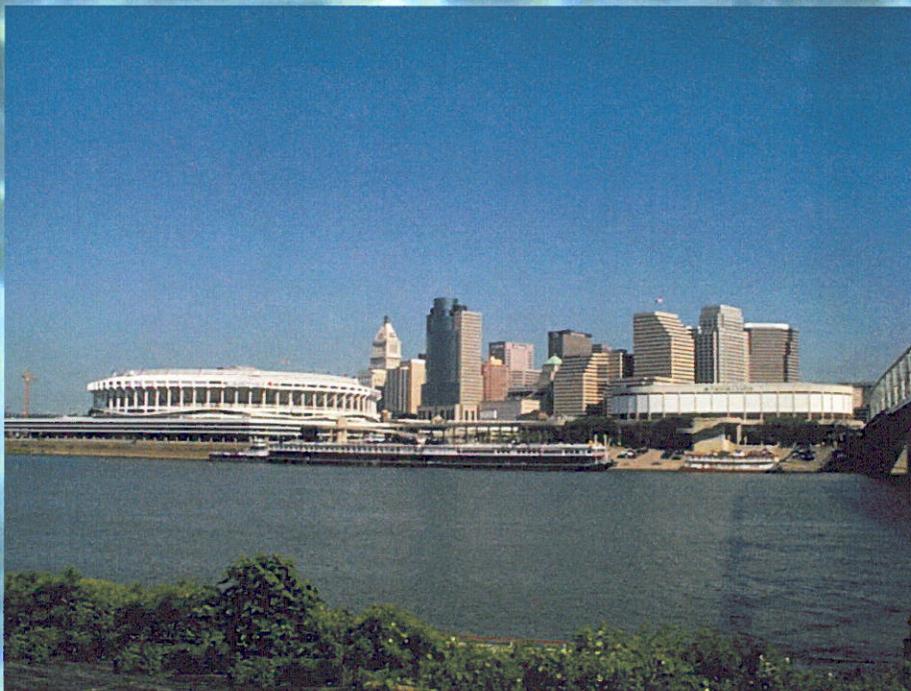


# City of Cincinnati, Ohio Department of Water Works



## Water Distribution System Master Plan



**BLACK & VEATCH**

September 1999

PN 62028



Department of Water Works  
Engineering Division

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## 1.0 Introduction

### 1.1 Purpose

The Water Distribution System Master Plan report has been prepared to provide Cincinnati Water Works (CWW) with a long-range plan for improvement and expansion of CWW's water distribution system. The Master Plan also includes an evaluation of improvements for CWW's water transmission main system. The recommended improvements will serve as a basis for the design, construction, and financing of facilities to meet CWW's anticipated population growth expansion and commercial development. The recommended system improvements will be required during the study period to provide an adequate and dependable supply of water to existing and future customers.

The study period for this study is from 1995 through the year 2020. Existing and projected populations, historical water use, and metered water sales were used to estimate water use for Base Year 1995 and Design Years 2010 and 2020. Opinions of probable cost for the recommended improvements are included.

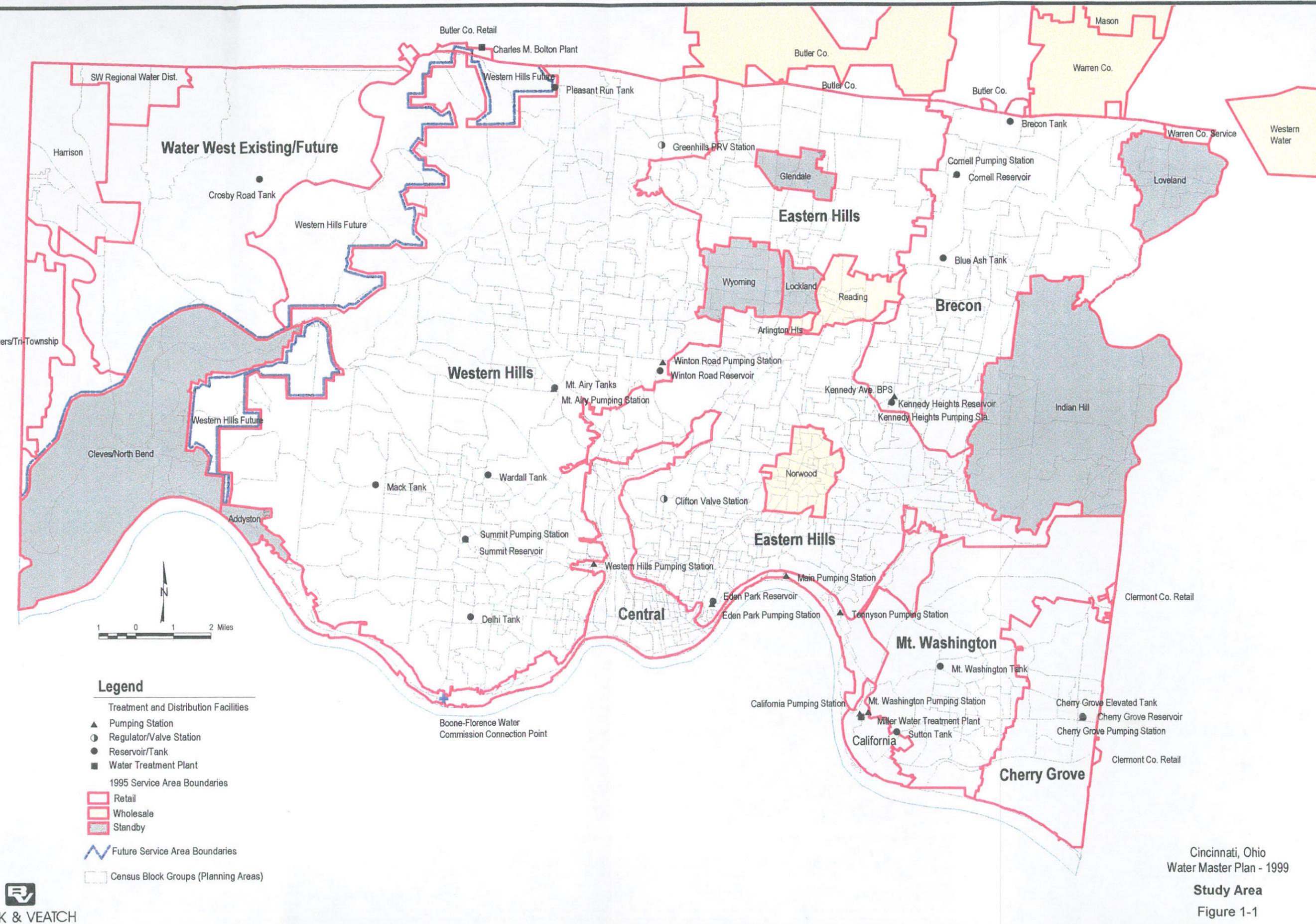
### 1.2 Scope

The Primary Study Area for this investigation includes all of Hamilton County. The Secondary Study area includes portions of Butler, Clermont, and Warren Counties and the Boone-Florence Water Commission (BFWC) Service Area. The Total Study Area (hereafter referred to as the Study Area) includes the Primary and Secondary Study Areas and is shown on Figure 1-1.

Wholesale customers located in the Primary Study Area who operate their own distribution system but receive supply from CWW include Norwood, Reading, and Arlington Heights (Arlington Heights converted to retail supply in 1996). Standby customers within the Primary Study Area include Addyston, Cleves (including parts of Miami Township), Glendale, the Village of Indian Hill (including parts of Madeira, Symmes Township, and Milford), Lockland, Loveland, North Bend, Terrance Park, and Wyoming. Small areas within Butler and Clermont Counties, which receive direct retail supply from CWW area also shown on Figure 1-1. The BFWC is designated as a wholesale customer. The Primary Study Area includes an area of over 300 square miles and had a 1995 population of about 886,000.



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- Legend**
- Treatment and Distribution Facilities
- ▲ Pumping Station
  - Regulator/Valve Station
  - Reservoir/Tank
  - Water Treatment Plant
- 1995 Service Area Boundaries
- Retail
  - Wholesale
  - Standby
- Future Service Area Boundaries
- Census Block Groups (Planning Areas)

Cincinnati, Ohio  
 Water Master Plan - 1999  
**Study Area**  
 Figure 1-1



The principal elements of this study include the following:

- Evaluate historical trends of population and employment growth, development, and water use.
- Prepare projections of future population, employment, and water requirements.
- Evaluate the adequacy of existing pumping, storage, and distribution system facilities to determine CWW's capability to meet future water requirements.
- Develop a computer network model and conduct hydraulic analyses to determine the ability of CWW's distribution system to hydraulically satisfy present and future water requirements.
- Conduct field tests to determine actual pressure and flow characteristics of the CWW water distribution system at selective locations within the Primary Study Area and to provide sufficient data for calibration and verification of the computer model. The tests were conducted by Pitometer Associates under subcontract to Black & Veatch. The Pitometer report summarizing the results of the field tests was submitted to CWW separately.
- Develop a master plan of recommended water distribution system improvements, including a phased construction program and opinions of probable cost.





### 1.3 Abbreviations

Abbreviations used in this report are as follows.

AD	Average Day
AWWA	American Water Works Association
BFWC	Boone-Florence Water Commission
CWW	Cincinnati Water Works
EPA	Energy Policy Act
EPS	extended period simulation
GAC	granular activated carbon
gcd	gallons per capita per day
ged	gallons per employee per day
GIS	geographical information system
gpm	gallons per minute
ICI	Industrial/Commercial/Institutional
MD	Maximum Day
MG	million gallons
mgd	million gallons per day
MH	Maximum Hour
MinD	Minimum Day
MM	Maximum Month
OKI	Ohio-Kentucky-Indiana Council of Governments
PRV	pressure reducing valve
psi	pounds per square inch
SCADA	supervisory control and data acquisition
TAZ	Traffic Analysis Zone
USGS	United States Geological Survey





## 1.4 Previous Reports

Previous reports reviewed, considered, or revised for this study are as follows:

- Report on Water Works Improvements - Cincinnati, Ohio, February 8, 1983.
- Letter Report on Brecon Service Area, Cornell Complex - Cincinnati, Ohio, December 21, 1987.
- Report on Mount Washington/Cherry Grove Water Distribution - Cincinnati, Ohio, August, 1990.
- Report on Service to Western Hamilton County - Cincinnati, Ohio, February 7, 1992.
- Report on Evaluation of Combining Brecon and Kennedy Heights Service Levels - Cincinnati, Ohio, July 20, 1992.
- Update Report on Western Hamilton County, Cincinnati, Ohio, November 1994.





## 2.0 Population and Employment

Development of a comprehensive water distribution system master plan begins with an evaluation of the area's historical population trends and projected growth patterns. To accurately predict future water demands, it is necessary to determine the magnitude, direction, and characteristics of future population growth.

Because a large portion of CWW's water sales are to industrial, commercial, and institutional (ICI) customers and because ICI water sales are closely related to the number of persons employed, current and future employment estimates were also prepared.

### 2.1 Historical Population

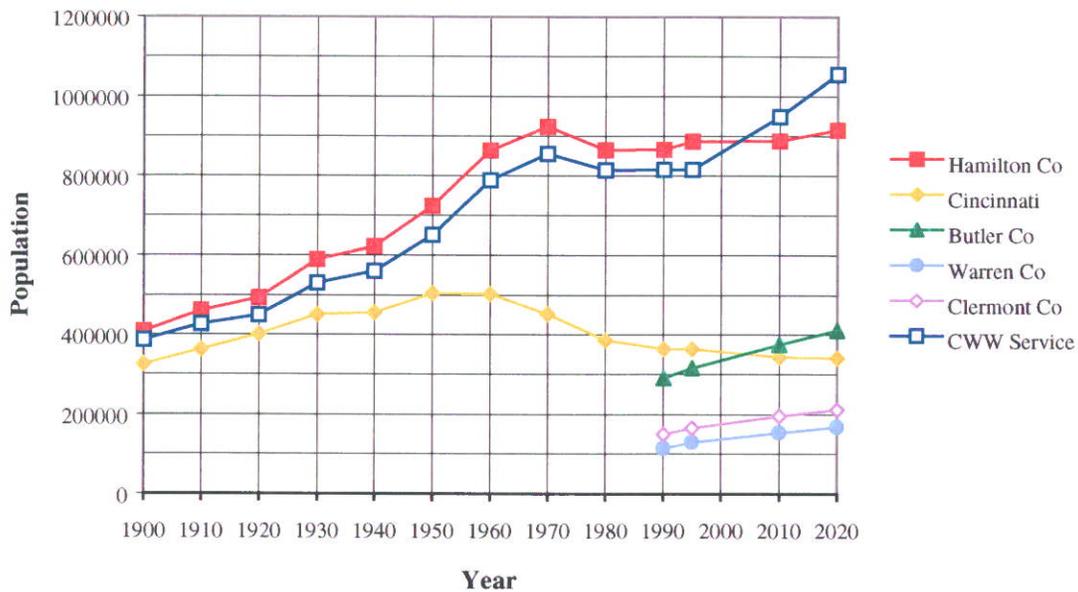
Historical population data for the CWW service area, Cincinnati, Hamilton County and surrounding Ohio counties obtained from the U.S. Census Bureau are given in Table 2-1 and shown on Figure 2-1. Historical CWW water service populations were compiled from previous Black & Veatch reports.

Year	Population					
	Hamilton County	Cincinnati	Butler County	Warren County	Clermont County	CWW Service Area
1900	409,478	325,902	-	-	-	387,568
1910	460,732	363,591	-	-	-	426,732
1920	493,678	401,247	-	-	-	449,197
1930	589,356	451,160	-	-	-	530,517
1940	621,987	455,610	-	-	-	560,437
1950	723,952	503,998	-	-	-	650,990
1960	864,121	502,550	-	-	-	788,925
1970	924,018	452,524	-	-	-	855,143
1980	865,149	385,487	-	-	-	814,643
1990	866,228	364,040	291,479	113,927	150,167	816,100
1995	886,050	363,800	316,150	130,060	165,230	815,750
2010	888,200	344,500	375,200	153,900	195,900	949,310
2020	916,000	341,400	411,600	167,400	212,100	1,055,600





**Figure 2-1**  
**Historical and Projected Population**  
**CWW Service Area and Surrounding Counties**



## 2.2 Population and Employment Projections

### 2.2.1 Population Projections

Population estimates (1995) and projections (2010 and 2020) for Cincinnati, Hamilton County and surrounding Ohio counties, and the CWW service area were obtained from the Ohio-Kentucky-Indiana Regional Council of Governments (OKI). Population estimates and projections are given in Table 2-1 and shown on Figure 2-1.

The population projections indicate that population in Hamilton County will remain fairly stable during the 1995 through 2020 study period. Population is projected to remain nearly constant between 1995 and 2010. Between 2010 and 2020, a population increase of about 28,000 is projected in Hamilton County. Population in the City of Cincinnati is projected to continue to decline through year 2020. Populations in each of the three Ohio counties surrounding Hamilton County (Butler, Warren, and Clermont) are projected to increase steadily between 1995 and 2020.

The CWW service population (based on CWW retail and wholesale customers served) is projected to increase from about 815,750 in 1995 to 1,055,600 in year 2020. The increase in CWW=s service population is based on a significant increase in the number of wholesale customers located outside of Hamilton County (Secondary Study Area). The projected CWW service populations in the Primary and Secondary Study





Areas are summarized in Table 2-2. The Secondary Study Area service population is projected to increase from about 1 percent of the total service population in 1995 to about 19 percent of the total service population in 2020.

Year	CWW Service Population				
	Primary Study Area <sup>(1)</sup>		Secondary Study Area <sup>(2)</sup>		Total Study Area
	Persons	% of Total	Persons	% of Total	
1995	808,790	99.1	6,960	0.9	815,750
2010	823,860	86.8	125,450	13.2	949,310
2020	853,020	80.8	202,580	19.2	1,055,600

<sup>(1)</sup> Hamilton County.  
<sup>(2)</sup> Butler, Clermont, Warren Counties.

### 2.2.2 Employment Projections

Employment estimates (1990 and 1995) and projections (2010 and 2020) for Cincinnati, Hamilton County, and surrounding Ohio counties were obtained from the Ohio-Kentucky-Indiana Regional Council of Governments (OKI). Employment estimates and projections are given in Table 2-3 and shown on Figure 2-2.

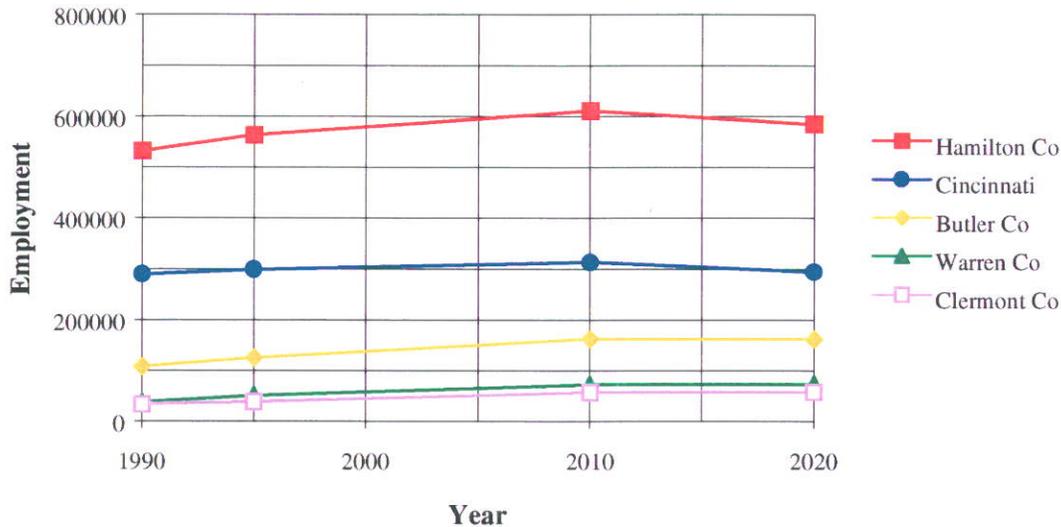
Employment is projected to increase moderately between 1995 and 2010 in Cincinnati, Hamilton County, and the surrounding Ohio counties. Between 2010 and 2020, employment in Cincinnati and Hamilton County is projected to decline while employment in Butler, Warren, and Clermont counties is expected to remain stable.

Year	Employment				
	Cincinnati	Hamilton County	Butler County	Warren County	Clermont County
1990	289,360	532,100	108,220	37,070	43,800
1995	298,570	563,588	125,707	51,184	48,440
2010	312,840	611,640	162,780	72,970	67,350
2020	294,040	584,750	161,670	73,580	67,810





**Figure 2-2**  
**Estimated and Projected Employment**



### 2.2.3 Hamilton County Census Block Group Population and Employment

Because the demand estimates and projections need to support sophisticated hydraulic and water quality modeling of the CWW water system, the following project approach was adopted for preparing future water use projections.

- X Population projections were prepared at the block group level and serve as the basis for residential water use projections.
- X Employment projections were prepared at the block group level and serve as the basis for Industrial/Commercial/Institutional (ICI) water use projections.

The water use projections completed at the census block group level within the Primary Study Area (Hamilton County) will enable accurate determination and assignment of water use for water system modeling.

Hamilton County has been divided into 482 Traffic Analysis Zones (TAZ) by the Ohio, Kentucky, Indiana Regional Council of Governments (OKI) for use in transportation and land use planning. OKI has prepared population and employment estimates for the TAZ for years, 1995, 2010, and 2020, which were adopted for use in preparing water use projections for this investigation.

The U.S. Bureau of the Census has divided Hamilton County into census tracts (CT) and blocks. These blocks have been aggregated into 878 block groups (BG).





To prepare water use projections at the census block group level, it was necessary to convert the 1995, 2010, and 2020 population and employment estimates and projections from the 482 TAZ to the 878 block groups within Hamilton County. The following tasks were performed to complete the conversion. It is noted that during the conversion of OKI TAZ population and employment data to census block groups, no changes were made to the original OKI estimates.

#### ***2.2.3.1 Task 1. 1990 Population Equivalency Table (Population Based)***

A “population equivalency table” was constructed which converted 1990 TAZ population estimates to census block group population estimates. The converted block group population estimates were compared with the actual 1990 census block group population data and there was nearly perfect agreement.

#### ***2.2.3.2 Task 2. 1990 Employment Equivalency Table (Area Based)***

A 1990 “employment equivalency table” was constructed to convert OKI TAZ employment estimates to census block groups. The employment equivalency table, based on an overlay of census block group and TAZ, is land area based.

#### ***2.2.3.3 Task 3. High Growth Area Identification, Land Use/Planning/Topographic Maps and Aerial Photograph Review.***

For construction of the 1995, 2010, and 2020 population and employment equivalency tables, the high growth TAZ were identified. For these high growth areas, existing land use maps and plans, aerial photographs, and USGS (7.5 minute quadrangle; 1:24,000 scale) topographic maps obtained from Hamilton County municipalities, OKI, and other sources were reviewed.

#### ***2.2.3.4 Task 4. 1995, 2010, and 2020 Population Equivalency Tables***

For the high population growth TAZ (Task 3), using land use maps and aerial photos, the population growth in the TAZ for the periods 1995 to 2010 and 2010 to 2020 were assigned to census block groups. The TAZ to census block group percentage assignments were then updated. For the period 1995 to 2010, population distribution in 67 TAZ was evaluated and redistributed as required. Population within the 67 TAZ represented over 25 percent of the total Hamilton County 2010 population. For the period 2010 to 2020, population distribution in 48 TAZ was evaluated and redistributed as required. Population within the 48 TAZ represented over 23 percent of the total





Hamilton County 2020 population. No adjustments of the percentage assignments were judged necessary for the 1995 population equivalency table.

#### ***2.2.3.5 Task 5. 1995, 2010, and 2020 Employment Equivalency Tables***

The 1995, 2010, and 2020 Employment Equivalency Tables were constructed in a manner similar to the 1995, 2010, and 2020 population equivalency tables.

Black & Veatch performed construction of the 1990 Population and Employment Equivalency Tables (Tasks 1 and 2). Identification of the high growth areas and construction of the 1995, 2010, and 2020 Population and Employment Equivalency Tables (Tasks 3, 4, and 5) was performed by Balke Engineers with consultation by Don Burrell, OKI.

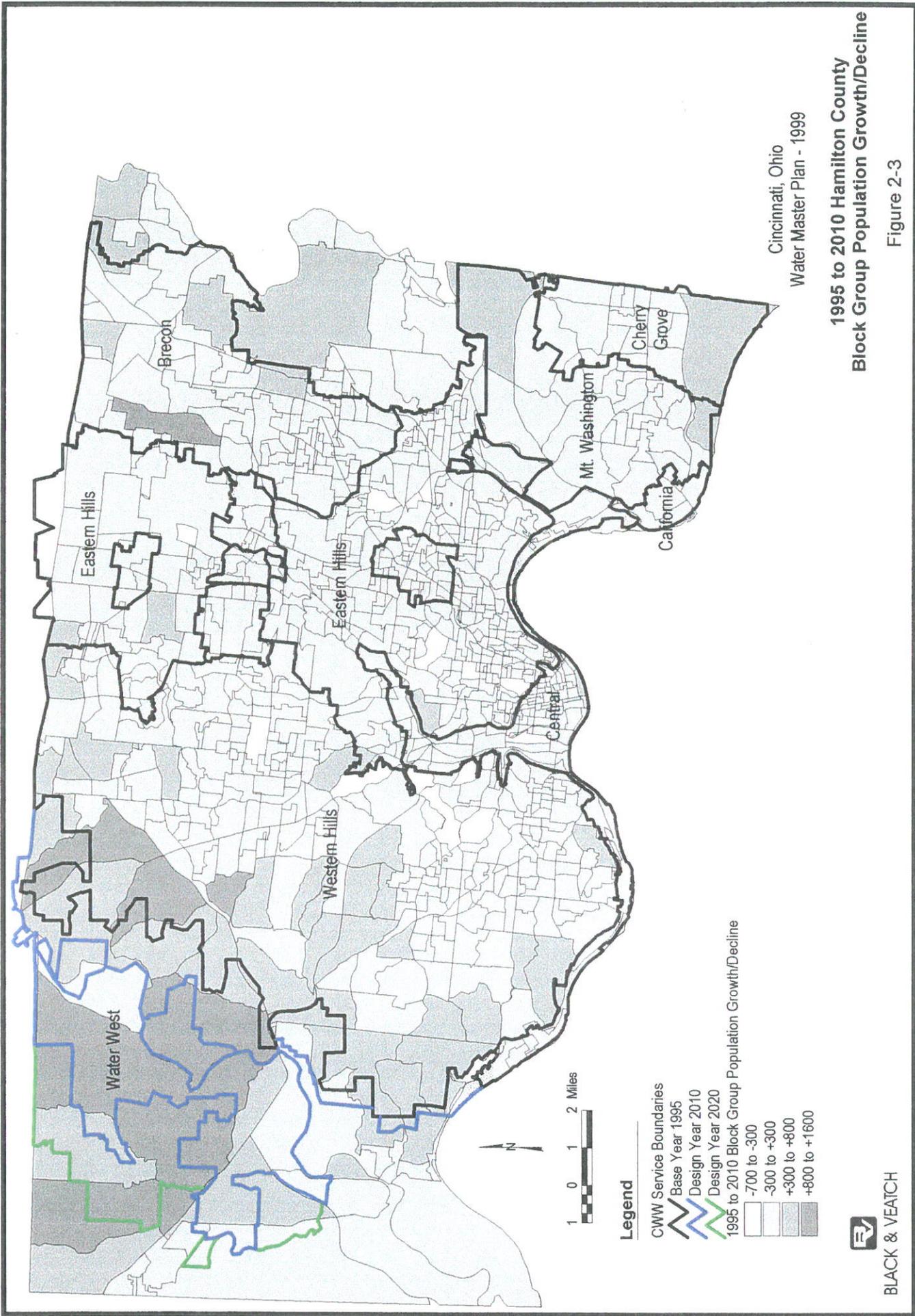
Population growth or decline for the block groups in the Primary Study Area (Hamilton County) between 1995 and 2010, between 2010 and 2020, and between 1995 and 2020, is shown on Figures 2-3, 2-4, and 2-5 respectively. Also shown on Figures 2-3 through 2-5 are 1995, 2010, and 2020 CWW retail and wholesales service boundaries for Hamilton County.

It is shown on Figure 2-3 that between 1995 and 2010, population growth will occur primarily in the western third of the county (Water West service level and the western portion of the Western Hills service level). Population growth between 2010 and 2020, depicted on Figure 2-4, demonstrates that this trend will continue through 2020.

Population growth is also predicted in the northern portions of the county (northern Western Hills and Eastern Hills and Brecon service levels).

Employment growth or decline for the block groups in the Primary Study Area (Hamilton County) between 1995 and 2010, between 2010 and 2020, and between 1995 and 2020, is shown on Figures 2-6, 2-7, and 2-8, respectively. It is demonstrated on Figure 2-6 that between 1995 and 2010, despite employment growth in some sections of the Cincinnati downtown business district, many areas of Cincinnati are projected to experience declines in employment. Employment growth is projected to occur in the western and northeast areas of the county (Western Hills, northern Eastern Hills, and Brecon service levels). Between 2010 and 2020 overall county employment is projected to decline; employment growth is expected in a limited number of areas in the western and northern portions of the county.





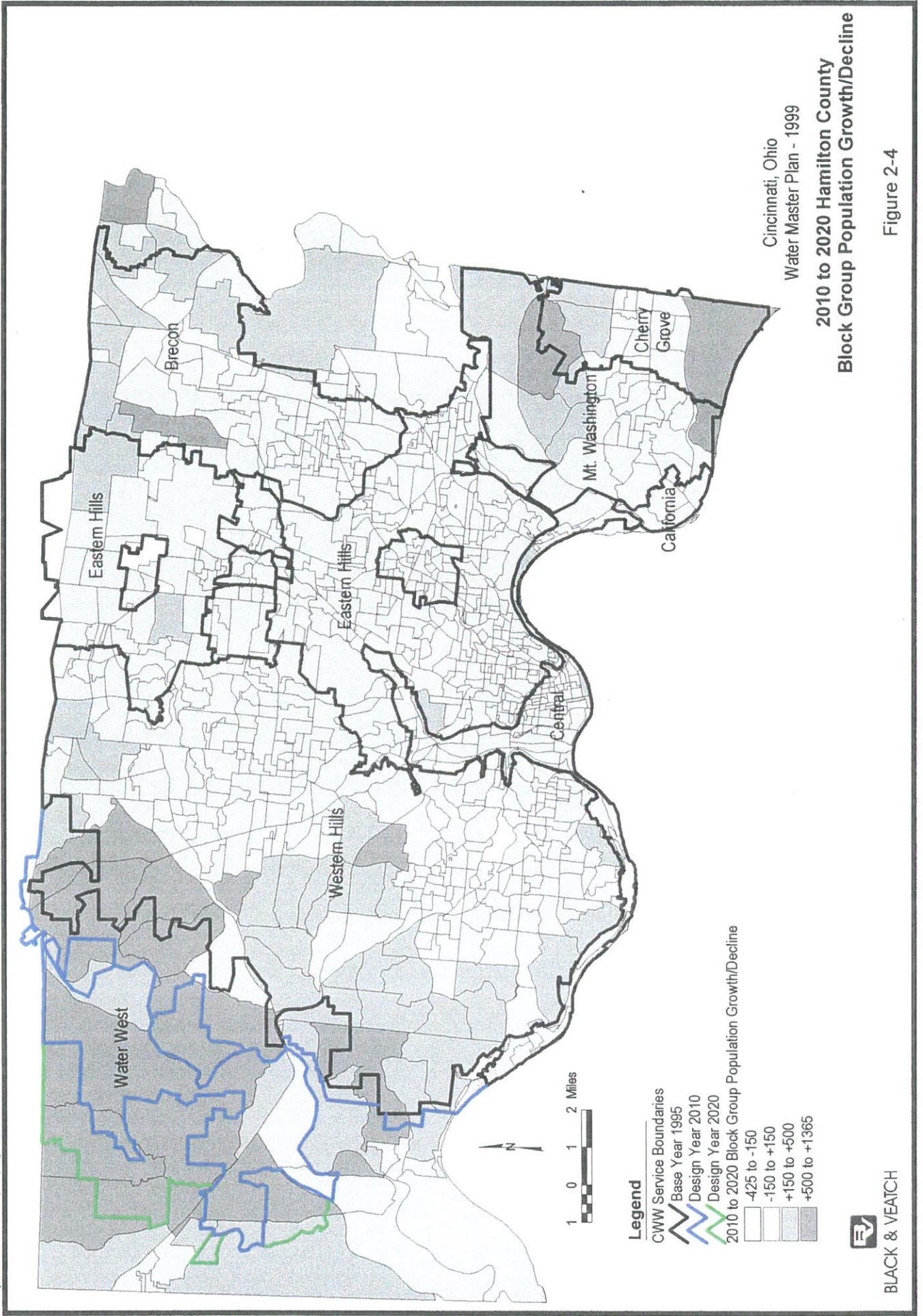
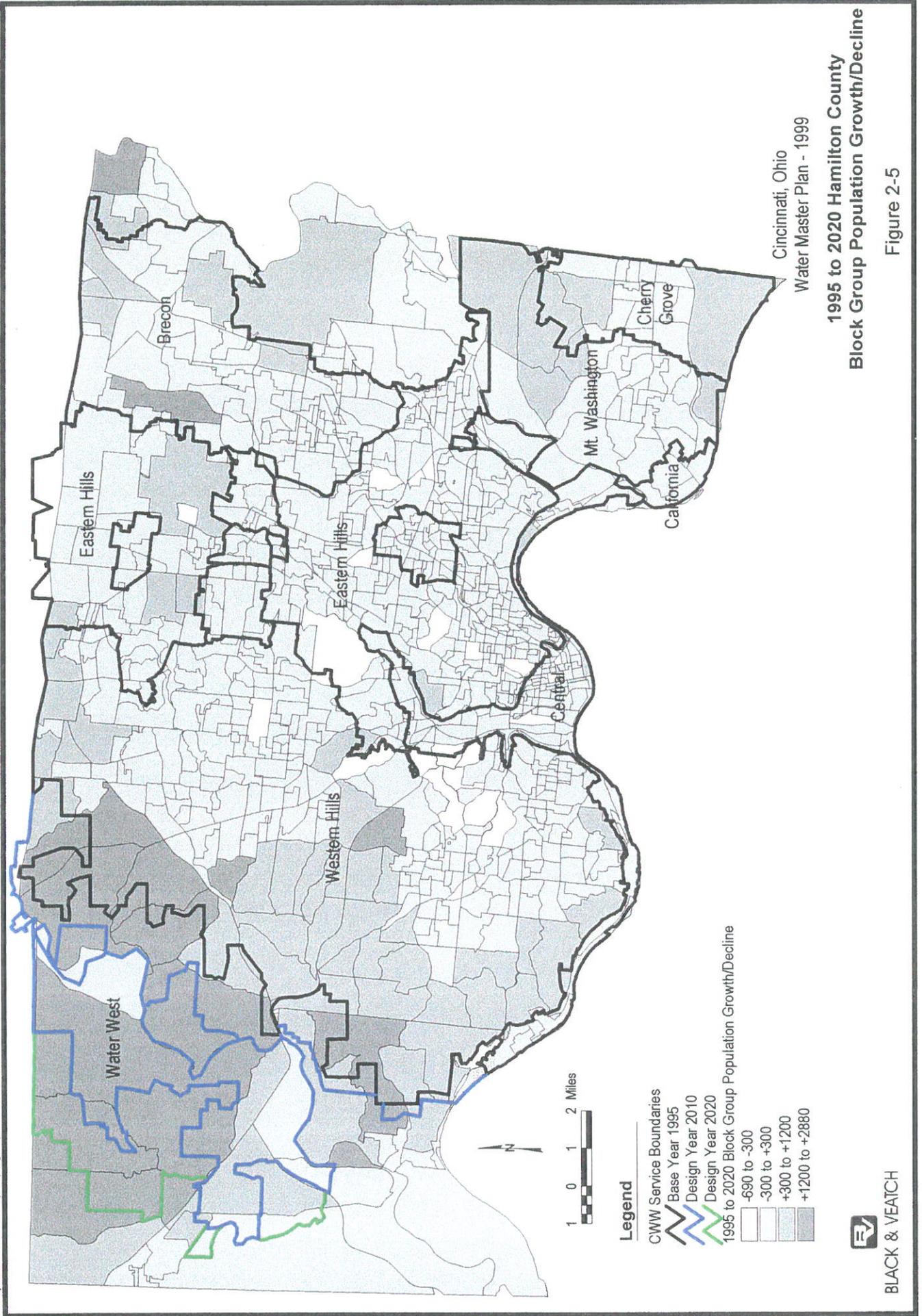
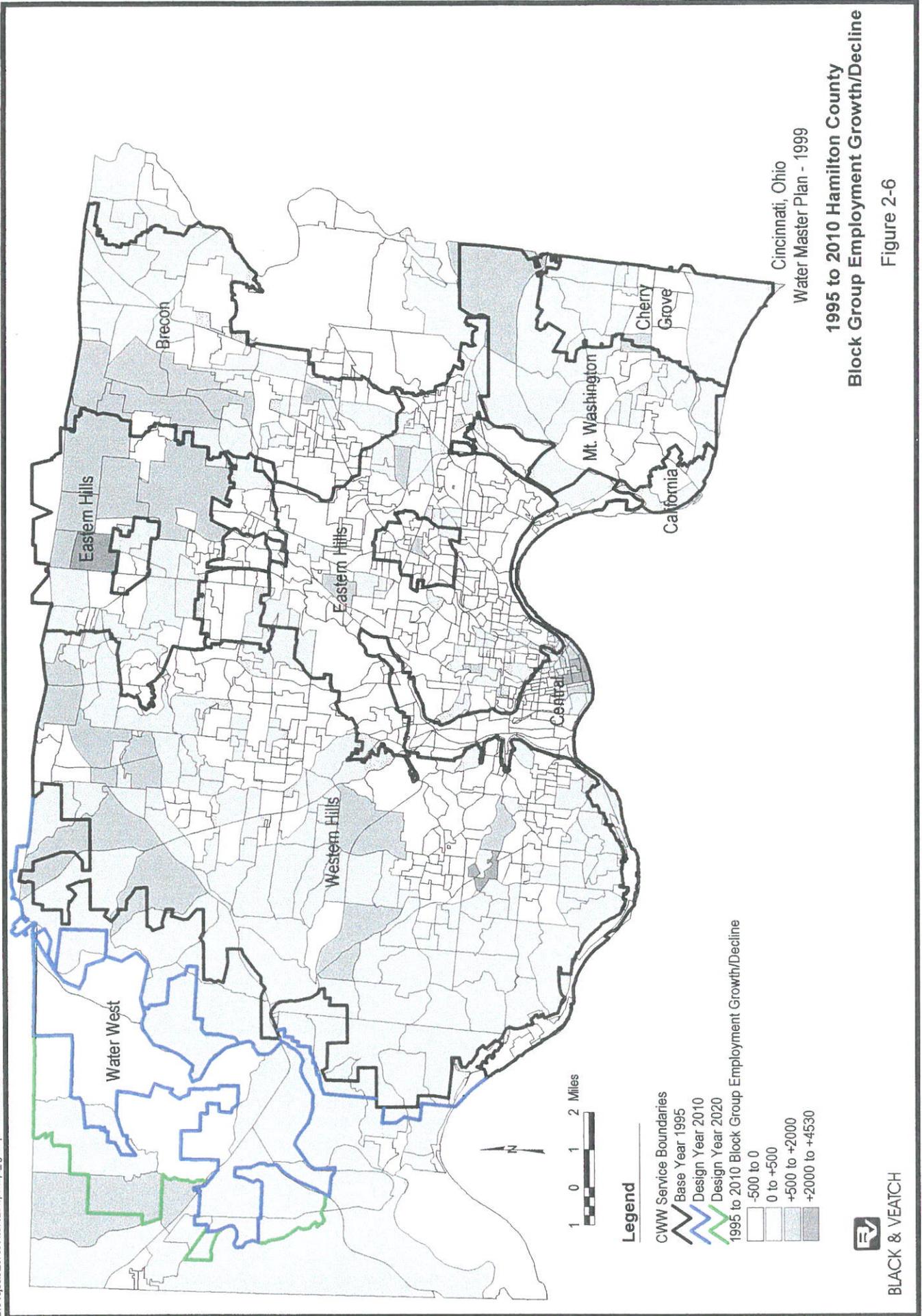
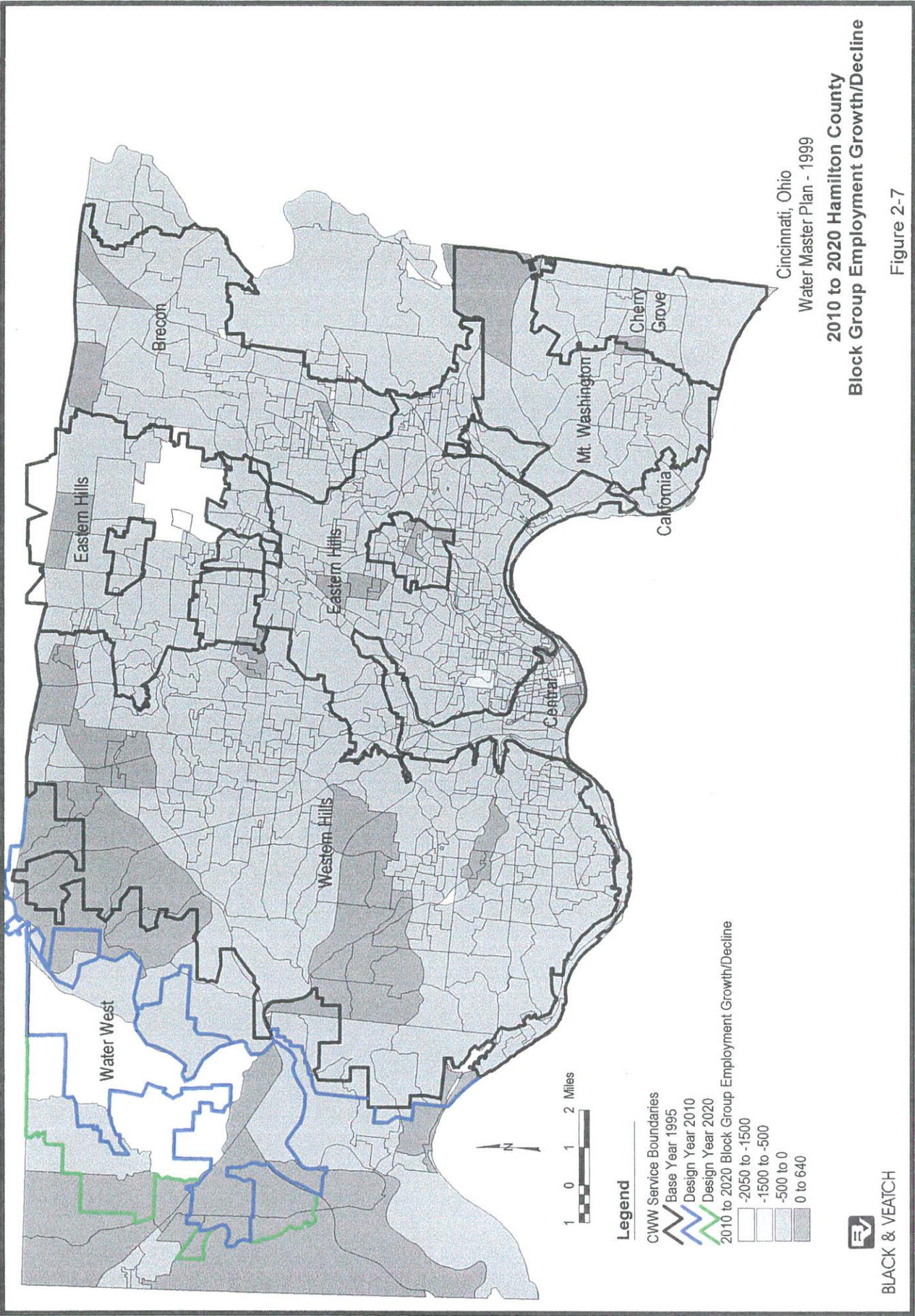
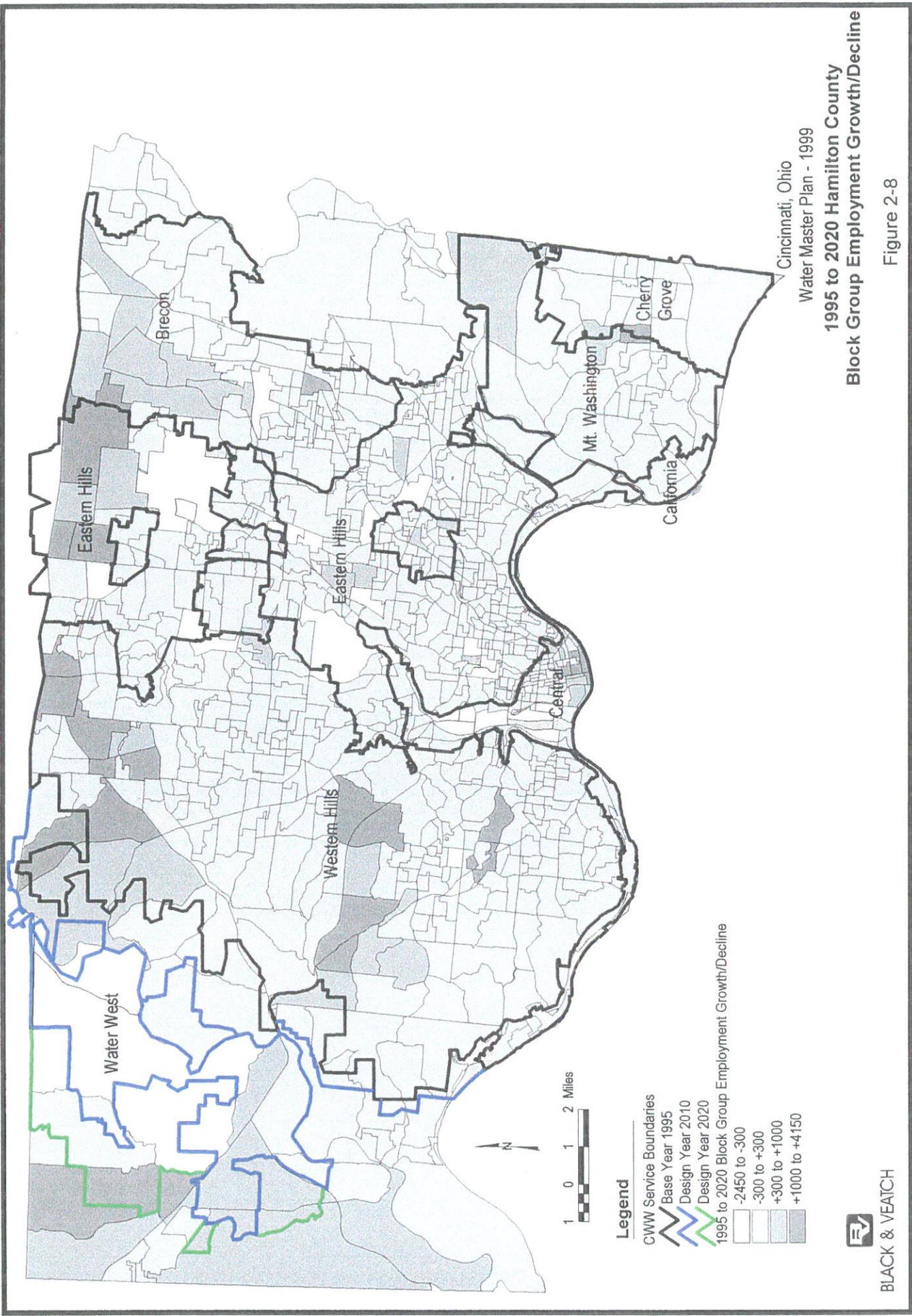


Figure 2-4









1995 to 2020 Hamilton County  
Block Group Employment Growth/Decline

Figure 2-8





### 2.2.4 Service Level Population

Population served by service level is given in Table 2-4 and shown on Figure 2-9. The service level populations include all retail and wholesale customers in the Primary and Secondary Study Areas except the BFWC service area. Table 2-4 also includes the service level population located specifically within the Primary Study Area (Hamilton County).

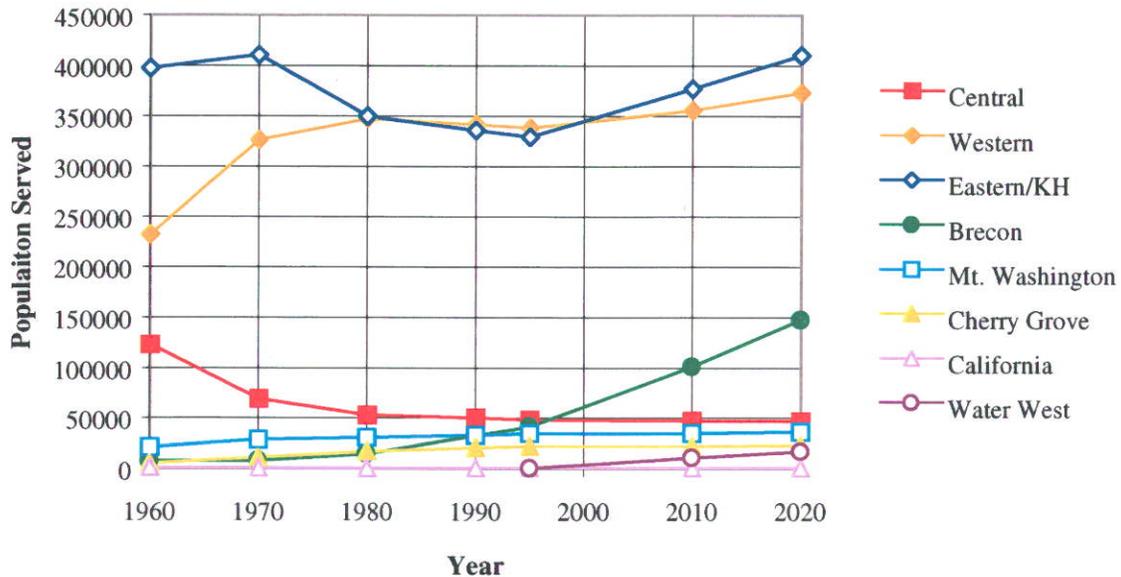
Service Level	Population Served <sup>(1)</sup>						
	Year						
	1960	1970	1980	1990	1995	2010	2020
Central <sup>(3)</sup>	123,254	69,201	53,375	50,258	48,700	47,350	46,960
Western Hills	232,329	326,559	347,872	341,611	338,480	355,320	372,960
Eastern Hills	397,665	410,702	350,177	336,226	329,250 322,890 <sup>(2)</sup>	376,930 310,310 <sup>(2)</sup>	410,000 309,100 <sup>(2)</sup>
Brecon	7,815	7,941	14,535	32,372	41,290 40,970 <sup>(2)</sup>	101,200 43,730 <sup>(2)</sup>	147,680 47,360 <sup>(2)</sup>
Mt. Washington	21,466	29,000	30,854	33,391	34,660	35,160	36,500
Cherry Grove	5,401	10,915	17,335	20,565	22,180 21,900 <sup>(2)</sup>	22,050 21,770 <sup>(2)</sup>	23,530 23,250 <sup>(2)</sup>
California	995	825	495	658	740	760	770
Water West	-	-	-	-	450	10,540 9,460 <sup>(2)</sup>	17,200 16,120 <sup>(2)</sup>
Total	788,925	855,143	814,643	815,081	815,750 808,790 <sup>(2)</sup>	949,310 823,860 <sup>(2)</sup>	1,055,600 853,020 <sup>(2)</sup>

(1) Includes Total Study Area retail and wholesale customers.  
(2) Service level population residing within Primary Study Area (Hamilton County).  
(3) Boone-Florence Water Commission population not included.





**Figure 2-9**  
**Population Served by Service Level**



The population data displayed in Table 2-4 and Figure 2-9 indicate that the Western Hills, Eastern Hills, Brecon, and Water West service level populations will grow steadily between 1995 and 2020. Between 1995 and 2020 the Eastern Hills service level population is projected to increase by about 80,750, attributable to an increase in the population served outside of Hamilton County. During this same period, the Eastern Hills service level population located within Hamilton County is projected to decrease by about 13,790.

Between 1995 and 2020 the Western Hills service level population is projected to increase by about 34,480, primarily due to population growth in the western portions of the existing service area and expansion of the service level boundary to the west. It is noted that after a number of decades of declining population in the Central service level, the population served is projected to remain relatively stable between 1995 and 2020.

Overall, the system-wide service population will grow from about 815,750 in 1995 to 1,055,600 in 2020, an increase of about 239,850. The increase in the CWW service population includes 44,230 residing within Hamilton County and about 195,620 located outside of Hamilton County.





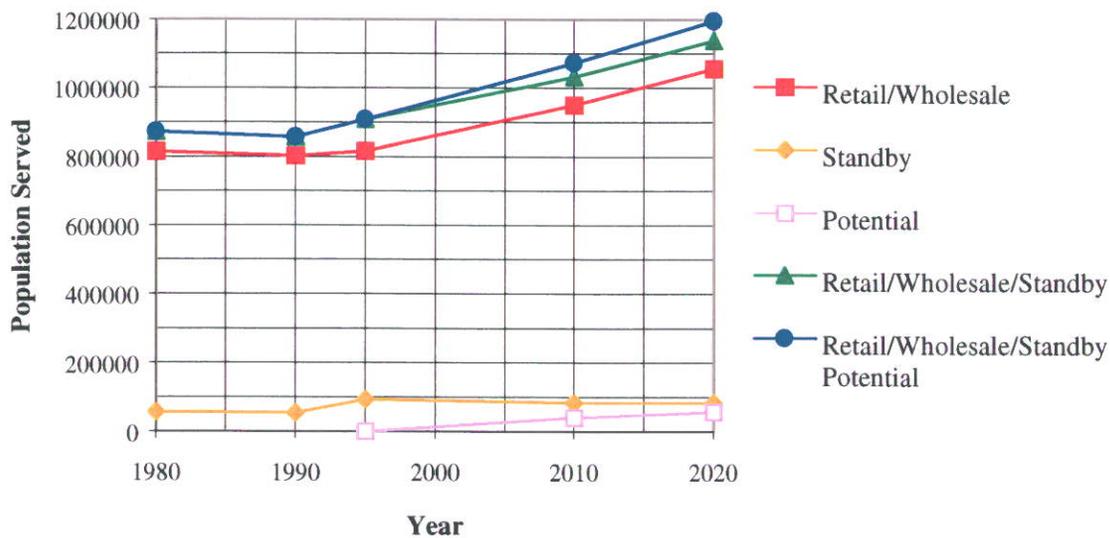
### 2.2.5 Population by Political Jurisdiction, Service Level, And Service Class

The populations served in political jurisdictions and areas receiving water service from CWW are summarized in Table 2-5. Some of the entities in Table 2-5 refer to general planning areas and do not conform to legal jurisdictional boundaries (e.g., Cleves “Retail”). The types of service currently received (1995) and projected to be provided in 2010 and 2020 are listed in Table 2-5. The types of service include retail, wholesale, standby, and “potential”. Potential service refers to areas which could potentially receive CWW retail or wholesale service in the future. Likely supply points and the associated service level were identified for a number of future customers and areas listed in Table 2-5.

The population served data in Table 2-5 indicates that the 1995 standby service population is about 92,880 and will decline to 82,580 in 2020, due to conversion of a number of standby customers to retail and wholesale service. The service population in the potential service areas is projected to be 40,460 in 2010 and 57,410 in 2020.

The retail/wholesale, standby, and potential service populations are shown on Figure 2-10 along with totals for the service types. The population projections given in Table 2-5 and displayed on Figure 2-10 indicate the total retail/wholesale/standby service population will grow from 908,630 in 1995 to 1,138,180 in 2020 (+25%). The total retail/wholesale/standby/potential service population will reach 1,195,590 million in 2020.

**Figure 2-10**  
**Population Served by Service Type**





**Table 2-5  
Population Served, Service Level, and Type of Service for  
Political Jurisdictions/Areas**

Political Jurisdiction/ Area	1995			2010			2020		
	Population Served	Service Level <sup>(1)</sup>	Service <sup>(2)</sup>	Population Served	Service Level <sup>(1)</sup>	Service <sup>(2)</sup>	Population Served	Service Level <sup>(1)</sup>	Service <sup>(2)</sup>
Addyston	1,230	WH	S	1,190	CE	R	1,280	CE	R
Arlington Hts.	1,020	EH	W	820	EH	R	800	EH	R
Butler County	190	EH	R	190	EH	R	190	EH	R
Butler County	6,170	EH	W	66,430	EH	W	100,710	EH	W
Butler County	320	BR	R	320	R	R	320	BR	R
Butler County				1,080	WW	R	1,080	WW	R
Clermont County	280	CG	R	280	CG	R	280	CG	R
Clermont County				7,140	BR	W	14,290	BR	W
Cleves "Retail"	1,290	WH	S	1,480	WW	R	1,540	WW	R
Cleves/N. Bend	6,510	WH	S	6,690	WW	P	7,580	WW	P
Fairfield	41,200	WH	S	44,560	WH	S	43,220	WW	S
Glendale	2,540	EH	S	2,300	EH	S	2,030	EH	S
Greendale				11,900	WW	P	12,000	WW	P
Harrison				8,920	WW	P	9,680	WW	P
Indian Hill	15,420	EH	S	15,120	EH	S	15,220	EH	S
Lawrenceburg				6,250	WW	P	6,750	WW	P
Lebanon							14,000	BR	P
Lockland	4,240	EH	S	3,830	EH	W	3,740	EH	R
Loveland	11,290	BR	S	11,950	BR	S	13,160	BR	S
Mason				17,860	BR	W	28,570	BR	R
Morrow				2,700	BR	P	3,000	BR	P
Norwood	23,640	EH	W	22,040	EH	W	21,850	EH	W
Reading	11,240	EH	W	10,930	EH	R	10,920	EH	R
South Lebanon				4,000	BR	P	4,400	BR	P
Warren County				17,860	BR	W	28,570	BR	W
Western Water				14,290	BR	W	28,570	BR	W
Wyoming	9,160	EH	S	8,990	EH	S	8,950	EH	S
Total Retail/ Wholesale <sup>(4)</sup>	42,860			165,740			242,710		
Total Standby	92,880			82,920			82,580		
Total Potential	-			40,460			57,410		
Other Hamilton County <sup>(3)</sup>	772,890	-	R	783,570	-	R	812,890	-	R
Total Retail/ Wholesale <sup>(4)</sup>	815,750			949,310			1,055,600		
Total Retail/ Wholesale/Standby	908,630			1,032,230			1,138,180		
Total Retail/ Wholesale/Standby/ Potential	908,630			1,072,690			1,195,590		

(1) CE=Central, EH=Eastern Hills, WH=Western Hills, BR=Becon, CG=Cherry Grove, WW=Water West.  
(2) R=Retail, W=Wholesale, P=Potential, S=Standby.  
(3) City of Cincinnati and Hamilton County unincorporated areas and incorporated areas not listed above (Retail).  
(4) Boone/Florence W.C. population not shown.

