek		
12059_598885_3420183				
12059_599136_3418265	146	West Pittman Creek		
12059_598568_3418405				
12059_602167_3419934				
12059_601760_3419857				
12059_600415_3419219				
12059_606923_3411670	49f	Choctawhatchee River		C2
12059_606111_3408200				
12059_593553_3415873	146	West Pittman Creek		
12059_598980_3417165				
12059_593915_3415962				
12059_598113_3416255				
12059_597988_3414206				
12059_597409_3417399	164	Timber Branch		
12059_599926_3411751	205	Bay Drain		
12059_600382_3411724				
12059_599642_3405100	210	Otter Creek		
12059_595243_3411442				
12059_597857_3408906				
12059_600902_3403815				
12059_601908_3413431	212	Reedy Creek		
12059_605172_3406628				
12059_601866_3408469				
12059_601172_3408729				
12059_602102_3408645				
12059_593982_3404088	249	Padgett Creek		
12059_599918_3405410	270	Goose Branch		
12059_592936_3404304	273	Parrish Creek		
12059_596249_3404471	289	Black Branch		
12059_596707_3404240				
12059_599227_3402110	298	Cow Branch		
12131_603548_3388701	49e	Choctawhatchee River	Walton	C3
12131_603917_3388406				
12131_604086_3387915				
12059_605137_3402312	212	Reedy Creek	Holmes	
12131_592169_3387913	343	Bruce Creek	Walton	
12131_600312_3387259				
12131_592387_3387504				
12131_596073_3387582				
12059_601141_3398948	349	Mill Creek	Holmes	
12131_600477_3395891	366	Oak Grove Branch	Walton	
12131_590198_3391114	371	Panther Creek		
12131_595137_3393850	373	White Creek		
12131_595982_3394340	382	White Creek		
12131_596880_3388321				
12131_601129_3390936	399	Hughes Ditch		
12131_601102_3391372				
12131_598012_3391393	404	Crooked Creek		
12131_597017_3391508	441	Peavy Creek		
12131_598106_3388730	457	Spears Branch		
12131_598977_3390609				
12131_590344_3373860	747	Unnamed creek		C4
12131_590457_3373824				

Table 5-23. Choctawhatchee-Pea Basin Crossings Impacted by Crossing Cleanouts Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12133_604043_3366921	49b	Choctawhatchee River	Washington	C5
12005_600965_3360125	950	Otter Creek	Bay	
12005_599121_3361813				
12005_599190_3361962				
12131_596726_3358868	983	Tenmile Branch	Walton	
12059_609588_3426163	47	Parrot Creek	Holmes	D1
12059_608751_3428168				
12059_615788_3428702	48	Whitewater Branch		
12059_615206_3428824				
12059_614478_3428556				
12059_632432_3427383	54	Wrights Creek		
12059_620534_3419184				
12059_615312_3424152	55	East Pittman Creek		
12059_616641_3426004				
12059_615306_3425537				
12059_623492_3419197	56	Tenmile Creek		
12059_624597_3429579				
12059_626640_3425941	61	Texas Branch		
12059_616556_3427853	69	Unnamed branch		
12059_621827_3422702	77	Little Creek		
12059_623336_3423834				
12059_622410_3421121				
12059_622519_3419867				
12059_622687_3419761				
12059_608330_3424331	94	Limestone Branch		
12059_607182_3424350				
12059_616749_3424615	108	Bee Branch		
12059_615200_3423100	121	Little Creek		
12059_610508_3420337	133	Ginhouse Branch		
12059_626096_3413298	206	Gum Branch		
12059_611822_3413212	49f	Choctawhatchee River		D2
12059_612706_3413958				
12059_612738_3415817				
12059_623817_3413615	54	Wrights Creek		
12059_613008_3410302				
12059_630729_3419945				
12059_613793_3412809				
12059_627229_3420965				
12059_619790_3417892				
12059_621864_3414904				
12059_624157_3414952				
12059_621668_3414077				
12059_622725_3416486	56	Tenmile Creek		
12059_622652_3417035				
12059_622848_3418245				
12059_622270_3417030	77	Little Creek		
12059_622291_3422114				
12059_621450_3421119				
12059_618628_3415535	143	Limestone Branch		
12059_614889_3413732	183	Catfish Branch		
12059_624966_3414933	206	Gum Branch		
12059_628994_3407640	232	Unnamed drain		
12133_620568_3404818	239	Gum Creek	Washington	
12059_622215_3403141			Holmes	
12059_623019_3408453				
12059_614624_3409574	240	Hathaway Mill Creek		
12059_619270_3409939				
12133_615537_3402016	261	Dram Branch	Washington	
12133_615819_3402419				
12059_618673_3407170			Holmes	
12059_618284_3407130				
12133_615342_3404831			Washington	
12133_618173_3404328				
12059_624503_3405170	286	Open Creek	Holmes	

Table 5-23. Choctawhatchee-Pea Basin Crossings Impacted by Crossing Cleanouts Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12133_614556_3400848	49	Choctawhatchee River	Washington	D3
12133_616501_3396220	239	Gum Creek		
12133_620956_3401344				
12133_620666_3399722				
12133_624733_3401517	286	Open Creek		
12133_624766_3401446				
12133_617534_3393617	348	Gully Creek		
12133_624814_3395782				
12133_612247_3396364	362	Yates Mill Creek		
12133_608657_3371568	49b	Choctawhatchee River		D4
12133_608895_3371613				
12133_608963_3371801				
12133_609783_3382380	59	Holmes Creek		
12133_609327_3383958				
12133_611570_3380601				
12133_611506_3380992				
12133_611506_3381437				
12133_611989_3382356				
12133_623909_3375974	526	Pine Log Creek		
12133_617731_3385316	550	Williams Branch		
12133_610428_3378697	651	Spring Run		
12133_609849_3378843				
12059_632080_3429420	54	Wrights Creek	Holmes	E1
12059_626690_3419538				
12059_632405_3427941				
12059_636667_3429703				
12059_633265_3428625				
12059_631373_3425390				
12059_636401_3428218				
12059_636345_3428232				
12059_632634_3429053				
12059_633090_3429287				
12059_627131_3428070	56	Tenmile Creek		
12059_627138_3424782				
12059_627468_3425739				
12059_627493_3422139				
12059_625607_3427827				
12059_625131_3429532				
12059_625048_3419399				
12059_631093_3427099	58	Mill Branch		
12059_635398_3418338	59	Holmes Creek		
12059_635376_3420591				
12059_635621_3421345				
12059_637103_3421585				
12059_635966_3421964				
12059_635924_3422889				
12059_639892_3429040				
12059_640506_3429418				
12059_640656_3430055				
12059_640825_3429170				
12059_641905_3429936				
12059_639577_3426066				
12059_639280_3424444				
12059_637554_3421906				
12063_638723_3421488			Jackson	
12059_638692_3424359			Holmes	
12059_638102_3424551				
12059_637109_3424203				
12059_637141_3425027				
12059_637320_3425437				
12059_638749_3425969				
12059_627639_3426295	61	Texas Branch		
12059_637934_3427072	86	Bell Branch		
12059_633525_3425328	103	Corbett Branch		
12059_630038_3423411	113	Register Branch		
12059_629531_3424126				
12059_606356_3422560	119	Windmill Branch		

Table 5-23. Choctawhatchee-Pea Basin Crossings Impacted by Crossing Cleanouts Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12063_642456_3421386	130	Fish Branch	Jackson	E1
12063_641318_3423413				
12063_642092_3422971				
12063_642168_3422706				
12059_633958_3420481	139	Jackson Branch	Holmes	
12059_634725_3419557				
12063_639229_3418951	147	Gum Creek	Jackson	
12063_640335_3419074				
12063_640089_3420588				
12063_640517_3421167				
12059_599786_3408536	205	Bay Drain	Holmes	
12059_601244_3399095	349	Mill Creek		
12059_626787_3415716	54	Wrights Creek		E2
12059_627159_3416907				
12059_624250_3414951				
12059_619399_3419998				
12059_630621_3416764				
12059_631631_3417650				
12059_632340_3409137	59	Holmes Creek		
12059_633049_3412290				
12063_636081_3418138			Jackson	
12133_634872_3410545			Washington	
12133_634790_3411395				
12063_635313_3413275			Jackson	
12059_633917_3414927			Holmes	
12059_631164_3405247				
12059_630721_3406621				
12059_632870_3408534				
12059_633585_3415689				
12059_634528_3416459				
12059_632475_3418231				
12059_629231_3426838	61	Texas Branch		
12133_638927_3410070	123	Alligator Creek	Washington	
12063_641043_3413302	130	Fish Branch	Jackson	
12063_640949_3413184				
12063_640904_3414891				
12063_641925_3414701				
12063_637804_3415298	147	Gum Creek		
12063_638716_3416059				
12063_641663_3417689				
12059_628864_3413520	206	Gum Branch	Holmes	
12059_628909_3413769				
12059_628312_3407385	251	Camp Branch		
12059_628565_3407554				
12059_627943_3408659				
12059_627555_3404690				
12059_627939_3404435				
12133_632556_3392055	59	Holmes Creek	Washington	E3
12133_630414_3397868				
12133_629502_3398783				
12133_630035_3399203				
12133_627090_3394392				
12133_627465_3394656				
12133_628817_3395596				
12133_637101_3402004				
12133_635561_3401290				
12133_634935_3399984				
12133_635587_3399509				
12133_636388_3399583				
12133_627510_3401084	286	Open Creek		
12133_635580_3396336	337	Flat Creek		
12133_642008_3397707				
12133_641030_3396310				
12133_639810_3397108				
12133_638794_3396780				
12133_641691_3387683	401	Hard Labor Creek		
12133_637868_3392298				
12133_639341_3387976				

Table 5-23. Choctawhatchee-Pea Basin Crossings Impacted by Crossing Cleanouts Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12133_642465_3390661	455	Davis Branch	Washington	E3
12133_636881_3386512	456	Reedy Creek		
12133_636843_3386378				
12133_625875_3387015	501	Pippin Mill Creek		
12133_631902_3387482	526	Pine Log Creek		
12133_635833_3385174	456	Reedy Creek		E4
12133_633767_3384797	526	Pine Log Creek		
12133_632519_3384737				
12133_630809_3381381				
12063_646364_3422088	123	Alligator Creek	Jackson	F1
12063_646433_3421396				
12063_642760_3418963	130	Fish Branch		
12063_642627_3414509				
12063_642743_3419649				
12063_643514_3419772				
12063_644237_3419882				
12063_642926_3422175				
12063_645738_3413309	123	Alligator Creek		F2
12133_644180_3408431			Washington	
12063_645775_3413975			Jackson	
12063_646228_3417776				
12063_645366_3413300				
12063_643582_3416447	130	Fish Branch		
12063_646844_3416549	157	Little Alligator Cr		
12063_648745_3414522	195	Scurlock Creek		
12063_648636_3414126				
12063_647255_3409221	233	Unnamed creek		
12063_647147_3409117				
12063_650607_3404144	262	Gilberts Mill Creek		
12063_649215_3408107				
12133_648715_3403157			Washington	
12133_643054_3393049	346	Little Hard Labor Creek		F3
12133_642967_3390542				
12133_643171_3387949	401	Hard Labor Creek		
12133_644049_3389298				
12133_642899_3388588				
12133_646259_3388743	490	Poley Creek		
Pea River Subbasin, HUC 03140202				
12131_570318_3428215	40	Limestone Branch	Walton	A1
12131_569835_3427686				
12131_569997_3427554				
12131_571101_3428871				
12131_573354_3425249				B1
12131_577263_3424973	42	Eighteen Mile Creek		
12131_579195_3426192				
12131_579103_3426422				
12131_577907_3426307				
12131_580805_3428008	43	Limestone Creek		
12131_585703_3428652				
12131_584186_3426376				
12131_584738_3426399				
12131_584945_3424329	66	Spring Branch		
12131_585542_3420465	68	Chestnut Creek		
12131_591261_3428489	43	Limestone Creek		C1
12059_601030_3428689	46	Pea River	Holmes	
12059_601754_3428790				
12059_598029_3426302	63	Hurricane Creek		
12059_598215_3426316				
12059_598541_3424859				
12059_595068_3423954				
12059_594827_3424131				
12059_596747_3427352	81	Mack Bay Branch		
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_578634_3396546	332	Cosson Mill Creek	Walton	B3
12131_578062_3396628				
12131_577085_3396991				
12131_576673_3397336				

Table 5-23. Choctawhatchee-Pea Basin Crossings Impacted by Crossing Cleanouts Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Choctawhatchee Bay Subbasin, HUC 03140102 Cont'd				
12131_581412_3395702	369	Sconiers Mill Creek	Walton	B3
12131_580921_3395729				
12131_580773_3395720				
12131_580186_3394422				
12131_579859_3394231				
12131_579533_3394149				
12131_578852_3375630	351a	Alaqua Creek		B4
12131_571853_3360706	881	Direct runoff to bay		B5
12131_573913_3362924				
12131_574146_3364860				

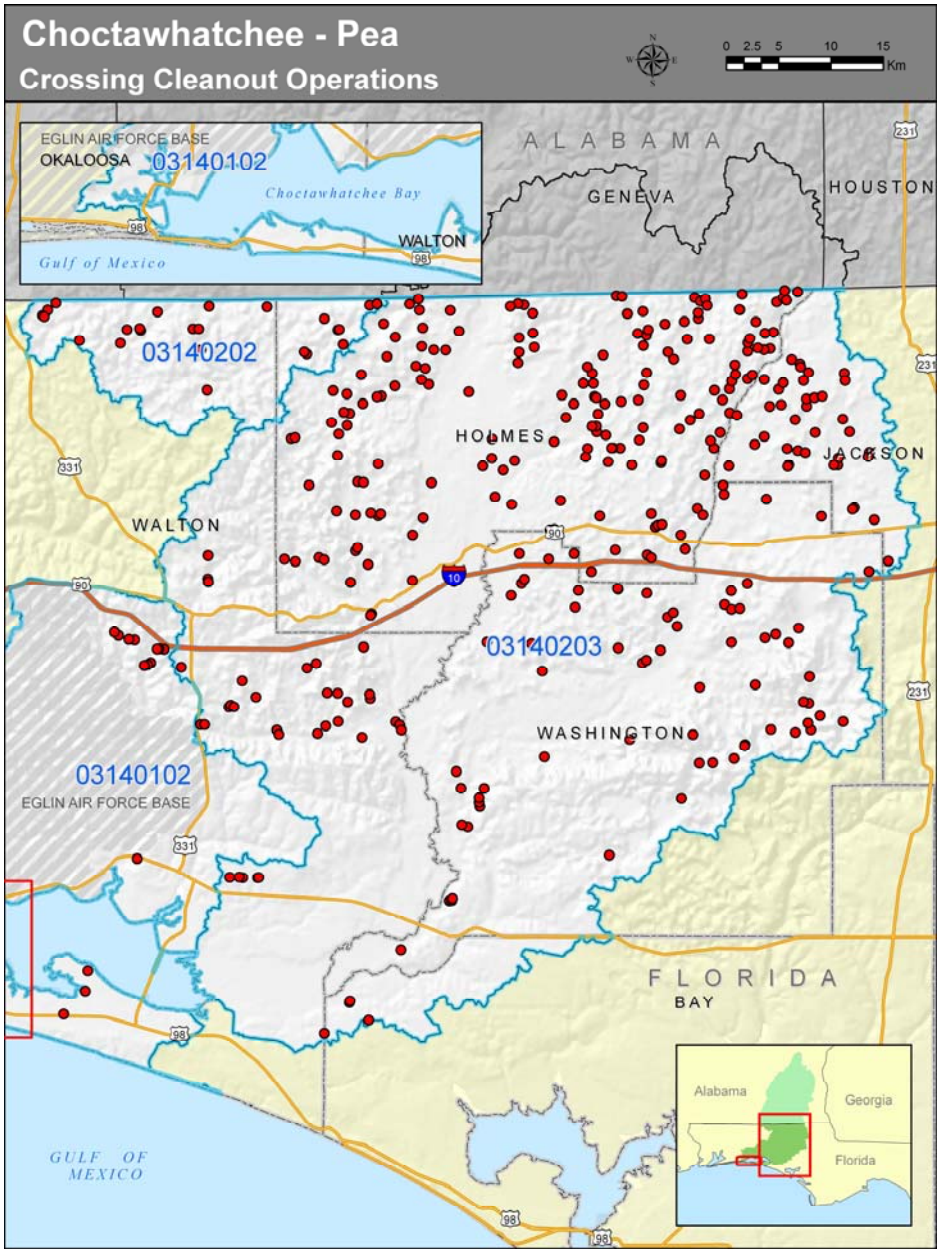


Figure 5-50. Choctawhatchee-Pea Basin Water Crossings Impacted by Crossing Cleanout Operations (David Rubino)

5.4.4 Beaver Activity

Beavers are natural hydrologic engineers that can significantly affect the form and function of aquatic ecosystems. Their activities of greatest consequence are beaver dam (Figure 5-51) construction and tree felling. Potential ecological effects of beaver dams include:

- Reduced water flow gradients
- Increased proportion and distribution of open water and wetland habitats within landscapes
- Transitions from lotic stream habitat to more lentic (ponded) conditions
- Increased stream and wetland retention of organic and inorganic materials
- Increased water temperatures
- Potential barriers to species migrations and access to upstream habitats



Figure 5-51. CPB Crossing Beaver Plug and Dam Structures (Mike Rainer)

The ecosystem engineering of beavers can directly affect the distribution and availability of aquatic habitats and, thus, the distribution of dependent species populations. The construction and maintenance of dam systems can also create dramatic changes in stream channel and floodplain morphology, water flow regimes, biomass inputs, and channel aggradation and degradation. One of the most pronounced effects of dam impoundments is the increase in the tropic base of the freshwater food web (Hagglund and Sjoberg, 1999).

The effects of beaver dams on sediment generation and delivery are not fully understood since they can serve both as a sediment sink and source. However, catastrophic erosion and sedimentation can occur during storm-related dam failures. The high-energy, outburst flooding associated with these events can displace sediments impounded within the beaver pond and cause extensive downstream scouring and erosion. The presence of a physical impoundment structure and reduced stream system water flows can also inhibit the capacity of streams to suspend and relocate sediments to the lowest points in the watershed.

Long-term crossing construction and maintenance may have significantly affected the extent and distribution of CPB beaver populations. The presence of crossing structures, particularly culverts, and extensive stream channel sedimentation are altering waterway morphology and creating conditions more amenable to beaver activity. Many CPB crossings may be functioning as catalysts that are artificially increasing the availability of potential beaver habitats.

The extensive use of culvert water crossings reduces the level of effort needed to construct and maintain a beaver dam. Beavers view a culvert crossing as a hole in a perfectly good dam that requires plugging. The presence of stream culverts may also contribute to adverse alterations in stream characteristics such as reduced stream flows and channel gradients that may encourage beaver site activity.

At crossings, beaver culvert plugs and dam structures frequently cause flooding and subsequent damage to road approaches and crossing structures. Periodically, mechanical cleanout operations are necessary to remove beaver obstructions. Wire screens and other beaver deterrents that are being utilized at some CPB crossings have been relatively ineffective, which increases the need for cleanout operations. These on-site disturbances displace vegetation and soils and destabilize slopes, which can result in accelerated sedimentation and turbidity (Figure 5-52).



Figure 5-52. CPB Culvert Crossing Following Beaver Plug and Dam Removal

Crossing dams were found to occur on one or both sides of a crossing and range from simple single dams to relatively complex, multitier dam systems. Few CPB crossings had measures such as culvert inlet screens installed to reduce beaver activity; only one instance of an effective beaver exclusion device was observed. The 50 CPB water crossings with beaver activity are listed in Table 5-24 and presented in Figure 5-53.

Table 5-24. Choctawhatchee-Pea Basin Crossings With Beaver Dams

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12131_587694_3373832	741	Unnamed run	Walton	B4
12059_606105_3426458	47	Parrot Creek	Holmes	C1
12059_604871_3428774				
12059_605717_3429264				
12059_605805_3428211				
12059_605456_3422790	119	Windmill Branch		
12059_598568_3418405	146	West Pittman Creek		C2
12059_598113_3416255				
12059_599137_3418171				
12059_595677_3410137	210	Otter Creek		
12059_601866_3408469	212	Reedy Creek		
12059_610676_3428692	49f	Choctawhatchee River		D1
12059_615312_3424152	55	East Pittman Creek		
12059_620441_3428234				
12059_620977_3426932				
12059_616749_3424615	108	Bee Branch		
12059_628994_3407640	232	Unnamed drain		D2
12059_623019_3408453	239	Gum Creek		
12059_614624_3409574	240	Hathaway Mill Creek		
12133_615537_3402016	261	Dram Branch	Washington	D3
12133_624766_3401446	286	Open Creek		
12133_608657_3371568	49b	Choctawhatchee River		D4
12133_608895_3371613				
12133_609783_3382380	59	Holmes Creek		
12133_611506_3381437				
12059_619565_3428353	53	Clark Mill Creek	Holmes	E1
12059_636667_3429703	54	Wrights Creek		
12059_631373_3425390				
12059_627131_3428070	56	Tenmile Creek		
12059_626549_3422359				
12059_639892_3429040	59	Holmes Creek		
12059_640656_3430055				
12059_639280_3424444				
12059_632326_3409458				E2
12059_631631_3417650	54	Wrights Creek		
12059_632035_3414226	59	Holmes Creek		
12059_633585_3415689				
12059_634528_3416459				
12133_629502_3398783			Washington	E3
12133_630035_3399203				
12133_627090_3394392				
12133_627465_3394656				
12133_637101_3402004				
12133_633767_3384797	526	Pine Log Creek		E4
12063_642760_3418963	130	Fish Branch	Jackson	F1
12133_644180_3408431	123	Alligator Creek	Washington	F2
Pea River Subbasin, HUC 03140202				
12131_571101_3428871	40	Limestone Branch	Walton	A1
12131_579195_3426192	42	Eighteen Mile Creek		B1
12131_580805_3428008	43	Limestone Creek		
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_578852_3375630	351a	Alaqua Creek	Walton	B4

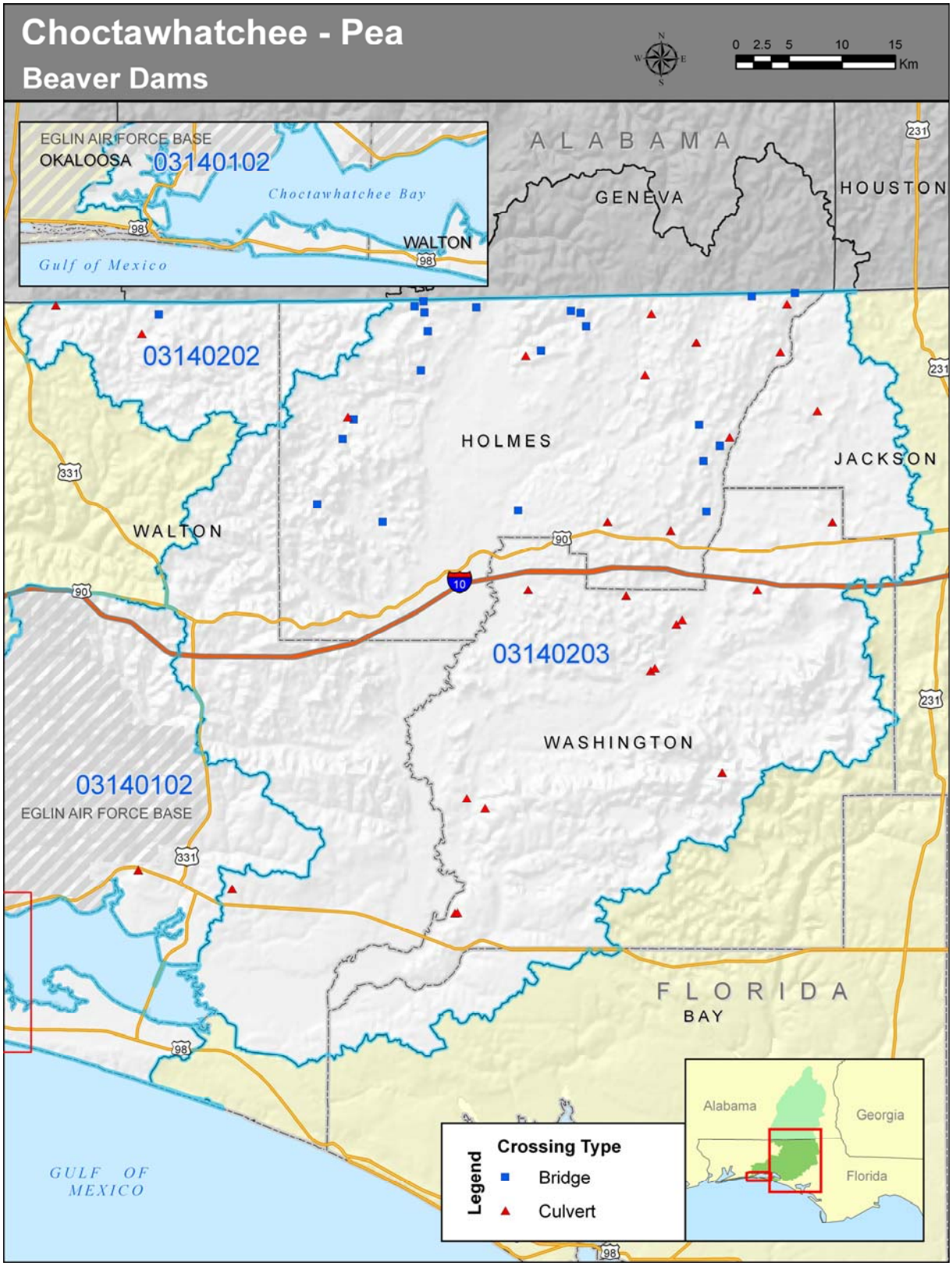


Figure 5-53. Choctawhatchee-Pea Basin Water Crossings With Beaver Dams (David Rubino)

5.4.5 Wetland Hydrology Disconnects

Because of their sensitivity to changes in hydroperiods, wetlands ecosystems are especially susceptible to impacts from roads, road culverts, and crossing structures. These features have an especially profound impact on wetlands, in that introducing a solid structure in a fluid system changes the hydrology of the system. The interruption of wetland hydroperiods can reduce groundwater recharge potentials and increase flooding events. Crossings also contribute disturbances that alter vegetation and wildlife habitat values. Amended wetland hydrology can initiate plant succession from wetland to terrestrial species, which could reduce wildlife habitat availability (Figure 5-54).



Figure 5-54. Opposing Landscape Views at a Road Wetland Connectivity Culvert that has Contributed to Changes in Wetland Hydroperiods and Succession (Mike Rainer)

Improperly installed culverts could dewater a wetland on one side of the road and cause an extended flood regime on the other side of the road. Even short-term alterations of hydroperiods and flood cycles can have a substantial, and long-term, effect on wetland vegetation. Minor changes in sensitive wetland hydrology parameters, such as an increase or decrease in average water elevations of a few inches or periods of extended low water or high sediment inputs, can cause a change in succession toward upland-type vegetation. This change may persist even if flooding regimes are restored and may reduce wildlife habitat availability (Adamus and Stockwell, 1983; Zeedyk, 1996). The 100 CPB noncrossing wetland connectivity culverts potentially impacting wetland environments are listed in Table 5-25 and shown in Figure 5-55.

Table 5-25. Choctawhatchee-Pea Basin Noncrossing Wetland Connectivity Culverts

Crossing Identification	WBID	WBID Name	County
Lower Choctawhatchee Subbasin, HUC 03140203			
12131_604192_3387969	49e	Choctawhatchee River	Walton
12059_635873_3428688	54	Wrights Creek	Holmes
12059_614150_3413593			
12059_613450_3414527			
12059_619888_3411406			
12059_616871_3412198			
12059_620806_3414471			
12059_617771_3410879			
12059_627253_3418521			
12059_619490_3419119			
12059_619409_3419482			
12059_619375_3421125			
12059_619389_3421433			
12059_633136_3423946			
12059_631978_3426381			
12059_632294_3421238			
12059_632475_3421360			
12133_626675_3390723	59	Holmes Creek	Washington

Table 5-25. Choctawhatchee-Pea Basin Noncrossing Wetland Connectivity Culverts Cont'd

Crossing Identification	WBID	WBID Name	County
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd			
12063_635757_3413289	59	Holmes Creek	Jackson
12063_634822_3411753			
12063_638106_3418159			
12063_638307_3420867			
12059_623332_3421392	77	Little Creek	Holmes
12059_624112_3423822			
12059_605617_3422763	119	Windmill Branch	
12133_643873_3410081	123	Alligator Creek	Washington
12133_640344_3410195			
12063_646227_3423312			Jackson
12063_646364_3423090			
12063_648734_3417374			
12063_643866_3422158	130	Fish Branch	
12059_594902_3419867	136	Pine Log Creek	Holmes
12059_596104_3419866			
12059_596377_3419876			
12059_598868_3419204			
12059_614853_3422136	142	Sikes Creek	
12063_638295_3413313	147	Gum Creek	Jackson
12063_638044_3413326			
12063_637063_3413319			
12063_637657_3415318			
12059_633450_3421361	150	Kelley Branch	Holmes
12063_647480_3417771	157	Little Alligator Cr	Jackson
12059_602642_3417452	163	Bay Branch	Holmes
12059_614925_3415941	183	Catfish Branch	
12059_614709_3415995			
12063_649754_3414750	195	Scurlock Creek	Jackson
12059_625513_3414584	206	Gum Branch	Holmes
12059_627627_3413285			
12059_627863_3413280			
12059_602130_3406687	212	Reedy Creek	
12059_603402_3403424			
12131_605805_3395392			Walton
12059_604644_3411334	227a	Hood Lake Drain	Holmes
12059_603009_3408387			
12063_649352_3409564	233	Unnamed creek	Jackson
12063_650694_3412443			
12059_625097_3411033	239	Gum Creek	Holmes
12059_622685_3405257			
12133_622538_3396866			Washington
12133_619261_3395348			
12059_618641_3408647	240	Hathaway Mill Creek	Holmes
12059_619019_3409051			
12059_619248_3409792			
12059_595364_3407476	249	Padgett Creek	
12133_640647_3409314	253	Helms Branch	Washington
12133_640834_3409186			
12133_642901_3409263			
12133_619381_3406699	261	Dram Branch	
12133_616083_3403335			
12133_618032_3402180			
12133_618584_3402164			
12133_616992_3401907			
12133_649185_3405304	262	Gilberts Mill Creek	
12059_624655_3402131	286	Open Creek	Holmes
12059_623446_3403558			
12059_623554_3402112			
12059_631094_3402219			
12131_594698_3386441	343	Bruce Creek	Walton
12131_600576_3387002			
12131_588742_3390426			
12131_602448_3389272			
12133_645638_3398146	346	Little Hard Labor Creek	Washington
12133_623567_3398534	348	Gully Creek	
12131_595380_3394091	373	White Creek	Walton
12131_598215_3391099	404	Crooked Creek	
12133_646650_3388454	490	Poley Creek	Washington

Table 5-25. Choctawhatchee-Pea Basin Noncrossing Wetland Connectivity Culverts Cont'd

Crossing Identification	WBID	WBID Name	County
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd			
12133_630350_3380969	526	Pine Log Creek	Washington
12005_602916_3364970			Bay
12131_604188_3378206	570	Seven Runs	Walton
12131_604207_3378203			
12131_595636_3358648	983	Tenmile Branch	
Pea River Subbasin, HUC 03140202			
12131_569191_3426077	40	Limestone Branch	Walton
12131_580598_3427525	43	Limestone Creek	
12131_587274_3426190	66	Spring Branch	
12131_584263_3424909			
12131_582514_3422603	68	Chestnut Creek	
12131_586139_3422033			
12131_591126_3425588			
Choctawhatchee Bay Subbasin, HUC 03140102			
12131_578259_3375712	351a	Alaqua Creek	Walton
12131_583183_3360574	981	Direct runoff to bay	

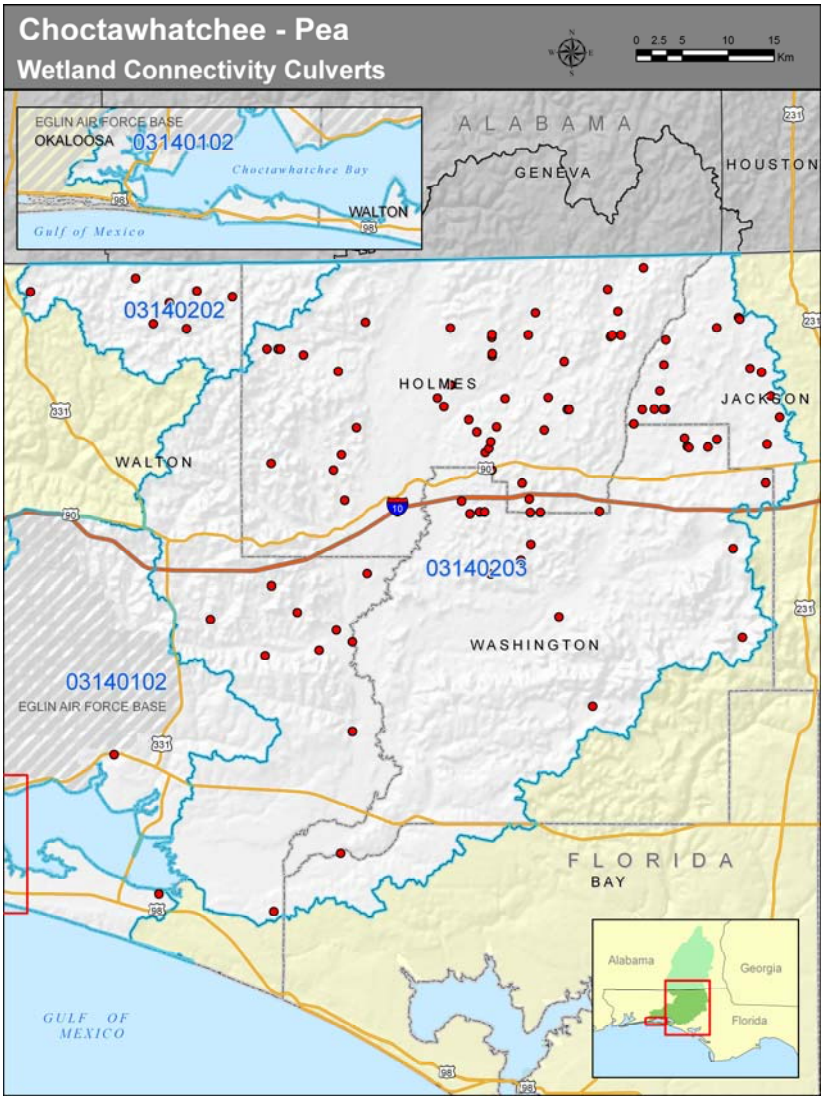


Figure 5-55. Choctawhatchee-Pea Basin Noncrossing Wetland Connectivity Culverts (David Rubino)

5.4.6 Disturbed Riparian Zones

Riparian zones (RZs) generally refer to lands that are adjacent to waterbodies (Section 3.5.7). Water crossings and land use activities such as agriculture, silviculture, and development can greatly impact RZs (Figure 5-56). The removal of RZ native vegetation associated with crossings and land use conversion is a catalyst for potential change within affected aquatic ecosystems. Destabilizing soils and altering hydrology affects the immediate ecosystem and other downstream environments. Impacts may include soil erosion, degraded floodplains, higher peak stream flows, reduced streambank stability, and altered stream channel morphology. Generally, potential impacts increase as human disturbances get closer to the stream.



Figure 5-56. Modified CPB Stream Riparian Zones

The capability of forested RZ buffer areas to filter surface runoff and prevent water pollution from point and nonpoint sources is well known. Studies have shown that the filtering and runoff retention functions of forested RZs can reduce sediment loading of waterways by 50 to 80 percent (Daniels and Gilliam, 1996; Lowrance et al., 1997). These buffers also trap, convert, and store nutrients and other chemical pollutants (Vellidis et al., 2003). RZs also provide important habitat attributes such as stream shading, streambank stabilization, and biological components of the food web (Chesapeake Bay Program, 1991).

A study by Horner et al. (date unknown) suggests that high biological health cannot be maintained unless development within RZs is low and RZ natural vegetation and soils are well preserved. In the Puget Sound portion of the study, streams with relatively wide RZs exhibited higher biological integrity values than streams with less RZ buffers. Until the watershed total impervious area exceeded 40 percent, declines in biological integrity were more strongly linked to the loss of habitats (woody debris, pool cover, etc.) by hydrologic fluctuations than declines in water and sediment quality. It was concluded that as RZ urbanization increases and natural cover decreases, relatively poor health of the stream system becomes inevitable. Land preservation was identified as a necessary component for maintaining biologically productive aquatic resources.

Although the RZs impacted by individual crossings may be relatively small, their collective influence may have greater significance. Crossing cleanout operations (Section 5.4.3) may remove vegetation from one or both sides of a stream that could alter RZ form and function. The 57 CPB crossings with pasture and row crop agriculture land uses that generally can have high, long-term RZ disturbance potentials are listed in Table 5-26 and shown in Figure 5-57.

Table 5-26. Choctawhatchee-Pea Basin Crossings With Pasture and Row Crop Agriculture Land Uses

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12059_603513_3425625	47	Parrot Creek	Holmes	C1
12059_606105_3426458				
12059_600205_3421948	109	Fowler Branch		
12059_606032_3421506	119	Windmill Branch		
12059_598568_3418405	146	West Pittman Creek		
12059_601908_3413431	212	Reedy Creek		C2
12131_595137_3393850	373	White Creek	Walton	C3
12059_615788_3428702	48	Whitewater Branch	Holmes	D1
12059_623492_3419197	56	Tenmile Creek		
12059_616556_3427853	69	Unnamed branch		
12059_622215_3403141	239	Gum Creek		D2
12059_619565_3428353	53	Clark Mill Creek		E1
12059_631786_3422866	54	Wrights Creek		
12059_631790_3427338	58	Mill Branch		
12059_635966_3421964	59	Holmes Creek		
12059_635924_3422889				
12059_640506_3429418				
12059_640656_3430055				
12059_638102_3424551				
12059_637109_3424203				
12059_637141_3425027				
12059_635621_3421345				
12063_642092_3422971	130	Fish Branch	Jackson	
12063_642168_3422706				
12063_639229_3418951	147	Gum Creek		
12063_640335_3419074				
12063_640517_3421167				
12059_631631_3417650	54	Wrights Creek	Holmes	E2
12059_632975_3417285	59	Holmes Creek		
12059_632475_3418231				
12133_638927_3410070	123	Alligator Creek	Washington	
12063_641200_3414909	130	Fish Branch	Jackson	
12063_641663_3417689	147	Gum Creek		
12063_637804_3415298				
12063_638716_3416059				
12133_642008_3397707	337	Flat Creek	Washington	E3
12133_641030_3396310				
12133_640400_3396919				
12063_642738_3418563	130	Fish Branch	Jackson	F1
12063_642926_3422175				
12063_645738_3413309	123	Alligator Creek		F2
12063_645775_3413975				
12063_646228_3417776				
12063_645366_3413300				
12063_643582_3416447	130	Fish Branch		
12063_642985_3417493				
12063_646844_3416549	157	Little Alligator Creek		
12063_647888_3417781				
12063_647819_3409694	233	Unnamed creek		
12063_647255_3409221				
12063_647147_3409117				
12063_650607_3404144	262	Gilberts Mill Creek		
12133_644049_3389298	401	Hard Labor Creek	Washington	F3
12133_642899_3388588				
Pea River Subbasin, HUC 03140202				
12131_570318_3428215	40	Limestone Branch	Walton	A1
12131_591261_3428489	43	Limestone Creek		C1
12059_598029_3426302	63	Hurricane Creek	Holmes	

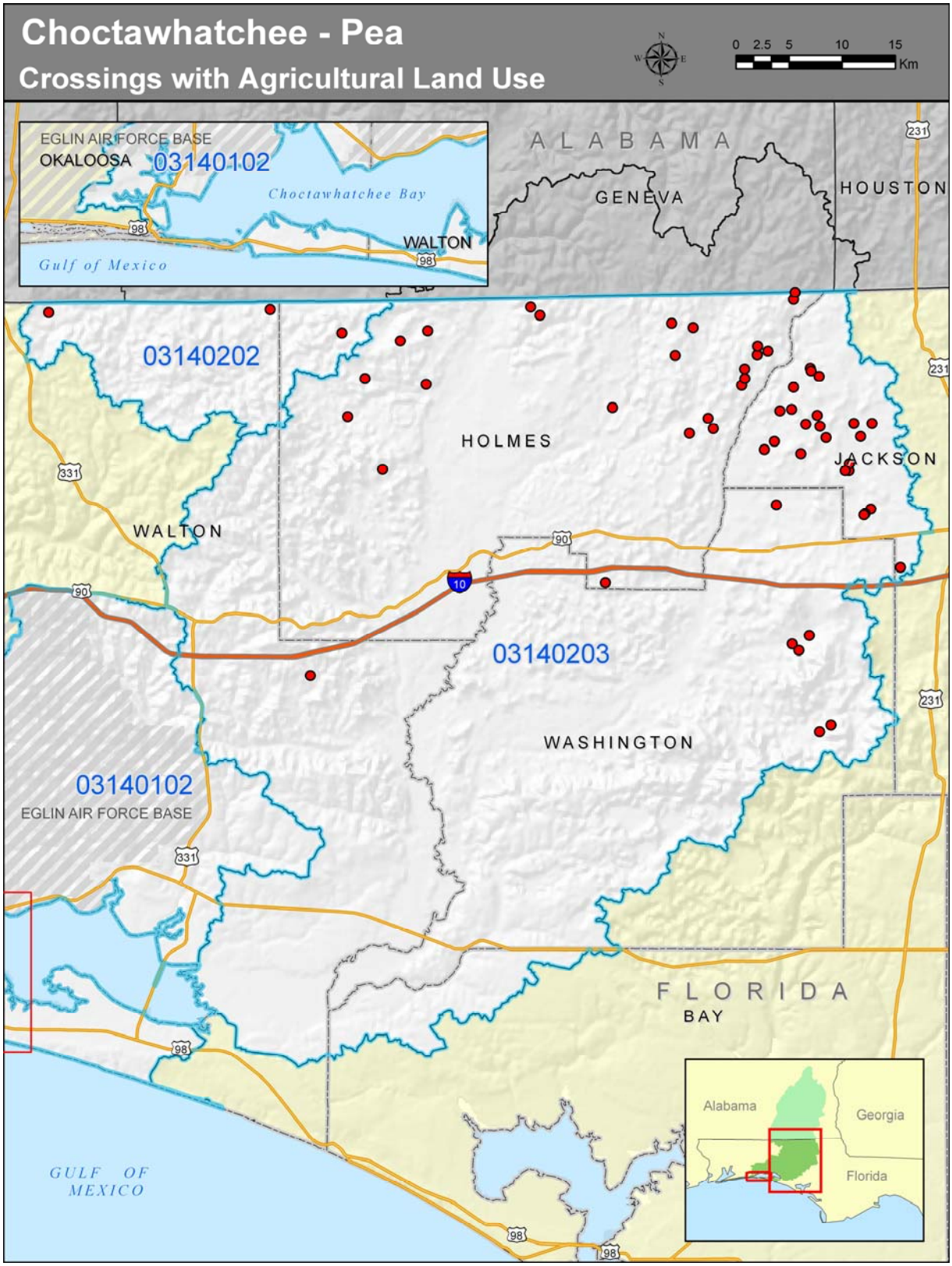


Figure 5-57. Choctawhatchee-Pea Basin Water Crossings With Agricultural Land Uses (David Rubino)

5.4.7 Impaired Aquatic Ecosystems

In 1993, FDEP developed the Stream Bioassessment (SB) method to screen, evaluate, and measure the relative health of stream, impoundment, and wetland ecosystems. The primary protocols of this methodology include Bioreconnaissance (BioRecon) and Stream Condition Index (SCI). These protocols differ in the number of dip net sweeps, sample sorting location (field or laboratory), and the index used for final assessments. The SCI process was recalibrated in 2007 using the Human Disturbance Gradient and Biological Condition Gradient protocol. The SB method is based on using benthic macroinvertebrates as primary indicators of aquatic conditions and impairment.

BioRecon is a screening process used to quickly assess field sites, prioritize the intensity of SCI site sampling, and assess future monitoring needs. During this process, aquatic habitat conditions are evaluated based on the results of four dip net sweeps of the most productive habitat areas with organisms (excluding Oligochaeta, Chironomidea, and Acarina) identified to the lowest practical taxonomic level. The relative abundance of macroinvertebrates is recorded in the field, and collected taxa are taken to a laboratory for verification and further identification. The BioRecon field sampling metrics include 1) number of taxa, 2) number of long-lived taxa (those that require more than one year to complete their life cycle, 3) number of sensitive taxa, 4) number of clinger taxa, 5) number of mayfly (Ephemeroptera) taxa, and 6) number of caddisfly (Tricoptera) taxa. Regionally based thresholds are set for each metric.

The SCI aquatic sampling process is used to define the relative health and extent of impairment based on a natural reference condition. The SCI is conducted within a 100-meter reach of a flowing stream. A composite macroinvertebrate community index is established by conducting 20 dip nets sweeps of the most productive habitat areas, with organisms identified to the lowest practical taxonomic level (Figure 5-58). Organisms collected in the field are taken to a laboratory for processing. Field data is used to identify species and assess the relative abundance of the organisms. Biological metrics used to calculate the SCI index include 1) number of taxa, 2) number of long-lived taxa (those that require more than one year to complete their life cycle, 3) number of mayfly (Ephemeroptera) taxa, 4) number of caddisfly (Tricoptera) taxa, 5) number of Florida sensitive taxa, 6) number of clinger taxa, 7) percent dominant taxon, 8) percent Tanytarsini, 9) percent very tolerant taxa, and 10) percent filterers. Points assigned to each metric are summed to score the overall biological health. Sites with scores from 100 to 67, 66 to 35, and 34 to 0 are considered “exceptional,” “healthy,” and “impaired,” respectively.

In conjunction with these SB processes, assessments of aquatic habitat quality and stream physical and chemical characteristics are also performed. Aquatic habitat quality is conducted by measuring water course characteristics that are known to have potential impacts on stream biota. Site habitat evaluation parameters include 1) substrate diversity, 2) substrate availability, 3) water velocity, 4) habitat smothering, 5) dredging/channelization, 6) bank stability, 7) riparian buffer zone width, and 8) riparian zone vegetation quality. Each parameter is scored from 1 to 20, with 20 being the highest quality. The scores are then averaged and assigned a ranking corresponding to four categories (“optimal,” “suboptimal,” “marginal,” and “poor”) based on the total score. Stream physical and chemical assessments are conducted by recording stream riparian and instream features and sediment substrate data. FDEP bioassessment, aquatic habitat quality, stream physical and chemical characteristics, and other assessment protocols are available at http://www.floridadep.org/labs/qa/finalrulesop/sops.htm or http://www.floridadep.org/labs/qa/sops.htm.



Figure 5-58. FDEP 2007 CPB Crossings Bioassessment Sampling (Photographer Donald Ray/Sampler Lawrence Donelan)

In 2007, Mr. Donald Ray, FDEP Stream Biologist, conducted stream bioassessments for 72 high priority crossing sites from the 2006 Lower Choctawhatchee Subbasin Road-Stream Crossings Assessment. The bioassessments found that all but three of the crossing sites were classified as impaired. The results of bioassessments are presented in Table 5-27 and shown in Figure 5-59.

Table 5-27. Lower Choctawhatchee Subbasin Crossing Site Bioassessment Summary

Crossing Identification	WBID	StreamX Score	Crossing Structure	Bioassessment Screening Criteria				Classification	Index Map Grid
				Taxa	FI	EPT	Habitat		
12059_602307_3426910	47	360	Bridge	25	4	1	0.36	Impaired	C1
12059_606105_3426458		380		13	0	1	0.24		
12059_605805_3428211		465		26	21	10	0.71		
12059_602167_3419934	146	400	Culvert	12	1	0	0.24		
12059_606111_3408200	49f	425		0	0	0	0		C2
12059_593915_3415962	146	510	Bridge	15	10	4	0.41		
12059_600902_3403815	210	400		39	27	14	0.52	Suspect	
12059_596942_3408843		437	Culvert	0	0	0	0	Impaired	
12059_595677_3410137		470	Bridge	13	3	0	0.41		
12059_594768_3410680		482	Culvert	10	3	1	0.3		
12059_595243_3411442		602		6	3	0	0.28		
12059_608751_3428168	47	435	Bridge	26	15	8	0.46		
12059_610676_3428692	49f	540		16	7	4	0.39		D1
12059_615312_3424152	55	402	Culvert	14	0	2	0.33		
12059_619077_3427196		400	Bridge	30	18	10	0.49		
12059_616641_3426004		485		4	0	0	0.1		
12059_615306_3425537		360		31	19	14	0.54		
12059_624597_3429579	56	392	Culvert	16	1	1	0.17		
12059_614393_3421453	142	437		14	3	1	0.45		
12059_615647_3419760		472		0	0	0	0.26		
12059_615210_3420390		495		15	5	2	0.34		
12059_610765_3414346	49f	562	Culvert	7	1	0	0.58		D2
12059_612738_3415817		425	Bridge	0	0	0	0.2		
12059_607716_3410489		457	Culvert	0	0	0	0.49		
12059_622848_3418245	56	400	Bridge	0	0	0	0.21		
12133_608657_3371568	49b	550	Culvert	23	7	5	0.46		D4
12133_608895_3371613		595		33	24	12	0.58	Suspect	
12059_625607_3427827	56	550	Bridge	9	3	0	0.36	Impaired	E1
12059_626736_3424561		395		11	2	0	0.5		
12059_627468_3425739		382	Culvert	9	0	0	0.38		
12059_627493_3422139		465		11	1	0	0.43		
12059_627131_3428070		427		8	1	0	0.53		
12059_625131_3429532		577		6	1	0	0.38		
12059_635924_3422889	59	440		5	5	1	0.24		
12059_640656_3430055		400	Bridge	31	15	5	0.42		
12059_639280_3424444		595	Culvert	8	0	0	0.36		
12059_637554_3421906		515		8	2	1	0.39		
12059_638102_3424551		477		18	6	6	0.26		
12059_637109_3424203		550		10	4	2	0.41		
12059_635376_3420591		370	Bridge	8	0	0	0.16		
12063_642168_3422706	130	460	Culvert	0	0	0	0.14		
12063_636081_3418138	59	430		6	1	0	0.72		E2
12059_630541_3408083		555		0	0	0	0.15		
12059_632340_3409137		477		8	2	2	0.28		
12059_633049_3412290		447		12	5	1	0.52		
12059_630721_3406621		570		20	4	1	0.33		
12059_632870_3408534		540		7	2	0	0.51		
12059_634528_3416459		480		11	0	1	0.21		
12059_632975_3417285		422		8	3	0	0.38		
12059_632475_3418231		620		5	1	0	0.3		
12063_640949_3413184	130	600		8	2	0	0.43		
12063_641200_3414909		420		10	0	0	0.5		
12059_627943_3408659	251	550		7	0	0	0.18		
12133_630414_3397868	59	487		9	2	1	0.42		E3
12133_629502_3398783		455		12	3	1	0.24		
12133_630035_3399203		535		8	0	1	0.21		
12133_635561_3401290		455	Bridge	10	2	1	0.45		
12133_633961_3399573		650	Culvert	10	0	0	0.21		
12133_635580_3396336	337	465	Bridge	8	1	1	0.43		
12133_642008_3397707		440		14	2	1	0.14		
12133_637868_3392298	401	472	Culvert	0	0	0	0.13		
12133_639341_3387976		512		19	7	4	0.49		
12133_636881_3386512	456	415		19	14	6	0.39		
12133_635833_3385174		540		22	14	10	0.56		E4

Taxa = Quantified species, number of different species
FI = Florida index, listed clean water indicator
EPT = mayfly (Ephemeroptera), stonefly (Plecoptera) and caddisfly (Trichoptera) index

Table 5-27. Lower Choctawhatchee Subbasin Crossing Site Bioassessment Summary Cont'd

Crossing Identification	WBID	StreamX Score	Crossing Structure	Bioassessment Screening Criteria				Classification	Index Map Grid
				Taxa	FI	EPT	Habitat		
12063_642743_3419649	130	490	Culvert	0	0	0	0.16	Impaired	F1
12063_644135_3419774		450	Culvert	0	0	0	0.07		
12063_642926_3422175		485	Culvert	0	0	0	0.09		
12063_643582_3416447		605	Culvert	4	0	0	0.18		F2
12063_642985_3417493		565	Culvert	0	0	0	0.24		
12133_644049_3389298	401	582	Culvert	4	2	0	0.28		F3
12133_642899_3388588		457	Culvert	15	9	6	0.21		
12133_647019_3392581		390	Bridge	0	0	0	0.26		

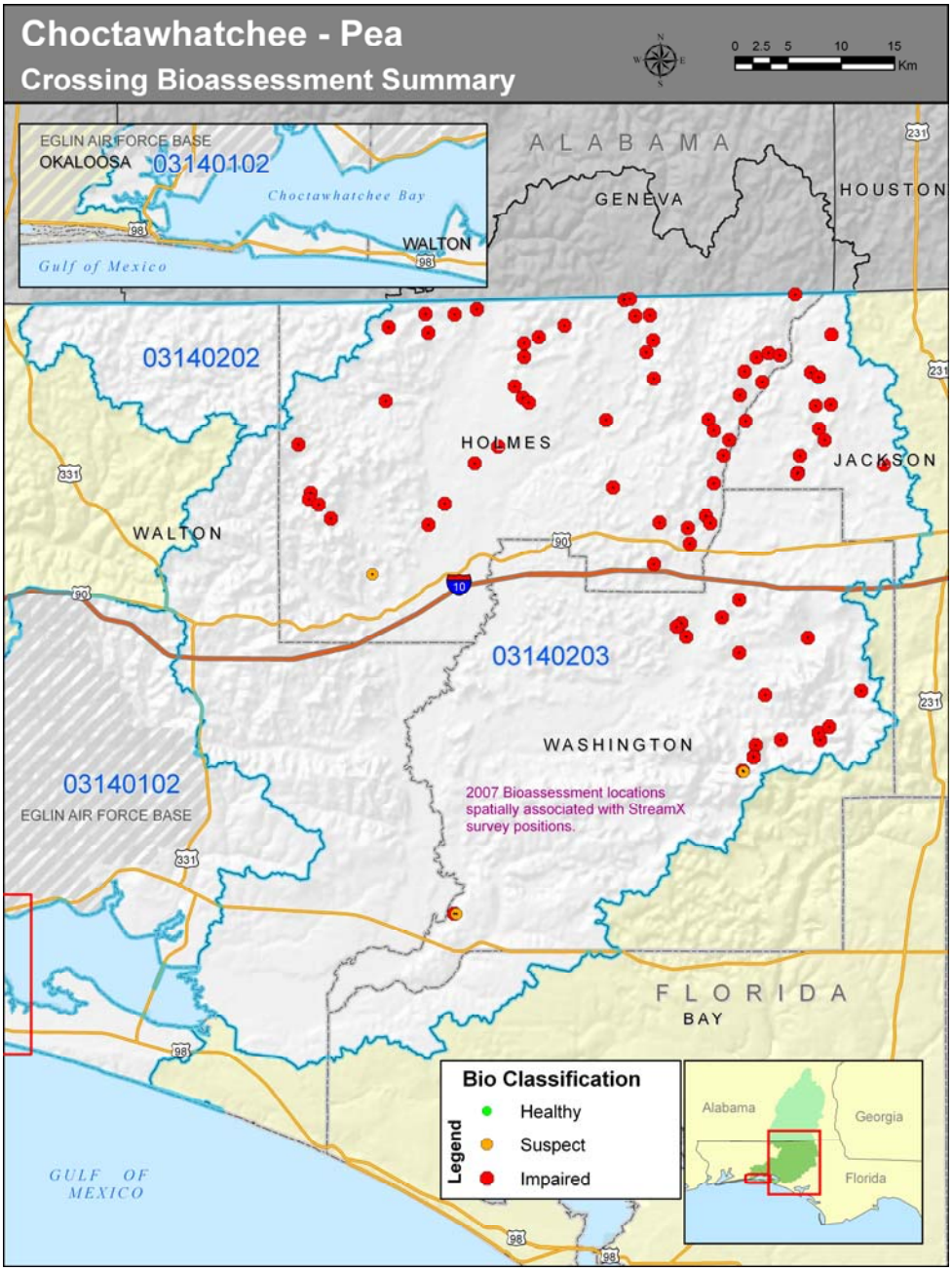


Figure 5-59. FDEP 2007 CPB Crossings Bioassessment Summary (David Rubino)

5.5 LITERATURE CITED

Adamus, P. R. and L. T. Stockwell. 1983. *A Method for Wetland Functional Assessment*. U.S. Department of Transportation, Federal Highway Administration, FHWA-IP-82-23. Washington, D.C.

Chesapeake Bay Program. 1997. *Riparian Forest Buffers: Linking Land and Water*. U.S. Environmental Protection Agency, Washington D.C.

Cousens, R. and M. Mortimer. 1995. Dynamics of Weed Populations. Cambridge University Press.

Daniels, R.B. and Gilliam, J.W. 1996. Sediment and Chemical Load Reduction by Grass and Riparian Filters. *Journal of the Soil Science Society of America*, 60(1):246-251.

Hagglund, A. and Sjoberg, G. 1999. *Effects* of Beaver Dams on the Fish Fauna and Forest Streams. *Forest Ecology and Management* 115:259-266

Horner, R., May C., Liningston, E., Blaha, D., Scoggins, M., Tims, J., and Maxted, J. Date Unknown. Structural and Non-Structural BMPs for Protecting Streams. Watershed Management Institute, Crawfordville, Florida.

Lowrance R., Altier, L.S., and Newbold, J.D. 1997. Water Quality Functions of Riparian Forest Buffers in Chesapeake Bay Watersheds. *Environmental Management*, 21(5):687-712.

Ray, Donald. 2007. Personal Communication from D. Ray, FDEP Stream Biologist. Subject: FDEP Stream Bioassessment Process, to M. Rainer, SAIC LMRG. May 19.

Schowalter, T. D. and J. E. Means. 1989. Pest Link Site Productivity to the Landscape. In: *Maintaining the Long-Term Productivity of Pacific Northwest Forest Ecosystems*. Perry, D.A., Meurisse, R., Thomas, B., Miller, R., Boyle, J., Means, J., Perry, C.R., and Powers, R.R. (Eds.). Timber Press, Portland, Oregon.

Vellidis, G., Lowrance, R., Gay, P., and Hubbard, P. 2003. Nutrient Transport in A Restored Riparian Wetland. *Journal of Environmental Quality*, 32(2):711-726.

Walters, C. 1996. *Weeds Control Without Poisons*. Acres U.S.A. Publishers, Metairie, Louisiana.

Zeedyk, W.D. 1996. Managing Roads for Wet Meadow Ecosystem Recovery. USDA Forest Service, Southwestern Region, USDOT. FHWA-FLP-96-016. Washington D.C.

CHAPTER SIX

ENVIRONMENTAL EFFECTS



This chapter describes the mechanics of crossing-induced soil erosion and sedimentation processes, generally defines the potential effects of crossings on the form and function of Choctawhatchee-Pea Basin aquatic ecosystems, identifies the relationship of crossing effects with the current regulatory environment, defines issues of concern, and articulates the challenge ahead.


Mike Rainer

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ACRONYMS

CFR	Code of Federal Regulations
CPB	Choctawhatchee-Pea Basin
CWA	Clean Water Act
ESA	Endangered Species Act
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FWRA	Florida Watershed Restoration Act
NPS	nonpoint source pollution
TMDL	total maximum daily load
USACE	U.S. Corps of Engineers
USC	United States Code
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WQ	water quality
WQA	Water Quality Act


Mike Rainer

6. ENVIRONMENTAL EFFECTS

6.1 SOIL EROSION AND SEDIMENTATION

The engineered components of crossings (i.e., structures and roadscapes) inherently favor soil detachment, transport, and deposition. The high-surface-area roads are designed to be relatively impermeable and remove surface runoff as expediently as possible, which is in opposition to the soil permeability and stability attributes of the natural environments they replace.

Soil erosion is a three-phase process of detachment, transport, and deposition of surface materials by water overland flow. It is a relentless process that is difficult to control and easily accelerated by humans. Accelerated erosion caused by humans occurs at rates much greater than under natural erosion conditions and detrimentally affects soils and ecosystems. Soil is a nonrenewable resource—once removed it is gone forever.

Soil erosion poses significant social and economic problems; it is an essential factor in assessing ecosystem health and function. Erosion causes three major types of environmental damage: reduced land productivity; water pollution; and upland, wetland, and aquatic habitat degradation. Human-induced soil disturbances, even minor or temporary ones, generally determine the type and extent of environmental effects. Soil environments impacted by erosion may take decades or centuries to recover.

Eroded soil particles moved and deposited by water are known as *sediment*. Once deposited in waterways, these particles can result in turbidity and sedimentation (Figure 6-1). *Turbidity* is a suspension of dissolved substances and inorganic and organic particles (generally less than 62 micrometers in diameter) in the water column that results in the scattering and absorption of sunlight (Henley et al., 2000). *Sedimentation* is a product of soil erosion processes through which soil materials are deposited on the substrates of any waterway, including streams, rivers, impoundments, and wetlands.

Human-induced sedimentation by volume is the largest and most pervasive nonpoint source pollutant of Northwest Florida waters. Sedimentation and turbidity have been identified by the U.S. Environmental Protection Agency (USEPA) as the most significant sources of water quality impairment and aquatic habitat degradation (USEPA, 1994). A study by Judy et al. (1984) estimated that excessive sedimentation has occurred in 46 percent of all streams and rivers in the United States and is considered the primary factor in limiting aquatic habitats.

Increased stream turbidity impairs water quality, decreases biologic productivity, and affects fish physiology, feeding, and mortality. Because of the dominance of sandy-textured soils in some parts of the Choctawhatchee-Pea Basin (CPB), turbidity levels may be relatively short-lived after rainfall once precipitation and runoff rates diminish. Heavier sand particles tend to fall out of suspension quicker than silt and clay soil particles, which are smaller and lighter. However, some streams, particularly higher-order streams, may exceed turbidity standards for extended periods following storms due to higher drainage densities and cumulative concentrations of clay and silt materials, as compared to low-order streams. Wagener and LaPerriere (1985) found that for stream invertebrates, increased turbidity was the strongest indicator of reduced density and biomass.

Large quantities of sediment delivered to streams can adversely affect channel morphology and impair water quality by increasing stream water column turbidity, altering water chemistry parameters, and introducing chemical contaminants and other pollutants. Changes in stream morphology alone can increase species mortality, decrease

amphibian and invertebrate abundance and diversity, and decrease habitat complexity. Sediments primarily impact aquatic habitats by smothering organisms and their habitats, as well as increasing water column turbidity (Figure 6-1). In particular, sediment can 1) alter channel width, depth, flow gradients, and habitat features such as pools and riffles; 2) block light to periphyton and algae; 3) smother streambeds; 4) reduce the percent dissolved oxygen and exertion of large oxygen demands on the water; 5) destroy bacterial slimes and periphyton that serve as the base of stream food chains; and 6) introduce chemical contaminants that may be attached to sediment particles.



Figure 6-1. CPB Stream Crossing-Induced Stream Turbidity and Sedimentation (Mike Rainer)

6.1.1 Crossing-Induced Soil Erosion

As presented in Chapter 5, CPB crossings exhibit a diversity of conditions that are capable of eroding gross amounts of soil materials. Crossing-induced soil erosion potentials are primarily based on the erodibility of roadscape (roadway and roadside) soils and, in the case of culvert crossings, the structure fill materials. Soil erodibility primarily depends on soil structure, infiltration, permeability, and organic matter and the ionic strength of the eroding water. Additional environmental factors that determine the susceptibility of landscapes to erosion include slope steepness, slope length, soil permeability, soil texture and structure, vegetative cover, rainfall duration and intensity, and other characteristics. Factors that may exacerbate soil crossing erosion potentials include high soil erodibility (*K* factor) and slope steepness.

Soil erodibility *K* factors estimate the capability of a soil to resist soil detachment and transport; *K* factor values normally range from near 0 to 0.70. A soil with a high *K* factor does not necessarily mean that the soil is eroding; *K* factor only indicates *susceptibility* to soil particle detachment. Force must be applied via wind or water to create active erosion. On flat slopes, raindrops can detach soil particles with a high *K* factor; however, transport is usually limited to the raindrop impact footprint. Variations in slope allow gravity to collect and move standing water. The work performed by moving water on the soil surface interacts with the infiltration capacity and structural stability of the soil (*K* factor) to estimate erosion potentials. Generally as slope increases, the velocity and erosive energy of surface runoff increases.


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Slopes are generally defined by slope angle (or gradient), slope length, and slope width. Under natural, undisturbed conditions, slopes do not appear as geometrically precise, featureless gradients but vary in both form and configuration. Depending on the geologic history, parent materials, and environmental setting, slope profiles help stabilize slope materials.

Force applied to slopes produces *shear stress* on slope materials. The force generated by stormwater runoff is subject to resistance, created by the structural strength and cohesiveness of soil materials and vegetation. These collective shear strengths act to harmlessly dissipate force; however, if the force exceeds the shear strength resistance of the slope materials, then the deformation and transport work of erosion may occur. This process is repeated on different portions of the slope, with the frequency and magnitude of force and strength of shear stress resistance varying over time (Toy and Hadley, 1987; Morgan, 1995). Wischmeier and Smith (1978) identified several basic principles of slope erosion processes: 1) soil loss increases as slopes steepen; 2) the logarithm of runoff to percent slope is directly proportional, and this relationship is unaffected by dense sod or smooth bare ground; 3) as slope materials become extremely wet, the effect of slope on runoff is reduced; and 4) slope angle is weighted over slope length in setting erosion potential criteria or measuring soil loss, because as slope steepness increases, slope length decreases, and so does its effect on erosion.

The influence of slope length on soil erosion tends to increase with increasing slope angle. As an example, doubling slope length from 100 to 200 feet on a 6 percent slope would increase potential soil loss by 29 percent, whereas the same slope length at a 20 percent slope angle would increase potential soil loss by 49 percent. Disturbance changes in slope configuration by means of gradient breaks and small, interslope convex and concave surfaces can have a dramatic impact on the concentration and drainage patterns of slope runoff.

6.1.2 Crossings and Soil Erosion Modeling

Crossings exhibit a diversity of physical features and condition variables that could affect the validity of traditional soil erodibility modeling. In addition to the debatable applicability of crossing soil erodibility *K* factor and slope analysis, crossing roadways present unique situations that directly impact erosion potential, including:

- Native soil disturbance and loss that, in many cases, has exposed highly erodible or erosion-resistant geologic layers.
- Importing sand to clayey soils and aggregate road fill materials that vary widely in soil erodibility potentials.
- Maintenance of compact, relatively impermeable unpaved road surfaces that increase the volume and velocity of stormwater runoff.
- Presence or absence of crossing practices that control road-induced erosion, runoff, and/or sediment.


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- Construction and maintenance of roadside ditch systems.
- Disturbed, denuded, and/or minimally vegetated roadside slope areas.
- The type and condition of the crossing structure.

As a result, the potential for soil erosion from crossings can be in direct contradiction to the estimated condition(s) associated with soil erodibility *K* factor and slope analysis estimates. In some cases, crossing road approaches with slopes of 2 percent or less can produce soil erosion at rates that equal or exceed crossings with more steeply sloped road approaches.

Generally, the native and mined sandy to clayey soil materials used to construct and maintain CPB unpaved roads cannot resist the erosive forces applied by stormwater runoff. As a consequence, these potentially unsustainable features create unique conditions that demand constant attention and application of specialized technologies to minimize environmental impacts and maintenance costs.

Estimating soil erosion potential is only a small component of the overarching crossing issues. The ground-disturbance regimes used to manage unpaved road crossings create imbalances in natural hydrology. These imbalances localize and concentrate water flows and alter the capacity of soils, vegetation, and ground litter to store and release water flows. Within this artificial environment of road management, the mechanics of sediment generation, delivery, and deposition can vary by extremes. As a result, not all soil materials that are detached from the road or roadside surfaces are moved and deposited into waterways. Some materials may be temporarily or permanently interred at locations somewhere between the point of detachment and the crossing (Figure 6-2). These same materials may be resuspended by runoff and transported further downslope or be disturbed by road maintenance activities in a manner that increase their susceptibility to transport by runoff. Some soil materials will move directly from the point of detachment into waterways, whereas others may cycle from one point to another indefinitely.



Figure 6-2. Eroded Road Materials Deposited Within CPB Roadside Ditches (Mike Rainer)

Based on reviews of the literature and interviews with practitioners, currently, there is not a model for road erosion and sediment production and delivery that uses empirical data to accurately estimate crossing-induced sedimentation. There are several models currently in use; however, the results they produce are highly questionable, largely due to the nature of soil erosion and transport processes. Even at the finest levels of resolution, modeling results may have little, if any, correlation with observed field data. Even when trends are observed, the errors may be so high that results are unreliable.

6.1.3 Crossing-Induced Sedimentation

Unpaved roads, and the crossings they create, are disturbance environments manufactured by humans that interact directly with CPB water resources. In contrast to natural conditions, unpaved roads are relatively impermeable areas that are designed to collect and move stormwater off-site as quickly as possible. Since water moves faster through a channel, road design configurations tend to transition runoff from sheet to channelized flow within constructed and/or false roadside ditches that discharge directly into crossing waterways (Figures 6-3). The process in and of itself may seem relatively benign; however, in reality, water flowing over incohesive, unprotected roads and roadsides that characterize most CPB crossings inevitably results in soil erosion and sedimentation. The chronic, unrelenting process of crossing-induced sedimentation in combination with other nonpoint sources of sediment has permanently altered the forms and functions of CPB aquatic ecosystems.

Crossing sediment sources include the road approaches, roadsides, road culverts, and culvert crossing fill materials (Figure 6-4). Sedimentation from crossings tends to vary based on road surface and crossing types and are primarily related to road surface and drainage features, frequency of ground-disturbing maintenance, and culvert crossing failures. Surface erosion rates from unpaved roads are normally orders of magnitude greater than erosion from undisturbed natural areas. Runoff and sediment delivery from crossing road approaches generally follow one of four potential pathways:

- Infiltration of runoff into the adjacent roadsides areas with limited delivery to the stream
- Direct delivery of water and sediment down the roadway and into the receiving stream at crossings
- Direct delivery of water and sediment through man-made drainage systems into the receiving stream
- Indirect delivery by overland flow below a road



Figure 6-3. Point of Transition of Inroad Runoff from Sheet Flow to More Erosive Roadside Channelized Flow (Mike Rainer) **and Resultant Crossing-Induced Stream Sedimentation** (Ted Hoehn)

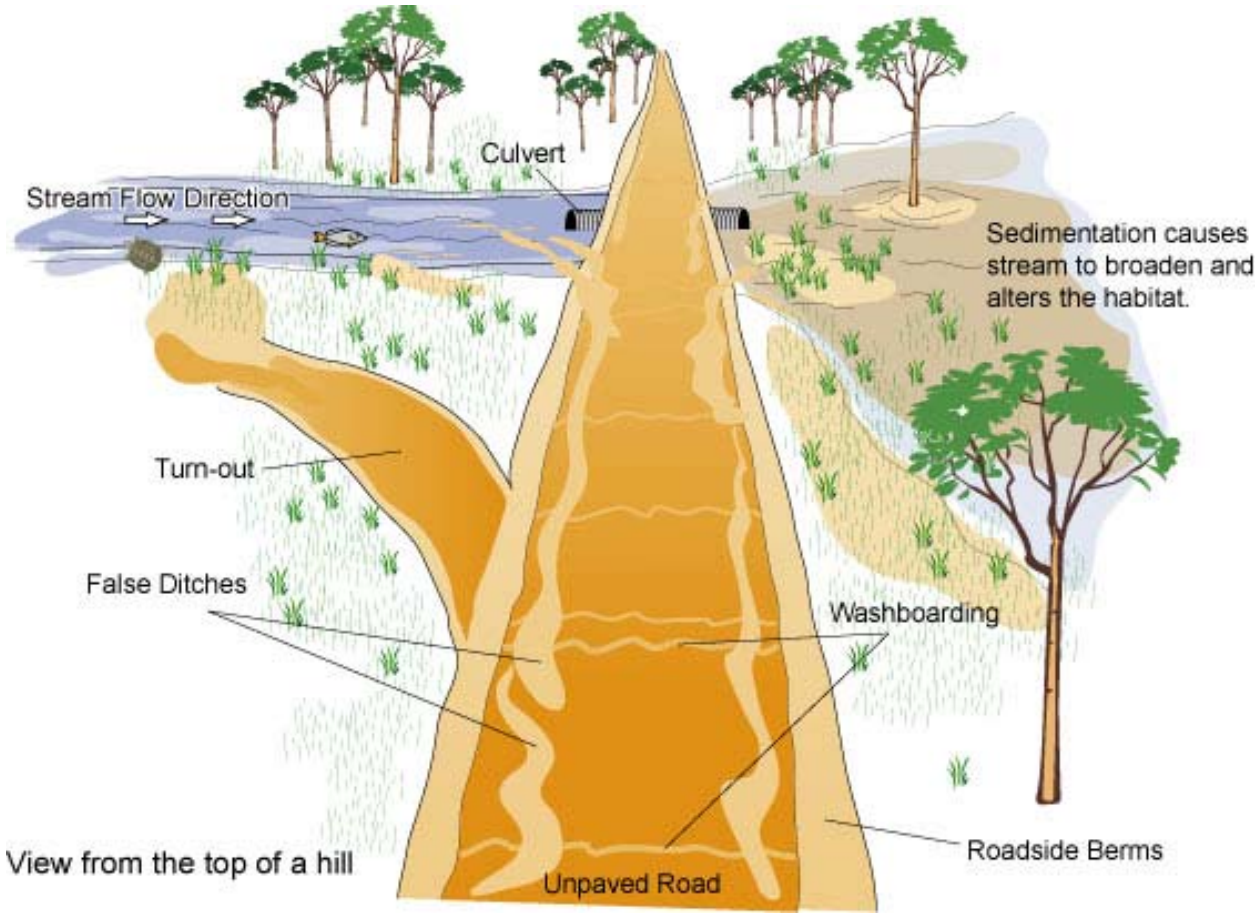


Figure 6-4. Crossing-Induced Sedimentation Process (Angie Kiefer)

6.2 CROSSING-INDUCED ENVIRONMENTAL EFFECTS

Three of the most pervasive effects of crossing-induced soil erosion and sedimentation on aquatic ecosystems include 1) stream channel alteration, 2) water quality impairment, and 3) aquatic habitat degradation. As discussed in Section 5.2.2, crossings with misaligned culverts can also impede the movement of aquatic species between habitats. These impacts can contribute to declines in the quantity, quality, diversity, and integrity of biological systems, which are directly linked to the socioeconomic and cultural welfare of CPB residents and communities.

6.2.1 Stream Channel Alteration

Crossings can dramatically influence the evolution of natural streams. Under natural conditions, stream channels are characterized by a dynamic equilibrium of sediment erosion, transport, sorting, and deposition processes that are continually altering the form of stream system channels, bedforms, and floodplains. Generally, minor disturbances result from minor changes in the system. However, major disturbances that alter the form and/or function of stream channels or floodplains can contribute to imbalances in stream system equilibrium, whether caused by crossing culverts, crossing-induced sedimentation, stream dredging and channelization, water impoundment, changes in land cover and hydrology from agriculture, silviculture, and development, or other disturbance.

Crossing disturbances in the form of stormwater runoff, sediment inputs, and ineffective culvert structures can significantly impact system wide stream evolution and stream stability. Streams react to stormwater runoff and sediment inputs by physically adjusting channel forms through a process known as *channel evolution*. During channel evolution, a channel typically progresses from a stable channel, to an incised channel, to a widened channel, and back to a stabilized channel (Figure 6-5). Stream adjustments resulting from increased channel flow and stream power may include streambank erosion that results in a wider shallower channel or streambed incision through degradation (streambed lowering by erosion). The effects of crossing-induced increases in stream flow and in-stream sediment deposition can dramatically alter natural channel evolution. In many instances, heavy sediment loading results in stream aggradation (rising of the streambed from sediment deposition), channel widening, and the development of multiple small channels (Figure 6-6); in-stream vegetation may also become established. Greater pressures are often applied to the opposing streambanks, resulting in increased soil erosion. Crossing-induced change to a shallower, wider, silted-in stream can have major impacts on water quality, aquatic habitats, and recreational uses.

Misaligned or improperly designed culvert crossings can function to stabilize grade, thereby inhibiting natural stream regrading processes. In some instances, the stream channel may be degrading on one side of the culvert and aggrading on the other side of the culvert. Considering that crossing inputs and structural disturbance conditions could be occurring at several locations along a given stream reach, the effects of multiple, interacting upstream and downstream channel alterations could have significant cumulative impacts on CPB aquatic ecosystems.

A primary mechanism that changes the volume and timing of stream peak flows is the unpaved road network, which essentially increases the drainage density of channels, intercepts subsurface water, and decreases the time needed for overland runoff to reach the stream channel. Even though the watershed receives the same amount of precipitation, it is transported through the system much more quickly, thus resulting in higher peak discharges and resultant increases in stream power. This increased stream power can more effectively erode the streambed and banks. Because the total amount of water remains relatively constant, base flows decrease because the rapid runoff reduces the total amount of water that can infiltrate and be stored in soil.

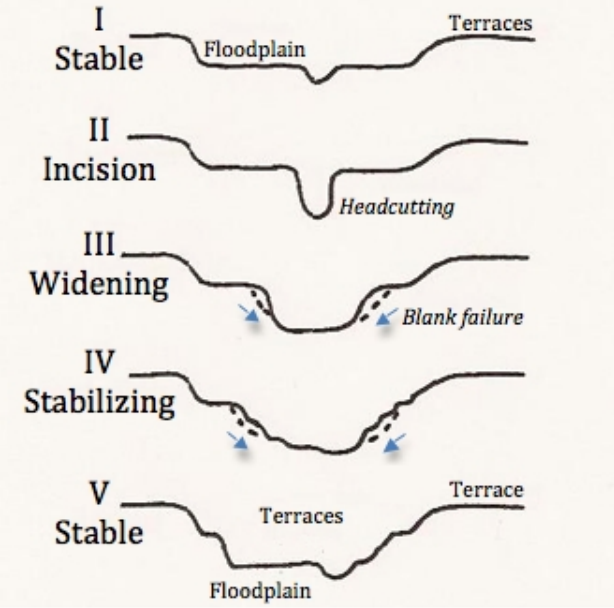


Figure 6-5. Stream Channel Evolution
(David Rubino)

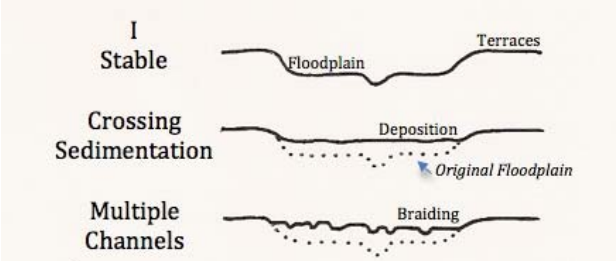


Figure 6-6. Sedimentation-Induced Changes to Stream Channel Evolution (David Rubino)

Over time, unpaved roads and crossings can cause chronic sedimentation problems and catastrophic damage during floods. Studies have shown a correlation between road density and degraded stream habitat conditions and fish populations. However, all roads do not deliver sediment to streams, and those that do, deliver it at highly variable rates (Quigley and Arbelbide, 1997; Gucinski et al., 2000). In most watersheds, specific road segments and crossings are responsible for a disproportionately high contribution of sediment discharge to waterways.

6.2.2 Water Quality Impairment

Water quality (WQ) is considered impaired if it fails to meet physical, chemical, and/or biological standards and/or designated aquatic life, primary contact and recreation, fish and shellfish consumption, and drinking water uses (Section 3.8). WQ impairment from pollution generally results from water contamination by chemical materials and/or water column turbidity produced by suspended sediments. In addition to the direct delivery of chemicals into streams, as might be associated with industrial plant discharges or residential stormwater runoff, chemicals may also be introduced into waterways by soil erosion and sedimentation processes. Chemicals deposited on the soil surface can become bound to high charged organic matter or silt and clay soils that, once eroded, are susceptible to discharge into streams as sediment.

Once suspended in the water column, sediments will continue to be transported by water flows unless water velocities are reduced or the sediments are physically removed. Heavy-settling sediments, such as course sand, may settle out rather quickly, whereas fine silt and clay particles may remain suspended for extended periods. Generally, the effects of water turbidity during and following CPB storm events ranges from minutes to days. The effects are most pronounced for very slow-moving streams and impoundments (Figure 6-7). Lower dissolved oxygen levels often kill fish eggs, and suspended sediment may change water temperatures (McCutcheon and Hayes, 1993).



Figure 6-7. Highly Turbid Slow Moving Stream and Beaver Dam Impoundment (Mike Rainer)

As shown in Table 6-1, the period required for soil and organic materials to settle 1 foot within small impoundments can range from a few seconds to years. Depending on the frequency of rain events, drainage discharge patterns, and sediment inputs, some water courses may sustain highly turbid conditions for extended periods. Generally, the temporal characteristics of turbidity will vary with the geomorphology, adjacent land uses, and flow regimes of the affected waterway. The overall clarity and short-term turbidity of some CPB streams is related to the dominance of sandy materials within surface soils and near-surface geologic layers. The coarse sands are readily eroded by stormwater runoff but tend to fall out of suspension rather quickly once deposited in streams. As the silt and clay content of runoff increases, so does the potential extent and duration of water turbidity.

Table 6-1. Small Impoundment Particle Settling Velocities

Particle Diameter (mm)	**Order of Size**	**Settling Velocity** (mm/sec)	**Time Required to Settle 1 Foot**
10.0	Gravel	1,000	0.3 Seconds
1.0		100	3.0 Seconds
0.8		83	
0.6		63	
0.5	Coarse Sand	53	
0.4		42	
0.3		32	
0.2		21	
0.15		15	
0.10		8	38.0 Seconds
0.08		6	
0.06		3.8	
0.05	Fine Sand	2.9	
0.04		2.1	
0.03		1.3	
0.02		0.62	
0.015		0.35	
0.010		0.154	33.0 Minutes
0.008		0.098	
0.006		0.065	
0.005	Silt	0.0385	
0.004		0.0247	
0.003		0.0138	
0.002		0.0062	
0.0015		0.0035	
0.0010	Bacteria	0.00154	55.0 Hours
0.0001	Clay	0.0000154	230.0 Days
0.00001	Colloidal Particles	0.000000154	63.0 Years

Source: US Environmental Protection Agency, 1975; mm = millimeters; sec = seconds

6.2.3 Aquatic Habitat Degradation

Aquatic habitat degradation generally relates to declines in the capability of aquatic ecosystems to support native flora and fauna. The interactions of humans with natural systems often results in the damage, fragmentation, or loss of critical habitat. Human-caused degradation generally results from activities that physically disturb waterway features, introduce hard structures to fluid systems, and/or accelerate the input of stormwater runoff and sediments above background levels. Whether terrestrial or aquatic, the quality and quantity of the habitat determines its capability to provide species with food and cover for all seasons, sexes, and ages. In many cases, aquatic habitat degradation is a primary reason for declines in aquatic species populations and the listing of species as rare and imperiled.

Channel disturbances associated with dredging, channelization, and channel cleanout create uniform bottom conditions with generally low habitat diversity and quality, compared with unaltered streams (Section 5.4.3). The alteration of riparian zone vegetation reduces an important source of organic leaf litter and root mat substrates, emergent habitats, shelter from predators, and reproduction staging areas. The construction of crossing culverts with hard structures can alter stream morphology and evolutionary processes important to the maintenance of aquatic habitats and interfere with the movement of species between seasonal habitats (Section 6.2.1). Water crossing bridge structures that cause minimal alteration in natural flow regimes are less likely to damage habitat and interfere with species movement (Warren and Pardew, 1998).


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Channel disturbances and accelerated soil erosion and stream sedimentation that characterize many CPB crossings can be particularly detrimental to aquatic habitats and species such as fish, mussels, and insects. High sediment inputs bury organic and streambed substrates that are essential to the survival of many aquatic species. Stream sedimentation can be particularly detrimental to aquatic insects. Species such as mayflies (Ephemeroptera), caddisflies (Trichoptera), and stoneflies (Plecoptera) depend on a gravelly streambed that is relatively free of soil sediments. They require space between gravely substrate for shelter, specialized feeding, harborage, and breeding. Sediments can quickly fill in and cover gravel bottoms, which destroys habitat and may result in immediate species declines (Benz and Collins, 1997).

Stonefly populations are particularly sensitive to channel disturbance and sedimentation. The loss of pea-sized gravel streambed habitats, loss of channel organic substrates, stagnant stream flow, low water oxygen levels, and increased water temperature fluctuations can lead to the elimination of most stonefly species, followed by mayfly and caddisfly species. Crossing channel disturbances and sedimentation destroy aquatic insect habitats, which can lead to drastic declines or removal of species populations; the effects of streambed smothering can be quite devastating (Section 5.4.2). Replacing gravel bottoms with layers of sediment precludes stream use by most aquatic insects (Section 3.9.3).

Because of its extent, crossing-induced sedimentation has directly or indirectly altered the form and function of all CPB aquatic ecosystems. It is theorized that the import of gross amounts of sediment has produced an increased number of water impoundments, reduced overall channel gradients, and created wider and shallower streams. This

effect is often drastically pronounced in landscapes that have mild terrace slopes and relatively flat floodplain areas. In addition to degrading habitat, crossing culverts may also restrict or exclude species access to desirable habitat areas (Section 5.2.2).

As discussed in Section 5.4.4, crossing culvert structures and contribution to stream sedimentation may have also prompted changes in CPB aquatic ecosystem biology. The presence of crossing culverts and development of shallow, slow-moving streams has created more favorable environments for beaver dam construction than would otherwise be available under natural undisturbed conditions. Culverts have been shown to alter stream channel gradients and flow regimes, and they are easily plugged by beavers. Culvert crossings and sedimentation not only increase the availability of dam construction sites within wetlands but also within stream channels. Once a dam is in place to control water flow, the construction of additional dam systems becomes more feasible. Crossing culvert blowouts may occur during catastrophic beaver dam failures from severe storms, resulting in gross amounts of sedimentation from the crossing fill collapse and scouring of the stream channel. Interventions to control beaver populations by removing dam structures have been relatively ineffective and may actually increase the potential for water quality impairment and habitat degradation. In some instances, beaver control and damage repair may be more costly than replacing culverts with bridges.

6.3 ENVIRONMENTAL REGULATIONS

Many crossing-induced changes to natural environments are within the jurisdiction of federal and state regulations because of their potential effects on aquatic ecosystem water quality, habitats, and/or species. The crossing-induced sedimentation that occurs at many CPB crossings violates federal regulations [Clean Water Act (CWA), Section 404 and Endangered Species Act (ESA) Section 9] and Florida statutes [Florida Administrative Code (FAC) 62-302 (Surface Water Protection), FAC 62-312 (Dredge and Fill)].

- The Clean Water Act (Section 319, as amended in 1987) states that nothing can be introduced into a stream or other water body that could potentially pollute the water.
- During storm events, some crossings are discharging sediment-laden stormwater directly into surface waters of the state and Outstanding Florida Waters, **a violation of FAC 62-302.**
- The transport and deposition of sediment into waters of the state by stormwater runoff is considered a fill activity, **a violation of FAC 62-312.** The statute defines “filling” as the deposition, **by any means**, of materials in waters of the state.
- Some rare and imperiled aquatic species habitats have been altered, damaged, or destroyed by crossing-induced sedimentation, **a potential violation of Section 9 of the ESA**.


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Although historically defined as nonpoint source (NPS) pollution sites, crossings are discrete, discernable geographic points at which sediment pollutants are discharged directly into receiving waters of the state. Generally, water quality parameters associated with crossing-induced sedimentation include turbidity, total suspended solids, and dissolved oxygen.

USEPA is enforcing Section 303(d) of the CWA through the total maximum daily load (TMDL) process. A TMDL represents the maximum amount of a given pollutant that a waterbody can assimilate and meet all of its designated uses. A waterbody that does not meet its designated uses is defined as "impaired." Under Section 303(d) and the Florida Watershed Restoration Act (FWRA), TMDLs must be developed for all waters that are not meeting their designated uses. Pollutant limits are then allocated to each pollutant source, both point sources and NPSs in an individual river basin. TMDLs and their associated allocations must be adopted by rule.

Section 404 of the CWA also protects jurisdictional wetlands in the United States. The regulatory definition of a "wetland" used by the U.S. Army Corps of Engineers (USACE) and USEPA for administering the Section 404 permit programs is as follows.

> Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas [40 Code of Federal Regulations (CFR) 230.3 and 33 CFR 328.3].

Wetlands possess three essential characteristics 1) hydrophytic vegetation, 2) hydric soils, and 3) hydrology. The three technical criteria specified are mandatory and must all be met for an area to be identified as a jurisdictional wetland. Several sections of the CWA pertain to wetland regulation, including:

- Section 101 of the CWA, Standards and Enforcement: Description of the objectives of the CWA that are primarily implemented through Title III (Standards and Enforcement).
- Section 301 of the CWA, Prohibitions: The discharge of dredged or fill material into the waters of the United States is subject to permitting specified under Title IV (Permits and Licenses) and Section 404 (Discharges of Dredge or Fill Material) of the CWA.
- Section 401 of the CWA, State Certification: Specifies additional requirements for permit review by state.


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- Section 404 of the CWA, Discharges of Dredge or Fill Material: Authorizes the USACE to issue or deny permits for the discharge of dredged or fill material into U.S. waters (Title 40, Part 230, Section 404[b][1], Guidelines for Specification of Disposal Sites for Dredged or Fill Material, Subparts A through I).
- Section 404(b)(1): Requires that, unless exempted, anyone wanting to discharge dredged or fill material in navigable waters of the United States, which include most wetlands, obtain a permit from one of the 38 USACE district regulatory offices. The permitting process provides the USACE with a mechanism for enforcing mitigation efforts.

The Florida Department of Environmental Protection (FDEP) Environmental Resource Permit program under Part IV, Florida Statutes Section 373, includes jurisdictional wetland regulations regarding dredge-and-fill operations in fresh and salt water.

The Water Quality Act (WQA) of 1987 (Public Law 100-4) strengthened existing mandates of the CWA and created new programs to protect water resources. Programs include 1) specified research, investigation, and training programs in water pollution control; 2) state and interstate pollution control programs; 3) undergraduate programs in water quality control; 4) grants for developing waste treatment management plans for areas with substantial water quality control problems; 5) water pollution control programs in agricultural areas; 6) agreements among government agencies providing for maximum use of existing programs for water quality control; 7) grants to states for lake pollution control; and 8) carrying out the CWA generally. The WQA also tightened controls for toxic pollutants.

Rare and imperiled aquatic species and other listed wildlife species are protected by the Endangered Species Act of 1973 as amended (16 United States Code § 1531). The ESA provides a means whereby the ecosystem(s) upon which endangered species depend may be conserved. The U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) collectively survey the status of species and list those species determined to be threatened or endangered (16 USC § 1533). Once a species is listed, the statute prohibits harm to the species or its habitat (16 UCS § 1538). Listing decisions must be based on the best available scientific and commercial information regarding the species and the reasons the species is threatened with extinction [50 CFR § 424.11(b)(1992)].

Sensitive species include those with federal endangered or threatened status, federal candidate species, and state endangered, threatened, and species of special concern status. Threatened species are those likely to become endangered within the foreseeable future throughout all or a significant portion of their range [16 USC § 1532(20)]. Endangered species are species in danger of extinction throughout all or a significant portion of their range [16 USC § 1532(6)]. Federal candidate species and state species of concern are those that should be given consideration during planning of projects but have no protection under the ESA.



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Section 9 of the ESA prohibits unauthorized taking of listed species [16 USC § 1538(a)(1); 16 USC § 1538(a)(1)(B)]. Taking is broadly defined to include any activity that would or would attempt to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect a species covered by the ESA. A take includes direct actions as well as indirect actions that result in harm from habitat alteration, modification, or destruction [16 USC § 1532(19); 50 CFR § 17.3 (1993)]. The pursuing, molesting, harming, harassing, capturing, or possession of any endangered species or parts of their nests or eggs, except as authorized by special permit, is allowed only when the activity enhances the survival potential of the species.

6.4 LITERATURE CITED

Benz, G.W., and Collins, D.E. 1997. *Aquatic Fauna in Peril: The Southeastern Perspective*, Southeast Aquatic Research Institute, Chattanooga, Tennessee.

Gucinski, H., J. J. Furniss, R. R. Ziemer, and M. H. Brookes (eds). 2000. *Forest Roads: A Synthesis of Scientific Information*. USDA Forest Service.

Henley, W.F., Patterson, M.A., Neves, R.J., and Lemly, A.D. 2000. Effects of Sedimentation and Turbidity on Lotic Food Webs: A Concise Review for Natural Resource Managers. *Reviews in Fisheries Science*, 8(2):125-139.

Judy, R.D., Seeley, P.N., Murray, T.M., Svirsky, S.C., Whitworth, M.R., and Ischinger, L.S. 1984. *National Fisheries Survey: 1982. Volume I. Technical Report: Initial Findings*. Report No. FWS/OBS-84/06. Washington, D.D., U.S Fish and Wildlife Service.

Quigley, T.M. and Arbelbide. 1997. *An Assessment of Ecosystem Components in the Interior Columbia Basin and Portion of the Klamath and Great Basins*. United States Department of Agriculture Forest Service, Pacific Northwest Research Station, Portland, Oregon. General Technical Report PNW-GTR-405

McCutcheon, S. C. and J. C. Hayes, 1993. Effects of Excess Sediment. In: Proceedings of the Technical Workshop of Sediments; February 3-7, 1992, Corvallis, OR, sponsored by the U.S. Environmental Protection Agency and U.S. Department of Agriculture, page 29-31. US Environmental Protection Agency, 1975

Morgan, R. P. C. 1995. *Soil Erosion & Conservation, Second Edition.* John Wiley & Sons, Inc., New York, NY.

Toy, T. J. and R. F. Hadley. 1987. *Geomorphology and Reclamation of Disturbed Lands*. Academic Press, Inc. Orlando, Florida.

U.S. Environmental Protection Agency (USEPA). 1994. *The Quality of Our Nation's Water: 1992*. Report No. EPA 841-S-94-002, U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

Wagener, S.M., and LaPerriere, J.D. 1985. Effects of Placer Mining on the Invertebrate Communities of Interior Alaska Streams. *Freshwater Invertebrate Biology*, 4:208-214.

Warren, M. L. and M. G. Pardew, 1998. Road Crossings as Barriers to Small-Stream Fish Movement. Transactions of the American Fisheries Society, 127:637-644.

Wischmeier, W. H. and D. D. Smith, 1978. *Predicting Rainfall Losses: A Guide to Conservation Planning*. U.S. Department of Agriculture, Handbook No. 537.

CHAPTER SEVEN

ANALYSIS AND SITE PRIORITIZATION



This chapter presents results of data analysis conducted as part of the Choctawhatchee-Pea Basin assessment to prioritize site for treatment, identify crossing management risks, and evaluate cumulative effects on resources.


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ACRONYMS

CPB	Choctawhatchee-Pea Basin
GIS	geographic information system
HUC	Hydrologic Unit Code
LRMG	Landscape Recovery and Management Group
ROC	Rules of combination
SSM	StreamX Synoptic Method
WBID	waterbody identification


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7. ANALYSIS AND SITE PRIORITIZATION

7.1 INTRODUCTION

The data collected during this assessment was analyzed to pinpoint crossing maintenance issues, aquatic resource impacts, and crossing treatment opportunities. The results will facilitate decision-making in allocating resources to remediate road-stream crossings for immediate benefit to natural resources, as well as promote long-term ecosystem recovery and sustainability.

The analysis associated data inputs and selectively interpreted the scale and complexity of data dependencies and interactions. The results were further scrutinized to establish a basis for targeting specific crossing sites for treatment. This analysis was used to score and rank sites for treatment and assess risks associated with Choctawhatchee-Pea Basin (CPB) crossing and aquatic resource interactions.

7.2 ANALYSIS CONCEPTS

Crossing structures and roadscapes (Sections 4.2 and 4.3) are physical features on the landscape that interact with and, in some cases, become permanent components of ecosystems. Concepts integrated into this analysis to assist in evaluating crossing and ecosystem interactions include connectivity, diversity, function, proximity, sustainability, and treatment.

7.2.1 Connectivity

Connectivity is the property of being connected by direct linkage or close association. The diversity in landscape habitats partly relies on the degree of connection between habitats that allows species movement. Frequently, riparian areas along streams, rivers, lakes, and wetlands are the corridors that connect habitats and facilitate the movement of species, nutrients, and energy between ecosystems. Groundwater may also function to connect habitats. Blocking the flow of nutrients and energy between forest habitats can lead to ecosystem impoverishment.


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Since roads are longer than they are wide, they create an ecosystem interface and ecotone environments that are temporally and spatially complex and diverse. Interactions within these environments may regulate the flow of energy and material between adjacent systems (Gucinski et al., 2000). Roads and culvert crossings may also block the movement of water between wetland communities. Alteration of hydrologic regimes can directly affect the form and function of ecosystems. Changes could include transition in vegetative community type and loss of critical habitat variables.

Crossing roadscapes also connect ecosystems to socioeconomic features. *Economic connectivity* refers to the state of local economies being functionally connected by the movement of market activities. Socioeconomic growth and development pressures are transferred to ecosystems through infrastructure and land use development.

7.2.2 Diversity

Diversity refers to an apparent abundance, variety, and/or difference in population types or association of constituents. Ecological diversity or heterogeneity relates to the differences within a landscape. A naturally diverse landscape includes a variety of flora and fauna within a variety of ecosystem types characterized by site-specific microclimate, soils, relief, hydrology, aspect, and other ecosystem variables. Typically, natural diversity tends to stabilize an ecosystem.


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Natural diversity aids in the persistence of species; generally, most species require more than one type of habitat to survive and reproduce. Species may also require specific habitat conditions that, once altered, may exclude species use of that habitat. Species diversity is also beneficial in that it promotes ecosystem redundancy. This is particularly important during minor to catastrophic ecosystem disturbances when important ecological functions must perform in more than one way. Ecosystem diversity may also reduce the threat of disease and pests within populations. Overall, a diverse ecosystem tends to sustain a relatively balanced matrix for various organisms.

7.2.3 Function

Function is the specific, natural, or proper action that belongs to an agent. The water quality and habitat functions of ecosystems are essential components of environmental integrity and sustainability. Based on the location, design, maintenance, and history of use and site environmental variables, crossings may have minimal to transitory or substantial effects on aquatic environments.

7.2.4 Proximity

Proximity refers to the state or fact of being near or next to or being in immediate relation with something else. Typically, people and other organisms live in proximity to the things that they value most. The proximity of land-disturbing activities to ecologic and cultural resources can affect the potential for resulting impacts. Generally, as the proximity of the disturbance action decreases, the impact potential increases.

Roads and crossings intersect or are frequently in close proximity to sensitive and valued natural resources. As an example, roads in riparian areas could adversely affect the form and hydrologic function of these transition environments between terrestrial and aquatic ecosystems. Equally important, roads provide access to areas for recreational uses such as hiking, hunting, fishing, camping, scenic enjoyment, and other activities. The intersection or closeness of a road to resources affects the impact of the road on a given resource.

7.2.5 Sustainability

The goal of environmental *sustainability* is to indefinitely sustain life-support systems and improve biological welfare by protecting the source and function of resource components, such as air, water, and soil. Sustainability also includes fair allocations of resources among generations. Generally it requires that resource usage by a generation should not exceed a level that would prevent future generations from achieving a level of well-being at least as great. Because of the potential for both beneficial and detrimental interactions with ecologic and socioeconomic environments, roads and crossings are important variables in ecosystem sustainability.

7.2.6 Treatment

Treatment is action taken to modify an outcome or condition. *Crossing treatment* includes actions to restore and maintain the crossing environment to a desired physical condition. Such treatment addresses the need to limit site disturbances to a level that both allows the road-stream crossing to be used for transportation and promotes environmental stewardship. Treatment, whether by road paving or site rehabilitation, is an expensive endeavor; decision-makers must consider ecological impacts and values as well as resource expenditures. Minimizing the impacts of soil erosion and sediment delivery at crossings mainly involves 1) stabilizing soils, 2) managing runoff, 3) controlling sediment, and 4) promoting ecosystem recovery.

7.2.6.1 Stabilize Soils

Stabilized soils are resistant to erosion. Under stable conditions, the soil — whether it occurs on the road prism, roadside areas, crossing structure, or adjacent streambanks — is a cohesively, armored (vegetative and/or structural) matrix of soil particles that is resistant to particle detachment and transport by stormwater. The goal of soil stabilization is to keep soil materials in place. This goal can be achieved by:

- *Manufacturing stable slope grades*. Soil erosion damage to slopes often creates an irregular, unstable profile that further accelerates water flows and inhibits vegetation. A slope, which is inherently unstable, will not support satisfactory vegetative cover until it has created a stable angle of repose, whether by erosion or mechanical reconstruction. Even under stable grades, bare soil is still susceptible to erosion.
- *Reconditioning damaged soils*. Many of the soils in the vicinity of unpaved road-stream crossings are structurally and chemically damaged or are depleted of vital soil components necessary for supporting vegetative growth. In a damaged, dysfunctional state, soils are easily eroded, overall ecosystem functions are adversely impacted, and water quality decreases. Soil reconditioning promotes soil structural stability; stimulates increases in the diversity, populations, and activity of soil organisms; restores soil humus components; and promotes nutrient recycling and soil water retention. Reestablishing vegetation depends on restoring the health and functions of soil environments.

- *Establishing permanent vegetative cover*. Vegetative covers provide the best-known soil protection. Vegetation minimizes the impacts of raindrops, reduces the velocity of runoff, holds soils in place, tends to be self-healing, is generally less expensive compared to structural features, and is often the only practical long-term solution for stabilization and erosion control on most disturbed sites. Although not all ground surfaces encountered at stream crossings are amenable to vegetative cover, the majority can support vegetation if properly prepared and maintained.


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- *Reinforcing roadway surface materials*. The stability of road surface materials is essential to minimizing crossing-induced stream sedimentation. Reducing the potential for sediment contribution depends on increasing the cohesiveness and resistance of the road surface to the erosive forces of flowing water. Unpaved roads disturbed by frequent road surface grading and ditch cleanout are highly susceptible to soil erosion and generation of sediment-laden runoff.

Soil stabilization applies to all ground surfaces hydrologically connected to the crossing, not just vicinity soils. Unstable soils at the road approach hillcrest and/or roadside slopes may have as much or more influence on sedimentation as streambank erosion.

7.2.6.2 Manage Runoff

Soil erosion and sediment transport is a product of flowing water. As gravity moves runoff downhill, the energy generated by its volume and velocity works to detach, suspend, and transport materials. Left unencumbered, flowing waters tend to concentrate and increase in velocity, which can result in the formation of high-energy rill and gully features that can erode and transport even greater amounts of soil. However, as flowing waters encounter resistance, the capacity of water to erode soils diminishes and allows suspended materials to fall out of suspension and deposit on the surface. Thus, the volume and velocity of flowing water must be controlled to control erosion and sedimentation.

The intention is not to stop the flow but to apply theoretical brakes that minimize the capacity of water to move soil particles and stabilize the surfaces over which it moves. The results of reducing the velocity of water flow can be quite dramatic. Reducing downhill water flows by half can reduce runoff erosion capacity by a factor of 4, the amount of sediment transported downhill can be reduced by 34 times, and the size of particles that can be pushed or rolled can be reduced 64 times (Roley, 1994). It is quite evident that slowing down the flow of water effectively reduces its erosive potential. Effective runoff controls function in two areas: the flowing column of water and the surface over which it moves. Runoff control includes:

- *Removing water from the road*. In all cases, the extended presence of stormwater on an unpaved road results in the degradation of road surface. As the unpaved road surface degrades, unstable road soil and fill materials are exposed to erosion. Road grading remains a frequent source of crossing soil erosion and sediment due to improper road designs and/or maintenance.
- *Utilizing native land drainway features to dissipate road runoff*. Whenever feasible, the floor of roadside forests and grasslands should be used to dissipate road runoff. The vegetation, ground cover, and undisturbed soils of these natural areas have a greater capacity to dissipate, filter, and absorb runoff in a nonerosive manner, compared to a constructed drainage ditch. The increased runoff infiltration capacity and rates, organic surface layer, subsurface root systems, and surface roughness that characterize undisturbed natural areas significantly reduce the erosive energy and sediment delivery potential of stormwater.
- *Intercept and defuse the erosive energy of runoff at multiple intervals.* Roadside drains frequently transport water at volumes and velocities beyond what would be encountered under natural conditions. As applicable, transition water flows into multiple discharge/dispersion points that avoid concentrating runoff into a single drain and discharge point. A runoff "braking system" reduces the velocity and dissipates the volume of runoff without trying to completely stop the flow. Smaller water volumes are easier to control and transport less sediment compared to larger water volumes. Vegetative and/or structural measures can be installed at designated intervals along water flow paths to intercept and disrupt flow without recreating a concentrated water flow problem in another location.


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- *Stabilizing soils exposed to runoff*. The surfaces over which runoff flows must be stabilized by vegetative and/or structural measures resist the erosive work energy of flowing water.

Runoff management not only minimizes soil erosion, it also provides effective sediment control. Soil particles that do become suspended in runoff can be filtered or deposited at resistance intervals along water flow pathways prior to discharge.

7.2.6.3 Control Sediment

Sediment control practices are temporary measures that treat the symptoms of soil erosion. Since sediment is the by-product of soil erosion, it must ultimately be controlled via effective erosion control practices. As such, sediment controls are typically used as temporary measures that only function until permanent erosion control practices are established. Once the generation of sediment is controlled at the source, sediment control practices are not required.

The goal of sediment control is to prevent the sediments already suspended in runoff from being delivered to waterways. Typically structures such as sediment basins, silt fences, and/or hay bales are installed to physically intercept runoff and create reduced water velocity conditions that allow sediments to fall out of suspension and be contained by the structure. When implemented as permanent structures, sediment controls tend to fail.





Since these structures collect sediment, at some point the threshold load capacity of the structure will be exceeded, and then the structure converts from a sediment sink to sediment source. As sediment control structures fail, their sediment loads are again suspended by runoff and delivered directly into drainage systems or streams.

7.2.6.4 Promoting Ecosystem Recovery

Within reasonable limits, aquatic ecosystem stability can be achieved from natural stream recovery processes. One of the most important concepts associated with the recovery of stream systems is that, within reasonable limits, streams are capable of repairing and sustaining themselves once the source(s) of disturbance are removed. The same channel evolution processes that result in stream degradation can be reversed as the stream reacts to reduced sediment inputs and works to reestablish stable channel forms and gradients.

In some instances, there are reasons for restoring a waterbody as quickly as possible, but there are other situations where immediate results are not critical. Under these conditions, allowing a stream to naturally heal over time without active intervention is preferred. Reducing or removing crossing-induced stream sedimentation can imitate stream system readjustments to reestablish a more dynamic equilibrium that is beneficial to water quality and aquatic species.

According to Rosgen (2001), the application of hard structure design variables, such as one-dimensional, uniform flow, and single objective management plans to natural streams, frequently result in ineffective, trapezoid-shaped channels. Structures have been used for centuries to stabilize stream channels; however, many hard structures such as gabions, concrete-lined channels, spur dikes, rock jetties, reinforced revetment, log cribs, and check dams have proven to be instrumental in increasing, rather than reducing, stream instability. In many cases, these “hard” structures violate the sediment transport and dimension, pattern, and profile attributes of stable stream systems. Hard structures are often installed as a patch for an unstable condition rather than as a practice to promote overall stream stability and integrity.

The eight most important interrelated variables of natural stream design include slope, width, depth, velocity, discharge, boundary roughness, size of transported sediment, and sediment concentration. In a stable condition, these variables exist in quasi-equilibrium. Changes in one or more variables will result in subsequent adjustments of other variables to reach a new equilibrium. Channel practices that are designed and installed in a manner that does not promote quasi-equilibrium will increase channel instabilities. Properly designed, channel practices should:

- Reduce near-bank shear stress and increase or decrease stream power; channel structures that reduce near-bank stress will reduce bank erosion by several orders of magnitude.
- Sustain central channel sheer stress, stream power, and channel capacity necessary for bankfull flow and sediment transport.
- Maintain stable channel dimension, pattern, and profile (width/depth ratios).
- Maintain fish passage at all flows and improve fish habitat (Rosgen, 2001).





The selection and installation of channel structures must coincide with achieving the desired conditions that produce a stable stream channel. Recovery practices are designed with flexibility in the use of construction materials native to the site. As an example, in the relatively low-sloping, sand-bottom streams, it may be more appropriate to use woody materials rather than rocks in the construction of channel structures. Woody debris provides a significant component of in-channel habitat native to CPB streams.

7.3 CROSSING INDEXING

The StreamX Synoptic Method (SSM) was developed by the SAIC Landscape Recovery and Management Group (LRMG) to systematically prioritize and analyze StreamX crossings data. The SSM analysis architecture and internal tools are utilized to customize a project-based technical approach designed to achieve stated objectives. The analysis process is driven by SSM index theme and indicator variables derived from StreamX data inputs and other integrated data sources and rules of combination (RoC) that provide temporal and spatial expressions of how crossings correlate and interact with natural resources.

Indices are the categorical theme(s) used to evaluate the resource impact potentials of crossings. Indices identify critical crossing features, conditions, linkages, and interactions between the crossing and other resource variables.

The index indicator is the actual data or metrics based on available data that are used individually or in combination to define the synoptic index. Indicators are limited to parameters for which data is accessible and uniformly available for the entire analysis area and are defined and correlated to proper spatial production requirements. Indicator coefficients that were designated as components of prioritization scoring matrices were numerically attributed.

Crossing interactions with and correlations to environmental components depends on establishing RoC for each synoptic index. RoCs are composed of selected index indicator coefficients values that are combined to create layers of spatial and attribute data that define scoring metrics. The end result is development of spatial products, database tables, and interpretative text that define crossing treatment opportunities and management risks.

CPB crossings analysis indices were constructed from environmental baseline GIS data (Chapter 3), field-verified StreamX crossing conditions (Chapter 5) data, and potential for crossing-induced environmental effects (Chapter 6). Indices were then grouped into crossing scoring and nonscoring indices, which are discussed in the following subsections.

7.3.1 Scoring Indices

The SSM crossing treatment prioritization scoring indices include:

- Crossing features index
- Hydrologic disturbance index
- Water quality index
- Aquatic habitat index
- Crossing stability index

Analysis of the CPB unpaved road network and surface hydrology was not performed because county roads data was inaccessible, and severe gaps and inconsistencies were identified in public domain roads and hydrology datasets. Numerous breaks were found in the digitization of linear streams, particularly in wetland areas, that preclude data use in calculating stream miles and density values. Additional work would be required to coordinate the collection, updating, and integration of current CPB road network and surface hydrology attributes. The CPB scoring indices are discussed in the following subsections.

7.3.1.1 Crossing Features Index

The purpose of the crossing features index is to develop CPB metrics that include the crossing type and structure, roadscape, and waterway components (Sections 2.1 and 2.2) and aquatic biology. This index provides a baseline dataset to analyze CPB crossing occurrence and dominance metrics and connectivity, diversity, function, proximity, sustainability, and treatment variables. The data is presented based on the total crossing feature/condition classification counts. The primary source of data for this analysis is the StreamX interim database; data on rare and imperiled aquatic species was acquired from state and federal geographic information system (GIS) data sources. Crossing feature index theme, indicators, and indicator coefficients are presented in Table 7-1.

Table 7-1. StreamX and GIS Crossing Features Index

Index Theme	Index Indicator(s)	Indicator Coefficient(s)
Crossing Features	*Crossing Type*	Water crossings
		Crossover site
		Proximity site
	Crossing Structure	Structure type
		Structure material
		Nonnative vegetation
		Bridge deck coverage
		Bridge deckholes/lipholes
		Bridge crossing grade
		Culvert inlet/outlet configuration
		Culvert structure configuration (number)
		Culvert embedment/extent
		Flood relief culverts
		Culvert hydrologic drop
		Culvert fill vegetation/cover
		Crossing drain discharge point locations
		Culvert inlet-stream configuration
		Culvert crossing grade
		Culvert upstream skew
		Culvert exposure
		Culvert endwalls type/location
		Culvert inlet damage
		Crossing catastrophic failure
	Roadscape	Road lanes (number)
		Road surface
		Road configuration
		Road width
		Road surface elevation
		Road BMPs
		Road maintenance level
		Road unimproved drain location
		Road constructed drain location
		Road drainage outlet location
		Road surface cohesion
		Inroad erosion (rill, gullies)
		Inroad drains (False ditches, multiple drains)
		Roadside grading berms
		Intersecting roads
		Natural drainway location
		Seepage flow
		Roadside drainage agriculture connectivity
		Sparse road aggregate
		Average road slope
		Road cutbank location
		Road edge erosion type/location
		Roadside ditch ground cover
		Roadside land cover
		Roadside land use
		Road surface cohesion
		Roadside erosion type/number/location
	Waterway	Water resource category
		Waterway category
		Waterbody category
		Flow regime
		Roagen classification
		Waterway alteration location
		Stream spoil bank location
		Instream woody material location
		Channel entrenchment location
		Stream clarity
		Sedimentation location
		Streambed smoothing location
		Instream debris location
		Channel straightening
		Streambank slope
		Turbidity
		Floodplain type
	Aquatic Biology	Rare and imperiled fishes/mussels*
		Beaver dam/plugs/controls

* Non-StreamX GIS data source

7.3.1.2 Hydrologic Disturbance Index

The purpose of hydrologic disturbance indexing is to identify and evaluate physical anthropogenic alterations of hydrologic features, including wetland connectivity, waterway, and crossing disturbances. Analysis evaluated the potential effects from crossing waterway channelization, dredging, and cleanout operations on CPB aquatic resources. Resultant metrics are expressed as total crossing counts. The source of the data for the hydrologic disturbance index analysis and prioritization is the interim StreamX database. The CPB hydrologic disturbance index indicators and coefficients are presented in Table 7-2.

Table 7-2. StreamX Hydrologic Disturbance Index

Index Theme	Index Indicators		Indicator Coefficients
	Base Indicators	**Indicator Subsets**	
Hydrologic Disturbance	Crossing Type	*Water Crossing*	Bridge crossing
			Culvert crossing
	Crossing Structure	*Flow Impedance*	Structure type
			Culvert inlet/outlet configuration
			Culvert embedment/extent
			Flood relief culverts
			Culvert inlet-stream configuration
			Culvert upstream skew
			Culvert inlet damage
			Crossing catastrophic failure
	Roadscape	*Channelized Inflow*	Road surface elevation
			Road BMPs
			Road maintenance level
			Road drainage outlet location
			Inroad erosion (rill, gullies)
			Inroad drains (false ditches, multiple drains)
			Roadside grading berms
			Intersecting roads
			Natural drainway location
			Seepage flow
			Average road slope
			Roadside ditch ground cover
			Roadside erosion type/number/location
	Waterway	*Hydrologic Connectivity*	Water resource category
			Waterway category
			Waterbody category
			Flow regime
		Waterway Alteration	Waterway alteration location
			Stream spoil bank location
			Instream woody material location
			Channel entrenchment location
			Sedimentation location
			Streambed smoothing location
			Channel straightening

7.3.1.3 Water Quality Index

Potential impacts to water quality evaluated by this analysis include the potential impairment of aquatic systems by sedimentation. The indicator coefficients for this analysis include sediment generation, sediment delivery, sediment deposition, flow impedance, and crossing fill stability. For this analysis, water crossings have a broad range of waterway impact potentials, whereas locations identified as crossover or proximity sites having validated connectivity with water resources are all considered to be potentially significant sources of sediment. These features also differ from water crossings, in that the site may exhibit extensive erosion and sediment generation but the point(s) of connectivity with water resources may not be readily observed because they are located on private lands. Because of extremes in variability associated with crossing road approach environments and lack of data fit for use, soil erodibility was excluded from the analysis.

Crossing-induced water quality impairment analysis indicator and indicator coefficient result metrics are expressed as total count of crossings and count of crossings by crossing type. The source of the data for the water quality index analysis and prioritization is the interim StreamX database and FDEP-STORET database. The CPB water quality index indicators and coefficients are presented in Table 7-3.

Table 7-3. StreamX and GIS Water Quality Index

Index Theme	Index Indicators		Indicator Coefficients
	Base Indicators	**Indicator Subsets**	
Water Quality	Crossing Type		Water crossings
			Crossover site
			Proximity site
	Crossing Structure	*Sediment Generation/Delivery*	Culvert crossing grade
			Bridge deck coverage
			Bridge deckholes/lipholes
			Bridge deck sediment delivery
			Bridge crossing grade
			Crossing drain discharge points
			Crossing catastrophic failure
		Culvert Fill Stability	Culvert crossing fill condition
			Culvert crossing structural condition
			Culvert crossing inlet condition
			Culvert crossing outlet condition
			Culvert crossing endwall condition
			Culvert fill vegetation/cover
			Culvert exposure
			Culvert inlet damage
			Culvert inlet/outlet configuration
			Culvert upstream skew
			Upstream beaver dam
	Roadscape	*Road Approach Sediment Generation/Delivery*	Road surface
			Road configuration
			Road surface elevation
			Road surface cohesion
			Inroad erosion
			Inroad drains
			Road surface cohesion
			Road unimproved drain location
			Road constructed drain location
			Road drainage outlet location
			Intersecting roads
			Sparse road aggregate
			Road slope
			Road edge erosion connectivity
			Roadside grading berms
			Roadside ditch ground cover
			Roadside drain outlet condition
			Roadside erosion type/number/connectivity
			Road drain-agriculture connectivity
	Waterway	*Hydrologic Connectivity*	Water resource category
			Waterway category
			Waterbody category
			Flow regime
		Sediment Generation/Delivery	Waterway alteration extent
			Streambank slope
			Floodplain type
		Sediment Deposition	Streambed smoothing extent
			Sedimentation extent

7.3.1.4 Aquatic Habitat Index

The purpose of aquatic habitat indexing is to identify crossing-induced impacts to habitat quantity and quality and the potential for restricting species movement between habitats. Special emphasis is placed on identifying watersheds where state and/or federally listed rare and imperiled fish and candidate mussel species are known to or have been known to occur. Index indicators for this analysis include perennial streams, fish passage, rare and imperiled species, hydrologic disturbance, and sedimentation (Table 7-4). The data analysis metrics are presented as the total count of crossings and count of crossings by crossing type for each CPB surveyed watershed and by the combined CPB watersheds work area. The sources of data for this analysis include the interim StreamX database, Florida Fish and Wildlife Conservation Commission Freshwater Fisheries of Florida database, and the U.S. Fish and Wildlife Service Candidate Mussels Species database.

Table 7-4. StreamX and GIS Aquatic Habitat Index

Index Theme	Index Indicator(s)	Indicator Coefficient(s)
Aquatic Habitat	*Crossing Type*	Water crossings
		Crossover site
		Proximity site
	Waterway	Flow regime
	Fish passage	Culvert hydrologic drop
	Aquatic biology	Rare and imperiled fish and mussel species*
	Hydrologic disturbance indicators and coefficients as presented in Table 7-3	
	Water quality index indicators and coefficients as presented in Table 7-4	

* Non-StreamX GIS data source

7.3.1.5 Crossing Stability Index

The crossing stability index is used to identify culvert crossings where there is a high probability that the crossing may experience severe damage or catastrophic failure during flood events. Catastrophic crossing failures can occur during annual floods or under extreme storm conditions that may accompany hurricanes and where rainfall may be measured in feet rather than inches. Deficiencies in culvert crossing design and installation can exacerbate the susceptibility of the structure to failure.

Typically, the crossing fill that stabilizes a culvert structure and provides the platform for road vehicle passage is composed of several cubic yards of soil and other materials that, if dislodged during flooding, can result in a potential 100 percent direct deposition of materials into receiving waterways. Culvert crossing issues of concern include damaged culverts, improperly sized culverts, and absence of flood relief culverts, unprotected fill surfaces, culvert misalignment, and culvert beaver plugs and/or upstream beaver dams.

The culvert crossing indicator coefficients for this analysis include crossing fill stability and beaver activity. Analysis metrics are presented as the total count of crossings and count of crossings by crossing type. The source of data for this analysis is the interim StreamX database. The CPB crossing stability index indicators and coefficients are presented in Table 7-5.

7.3.2 Nonscoring Indices

The nonscoring indices are used to define CPB geographic attributes and account for noncrossing, county-maintained road culverts (Section 4.4). The geographic index provides basin, waterbody identification (WBID), and crossings site scale location, size, soils, land use, land cover, water quality, and biology data summaries. Geographic index data was collected from public GIS sources.

The road culverts index is populated by StreamX metrics for the type and location of CPB road culverts; no road culvert condition data was recorded during field surveys. These road culvert features have particular importance to county road maintenance and aquatic resource impact potentials. As described in Section 5.4.5, some CPB wetland connectivity culverts interact directly with wetland hydrology. The road culvert index indicators and coefficients are presented in Table 7-6.

Table 7-5. StreamX Culvert Crossing Stability Index

Index Theme	Index Indicator(s)	Indicator Coefficient(s)
Culvert Crossing Stability	Crossing Type	Water crossing – culvert crossings
	Crossing Structure	Culvert inlet/outlet configuration
		Culvert structure configuration (number)
		Culvert embedment/extent
		Flood relief culverts
		Culvert fill vegetation/cover
		Crossing drain discharge point locations
		Culvert inlet-stream configuration
		Culvert crossing grade
		Culvert upstream skew
		Culvert exposure
		Culvert inlet damage
		Crossing catastrophic failure
	Waterway	Water resource category
		Waterway category
		Waterbody category
		Flow regime
		Waterway alteration location
		Stream spoil bank location
		Instream woody material location
		Channel entrenchment location
		Sedimentation location
		Streambed smoothing location
		Instream debris location
		Channel straightening
		Streambank slope
		Floodplain type
	Aquatic Biology	Beaver dam/plugs/controls

Table 7-6. StreamX Noncrossing Road Culverts Index

Index Theme	Index Indicator(s)	Indicator Coefficient(s)
Noncrossing Road Culverts	Road Culvert Type	Road cross drains
		Road flood relief culverts
		Road wetland connectivity culverts

7.4 CROSSING TREATMENT PRIORITIZATION

Using SSM scoring indexing results (Section 7.3.1), a summary prioritization system was created for the CPB water crossings, crossover sites, and proximity sites. There were 445 CPB water crossing sites with scores that ranged from a high of 760 to a low of 10; sites that scored less than 10 were excluded from the analysis (Table 7-7). The score ranking classification included *High* for scores from 760 to 441, *Medium* for scores from 440 to 286, and *Low* for scores of 285 and less. High scores signify problematic sites that need to be addressed with regard to crossing resources, hydrologic disturbance, water quality, aquatic habitat, and/or crossing stability risk potentials. The 62 CPB crossover site crossings (Section 5.3.1.11, Table 5-16, Figure 5-35) with direct or indirect water resource connectivity are considered high priority; no prioritization has been defined for the 205 crossover sites with undetermined water resource connectivity. The 11 proximity site crossings (Section 5.3.1.12, Table 5-17, Figure 5-37) with direct or indirect water resource connectivity are considered high priority; no prioritization has been defined for the 35 sites with undetermined water resource connectivity. An accounting of the CPB crossing site

prioritization is available within the *Northwest Florida Road-Stream Crossings* website (https://www.gcsaic.com/streamx2) at the *Northwest Florida Choctawhatchee-Pea Basin Road-Stream Crossings Assessment* project webpage.

In addition to the website, the *Choctawhatchee-Pea Basin Road-Stream Crossings Index* map (Appendix A) is provided to assist readers in locating crossings identified throughout this chapter. The map subdivides the basin by county, HUC, and WBID (Section 1.3) and provides the crossing site identification number, type (Section 4.2), and treatment priority score (Section 7.4). It provides a quick reference to pinpoint crossings of interest presented in the crossing prioritization (Table 7-7) and the results tables and thematic maps presented in the crossing analysis sections that follow. The index map may also be viewed or downloaded from the website *Northwest Florida Choctawhatchee-Pea Basin Road-Stream Crossings Assessment*, Resources, Map Library page.

Table 7-7. Choctawhatchee-Pea Basin High-Priority Water Crossings

Score	Crossing Identification	Crossing Type	Subbasin HUC	WBID	WBID Name	County	Index Map Grid
760	12131_587694_3373832	Culvert	03140203	741	Unnamed Run	Walton	B4
690	12133_631902_3387482			526	Pine Log Creek	Washington	E3
675	12059_616556_3427853			69	Unnamed Branch	Holmes	D1
675	12131_588597_3373858			739	Pate Branch	Walton	B4
655	12131_577085_3396991		03140102	332	Cosson Mill Creek	Walton	B3
650	12133_633961_3399573		03140203	59	Holmes Creek	Washington	E3
640	12131_588901_3373806			739	Pate Branch	Walton	B4
620	12059_632475_3418231			59	Holmes Creek	Holmes	E2
610	12133_627510_3401084			286	Open Creek	Washington	E3
607	12133_624814_3395782			348	Gully Creek	Washington	D3
605	12063_643582_3416447			130	Fish Branch	Jackson	F2
602	12059_595243_3411442			210	Otter Creek	Holmes	C2
600	12063_640949_3413184			130	Fish Branch	Jackson	E2
597	12059_624503_3405170			286	Open Creek	Holmes	D2
595	12131_578852_3375630		03140102	351a	Alaqua Creek	Walton	B4
595	12059_639280_3424444		03140203	59	Holmes Creek	Holmes	E1
595	12063_641043_3413302			130	Fish Branch	Jackson	E2
595	12133_608895_3371613			49b	Choctawhatchee River	Washington	D4
590	12133_623909_3375974			526	Pine Log Creek	Washington	D4
582	12133_644049_3389298			401	Hard Labor Creek	Washington	F3
577	12131_574146_3364860		03140102	881	Direct Runoff To Bay	Walton	B5
577	12059_625131_3429532		03140203	56	Tenmile Creek	Holmes	E1
577	12131_579859_3394231		03140102	369	Sconiers Mill Creek	Walton	B3
570	12059_630721_3406621		03140203	59	Holmes Creek	Holmes	E2
570	12059_599918_3405410			270	Goose Branch	Holmes	C2
567	12131_579533_3394149		03140102	369	Sconiers Mill Creek	Walton	B3
565	12063_642985_3417493		03140203	130	Fish Branch	Jackson	F2
562	12059_610765_3414346			49f	Choctawhatchee River	Holmes	D2
555	12059_630541_3408083			59	Holmes Creek	Holmes	E2
555	12133_633767_3384797			526	Pine Log Creek	Washington	E4
552	12059_595068_3423954		03140202	63	Hurricane Creek	Holmes	C1
552	12133_642465_3390661		03140203	455	Davis Branch	Washington	E3
550	12133_608657_3371568			49b	Choctawhatchee River	Washington	D4
550	12059_615788_3428702	Bridge		48	Whitewater Branch	Holmes	D1
550	12063_640335_3419074	Culvert		147	Gum Creek	Jackson	E1
550	12059_627943_3408659			251	Camp Branch	Holmes	E2
550	12059_625607_3427827	Bridge		56	Tenmile Creek	Holmes	E1
550	12059_637109_3424203	Culvert		59	Holmes Creek	Holmes	E1
545	12059_637934_3427072	Bridge		86	Bell Branch	Holmes	E1
542	12131_583070_3393990	Culvert		350	Bay Branch	Walton	B3
542	12063_638723_3421488			59	Holmes Creek	Jackson	E1
540	12059_610676_3428692	Bridge		49f	Choctawhatchee River	Holmes	D1
540	12133_635833_3385174	Culvert		456	Reedy Creek	Washington	E4

Table 7-7. Choctawhatchee-Pea Basin High-Priority Water Crossings Cont'd

Score	Crossing Identification	Crossing Type	Subbasin HUC	WBID	WBID Name	County	Index Map Grid
540	12059_632870_3408534	Culvert	03140203	59	Holmes Creek	Holmes	E2
535	12133_630035_3399203			59	Holmes Creek	Washington	E3
532	12059_633525_3425328			103	Corbett Branch	Holmes	E1
532	12133_646584_3388217			490	Poley Creek	Washington	F3
530	12059_623019_3408453			239	Gum Creek	Holmes	D2
530	12133_617534_3393617			348	Gully Creek	Washington	D3
530	12059_617677_3408660			240	Hathaway Mill Creek	Holmes	D2
525	12005_599121_3361813			950	Otter Creek	Bay	C5
520	12063_640517_3421167			147	Gum Creek	Jackson	E1
515	12059_637554_3421906			59	Holmes Creek	Holmes	E1
515	12059_599869_3428008		03140202	63	Hurricane Creek	Holmes	C1
515	12131_587566_3412505		03140203	178	Sandy Creek	Walton	B2
512	12133_639341_3387976			401	Hard Labor Creek	Washington	E3
510	12133_609849_3378843			651	Spring Run	Washington	D4
510	12059_593915_3415962	Bridge		146	West Pittman Creek	Holmes	C2
507	12133_646259_3388743	Culvert		490	Poley Creek	Washington	F3
507	12133_643054_3393049			346	Little Hard Labor Cr	Washington	F3
502	12133_632519_3384737			526	Pine Log Creek	Washington	E4
500	12059_606032_3421506	Bridge		119	Windmill Branch	Holmes	C1
495	12133_615819_3402419	Culvert		261	Dram Branch	Washington	D2
495	12131_585279_3388430			486	Mill Creek	Walton	B3
495	12131_598012_3391393	Bridge		404	Crooked Creek	Walton	C3
495	12059_615210_3420390	Culvert		142	Sikes Creek	Holmes	D1
490	12059_626690_3419538	Bridge		54	Wrights Creek	Holmes	E1
490	12059_626787_3415716			54	Wrights Creek	Holmes	E2
490	12063_642743_3419649	Culvert		130	Fish Branch	Jackson	F1
487	12133_604043_3366921			49b	Choctawhatchee River	Washington	C5
487	12063_645775_3413975			123	Alligator Creek	Jackson	F2
487	12133_630414_3397868			59	Holmes Creek	Washington	E3
485	12063_642926_3422175			130	Fish Branch	Jackson	F1
485	12059_634725_3419557	Bridge		139	Jackson Branch	Holmes	E1
485	12133_636843_3386378	Culvert		456	Reedy Creek	Washington	E3
485	12059_616641_3426004	Bridge		55	East Pittman Creek	Holmes	D1
482	12059_626640_3425941	Culvert		61	Texas Branch	Holmes	D1
482	12059_594768_3410680			210	Otter Creek	Holmes	C2
482	12059_624944_3426115			56	Tenmile Creek	Holmes	E1
480	12059_634528_3416459			59	Holmes Creek	Holmes	E2
480	12059_614478_3428556	Bridge		48	Whitewater Branch	Holmes	D1
480	12059_601908_3413431	Culvert		212	Reedy Creek	Holmes	C2
480	12059_605137_3402312	Bridge		212	Reedy Creek	Holmes	C3
480	12059_618673_3407170	Culvert		261	Dram Branch	Holmes	D2
480	12059_631373_3425390			54	Wrights Creek	Holmes	E1
480	12059_628994_3407640			232	Unnamed Drain	Holmes	D2
477	12059_632340_3409137			59	Holmes Creek	Holmes	E2
477	12059_638102_3424551			59	Holmes Creek	Holmes	E1
472	12059_615647_3419760			142	Sikes Creek	Holmes	D1
472	12059_627555_3404690			251	Camp Branch	Holmes	E2
472	12059_613008_3410302			54	Wrights Creek	Holmes	D2
472	12133_637868_3392298			401	Hard Labor Creek	Washington	E3
470	12059_635539_3419224	Bridge		139	Jackson Branch	Holmes	E1
470	12131_587757_3390255			343	Bruce Creek	Walton	B3
470	12059_595677_3410137			210	Otter Creek	Holmes	C2
465	12059_615200_3423100			121	Little Creek	Holmes	D1
465	12059_627493_3422139	Culvert		56	Tenmile Creek	Holmes	E1
465	12059_633958_3420481	Bridge		139	Jackson Branch	Holmes	E1
465	12131_584945_3424329	Culvert	03140202	66	Spring Branch	Walton	B1
465	12133_635580_3396336	Bridge	03140203	337	Flat Creek	Washington	E3
465	12059_605805_3428211			47	Parrot Creek	Holmes	C1
462	12131_585620_3402440	Culvert		283a	Lake Juniper Drain	Walton	B2

Table 7-7. Choctawhatchee-Pea Basin High-Priority Water Crossings Cont'd

Score	Crossing Identification	Crossing Type	Subbasin HUC	WBID	WBID Name	County	Index Map Grid
462	12133_643171_3387949	Culvert	03140203	401	Hard Labor Creek	Washington	F3
460	12059_614889_3413732			183	Catfish Branch	Holmes	D2
460	12131_585703_3428652		03140202	43	Limestone Creek	Walton	B1
460	12063_642168_3422706		03140203	130	Fish Branch	Jackson	E1
457	12133_642899_3388588			401	Hard Labor Creek	Washington	F3
457	12059_607716_3410489			49f	Choctawhatchee River	Holmes	D2
455	12133_642967_3390542			346	Little Hard Labor Creek	Washington	F3
455	12059_623492_3419197			56	Tenmile Creek	Holmes	D1
455	12059_624966_3414933	Bridge		206	Gum Branch	Holmes	D2
455	12133_629502_3398783	Culvert		59	Holmes Creek	Washington	E3
455	12133_615537_3402016			261	Dram Branch	Washington	D2
455	12133_635561_3401290	Bridge		59	Holmes Creek	Washington	E3
452	12063_640089_3420588	Culvert		147	Gum Creek	Jackson	E1
450	12063_644135_3419774			130	Fish Branch	Jackson	F1
450	12059_631093_3427099			58	Mill Branch	Holmes	E1
450	12059_606356_3422560			119	Windmill Branch	Holmes	E1
447	12133_624766_3401446			286	Open Creek	Washington	D3
447	12059_633049_3412290			59	Holmes Creek	Holmes	E2
447	12133_646316_3387889			490	Poley Creek	Washington	F3
445	12063_645738_3413309			123	Alligator Creek	Jackson	F2
445	12131_584870_3388458			486	Mill Creek	Walton	B3

HUC = Hydrologic Unit Code; WBID = waterbody identification

7.5 CROSSING ANALYSIS

In addition to treatment prioritization, this assessment also presents an opportunity to strategically clarify and define crossing issues and establish a basis for evaluating the relevance of crossing-aquatic resource interactions and potential maintenance requirements. The approach taken was to develop analysis categories and questions, drawing selective information from the Choctawhatchee-Pea Basin StreamX Database, and provide a metric and spatial summary of the results. The analysis question topics included crossing types, structure, roadscape, waterway, and environmental effects. Questions were formed based on CPB crossing issue significance outlined in the previous chapters, best professional judgment, and data utility. The *Northwest Florida Road-Stream Crossings* website (https://www.gcsaic.com/streamx2) can be used to selectively investigate the scope and significance of user-defined CPB issues, and the enclosed *Choctawhatchee-Pea Basin Road-Stream Crossings Index* map (Appendix A) provides a quick reference to located crossings of interest. CPB crossing report analysis questions and results are presented in the following subsections.

7.5.1 What types of county-maintained crossings and noncrossings are within the CPB?

The CPB is composed of crossings that intersect (bridges, culverts, and low water crossings) and occur near water resources (i.e., crossover and proximity sites), along with noncrossing culverts that assist in providing road drainage, wetland hydrologic connectivity, and flood relief. The numbers of CPB water crossings and noncrossing road culverts are presented in Tables 7-8 and 7-9. For a description of water crossings and noncrossing road culverts, see Sections 4.2.1 and 4.4.

Table 7-8. Choctawhatchee-Pea Basin Crossings

Crossing Type	Occurrence Count
Water Crossings	
Bridge	207
Culvert	240
Low-Water Crossing	0
Subtotal	***447***
Crossover Site Crossings	267
Proximity Site Crossings	46
Subtotal	*312*
Total	**760**

Table 7-9. Choctawhatchee-Pea Basin Noncrossing Road Culverts

Road Culvert Type	Occurrence Count
Road Drains	1,352
Flood Relief Culverts	305
Wetland Connectivity Culverts	99
Total	**1,756**

Of the CPB crossings identified during the study, 266 (35 percent) were crossover sites and 240 (32 percent) were culvert water crossings (Figure 7-1). Road drains accounted for 77 percent (1,352 culverts) of CPB noncrossing road culverts (Figure 7-2).

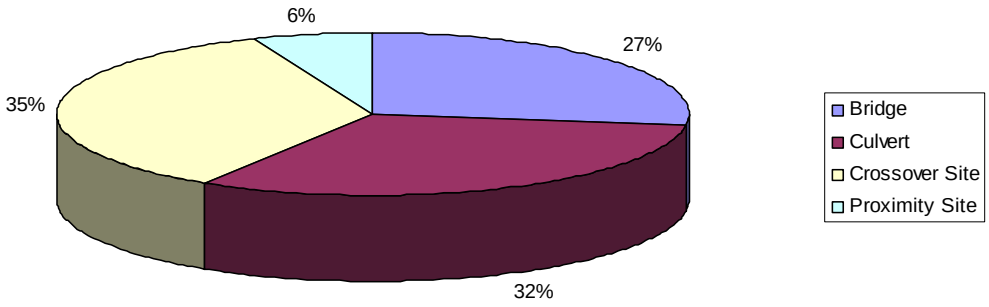


Figure 7-1. County-Maintained Unpaved Road Crossings

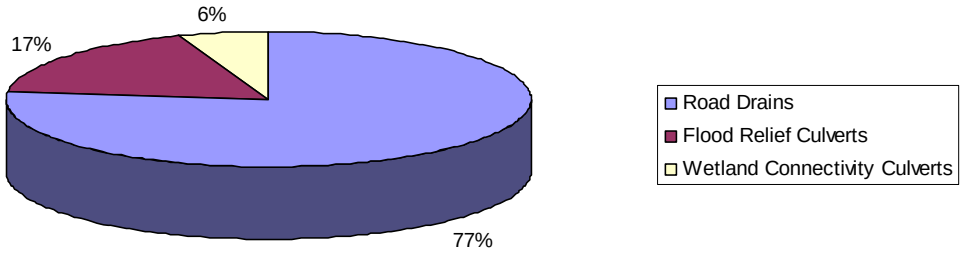


Figure 7-2. County-Maintained Unpaved Road Noncrossing Road Culverts

As shown in Table 7-10 and Figure 7-3, the CPB Holmes County area had a proportionally higher number of noncrossing road culverts than the Bay, Jackson, Walton, or Washington County areas. Based on field observations, it is estimated that Holmes County also contains the greatest density of CPB unpaved roads; typically, areas with high unpaved road densities will exhibit a greater number of road culverts compared to areas with mostly paved roads. Data fit for use was not available to analyze CPB county area road densities.

Table 7-10. Choctawhatchee-Pea Basin County Noncrossing Road Culverts

County	Road Culvert Occurrence Count			Total
	Road Drain	Flood Relief	Wetland Connectivity	
Bay	3	2	1	**6**
Holmes	732	158	45	**935**
Jackson	172	39	16	**227**
Walton	86	17	20	**123**
Washington	359	89	17	**465**
Total	**1,352**	**305**	**99**	**1,756**

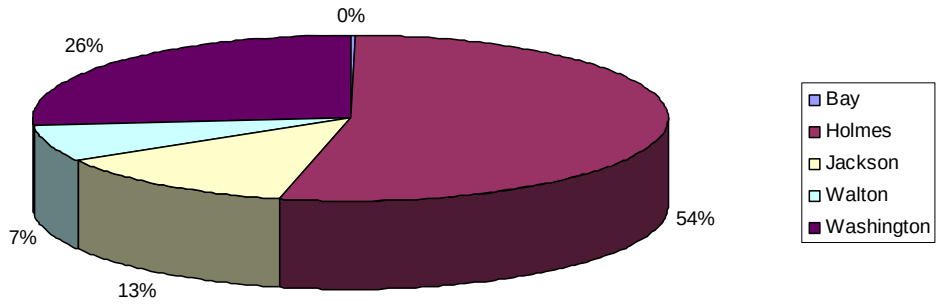


Figure 7-3. CPB County Noncrossing Road Culverts

7.5.2 What are the characteristics of CPB water resources intersected by water crossings?

Of the CPB water resource features intersected by water crossings, 73 percent (658 sites) were single channels, 4 percent (35 sites) were braided channels, and 23 percent (207 sites) were wetlands (Table 7-11 and Figure 7-4). Waterway definition was constrained to field observations in the immediate proximity to the crossing. In some cases, a water crossing might include more than one type of water resource feature. As an example, a forested swamp wetland may be present on the upstream side and a discharge stream channel may be on the downstream side of the crossing. In addition, the same water feature crossing occurrence would be counted twice (Table 7-12) if it occurs on both the upstream and downstream of the crossing.

Table 7-11. Water Resource Features

Water Feature	Crossing Occurrence
Single Channel	658
Braided Channel	35
Swamp/Slough	141
Shrub/Scrub Wetland	8
Marsh	5
Beaver Pond	47
Pond	4
Reservoir	1
Spring	1

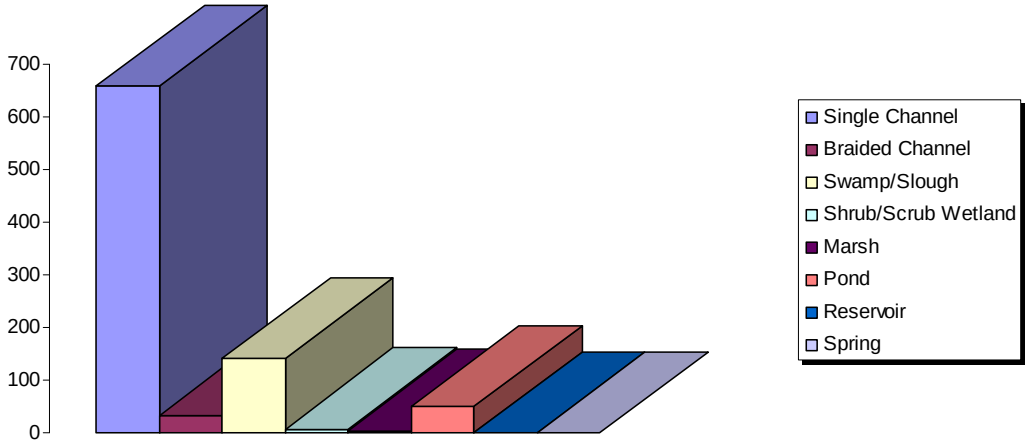


Figure 7-14. Water Resource Features

The physical configuration of 59 percent (C1, C2, S2, S3, D2, plus D3 crossing occurrences) of CPB crossing streams have been significantly altered by dredging and/or channelization (Table 7-12 and Figure 7-5). Stream feature definitions are presented in Table 7-13. The most frequently observed type of CPB crossing stream was highly altered S3 streams (30 percent), followed by S1 streams (27 percent) that exhibit more natural, unaltered physical conditions. The extensive physical alteration of streams observed at CPB crossings is linked to changes in land use and crossing cleanouts that require reconfiguration of channel shape and grades to expedite water collection and removal and sustain the drainage capacity of streams impacted by sedimentation.

Table 7-12. Stream Features

Stream Type	Crossing Occurrence
C1 canal	1
C2 canal	4
D1 wetland drain	56
D2 wetland drain	51
D3 wetland drain	15
S1 stream	110
S2 stream	46
S3 stream	125
Outlet	5

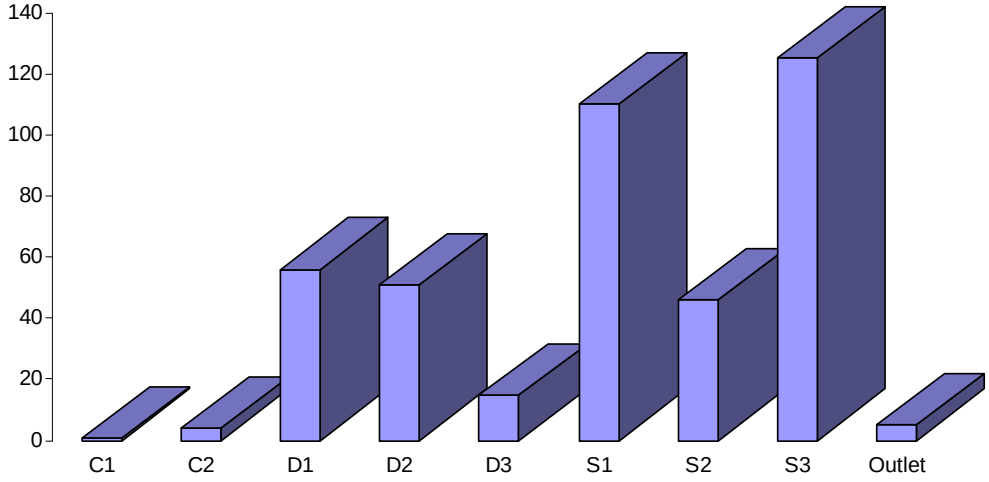


Figure 7-5. Stream Features

Table 7-13. Stream Feature Definitions

Stream Feature	Definition
Canal (C1)	A C1 canal is a minor- or moderate-capacity artificial urban or agricultural drainage channel.
Canal (C2)	A C2 canal is a major artificial urban or agricultural drainage channel.
Stream (S1)	An S1 stream is a natural surface feature with flow in a defined channel.
Stream (S2)	An S2 stream is a natural surface feature with flow in a defined channel that has undergone minor or moderate alteration by stream cleanouts, dredging, and/or channelization.
Stream (S3)	An S3 stream is a natural surface feature with flow in a defined channel that has undergone extensive alteration by stream cleanouts, dredging, and/or channelization.
Wetland drain (D1)	A D1 wetland drain is a small stream within a confined channel that typically accepts overflow from a swamp, shrub/scrub wetland, beaver impoundment, depression, or other natural water residence feature.
Wetland drain (D2)	A D2 wetland drain is a D1 drain that has been partly altered by stream crossing cleanout operations; the extent of alteration is limited to sections of the channel near the crossing.
Wetland drain (D3)	A D3 wetland drain is a D1 drain that has been severely altered by extensive dredging and/or channelization.
Outlet	An outlet is the overflow discharge stream from a constructed impoundment such as a lake or pond.

For this study, crossing streams were classified according to water surface slope, entrenchment, width/depth ratio, and sinuosity in accordance with the Level 1 Rosgen stream classification system (Rosgen, 1994). The majority of CPB crossing stream were classified as C (47 percent) and E (30 percent) stream types (Table 7-14 and Figure 7-6). The Rosgen Level 1 stream classification protocol is presented in Figure 7-7. CPB streams severely impacted by sedimentation frequently exhibit a D, DA, or E stream type configuration.

Table 7-14. Stream Rosgen Classification

Stream Class	Crossing Occurrence
A	6
B	16
C	336
D	65
DA	54
E	212
F	25
G	1
Total	**715**

The CPB also contains unique stream types that are generally defined by their water clarity. Clearwater streams are generally fed by springs and groundwater seepage through sandy soils, whereas the tannin-stained waters of blackwater streams originate in wetland areas (Sections 3.5.1.1 and 3.4.1.2). Location information for the 31 blackwater and 43 clearwater crossing streams in the CPB are listed in Tables 7-15 and 7-16 and shown in Figure 7-8.

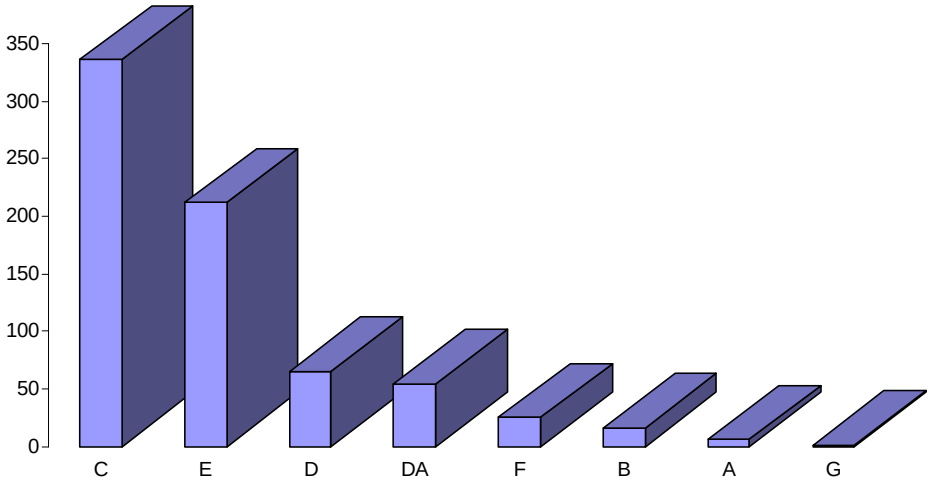


Figure 7-6. Rosgen Stream Classification

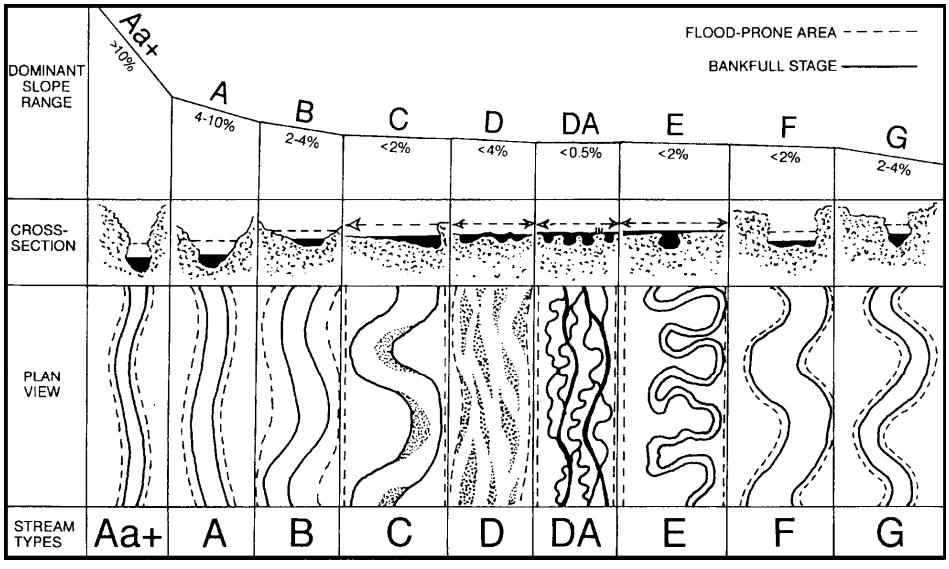


Figure 7-7. Rosgen Level 1 Stream Classification (Harrelson et al., 1994)

Table 7-15. Choctawhatchee-Pea Basin Crossings With Blackwater Streams

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12131_587566_3412505	178	Sandy Creek	Walton	B2
12131_585653_3402149	269	West Sandy Creek		
12131_585644_3400896				B3
12131_583070_3393990	350	Bay Branch		
12131_587757_3390255	343	Bruce Creek		
12131_587694_3373832	741	Unnamed run		B4
12059_601172_3408729	212	Reedy Creek	Holmes	C2
12059_602867_3405332				C3
12131_589556_3387946	343	Bruce Creek	Walton	
12005_600965_3360125	950	Otter Creek	Bay	C5
12131_596726_3358868	983	Tenmile Branch	Walton	
12059_614478_3428556	48	Whitewater Branch	Holmes	D1
12059_619790_3417892	54	Wrights Creek		D2
12059_621450_3421119	77	Little Creek	Holmes	
12133_615537_3402016	261	Dram Branch	Washington	
12133_614932_3398772	239	Gum Creek	Washington	D3
12133_612247_3396364	362	Yates Mill Creek		
12059_619565_3428353	53	Clark Mill Creek	Holmes	E1
12059_631373_3425390	54	Wrights Creek		
12133_639437_3389888	401	Hard Labor Creek	Washington	E3
12133_631902_3387482	526	Pine Log Creek		
12133_633767_3384797				E4
12063_647255_3409221	233	Unnamed creek	Jackson	F2
Pea River Subbasin, HUC 03140202				
12131_571101_3428871	40	Limestone Branch	Walton	A1
12131_574345_3425295	42	Eighteen Mile Creek		B1
12131_577263_3424973				
12131_579195_3426192				
12131_580805_3428008	43	Limestone Creek		
12131_584991_3420465	68	Chestnut Creek		
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_576836_3375767	351a	Alaqua Creek	Walton	B4
12131_578852_3375630				

Table 7-16. Choctawhatchee-Pea Basin Crossings With Clearwater Streams

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12131_585614_3404688	269	West Sandy Creek	Walton	B2
12131_587594_3390119	343	Bruce Creek		B3
12131_588901_3373806	739	Pate Branch		B4
12059_606026_3424697	94	Limestone Branch	Holmes	C1
12059_606032_3421506	119	Windmill Branch		
12059_595428_3402370	178	Sandy Creek		C2
12059_601866_3408469	212	Reedy Creek		
12131_603917_3388406	49e	Choctawhatchee River	Walton	C3
12059_605393_3398698	212	Reedy Creek	Holmes	
12131_592407_3387439	343	Bruce Creek	Walton	
12131_595137_3393850	373	White Creek		
12131_590344_3373860	747	Unnamed creek		C4
12131_590457_3373824				
12005_601942_3362462	950	Otter Creek	Bay	C5
12005_599121_3361813				
12005_599190_3361962				
12059_615206_3428824	48	Whitewater Branch	Holmes	D1
12059_622410_3421121	77	Little Creek		
12059_621827_3422702				
12059_608330_3424331	94	Limestone Branch		
12059_613887_3411040	54	Wrights Creek		D2
12059_613793_3412809				
12059_622270_3417030	77	Little Creek		
12059_618628_3415535	143	Limestone Branch		
12059_614624_3409574	240	Hathaway Mill Creek		
12059_631786_3422866	54	Wrights Creek		E1
12059_633823_3428214				
12059_631093_3427099	58	Mill Branch		
12059_630038_3423411	113	Register Branch		
12059_625263_3415772	54	Wrights Creek		E2

Table 7-16. Choctawhatchee-Pea Basin Crossings With Clearwater Streams Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12133_625875_3387015	501	Pippin Mill Creek	Washington	E3
12133_646316_3387889	490	Poley Creek		F3
12133_646584_3388217				
12133_646259_3388743				
Pea River Subbasin, HUC 03140202				
12131_569835_3427686	40	Limestone Branch	Walton	A1
12131_575631_3428399	40a	Natural Bridge Creek		B1
12131_585703_3428652	43	Limestone Creek		
12131_591261_3428489				C1
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_571853_3360706	881	Direct runoff to bay	Walton	B5
12131_573913_3362924				
12131_578634_3396546	332	Cosson Mill Creek		B3
12131_580649_3395756	340	Kiser Branch		
12131_580186_3394422	369	Sconiers Mill Creek		

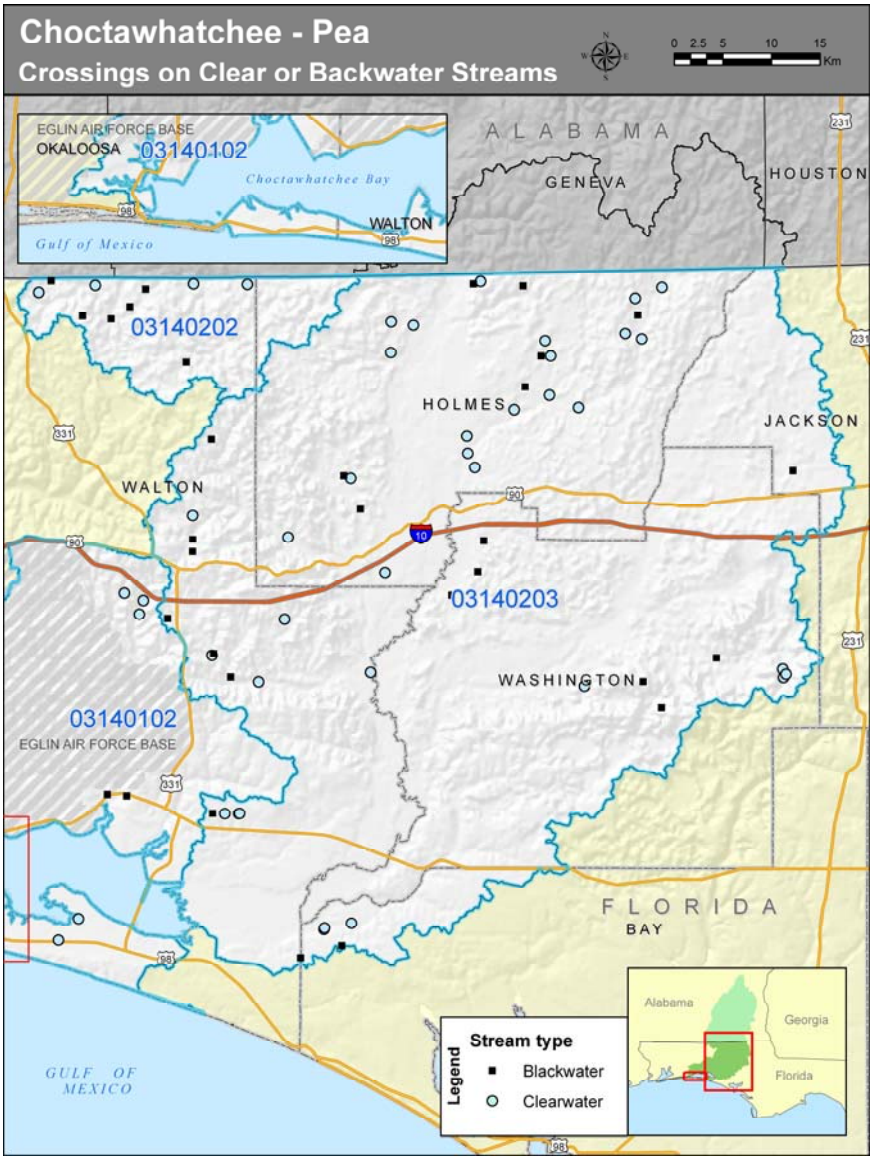


Figure 7-8. Clearwater and Blackwater Crossing Streams (David Rubino)

CPB crossing stream hydrology may also be classified by flow regime. Of the 414 documented crossing streams, 213 were perennial and 201 were intermittent. A *perennial* stream has baseflow that is primarily generated by groundwater discharge and has continuous flow during both wet and dry periods. An *intermittent* stream flows only during certain times of the years. Seasonal flows typically last longer than 30 days per year. The 409 CPB crossings with perennial and intermittent streams are listed in Table 7-17and presented in Figure 7-9.

Table 7-17. Choctawhatchee-Pea Basin Crossing Perennial and Intermittent Streams

Crossing Identification	WBID	WBID Name	County	Flow Regime	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203					
12131_570318_3428215	40	Limestone Branch	Walton	Intermittent	A1
12131_569997_3427554					
12131_571101_3428871					
12131_575631_3428399	40a	Natural Bridge Creek		Perennial	B1
12131_577263_3424973	42	Eighteen Mile Creek		Intermittent	
12131_579149_3425387				Perennial	
12131_579195_3426192				Intermittent	
12131_579103_3426422					
12131_577907_3426307					
12131_580828_3425985					
12131_580805_3428008	43	Limestone Creek		Perennial	
12131_585703_3428652					
12131_584186_3426376				Intermittent	
12131_584738_3426399					
12131_584945_3424329	66	Spring Branch			
12131_585542_3420465	68	Chestnut Creek			
12131_587566_3412505	178	Sandy Creek		Perennial	B2
12131_585614_3404688	269	West Sandy Creek			
12131_585620_3402440	283a	Lake Juniper Drain		Intermittent	
12131_585644_3400896	269	West Sandy Creek		Perennial	B3
12131_587594_3390119	343	Bruce Creek			
12131_587757_3390255					
12131_588111_3390200				Intermittent	
12131_588846_3392706					
12131_583070_3393990	350	Bay Branch		Perennial	
12131_584870_3388458	486	Mill Creek		Intermittent	
12131_585279_3388430					
12131_588597_3373858	739	Pate Branch			B4
12131_588901_3373806				Perennial	
12131_587694_3373832	741	Unnamed run			
12131_591261_3428489	43	Limestone Creek			C1
12059_601030_3428689	46	Pea River	Holmes	Intermittent	
12059_601754_3428790					
12059_604871_3428774	47	Parrot Creek		Perennial	
12059_605717_3429264					
12059_605805_3428211					
12059_603513_3425625					
12059_606026_3424697	94	Limestone Branch		Intermittent	
12059_600205_3421948	109	Fowler Branch			
12059_602721_3423728	112	Angelico Branch			
12059_603459_3420893					
12059_606032_3421506	119	Windmill Branch		Perennial	
12059_605456_3422790				Intermittent	
12059_606703_3421024	126	Dada Branch			
12059_598568_3418405	146	West Pittman Creek		Perennial	
12059_602167_3419934					
12059_601760_3419857				Intermittent	
12059_600415_3419219					
12059_606923_3411670	49f	Choctawhatchee River		Perennial	C2
12059_606111_3408200					
12059_606243_3410154					
12059_604566_3414628				Intermittent	
12059_593553_3415873	146	West Pittman Creek		Perennial	
12059_593915_3415962					
12059_597988_3414206				Intermittent	
12059_597409_3417399	164	Timber Branch			
12059_595428_3402370	178	Sandy Creek		Perennial	
12059_599926_3411751	205	Bay drain		Intermittent	
12059_600382_3411724					

Table 7-17. Choctawhatchee-Pea Basin Crossing Perennial and Intermittent Streams Cont'd

Crossing Identification	WBID	WBID Name	County	Flow Regime	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd					
12059_599642_3405100	210	Otter Creek	Holmes	Perennial	C2
12059_597857_3408906					
12059_596942_3408843					
12059_595677_3410137					
12059_594768_3410680					
12059_595243_3411442					
12059_600902_3403815					
12059_605172_3406628	212	Reedy Creek		Intermittent	
12059_601908_3413431					
12059_601866_3408469				Perennial	
12059_601172_3408729					
12059_602102_3408645				Intermittent	
12059_593982_3404088	249	Padgett Creek			
12059_599918_3405410	270	Goose Branch			
12059_592936_3404304	273	Parrish Creek			
12059_596249_3404471	289	Black Branch			
12059_596707_3404240					
12059_599227_3402110	298	Cow Branch			
12131_603548_3388701	49e	Choctawhatchee River	Walton		C3
12131_603917_3388406				Perennial	
12131_604086_3387915					
12059_605393_3398698	212	Reedy Creek	Holmes		
12059_602867_3405332					
12059_605137_3402312					
12131_589556_3387946	343	Bruce Creek	Walton		
12131_592169_3387913				Intermittent	
12131_592387_3387504					
12131_600312_3387259					
12131_592407_3387439				Perennial	
12131_594230_3388124				Intermittent	
12131_596073_3387582					
12059_601141_3398948	349	Mill Creek	Holmes	Perennial	
12131_600477_3395891	366	Oak Grove Branch	Walton	Intermittent	
12131_590198_3391114	371	Panther Creek			
12131_595137_3393850	373	White Creek		Perennial	
12131_594023_3392453	382			Intermittent	
12131_595982_3394340					
12131_596880_3388321				Perennial	
12131_601129_3390936	399	Hughes Ditch		Intermittent	
12131_601102_3391372					
12131_598012_3391393	404	Crooked Creek			
12131_597017_3391508	441	Peavy Creek			
12131_598106_3388730	457	Spears Branch			
12131_598977_3390609					
12131_590344_3373860	747	Unnamed creek		Perennial	C4
12131_590457_3373824					
12133_604043_3366921	49b	Choctawhatchee River	Washington	Intermittent	C5
12005_601942_3362462	950	Otter Creek	Bay	Perennial	
12005_600965_3360125					
12005_599121_3361813					
12005_599190_3361962					
12131_596726_3358868	983	Tenmile Branch	Walton		
12059_609588_3426163	47	Parrot Creek	Holmes	Perennial	D1
12059_608364_3427017					
12059_615788_3428702	48	Whitewater Branch		Intermittent	
12059_615206_3428824				Perennial	
12059_614478_3428556					
12059_610676_3428692	49f	Choctawhatchee River			
12059_620534_3419184	54	Wrights Creek		Intermittent	
12059_632432_3427383					
12059_615312_3424152	55	East Pittman Creek		Perennial	
12059_619077_3427196					
12059_616641_3426004					
12059_615306_3425537					
12059_620441_3428234					
12059_620977_3426932					

Table 7-17. Choctawhatchee-Pea Basin Crossing Perennial and Intermittent Streams Cont'd

Crossing Identification	WBID	WBID Name	County	Flow Regime	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd					
12059_624460_3424379	56	Tenmile Creek	Holmes	Perennial	D1
12059_624597_3429579					
12059_623492_3419197					
12059_626640_3425941	61	Texas Branch		Intermittent	
12059_615802_3425995	69	Unnamed branch		Perennial	
12059_616556_3427853				Intermittent	
12059_621827_3422702	77	Little Creek		Perennial	
12059_623336_3423834				Intermittent	
12059_622410_3421121				Perennial	
12059_622519_3419867				Intermittent	
12059_622687_3419761					
12059_608330_3424331	94	Limestone Branch		Perennial	
12059_607182_3424350				Intermittent	
12059_610508_3420337	133	Ginhouse Branch			
12059_626096_3413298	206	Gum Branch			
12059_611822_3413212	49f	Choctawhatchee River		Perennial	D2
12059_607716_3410489					
12059_612738_3415817					
12059_619790_3417892	54	Wrights Creek		Intermittent	
12059_621668_3414077					
12059_630729_3419945					
12059_624157_3414952					
12059_621864_3414904					
12059_619470_3412825					
12059_613887_3411040				Perennial	
12059_613793_3412809				Intermittent	
12059_623817_3413615					
12059_613008_3410302					
12059_627229_3420965					
12059_622725_3416486	56	Tenmile Creek		Perennial	
12059_622652_3417035					
12059_622848_3418245				Intermittent	
12059_622291_3422114	77	Little Creek			
12059_622270_3417030				Perennial	
12059_621450_3421119				Intermittent	
12059_609796_3415694	142	Sikes Creek		Perennial	
12059_618628_3415535	143	Limestone Branch			
12059_614889_3413732	183	Catfish Branch		Intermittent	
12059_624966_3414933	206	Gum Branch			
12059_628994_3407640	232	Unnamed drain			
12059_622215_3403141	239	Gum Creek		Intermittent	D2
12059_623019_3408453					
12133_620568_3404818			Washington		
12059_614624_3409574	240	Hathaway Mill Creek	Holmes	Perennial	
12059_617677_3408660				Intermittent	
12059_619270_3409939					
12133_615342_3404831	261	Dram Branch	Washington		
12133_618173_3404328					
12059_618673_3407170			Holmes		
12059_618284_3407130					
12133_615537_3402016			Washington	Perennial	
12133_615819_3402419				Intermittent	
12059_624503_3405170	286	Open Creek	Holmes		
12133_614556_3400848	49	Choctawhatchee River	Washington	Perennial	D3
12133_620956_3401344	239	Gum Creek		Intermittent	
12133_616501_3396220					
12133_620666_3399722					
12133_614932_3398772				Perennial	
12133_624766_3401446	286	Open Creek		Intermittent	
12133_624733_3401517					
12133_617534_3393617	348	Gully Creek			
12133_624814_3395782					
12133_612247_3396364	362	Yates Mill Creek			
12133_608657_3371568	49b	Choctawhatchee River		Perennial	D4
12133_608895_3371613					
12133_608963_3371801					

Table 7-17. Choctawhatchee-Pea Basin Crossing Perennial and Intermittent Streams Cont'd

Crossing Identification	WBID	WBID Name	County	Flow Regime	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd					
12133_609783_3382380	59	Holmes Creek	Washington	Perennial	D4
12133_609327_3383958					
12133_611570_3380601					
12133_611506_3380992					
12133_611506_3381437					
12133_611989_3382356					
12133_623909_3375974	526	Pine Log Creek		Intermittent	
12133_614218_3385675	545	Reedy Branch			
12133_617731_3385316	550	Williams Branch			
12133_610428_3378697	651	Spring Run		Perennial	
12133_609849_3378843				Intermittent	
12059_619565_3428353	53	Clark Mill Creek	Holmes	Perennial	E1
12059_631786_3422866	54	Wrights Creek			
12059_625115_3419525					
12059_632080_3429420				Intermittent	
12059_632634_3429053					
12059_633090_3429287					
12059_626690_3419538					
12059_636667_3429703					
12059_632405_3427941					
12059_631373_3425390				Perennial	
12059_632280_3428832				Intermittent	
12059_633265_3428625					
12059_633823_3428214				Perennial	
12059_636401_3428218				Intermittent	
12059_636345_3428232					
12059_627131_3428070	56	Tenmile Creek		Perennial	
12059_626736_3424561					
12059_627138_3424782					
12059_627468_3425739					
12059_625102_3424144					
12059_625166_3424067					
12059_628150_3424588					
12059_626549_3422359					
12059_627493_3422139	56	Tenmile Creek		Perennial	E1
12059_624944_3426115					
12059_625607_3427827					
12059_625131_3429532					
12059_624895_3419454					
12059_625048_3419399					
12059_631093_3427099	58	Mill Branch		Intermittent	
12059_631790_3427338					
12059_635966_3421964	59	Holmes Creek		Perennial	
12059_635924_3422889					
12059_639892_3429040					
12059_640656_3430055					
12059_640825_3429170					
12059_641905_3429936					
12059_642412_3429094					
12059_639577_3426066					
12059_639280_3424444					
12059_637554_3421906					
12059_638798_3423643					
12059_638692_3424359					
12059_638102_3424551					
12059_637109_3424203					
12059_637141_3425027					
12063_638723_3421488			Jackson	Intermittent	
12059_638749_3425969			Holmes	Perennial	
12059_640289_3424608					
12059_635398_3418338					
12059_635376_3420591					
12059_635621_3421345					
12059_637103_3421585					
12059_627639_3426295	61	Texas Branch		Intermittent	
12059_637934_3427072	86	Bell Branch			
12059_633525_3425328	103	Corbett Branch			

Table 7-17. Choctawhatchee-Pea Basin Crossing Perennial and Intermittent Streams Cont'd

Crossing Identification	WBID	WBID Name	County	Flow Regime	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd					
12059_629531_3424126	113	Register Branch	Holmes	Intermittent	E1
12059_630038_3423411				Perennial	
12059_606356_3422560	119	Windmill Branch		Intermittent	
12063_641318_3423413	130	Fish Branch	Jackson	Perennial	
12063_642456_3421386					
12063_642168_3422706				Intermittent	
12059_633958_3420481	139	Jackson Branch	Holmes		
12059_634725_3419557					
12059_635539_3419224					
12063_639229_3418951	147	Gum Creek	Jackson		
12063_640335_3419074					
12063_640089_3420588					
12063_640517_3421167					
12059_599786_3408536	205	Bay Drain	Holmes		
12059_601244_3399095	349	Mill Creek			
12059_626787_3415716	54	Wrights Creek			E2
12059_624250_3414951					
12059_619399_3419998					
12059_630621_3416764					
12059_631631_3417650					
12059_627159_3416907					
12059_625263_3415772				Perennial	
12059_630541_3408083	59	Holmes Creek			
12059_632340_3409137					
12059_632326_3409458					
12059_633049_3412290					
12059_633419_3413576					
12059_633917_3414927	59	Holmes Creek		Perennial	E2
12063_636081_3418138			Jackson		
12063_635313_3413275					
12059_631164_3405247			Holmes		
12059_630721_3406621					
12059_632870_3408534					
12059_633587_3408266					
12059_632035_3414226					
12059_633585_3415689					
12059_632975_3417285					
12059_632475_3418231					
12059_629231_3426838	61	Texas Branch		Intermittent	
12133_638927_3410070	123	Alligator Creek	Washington		
12063_641043_3413302	130	Fish Branch	Jackson	Perennial	
12063_640949_3413184					
12063_641200_3414909					
12063_641925_3414701					
12063_637804_3415298	147	Gum Creek		Intermittent	
12063_638716_3416059					
12063_641663_3417689					
12059_628864_3413520	206	Gum Branch	Holmes		
12059_628909_3413769		Gum Branch			
12059_628312_3407385	251	Camp Branch		Perennial	
12059_628565_3407554					
12059_627943_3408659					
12059_627555_3404690					
12059_627939_3404435					
12133_632556_3392055	59	Holmes Creek	Washington		E3
12133_630414_3397868					
12133_629502_3398783					
12133_630035_3399203					
12133_627090_3394392					
12133_627465_3394656					
12133_637101_3402004					
12133_635561_3401290					
12133_634935_3399984					
12133_635587_3399509					
12133_636388_3399583					
12133_633961_3399573					
12133_627510_3401084	286	Open Creek		Intermittent	
12133_642008_3397707	337	Flat Creek		Perennial	

Table 7-17. Choctawhatchee-Pea Basin Crossing Perennial and Intermittent Streams Cont'd

Crossing Identification	WBID	WBID Name	County	Flow Regime	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd					
12133_641030_3396310	337	Flat Creek	Washington	Intermittent	E3
12133_635580_3396336					
12133_640400_3396919					
12133_639810_3397108					
12133_638794_3396780					
12133_639341_3387976	401	Hard Labor Creek		Perennial	
12133_639437_3389888					
12133_637868_3392298				Intermittent	
12133_633249_3394653				Perennial	
12133_641691_3387683					
12133_642465_3390661	455	Davis Branch		Intermittent	
12133_635494_3387474	456	Reedy Creek		Perennial	
12133_636881_3386512					
12133_636843_3386378					
12133_625875_3387015	501	Pippin Mill Creek			
12133_631902_3387482	526	Pine Log Creek			
12133_635833_3385174	456	Reedy Creek		Perennial	E4
12133_630809_3381381	526	Pine Log Creek		Intermittent	
12133_626142_3374258					
12133_632519_3384737					
12133_633767_3384797				Perennial	
12063_646364_3422088	123	Alligator Creek	Jackson	Intermittent	F1
12063_646433_3421396					
12063_642738_3418563	130	Fish Branch		Perennial	
12063_642760_3418963					
12063_642743_3419649					
12063_643514_3419772					
12063_644135_3419774					
12063_644237_3419882					
12063_642926_3422175				Intermittent	F2
12063_645366_3413300	123	Alligator Creek			
12063_645738_3413309					
12063_645775_3413975					
12063_646733_3414135					
12133_644180_3408431			Washington		
12063_646050_3416437			Jackson		
12063_646228_3417776					
12063_643582_3416447	130	Fish Branch			
12063_642985_3417493				Perennial	
12063_647888_3417781	157	Little Alligator Creek		Intermittent	
12063_646844_3416549					
12063_648745_3414522	195	Scurlock Creek			
12063_648636_3414126					
12063_647819_3409694	233	Unnamed creek			
12063_647255_3409221				Perennial	
12063_647147_3409117				Intermittent	
12063_650607_3404144	262	Gilberts Mill Creek			
12063_649215_3408107					
12133_648715_3403157			Washington		
12133_643054_3393049	346	Little Hard Labor Creek			F3
12133_642967_3390542					
12133_642899_3388588	401	Hard Labor Creek		Perennial	
12133_647019_3392581				Intermittent	
12133_643171_3387949				Perennial	
12133_644049_3389298				Intermittent	
12133_646316_3387889	490	Poley Creek		Perennial	
12133_646584_3388217					
12133_646259_3388743					
Pea River Subbasin, HUC 03140202					
12131_573354_3425249	40	Limestone Branch	Walton	Intermittent	B1
12131_574345_3425295	42	Eighteen Mile Creek		Perennial	
12059_599869_3428008	63	Hurricane Creek	Holmes	Intermittent	C1
12059_598029_3426302				Perennial	
12059_598215_3426316				Intermittent	
12059_598541_3424859					
12059_595068_3423954					
12059_594827_3424131					
12059_596747_3427352	81	Mack Bay Branch			

Table 7-17. Choctawhatchee-Pea Basin Crossing Perennial and Intermittent Streams Cont'd

Crossing Identification	WBID	WBID Name	County	Flow Regime	Index Map Grid
Choctawhatchee Bay Subbasin, HUC 03140102					
12131_581412_3395702	369	Sconiers Mill Creek	Walton	Intermittent	B3
12131_580921_3395729					
12131_580773_3395720					
12131_577085_3396991	332	Cosson Mill Creek			
12131_576673_3397336					
12131_578634_3396546				Perennial	
12131_578062_3396628				Intermittent	
12131_580649_3395756	340	Kiser Branch		Perennial	
12131_580186_3394422	369	Sconiers Mill Creek			
12131_579859_3394231				Intermittent	
12131_579533_3394149					
12131_576836_3375767	351a	Alaqua Creek		Perennial	B4
12131_578852_3375630					
12131_571853_3360706	881	Direct runoff to bay			B5
12131_573913_3362924					
12131_574146_3364860					

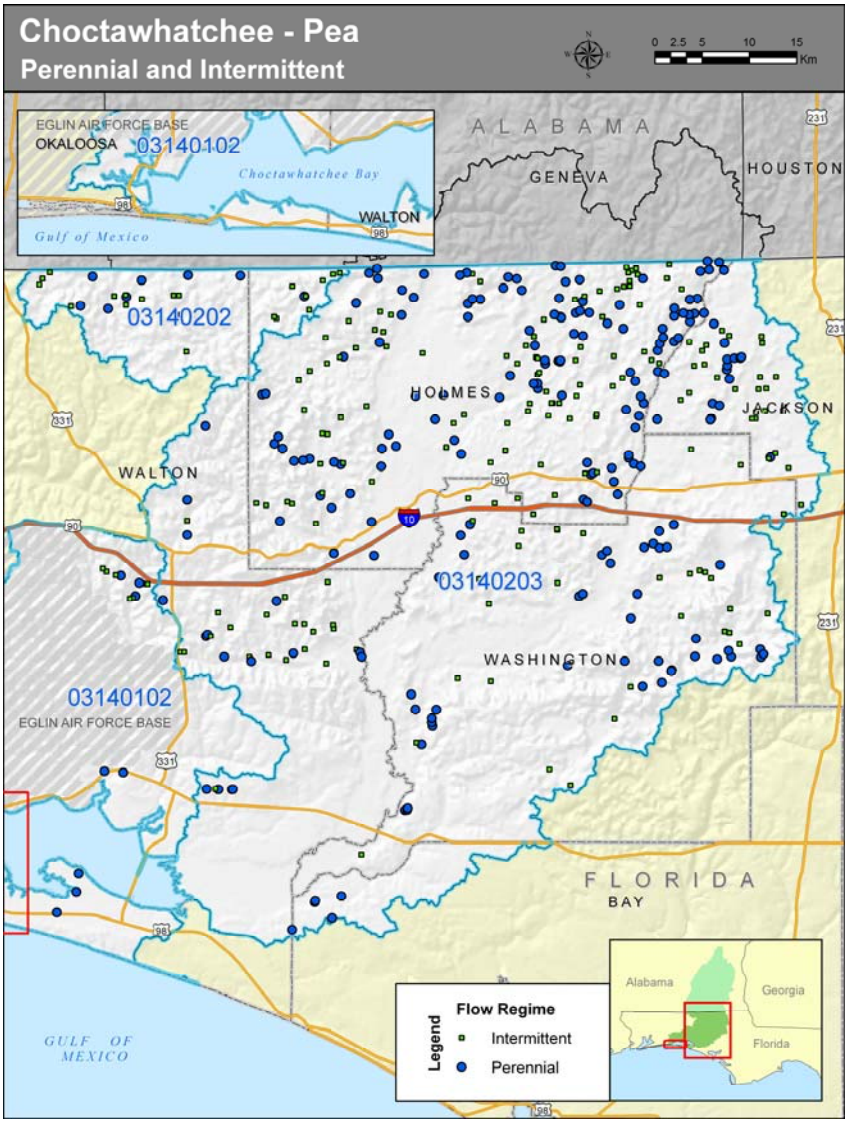


Figure 7-9. Crossing Perennial and Intermittent Streams (David Rubino)

7.5.3 What are the water crossing road approach configurations and surface types within the CPB?

As defined in Section 4.1.2, the overall objective of CPB road maintenance is to sustain a roadway that provides a safe corridor for travel while minimally impacting affected environments. Road surface type and configuration strongly influence maintenance requirements and the potential impacts of the roadway on aquatic ecosystems. CPB crossing road approach surface types and configurations are summarized in Tables 7-18 and 7-19 and Figures 7-10 and 7-11.

Table 7-18. Crossing Road Surface Type

Surface Type	Crossing Occurrence
Sand/Clay	554
Aggregate	235
Native Soil	89
Asphalt Approach	10
Sand	11
Total	**899**

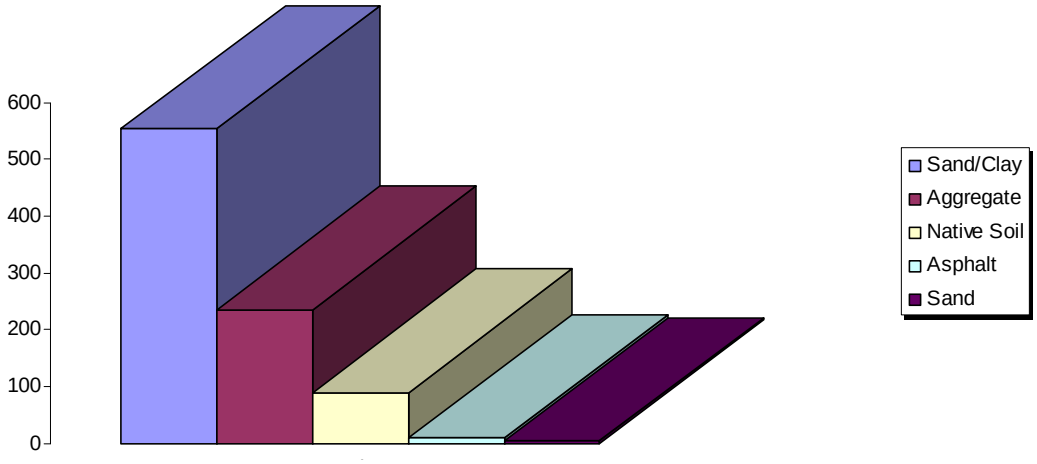


Figure 7-10. Crossing Road Approach Surface Type

Table 7-19 Crossing Road Configuration

Surface Configuration	Crossing Occurrence
Crowned	714
Flat	153
Inslope	20
Outslope	9
Inverted	3
Total	**899**

Sixty-two percent (554 occurrences) of CPB water crossing road approaches were surfaced with sand/clay material, and 26 percent (235 occurrences) were surfaced with aggregate materials. Generally, unpaved roads surfaced with aggregate are more resistant to soil erosion, compared with roads surfaced with sand/clay material. Frequently used CPB aggregate materials include gravel and crushed limestone rock. There were 10 instances where unpaved crossing road approaches were paved with asphalt.

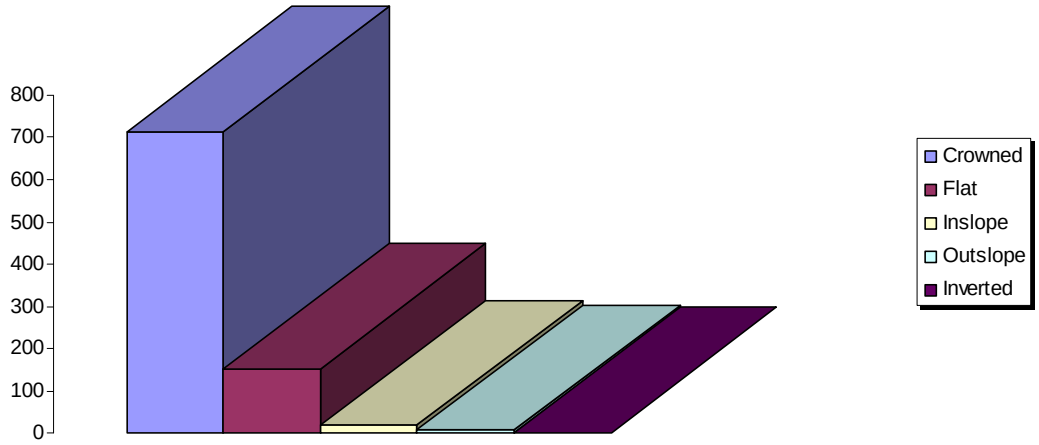


Figure 7-11. Crossing Road Approach Configuration

The majority of CPB crossing road approaches (79 percent) were observed to have a crowned surface configuration. A wide degree of variability occurred in crowned road cross slope grade, from the road centerline to the road edge. Many CPB sand/clay roads with minor 1- to 2-inch crowns and uneven road slopes prevented expedient removal of stormwater runoff, resulting in washouts and road surface deformation. In contrast, CPB unpaved sand/clay roads with exaggerated crowns greater than 3 inches create relatively high cross slope runoff velocities, which promote inroad and road edge rill erosion (Sections 5.3.1.5 and 5.3.1.6).

7.5.4 Which CPB crossing waterways have been mechanically altered?

All CPB waterways have been altered by historical changes in land use and the installation of land drainage systems to support agriculture and silviculture production, navigation, and flood control (Sections 2.3 and 3.5.8). Some changes in hydrology, such as localized ditching, had minor effects, whereas extensive stream dredging and channelization dramatically altered the form and function of CPB hydrology. Although river dredging and channelization have declined significantly, CPB crossing cleanout operations (Section 5.4.3) continue regularly. The primary reason is to remove sediments generated by the crossings. Reductions in crossing sedimentation will not only improve environmental conditions but also reduce disturbances and costs of crossing maintenance. The 394 CPB crossing waterways recently and historically altered by humans are listed in Table 7-20 and presented in Figure 7-12.

Table 7-20. Choctawhatchee-Pea Basin Crossings With Mechanically Altered Waterways

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12131_570318_3428215	40	Limestone Branch	Walton	A1
12131_569835_3427686				
12131_569997_3427554				
12131_571101_3428871				
12131_577263_3424973	42	Eighteen Mile Creek		B1
12131_579195_3426192				
12131_579103_3426422				
12131_577907_3426307				
12131_585933_3428376	43	Limestone Creek		
12131_585703_3428652				
12131_580805_3428008				
12131_584186_3426376				
12131_584738_3426399				
12131_584945_3424329	66	Spring Branch		
12131_585542_3420465	68	Chestnut Creek		
12131_585653_3402149	269	West Sandy Creek		B2
12131_585614_3404688				
12131_585620_3402440	283a	Lake Juniper Drain		
12131_587594_3390119	343	Bruce Creek		B3
12131_587757_3390255				
12131_588111_3390200				
12131_588846_3392706				
12131_583070_3393990	350	Bay Branch		
12131_584870_3388458	486	Mill Creek		
12131_585279_3388430				
12131_588901_3373806	739	Pate Branch		B4
12131_588597_3373858				
12131_587694_3373832	741	Unnamed run		
12059_602307_3426910	47	Parrot Creek	Holmes	C1
12059_603513_3425625				
12059_606105_3426458				
12059_604871_3428774				
12059_605717_3429264				
12059_605805_3428211				
12059_606026_3424697	94	Limestone Branch		
12059_600205_3421948	109	Fowler Branch		
12059_602721_3423728	112	Angelico Branch		
12059_603459_3420893				
12059_605456_3422790	119	Windmill Branch		
12059_606032_3421506				
12059_606703_3421024	126	Dada Branch		
12059_597554_3420415	136	Pine Log Creek		
12059_598885_3420183				
12059_599136_3418265	146	West Pittman Creek		
12059_598568_3418405				
12059_602167_3419934				
12059_601760_3419857				
12059_600415_3419219				

Table 7-20. Choctawhatchee-Pea Basin Crossings With Mechanically Altered Waterways Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12059_606923_3411670	49f	Choctawhatchee River	Holmes	C2
12059_606111_3408200				
12059_606243_3410154				
12059_593553_3415873	146	West Pittman Creek		
12059_593915_3415962				
12059_598113_3416255				
12059_598980_3417165				
12059_597988_3414206				
12059_597409_3417399	164	Timber Branch		
12059_600382_3411724	205	Bay Drain		
12059_599926_3411751				
12059_600902_3403815	210	Otter Creek		
12059_599642_3405100				
12059_600562_3405537				
12059_597857_3408906				
12059_596942_3408843				
12059_595677_3410137				
12059_594768_3410680				
12059_595243_3411442				
12059_602102_3408645	212	Reedy Creek		
12059_601908_3413431				
12059_605172_3406628				
12059_601866_3408469				
12059_601172_3408729				
12059_593982_3404088	249	Padgett Creek		
12059_599918_3405410	270	Goose Branch		
12059_592936_3404304	273	Parrish Creek		
12059_596249_3404471	289	Black Branch		
12059_596707_3404240				
12059_599227_3402110	298	Cow Branch		
12131_603548_3388701	49e	Choctawhatchee River	Walton	C3
12131_603917_3388406				
12131_604086_3387915				
12059_605137_3402312	212	Reedy Creek	Holmes	
12131_600312_3387259	343	Bruce Creek	Walton	
12131_592169_3387913				
12131_592387_3387504				
12131_596073_3387582				
12059_601141_3398948	349	Mill Creek	Holmes	
12131_600477_3395891	366	Oak Grove Branch	Walton	
12131_590198_3391114	371	Panther Creek		
12131_595137_3393850	373	White Creek		
12131_595982_3394340	382	White Creek		
12131_596880_3388321				
12131_601129_3390936	399	Hughes Ditch		
12131_601102_3391372				
12131_598012_3391393	404	Crooked Creek		
12131_597017_3391508	441	Peavy Creek		
12131_598106_3388730	457	Spears Branch		
12131_598977_3390609				
12131_590344_3373860	747	Unnamed creek		C4
12131_590457_3373824				
12133_604043_3366921	49b	Choctawhatchee River	Washington	C5
12005_600965_3360125	950	Otter Creek	Bay	
12005_599121_3361813				
12005_599190_3361962				
12131_596726_3358868	983	Tenmile Branch	Walton	
12059_608364_3427017	47	Parrot Creek	Holmes	D1
12059_608751_3428168				
12059_609588_3426163				
12059_615788_3428702	48	Whitewater Branch		
12059_615206_3428824				
12059_614478_3428556				
12059_610676_3428692	49f	Choctawhatchee River		
12059_632432_3427383	54	Wrights Creek		
12059_620534_3419184				

Table 7-20. Choctawhatchee-Pea Basin Crossings With Mechanically Altered Waterways Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12059_615306_3425537	55	East Pittman Creek	Holmes	D1
12059_616641_3426004				
12059_620441_3428234				
12059_615312_3424152				
12059_619077_3427196				
12059_624460_3424379	56	Tenmile Creek		
12059_623492_3419197				
12059_624597_3429579				
12059_626640_3425941	61	Texas Branch		
12059_616556_3427853	69	Unnamed branch		
12059_615802_3425995				
12059_621827_3422702	77	Little Creek		
12059_623336_3423834				
12059_622410_3421121				
12059_622519_3419867				
12059_622687_3419761				
12059_608330_3424331	94	Limestone Branch		
12059_607182_3424350				
12059_616749_3424615	108	Bee Branch		
12059_615200_3423100	121	Little Creek		
12059_610508_3420337	133	Ginhouse Branch		
12059_626096_3413298	206	Gum Branch		
12059_611822_3413212	49f	Choctawhatchee River		D2
12059_612706_3413958				
12059_607716_3410489				
12059_612738_3415817				
12059_613008_3410302	54	Wrights Creek		
12059_623817_3413615				
12059_619790_3417892				
12059_624157_3414952				
12059_621864_3414904				
12059_613793_3412809				
12059_627229_3420965				
12059_630729_3419945				
12059_621668_3414077				
12059_622725_3416486	56	Tenmile Creek		
12059_622652_3417035				
12059_622848_3418245				
12059_622291_3422114	77	Little Creek		
12059_622270_3417030				
12059_621450_3421119				
12059_609796_3415694	142	Sikes Creek		
12059_618628_3415535	143	Limestone Branch		
12059_614889_3413732	183	Catfish Branch		
12059_624966_3414933	206	Gum Branch		
12059_628994_3407640	232	Unnamed drain		
12133_620568_3404818	239	Gum Creek	Washington	
12059_622215_3403141			Holmes	
12059_623019_3408453				
12059_614624_3409574	240	Hathaway Mill Creek		
12059_617677_3408660				
12059_619270_3409939				
12133_615537_3402016	261	Dram Branch	Washington	
12133_615819_3402419				
12059_618673_3407170			Holmes	
12059_618284_3407130				
12133_615342_3404831			Washington	
12133_618173_3404328				
12059_624503_3405170	286	Open Creek	Holmes	
12133_614556_3400848	49	Choctawhatchee River	Washington	D3
12133_616501_3396220	239	Gum Creek		
12133_620956_3401344				
12133_620666_3399722				
12133_624766_3401446	286	Open Creek		
12133_624733_3401517				
12133_617534_3393617	348	Gully Creek		
12133_624814_3395782				
12133_612247_3396364	362	Yates Mill Creek		

Table 7-20. Choctawhatchee-Pea Basin Crossings With Mechanically Altered Waterways Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12133_608657_3371568	49b	Choctawhatchee River	Washington	D4
12133_608895_3371613				
12133_608963_3371801				
12133_609783_3382380	59	Holmes Creek		
12133_609327_3383958				
12133_611570_3380601				
12133_611506_3380992				
12133_611506_3381437				
12133_611989_3382356				
12133_623909_3375974	526	Pine Log Creek		
12133_617731_3385316	550	Williams Branch		
12133_610428_3378697	651	Spring Run		
12133_609849_3378843				
12059_631373_3425390	54	Wrights Creek	Holmes	E1
12059_625115_3419525				
12059_632080_3429420				
12059_632634_3429053				
12059_633090_3429287				
12059_636667_3429703				
12059_626690_3419538				
12059_632405_3427941				
12059_632280_3428832				
12059_633265_3428625				
12059_633823_3428214				
12059_636401_3428218				
12059_636345_3428232				
12059_626549_3422359	56	Tenmile Creek		
12059_626736_3424561				
12059_627138_3424782				
12059_627468_3425739				
12059_627131_3428070				
12059_625102_3424144				
12059_625166_3424067				
12059_624944_3426115				
12059_625607_3427827				
12059_625131_3429532				
12059_625048_3419399				
12059_628150_3424588				
12059_627493_3422139				
12059_631093_3427099	58	Mill Branch		
12059_635398_3418338	59	Holmes Creek		
12059_635376_3420591				
12059_635621_3421345				
12059_638692_3424359				
12059_638102_3424551				
12059_637109_3424203				
12059_637141_3425027				
12059_637320_3425437				
12059_638749_3425969				
12059_637103_3421585				
12059_635966_3421964				
12059_635924_3422889				
12059_639892_3429040				
12059_640506_3429418				
12059_640656_3430055				
12063_638723_3421488			Jackson	
12059_640825_3429170			Holmes	
12059_641905_3429936				
12059_642412_3429094				
12059_639577_3426066				
12059_639280_3424444				
12059_637554_3421906				
12059_638798_3423643				
12059_627639_3426295	61	Texas Branch		
12059_637934_3427072	86	Bell Branch		
12059_633525_3425328	103	Corbett Branch		
12059_630038_3423411	113	Register Branch		
12059_629531_3424126				

Table 7-20. Choctawhatchee-Pea Basin Crossings With Mechanically Altered Waterways Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12059_606356_3422560	119	Windmill Branch	Holmes	E1
12063_642456_3421386	130	Fish Branch	Jackson	
12063_641318_3423413				
12063_642092_3422971				
12063_642168_3422706				
12059_633958_3420481	139	Jackson Branch	Holmes	
12059_634725_3419557				
12059_635539_3419224				
12063_639229_3418951	147	Gum Creek	Jackson	
12063_640335_3419074				
12063_640089_3420588				
12063_640517_3421167				
12059_599786_3408536	205	Bay Drain	Holmes	
12059_601244_3399095	349	Mill Creek		
12059_626787_3415716	54	Wrights Creek		E2
12059_624250_3414951				
12059_619399_3419998				
12059_630621_3416764				
12059_631631_3417650				
12059_627159_3416907				
12133_634872_3410545	59	Holmes Creek	Washington	
12133_634790_3411395				
12063_636081_3418138			Jackson	
12063_635313_3413275				
12059_630541_3408083			Holmes	
12059_632340_3409137				
12059_632326_3409458				
12059_633049_3412290				
12059_633419_3413576				
12059_633917_3414927				
12059_631164_3405247				
12059_630721_3406621				
12059_632870_3408534				
12059_633585_3415689				
12059_634528_3416459				
12059_632975_3417285				
12059_632475_3418231				
12059_629231_3426838	61	Texas Branch		
12133_638927_3410070	123	Alligator Creek	Washington	
12063_641043_3413302	130	Fish Branch	Jackson	
12063_640949_3413184				
12063_640904_3414891				
12063_641200_3414909				
12063_641925_3414701				
12063_637804_3415298	147	Gum Creek		
12063_638716_3416059				
12063_641663_3417689				
12059_628864_3413520	206	Gum Branch	Holmes	
12059_628909_3413769				
12059_628312_3407385	251	Camp Branch		
12059_628565_3407554				
12059_627943_3408659				
12059_627555_3404690				
12059_627939_3404435				
12133_632556_3392055	59	Holmes Creek	Washington	E3
12133_630414_3397868				
12133_629502_3398783				
12133_630035_3399203				
12133_627090_3394392				
12133_627465_3394656				
12133_628817_3395596				
12133_637101_3402004				
12133_635561_3401290				
12133_634935_3399984				
12133_635587_3399509				
12133_636388_3399583				
12133_633961_3399573				

Table 7-20. Choctawhatchee-Pea Basin Crossings With Mechanically Altered Waterways Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12133_627510_3401084	286	Open Creek	Washington	E3
12133_635580_3396336	337	Flat Creek		
12133_642008_3397707				
12133_641030_3396310				
12133_639810_3397108				
12133_638794_3396780				
12133_637868_3392298	401	Hard Labor Creek		
12133_633249_3394653				
12133_639341_3387976				
12133_641691_3387683				
12133_642465_3390661	455	Davis Branch		
12133_636881_3386512	456	Reedy Creek		
12133_636843_3386378				
12133_625875_3387015	501	Pippin Mill Creek		
12133_631902_3387482	526	Pine Log Creek		
12133_635833_3385174	456	Reedy Creek		E4
12133_630809_3381381	526	Pine Log Creek		
12133_632519_3384737				
12133_633767_3384797				
12063_646364_3422088	123	Alligator Creek	Jackson	F1
12063_646433_3421396				
12063_642738_3418563	130	Fish Branch		
12063_642760_3418963				
12063_642743_3419649				
12063_643514_3419772				
12063_644135_3419774				
12063_644237_3419882				
12063_642926_3422175				
12063_645366_3413300	123	Alligator Creek		F2
12063_645738_3413309				
12063_645775_3413975				
12133_644180_3408431			Washington	
12063_646228_3417776			Jackson	
12063_642627_3414509	130	Fish Branch		
12063_643582_3416447				
12063_642985_3417493				
12063_646844_3416549	157	Little Alligator Creek		
12063_648636_3414126	195	Scurlock Creek		
12063_648745_3414522				
12063_647255_3409221	233	Unnamed creek		
12063_647147_3409117				
12063_650607_3404144	262	Gilberts Mill Creek		
12063_649215_3408107				
12133_648715_3403157			Washington	F3
12133_643054_3393049	346	Little Hard Labor Creek		
12133_642967_3390542				
12133_643171_3387949	401	Hard Labor Creek		
12133_644049_3389298				
12133_642899_3388588				
12133_647019_3392581				
12133_646259_3388743	490	Poley Creek		
Pea River Subbasin, HUC 03140202				
12131_574345_3425295	42	Eighteen Mile Creek	Walton	B1
12131_573354_3425249	40	Limestone Branch		
12131_591261_3428489	43	Limestone Creek		C1
12059_601030_3428689	46	Pea River	Holmes	
12059_601754_3428790				
12059_599869_3428008	63	Hurricane Creek		
12059_598029_3426302				
12059_598215_3426316				
12059_598541_3424859				
12059_595068_3423954				
12059_594827_3424131				
12059_596747_3427352	81	Mack Bay Branch		

Table 7-20. Choctawhatchee-Pea Basin Crossings With Mechanically Altered Waterways Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_577085_3396991	332	Cosson Mill Creek	Walton	B3
12131_576673_3397336				
12131_578634_3396546				
12131_578062_3396628				
12131_581412_3395702	369	Sconiers Mill Creek		
12131_580921_3395729				
12131_580773_3395720				
12131_580186_3394422				
12131_579859_3394231				
12131_579533_3394149				
12131_578852_3375630	351a	Alaqua Creek		B4
12131_571853_3360706	881	Direct runoff to bay		B5
12131_573913_3362924				
12131_574146_3364860				

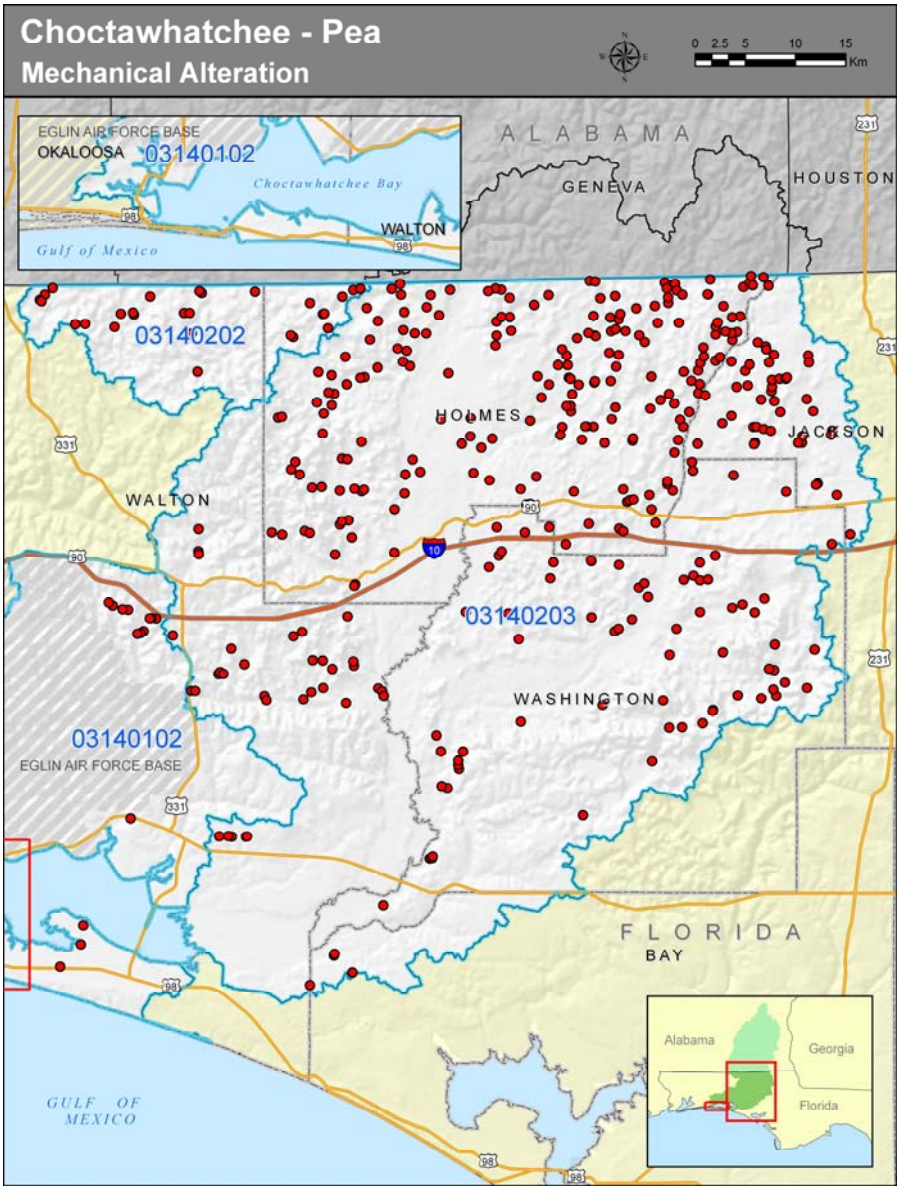


Figure 7-12. Crossings With Mechanically Altered Waterways (David Rubino)

7.5.5 Which CPB water crossings have multiple culverts?

In many cases, CPB crossings with multiple culverts occur at sites frequently subjected to major flooding events. Although the original crossing may have only had a single structure, additional culverts are often added in response to flooding damage or catastrophic failure. Replacement of culverts with a bridge structure or use of crossing stabilization techniques may be needed at sites that experience repetitive damage and/or loss during floods. CPB multiculvert crossings information is presented in Table 7-21 and Figure 7-13.

Table 7-21. Choctawhatchee-Pea Basin Multi-Culvert Crossings

Crossing Identification	WBID	WBID Name	County	Culvert Count	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203					
12131_587566_3412505	178	Sandy Creek	Walton	2	B2
12131_585614_3404688	269	West Sandy Creek			
12131_585620_3402440	283a	Lake Juniper Drain			
12131_585279_3388430	486	Mill Creek		3	B3
12131_587694_3373832	741	Unnamed run			B4
12059_602167_3419934	146	West Pittman Creek	Holmes	2	C1
12059_597988_3414206					C2
12059_596942_3408843	210	Otter Creek			
12059_605172_3406628	212	Reedy Creek			
12059_596707_3404240	289	Black Branch			
12059_599918_3405410	270	Goose Branch		3	
12131_600477_3395891	366	Oak Grove Branch	Walton	2	C3
12131_603548_3388701	49e	Choctawhatchee River		3	
12131_598977_3390609	457	Spears Branch			
12005_600965_3360125	950	Otter Creek	Bay	2	C5
12059_626640_3425941	61	Texas Branch	Holmes	3	D1
12059_622519_3419867	77	Little Creek		2	
12059_608330_3424331	94	Limestone Branch		4	
12059_616556_3427853	69	Unnamed Branch		5	
12059_607716_3410489	49f	Choctawhatchee River		2	D2
12059_623019_3408453	239	Gum Creek			
12059_617677_3408660	240	Hathaway Mill Creek			
12059_624503_3405170	286	Open Creek			
12133_618173_3404328	261	Dram Branch	Washington		
12059_613008_3410302	54	Wrights Creek	Holmes	3	
12059_614889_3413732	183	Catfish Branch			
12133_615342_3404831	261	Dram Branch	Washington		
12133_615819_3402419					
12133_614556_3400848	49	Choctawhatchee River		2	D3
12133_624814_3395782	348	Gully Creek			
12133_612247_3396364	362	Yates Mill Creek		3	
12133_616501_3396220	239	Gum Creek			
12133_620666_3399722				4	
12133_608657_3371568	49b	Choctawhatchee River		2	D4
12133_609783_3382380	59	Holmes Creek			
12133_611506_3380992					
12133_623909_3375974	526	Pine Log Creek			
12133_610428_3378697	651	Spring Run			
12133_614218_3385675	545	Reedy Branch		3	
12059_632405_3427941	54	Wrights Creek	Holmes	2	E1
12059_627138_3424782	56	Tenmile Creek			
12059_631093_3427099	58	Mill Branch			
12059_639892_3429040	59	Holmes Creek			
12059_638798_3423643					
12059_638692_3424359					
12059_633525_3425328	103	Corbett Branch			
12063_640517_3421167	147	Gum Creek	Jackson		
12059_625102_3424144	56	Tenmile Creek	Holmes	3	
12059_638102_3424551	59	Holmes Creek			
12059_619399_3419998	54	Wrights Creek		2	E2
12059_630721_3406621	59	Holmes Creek			
12059_632975_3417285					
12063_635313_3413275			Jackson		
12059_627555_3404690	251	Camp Branch	Holmes		
12063_641200_3414909	130	Fish Branch	Jackson		
12063_641043_3413302		Fish Branch			
12063_640949_3413184				3	

Table 7-21. Choctawhatchee-Pea Basin Multi-Culvert Crossings Cont'd

Crossing Identification	WBID	WBID Name	County	Culvert Count	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd					
12133_632556_3392055	59	Holmes Creek	Washington	2	E3
12133_630414_3397868					
12133_630035_3399203					
12133_628817_3395596					
12133_637101_3402004					
12133_639341_3387976	401	Hard Labor Creek			
12133_642465_3390661	455	Davis Branch			
12133_635494_3387474	456	Reedy Creek			
12133_633961_3399573	59	Holmes Creek		3	
12133_626142_3374258	526	Pine Log Creek		2	E4
12133_633767_3384797					
12133_630809_3381381					
12133_632519_3384737				4	
12063_643514_3419772	130	Fish Branch	Jackson	2	F1
12063_642760_3418963				3	
12063_644135_3419774					
12063_644237_3419882					
12063_646433_3421396	123	Alligator Creek		4	
12063_646364_3422088				5	
12063_645738_3413309				2	F2
12133_644180_3408431			Washington		
12063_645775_3413975			Jackson		
12063_643582_3416447	130	Fish Branch		3	
12063_647888_3417781	157	Little Alligator Creek			
12063_648745_3414522	195	Scurlock Creek			
12063_646844_3416549	157	Little Alligator Creek		4	
12063_648636_3414126	195	Scurlock Creek		7	
12133_644049_3389298	401	Hard Labor Creek	Washington	2	F3
12133_642899_3388588					
12133_646259_3388743	490	Poley Creek			
Pea River Subbasin, HUC 03140202					
12131_570318_3428215	40	Limestone Branch	Walton	2	A1
12131_569835_3427686					
12131_569997_3427554				3	
12131_571101_3428871					
12131_584186_3426376	43	Limestone Creek		2	B1
12131_585703_3428652					
12059_598541_3424859	63	Hurricane Creek	Holmes		C1
Choctawhatchee Bay Subbasin, HUC 03140102					
12131_576836_3375767	351a	Alaqua Creek	Walton	2	B4
12131_578852_3375630				3	B4
12131_571853_3360706	881	Direct runoff to bay		2	B5

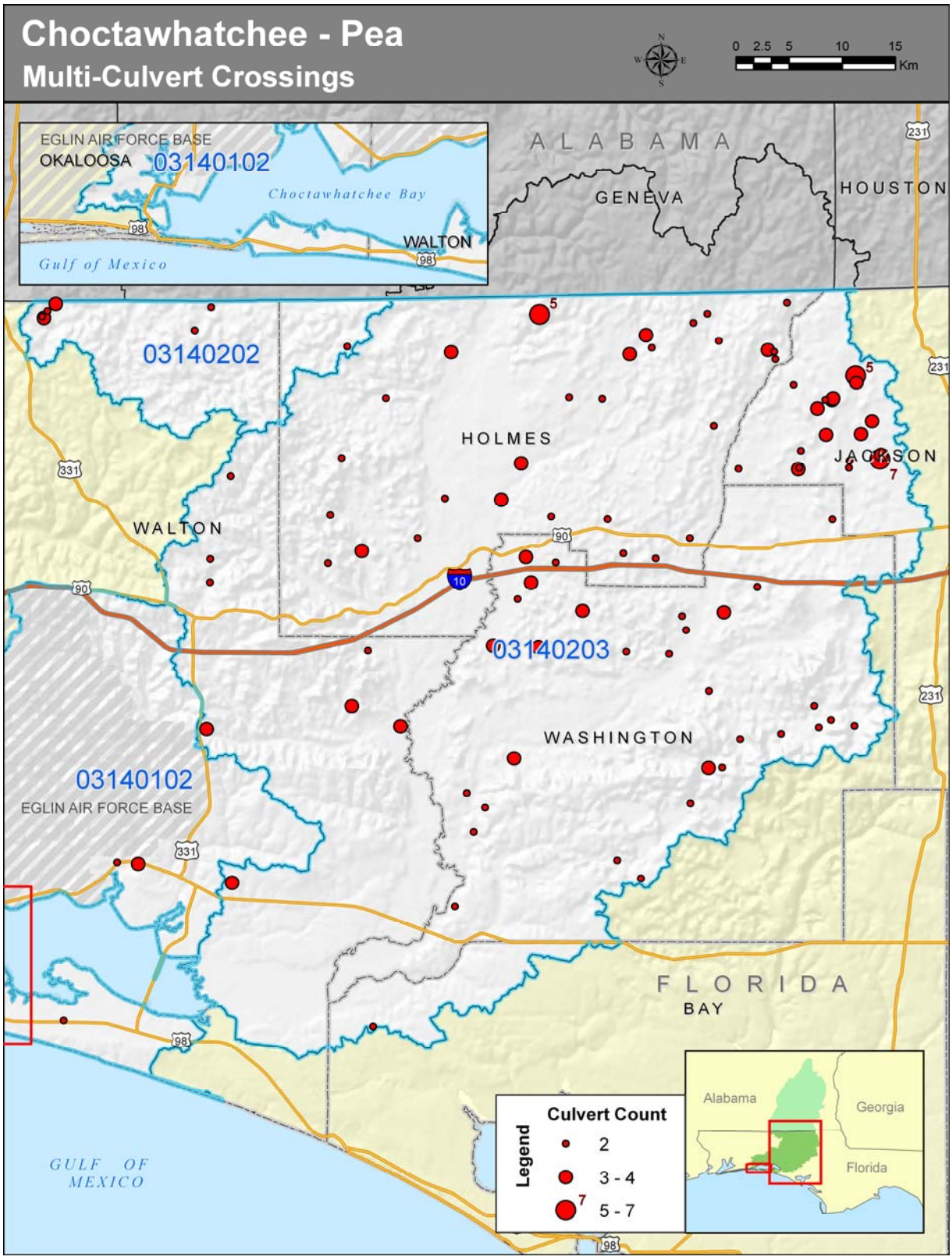


Figure 7-13. Multiculvert Crossings (David Rubino)

7.5.6 Where do county wooden bridge crossings occur in the CPB?

CPB wooden bridges typically cross smaller streams and tend to deteriorate quicker and require more maintenance than comparable steel or concrete structures. Based on conversations with local residents, the wood used in the past for bridge construction was more dense and durable than current sources of bridge timber, resulting in shortened life spans and increased maintenance of bridges. As evidenced by the 2005 wooden bridge accident in Holmes County, they also have weight limits that can restrict their use and present potential safety concerns (Figure 7-14). CPB county wooden bridges identified during StreamX field surveys are presented in Table 7-22 and Figure7-15; bridge condition data was not collected.



Figure 7-14. Holmes County Bridge Collapse Caused by an Overweight Dump Truck (Amy Loflin)

Of the 188 documented wooden bridges at CPB county crossings, 73 percent (137 crossings) occur in Holmes County.

Table 7-22. Choctawhatchee-Pea Basin County Wooden Bridge Crossings

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12131_587594_3390119	343	Bruce Creek	Walton	B3
12131_587757_3390255				
12059_602307_3426910	47	Parrot Creek	Holmes	C1
12059_604871_3428774				
12059_605717_3429264				
12059_605805_3428211				
12059_606105_3426458				
12059_606026_3424697	94	Limestone Branch		
12059_600205_3421948	109	Fowler Branch		
12059_603459_3420893	112	Angelico Branch		
12059_605456_3422790	119	Windmill Branch		
12059_606032_3421506				
12059_606703_3421024	126	Dada Branch		
12059_597554_3420415	136	Pine Log Creek		
12059_598885_3420183				
12059_599136_3418265	146	West Pittman Creek		
12059_601760_3419857				
12059_600415_3419219				
12059_606243_3410154	49f	Choctawhatchee River		C2
12059_593915_3415962	146	West Pittman Creek		
12059_598113_3416255				
12059_599137_3418171				
12059_598980_3417165				
12059_597409_3417399	164	Timber Branch		
12059_595428_3402370	178	Sandy Creek		
12059_600382_3411724	205	Bay Drain		
12059_599926_3411751				
12059_599642_3405100	210	Otter Creek		
12059_600562_3405537				
12059_600902_3403815				
12059_597857_3408906				
12059_595677_3410137				
12059_602102_3408645	212	Reedy Creek		
12059_601866_3408469				
12059_601172_3408729				
12059_593982_3404088	249	Padgett Creek		
12059_599227_3402110	298	Cow Branch		
12131_604086_3387915	49e	Choctawhatchee River	Walton	C3
12131_602720_3391759	178	Sandy Creek		
12059_605393_3398698	212	Reedy Creek	Holmes	
12059_602867_3405332				
12059_605137_3402312				
12131_592387_3387504	343	Bruce Creek	Walton	
12131_592407_3387439				
12059_601141_3398948	349	Mill Creek	Holmes	
12131_590198_3391114	371	Panther Creek	Walton	
12131_595137_3393850	373	White Creek		
12131_595982_3394340	382	White Creek		
12131_596880_3388321				
12131_598012_3391393	404	Crooked Creek		
12005_601942_3362462	950	Otter Creek	Bay	C5
12059_609588_3426163	47	Parrot Creek	Holmes	D1
12059_608364_3427017				
12059_608751_3428168				
12059_615788_3428702	48	Whitewater Branch		
12059_615206_3428824				
12059_614478_3428556				
12059_610676_3428692	49f	Choctawhatchee River		
12059_620534_3419184	54	Wrights Creek		
12059_632432_3427383				
12059_619077_3427196	55	East Pittman Creek		
12059_616641_3426004				
12059_615306_3425537				
12059_620441_3428234				
12059_620977_3426932				
12059_624460_3424379	56	Tenmile Creek		
12059_615802_3425995	69	Unnamed branch		

Table 7-22. Choctawhatchee-Pea Basin County Wooden Bridge Crossings Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12059_622410_3421121	77	Little Creek	Holmes	D1
12059_621827_3422702				
12059_623336_3423834				
12059_616749_3424615	108	Bee Branch		
12059_615200_3423100	121	Little Creek		
12059_610508_3420337	133	Ginhouse Branch		
12059_626096_3413298	206	Gum Branch		
12059_612738_3415817	49f	Choctawhatchee River		D2
12059_624157_3414952	54	Wrights Creek		
12059_627229_3420965				
12059_619790_3417892				
12059_621864_3414904				
12059_619470_3412825				
12059_630729_3419945				
12059_621668_3414077				
12059_613887_3411040				
12059_613793_3412809				
12059_623817_3413615				
12059_622652_3417035	56	Tenmile Creek		
12059_622848_3418245				
12059_621450_3421119	77	Little Creek		
12059_622291_3422114				
12059_622270_3417030				
12059_609796_3415694	142	Sikes Creek		
12059_618628_3415535	143	Limestone Branch		
12059_624966_3414933	206	Gum Branch		
12133_620568_3404818	239	Gum Creek	Washington	
12059_622215_3403141			Holmes	
12059_614624_3409574	240	Hathaway Mill Creek		
12059_619270_3409939				
12059_618284_3407130	261	Dram Branch		
12133_620956_3401344	239	Gum Creek	Washington	D3
12133_614932_3398772				
12133_611989_3382356	59	Holmes Creek		D4
12059_619565_3428353	53	Clark Mill Creek	Holmes	E1
12059_632280_3428832	54	Wrights Creek		
12059_633265_3428625				
12059_633823_3428214				
12059_636345_3428232				
12059_633090_3429287				
12059_625115_3419525				
12059_626690_3419538				
12059_636667_3429703				
12059_631786_3422866				
12059_624895_3419454	56	Tenmile Creek		
12059_626736_3424561				
12059_625166_3424067				
12059_635398_3418338	59	Holmes Creek		
12059_635376_3420591				
12059_637103_3421585				
12059_635966_3421964				
12059_640506_3429418				
12059_640656_3430055				
12059_640825_3429170				
12059_641905_3429936				
12059_642412_3429094				
12059_639577_3426066				
12059_638749_3425969				
12059_640289_3424608				
12059_637934_3427072	86	Bell Branch		
12059_630038_3423411	113	Register Branch		
12059_629531_3424126				
12063_641318_3423413	130	Fish Branch	Jackson	
12059_633958_3420481	139	Jackson Branch	Holmes	
12059_634725_3419557				
12059_635539_3419224				
12059_599786_3408536	205	Bay Drain		
12059_601244_3399095	349	Mill Creek		

Table 7-22. Choctawhatchee-Pea Basin County Wooden Bridge Crossings Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12059_626787_3415716	54	Wrights Creek	Holmes	E2
12059_627159_3416907				
12059_624250_3414951				
12059_630621_3416764				
12059_631631_3417650				
12059_632326_3409458	59	Holmes Creek		
12059_633917_3414927				
12059_633587_3408266				
12059_632035_3414226				
12059_633585_3415689				
12133_634872_3410545			Washington	
12133_634790_3411395				
12133_638927_3410070	123	Alligator Creek		
12063_641925_3414701	130	Fish Branch	Jackson	
12063_637804_3415298	147	Gum Creek		
12063_638716_3416059				
12063_641663_3417689				
12059_628864_3413520	206	Gum Branch	Holmes	
12059_628909_3413769				
12059_628312_3407385	251	Camp Branch		
12059_628565_3407554				
12059_627939_3404435				
12133_635561_3401290	59	Holmes Creek	Washington	E3
12133_635587_3399509				
12133_636388_3399583				
12133_642008_3397707	337	Flat Creek		
12133_640400_3396919				
12133_638794_3396780				
12133_635580_3396336				
12133_633249_3394653	401	Hard Labor Creek		
12133_625875_3387015	501	Pippin Mill Creek		
12063_642738_3418563	130	Fish Branch	Jackson	F1
12063_647819_3409694	233	Unnamed creek		F2
12063_647255_3409221				
12063_647147_3409117				
12063_650607_3404144	262	Gilberts Mill Creek		
12063_649215_3408107				
12133_648715_3403157			Washington	
12133_647019_3392581	401	Hard Labor Creek		F3
Pea River Subbasin, HUC 03140202				
12131_577263_3424973	42	Eighteen Mile Creek	Walton	B1
12131_579103_3426422				
12131_577907_3426307				
12131_585933_3428376	43	Limestone Creek		
12131_580805_3428008				
12131_584738_3426399				
12131_584991_3420465	68	Chestnut Creek		
12059_601754_3428790	46	Pea River	Holmes	C1
12059_598029_3426302	63	Hurricane Creek		
12059_594827_3424131				
12059_596747_3427352	81	Mack Bay Branch		
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_578634_3396546	332	Cosson Mill Creek	Walton	B3
12131_578062_3396628				
12131_580186_3394422	369	Sconiers Mill Creek		

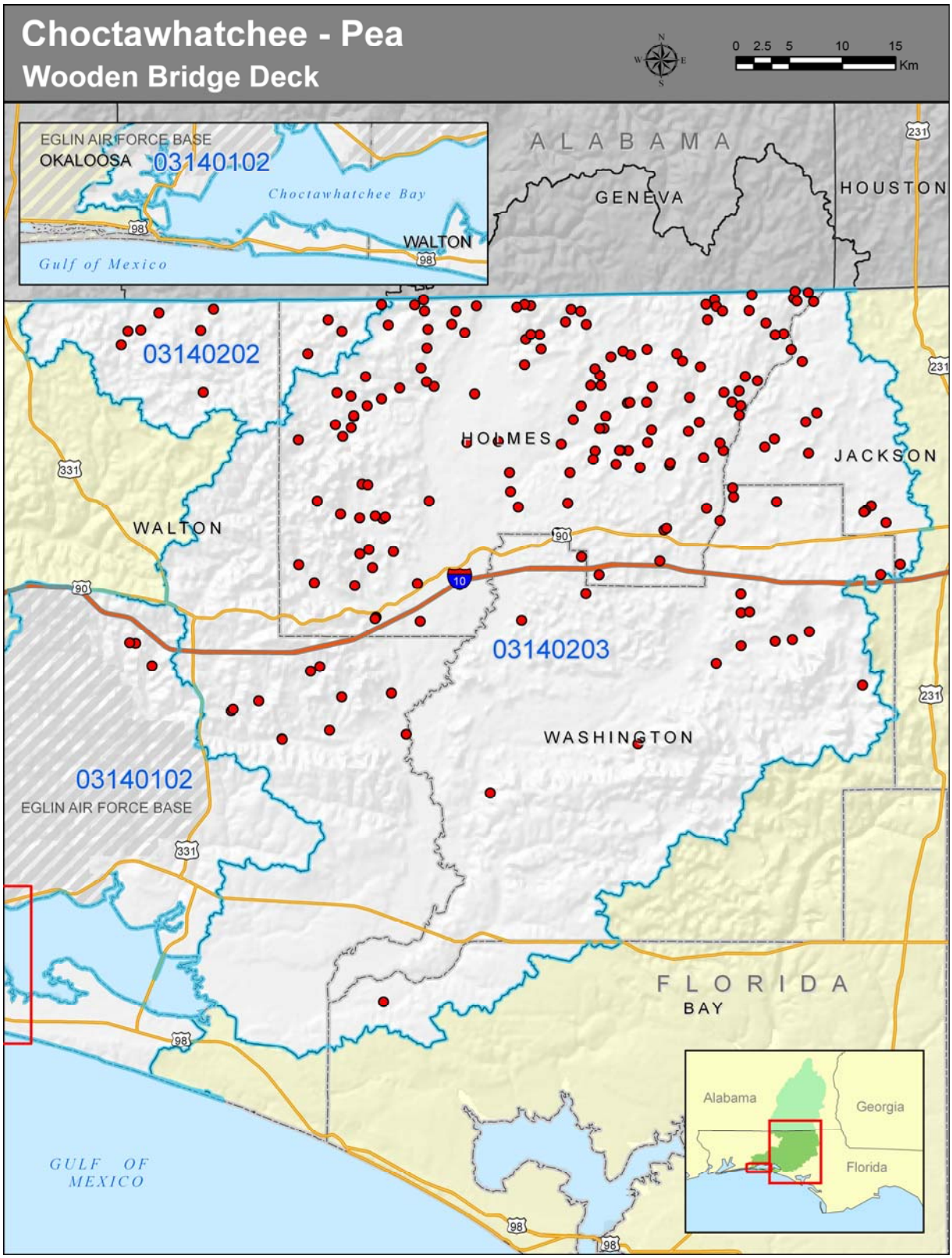


Figure 7-15. County Wooden Bridge Crossings (David Rubino)

7.5.7 Which CPB water crossings had severe to extreme levels of sedimentation?

Crossing- and land use-induced sedimentation has altered the form and function of CPB waterways, resulting in impaired water quality, degraded habitats, and diminished recreation values (Sections 5.4.1 and 6.2). The extent of crossing sedimentation ranged from minor to extreme. Ecosystem impacts were most pronounced at crossings that exhibited severe and extreme sedimentation. A *severe* rating represents crossings where sources of soil erosion are capable of contributing gross amounts of material to the waterway, along with discernible sediment-induced impacts (sediment plugs, sediment islands, streambed smoothing) that have altered the physical form of the waterway. An *extreme* rating is assigned to crossings that have suffered catastrophic, long-term sedimentation damage. Crossings with these ratings represent locations where crossing-induced sediment impacts are likely to be significant. Data was unavailable to assess sediment contributions from CPB land uses such as agriculture, silviculture, or development. The 181 CPB crossings with severe and extreme sedimentation conditions are presented in Table 7-23 and Figure 7-16.

Table 7-23. Choctawhatchee-Pea Basin Water Crossings With Extreme and Severe Sedimentation Conditions

Crossing Identification	WBID	WBID Name	County	Sedimentation Extent	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203					
12131_587566_3412505	178	Sandy Creek	Walton	Extreme	B2
12131_585614_3404688	269	West Sandy Creek		Severe	
12131_587757_3390255	343	Bruce Creek		Extreme	B3
12131_583070_3393990	350	Bay Branch			
12131_588901_3373806	739	Pate Branch			B4
12131_588597_3373858					
12131_587694_3373832	741	Unnamed run			
12059_602167_3419934	146	West Pittman Creek	Holmes	Severe	C1
12059_602307_3426910	47	Parrot Creek			
12059_606105_3426458					
12059_604871_3428774					
12059_605805_3428211					
12059_605456_3422790	119	Windmill Branch			
12059_598885_3420183	136	Pine Log Creek			
12059_597988_3414206	146	West Pittman Creek			C2
12059_593915_3415962				Extreme	
12059_596942_3408843	210	Otter Creek			
12059_600902_3403815				Severe	
12059_599642_3405100					
12059_595677_3410137					
12059_594768_3410680					
12059_595243_3411442					
12059_601866_3408469	212	Reedy Creek			
12059_601908_3413431					
12059_599918_3405410	270	Goose Branch			
12059_596707_3404240	289	Black Branch			
12059_599227_3402110	298	Cow Branch			
12059_605393_3398698	212	Reedy Creek		Extreme	C3
12059_605137_3402312				Severe	
12131_592169_3387913	343	Bruce Creek	Walton		
12131_598012_3391393	404	Crooked Creek			
12133_604043_3366921	49b	Choctawhatchee River	Washington		C5
12005_599121_3361813	950	Otter Creek	Bay		
12059_608751_3428168	47	Parrot Creek	Holmes	Extreme	D1
12059_614478_3428556	48	Whitewater Branch			
12059_615788_3428702				Severe	
12059_610676_3428692	49f	Choctawhatchee River			
12059_616641_3426004	55	East Pittman Creek		Extreme	
12059_615306_3425537				Severe	
12059_615312_3424152					
12059_619077_3427196					
12059_624597_3429579	56	Tenmile Creek			
12059_616556_3427853	69	Unnamed branch		Extreme	
12059_615802_3425995				Severe	
12059_615200_3423100	121	Little Creek			

Table 7-23. Choctawhatchee-Pea Basin Water Crossings With Extreme and Severe Sedimentation Conditions Cont'd

Crossing Identification	WBID	WBID Name	County	Sedimentation Extent	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd					
12059_616749_3424615	108	Bee Branch	Holmes	Severe	D1
12059_612738_3415817	49f	Choctawhatchee River			D2
12059_607716_3410489					
12059_630729_3419945	54	Wrights Creek		Extreme	
12059_624157_3414952				Severe	
12059_613793_3412809					
12059_623817_3413615					
12059_618628_3415535	143	Limestone Branch			
12059_614889_3413732	183	Catfish Branch			
12059_624966_3414933	206	Gum Branch			
12059_623019_3408453	239	Gum Creek			
12059_617677_3408660	240	Hathaway Mill Creek			
12059_614624_3409574					
12133_618173_3404328	261	Dram Branch	Washington		
12133_615819_3402419					
12059_624503_3405170	286	Open Creek	Holmes	Extreme	
12133_620666_3399722	239	Gum Creek	Washington	Severe	D3
12133_624766_3401446	286	Open Creek			
12133_624814_3395782	348	Gully Creek			
12133_617534_3393617					D4
12133_608657_3371568	49b	Choctawhatchee River			
12133_608895_3371613					
12133_609327_3383958	59	Holmes Creek			
12133_623909_3375974	526	Pine Log Creek			
12133_610428_3378697	651	Spring Run			
12133_609849_3378843					
12059_619565_3428353	53	Clark Mill Creek	Holmes		E1
12059_631373_3425390	54	Wrights Creek			
12059_626690_3419538					
12059_636401_3428218					
12059_624944_3426115	56	Tenmile Creek			
12059_625607_3427827					
12059_625131_3429532					
12059_627138_3424782					
12059_627468_3425739					
12059_625102_3424144					
12059_627493_3422139					
12059_627131_3428070					
12059_637554_3421906	59	Holmes Creek		Extreme	
12059_635376_3420591				Severe	
12059_635621_3421345					
12059_635924_3422889					
12059_640656_3430055					
12059_640825_3429170					
12059_642412_3429094					
12059_639280_3424444					
12063_638723_3421488			Jackson		
12059_638102_3424551			Holmes		
12059_637109_3424203					
12059_637141_3425027					
12059_638749_3425969					
12059_637934_3427072	86	Bell Branch			
12059_633525_3425328	103	Corbett Branch			
12059_630038_3423411	113	Register Branch			
12063_642168_3422706	130	Fish Branch	Jackson		
12063_642456_3421386					
12059_633958_3420481	139	Jackson Branch	Holmes	Extreme	
12059_634725_3419557				Severe	
12059_635539_3419224					
12063_640335_3419074	147	Gum Creek	Jackson		
12063_640089_3420588					
12063_640517_3421167					
12059_626787_3415716	54	Wrights Creek	Holmes	Extreme	E2
12059_625263_3415772				Severe	

Table 7-23. Choctawhatchee-Pea Basin Water Crossings With Extreme and Severe Sedimentation Conditions Cont'd

Crossing Identification	WBID	WBID Name	County	Sedimentation Extent	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd					
12059_632870_3408534	59	Holmes Creek	Holmes	Extreme	E2
12059_630541_3408083				Severe	
12059_633049_3412290					
12059_633419_3413576					
12059_633917_3414927					
12059_630721_3406621					
12059_632475_3418231					
12063_641043_3413302	130	Fish Branch	Jackson		
12063_640949_3413184					
12063_641200_3414909					
12063_641925_3414701					
12059_627555_3404690	251	Camp Branch	Holmes	Extreme	
12059_628312_3407385				Severe	
12059_628565_3407554					
12059_627943_3408659					
12059_627939_3404435					
12133_635561_3401290	59	Holmes Creek	Washington	Extreme	E3
12133_632556_3392055				Severe	
12133_630414_3397868					
12133_629502_3398783					
12133_630035_3399203					
12133_635587_3399509					
12133_633961_3399573					
12133_627510_3401084	286	Open Creek		Extreme	
12133_635580_3396336	337	Flat Creek			
12133_642008_3397707					
12133_637868_3392298	401	Hard Labor Creek			
12133_639341_3387976					
12133_641691_3387683				Severe	
12133_642465_3390661	455	Davis Branch			
12133_635494_3387474	456	Reedy Creek		Extreme	
12133_636843_3386378					
12133_636881_3386512				Severe	
12133_631902_3387482	526	Pine Log Creek		Extreme	
12133_635833_3385174	456	Reedy Creek			E4
12133_633767_3384797	526	Pine Log Creek		Severe	
12133_632519_3384737					
12063_645738_3413309	123	Alligator Creek	Jackson		F2
12063_645775_3413975					
12063_642926_3422175	130	Fish Branch			
12063_643582_3416447					
12063_642985_3417493					
12063_648636_3414126	195	Scurlock Creek		Extreme	
12133_643054_3393049	346	Little Hard Labor Creek	Washington		F3
12133_644049_3389298	401	Hard Labor Creek		Severe	
12133_643171_3387949					
12133_642899_3388588					
12133_647019_3392581					
12133_646259_3388743	490	Poley Creek			
12133_646316_3387889					
12133_646584_3388217					
Pea River Subbasin, HUC 03140202					
12131_571101_3428871	40	Limestone Branch	Walton	Severe	A1
12131_575631_3428399	40a	Natural Bridge Creek		Extreme	B1
12131_577263_3424973	42	Eighteen Mile Creek			
12131_577907_3426307				Severe	
12131_580828_3425985					
12131_585933_3428376	43	Limestone Creek		Extreme	
12131_585703_3428652				Severe	
12131_584945_3424329	66	Spring Branch			
12059_601754_3428790	46	Pea River	Holmes		C1
12059_598029_3426302	63	Hurricane Creek		Extreme	
12059_599869_3428008				Severe	
12059_595068_3423954					
12059_594827_3424131					
12059_596747_3427352	81	Mack Bay Branch			

Table 7-23. Choctawhatchee-Pea Basin Water Crossings With Extreme and Severe Sedimentation Conditions Cont'd

Crossing Identification	WBID	WBID Name	County	Sedimentation Extent	Index Map Grid
Choctawhatchee Bay Subbasin, HUC 03140102					
12131_577085_3396991	332	Cosson Mill Creek	Walton	Extreme	B3
12131_576673_3397336				Severe	
12131_578634_3396546					
12131_579859_3394231	369	Sconiers Mill Creek			
12131_579533_3394149					
12131_578852_3375630	351a	Alaqua Creek			B4
12131_574146_3364860	881	Direct Runoff To Bay			B5

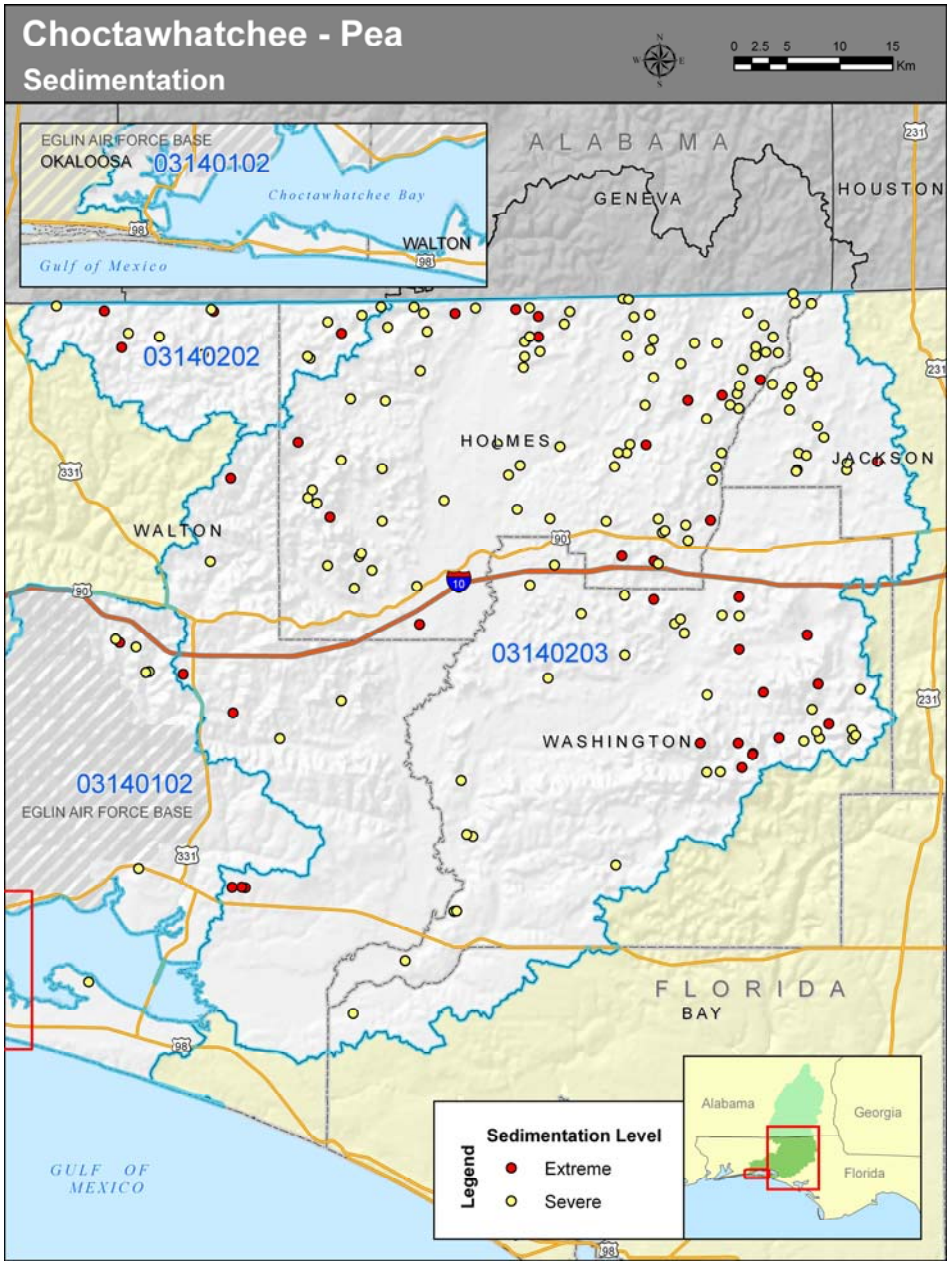


Figure 7-16. Water Crossings with Extreme and Severe Sedimentation Conditions (David Rubino)

7.5.8 Which WBIDs within the CPB are most affected by crossing-induced aquatic resource impacts?

CPB WBID aquatic resource impact indicator scores were derived by averaging the combined crossing prioritization scores for each WBID. The analysis results are presented in Table 7-24 and Figure 7-17. Of the 114 WBIDs with scored crossings, 75 had 1 to 5 crossings, 32 had 6 to 20 crossings, and 7 had greater than 20 crossings. As anticipated, the larger WBIDs had the highest number of crossings; Holmes Creek (WBID 59) had 85 crossings followed by Wrights Creek (WBID 54) with 74 crossings. WBID crossing impact indicator scores ranged from 760 to 5. WBIDs with scores of 760 to 400 are considered to be at greatest risk of cumulative crossing-induced impacts on aquatic resources. As indicator scores decrease, so do the crossings impact potentials. This analysis is valuable in that it provides a relative measure of the distribution and cumulative impact potentials of CPB crossings and a framework for watershed-based crossing treatment planning.

Table 7-24. Choctawhatchee-Pea Basin WBID Crossing-Induced Aquatic Resource Impacts

WBID	WBID Name	County	Crossing Count	WBID Impact
Lower Choctawhatchee Subbasin, HUC 03140203				
58	Mill Branch	Holmes	2	Highest
108	Bee Branch		1	
119	Windmill Branch		3	
121	Little Creek		1	
139	Jackson Branch		3	
142	Sikes Creek		7	
143	Limestone Branch		1	
269	West Sandy Creek	Walton	3	
283a	Lake Juniper Drain		1	
289	Black Branch	Holmes	2	
350	Bay Branch	Walton	1	
366	Oak Grove Branch	Walton	1	
		Holmes		
371	Panther Creek	Walton	1	
373	White Creek		1	
404	Crooked Creek		1	
441	Peavy Creek		1	
455	Davis Branch	Washington	1	
486	Mill Creek	Walton	2	
550	Williams Branch	Washington	1	
651	Spring Run		2	
739	Pate Branch	Walton	3	
741	Unnamed run		1	
950	Otter Creek	Bay	4	
47	Parrot Creek	Holmes	9	High
49b	Choctawhatchee River	Walton	8	
		Washington		
49f		Holmes	12	
53	Clark Mill Creek		1	
55	East Pittman Creek		6	
56	Tenmile Creek		24	
59	Holmes Creek	Jackson	85	
		Washington		
61	Texas Branch	Holmes	4	
94	Limestone Branch		5	
112	Angelico Branch		3	
123	Alligator Creek	Jackson	13	
		Washington		
126	Dada Branch	Holmes	1	
130	Fish Branch	Jackson	22	
147	Gum Creek		10	

Table 7-24. Choctawhatchee-Pea Basin WBID Crossing-Induced Aquatic Resource Impacts Cont'd

WBID	WBID Name	County	Crossing Count	WBID Impact
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
147	Gum Creek	Washington	10	High
183	Catfish Branch	Holmes	2	
195	Scurlock Creek	Jackson	3	
205	Bay Drain	Holmes	3	
206	Gum Branch		6	
210	Otter Creek		14	
232	Unnamed drain		2	
251	Camp Branch		6	
261	Dram Branch		11	
		Washington		
273	Parrish Creek	Holmes	1	
		Walton		
286	Open Creek	Holmes	10	
		Washington		
337	Flat Creek		10	
343	Bruce Creek	Holmes	15	
		Walton		
348	Gully Creek	Washington	5	
382	White Creek	Walton	3	
399	Hughes Ditch		2	
456	Reedy Creek	Washington	7	
457	Spears Branch	Walton	3	
545	Reedy Branch	Washington	1	
747	Unnamed creek	Walton	2	
69	Unnamed Branch	Holmes	6	Medium
86	Bell Branch		3	
103	Corbett Branch		3	
113	Register Branch		4	
146	West Pittman Creek		17	
		Walton		
164	Timber Branch	Holmes	2	
157	Little Alligator Creek	Jackson	3	
178	Sandy Creek	Walton	5	
		Holmes		
233	Unnamed creek	Jackson	3	
		Washington		
249	Padgett Creek	Holmes	2	
		Walton		
262	Gilberts Mill Creek	Jackson	4	
		Washington		
270	Goose Branch	Holmes	3	
298	Cow Branch		2	
401	Hard Labor Creek	Washington	23	
490	Poley Creek	Jackson	9	
		Washington		
501	Pippin Mill Creek		2	
48	Whitewater Branch	Holmes	11	Low
49	Choctawhatchee River		5	
		Walton		
		Washington		
49e			7	
		Walton		
54	Wrights Creek	Holmes	74	
77	Little Creek		12	
109	Fowler Branch		6	
120	Unnamed branch		3	
133	Ginhouse Branch		5	
136	Pine Log Creek		5	
150	Kelley Branch		3	

Table 7-24. Choctawhatchee-Pea Basin WBID Crossing-Induced Aquatic Resource Impacts Cont'd

WBID	WBID Name	County	Crossing Count	WBID Impact
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
163	Bay Branch	Holmes	2	Low
212	Reedy Creek	Holmes	21	
		Walton		
227a	Hood Lake Drain	Holmes	3	
235	Pine Barn Creek	Jackson	1	
239	Gum Creek	Washington	31	
		Holmes		
240	Hathaway Mill Creek	Holmes	14	
346	Little Hard Labor Creek	Washington	10	
349	Mill Creek	Holmes	4	
		Walton		
362	Yates Mill Creek	Washington	7	
414	Folks Creek	Walton	2	
450	Shaky Joe Branch	Washington	3	
526	Pine Log Creek	Washington	19	
		Bay		
549	Fanning Branch	Washington	1	
869	East River	Bay	1	
		Washington		
		Walton		
983	Tenmile Branch	Walton	7	
		Bay		
Pea River Subbasin, HUC 03140202				
40a	Natural Bridge Creek	Walton	1	Highest
46	Pea River	Holmes	2	
63	Hurricane Creek	Holmes	7	
66	Spring Branch	Walton	1	
40	Limestone Branch	Walton	5	High
42	Eighteen Mile Creek	Walton	9	
43	Limestone Creek	Walton	7	
		Holmes		
68	Chestnut Creek	Walton	2	
		Holmes		
81	Mack Bay Branch	Holmes	2	Medium
Choctawhatchee Bay Subbasin, HUC 03140102				
351a	Alaqua Creek	Walton	2	Highest
369	Sconiers Mill Creek	Walton	6	
332	Cosson Mill Creek	Walton	6	High
340	Kiser Branch	Walton	1	
881	Direct Runoff To Bay	Walton	3	
731	Alaqua Bayou	Walton	2	Medium
436	Blount Creek	Walton	4	Low

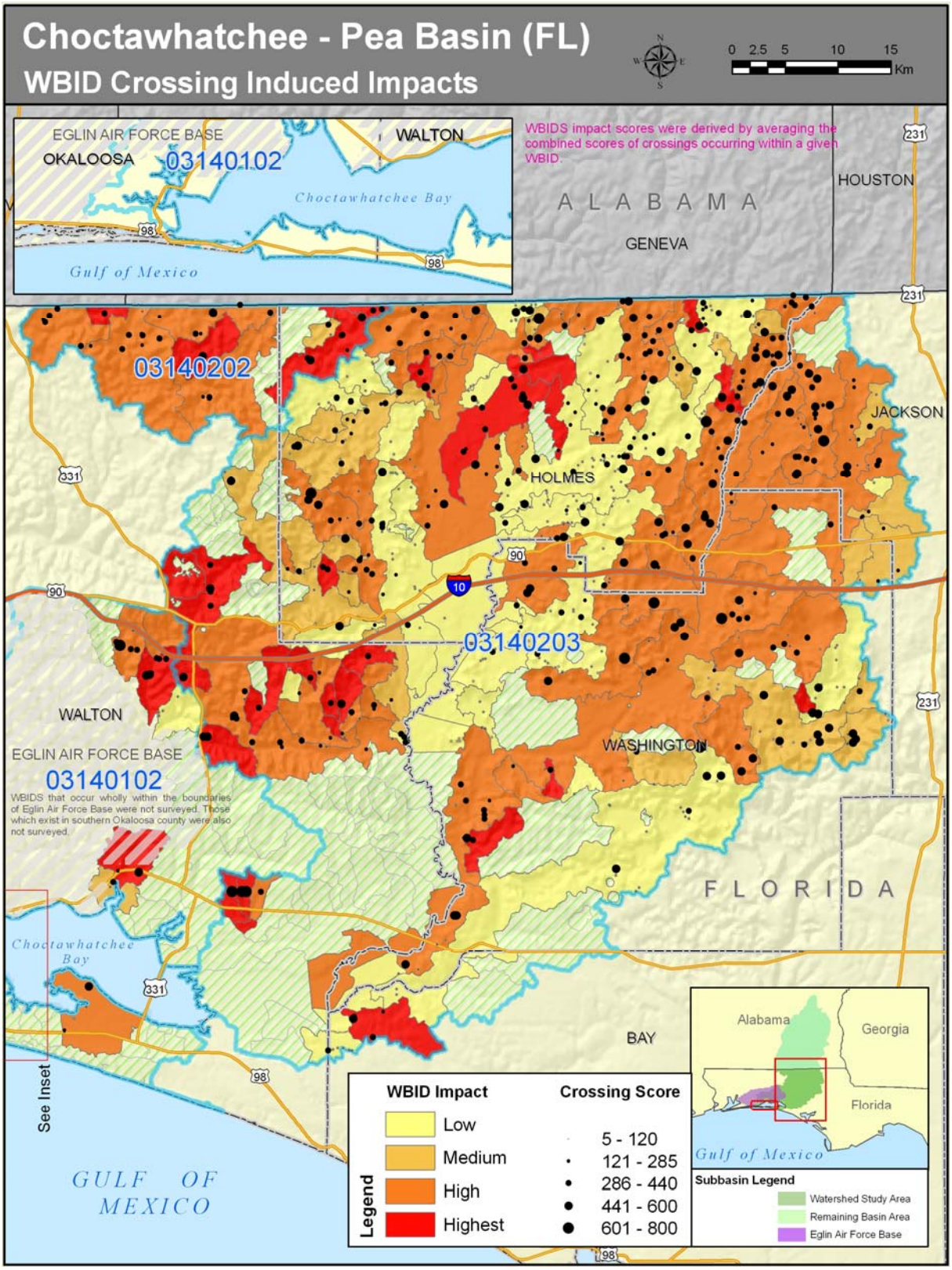


Figure 7-17. WBID-Based Aquatic Resource Impact Potentials (David Rubino)

7.5.9 Which crossings occur in watersheds with known occurrences of rare and imperiled aquatic species and which ones are potential fish barriers?

Crossing-induced sedimentation and culvert crossings that alter species access to habitats are potential threats to rare and imperiled aquatic species (Section 3.9) and overall environmental diversity, function, and sustainability. The introduction of sediments reduces the quantity and quality of aquatic habitats, and improperly sized and/or aligned crossing culverts can block or restrict the movement of species between upstream and downstream habitats. As discussed in Section 5.2.2, culvert crossings with downstream outlet outfalls can inhibit or exclude the movement of fish and other aquatic species between habitats. The 191 CPB crossings within WBIDs with known occurrences of rare and imperiled fish and mussel species and 20 culvert crossings in WBIDs with both rare and imperiled aquatic species that are potential fish barriers are presented in Table 7-25 and Figure 7-18.

Table 7-25. Choctawhatchee-Pea Basin Water Crossings WBIDs With Rare and Imperiled Aquatic Species

Crossing Identification	WBID	WBID Name	County	Potential Fish Barrier	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203					
12131_587566_3412505	178	Sandy Creek	Walton	No	B2
12131_587594_3390119	343	Bruce Creek			B3
12131_587757_3390255					
12131_588111_3390200					
12131_588846_3392706					
12059_606923_3411670	49f	Choctawhatchee River	Holmes	Yes	C2
12059_606111_3408200					
12059_606243_3410154				No	
12059_604984_3413972					
12059_604566_3414628					
12131_603548_3388701	49e		Walton	Yes	C3
12131_603917_3388406				No	
12131_604086_3387915					
12131_602720_3391759	178	Sandy Creek			
12131_589556_3387946	343	Bruce Creek			
12131_592169_3387913					
12131_592387_3387504					
12131_592407_3387439					
12131_594230_3388124					
12131_596073_3387582					
12131_600312_3387259					
12133_604043_3366921	49b	Choctawhatchee River	Washington		C5
12059_610676_3428692			Holmes		D1
12059_620534_3419184	54	Wrights Creek			
12059_616641_3426004	55	East Pittman Creek			
12059_615312_3424152					
12059_619077_3427196					
12059_615306_3425537					
12059_620441_3428234					
12059_620977_3426932					
12059_624460_3424379	56	Tenmile Creek			
12059_623492_3419197					
12059_624597_3429579				Yes	
12059_622519_3419867	77	Little Creek			
12059_607716_3410489	49f	Choctawhatchee River		No	D2
12059_611822_3413212					
12059_612706_3413958					
12059_612738_3415817					
12059_610765_3414346					
12059_621668_3414077	54	Wrights Creek			
12059_613887_3411040					
12059_613793_3412809					
12059_621864_3414904					
12059_619470_3412825					
12059_624157_3414952					
12059_613008_3410302					
12059_623817_3413615					
12059_622725_3416486	56	Tenmile Creek			
12059_622652_3417035					
12059_622848_3418245					

Table 7-25. Choctawhatchee-Pea Basin Water Crossings WBIDs With Rare and Imperiled Aquatic Species Cont'd

Crossing Identification	WBID	WBID Name	County	Potential Fish Barrier	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd					
12059_621450_3421119	77	Little Creek	Holmes	No	D2
12059_622291_3422114					
12059_622270_3417030					
12059_614889_3413732	183	Catfish Branch			
12059_624966_3414933	206	Gum Branch			
12059_617677_3408660	240	Hathaway Mill Creek			
12059_614624_3409574					
12133_614556_3400848	49	Choctawhatchee River	Washington	Yes	D3
12133_608657_3371568	49b			No	D4
12133_608895_3371613					
12133_608963_3371801					
12133_611570_3380601	59	Holmes Creek		Yes	
12133_609783_3382380				No	
12133_609327_3383958					
12133_611506_3380992					
12133_611506_3381437					
12133_611989_3382356					
12133_623909_3375974	526	Pine Log Creek			
12059_632280_3428832	54	Wrights Creek	Holmes		E1
12059_633265_3428625					
12059_633823_3428214					
12059_632405_3427941					
12059_636401_3428218					
12059_636345_3428232					
12059_625115_3419525					
12059_626690_3419538					
12059_636667_3429703					
12059_632634_3429053					
12059_633090_3429287					
12059_625048_3419399	56	Tenmile Creek		Yes	
12059_627138_3424782					
12059_624944_3426115				No	
12059_625607_3427827					
12059_625131_3429532					
12059_624895_3419454					
12059_626549_3422359					
12059_626736_3424561					
12059_627468_3425739					
12059_625102_3424144					
12059_625166_3424067					
12059_628150_3424588					
12059_627493_3422139					
12059_627131_3428070					
12059_631790_3427338	58	Mill Branch			
12059_635621_3421345	59	Holmes Creek		Yes	
12059_635398_3418338					
12059_635966_3421964					
12059_635924_3422889					
12059_639892_3429040					
12059_640506_3429418					
12059_640656_3430055					
12059_640825_3429170					
12059_641905_3429936					
12059_642412_3429094					
12059_639577_3426066				No	
12059_639280_3424444					
12059_637554_3421906					
12059_638798_3423643					
12059_638692_3424359					
12059_638102_3424551					
12059_637109_3424203					
12059_637141_3425027					
12059_637320_3425437					
12059_638749_3425969					
12059_640289_3424608					
12059_637103_3421585					

Table 7-25. Choctawhatchee-Pea Basin Water Crossings WBIDs With Rare and Imperiled Aquatic Species Cont'd

Crossing Identification	WBID	WBID Name	County	Potential Fish Barrier	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd					
12063_638723_3421488			Jackson	No	E1
12059_637934_3427072	86	Bell Branch	Holmes		
12059_633525_3425328	103	Corbett Branch			
12059_629531_3424126	113	Register Branch			
12059_606356_3422560	119	Windmill Branch		Yes	
12059_633958_3420481	139	Jackson Branch		No	
12059_599786_3408536	205	Bay Drain			
12059_619399_3419998	54	Wrights Creek		Yes	E2
12059_631631_3417650				No	
12059_626787_3415716					
12059_627159_3416907					
12059_625263_3415772					
12133_634872_3410545	59	Holmes Creek	Washington		
12133_634790_3411395					
12059_630541_3408083			Holmes		
12059_632340_3409137					
12059_632326_3409458					
12059_633049_3412290					
12059_633419_3413576					
12059_633917_3414927					
12059_631164_3405247					
12059_630721_3406621					
12059_632870_3408534					
12059_633587_3408266					
12059_632035_3414226					
12059_633585_3415689					
12059_634528_3416459					
12059_632975_3417285					
12059_632475_3418231					
12063_636081_3418138			Jackson		
12063_635313_3413275					
12059_629231_3426838	61	Texas Branch	Holmes		
12133_638927_3410070	123	Alligator Creek	Washington		
12133_637101_3402004	59	Holmes Creek		Yes	E3
12133_627465_3394656				No	
12133_629502_3398783					
12133_632556_3392055					
12133_630414_3397868					
12133_630035_3399203					
12133_627090_3394392					
12133_628817_3395596					
12133_635561_3401290					
12133_634935_3399984					
12133_635587_3399509					
12133_636388_3399583					
12133_633961_3399573					
12133_631902_3387482	526	Pine Log Creek			E4
12133_633767_3384797					
12133_630809_3381381					
12133_626142_3374258				Yes	
12133_632519_3384737				No	
12063_646364_3422088	123	Alligator Creek	Jackson	Yes	F1
12063_646433_3421396				No	
12133_644180_3408431			Washington	Yes	F2
12063_645738_3413309			Jackson	No	
12063_645775_3413975					
12063_646733_3414135					
12063_646050_3416437					
12063_646228_3417776					
12063_645366_3413300					
Pea River Subbasin, HUC 03140202					
12131_579149_3425387	42	Eighteen Mile Creek	Walton	Yes	B1
12131_574343_3425295				No	
12131_574345_3425295					
12131_577263_3424973					
12131_579195_3426192					

Table 7-25. Choctawhatchee-Pea Basin Water Crossings WBIDs With Rare and Imperiled Aquatic Species Cont'd

Crossing Identification	WBID	WBID Name	County	Potential Fish Barrier	Index Map Grid
Pea River Subbasin, HUC 03140202 Cont'd					
12131_579103_3426422	42	Eighteen Mile Creek	Walton	No	B1
12131_577907_3426307					
12131_580828_3425985					
12131_584186_3426376	43	Limestone Creek		Yes	
12131_580805_3428008				No	
12131_584738_3426399					
12131_585933_3428376					
12131_585703_3428652					
12131_588448_3429221					
12131_591261_3428489					C1

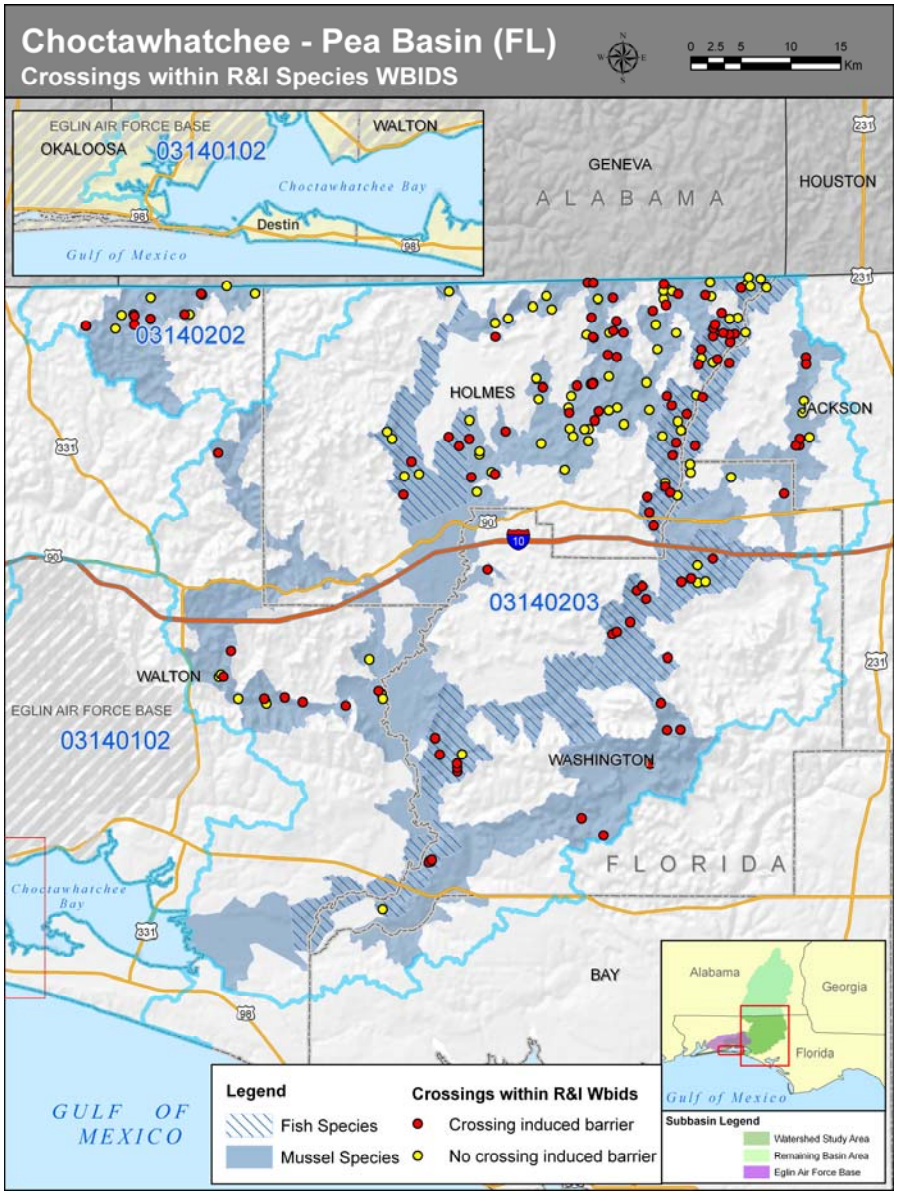


Figure 7-18. Water Crossings in WBIDs With Rare and Imperiled Aquatic Species (David Rubino)

7.5.10 Which culvert crossings have a high potential for crossing failure?

Culvert crossing failure caused by flooding is expensive both in terms of financial loss and aquatic impacts. Catastrophic failure can result in the complete loss of the structure and significant sedimentation as fill materials are deposited directly into waterways. An analysis of culvert crossing failure potentials was conducted based on the crossing stability index described in Section 7.3.1.5. At-risk culvert crossings are presented in Table 7-26 and Figure 7-19. Treatment issues to be addressed on a crossing-by-crossing basis could include culvert condition, configuration, alignment, and flow capacity; crossing fill stability; and upstream beaver activity.

Table 7-26. Choctawhatchee-Pea Basin Culvert Crossings With a High Failure Potential

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12131_587566_3412505	178	Sandy Creek	Walton	B2
12131_583070_3393990	350	Bay Branch		B3
12131_587694_3373832	741	Unnamed run		B4
12131_588597_3373858	739	Pate Branch		
12131_588901_3373806				
12059_594768_3410680	210	Otter Creek	Holmes	C2
12059_595243_3411442				
12059_599918_3405410	270	Goose Branch		
12059_601908_3413431	212	Reedy Creek		
12005_599121_3361813	950	Otter Creek	Bay	C5
12059_610676_3428692	49f	Choctawhatchee River	Holmes	D1
12059_615312_3424152	55	East Pittman Creek		
12059_626640_3425941	61	Texas Branch		
12059_616556_3427853	69	Unnamed branch		
12059_610765_3414346	49f	Choctawhatchee River		D2
12059_623019_3408453	239	Gum Creek		
12059_617677_3408660	240	Hathaway Mill Creek		
12059_624503_3405170	286	Open Creek		
12133_624814_3395782	348	Gully Creek	Washington	D3
12133_617534_3393617				
12133_608657_3371568	49b	Choctawhatchee River		D4
12133_608895_3371613				
12133_623909_3375974	526	Pine Log Creek		
12133_609849_3378843	651	Spring Run		
12059_624944_3426115	56	Tenmile Creek	Holmes	E1
12059_625131_3429532				
12059_637109_3424203	59	Holmes Creek		
12059_637554_3421906				
12059_638102_3424551				
12059_639280_3424444				
12063_638723_3421488			Jackson	
12059_633525_3425328	103	Corbett Branch	Holmes	
12063_642168_3422706	130	Fish Branch	Jackson	
12063_640335_3419074	147	Gum Creek		
12059_627943_3408659	251	Camp Branch	Holmes	E2
12059_630541_3408083	59	Holmes Creek		
12059_630721_3406621				
12059_632475_3418231				
12059_632870_3408534				
12059_634528_3416459				
12063_640949_3413184	130	Fish Branch	Jackson	
12063_641043_3413302				
12133_633961_3399573	59	Holmes Creek	Washington	E3
12133_629502_3398783				
12133_630035_3399203				
12133_627510_3401084	286	Open Creek		
12133_637868_3392298	401	Hard Labor Creek		
12133_639341_3387976				
12133_642465_3390661	455	Davis Branch		
12133_636843_3386378	456	Reedy Creek		
12133_631902_3387482	526	Pine Log Creek		
12133_635833_3385174	456	Reedy Creek		E4
12133_633767_3384797	526	Pine Log Creek		
12063_642743_3419649	130	Fish Branch	Jackson	F1
12063_642926_3422175				

Table 7-26. Choctawhatchee-Pea Basin Culvert Crossings With a High Failure Potential Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12063_642985_3417493	130	Fish Branch	Jackson	F2
12063_643582_3416447				
12133_643054_3393049	346	Little Hard Labor Creek	Washington	F3
12133_642899_3388588	401	Hard Labor Creek		
12133_644049_3389298				
Pea River Subbasin, HUC 03140202				
12059_595068_3423954	63	Hurricane Creek	Holmes	C1
12059_599869_3428008				
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_577085_3396991	332	Cosson Mill Creek	Walton	B3
12131_579533_3394149	369	Sconiers Mill Creek		
12131_579859_3394231				
12131_578852_3375630	351a	Alaqua Creek		B4
12131_574146_3364860	881	Direct runoff to bay		B5

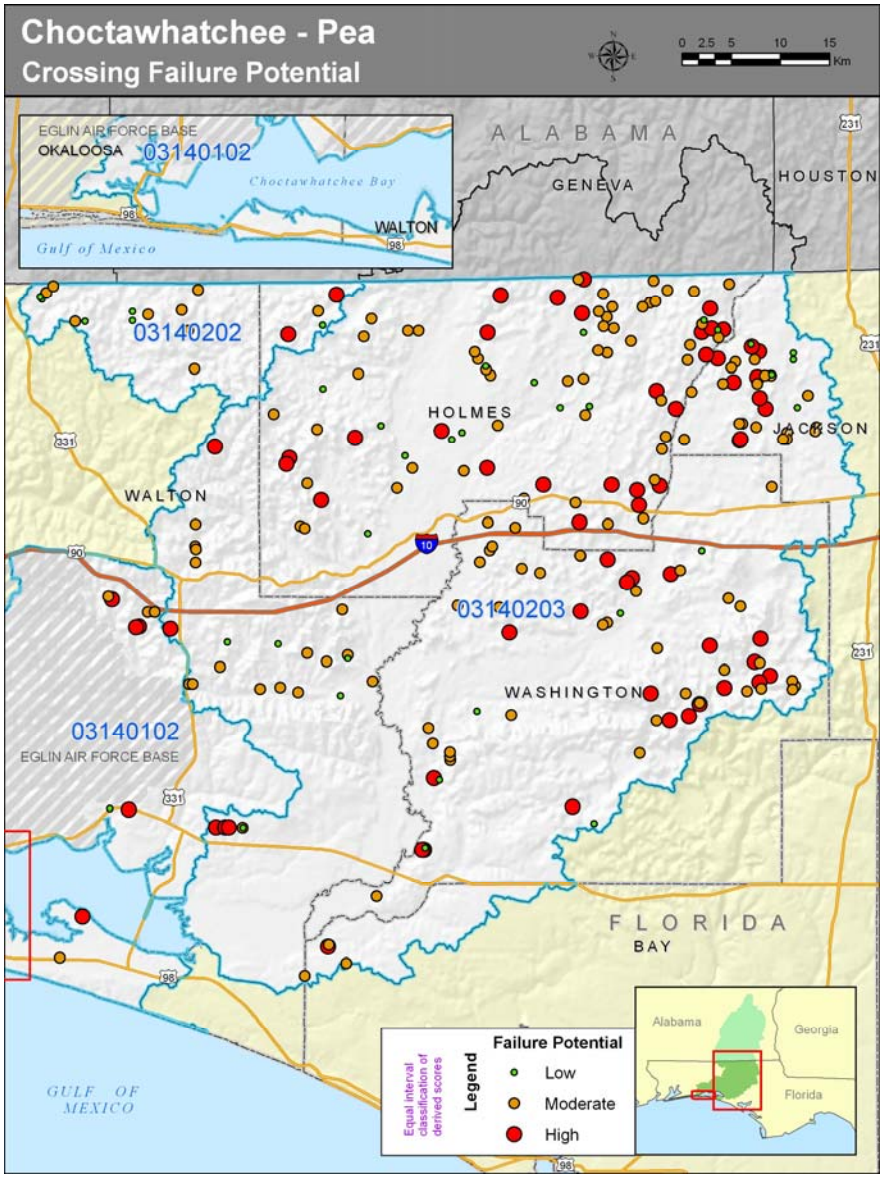


Figure 7-19. Culvert Crossing Failure Potentials (David Rubino)

7.5.11 Which CPB water crossings are potential candidates for establishing road approach natural drainways?

Use of natural drainways (NDs) means creating relatively seamless hydrologic connectivity between road runoff and the natural landscape drainage features adjacent to roads. As discussed in Section 4.1.2.3, NDs promote the sheet flow dispersion of water into native land areas of standing grasses, forbs, shrubs, and trees and over ground litter layers that subsequently act as effective infiltration sinks and filtering buffers. These areas are intended to be featureless in that the flow of water is allowed to move unencumbered off the road and into the natural, undisturbed drainage system of the adjourning lands. The high infiltration rates of sandy soils that typify much of the CPB and the soil binding and water transpiration rates of native woody and herbaceous vegetation make NDs a preferred system of water disposal. This type of drainage system avoids the construction and maintenance of ditches and other costly drainage features that further concentrate water flows. Generally, if the construction of drainage ditches can be avoided, it is advantageous from an economic and environmental perspective to do so.

In some parts of the CPB, decades of road grading have created berms of road fill materials along the sides of many roads that sever the connectivity between road runoff and native lands hydrology. In many cases, reconnecting the road and native land hydrology may simply be a matter of removing legacy road grading berms or adding fill material to raise the road surface elevation. Guidelines for the use of NDs are presented below.

- ND candidates are generally limited to relatively flat to gently sloping road segments that are slightly above the grade of adjoining natural ground. Investigating and understanding of hydrologic character of the natural terrain is crucial to determining the suitability of NDs to the area.
- As applicable, remove roadside berms to reestablish sheet flow between the road and adjacent native lands. Berm soil materials are removed using excavation equipment and transported off-site to an appropriate disposal site. Limit excavations to the extent that soil removal ties road runoff to native area downslope flows. Do not deconstruct berms by grading the materials over native land areas.
- Roadside runoff is not allowed to drain directly into stream steephead features (Section 3.5.3) or over slopes with limited vegetative cover. Water flow over a steephead could result in the erosion and instability of these environmentally sensitive features. If runoff is directed over slopes with limited vegetative cover, the impacted area is to be planted with native species that will increase the buffering capacity of the slope and avoid erosion.
- Generally NDs should not be used as primary water disposal for thalweg crossings (Section 5.2.4) or deeply incised crossings with moderate to steeply sloped road approaches.
- If rills or gullies begin to form within the ND area, the runoff is to be channelized into a roadside ditch and transported to an appropriate discharge site. It is important to regularly survey these areas to ensure that damage is not occurring.

The accumulation of sediment in the ND is an indication that erosion and runoff management are ineffective in controlling sediment generation and require immediate attention.

The 51 CPB water crossings with one or both road approaches that exhibit roadside grading berm and average road elevation conditions that range from 1 foot below to greater than 1 foot above roadside natural ground that are potential candidates for establishing NDs are presented in Table 7-27 and Figure 7-20. Depending on prevailing conditions, candidate crossings may include one or both road approaches and may require regarding the road surface to an outslope configuration (Section 4.1.1, Figure 4-2) to hydrologically connect with receiving roadside slopes.

Table 7-27. Choctawhatchee-Pea Basin Candidate Natural Drainway Crossings

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12131_585653_3402149	269	West Sandy Creek	Walton	B2
12131_585614_3404688				
12131_585620_3402440	283a	Lake Juniper Drain		
12131_585644_3400896	269	West Sandy Creek		B3
12131_588111_3390200	343	Bruce Creek		
12131_585279_3388430	486	Mill Creek		
12131_588901_3373806	739	Pate Branch		B4
12131_588597_3373858				
12131_587694_3373832	741	Unnamed run		
12059_605805_3428211	47	Parrot Creek	Holmes	C1
12059_606923_3411670	49f	Choctawhatchee River		C2
12059_599926_3411751	205	Bay Drain		
12131_603548_3388701	49e	Choctawhatchee River	Walton	C3
12131_603917_3388406				
12131_604086_3387915				
12131_592169_3387913	343	Bruce Creek		
12131_590198_3391114	371	Panther Creek		
12131_590344_3373860	747	Unnamed creek		C4
12005_600965_3360125	950	Otter Creek	Bay	C5
12005_599121_3361813				
12005_599190_3361962				
12059_609588_3426163	47	Parrot Creek	Holmes	D1
12059_608364_3427017				
12059_607182_3424350	94	Limestone Branch		
12059_622725_3416486	56	Tenmile Creek		D2
12133_611570_3380601	59	Holmes Creek	Washington	D4
12133_623909_3375974	526	Pine Log Creek		
12059_640825_3429170	59	Holmes Creek	Holmes	E1
12059_642412_3429094				
12063_642168_3422706	130	Fish Branch	Jackson	
12063_640089_3420588	147	Gum Creek		
12063_640949_3413184	130	Fish Branch		E2
12063_641925_3414701				
12133_639810_3397108	337	Flat Creek	Washington	E3
12133_641691_3387683	401	Hard Labor Creek		
12133_642465_3390661	455	Davis Branch		
12133_636881_3386512	456	Reedy Creek		
12063_645738_3413309	123	Alligator Creek	Jackson	F2
12063_642627_3414509	130	Fish Branch		
12063_647819_3409694	233	Unnamed creek		
12063_647255_3409221				
12133_643171_3387949	401	Hard Labor Creek	Washington	F3
12133_647019_3392581				
12133_642967_3390542	346	Little Hard Labor Creek		
Pea River Subbasin, HUC 03140202				
12131_584991_3420465	68	Chestnut Creek	Walton	B1
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_580649_3395756	340	Kiser Branch	Walton	B3
12131_580773_3395720	369	Sconiers Mill Creek		
12131_580186_3394422				
12131_579859_3394231				
12131_579533_3394149				
12131_578852_3375630	351a	Alaqua Creek		B4

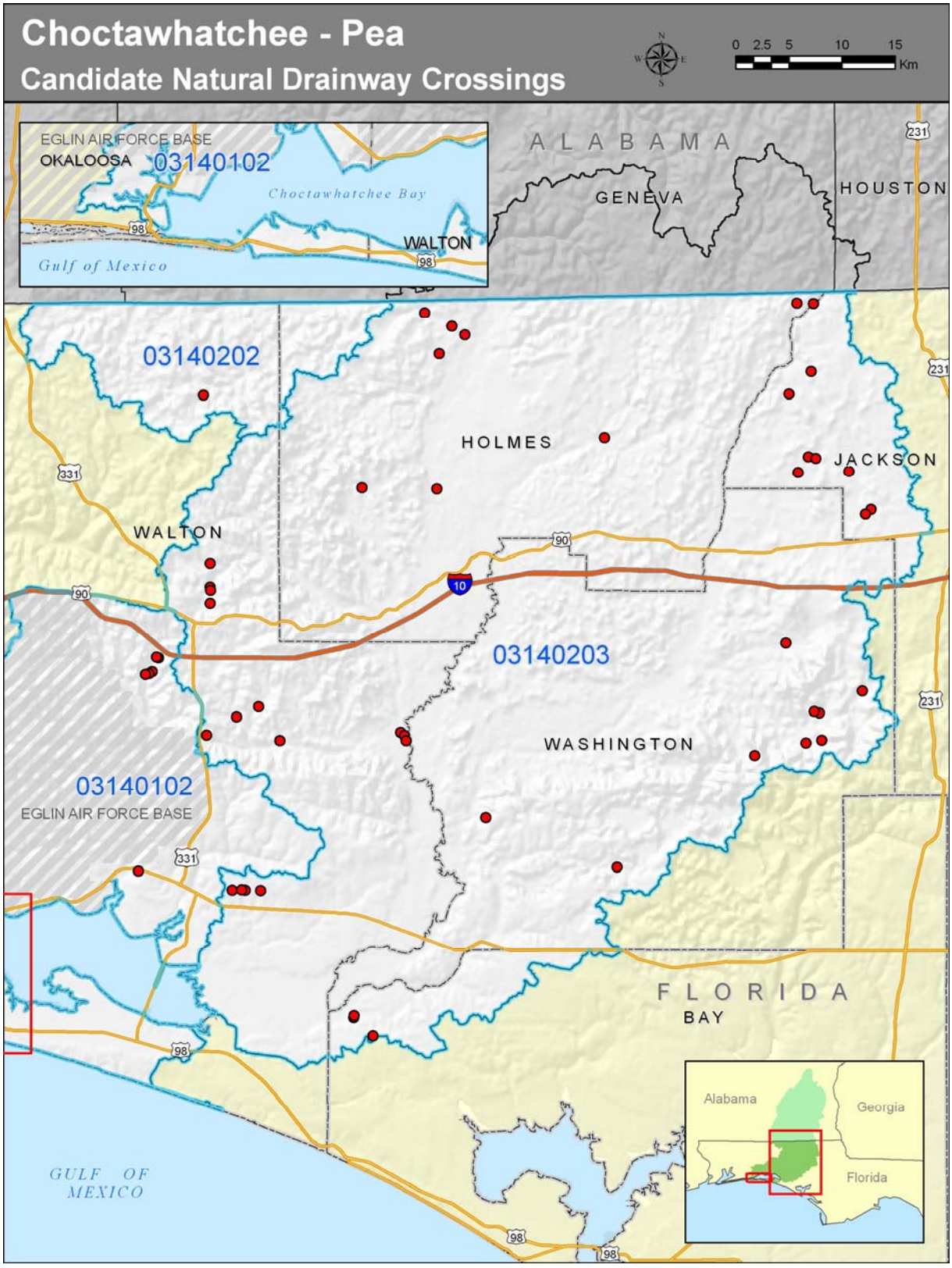


Figure 7-20. Candidate Natural Drainway Crossings (David Rubino)

7.6 LITERATURE CITED

Barrios, K. 2005. *Choctawhatchee River Springs Inventory Holmes, Walton, and Washington Counties, Florida*. Northwest Florida Water Management District, Havana, Florida, Water Resources Special Report 05-02.

Gucinski, H., J. J. Furniss, R. R. Ziemer, and M. H. Brookes, (eds.). 2000. *Forest Roads: A Synthesis of Scientific Information*. USDA Forest Service.

Harrelson, C.C., Rawlins, C.L., and Potyondy, J.P. 1994. *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*. General Technical Report RM-245. Fort Collins, Colorado: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Rosgen, D. L. 2001. The Cross Vane, W-Weir, and J-Hook Vane Structures: Their Description, Design, and Application for Stream Stabilization and River Restoration. In: *Proceedings of the Wetlands Engineering and River Restoration Conference*, Reno, Nevada, August 21-31. Reston Virginia: American Society of Civil Engineers.


Mike Rainer

CHAPTER EIGHT

ISSUES, RECOMMENDATIONS, AND CHALLENGES


Mike Rainer

This chapter presents strategic issues of concern for the Choctawhatchee-Pea Basin along with recommendations and challenges identified during the crossings assessment. It provides general guidelines for moving forward with corrective measures to recover damaged aquatic ecosystems and support sustainable growth and development.


Mike Rainer

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ACRONYMS

AM	adaptive management
CBA	cost benefit analysis
CPB	Choctawhatchee-Pea Basin
FSWS	Florida Surface Waters of the State
RZ	riparian zone


Mike Rainer

8. ISSUES, RECOMMENDATIONS, AND CHALLENGES

8.1 ISSUES

Based on field observations at Choctawhatchee-Pea Basin (CPB) crossings and data analysis, specific issues summarize conditions of concern, pinpoint significant impacts, and provide a framework for planning and targeting corrective action. Issues represent the linkage and cause-effect interactions between road and crossing conditions and surrounding ecological, political, and socioeconomic environments. These issues are expressed in terms of *adverse*, *benign*, or *beneficial localized*, along with *cumulative impact potentials*. Generally, issues have a historical context that has affected the current state. Strategic crossing issues that reflect the unique challenges facing the CPB include:

- **Issue 1** – Changes to the CPB have been substantial since Euro-American settlement. All CPB water resources have been affected in varying degrees by human intervention to control and manage surface and groundwater drainage for support agriculture, development, and land management.
- **Issue 2** – Over 100 years of road construction and maintenance has resulted in a labyrinth of roads that have permanently altered the CPB landscape. As early as 1910, over 2,000 miles of CPB roads had been developed, the majority of which are still in use. Many roads, particularly in predominantly rural areas such as Holmes County, remain unpaved and require frequent maintenance.
- **Issue 3** – The majority of CPB county-maintained unpaved roadways and roadside areas are readily altered by stormwater, resulting in soil erosion that degrades the roadway, stimulating frequent road maintenance activity and producing sediment-laden runoff.
- **Issue 4 –** CPB unpaved roads surfaced with noncohesive soil materials and disturbed by frequent surface grading and ditch cleanout generally cannot resist the erosive forces of stormwater runoff. Soils are dislodged with each storm event, and roadside drains lack the stabilizing effects of vegetative cover. Reductions in crossing-induced aquatic ecosystem sedimentation cannot be achieved with an unstable roadway.
- **Issue 5** – In most cases, sediment-laden runoff is delivered by CPB road drains over unprotected crossing discharge points, directly into receiving streams and wetlands.
- **Issue 6** – CPB crossing-induced sedimentation ***has not been*** and ***cannot be*** controlled by surfacing crossing road approaches with noncohesive soil materials and maintaining bare-ground roadside drainage systems. Assuming that the continued maintenance cycle of roadfill loss to erosion and replacement with imported materials from clay mines, CPB crossings become a theoretically ***inexhaustible sediment source***.
- **Issue 7** – The discharge of sediment at CPB crossings into regulated Florida Surface Waters of the State (FSWS) is a violation of Florida environmental statutes and federal laws. Crossings are discrete, discernable sites discharging sediment into FSWS where a determination of compliance or noncompliance with environmental regulations can be made.
- **Issue 8** – County reserves of high-quality clay roadfill materials are being depleted. Mined surfacing clay from unpaved roads is an irreplaceable resource. The conservation of applied roadfill materials, through proper road design and maintenance, utilization of alternative road-surfacing materials, and implementation

and maintenance of crossing best practices is essential to the long-term sustainability of county clay-mining operations.

- **Issue 9** – CPB crossing-induced sedimentation has significantly altered the form and function of CPB aquatic ecosystems, resulting in impaired water quality and degraded habitats. In many cases, the impacts have been catastrophic. Ecosystem degradation will continue unabated under some current maintenance regimes.
- **Issue 10** – The long-term cumulative impacts of decades of sedimentation from hundreds of CPB crossings and other sources are not localized but directly affect the quality and uses of downstream natural and socioeconomic environments from the northern most part of the basin to Choctawhatchee Bay and the Gulf of Mexico. Sediments eroded into waterways over the last century continue to be resuspended, relocated, and redeposited.
- **Issue 11** – Unique CPB steephead, spring, seepage bog, and perched pond wetland aquatic ecosystems are particularly sensitive to crossing-induced soil erosion and sedimentation. In some cases, impacts have been catastrophic and resulted in the permanent loss of ecosystem attributes.
- **Issue 12** – Depletion of CPB riparian zones associated with CPB crossings and human land uses have accelerated declines in ecosystem biological diversity and integrity.
- **Issue 13** – Habitats of rare and imperiled fish, mussels, and aquatic insects have been adversely impacted by crossing-induced sedimentation, and some CPB culvert crossings may be physically inhibiting rare and imperiled species habitat access.
- **Issue 14 –** The extensive alteration of CPB stream and wetland geomorphology and hydrologic regimes associated with shifts in land use and long-term, human-induced sedimentation and hydrologic disturbances have created transitions in aquatic environments; these transitions include diminished diversity of flora and fauna, proliferation of opportunistic nonnative species, increased beaver activity, and reduced recreational and socioeconomic values.
- **Issue 15** – Over the next few years, CPB growth and development trends will exert increased pressures on unpaved roads, which will require targeted crossing management to maintain traffic standards and minimize aquatic impacts.

8.2 RECOMMENDATIONS

The purpose of this work was to identify and prioritize CPB county-maintained unpaved crossings and provide users with access to field-validated crossing data. Decision-making, whether aligned with high-level agency policies and funding, research, or crossing project designs, requires accurate and reliable data; as data quality improves so do the long-term benefits and opportunities associated with its use. The technical tools and methods used for this project were developed to maximize the quantity and quality of CPB crossings data necessary to support targeted crossing evaluations, resource investments, and crossing site treatments that promote the sustainable recovery of CPB aquatic resources. The Three Rivers Resource Conservation and Development Council, Inc., *Northwest Florida Road-Stream Crossings* website (https://www.gcsaic.com/streamx2) will serve as the centralized "warehouse" for disseminating CPB crossings and resource data. The following subsections detail recommendations, including:

- Promote stakeholder participation
- Develop crossing treatment prescriptions
- Conduct crossing treatment cost-benefit analysis
- Implement crossing treatment projects
- Monitor crossing project progress
- Integrate crossings data with other planning initiatives
- Define future work

These recommendations are discussed in the following subsections.

8.2.1 Stakeholder Participation

In addition to technical requirements, stakeholder ownership is essential to project success. Generally, project ownership is a product of end-user participation and investment in the desired outcomes. Crossing projects without owners tend to fail. In nearly every case, CPB crossing project implementation and maintenance will be the responsibility of the affected county. It is therefore imperative that county governments actively participate in developing and implementing crossing projects that both address environmental issues and represent treatment options embraced by the county road maintenance organizations. The counties vary in their technical and administrative capabilities, which will need to be addressed on a county-by-county basis.

Stakeholder participation is being partly addressed by Phase II of this project, *Northwest Florida Unpaved Road-Stream Crossings County Maintenance Inventory*. The purpose of the project is to conduct an inventory of Northwest Florida county unpaved roads and crossings maintenance. The scope of the project will be configured to the counties associated with the CPB Road-Stream Crossings Assessment, which includes Bay, Holmes, Jackson, Walton, and Washington Counties and Northwest Florida counties that are conducting FDEP funded crossing treatment projects, which includes Okaloosa and Liberty Counties. The project objectives are to:

- Document the practice of Northwest Florida unpaved roads and crossings maintenance
- Develop an information baseline that quantifies maintenance issues and concerns
- Promote county and other affected entities in the development of crossing treatment programs and projects
- Assess the potentials for contact respondents to adopt new crossing maintenance practices and participate in crossing treatment training workshops
- Inventory project area county, state, federal, and large commercial land owners

The inventory will document individual county maintenance program procedures, practices, and issues based on real-time information collected directly from county road maintenance personnel. It will also identify county-based technical capabilities and resource deficits. The data compiled will be instrumental in establishing a baseline of knowledge regarding current maintenance programs and issues and provide information critical to developing targeted road-crossing solutions, efficiently allocating resources, designing crossing treatment training programs, and promoting multi-organization cooperation in addressing crossing-related environmental issues. Phase II will also stimulate the local-level support and advocacy necessary for long-term crossing treatment project success.

8.2.2 Crossing Treatment Prescriptions

Developing projects to meet the diverse needs, capabilities, and resources of CPB county managers and aquatic resource recovery must be accompanied by access to an equally diverse inventory of practical treatment alternatives for crossings. Based on the treatment technical approach described in Section 7.2.6, crossing projects should be based on the implementation of practices that stabilize soils, manage runoff, control sediment, and promote ecosystem recovery. Primary treatment alternatives must include road approach stabilization, roadside drainage systems, and crossing structures.

Crossing treatments (CTs) are the methods, measures, processes, features, and/or techniques that are selectively applied to crossings in a manner that maintains the purpose, utility, and integrity of the road system and minimizes on- and off-site environmental impact potentials. CTs are designed in accordance with the unique characteristics of local environments to provide practical, cost-effective solutions to environmental and road maintenance issues. Characteristics of CTs include:

- CTs are based on scientific studies and testing. Their effectiveness in controlling erosion, runoff, and/or sediment is evaluated for type cases and best professional judgments are employed to assess their applicability to other situations. The application of CTs can be broad or quite narrow in the realm of their effectiveness.
- CTs are designed to be feasible in the sense that they are unlikely to eliminate all erosion and sediment production; however, their design and correct application can minimize impacts within the constraints of political, economic, and/or technical factors.
- CTs are site specific in that their selection is dependent on an understanding of site characteristics and influencers.
- The CT implementation success is embodied with a level of risk and responsibility. Since their effectiveness is not measured against water quality compliance standards, it is assumed that their correct application would result in acceptable results. It is the responsibility of end users to take calculated risks in the interpretation of site variability and extrapolate best available information to formulate and implement project plans.
- CTs are not “build and walk away” features. All CTs require a level of inspection, monitoring, and maintenance to ensure their longevity and effectiveness.
- A measure of CT effectiveness is the ability of field personnel and engineers to make practice modifications to accommodate site-specific characteristics. This requires knowledge and understanding of natural features and processes and the capabilities of the CT practice.
- CTs employed to amend site conditions must be designed with flexibility in the use of construction materials native to the site. As an example, in the relatively low sloping, sand-bottom streams of the CPB, it may be more appropriate to use woody materials rather than rocks in the construction of channel structures. Woody debris provides a significant component of in-channel habitat native to CPB streams.

Current CTs for CPB crossing road approaches are generally limited to asphalt paving. Although effective in stabilizing unpaved roads, asphalt paving is costly and requires significant maintenance. Thus, aggregate and/or chemical treatment alternatives are needed to effectively meet road stabilization objectives. In some instances, less-expensive alternatives can provide a more sustainable option than paving. As an example, CPB aggregate-based road-surfacing alternatives used in northern Walton County are providing a stable, low-maintenance option for unpaved crossing road approaches (Figure 8-1). Also, numerous chemical treatment options for roadfill could be effective under certain conditions.



Figure 8-1. CPB Unpaved Roads Surface Stabilized With Crushed Rock (Mike Rainer)

Having confirmed that crossing-induced sedimentation cannot be controlled under current conditions (bare-ground ditches and direct discharge of runoff at unprotected outlets) (Sections 5.3.1.7 and 5.3.1.8), practical roadside drainage system alternatives are essential. One of the most challenging tasks is to establish and maintain stabilizing ditch vegetation (Figure 8-2). The extensive erosion (Sections 5.3.1.5, 5.3.1.6, and 5.3.1.9) and frequent maintenance requirements (Sections 5.3.1.1 and 5.3.1.2) of most CPB unpaved roads constantly disturbs roadside ditches. However, as exhibited at some CPB crossing road approaches, reducing both road erosion and maintenance grading with stabilizing aggregate materials minimizes the need for ditch cleanouts and promotes the establishment of roadside vegetation (Figure 8-1). Specialized vegetation protocols are needed to promote low-cost and low maintenance options that have defined applications within CPB environments. Stabilizing road surfaces and roadside drains reduce pressures on drain outlets; however, in some instances, hard structure outlets such as pipe drops (Figure 8-3), headcut structures, or energy dissipators (Figure 8-4) may be needed.

Culvert crossing structures, although effective in some instances, are often improperly designed, installed, and/or maintained (Sections 5.2.1, 5.2.2, and 5.2.3). For many CPB crossings, it would be more cost-effective and less environmentally intrusive to install a bridge than to maintain problematic crossing culverts. Bridges also alleviate many of the streamflow obstruction and flooding issues associated with culvert crossings (Figure 8-5). A CPB crossing treatment manual may be needed to define applicable treatment practices, conditions for their use, and protocols for their implementation and maintenance.



Figure 8-2. CPB Bare-Ground Ditch and Roadside Ditch with Ineffective Revegetation Treatments (Mike Rainer)

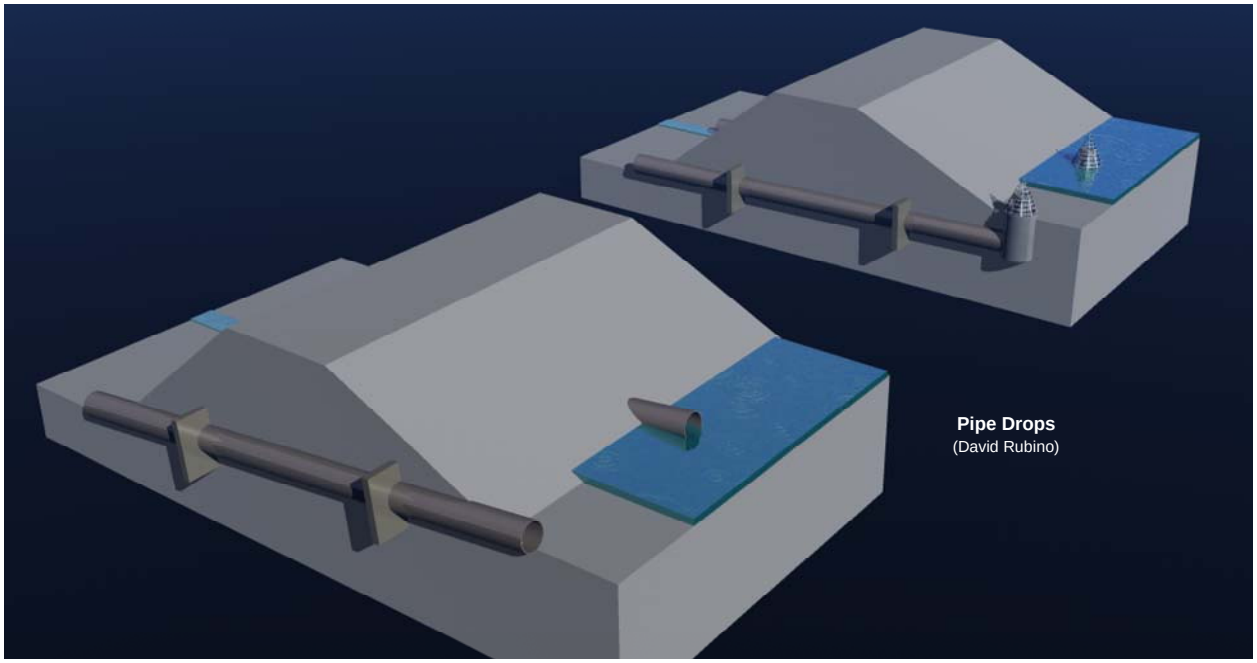


Figure 8-3. Pipe Drop Drain Outlet Structures

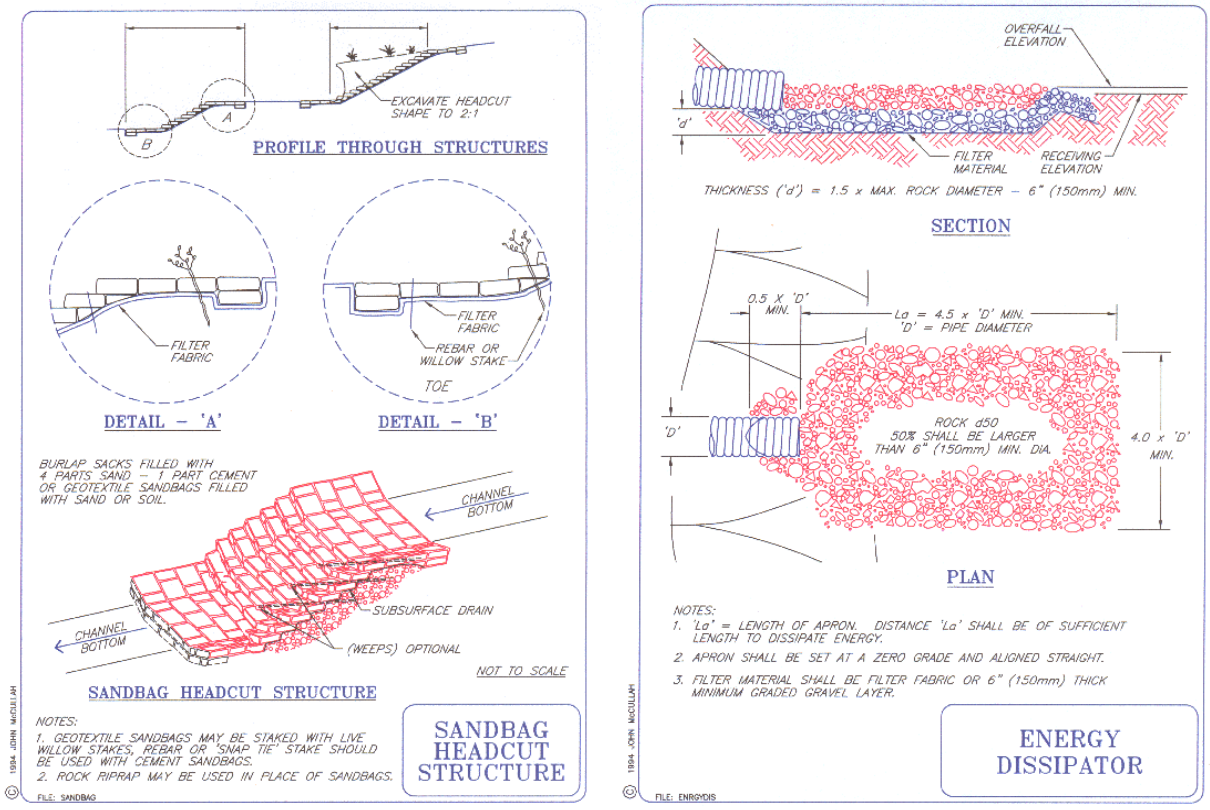


Figure 8-4. Headcut, and Energy Dissipator Drain Outlet Structures

(Salix Applied Earthcare)



Figure 8-5. Modular Bridge Stream Crossing (U.P. Engineers & Architects, Inc.)

CT prescriptions are the alternative solution sets created from CT combinations that guide crossing project corrective actions. Crossing site prescriptions are a culminating step that integrates crossing site data from Phase I Field Reconnaissance Design Surveys (FoRDS) (Section 1.5.1) and Phase III Project Design Data Systems (PoDDS) surveys. Whereas, FoRDS data collection is based on crossing field observations, PoDDS surveys are conducted to collect crossing waterway, road approach, and crossing structure metrics and engineering data, which are necessary to develop and evaluate crossing treatment alternatives and design customized treatment prescriptions.

From a technical perspective creating project prescriptions focuses on determining what normally would exist on the site, how the physical disturbances associated with the unpaved road crossings have affected site features and processes, to what degree the self-sustaining features of natural ecosystems can be mimicked to minimize soil erosion and sediment delivery potentials, and what structural features are needed to manage runoff-induced stresses.

In some instances, mimicking the features and processes of natural ecosystems is far more reliable than pouring concrete or throwing seed and fertilizer and hoping something will happen. The native plant components of erosion-, runoff-, and sediment-control practices adapt to the stresses of the road disturbance environments and, in many cases, actually become stronger and more effective over time, whereas many structural features tend to deteriorate. This approach is tempered by an understanding that the altered hydrology and manufactured slope conditions at crossings may exceed the tolerance capabilities of native soils and vegetation. Therefore, in some instances, structural measures are integrated into erosion-, runoff-, and sediment-control measures.

Developing crossing treatment alternatives and implementing CT prescriptions on county-maintained unpaved road-stream crossings are tools for achieving a condition of *managed road disturbance* that minimizes environmental impact potentials and is socioeconomically sustainable. An implicit component of a managed unpaved road disturbance system is the permanence of road surface and roadside area maintenance—as long as a road exists it will require maintenance. Disturbance equates to sustained alterations in soil and/or landscape physical or chemical conditions that are other than what would occur under natural conditions in the absence of human activities. Unpaved roads are considered high-level managed road disturbance systems compared to paved roads, which are typically low-level managed road disturbance systems.

8.2.3 Crossing Cost-Benefit Analysis

Crossing treatment projects, whether paving or rehabilitating crossing road approaches, rehabilitating roadsides, repairing or replacing crossing structures, or continuing with the baseline crossing maintenance program, are expensive endeavors that must be explicitly examined by decision-makers, not only in terms of environmental impacts and values but also in terms of the expenditure of economic resources. From an economic perspective, crossing treatment benefits are not always as evident as the costs. It is important to enumerate the costs and benefits to ensure that anticipated benefits are fully recognized, the project costs are distributed in an equitable manner, and limited resources are used efficiently. Cost-benefit analysis (CBA) is a systematic process used to express project values, expenditures, and tradeoffs in comparable monetary units that ensure all cost and benefit parameters are equally weighted. The process can also support collaboration among diverse stakeholders in developing optimal management strategies and balancing competing resource management objectives.

The time and resources invested in developing problem solutions should also be reflected in the selection of a treatment alternative that produces the desired results in a cost-effective manner. The CBA complements this process in that it establishes the framework for expressing project values and expenditures in comparable monetary units of measure that ensures all cost and benefit parameters are equally analyzed, compared, and weighted. The principal components of the CBA process include:

- Valuating, to the degree possible, the environmental and maintenance costs and benefits associated with crossing treatments
- Aggregating projected costs and benefits over the economic life cycle of the treatment project
- Discerning the justifications for treatment projects based on defined assumptions, criteria, and rules

Typically, projects are considered justified if the benefits outweigh the costs. Costs are either one-time or ongoing, whereas, benefits most often occur over time. Time is calculated into the CBA process using a *payback period*. This is the time it takes for the benefits of a project to repay the costs. Payback periods generally range from three to five years. One of the more challenging components of CBA is assigning currency value to intangibles. For example: How much is a stream segment worth, $10,000 or $100,000? The answer can be highly subjective.

Use values are created by the benefits gained by the use of the environment and may include private-sector use; recreation benefits; education, research, and scientific benefits; and diverse amenity and landscape benefits. *Nonuse values* relate to individual desires and preferences, such as conserving and protecting the environment for future generations and preserving environmental assets.

The cost-benefit ratio is used to evaluate the relationship between project costs and benefits and investigate the allocation of limited funds among competing projects or project alternatives. A project's net present value is a measure of economic gains or losses resulting from project implementation but does not reveal who receives the benefits or who pays the costs. The incremental cost-benefit ratio is used to determine if additional benefits of increased project controls outweigh additional costs.

Crossing treatment CBA modeling provides a framework to realistically evaluate and compare crossing treatment alternatives in relation to defensible environmental and socioeconomic cost and benefit parameters. An important model feature is the capability to quantify to the degree possible the costs and benefits associated with replacing existing crossing maintenance practices that are a source of sediment generation and delivery with crossing maintenance practices that significantly reduce site-specific waterway sedimentation. In addition to the costs of

maintaining the status quo and crossing project alternative, the CBA model provides monetary estimates of use and nonuse values.

CBA models are designed to provide users with a data entry interface, automated data processing, and custom report generation. A computer-based data entry and report form allows the entry of front-end information, select status quo and proposed project practices, and entry of the required practice metrics (quantity, units, etc.). The software automatically populates entry fields with the defined monetary and practice life cycle values and calculates project alternative cost and benefit total, cost-benefit ratio, net present value, incremental cost-benefit ratio, payback period, and score. The model also allows the user to develop, test, and compare different crossing treatment and maintenance alternatives.

8.2.4 Crossing Treatment Projects

Having provided information within this report that locates and characterizes CPB crossings and prioritizes their treatment and having defined the need for stakeholder participation, crossing treatment alternatives and prescriptions, and cost-benefit analysis it is essential to implement on the ground projects to achieve aquatic resource recovery. Each crossing project will represent a unique situation that will require planning and design engineering to ensure problems are corrected, treatment objectives are met, and sustainable solutions are put in place. Short-term project implementation and long-term maintenance funding will be required. Each project will also require a plan that outlines short-term and long-term monitoring needs.

During the CPB StreamX field reconnaissance, a unique crossing was identified that requires special consideration. The natural bridge crossing (12131_575631_3428399), located on Natural Bridge Road in northern Walton County (Figure 8-6), is at risk of catastrophic damage from crossing-induced sediment impacts. The extent of sedimentation, created by constructed road drains, has damaged the site and, if not corrected, could alter the hydrological integrity of this unique ecosystem. The crossing is located over Natural Bridge Rise, which is a first-order spring system, and is unique in that the road crosses a natural limestone karst formation and does not have a culvert or bridge structure. Regarding impacts, the site has a relatively low SSM prioritization score of 400. This score value is primarily due to the absence of a manufactured water crossing structure, which is an integral part of the prioritization protocol.

The spring emerges from an 8-foot-wide limestone vent into a pool approximately 20 feet wide. Water flowing from the Floridan Aquifer at a rate of 6.9 cubic feet per second moves from the pool into a 30-foot-wide karst window and emerges as Natural Bridge Creek (Figures 8-7 through 8-9). During high flow conditions, spring water frequently overtops the road (Barrios, 2005).

As shown in Figure 8-8, a large plug of road sediments is being deposited directly into the spring pool on the east side of the road. The primary sediment source is the incised unpaved road and the drainage gully constructed along the east side of Natural Bridge Road, north of the crossing. The extensive excavation has created severe soil instabilities and a point of discharge for sediment-laden runoff on the east side of the spring (Figures 8-10 and 8-12).

The recommended treatment for this site is to decommission Natural Bridge Road between the crossing and State Road 181 (Figures 8-13 and 8-14), remove the sediment plug from the spring pool, remove the constructed roadside drainage gully and all spring discharge points, and stabilize the crossing's southern road approach and drainage system. The decommissioned road segment would be obliterated by restoring the natural topography and planting native vegetation. The road south of the crossing would continue to permit landowner and recreation access to the area. A stabilized parking area would help in minimizing recreational disturbance of the areas near the spring.

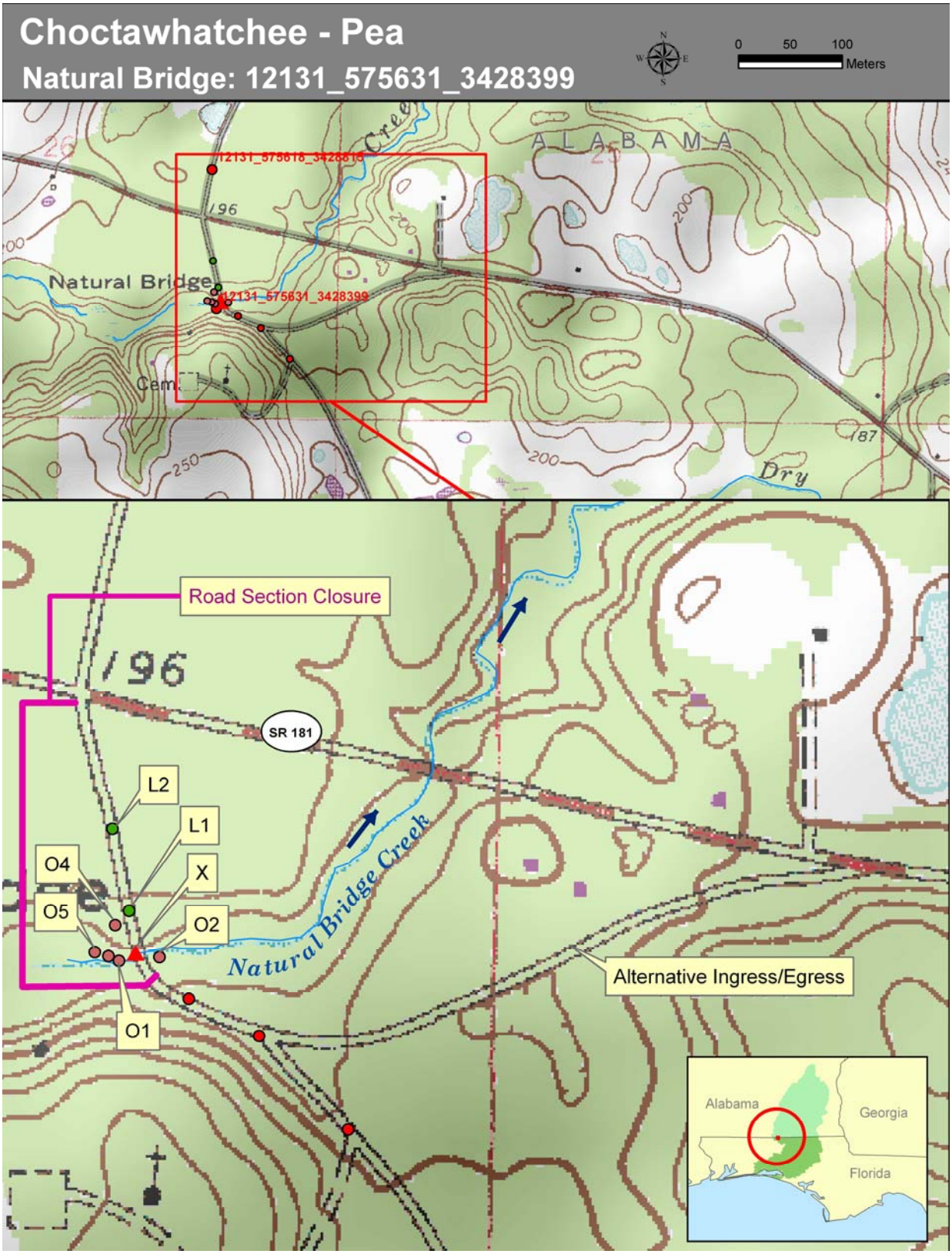


Figure 8-6. Natural Bridge Road Crossing Map (David Rubino)



Figure 8-7. Upstream and Downstream View of the Natural Rise System (X Map Position)



Figure 8-8. Natural Bridge Rise Vent, Pool, and Sediment Plug (O1 Map Position)



Figure 8-9. Downstream View of the Karst Window and Creek (O2 Map Position)



Figure 8-10. Left Road Approach Toward and Away From the Crossing (L1 Position)



Figure 8-11. Left Road Approach Drainage Gully System (L1 Position)



Figure 8-12. Left Road Approach Drainage Gully System (O4 Position)



Figure 8-13. Left Road Approach Drainage Gully System (O5 Position)

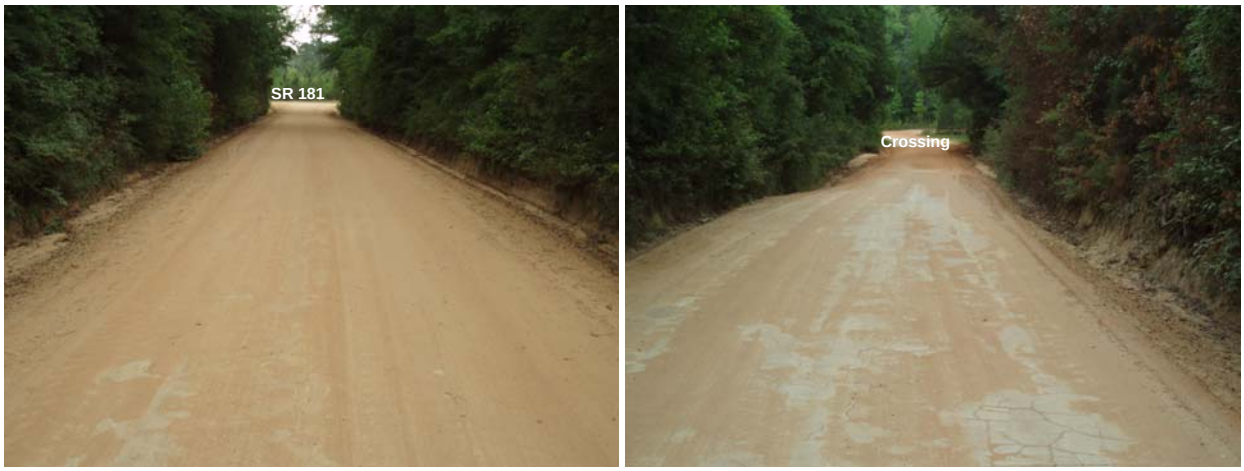


Figure 8-14. Left Road Approach to Be Decommissioned (L2 Map Position)

8.2.5 Crossing Project Monitoring

Crossing project monitoring is the repeated documentation or measurement of conditions at one or more site locations for comparison over time and is indispensable to sustainable project success. All crossing treatment projects regardless of their cost require periodic monitoring. Validation of aquatic resource recovery will require long-term data collection at relatively frequent intervals; although expensive, this is critical to addressing aquatic resource trends at variable scales. Crossings are also dynamic, in that a storm event or change in maintenance can create significant changes at crossing sites. The Crossing Knowledge Support System StreamX field reconnaissance protocol (Section 1.5.1) was created to provide a temporal and spatially based-photo record of existing features and conditions, as well as provide a means to reacquire these photopoints for monitoring. Four types of monitoring for consideration in developing a comprehensive crossing monitoring program include:

- *Implementation monitoring* – Process used to evaluate if a planned action has occurred
- *Compliance monitoring* – Monitoring used to determine if regulatory standards have been met
- *Effectiveness monitoring* – Process to determine if the implemented action has had the desired effect(s)

- *Trend monitoring* – Process used to evaluate environmental changes at broad watershed, basin, and regional scales

Monitoring is conducted at various levels, depending on the purpose, required degree of detail, and technical needs; costs will vary concurrently with the imposed monitoring complexity. Each type of monitoring requires the development of specific parameters and indicators (quantitative or qualitative). Project-effectiveness monitoring is based on quantitative methods in situations where potential risks to resources, in case of failure, are unacceptable.

All projects will require a minimum of before-and-after qualitative monitoring to validate proper implementation. Post implementation monitoring time frames will vary by project type and monitoring plan designs. Monitoring protocols are field-tested to determine project applicability. Protocol modifications are implemented to improve overall reliability and validate project applicability. In some cases, the initial phases of project-effectiveness monitoring occur in conjunction with implementation monitoring.

8.2.6 Crossing Adaptive Management

Crossing Adaptive management (CAM) is a systemic process in which new data associated with crossings is incorporated into watershed-scale resource management planning. CAM combines the results of project monitoring and scientific research to document lessons learned and results in the development of practical decision-making processes that produce successful, replicable solutions. This type of planning requires explicit examination of project implementations and adaptive correlations with defined resource management goals and objectives and receptor environmental and socioeconomic systems. The general steps in the process include:

- Develop an adaptive management plan
- Implement project monitoring
- Evaluate monitoring results
- Adjust watershed/resource management plans

CAM relies heavily on the consistent implementation of project monitoring and evaluation of monitoring data. The CAM process compliments adjustments in existing management plans and/or the development of new resource management plans. The design of a CAM plan is best accomplished through cooperative efforts with policy-level decision-makers (those with authority to make commitments of resources and technical expertise). A CAM working group would define specific goals and objectives and establish timelines for monitoring and plan development.

8.2.7 Future Work

Based on the results of this assessment, areas for CPB future work could include:

- Crossover and proximity crossing site evaluations
- Resource data gaps amendment
- Crossing stream bioassessments
- Private and public lands crossings assessment
- Crossing monitoring volunteer crops
- Stream order classification
- Stream alterations – A historical perspective
- Riparian zone assessment

- Roadscape trajectories analysis
- Wetland connectivity assessments
- Priority Watershed Assessments

8.2.7.1 Crossover and Proximity Crossing Site Evaluations

There are 205 crossover site and 35 proximity site crossings (Sections 4.2.2 and 4.2.3) with undetermined waterway connectivity and impacts. CPB StreamX field reconnaissance was restricted to the roadway and adjacent rights-of-way; sites that discharge off-site where visual observation of connectivity and impacts could not be determined will require access to private lands. In-office research and field surveys would be conducted to validate connectivity and impact issues. Sites identified as having no hydrologic connectivity with water resources would be removed from further analysis, and sites validated as sources of watercourse sedimentation would be further assessed for treatment.

8.2.7.2 Resource Data Gaps

Data issues refer to missing or incomplete CPB natural and infrastructure resource data. They include instances where little or no data exists or where there are data gaps, lack of dataset metadata, missing data updates, or deficiencies in the quality of the data. Issues identified during the study included:

- *County-maintained unpaved roads* – Many CPB areas had little or no data to signify the location of county unpaved roads. Many unpaved roads are being paved as funding becomes available especially in the southern portions Walton and Washington Counties that are experiencing accelerated growth and development.
- *Surface hydrology* – Water resource analysis was limited by the condition of hydrology data. In many instances, there are gaps in the hydrology feature line work that prevented its use during analysis. This was most prominent in broad wetland and floodplain areas where there were line work disconnects between linear streams and polygon wetland features. There was also no known source of data for man-made ponds on private lands or WBID stream orders.
- *Vulnerable aquatic ecosystems* – Little or no data were available to locate potentially at risk steephead streams (Section 3.5.3), perched pond wetlands (Section 3.5.4), seepage slopes (Section 3.5.4), and other vulnerable ecosystems. These ecosystems frequently include rare and imperiled flora and fauna and may be especially sensitive to impacts associated with crossing-induced erosion and sedimentation.

8.2.7.3 Crossing Stream Bioassessments

As provided by Mr. Donald Ray, FDEP Stream Biologist, in 2007, additional bioassessments (Section 5.4.7) of prioritized crossings identified by this project would be instrumental in correlating crossing-induced sedimentation and aquatic ecosystem impairment. The continued implementation of follow-up crossing stream bioassessments and future crossing site monitoring will need to be addressed as a role of government agencies or the private sector or a hybrid of the two. The duration of crossing bioassessment monitoring would depend on site, watershed, and basin changes, corrective actions, and prevailing conditions; it may take 10 years or longer to achieve the desired level of ecosystem recovery once corrective measures are in place and maintained.

8.2.7.4 Private and Public Lands Crossings Assessment

Although county-maintained unpaved road crossings account for many CPB crossings, a significant number of potential crossings exist on private and public lands that are contributing to aquatic ecosystem impairment. Private land crossings occur on small tracts as well as large commercial tracts located in the central and southern portions of

the CPB. Public land crossings would include federal, state, and locally owned lands and conservation areas (Section 3.7) not maintained by the counties. Although the use of private and public land roads may not be as intensive as county-maintained roads, the aquatic impact potentials can be considered cumulatively significant.

8.2.7.5 Crossing Monitoring Volunteer Crops

A basin-, county-, or watershed-based volunteer corps, composed of local residents, would be instrumental in promoting public ownership of crossing treatment projects and water resource recovery projects and facilitating real-time, cost-effective monitoring data collection. Local citizens would be empowered and equipped to assist in monitoring the conditions of crossings near their homes and the streams and wetlands they value. The volunteer corps would put the responsibility for influencing and participating in ecosystem recovery directly in the hands of those most effective in sustaining long-term change.

Monitoring data collection could include water and biological sampling, measuring sedimentation and erosion, and immediate photopoint documentation of issues. Local residents could quickly access crossings following major storm events to record damage or other problems. A customized crossing monitoring data transfer system could be developed to link volunteer home computers with a crossing database repository. The system would be designed to be flexible and multi-functional and simultaneously combine necessary tasks to expedite data transfer from the field to file structure and ensure data quality.

8.2.7.6 Stream Order Classification

As gaps in surface hydrology data are addressed, there will be opportunities to define CPB stream networks based on the Strahler (1957) and Horton (1947) stream classification method. This process ranks the size and potential power of streams based on a stream hierarchy system. Stream orders range from small first-order streams with no branches to large tenth-order streams, such as the Mississippi River with many tributaries. CPB stream order information could be useful in screening the magnitude of crossing-induced sedimentation impacts based on sediment transport capabilities associated with stream order.

8.2.7.7 Stream Alterations - A Historical Perspective

A resource to establish a historical point of reference to validate impacts from crossings and other sediment sources on CPB aquatic ecosystems is available but has not been systematically documented. This resource includes first-hand accounts of local residents. Conversations with locals during crossing field surveys revealed a wealth of site-specific information based on years of observing changes to their favorite fishing spot or swimming hole. Their historical reference extends over years of observing cause-effect relationships and direct impacts to waterways. As an example, a bridge was identified in northern Walton County where dry land was immediately below the crossing structure with no evidence of recent water flows (Figure 8-15). A local resident, having stopped to visit, stated that he fished the small stream spur when he was young but over the past 20 years the waterway had completely filled in with road sediments. In another case, a Holmes County farmer was able to provide information on the type and timeframe for historical dredging and channelization of a crossing stream near his home.

The objective would be to interview older local residents and document their accounts of changes to CPB aquatic systems. Emphasis would be placed on spatially and temporarily documenting historical, site-specific waterway changes. As applicable, sites would be visited with participants to verify information and collect photographic records.



Figure 8-15. CPB Crossing Site Bridge Resting on Dry Ground and Remnant Stream Channel (Mike Rainer)

8.2.7.8 Riparian Zone Assessment

This project identified significant alternations to crossing riparian zones (RZs) (Sections 2.3, 3.5.7, 3.6, and 5.4.3) and their importance to the overall health and viability of aquatic ecosystems (Section 5.4.6). Loss or depletion of the integrity (form and functions) of RZs through land use conversions and removal of native vegetation significantly impact aquatic ecosystems (Figure 8-16). The objective would be to locate and assess the effects of RZ depletion along noncrossing portions of CPB waterways. A remote-sensing/GIS methodology would be used to identify, discriminate, and delineate RZs; features and conditions would be ground-truthed; and RZ treatment areas would be prioritized.



Figure 8-16. CPB Crossing Streams With Depleted Riparian Zones (Donald Ray)

8.2.7.9 Roadscape Trajectories Analysis

Roadscape trajectories analysis (RTA) comparatively investigates alternative futures associated with the implementation of crossing and roadway treatment scenarios to analytically evaluate what is possible and what is practical. Defining potential roadscape trajectories forces written specificity of strongly held but vaguely defined issues, values, and opinions. The purpose is to articulate and comparatively analyze alternatives that represent potentially conflicting yet significant sets of issues. Testing alternatives against what is possible facilitates measurable progress on complex, partially understood problems despite incomplete information and divergent

viewpoints. RTA lays a foundation for engagement and communication among interested parties to review plausible actions in concert with potential impacts and consequences. It emphasizes the importance of analyzing alternative futures rather than prematurely embracing a single alternative.

RTA focuses on developing and evaluating actions that functionally diminish or eliminate road and stream crossing induced water quality and aquatic habitat sedimentation impacts. The approach is to evaluate principle alternatives and project anticipated consequences associated with changes in sedimentation rates, road and stream crossing maintenance requirements, and treatment costs. A second phase of the analysis evaluates treatments in quantitative forms and analyzes spatially explicit scenarios using scientifically defensible metrics and GIS mapping tools. Alternative evaluations are conducted using quantitative models to map future roadscapes and SC treatment scenarios.

RTA provides decision-makers with tangible evidence of how different policies and actions can impact outcomes. Some alternatives may produce nearly identical outcomes, whereas others may produce significantly divergent outcomes. In most instances, it will be a synergetic combination of practical options that define the final outcome.

8.2.7.10 Wetland Connectivity Assessments

As discussed in Section 5.4.5, CPB unpaved roads that dissect wetlands can impact ecosystem hydroperiods and alter vegetative succession. Road culverts placed under wetland roads to prevent overtopping that are improperly located, sized, and/or installed or have been damaged or abandoned can restrict sustaining water flows between dissected wetland areas. In some instances, a contiguous wetland may be dissected multiple times by unpaved roads. Altered hydrology can reduce wetland water quality benefits and diminish biological integrity.

The purpose of CPB wetland connectivity assessments would be to inventory and characterize impacted wetlands, identify site hydroperiod conditions and alterations, assess interactions with adjacent land uses, inventory connectivity culvert structures, conduct wetland impact analysis, and develop site hydrologic connectivity restoration, maintenance, and monitoring plans. The CPB unpaved roads with identified wetland connectivity culverts (Table 5-25) would serve as a project baseline for locating assessment sites. Treatment projects would include replacing damaged structures at minimally impacted sites, reducing road erosion, and retrofitting heavily impacted sites to restore hydroperiods. Restoration projects would focus on installing and maintaining appropriate structures in locations that minimize road flooding and facilitate the maintenance of hydroperiods necessary to sustain the desired wetland ecosystem.

8.3 CHALLENGES

In an ecosystem, each part of the environment interacts to contribute to the working of the system as a whole. A change in one component can produce changes in many other components which, in turn, alter still other parts of the environment. The web of impacts can expand dynamically as a result of a single action, with the entire system being directly affected by a change in any one of its parts. Similarly, an impact is not generally the result of one lone cause but of many combined changes. This fact makes the mitigation of impacts an especially difficult, yet necessary, task.

Because of the distribution of crossings on the CPB landscape, direct linkage to aquatic ecosystems, and potential to intersect multiple surface and subsurface drainage features, crossings can profoundly affect aquatic ecosystems; one of the most pervasive is sedimentation. Streams are the theoretical “conveyor belts” that move energy and materials

to the lowest points in the watershed. They work relentlessly toward stability by constantly moving and depositing sediments between small and large streams, floodplains, and wetlands during low-flow conditions, as well as during floods. Left undisturbed over time, natural stream systems attain a self-adjusting steady state in their dimension, pattern, and profile that is neither degrading (erosion) nor aggrading (sediment deposition). Under such conditions, minor changes in sediment inputs have minimal effects. However, streams typically react to major increases in sediment or runoff inputs by physically adjusting their channel form, which can adversely impact ecosystem water quality and aquatic habitats.

The high volume of sediment inputs and increased runoff at many CPB crossings has altered the steady-state equilibrium of many aquatic ecosystems. Generally, turbidity levels following storms have increased, and many affected streams have become shallower and wider. In some instances, crossing culverts are functioning as grade-stabilization structures and preventing streambed incision adjustments, by inhibiting upstream headcutting and channel regrading. In cases of heavy sediment loading, streambeds are smothered by sediments, resulting in damage to aquatic species and their habitats.

Crossing site sedimentation is not just a localized event but has direct implications on the overall ecological health of the CPB. Considering that there are approximately 759 confirmed county-maintained unpaved crossings within the CPB, the sediment contribution from each, whether minor or catastrophic, is a cumulative component of how sedimentation is impacting the basin. Sedimentation is pervasive, in that its impacts not only affect waterways at the point of discharge but are transported throughout downstream environments. Over time, sediments that enter streams at crossings along the northern boundary of the CPB directly affect ecosystems at the southern CPB discharge point – Choctawhatchee Bay (Figure 8-17). Because of the hydrologic connectivity of the CPB, sedimentation should be viewed within a context of localized crossing site and stream effects, as well as potential cumulative effects on the basin and its rivers. The rapid growth and development of Northwest Florida will place increasing demands and pressures on CPB transportation networks and road-stream crossings.

Although crossings contribute to the degradation of aquatic ecosystems, efforts to minimize sediment impacts have been relatively ineffective, primarily due to the lack of information upon which to base decision-making, adherence to historical road maintenance paradigms; improperly designed, installed, and/or maintained crossing structures; and lack of resources. Long-term fixes can be made by implementing solutions that account for the diversity of crossing environmental impact variables, target high-priority treatment sites, embrace shifts in road maintenance paradigms, and produce sustainable treatment options.



Figure 8-17. CPB Crossing Site Sedimentation and Choctawhatchee Bay Discharge Into the Gulf of Mexico at Destin Pass

The recovery, protection, and conservation of impacted CPB ecosystems is a daunting but necessary endeavor that is indispensable to the health of CPB environments, socioeconomic prosperity, and the overall well-being of its inhabitants. Considering that there may be thousands of unpaved crossings in Northwest Florida, it is critical to establish a systematic program for developing technologies, managing information, addressing issues, implementing treatment projects, and monitoring results.

8.4 LITERATURE CITED

Horton, R.E. 1947. Erosional Development of Streams and Their Drainage Basins: Hydrophysical Approach to Quantitative Morphology. *Geological Society of America Bulletin* 56: 275-370.

Salix Applied Earthcare. 1999. *Erosion Draw 3.0*. John McCullah, Redding, CA.

Strahler, A.N. 1957. Quantitative Analysis of Watershed Geomorphology. *American Geophysical Union Transactions*. 38: 913-920.

APPENDIX A

CHOCTAWHATCHEE-PEA BASIN ROAD-STREAM CROSSINGS INDEX MAP



This appendix provides an index map showing the location of all crossings identified during the Choctawhatchee-Pea Basin Road-Stream Crossings assessment. In addition, lookup tables are provided for water, crossover site, and proximity site crossings, which are cross-referenced on the index map grid.


Mike Rainer

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A.3 Choctawhatchee-Pea Basin Road-Stream Crossings Index Map ..... pocket insert

ACRONYMS

CI	crossing identification
CPB	Choctawhatchee-Pea Basin


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A.1 CHOCTAWHATCHEE-PEA BASIN ROAD-STREAM CROSSINGS INDEX MAP LOOKUP TABLES

A.1.1 WATER CROSSINGS LOOKUP TABLE

The 447 Choctawhatchee-Pea Basin (CPB) water crossings listed in Table A-1 are sorted by subbasin and crossing identification (CI) number. The last seven-digit number in the CI is sorted in ascending order (from lowest to highest).

Table A-1. Choctawhatchee-Pea Basin Water Crossings

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12005_600965_3360125	950	Otter Creek	Bay	C5
12005_599121_3361813	950	Otter Creek	Bay	C5
12005_599190_3361962	950	Otter Creek	Bay	C5
12005_601942_3362462	950	Otter Creek	Bay	C5
12133_604043_3366921	49b	Choctawhatchee River	Washington	C5
12133_608657_3371568	49b	Choctawhatchee River	Washington	D4
12133_608895_3371613	49b	Choctawhatchee River	Washington	D4
12133_608963_3371801	49b	Choctawhatchee River	Washington	D4
12131_590457_3373824	747	Unnamed creek	Walton	C4
12131_590344_3373860	747	Unnamed creek	Walton	C4
12131_588901_3373806	739	Pate Branch	Walton	B4
12131_588597_3373858	739	Pate Branch	Walton	B4
12131_587694_3373832	741	Unnamed run	Walton	B4
12133_626142_3374258	526	Pine Log Creek	Washington	E4
12133_623909_3375974	526	Pine Log Creek	Washington	D4
12133_610428_3378697	651	Spring Run	Washington	D4
12133_609849_3378843	651	Spring Run	Washington	D4
12133_611570_3380601	59	Holmes Creek	Washington	D4
12133_611506_3380992	59	Holmes Creek	Washington	D4
12133_630809_3381381	526	Pine Log Creek	Washington	E4
12133_611506_3381437	59	Holmes Creek	Washington	D4
12133_609783_3382380	59	Holmes Creek	Washington	D4
12133_611989_3382356	59	Holmes Creek	Washington	D4
12133_609327_3383958	59	Holmes Creek	Washington	D4
12133_632519_3384737	526	Pine Log Creek	Washington	E4
12133_633767_3384797	526	Pine Log Creek	Washington	E4
12133_635833_3385174	456	Reedy Creek	Washington	E4
12133_617731_3385316	550	Williams Branch	Washington	D4
12133_614218_3385675	545	Reedy Branch	Washington	D4
12133_636843_3386378	456	Reedy Creek	Washington	E3
12133_636881_3386512	456	Reedy Creek	Washington	E3
12133_625875_3387015	501	Pippin Mill Creek	Washington	E3
12131_600312_3387259	343	Bruce Creek	Walton	C3
12131_592407_3387439	343	Bruce Creek	Walton	C3
12133_635494_3387474	456	Reedy Creek	Washington	E3
12133_631902_3387482	526	Pine Log Creek	Washington	E3
12131_592387_3387504	343	Bruce Creek	Walton	C3
12131_596073_3387582	343	Bruce Creek	Walton	C3
12133_641691_3387683	401	Hard Labor Creek	Washington	E3
12133_646316_3387889	490	Poley Creek	Washington	F3
12131_592169_3387913	343	Bruce Creek	Walton	C3
12131_589556_3387946	343	Bruce Creek	Walton	C3
12131_604086_3387915	49e	Choctawhatchee River	Walton	C3
12133_643171_3387949	401	Hard Labor Creek	Washington	F3
12133_639341_3387976	401	Hard Labor Creek	Washington	E3
12131_594230_3388124	343	Bruce Creek	Walton	C3
12133_646584_3388217	490	Poley Creek	Washington	F3
12131_596880_3388321	382	White Creek	Walton	C3
12131_603917_3388406	49e	Choctawhatchee River	Walton	C3
12131_584870_3388458	486	Mill Creek	Walton	B3
12131_585279_3388430	486	Mill Creek	Walton	B3
12133_642899_3388588	401	Hard Labor Creek	Washington	F3
12131_603548_3388701	49e	Choctawhatchee River	Walton	C3

Table A-1. Choctawhatchee-Pea Basin Water Crossings Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12131_598106_3388730	457	Spears Branch	Walton	C3
12133_646259_3388743	490	Poley Creek	Washington	F3
12133_644049_3389298	401	Hard Labor Creek	Washington	F3
12133_639437_3389888	401	Hard Labor Creek	Washington	E3
12131_587594_3390119	343	Bruce Creek	Walton	B3
12131_588111_3390200	343	Bruce Creek	Walton	B3
12131_587757_3390255	343	Bruce Creek	Walton	B3
12133_642967_3390542	346	Little Hard Labor Cr	Washington	F3
12133_642465_3390661	455	Davis Branch	Washington	E3
12131_598977_3390609	457	Spears Branch	Walton	C3
12131_601129_3390936	399	Hughes Ditch	Walton	C3
12131_590198_3391114	371	Panther Creek	Walton	C3
12131_601102_3391372	399	Hughes Ditch	Walton	C3
12131_598012_3391393	404	Crooked Creek	Walton	C3
12131_597017_3391508	441	Peavy Creek	Walton	C3
12131_602720_3391759	178	Sandy Creek	Walton	C3
12133_632556_3392055	59	Holmes Creek	Washington	E3
12133_637868_3392298	401	Hard Labor Creek	Washington	E3
12131_594023_3392453	382	White Creek	Walton	C3
12133_647019_3392581	401	Hard Labor Creek	Washington	F3
12131_588846_3392706	343	Bruce Creek	Walton	B3
12133_643054_3393049	346	Little Hard Labor Cr	Washington	F3
12133_617534_3393617	348	Gully Creek	Washington	D3
12131_595137_3393850	373	White Creek	Walton	C3
12131_583070_3393990	350	Bay Branch	Walton	B3
12133_627090_3394392	59	Holmes Creek	Washington	E3
12131_595982_3394340	382	White Creek	Walton	C3
12133_627465_3394656	59	Holmes Creek	Washington	E3
12133_633249_3394653	401	Hard Labor Creek	Washington	E3
12133_628817_3395596	59	Holmes Creek	Washington	E3
12133_624814_3395782	348	Gully Creek	Washington	D3
12131_600477_3395891	366	Oak Grove Branch	Walton	C3
12133_616501_3396220	239	Gum Creek	Washington	D3
12133_635580_3396336	337	Flat Creek	Washington	E3
12133_641030_3396310	337	Flat Creek	Washington	E3
12133_612247_3396364	362	Yates Mill Creek	Washington	D3
12133_638794_3396780	337	Flat Creek	Washington	E3
12133_640400_3396919	337	Flat Creek	Washington	E3
12133_639810_3397108	337	Flat Creek	Washington	E3
12133_642008_3397707	337	Flat Creek	Washington	E3
12133_630414_3397868	59	Holmes Creek	Washington	E3
12133_629502_3398783	59	Holmes Creek	Washington	E3
12133_614932_3398772	239	Gum Creek	Washington	D3
12059_605137_3402312	212	Reedy Creek	Holmes	C3
12059_601141_3398948	349	Mill Creek	Holmes	C3
12059_605393_3398698	212	Reedy Creek	Holmes	C3
12133_630035_3399203	59	Holmes Creek	Washington	E3
12133_635587_3399509	59	Holmes Creek	Washington	E3
12133_633961_3399573	59	Holmes Creek	Washington	E3
12133_636388_3399583	59	Holmes Creek	Washington	E3
12133_620666_3399722	239	Gum Creek	Washington	D3
12133_634935_3399984	59	Holmes Creek	Washington	E3
12133_618786_3400131	239	Gum Creek	Washington	D3
12131_585644_3400896	269	West Sandy Creek	Walton	B3
12133_614556_3400848	49	Choctawhatchee River	Washington	D3
12133_627510_3401084	286	Open Creek	Washington	E3
12133_635561_3401290	59	Holmes Creek	Washington	E3
12133_620956_3401344	239	Gum Creek	Washington	D3
12133_624766_3401446	286	Open Creek	Washington	D3
12133_624733_3401517	286	Open Creek	Washington	D3
12059_602867_3405332	212	Reedy Creek	Holmes	C3
12133_637101_3402004	59	Holmes Creek	Washington	E3
12133_615537_3402016	261	Dram Branch	Washington	D2
12059_595428_3402370	178	Sandy Creek	Holmes	C2
12131_585653_3402149	269	West Sandy Creek	Walton	B2
12133_615819_3402419	261	Dram Branch	Washington	D2
12131_585620_3402440	283a	Lake Juniper Drain	Walton	B2
12059_622215_3403141	239	Gum Creek	Holmes	D2

Table A-1. Choctawhatchee-Pea Basin Water Crossings Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12133_648715_3403157	262	Gilberts Mill Creek	Washington	F2
12059_605172_3406628	212	Reedy Creek	Holmes	C2
12059_600902_3403815	210	Otter Creek	Holmes	C2
12059_593982_3404088	249	Padgett Creek	Holmes	C2
12063_650607_3404144	262	Gilberts Mill Creek	Jackson	F2
12059_596707_3404240	289	Black Branch	Holmes	C2
12059_592936_3404304	273	Parrish Creek	Holmes	C2
12133_618173_3404328	261	Dram Branch	Washington	D2
12059_627939_3404435	251	Camp Branch	Holmes	E2
12059_596249_3404471	289	Black Branch	Holmes	C2
12131_585614_3404688	269	West Sandy Creek	Walton	B2
12059_627555_3404690	251	Camp Branch	Holmes	E2
12133_620568_3404818	239	Gum Creek	Washington	D2
12133_615342_3404831	261	Dram Branch	Washington	D2
12059_624503_3405170	286	Open Creek	Holmes	D2
12059_599642_3405100	210	Otter Creek	Holmes	C2
12059_631164_3405247	59	Holmes Creek	Holmes	E2
12059_599926_3411751	205	Bay Drain	Holmes	C2
12059_600562_3405537	210	Otter Creek	Holmes	C2
12059_630721_3406621	59	Holmes Creek	Holmes	E2
12059_628994_3407640	232	Unnamed drain	Holmes	D2
12059_599918_3405410	270	Goose Branch	Holmes	C2
12059_618284_3407130	261	Dram Branch	Holmes	D2
12059_618673_3407170	261	Dram Branch	Holmes	D2
12059_628312_3407385	251	Camp Branch	Holmes	E2
12059_628565_3407554	251	Camp Branch	Holmes	E2
12059_628864_3413520	206	Gum Branch	Holmes	E2
12063_649215_3408107	262	Gilberts Mill Creek	Jackson	F2
12059_630541_3408083	59	Holmes Creek	Holmes	E2
12059_601866_3408469	212	Reedy Creek	Holmes	C2
12059_633587_3408266	59	Holmes Creek	Holmes	E2
12059_606111_3408200	49f	Choctawhatchee River	Holmes	C2
12133_644180_3408431	123	Alligator Creek	Washington	F2
12059_601172_3408729	212	Reedy Creek	Holmes	C2
12059_602102_3408645	212	Reedy Creek	Holmes	C2
12059_632870_3408534	59	Holmes Creek	Holmes	E2
12059_614624_3409574	240	Hathaway Mill Creek	Holmes	D2
12059_600382_3411724	205	Bay Drain	Holmes	C2
12059_623019_3408453	239	Gum Creek	Holmes	D2
12059_627943_3408659	251	Camp Branch	Holmes	E2
12059_599227_3402110	298	Cow Branch	Holmes	C2
12059_596942_3408843	210	Otter Creek	Holmes	C2
12059_597857_3408906	210	Otter Creek	Holmes	C2
12063_647147_3409117	233	Unnamed creek	Jackson	F2
12059_632340_3409137	59	Holmes Creek	Holmes	E2
12063_647255_3409221	233	Unnamed creek	Jackson	F2
12059_632326_3409458	59	Holmes Creek	Holmes	E2
12063_647819_3409694	233	Unnamed creek	Jackson	F2
12059_619270_3409939	240	Hathaway Mill Creek	Holmes	D2
12059_630729_3419945	54	Wrights Creek	Holmes	D2
12059_613008_3410302	54	Wrights Creek	Holmes	D2
12133_638927_3410070	123	Alligator Creek	Washington	E2
12059_606243_3410154	49f	Choctawhatchee River	Holmes	C2
12059_595677_3410137	210	Otter Creek	Holmes	C2
12059_607716_3410489	49f	Choctawhatchee River	Holmes	D2
12059_617677_3408660	240	Hathaway Mill Creek	Holmes	D2
12133_634872_3410545	59	Holmes Creek	Washington	E2
12059_613887_3411040	54	Wrights Creek	Holmes	D2
12059_594768_3410680	210	Otter Creek	Holmes	C2
12059_621668_3414077	54	Wrights Creek	Holmes	D2
12133_634790_3411395	59	Holmes Creek	Washington	E2
12059_595243_3411442	210	Otter Creek	Holmes	C2
12059_606923_3411670	49f	Choctawhatchee River	Holmes	C2
12059_633049_3412290	59	Holmes Creek	Holmes	E2
12059_613793_3412809	54	Wrights Creek	Holmes	D2
12131_587566_3412505	178	Sandy Creek	Walton	B2
12059_622291_3422114	77	Little Creek	Holmes	D2
12063_640949_3413184	130	Fish Branch	Jackson	E2

Table A-1. Choctawhatchee-Pea Basin Water Crossings Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12059_611822_3413212	49f	Choctawhatchee River	Holmes	D2
12063_635313_3413275	59	Holmes Creek	Jackson	E2
12059_630621_3416764	54	Wrights Creek	Holmes	E2
12063_645738_3413309	123	Alligator Creek	Jackson	F2
12063_641043_3413302	130	Fish Branch	Jackson	E2
12063_645366_3413300	123	Alligator Creek	Jackson	F2
12059_601908_3413431	212	Reedy Creek	Holmes	C2
12059_619470_3412825	54	Wrights Creek	Holmes	D2
12059_633419_3413576	59	Holmes Creek	Holmes	E2
12059_618628_3415535	143	Limestone Branch	Holmes	D2
12059_628909_3413769	206	Gum Branch	Holmes	E2
12059_624966_3414933	206	Gum Branch	Holmes	D2
12059_612706_3413958	49f	Choctawhatchee River	Holmes	D2
12059_604984_3413972	49f	Choctawhatchee River	Holmes	C2
12063_645775_3413975	123	Alligator Creek	Jackson	F2
12063_646733_3414135	123	Alligator Creek	Jackson	F2
12063_648636_3414126	195	Scurlock Creek	Jackson	F2
12059_610765_3414346	49f	Choctawhatchee River	Holmes	D2
12059_623817_3413615	54	Wrights Creek	Holmes	D2
12059_632035_3414226	59	Holmes Creek	Holmes	E2
12059_597988_3414206	146	West Pittman Creek	Holmes	C2
12063_642627_3414509	130	Fish Branch	Jackson	F2
12063_648745_3414522	195	Scurlock Creek	Jackson	F2
12059_604566_3414628	49f	Choctawhatchee River	Holmes	C2
12063_641925_3414701	130	Fish Branch	Jackson	E2
12059_614889_3413732	183	Catfish Branch	Holmes	D2
12059_633917_3414927	59	Holmes Creek	Holmes	E2
12063_640904_3414891	130	Fish Branch	Jackson	E2
12063_641200_3414909	130	Fish Branch	Jackson	E2
12059_622270_3417030	77	Little Creek	Holmes	D2
12059_624250_3414951	54	Wrights Creek	Holmes	E2
12059_624157_3414952	54	Wrights Creek	Holmes	D2
12059_621864_3414904	54	Wrights Creek	Holmes	D2
12063_637804_3415298	147	Gum Creek	Jackson	E2
12059_626787_3415716	54	Wrights Creek	Holmes	E2
12059_619790_3417892	54	Wrights Creek	Holmes	D2
12059_609796_3415694	142	Sikes Creek	Holmes	D2
12059_633585_3415689	59	Holmes Creek	Holmes	E2
12059_629231_3426838	61	Texas Branch	Holmes	E2
12059_612738_3415817	49f	Choctawhatchee River	Holmes	D2
12059_593553_3415873	146	West Pittman Creek	Holmes	C2
12059_593915_3415962	146	West Pittman Creek	Holmes	C2
12063_638716_3416059	147	Gum Creek	Jackson	E2
12059_598113_3416255	146	West Pittman Creek	Holmes	C2
12063_643582_3416447	130	Fish Branch	Jackson	F2
12059_634528_3416459	59	Holmes Creek	Holmes	E2
12059_622725_3416486	56	Tenmile Creek	Holmes	D2
12063_646844_3416549	157	Little Alligator Cr	Jackson	F2
12063_646050_3416437	123	Alligator Creek	Jackson	F2
12059_619399_3419998	54	Wrights Creek	Holmes	E2
12059_625263_3415772	54	Wrights Creek	Holmes	E2
12059_631631_3417650	54	Wrights Creek	Holmes	E2
12059_622652_3417035	56	Tenmile Creek	Holmes	D2
12059_627159_3416907	54	Wrights Creek	Holmes	E2
12059_598980_3417165	146	West Pittman Creek	Holmes	C2
12059_627229_3420965	54	Wrights Creek	Holmes	D2
12059_632975_3417285	59	Holmes Creek	Holmes	E2
12059_597409_3417399	164	Timber Branch	Holmes	C2
12059_611640_3417509	142	Sikes Creek	Holmes	D2
12063_642985_3417493	130	Fish Branch	Jackson	F2
12063_641663_3417689	147	Gum Creek	Jackson	E2
12063_647888_3417781	157	Little Alligator Cr	Jackson	F2
12063_646228_3417776	123	Alligator Creek	Jackson	F2
12059_621450_3421119	77	Little Creek	Holmes	D2
12063_636081_3418138	59	Holmes Creek	Jackson	E2
12059_599137_3418171	146	West Pittman Creek	Holmes	C2
12059_622848_3418245	56	Tenmile Creek	Holmes	D2
12059_632475_3418231	59	Holmes Creek	Holmes	E2

Table A-1. Choctawhatchee-Pea Basin Water Crossings Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12059_599136_3418265	146	West Pittman Creek	Holmes	C1
12059_635398_3418338	59	Holmes Creek	Holmes	E1
12059_598568_3418405	146	West Pittman Creek	Holmes	C1
12063_642738_3418563	130	Fish Branch	Jackson	F1
12063_642760_3418963	130	Fish Branch	Jackson	F1
12063_639229_3418951	147	Gum Creek	Jackson	E1
12063_640335_3419074	147	Gum Creek	Jackson	E1
12059_622519_3419867	77	Little Creek	Holmes	D1
12059_600415_3419219	146	West Pittman Creek	Holmes	C1
12059_623492_3419197	56	Tenmile Creek	Holmes	D1
12059_624895_3419454	56	Tenmile Creek	Holmes	E1
12059_625048_3419399	56	Tenmile Creek	Holmes	E1
12059_635539_3419224	139	Jackson Branch	Holmes	E1
12059_626096_3413298	206	Gum Branch	Holmes	D1
12059_625115_3419525	54	Wrights Creek	Holmes	E1
12059_616749_3424615	108	Bee Branch	Holmes	D1
12059_633958_3420481	139	Jackson Branch	Holmes	E1
12063_642743_3419649	130	Fish Branch	Jackson	F1
12063_643514_3419772	130	Fish Branch	Jackson	F1
12063_644135_3419774	130	Fish Branch	Jackson	F1
12059_615647_3419760	142	Sikes Creek	Holmes	D1
12059_601760_3419857	146	West Pittman Creek	Holmes	C1
12063_644237_3419882	130	Fish Branch	Jackson	F1
12059_622687_3419761	77	Little Creek	Holmes	D1
12059_602167_3419934	146	West Pittman Creek	Holmes	C1
12059_620534_3419184	54	Wrights Creek	Holmes	D1
12059_598885_3420183	136	Pine Log Creek	Holmes	C1
12059_626690_3419538	54	Wrights Creek	Holmes	E1
12059_610508_3420337	133	Ginhouse Branch	Holmes	D1
12059_615210_3420390	142	Sikes Creek	Holmes	D1
12059_597554_3420415	136	Pine Log Creek	Holmes	C1
12059_634725_3419557	139	Jackson Branch	Holmes	E1
12059_635376_3420591	59	Holmes Creek	Holmes	E1
12063_640089_3420588	147	Gum Creek	Jackson	E1
12059_615200_3420666	142	Sikes Creek	Holmes	D1
12059_603459_3420893	112	Angelico Branch	Holmes	C1
12059_606703_3421024	126	Dada Branch	Holmes	C1
12059_622410_3421121	77	Little Creek	Holmes	D1
12063_640517_3421167	147	Gum Creek	Jackson	E1
12059_635621_3421345	59	Holmes Creek	Holmes	E1
12063_646433_3421396	123	Alligator Creek	Jackson	F1
12063_642456_3421386	130	Fish Branch	Jackson	E1
12059_606032_3421506	119	Windmill Branch	Holmes	C1
12059_614393_3421453	142	Sikes Creek	Holmes	D1
12063_638723_3421488	59	Holmes Creek	Jackson	E1
12059_637103_3421585	59	Holmes Creek	Holmes	E1
12059_637554_3421906	59	Holmes Creek	Holmes	E1
12059_600205_3421948	109	Fowler Branch	Holmes	C1
12059_635966_3421964	59	Holmes Creek	Holmes	E1
12063_646364_3422088	123	Alligator Creek	Jackson	F1
12059_627493_3422139	56	Tenmile Creek	Holmes	E1
12059_614072_3422157	142	Sikes Creek	Holmes	D1
12063_642926_3422175	130	Fish Branch	Jackson	F1
12059_626549_3422359	56	Tenmile Creek	Holmes	E1
12059_623336_3423834	77	Little Creek	Holmes	D1
12063_642168_3422706	130	Fish Branch	Jackson	E1
12059_605456_3422790	119	Windmill Branch	Holmes	C1
12059_635924_3422889	59	Holmes Creek	Holmes	E1
12059_637934_3427072	86	Bell Branch	Holmes	E1
12063_642092_3422971	130	Fish Branch	Jackson	E1
12059_615200_3423100	121	Little Creek	Holmes	D1
12059_630038_3423411	113	Register Branch	Holmes	E1
12059_631093_3427099	58	Mill Branch	Holmes	E1
12063_641318_3423413	130	Fish Branch	Jackson	E1
12059_638798_3423643	59	Holmes Creek	Holmes	E1
12059_602721_3423728	112	Angelico Branch	Holmes	C1
12059_621827_3422702	77	Little Creek	Holmes	D1
12059_625166_3424067	56	Tenmile Creek	Holmes	E1

Table A-1. Choctawhatchee-Pea Basin Water Crossings Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12059_631786_3422866	54	Wrights Creek	Holmes	E1
12059_625102_3424144	56	Tenmile Creek	Holmes	E1
12059_615312_3424152	55	East Pittman Creek	Holmes	D1
12059_637109_3424203	59	Holmes Creek	Holmes	E1
12059_608330_3424331	94	Limestone Branch	Holmes	D1
12059_607182_3424350	94	Limestone Branch	Holmes	D1
12059_624460_3424379	56	Tenmile Creek	Holmes	D1
12059_638692_3424359	59	Holmes Creek	Holmes	E1
12059_639280_3424444	59	Holmes Creek	Holmes	E1
12059_638102_3424551	59	Holmes Creek	Holmes	E1
12059_599786_3408536	205	Bay Drain	Holmes	E1
12059_626736_3424561	56	Tenmile Creek	Holmes	E1
12059_628150_3424588	56	Tenmile Creek	Holmes	E1
12059_640289_3424608	59	Holmes Creek	Holmes	E1
12059_606026_3424697	94	Limestone Branch	Holmes	C1
12059_627138_3424782	56	Tenmile Creek	Holmes	E1
12059_637141_3425027	59	Holmes Creek	Holmes	E1
12059_629531_3424126	113	Register Branch	Holmes	E1
12059_637320_3425437	59	Holmes Creek	Holmes	E1
12059_603513_3425625	47	Parrot Creek	Holmes	C1
12059_615306_3425537	55	East Pittman Creek	Holmes	D1
12059_627468_3425739	56	Tenmile Creek	Holmes	E1
12059_638749_3425969	59	Holmes Creek	Holmes	E1
12059_616641_3426004	55	East Pittman Creek	Holmes	D1
12059_615802_3425995	69	Unnamed branch	Holmes	D1
12059_639577_3426066	59	Holmes Creek	Holmes	E1
12059_624944_3426115	56	Tenmile Creek	Holmes	E1
12059_609588_3426163	47	Parrot Creek	Holmes	D1
12059_627639_3426295	61	Texas Branch	Holmes	E1
12059_606105_3426458	47	Parrot Creek	Holmes	C1
12059_633525_3425328	103	Corbett Branch	Holmes	E1
12059_631790_3427338	58	Mill Branch	Holmes	E1
12059_632080_3429420	54	Wrights Creek	Holmes	E1
12059_608364_3427017	47	Parrot Creek	Holmes	D1
12059_602307_3426910	47	Parrot Creek	Holmes	C1
12059_620977_3426932	55	East Pittman Creek	Holmes	D1
12059_619077_3427196	55	East Pittman Creek	Holmes	D1
12059_631373_3425390	54	Wrights Creek	Holmes	E1
12059_619565_3428353	53	Clark Mill Creek	Holmes	E1
12059_601244_3399095	349	Mill Creek	Holmes	E1
12059_632405_3427941	54	Wrights Creek	Holmes	E1
12059_632432_3427383	54	Wrights Creek	Holmes	D1
12059_626640_3425941	61	Texas Branch	Holmes	D1
12059_616556_3427853	69	Unnamed branch	Holmes	D1
12059_632280_3428832	54	Wrights Creek	Holmes	E1
12059_625607_3427827	56	Tenmile Creek	Holmes	E1
12059_627131_3428070	56	Tenmile Creek	Holmes	E1
12059_608751_3428168	47	Parrot Creek	Holmes	D1
12059_636345_3428232	54	Wrights Creek	Holmes	E1
12059_605805_3428211	47	Parrot Creek	Holmes	C1
12059_620441_3428234	55	East Pittman Creek	Holmes	D1
12059_606356_3422560	119	Windmill Branch	Holmes	E1
12059_636401_3428218	54	Wrights Creek	Holmes	E1
12059_614478_3428556	48	Whitewater Branch	Holmes	D1
12059_610676_3428692	49f	Choctawhatchee River	Holmes	D1
12059_615788_3428702	48	Whitewater Branch	Holmes	D1
12059_633823_3428214	54	Wrights Creek	Holmes	E1
12059_604871_3428774	47	Parrot Creek	Holmes	C1
12059_633265_3428625	54	Wrights Creek	Holmes	E1
12059_615206_3428824	48	Whitewater Branch	Holmes	D1
12059_633090_3429287	54	Wrights Creek	Holmes	E1
12059_639892_3429040	59	Holmes Creek	Holmes	E1
12059_642412_3429094	59	Holmes Creek	Holmes	E1
12059_640825_3429170	59	Holmes Creek	Holmes	E1
12059_605717_3429264	47	Parrot Creek	Holmes	C1
12059_632634_3429053	54	Wrights Creek	Holmes	E1
12059_640506_3429418	59	Holmes Creek	Holmes	E1
12059_625131_3429532	56	Tenmile Creek	Holmes	E1

Table A-1. Choctawhatchee-Pea Basin Water Crossings Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd				
12059_624597_3429579	56	Tenmile Creek	Holmes	D1
12059_636667_3429703	54	Wrights Creek	Holmes	E1
12059_641905_3429936	59	Holmes Creek	Holmes	E1
12059_640656_3430055	59	Holmes Creek	Holmes	E1
12131_596726_3358868	983	Tenmile Branch	Walton	C5
Pea River Subbasin, HUC 03140202				
12131_585542_3420465	68	Chestnut Creek	Walton	B1
12131_584991_3420465	68	Chestnut Creek	Walton	B1
12059_595068_3423954	63	Hurricane Creek	Holmes	C1
12059_594827_3424131	63	Hurricane Creek	Holmes	C1
12131_584945_3424329	66	Spring Branch	Walton	B1
12059_598541_3424859	63	Hurricane Creek	Holmes	C1
12131_577263_3424973	42	Eighteen Mile Creek	Walton	B1
12131_574343_3425295	42	Eighteen Mile Creek	Walton	B1
12131_573354_3425249	40	Limestone Branch	Walton	B1
12131_574345_3425295	42	Eighteen Mile Creek	Walton	B1
12131_579149_3425387	42	Eighteen Mile Creek	Walton	B1
12131_580828_3425985	42	Eighteen Mile Creek	Walton	B1
12131_579195_3426192	42	Eighteen Mile Creek	Walton	B1
12059_598029_3426302	63	Hurricane Creek	Holmes	C1
12059_598215_3426316	63	Hurricane Creek	Holmes	C1
12131_577907_3426307	42	Eighteen Mile Creek	Walton	B1
12131_584738_3426399	43	Limestone Creek	Walton	B1
12131_584186_3426376	43	Limestone Creek	Walton	B1
12131_579103_3426422	42	Eighteen Mile Creek	Walton	B1
12059_596747_3427352	81	Mack Bay Branch	Holmes	C1
12131_569997_3427554	40	Limestone Branch	Walton	A1
12131_569835_3427686	40	Limestone Branch	Walton	A1
12059_599869_3428008	63	Hurricane Creek	Holmes	C1
12131_580805_3428008	43	Limestone Creek	Walton	B1
12131_570318_3428215	40	Limestone Branch	Walton	A1
12131_585933_3428376	43	Limestone Creek	Walton	B1
12131_575631_3428399	40a	Natural Bridge Creek	Walton	B1
12131_585703_3428652	43	Limestone Creek	Walton	B1
12131_591261_3428489	43	Limestone Creek	Walton	C1
12059_601754_3428790	46	Pea River	Holmes	C1
12059_601030_3428689	46	Pea River	Holmes	C1
12131_571101_3428871	40	Limestone Branch	Walton	A1
12131_588448_3429221	43	Limestone Creek	Walton	B1
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_571853_3360706	881	Direct runoff to bay	Walton	B5
12131_573913_3362924	881	Direct runoff to bay	Walton	B5
12131_574146_3364860	881	Direct runoff to bay	Walton	B5
12131_576454_3374724	731	Alaqua Bayou	Walton	B4
12131_578852_3375630	351a	Alaqua Creek	Walton	B4
12131_576836_3375767	351a	Alaqua Creek	Walton	B4
12131_579533_3394149	369	Sconiers Mill Creek	Walton	B3
12131_579859_3394231	369	Sconiers Mill Creek	Walton	B3
12131_580186_3394422	369	Sconiers Mill Creek	Walton	B3
12131_580921_3395729	369	Sconiers Mill Creek	Walton	B3
12131_580773_3395720	369	Sconiers Mill Creek	Walton	B3
12131_581412_3395702	369	Sconiers Mill Creek	Walton	B3
12131_580649_3395756	340	Kiser Branch	Walton	B3
12131_578634_3396546	332	Cosson Mill Creek	Walton	B3
12131_578062_3396628	332	Cosson Mill Creek	Walton	B3
12131_577085_3396991	332	Cosson Mill Creek	Walton	B3
12131_576673_3397336	332	Cosson Mill Creek	Walton	B3

A.1.2 CROSSOVER SITE CROSSINGS LOOKUP TABLE

The 267 Choctawhatchee-Pea Basin (CPB) crossover site crossings listed in Table A-2 are sorted by subbasin, crossing identification (CI) number, and an index map cross-reference number. The last seven-digit number in the CI is sorted in ascending order (from lowest to highest).

Table A-2. Choctawhatchee-Pea Basin Crossover Site Crossings

Crossing Identification	WBID	WBID Name	County	Index Map Cross Reference	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203					
12005_598997_3358866	983	Tenmile Branch	Bay	59-2	C5
12005_598732_3358912	983	Tenmile Branch	Bay	59-3	C5
12005_596991_3358959	983	Tenmile Branch	Bay	59-7	C5
12005_597232_3358998	983	Tenmile Branch	Bay	59-6	C5
12005_597689_3359106	983	Tenmile Branch	Bay	59-5	C5
12005_598176_3359127	983	Tenmile Branch	Bay	59-4	C5
12005_603244_3364095	526	Pine Log Creek	Bay	60-0	C5
12005_603243_3364599	526	Pine Log Creek	Bay	60-1	C5
12133_603447_3366053	869	East River	Washington	60-224	C5
12133_605247_3366456	49b	Choctawhatchee River	Washington	60-223	C5
12133_604021_3366648	49b	Choctawhatchee River	Washington	60-222	C5
12133_607046_3368875	49b	Choctawhatchee River	Washington	60-221	D5
12133_607848_3369303	49b	Choctawhatchee River	Washington	60-220	D5
12133_625837_3373913	526	Pine Log Creek	Washington	62-247	E4
12133_623927_3375377	526	Pine Log Creek	Washington	62-248	D4
12133_626864_3379463	526	Pine Log Creek	Washington	62-249	E4
12133_608862_3381962	59	Holmes Creek	Washington	60-216	D4
12133_608803_3381960	59	Holmes Creek	Washington	60-215	D4
12133_627555_3384000	501	Pippin Mill Creek	Washington	62-250	E4
12133_633484_3384274	526	Pine Log Creek	Washington	63-252	E4
12133_632307_3384895	526	Pine Log Creek	Washington	63-251	E4
12133_635798_3387457	456	Reedy Creek	Washington	63-188	E3
12133_639550_3387536	401	Hard Labor Creek	Washington	63-192	E3
12133_635979_3387574	456	Reedy Creek	Washington	63-189	E3
12133_641510_3387835	401	Hard Labor Creek	Washington	64-194	E3
12133_641984_3387850	401	Hard Labor Creek	Washington	64-195	E3
12133_645831_3387877	490	Poley Creek	Washington	64-245	F3
12131_589669_3388007	343	Bruce Creek	Walton	58-169	C3
12133_608972_3388027	49e	Choctawhatchee River	Washington	60-214	D3
12133_642302_3388135	401	Hard Labor Creek	Washington	64-196	E3
12133_638826_3388225	401	Hard Labor Creek	Washington	63-191	E3
12133_643164_3388355	401	Hard Labor Creek	Washington	64-193	F3
12133_612208_3388397	450	Shaky Joe Branch	Washington	61-235	D3
12133_645903_3388692	490	Poley Creek	Washington	64-265	F3
12133_645986_3388700	490	Poley Creek	Washington	64-266	F3
12133_637565_3388948	401	Hard Labor Creek	Washington	63-244	E3
12133_636234_3389144	456	Reedy Creek	Washington	63-190	E3
12133_611574_3389202	59	Holmes Creek	Washington	61-234	D3
12133_611282_3389283	59	Holmes Creek	Washington	61-213	D3
12133_627268_3389388	59	Holmes Creek	Washington	62-253	E3
12133_649651_3390054	490	Poley Creek	Washington	64-264	F3
12133_632345_3390264	59	Holmes Creek	Washington	63-178	E3
12133_649404_3390547	490	Poley Creek	Washington	64-263	F3
12133_642804_3390660	346	Little Hard Labor Cr	Washington	64-259	F3
12133_611426_3390649	450	Shaky Joe Branch	Washington	61-212	D3
12133_632270_3391315	59	Holmes Creek	Washington	63-179	E3
12133_645543_3391573	401	Hard Labor Creek	Washington	64-262	F3
12133_611087_3391716	450	Shaky Joe Branch	Washington	61-236	D3
12131_588834_3391961	343	Bruce Creek	Walton	58-175	B3
12133_642836_3392014	346	Little Hard Labor Cr	Washington	64-258	F3
12133_633496_3392882	401	Hard Labor Creek	Washington	63-197	E3
12133_644840_3393109	346	Little Hard Labor Cr	Washington	64-260	F3
12133_645534_3393096	346	Little Hard Labor Cr	Washington	64-261	F3
12133_643326_3393321	346	Little Hard Labor Cr	Washington	64-257	F3
12133_633637_3393333	401	Hard Labor Creek	Washington	63-198	E3
12133_610475_3393618	362	Yates Mill Creek	Washington	61-233	D3
12133_646894_3393920	401	Hard Labor Creek	Washington	64-254	F3

Table A-2. Choctawhatchee-Pea Basin Crossover Site Crossings Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Cross Reference	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd					
12133_632706_3393942	401	Hard Labor Creek	Washington	63-199	E3
12133_622248_3394420	239	Gum Creek	Washington	62-242	D3
12131_593100_3394734	414	Folks Creek	Walton	59-176	C3
12133_618227_3394944	239	Gum Creek	Washington	61-240	D3
12133_621653_3395028	239	Gum Creek	Washington	62-243	D3
12133_618518_3395018	239	Gum Creek	Washington	61-241	D3
12133_617547_3395355	239	Gum Creek	Washington	61-239	D3
12133_617274_3395498	239	Gum Creek	Washington	61-238	D3
12133_611149_3395571	362	Yates Mill Creek	Washington	61-232	D3
12133_644725_3395642	346	Little Hard Labor Cr	Washington	64-256	F3
12133_611392_3395721	362	Yates Mill Creek	Washington	61-231	D3
12133_611621_3395767	362	Yates Mill Creek	Washington	61-230	D3
12133_624296_3395777	348	Gully Creek	Washington	62-204	D3
12133_616718_3395822	239	Gum Creek	Washington	61-237	D3
12133_624580_3395876	348	Gully Creek	Washington	62-205	D3
12133_622595_3396421	239	Gum Creek	Washington	62-203	D3
12133_643224_3396626	337	Flat Creek	Washington	64-186	F3
12133_612556_3396685	362	Yates Mill Creek	Washington	61-229	D3
12133_644687_3396782	346	Little Hard Labor Cr	Washington	64-255	F3
12133_615694_3396819	239	Gum Creek	Washington	61-210	D3
12133_612947_3396903	362	Yates Mill Creek	Washington	61-228	D3
12133_622412_3397065	239	Gum Creek	Washington	62-207	D3
12133_613824_3397285	239	Gum Creek	Washington	61-227	D3
12133_615690_3397409	239	Gum Creek	Washington	61-211	D3
12133_627049_3397420	59	Holmes Creek	Washington	62-206	E3
12133_635567_3397721	337	Flat Creek	Washington	63-184	E3
12133_620328_3397742	239	Gum Creek	Washington	62-208	D3
12133_640200_3397929	337	Flat Creek	Washington	64-187	E3
12133_614790_3398393	239	Gum Creek	Washington	61-226	D3
12059_597786_3398851	349	Mill Creek	Holmes	59-79	C3
12059_607785_3399633	49	Choctawhatchee River	Holmes	60-99	C3
12133_629484_3398966	59	Holmes Creek	Washington	62-180	E3
12133_621774_3399044	239	Gum Creek	Washington	62-209	D3
12133_630298_3399349	59	Holmes Creek	Washington	63-181	E3
12133_630364_3399373	59	Holmes Creek	Washington	63-182	E3
12133_614942_3399917	49	Choctawhatchee River	Washington	61-225	D3
12133_619896_3400250	239	Gum Creek	Washington	61-201	D3
12133_617756_3400317	239	Gum Creek	Washington	61-202	D3
12133_619913_3400487	239	Gum Creek	Washington	61-200	D3
12133_635931_3400790	59	Holmes Creek	Washington	63-183	E3
12059_604975_3402459	212	Reedy Creek	Holmes	60-47	C2
12059_598379_3407127	270	Goose Branch	Holmes	59-102	C2
12059_604939_3402611	212	Reedy Creek	Holmes	60-48	C2
12059_603177_3403735	212	Reedy Creek	Holmes	60-49	C2
12059_622809_3402724	286	Open Creek	Holmes	62-141	D2
12133_644599_3403200	123	Alligator Creek	Washington	64-218	F2
12133_646968_3403239	262	Gilberts Mill Creek	Washington	64-217	F2
12059_623340_3403021	286	Open Creek	Holmes	62-140	D2
12133_645203_3403971	123	Alligator Creek	Washington	64-219	F2
12059_598116_3404029	298	Cow Branch	Holmes	59-11	C2
12059_599252_3404259	210	Otter Creek	Holmes	59-8	C2
12059_595419_3404520	178	Sandy Creek	Holmes	59-39	C2
12059_624489_3405231	286	Open Creek	Holmes	62-142	D2
12059_624250_3406851	239	Gum Creek	Holmes	62-159	D2
12059_601858_3407775	212	Reedy Creek	Holmes	60-100	C2
12059_604296_3398989	212	Reedy Creek	Holmes	60-98	C2
12059_623591_3410293	239	Gum Creek	Holmes	62-81	D2
12059_602579_3408018	227a	Hood Lake Drain	Holmes	60-50	C2
12133_615784_3407022	49	Choctawhatchee River	Washington	61-185	D2
12059_613879_3407094	49	Choctawhatchee River	Holmes	61-10	D2
12059_617792_3407166	261	Dram Branch	Holmes	61-105	D2
12059_616943_3407387	261	Dram Branch	Holmes	61-106	D2
12059_597755_3407367	270	Goose Branch	Holmes	59-9	C2
12059_619068_3407251	261	Dram Branch	Holmes	61-104	D2
12059_618986_3408465	261	Dram Branch	Holmes	61-107	D2
12059_627694_3407512	251	Camp Branch	Holmes	62-14	E2
12059_629321_3407685	232	Unnamed drain	Holmes	62-160	E2

Table A-2. Choctawhatchee-Pea Basin Crossover Site Crossings Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Cross Reference	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd					
12059_601879_3408170	212	Reedy Creek	Holmes	60-101	C2
12059_602813_3405722	212	Reedy Creek	Holmes	60-97	C2
12059_595336_3408291	249	Padgett Creek	Holmes	59-40	C2
12059_625097_3410720	239	Gum Creek	Holmes	62-112	D2
12059_619335_3408638	240	Hathaway Mill Creek	Holmes	61-108	D2
12059_619810_3408643	240	Hathaway Mill Creek	Holmes	61-109	D2
12059_620725_3408657	240	Hathaway Mill Creek	Holmes	62-110	D2
12059_621059_3408650	239	Gum Creek	Holmes	62-111	D2
12059_619289_3409479	240	Hathaway Mill Creek	Holmes	61-91	D2
12133_643996_3409017	123	Alligator Creek	Washington	64-246	F2
12059_614779_3409982	54	Wrights Creek	Holmes	61-118	D2
12059_620240_3410751	240	Hathaway Mill Creek	Holmes	62-144	D2
12059_615310_3410366	54	Wrights Creek	Holmes	61-90	D2
12059_613154_3411401	54	Wrights Creek	Holmes	61-120	D2
12059_623702_3410926	54	Wrights Creek	Holmes	62-82	D2
12059_619928_3411163	240	Hathaway Mill Creek	Holmes	61-92	D2
12059_615794_3410112	54	Wrights Creek	Holmes	61-89	D2
12059_620773_3410072	240	Hathaway Mill Creek	Holmes	62-146	D2
12059_593636_3410562	210	Otter Creek	Holmes	59-12	C2
12059_625001_3412010	206	Gum Branch	Holmes	62-113	E2
12059_620887_3410399	240	Hathaway Mill Creek	Holmes	62-145	D2
12059_617186_3410384	240	Hathaway Mill Creek	Holmes	61-88	D2
12059_623723_3411677	54	Wrights Creek	Holmes	62-83	D2
12059_617403_3411516	54	Wrights Creek	Holmes	61-93	D2
12059_613738_3412344	54	Wrights Creek	Holmes	61-119	D2
12059_612904_3410056	54	Wrights Creek	Holmes	61-153	C2
12059_615121_3415916	183	Catfish Branch	Holmes	61-121	D2
12059_617368_3411642	54	Wrights Creek	Holmes	61-94	D2
12059_619403_3407392	261	Dram Branch	Holmes	61-103	C2
12059_622267_3410858	54	Wrights Creek	Holmes	62-95	D2
12059_622766_3414973	54	Wrights Creek	Holmes	62-84	D2
12059_613465_3408632	54	Wrights Creek	Holmes	61-117	D2
12059_624814_3412196	54	Wrights Creek	Holmes	62-114	E2
12059_624530_3412403	54	Wrights Creek	Holmes	62-115	E2
12063_648344_3412436	235	Pine Barn Creek	Jackson	64-157	F2
12059_623484_3412059	54	Wrights Creek	Holmes	62-116	D2
12059_617502_3410765	54	Wrights Creek	Holmes	61-87	D2
12059_603281_3413293	212	Reedy Creek	Holmes	60-46	C2
12059_626980_3413290	206	Gum Branch	Holmes	62-134	E2
12059_597633_3413261	146	West Pittman Creek	Holmes	59-25	C2
12059_602883_3413427	212	Reedy Creek	Holmes	60-43	C2
12059_603943_3413394	49f	Choctawhatchee River	Holmes	60-45	C2
12059_603124_3413428	212	Reedy Creek	Holmes	60-44	C2
12059_602557_3413429	212	Reedy Creek	Holmes	60-42	C2
12059_602093_3413429	212	Reedy Creek	Holmes	60-41	C2
12131_587015_3413516	178	Sandy Creek	Walton	58-168	B2
12059_624130_3413727	54	Wrights Creek	Holmes	62-127	D2
12059_624617_3413740	54	Wrights Creek	Holmes	62-128	D2
12059_628184_3415403	54	Wrights Creek	Holmes	62-161	E2
12059_621869_3414626	54	Wrights Creek	Holmes	62-96	D2
12059_619867_3413439	54	Wrights Creek	Holmes	61-86	D2
12059_620380_3414123	54	Wrights Creek	Holmes	62-85	D2
12059_623124_3414190	54	Wrights Creek	Holmes	62-126	D2
12059_622831_3414496	54	Wrights Creek	Holmes	62-125	D2
12059_622809_3414620	54	Wrights Creek	Holmes	62-124	D2
12059_620393_3409911	240	Hathaway Mill Creek	Holmes	62-143	D2
12059_597934_3414791	146	West Pittman Creek	Holmes	59-24	C2
12059_624251_3414917	54	Wrights Creek	Holmes	62-131	D2
12059_623620_3414973	54	Wrights Creek	Holmes	62-129	D2
12059_622952_3414872	54	Wrights Creek	Holmes	62-130	D2
12059_602963_3415209	163	Bay Branch	Holmes	60-34	C2
12059_593176_3415248	146	West Pittman Creek	Holmes	59-23	C2
12059_627498_3417049	54	Wrights Creek	Holmes	62-162	E2
12059_592508_3415886	146	West Pittman Creek	Holmes	59-22	C2
12059_616346_3414731	54	Wrights Creek	Holmes	61-122	D2
12059_602642_3416374	163	Bay Branch	Holmes	60-35	C2
12059_598377_3416501	146	West Pittman Creek	Holmes	59-26	C2

Table A-2. Choctawhatchee-Pea Basin Crossover Site Crossings Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Cross Reference	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd					
12059_633103_3416915	59	Holmes Creek	Holmes	63-19	E2
12063_642392_3416997	130	Fish Branch	Jackson	64-165	E2
12059_625650_3416662	54	Wrights Creek	Holmes	62-133	E2
12059_631911_3418579	150	Kelley Branch	Holmes	63-135	E2
12063_641436_3417966	147	Gum Creek	Jackson	64-154	E2
12063_641397_3418044	147	Gum Creek	Jackson	64-155	E2
12063_641176_3418543	147	Gum Creek	Jackson	64-156	E1
12059_632120_3419016	150	Kelley Branch	Holmes	63-136	E1
12059_635601_3418555	59	Holmes Creek	Holmes	63-18	E1
12059_632296_3419206	150	Kelley Branch	Holmes	63-137	E1
12059_633522_3426152	103	Corbett Branch	Holmes	63-147	E1
12059_626663_3420234	54	Wrights Creek	Holmes	62-138	E1
12059_597060_3419372	164	Timber Branch	Holmes	59-38	C1
12059_595995_3419869	136	Pine Log Creek	Holmes	59-36	C1
12059_623355_3403374	286	Open Creek	Holmes	62-139	E1
12059_611286_3419473	133	Ginhouse Branch	Holmes	61-71	D1
12059_596711_3419976	136	Pine Log Creek	Holmes	59-37	C1
12059_610873_3420041	133	Ginhouse Branch	Holmes	61-70	D1
12059_597702_3420478	136	Pine Log Creek	Holmes	59-28	C1
12059_610805_3420143	133	Ginhouse Branch	Holmes	61-69	D1
12063_648543_3420751	157	Little Alligator Cr	Jackson	64-158	F1
12059_626036_3417359	54	Wrights Creek	Holmes	62-132	E1
12059_622533_3414594	54	Wrights Creek	Holmes	62-123	D1
12059_600336_3421083	109	Fowler Branch	Holmes	60-29	C1
12059_610025_3421118	133	Ginhouse Branch	Holmes	61-68	D1
12063_642572_3421208	130	Fish Branch	Jackson	64-164	E1
12059_605814_3421310	146	West Pittman Creek	Holmes	60-52	C1
12059_610277_3421477	120	Unnamed branch	Holmes	61-67	D1
12059_610500_3421627	120	Unnamed branch	Holmes	61-66	D1
12059_598435_3422393	109	Fowler Branch	Holmes	59-53	C1
12059_611831_3422423	120	Unnamed branch	Holmes	61-65	D1
12059_629895_3423310	113	Register Branch	Holmes	62-152	E1
12059_626594_3422636	56	Tenmile Creek	Holmes	62-15	E1
12059_622725_3406217	239	Gum Creek	Holmes	62-80	D1
12059_626619_3422890	56	Tenmile Creek	Holmes	62-16	E1
12059_600987_3423652	109	Fowler Branch	Holmes	60-30	C1
12059_600929_3423802	109	Fowler Branch	Holmes	60-31	C1
12059_638651_3423856	59	Holmes Creek	Holmes	63-20	E1
12059_602634_3423915	112	Angelico Branch	Holmes	60-33	C1
12059_615685_3427615	69	Unnamed branch	Holmes	61-163	D1
12059_638693_3424258	59	Holmes Creek	Holmes	63-21	E1
12059_600367_3424409	109	Fowler Branch	Holmes	60-32	C1
12059_620988_3425504	77	Little Creek	Holmes	62-72	D1
12059_608692_3424863	94	Limestone Branch	Holmes	60-51	D1
12059_627817_3424956	56	Tenmile Creek	Holmes	62-17	E1
12059_620980_3426123	77	Little Creek	Holmes	62-73	D1
12059_633491_3426309	103	Corbett Branch	Holmes	63-148	E1
12059_620981_3426392	77	Little Creek	Holmes	62-74	D1
12059_637149_3427162	86	Bell Branch	Holmes	63-149	E1
12059_622428_3427716	77	Little Creek	Holmes	62-75	D1
12059_628016_3426809	61	Texas Branch	Holmes	62-76	E1
12059_616339_3426883	69	Unnamed branch	Holmes	61-54	D1
12059_636820_3429626	54	Wrights Creek	Holmes	63-150	E1
12059_614078_3427612	48	Whitewater Branch	Holmes	61-64	D1
12059_616594_3427680	69	Unnamed branch	Holmes	61-55	D1
12059_614558_3427670	48	Whitewater Branch	Holmes	61-63	D1
12059_616184_3427755	69	Unnamed branch	Holmes	61-56	D1
12059_614485_3427824	48	Whitewater Branch	Holmes	61-62	D1
12059_637344_3427333	86	Bell Branch	Holmes	63-78	E1
12063_642706_3428487	59	Holmes Creek	Jackson	64-166	F1
12059_614941_3428816	48	Whitewater Branch	Holmes	61-61	D1
12059_635753_3428207	54	Wrights Creek	Holmes	63-77	E1
12059_614470_3429177	48	Whitewater Branch	Holmes	61-60	D1
12059_624268_3429261	56	Tenmile Creek	Holmes	62-13	D1
12059_615972_3429210	48	Whitewater Branch	Holmes	61-57	D1
12059_616292_3429243	48	Whitewater Branch	Holmes	61-58	D1
12059_629716_3422620	113	Register Branch	Holmes	62-151	E1

Table A-2. Choctawhatchee-Pea Basin Crossover Site Crossings Cont'd

Crossing Identification	WBID	WBID Name	County	Index Map Cross Reference	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203 Cont'd					
12059_614473_3429628	48	Whitewater Branch	Holmes	61-59	D1
Pea River Subbasin, HUC 03140202					
12059_596965_3426519	81	Mack Bay Branch	Holmes	59-27	C1
12131_579218_3428629	42	Eighteen Mile Creek	Walton	57-167	B1
Choctawhatchee Bay Subbasin, HUC 03140102					
12131_576168_3374311	731	Alaqua Bayou	Walton	57-177	B4
12131_580772_3390406	436	Blount Creek	Walton	58-172	B3
12131_580775_3390689	436	Blount Creek	Walton	58-171	B3
12131_582491_3392217	436	Blount Creek	Walton	58-174	B3
12131_576727_3396682	332	Cosson Mill Creek	Walton	57-173	B3
12131_578328_3398500	332	Cosson Mill Creek	Walton	57-170	B3

A.1.3 PROXIMITY SITE CROSSINGS LOOKUP TABLE

The 46 Choctawhatchee-Pea Basin (CPB) proximity site crossings listed in Table A-3 are sorted by subbasin and crossing identification (CI) number. The last seven-digit number in the CI is sorted in ascending order (from lowest to highest).

Table A-3. Choctawhatchee-Pea Basin Proximity Site Crossings

Crossing Identification	WBID	WBID Name	County	Index Map Grid
Lower Choctawhatchee Subbasin, HUC 03140203				
12133_609460_3378858	59	Holmes Creek	Washington	D4
12133_611940_3380042	59	Holmes Creek	Washington	D4
12133_630854_3380694	526	Pine Log Creek	Washington	E4
12133_630518_3380886	526	Pine Log Creek	Washington	E4
12133_630318_3381300	526	Pine Log Creek	Washington	E4
12133_630058_3381700	526	Pine Log Creek	Washington	E4
12133_623387_3381901	526	Pine Log Creek	Washington	D4
12133_623320_3381982	526	Pine Log Creek	Washington	D4
12133_620011_3383005	549	Fanning Branch	Washington	D4
12133_624640_3384304	59	Holmes Creek	Washington	D4
12131_596564_3387504	343	Bruce Creek	Walton	C3
12133_645763_3387764	490	Poley Creek	Washington	F3
12133_640707_3387929	401	Hard Labor Creek	Washington	E3
12133_609211_3388028	49e	Choctawhatchee River	Washington	D3
12133_608401_3387993	49e	Choctawhatchee River	Washington	D3
12131_602813_3388256	343	Bruce Creek	Walton	C3
12133_609139_3388312	49e	Choctawhatchee River	Washington	D3
12131_599727_3390188	457	Spears Branch	Walton	C3
12133_618911_3394452	348	Gully Creek	Washington	D3
12131_593153_3394700	414	Folks Creek	Walton	C3
12133_633309_3394975	401	Hard Labor Creek	Washington	E3
12133_633394_3395122	337	Flat Creek	Washington	E3
12131_598788_3396430	349	Mill Creek	Walton	C3
12133_644826_3397035	346	Little Hard Labor Cr	Washington	F3
12059_601939_3401887	212	Reedy Creek	Holmes	D3
12133_625045_3400811	286	Open Creek	Washington	E3
12059_624670_3404872	286	Open Creek	Holmes	D2
12059_600358_3404206	210	Otter Creek	Holmes	C2
12059_598972_3404228	210	Otter Creek	Holmes	C2
12059_598589_3409073	210	Otter Creek	Holmes	C2
12059_619284_3409785	240	Hathaway Mill Creek	Holmes	D2
12059_614944_3410617	54	Wrights Creek	Holmes	D2
12059_615284_3410375	54	Wrights Creek	Holmes	D2
12059_596136_3410952	210	Otter Creek	Holmes	C2
12059_632330_3411446	59	Holmes Creek	Holmes	E2
12059_603487_3411827	227a	Hood Lake Drain	Holmes	C2
12059_604613_3411972	227a	Hood Lake Drain	Holmes	C2
12063_647799_3414127	195	Scurlock Creek	Jackson	F2
12059_620757_3414454	54	Wrights Creek	Holmes	D2
12059_636193_3421360	59	Holmes Creek	Holmes	E1
12059_637573_3421899	59	Holmes Creek	Holmes	E1
12063_642643_3422166	130	Fish Branch	Jackson	F1
12059_607972_3424275	94	Limestone Branch	Holmes	D1
12131_588295_3373840	739	Pate Branch	Walton	B4
Pea River Subbasin, HUC 03140202				
12059_594100_3424486	63	Hurricane Creek	Holmes	C1
Choctawhatchee Bay Subbasin, HUC 03140102				
12131_581151_3390866	436	Blount Creek	Walton	B3

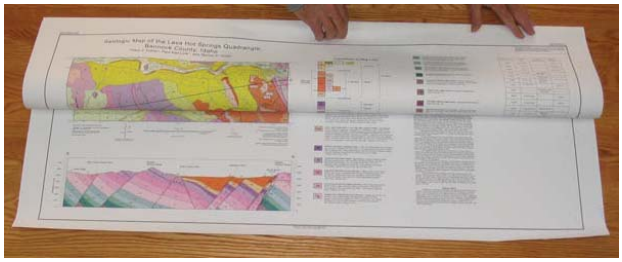
A.2 INDEX MAP FOLDING INSTRUCTIONS

The section provides illustrated instructions for folding the Choctawhatchee-Pea Basin Road-Stream Crossings Index Map contained in the Section A.3 pocket insert. These instructions are also available at http://www.idahogeology.org/PDF/4x3fold.pdf.

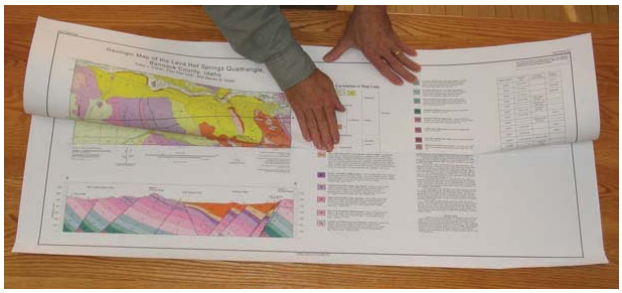
Step 1: Carefully align top of map with the bottom.



Step 2: Fold top of map back on itself, align with crease made in Step 1 (2A and 2B).



2A



2B

Step 3: Turn map over and fold the bottom of the map back on itself (3A). Align bottom of map with crease made in Step 1 (3B).

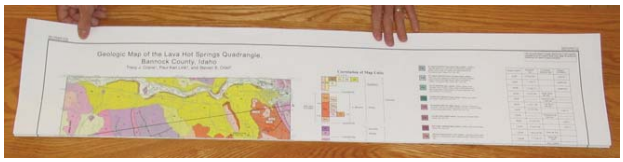


3A



3B

Step 4: Turn map so legend is facing up (4A). Fold over right map edge so that the edge lands approximately 14 3/4 inches from the left edge (4B).



4A



4B

Step 5: Fold flap from Step 4 back on itself and align with right edge of map.



5

Step 6: Unfold map edge from Step 4 (6A). Fold left map edge all the way to the right (crease from Step 4) (6B).



6A



6B



8B

Step 7: Fold left map flap from Step 6 back on itself and align with left edge of map.



7

Step 8: Refold as in Step 5. Map should look like (8A). Fold map in half as shown (8B). Align edges (8C).



8A



8C


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