TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 CARRIZO CREEK NEAR CARRIZO SPRINGS, TEXAS

1.1 STUDY AREA OVERVIEW

1.1.1 Study Area Description

The Carrizo Creek study area is located downstream of Carrizo Springs, the seat of Dimmit County, Texas. Population (according to 1990 Census data) is 5,745 and is served by the Carrizo Springs Wastewater Treatment Plant (WWTP). Discharge from the plant flows through a small polishing wetlands and is conveyed to the creek in a small, unlined ditch. The site is located 123 miles southwest of San Antonio in the Gulf Coastal Plain Physiographic Province. Topography is flat and featureless, sloping gradually up to the north and northwest where it is bordered by the Balcones Fault Zone, a major structural boundary, separating the coastal plain from the Texas Hill Country.

1.1.2 Ecoregion Description

Carrizo Springs and Carrizo Creek are located in Ecoregion 31, Southern Texas Plains (Omernick and Bailey 1997). Ecoregion 31 occupies a large area in southern Texas between the Rio Grande and the Western Gulf Coastal Plain. The land surface is primarily smooth to irregular plains with relatively little relief. This ecoregion has subhumid to semi-arid climatic conditions, with hot summers and mild winters. Natural vegetation in this ecoregion is a mixture of mesquite/acacia savanna and mesquite/live oak savanna. This region has been subjected to heavy grazing for a long time, and is now dominated by thorny brush. Some characteristic plant species of this region include honey mesquite, huisache, live oak, big bluestem, and bristlegrass. Some of the vertebrate wildlife species that are characteristic of Ecoregion 31 include leafchin bat, Mexican ground squirrel, Texas pocket gopher, armadillo, white-tailed kite, crested caracara, common ground-dove, common pauraque, green kingfisher, golden-fronted woodpecker, long-billed thrasher, Texas toad, Texas horned lizard, and Texas spotted whiptail (URS 2000).

1.2 WATER QUALITY STANDARDS

Carrizo Creek is an unclassified water located within the Nueces River Basin. However, the Nueces River above Holland Dam into which Carrizo Creek possibly flows is designated for the following uses:

- contact recreation
- high aquatic life use
- public water supply

Table C-9-1 shows the water quality standards for protection of the uses provided above.

Table C-9-1
Water Quality Standards for Constituents of Concern for Carrizo Creek Near Carrizo Springs, Texas

Constituent of Concern	Contact Recreation	High Aquatic Life Use	Public Water Supply
Ammonia	–	–	–
Arsenic	–	360 µg/L dissolved (acute) 190 µg/L dissolved (chronic)	50 µg/L total recoverable
Beryllium	–	–	–
Cadmium	–	33.7 µg/L dissolved (acute)* 1.1 µg/L dissolved (chronic)*	5 µg/L total recoverable
Chlorine	–	–	–
Copper	–	19.2 µg/L dissolved (acute)* 12.8 µg/L dissolved (chronic)*	–
DDT	–	1.1 µg/L (acute) 0.0010 µg/L (chronic)	0.0527 µg/L
Mercury	–	2.4 µg/L (acute) 1.3 µg/L (chronic)	0.0122 µg/L
PCBs	–	2.0 µg/L (acute) 0.014 µg/L (chronic)	0.0013 µg/L
Selenium	–	20 µg/L (acute) 0.014 µg/L (chronic)	50 µg/L total recoverable
Fecal Coliform Bacteria	<200 cfu/100 mL (geometric mean from 5 samples in 30-day period) 400 cfu/100 mL (cannot exceed in 10% of all samples analyzed during 30-day period)	–	–
Ph	–	6.5 - 9.0	–
Temperature	–	90°F	–
Turbidity	–	–	–
Dissolved Oxygen	–	5.0/3.0 mg/L (mean/min) 5.5/4.5 mg/L (mean/min for Spring)	–
Total Dissolved Solids	–	900 mg/L	–
Nutrients	–	–	–
Salinity	–	–	–

* Criteria calculated via formula based on hardness of 100 mg/L as $CaCO_3$
µg/L – microgram(s) per liter
mg/L – milligram(s) per liter
cfu – colony forming unit
mL – milliliter(s)

1.3 WASTEWATER TREATMENT PLANTS DISCHARGING TO THE STUDY AREA

The Carrizo Springs WWTP serves the community of Carrizo Springs, Texas (**Figure C-9-1**). All effluent produced at the facility is discharged to Carrizo Creek in accordance with the plant's National Pollutant Discharge Elimination System (NPDES) discharge permit. No reuse of effluent occurs at this facility.

1.3.1 National Pollutant Discharge Elimination System Discharge Permits

A summary of selected NPDES permit parameters for the Carrizo Springs WWTP is provided in Table C-9-2. This permit expires on June 1, 2002. A copy of the permit is included in **Appendix L**.

Table C-9-2
Summary of Selected NPDES Permit Parameters for Carrizo Springs WWTP

Parameter	Units	Limit Type	Value
$CBOD_5$	mg/L	7-day average Daily maximum	15 25
Total Suspended Solids	mg/L	7-day average Daily maximum	25 40
Wet Testing		Required/Not Required	Not Required
Total Ammonia	mg/L as N	7-day average Daily maximum	6 10
Chlorine Residual	mg/L	Minimum Maximum	1 4
pH	S.U.	Minimum Maximum	6 9
Dissolved Oxygen (DO)	mg/L	Minimum	4
S.U. – Standard Units			

1.3.2 Effluent Quality

The U.S. Environmental Protection Agency's (EPA's) Permit Compliance System (PCS) was queried to obtain historical data on effluent quality as reported by the WWTP of interest. This system is a holding of Discharge Monitoring Reports that are submitted to EPA by state NPDES programs. Table C-9-3 shows a summary of the discharge monitoring data for the Carrizo Springs WWTP.

Table C-9-3
Summary of Selected PCS Parameters for the City of Carrizo Springs WWTP, Texas

Parameter	Units	Average Reporting Concentrations		Number of Measurements	Period of Record
$CBOD_5$	mg/L	Minimum Average Maximum	 3.7 	0 5 0	1999-2000
PH	S.U.	Minimum	7.38	5	1999-2000

Table C-9-3
Summary of Selected PCS Parameters for the City of Carrizo Springs WWTP, Texas

Parameter	Units	Average Reporting Concentrations		Number of Measurements	Period of Record
		Maximum		0	
Total Ammonia (as N)	mg/L	Minimum		0	1999-2000
		Average	1.4	5	
		Maximum		0	
Total Residual Chlorine	mg/L	Minimum	1.15	5	1999-2000
		Average		0	
		Maximum		0	
Total Suspended Solids	mg/L	Minimum		0	1999-2000
		Average	3.4	5	
		Maximum		0	
Dissolved Oxygen (DO)	mg/L	Minimum	4.96	5	1999-2000
		Average		0	
		Maximum		0	

1.3.3 WWTP Processes

Constructed in 1978, the Carrizo Springs WWTP is owned and operated by the City of Carrizo Springs. All effluent from the plant is discharged to Carrizo Creek, although golf course irrigation using plant effluent may be considered in the future. Originally designed for a capacity of 2.5 million gallons per day (mgd), the plant is currently permitted at 0.995 mgd, making it a "minor" plant for permitting purposes. No major process upgrades have been implemented at the plant since its original construction. Liquid-train process components at the plant include the following:

- bar screens
- aeration basins for secondary treatment
- secondary clarification
- chlorination

Dechlorination was considered at one time, but is not required due to the plant's "minor" discharger categorization. No nitrification or denitrification occurs at the plant. No process upgrades are planned at this time.

1.3.4 WWTP Flows to Receiving Water and Reuse

The Carrizo Springs WWTP is authorized to discharge treated effluent into Carrizo Creek. Flow data for discharges to the Carrizo Creek are available in hard copy format only. No effluent is reused from the facility, but consideration has been given to possible future use of effluent for irrigation at a local golf course.

Data Set	Map Reference	Document Reference
Historic Chemical Data	C1	TX0640022

WWTP

1

2

3

4

C1

Arid West Water Quality Research Project Habitat Characterization Study
Carrizo Creek Near Carrizo Springs, Texas

Legend

- Stream Study Area
- Reconnaissance Data (1 - 4)
- Historic Chemical Data (C1)
- Wastewater Treatment Plant (WWTP)

1 0 1

Scale in Miles

N

Source: US Geological Survey 7.5 Minute Quadrangle Maps
Carrizo Springs East, Texas (1972)

URS

Figure C-9-1

X:\PimaCounty\WQRP\Projects\Texas.apr

1.4 PHYSICAL DATA OVERVIEW

There are no historical streamflow or geomorphology data on Carrizo Creek, except for site visit data presented below. Climate data is available and summarized in Table C-9-4.

Table C-9-4
Average Monthly Precipitation and Temperature
for Carrizo Creek at Carrizo Springs, Texas

Month	Precipitation (Inches)	Temperature (°F)
January	0.5	53
February	0.3	58
March	0.8	65
April	1.1	73
May	2.3	79
June	2.8	84
July	2.8	87
August	3.7	86
September	2.1	82
October	1.3	73
November	0.7	62
December	0.5	55

1.4.1 Geomorphological Site Reconnaissance Summary

The watershed above the WWTP constitutes 46.6 square miles of the 1,862-square-mile Upper Nueces River basin. The Upper Nueces River includes a northern headwater fed by spring discharges from the carbonate Edwards Aquifer, a groundwater source of regional extent. However, Carrizo Creek drains the southern portion of the basin and is supplied with very limited base flow from the semi-consolidated sandstone of the Texas Coastal aquifer system. Precipitation in the Upper Nueces Basin is sparse, approximately 22 inches mean annual precipitation, primarily falling in the summer and early fall. Mean annual temperature is 71°F.

A site visit was conducted in May 2000 to collect data from the following five sites within the study area (all shown on **Figure C-9-1**):

- Site 1 – Above the Carrizo Springs WWTP discharge to Carrizo Creek.
- Site 2 – Below the Carrizo Springs WWTP discharge to Carrizo Creek
- Site 3 – At the East Road crossing.
- Site 4 – At the County Road 1407 crossing.
- Site 5 – No sample site; access to the creek below Site 4 was restricted because of private property, and a fifth site along Carrizo Creek could not be investigated.

Table C-9-5 presents the data retrieved from the site reconnaissance and used in the discussion below.

Table C-9-5 Morphometric Data from Carrizo Creek Near Carrizo Springs, Texas

	Site 1	Site 2	Site 3	Site 4	Site 5
Site description	Above Carrizo Springs WWTP	Below Carrizo Springs WWTP	At East Road Crossing	At County Road 1407 Crossing	No Sample Site
Discharge (cfs)					
Bedload texture					
Channel texture	Loamy silt and fine sand	Loamy silt and fine sand	Fine to very fine sand and gravel		
Bank texture					
Sinuosity	1.07	1.07			
Channel gradient	0.0009	0.0009			
Channel width (ft)	33	39.4	9.8 to 39.4		
Channel depth (ft)	4.3		1.2 to 3.0		
Channel incision (ft)					
Floodplain width (ft)	42.7	3.3	3.3 to 9.8		
Floodplain bank height (ft)					
Channel vegetation	Elms, hackberries, forbs, and grasses	Elms, hackberries, forbs, and grasses	Netvein hackberry, elms	Hacberry, willows, forbs, and grasses	
Floodplain vegetation					
Terrace vegetation					

[1] Constructed channel

1.4.1.1 Reach Streamflow

There are no U.S. Geological Survey (USGS) stream gaging stations on Carrizo Creek. The creek was dry at Site 1, above the WWTP, at the time of inspection, although the channel substrate was wet and small puddles of water were present. A state highway crosses the creek upstream of the plant and could easily supply enough runoff to account for the standing water and damp soil.

At the outfall, an unlined ditch connects the creek to a pond and wetland of less than 10 acres. During the site reconnaissance, the creek was flowing at approximately 1.1 cfs. EPA records for the plant suggest that the plant normally treats approximately 0.48 million gallons per day (mgd) or 0.74 cfs. The flow backs a few meters upstream of the discharge point, forming a pool of slightly turbid, mildly fetid water. At Site 2 the flow is approximately 2.1 cfs and extends from bank to bank. The flow is more shallow at Site 3 where it is 1.1 cfs) and similar at Site 4 where it is approximately 1.4 cfs. Although it appears that discharge slightly decreases downstream, the change is probably within error.

Because there are no stream gaging stations on Carrizo Creek it is difficult to calculate transmission losses or even determine if the stream is losing or gaining.

1.4.1.2 Site 1 and 2 Field Observations

Sites 1 and 2 are located approximately 0.25 mile up and downstream, respectively, of the WWTP outfall. The surrounding area is a moderately disturbed and semi-rural area that includes either cultivated land or typical Chihuahuan mesquite scrub. The vegetation is open but within the floodplain, forbs and willow or elm saplings increase in density. The floodplain stands approximately 3.3 to 6.6 feet below the adjacent fields and is 42.7 feet wide above at Site 1 and shrinks to approximately 3.3 feet at Site 2. Floodplain material includes loamy silt and fine sand, light brown and similar to the cultivated soil adjacent. The channel at Site 1 is dry and approximately 33 feet wide. It is incised approximately 4.3 feet deep and dry, although damp spots and a few puddles suggest that stormwater is being discharged to it nearby. The channel substrate is compacted clay and silt with no evidence for recent deposition. Leaf litter and trash are also scattered about. Vegetation in the channel is vigorous, with numerous mature (up to 6.6 feet in diameter) elms or hackberry trees. Forbs and grasses are on the banks and in the channel. Cattails and other rooted aquatic plants have occupied some of the damp spots.

Downstream of the discharge point the introduced effluent extends bank to bank approximately 39.4 feet, with less than 3 feet of freeboard against the vertical channel walls. Although vegetation is less dense, the floodplain is greatly restricted and the floodplain slopes approximately 6.6 feet up to the adjacent open meadow. The water in the channel was slightly turbid with only a very mild fetid odor on the day of inspection. Sinuosity along the reach of the two sites is 1.07 and the gradient is 0.0009.

1.4.1.3 Site 3 Field Observations

Site 3, at the intersection of the creek with East Avenue, shows even more disturbance and modification than the area around the wastewater treatment plant. A 6.6-foot-deep by 9.8-foot-wide stormwater diversion channel follows the upstream side of East Road and discharges to Carrizo Creek above the culvert. This fact and the very low level of apparent historic flow in the creek makes a geomorphological interpretation difficult. Water is backed up behind two concrete culverts and ponded to approximately 3 feet deep and 39.4 feet wide. Further upstream, the flow narrows and shallows to approximately 9.8 feet wide by 1.2-foot depth.

Bed load is low, primarily fine sand with gravel and the channel substrate is dark brown, fine to very fine sand with 0.4- to 0.6-inch gravel. The water is slightly turbid and fetid and there is no emergent vegetation, other than sparse grass along the banks. Banks are cut into a very narrow floodplain, approximately 9.8 feet wide on the northwest bank and 3.3 feet on the southeast side. The floodplain is made of brown to light brown, well sorted, slightly plastic, medium sand with approximately 10 percent organic material and is vegetated with willows, Netvein hackberry, elms, up to 10 inches in diameter. Brown sandy-silt loam banks rise approximately 2.6 feet to cultivated fields.

1.4.1.4 Site 4 Field Observations

The site is again located upstream of a road crossing accommodated by two corrugated metal culverts at grade. The channel is approximately 3.3 feet wide and 1.2 feet deep. Bed load is a small amount of silt and sand. The channel is cut into dark brown to black, fine sand and silt, with organic material but no strong odor. The water is clear and slightly fetid. At this location, the flow splits around interfluves composed of fine sand and supporting mature hackberry, willows (up to 12 inches in diameter), forbs, and grass. The channel supports no vegetation other than grassy banks, which join a bank-to-bank 42-foot-wide floodplain. The floodplain slopes up only approximately 3.3 feet where it merges with the adjacent cultivated fields. Floodplain material is a black, organic-rich, highly indurated hardpan. The upper banks are silty loam.

The site and stream have been extensively disturbed by grazing with abundant cattle prints and manure. Further evidence is given by a large stand of Scotch broom invading onto the floodplain from the upland fields.

1.5 PHYSICAL ANALYSIS

1.5.1 Climate Assessment

Air temperature and precipitation data were recorded in Carrizo Springs at National Climatic Data Center (NCDC) station number 1486 (refer to **Figure C-9-1**) from 1912 through 1999. The estimated average annual precipitation is 21 inches. The estimated average daily temperature in this area is 71ºF, the minimum daily temperature is 44° F, and the maximum daily temperature is 90°F. Table C-9-6 presents the average monthly precipitation and maximum daily precipitation. Table C-9-7 presents the minimum, mean, and maximum temperature.

Table C-9-6
Mean Monthly Precipitation and Maximum Daily Precipitation
Near Carrizo Springs, Texas

NCDC Station 1486 (1912-1999)		
Month	**Mean Monthly Precipitation (Inches)**	**Maximum Daily Precipitation (Inches)**
January	0.95	4.74
February	1.04	5.29
March	0.90	4.79
April	1.69	7.15
May	3.24	9.09
June	2.50	13.52
July	1.46	11.61
August	2.24	12.46
September	2.76	11.00
October	2.43	9.37
November	1.03	4.70
December	1.03	5.75
Annual Precipitation Total (inches)	21.3	

Table C-9-7
Mean, Maximum, and Minimum Monthly Temperature
Near Carrizo Springs, Texas

NCDC Station 1486 (1912-1999)			
Month	**Minimum Temperature (°F)**	**Mean Temperature (°F)**	**Maximum Temperature (°F)**
January	45.11	53.35	61.71
February	48.27	57.95	67.16
March	54.44	64.59	72.82
April	64.97	72.67	80.13
May	72.39	78.69	83.86
June	80.00	84.15	89.47
July	80.81	86.53	90.21
August	80.39	86.42	89.55
September	76.82	81.61	85.77
October	63.40	72.86	79.27
November	53.02	62.27	67.63
December	43.97	54.87	62.11
Min/Mean/Max	43.968	71	90

1.5.2 Flow Assessment

There are no USGS stream gaging stations along Carrizo Creek. The Carrizo Springs WWTP Texas PDES permit allows the plant to discharge a daily average of no more than 0.95 mgd (1.5 cfs) or 2,062 gpm (4.6 cfs) for a two-hour peak flow. According to monitoring records, the plant normally discharges at about 0.47 cfs to Carrizo Creek. During the reconnaissance visit in May of 2001, the flow was estimated to be about 1 cfs.

1.6 CHEMICAL DATA OVERVIEW

Data for station number TX0640022 were obtained from EPA's Storage and Retrieval (*STORET)* database and are summarized in Table C-9-8. This station was sampled for nutrients, trace elements, major ions, organics, and radioactivity. The period of record for station TX0640022 is limited to one month (November 1984). No significant amounts of data were available for any of the constituent categories.

All of the sample results for station TX0640022 were collected and analyzed by the EPA Headquarters in Washington, D.C.; thus, it is believed that EPA-acceptable methods and quality control procedures were adhered to during sampling and analysis.

Table C-9-8
Summary of Records Available for Carrizo Creek Near Carrizo Springs, Texas

Parameter Category	**TX0640022**	
	Period of Record	**Description**
Physical Parameters		None Available
Nutrients	11/84	No data available above detection limit
Trace Elements	11/84	No data available above detection limit

Table C-9-8
Summary of Records Available for Carrizo Creek Near Carrizo Springs, Texas

Parameter Category	TX0640022	
	Period of Record	Description
Major Ions	11/84	Minimal data available
Radiological		None Available
Sediments		None Available
Radiological	11/84	Minimal data available
Isotopical		None Available

* Less than 10 records available for each parameter within a parameter category.

1.7 CHEMICAL ANALYSIS

There are no historical chemical data available for Carrizo Creek.

1.8 AQUATIC HABITAT AND SPECIES OVERVIEW

Appendix N reports the habitat scoring results using the Rapid Bioassessment (RBP) Habitat Assessment Method and the habitat scoring results using the Project Habitat Assessment Method. **Appendix N** also summarizes the results of macroinvertebrate sampling as well as descriptive information gathered from each sample site.

1.8.1 Evaluation of Aquatic Habitat Quality

Access to this creek was difficult because of dense vegetation and private property. Consequently, Sites 3 and 4, by necessity, had to be located at road crossings. Habitat evaluations considered the reach that could be observed upstream and downstream of the culverted road crossing rather than just the crossing itself. The result was higher habitat scores than might have been obtained if only the culverted portion of the stream had been assessed.

1.8.1.1 Site 1 – Reference Reach Upstream of the Carrizo Springs WWTP Outfall

The reference reach that was sampled appears to be perennial. However, the source of the water is unknown since several hundred yards upstream, the channel is dry. Sources may include groundwater, springs, or backflow from where the effluent enters the creek. Habitat scores are high for the RBP Habitat Assessment Method and comparatively low for the Project Habitat Assessment Method. The difference is caused by the different factors used for instream habitat quality. Both riparian habitat and channel morphology factors generally scores the same for both methods (i.e., high quality). However, because instream habitat is limited to a fairly stagnant pool, the lack of riffle and run habitats causes a lower score overall using the Project Habitat Method. The pool at this site is deep and difficult to sample with a kicknet.

Carrizo Springs Site 1 Near Road.

Carrizo Springs Site 1.

Substrates are limited to very soft mud and silt. Emergent vegetation was dense along the sides of the pools.

1.8.1.2 Site 2 – Downstream of the Carrizo Springs WWTP Outfall

Habitat scores decline for this site using the RBP method, but increase using the Project method. Again, the difference relates to instream habitat diversity. Riffles, pools, and runs are present in this reach resulting in a higher score for the Project method. However, the quality of the riparian habitat and pools is poorer at Site 2 than at Site 1 resulting in a lower score for the RBP method. Substrates are composed of gravel and silt with a mix of roots and debris, which increase habitat diversity. Filamentous algae were absent and emergent macrophytes were much less dense as compared to Site 1.

Carrizo Springs Site 2.

1.8.1.3 Site 3 – Carrizo Creek at the East Road Crossing

Carrizo Springs Site 3.

Site 3 is very similar in habitat quality to Site 1 resulting to differences in habitat scoring using the two methods (see discussion above under Site 1). The East Road culvert strongly influenced the channel structure of this reach. Substrates are very soft mud and silt. A dense bed of emergent vegetation was present along the side of the channel. Flow is fairly stagnant in this reach. Riparian habitat is generally well developed and dense.

1.8.1.4 Site 4 – Carrizo Creek at the County Road 1407 Crossing

Site 4 is similar to Sites 1 and 3. Substrates are composed of silt and some embedded gravels. Odors of oil and hydrogen sulfide are distinctive at this site when bottom sediments are disturbed. Given the location of the sample site at a road culvert, the odors are not surprising and probably a result of stormflows washing roadway debris into the channel.

Carrizo Springs Site 4.

1.8.1.5 Site 5 – No Sample Site

Because of private land restrictions, Carrizo Creek could not be accessed downstream of Site 4.

1.8.2 Comparison of Results of Habitat Scoring Methods

Differences occur between the habitat scoring methods at most sites. The cause of the differences is discussed above (see discussion under Site 1). Generally speaking, opposite results are obtained. Sites 1, 3, and 4 have similar as well as the highest habitat scores using the RBP method. In contrast, these same sites have similar as well as the lowest habitat scores using the Project method.

1.8.3 Evaluation of Macroinvertebrate Community

The results of the May 25, 2000 macroinvertebrate sampling are documented in Table 3. The macroinvertebrate sampling was carried out as a screening level assessment only. The identification of aquatic organisms was limited to field recognition; no organisms were taken to a laboratory for complete identification. Consequently, many of the organisms observed could only be identified to the class or order level and comparisons with the results of historical data collection efforts are limited.

The number of samples that could be collected from the Carrizo Creek sites was limited by access, extremely soft substrates, and deep water. Consequently, a full complement of three samples per site could not always be collected. Following is a brief description of the results of the screening level macroinvertebrate sampling at each site.

1.8.3.1 Site 1 – Reference Reach Upstream of the Carrizo Springs WWTP Outfall

Fifteen taxa were collected from Site 1. Two *Ephemeroptera, Plecoptera, Trichoptera* (EPT) taxa were represented: baetid and caenid mayflies. Hydracarina (water mites) were dominant, constituting more than 90 percent of the animals collected. Many of the taxa collected were indicative of pond habitats (e.g., nepid bugs, snails, fairy shrimp, dragonflies, damselflies, and beetles). Large fish, including gar, were observed.

1.8.3.2 Site 2 – Downstream of the Carrizo Springs WWTP Outfall

The number of taxa declined to five at this site; none of them belonged to the EPT group. Amphipods constituted greater than 99 percent of all animals collected from this site. A few damselflies, snails, hemipterans, and chironomid midges were also collected. Small fish were observed.

1.8.3.3 Site 3 – Carrizo Creek at the East Road Crossing

Taxa richness increased to 11 at this site. Amphipods remained the dominant taxon, constituting more than 98 percent of the animals collected. A few baetid mayflies representing the EPT group were also found. Other taxa included damselflies, snails, hemipterans, crayfish, and chironomid midges. Fish, including gar, as well as a water snake were observed.

1.8.3.4 Site 4 - Carrizo Creek at the County Road 1407 Crossing

The number of taxa declined to seven; none of which were EPT taxa. Invertebrate abundance also declined markedly. Amphipods remained dominant, constituting more than 99 percent of the animals collected. Numerous small fish were observed as well as many dead fingernail clams. Other taxa included several different types of beetle taxa, crayfish, and hemipterans.

1.8.3.5 Site 5 - No Sample Site

Because of private land restrictions, Carrizo Creek could not be accessed downstream of Site 4.

1.8.4 Summary of Changes Downstream of Outfall

The number of taxa declined below the reference reach and only rebounded somewhat downstream of the discharge. Dominance shifted from water mites in the reference reach to amphipods downstream of the discharge. The invertebrate community was generally more indicative of a stagnant pond than a flowing stream.

1.9 AQUATIC BIOLOGY ANALYSIS

1.9.1 Review of Historical Data

No published reports on the aquatic community of Carrizo Creek have been identified. Consequently, the analysis of aquatic biological data will be restricted to the macroinvertebrate and habitat data collected during the site reconnaissance.

1.9.2 Analysis of Available Data

1.9.2.1 Macroinvertebrates

1.9.2.1.1 Reconnaissance Site Sample Locations

Samples were collected from the following five sites in May 2000 (all shown on **Figure C-9-1**):

- Site 1 – Above the Carrizo Springs WWTP discharge to Carrizo Creek.
- Site 2 – Below the Carrizo Springs WWTP discharge to Carrizo Creek
- Site 3 – At the East Road crossing.
- Site 4 – At the County Road 1407 crossing.
- Site 5 – No sample site; access to the creek below Site 4 was restricted because of private property, and a fifth site along Carrizo Creek could not be investigated.

The reconnaissance study represents a very brief snapshot in time since sampling was conducted only once and the method was limited to a field screening technique (three one-minute kicknet samples (500 micron mesh) with field identification of invertebrates only).

Only four sites could be sampled because of access problems. In addition, downstream of the effluent outfall access to the stream was limited to road crossings, and sampling at these crossings was limited to areas adjacent to the roadways because of fenced, private land or extremely dense riparian vegetation.

1.9.3 Data Analysis Results

1.9.3.1 Macroinvertebrates

Four aquatic biological measures were used to compare data results: total number of taxa, Hilsenhoff Biotic Index (HBI) values; percent EPT taxa; and relative abundance of the following major taxonomic groups: Oligochaetes (segmented worms); Diptera (flies); Other (primarily Crustacea, Gastropoda [snails], Odonata [dragonflies and damselflies], Hemiptera [true bugs] and Coleoptera [beetles]).

1.9.3.1.1 Longitudinal Patterns in Macroinvertebrate Community Structure

Number of Families/Orders. The number of macroinvertebrate taxa was highest upstream of the effluent discharge and lowest at the site immediately below the discharge (**Figure C-9-2**). Downstream sites showed some increase in taxa richness, but not to the levels found upstream of the discharge.

HBI Values. HBI values were greatest upstream of the discharge and essentially the same (approximately 6.00) at all other sites (**Figure C-9-3**). However, at Site 1 the community was dominated by water mites and at all other sites the aquatic community was dominated by amphipods. The level of taxonomic identification for these organisms was at the order level, and as a consequence, the results were likely influenced by this high level of taxonomic identification. For example, amphipods, as a group, are relatively tolerant of organic pollution, but the tolerance values for genera range between 4 and 8. An analysis of the types of amphipods present in the stream would be necessary to truly evaluate and compare site HBI values.

Percent EPT Taxa. Percent abundance of EPT taxa ranged between zero at two sites to slightly more than 1 percent at the site upstream of the WWTP discharge. EPT taxa were limited to two mayfly families (Baetidae and Caenidae). The aquatic community was so heavily dominated by water mites at Site 1 and amphipods at all other sites that the percent contribution by EPT organisms was limited at any site in which they were present.

Relative Abundance. **Figure C-9-4** illustrates well the dominance by amphipods or water mites ("other" taxa). The dominance by these groups, as well as additional "other" taxa, was so great that the few Diptera and EPT taxa present at some sites contributed too low a percentage to be obviously visible on **Figure C-9-5**. In addition to amphipods and mites, the "other" taxa group included three odonate families (damselflies and dragonflies), five hemipteran families (true

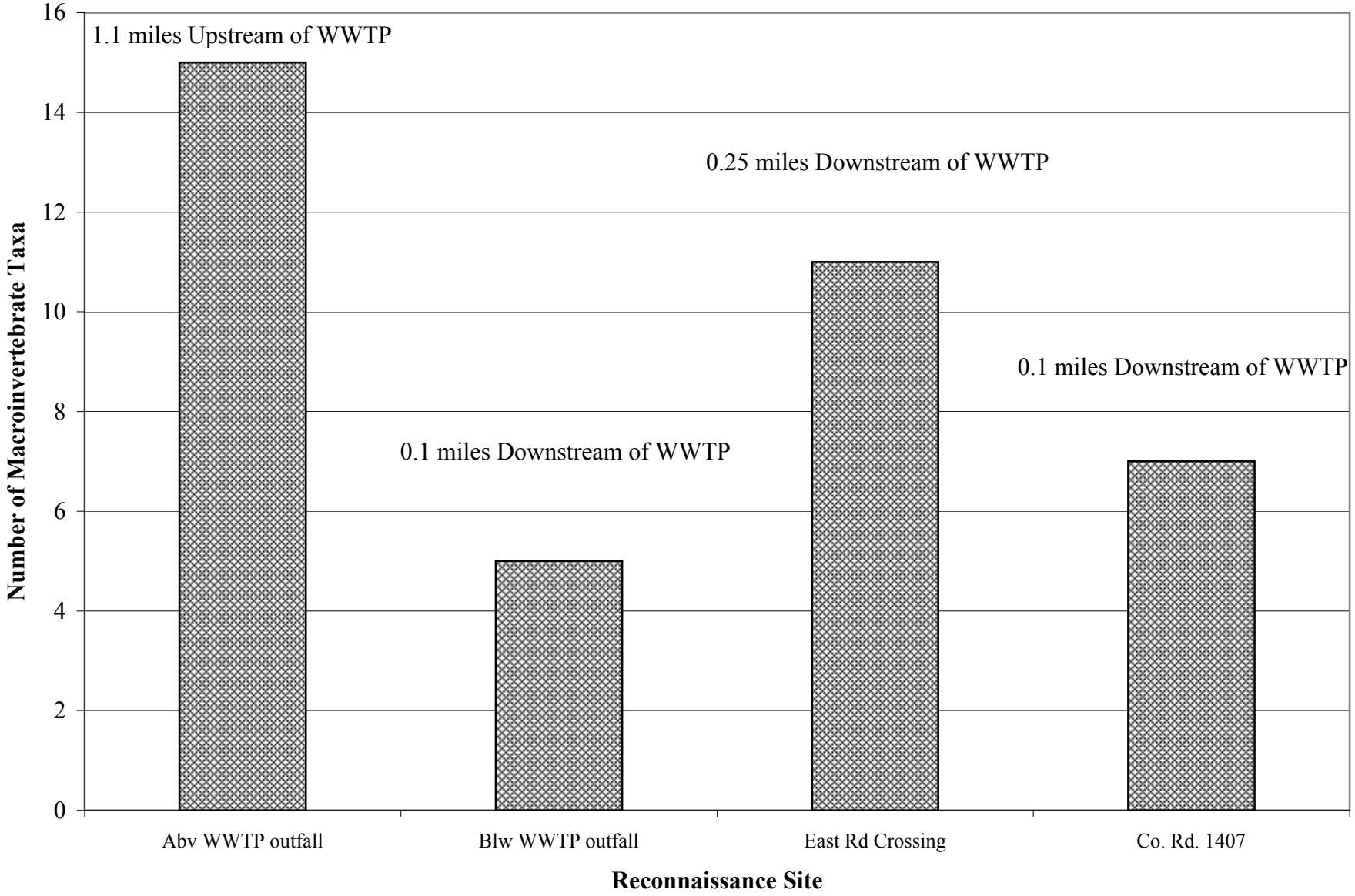


Figure C-9-2
Number of Macroinvertebrate Taxa:
Site Reconnaissance 2000
Carrizo Creek Near Carrizo Springs, Texas

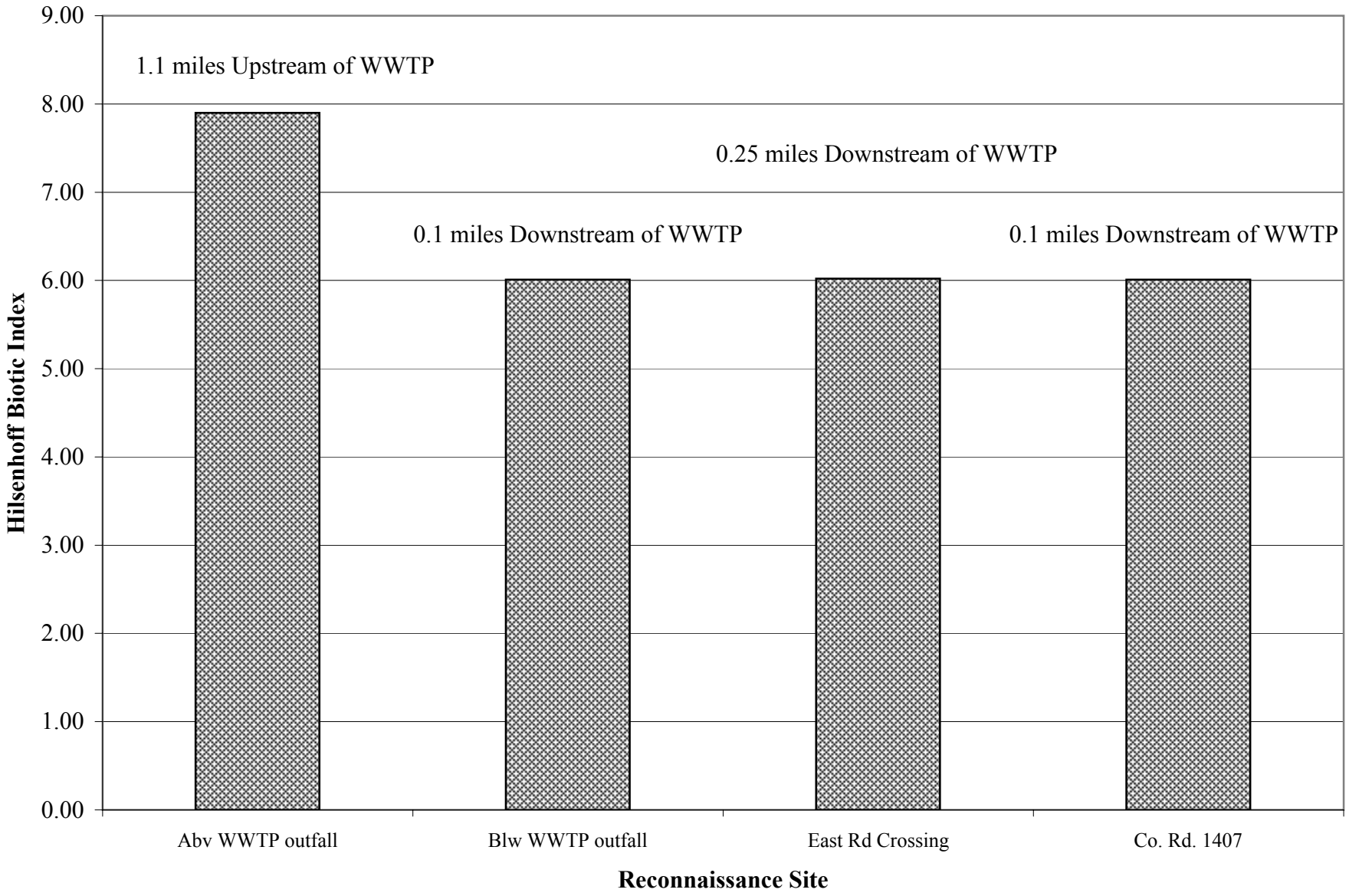


Figure C-9-3
Hilsenhoff Biotic Index:
Site Reconnaissance 2000
Carrizo Creek Near Carrizo Springs, Texas

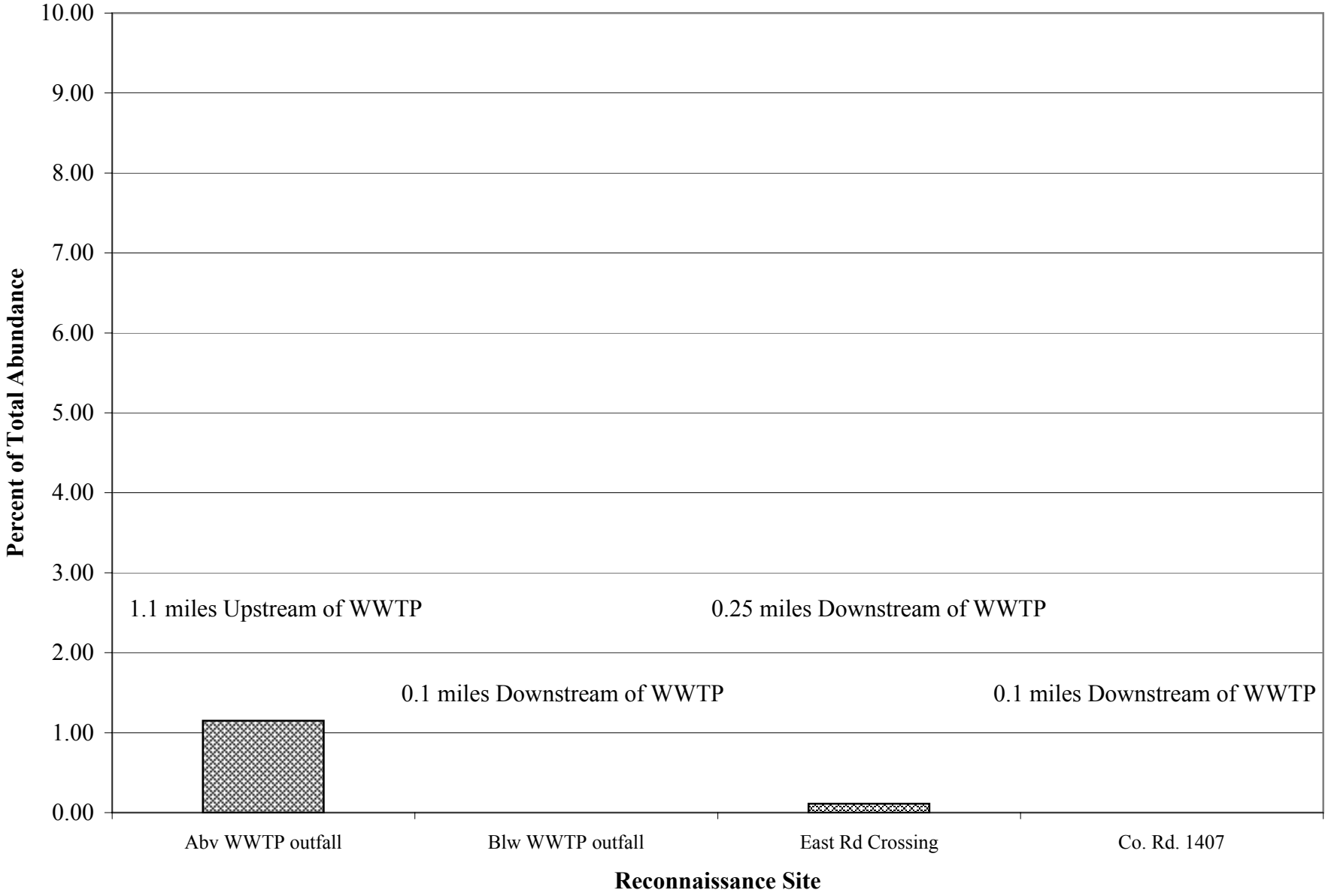


Figure C-9-4
Percent Mayflies, Stoneflies and Caddisflies (EPT Taxa):
Site Reconnaissance 2000
Carrizo Creek Near Carrizo Springs, Texas

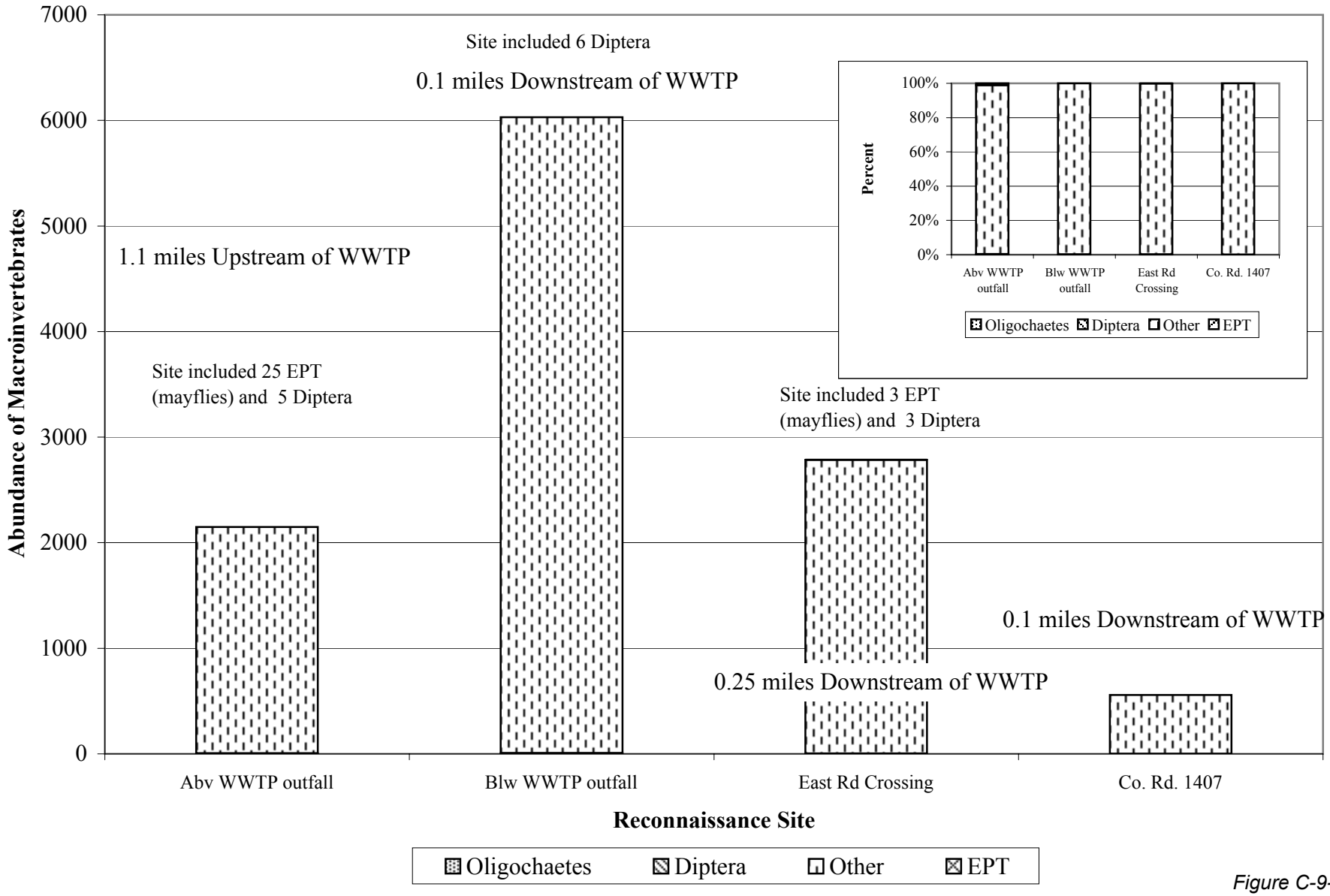


Figure C-9-5
Relative (Percent of Total Abundance) and
Total Abundance of Macroinvertebrates:
Site Reconnaissance 2000
Carrizo Creek Near Carrizo Springs, Texas

bugs), and five non-insect groups (e.g., crayfish and flatworms). However, even with this seemingly high diversity, water mites constituted more than 90 percent of the total macroinvertebrate abundance at Site 1 and amphipods constituted more than 98 percent of the abundance at all other sites.

1.9.3.2 Habitat Quality

Overall, both habitat quality assessment found minor differences among all sites (**Figure C-9-6**). The range among Project habitat scores was 40 and 61, and the range among RBP habitat scores was between 143 and 160. Although differences among sites were small, the Project method typically rated sites in a manner opposite from the RBP method. For example, the Project method rated Site 2 as having "better" habitat than Site 1. However, the RBP method rated Site 2 as having "poorer" habitat than Site 1. A linear regression between habitat scoring methods reflected this pattern showing a negative relationship between methods (r2 = 0.6598) (**Figure C-9-7**). However, because of a low sample size and small range among scores, this negative relationship was not found to be statistically significant.

The most obvious difference between habitat scoring methods was the scoring for instream habitat at Site 2 (**Figures C-9-8 and C-9-9**). The Project method scored Site 2 as having considerably better instream habitat than was scored using the RBP method. Specifically, Site 2 was considered to have improved habitat diversity, especially substrates available for colonization. In contrast, the RBP method rated Site 2 as having slightly poorer habitat quality than Site 1. This difference was caused by lower ratings for pool habitat factors.

The habitat assessment methods rated channel morphology differently (**Figures C-9-8 and C-9-9**). The RBP method rated all sites similarly, while the Project method found lower scores at Sites 3 and 4. This difference resulted from the inclusion of a rating factor in the Project method for instream structures; e.g., bridges and roads that impact channel morphology. Such a rating factor is not included in the RBP method. Riparian factors were scored more variably with the RBP method than with the Habitat method, especially at Site 2 (**Figures C-9-8 and C-9-9**).

1.10 TERRESTRIAL HABITAT AND SPECIES OVERVIEW AND ANALYSIS

No sources of historical data regarding terrestrial habitats or species along Carrizo Creek were located. **Appendix O** lists threatened, endangered, and special status species that occur in Dimmit County; mammal, bird, reptile, amphibian, and fish species that may be found in vegetation communities along Carrizo Creek; and wildlife species seen during the site reconnaissance.

1.10.1 Site 1 – Upstream of the Carrizo Springs WWTP Outfall

The width of the riparian zone along Carrizo Creek immediately upstream of the wastewater treatment plant is approximately 200 feet on the left bank, because of a pond's influence, and 100 feet on the right bank. The tree species present at this site include honey mesquite, netleaf hackberry, Mexican paloverde, willow, sweet acacia, and cedar elm. White mulberry is a fairly

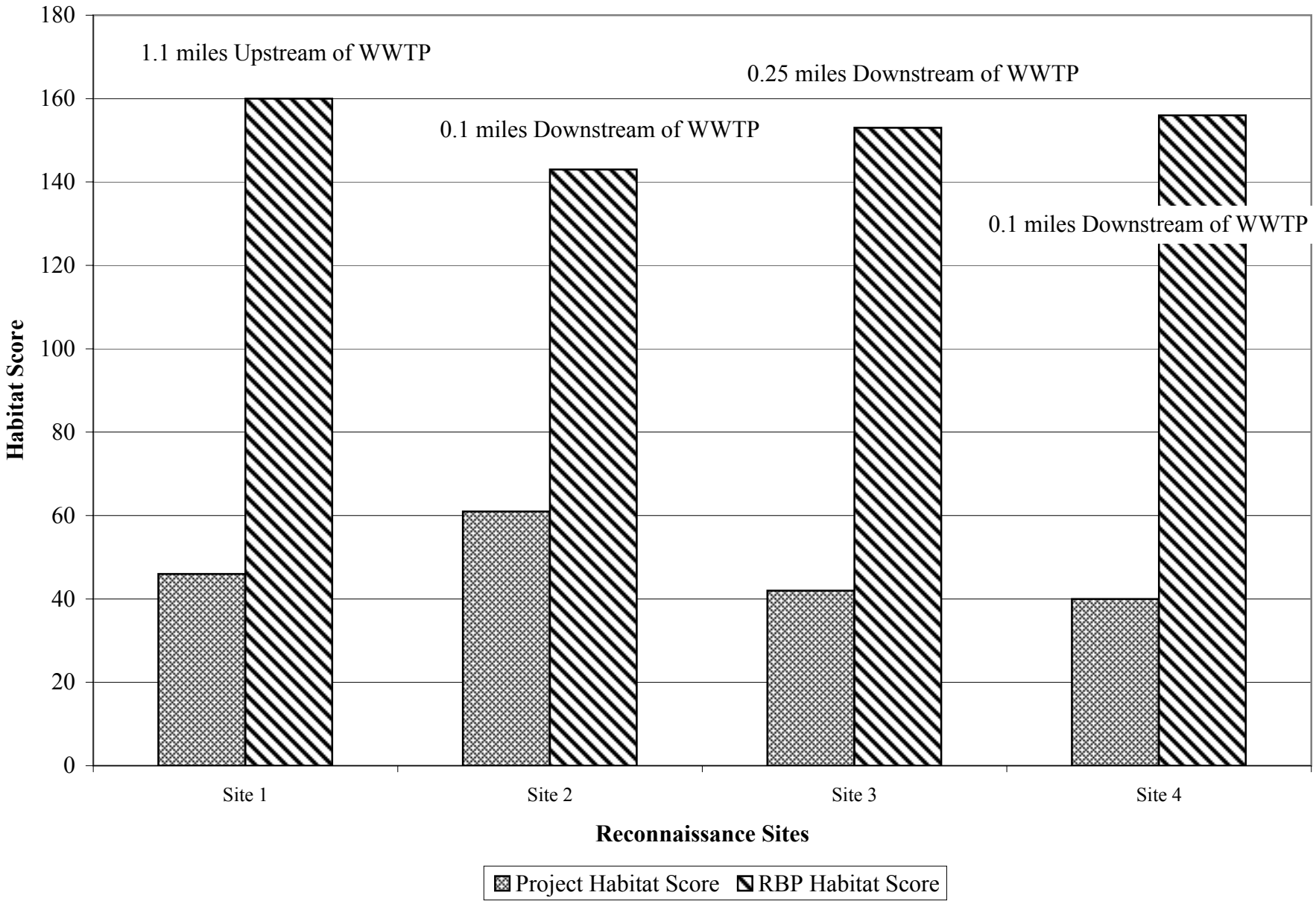


Figure C-9-6
Project Habitat vs. RBP Habitat Scores
Carrizo Creek Near Carrizo Springs, Texas

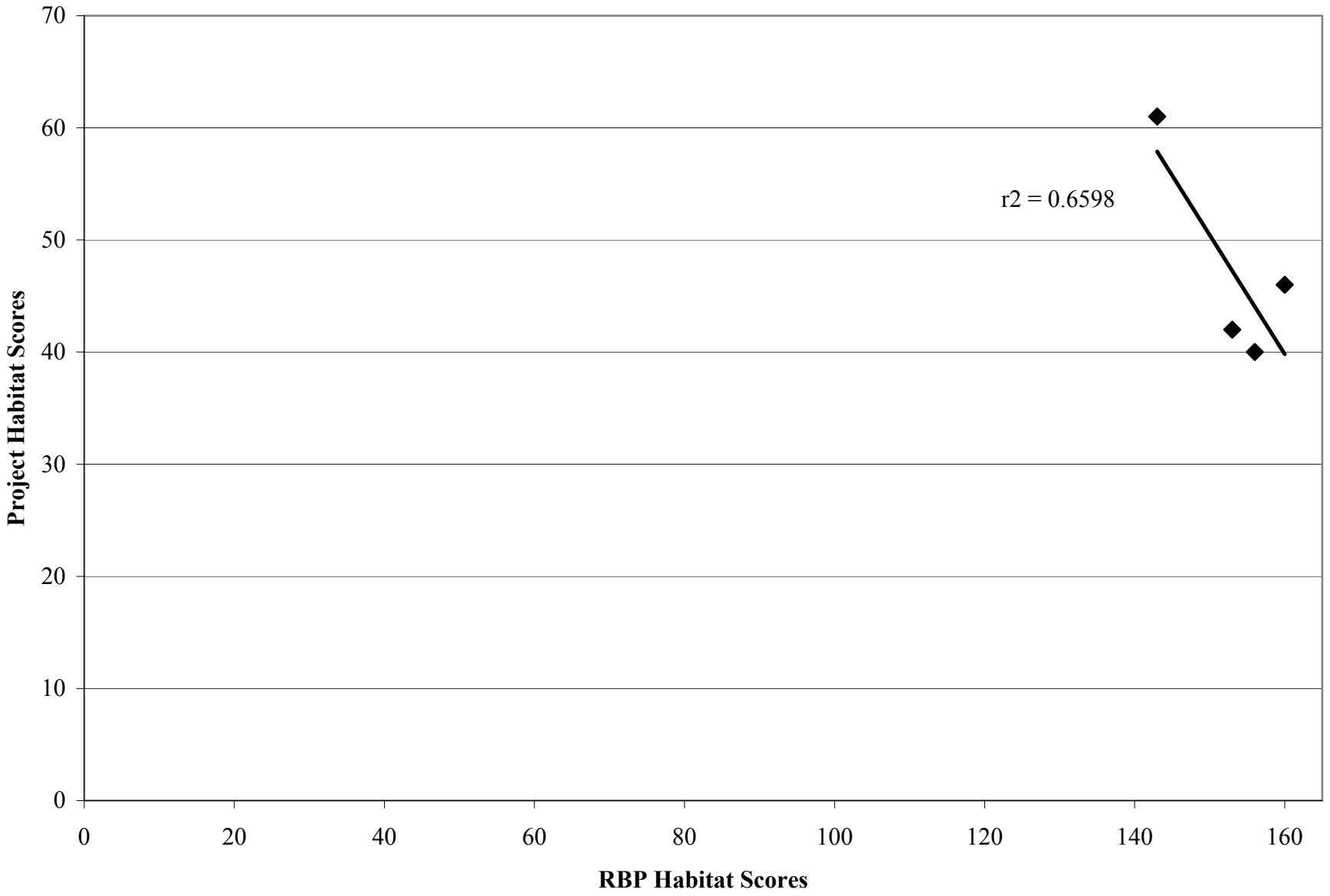


Figure C-9-7
Linear Regression:
RBP vs. Project Habitat Scores
Carrizo Creek Near Carrizo Springs, Texas

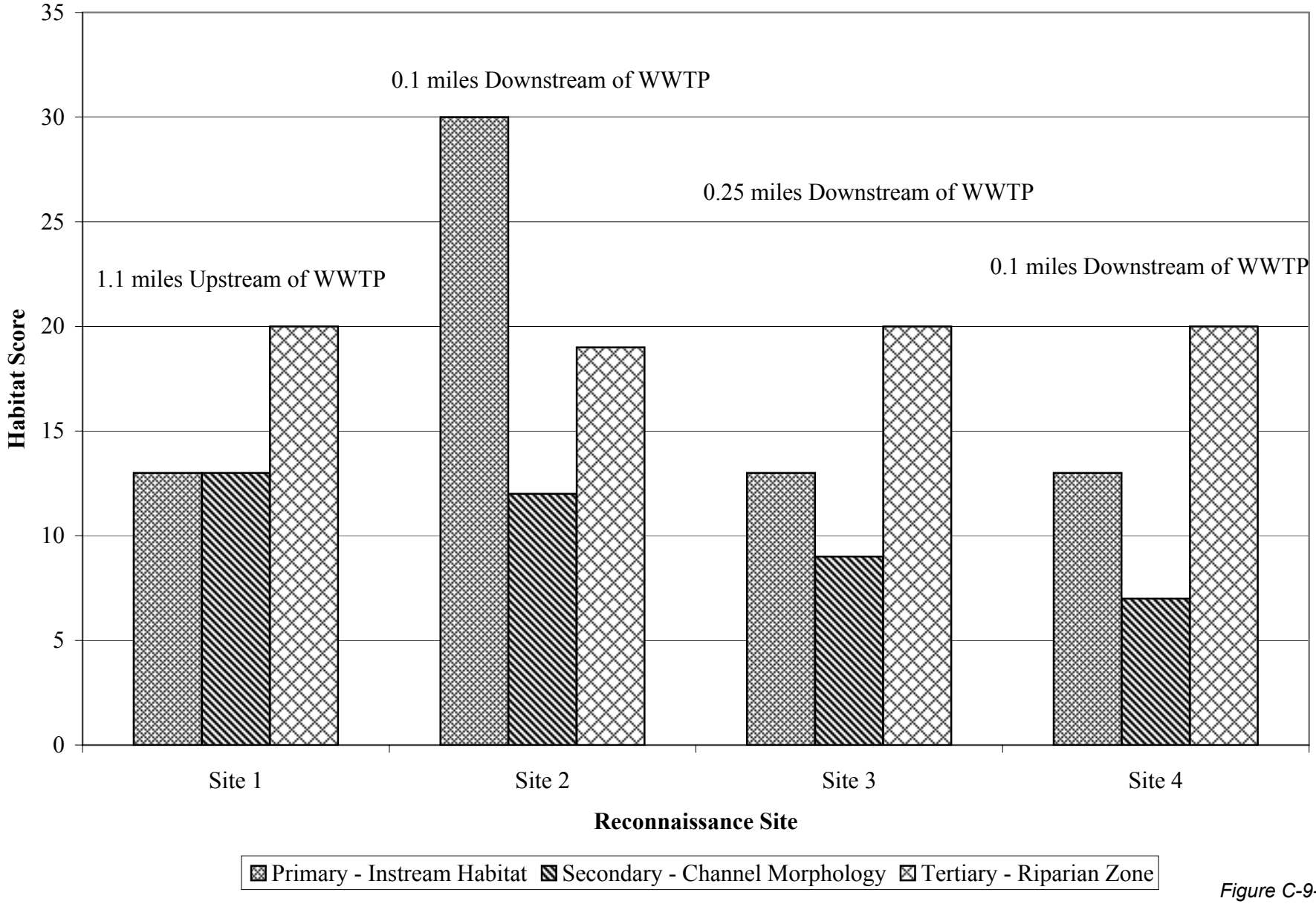


Figure C-9-8
Project Habitat Scores:
Comparison Among Primary, Secondary and Tertiary Factors
Carrizo Creek Near Carrizo Springs, Texas

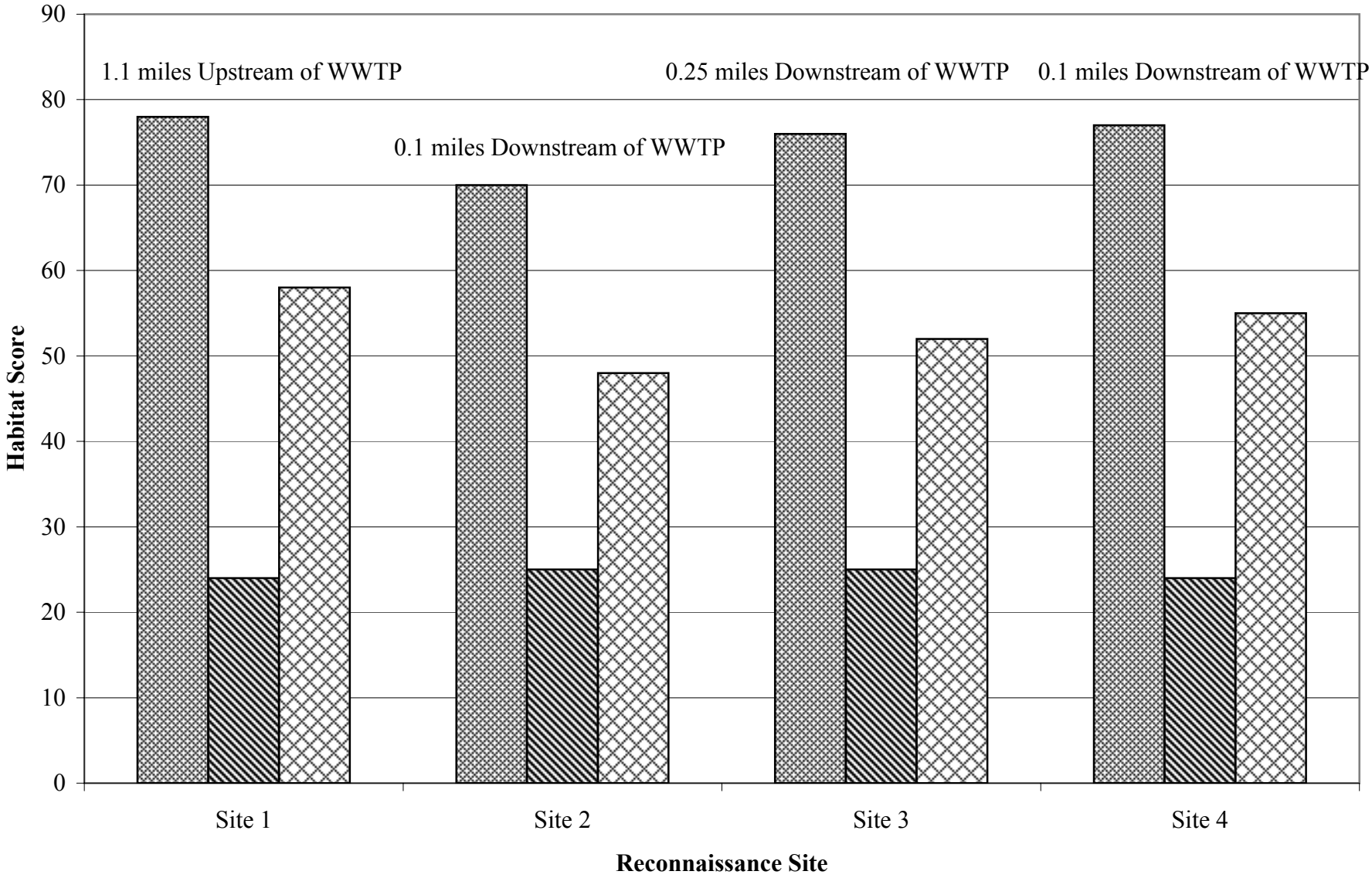


Figure C-9-9
RBP Habitat Scores:
Comparison Among Instream Habitat,
Channel Morphology and Riparian Zone Factors
Carrizo Creek Near Carrizo Springs, Texas

common small tree. The honey mesquite and netleaf hackberry are also present as shrubs, along with white-thorn acacia. Herbaceous plants include amaranth, thistle, sunflower, nightshade, scarlet gaura, ruellia, and Merremia quinquifolia. Johnson grass, blue panic grass, and buffelgrass are also found at this location. Water primrose (Ludwigia octovalis) and cattail comprise the emergent vegetation here.

The Highway 85 bridge across Carrizo Creek upstream of the Carrizo Springs WWTP. The stream is not flowing at this location, which is about 0.4 mile upstream of the treatment plant outfall. Despite lack of flow, there were puddles in the stream channel at this location.

The left bank has heavy canopy and understory cover. The right bank has a moderate amount of canopy cover and heavy to very heavy understory cover. Both sides of the creek have only moderate amounts of shrubs and seedlings in the form of ground cover, but there is very heavy herb, grass, and forb ground cover. Bare dirt or duff is sparse on both banks. The adjacent non-riparian vegetation is mesquite scrub. There are no special habitat features or human influences along this portion of Carrizo Creek.

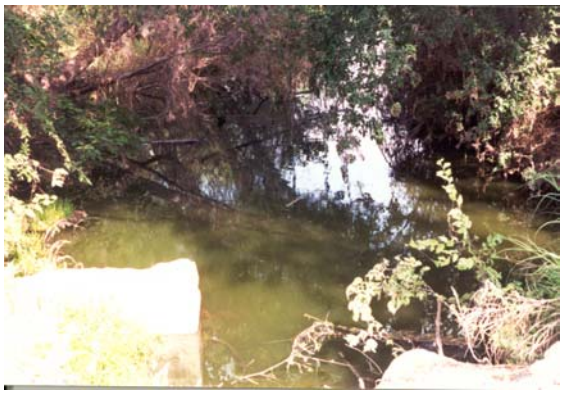
Carrizo Creek just upstream from the Carizzo Springs WWTP. Water at this location is believed to be either from rainfall or back-up from the effluent outfall.

With the riparian classification system, Site 1 is described as a forested, mixed deciduous community. The riparian vegetation score is high because of moderate species diversity and moderate to high percent cover in all vegetative layers. The score for other habitat characteristics is high because of high riparian habitat continuity, and a very wide riparian zone. The wildlife score is low because the site provides potential habitat for relatively few vertebrate species, and there is potential habitat for very few threatened, endangered, or sensitive species. The overall quality score is very high because of a low density of invasive and low levels of other disturbances.

1.10.2 Site 2 – Downstream of the Carrizo Springs WWTP Outfall

At the outfall of the wastewater treatment plant, the width of the riparian band is 5 meters on the right bank and 30 feet on the left bank. The most common trees at this site are willow and sweet acacia. Netleaf hackberry and honey mesquite are also present, but uncommon. Other vegetation that is uncommon includes Mexican paloverde and tree tobacco. Two woody vines, virgin bower and cissus, are prevalent in this area. Common herbaceous species include amaranth, bursage, sunflower, evening primrose, nightshade, and scarlet gaura. Other herbaceous species that are present, but uncommon are spiderling, puncture vine (*Tribulus* sp.), and Mexican hat. Grasses found at this site are dominated by Bermuda grass, but bristle grass, Johnson grass, blue panic

grass, and buffelgrass are also present. The only emergent vegetation is water primrose (Ludwigia octovalis).



Terminus of a sewage pond that leads to the outfall culvert that discharges water into Carrizo Creek. Gar, bullfrogs, and an indigo snake were observed at this location.

Both sides of the creek have a heavy canopy and a very heavy shrub and sapling understory cover. Understory cover of herbs, grasses, and forbs is moderate along both banks. Ground cover is heavy on both banks. Bare dirt or duff is sparse on the left bank while there is a moderate amount on the right bank. The adjacent non-riparian vegetation is mesquite scrub, and it generally begins more than 650 feet from the riparian vegetation. Special habitat features at this site are dead limbs and dead and downed trees. The only human influence at this site is the WWTP outfall on the left bank.

Typical streamside vegetation on Carrizo Creek consisting of netleaf hackberry, Texas mulberry, sweet acacia, willow, Mexican palo verde, and cedar elm. Several species of vines including virgin's bower, cissus, and Merremia form a very dense vegetative cover along Carrizo Creek.

With the riparian classification system, this site is described as a forested, deciduous, willow community. The riparian vegetation score is very high because of very high species diversity and moderate to high percent cover in all vegetative layers. The score for other habitat characteristics is moderate because of high riparian habitat continuity, high contrast with adjacent vegetation, and a relatively narrow riparian zone. The wildlife score is moderate because several species were observed during the site visit, and there is potential habitat for several threatened, endangered, or sensitive species. The score for disturbance characteristics is very high because of a low density of invasive plants and low levels of other disturbances.

1.10.3 Site 3 – Carrizo Creek at the East Road Crossing

The riparian band varies in width between 10 and 50 feet on the left bank and 10 and 30 feet on the right bank. Common trees along this portion of the creek are willow and honey mesquite. Netleaf hackberry, Mexican paloverde, and cedar elm are uncommon in this area. Common shrubs are netleaf hackberry, sweet acacia, and Texas mulberry. Virgin bower and cissus are also common at this site. Herbaceous plants present include amaranth, bursage, spiderling, thistle, sunflower, nightshade, Mexican hat, scarlet gaura, California loosestrife, and Merremia quinquifolia. The grasses present at this site are fingergrass, Johnson grass, bermuda grass, blue panic grass, and buffelgrass. Emergent vegetation includes knotweed and water primrose (Ludwigia octovalis).

Canopy cover is heavy on both sides of the creek. There is a very heavy understory cover along the banks, and ground cover is heavy on both sides of the creek. The adjacent non-riparian vegetation type is mesquite-acacia scrub. There are no special habitat features at this site. There is a paved road more than 30 feet from the banks of the creek, and there is trash directly on the banks. There is also riprap along the right bank.

With the riparian classification system, this site is described as a forested, mixed deciduous community. The riparian vegetation score is very high because of moderate species diversity and high percent cover in all vegetative layers. The score for other habitat characteristics is relatively low because of no special habitat types or features and a relatively narrow riparian zone. The wildlife score is low because very few species were observed during the site visit and there is potential habitat for relatively few threatened, endangered, or sensitive species. The score for disturbance characteristics is relatively high because of a low density of invasive plants, no grazing pressure, and moderate levels of other disturbances.

1.10.4 Site 4 – Carrizo Creek at the County Road 1407 Crossing

The width of the riparian band at this site is 15 feet on each side of the creek. Willow is abundant and netleaf hackberry, honey mesquite, and white-thorn acacia are common at this site. Herbaceous plants include common reed, alfalfa, Mexican hat, amaranth, bursage, thistle, sunflower, evening primrose, scarlet gaura, and cissus. The grasses present are bristle grass, fingergrass, bermuda grass, blue panic grass, buffelgrass, and Johnson grass.

Desertscrub vegetation away from the influence of water in Carrizo Creek. The primary tree species at this location is western honey mesquite. Sweet acacia is also a fairly common small tree species. Understory shrubs include at least two species of acacia and occasional Texas rangers.

The left bank has heavy canopy cover. The right bank has moderate canopy cover. Both sides of the creek have heavy understory cover. Ground cover is very heavy along the banks, and there are no barren areas. There are no special habitat features at this site. Adjacent non-riparian vegetation is mesquite scrub with acacia. Paved roads are within 30 feet of both banks. There is pasture more than 30 feet from the banks on both sides of the creek.

Using the riparian classification system, Site 4 is described as a forested, deciduous, willow community. The riparian vegetation score is high because of moderate species diversity and moderate to high percent cover in all vegetative layers. The score for other habitat characteristics is low because of no special habitat types or features and a narrow riparian zone. The wildlife score is low because relatively few species were observed during the site visit and there is potential habitat for relatively few threatened, endangered, or sensitive species. The score for disturbance characteristics is relatively high because of a relatively low density of invasive plants, very little grazing, and moderate levels of other disturbances.

1.10.5 Site 5 – No Sample Site

Access to the creek below Station 4 was restricted because of private property, and a fifth site along Carrizo Creek could not be investigated.