Report

West Fork Sustainable Watershed Evaluation

MSA No. 95X10595
Task Order No. 038090032

Metropolitan Sewer District of Greater Cincinnati, OH

August 2010
Revised May 2011

Report for

Metropolitan Sewer District of Greater Cincinnati, Ohio

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EXECUTIVE SUMMARY

In response to a United States Environmental Protection Agency (USEPA) consent decree, the Metropolitan Sewer District of Greater Cincinnati (MSDGC), Ohio, is in the process of evaluating a variety of approaches to control its annual 14-billion-gallon combined sewer overflow (CSO) discharge. The West Fork Basin's 15 CSOs account for 427 millon gallons (mil gals) of CSO annually.

The purpose of the West Fork Sustainable Watershed Evaluation is to evaluate the collective impact of wet weather projects currently underway with the West Fork Basin as well as identify and evaluate additional opportunities throughout the watershed. The recommended solution for this watershed includes:

1. Three new stormwater detention basins and outfall to channel.
2. Sewer separation in CSO basins 126, 117, 203, 194, 195, and 525.
3. Express pipe separation of basins 127 and 128.
4. Sewer separation, inlet sealing, and microtunneling under I-74 in basin 130.
5. Property acquisition along West Fork Road.
6. Basin enhancements for water quality improvements.
7. Installing 6,000 linear feet of 48-inch interceptor pipe and 2.25 mil gals of CSO storage.
8. Naturalizing 6,000 linear feet of the west fork channel.

The hydrology and hydraulic feasibility of the proposed alternatives as evaluated using existing available topographic and utility information. The Cincinnati Area Geographical Information System (CAGIS) was the primary source of this information. This information was supplemented with hydrologic and hydraulic modeling of stormwater runoff for the West Fork Basin using HEC-HMS and HEC-RAS modeling software. The recommended solution will keep 551 million gallons of stormwater that was previously being conveyed and treated out of the combined sewer system. Although additional modeling of the combined sewer system by MSDGC will be required to confirm these results, based on updates to the systemwide model to date, these improvements could eliminate up to 319 mil gals of CSO annually.

The separated stormwater discharge is proposed to be directed to a separated conveyance system in parallel with the sanitary sewer interceptor and to discharge directly to Mill Creek. The proposed geometric configuration of this conceptual conveyance system accommodates runoff from the 100-year design storm over the entire basin and lowers the 100-year floodplain by approximately 1 foot.

The opinion of probable construction cost for the above improvements is $65.1 million in 2006 dollars. This equates to $0.20 a gallon of CSO eliminated. Costs for architectural and engineering services and other professional services have not been included. Life cycle cost effects have not been analyzed. Such analysis should be completed as implementation schedules are clarified.

SECTION 1
BACKGROUND

1.01 WATERSHED OVERVIEW

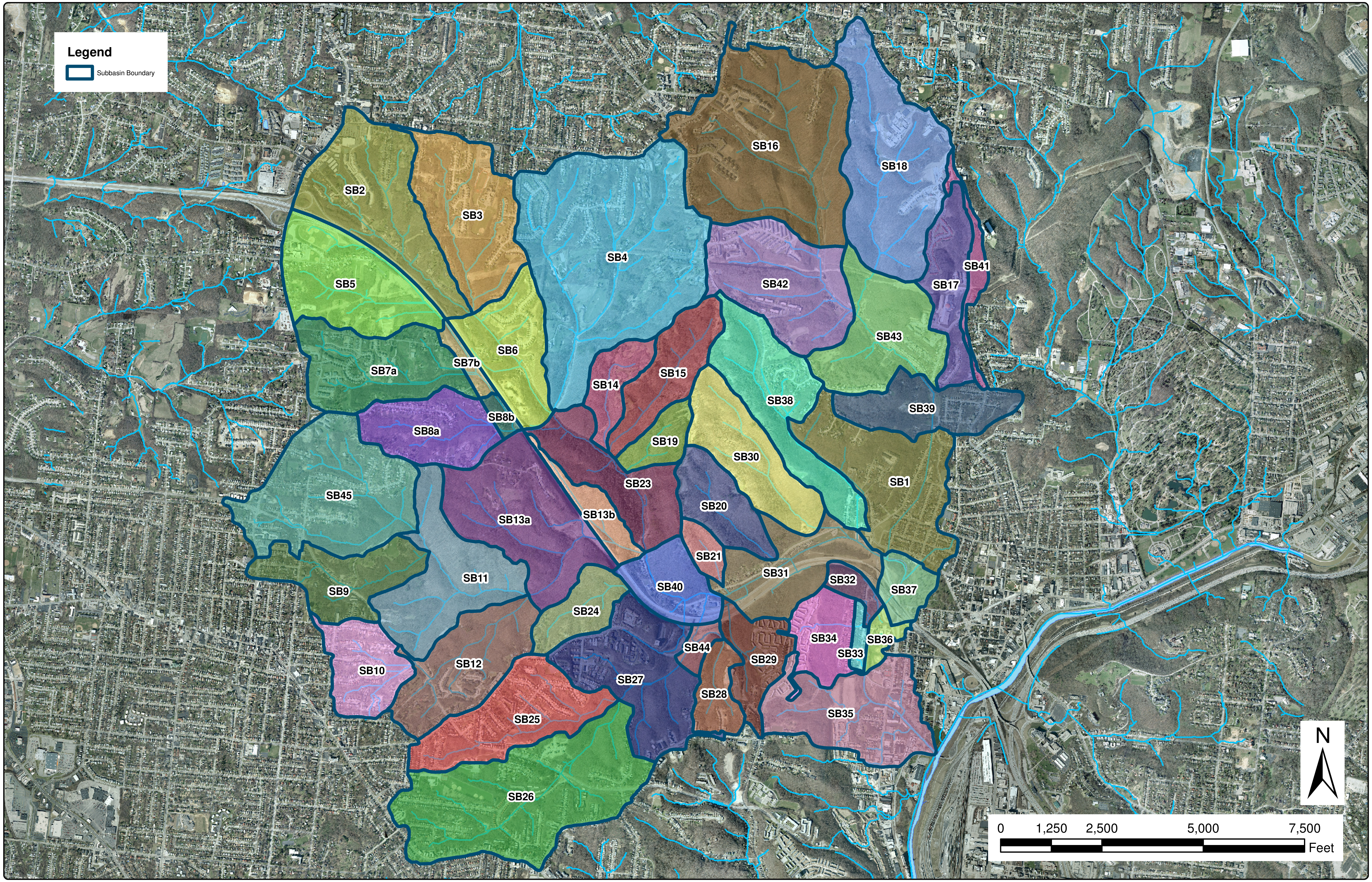
The West Fork watershed in the Lower Mill Creek is comprised of 6,117 acres within the City of Cincinnati, Ohio. Seven neighborhoods (Mount Airy, College Hill, Northside, South Cumminsville, Fay Apartments, East Westwood, Westwood) and two jurisdictions (Green Township and Chevoit) are part of the watershed. The main transportation corridors include Interstate 74, Colerain Avenue, West Fork Road, Montana Avenue, North Bend Road, Westwood Northern Boulevard, and Hamilton Avenue. The Cincinnati Park Board and the Cincinnati Board of Education are the two key property owners within the watershed. Figure 1.01-1 shows the delineation of the watershed boundaries and subbasins.

Figure 1.01-2 shows the 15 combined sewer overflow (CSO) locations throughout the watershed that create an estimated 729 million gallons of annual overflow volume. Throughout the year, 581 events have been documented. Table 1.01-1 outlines the CSO locations, annual events, and average annual overflow volume (AAOV) for the watershed. For more specific information relating to the watershed characteristics, refer to the *November 2009 Lower Mill Creek Watershed Coarse Evaluation.*

CSO No.	CSO Name	Events	AAOV (MG)
117	Dreman Grating	57	31
123	Hoffner Grating	50	0.2
125	Badgeley Run Grating	58	226.7
126	Todd No.1 Grating	69	148.3
127	Hays Grating	49	79.8
128	Todd No. 2 Grating	52	28.3
130	Butte Grating	58	205.75
194	Highpoint Grating	43	6
195	Westwood Northern Grating	53	13
203	Twin Grating	44	8.29
525	Mt. Airy Grating	43	6
527	Power Street No.1 Grating	4	-
528	Beekman North Grating	3	-
529	Llewellyn Grating	3	-
530	Beekman South Grating	13	-
	Total	581	728.84

Source: Metropolitan Sewer District of Greater Cincinnati

Table 1.01-1 Combined Sewer Overflows in the West Fork Subbasin



WEST FORK SUBBASIN MAP

WEST FORK WATERSHED
MSDGC
CINCINNATI OH

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 1.01-1
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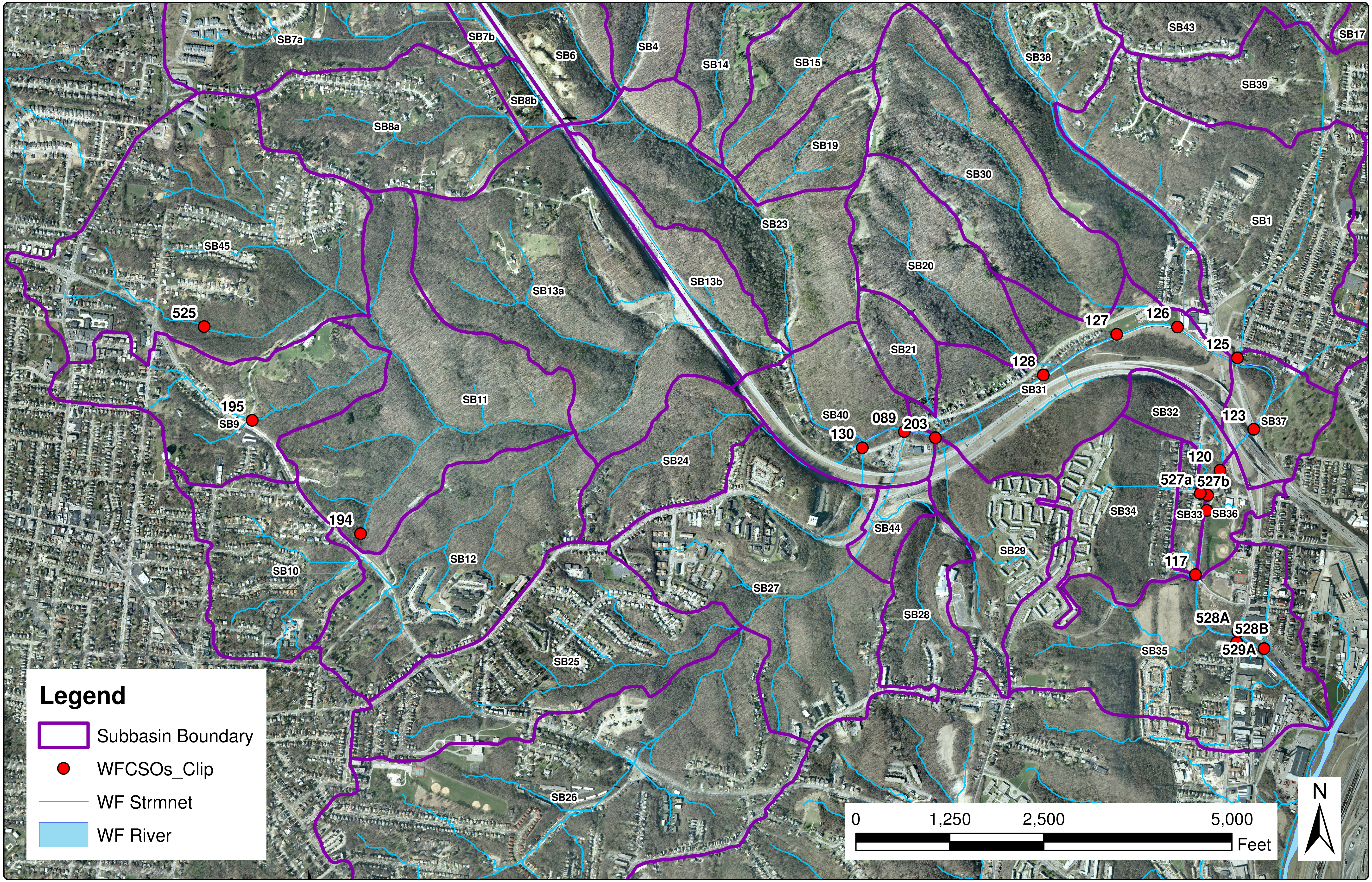

EXISTING COMBINED SEWER OVERFLOW (CSO) LOCATIONS

WEST FORK WATERSHED
MSDGC
CINCINNATI OH

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 1.01-2
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1.02 PREVIOUS PROGRESS

In 2009, Strand Associates, Inc.® (Strand) performed a preliminary watershed evaluation in the West Fork Watershed to identify opportunities for CSO volume reduction. Through this process, coarse level opportunities were identified including large scale retention and detention, stormwater separation, and flood mitigation. These opportunities merited further exploration, which led to having XCG Consultants model the impact of the following projects in the watershed:

- Separation of 129 acres of stormwater runoff from CSO 127.
- Separation of 82 acres of stormwater runoff from CSO 128.
- Separation of 634 acres of stormwater runoff from CSO 130.
- Installation of three stormwater detention basins in the CSO 125 sewershed.
- Modifications to the West Fork Channel to decrease inflow.

Modeling these opportunities resulted in an overall CSO volume reduction for the typical year of 230 million gallons. Additionally, stormwater entering the sanitary sewer through invert grates decreased by 90 million gallons. These preliminary modeling results indicate an opportunity for cost-effective CSO control in this watershed.

As part of the preliminary watershed evaluation, a grant application was submitted to the Ohio Emergency Management Agency (OEMA) by Metropolitan Sewer District of Greater Cincinnati (MSDGC) with assistance from Strand and Human Nature for the West Fork Creek Flood Prone Property Acquisition Project. This grant would aid in property acquisition along the channel, creating the ability to utilize the floodplain area for overall CSO volume reduction. Utilizing this area as stated ties in to the Hamilton County Hazard Mitigation Plan because loss of life and property damage risks will be alleviated. This is consistent with Goal No. 1 and Goal No. 2 of the State Hazard Mitigation Plan as well.

There are 22 properties currently in the floodplain that have been identified as parcels to be obtained using the grant. These properties are along West Fork Road, Ammon Avenue, and Hayes Avenue within the City of Cincinnati. Once purchased, the houses will be razed and the land developed into a more effective, natural floodplain and floodway. Flood hazards will be lessened and flood storage increased through this project. This project fits into MSDGC’s Communities of the Future initiative as well.

Strand completed a geographical information system (GIS) analysis of the parcels that are located within the floodplain and floodway. The location of the parcels, along with the classification of parcel type and parcel value, were obtained. Following this, photographs were taken of each property identified in the analysis, according to grant requirements.

Beyond Strand’s previous work in the West Fork watershed, MSDGC began conceptual design on several projects within the watershed targeted at CSO volume reduction. These projects include the following:

1. Westwood Northern Bundle–This project is targeted at strategic separation projects to reduce overflows from CSOs 525, 195, and 194.

2. Stormwater Removal and Detention–This project is proposing to build three new detention basins to detain and redirect stormwater flows from the northern portions of the CSO 125 basin. This project includes the construction of 6,500 linear feet of 36-inch-diameter storm sewer that will serve as the outlet for the three detention basins.

3. Express Pipe–This project is focused on separation of the stream entry points that are currently flowing into CSOs 127 and 128.

4. Stormwater Removal and Naturalization–This project is focused on storm sewer separation in the upper parts of the watershed and channel/ravine naturalization in the lower parts of the watershed that currently flow to CSO 130.

5. Inlet Removal and Separation–The goal of this project is to seal existing inlets to the combined system and redirect stormwater to an existing channel for separate conveyance.

1.03 SCOPE OF THE STUDY

The purpose of this effort is to analyze potential opportunities for CSO volume reduction within the West Fork Watershed. Throughout the watershed, these opportunities are evaluated with respect to their combined impact in relation to potential modifications to the existing West Fork Channel. The analyses were conducted in the following manner:

1. Opportunities for CSO volume reduction were identified and prioritized based on their potential impact. These opportunities include ongoing MSDGC projects, as well as other opportunities throughout the watershed, including modifications to the West Fork Channel.

2. The solutions were evaluated with consideration of MSDGC's Communities of the Future, a concept that seeks to comply with United States Environmental Protection Agency (USEPA) consent decree mandates while also maximizing community benefits from infrastructure improvements.

3. Concepts were evaluated using various models to estimate CSO volume impacts and floodplain impacts. Hydrologic data for the West Fork Watershed was developed using HEC-HMS modeling software. The open water stormwater conveyance elements were primarily modeled using HEC-RAS. Impacts to CSO volumes were modeled by XCG Consultants using the established MSDGC CSO model.

Information and data used for these analyses were obtained from the Cincinnati Area Geographical Information System (CAGIS) as well as existing record drawings, site visits, reports, and records of the various elements associated with the physical environment in the basin.

1.04 DEFINITIONS

AAOV	average annual overflow volume
CAGIS	Cincinnati Area Geographical Information System
CN	runoff curve number
CSO	combined sewer overflow
CSS	combined sewer system
FEMA	Federal Emergency Management Agency
GIS	Geographical Information System
HEC-RAS	Hydrologic Engineering Centers River Analysis System
HRT	high rate treatment
HSG	Hydrologic Soil Groups
mil gal	million gallons
MSDGC	Metropolitan Sewer District of Greater Cincinnati
NRCS	Natural Resource Conservation Service
ODNR	Ohio Department of Natural Resources
ODOT	Ohio Department of Transportation
OEMA	Ohio Emergency Management Agency
OEPA	Ohio Environmental Protection Agency
Strand	Strand Associates, Inc.®
T_c	time of concentration
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
WWIP	wet weather improvement plan
WWTP	wastewater treatment plant

SECTION 2
EXISTING CONDITIONS MODELING

2.01 WEST FORK EXISTING CONDITION MODELING

MSDGC has updated the systemwide combined sewer models of the West Fork Watershed to represent the existing conditions with the best available data. Our team has created a HEC-HMS model of the watershed and a HEC-RAS model of the West Fork Channel. These models will be used to evaluate the stormwater hydrology throughout the watershed and the hydraulics within the channel proper.

A. Watershed Characteristics

The amount of stormwater runoff produced by a storm event is impacted by the types of soil underlying the watershed. Soils having a high percentage of sand and gravel will absorb a higher percentage of stormwater runoff than will soils having high clay content. This means sandy soil generally produces less runoff than clay soil. The Natural Resource Conservation Service (NRCS) classifies soil types in categories known as Hydrologic Soil Groups (HSG). Group A soils consist of sandy soils having high infiltration rates and low runoff potential. Group B soils have moderately fine to moderately coarse textures and moderate runoff potential. Group C soils are typically sandy clay loam soils having moderately fine to fine textures and a low infiltration capacity. Examples of Group D soils are clays, soils with a permanent high water table, and shallow soils over nearly impervious material. Group D soils have a very low infiltration capacity and have high runoff potential.

The percentages of each HSG in the West Fork Watershed are shown in Table 2.01-1. Review of this data indicates that 80 percent of the watershed consists of HSG C soils and nearly all of the remaining 20 percent consisting of HSG B soils. Note the small percentage of the unnamed soils within watersheds were assumed to be HSG D soils to be conservative.

HSG	Area (Acres)	Percent of Watershed
A	23.0	0.4%
B	1065.4	17.4%
C	5015.3	82.1%
D	0.0	0.0%
Unnamed	7.0	0.1%
Total	**6110.7**	**100%**

Table 2.01-1 Hydrologic Soil Groups

Land Use	Area (acres)	Percent of Watershed
Agricultural	95.9	1.6%
Nonresidential (Private)	502.6	8.2%
Nonresidential (Public)	2413.3	39.5%
Residential	2695.5	44.1%
Unknown	403.3	6.6%
Total	**6110.7**	**100.0%**

Table 2.01-2 Land Use Summary

Land use is another factor affecting the amount of stormwater runoff produced by a rainstorm. Urbanization and development reduce the ability of the ground to absorb stormwater, typically causing peak discharges and runoff volumes to increase. The time from the beginning of the storm event to the occurrence of the peak runoff may also be significantly shortened. Table 2.01-2 summarizes the areas and percentages of each land use type within the watershed.

B. HEC-HMS Model Overview

The West Fork hydrologic model was developed using the computer program HEC-HMS (Version 3.4). HEC-HMS is a computer program developed by the United States Army Corps of Engineers (USACE) that simulates the precipitation-runoff process. HEC-HMS estimates peak stormwater discharges and volumes based on mathematical input parameters representing precipitation depth and time distribution, drainage area, land use, and time of concentration (T_c). for each subbasin. Primary input parameters include the drainage area, runoff curve number (CN), and T_c. The CN considers land use, soil types, and saturation conditions and impacts the volume of stormwater runoff for a given rainfall depth. The T_c is the time it takes for stormwater to travel from the most hydrologically remote point in the watershed to the outfall. Parameters representing rainfall depth and distribution and watershed storage are also included in the model. Based upon user input coding, HEC-HMS generates hydrographs for each subbasin, routes them through storage areas, and combines them at appropriate locations. The result is a rainfall-runoff model of the storm event of interest. Figure 2.01-1 shows the schematic of the HMS model.

To model the West Fork watershed, data for the input parameters was collected using MSDGC's GIS. Forty-seven subwatersheds were delineated within the West Fork watershed. Twelve existing detention areas were identified and modeled in HEC-HMS. Measurements of outlet control structures were obtained during a site visit.

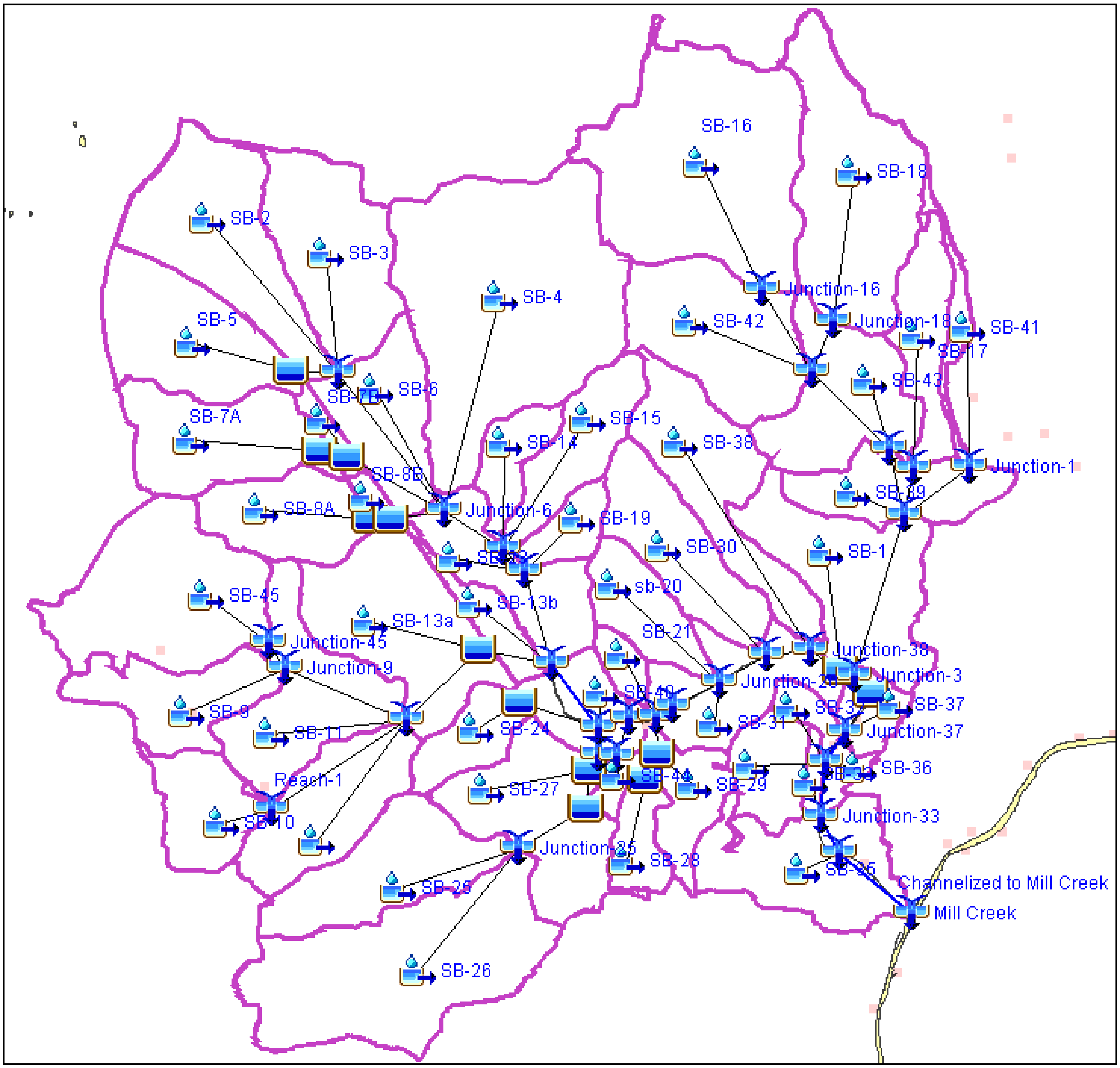
Rainfall depths used for the hydrologic analysis were taken from Bulletin 71, *Rainfall Frequency Atlas of the Midwest,* Floyd A. Huff and James R. Angel, 1992. Appropriate Huff rainfall time distributions taken from Circular 173, *Time Distribution of Heavy Rainstorms in Illinois,* Floyd A. Huff, 1990, were applied for the analysis. Table 2.01-3 summarizes expected rainfall depths for the 1-year through 100-year storm frequencies for the region.

Frequency (yr)	**Storm Duration (hours)**							
	0.5	**1**	**2**	**3**	**6**	**12**	**18**	**24**
1	0.86	1.10	1.35	1.49	1.75	2.03	2.19	2.33
2	1.06	1.34	1.66	1.83	2.14	2.49	2.69	2.86
5	1.29	1.64	2.02	2.23	2.62	3.04	3.28	3.49
10	1.48	1.88	2.31	2.55	2.99	3.47	3.75	3.99
25	1.74	2.21	2.73	3.01	3.52	4.09	4.42	4.70
50	1.97	2.50	3.09	3.40	3.99	4.63	5.00	5.32
100	2.23	2.84	3.50	3.87	4.53	5.25	5.68	6.04

Table 2.01-3 Design Storm Rainfall Depths, Bulletin 71

FIGURE 2.01-1

HEC-HMS WATERSHED SCHEMATIC



C. HEC-RAS Model Overview

HEC-RAS was used to conduct step backwater modeling throughout the West Fork channel. A HEC-2 model of the West Fork Channel was obtained from the Army Corps of Engineers 1970 flood study. This model served as a starting point for the updated model. Channel dimensions and elevations were modeled, taking each bridge and culvert into account. There were seven bridges along the channel. A site visit determined that an additional two bridges were abandoned and hence removed from the model. All bridge deck, pier, and culvert dimensions were verified using record drawings from Hamilton County Engineer's Office, and the Ohio Department of Transportation (ODOT).

2.02 EXISTING CONDITIONS MODELING RESULTS

A. HEC-HMS Model

The results of the existing conditions HEC-HMS model indicate that 289 million gallons of stormwater runoff are generated from the West Fork Watershed in the 100-year, 1-hour storm event. Large quantities of this stormwater are currently entering the combined sewer system. Peak discharge, time of peak discharge, and volume of discharge for each basin were determined during modeling of storm events. The results of the existing conditions model by basin are shown in Table 2.02-1.

TABLE 2.02-1

HEC-HMS EXISTING CONDITIONS RESULTS

Basin	Area (mi^2)	100-Year Peak Discharge (cfs)	Time of Peak (min)	Volume (in)
SB-2	0.34	538	20	1.39
SB-3	0.29	489	21	1.45
SB-5	0.27	617	23	2.1
SB-4	0.73	1009	29	1.45
SB-7A	0.25	633	20	2.2
SB-7B	0.03	58.3	18	1.68
SB-8A	0.18	531	17	2.39
SB-8B	0.02	40	18	1.68
SB-6	0.19	272	22	1.25
SB-15	0.16	401	19	2.1
SB-14	0.09	211	19	2.1
SB-23	0.20	489	21	2.2
SB-19	0.07	184	16	2.2
SB-45	0.39	726	18	1.53
SB-9	0.19	380	21	1.84
SB-11	0.27	578	24	2.01
SB-12	0.23	388	29	1.76
SB-10	0.14	203	25	1.39
SB-13a	0.33	1047	14	2.39
SB-13b	0.07	248	13	2.5
SB-26	0.52	833	26	1.6
SB-25	0.25	441	19	1.45
SB-27	0.29	485	20	1.45
SB-40	0.12	249	22	1.84
SB-24	0.10	202	18	1.68
SB-44	0.03	53	23	1.76
SB-29	0.11	234	18	1.68
SB-28	0.08	141	18	1.53
SB-21	0.04	87	20	2.01
SB-31	0.21	411	27	2.01
SB-20	0.13	350	15	2.1
SB-30	0.21	492	22	2.1
SB-38	0.26	553	21	1.84
SB-1	0.32	520	23	1.53
SB-16	0.59	1038	20	1.53
SB-18	0.41	915	20	1.92
SB-42	0.30	696	17	1.84
SB-43	0.25	438	22	1.6
SB-39	0.17	315	18	1.53
SB-17	0.14	318	17	1.76
SB-41	0.05	79	29	1.76
SB-37	0.07	135	21	1.84
SB-34	0.11	162	30	1.6
SB-32	0.04	86	19	2.01
SB-36	0.03	63	18	1.68
SB-33	0.02	33	19	1.39
SB-35	0.27	529	19	1.6

A sensitivity analysis was performed to estimate the storm duration generating the highest peak discharges at critical points along the main channel corridor. Based on the results of this critical duration sensitivity analysis, it was concluded the 1-hour storm duration produces the highest peak discharges. Table 2.02-2 summarizes the results of the critical duration analysis. Table 2.02-3 indicates the peak 100-year discharges to be input into the HEC-RAS model and the channel reach sections where they are to be applied.

HEC-HMS Node	Peak 100-Year Discharge (cfs)				
	0.5 Hour	1 Hour	2 Hour	3 Hour	6 Hour
Beekman Crossing	5634	5947	5997	5726	4973
Channelized to Mill Creek	7404	7917	7971	7644	6660
I-74 Crossing	7149	7540	7545	7242	6300
Junction Detention Start	7586	7724	7088	6381	4922
Junction-20	8213	8371	7645	6850	5267
Junction-21	7586	7724	7088	6382	4922
Junction-3	8172	8266	7948	7511	6332
Junction-32	7397	7819	7792	7457	6474
Junction-33	7395	7814	7801	7469	6485
Junction-35	7416	7924	7975	7647	6661
Junction-37	7217	7618	7609	7300	6348
Junction-38	9233	9365	8450	7506	5751
Junction-40	7192	7316	6733	6081	4705
Junction-41	7246	7367	6777	6117	4731
Mill Creek	7404	7917	7971	7644	6660

Table 2.02-2 Critical Duration Analysis

HEC-HMS Node	Reach Location	Drainage Area (acres)	Peak 100-Year Discharge (cfs)
Mill Creek	From Mill Creek to Beekman Street	6109	7917
Junction-35	From Beekman Street to Dreman Street	6109	7924
Junction-33	From Dreman Street to Powers Street	5934	7814
Junction-32	From Powers Street to Beekman Street	5921	7819
Junction-37	From Beekman Street to I-74 Crossing culverts	5808	7618
I-74 Crossing	From Culverts under Beekman Street near I-74	5766	7540
Junction-3	From I-74 Crossing culverts to Beekman Crossing culverts	5766	8266
Beekman Crossing	From Culverts under Beekman Street near Colerain Avenue	4544	5947
Junction-38	From CSO 126 to CSO 127	4342	9365
Junction-20	In channel, North of I-74	4037	8371
Junction Detention Start	In channel, North of I-74, after CSO 130	3821	7724
Junction-21	From CSO 203 to West Fork Road	3821	7724
Junction-41	From West Fork Road to CSO 130	3676	7367
Junction-40	From CSO 130 to natural stream	3657	7316

Table 2.02-3 Peak Discharge Summary

B. HEC-RAS Model

The HEC-RAS model was used to conduct steady-flow hydraulic modeling on the West Fork watershed. The outputs of the HEC-RAS model show the channel proper varies in capacity between the 5-year and 10-year storm events. Overflow from the channel will occur if the storm intensity is greater than that capacity. The existing conditions models highlighted the constraints of the system during large storm events. The two 10x18 box culverts between Beekman Road and Interstate 74 do not have enough capacity for a 10-year storm event; overtopping of the culverts will occur with a greater intensity storm event. Table 2.02-4 summarizes the 100-year storm frequency hydraulic modeling results from the design conditions HEC-RAS model and Figure 2.02-1 displays the inadequate capacity for the 100-year storm event. Review of the hydraulic modeling results indicates that estimated channel velocities generally range from 4 to 15 feet per second along the entire channel. Table 2.02-5 shows the existing condition Flood Profile for the 1- through 100-year design storms.

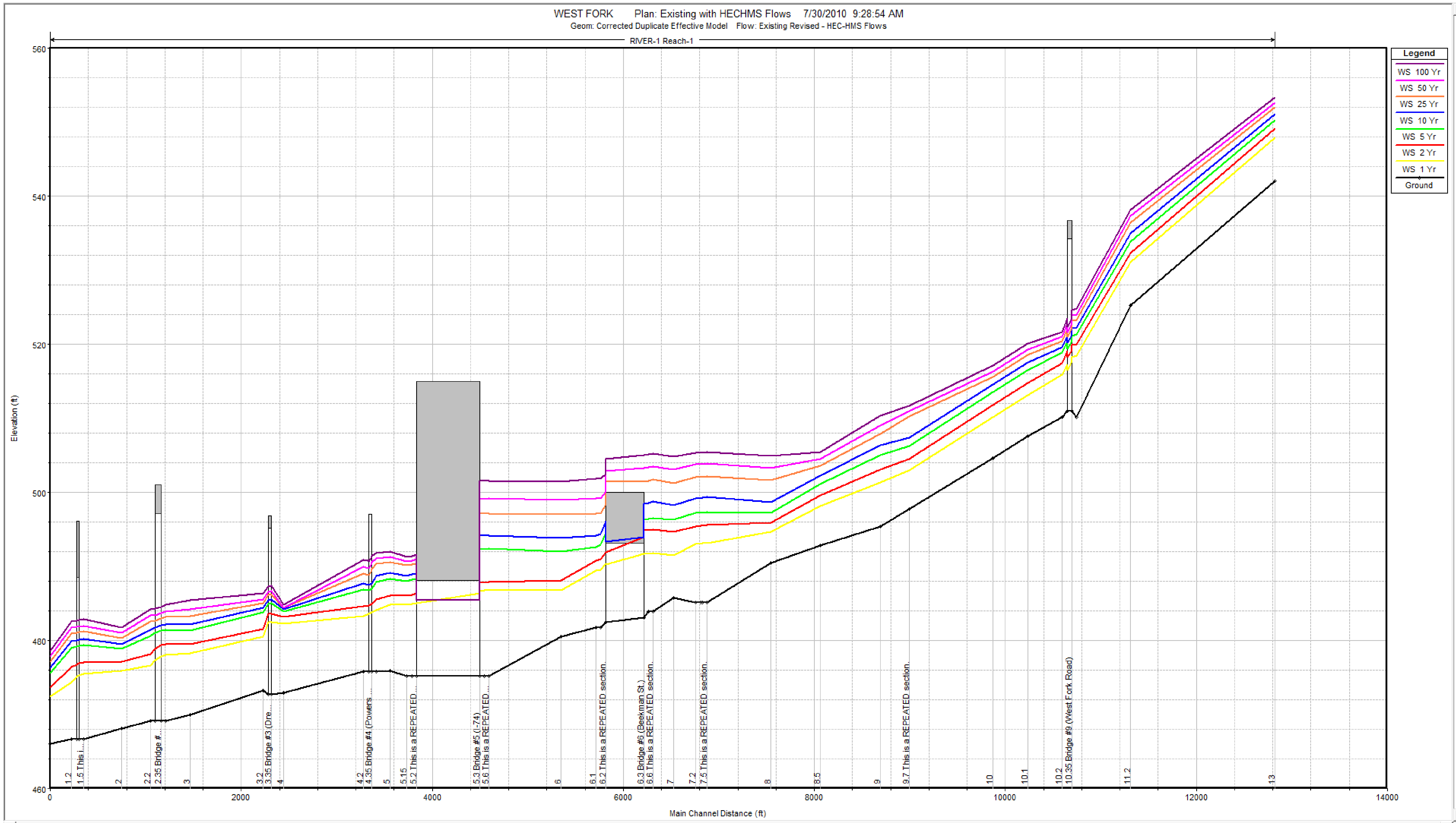
TABLE 2.02-4

HYDRAULIC RESULTS

Bridge Name	Proposed River Sta	Design Profile	Existing Q Total (cfs)	Existing W.S. Elev (ft)
West Fork Road	10.6	1 Yr	1887	518.27
West Fork Road	10.6	2 Yr	2744	519.85
West Fork Road	10.6	5 Yr	3814	521.17
West Fork Road	10.6	10 Yr	4662	522.11
West Fork Road	10.6	25 Yr	5692	523.15
West Fork Road	10.6	50 Yr	6464	523.89
West Fork Road	10.6	100 Yr	7316	524.67
Beekman Street	6.4	1 Yr	2235	491.79
Beekman Street	6.4	2 Yr	2952	494.92
Beekman Street	6.4	5 Yr	4291	496.36
Beekman Street	6.4	10 Yr	4564	498.43
Beekman Street	6.4	25 Yr	5074	501.45
Beekman Street	6.4	50 Yr	5494	503.32
Beekman Street	6.4	100 Yr	5947	505.05
I-74	5.4	1 Yr	2756	486.7
I-74	5.4	2 Yr	3607	487.78
I-74	5.4	5 Yr	5113	492.35
I-74	5.4	10 Yr	5620	494.16
I-74	5.4	25 Yr	6327	497.15
I-74	5.4	50 Yr	6889	499.17
I-74	5.4	100 Yr	7540	501.55
Powers Street	4.4	1 Yr	2756	483.77
Powers Street	4.4	2 Yr	3607	484.94
Powers Street	4.4	5 Yr	5113	487
Powers Street	4.4	10 Yr	5620	487.74
Powers Street	4.4	25 Yr	6327	489.68
Powers Street	4.4	50 Yr	6889	490.56
Powers Street	4.4	100 Yr	7540	491.4
Dreman Avenue	3.4	1 Yr	2756	482.5
Dreman Avenue	3.4	2 Yr	3607	483.62
Dreman Avenue	3.4	5 Yr	5113	485.01
Dreman Avenue	3.4	10 Yr	5620	485.54
Dreman Avenue	3.4	25 Yr	6327	486.2
Dreman Avenue	3.4	50 Yr	6889	486.68
Dreman Avenue	3.4	100 Yr	7540	487.36
Beekman Street	2.4	1 Yr	2860	477.83
Beekman Street	2.4	2 Yr	3763	479.34
Beekman Street	2.4	5 Yr	5274	481.34
Beekman Street	2.4	10 Yr	5835	482.05
Beekman Street	2.4	25 Yr	6605	482.98
Beekman Street	2.4	50 Yr	7207	483.7
Beekman Street	2.4	100 Yr	7924	484.56
Railroad Bridge	1.4	1 Yr	2860	475.29
Railroad Bridge	1.4	2 Yr	3763	476.9
Railroad Bridge	1.4	5 Yr	5274	479.26
Railroad Bridge	1.4	10 Yr	5835	480.07
Railroad Bridge	1.4	25 Yr	6605	481.12
Railroad Bridge	1.4	50 Yr	7207	481.89
Railroad Bridge	1.4	100 Yr	7924	482.75

FIGURE 2.02-2

FLOOD PROFILE SUMMARY



Structure Location	Structure Size and Type	Approximate Top of Road/Railroad Elevation (feet)	100-Year Headwater Elevation (feet)	Estimated Capacity (design storm)
West Fork Road (River Sta. 10.35)	Two 24-foot by 40-foot arches	538	526.2	100 Yr
Beekman Street (River Sta. 6.3)	Two 10-foot by 18-foot culverts	530	520.8	10 Yr
I-74 (River Sta. 5.3)	Two 10-foot by 18-foot culverts	525	505.0	100 Yr
Powers Street (River Sta. 4.35)	Single-span with two 6-foot by 36-foot side culverts	498	492.2	100 Yr
Dreman Avenue (River Sta. 3.35)	89.5-foot Single-span bridge	498	487.8	100 Yr
Beekman Street (River Sta. 2.35)	52-foot Single-span bridge	501	484.0	100 Yr
Railroad Abutments (River Sta. 1.35)	Railway abutments	497	481.5	100 Yr

Table 2.02-5 Crossing Structure Summary

SECTION 3
OPPORTUNITIES ASSESSMENT AND MODELING

3.01 WET WEATHER OPPORTUNITIES

After completing the watershed inventory analysis of the West Fork watershed, various wet weather strategies for the watershed were determined. The approach includes strategic storm sewer separation, retrofit and naturalization of the existing channel configuration, and potential retrofit of detention basins. Throughout this process, the Communities of the Future program was considered, and redevelopment and revitalization opportunities were assessed.

A. Strategic Storm Sewer Separation

The first step in the sewer separation evaluation included an assessment of subcatchments where stormwater could be cost-effectively offloaded from the combined system. The plan is to separately convey the offloaded stormwater and allow the existing combined sewers to serve sanitary conveyance needs. The subcatchments were strategically evaluated with the goal of capturing as much stormwater as possible while constructing the least amount of new storm sewer. The strategic sewer separation approach targeted stream entry points, large undeveloped hillsides, and already separated areas but eventually discharged into the combined sewer system (CSS).

In order to estimate the reduction in CSO volume, each basin was given an effective stormwater separation percentage that was applied to the model. Percent effective numbers were based on existing GIS information including impervious area, land use, topography, and soils, as well as other proposed projects currently being designed. A high percent effective number was used in undeveloped areas, while lower percent effective numbers were used in highly developed areas. In all areas, we utilized a 5 percent factor of safety to allow for uncertainty, meaning that in basins where the objective is 100 percent separation of stormwater flows, we will utilize 95 percent as the effective separation rate for modeling purposes. Ongoing MSDGC projects were also taken into account through this exercise. Table 3.01-1 shows the effective percent of stormwater separation for each of the subbasins.

Basin	Percent Effective
SB1	0%
SB10	75%
SB11	95%
SB12	95%
SB13a	95%
SB13b	95%
SB14	95%
SB15	95%
SB16	95%
SB17	0%
SB18	95%
SB19	95%
SB2	95%
SB20	95%
SB21	95%
SB23	95%

Basin	Percent Effective
SB24	95%
SB25	50%
SB26	50%
SB27	75%
SB28	95%
SB29	50%
SB3	95%
SB30	95%
SB31	90%
SB32	95%
SB33	90%
SB34	50%
SB35	90%
SB36	90%
SB37	95%
SB38	90%

Basin	Percent Effective
SB39	0%
SB4	95%
SB40	95%
SB41	0%
SB42	95%
SB43	0%
SB44	95%
SB45	95%
SB5	95%
SB6	95%
SB7a	95%
SB7b	95%
SB8a	95%
SB8b	95%
SB9	90%

Table 3.01-1 Percent of Effective Stormwater Separation per Basin

B. Channel Retrofits and Naturalization

The existing West Fork Channel provides a tremendous opportunity to convey separated stormwater to the Mill Creek; however, it also provides a hydraulic design challenge as it currently experiences a complex interaction with the CSS. The intent of the channel reconfiguration is to identify the most beneficial way to convey the separate stormwater runoff that has been removed from the CSS to directly discharge to the Mill Creek without entering or interacting with the CSS. A variety of options have been evaluated for the West Fork Channel retrofits, as described in Section 3.02. The revised conveyance system will be sized to provide the community with an equivalent or greater level of flood protection than exists today. The other major opportunity this naturalized channel provides is the creation of a community amenity and revitalization of the channel side neighborhoods.

Water quality and quantity benefits are achieved by removing stormwater from the combined sewer and returning it to a new, redeveloped urban stream channel. When stormwater is removed from the combined system, it frees up capacity in the system for sanitary flow. The additional capacity in the combined sewer can accommodate the sanitary flow and fewer overflows will discharge into the Mill Creek. Stormwater runoff flowing through the urban stream channel will improve the quality of the Mill Creek and enhance the diversity of fish and other aquatic life.

C. Retrofitted/Proposed Detention Basins

Our team has reviewed the West Fork watershed to identify existing detention basins and evaluate their outlet control structures for potential retrofit opportunities. The evaluation led to the identification of twelve low-lying areas. Based on our existing condition modeling, it appears all of the existing detention basins have been constructed to obtain the maximum benefit for the West Fork Channel. The State of Ohio Drainage Design Manual Section 1006.2 Controls states the Headwater depth for all culverts shall not exceed 4 feet above the inlet crown of a culvert in a deep ravine. Because of this headwater limitation and the existing steep side slopes within the ravines throughout the West Fork Watershed, it does not appear feasible to retrofit these basins for additional water quantity benefits. However, these basins do present an opportunity for future retrofits for water quality benefits. Additionally, a wet detention basin could be incorporated near the outfall for each existing detention basin to help control total suspended solids that would drain to the West Fork Channel.

3.02 DESCRIPTION OF OPPORTUNITIES

CSO reduction opportunities identified through this evaluation are discussed in this section by sewershed. This information includes currently planned or designed projects as well as other opportunities to be considered in the future.

A. CSO 117

Subbasin 34 is the only subbasin that feeds into CSO 117. This basin represents an opportunity for partial separation of stormwater runoff from the hillside and surrounding apartments. A stormwater separation rate of 50 percent is assumed for modeling purposes. This area is shown in Figure 3.02-1.

B. CSO 123

Subbasin 37 is the only subbasin that drains into CSO 123. Separation of 95 percent is assumed in this subbasin as the combined sewer piping can be reconfigured, eliminating all combined sewer overflows. Figure 3.02-2 denotes the location of the CSO 123 and the combined sewer pipes to be reconfigured.

FIGURE 3.02-1

SEPARATION OF CSO 117

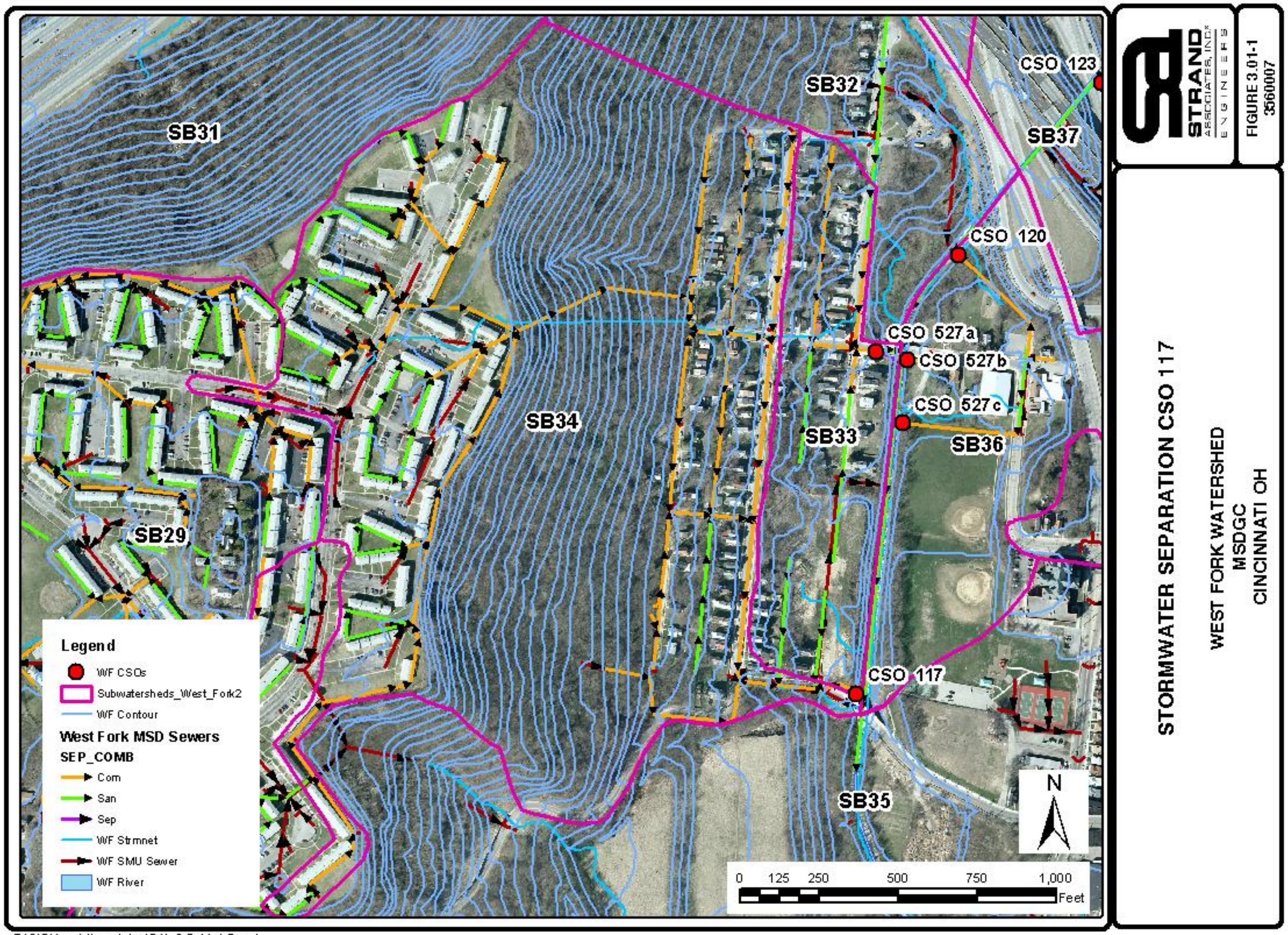


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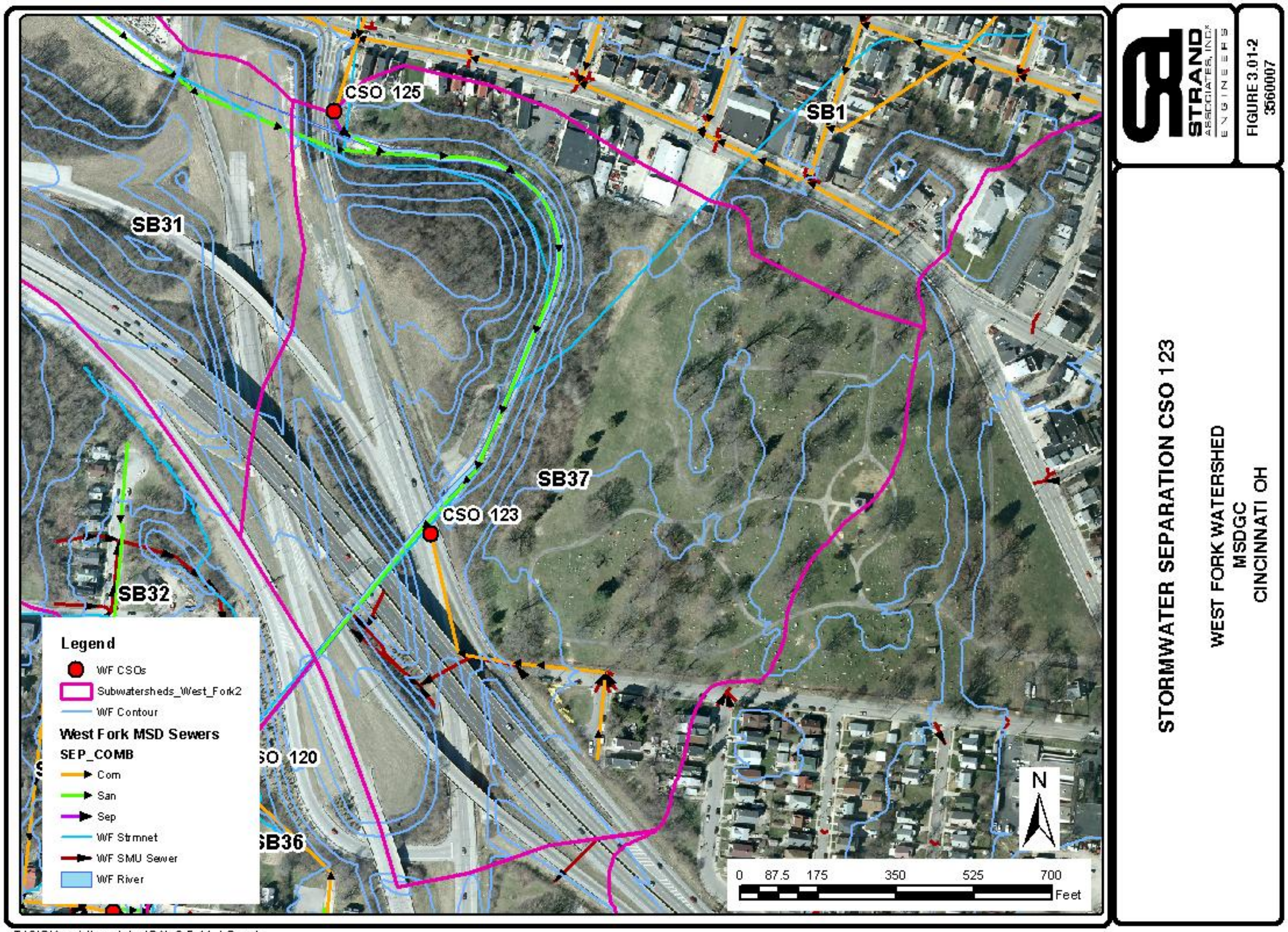
FIGURE 3.02-2

ASSUMED SEPARATION FOR CSO 123



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C. CSO 125 (Stormwater Removal and Detention)

CSO 125 is the largest of the CSOs within the West Fork watershed in terms of average annual overflow volume. This CSO is fed by Subbasins 1, 16, 17, 18, 39, 41, 42, and 43. The cumulative watershed area of CSO 125 is approximately 1,427 acres.

As shown in Figure 3.02-3, three detention basins are currently proposed to reduce peak runoff flows from primarily undeveloped northern areas of the CSO 125 drainage area, specifically Subbasins 16, 18, and 42. Separation of 95 percent for these subbasins has been assumed. The North Detention Basin, located in Subbasin 43, will have a surface area of 1.92 acres and be 14 feet deep; it is located on the southern side of Kirby Avenue. Also in Subbasin 43 on the south side of Kirby Avenue is the South Detention Basin, connected in series with the North Basin. The South Basin will have a surface area of 0.78 acres and be 12 feet deep. The Martha Detention Basin is the third detention basin in this CSO area. It is located along the border of Subbasins 1 and 39, which is the intersection of Kirby Avenue and Martha Street. This detention basin has a surface area of 0.95 acres and a depth of 6 feet. The Martha Basin will have a weir as an outlet control structure and an area for controlled overflow. Flows from all basins will outlet to separate stormwater systems and will not reenter the combined sewer system.

Preliminary modeling of this solution indicates that it will provide 8.1 mil gals of stormwater detention and offloading from the combined system. On an annual basis, this solution is anticipated to provide 511 mil gals of stormwater control.

Additional separation is possible for this CSO. With implementation of a membrane or high rate treatment plant, overflow events still occurring could be cleansed before entering the channel. An open channel may be able to be created between Martha Basin and the West Fork Channel, allowing more conveyance of the stormwater from the basins.

D. CSO 126

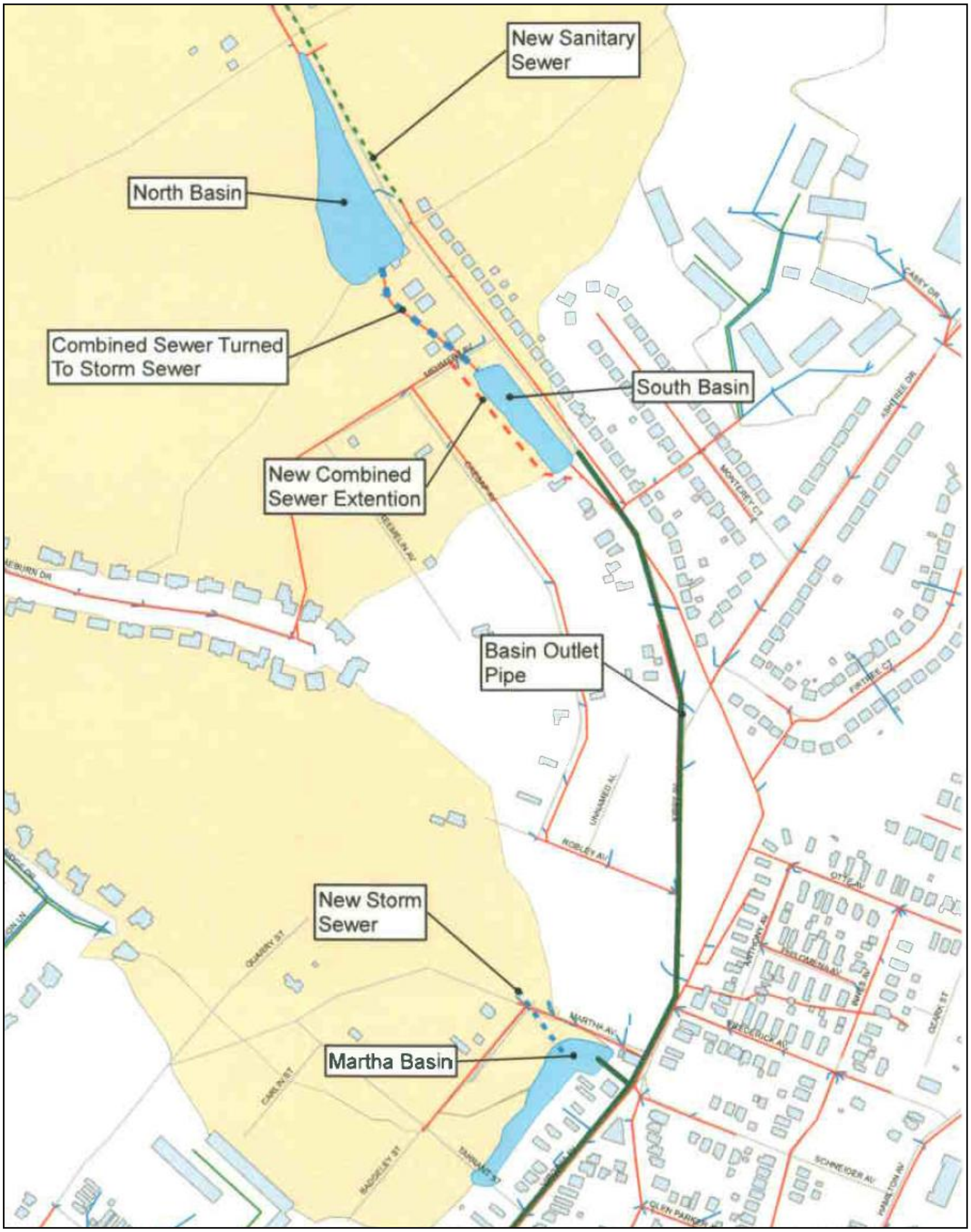
Subbasin 38, shown in Figure 3.02-4, feeds into CSO 126 and has the most overflow events annually. It is anticipated the CSO 126 will achieve 90 percent stormwater separation. Several separation projects have already been completed in the watershed, making 90 percent stormwater separation a very realistic target for this area. Additionally, there is potential for green BMPs in the open space prior to the discharge point from this subbasin.

E. CSOs 127 (Express Pipe)

CSO 127 is comprised of Subbasins 30 and 31. The locations of these subbasins and CSO 127 can be found in Figure 3.02-4. An express stormwater pipe is the proposed solution for conveying stormwater from subbasin 30 directly to the channel. There is also the potential for green BMPs within these areas. Subbasin 31, which houses a portion of the channel, will be modeled as 90 percent separation since the majority of the surrounding area is able to drain directly into the channel.

FIGURE 3.02-3

CSO 125 OFFLOADING



Source: MSDGC

F. CSO 128 (Express Pipe)

Subbasin 31 also feeds into CSO 128 and is set up similar to CSO 127. This subbasin will be modeled as 90 percent separated because of the proximity to the channel. Also similar to CSO 127, an express pipe is the proposed solution for conveying stormwater to the channel from Subbasin 20. The existing combined sewer pipe will be disconnected, and a new stormwater pipe will be laid from West Fork Road to the channel. Additional detention via ponds and green BMPs may also be possible in this area. See Figure 3.02-4 for location details.

G. CSO 130

CSO 130 is composed of Subbasins 25, 26, and 27. The objective for the CSO area is to seal off the stormwater inlets to the combined system and restore a natural drainage system to convey the separated stormwater without entry into the CSS. As a result of this, Subbasins 25 and 26 are assumed to have 50 percent effective stormwater separation from the CSS, and Subbasin 27 is assumed to have 75 percent separation from the CSS. This area is shown in Figure 3.02-5. There are two existing detention areas located in this subbasin, which present an opportunity for retrofitting the outlet control structures for peak flow reduction. Realized peak flow reductions will reduce the storm sewer conveyance sizing required to the West Fork Channel.

H. CSOs 194, 195, and 525 (Westwood Northern Bundle)

The Westwood Northern bundle is comprised of Subbasins 9, 10, and 45. The cumulative watershed area of CSOs 194, 195, and 525 is approximately 461 acres. As shown in Figure 3.02-6, these subbasins feed into CSOs 195, 194, and 525, respectively. CSO 195 is assumed to reach 90 percent separation as there is some combined sewer pipe but also a large amount of wooded area. CSO 194 is assumed to reach 75 percent separation because, while there is a fair amount of residential area with combined sewers, there is a wooded area directly before CSO 194 that should allow for some conveyance from the CSO. CSO 525, in Subbasin 45, is targeted to reach 95 percent separation because of the large amount of existing sanitary pipe and few combined sewers in the area. These separation assumptions can be updated as the Westwood Northern Bundle project progresses. The downstream conveyance system (consisting of ditches and ravines) that will be used to convey the newly separated stormwater should be investigated for erosion, stabilization, and capacity to convey the additional flows.

I. CSO 203

Subbasin 29 comprises the entire area that feeds into CSO 203. The cumulative watershed area of CSO 203 is approximately 70 acres. Fifty percent separation is assumed for this subbasin as there are many apartments in the area currently connected to the combined system. Efforts to remedy this problem would prove to be less beneficial than others in the watershed. In Figure 3.02-7, the combined sewers are denoted by the orange lines.

FIGURE 3.02-4

OPPORTUNITIES FOR CSOs 126, 127, 128

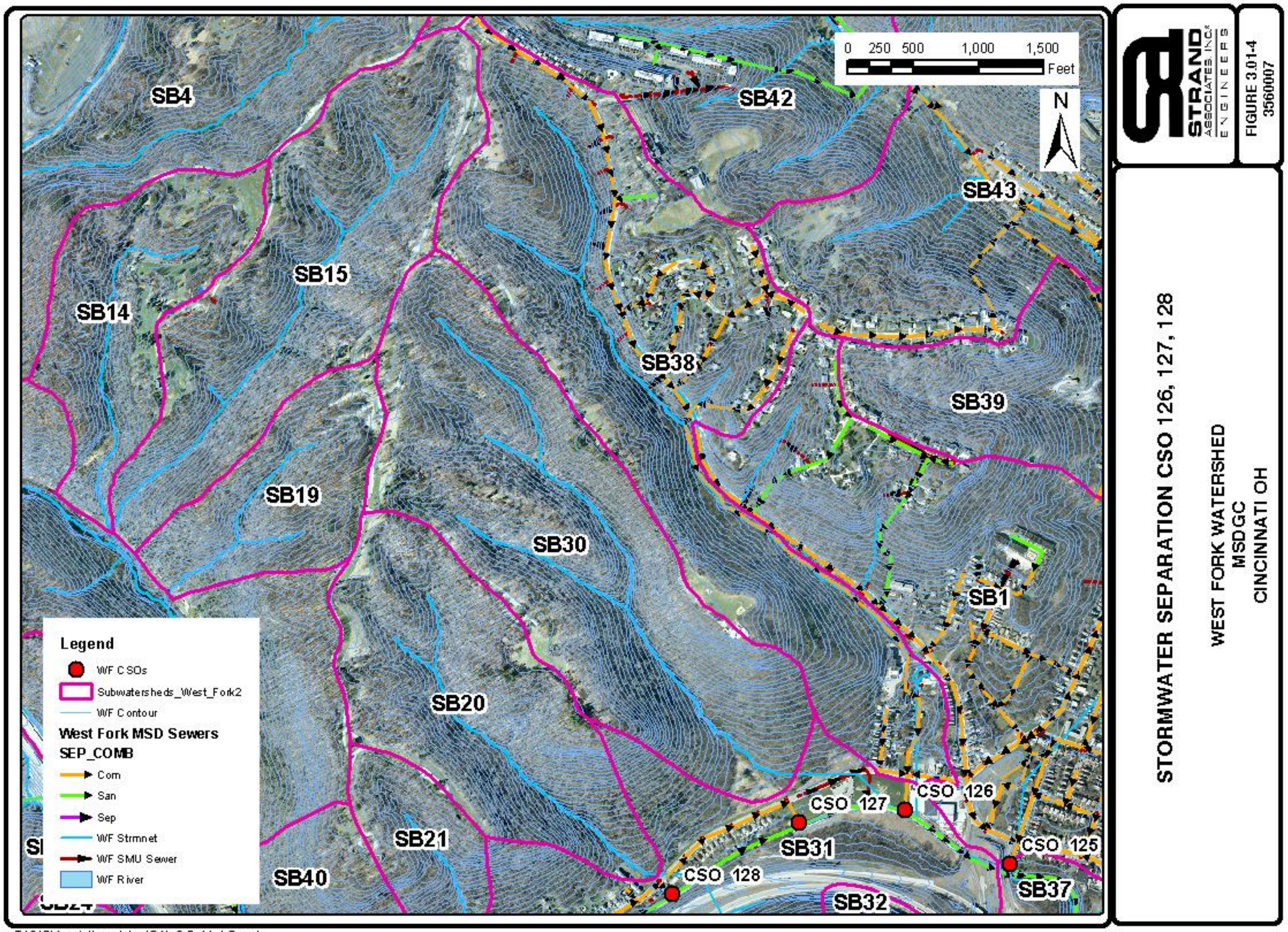


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FIGURE 3.02-5

ASSUMED SEPARATION FOR CSO 130

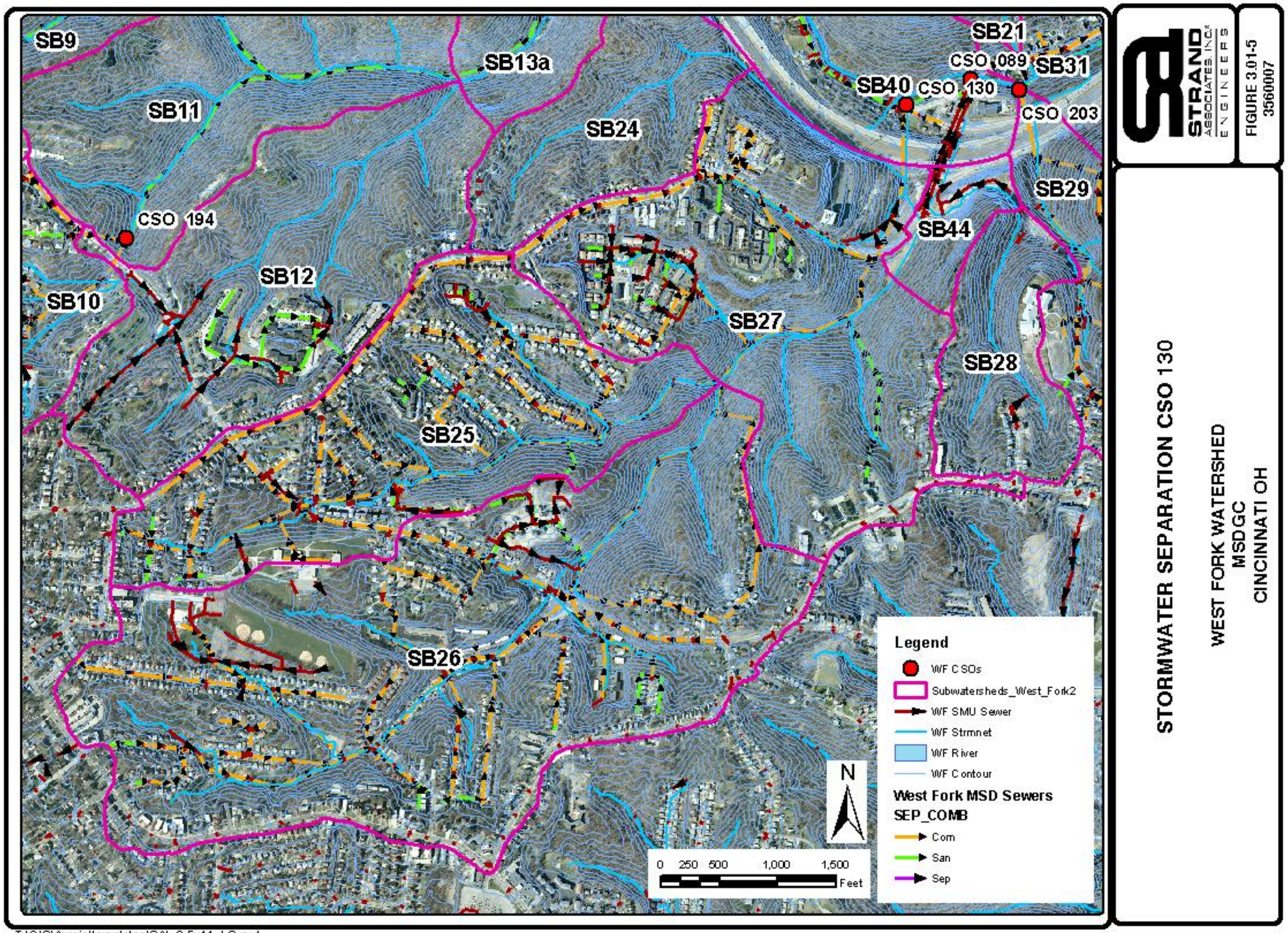

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FIGURE 3.02-6

ASSUMED SEPARATION FOR CSOs 194, 195, and 525

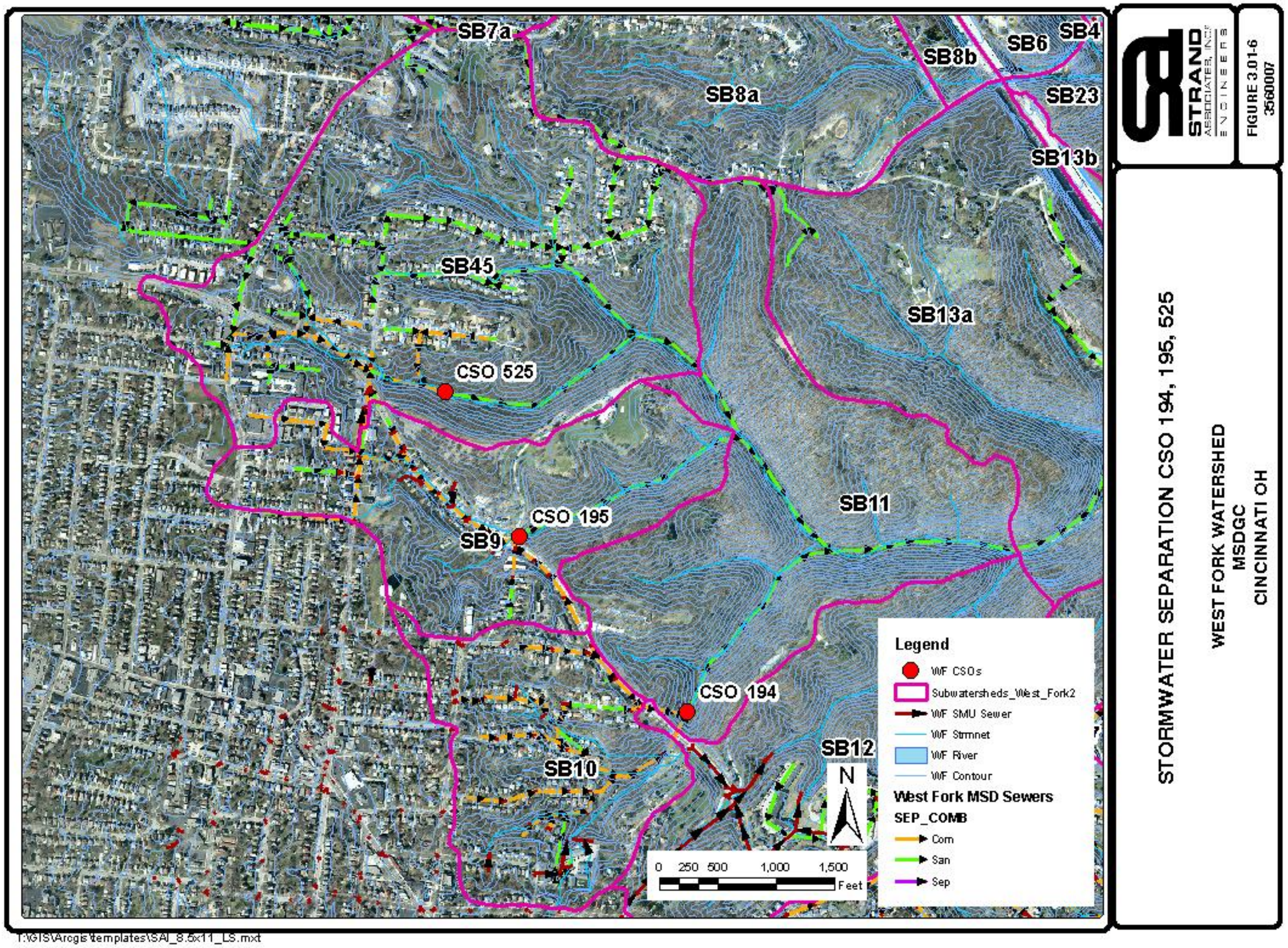
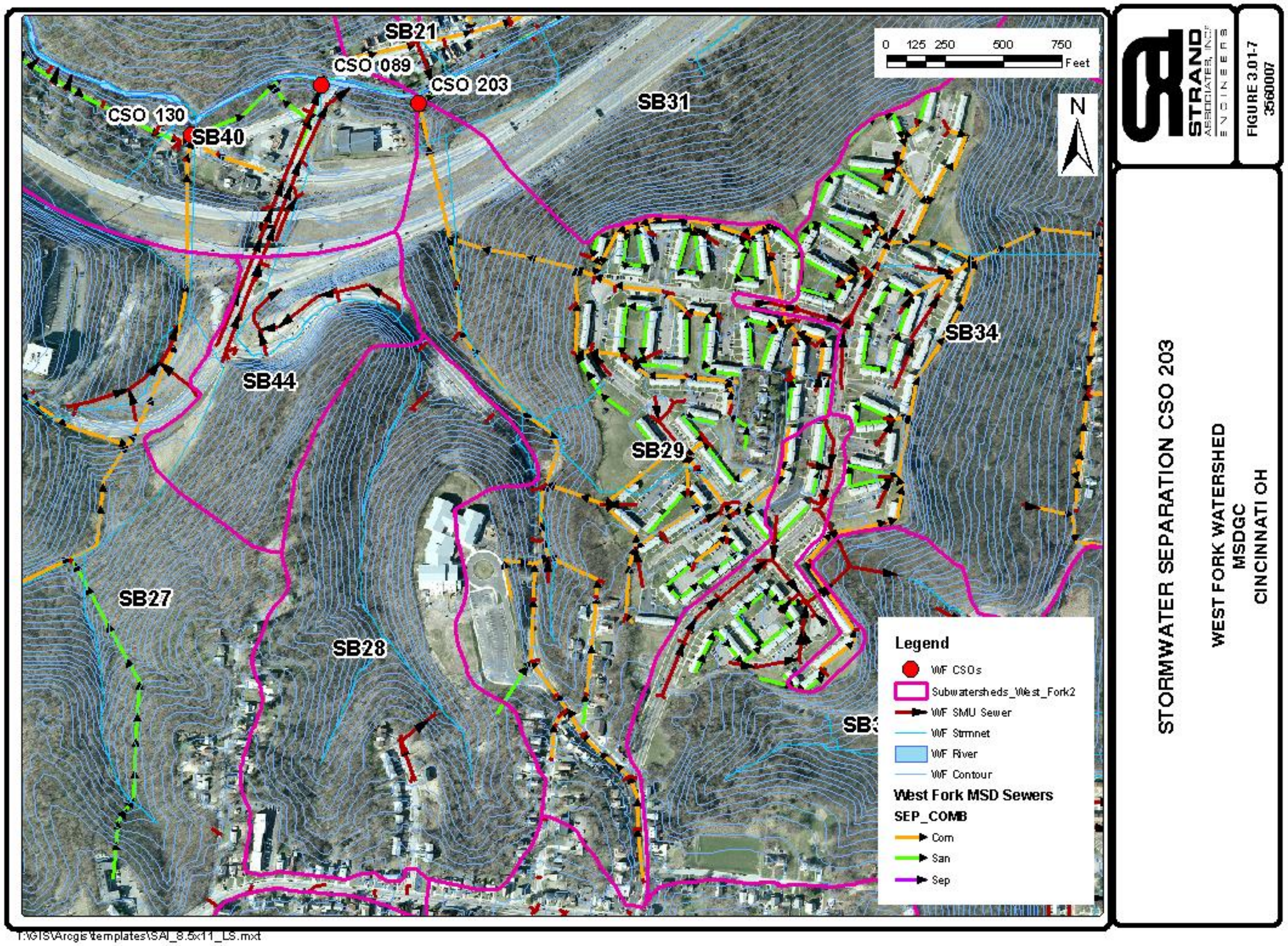


FIGURE 3.02-7

ASSUMED SEPARATION FOR CSO 203



J. CSO 527

Two subbasins, 33 and 36, drain to CSO 527. The cumulative watershed area of CSO 527 is approximately 32 acres. As shown in Figure 3.02-8, the three CSOs 527a, 527b, and 527c have been combined into one. There is very little combined sewer piping within these two subbasins, so 95 percent separation of storm and sanitary should be able to be achieved.

K. CSOs 528, 529, and 530

Subbasin 35 contains CSOs 528, 529, and 530. The cumulative watershed area of CSOs 528, 529, and 530 is approximately 173 acres. These CSOs have been renamed from those in Figure 3.02-9. CSO 528 is shown as 528a, CSO 529 is shown as 529a, and CSO 530 is shown as 528b. These three CSOs are all assumed to achieve 95 percent separation.

L. Remaining Subbasins (Inlet Removal and Separation)

The remaining subbasins (2, 3, 4, 5, 6, 7a, 7b, 8a, 8b, 11, 12, 13a, 13b, 14, 15, 19, 21, 23, 24, 28, 32, 40, and 44) do not feed directly into any CSO. The cumulative watershed area of the remaining subbasins is approximately 2,643 acres. These subbasins are primarily undeveloped lands, including 1,430 acres located within Mount Airy Forest. Those areas that are developed are primarily served by separate storm and sanitary sewers. For this reason, 95 percent of the stormwater can be routed directly to a separate stormwater channel. The locations of these subbasins are denoted by the shading in Figure 3.02-10. It is important to note that CSO 120 no longer exists, but it was located in Subbasin 32. CSO 89, which was located in Subbasin 44, also no longer exists.

In the northwestern region of the watershed, the steep slopes are a major challenge for the construction of new detention areas, and as such, no new detention basins are currently proposed in this area. There are opportunities to retrofit existing retention ponds in Subbasins 2, 3, and 4, but because of the location of these wet ponds in the upper areas of the watershed, significant benefits will likely not be achieved.

FIGURE 3.02-8

ASSUMED SEPARATION FOR CSO 527

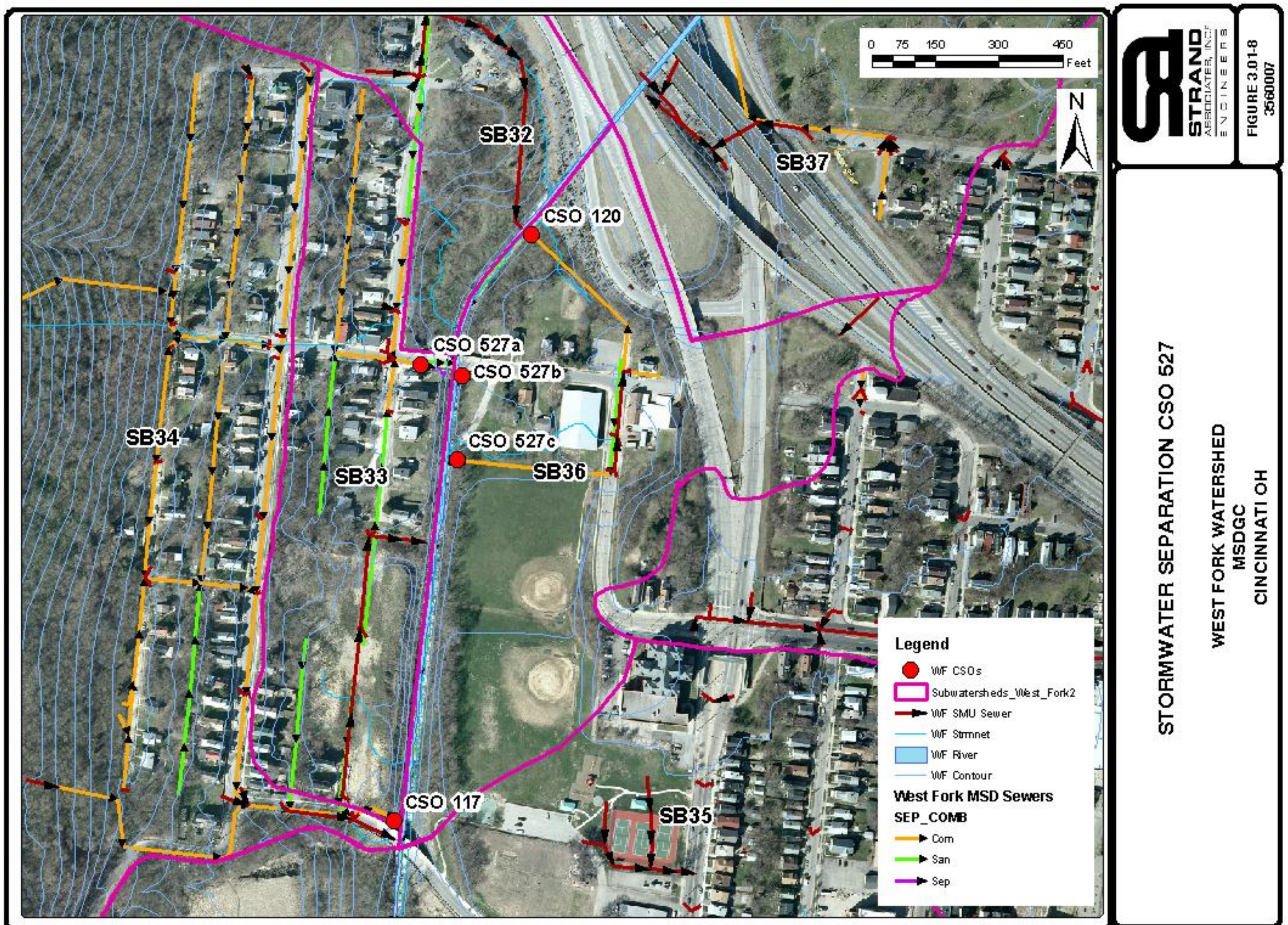


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FIGURE 3.02-9

ASSUMED SEPARATION FOR CSOS 528, 529, 530

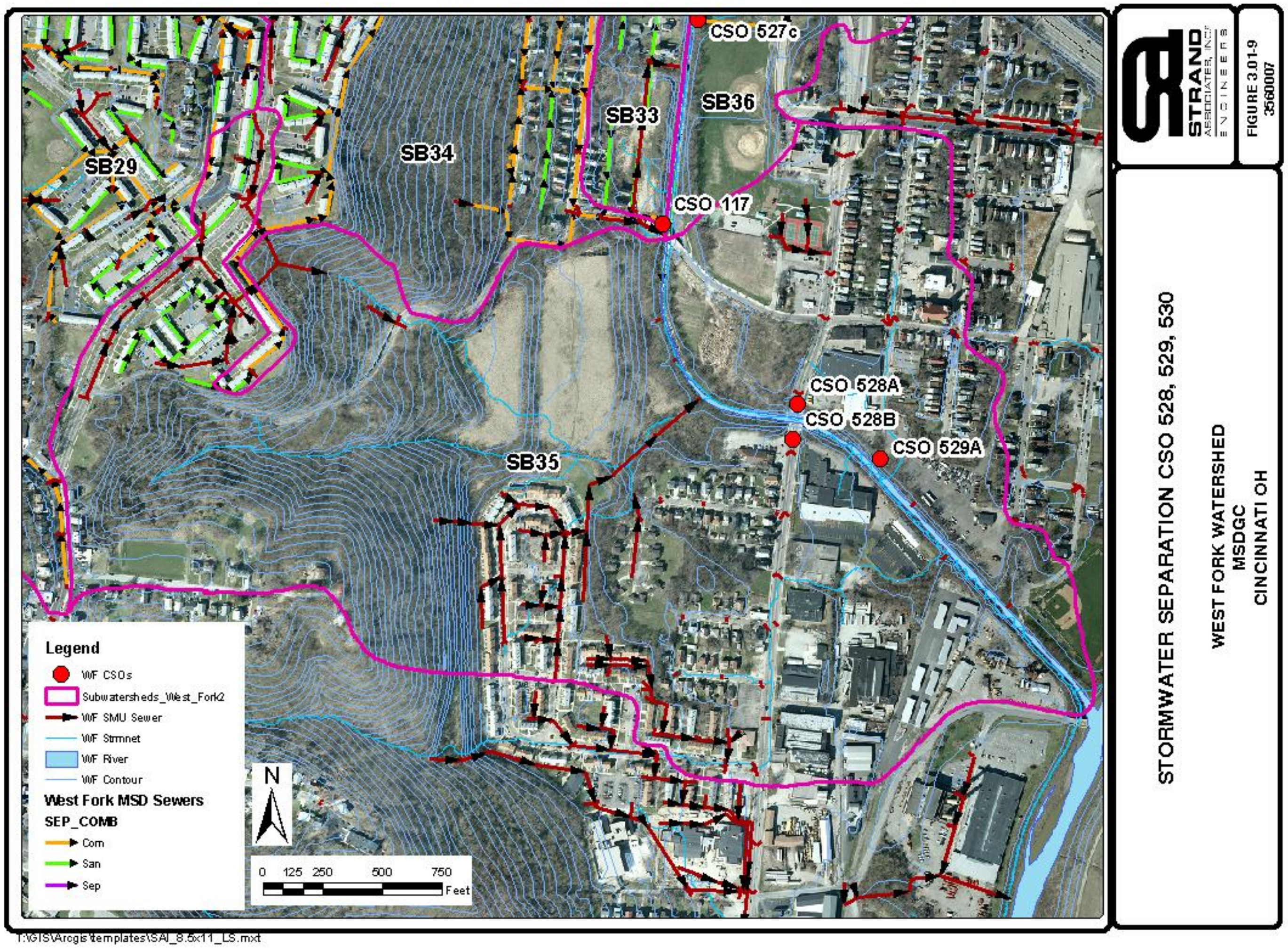
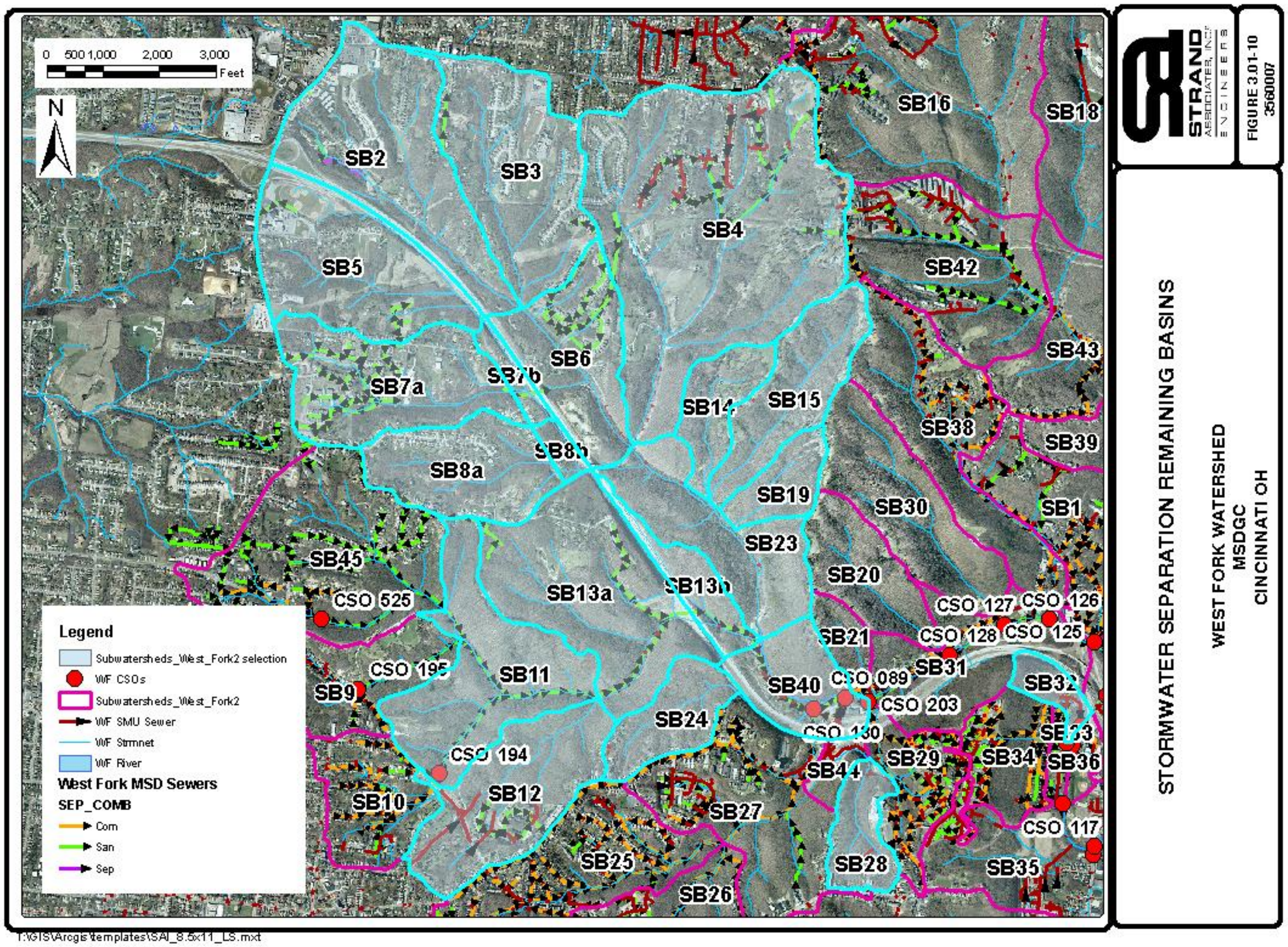


FIGURE 3.02-10

ASSUMED SEPARATION FOR REMAINING SUBBASINS



M. Naturalization of West Fork Channel

One of the primary wet weather strategies during the conceptual exploration phase was strategically removing stormwater from the combined sewer network. Naturalizing all or portions of the West Fork Channel creates an opportunity to effectively reduce CSOs, but it also creates a centerpiece for economic and community redevelopment. Separating West Fork Creek from the combined sewer creates an opportunity to allow stormwater runoff and base flows to flow more naturally to the Mill Creek.

A channel naturalization priority ranking was conducted to identify segments of the channel that were most beneficial for naturalization. Segments were ranked into four categories: High Priority Naturalization, Moderate Priority Naturalization, Moderate-Low Priority Naturalization, and Nonpriority Naturalization. Ranking considered many elements unique to each channel segment including the community use, accessibility of the area, current configuration of the roads and other structures, parcel ownership, availability of vacant lands, nearby community linkages, obstacles to naturalization, and similar. For prioritization, the assumption was made that the proposed Federal Emergency Management Agency (FEMA) grant was accepted for property procurement.

The priority ranking of each segment and the reasoning for that ranking are as follows:

1. Channel Start near CSO 130 to Beekman Culverts: High Priority (5,025 Linear Feet)

The first 550 feet of this segment starts in Mount Airy Forest, which could provide an opportunity to connect the restored stream with the existing trails located about 1000 feet away. (The park-owned land also provides an opportunity to partner with the park on the project). The public park area could provide an opportunity for the community to utilize the restored stream as an amenity. The segment is at the beginning of the channel, and naturalizing this segment would provide the greatest opportunity to truly restore a stream and reconnect it with the existing natural stream. Additionally, being the start of the channel, this segment has higher potential for CSO volume reduction and overflow elimination. Downstream of Mount Airy Forest, the channel runs behind residential properties located on West Fork Road. Assuming these properties are acquired, this land will become a public amenity with high visibility of the channel. Downstream of the residential lots, the channel is located next to an existing public park with very high visibility. A chain link fence separates the channel from the park. This location provides an opportunity to naturalize the stream in an area that will serve as a community amenity and have a revitalization impact. Located between Northside neighborhood and Mount Airy Forest, this area will act as a gateway to both areas. (The location on public lands provides an opportunity to partner with the park). This segment currently contains CSOs 127 and 126, which are scheduled for 90 percent separation–meaning there is a high likelihood this segment of channel will have no overflows occurring. Another opportunity this area presents is the opportunity for recognition of the historical West Fork stream; the original stream flowed up and through what is now the park. Note the assumption the FEMA grant is successful, and all other properties in the area are purchased.

The 550 feet of channel in Mount Airy Forest is currently not easily accessible or visible to the public. Trails or a similar-type project would be necessary to truly make this restoration an amenity.

After evaluating the opportunities and constraints for stream naturalization, this channel segment has been assigned a high priority ranking.

2. Start of Beekman Culverts to Powers Street: Nonpriority (2,800 Linear Feet)

The portion of this segment between the two box culverts is located on municipally owned and vacant lands; this could provide an opportunity to utilize this land. The historical West Fork stream looked significantly different in this area and could provide an opportunity to recognize this change.

Nothing can feasibly be changed about the box culverts under Beekman Street and I-74. Though the area between the culverts is located on municipal and vacant lands, this area is not easily accessible or visible to the public. However there is an existing MSD access drive off Beekman Street that could potentially provide access to the area if it were restored. This area is currently forested, and is bound by Beekman Street on the west, a cemetery on the east, and residential/commercial structures along Colerain Avenue on the north.

After evaluating the opportunities and constraints for stream naturalization, this channel segment has been assigned a nonpriority ranking.

3. Powers Street to Dreman Avenue: High Priority (1,100 Linear Feet)

This segment is located on the West side of a public park called Wayne Playground in South Cumminsville. The park has baseball diamonds (2), tennis courts (3), basketball courts (2), and other playground equipment–this is indicative of a well-used park facility. The park is highly visible from Beekman Street, Dreman Avenue, Sylvan Avenue, Powers Street, and Herron Avenue. Similar to the park on West Fork Road, this public space provides an opportunity for stream naturalization to serve as a community amenity and have a revitalization impact on the South Cumminsville community. Also, it provides an opportunity to partner with parks and to utilize already public lands without the property acquisition obstacle. Again, the historic West Fork stream looked significantly different from the current straight channel, which could provide an opportunity to recognize the original stream location. The areas to the west and the south of the channel contain several vacant residentially zoned lots which could provide an opportunity for expanding the park/stream feature further, or incorporating other stormwater features.

The existing channel segment has a generally straight alignment and steep overbank slopes, so there would be limited room for meanders and natural features. Both the Powers Street and Dreman Avenue bridges are fixed and should not be moved or altered which constrains the channel from moving laterally.

After evaluating the opportunities and constraints for stream naturalization, this channel segment has been assigned a high priority ranking.

4. Dreman Avenue to Beekman Street: Moderate Priority (1,115 Linear Feet)

Located downstream of the Wayne Playground Park, this segment of channel is surrounded mostly by open space that is either vacant or owned by Metropolitan Housing Authority. This open space provides land for revitalization adjacent to an existing park. This could act as an extension of the park and another opportunity for community enhancement.

This segment is currently well vegetated with trees and has little existing access to the channel, which means the existing channel has low visibility to the public. The Dreman and Beekman Bridges constrain the lateral location of the channel or stream. Located downstream of many of the major CSO overflows, this area has a good potential to still receive active CSO volumes. Without the assurance of constant clean water in this segment, the public will not be encouraged to frequent this portion of the channel.

After evaluating the opportunities and constraints for stream naturalization, this channel segment has been assigned a moderate priority ranking.

5. Beekman Street to Mill Creek: Moderate-Low Priority (1,750 Linear Feet)

The last 600 feet of this segment prior to discharge to the Mill Creek runs along the south side of a public baseball field. Similar to the public parks, this land is publicly owned, and it provides opportunities for revitalization for the neighborhood. It should not have concerns in terms of property acquisition. The land on the south side of the channel in this area is municipally owned, but this area is utilized as a municipal garage for sanitation equipment.

The first 1,150 feet of this segment (prior to the ball field) is dominated by warehouse property and industrial lands. This area is not a high priority for naturalization because it is not accessible or visible to the public. Additionally, being the farthest downstream segment of the channel, the issue of remaining CSO volumes discharging to this channel segment is a major concern.

After evaluating the opportunities and constraints for stream naturalization, this channel segment has been assigned a moderate–low-priority ranking.

N. Floodplain Acquisition

The pending Ohio Emergency Management Agency (OEMA) grant provides a wonderful opportunity for community revitalization. This project identified 22 properties for acquisition and demolition along the channel. The land would then shift toward being a natural floodplain for the channel again. This natural solution will reduce damage and life risks that currently exist for the residents of these properties. Figures 3.03-1 and 3.02-2 identify the locations of the 22 properties within the 100-year floodplain.

Although 22 properties were listed for acquisition near the channel, not all houses within the 100-year floodplain were included in the grant. Properties of interest located in the area from Figure 3.03-1 are single-family residential or municipal-owned mostly, with one duplex property. The areas in Figure 3.03-2 not listed in the OEMA grant are mostly single-family homes, with a small amount of land owned by municipalities. Approximately 30 properties will remain to be purchased if the OEMA grant is awarded.

3.03 PERMITS AND REGULATORY AGENCIES

Coordination with federal, state, and local agencies will be required as an important component of the proposed project. These agencies will guide MSDGC in obtaining legal authorization for the proposed project through relevant required permits.

Coordination between MSDGC and the Regulatory Branch of the USACE, Louisville, will be required in obtaining appropriate permits for the proposed project. USACE permits are required for all work that occurs in "Waters of the United States" that are regulated by the USACE pursuant to Section 10 of the Rivers and Harbors Act and Section 404 of the Clean Water Act. The connection of the proposed West Fork channel to Mill Creek would fall within this requirement.

On a state level, coordination between MSDGC and the Ohio Environmental Protection Agency (OEPA) will be required to obtain permits for water main and sanitary sewer relocations and sanitary sewer extensions. Before submitting permit applications to the OEPA, it is recommended MSDGC contact the local OEPA Southwest District office to discuss the proposed project and identify appropriate permits for the project. Coordination will be required with Ohio Department of Natural Resources (ODNR) regarding erosion control.

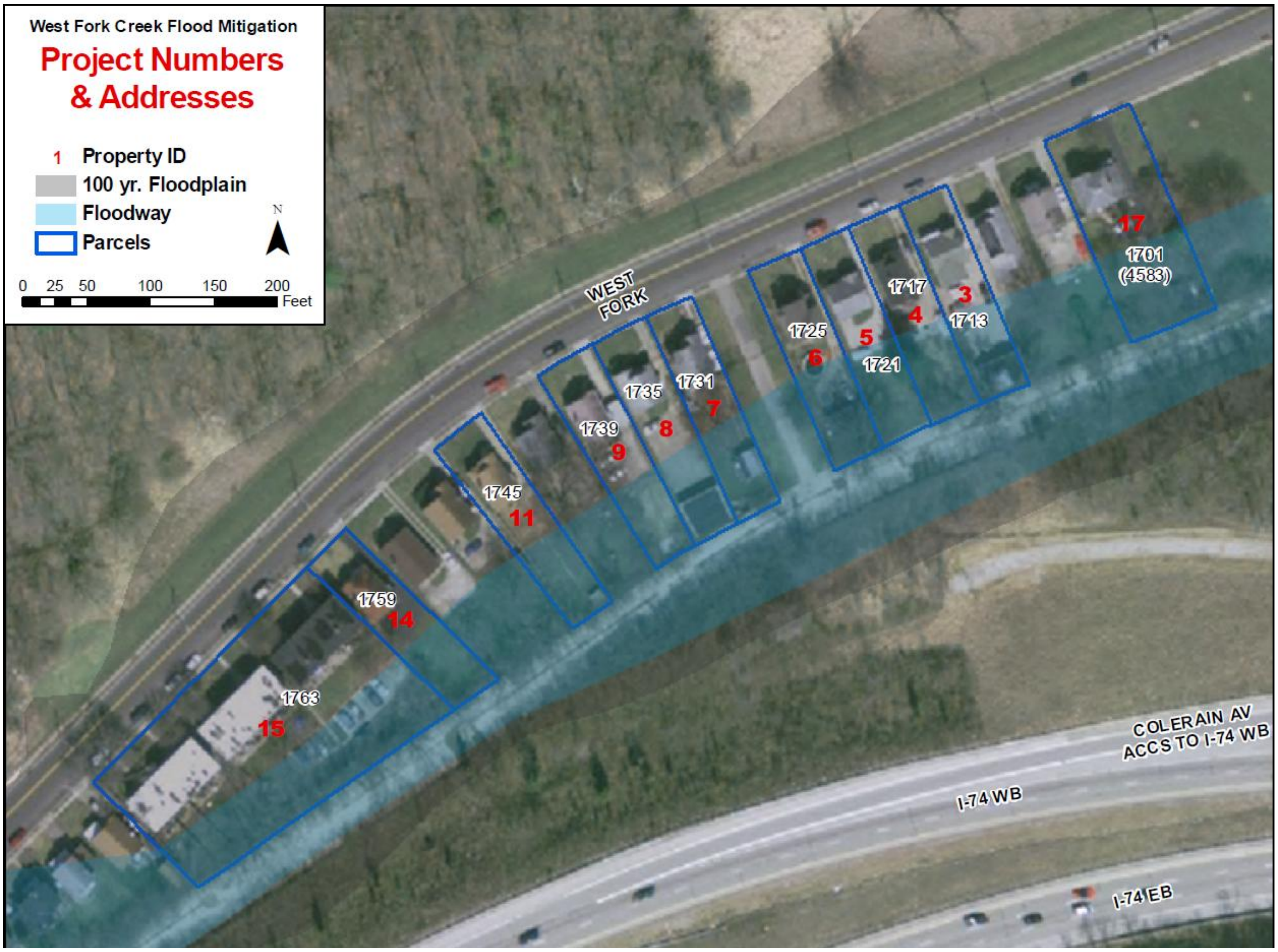
It is anticipated that local permits will be required from the City of Cincinnati Water Department, Division of Stormwater Management Utility, and the Public Works Department for proposed adjustments, relocations, and disturbance to their facilities. A comprehensive listing of proposed impacts to these facilities should be developed for review with appropriate local staff to determine actual permit requirements.

FIGURE 3.03-1

FEMA GRANT PROPERTIES IN NORTHWESTERN AREA

FIGURE 3.03-2

FEMA GRANT PROPERTIES IN SOUTHWESTERN AREA



3.04 MODEL RESULTS

Once the watershed opportunities were identified, the alternatives were prioritized based on the benefit provided by each control. To determine the benefits of the proposed opportunities, they were modeled in the existing systemwide model to demonstrate the modeled CSO reductions. The results of this modeling exercise are presented in Appendix A. In summary, the results of incorporating the sewer separation projects into the systemwide model showed the following major concerns:

1. The interceptor below the west fork channel was undersized causing increased CSO volumes.

2. The complex interaction between the grates, underflow sewers, CSOs, and channel was creating a major problem. Upstream sewer separation projects would not be as effective because the overflows would just occur somewhere downstream.

Figure 3.04-1 and Table 3.04-1 present the hydraulic/hydrologic modeling results.

The natural restrictions within the West Fork Watershed have limited the possibilities to provide additional storage within the watershed. We have analyzed the addition of detention just upstream of the I-74/Beekman Street culvert crossing. The proposed detention was incorporated to provide additional flood storage and to offset the decrease in capacity because of an increase in friction with the naturalization. This basin will be an online pond maximizing the storage volume within the existing floodplain. The proposed detention provides an additional 29.5 acre-feet of storage during the 100-year design storm. This detention basin was preliminarily designed with a narrow linear wet pool. The reasons for inclusion of the wet pool is to maximize the available storage volume, provide an amenity to the community, and provide additional water quality benefits for the watershed. The outlet control structure for this detention basin will be the existing Beekman cross culverts. This proposed detention in conjunction with the naturalization discussed above as incorporated into the final channel hydraulics model. The blue line is the existing 100-year water surface elevation and the green line is the proposed condition. As can be seen, the additional storage volume and the naturalization of the channel combine to create a lower 100-year water surface profile.

FIGURE 3.04-1

HEC-RAS MODEL RESULTS

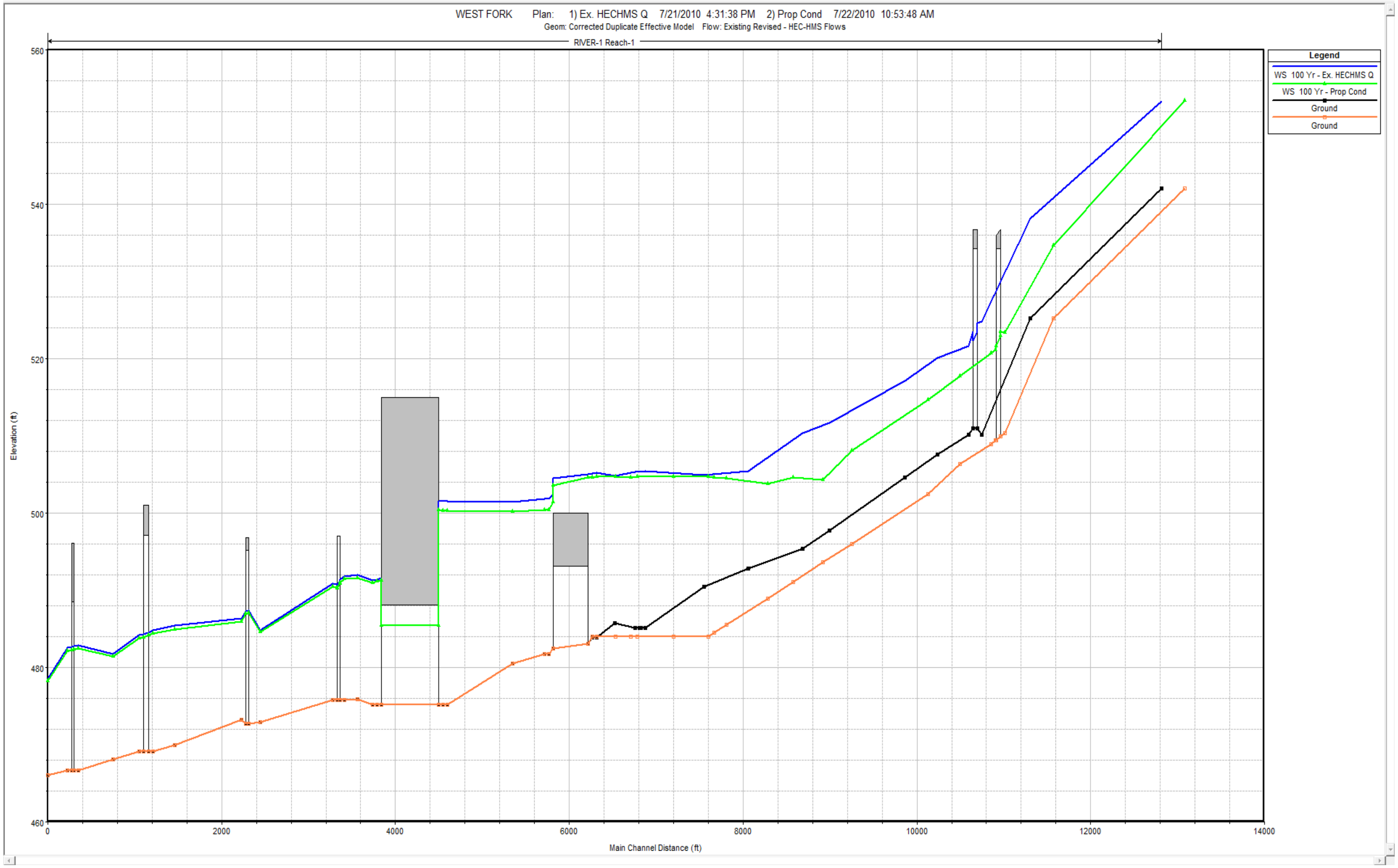


TABLE 3.04-1

HEC-RAS MODEL RESULTS

Bridge Name	Proposed River Sta	Design Profile	Proposed Q Total (cfs)	Proposed W.S. Elev (ft)	Existing Q Total (cfs)	Existing W.S. Elev (ft)	Difference (ft)
West Fork Road	10.6	1 Yr	1,884	517.27	1,887	518.27	1
West Fork Road	10.6	2 Yr	2,738	518.66	2,744	519.85	1.19
West Fork Road	10.6	5 Yr	3,802	520.08	3,814	521.17	1.09
West Fork Road	10.6	10 Yr	4,658	521.06	4,662	522.11	1.05
West Fork Road	10.6	25 Yr	5,758	522.13	5,692	523.15	1.02
West Fork Road	10.6	50 Yr	6,554	522.79	6,464	523.89	1.1
West Fork Road	10.6	100 Yr	7,462	523.48	7,316	524.67	1.19
Beekman Street	6.4	1 Yr	2,037	491.29	2,235	491.79	0.5
Beekman Street	6.4	2 Yr	2,605	494.69	2,952	494.92	0.23
Beekman Street	6.4	5 Yr	3,700	495.71	4,291	496.36	0.65
Beekman Street	6.4	10 Yr	4,386	497.62	4,564	498.43	0.81
Beekman Street	6.4	25 Yr	4,812	500.47	5,074	501.45	0.98
Beekman Street	6.4	50 Yr	5,250	502.66	5,494	503.32	0.66
Beekman Street	6.4	100 Yr	5,716	504.58	5,947	505.05	0.47
I-74	5.4	1 Yr	2,453	485.81	2,756	486.7	0.89
I-74	5.4	2 Yr	3,196	486.69	3,607	487.78	1.09
I-74	5.4	5 Yr	4,351	489.89	5,113	492.35	2.46
I-74	5.4	10 Yr	5,301	493	5,620	494.16	1.16
I-74	5.4	25 Yr	6,011	495.62	6,327	497.15	1.53
I-74	5.4	50 Yr	6,573	498.05	6,889	499.17	1.12
I-74	5.4	100 Yr	7,226	500.39	7,540	501.55	1.16
Powers Street	4.4	1 Yr	2,453	483.33	2,756	483.77	0.44
Powers Street	4.4	2 Yr	3,196	484.37	3,607	484.94	0.57
Powers Street	4.4	5 Yr	4,351	485.93	5,113	487	1.07
Powers Street	4.4	10 Yr	5,301	487.27	5,620	487.74	0.47
Powers Street	4.4	25 Yr	6,011	488.34	6,327	489.68	1.34
Powers Street	4.4	50 Yr	6,573	490.11	6,889	490.56	0.45
Powers Street	4.4	100 Yr	7,226	491.02	7,540	491.4	0.38
Dreman Avenue	3.4	1 Yr	2,453	482.17	2,756	482.5	0.33
Dreman Avenue	3.4	2 Yr	3,196	483.13	3,607	483.62	0.49
Dreman Avenue	3.4	5 Yr	4,351	484.26	5,113	485.01	0.75
Dreman Avenue	3.4	10 Yr	5,301	485.23	5,620	485.54	0.31
Dreman Avenue	3.4	25 Yr	6,011	485.93	6,327	486.2	0.27
Dreman Avenue	3.4	50 Yr	6,573	486.43	6,889	486.68	0.25
Dreman Avenue	3.4	100 Yr	7,226	487.04	7,540	487.36	0.32
Beekman Street	2.4	1 Yr	2,529	477.09	2,860	477.83	0.74
Beekman Street	2.4	2 Yr	3,351	478.74	3,763	479.34	0.6
Beekman Street	2.4	5 Yr	4,511	480.34	5,274	481.34	1
Beekman Street	2.4	10 Yr	5,507	481.64	5,835	482.05	0.41
Beekman Street	2.4	25 Yr	6,281	482.6	6,605	482.98	0.38
Beekman Street	2.4	50 Yr	6,892	483.32	7,207	483.7	0.38
Beekman Street	2.4	100 Yr	7,602	484.17	7,924	484.56	0.39
Railroad Bridge	1.4	1 Yr	2,529	474.52	2,860	475.29	0.77
Railroad Bridge	1.4	2 Yr	3,351	476.2	3,763	476.9	0.7
Railroad Bridge	1.4	5 Yr	4,511	478.1	5,274	479.26	1.16
Railroad Bridge	1.4	10 Yr	5,507	479.6	5,835	480.07	0.47
Railroad Bridge	1.4	25 Yr	6,281	480.69	6,605	481.12	0.43
Railroad Bridge	1.4	50 Yr	6,892	481.49	7,207	481.89	0.4
Railroad Bridge	1.4	100 Yr	7,602	482.37	7924	482.75	0.38

SECTION 4
RECOMMENDED SOLUTION

4.01 COST BENEFIT ANALYSIS

Based on the modeling results, two alternatives were developed to address the problems associated with the West Fork Channel and its interactions with the interceptor and CSOs.

The key issues driving the development of these alternatives were as follows:

1. Large areas of underdeveloped land entering the CSS.
2. Floodprone properties.
3. Significant hydraulic interaction between channel and interceptor.
4. Proposed gray control conveys significant amounts of stormwater.

The overarching goals in developing these alternatives were as follows:

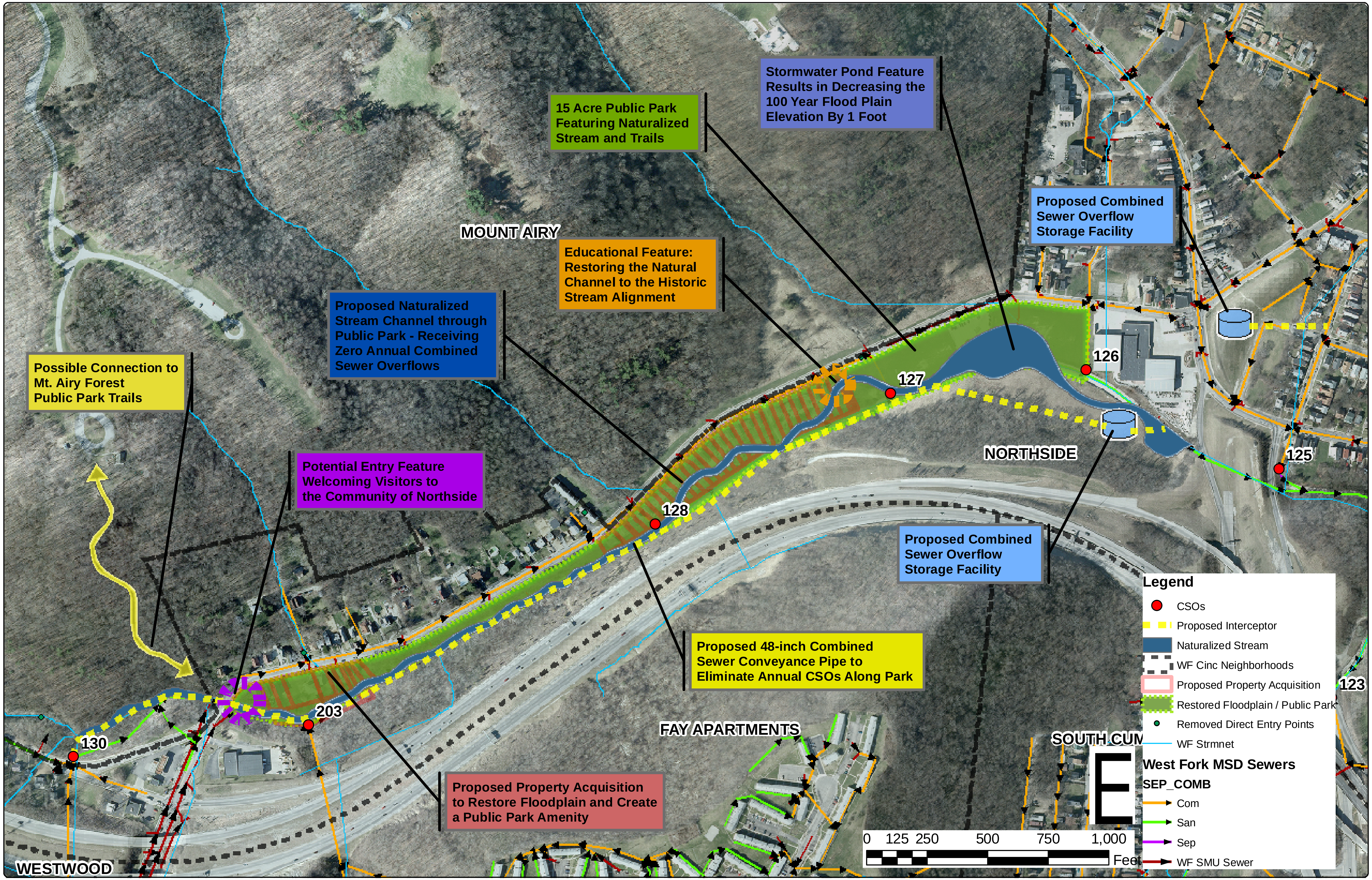
1. Provide cost-effective compliance with Consent Decree.
2. Reduce stormwater that is conveyed and treated.
3. Reestablish a more natural conveyance system.
4. Maximize the Triple Bottom Line.

A. Channel Naturalization Alternative A

Channel naturalization Alternative A is shown in Figure 4.01-1. This alternative proposes 6,000 linear feet of a new 48-inch interceptor to be installed adjacent to the existing channel from CSO 130 to the Beekman Street culverts just upstream of CSO 125. This new interceptor will replace the old interceptor, and all existing CSOs along this stretch will be abandoned when connections are made to the new 48-inch interceptor. The new interceptor will feed into a 1 mil gal storage tank that will provide CSO control by storing the combined sewage until capacity becomes available in the former interceptor to convey the remaining flow to the wastewater treatment plant (WWTP). This proposed configuration will eliminate CSOs 130, 203, 128, 127, 126, 525, 195, and 194. These CSOs will no longer be active, as the flows will instead be conveyed to the new interceptor and storage facility. A new overflow point will be created downstream from the storage tank, and this point will provide relief in the larger storm events; this point will be the most upstream CSO in the West Fork basin.

A 1.25-million-gallon storage facility is proposed upstream of the real-time control at CSO 125. This facility will function like the other storage facility by detaining combined sewage until the interceptor has capacity available.

Abandoning the old interceptor and CSO locations and relocating any remaining overflow downstream of West Fork Road Park allows the opportunity to naturalize the first 6,000 linear feet of West Fork Channel. All the separated stormwater will be directed to this naturalized stream. This alternative proposes the acquisition of the homes along the southern side of West Fork Road, which will create a 15-acre public park. This park will include a stormwater detention feature that will effectively lower the 100-year floodplain in this area by 1 foot despite the additional stormwater that will now be directed to this stream.



WEST FORK SUSTAINABLE WATERSHED EVALUATION
ALTERNATIVE A

WEST FORK WATERSHED
METROPOLITAN SEWER DISTRICT OF GREATER CINCINNATI

STRAND ASSOCIATES, INC.® ENGINEERS

FIGURE 4.01-1
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The key benefits of this alternative are as follows:

1. The interaction between the channel, CSOs, and interceptor is eliminated and replaced by a more functional system.

2. The new system in conjunction with the sewer separation projects will keep 551 million gallons of stormwater from entering the CSS and either causing CSOs or being treated at the WWTP.

3. Approximately 319 million gallons of CSO will be eliminated annually from the West Fork Basin; this is equivalent to an 89 percent reduction in total CSO volume for the typical year.

4. Approximately 6,000 linear feet of historic stream will be restored in a new 15-acre park facility.

The costs associated with this alternative are shown in Table 4.01-1. These costs represent capital costs at the planning level in 2006 dollars.

Project Area	Estimated Cost
CSO 125–Three basins and 36-inch Outfall Pipe	$8,210,000*
CSO 126 Sewer Separation	$2,600,000*
CSO 127 and 128–Express Pipe	$1,400,000*
CSO 130–Separation and Inlet Sealing	$18,000,000*
CSO 194, 195, 525 Westwood Northern Bundle	$14,000,000*
CSO 117 and 203 Sewer Separation (Fay Apartments)	$5,800,000
Property Acquisition[1]	$3,626,445
Basin Enhancements[2]	$1,250,000
Channel Naturalization–West Fork Road[3]	$13,010,914
2.25 MG Storage	$11,250,000
Total–2010	$79,147,359
Total–2006	$70,070,978

Note: All costs are preliminary and are based on the best available data. These costs are subject to change.

* Cost estimate provided by MSDGC.

[1]Assuming $4.3 Million FEMA Grant is Awarded.

[2] To Provide Water Quality Benefits.

[3]Includes Stormwater Ponds, Demolition of Existing Channel, Installation of 48-inch New Interceptor, Bank Stability Features, and Naturalized Channel Creation.

Table 4.01-1 Project Costs for Alternative A

B. Channel Naturalization Alternative B

Channel naturalization Alternative B is shown in Figure 4.01-2. The concept for Alternative B was to evaluate the feasibility of eliminating all CSOs in West Fork and restoring as much of the channel as realistic. Therefore, Alternative B includes everything outlined in Alternative A including the new 48-inch interceptor, the two combined sewage storage facilities, and the 6,000 feet of naturalized stream along West Fork Road. However, to eliminate the remaining CSO volumes in the typical year, Alternative B proposes the installation of a High Rate Treatment (HRT) facility to treat the remaining CSO volume and discharge the effluent to West Fork Channel. This will allow for the naturalization of an additional 6,000-foot segment of West Fork Channel between CSO 527 and 528.

The key benefits of this alternative are as follows:

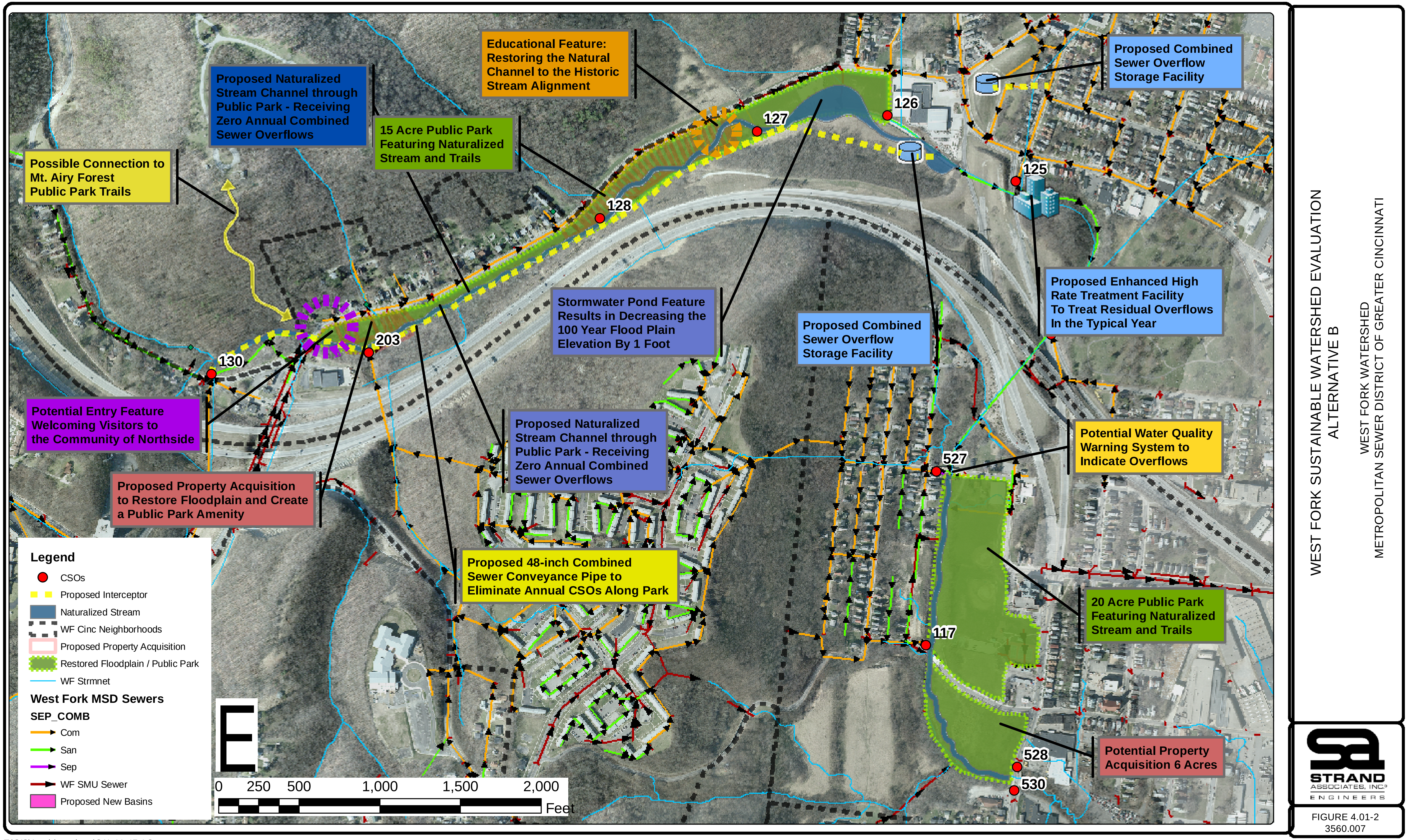
1. The interaction between the channel, CSOs, and interceptor is eliminated and replaced by a more functional system.

2. The new system in conjunction with the sewer separation projects will keep 551 million gallons of stormwater from entering the CSS and either causing CSOs or being treated at the WWTP.

3. Approximately 426 million gallons of CSO will be eliminated annually from the West Fork Basin; this is equivalent to nearly 100 percent reduction in total CSO volume for the typical year.

4. Approximately 12,000 linear feet of historic stream will be restored in two new park facilities totaling 35 acres.

Table 4.01-2 shows costs associated with these projects are shown in Table 4.01-2.



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Project Area	Estimated Cost
CSO 125–Three basins and 36-inch Outfall Pipe	$8,210,000*
CSO 126 Sewer Separation	$2,600,000*
CSO 127 and 128–Express Pipe	$1,400,000*
CSO 130–Separation and Inlet Sealing	$18,000,000*
CSO 194, 195, 525 Westwood Northern Bundle	$14,000,000*
CSO 117 and 203 Sewer Separation (Fay Apartments)	$5,800,000
Property Acquisition[1]	$3,626,445
Basin Enhancements[2]	$1,250,000
Channel Naturalization–West Fork Rd[3]	$13,010,914
Channel Naturalization–Powers to Beekman[4]	$4,017,200
2.25 MG Storage	$11,250,000
EHRT and Storage	$80,000,000
Total–2010	$163,164,559
Total–2006	$144,453,337

Note: All costs are preliminary and are based on the best available data. These costs are subject to change.
* Cost estimate provided by MSDGC.
[1] Assuming $4.3 Million FEMA Grant is Awarded.
[2] To Provide Water Quality Benefits.
[3] Includes Stormwater Ponds, Demolition of Existing Channel, Installation of 48-inch New Interceptor, Bank Stability Features, and Naturalized Channel Creation.
[4] Includes Demolition of Existing Channel, Installation of New Interceptor, Bank Stability Features, and Naturalized Channel Creation.

Table 4.01-2 Project Costs Alternative B

4.02 RECOMMENDED ALTERNATIVE

Table 4.02-1 presents a comparison of Alternative A, Alternative B, and the planned solution from the wet weather improvement plan (WWIP). This comparison demonstrates that Alternative A has a cost per gallon of CSO removed of $0.22 while Alternative B has a cost per gallon removed of $0.34. The planned gray solution from the WWIP has a cost per gallon removed of $0.18; however, it should be noted that this figure is based on an older version of the systemwide model, and as such, this result is likely to change.

Based on the evaluation presented in this report, the recommended solution for West Fork Watershed is Alternative A.

Table 4.02-2 shows the percent control and CSO remaining for the typical year compared to the planned WWIP to the proposed solution.

A preliminary schedule and construction phasing is shown in Figure 4.02-1.

	Total Cost in 2006 Dollars	Total Annual CSO Eliminated (mil gal)	Percent Control	Cost Per Gallon Removed
Alternative A–Stormwater offloading, 6,000 linear feet of naturalized stream	$70,070,978	319	89%	$ 0.22
Alternative B–Stormwater offloading, 12,000 linear feet of naturalized stream, HRT	$144,453,337	426	100%	$ 0.34
WWIP Planned Gray Solution–12,600 linear feet of 84-inch sewer and partial separation	$99,800,000*	570**	85%	$ 0.18**

Note: All costs are preliminary and are based on the best available data. These costs are subject to change.

*Annual costs to convey and treat the additional 551 Million gallons of stormwater entering the CSS are not included in this cost.
**Based on results from previous WWIP models; subject to change as modeling results are updated.

Table 4.02-1 Alternative Comparison

CSO Number	Percent Control for the Typical Year (%)		CSO Remaining (mil gal/typical year)		Existing Overflow Volume Updated Model (mil gal)
	Planned WWIP	Proposed	Planned WWIP	Proposed	
117	51	91	9.4	2.2	9.4
123	100	100	0.0	0	0
125	51	88	68.9	44	225
126	33	-	33.2	0	11.5
127	19	-	0.2	0	6.8
128	60	-	0.3	0	14.2
130	45	-	56.3	0	117.5
203	77	-	5.4	0	10.2
*****	-	86	-	60.9	0
194	80	99	3.0	0.2	4.3
195	63	97	3.7	0.8	15.8
525	83	100	2.5	0	10.5
527	94	100	0.4	0	0.5
528	96	100	0.2	0	0.2
529	97	100	0.1	0	0.4
530	95	100	0.9	0	0.7
TOTAL			**184.5**	**108.1**	**427**

*New Overflow Downstream of Naturalization (Sum of remaining overflow from 126, 127, 128, 130, 203)

Table 4.02-2 Comparison of Percent Control and CSO Remaining

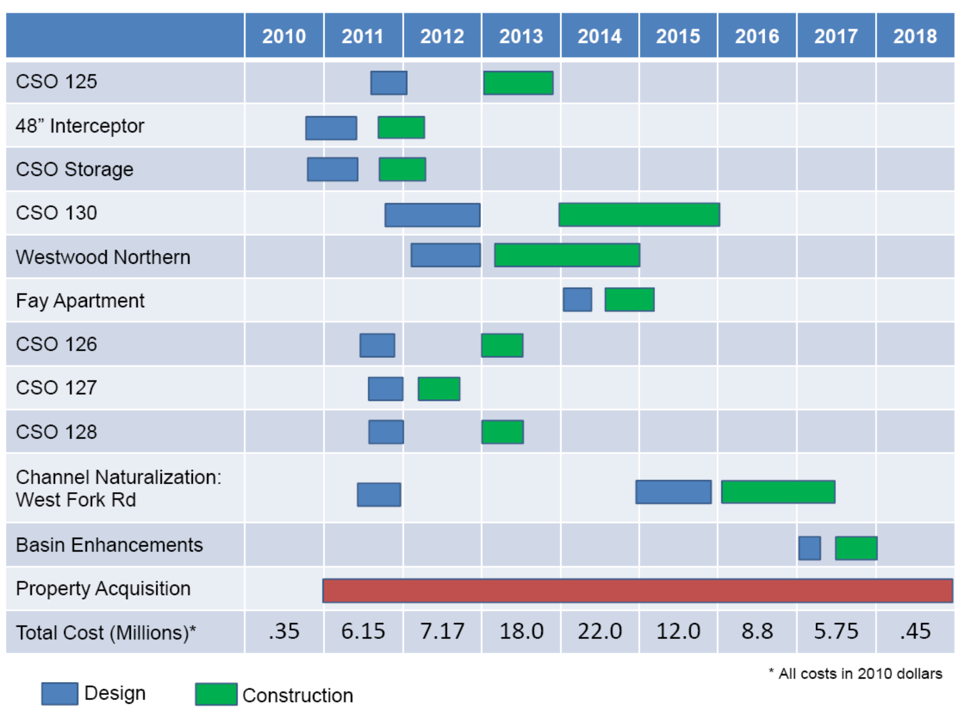

Figure 4.02-1 Proposed Schedule and Phasing

APPENDIX
SYSTEMWIDE MODEL RESULTS

West Fork

Existing: Existing Condition with Badgeley RTC.

Stor125-3ft: Area separated. Removed drop grates in channel. 4' pipe conveys all flow from CSO 130, 203, 128, 127, and 126 to storage at CSO 126 during wet weather flow. Storage drains when capacity is available in the interceptor. Badgeley separation pipe changed to a 36" pipe which conveys up to a 3 month storm. Storage added at CSO 125 to store all overflows from CSO 125. Storage drains when capacity is available in the interceptor and after CSO 126 storage drains.

Typical Year

CSO	Scenario	WWF Volume (MG)				Peak Flow (cfs)			Overflow Duration (hrs)	Overflow Events
		Inflow	Overflow	Underflow	% Control	Inflow	Overflow	Underflow		
525	Existing	42.8	10.5	32.3	75%	49.4	43.1	6.3	47	28
	Stor125-3ft	9.6	0.0	9.6	100%	2.7	0.0	2.7	0	0
195	Existing	31.5	15.8	15.7	50%	47.1	44.8	2.4	353	66
	Stor125-3ft	9.7	0.8	8.8	97%	5.4	3.6	1.8	97	24
194	Existing	27.8	4.3	23.5	84%	44.5	37.6	7.1	19	11
	Stor125-3ft	12.6	0.2	12.4	99%	10.6	3.3	6.6	3	2
130	Existing	324.3	117.5	206.8	64%	319.9	299.9	18.3	374	58
	Stor125-3ft	204.3	-	-	-	198.9	-	-	-	-
203	Existing	27.1	10.2	16.8	62%	51.0	47.7	5.2	60	34
	Stor125-3ft	13.8	-	-	-	27.0	-	-	-	-
128	Existing	26.5	14.2	12.3	46%	41.5	38.2	3.1	415	76
	Stor125-3ft	0.9	-	-	-	10.1	-	-	-	-
127	Existing	26.9	6.8	20.1	75%	34.4	32.6	5.5	71	30
	Stor125-3ft	0.4	-	-	-	1.9	-	-	-	-
126	Existing	27.2	11.5	15.8	58%	54.9	49.5	5.6	106	43
	Stor125-3ft	2.4	-	-	-	7.1	-	-	-	-
CSO 126, 127, 128, 203, 130	Existing	432.0	160.2	271.8	63%	-	-	-	-	-
	Stor125-3ft	221.8	60.9	160.9	86%	94.6	89.8	9.5	217	20
125	Existing	365.0	225.0	140.0	38%	613.1	597.6	10.5	222	18
	Stor125-3ft	136.3	44.0	92.3	88%	326.1	343.8	10.5	56	5
123	Existing	0.5	0.0	0.5	100%	1.0	0.0	1.0	0	0
	Stor125-3ft	0.0	0.0	0.0	100%	0.0	0.0	0.0	0	0
527A	Existing	3.8	0.5	3.4	88%	9.7	6.3	3.7	4	3
	Stor125-3ft	0.3	0.0	0.3	100%	1.1	0.0	1.1	0	0
117	Existing	26.0	9.4	16.6	64%	64.9	61.5	4.6	30	14
	Stor125-3ft	10.1	2.2	7.9	91%	24.6	21.3	4.5	11	4
528A	Existing	6.7	0.2	6.5	97%	8.7	3.1	5.8	3	3
	Stor125-3ft	0.7	0.0	0.7	100%	0.9	0.0	0.9	0	0
528B	Existing	13.2	0.7	12.5	95%	16.6	9.2	7.5	6	5
	Stor125-3ft	1.3	0.0	1.3	100%	1.6	0.0	1.6	0	0
529B	Existing	4.7	0.4	4.3	92%	6.0	3.7	2.4	16	14
	Stor125-3ft	0.5	0.0	0.5	100%	0.6	0.0	0.6	0	0
Total	Existing	953.8	426.7	527.1	55%	-	-	-	-	-
	Stor125-3ft	402.8	108.1	294.7	89%	-	-	-	-	-
West Fork Interceptor	Existing	-	-	462.7	-	-	-	22.2	-	-
	Stor125-3ft	-	-	399.1	-	-	-	19.3	-	-

Notes: West Fork Interceptor underflow volume is lower than the total of the CSO underflow because CSOs 525, 194, and 195 underflows flow into CSO 130 and therefore the volume is counted twice in the CSOs total underflow.
Percent Control for each scenario is calculated as Existing Inflow minus Scenario Overflow divided by Existing Inflow