

DRAINAGE STUDY

VARIOUS LOCATIONS

TOWN OF CROMWELL



Prepared by:

CARDINAL
ENGINEERING ASSOCIATES

June 2023

Drainage Study

Various Locations Town of Cromwell

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
Project Background.....	1
Project Approach... ..	3
Design Criteria & Analysis... ..	4
Hydrology... ..	4
Hydraulics... ..	7
Project Area Summaries... ..	7
Area 1-Cedar Drive and Coles Road	9
Area 2-Nooks Hill Road	14
Area 3-Evergreen Road at Millennium Drive.....	18
Area 4-Evergreen Road & Copper Knoll Lane	21
Area 5-Geer Street	25
Area 6-Pierson Park & West Street.....	29
Area 7-Glenwood Terrace & Field Road.....	35
Area 8-South Street.....	39
Area 9-Franklin Road & Chelsea Drive.....	49
Area 10-Evergreen Road & Willowbrook Road.....	54
Recommendations.....	57

Figures

Figure 1	Site Locations Map.....	2
Figure 1A	Cedar Drive & Coles Road Alternate A.....	12
Figure 1B	Cedar Drive & Coles Road Alternate B.....	13
Figure 2	Nooks Hill Alternate	17
Figure 3	Willow Brook Culvert, Evergreen Road	20
Figure 4	Evergreen Road & Copper Knoll.....	24
Figure 5	Geer Street over Coles Brook.....	28
Figure 6A	Pierson Park Alternate A	33

Figure 6B	Pierson Park Alternate B	34
Figure 7A	Glenwood Terrace & Field Road Alternate A	37
Figure 7B	Glenwood Terrace & Field Road Alternate B	38
Figure 8A	South Street Alternate A	45
Figure 8B	South Street Alternate B	46
Figure 8B-1	South Street	47
Figure 8C	South Street Alternate C	48
Figure 9A	Franklin Road & Chelsea Drive Alternate A	52
Figure 9B	Franklin Road & Chelsea Drive Alternate B	53
Figure 10	Willow Brook culvert at 170 Evergreen Road.....	56

Tables

Table 1	Rational Method Coefficients, (Area 1 through Area 10).....	5
Table 2	Rational Method Variables (Area 1 through Area 10)	6
Table 3	Calculated Peak Flows (Area 1 through Area 10).....	6
Table 4	Report Recommendations	57

Appendices (includes cost estimates, drainage area mapping, and FEMA data)

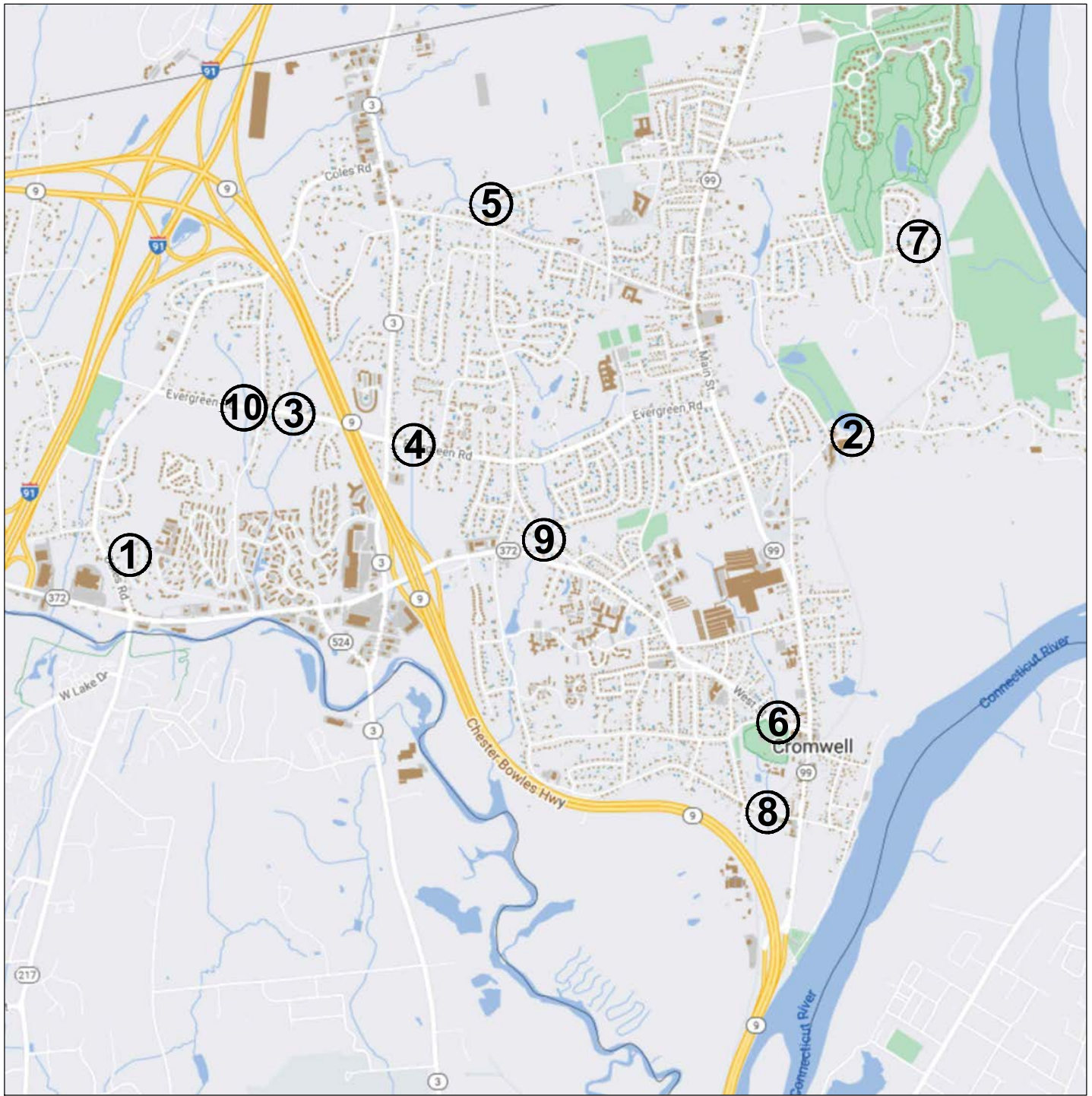
Appendix A	Supporting Documentation for Area 1-Cedar Drive & Coles Road
Appendix B	Supporting Documentation for Area 2-Nooks Hill Road
Appendix C	Supporting Documentation for Area 3-Willow Brook & Evergreen Road
Appendix D	Supporting Documentation for Area 4-Evergreen Road & Copper Knoll
Appendix E	Supporting Documentation for Area 5-Geer Street
Appendix F	Supporting Documentation for Area 6-Pierson Park
Appendix G	Supporting Documentation for Area 7-Glenwood Terrace & Field Road
Appendix H	Supporting Documentation for Area 8-South Street
Appendix I	Supporting Documentation for Area 9-Franklin Road & Chelsea Drive
Appendix J	Supporting Documentation for Area 10-Willow Brook culvert at 170 Evergreen
Appendix K	Rainfall Data

Project Background

Cardinal Engineering Associates, Inc. was retained by the Town of Cromwell to perform a study of ten separate areas of the town that have experienced flooding. This report summarizes the work that was completed as part of the study. The report includes a description of the nature and frequency of the flooding at each area along with the identified deficiencies of the existing stormwater system (including pipes, swales, and culverts). The report includes a description of alternates (typically two alternates per area), preliminary sizing of the recommended improvements, and a conceptual schematic of the alternates at each area. A conceptual project cost estimate for each alternate has been provided which includes estimated costs for construction, design, permitting, and construction inspection. Allowances for rights of way and utility relocations have been included. The town is in the process of identifying available funding for the drainage improvements necessary at each of the areas. The ten project locations are shown on Figure 1 and are as follows:

- Area 1: Cedar Drive and Coles Road
- Area 2: Shadow Brook Culvert at Nooks Hill Road
- Area 3: Willow Brook Cross Culvert at Evergreen Road
- Area 4: Culverts at Evergreen Road & Copper Knoll Drive
- Area 5: Geer Street Culverts
- Area 6: Pierson Park
- Area 7: Glenwood Terrace/Field Road
- Area 8: South Street Culverts at Cromwell Creek
- Area 9: Franklin Road & Chelsea Drive
- Area 10: Willow Brook Cross Culvert at 170 Evergreen

The ten areas include three locations off West Street or Route 372 - (Areas 1, 6, & 9), three areas on Evergreen Road (Areas 3, 4, & 10), two areas in the eastern part of Cromwell (Areas 2 & 7), a location in the northern part of town on Geer Street (Area 5), and an area in the southern part of town off Main Street (Area 8). The flooding conditions observed involve several different named watercourses (Cromwell Creek, Willow Brook, Shunpike Creek, Coles Brook, Shadow Lake Brook, and Chestnut Brook) along with an intermittent watercourse at Cedar Drive. Most of the watercourses either discharge to the Mattabesset River or the Connecticut River with some having connections to CT DOT drainage systems. Some of the areas that have flooding issues are located within the FEMA 100-year floodplain (Zone A and Zone AE), but several are located in areas not identified by FEMA as prone to flooding (Zone X). The areas associated with Cromwell Creek contain a floodway which restricts development and requires that there be zero rise in water



NOT TO SCALE

PROJECT TITLE: TOWN DRAINAGE IMPROVEMENTS VARIOUS LOCATIONS CROMWELL, CT		
DRAWING TITLE: SITE LOCATIONS MAP		
DRAFTER: DL	DATE: 6/1/2023	DRAWING NUMBER: FIGURE 1

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surface elevation for proposed conditions. A FEMA Letter of Map Revision (LOMR) would be required if that cannot be achieved.

Many of the areas investigated had significant flooding during the tropical storms in 2021 (Elsa on July 9th, 2021, and Ida on September 1st, 2021). The nearby National Weather Service location at Brainard Airport in Hartford recorded 3.57 inches of rainfall on July 9, 2021 and 4.43 inches on September 1, 2021. Both rainfall events were extremely intense (most of the rainfall occurred in less than six hours). Tropical Storm Elsa in July can be classified as a 25-year storm and Storm Ida in September as a 100-year storm. Storm Ida resulted in significantly more flooding than Storm Elsa, but Storm Ida occurred during the night so very few pictures of the flooding are available. Other events of less magnitude have caused flooding in some of these locations including storms on July 2, 2021, January 23, 2018, and December 20, 2002. The July 2, 2021 storm was approximately a week earlier than Tropical Storm Elsa and 2.44 inches of rainfall was recorded at Brainard in Hartford. The flooding was mainly caused by the watercourses overflowing their banks and roadway storm sewer systems and cross culverts being overwhelmed.

Based on the existing conditions flood elevations, existing hydraulic calculations, and engineering considerations, Cardinal identified alternatives suitable for each area. The alternatives mainly included the replacement of existing storm sewers or culverts or construction of supplemental culverts, but in a few areas, other alternatives were identified. Other alternatives included dredging of watercourses, and construction of storage/detention facilities. Other improvements considered to mitigate flooding included installation of earthen berms or walls and the installation of tide gates.

Project Approach

Cardinal Engineering reviewed the existing conditions at each of the flooding locations. The existing conditions analysis included data collection, meetings with town staff and other stakeholders, field walks, and obtaining engineering plans from the Town and CT DOT for state drainage systems. Information on CT DOT drainage systems was obtained for three areas: Area 1 Cedar Drive, Area 6 Pierson Park, and Area 8 South Street.

During the data collection stage, Cardinal performed an extensive review of available data relevant to flooding in the different areas including mapping, watercourse flow data, rainfall data for previous major storms, FEMA data/mapping, town GIS, Town wetlands mapping, utilities, soil mapping, climatological and topographical records, plan of development, and zoning regulations, and any other available information relevant to this project. Cardinal met with Town officials (including the Town Engineer, Town Engineering Staff, the Director of Public Works, and the Town Manager) on several occasions during the study. The meetings were to review the key issues

and goals of the project, discuss the sites in further detail, establish design criteria, discuss specific problem areas and potential solutions. CEA performed field reconnaissance of the various watercourses (Willow Brook, Coles Brook, Cromwell Creek, and Chestnut Brook) and their watersheds including downstream crossings and culverts. Field walks included a review of channel geometry, hydraulic conditions and streambed/channel bank stability. Flood-prone residential and commercial structures in the immediate area of the flooding areas were viewed and photographed. Cardinal also met with several homeowners informally as part of the study to better understand the nature and severity of the problems.

Cardinal's analysis of each area is preliminary and the alternates that were developed are conceptual. The alternates were based upon limited data in some of the flood areas. Field assessments and inspections were not conducted for the existing storm drainage systems and the culverts. Topographic survey was not performed during this study and for most of the areas very limited survey and engineering plans were available. There were no plans available for Area 2 Nooks Hill Road, Area 3 & 10 on Evergreen Road, Area 6 at Pierson Park, Area 8 at South Street, and Area 9 at Franklin & Chelsea.

Design Criteria & Analysis

Hydrology

The hydrologic analysis methods utilized for each culvert and storm sewer system was selected based on the watershed drainage area in accordance with the CT DOT Drainage Manual. Hydrological methods that were used were the Rational Method and USGS StreamStats depending on the size of the watersheds.

The Rational Method was used in Hydraflow Hydrographs software to compute the existing and proposed conditions stormwater flows all of the areas except for Area 2 Nooks Hill Road, Area 6 Pierson Park, Area 8 South Street, and Area 9 Franklin Road. The NOAA Atlas 14 rainfall amounts for Cromwell were used to create an intensity-duration-frequency (IDF) curve for the project and used in the Hydraflow program.

The rational method is an approved CT DOT method for drainage areas less than 200 acres in size. The project watersheds were delineated and divided into catchment areas. The catchment areas were delineated using the results from town GIS mapping, UCONN Lidar data, and engineering field visits. For the areas where the rational method was used, the values for time of concentration were calculated by TR-55 which calculates time travel based on slope, land cover, channel size, and roughness. For Area 1 where an existing stormwater drainage system was evaluated, the

contributing runoff to individual catch basin inlets was determined and time of concentration for the areas along Coles Road were assumed based on the area and type of land cover as follows:

- Tc for impervious areas less than 5,000 sf assumed to be 5 minutes
- Tc for areas from 0.5 acres to 1.0 acres assumed to be 7.5 minutes
- Tc for areas greater than 1.0 ac up to 5.0 acres to be 10 minutes
- Tc for areas greater than 5.0 acres assumed to be 15 minutes

Table 1 shows the rational method runoff coefficients that were used to determine the average runoff coefficients for each of the project areas. The areas of each of the specific types of land use were multiplied by the C factor and then the total of $C \times A$ for all of the subareas was divided by the total drainage area to obtain an average runoff coefficient for the entire drainage area. Table 2 shows the Rational Method Variables that were used to determine the design flows for each area. Tables 1 and 2 are shown below.

**Table 1 – Rational Method Runoff Coefficients, C
Area 1 through Area 10**

Land Use Description	C
Wetland Area	0.10
Meadow Area	0.15
Golf Course Area	0.15
Wooded Area	0.20
Nursery Area	0.20
Large Residential lots (>1.2 ac)	0.25
Small Residential lots (<1.2 ac)	0.35
School Property Area	0.40
Condo Area	0.50
Roads	0.90

**Table 2 – Rational Method Variables
Area 1 through Area 10**

Rational Method Variable	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7	Area 8	Area 9	Area 10
Area (ac)	25	NA	159	148	185	NA	30	NA	NA	90
C	0.20	NA	0.36	0.40	0.33	NA	0.33	NA	NA	0.33
Tc (min)	12	NA	19	22	36	NA	17	NA	NA	38

Notes:

C= runoff coefficient, Tc= time of concentration , and NA=not applicable (Streamstats used for flow determination)

StreamStats was used to determine the design flows for the larger areas. StreamStats, which is based on the peak flow regression equations developed by the United States Geological Survey (USGS) that are incorporated in the USGS StreamStats program, is applicable to drainage areas 0.69 square miles or larger that don't have significant storage. The watersheds for areas 2, 6, 8 and 9 were also determined to be urbanized so the Streamstats results were increased for urbanization. The variables for the urban seven parameter equation were determined from Streamstats basin summaries and the basin development factor (BDF) was assumed to be 3 (a typical value). At areas 6 and 9, the urbanized flows were transferred upstream. The flow values at Area 6 Pierson Park were determined by using the urbanized flow values for Cromwell Creek at South Street and transferring the values upstream to West Street by a factor of the drainage area. This method was also used for the Franklin Road and Chelsea Drive culverts. The flow value of Chestnut Brook was calculated at Missionary Road and then adjusted downward to the project area at Franklin Road and Chelsea Drive. Table 3 shows the drainage area for each of the ten areas along with the calculated peak flows for the various storms (2-year through 100-year).

**Table 3 – Calculated Peak Flows (cfs)
Area 1 through Area 10**

STORM (years)	Area 1* 25 ac	Area 2 653 ac	Area 3 159 ac	Area 4 148 ac	Area 5 185 ac	Area 6 326 ac	Area 7** 30 ac	Area 8 460 ac	Area 9 418 ac	Area 10 90 ac
2	6.2	92	147	141	125	84	24	119	75	50
10	9.3	191	221	212	188	166	35	233	115	75
25	12	250	266	256	226	212	44	298	150	91
50	13	311	301	289	255	261	50	367	185	102
100	---	368	---	---	---	---	---	---	---	---

Notes:

*Flow is swale discharge at 20 Cedar Drive; total drainage area for Coles Road system is 48 acres

** Flow is overland flow in swale discharging to 95 Field Road; total drainage area discharging to 111 Field Road is 39 ac

Hydraulics

The hydraulic evaluation of the existing and proposed drainage systems was conducted according to the 2000 Connecticut DOT Drainage Manual. The drainage improvements were based on CT DOT's hydraulic standards for sizing of culverts and stormwater pipe systems. For the existing culverts, a hydraulic analysis using FHWA's HY 8 Culvert Analysis program was used to analyze the crossing and adjacent channels. Channel sections were approximated as trapezoidal with dimensions based on field walks. Culvert capacity was calculated by HY-8 using normal depth in downstream channel except for Area 8 South Street where tailwater elevation was assumed to be 6 inches below the top the culvert (elevation 10.3 feet) for existing condition analysis which has been typically observed at that location. For the proposed condition, a tailwater of 14.9 feet was used which is based on a HY-8 calculation of all the downstream culverts at the 10 year flow. The drainage improvements were based on CT DOT's hydraulic standards for sizing of culvert. For culverts, CT DOT criteria is based on drainage area (e.g., culverts with drainage area over 1.0 sq mile are required to pass the 100-year storm with 1 foot of freeboard and culverts with less than 1.0 square miles within a defined watercourse are required to pass the 50-year storm with 1 foot of freeboard). Replacement culverts were sized for hydraulic capacity which is limited by one or more of the following DOT criteria for allowable headwater:

- Non-damaging to upstream property
- 1 foot below the established hydraulic control
- Equal to a headwater to diameter (HW/D) ratio no greater than 1.5
- The elevation where flow is diverted from the area tributary to the culvert.

The existing drainage system at Areas 1 (Coles Road) and 7(Glenwood Terrace) consists of storm sewers. The pipe networks associated with these smaller drainage areas were evaluated for smaller storms (less rainfall). Coles Road and Cedar Drive were evaluated for a 25-year storm. Glenwood Terrace/Field Road, where there is no established watercourse, were evaluated for the 10-year storm event. For these areas, a hydraulic analysis was performed using Hydraflow Stormsewers software to determine the capacity of the existing drainage system (pipes and catch basins) and to determine the necessary improvements. The drainage systems were evaluated based on their ability to convey the stormwater flow without excessive surcharge (overtopping) of the existing drainage structures.

Project Area Summaries

The following pages contain summaries for each area. The summaries include a description of the flooding problem at each area, the existing drainage system and its capacity, and a discussion of the options that were considered and the alternatives investigated. Also included is a summary of the hydrologic and hydraulic analysis performed and the design flows calculated. For each alternative investigated, a schematic plans and conceptual construction cost estimate has been

developed. These estimates were developed based on available information and schematic designs. In order to obtain a more accurate estimate of construction costs, detailed field survey and mapping, soil borings and geotechnical analysis, wetland delineation and other environmental investigations and a full design will be required. An allowance for these costs has been incorporated into the total project costs estimate which also includes an allowance for permitting, utility relocations, and right of way acquisition. All cost estimates are in 2023 dollars.

Area 1: Cedar Drive and Coles Road

There has periodically been flooding during large rainfall events on Cedar Drive at the intersection of Coles Road. Flooding has been experienced at 20 Cedar Drive and 18 Coles Road.

Present Condition:

The Cedar Drive area is located in the western part of Cromwell close to the intersection of State Route 217 and 372 (Coles Road). The storm drainage system on Cedar Drive connects to the Coles Road storm drainage system which is located on the east side of Coles Road and connects to the DOT drainage system on Route 372 which discharges to the Mattabassett River. A swale or intermittent watercourse flows along the east and south sides of the 20 Cedar Drive parcel which collects stormwater from a wetland area farther to the north. This drainage swale flows to the south where it is collected by the Cedar Drive storm drainage system via a 18-inch HDPE pipe located at end of the swale on the 20 Cedar Drive parcel. The HDPE pipe is in good condition, but is undersized and too shallow to develop suitable headwater. The town installed drainage improvements in August 2022 (a drainage diversion from Cedar Drive to Coles Road) to reduce flooding.

Based on a review of the FEMA map, the area is not in a designated flood area and is mapped as outside of the 500-year floodplain (Zone X). The drainage area for the inlet at the end of the swale at 20 Cedar Street is approximately 25 acres and contains the Cedar Drive Area and extends up to Woodsboro Circle on the north. The drainage area includes a large portion of the 20 Winchester Way lot owned by the town, and also contains a wetland area. The wetland area runs north to south from Winchester Way to Cedar Drive. The Coles Road drainage system is composed of a drainage area of 48 acres.



Pipe Inlet in Swale at 20 Cedar Drive



*20 Cedar Drive after
July 2021 storm*



Cedar Drive Looking East from Coles Rd. and No. 20



Cedar Dr/Coles Rd Intersection



Coles Road System Outlet to Mattabassett River

Hydrology and Hydraulics

Due to the small size of the watershed (less than 200 acres), the 2-year through 50-year discharges were computed using the Rational method. The 2-year through 50-year peak flows associated with the swale and the Coles Road stormwater system were determined to be the following:

Flow in Swale at 20 Cedar Drive

$Q_2 = 6 \text{ cfs}$ $Q_{10} = 9 \text{ cfs}$ $Q_{25} = 12 \text{ cfs}$ $Q_{50} = 13 \text{ cfs}$

Coles Rd Stormwater System Discharge into Mattabesset River

$Q_2 = 19 \text{ cfs}$ $Q_{10} = 29 \text{ cfs}$ $Q_{25} = 35 \text{ cfs}$ $Q_{50} = 40 \text{ cfs}$

Typically, a drainage system including pipe and catch basins are designed to collect and convey the 10-year storm event. Cardinal used the 25-year design flow (12 cfs) to provide more protection for 20 Cedar Drive where there were known issues with flooding. Hydraflow Stormsewers program was used for analysis of existing and proposed conditions. The tailwater of the system (the Mattabassett River elevation) was determined based on joint probability analysis in accordance with the CTDOT Hydraulic Manual. The ratio of drainage area of the Mattabassett River to that of the Coles Road system is approximately 1000:1. Therefore the 2-year water surface elevation of the Mattabassett River was used as tailwater for the analysis of the 25-year storm event. The 2-year tailwater elevation was estimated to be 12.5 based on the FEMA 10-year elevation for the Mattabassett River.

The existing inlet at 20 Cedar Drive along with the Coles Road drainage system (including the 2022 town improvements) were analyzed for hydraulic capacity for a 25-year storm. It was determined that the 18-inch pipe inlet and the swale at 20 Cedar were both hydraulically inadequate. A portion of the Coles Road system was also found to be inadequate.

Options Evaluated

Cardinal evaluated several options including drainage improvements at 20 Cedar Drive, drainage improvements to the Coles Road storm sewer system, and installation of a relief storm sewer. The options evaluated were as follows:

- Regrade swale and install earthen berm along west side of swale at 20 Cedar to channel runoff to a larger inlet pipe (this option helped, but it was insufficient as a standalone option)
- Upgrade the Coles Road storm sewer system to pass the 25-year storm and install a berm and new inlet at 20 Cedar Drive.
- Installation of a relief storm sewer to collect the flow from the Cedar Drive system including flow from the 20 Cedar swale and diverting the flow to existing intermittent watercourse at the rear of the property at 27 Coles Road; this option included the proposed berm on 20 Cedar.

Alternates Identified

- Alternate A: Drainage Improvements at 20 Cedar Drive and the Coles Road storm sewer system
Replace 735 feet of 18-inch pipe on Coles Road with a 24-inch pipe to increase capacity to the 25-year flow. Install a berm along with a larger inlet pipe at 20 Cedar Drive to intercept more flow into the Coles Road system and to eliminate flooding on Cedar Drive.
- Alternate B: Install relief storm sewer for Cedar Drive
Install a 620 foot long, 18-inch relief sewer to collect flows from 20 Cedar Drive and discharge it to the intermittent watercourse at the rear of 27 Coles Road. This option will reduce flow in the Coles Road system and increase its capacity.

Estimated Costs*

- Alternate A: Construction Cost \$ 390,000
Project Cost \$ 500,000
- Alternate B: Construction Cost \$ 330,000
Project Cost \$ 470,000

* Project cost includes, construction, design, permitting, construction inspection, and an allowance for rights of way and utility relocations. Construction costs includes a 20% contingency.

Permits Required

It is anticipated that the following permits will be required for this project: Town of Cromwell Inland Wetlands Permit.

Additional Findings and Recommendations

Alternate A is recommended although it has a higher cost since Option B would require drainage easements on several Coles Road properties which may not be favorably viewed by property owners.

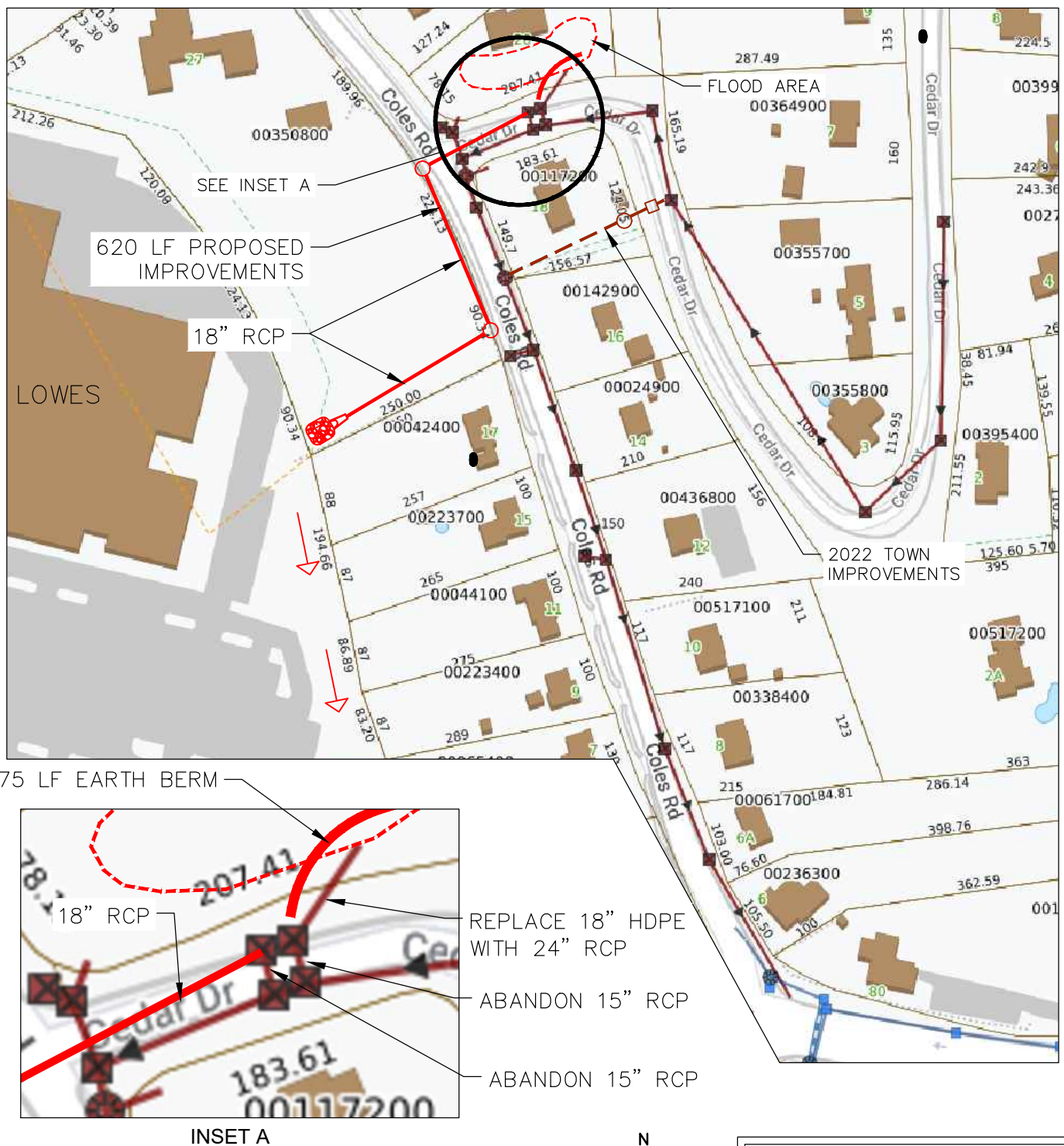
INCREASE STORMWATER PIPE CAPACITY ON COLES ROAD & CEDAR DRIVE



100 RESEARCH PKWY | MERIDEN, CT 06450 | 203-238-1969
457 BANTAM RD | LITCHFIELD, CT 06769 | 860-597-9106

AREA 1: CEDAR DRIVE & COLES ROAD - ALTERNATE B

INSTALL RELIEF STORMWATER SYSTEM TO WEST SIDE OF COLES ROAD



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FIGURE 1B

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457 BANTAM RD | LITCHFIELD, CT 06769 | 860-597-9106

Area 2: Shadow Brook Culvert at Nooks Hill Road

The culvert at Nooks Hill Road periodically floods during large rainfall events due to the limited hydraulic capacity of the existing culverts and storm drainage system, but the frequency of flooding is not well documented. The town has submitted this project to NRCS for funding.

Present Condition:

Nooks Hill Road is in the eastern part of Cromwell approximately 0.5 miles east of Main Street. The Shadow Brook Culvert is located just to the west of the railroad overpass Nooks Hill Road. The existing 4' x 3' culvert, located at the outlet of Fire Pond, has stone masonry walls and a concrete slab top. The culvert transitions to a 36" pipe which crosses the commercial property at 48 Nooks Hill Road and conveys the flow to a 4' x 4' box culvert which crosses under the railroad embankment and discharges to the east of the embankment. The Nooks Hill Road and Shadow Lane storm sewer system discharges into this 36" pipe.

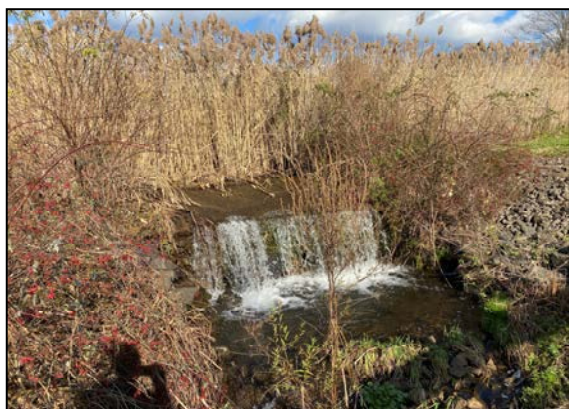
Fire Pond, which has an area of 2.5 acres, is silted in and overgrown with invasive species. As the flow typically runs over the dam, the pond has no storage capacity. From a review of historical aerial photography, the pond seemed to have started filling in with sediment in the late 1990s-early 2000 time-period.



Aerial View



Nooks Hill Road looking west



Pond discharge upstream of culvert



Nooks Hill Road culvert inlet



Culvert Transition to 36" Pipe



Railroad culvert outlet

Based on a review of FEMA data, the area is located within a 100-year flood area (Zone A). The drainage area for the culvert is approximately 1.03 square miles (660 acres). The drainage area extends north just past Golf Club Road, to Woodside school on the northwest, Main Street on the southwest, and to South Ridge Lane on the east. The watershed for the Nooks Road culvert contains several other ponds (Northern Pond, Creamery Pond, unnamed pond in nursery area north of Shadow Lane) besides Fire Pond. These other ponds have dams and large wetland areas that were historically maintained by the Cromwell Fire District. Northern Pond dam located off of Shadow Lane was recently breached and sedimentation accumulation in the ponds has further reduced storage capacity and peak flow attenuation in the watershed.

Hydrology and Hydraulics

Based on the drainage area, which is greater than 1.0 square mile, the existing culverts are classified according to CTDOT as an “Intermediate Structure” requiring them to pass the 100-year design flow with 1-foot of freeboard. The 2-year through 100-year discharges were computed using the USGS StreamStats method. StreamStats flows were adjusted upward for urbanization since the developed area of the watershed is greater than 25%. The following are the computed design flows at the stream crossing:

$$Q_2 = 92 \text{ cfs} \quad Q_{10} = 191 \text{ cfs} \quad Q_{25} = 250 \text{ cfs} \quad Q_{50} = 311 \text{ cfs} \quad Q_{100} = 368 \text{ cfs}$$

The existing culverts (the Nooks Hill Road culvert and railroad culvert) were analyzed for their hydraulic capacity, and it was determined that both are inadequate. The existing Nooks Hill Road culvert has the capacity to only pass a 2-year storm. The railroad culvert has approximately a 25-year capacity. For both culverts, higher flows would result in water overtopping Nooks Hill Road and flooding the 48 Nooks Hill property.

Options Evaluated

Cardinal reviewed and analyzed the replacement of the culverts, installing detention upstream of the crossing, installing a new dam upstream, and dredging of the existing Fire Pond. Cardinal also considered maintaining a portion of the existing drainage system and supplementing it with additional capacity. Installation of detention upstream of the crossing was reviewed along with dredging of Fire Pond but this was not seen as practical. Fire Pond restored to its original depth of 5.5 feet provides approximately 14 acre-ft of storage, but available storage would need to be close to 40 ac-ft to reduce the peak runoff leaving the pond to a value low enough to eliminate the need for upgrades to any of the existing culverts or stormwater system.

Alternate Identified

Only one alternate was identified that would significantly improve the existing conditions. The one alternate identified was the following:

Replacement of the Nooks Hill Road cross culvert and supplement the existing railroad culvert with an additional culvert- a 8 foot by 4 foot box culvert (425 feet long) would be installed from Nooks Hill Road to the railroad culvert to convey the 100-year storm; at the railroad, a 60-inch RCP culvert with a length of 150 feet would be installed by jacking it adjacent to the railroad culvert.

Estimated Costs*

Construction Cost	\$3.2 Million
Project Cost	\$3.5 Million

*Project cost includes construction, design, permitting, construction inspection, and an allowance for rights of way and utility relocations. Construction costs include a 20% contingency.

Permits Required

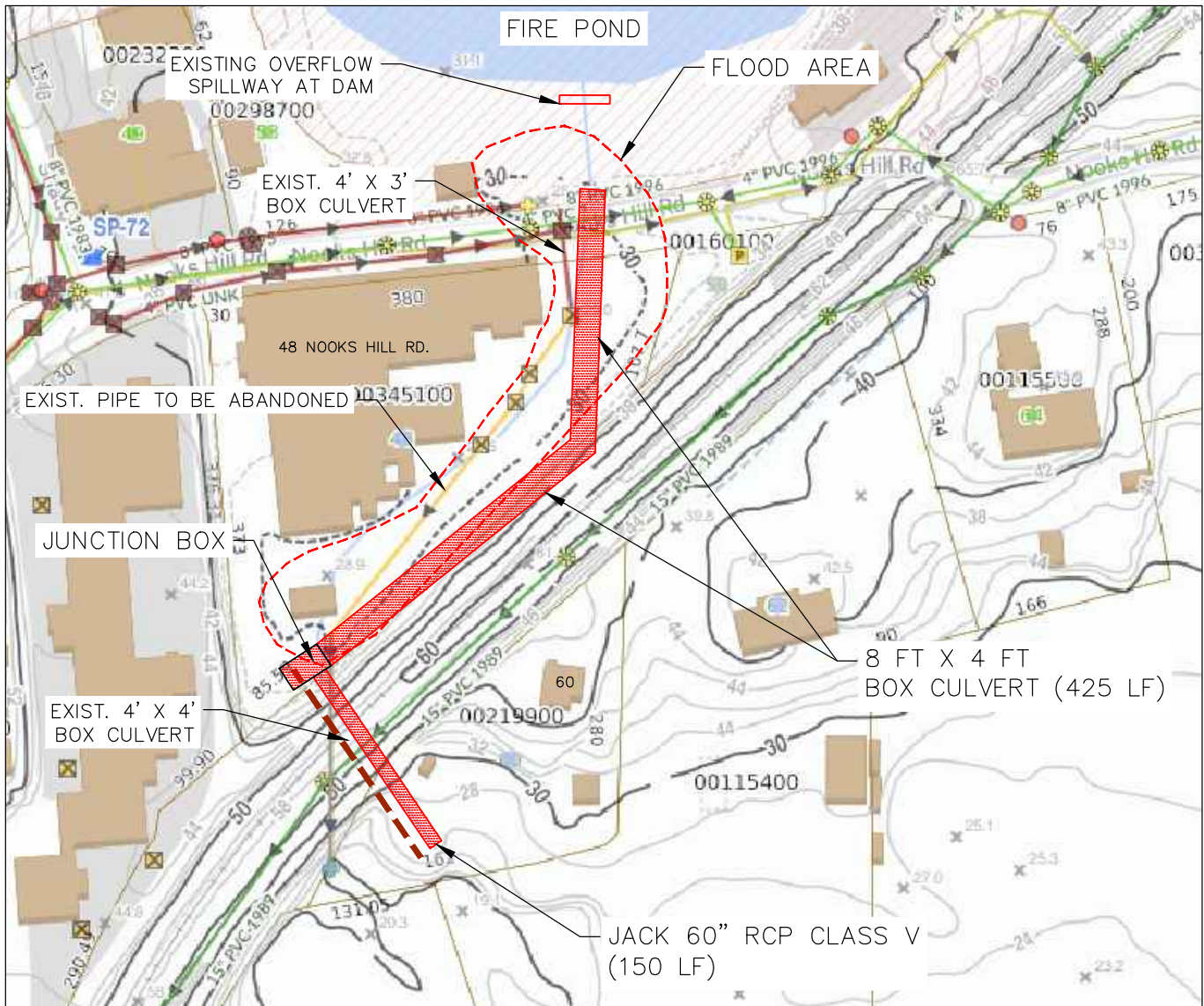
It is expected that the following permits will be needed for this project: Town of Cromwell Inland Wetlands Permit, Army Corps of Engineers, and CTDEEP 401 Water Quality Certification. If State funding is received for this project, CTDEEP Flood Management Certification may be required.

Additional Findings and Recommendations

For this alternate, since the existing railroad culvert will remain, it should be video inspected to identify any deficiencies and to determine whether they can be addressed. Any debris observed should be removed.

AREA 2: NOOKS HILL ROAD

1. REPLACE NOOKS HILL RD CROSS CULVERT
2. REPLACE STORM SEWER AT 48 NOOKS HILL ROAD WITH BOX CULVERT
3. JACK 60" RCP UNDER RAILROAD



DRAINAGE AREA = 1.0 SQ. MI.
100 YEAR FLOW=365 CFS

FIGURE 2



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Area 3: Willow Brook Cross Culvert at Evergreen Road

The Culvert on Evergreen Road area just east of Millennium Drive periodically floods during large rainfall events due to the limited capacity of the existing cross culvert. There are photos of this culvert flooding during the July 2021 tropical storm making the road impassable.



Willow Brook Cross Culvert/Evergreen Road (7/9/2021)



Brook downstream of culvert

Present Condition

The culvert is located approximately 0.5 miles west of Shunpike Road (Route 3) and approximately 150 feet east of Millennium Drive. The culvert is 35 feet long consisting of single 36-inch RCP and carries Willow Brook. The upstream side has a concrete end wall with wing walls and the downstream consists of a brownstone end wall with slope paving. The road above the culvert has a single catch basin on the north side and twin catch basin on the south side.



36 inch RCP outlet with brownstone endwall



Looking west on Evergreen Road

Based upon a review of FEMA mapping, the area is in the 100-year flood area (Zone A). The drainage area for the culvert is approximately 160 acres. The drainage area extends to the north at a high point on Sovereign Ridge. The drainage area is bordered on the west by Willow Brook and Shunpike Road on the east.

Hydrology and Hydraulics

Based on the drainage area, the culvert is classified according to CTDOT as a “Small Structure” requiring them to pass the 50-year design flow with 1-foot of freeboard. Due to the small size of the watershed (less than 200 acres), the 2-year through 50-year discharges were computed using the Rational method. The 2-year through 50-year peak flows were determined to be the following:

$$Q_2 = 147 \text{ cfs} \quad Q_{10} = 221 \text{ cfs} \quad Q_{25} = 266 \text{ cfs} \quad Q_{50} = 301 \text{ cfs}$$

The analysis of the existing culverts and their replacement was sized using HY-8 (FHWA’s Culvert Analysis computer program) based on information gathered during several field visits. The existing culvert was analyzed for its hydraulic capacity and it was determined to be inadequate. The existing culvert has the capacity of less than a 2-year storm, but the typical design standard for these culverts is the 50-year storm.

Options Evaluated

- Replacement of culvert sized for 25-year and 50-year storms.

Alternate Identified

- Alternate A: One 8 ft by 5 ft precast concrete box culvert (meets 50-year storm criteria)
The Evergreen Culvert would be replaced with a box culvert which provides the 50-year storm capacity and would significantly reduce flooding. Due to the condition of the existing culvert and end wall, it is recommended to do a full replacement than supplement with an additional culvert. The box culvert would less prone to blockage by debris.
- Alternate B: One 6 ft by 5 ft precast concrete box culvert (meets 25 year storm criteria)
The Evergreen Culvert would be replaced with a box culvert which provides significantly more capacity than the existing structure, but would not meet the design criteria of 50 years.

Estimated Costs

- Alternate A: Construction Cost: \$700,000
 Project Cost*: \$930,000
- Alternate B: Construction Cost: \$600,000
 Project Cost: \$825,000

* Project costs include construction, design, permitting, construction inspection, and an allowance for rights of way and utility relocations. Construction costs include a 20% contingency.

Permits Required

Alternate A: It is anticipated that the following permits will be required for this project: Town of Cromwell Inland Wetlands Permit, Army Corps Self-Verification (SV) Permit, and DEEP 401 Water Quality Certification SV.

Alternate B: It is anticipated that the following permits will be required for this project: Town of Cromwell Inland Wetlands Permit, Army Corps PCN Permit, and DEEP 401 Water Quality Certification PCN. A PCN would be necessary since the smaller structure would not meet the hydraulic design criteria.

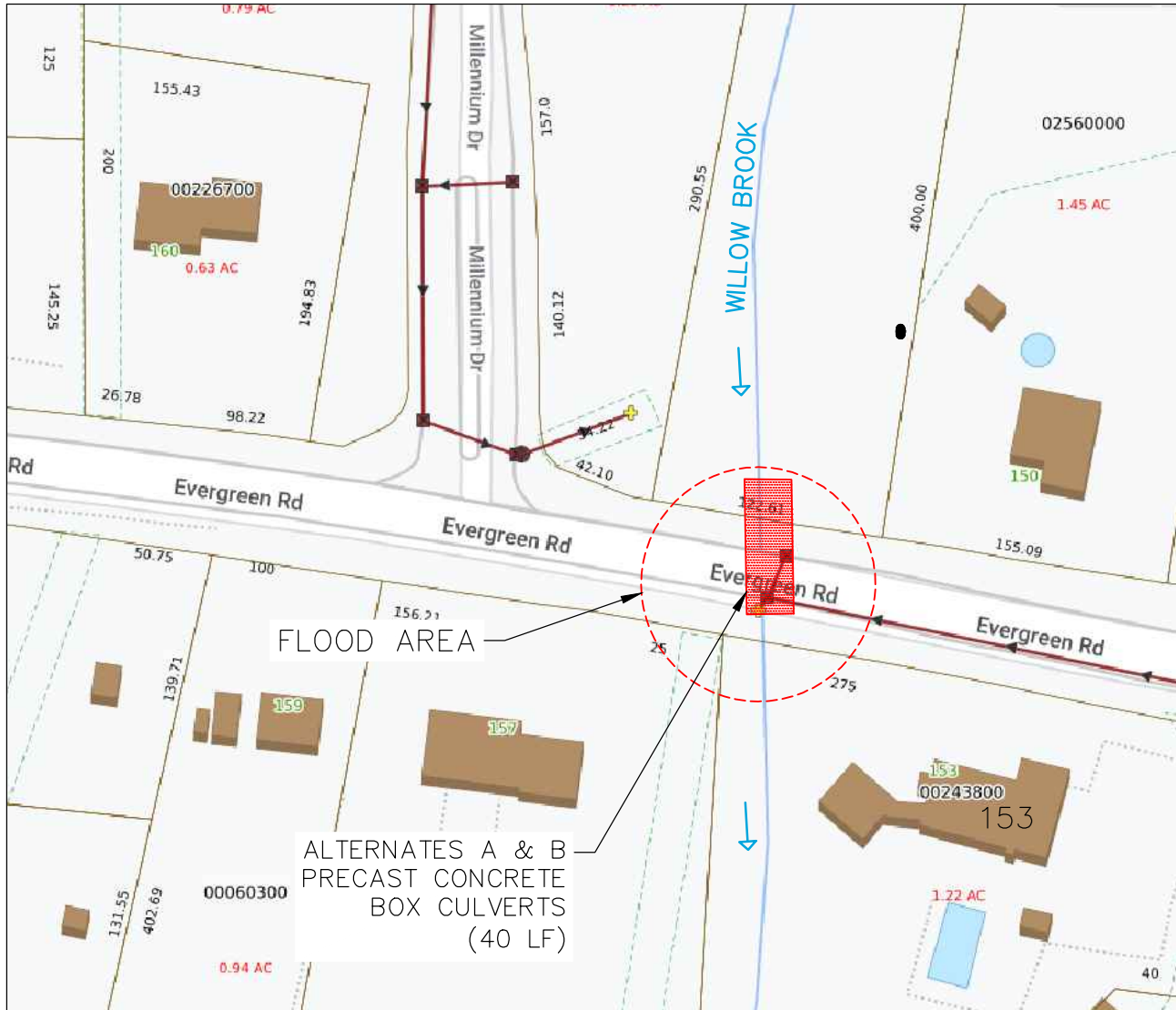
Additional Findings and Recommendations:

Alternate A is recommended since it meets the DOT design standard and is not significantly more expensive than alternate B.

AREA 3: WILLOW BROOK CULVERT, EVERGREEN ROAD

ALTERNATE A: PRECAST CONCRETE BOX CULVERT 8 FT X 5 FT (50 YEAR STORM)

ALTERNATE B: PRECAST CONCRETE BOX CULVERT 6 FT X 5 FT (25 YEAR STORM)



DRAINAGE AREA=159 AC
50 YEAR FLOW=301 CFS



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FIGURE 3

Area 4: Culverts at Evergreen Road & Copper Knoll Drive



Evergreen Road Flooding 12/20/2002

Evergreen Road and Copper Knoll Drive are periodically flooded during large rainfall events due to the capacity of the existing cross culverts. The frequency of flooding is not well documented. The flooding has resulted in complaints from adjacent properties.

Present Condition:

The culverts on Evergreen Road & Copper Knoll Drive are located approximately 0.25 miles east of Shunpike Road (Route 3). The Evergreen Road culvert is 115 feet long consisting of twin 48-inch HDPE pipes and carries Shunpike Creek along with stormwater from the Copper Knoll Drive culvert which is connected to the 48 inch pipes. The Copper Knoll Drive culvert is fed by a roadside drainage swale. The Copper Knoll culvert is 220 feet long and consists of twin 36-inch RCP.



Evergreen Rd culvert inlet



Evergreen culvert outlet



Copper Knoll-upstream side (twin 36-inch RCP)

Based on a review of FEMA data and mapping, the Evergreen Road culvert is in the 100-year flood area with a defined flood elevation (Zone AE) with a floodway. The area of the Copper Knoll culvert is mapped as outside of the 500-year floodplain (Zone X). The drainage area for the Copper Knoll culvert is 86 acres. Shunpike Creek has a drainage area of 62 acres at Evergreen Road. The total drainage area for the Evergreen Road culvert is 148 acres. The drainage area extends west to approximately Route 9, north along Shunpike Road to the Alexander Drive area and

almost to Washington Road on the east (approximately 150 west of Washington Road). The drainage area is bounded by Evergreen Road on the south.

Hydrology and Hydraulics

Based on the drainage area, both of these culverts are classified according to CTDOT as “Small Structures” requiring them to pass the 50-year design flow with 1-foot of freeboard. Due to the small size of the watershed (less than 200 acres), the 2-year through 50-year discharges were computed using the Rational method. The 2-year through 50-year peak flows were determined to be the following:

Copper Knoll Culvert

$Q_2 = 90 \text{ cfs}$ $Q_{10} = 135 \text{ cfs}$ $Q_{25} = 162 \text{ cfs}$ $Q_{50} = 185 \text{ cfs}$

Evergreen Rd Culvert

$Q_2 = 141 \text{ cfs}$ $Q_{10} = 212 \text{ cfs}$ $Q_{25} = 256 \text{ cfs}$ $Q_{50} = 290 \text{ cfs}$

The analysis of the existing culverts and their replacement was performed using HY-8 (FHWA’s Culvert Analysis computer program) based on information gathered during several field visits. The existing culverts were analyzed for their hydraulic capacity, and it was determined that the Copper Knoll culvert is inadequate, but the Evergreen Road culvert is sufficient (can pass 50 year storm). The existing Copper Knoll culverts have the capacity to only pass a 2-year storm due to their shallow location where there is limited headwater. The Evergreen Road culvert has a 50-year capacity.

Options Evaluated

Several options were evaluated to correct the flooding issue and they included the following:

- Diversion of a portion of the stormwater flowing to the Copper Knoll culvert
- Add additional culvert adjacent to Copper Knoll culvert to provide 50-year storm capacity
- Replacement of the Copper Knoll culvert completely

Alternates Identified

- Alternate A: Supplement Copper Knoll pipe culverts with a 7 ft by 3 ft precast concrete box culvert discharging to Shunpike Creek south of Evergreen Road

The new culvert would be located parallel to Copper Knoll, cross Evergreen Road and travel along the property lines of 101 Evergreen and 2 Summer Brook Lane. The new box culvert would collect a portion of the water currently traveling through the Copper Knoll culverts and divert it to an existing drainage swale behind 101 Evergreen Road. The existing swale currently serves as the discharge location for the town’s drainage system on Summer Brook Lane. The swale flows to the southwest and discharges into Shunpike Creek. The existing culvert on Copper Knoll and Evergreen Road would not be replaced.

- Alternate B: Replace Copper Knoll pipe culverts with 9 ft by 4 ft precast concrete box culvert
- The Copper Knoll culvert would be replaced with a box culvert which discharges into Shunpike Creek upstream of the Evergreen Culvert. The culvert would not be connected to the existing eastern barrel of the Evergreen culvert as it currently does since that connection reduces the capacity of the Evergreen culvert.

Estimated Costs*

- Alternate A: Construction Cost \$1.60 Million
Project Cost \$1.85 Million
- Alternate B: Construction Cost \$2.10 Million
Project Cost \$2.30 Million

* Project costs include construction, design, permitting, construction inspection, and an allowance for rights of way and utility relocations. Construction costs include a 20% contingency.

Permits Required

It is anticipated that the following permits will be required for this project: Town of Cromwell Inland Wetlands Permit, Army Corps Self-Verification (SV) Permit, and DEEP 401 Water Quality Certification SV.

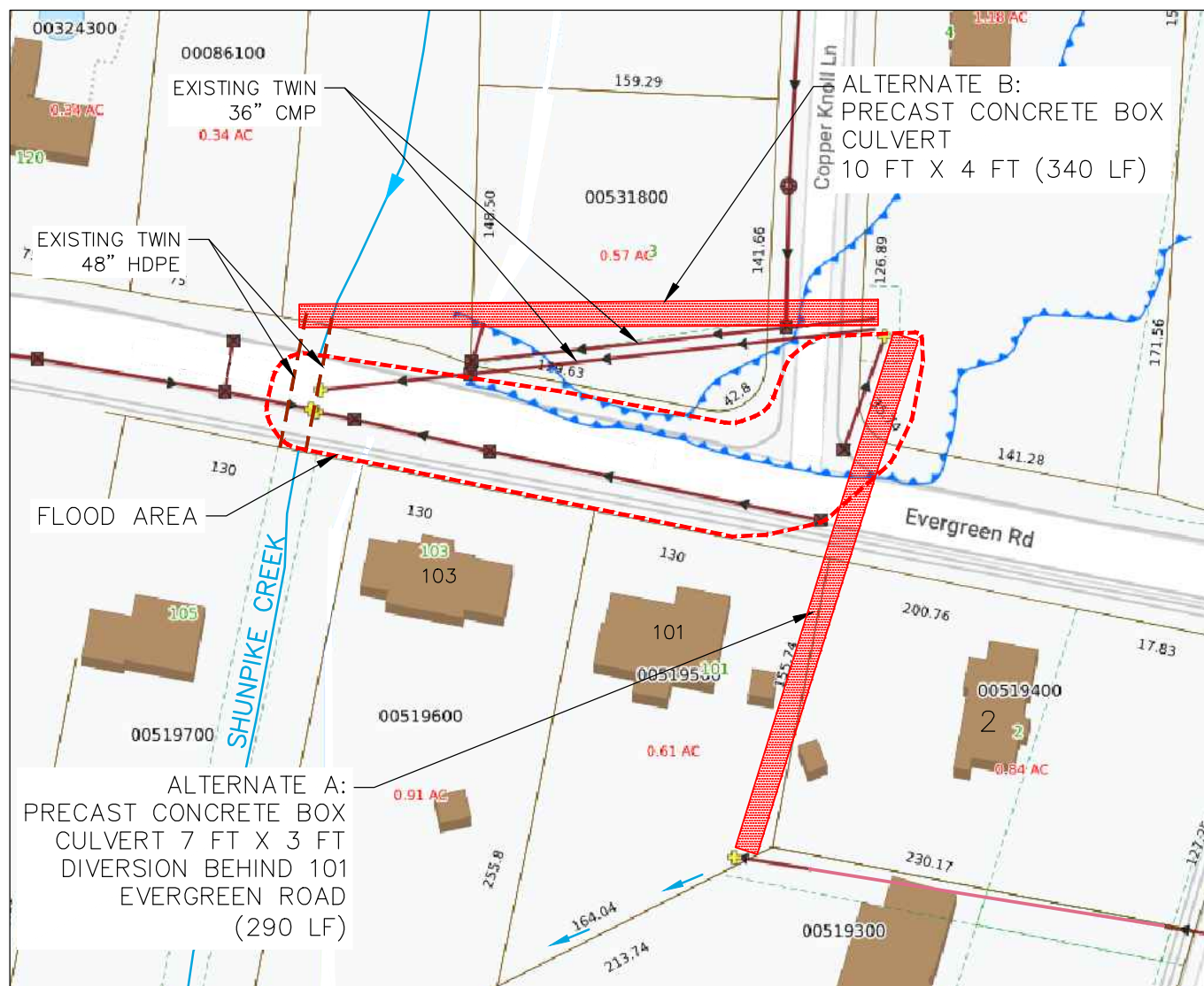
Additional Findings and Recommendations

Alternate A is recommended since it is significantly less expensive than Alternate B. For this alternate which retains the existing culverts, the existing culverts should be field inspected, and CCTV should be performed. Any deficiencies identified should be addressed. Any debris identified in the culverts or drainage system should be removed. Both culverts have connection to catch basins so those structures should be inspected as well.

Easements would be required from 4 Copper Knoll Lane, 101 Evergreen and 2 Summer Brook Lane for Alternate A and easements would be required from 3 Copper Knoll Lane, 4 Copper Knoll Lane, and 118 Evergreen Road for Alternate B.

ALTERNATE A: INSTALL ADDITIONAL CULVERT – PRECAST CONCRETE BOX CULVERT
(7 FT X 3 FT)

ALTERNATE B: REPLACE EXISTING TWIN 36" CMP W/PRECAST CONCRETE BOX CULVERT
(9 FT X 4 FT)



DRAINAGE AREA=148 AC
50 YEAR FLOW=290 CFS
(COPPER KNOLL 184 CFS)



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FIGURE 4

Area 5: Geer Street Cross Culvert

The Geer Street area periodically floods during large rainfall events due to the limited capacity of the existing cross culverts, but the frequency of flooding is not well documented. The flooding has been mainly to the property to the south of the culverts.

Present Condition:

The Geer Street Culvert carrying Coles Brook is in the northerly part of Cromwell, approximately 0.5 miles east of Route 3, and a short distance from the Court Street Fire House. The culvert consists of an 18-inch and a 24-inch RCP pipe (approximately 40 feet long). Immediately downstream of this culvert, there is a 36-inch cross culvert with brownstone end walls with a length of 30 feet conveying the brook underneath the dirt road accessing the nursery property.



Downstream side of 18 & 24 inch RCP pipe culverts



Looking north at crossing

Based upon a review of FEMA data, the area is not in a designated flood area and is mapped as outside of the 500-year floodplain (Zone X). The drainage area for the culverts is 185 acres extending to the south along Washington Road to Senator Drive and to the east to the Woodside School property.



Upstream channel



Looking at downstream location

Hydrology and Hydraulics

Based on the drainage area, these culverts are classified according to CTDOT as “Small Structures” requiring them to pass the 50-year design flow with 1-foot of freeboard. Due to the small size of the watershed (less than 200 acres), the 2-year through 50-year discharges were computed using the Rational method. The 2-year through 50-year peak flows were determined to be the following:

$$Q_2 = 125 \text{ cfs} \quad Q_{10} = 188 \text{ cfs} \quad Q_{25} = 226 \text{ cfs} \quad Q_{50} = 255 \text{ cfs}$$

The 50-year design flow was determined to be 255 cfs. The analysis of the existing culverts and their replacement was sized using HY-8 (FHWA’s Culvert Analysis computer program) based on information gathered during several field visits.

The hydraulic capacity of the existing culverts were analyzed and both were determined to be inadequate. The existing culverts have the capacity to pass only a 2-year storm.

Options Evaluated

The only options evaluated were replacement of the culverts since their condition was poor and they were significantly under capacity. The box culvert would be less prone to blockage by debris. The options specified evaluated were:

- Replacement of both culverts for the 25-year storm
- Replacement of both culverts for the 50-year storm

Alternate Identified

Two alternates were identified:

- Alternate A: Replace the culverts with two 10 ft by 4 ft precast concrete box culverts

Both culverts would be replaced with a box culvert which provides the 25 year storm capacity and would significantly reduce flooding. For both of the alternates, the box culvert would have cast-in-place or pre-cast wingwalls and cut-off walls. The invert will be depressed 1 foot below the existing streambed. One foot of natural streambed material will be placed in the bottom of the new box culvert to facilitate fish passage as required by the CT DEEP Stream Crossing Guidelines and U.S. ACOE. The roadway profile may require minor adjustments with the total anticipated project limits stretching approx. 50 feet, centered on the culvert.

- Alternate B: Replace the culverts with two 12 ft by 4 ft precast concrete box culverts

Both culverts would be replaced with a box culvert which provides the 50 year storm capacity and would significantly reduce flooding. For both of the alternates, the box culvert would have cast-in-place or pre-cast wingwalls and cut-off walls. The invert will be depressed 1 foot below the existing streambed. One foot of natural streambed material will be placed in the bottom of the new box culvert to facilitate fish passage as required by the CT DEEP Stream Crossing Guidelines and U.S. ACOE. The roadway profile may require minor adjustments with the total anticipated project limits stretching approx. 50 feet, centered on the culvert.

Estimated Costs*

- Alternate A: Construction Cost \$750,000
Project Cost \$990,000
- Alternate B: Construction Cost \$860,000
Project Cost \$1,100,000

* Project costs include construction, design, permitting, construction inspection, and an allowance for rights of way and utility relocations. Construction costs include a 20% contingency.

Permits Required

Alternate A: It is anticipated that the following permits will be required for this project: Town of Cromwell Inland Wetlands Permit, Army Corps PCN Permit, and CTDEEP 401 Water Quality Certification PCN.

Alternate B: It is anticipated that the following permits will be required for this project: Town of Cromwell Inland Wetlands Permit, Army Corps Self-Verification (SV) Permit, and CTDEEP 401 Water Quality Certification SV.

Additional Findings and Recommendations

Alternate B is recommended since it meets the DOT design standard and is not significantly more expensive than alternate A. In addition, permitting could be done through the SV process which saves money and allows the project to be constructed sooner.

AREA 5: GEER STREET CULVERT

PRECAST CONCRETE BOX CULVERT AT EACH CROSSING

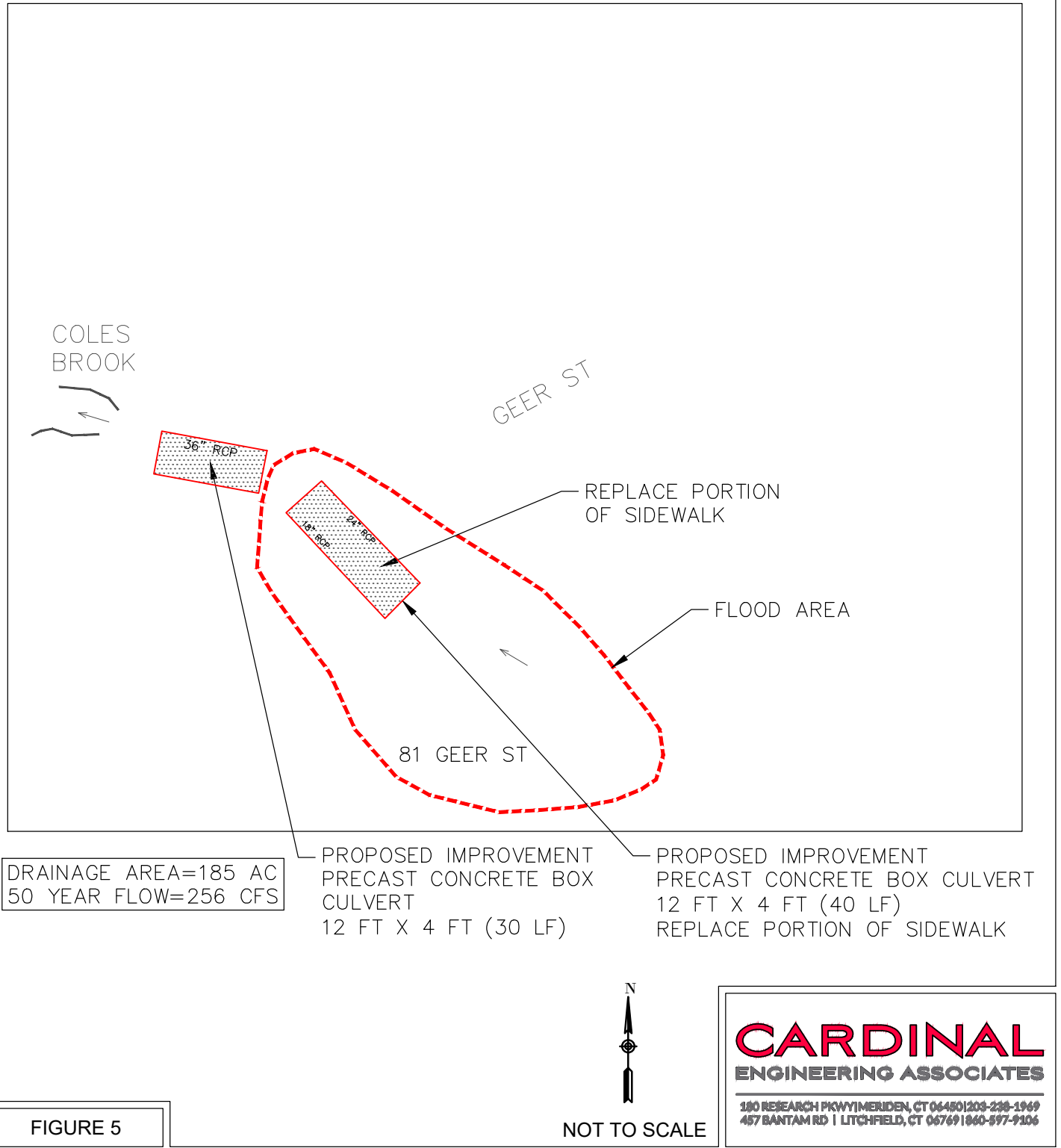


FIGURE 5

Area 6: Pierson Park and West Street

Cromwell Creek is conveyed by a 440 linear foot pipe culvert from the upstream side of West Street to its outlet at the south end of Pierson Park. This culvert which crosses West Street does not typically flood however, during the July 2021 tropical storm, the culvert surcharged and West Street was overtopped. The adjacent house (12 West Street) had several feet of water inside the house and detached garage. The area around the Cromwell Police Station was also flooded.

Present Condition:

The culvert on West Street (Route 372) is located approximately 500 feet west of Main Street across from the entrance to Pierson Park. The existing culvert is a 6-foot diameter 330 foot-long CMP pipe from the upstream entrance on West Street to a catch basin in the parking lot. From that point to the outlet, a distance of 110 linear feet, the culvert is a 5-foot diameter HDPE. This pipe discharges to Cromwell Creek at a concrete endwall with wingwalls. The storm drainage on West Street to the west of the Pierson Park entrance is connected to this culvert.



West Street Flooding (7/9/2021)

Based on a review of FEMA mapping and data, the area upstream and downstream of the culvert crossing is located within the 100-year flood area with a defined flood elevation (Zone AE). The area is also designated as a floodway. Due to the floodway designation, proposed drainage improvements need to be designed such that there is no rise in water surface elevation in the floodway. The FEMA profile which is based on an engineering study conducted in 1999 shows that West Street is not overtopped even during the large storms (50-year, 100-year, and 500-year).

Cromwell Creek originates from a small pond to the east of Hillside Road in Cromwell and ultimately discharges to the Connecticut River. The creek flows south from the pond through the greenhouse area of the Town and underneath New Lane then to West Street. The drainage area of Cromwell Creek at West Street is approximately 0.51 square miles or 326 acres.



Looking in Direction of Culvert Inlet



Culvert outlet at Park



Culvert Inlet



*Culvert Discharge at Pierson Park
(3-24-2023)*



Creek downstream of discharge



Looking north towards West Street

Hydrology and Hydraulics

Based on the drainage area, this culvert is classified according to CTDOT as a “Small Structure” requiring them to pass the 50-year design flow with 1-foot of freeboard. The 2-year through 50-year discharges were computed using the flows that were calculated for South Street by StreamStats urban regression and transferring them upstream by the ratio of drainage areas. The 50-year design flow was

determined to be 260 cfs. The 50-year FEMA flow for Cromwell Creek at the upstream South Street location using the discharge-drainage area ratio, was calculated to be 150 cfs or significantly lower than the value calculated by the urban regression equations. To be conservative, the urban regression values were used for sizing of the culverts at West Street. The following are the computed design flows at the stream crossing:

$$Q_2 = 84 \text{ cfs} \quad Q_{10} = 166 \text{ cfs} \quad Q_{25} = 212 \text{ cfs} \quad Q_{50} = 261 \text{ cfs}$$

Culvert analysis and sizing was performed using HY-8 FHWA's Culvert Analysis computer program) based on dimensions (culvert diameter, cover on the culverts & downstream channel dimensions) collected during field visits. The existing culvert was analyzed for the hydraulic capacity and it was determined that the culvert is inadequate. The existing culvert has the capacity to only pass a 25-year storm.

Options Evaluated

- Add additional culvert alongside the existing culvert to provide 50-year storm capacity
- Replacement of the culvert with a box culvert to provide 50-year storm capacity

Alternates Identified

- Alternate A: 48-inch RCP installed as additional culvert
The additional culvert would be installed alongside the existing culvert on the west side and discharge at the same location in the park. The existing culvert would not be replaced. The additional culvert would provide an additional 80 cfs of capacity to supplement the existing 180 cfs capacity.
- Alternate B: 6 ft by 6 ft precast concrete box culvert installed as replacement culvert
The culvert would be replaced with a box culvert and discharge at the same location within the park. The connections to the existing catch basins which tie into the culvert would be replaced and drainage improvements made. Most of the existing culvert would be replaced rather than abandoned in place.

Estimated Costs*

- Alternate A: Construction Cost \$420,000
 Project Cost \$610,000
- Alternate B: Construction Cost \$3,200,000
 Project Cost \$3,450,000

Permits Required

Alternate A: It is anticipated that the following permits will be required for both alternates: Town of Cromwell Inland Wetlands Permit, Army Corps Self-Verification (SV) Permit, and DEEP 401 Water Quality Certification SV.

Alternate B: It is anticipated that the following permits will be required for this project: Town of Cromwell Inland Wetlands Permit, Army Corps PCN Permit, and CTDEEP 401 Water Quality Certification PCN. If state funding is received for this project, CTDEEP Flood Management Certification will be necessary.

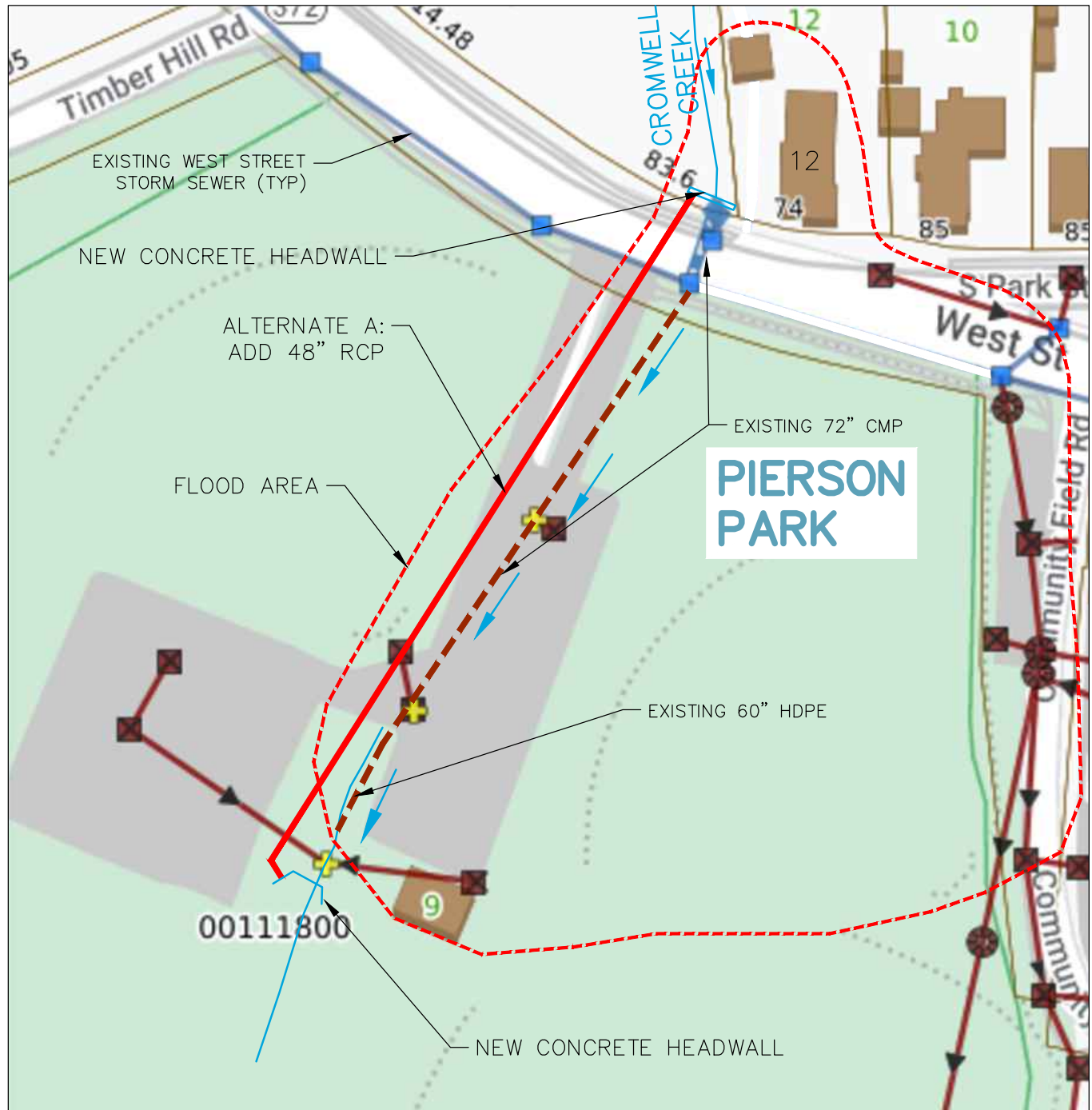
Additional Findings and Recommendations

Alternate A is recommended since it provides the same hydraulic capacity as Alternate B at a significantly reduced cost. For this alternate, where the existing culvert will remain, the existing culvert should be assessed in the field to identify any deficiencies and to determine if there are any existing blockages. The field assessment should include a detailed report of conditions inside the pipe. For any sections that can not be entered, a CCTV inspection should be performed.

For both alternates, a geotechnical assessment should be performed of the subsurface conditions in the Pierson Park area. This portion of the culvert was constructed over a large filled area and stability of the subsurface has to be investigated. In addition, stream channel work will be needed on the upstream side to stabilize the slope on the eastern bank. Further analysis and design will be needed to determine possible slope stabilization measures upstream and this should be included during preliminary design.

AREA 6: PIERSON PARK - ALTERNATIVE A

ADDITION OF 48" RCP (440 LF)



DRAINAGE AREA = 325 ACRES (0.51 SQ MILES)
50 YEAR FLOW=261 CFS



NOT TO SCALE

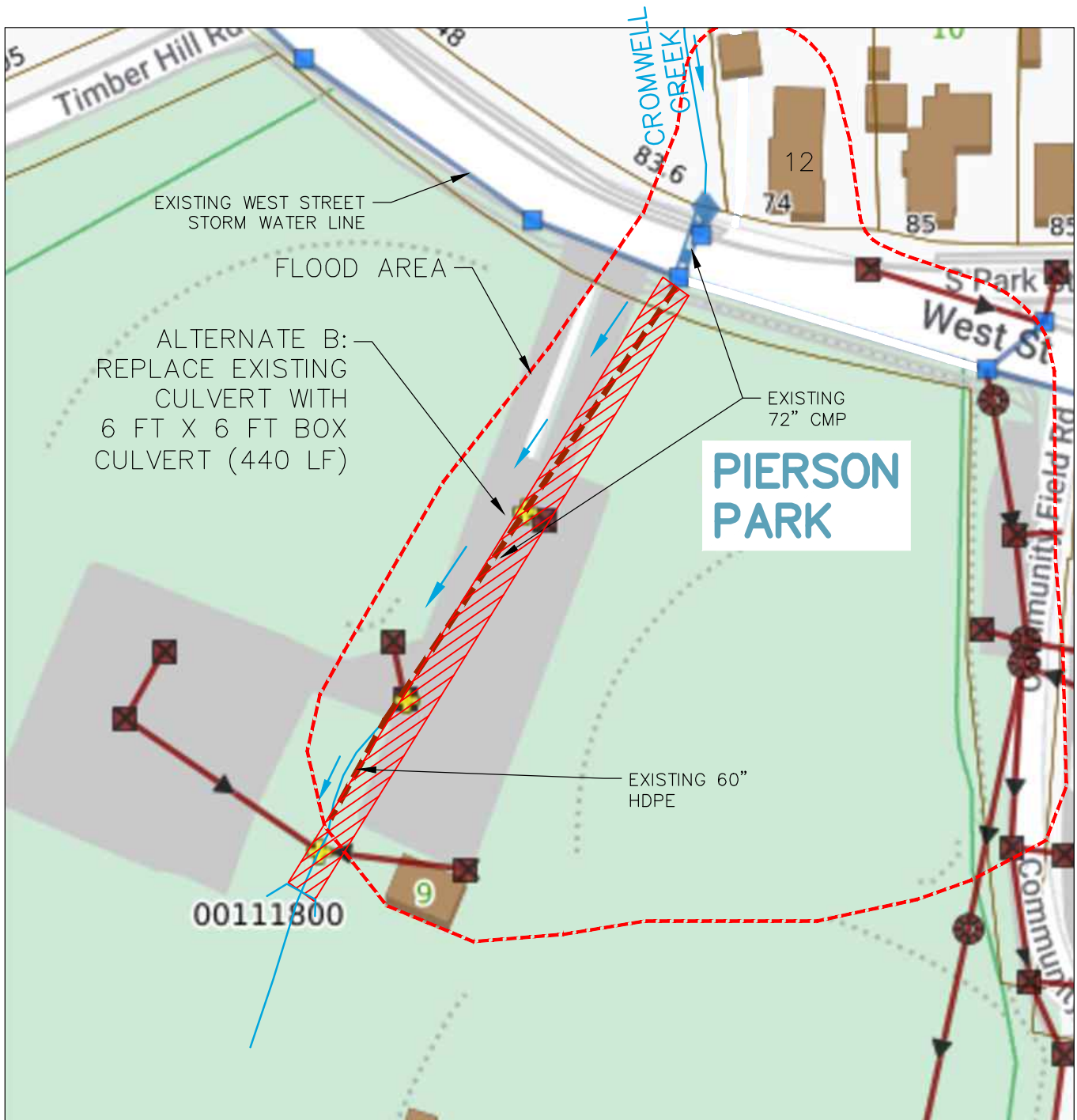
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FIGURE 6A

AREA 6: PIERSON PARK - ALTERNATIVE B

REPLACE EXISTING CULVERT WITH A 6 FT X 6 FT BOX CULVERT



DRAINAGE AREA = 325 ACRES
(0.51 SQ MILES)
50 YEAR FLOW=261 CFS



NOT TO SCALE

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FIGURE 6B

Area 7: Glenwood Terrace & Field Road

There has periodically been flooding affecting properties on Glenwood Terrace and Field Road during large rainfall events. The frequency of flooding is not well documented. The flooding appears to particularly affect the rear of the property at 12 Glenwood Terrace and two properties on Field Road (95 Field and 97 Field).

Present Condition:

The Glenwood Terrace area is located in the eastern part of Cromwell near the TPC River Highlands Golf Club. Glenwood Terrace drainage system consists of a series of drywell catch basins used to infiltrate runoff. During storm events, the existing dry wells in front of 8 and 10 Glenwood overflow into an existing swale that starts on Glenwood Terrace and runs behind the houses on Field Road. The swale discharges behind the houses on Field Road and the stormwater flows in east ward direction until being redirected by the railroad embankment. At the embankment, the water is redirected to the south before pooling up and infiltrating at 111 Field Road. Stormwater collected from a catch basin in a sag location also discharges to 111 Field Road by a 15" HDPE. The area where the stormwater infiltrates is located in a wooded area that is approximately 150 ft long by 50 wide by 3 feet deep.

Based on a review of the FEMA map, the area is not in a designated flood area and is mapped as outside of the 500-year floodplain (Zone X). The drainage area for the area that is generating stormwater runoff is approximately 25 acres composed mainly of the Glenwood Terrace Area (small residential 1 acre lots) and a portion of the golf course. The golf course accounts for approximately 20% of the drainage area.



*Drainage Swale Downstream
of Glenwood Terrace*



*Swale discharge at rear
of 95 Field Road*



*Rear of 97 Field Road
where water enters house*

Hydrology & Hydraulics

Due to the small size of the watershed (less than 200 acres), the 2-year through 50-year discharges were computed using the Rational method. The 2-year through 50-year peak flows associated with the swale were determined to be the following:

$$Q_2 = 24 \text{ cfs} \quad Q_{10} = 35 \text{ cfs} \quad Q_{25} = 44 \text{ cfs} \quad Q_{50} = 50 \text{ cfs}$$

Options Evaluated

Several options were considered including diversion of the water away from the houses on Field Road and collecting the runoff upstream of the houses and piping it to a discharge point at the railroad embankment to the east. Collection of the runoff upstream of the septic fields behind the houses was seen to be a better option than diverting the runoff. Diversion was also limited by the topography at 95

Field Road. Discharge options were reviewed to insure that peak flow rates downstream were not significantly increased.

Alternates Identified

- Alternate A: Intercept Runoff and Pipe to Existing Discharge Point at 111 Field Road (see Figure 7a)

A depressed inlet structure with a trash rack would be installed on the edge of the woods where the swale flows onto 95 Field Road. The stormwater would be piped behind the houses to a new drainage system on Field Road to the existing discharge at 111 Field Road. The outlet pipe would be increased in size and outlet protection would be added for erosion control. A stone infiltration trench would be installed to more efficiently infiltrate the stormwater.

- Alternate B: Intercept Runoff and Pipe under Railroad to Existing Brook (see Figure 7b)

This alternate is similar to Alternate A, except that the storm sewer would discharge into the existing brook east of the railroad embankment in the vicinity of 99 Field Road. The pipe would be installed close to the southern property line of 99 Field Road so as not to interfere with future use of that property. This alternate would reduce the amount of water being discharged to 111 Field Road where there is visual evidence of highly erosive flows at the existing discharge.

Estimated Costs

• Alternate A:	Construction Cost	\$370,000
	Project Cost*	\$500,000
• Alternate B:	Construction Cost	\$770,000
	Project Cost	\$980,000

* Project cost includes construction, design, permitting, inspection, ROW, & utilities)

Permits Required

For Alternate A, it is anticipated that a Town of Cromwell Inland Wetlands Permit would be needed. For Alternate B, it is anticipated that additional permitting would be needed. The following permits are anticipated to be required for Alternate B: Town of Cromwell Inland Wetlands Permit, Army Corps PCN Permit, and DEEP 401 Water Quality Certification PCN. A Corps and DEEP PCN would required due impacts of wetlands and brook. Alternate B would also require a permit for the pipe crossing.

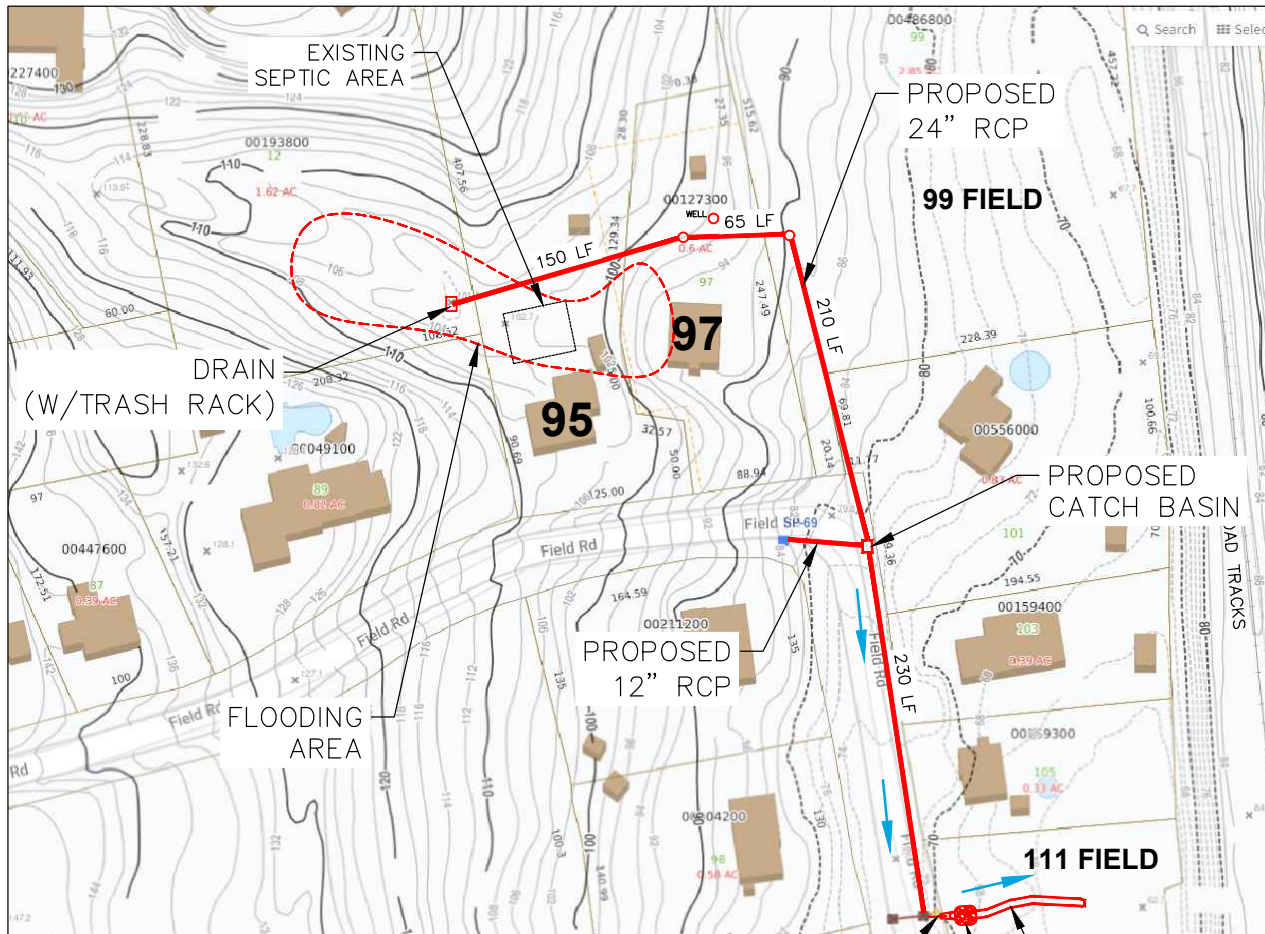
Additional Findings and Recommendations:

Alternate A is recommended since it is significantly less expensive and doesn't involve permitting challenges associated with Alternate B (permitting a rail crossing). For both alternates, the location of the septic system at 95 Field Road would need to be verified during design.

Easements would be required from 95 Field Road, 97 Field Road, 99 Field Road, and 111 Field Road Lane for Alternate A. For Alternate B, easements would be required from 95 Field Road, 97 Field Road, 99 Field Road, and the CT DOT for the rail crossing.

AREA 7: FIELD ROAD & GLENWOOD TERRACE - ALTERNATE A

INTERCEPT RUNOFF AND PIPE TO EXISTING STORM DISCHARGE LOCATION IN FIELD ROAD



DRAINAGE AREA=28 ACRES
10 YEAR FLOW=35 CFS

PROPOSED
36" PIPE AT
DISCHARGE

STONE
INFILTRATION
TRENCH

RIP RAP
SCOUR HOLE



NOT TO SCALE

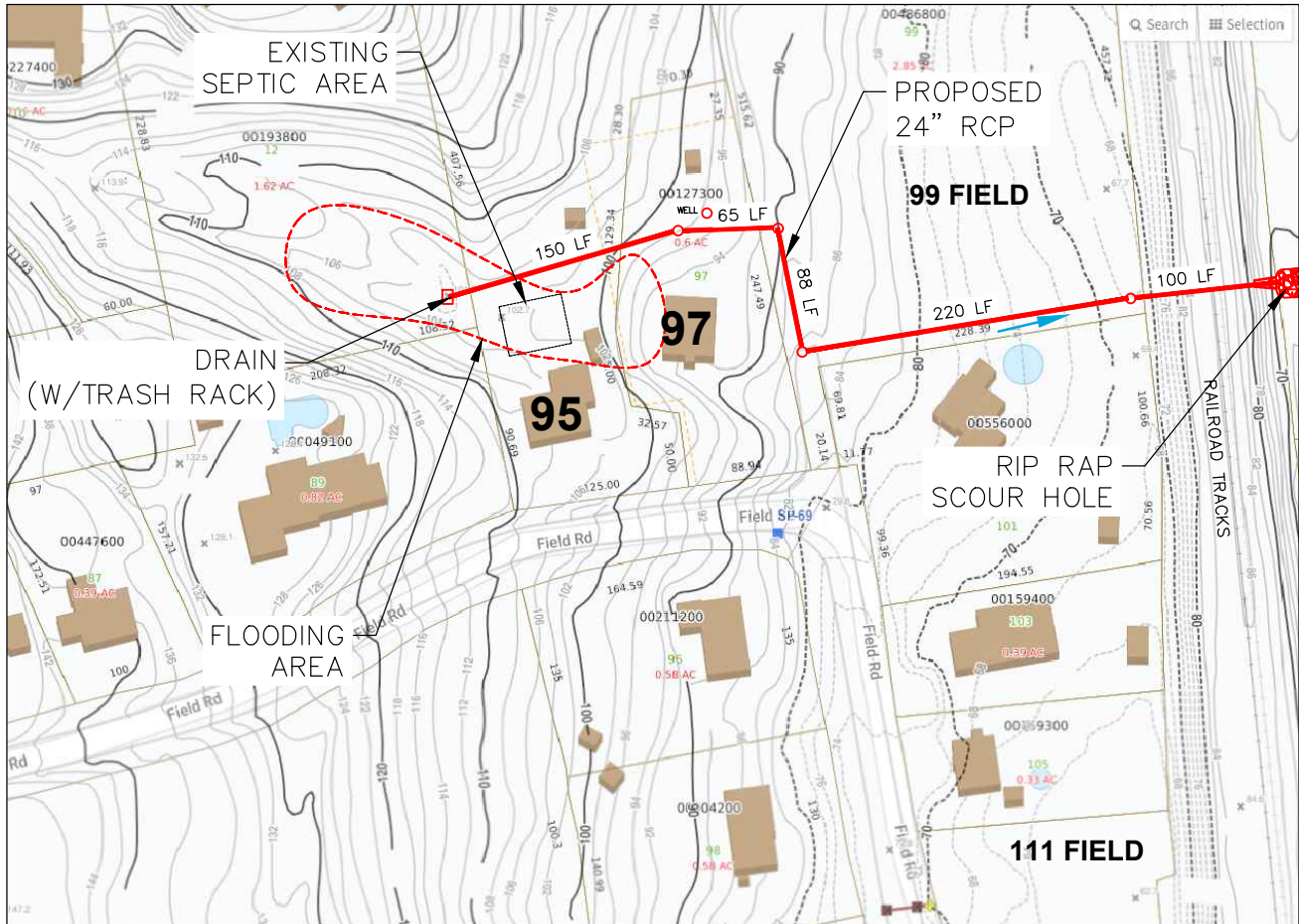
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FIGURE 7A

AREA 7: FIELD ROAD & GLENWOOD TERRACE - ALTERNATE B

INTERCEPT RUNOFF AND PIPE UNDER RAILROAD TO EXISTING BROOK



DRAINAGE AREA=28 ACRES
10 YEAR SWALE FLOW=35 CFS



NOT TO SCALE

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FIGURE 7B

Area 8: South Street Culvert at Cromwell Creek

The culvert at South Street routinely floods during rainfall events requiring the road to be closed. The flooding occurs several times a year and Cromwell Public Works puts up temporary barriers and signs that the road is closed and traffic is detoured. Cromwell Creek is also subjected to flooding during periods when the Connecticut River is at flood stage.

The hydraulic capacity of the existing cross culvert under South Street was analyzed, and it was determined that the culvert is severely inadequate. The existing culvert capacity is less than a 2-year storm. The typical design standard for this culvert is the 50-year storm.

Present Condition:

The culverts on South Street (twin 43 inch by 27-inch CMP) are located approximately 700 feet west of Main Street. The culvert conveys Cromwell Creek underneath South Street to the Connecticut River approximately 3,000 feet to the south. The culvert conveys the Creek between the abutments of the railroad overpass which has approximately 11 feet of vertical clearance from the top of road. The capacity of the culverts is limited significantly by the high water surface elevation in the downstream channel (tailwater) and the low roadway elevation (the top of the roadway is only six inches above the top of culverts) which limits headwater.



Cromwell Creek originates from a small pond off Hillside Road and ultimately discharges to the Connecticut River. The creek flows through the greenhouse area of the Town, through the center of town including Pierson Park, and a five acre wetland area before crossing South Street. After crossing South Street, the creek passes through a large swampy area (approximately 10 acres) then through twin culverts located at the Mattabasset sewer embankment. Downstream of the sewer embankment, the Creek crosses underneath the Route 9 ramps and River Road prior to discharging to the Connecticut River. The culverts downstream of South Street are adequate for the larger storms up to the 50-year storm. Field visits found that the water level in these culverts fluctuated considerably and, during dry periods, the water levels were low (approximately 12 inches above the inverts) in these culverts. In contrast, the South Street culvert water level rarely changes and is typically only 3 to 10 inches below the inverts even during extended dry periods.



Looking west on South Street

Based on the FEMA data, the area upstream and downstream of the culvert crossing is in the 100-year flood zone with a defined flood elevation (Zone AE). The area is also within a floodway. Due to this designation, proposed drainage improvements need to be designed so that there is no rise in elevation in the floodway or a Letter of Map Revision (LOMR) would need to be obtained. The creek is subject to flooding from Connecticut River and this backwater effect extends to South Street. The FEMA cross section at South Street correlates to cross section H and at this cross section, the flood profile for the Connecticut River shows the culvert

is overtopped during the 10-year storm event which corresponds to a water surface elevation of 17.4 feet. It should be noted that the Cromwell River elevation fluctuates

constantly throughout the year. There are other times of the year in which the river elevation is high enough to impede flow through the culverts. The drainage area for Cromwell Creek at the culvert is 0.72 square miles or 460 acres.



Typical water level at South St



Flooded catch basins after storm



Looking west on South St in area of proposed berm



Looking north from Mattabassett Sewer Embankment



Downstream channel at South Street



Cromwell Creek discharge to CT River at River Rd

Hydrology and Hydraulics

Based on the drainage area, this culvert is classified according to CTDOT as a “Small Structure” requiring them to pass the 50-year design flow with 1-foot of freeboard. The 2-year through 50-year discharges were computed using the flows that were computed using the USGS StreamStats software using rural regression equations. However, since watershed has a developed area greater than 25% (the actual is close to 85 %), the flows had to be adjusted upward to account for urbanization. The following are the computed design flows at the stream crossing:

$$Q_2 = 119 \text{ cfs} \quad Q_{10} = 233 \text{ cfs} \quad Q_{25} = 298 \text{ cfs} \quad Q_{50} = 367 \text{ cfs}$$

There is FEMA flow data available for Cromwell Creek. FEMA flow data for Cromwell Creek for the 50-year storm is provided at the confluence of the creek with the Connecticut River (330 cfs). This flow value was determined by FEMA by transferring gage records of nearby streams and adjusting for drainage area. The 50-year FEMA flow for Cromwell Creek at the upstream South Street location using the discharge-drainage area ratio, was calculated to be 208 cfs or significantly lower than the value calculated by the urban regression equations. To be conservative, the urban regression values were used for sizing of a replacement culvert at South Street. The replacement culvert was sized using HY-8 (FHWA’s Culvert Analysis computer program) based on information gathered during several field visits.

The existing culvert was analyzed for its hydraulic capacity and it was determined to be inadequate. The existing culvert has the capacity for approximately a 1-year storm.

Options Evaluated

Cardinal reviewed and analyzed the replacement of the culverts, possible modifications to the existing bridge, dredging of the upstream and downstream channels, installing detention upstream of the crossing, installing a pump station and tide gates, and low costs methods to manage flooding in the area. Installation of detention upstream of the crossing was reviewed, but was not seen as practical. There is a parcel immediately upstream that is the best location for detention. The parcel isn’t town owned, significant grading/excavation would be required. Other options including modifications to the bridge and installation of a pump station didn’t seem practical and were cost prohibitive.

Alternates Identified

Two alternates were identified that could increase the capacity of the crossing and reduce flooding frequency and magnitude. One alternate doesn’t replace the culvert, but instead better manages the frequent flooding.

- Alternate A: Install 12 ft by 4 ft box culvert as a replacement culvert, construct a 150 foot berm along north side of the road, and perform downstream dredging of the channel to provide a 10 year storm capacity at South Street.

This alternate is composed of three main improvements. This alternate is a significant improvement, but only upgrades the hydraulic capacity to a 10-year capacity (233 cfs) assuming that the Connecticut River level is not elevated. The capacity of the South Street culvert depends on the Connecticut River level. The Connecticut River elevation fluctuates significantly every year and there can be several times during the course of the year where the elevation can be elevated. Typically, it is in the spring, but it can occur

during other times of the year also. This alternate will result in South Street flooding less frequently but flooding will still occur during storms exceeding the 10 year rainfall event and when the river is high.

The first part of Alternate A would be to install the new box culvert. The existing culvert would be replaced with a box culvert having significantly more open area and a higher hydraulic capacity. The box culvert would have an open area of 36 square feet vs. the existing condition of 12.5 square feet. The box culvert would have cast-in-place or pre-cast wingwalls and cut-off walls. The invert will be depressed one foot below the existing streambed. One foot of natural streambed material will be placed in the bottom of the new box culvert to facilitate fish passage as required by the CT DEEP Stream Crossing Guidelines and U.S. ACOE. The roadway profile may require minor adjustments within the anticipated project limits.

The second part is to install a 150-foot long berm or headwall to elevation 16.0 feet along the north side of the roadway. The berm would start at the railroad embankment and continue along the north side of the road until the property line at 46 South Street. The purpose of the berm would be to develop a higher headwater during storms which would push more water through the culvert. The cost estimate assumes a concrete retaining wall would be used for the berm.

The third part is to perform dredging of the channel from South Street downstream to the next crossing (the berm that contains the Mattabassett discharge pipe). The purpose of the dredging would be to increase the capacity of the channel and lower the tailwater downstream of the South Street culvert. The channel would be widened to a 40-foot width immediately south of South Street along 43 South Street and to a width of approximately 100 feet wide within the large wetland downstream. The limit on the south end for the dredging would be the Mattabassett sewer discharge pipe which is approximately 1,500 feet south of South Street. The channel width should be approximately 40 feet wide with a depth of 18 inches and side slopes of 4H:1V from South Street to the Mattabassett embankment to convey the 10 year flow. Dredging would result in large amounts of sediments that would need to be dewatered and dried prior to transport and disposal offsite. Sediments would need to be characterized for environmental contamination prior to offsite disposal. Management of the excavated sediment would require a large area or laydown area located outside of the wetlands where the sediment could be temporarily stored and frac tanks could be set up for dewatering. The area would also need to be easily accessible for dump trucks and construction equipment.

- Alternate B: Install 12 ft by 4 ft box culvert as replacement culvert, downstream dredging of the entire large wetland area downstream to create detention, and installation of tide gates.

As in Alternate A, the culvert will be replaced with a 12ft. by 4 ft. box and a berm or headwall would be constructed upstream. Alternate B would also include installation of a tide gate at the Mattabassett embankment and at Main Street (there is an existing cross culvert that connects the wetlands west of Main Street with those east of Main Street) to prevent backup of the Connecticut River for up to the 20-year flood stage. The berm has a height of 18 feet so it would prevent backup of the Connecticut River until the Connecticut river reaches a flood stage greater than the 20 year storm. The entire wetland upstream of the Mattabassett embankment would be dredged to provide detention to store up to a 10-year storm during periods when the river is at flood stage. As with Alternative A, dredging would result in large amounts of sediments that would need to be dewatered and dried prior to transport and disposal offsite. A lay down area located outside of the wetland would need to be available for management of the excavated sediments prior to disposal offsite. Invasive species identified in the wetland area will be targeted for removal and native plants and vegetation will be seeded during restoration of the wetland.

- Alternate C: Install gates that could be used to close South Street during flooding

Since the area has historically been prone to flooding and is located at one of the lowest elevations in town, a low cost alternate was developed that would not change the flooding, but would involve managing its impacts. The town's Department of Public Works typically puts up signs during flooding events, but often the police department is first to respond. This alternate involves installing swing gates on each side of the railroad trestle so the police can swing the gate across the road to close the road preventing vehicles from trying to cross the floodwaters. The gates would have have a sign saying the road is closed.

Estimated Costs*

•	Alternate A:	Construction Cost	\$2.10 Million
		Project Cost	\$2.33 Million
•	Alternate B:	Construction Cost	\$4.00 Million
		Project Cost	\$4.30 Million
•	Alternate C:	Construction Cost	\$30,000
		Project Cost	\$40,000

*Project costs include construction, design, permitting, construction inspection, and an allowance for rights of way and utility relocations; Construction costs include a 25% contingency for Alternate A and a 15% contingency for Alternate B; costs for handling & disposal of controlled materials is not included since additional information is needed.

Permits Required

Alternates A & B: It is anticipated that the following permits will be required for this project: Town of Cromwell Inland Wetlands Permit, Army Corps of Engineers PCN Permit, and CTDEEP 401 Water Quality Certification PCN. If state funding is received for this project, CTDEEP Flood Management Certification may be necessary. Since the work is within and affects the FEMA floodway, a Letter of Map Revision (LOMR) will be required. The sediments and groundwater in the wetland to be dredged may be environmentally impacted (controlled materials). As a result, special storage, treatment, and transportation of these materials may be required. Both of the alternates may also require extensive environmental impact evaluations. The cost for wetland compensation, environmental impact evaluations or the treatment of controlled materials has not been included in cost estimates. Impacts to the wetlands and watercourses in excess of the 5,000 sf. threshold established by the Army Corps would require compensation of approximately \$7.50 per square feet.

Alternate C: It is anticipated that a Town of Cromwell Inland Wetlands Permit would be necessary for work within the 100-foot wetland buffer area.

Additional Findings and Recommendations:

After considering all the alternates identified, Alternate C is recommended since it is significantly less expensive than the other alternates and doesn't involve significant permitting challenges. In addition, although Alternates A and B would reduce the frequency of flooding at the location significantly so the town does not have to constantly be closing the road, but flooding would still occur during very large storms such as the two storms that occurred in July and September 2021.

If the town wanted to pursue Alternate A or B, then additional work should be conducted prior to starting design and permitting. The South Street culvert and culvert at the Mattabassett embankment should be

inspected to identify any deficiencies including blockages. If these are identified, the culverts should be replaced or repaired as required. To perform an inspection of the South Street culvert, the area around the culvert would need to be dewatered so the pipes can be viewed in the dry. In addition, an ecological assessment should be conducted of the 9 acre wetland upstream of the Mattabassett embankment which would be dredged. This area is close to the Connecticut River and the Cromwell Meadows Wildlife Management Area. The assessment should verify the wetlands (inland and tidal) present and include an inventory of the ecological habitat. A state listed species survey should be performed as a portion of the wetlands is mapped as a natural diversity (NDDB) area. Sediment samples should be collected of the areas to be dredged and pre-characterized for environmental impacts.

AREA 8: SOUTH STREET - ALTERNATE A

REPLACE CULVERT WITH A PRECAST CONCRETE BOX CULVERT, INSTALL ROAD BERM, AND DREDGE DOWNSTREAM CHANNEL



DRAINAGE AREA=0.72 SQ MI (460 AC)
50 YEAR FLOW=365 CFS

FIGURE 8A



NOT TO SCALE

CARDINAL
ENGINEERING ASSOCIATES

110 RESEARCH PKWY | MERIDEN, CT 06450 | 203-238-1969
457 BANTAM RD | LITCHFIELD, CT 06769 | 860-597-9106

AREA 8: SOUTH STREET - ALTERNATE B

REPLACE EXISTING CULVERT WITH A PRECAST CONCRETE BOX CULVERT, DREDGE ENTIRE WETLAND AREA UP TO 2 FT DEEP, INSTALL FLOOD GATE.



DRAINAGE AREA=0.72 SQ MI (460 AC)
50 YEAR FLOW=365 CFS



NOT TO SCALE

FIGURE 8B

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457 BANTAM RD | LITCHFIELD, CT 06769 | 860-597-9106

AREA 8: SOUTH STREET



NOT TO SCALE

FIGURE 8B-1

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457 BANTAM RD | LITCHFIELD, CT 06769 | 860-597-9106

AREA 8: SOUTH STREET - ALTERNATE C

TWO 20-FT METAL SWING GATES



DRAINAGE AREA=460 AC (0.72 SQ MI)
50 YEAR FLOW=365 CFS



TYPICAL STYLE SWING GATE



NOT TO SCALE

FIGURE 8C

CARDINAL
ENGINEERING ASSOCIATES

180 RESEARCH PKWY/MERIDEN, CT 06450/203-236-1969
457 BANTAM RD | LITCHFIELD, CT 06769/860-897-9106

Area 9: Franklin Road and Chelsea Drive

The Franklin Road area at Chelsea Drive sporadically floods during large rainfall events due to the limited hydraulic capacity of the existing cross culverts, but the frequency of flooding is not well documented. Flooding appears to happen towards the rear of the properties located at 22 and 26 Franklin Road. Flooding would be expected along the back of the properties on Cambridge Drive and Lancaster Road based on FEMA mapping and the existing grades in that area.

Present Condition:

The Chelsea Drive intersection with Franklin Road is located approximately 0.5 miles north of West Street or Route 372. The culverts at this location convey Chestnut Brook to the south. Chestnut Brook first crosses Chelsea Drive then flows for a short stretch in a channel before entering the Franklin Road culverts. The Chelsea Drive culverts are approximately 30 feet-long consisting of twin 49 inch by 33-inch CMP pipes. The Franklin Road culvert consists of two culverts approximately 250 feet long. One culvert is a 51 inch by 31-inch concrete pipe arch. The other culvert consists of a 36-inch pipe of various materials (RCP inlet and CMP outlet). The roadway storm drainage system on Franklin Road discharges into both culverts.

Based on FEMA mapping, the area is in 100-year flood area (Zone A). Downstream of the area prior to Chestnut's Crossing of West Street, there is a floodway and the FEMA zone changes to AE. Upstream of the Chelsea culvert, the floodplain widens significantly and shows road flooding on Lancaster and Cambridge. The drainage area for the culverts is approximately 0.65 square miles or 418 acres. The drainage area extends north to Court Street to Main Street on the east, and is bounded on the west by Washington Road. Chestnut Brook originates in swamp area to the east of Washington Road and to the west of the Cromwell High School. The brook eventually empties into the Mattabassett River south of Route 9.



Franklin Rd culvert inlets



Chelsea Drive intersection with Franklin Rd



Franklin Rd culverts outlets



*Looking upstream of Franklin culverts
(Outbuilding at 22 Franklin on right)*

Hydrology and Hydraulics

Based on the drainage area, these culverts are classified according to CTDOT as a “Small Structures” requiring them to pass the 50-year design flow with 1-foot of freeboard. The 2-year through 50-year discharges were computed using USGS StreamStats. The stream flow was calculated for Chestnut Brook further downstream (at the Missionary Road crossing) where the minimum area requirement for StreamStats was met (0.69 sq miles minimum). This value was urbanized and then transferred upstream to Franklin Road by the ratio of drainage area. The following are the computed design flows at Franklin Road and Chelsea Drive crossings:

$$Q_2 = 75 \text{ cfs} \quad Q_{10} = 115 \text{ cfs} \quad Q_{25} = 150 \text{ cfs} \quad Q_{50} = 185 \text{ cfs}$$

Culvert analysis and sizing was performed using HY-8 FHWA’s Culvert Analysis computer program) based on dimensions (culvert diameter, cover on the culverts & downstream channel dimensions, etc.) collected during field visits. The existing culverts were analyzed for the hydraulic capacity and it was determined that the culverts are inadequate. The existing Chelsea Road culvert has the capacity to only pass a 20-year storm and the existing Franklin Road culverts have a 25-year capacity.

Options Evaluated

Several options were evaluated for this area. The options included the following:

- Installing an additional culvert at Franklin Road to provide 50-year storm capacity (this option was not selected since it didn’t correct issues at Chelsea Drive)
- Replacement of the Franklin Road culverts to provide 50-year storm capacity (this option was not selected since it didn’t correct issues at Chelsea Drive)
- Installing an additional culvert at Chelsea Drive to provide 50-year storm capacity (this option was not selected since it didn’t correct issues at Franklin Road)
- Replacement of the Chelsea Drive culvert to provide 50-year storm capacity (this option was not selected since it didn’t correct issues at Chelsea Drive)

Alternates Identified

Two alternates were identified that addressed the flooding at Franklin Road and the flooding at Chelsea Drive. The alternates are shown on figures 9A and 9B.

- Alternate A: Replace the 36-inch RCP at Franklin Road with a 48-inch RCP pipe and replace the cross culvert at Chelsea Drive with a single 6 ft x 4 ft precast concrete box culvert.

Alternate A would replace the existing 36-inch culvert at Franklin Road. This culvert has the least capacity of both Franklin Road culverts and has a blockage as noted by the town public works department when a video inspection was attempted. The Chelsea Drive culvert which consists of twin CMP would be replaced with one box culvert to reduce the potential for blockage and to increase hydraulic capacity. The brook channel from Chelsea Drive to Franklin Road would be improved to provide adequate hydraulic capacity.

- Alternate B: Replace both Franklin Road pipe culverts with one 5 ft by 5 ft precast concrete box culvert and replace the Chelsea Drive culvert with one and 6 ft by 4 ft precast concrete box culvert.

Alternate B would involve the replacement of both the Franklin Road and Chelsea Drive culverts with a box culvert. The box culverts would increase hydraulic capacity and significantly reduce the potential for blockage. The brook channel from Chelsea Drive to Franklin Road would be improved to ensure adequate hydraulic capacity.

Estimated Costs*

- | | | |
|----------------|-------------------|----------------|
| • Alternate A: | Construction Cost | \$870,000. |
| | Project Cost | \$1.1 Million |
| • Alternate B: | Construction Cost | \$1.70 Million |
| | Project Cost | \$1.90 Million |

*Project costs includes construction, design, permitting, construction inspection, and an allowance for rights of way and utility relocations. Construction costs include a 20% contingency.

Permits Required

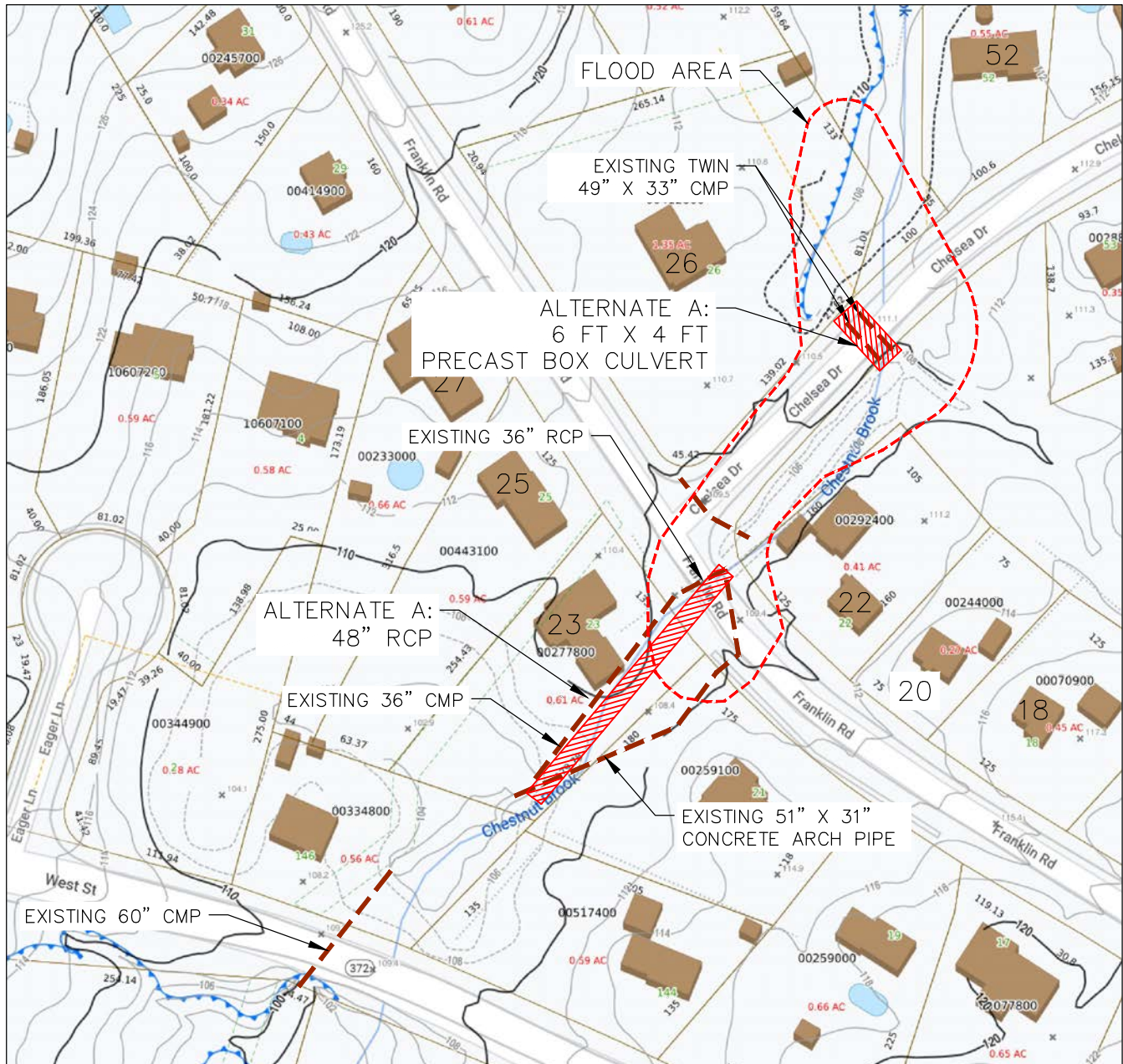
It is anticipated that the following permits will be required for this project (either Alternate): Town of Cromwell Inland Wetlands Permit, Army Corps of Engineers Permit, and CTDEEP 401 Water Quality Certification.

Additional Findings and Recommendations

It is recommended to clean the Franklin Road culverts and then perform a CCTV inspection of the culverts. Following this work, the culverts should be observed to determine if flow has been improved. If improvement is not observed then the Town should pursue Alternate A. Alternate A is recommended since it is significantly less expensive than Alternate B.

AREA 9: FRANKLIN ROAD & CHELSEA DRIVE CULVERT - ALTERNATE A

REPLACE EXISTING 36" CULVERT AT FRANKLIN ROAD WITH A 48" RCP AND REPLACE CHELSEA DRIVE CULVERTS WITH A 6 FT X 4 FT BOX CULVERT.



DRAINAGE AREA=418 ACRES, (0.61 SQ MILES)
50 YEAR FLOW=185 CFS



NOT TO SCALE

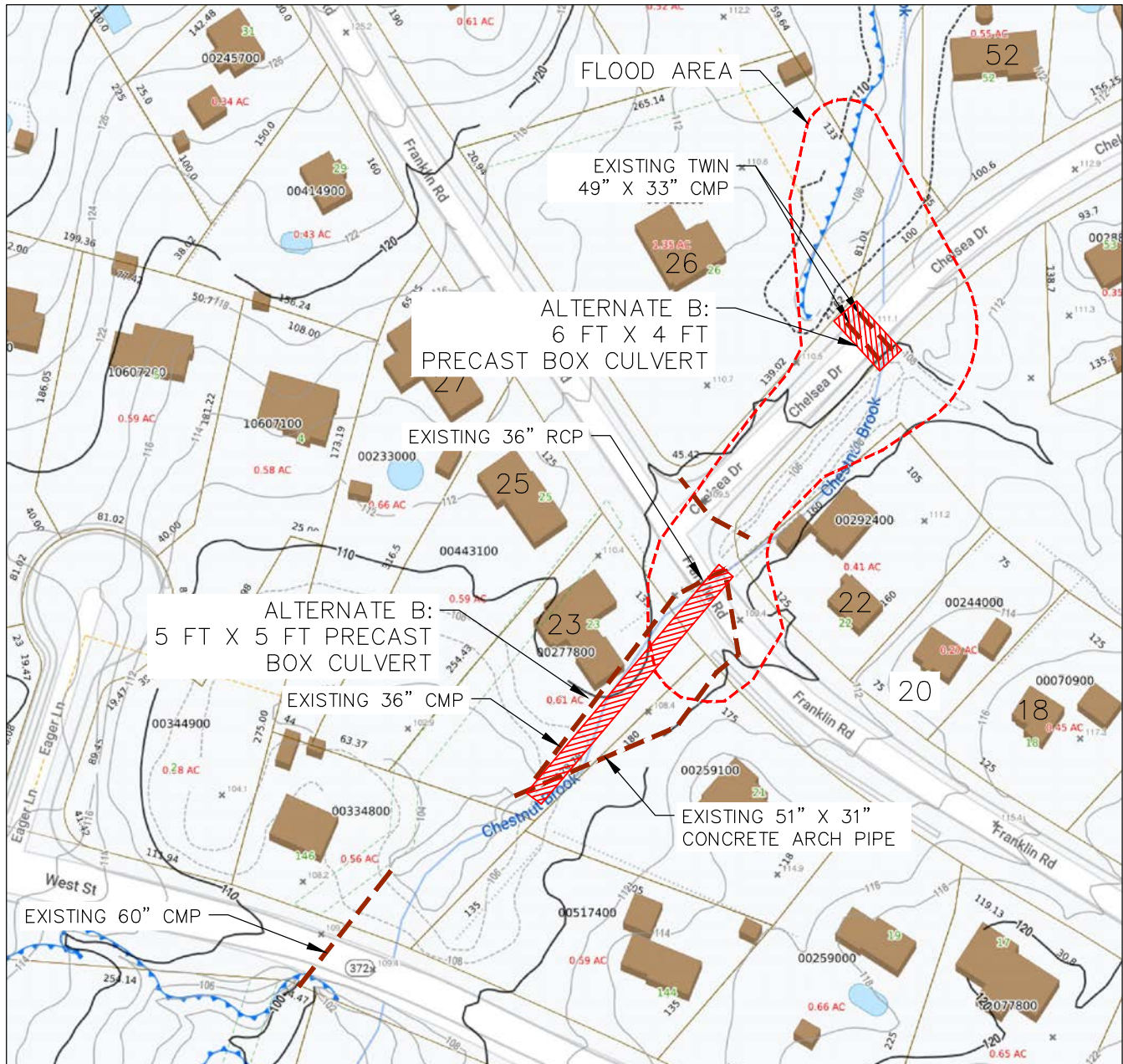
CARDINAL
ENGINEERING ASSOCIATES

190 RESEARCH PKWY MERIDEN, CT 06450 | 203-238-1969
457 BANTAM RD | LITCHFIELD, CT 06769 | 860-597-9106

FIGURE 9A

AREA 9: FRANKLIN ROAD & CHELSEA DRIVE CULVERT - ALTERNATE B

REPLACE FRANKLIN ROAD CULVERTS WITH A 5 FT X 5 FT BOX CULVERT AND REPLACE CHELSEA DRIVE CULVERTS WITH A 6 FT X 4 FT BOX CULVERT.



DRAINAGE AREA=418 ACRES, (0.61 SQ MILES)
50 YEAR FLOW=185 CFS



NOT TO SCALE

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FIGURE 9B

Area 10: Willow Brook Cross Culvert at Evergreen Road

The Evergreen Road area west of Willowbrook Road adjacent to 170 Evergreen Road periodically floods during large rainfall events. The frequency of flooding is not well documented. A recent plan to develop 170 Evergreen Road (construction of 6 houses on Willowbrook Road) has resulted in the Town evaluating the capacity of the existing culvert which conveys Willow Brook.

Present Condition:

The Evergreen Road Culvert over Willow Brook is located approximately 0.75 miles west of Route 3. The culvert inlet is located on the property of 170 Evergreen Road. The culvert is a 35 foot long 18-inch RCP pipe which carries the western branch of Willow Brook. There are no headwalls or endwalls.



Water pooling at inlet



Looking at culvert inlet

Based upon a review of the FEMA map, the area immediately downstream is in the 100-year flood area (Zone A), but the area immediately upstream is not within Zone A. The drainage area for the culvert is approximately 90 acres. The drainage area extends to the west and north of Coles Road, to east along Willowbrook Road, and is bounded by Evergreen Road on the south.



Downstream channel



Looking southeast towards discharge

Hydrology and Hydraulics

Based on the drainage area, the culvert is classified by CTDOT as a “Small Structure” requiring it to pass the 50-year design flow with 1-foot of freeboard. Due to the watershed’s small size (less than 200 acres), the 2-year through 100-year discharges were computed using the Rational method. Both the existing and proposed conditions (assuming the development is completed as planned) would have the same flows. The peak runoff will not change with the proposed development since the development

includes the installation of underground retention on each lot. The 2-year through 50-year peak flows were determined to be the following for both the existing and proposed:

$$Q_2 = 50 \text{ cfs} \quad Q_{10} = 75 \text{ cfs} \quad Q_{25} = 91 \text{ cfs} \quad Q_{50} = 102 \text{ cfs}$$

The analysis of the existing culverts and their replacement was sized using HY-8 (FHWA's Culvert Analysis computer program) based on information gathered during several field visits. The hydraulic capacity of the existing culvert was analyzed and determined to be inadequate. The capacity is less than a 2-year storm. The typical design standard for this culvert is the 50-year storm.

Options Evaluated

- Adding additional culvert capacity to pass the 25-year or 50-year storm

Alternates Identified

- Alternate A: Additional 42-inch RCP culvert (provides 25-year storm capacity)
The culvert capacity would be increased with installation of a pipe located parallel to the existing culvert.
- Alternate B: 5 ft by 4 ft precast concrete box culvert (provides 50-year storm capacity)

Estimated Costs*

- Alternate A: Construction Cost: \$100,000
Project Cost: \$175,000
- Alternate B: Construction Cost: \$380,000
Project Cost: \$470,000

*Project cost includes construction, design, permitting, and an allowance for rights of way and utility relocations. As it is assumed the work would be performed by Town forces, construction inspection is not included. Construction costs include contingency.

Permits Required

It is anticipated that the following permits will be required for this project: Town of Cromwell Inland Wetlands Permit, Army Corps of Engineers Self-Verification (SV) Permit, and CTDEEP 401 Water Quality Certification SV.

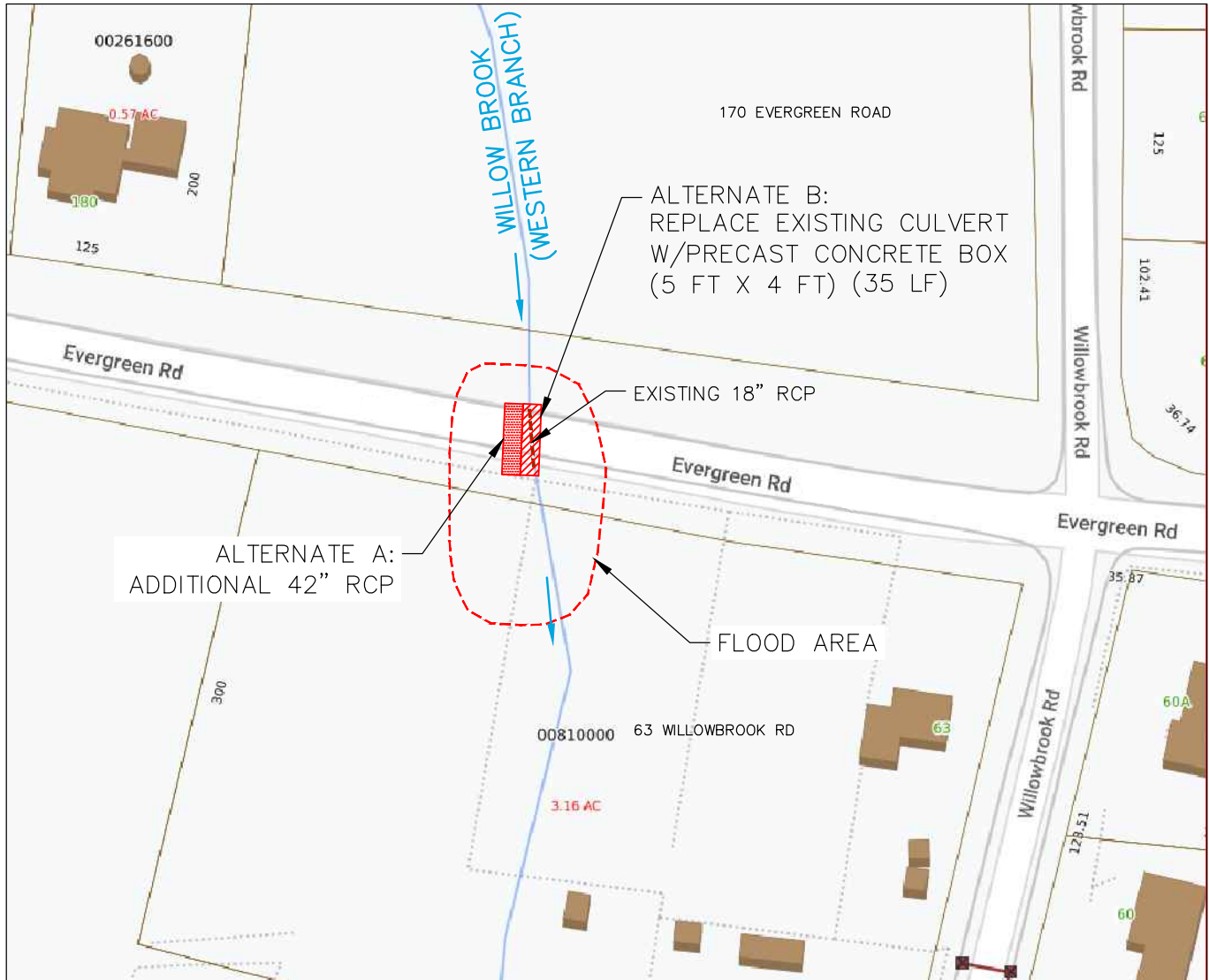
Additional Findings and Recommendations

Alternate B is recommended since it meets the DOT design standard, would alleviate flooding issues for this roadway, and would eliminate necessary maintenance associated with the old culvert by Town forces. Alternate B would also decrease the upstream water surface by approximately six inches at the culvert as compared to alternate A which will reduce the limits of flooding on upstream properties to be developed.

AREA 10: WILLOW BROOK CULVERT - 170 EVERGREEN ROAD

ALTERNATE A: ADD 42" RCP IN CONJUNCTION WITH EXISTING 18" RCP (25 YEAR CAPACITY)

ALTERNATE B: REPLACE RCP W/PRECAST CONCRETE BOX CULVERT 5 FT X 4 FT (50 YEAR CAPACITY)



DRAINAGE AREA = 90 ACRES
50 YEAR FLOW=120 CFS



NOT TO SCALE

CARDINAL
ENGINEERING ASSOCIATES

180 RESEARCH PKWY MERIDEN, CT 06450 | 203-238-1969
457 BANTAM RD | LITCHFIELD, CT 06769 | 860-597-9106

FIGURE 10

Recommendations

The following table includes a description of the improvements recommended and a conceptual construction cost estimate and total project cost for each area.

Table 4 – Report Recommendations

Area	Recommendation	Conceptual Construction Cost Estimate	Total Project Cost Estimate
Area 1: Cedar Drive and Coles Road	Alternate A: Increase stormwater pipe capacity on Coles Road & Cedar Drive	\$390K	\$500K
Area 2: Shadow Brook Culvert at Nooks Hill Road	Replace cross culvert and storm sewer with box culvert; install additional 60" RCP under RR embankment.	\$3.2 Million	\$3.5 Million
Area 3: Willow Brook Cross Culvert at Evergreen Road	Alternate A: Replace existing culvert with 8 ft x 5ft box culvert	\$700K	\$930K
Area 4: Culverts at Evergreen Road & Copper Knoll Drive	Alternate A: Construct additional 7 ft by 3 ft culvert	\$1.60 Million	\$1.85 Million
Area 5: Geer Street Culverts	Alternate B: Replace both culverts with 12 ft by 4 ft box culverts	\$860K	\$1.10 Million
Area 6: Pierson Park	Alternate A: Construct additional 48" RCP culvert	\$420K	\$610K
Area 7: Glenwood Terrace/Field Road	Alternate A: Intercept Runoff and Pipe to Existing Discharge Point at 111 Field Road	\$370K	\$500K
Area 8: South Street Culverts at Cromwell Creek	Alternate C: Install gates to close road during flooding	\$30K	\$40K
Area 9: Franklin Road & Chelsea Drive	Alternate A: Replace 36"RCP with 48" RCP at Franklin Road; Replace Chelsea Drive culvert with 6 ft x 4 ft box culvert	\$870K	\$1.10 Million
Area 10: Willow Brook Cross Culvert at 170 Evergreen	Alternate B: Replace culvert with 5 ft x 4 ft box culvert	\$380K	\$470K

APPENDIX A

Area 1-Cedar Drive & Coles Road Supporting Documents

180 Research Parkway
 Meriden, Connecticut 06450
 (203) 238-1969

OPINION OF PROBABLE CONSTRUCTION COST

 Town **Town of Cromwell**
 Project **Drainage Improvements**
 Area **#1 Alternate A**
Increase Stormwater Pipe Capacity on Coles Road

 Calculated by DL DATE 6/8/2023

Checked by _____

	Item Number	Items	Unit	Quantities	Unit Price	Cost
1	0201001A	CLEARING AND GRUBBING	LS	1	*	*
2	0202000A	EARTH EXCAVATION	CY	200	\$25.00	\$5,000.00
3	0202529	CUT BITUMINOUS CONCRETE PAVEMENT	LF	800	\$3.00	\$2,400.00
4	0213100	GRANULAR FILL (INCL BERM 75'X15'X4')	CY	170	\$60.00	\$10,200.00
5	0219001	SEDIMENTATION CONTROL SYSTEM	LF	800	\$6.00	\$4,800.00
6	0219011	SEDIMENTATION CONTROL SYSTEM AT CATCH BASIN	EA	7	\$120.00	\$840.00
7	0406128.20	BITUMINOUS CONCRETE PATCHING - FULL DEPTH	SY	550	\$100.00	\$55,000.00
8	0686000.18	18" R.C. PIPE - 0' - 10' DEEP	LF	15	\$85.00	\$1,275.00
9	0686000.24	24" R.C. PIPE - 0' - 10' DEEP	LF	760	\$135.00	\$102,600.00
10	0703012	MODIFIED RIP RAP	CY	15	\$300.00	\$4,500.00
11	0815001	BITUMINOUS CONCRETE LIP CURB	LF	800	\$8.00	\$6,400.00
12	0944000	FURNISHING AND PLACING TOPSOIL	SY	900	\$7.00	\$6,300.00
13	0950005	TURF ESTABLISHMENT	SY	900	\$2.00	\$1,800.00
14	0970007	TRAFFICPERSON (UNIFORMED FLAGGER)	HR	480	\$40.00	\$19,200.00
15	0971001A	MAINTENANCE AND PROTECTION OF TRAFFIC	LS	1	*	*
16	0975004	MOBILIZATION AND PROJECT CLOSE-OUT	LS	1	*	*
17	0980001	CONSTRUCTION STAKING	LS	1	*	*
						\$0.00
Major Items Subtotal						\$220,315.00
Minor Items Subtotal (0% at Final Design)			20	% of Major Items Subtotal		\$44,063.00
Contract Items Subtotal						\$264,378.00

*** Other Item Allowances**

Clearing and Grubbing	2	% of Contract Items Subtotal	\$	5,288
M & P of Traffic	5	% of Contract Items Subtotal	\$	13,219
Mobilization	4	% of Contract Items Subtotal	\$	10,575
Construction Staking	1	% of Contract Items Subtotal	\$	2,644
Other Items Subtotal				\$ 31,726

CONTRACT SUBTOTAL	\$ 296,104
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Inflation Costs (Simple Method)

Date of Estimate (provide date of estimate)	Jun-23			
Anticipated Bid Date (provide anticipated bid date)	May-24			
Base Years	0.9			
Annual Inflation (3.5% annually, 0% at Final Design)	5.0%			
Inflation Subtotal	4.5%	of Subtotal	\$	13,325

TOTAL CONTRACT COST ESTIMATE (Rounded to nearest \$1000)	\$ 309,000
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Project Costs Summary (Construction Phase)				
Contract Cost Estimate (Line "G")				\$ 309,000
Contingencies	25.0%			\$ 77,250
Construction Engineering/Incidentals	13.0%			\$ 40,170
ROW				\$ 5,000
Utilities				\$ 15,000
Engineering Design & Permitting	17.0%			\$ 52,530
TOTAL PROJECT COST(Rounded to nearest \$1000)	LS			\$ 499,000

180 Research Parkway
 Meriden, Connecticut 06450
 (203) 238-1969

OPINION OF PROBABLE CONSTRUCTION COST

 Town **Town of Cromwell**
 Project **Drainage Improvements**
 Area **#1 Alternate B**
Install Relief Stormwater System to West Side of Coles Road

 Calculated by DL DATE 6/8/2023

Checked by _____

	Item Number	Items	Unit	Quantities	Unit Price	Cost
1	0201001A	CLEARING AND GRUBBING	LS	1	*	*
2	0202000A	EARTH EXCAVATION	CY	200	\$25.00	\$5,000.00
3	0202529	CUT BITUMINOUS CONCRETE PAVEMENT	LF	100	\$3.00	\$300.00
4	0213100	GRANULAR FILL (INCL BERM 75'X15'X4')	CY	170	\$60.00	\$10,200.00
5	0219001	SEDIMENTATION CONTROL SYSTEM	LF	800	\$6.00	\$4,800.00
6	0219011	SEDIMENTATION CONTROL SYSTEM AT CATCH BASIN	EA	4	\$120.00	\$480.00
7	0406128.20	BITUMINOUS CONCRETE PATCHING - FULL DEPTH	SY	70	\$100.00	\$7,000.00
8	0586501.05	MANHOLE (5' DIAMETER) - 0'-10' DEEP	EA	2	\$6,000.00	\$12,000.00
9	0686000.18	18" R.C. PIPE - 0' - 10' DEEP	LF	700	\$125.00	\$87,500.00
10	0686700.18	18" R.C. DRAINAGE PIPE END	EA	1	\$2,500.00	\$2,500.00
11	0686000.24	24" R.C. PIPE - 0' - 10' DEEP	LF	25	\$135.00	\$3,375.00
12	0703012	MODIFIED RIP RAP	CY	30	\$300.00	\$9,000.00
13	0815001	BITUMINOUS CONCRETE LIP CURB	LF	40	\$8.00	\$320.00
14	0921001	CONCRETE SIDEWALK	SF	1250	\$15.00	\$18,750.00
15	0944000	FURNISHING AND PLACING TOPSOIL	SY	1000	\$7.00	\$7,000.00
16	0950005	TURF ESTABLISHMENT	SY	1000	\$2.00	\$2,000.00
17	0970007	TRAFFICPERSON (UNIFORMED FLAGGER)	HR	360	\$40.00	\$14,400.00
18	0971001A	MAINTENANCE AND PROTECTION OF TRAFFIC	LS	1	*	*
19	0975004	MOBILIZATION AND PROJECT CLOSE-OUT	LS	1	*	*
20	0980001	CONSTRUCTION STAKING	LS	1	*	*
						\$0.00
Major Items Subtotal						\$184,625.00
Minor Items Subtotal (0% at Final Design)			20	% of Major Items Subtotal		\$36,925.00
Contract Items Subtotal						\$221,550.00

*** Other Item Allowances**

Clearing and Grubbing	2	% of Contract Items Subtotal	\$	4,431
M & P of Traffic	5	% of Contract Items Subtotal	\$	11,078
Mobilization	4	% of Contract Items Subtotal	\$	8,862
Construction Staking	1	% of Contract Items Subtotal	\$	2,216
Other Items Subtotal				\$ 26,587

CONTRACT SUBTOTAL	\$ 248,137
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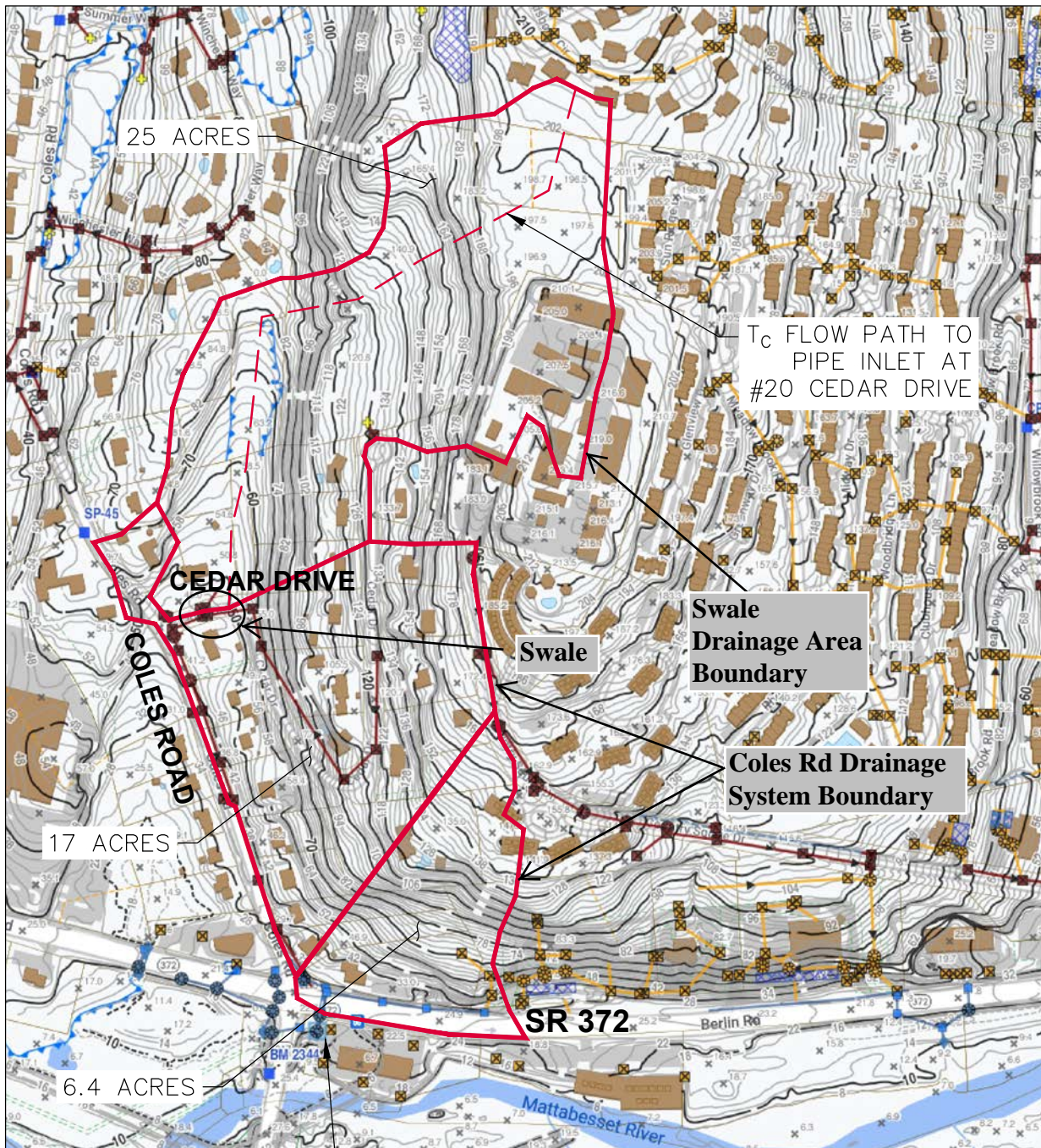
Inflation Costs (Simple Method)

Date of Estimate (provide date of estimate)	Apr-23		
Anticipated Bid Date (provide anticipated bid date)	May-24		
Base Years	1		
Annual Inflation (3.5% annually, 0% at Final Design)	5.0%		
Inflation Subtotal	5.0% of Subtotal	\$	12,407

TOTAL CONTRACT COST ESTIMATE (Rounded to nearest \$1000)	\$ 261,000
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Project Costs Summary (Construction Phase)				
Contract Cost Estimate (Line "G")				\$ 261,000
Contingencies	25.0%			\$ 65,250
Construction Engineering/Incidentals	13.0%			\$ 33,930
ROW				\$ 25,000
Utilities				\$ 40,000
Engineering Design & Permitting	17.0%			\$ 44,370
TOTAL PROJECT COST(Rounded to nearest \$1000)	LS			\$ 470,000

AREA 1: CEDAR DRIVE & COLES ROAD -WATERSHED AREA



FEMA DATA

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NGS Information Services
NOAA, NNGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at <http://www.ngs.noaa.gov/>.

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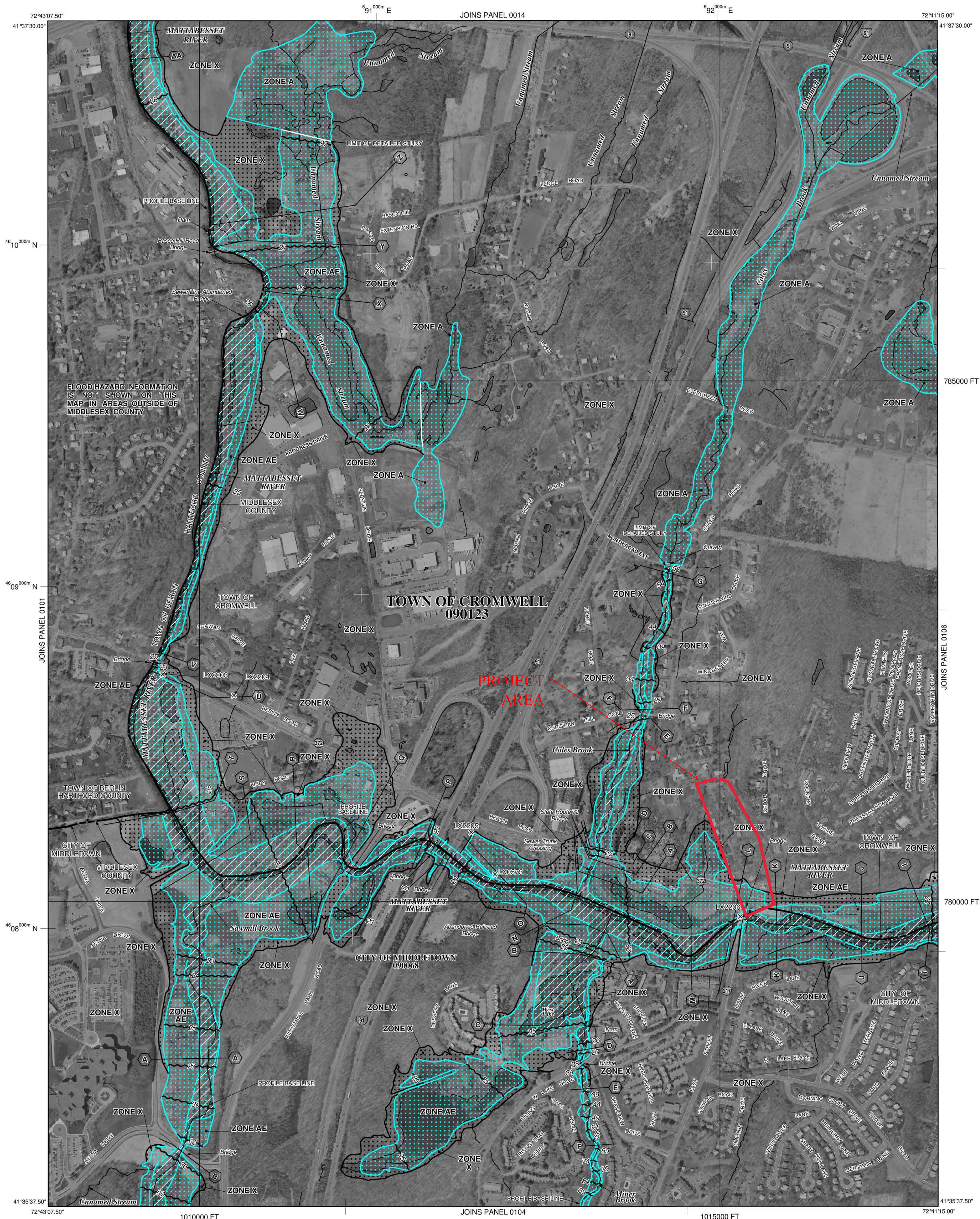
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LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

- ZONE A** No Base Flood Elevations determined.
- ZONE AE** Base Flood Elevations determined.
- ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
- ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- ZONE AR** Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

- ZONE X** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

- ZONE X** Areas determined to be outside the 0.2% annual chance floodplain.
- ZONE D** Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- Base Flood Elevation line and value; elevation in feet*
- Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

- Cross section line
- Transect line
- Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 1000-meter Universal Transverse Mercator grid, zone 18
- 5000-foot grid : Connecticut State Plane coordinate system, (FIPSZONE 0600), Lambert Conformal Conic
- Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5 River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
August 28, 2008
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.



MAP SCALE 1" = 500'
250 0 500 1000 FEET
150 0 150 300 METERS

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0102G

FIRM FLOOD INSURANCE RATE MAP MIDDLESEX COUNTY, CONNECTICUT (ALL JURISDICTIONS)

PANEL 102 OF 450
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)
CONTAINS:
COMMUNITY NUMBER PANEL SUFFIX
CROMWELL, TOWN OF 090123 0102 G
MIDDLETOWN, CITY OF 090068 0102 G

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.



MAP NUMBER
09007C0102G

EFFECTIVE DATE
AUGUST 28, 2008

Federal Emergency Management Agency

APPENDIX B

Area 2-Nooks Hill Road Supporting Documents

Conceptual Construction Cost Estimate

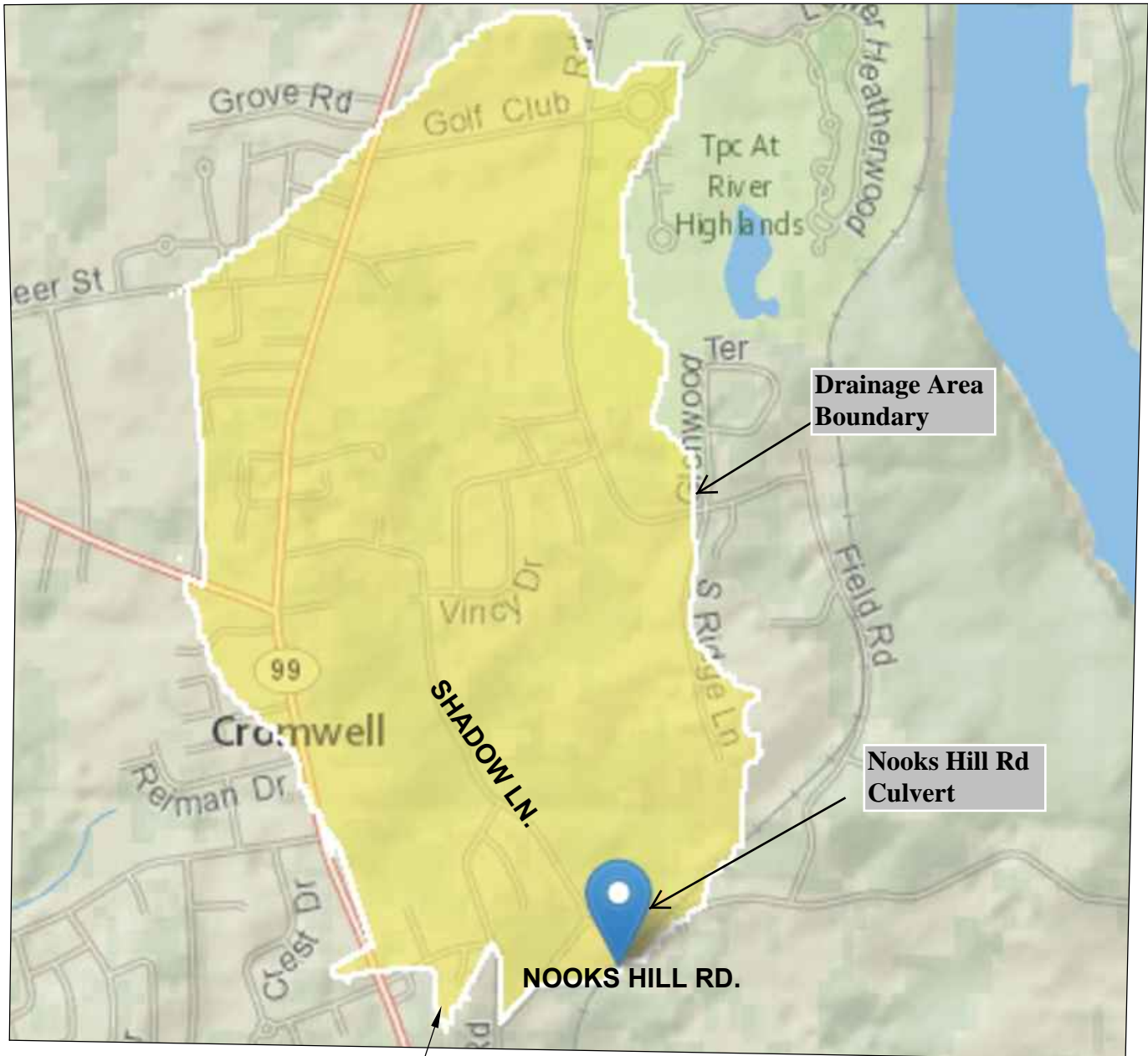
Town Drainage Improvements, Area 2, Nooks Hill Road, 425 ft box (8x4) & 150 ft 60"RCP

Cromwell, CT 7/3/23

Major and Minor Contract Items

Item No.	DOT Item	Item	Unit	Quantity	Unit \$	Total Cost
1	0201001	CLEARING AND GRUBBING	LS	1	*	*
2	0202000	EARTH EXCAVATION	CY	600	\$ 30.00	\$ 18,000.00
3	0202216A	EXCAVATION AND REUSE OF EXISTING CHANNEL BOTTOM MATERIAL	CY	0	\$ 80.00	\$ -
4	0202217A	SUPPLEMENTAL STREAMBED CHANNEL MATERIAL	CY	0	\$ 200.00	\$ -
5	0203000	STRUCTURE EXCAVATION - EARTH (COMPLETE)	CY	1000	\$ 35.00	\$ 35,000.00
6	0203100	STRUCTURE EXCAVATION - ROCK (COMPLETE)	CY	40	\$ 85.00	\$ 3,400.00
7	0204151	HANDLING WATER	LS	1	\$ 100,000.00	\$ 100,000.00
8	0209001	FORMATION OF SUBGRADE	SY	250	\$ 10.00	\$ 2,500.00
9	0210303	TURBIDITY CONTROL CURTAINS	LS	1	\$ 5,000.00	\$ 5,000.00
10	0212000	SUBBASE	CY	250	\$ 58.00	\$ 14,500.00
11	0213100	GRANULAR FILL	CY	100	\$ 72.00	\$ 7,200.00
12	0216000	PERVIOUS STRUCTURE BACKFILL	CY	1090	\$ 65.00	\$ 70,850.00
13	0219001	SEDIMENTATION CONTROL SYSTEM	LF	350	\$ 8.00	\$ 2,800.00
14	0304002	PROCESSED AGGREGATE BASE	CY	30	\$ 60.00	\$ 1,800.00
15	0305001	PROCESSED AGGREGATE	CY	10	\$ 100.00	\$ 1,000.00
16	0406171	HMA 50.50	TON	60	\$ 250.00	\$ 15,000.00
17	0503866	REMOVAL OF EXISTING CULVERT	LS	1	\$ 25,000.00	\$ 25,000.00
18	0601062	FOOTING CONCRETE	CY	20	\$ 750.00	\$ 15,000.00
19	0601064	ABUTMENT AND WALL CONCRETE	CY	20	\$ 850.00	\$ 17,000.00
20		JUNCTION CHAMBER	EA	1	\$ 50,000.00	\$ 50,000.00
21	0601125	8' x 4' PRECAST CONCRETE BOX CULVERT	LF	425	\$ 2,700.00	\$ 1,147,500.00
22	0602030	DEFORMED STEEL BARS - GALVANIZED	LB	5500	\$ 2.00	\$ 11,000.00
23		JACKING PIT	EA	1	\$ 50,000.00	\$ 50,000.00
24		JACK 60" PIPE CLASS V	LF	150	\$ 2,200.00	\$ 330,000.00
25	0703012	INTERMEDIATE RIPRAP	CY	20	\$ 90.00	\$ 1,800.00
26	0707009	MEMBRANE WATERPROOFING (COLD LIQUID ELASTOMERIC)	SY	40	\$ 179.00	\$ 7,160.00
27	0708001	DAMP PROOFING	SY	10	\$ 20.00	\$ 200.00
28	0822001	TEMPORARY PRECAST CONCRETE BARRIER CURB	LF	100	\$ 72.00	\$ 7,200.00
29	0910184	METAL BEAM RAIL SPAN SECTION TYPE II	EA	2	\$ 4,500.00	\$ 9,000.00
30	0911924	R-B END ANCHORAGE TYPE II	EA	4	\$ 2,000.00	\$ 8,000.00
31	0944000	FURNISHING AND PLACING TOPSOIL	SY	140	\$ 21.00	\$ 2,940.00
32	0950005	TURF ESTABLISHMENT	SY	140	\$ 6.00	\$ 840.00
33	0969060	CONSTRUCTION FIELD OFFICE (SMALL)	MO	3	\$ 2,800.00	\$ 8,400.00
34	0970001	MAINTENANCE AND PROTECTION OF TRAFFIC	LS	1	*	*
35	0970006	TRAFFICPERSON (MUNICIPAL POLICE OFFICER)	EST	1	\$ 6,000.00	\$ 6,000.00
36	0975004	MOBILIZATION AND PROJECT CLOSE-OUT	LS	1	*	*
37	0979003	CONSTRUCTION BARRICADE - TYPE III	EA	6	\$ 130.00	\$ 780.00
38	0980001	CONSTRUCTION STAKING	LS	1	*	*
39	1209007	PAINTED PAVEMENT MARKINGS - 4" YELLOW	LF	100	\$ 1.00	\$ 100.00
40	1220027	CONSTRUCTION SIGNS	SF	200	\$ 25.00	\$ 5,000.00
41	1700005	TESTING	EST	1	\$ 6,000.00	\$ 6,000.00
						\$ -
						\$ -
						\$ -
						\$ -
						\$ -
						\$ -
A	Major Items Subtotal					\$ 1,985,970
B	Minor Items Subtotal		15	% of Line "A"		\$ 297,896
C	Major and Minor Contract Items Subtotal (A + B)					\$ 2,283,866
	Other Item Allowances					
	Clearing and Grubbing		1	% of Line "C"		\$ 22,839
	M & P of Traffic		3	% of Line "C"		\$ 68,516
	Mobilization		5	% of Line "C"		\$ 114,193
	Construction Staking		1	% of Line "C"		\$ 22,839
D	Other Items Subtotal					\$ 228,387
E	CONTRACT SUBTOTAL (C + D)					\$ 2,512,253
	Inflation Costs (Simple Method)					
	Date of Estimate		Apr-23			
	Anticipated Bid Date		May-24			
	Annual Inflation		5%			
F	Inflation Subtotal		5.0%	of Line "E"		\$ 125,613
G	TOTAL CONTRACT COST ESTIMATE (E + F) (Rounded to nearest \$1000)					\$ 2,638,000
	Project Costs Summary					
	Contract Cost Estimate (Line "G")					\$ 2,638,000
	Contingencies		20%			\$ 527,600
	Construction Engineering / Incidentals		LS			\$ 100,000
	ROW		LS			\$ 40,000
	Utilities		LS			\$ 50,000
	Engineering Design & Permitting					\$ 140,000
	TOTAL PROJECT COST (Rounded to nearest \$10000)					\$ 3,500,000

AREA 2 DRAINAGE AREA FOR NOOKS HILL ROAD CULVERT



DRAINAGE AREA
=1.02 SQUARE
MILES (653 AC)



NOT TO SCALE

CARDINAL
ENGINEERING ASSOCIATES

180 RESEARCH PKWY | MERIDEN, CT 06450 | 203-238-1969
457 BANTAM RD | LITCHFIELD, CT 06769 | 860-397-9106

FEMA DATA

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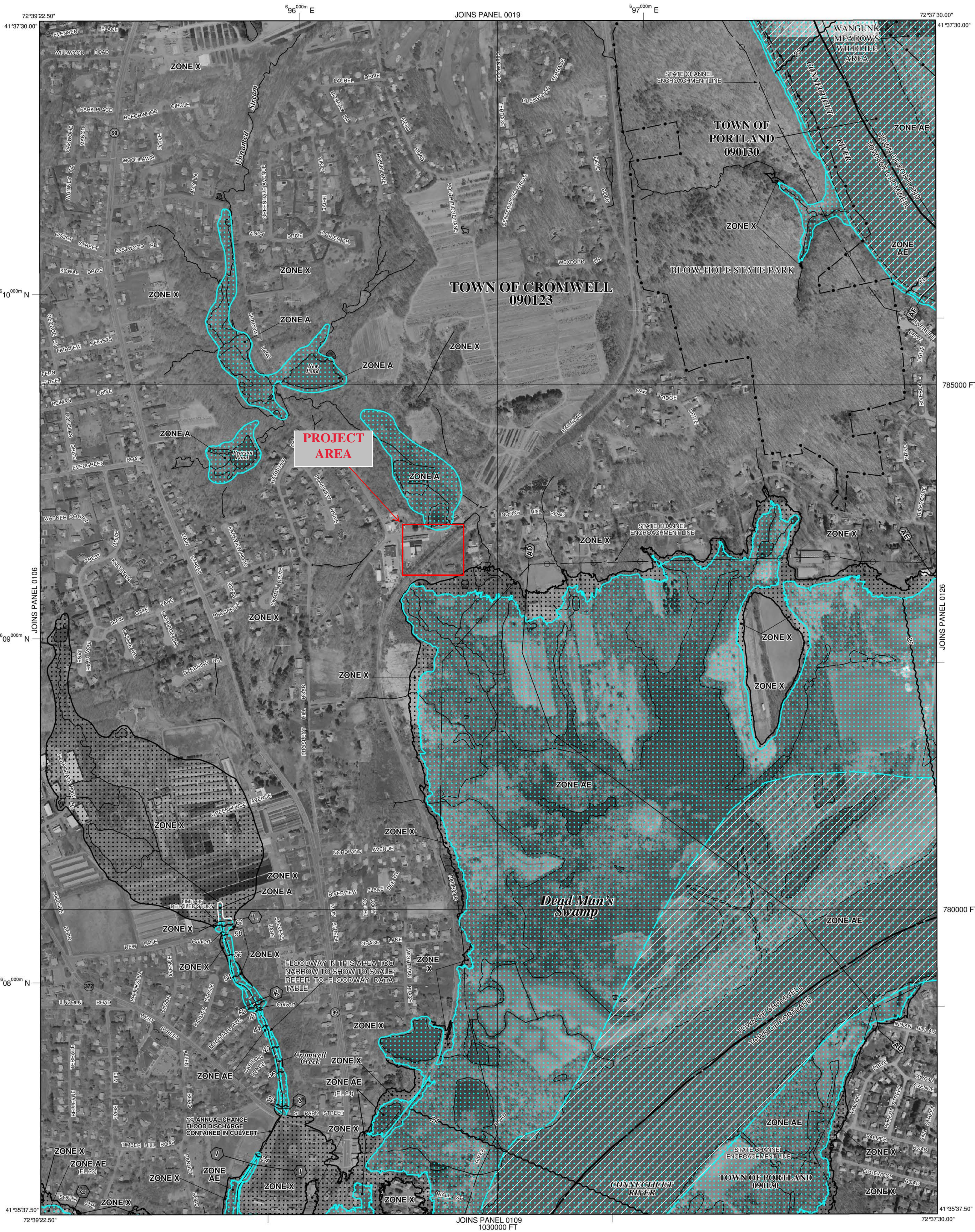
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LEGEND

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- ZONE AE** Base Flood Elevations determined.
- ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
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- ZONE AR** Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

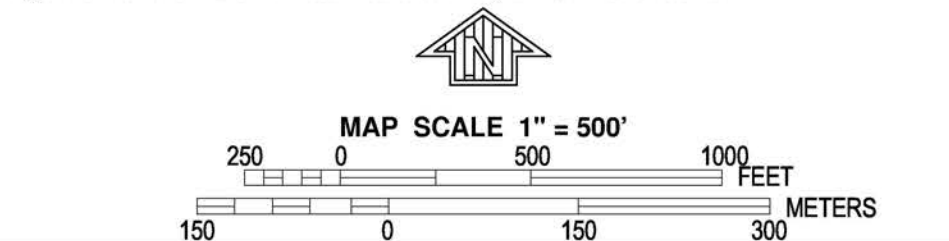
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- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- Base Flood Elevation line and value; elevation in feet*
- Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

- Cross section line
- Transect line
- Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 1000-meter Universal Transverse Mercator grid, zone 18
- 5000-foot grid : Connecticut State Plane coordinate system, (FIPSZONE 0600), Lambert Conformal Conic
- Bench mark (see explanation in Notes to Users section of this FIRM panel)
- River Mile
- MAP REPOSITORIES
- Refer to Map Repositories list on Map Index
- EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
- August 28, 2008
- EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.



NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0107G

FIRM FLOOD INSURANCE RATE MAP MIDDLESEX COUNTY, CONNECTICUT (ALL JURISDICTIONS)

PANEL 107 OF 450
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CROMWELL, TOWN OF	090123	0107	G
PORTLAND, TOWN OF	090130	0107	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.



MAP NUMBER
09007C0107G

EFFECTIVE DATE
AUGUST 28, 2008

Federal Emergency Management Agency

APPENDIX C

Area 3-Willow Brook & Evergreen Road Supporting Documents



180 Research Parkway
Meriden, Connecticut 06450
(203) 238-1969

OPINION OF PROBABLE CONSTRUCTION COST

Town **Town of Cromwell**
Project **Drainage Improvements**
Area **#3 Alternate A**
8x5 BOX CULVERT

Calculated by DL DATE 6/14/2023
Checked by CH

	Item Number	Items	Unit	Quantities	Unit Price	Cost
1	0201001	CLEARING AND GRUBBING	LS	1	*	*
2	0202216A	EXCAVATION AND REUSE OF EXISTING CHANNEL BOTTOM MATERIAL	CY	50	\$80.00	\$4,000.00
3	0202217A	SUPPLEMENTAL STREAMBED CHANNEL MATERIAL	CY	50	\$200.00	\$10,000.00
4	0203000	STRUCTURE EXCAVATION - EARTH (COMPLETE)	CY	150	\$35.00	\$5,250.00
5	0203100	STRUCTURE EXCAVATION - ROCK (COMPLETE)	CY	20	\$85.00	\$1,700.00
6	0204151	HANDLING WATER	LS	1	\$100,000.00	\$100,000.00
7	0210303	TURBIDITY CONTROL CURTAIN	LS	1	\$5,000.00	\$5,000.00
8	0213100	GRANULAR FILL	CY	50	\$72.00	\$3,600.00
9	0216000	PERVIOUS STRUCTURE BACKFILL	CY	300	\$65.00	\$19,500.00
10	0219001	SEDIMENTATION CONTROL SYSTEM	LF	250	\$8.00	\$2,000.00
11	0406128.20	BITUMINOUS CONCRETE PATCHING - FULL DEPTH	SY	40	\$125.00	\$5,000.00
12	0503866	REMOVAL OF EXISTING CULVERT	LS	1	\$10,000.00	\$10,000.00
13	0586006.6	SINGLE C CATCH BASIN WITH 4' SUMP	EA	2	\$4,500.00	\$9,000.00
14	0586006.10	DOUBLE TYPE CL CATCH BASIN WITH 4' SUMP	EA	1	\$7,500.00	\$7,500.00
15	0601062	FOOTING CONCRETE	CY	30	\$750.00	\$22,500.00
16	0601064	ABUTMENT AND WALL CONCRETE	CY	30	\$850.00	\$25,500.00
17	0601125	8' x 5' PRECAST CONCRETE BOX CULVERT	LF	40	\$3,500.00	\$140,000.00
18	0686000.12	12" R.C. PIPE - 0' - 10' DEEP	LF	40	\$90.00	\$3,600.00
19	0703012	INTERMEDIATE RIPRAP	CY	20	\$90.00	\$1,800.00
20	0707009	MEMBRANE WATERPROOFING (COLD LIQUID ELASTOMERIC)	SY	50	\$179.00	\$8,950.00
21	0910184	METAL BEAM RAIL SPAN SECTION TYPE II	EA	2	\$4,500.00	\$9,000.00
22	0911924	R-B END ANCHORAGE TYPE II	EA	4	\$2,000.00	\$8,000.00
23	0921001	CONCRETE SIDEWALK	SF	60	\$50.00	\$3,000.00
24	0944000	FURNISHING AND PLACING TOPSOIL	SY	140	\$21.00	\$2,940.00
25	0950005	TURF ESTABLISHMENT	SY	140	\$6.00	\$840.00
26	0970001	MAINTENANCE AND PROTECTION OF TRAFFIC	LS	1	*	*
27	0970006	TRAFFICPERSON (MUNICIPAL POLICE OFFICER)	EST	1	\$6,000.00	\$6,000.00
28	0975004	MOBILIZATION AND PROJECT CLOSE-OUT	LS	1	*	*
29	0980001	CONSTRUCTION STAKING	LS	1	*	*
						\$0.00
Major Items Subtotal						\$400,680.00
Minor Items Subtotal (0% at Final Design)			20	% of Major Items Subtotal		\$80,136.00
Contract Items Subtotal						\$480,816.00

* Other Item Allowances

Clearing and Grubbing	2	% of Contract Items Subtotal	\$ 9,616
M & P of Traffic	3	% of Contract Items Subtotal	\$ 14,424
Mobilization	5	% of Contract Items Subtotal	\$ 24,041
Construction Staking	2	% of Contract Items Subtotal	\$ 9,616
Other Items Subtotal			\$ 57,697

CONTRACT SUBTOTAL	\$ 538,513
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Inflation Costs (Simple Method)

Date of Estimate (provide date of estimate)	Jun-23		
Anticipated Bid Date (provide anticipated bid date)	May-24		
Base Years	0.9		
Annual Inflation (5.0% annually, 0% at Final Design)	5.0%		
Inflation Subtotal	4.5%	of Subtotal	\$ 24,233

TOTAL CONTRACT COST ESTIMATE (Rounded to nearest \$1000)	\$ 563,000
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Project Costs Summary (Construction Phase)				
Contract Cost Estimate (Line "G")	25.0%			\$ 563,000
Contingencies				\$ 140,750
Construction Engineering/Incidentals				\$ 85,000
ROW				\$ 20,000
Utilities				\$ 20,000
Engineering Design & Permitting				\$ 100,000
TOTAL PROJECT COST(Rounded to nearest \$1000)	LS			\$ 929,000



180 Research Parkway
Meriden, Connecticut 06450
(203) 238-1969

OPINION OF PROBABLE CONSTRUCTION COST

Town **Town of Cromwell**
Project **Drainage Improvements**
Area **#3 Alternate B**
6x4 BOX CULVERT

Calculated by DL DATE 6/14/2023
Checked by CH

	Item Number	Items	Unit	Quantities	Unit Price	Cost
1	0201001	CLEARING AND GRUBBING	LS	1	*	*
2	0202216A	EXCAVATION AND REUSE OF EXISTING CHANNEL BOTTOM MATERIAL	CY	50	\$80.00	\$4,000.00
3	0202217A	SUPPLEMENTAL STREAMBED CHANNEL MATERIAL	CY	50	\$200.00	\$10,000.00
4	0203000	STRUCTURE EXCAVATION - EARTH (COMPLETE)	CY	100	\$35.00	\$3,500.00
5	0203100	STRUCTURE EXCAVATION - ROCK (COMPLETE)	CY	20	\$85.00	\$1,700.00
6	0204151	HANDLING WATER	LS	1	\$100,000.00	\$100,000.00
7	0210303	TURBIDITY CONTROL CURTAIN	LS	1	\$5,000.00	\$5,000.00
8	0213100	GRANULAR FILL	CY	40	\$72.00	\$2,880.00
9	0216000	PERVIOUS STRUCTURE BACKFILL	CY	200	\$65.00	\$13,000.00
10	0219001	SEDIMENTATION CONTROL SYSTEM	LF	250	\$8.00	\$2,000.00
11	0406128.20	BITUMINOUS CONCRETE PATCHING - FULL DEPTH	SY	35	\$125.00	\$4,375.00
12	0503866	REMOVAL OF EXISTING CULVERT	LS	1	\$10,000.00	\$10,000.00
13	0586006.6	SINGLE C CATCH BASIN WITH 4' SUMP	EA	2	\$4,500.00	\$9,000.00
14	0586006.10	DOUBLE TYPE CL CATCH BASIN WITH 4' SUMP	EA	1	\$7,500.00	\$7,500.00
15	0601062	FOOTING CONCRETE	CY	30	\$750.00	\$22,500.00
16	0601064	ABUTMENT AND WALL CONCRETE	CY	30	\$850.00	\$25,500.00
17	0601125	6' x 5' PRECAST CONCRETE BOX CULVERT	LF	40	\$2,200.00	\$88,000.00
18	0686000.12	12" R.C. PIPE - 0' - 10' DEEP	LF	40	\$90.00	\$3,600.00
19	0703012	INTERMEDIATE RIPRAP	CY	20	\$90.00	\$1,800.00
20	0707009	MEMBRANE WATERPROOFING (COLD LIQUID ELASTOMERIC)	SY	40	\$179.00	\$7,160.00
21	0910184	METAL BEAM RAIL SPAN SECTION TYPE II	EA	2	\$4,500.00	\$9,000.00
22	0911924	R-B END ANCHORAGE TYPE II	EA	4	\$2,000.00	\$8,000.00
23	0921001	CONCRETE SIDEWALK	SF	60	\$50.00	\$3,000.00
24	0944000	FURNISHING AND PLACING TOPSOIL	SY	140	\$21.00	\$2,940.00
25	0950005	TURF ESTABLISHMENT	SY	140	\$6.00	\$840.00
26	0970001	MAINTENANCE AND PROTECTION OF TRAFFIC	LS	1	*	*
27	0970006	TRAFFICPERSON (MUNICIPAL POLICE OFFICER)	EST	1	\$6,000.00	\$6,000.00
28	0975004	MOBILIZATION AND PROJECT CLOSE-OUT	LS	1	*	*
29	0980001	CONSTRUCTION STAKING	LS	1	*	*
						\$0.00
Major Items Subtotal						\$337,295.00
Minor Items Subtotal (0% at Final Design)			20	% of Major Items Subtotal		\$67,459.00
Contract Items Subtotal						\$404,754.00

* Other Item Allowances

Clearing and Grubbing	2	% of Contract Items Subtotal	\$ 8,095
M & P of Traffic	3	% of Contract Items Subtotal	\$ 12,143
Mobilization	5	% of Contract Items Subtotal	\$ 20,238
Construction Staking	2	% of Contract Items Subtotal	\$ 8,095
Other Items Subtotal			\$ 48,571

CONTRACT SUBTOTAL	\$ 453,325
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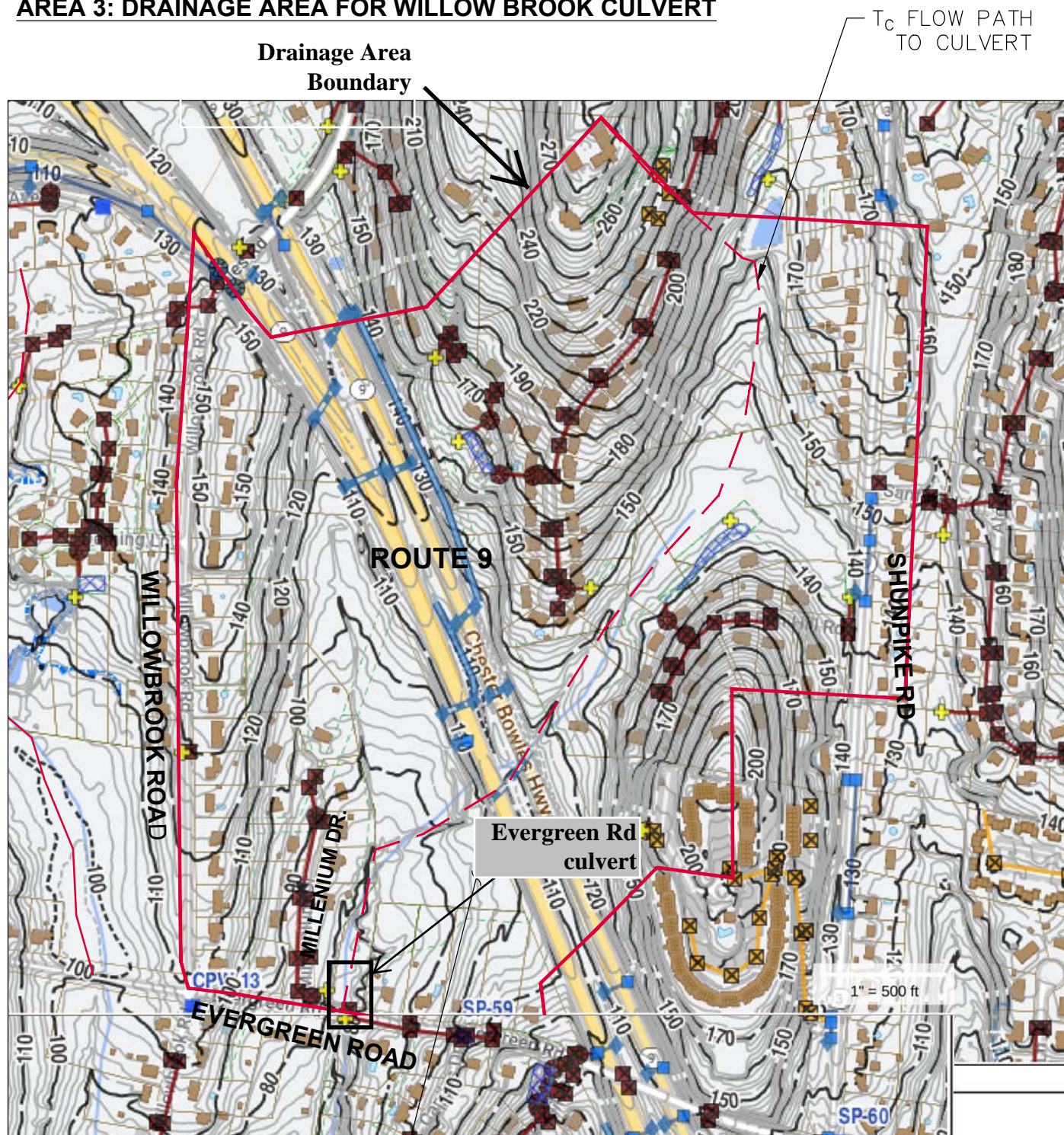
Inflation Costs (Simple Method)

Date of Estimate (provide date of estimate)	Jun-23		
Anticipated Bid Date (provide anticipated bid date)	May-24		
Base Years	0.9		
Annual Inflation (5.0% annually, 0% at Final Design)	5.0%		
Inflation Subtotal	4.5%	of Subtotal	\$ 20,400

TOTAL CONTRACT COST ESTIMATE (Rounded to nearest \$1000)	\$ 474,000
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Project Costs Summary (Construction Phase)				
Contract Cost Estimate (Line "G")	25.0%			\$ 474,000
Contingencies				\$ 118,500
Construction Engineering/Incidentals				\$ 90,000
ROW				\$ 20,000
Utilities				\$ 20,000
Engineering Design & Permitting				\$ 100,000
TOTAL PROJECT COST(Rounded to nearest \$1000)	LS			\$ 823,000

AREA 3: DRAINAGE AREA FOR WILLOW BROOK CULVERT



NOT TO SCALE

CARDINAL
ENGINEERING ASSOCIATES

180 RESEARCH PKWY MERIDEN, CT 06450 203-238-1969
457 BANTAM RD | LITCHFIELD, CT 06769 860-397-9106

FEMA DATA

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Connecticut State Plane (FIPSZONE 0600). The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRM for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov/> or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, NNGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at <http://www.ngs.noaa.gov/>.

Base map information shown on this FIRM was provided in digital format by the Connecticut Department of Environmental Protection. This information was derived from digital orthophotos produced at a scale of 1:12,000 from aerial photography flown in 2004 supplemented with aerial photography from 2000.

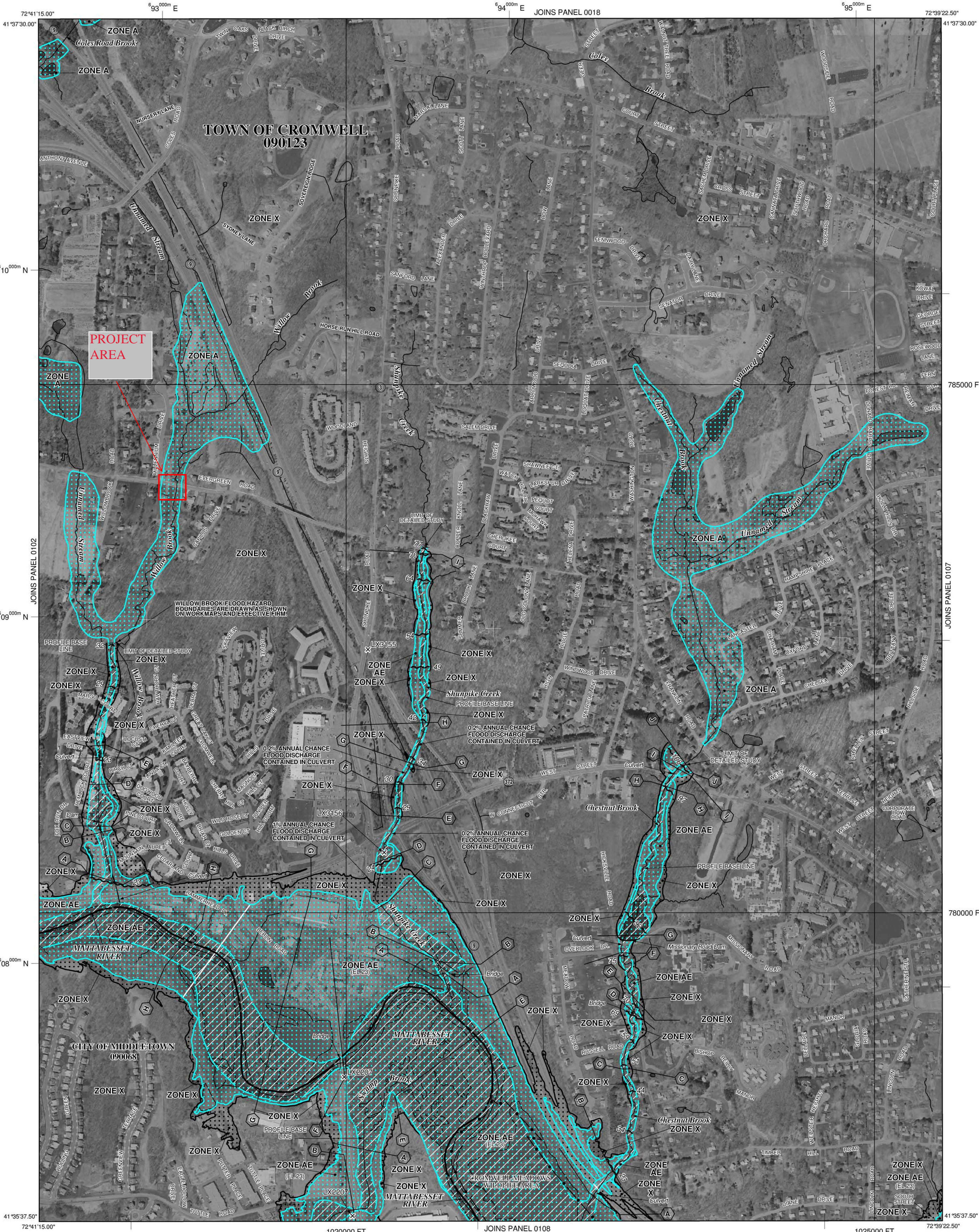
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at <http://www.msc.fema.gov/>.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call 1-877-FEMA MAP (1-877-336-2627) or visit the FEMA website at <http://www.fema.gov/>.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

- ZONE A** No Base Flood Elevations determined.
- ZONE AE** Base Flood Elevations determined.
- ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
- ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- ZONE AR** Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE AE Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

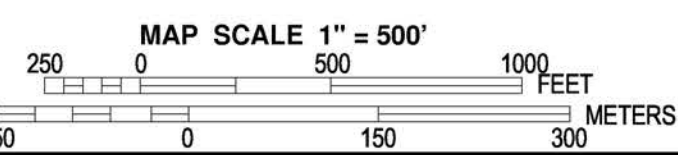
- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- Base Flood Elevation line and value; elevation in feet*
- Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

- A** Cross section line
- 23** Transsect line
- 97°07'30", 32°22'30" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 42°5'00"N 1000-meter Universal Transverse Mercator grid, zone 18
- 6000000 FT 5000-foot grid : Connecticut State Plane coordinate system, (FIPSZONE 0600), Lambert Conformal Conic
- DX5510** Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5** River Mile
- MAP REPOSITORIES** Refer to Map Repositories list on Map Index
- EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP** August 28, 2008
- EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL**

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.



NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0106G

FIRM
FLOOD INSURANCE RATE MAP

MIDDLESEX COUNTY,
CONNECTICUT
(ALL JURISDICTIONS)

PANEL 106 OF 450
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)
CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CROMWELL, TOWN OF	090123	0106	G
MIDDLETOWN, CITY OF	090068	0106	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.



MAP NUMBER
09007C0106G

EFFECTIVE DATE
AUGUST 28, 2008

Federal Emergency Management Agency

APPENDIX D

Area 4-Evergreen Road & Copper Knoll Supporting Documents

180 Research Parkway
 Meriden, Connecticut 06450
 (203) 238-1969

OPINION OF PROBABLE CONSTRUCTION COST

 Town **Town of Cromwell**
 Project **Drainage Improvements**
 Area **#4 Alternate A**
7X3 BOX CULVERT DIVERSION

 Calculated by DL DATE 6/14/2023
 Checked by CH

	Item Number	Items	Unit	Quantities	Unit Price	Cost
1	0201001	CLEARING AND GRUBBING	LS	1	*	*
2	0203000	STRUCTURE EXCAVATION - EARTH (COMPLETE)	CY	600	\$35.00	\$21,000.00
3	0203100	STRUCTURE EXCAVATION - ROCK (COMPLETE)	CY	40	\$85.00	\$3,400.00
4	0204151	HANDLING WATER	LS	1	\$50,000.00	\$50,000.00
5	0210303	TURBIDITY CONTROL CURTAIN	LS	1	\$5,000.00	\$5,000.00
6	0213100	GRANULAR FILL	CY	100	\$72.00	\$7,200.00
7	0216000	PERVIOUS STRUCTURE BACKFILL	CY	800	\$65.00	\$52,000.00
8	0219001	SEDIMENTATION CONTROL SYSTEM	LF	250	\$8.00	\$2,000.00
9	0406128.20	BITUMINOUS CONCRETE PATCHING - FULL DEPTH	SY	40	\$125.00	\$5,000.00
10	0601062	FOOTING CONCRETE	CY	30	\$750.00	\$22,500.00
11	0601064	ABUTMENT AND WALL CONCRETE	CY	30	\$850.00	\$25,500.00
12	0601125	7' x 3' PRECAST CONCRETE BOX CULVERT	LF	280	\$2,500.00	\$700,000.00
13	0703012	INTERMEDIATE RIPRAP	CY	20	\$90.00	\$1,800.00
14	0707009	MEMBRANE WATERPROOFING (COLD LIQUID ELASTOMERIC)	SY	30	\$179.00	\$5,370.00
15	0921001	CONCRETE SIDEWALK	SF	75	\$50.00	\$3,750.00
16	0944000	FURNISHING AND PLACING TOPSOIL	SY	200	\$21.00	\$4,200.00
17	0950005	TURF ESTABLISHMENT	SY	200	\$6.00	\$1,200.00
18	0970001	MAINTENANCE AND PROTECTION OF TRAFFIC	LS	1	*	*
19	0970006	TRAFFICPERSON (MUNICIPAL POLICE OFFICER)	EST	1	\$6,000.00	\$6,000.00
20	0975004	MOBILIZATION AND PROJECT CLOSE-OUT	LS	1	*	*
21	0980001	CONSTRUCTION STAKING	LS	1	*	*
						\$0.00
Major Items Subtotal						\$915,920.00
Minor Items Subtotal (0% at Final Design)			20	% of Major Items Subtotal		\$183,184.00
Contract Items Subtotal						\$1,099,104.00

*** Other Item Allowances**

Clearing and Grubbing	2	% of Contract Items Subtotal	\$	21,982
M & P of Traffic	3	% of Contract Items Subtotal	\$	32,973
Mobilization	5	% of Contract Items Subtotal	\$	54,955
Construction Staking	2	% of Contract Items Subtotal	\$	21,982
Other Items Subtotal			\$	131,892

CONTRACT SUBTOTAL					\$	1,230,996
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Inflation Costs (Simple Method)

Date of Estimate (provide date of estimate)	Jun-23			
Anticipated Bid Date (provide anticipated bid date)	May-24			
Base Years	0.9			
Annual Inflation (5.0% annually, 0% at Final Design)	5.0%			
Inflation Subtotal	4.5%	of Subtotal	\$	55,395

TOTAL CONTRACT COST ESTIMATE (Rounded to nearest \$1000)					\$	1,286,000
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Project Costs Summary (Construction Phase)					
Contract Cost Estimate (Line "G")					\$ 1,286,000
Contingencies	25.0%				\$ 321,500
Construction Engineering/Incidentals	LS				\$ 100,000
ROW					\$ 20,000
Utilities					\$ 20,000
Engineering Design & Permitting					\$ 100,000
TOTAL PROJECT COST(Rounded to nearest \$1000)	LS				\$ 1,848,000

180 Research Parkway
 Meriden, Connecticut 06450
 (203) 238-1969

OPINION OF PROBABLE CONSTRUCTION COST

 Town **Town of Cromwell**
 Project **Drainage Improvements**
 Area **#4 Alternate B**
9X4 BOX CULVERT DIVERSION

 Calculated by DL DATE 6/14/2023
 Checked by CH

	Item Number	Items	Unit	Quantities	Unit Price	Cost
1	0201001	CLEARING AND GRUBBING	LS	1	*	*
2	0203000	STRUCTURE EXCAVATION - EARTH (COMPLETE)	CY	750	\$35.00	\$26,250.00
3	0203100	STRUCTURE EXCAVATION - ROCK (COMPLETE)	CY	50	\$85.00	\$4,250.00
4	0204151	HANDLING WATER	LS	1	\$75,000.00	\$75,000.00
5	0210303	TURBIDITY CONTROL CURTAIN	LS	1	\$5,000.00	\$5,000.00
6	0213100	GRANULAR FILL	CY	150	\$72.00	\$10,800.00
7	0216000	PERVIOUS STRUCTURE BACKFILL	CY	950	\$65.00	\$61,750.00
8	0219001	SEDIMENTATION CONTROL SYSTEM	LF	250	\$8.00	\$2,000.00
9	0406128.20	BITUMINOUS CONCRETE PATCHING - FULL DEPTH	SY	30	\$125.00	\$3,750.00
10	0601062	FOOTING CONCRETE	CY	40	\$750.00	\$30,000.00
11	0601064	ABUTMENT AND WALL CONCRETE	CY	40	\$850.00	\$34,000.00
12	0601125	9' x 4' PRECAST CONCRETE BOX CULVERT	LF	300	\$3,000.00	\$900,000.00
13	0703012	INTERMEDIATE RIPRAP	CY	30	\$90.00	\$2,700.00
14	0707009	MEMBRANE WATERPROOFING (COLD LIQUID ELASTOMERIC)	SY	30	\$179.00	\$5,370.00
15	0921001	CONCRETE SIDEWALK	SF	50	\$50.00	\$2,500.00
16	0944000	FURNISHING AND PLACING TOPSOIL	SY	150	\$21.00	\$3,150.00
17	0950005	TURF ESTABLISHMENT	SY	150	\$6.00	\$900.00
18	0970001	MAINTENANCE AND PROTECTION OF TRAFFIC	LS	1	*	*
19	0970006	TRAFFICPERSON (MUNICIPAL POLICE OFFICER)	EST	1	\$4,000.00	\$4,000.00
20	0975004	MOBILIZATION AND PROJECT CLOSE-OUT	LS	1	*	*
21	0980001	CONSTRUCTION STAKING	LS	1	*	*
						\$0.00
Major Items Subtotal						\$1,171,420.00
Minor Items Subtotal (0% at Final Design)			20	% of Major Items Subtotal		\$234,284.00
Contract Items Subtotal						\$1,405,704.00

*** Other Item Allowances**

Clearing and Grubbing	2	% of Contract Items Subtotal	\$	28,114
M & P of Traffic	3	% of Contract Items Subtotal	\$	42,171
Mobilization	5	% of Contract Items Subtotal	\$	70,285
Construction Staking	2	% of Contract Items Subtotal	\$	28,114
Other Items Subtotal				\$ 168,684

CONTRACT SUBTOTAL	\$ 1,574,388
--------------------------	---------------------

Inflation Costs (Simple Method)

Date of Estimate (provide date of estimate)	Jun-23		
Anticipated Bid Date (provide anticipated bid date)	May-24		
Base Years	0.9		
Annual Inflation (5.0% annually, 0% at Final Design)	5.0%		
Inflation Subtotal	4.5%	of Subtotal	\$ 70,847

TOTAL CONTRACT COST ESTIMATE (Rounded to nearest \$1000)	\$ 1,645,000
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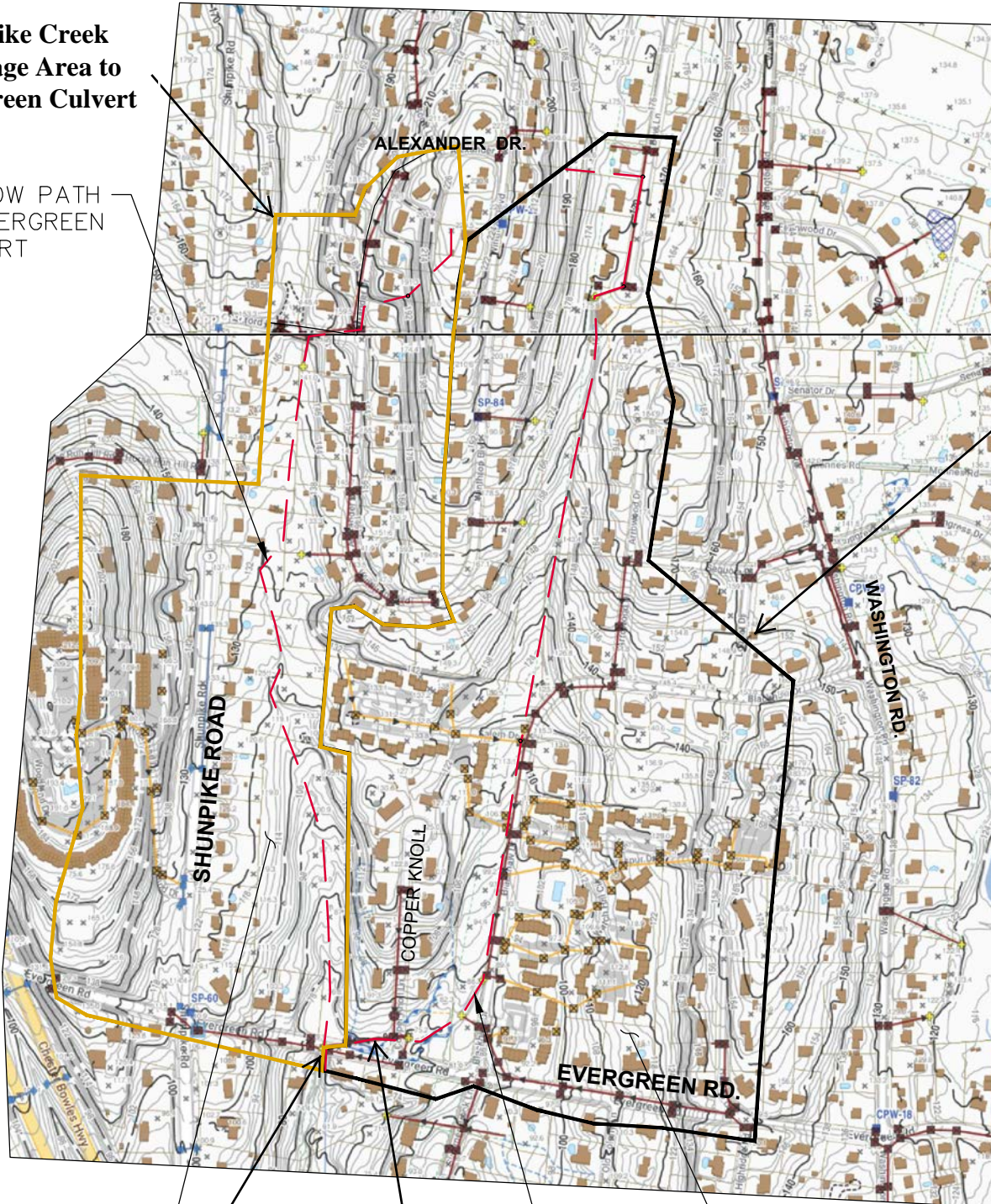
Project Costs Summary (Construction Phase)				
Contract Cost Estimate (Line "G")				\$ 1,645,000
Contingencies	25.0%			\$ 411,250
Construction Engineering/Incidentals	LS			\$ 100,000
ROW				\$ 20,000
Utilities				\$ 20,000
Engineering Design & Permitting	7.0%			\$ 115,150
TOTAL PROJECT COST(Rounded to nearest \$1000)	LS			\$ 2,312,000

AREA 4: DRAINAGE AREA FOR SHUNPIKE CREEK AT EVERGREEN CULVERT

Shunpike Creek
Drainage Area to
Evergreen Culvert

T_C FLOW PATH
TO EVERGREEN
CULVERT

Drainage Area
to Copper
Knoll culvert



DRAINAGE AREA =
62 ACRES

Evergreen Rd
culvert

Copper Knoll
culvert

T_C FLOW PATH TO
COPPER KNOLL CULVERT

DRAINAGE AREA = 86 ACRES

TOTAL DRAINAGE AREA = 148 ACRES



NOT TO SCALE

CARDINAL
ENGINEERING ASSOCIATES

180 RESEARCH PKWY | MERIDEN, CT 06450 | 203-238-1969
457 BANTAM RD | LITCHFIELD, CT 06769 | 860-397-9106

FEMA DATA

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Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

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NGS Information Services
NOAA, NNGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

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LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

- ZONE A** No Base Flood Elevations determined.
- ZONE AE** Base Flood Elevations determined.
- ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
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- ZONE AR** Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

- ZONE X** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

- ZONE AE** Areas determined to be outside the 0.2% annual chance floodplain.
- ZONE D** Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

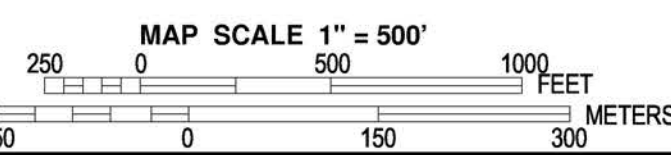
- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- Base Flood Elevation line and value; elevation in feet*
- Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

- A** Cross section line
- 23** Transect line
- 97°07'30", 32°22'30" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 42°5'00"N 1000-meter Universal Transverse Mercator grid, zone 18
- 6000000 FT 5000-foot grid : Connecticut State Plane coordinate system, (FIPSZONE 0600), Lambert Conformal Conic
- DX5510** Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5** River Mile
- MAP REPOSITORIES** Refer to Map Repositories list on Map Index
- EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP** August 28, 2008
- EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL**

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.



NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0106G

FIRM FLOOD INSURANCE RATE MAP

MIDDLESEX COUNTY,
CONNECTICUT
(ALL JURISDICTIONS)

PANEL 106 OF 450
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CROMWELL, TOWN OF	090123	0106	G
MIDDLETOWN, CITY OF	090068	0106	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.



MAP NUMBER
09007C0106G

EFFECTIVE DATE
AUGUST 28, 2008

Federal Emergency Management Agency

APPENDIX E

Area 5-Geer Street Supporting Documents

CARDINAL
ENGINEERING ASSOCIATES
180 Research Parkway
Meriden, Connecticut 06450
(203) 238-1969

OPINION OF PROBABLE CONSTRUCTION COST

Town **Town of Cromwell**
Project **Drainage Improvements**
Area **#5**

Alt A: Two 10x4 BOX CULVERTS

Calculated by DL DATE 7/3/2023
Checked by CH

	Item Number	Items	Unit	Quantities	Unit Price	Cost
1	0201001	CLEARING AND GRUBBING	LS	1	*	*
2	0202216A	EXCAVATION AND REUSE OF EXISTING CHANNEL BOTTOM MATERIAL	CY	40	\$80.00	\$3,200.00
3	0202217A	SUPPLEMENTAL STREAMBED CHANNEL MATERIAL	CY	40	\$200.00	\$8,000.00
4	0203000	STRUCTURE EXCAVATION - EARTH (COMPLETE)	CY	100	\$35.00	\$3,500.00
5	0203100	STRUCTURE EXCAVATION - ROCK (COMPLETE)	CY	20	\$85.00	\$1,700.00
6	0204151	HANDLING WATER	LS	1	\$75,000.00	\$75,000.00
7	0210303	TURBIDITY CONTROL CURTAIN	LS	1	\$5,000.00	\$5,000.00
8	0213100	GRANULAR FILL	CY	60	\$72.00	\$4,320.00
9	0216000	PERVIOUS STRUCTURE BACKFILL	CY	160	\$65.00	\$10,400.00
10	0219001	SEDIMENTATION CONTROL SYSTEM	LF	250	\$8.00	\$2,000.00
11	0406128.20	BITUMINOUS CONCRETE PATCHING - FULL DEPTH	SY	50	\$125.00	\$6,250.00
12	0503866	REMOVAL OF EXISTING CULVERT	LS	2	\$10,000.00	\$20,000.00
#REF!	0601062	FOOTING CONCRETE	CY	30	\$750.00	\$22,500.00
#REF!	0601064	ABUTMENT AND WALL CONCRETE	CY	30	\$850.00	\$25,500.00
#REF!	0601125	10' x 4' PRECAST CONCRETE BOX CULVERT	LF	70	\$3,000.00	\$210,000.00
#REF!	0703012	INTERMEDIATE RIPRAP	CY	30	\$90.00	\$2,700.00
#REF!	0707009	MEMBRANE WATERPROOFING (COLD LIQUID ELASTOMERIC)	SY	40	\$179.00	\$7,160.00
#REF!	0910184	METAL BEAM RAIL SPAN SECTION TYPE II	EA	2	\$4,500.00	\$9,000.00
#REF!	0911924	R-B END ANCHORAGE TYPE II	EA	4	\$2,000.00	\$8,000.00
#REF!	0921001	CONCRETE SIDEWALK	SF	60	\$50.00	\$3,000.00
#REF!	0944000	FURNISHING AND PLACING TOPSOIL	SY	140	\$21.00	\$2,940.00
#REF!	0950005	TURF ESTABLISHMENT	SY	140	\$6.00	\$840.00
#REF!	0970001	MAINTENANCE AND PROTECTION OF TRAFFIC	LS	1	*	*
#REF!	0970006	TRAFFICPERSON (MUNICIPAL POLICE OFFICER)	EST	1	\$6,000.00	\$6,000.00
#REF!	0975004	MOBILIZATION AND PROJECT CLOSE-OUT	LS	1	*	*
#REF!	0980001	CONSTRUCTION STAKING	LS	1	*	*
						\$0.00
Major Items Subtotal						\$425,810.00
Minor Items Subtotal (0% at Final Design)			20	% of Major Items Subtotal		\$85,162.00
Contract Items Subtotal						\$510,972.00

*** Other Item Allowances**

Clearing and Grubbing	2	% of Contract Items Subtotal	\$	10,219
M & P of Traffic	3	% of Contract Items Subtotal	\$	15,329
Mobilization	5	% of Contract Items Subtotal	\$	25,549
Construction Staking	2	% of Contract Items Subtotal	\$	10,219
Other Items Subtotal			\$	61,316

CONTRACT SUBTOTAL **\$ 572,288**

Inflation Costs (Simple Method)

Date of Estimate (provide date of estimate)	Jun-23			
Anticipated Bid Date (provide anticipated bid date)	May-24			
Base Years	0.9			
Annual Inflation (5.0% annually, 0% at Final Design)	5.0%			
Inflation Subtotal	4.5%	of Subtotal	\$	25,753

TOTAL CONTRACT COST ESTIMATE (Rounded to nearest \$1000) **\$ 598,000**

Project Costs Summary (Construction Phase)			
Contract Cost Estimate (Line "G")	25.0%		\$ 598,000
Contingencies			\$ 149,500
Construction Engineering/Incidentals			\$ 100,000
ROW			\$ 20,000
Utilities			\$ 20,000
Engineering Design & Permitting			\$ 100,000
TOTAL PROJECT COST(Rounded to nearest \$1000)	LS		\$ 987,500



180 Research Parkway
Meriden, Connecticut 06450
(203) 238-1969

OPINION OF PROBABLE CONSTRUCTION COST

Town **Town of Cromwell**
Project **Drainage Improvements**
Area **#5**

Two 12x4 BOX CULVERTS

Calculated by DL DATE 6/14/2023
Checked by CH

	Item Number	Items	Unit	Quantities	Unit Price	Cost
1	0201001	CLEARING AND GRUBBING	LS	1	*	*
2	0202216A	EXCAVATION AND REUSE OF EXISTING CHANNEL BOTTOM MATERIAL	CY	50	\$80.00	\$4,000.00
3	0202217A	SUPPLEMENTAL STREAMBED CHANNEL MATERIAL	CY	50	\$200.00	\$10,000.00
4	0203000	STRUCTURE EXCAVATION - EARTH (COMPLETE)	CY	130	\$35.00	\$4,550.00
5	0203100	STRUCTURE EXCAVATION - ROCK (COMPLETE)	CY	20	\$85.00	\$1,700.00
6	0204151	HANDLING WATER	LS	1	\$75,000.00	\$75,000.00
7	0210303	TURBIDITY CONTROL CURTAIN	LS	1	\$5,000.00	\$5,000.00
8	0213100	GRANULAR FILL	CY	60	\$72.00	\$4,320.00
9	0216000	PERVIOUS STRUCTURE BACKFILL	CY	200	\$65.00	\$13,000.00
10	0219001	SEDIMENTATION CONTROL SYSTEM	LF	250	\$8.00	\$2,000.00
11	0406128.20	BITUMINOUS CONCRETE PATCHING - FULL DEPTH	SY	55	\$125.00	\$6,875.00
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#REF!	0601064	ABUTMENT AND WALL CONCRETE	CY	40	\$850.00	\$34,000.00
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#REF!	0980001	CONSTRUCTION STAKING	LS	1	*	*
						\$0.00
Major Items Subtotal						\$488,085.00
Minor Items Subtotal (0% at Final Design)			20	% of Major Items Subtotal		\$97,617.00
Contract Items Subtotal						\$585,702.00

* Other Item Allowances

Clearing and Grubbing	2	% of Contract Items Subtotal	\$	11,714
M & P of Traffic	3	% of Contract Items Subtotal	\$	17,571
Mobilization	5	% of Contract Items Subtotal	\$	29,285
Construction Staking	2	% of Contract Items Subtotal	\$	11,714
Other Items Subtotal			\$	70,284

CONTRACT SUBTOTAL **\$ 655,986**

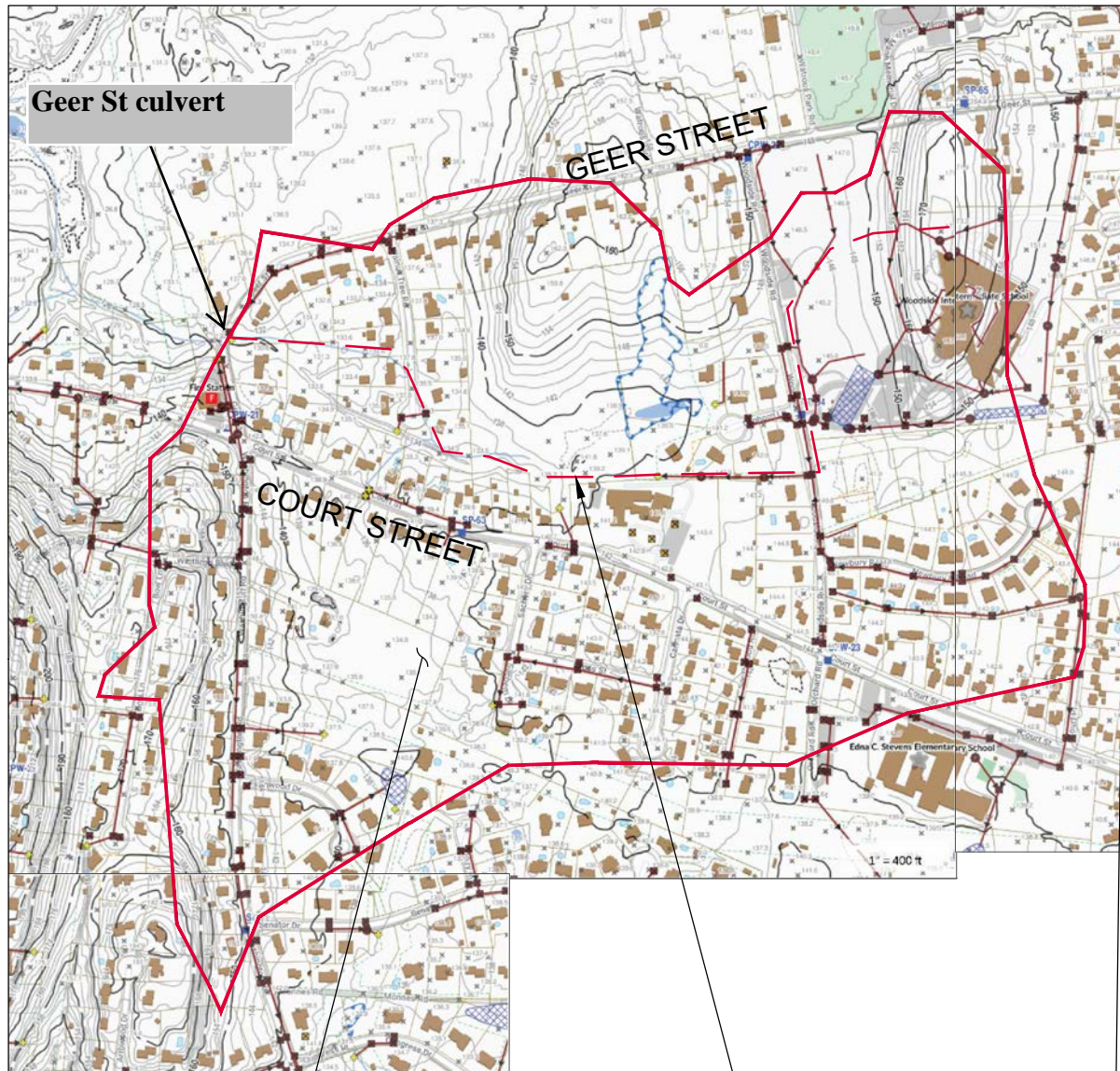
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Inflation Subtotal	4.5%	of Subtotal	\$	29,519

TOTAL CONTRACT COST ESTIMATE (Rounded to nearest \$1000) **\$ 686,000**

Project Costs Summary (Construction Phase)			
Contract Cost Estimate (Line "G")	25.0%		\$ 686,000
Contingencies			\$ 171,500
Construction Engineering/Incidentals			\$ 100,000
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Utilities			\$ 20,000
Engineering Design & Permitting			\$ 100,000
TOTAL PROJECT COST(Rounded to nearest \$1000)	LS		\$ 1,098,000

AREA 5: DRAINAGE AREA FOR COLES BROOK AT GEER STREET



DRAINAGE AREA =
105 ACRES

T_c FLOW PATH
TO CULVERT



NOT TO SCALE

CARDINAL
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180 RESEARCH PKWY | MERIDEN, CT 06450 | 203-238-1969
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LEGEND

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- ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

- ZONE X** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

- ZONE X** Areas determined to be outside the 0.2% annual chance floodplain.
- ZONE D** Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

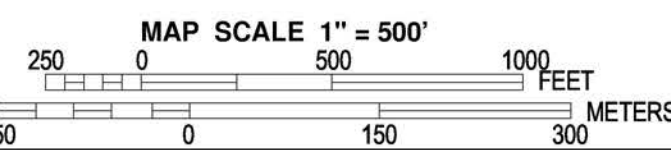
- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- Base Flood Elevation line and value; elevation in feet*
- Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

- (A) --- (A)** Cross section line
- (2) --- (2)** Transsect line
- Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 1000-meter Universal Transverse Mercator grid, zone 18
- 5000-foot grid : Connecticut State Plane coordinate system, (FIPSZONE 0600), Lambert Conformal Conic
- DX5510** Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5** River Mile
- MAP REPOSITORIES** Refer to Map Repositories list on Map Index
- EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP** August 28, 2008
- EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL**

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.



NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0106G

FIRM FLOOD INSURANCE RATE MAP MIDDLESEX COUNTY, CONNECTICUT (ALL JURISDICTIONS)

PANEL 106 OF 450

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CROMWELL, TOWN OF	090123	0106	G
MIDDLETOWN, CITY OF	090068	0106	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.



MAP NUMBER
09007C0106G

EFFECTIVE DATE
AUGUST 28, 2008

Federal Emergency Management Agency

APPENDIX F

Area 6 Pierson Park Supporting Documents

180 Research Parkway
 Meriden, Connecticut 06450
 (203) 238-1969

OPINION OF PROBABLE CONSTRUCTION COST

 Town **Town of Cromwell**
 Project **Drainage Improvements**
 Area **#6 Alternate A**
Increase Stormwater Pipe Capacity at Pierson Park
 Calculated by CH/DL DATE 7/4/2023
 Checked by _____

	Item Number	Items	Unit	Quantities	Unit Price	Cost
1	0201001A	CLEARING AND GRUBBING	LS	1	*	*
2	0202200	CHANNEL EXCAVATION - EARTH	CY	20	\$30.00	\$600.00
3	0202529	CUT BITUMINOUS CONCRETE PAVEMENT	LF	100	\$3.00	\$300.00
4	0213100	GRANULAR FILL	CY	80	\$60.00	\$4,800.00
5	0219001	SEDIMENTATION CONTROL SYSTEM	LF	200	\$6.00	\$1,200.00
6	0219011	SEDIMENTATION CONTROL SYSTEM AT CATCH BASIN	EA	6	\$120.00	\$720.00
7	0406128.20	BITUMINOUS CONCRETE PATCHING - FULL DEPTH	SY	550	\$125.00	\$68,750.00
8	0506040	PRECAST CONCRETE HEADWALL	EA	1	\$5,000.00	\$5,000.00
9	0601062	FOOTING CONCRETE	CY	10	\$750.00	\$7,500.00
10	0601064	ABUTMENT AND WALL CONCRETE	CY	20	\$750.00	\$15,000.00
11	0686000.48	48" R.C. PIPE - 0' - 10' DEEP	LF	440	\$250.00	\$110,000.00
12	0703012	MODIFIED RIP RAP	CY	15	\$105.00	\$1,575.00
13	0755001	NON-WOVEN FILTER FABRIC	SY	70	\$4.00	\$280.00
14	0815001	BITUMINOUS CONCRETE LIP CURB	LF	100	\$8.00	\$800.00
15	0921001	CONCRETE SIDEWALK	SF	100	\$15.00	\$1,500.00
16	0944000	FURNISHING AND PLACING TOPSOIL	SY	100	\$7.00	\$700.00
17	0950005	TURF ESTABLISHMENT	SY	100	\$2.00	\$200.00
18	0970007	TRAFFICPERSON (UNIFORMED FLAGGER)	HR	200	\$40.00	\$8,000.00
19	0971001A	MAINTENANCE AND PROTECTION OF TRAFFIC	LS	1	*	*
20	0975004	MOBILIZATION AND PROJECT CLOSE-OUT	LS	1	*	*
21	0980001	CONSTRUCTION STAKING	LS	1	*	*
						\$0.00
Major Items Subtotal						\$226,925.00
Minor Items Subtotal (0% at Final Design)			20	% of Major Items Subtotal		\$45,385.00
Contract Items Subtotal						\$272,310.00

*** Other Item Allowances**

Clearing and Grubbing	2	% of Contract Items Subtotal	\$	5,446
M & P of Traffic	10	% of Contract Items Subtotal	\$	27,231
Mobilization	10	% of Contract Items Subtotal	\$	27,231
Construction Staking	1	% of Contract Items Subtotal	\$	2,723
Other Items Subtotal			\$	62,631
CONTRACT SUBTOTAL			\$	334,941

Inflation Costs (Simple Method)

Date of Estimate (provide date of estimate)	Jun-23			
Anticipated Bid Date (provide anticipated bid date)	May-24			
Base Years	0.9			
Annual Inflation (5.0% annually, 0% at Final Design)	5.0%			
Inflation Subtotal	4.5%	of Subtotal	\$	15,072

TOTAL CONTRACT COST ESTIMATE (Rounded to nearest \$1000)	\$	350,000
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Project Costs Summary (Construction Phase)				
Contract Cost Estimate (Line "G")				\$ 350,000
Contingencies	20.0%			\$ 70,000
Construction Engineering/Incidentals				\$ 75,000
ROW				\$ -
Utilities				\$ 15,000
Engineering Design & Permitting				\$ 100,000
TOTAL PROJECT COST(Rounded to nearest \$1000)	LS			\$ 610,000

180 Research Parkway
 Meriden, Connecticut 06450
 (203) 238-1969

OPINION OF PROBABLE CONSTRUCTION COST

 Town **Town of Cromwell**
 Project **Drainage Improvements**
 Area **#6**
6X6 BOX CULVERT

 Calculated by DL DATE 7/3/2023
 Checked by CH

	Item Number	Items	Unit	Quantities	Unit Price	Cost
1	0201001	CLEARING AND GRUBBING	LS	1	*	*
2	0202216A	EXCAVATION AND REUSE OF EXISTING CHANNEL BOTTOM MATERIAL	CY	50	\$80.00	\$4,000.00
#REF!	0203000	STRUCTURE EXCAVATION - EARTH (COMPLETE)	CY	730	\$35.00	\$25,550.00
#REF!	0203100	STRUCTURE EXCAVATION - ROCK (COMPLETE)	CY	80	\$85.00	\$6,800.00
#REF!	0204151	HANDLING WATER	LS	1	\$100,000.00	\$100,000.00
#REF!	0210303	TURBIDITY CONTROL CURTAIN	LS	1	\$5,000.00	\$5,000.00
#REF!	0213100	GRANULAR FILL	CY	150	\$72.00	\$10,800.00
#REF!	0216000	PERVIOUS STRUCTURE BACKFILL	CY	2400	\$65.00	\$156,000.00
#REF!	0219001	SEDIMENTATION CONTROL SYSTEM	LF	250	\$8.00	\$2,000.00
#REF!	0406128.20	BITUMINOUS CONCRETE PATCHING - FULL DEPTH	SY	600	\$125.00	\$75,000.00
#REF!	0503866	REMOVAL OF EXISTING CULVERT	LS	1	\$35,000.00	\$35,000.00
#REF!	0601062	FOOTING CONCRETE	CY	40	\$750.00	\$30,000.00
#REF!	0601064	ABUTMENT AND WALL CONCRETE	CY	40	\$850.00	\$34,000.00
#REF!	0601125	6' x 6' PRECAST CONCRETE BOX CULVERT	LF	440	\$3,000.00	\$1,320,000.00
#REF!	0703012	INTERMEDIATE RIPRAP	CY	60	\$90.00	\$5,400.00
#REF!	0707009	MEMBRANE WATERPROOFING (COLD LIQUID ELASTOMERIC)	SY	400	\$179.00	\$71,600.00
#REF!	0910184	METAL BEAM RAIL SPAN SECTION TYPE II	EA	2	\$4,500.00	\$9,000.00
#REF!	0911924	R-B END ANCHORAGE TYPE II	EA	4	\$2,000.00	\$8,000.00
#REF!	0921001	CONCRETE SIDEWALK	SF	150	\$50.00	\$7,500.00
#REF!	0944000	FURNISHING AND PLACING TOPSOIL	SY	200	\$21.00	\$4,200.00
#REF!	0950005	TURF ESTABLISHMENT	SY	200	\$6.00	\$1,200.00
#REF!	0970001	MAINTENANCE AND PROTECTION OF TRAFFIC	LS	1	*	*
#REF!	0970006	TRAFFICPERSON (MUNICIPAL POLICE OFFICER)	EST	1	\$6,000.00	\$6,000.00
#REF!	0975004	MOBILIZATION AND PROJECT CLOSE-OUT	LS	1	*	*
#REF!	0980001	CONSTRUCTION STAKING	LS	1	*	*
						\$0.00
Major Items Subtotal						\$1,913,050.00
Minor Items Subtotal (0% at Final Design)			20	% of Major Items Subtotal		\$382,610.00
Contract Items Subtotal						\$2,295,660.00

*** Other Item Allowances**

Clearing and Grubbing	1	% of Contract Items Subtotal	\$ 22,957
M & P of Traffic	3	% of Contract Items Subtotal	\$ 68,870
Mobilization	5	% of Contract Items Subtotal	\$ 114,783
Construction Staking	1	% of Contract Items Subtotal	\$ 22,957
Other Items Subtotal	\$ 229,567		

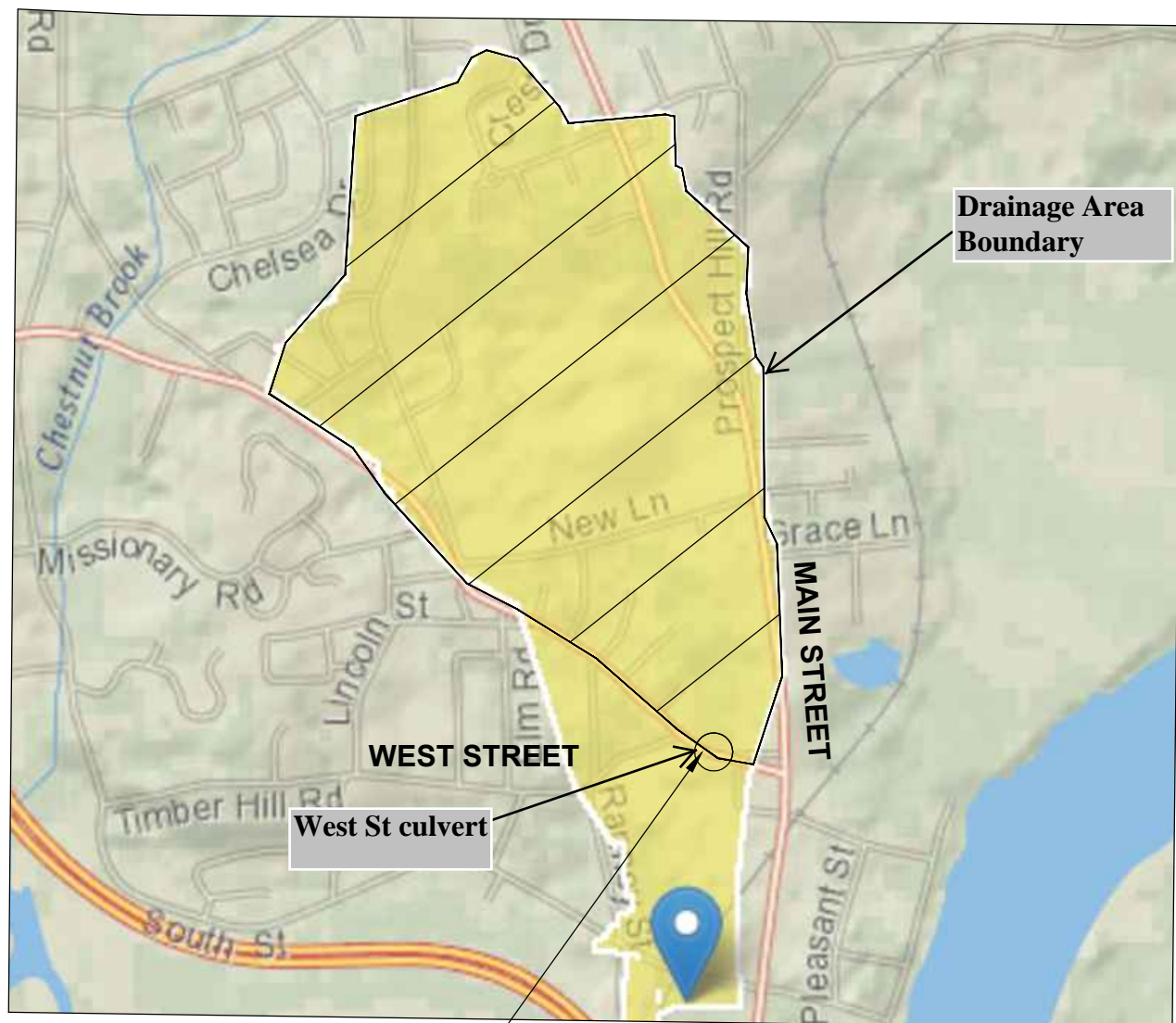
CONTRACT SUBTOTAL **\$ 2,525,227**
Inflation Costs (Simple Method)

Date of Estimate (provide date of estimate)	Jun-23
Anticipated Bid Date (provide anticipated bid date)	May-24
Base Years	0.9
Annual Inflation (5.0% annually, 0% at Final Design)	5.0%
Inflation Subtotal	4.5% of Subtotal \$ 113,635

TOTAL CONTRACT COST ESTIMATE (Rounded to nearest \$1000) **\$ 2,639,000**

Project Costs Summary (Construction Phase)			
Contract Cost Estimate (Line "G")			\$ 2,639,000
Contingencies	20.0%		\$ 527,800
Construction Engineering/Incidentals			\$ 100,000
ROW			\$ 20,000
Utilities			\$ 20,000
Engineering Design & Permitting			\$ 120,000
TOTAL PROJECT COST(Rounded to nearest \$1000)	LS		\$ 3,427,000

AREA 6 DRAINAGE AREA FOR WEST STREET CULVERT (PIERSON PARK)



DRAINAGE AREA = 326 AC



NOT TO SCALE

CARDINAL
ENGINEERING ASSOCIATES

180 RESEARCH PKWY | MERIDEN, CT 06450 | 203-238-1969
457 BANTAM RD | LITCHFIELD, CT 06769 | 860-397-9106

FEMA DATA

APPENDIX G

Area 7-Glenwood Terrace & Field Road Supporting Documents

CARDINAL
ENGINEERING ASSOCIATES
180 Research Parkway
Meriden, Connecticut 06450
(203) 238-1969

OPINION OF PROBABLE CONSTRUCTION COST

Town **Town of Cromwell**
Project **Drainage Improvements**
Area **#7 Alternate A**
Install Interceptor Drain/Connect to Town Drainage
Calculated by DL DATE 6/8/2023
Checked by _____

	Item Number	Items	Unit	Quantities	Unit Price	Cost
1	0201001A	CLEARING AND GRUBBING	LS	1	*	*
2	0202000A	EARTH EXCAVATION	CY	500	\$25.00	\$12,500.00
3	0202200	CHANNEL EXCAVATION - EARTH	CY	150	\$30.00	\$4,500.00
4	0202529	CUT BITUMINOUS CONCRETE PAVEMENT	LF	400	\$3.00	\$1,200.00
5	0209001	FORMATION OF SUBGRADE	SY	400	\$4.00	\$1,600.00
6	0213100	GRANULAR FILL	CY	40	\$60.00	\$2,400.00
7	0219001	SEDIMENTATION CONTROL SYSTEM	LF	800	\$6.00	\$4,800.00
8	0219011	SEDIMENTATION CONTROL SYSTEM AT CATCH BASIN	EA	1	\$120.00	\$120.00
9	0304002	PROCESSED AGGREGATE BASE	CY	25	\$45.00	\$1,125.00
10	0406171	HMA S 0.5	TON	60	\$150.00	\$9,000.00
11	0507598	TRASH RACK	EA	1	\$5,000.00	\$5,000.00
12	0586006.6	SINGLE C CATCH BASIN WITH 4' SUMP	EA	1	\$5,500.00	\$5,500.00
13	0586006.10	DOUBLE TYPE CL CATCH BASIN WITH 4' SUMP	EA	1	\$7,500.00	\$7,500.00
14	0586501.05	MANHOLE (5' DIAMETER) - 0'-10' DEEP	EA	2	\$6,000.00	\$12,000.00
15	0686000.12	12" R.C. PIPE - 0' - 10' DEEP	LF	20	\$90.00	\$1,800.00
16	0686000.18	24" R.C. PIPE - 0' - 10' DEEP	LF	655	\$135.00	\$88,425.00
17	0686000.18	36" R.C. PIPE - 0' - 10' DEEP	LF	15	\$175.00	\$2,625.00
18	0703012	MODIFIED RIP RAP	CY	100	\$300.00	\$30,000.00
19	0755001	NON-WOVEN FILTER FABRIC	SY	50	\$4.00	\$200.00
20	0815001	BITUMINOUS CONCRETE LIP CURB	LF	50	\$8.00	\$400.00
21	0944000	FURNISHING AND PLACING TOPSOIL	SY	500	\$10.00	\$5,000.00
22	0950005	TURF ESTABLISHMENT	SY	500	\$5.00	\$2,500.00
23	0970007	TRAFFICPERSON (UNIFORMED FLAGGER)	HR	80	\$40.00	\$3,200.00
24	0971001A	MAINTENANCE AND PROTECTION OF TRAFFIC	LS	1	*	*
25	0975004	MOBILIZATION AND PROJECT CLOSE-OUT	LS	1	*	*
26	0980001	CONSTRUCTION STAKING	LS	1	*	*
						\$0.00
Major Items Subtotal						\$201,395.00
Minor Items Subtotal (0% at Final Design)			20	% of Major Items Subtotal		\$40,279.00
Contract Items Subtotal						\$241,674.00

*** Other Item Allowances**

Clearing and Grubbing	1	% of Contract Items Subtotal	\$ 2,417
M & P of Traffic	5	% of Contract Items Subtotal	\$ 12,084
Mobilization	8	% of Contract Items Subtotal	\$ 19,334
Construction Staking	1	% of Contract Items Subtotal	\$ 2,417
Other Items Subtotal	\$ 36,252		

CONTRACT SUBTOTAL	\$ 277,926
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Inflation Costs (Simple Method)

Date of Estimate (provide date of estimate)	Jun-23
Anticipated Bid Date (provide anticipated bid date)	May-24
Base Years	0.9
Annual Inflation (3.5% annually, 0% at Final Design)	5.0%
Inflation Subtotal	4.5% of Subtotal \$ 12,507

TOTAL CONTRACT COST ESTIMATE (Rounded to nearest \$1000)	\$ 290,000
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Project Costs Summary (Construction Phase)				
Contract Cost Estimate (Line "G")				\$ 290,000
Contingencies	25.0%			\$ 72,500
Construction Engineering/Incidentals	15.0%			\$ 43,500
ROW				\$ 20,000
Utilities				\$ 10,000
Engineering Design & Permitting	20.0%			\$ 58,000
TOTAL PROJECT COST(Rounded to nearest \$1000)	LS			\$ 494,000

180 Research Parkway
 Meriden, Connecticut 06450
 (203) 238-1969

OPINION OF PROBABLE CONSTRUCTION COST

 Town **Town of Cromwell**
 Project **Drainage Improvements**
 Area **#7 Alternate B**
Install Interceptor Drain/Discharge across railroad

 Calculated by DL DATE 6/8/2023

Checked by _____

	Item Number	Items	Unit	Quantities	Unit Price	Cost
1	0201001A	CLEARING AND GRUBBING	LS	1	*	*
2	0202000A	EARTH EXCAVATION	CY	500	\$25.00	\$12,500.00
3	0213100	GRANULAR FILL	CY	40	\$60.00	\$2,400.00
4	0219001	SEDIMENTATION CONTROL SYSTEM	LF	550	\$6.00	\$3,300.00
5	0219011	SEDIMENTATION CONTROL SYSTEM AT CATCH BASIN	EA	1	\$120.00	\$120.00
6	0406128.20	BITUMINOUS CONCRETE PATCHING - FULL DEPTH	SY	20	\$100.00	\$2,000.00
7	0507598	TRASH RACK	EA	1	\$5,000.00	\$5,000.00
8	0586006.10	DOUBLE TYPE CL CATCH BASIN WITH 4' SUMP	EA	1	\$7,500.00	\$7,500.00
9	0586501.05	MANHOLE (5' DIAMETER) - 0'-10' DEEP	EA	4	\$6,000.00	\$24,000.00
10	0651049	JACK and BORE 24" RCP CLASS V	LF	100	\$2,500.00	\$250,000.00
11		JACKING PIT	EA	1	\$50,000.00	\$50,000.00
12		RECEIVING PIT	EA	1	\$30,000.00	\$30,000.00
13	0686000.18	24" R.C. PIPE - 0' - 10' DEEP	LF	435	\$135.00	\$58,725.00
14	0703012	MODIFIED RIP RAP	CY	30	\$300.00	\$9,000.00
15	0944000	FURNISHING AND PLACING TOPSOIL	SY	600	\$10.00	\$6,000.00
16	0950005	TURF ESTABLISHMENT	SY	600	\$5.00	\$3,000.00
17	0970007	TRAFFICPERSON (UNIFORMED FLAGGER)	HR	0	\$40.00	\$0.00
18	0971001A	MAINTENANCE AND PROTECTION OF TRAFFIC	LS	1	*	*
19	0975004	MOBILIZATION AND PROJECT CLOSE-OUT	LS	1	*	*
20	0980001	CONSTRUCTION STAKING	LS	1	*	*
						\$0.00
Major Items Subtotal						\$463,545.00
Minor Items Subtotal (0% at Final Design)			20	% of Major Items Subtotal		\$92,709.00
Contract Items Subtotal						\$556,254.00

*** Other Item Allowances**

Clearing and Grubbing	2	% of Contract Items Subtotal	\$	11,125
M & P of Traffic	1	% of Contract Items Subtotal	\$	5,563
Mobilization	5	% of Contract Items Subtotal	\$	27,813
Construction Staking	1	% of Contract Items Subtotal	\$	5,563
Other Items Subtotal			\$	50,064

CONTRACT SUBTOTAL	\$ 606,318
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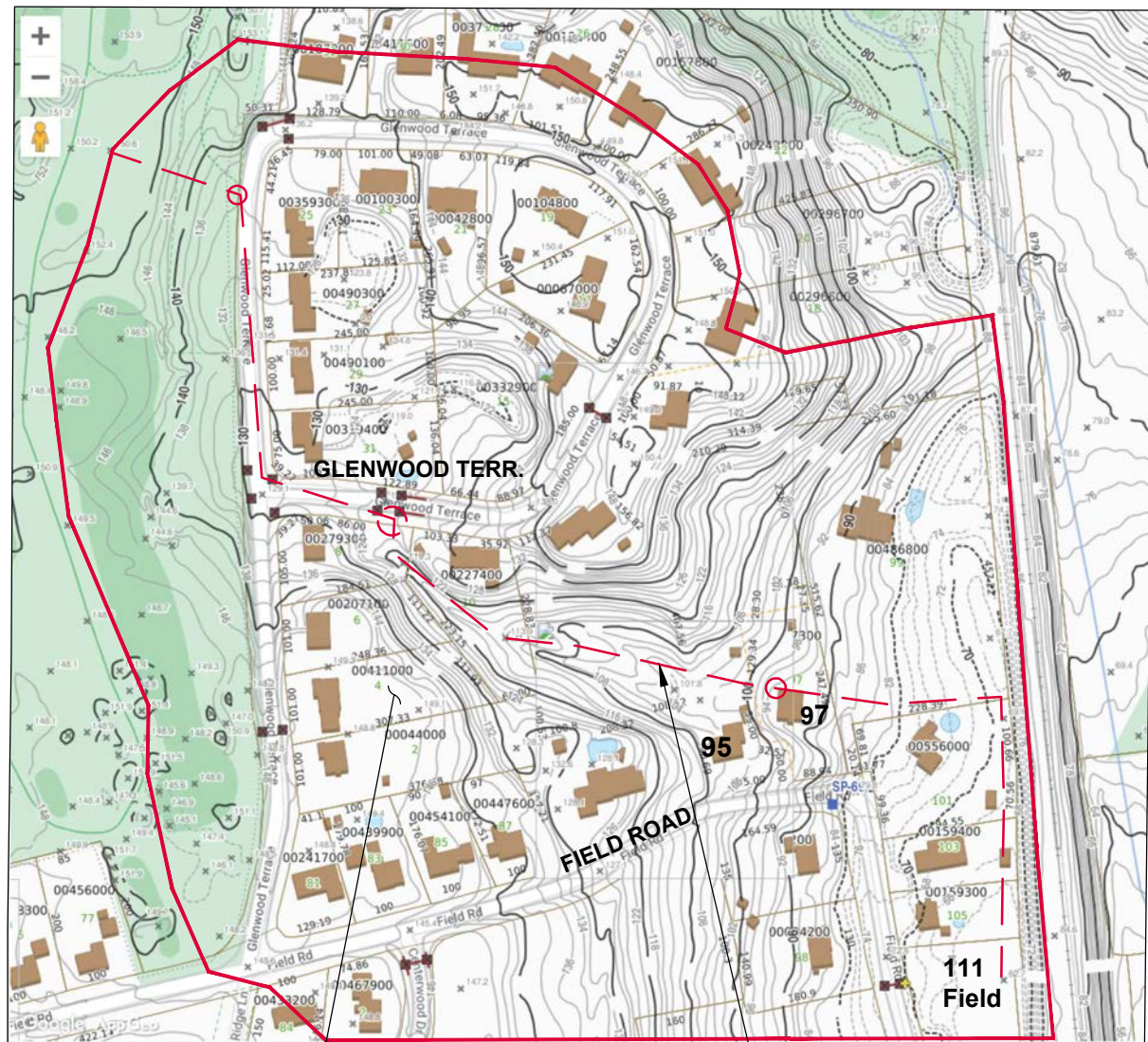
Inflation Costs (Simple Method)

Date of Estimate (provide date of estimate)	Jun-23			
Anticipated Bid Date (provide anticipated bid date)	May-24			
Base Years	0.9			
Annual Inflation (3.5% annually, 0% at Final Design)	5.0%			
Inflation Subtotal	4.5%	of Subtotal	\$	27,284

TOTAL CONTRACT COST ESTIMATE (Rounded to nearest \$1000)	\$ 634,000
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Project Costs Summary (Construction Phase)				
Contract Cost Estimate (Line "G")				\$ 634,000
Contingencies	20.0%			\$ 126,800
Construction Engineering/Incidentals				\$ 60,000
ROW				\$ 50,000
Utilities				\$ 30,000
Engineering Design & Permitting				\$ 80,000
TOTAL PROJECT COST(Rounded to nearest \$1000)	LS			\$ 981,000

AREA 7: DRAINAGE AREA FOR STORMWATER FLOWING TO 111 FIELD ROAD FROM NORTH



DRAINAGE AREA = 39 ACRES

T_c FLOW PATH TO #111 FIELD ROAD

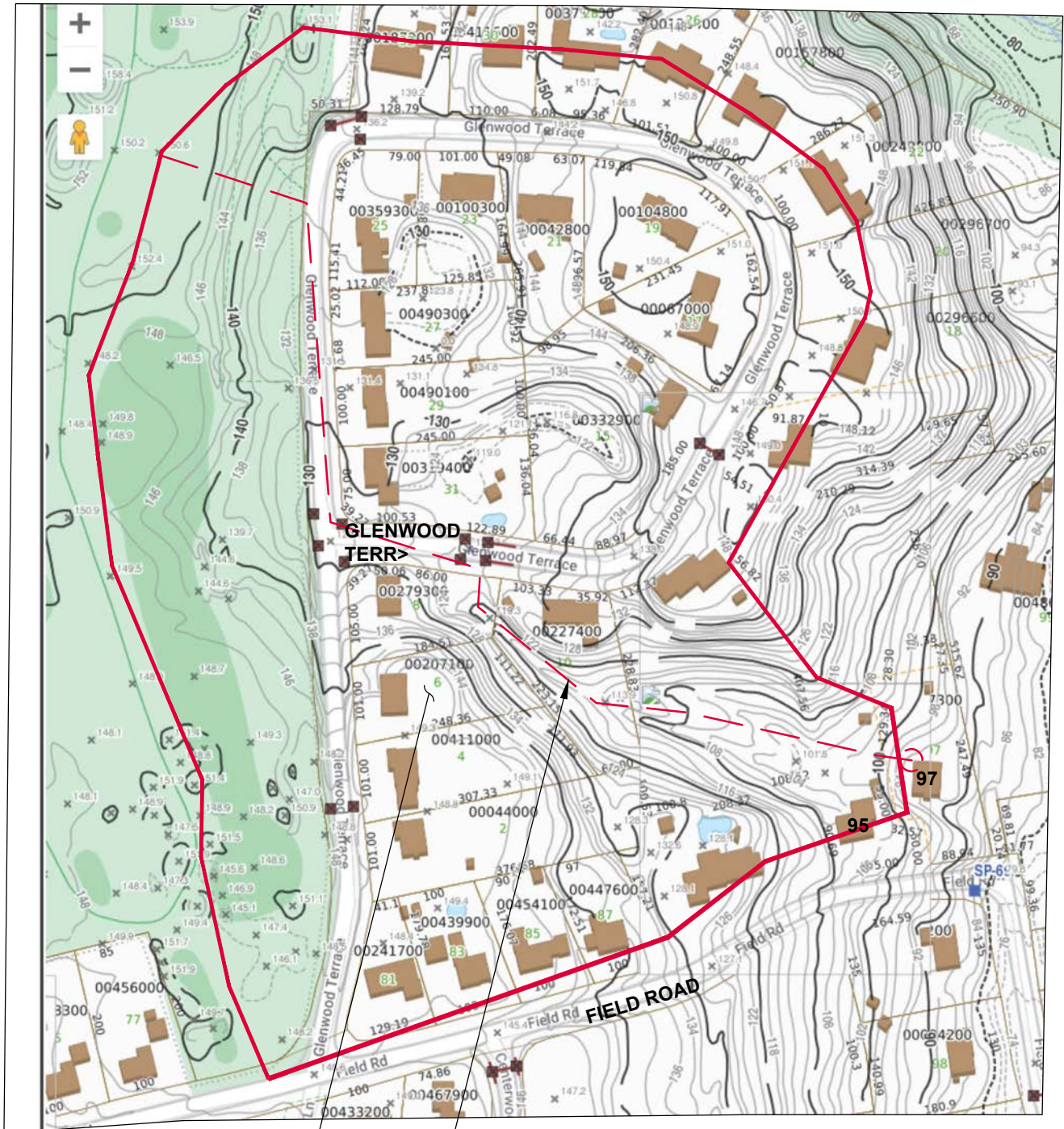


NOT TO SCALE

CARDINAL
ENGINEERING ASSOCIATES

180 RESEARCH PKWY | MERIDEN, CT 06450 | 203-238-1969
457 BANTAM RD | LITCHFIELD, CT 06769 | 860-397-9106

AREA 7: DRAINAGE AREA FOR SWALE BEHIND 95 & 97 FIELD ROAD



DRAINAGE AREA =
25 ACRES

T_c FLOW PATH TO LOCATION
BEHIND #97 FIELD ROAD



NOT TO SCALE

CARDINAL
ENGINEERING ASSOCIATES

180 RESEARCH PKWY | MERIDEN, CT 06450 | 203-238-1969
457 BANTAM RD | LITCHFIELD, CT 06769 | 860-397-9106

FEMA MAP

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Connecticut State Plane (FIPSZONE 0600). The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov/> or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, NNGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at <http://www.ngs.noaa.gov/>.

Base map information shown on this FIRM was provided in digital format by the Connecticut Department of Environmental Protection. This information was derived from digital orthophotos produced at a scale of 1:12,000 from aerial photography flown in 2004 supplemented with aerial photography from 2000.

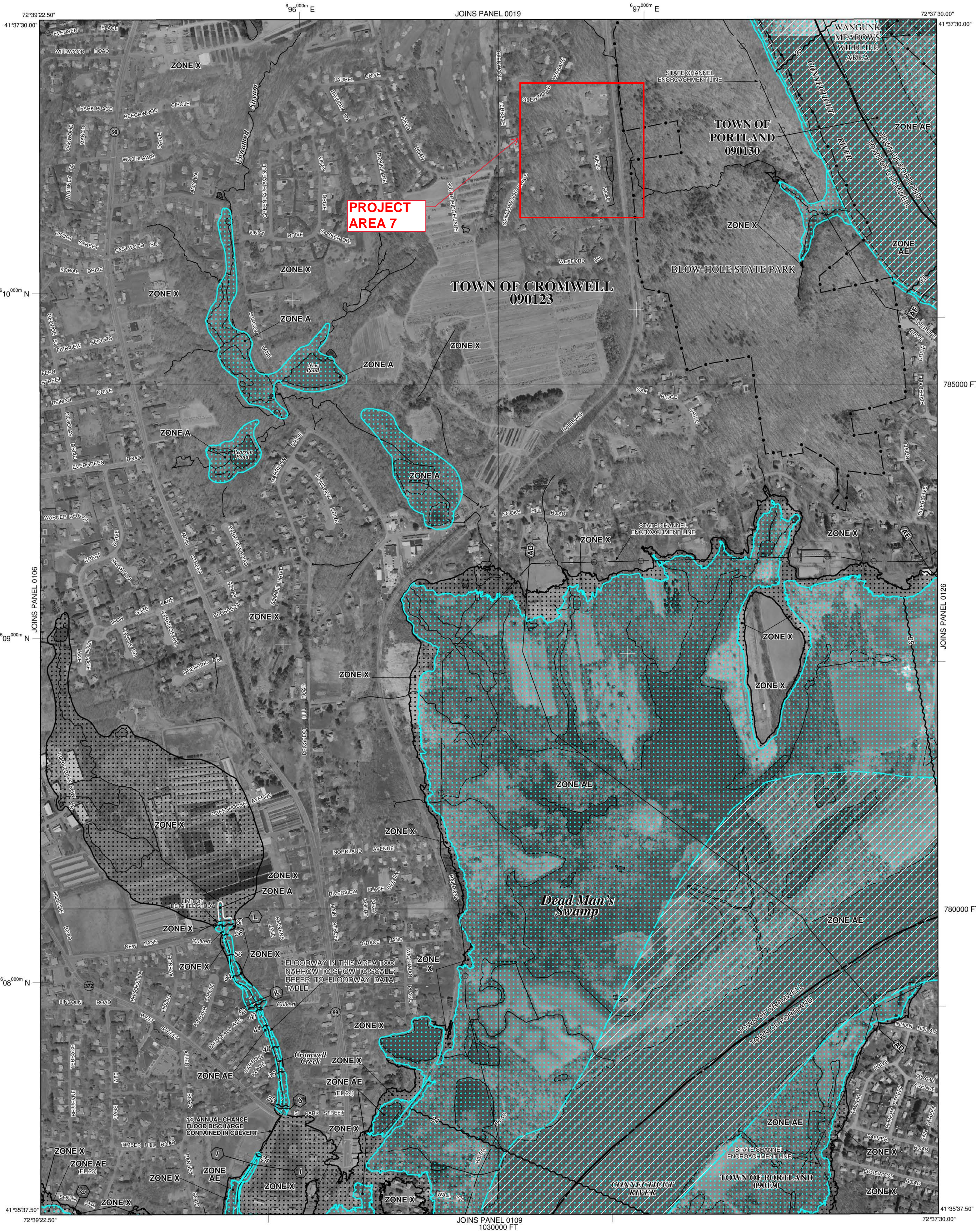
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the *Flood Insurance Study report* (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a *Flood Insurance Study report*, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at <http://www.msc.fema.gov/>.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call 1-877-FEMA MAP (1-877-336-2627) or visit the FEMA website at <http://www.fema.gov/>.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

- ZONE A** No Base Flood Elevations determined.
- ZONE AE** Base Flood Elevations determined.
- ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
- ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- ZONE AR** Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

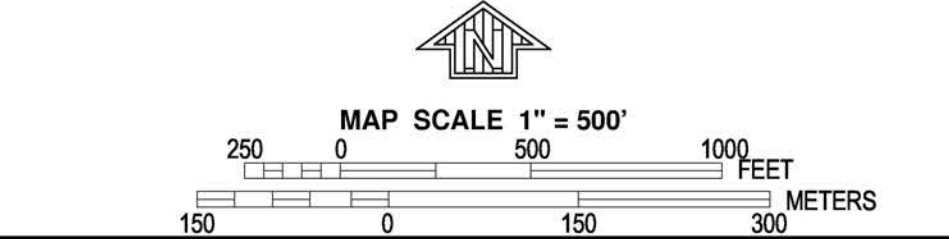
- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- Base Flood Elevation line and value; elevation in feet*
- Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

- (A) (A)** Cross section line
- (2) (2)** Transsect line
- Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 1000-meter Universal Transverse Mercator grid, zone 18
- 5000-foot grid : Connecticut State Plane coordinate system, (FIPSZONE 0600), Lambert Conformal Conic
- DX5510** Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5** River Mile
- MAP REPOSITORIES**
Refer to Map Repositories list on Map Index
- EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP**
August 28, 2008
- EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL**

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.



NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0107G
FIRM
FLOOD INSURANCE RATE MAP
MIDDLESEX COUNTY,
CONNECTICUT
(ALL JURISDICTIONS)

PANEL 107 OF 450
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)
CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CROMWELL, TOWN OF	090123	0107	G
PORTLAND, TOWN OF	090130	0107	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
09007C0107G
EFFECTIVE DATE
AUGUST 28, 2008

Federal Emergency Management Agency

APPENDIX H

Area 8-South Street Supporting Documents

Construction Cost Estimate

Area 8 South Street Culvert (Alternate A - Dredging Downstream, 12 x 4 Box Culvert & 150 ft Berm along road)

Cromwell, CT

Major and Minor Contract Items

Item No.	Item	Unit	Quantity	Unit \$	Total Cost
1	CLEARING AND GRUBBING	LS	1	*	*
2	EARTH EXCAVATION	CY	250	\$ 30.00	\$ 7,500.00
3	EXCAVATE TRAP CHANNEL IN WETLAND TO TRUNK SEWER (1400 LF, 100' WIDE, 1' DEEP)	CY	5000	\$ 75.00	\$ 375,000.00
4	TRAPEZOIDAL CHANNEL IMMEDIATELY DS OF CULVERT (300 LF, 40' WIDE, 2.0' DEEP)	CY	1000	\$ 75.00	\$ 75,000.00
5	INSTALL RIP RAP IN CHANNEL	CY	500	\$ 150.00	\$ 75,000.00
6	INSTALL GEOTEXTILE IN CHANNEL	SY	1000	\$ 15.00	\$ 15,000.00
7	SHEETING ALONG PROPERTY LINE (43 SOUTH ST)	SF	3000	\$ 30.00	\$ 90,000.00
8	CONCRETE HEADWALL ALONG SOUTH ST TO ELEV 15.0 FT	CY	45	\$ 850.00	\$ 38,250.00
9	STRUCTURE EXCAVATION - EARTH (COMPLETE)	CY	150	\$ 35.00	\$ 5,250.00
10	WATER HANDLING	LS	1	\$ 100,000.00	\$ 100,000.00
11	FORMATION OF SUBGRADE	SY	250	\$ 10.00	\$ 2,500.00
12	SUBBASE	CY	100	\$ 58.00	\$ 5,800.00
13	GRANULAR FILL	CY	60	\$ 72.00	\$ 4,320.00
14	PROCESSED AGGREGATE BASE	CY	50	\$ 60.00	\$ 3,000.00
15	HMA 50.50 WITH 4" THICKNESS	TON	65	\$ 250.00	\$ 16,250.00
16	PERVIOUS STRUCTURE BACKFILL	CY	100	\$ 65.00	\$ 6,500.00
17	EROSION AND SEDIMENT CONTROLS	LS	1	\$ 100,000.00	\$ 100,000.00
18	REMOVAL OF EXISTING CULVERT	LS	1	\$ 10,000.00	\$ 10,000.00
19	FOOTING CONCRETE	CY	30	\$ 750.00	\$ 22,500.00
20	ABUTMENT AND WALL CONCRETE	CY	30	\$ 850.00	\$ 25,500.00
21	12' x 4' PRECAST CONCRETE BOX CULVERT	LF	70	\$ 3,600.00	\$ 252,000.00
22	MEMBRANE WATERPROOFING (COLD LIQUID ELASTOMERIC)	SY	80	\$ 180.00	\$ 14,400.00
23	TEMPORARY PRECAST CONCRETE BARRIER CURB	LF	60	\$ 72.00	\$ 4,320.00
24	CONSTRUCTION FIELD OFFICE (SMALL)	MO	4	\$ 3,000.00	\$ 12,000.00
25	MAINTENANCE AND PROTECTION OF TRAFFIC	LS	1	*	*
26	TRAFFICPERSON (MUNICIPAL POLICE OFFICER)	EST	1	\$ 10,000.00	\$ 10,000.00
27	TRAFFICPERSON (UNIFORMED FLAGGER)	HR	200	\$ 40.00	\$ 8,000.00
28	MOBILIZATION AND PROJECT CLOSE-OUT	LS	1	*	*
					\$ -
					\$ -
					\$ -
					\$ -
					\$ -
Major Items Subtotal					\$ 1,278,090
Minor Items Subtotal		15	% of Line "A"		\$ 191,714
Major and Minor Contract Items Subtotal (A + B)					\$ 1,469,804
Other Item Allowances					
Clearing and Grubbing		2	% of Line "C"		\$ 29,396
M & P of Traffic		3	% of Line "C"		\$ 44,094
Mobilization		4	% of Line "C"		\$ 58,792
Construction Staking		1	% of Line "C"		\$ 14,698
Other Items Subtotal					\$ 146,980
CONTRACT SUBTOTAL (C + D)					\$ 1,616,784
Inflation Costs (Simple Method)					
Date of Estimate		Jun-23			
Anticipated Bid Date		May-24			
Annual Inflation		5%			
Inflation Subtotal		4.0%		of Line "E"	
TOTAL CONTRACT COST ESTIMATE (E + F) (Rounded to nearest \$1000)					\$ 1,681,000

LOTICIP Project Costs Summary					
Contract Cost Estimate (Line "G")					\$ 1,681,000
Contingencies					\$ 420,250
Construction Engineering / Incidentals					\$ 75,000
ROW					\$ 25,000
Utilities					\$ 25,000
Engineering Design & Permitting					\$ 100,860
TOTAL PROJECT COST (Rounded to nearest \$10000)					\$ 2,330,000

Construction Cost Estimate

Area 8 South Street Culvert (Alternate B - Dredging Downstream, 12 x 4 Box Culvert & Tide Gate, road berm)

Cromwell, CT

Major and Minor Contract Items

Item No.	Item	Unit	Quantity	Unit \$	Total Cost
1	CLEARING AND GRUBBING	LS	1	*	*
2	EARTH EXCAVATION	CY	250	\$ 30.00	\$ 7,500.00
3	EXCAVATE TRAP CHANNEL IN WETLAND TO TRUNK SEWER (1400 LF, 100' WIDE, 1' DEEP)	CY	5000	\$ 75.00	\$ 375,000.00
4	DREDGE LARGE WETLAND DOWNSTREAM (9 acres, 2' depth)	CY	30000	\$ 50.00	\$ 1,500,000.00
5	INSTALL RIP RAP IN CHANNEL	CY	500	\$ 150.00	\$ 75,000.00
6	INSTALL GEOTEXTILE IN CHANNEL	SY	1000	\$ 15.00	\$ 15,000.00
7	SHEETING ALONG PROPERTY LINE (43 SOUTH ST)	SF	3000	\$ 30.00	\$ 90,000.00
8	CONCRETE HEADWALL ALONG SOUTH ST TO ELEV 16.0 FT	CY	45	\$ 850.00	\$ 38,250.00
9	STRUCTURE EXCAVATION - EARTH (COMPLETE)	CY	150	\$ 35.00	\$ 5,250.00
10	WATER HANDLING	LS	1	\$ 100,000.00	\$ 100,000.00
11	FORMATION OF SUBGRADE	SY	250	\$ 10.00	\$ 2,500.00
12	SUBBASE	CY	100	\$ 58.00	\$ 5,800.00
13	GRANULAR FILL	CY	60	\$ 72.00	\$ 4,320.00
14	PROCESSED AGGREGATE BASE	CY	50	\$ 60.00	\$ 3,000.00
15	HMA 50.50 WITH 4" THICKNESS	TON	65	\$ 250.00	\$ 16,250.00
16	PERVIOUS STRUCTURE BACKFILL	CY	100	\$ 65.00	\$ 6,500.00
17	EROSION AND SEDIMENT CONTROLS	LS	1	\$ 100,000.00	\$ 100,000.00
18	REMOVAL OF EXISTING CULVERT	LS	1	\$ 10,000.00	\$ 10,000.00
19	FOOTING CONCRETE	CY	30	\$ 750.00	\$ 22,500.00
20	ABUTMENT AND WALL CONCRETE	CY	30	\$ 850.00	\$ 25,500.00
21	12' x 4' PRECAST CONCRETE BOX CULVERT	LF	70	\$ 3,600.00	\$ 252,000.00
22	TIDE GATE	LS	1	\$ 25,000.00	\$ 25,000.00
23	MEMBRANE WATERPROOFING (COLD LIQUID ELASTOMERIC)	SY	80	\$ 180.00	\$ 14,400.00
24	TEMPORARY PRECAST CONCRETE BARRIER CURB	LF	60	\$ 72.00	\$ 4,320.00
25	CONSTRUCTION FIELD OFFICE (SMALL)	MO	4	\$ 3,000.00	\$ 12,000.00
26	MAINTENANCE AND PROTECTION OF TRAFFIC	LS	1	*	*
27	TRAFFICPERSON (MUNICIPAL POLICE OFFICER)	EST	1	\$ 10,000.00	\$ 10,000.00
28	TRAFFICPERSON (UNIFORMED FLAGGER)	HR	200	\$ 40.00	\$ 8,000.00
29	MOBILIZATION AND PROJECT CLOSE-OUT	LS	1	*	*
					\$ -
					\$ -
					\$ -
					\$ -
					\$ -
					\$ -
A	Major Items Subtotal				\$ 2,728,090
B	Minor Items Subtotal	15	% of Line "A"		\$ 409,214
C	Major and Minor Contract Items Subtotal (A + B)				\$ 3,137,304

Other Item Allowances

Clearing and Grubbing	1	% of Line "C"	\$ 31,373
M & P of Traffic	1	% of Line "C"	\$ 31,373
Mobilization	4	% of Line "C"	\$ 125,492
Construction Staking	1	% of Line "C"	\$ 31,373
D Other Items Subtotal			\$ 219,611

E CONTRACT SUBTOTAL (C + D) \$ 3,356,915

Inflation Costs (Simple Method)

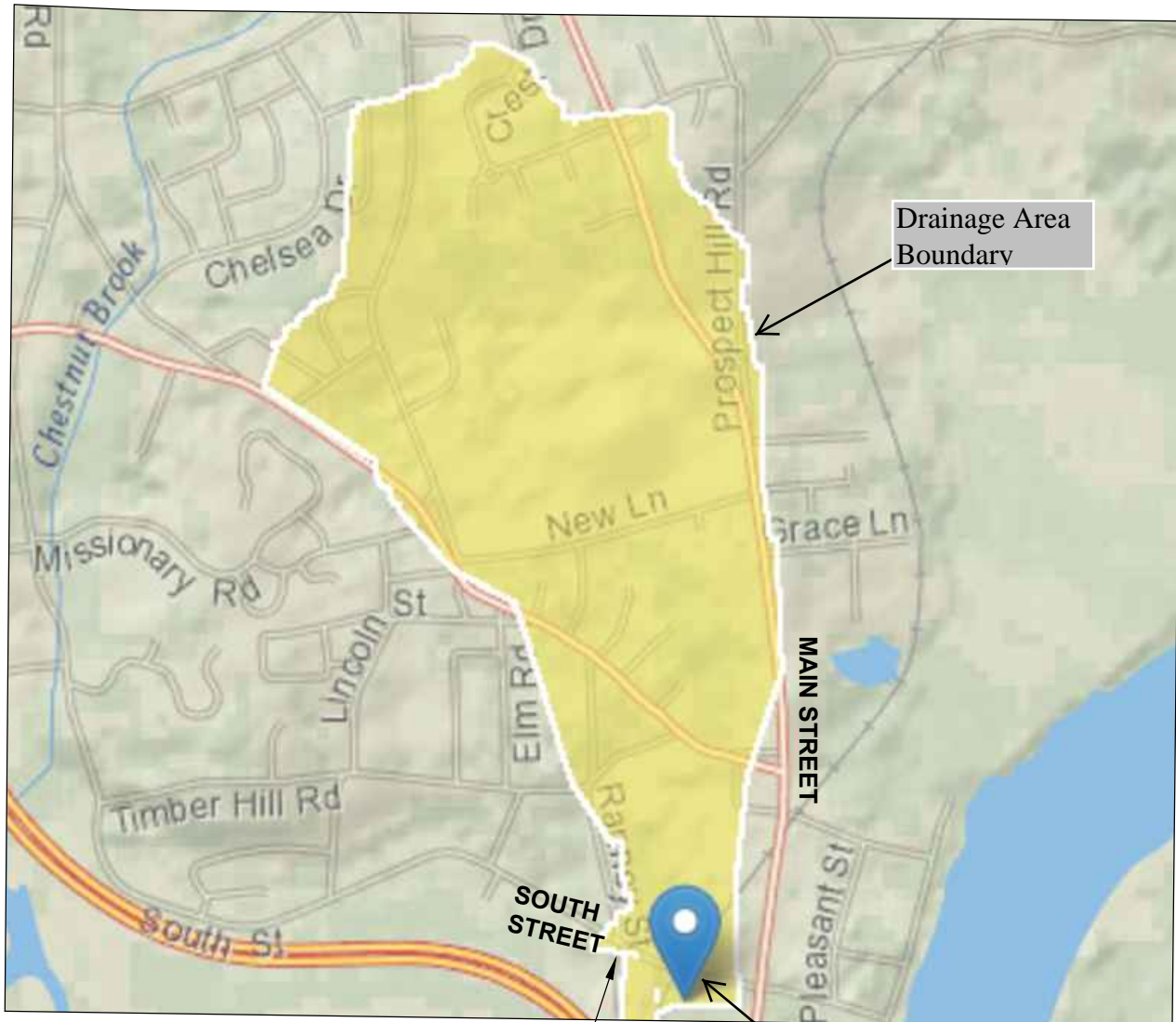
Date of Estimate	May-23
Anticipated Bid Date	May-24
Annual Inflation	5%
F Inflation Subtotal	4.5% of Line "E" \$ 151,061

G TOTAL CONTRACT COST ESTIMATE (E + F) (Rounded to nearest \$1000) \$ 3,508,000

LOT/CP Project Costs Summary

Contract Cost Estimate (Line "G")		\$ 3,508,000
Contingencies	15%	\$ 526,200
Construction Engineering / Incidentals	LS	\$ 100,000
ROW	LS	\$ 25,000
Utilities	LS	\$ 25,000
Engineering Design & Permitting	3%	\$ 115,764
TOTAL PROJECT COST (Rounded to nearest \$10000)		\$ 4,300,000

AREA 8 DRAINAGE AREA FOR SOUTH STREET CULVERT



DRAINAGE AREA = 460 AC

South St culvert



NOT TO SCALE

CARDINAL
ENGINEERING ASSOCIATES

180 RESEARCH PKWY | MERIDEN, CT 06450 | 203-238-1969
457 BANTAM RD | LITCHFIELD, CT 06769 | 860-397-9106

FEMA DATA

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Connecticut State Plane (FIPSZONE 0600). The **horizontal datum** was NAD83, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of the FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov/> or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, NNGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at <http://www.ngs.noaa.gov/>.

Base map information shown on this FIRM was provided in digital format by the Connecticut Department of Environmental Protection. This information was derived from digital orthophotos produced at a scale of 1:12,000 from aerial photography flown in 2004 supplemented with aerial photography from 2000.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

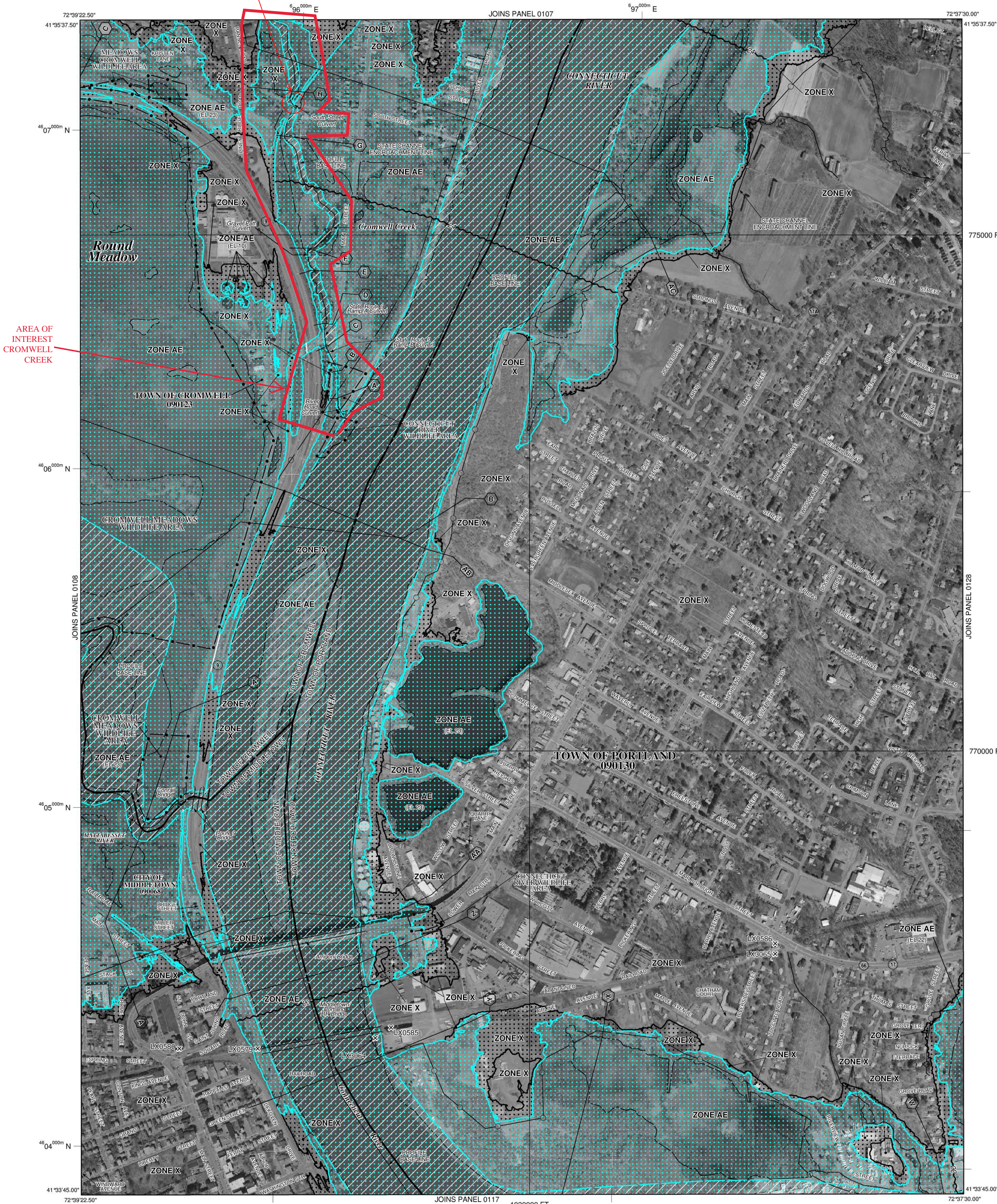
Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at <http://www.msc.fema.gov/>.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call 1-877-FEMA MAP (1-877-336-2627) or visit the FEMA website at <http://www.fema.gov/>.

Site Location



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

- ZONE A** No Base Flood Elevations determined.
- ZONE AE** Base Flood Elevations determined.
- ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
- ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- ZONE AR** Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

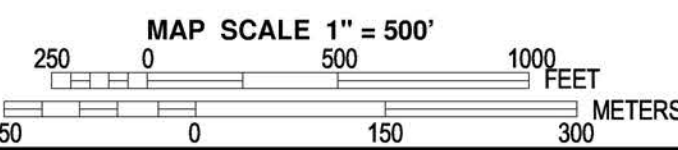
- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- Base Flood Elevation line and value; elevation in feet* (EL 987)
- Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

- Cross section line
- Transect line
- Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 1000-meter Universal Transverse Mercator grid, zone 18
- 5000-foot grid : Connecticut State Plane coordinate system, (FIPSZONE 0600), Lambert Conformal Conic
- Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5 River Mile
- MAP REPOSITORIES
- Refer to Map Repositories list on Map Index
- EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
- August 28, 2008
- EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.



NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0109G

FIRM FLOOD INSURANCE RATE MAP

MIDDLESEX COUNTY,
CONNECTICUT
(ALL JURISDICTIONS)

PANEL 109 OF 450

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CROMWELL, TOWN OF	090123	0109	G
MIDDLETOWN, CITY OF	090068	0109	G
PORTLAND, TOWN OF	090130	0109	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.



MAP NUMBER
09007C0109G

EFFECTIVE DATE
AUGUST 28, 2008

Federal Emergency Management Agency

APPENDIX I

Area 9-Franklin Road Supporting Documents



180 Research Parkway
Meriden, Connecticut 06450
(203) 238-1969

CONCEPTUAL CONSTRUCTION COST ESTIMATE

Town **Town of Cromwell**
Project **Drainage Improvements**
Area **#9 Alternate A**
48" RCP & 6X4 BOX CULVERT

Calculated by DL DATE 7/3/2023
Checked by _____

	Item Number	Items	Unit	Quantities	Unit Price	Cost
1	0201001	CLEARING AND GRUBBING	LS	1	*	*
	0202259	CT BITUMINOUS CONCRETE PAVEMENT	LS	100	\$5.00	\$500.00
2	0203000	STRUCTURE EXCAVATION - EARTH (COMPLETE)	CY	340	\$35.00	\$11,900.00
3	0203100	STRUCTURE EXCAVATION - ROCK (COMPLETE)	CY	30	\$85.00	\$2,550.00
4	0204151	HANDLING WATER	LS	1	\$120,000.00	\$120,000.00
5	0210303	TURBIDITY CONTROL CURTAIN	LS	1	\$5,000.00	\$5,000.00
6	0213100	GRANULAR FILL	CY	70	\$72.00	\$5,040.00
7	0216000	PERVIOUS STRUCTURE BACKFILL	CY	600	\$65.00	\$39,000.00
8	0219001	SEDIMENTATION CONTROL SYSTEM	LF	300	\$8.00	\$2,400.00
9	0406128.20	BITUMINOUS CONCRETE PATCHING - FULL DEPTH	SY	60	\$125.00	\$7,500.00
	0503866	REMOVAL OF EXISTING CULVERT	LS	1	\$35,000.00	\$35,000.00
	0506040	PRECAST CONCRETE HEADWALL	EA	3	\$5,000.00	\$15,000.00
10	0601062	FOOTING CONCRETE	CY	40	\$750.00	\$30,000.00
11	0601064	ABUTMENT AND WALL CONCRETE	CY	40	\$850.00	\$34,000.00
12	0601125	6' x 4' PRECAST CONCRETE BOX CULVERT	LF	35	\$2,200.00	\$77,000.00
	0686000.48	48" R.C. PIPE - 0' - 10' DEEP	LF	220	\$250.00	\$55,000.00
13	0703012	INTERMEDIATE RIPRAP	CY	30	\$90.00	\$2,700.00
14	0707009	MEMBRANE WATERPROOFING (COLD LIQUID ELASTOMERIC)	SY	30	\$179.00	\$5,370.00
15	0910184	METAL BEAM RAIL SPAN SECTION TYPE II	EA	3	\$4,500.00	\$13,500.00
	0911924	R-B END ANCHORAGE TYPE II	EA	3	\$4,500.00	\$13,500.00
16	0944000	FURNISHING AND PLACING TOPSOIL	SY	150	\$21.00	\$3,150.00
17	0950005	TURF ESTABLISHMENT	SY	150	\$6.00	\$900.00
18	0970001	MAINTENANCE AND PROTECTION OF TRAFFIC	LS	1	*	*
19	0970006	TRAFFICPERSON (MUNICIPAL POLICE OFFICER)	EST	1	\$30,000.00	\$30,000.00
20	0975004	MOBILIZATION AND PROJECT CLOSE-OUT	LS	1	*	*
21	0980001	CONSTRUCTION STAKING	LS	1	*	*
						\$0.00
Major Items Subtotal						\$509,010.00
Minor Items Subtotal (0% at Final Design)			20	% of Major Items Subtotal		\$101,802.00
Contract Items Subtotal						\$610,812.00

* Other Item Allowances

Clearing and Grubbing	2	% of Contract Items Subtotal	\$ 12,216
M & P of Traffic	5	% of Contract Items Subtotal	\$ 30,541
Mobilization	4	% of Contract Items Subtotal	\$ 24,432
Construction Staking	2	% of Contract Items Subtotal	\$ 12,216
Other Items Subtotal			\$ 79,405

CONTRACT SUBTOTAL	\$ 690,217
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Inflation Costs (Simple Method)

Date of Estimate (provide date of estimate)	Jun-23
Anticipated Bid Date (provide anticipated bid date)	May-24
Base Years	0.9
Annual Inflation (5.0% annually, 0% at Final Design)	5.0%
Inflation Subtotal	4.5% of Subtotal \$ 31,060

TOTAL CONTRACT COST ESTIMATE (Rounded to nearest \$1000)	\$ 721,000
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Project Costs Summary (Construction Phase)			
Contract Cost Estimate (Line "G")			\$ 721,000
Contingencies	20.0%		\$ 144,200
Construction Engineering/Incidentals	LS		\$ 75,000
ROW			\$ 20,000
Utilities			\$ 20,000
Engineering Design & Permitting			\$ 130,000
TOTAL PROJECT COST(Rounded to nearest \$1000)	LS		\$ 1,110,200



180 Research Parkway
Meriden, Connecticut 06450
(203) 238-1969

CONCEPTUAL CONSTRUCTION COST ESTIMATE

Town **Town of Cromwell**
Project **Drainage Improvements**
Area **#9 Alternate B**
5X5 BOX & 6X4 BOX CULVERT

Calculated by DL DATE 6/14/2023
Checked by _____

	Item Number	Items	Unit	Quantities	Unit Price	Cost
1	0201001	CLEARING AND GRUBBING	LS	1	*	*
	0202259	CT BITUMINOUS CONCRETE PAVEMENT	LS	100	\$5.00	\$500.00
2	0203000	STRUCTURE EXCAVATION - EARTH (COMPLETE)	CY	340	\$35.00	\$11,900.00
3	0203100	STRUCTURE EXCAVATION - ROCK (COMPLETE)	CY	30	\$85.00	\$2,550.00
4	0204151	HANDLING WATER	LS	1	\$120,000.00	\$120,000.00
5	0210303	TURBIDITY CONTROL CURTAIN	LS	1	\$5,000.00	\$5,000.00
6	0213100	GRANULAR FILL	CY	70	\$72.00	\$5,040.00
7	0216000	PERVIOUS STRUCTURE BACKFILL	CY	600	\$65.00	\$39,000.00
8	0219001	SEDIMENTATION CONTROL SYSTEM	LF	300	\$8.00	\$2,400.00
9	0406128.20	BITUMINOUS CONCRETE PATCHING - FULL DEPTH	SY	60	\$125.00	\$7,500.00
	0503866	REMOVAL OF EXISTING CULVERT	LS	2	\$35,000.00	\$70,000.00
	0506040	PRECAST CONCRETE HEADWALL	EA	3	\$5,000.00	\$15,000.00
10	0601062	FOOTING CONCRETE	CY	40	\$750.00	\$30,000.00
11	0601064	ABUTMENT AND WALL CONCRETE	CY	40	\$850.00	\$34,000.00
12	0601125	6' x 4' PRECAST CONCRETE BOX CULVERT	LF	35	\$2,200.00	\$77,000.00
	0601125	5' x 5' PRECAST CONCRETE BOX CULVERT	LF	220	\$2,200.00	\$484,000.00
13	0703012	INTERMEDIATE RIPRAP	CY	30	\$90.00	\$2,700.00
14	0707009	MEMBRANE WATERPROOFING (COLD LIQUID ELASTOMERIC)	SY	30	\$179.00	\$5,370.00
15	0910184	METAL BEAM RAIL SPAN SECTION TYPE II	EA	3	\$4,500.00	\$13,500.00
	0911924	R-B END ANCHORAGE TYPE II	EA	3	\$4,500.00	\$13,500.00
16	0944000	FURNISHING AND PLACING TOPSOIL	SY	150	\$21.00	\$3,150.00
17	0950005	TURF ESTABLISHMENT	SY	150	\$6.00	\$900.00
18	0970001	MAINTENANCE AND PROTECTION OF TRAFFIC	LS	1	*	*
19	0970006	TRAFFICPERSON (MUNICIPAL POLICE OFFICER)	EST	1	\$30,000.00	\$30,000.00
20	0975004	MOBILIZATION AND PROJECT CLOSE-OUT	LS	1	*	*
21	0980001	CONSTRUCTION STAKING	LS	1	*	*
						\$0.00
Major Items Subtotal						\$972,510.00
Minor Items Subtotal (0% at Final Design)			20	% of Major Items Subtotal		\$194,502.00
Contract Items Subtotal						\$1,167,012.00

* Other Item Allowances

Clearing and Grubbing	2	% of Contract Items Subtotal	\$	23,340
M & P of Traffic	5	% of Contract Items Subtotal	\$	58,351
Mobilization	5	% of Contract Items Subtotal	\$	58,351
Construction Staking	2	% of Contract Items Subtotal	\$	23,340
Other Items Subtotal			\$	163,382

CONTRACT SUBTOTAL	\$ 1,330,394
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Inflation Costs (Simple Method)

Date of Estimate (provide date of estimate)	Jun-23			
Anticipated Bid Date (provide anticipated bid date)	May-24			
Base Years	0.9			
Annual Inflation (5.0% annually, 0% at Final Design)	5.0%			
Inflation Subtotal	4.5%	of Subtotal	\$	59,868

TOTAL CONTRACT COST ESTIMATE (Rounded to nearest \$1000)	\$ 1,390,000
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Project Costs Summary (Construction Phase)				
Contract Cost Estimate (Line "G")				\$ 1,390,000
Contingencies	20.0%			\$ 278,000
Construction Engineering/Incidentals	LS			\$ 75,000
ROW				\$ 20,000
Utilities				\$ 20,000
Engineering Design & Permitting	10.0%			\$ 130,000
TOTAL PROJECT COST(Rounded to nearest \$1000)	LS			\$ 1,913,000

AREA 9: DRAINAGE AREA FOR CHESTNUT BROOK AT FRANKLIN ROAD



Drainage Area
Boundary

T_C FLOW PATH
TO CULVERT



NOT TO SCALE

CARDINAL
ENGINEERING ASSOCIATES

180 RESEARCH PKWY | MERIDEN, CT 06450 | 203-238-1969
457 BANTAM RD | LITCHFIELD, CT 06769 | 860-397-9106

FEMA MAP

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NGS Information Services
NOAA, NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

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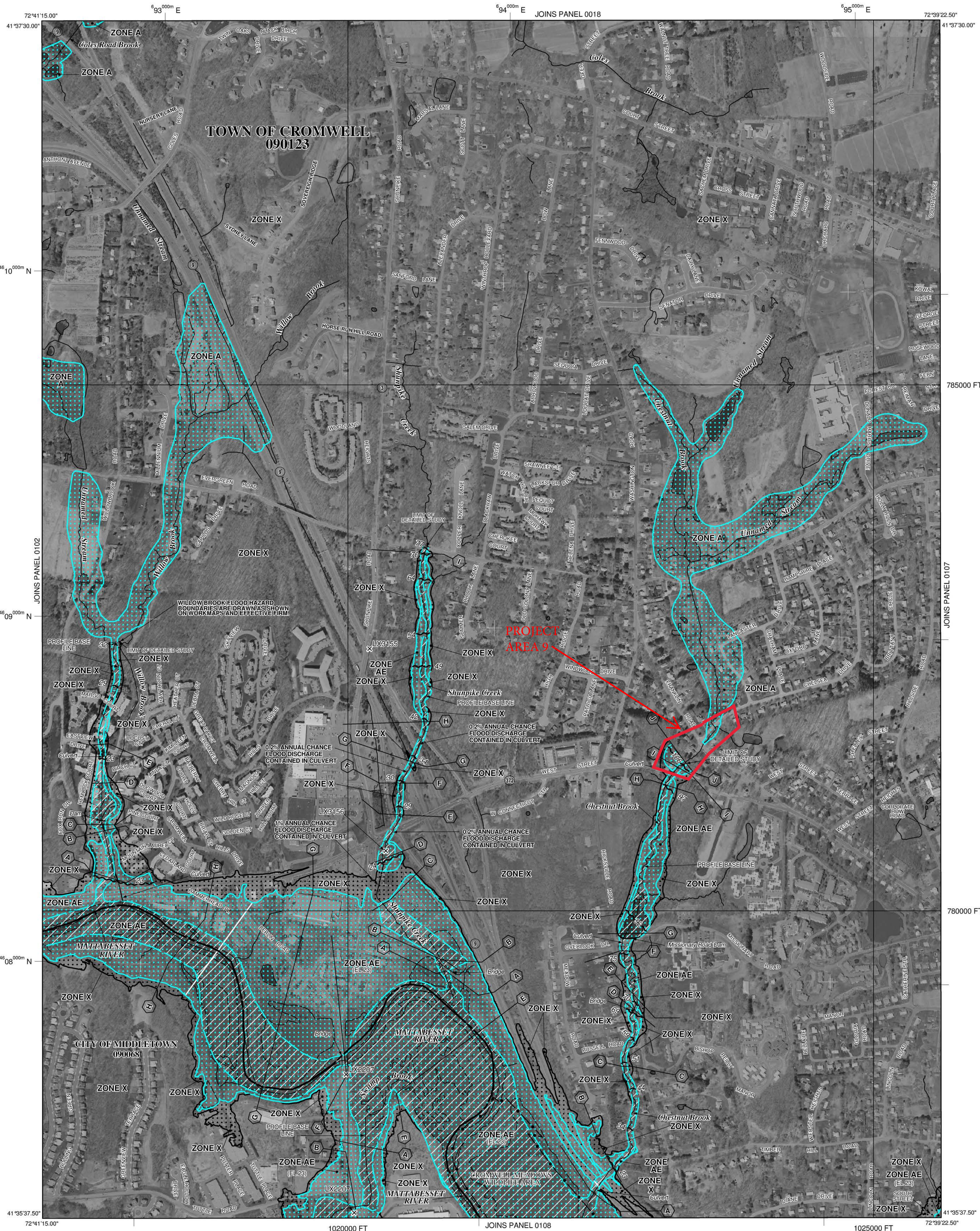
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Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at <http://www.msc.fema.gov/>.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call 1-877-FEMA MAP (1-877-336-2627) or visit the FEMA website at <http://www.fema.gov/>.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

- ZONE A** No Base Flood Elevations determined.
- ZONE AE** Base Flood Elevations determined.
- ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
- ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- ZONE AR** Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

- ZONE X** Areas determined to be outside the 0.2% annual chance floodplain.
- ZONE D** Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

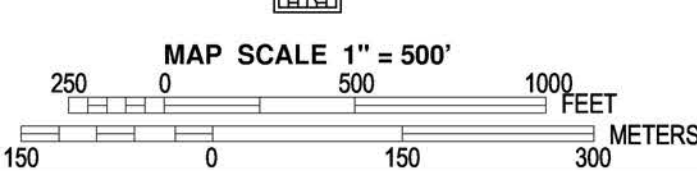
- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- Base Flood Elevation line and value; elevation in feet*
- Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

- Transsect line
- Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 1000-meter Universal Transverse Mercator grid, zone 18
- 5000-foot grid : Connecticut State Plane coordinate system, (FIPSZONE 0600), Lambert Conformal Conic
- Bench mark (see explanation in Notes to Users section of this FIRM panel)
- River Mile
- MAP REPOSITORIES
- Refer to Map Repositories list on Map Index
- EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
- August 28, 2008
- EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.



NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0106G

FIRM FLOOD INSURANCE RATE MAP MIDDLESEX COUNTY, CONNECTICUT (ALL JURISDICTIONS)

PANEL 106 OF 450

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CROMWELL, TOWN OF	090123	0106	G
MIDDLETOWN, CITY OF	090068	0106	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.



MAP NUMBER
09007C0106G

EFFECTIVE DATE
AUGUST 28, 2008

Federal Emergency Management Agency

APPENDIX J

Area 10-Willow Brook Culvert at 170 Evergreen Supporting Documents

180 Research Parkway
 Meriden, Connecticut 06450
 (203) 238-1969

OPINION OF PROBABLE CONSTRUCTION COST

 Town **Town of Cromwell**
 Project **Drainage Improvements**
 Area **#10 Alternate A**
Increase Stormwater Pipe Capacity 42" RCP
 Calculated by CH/DL DATE 6/17/2023
 Checked by _____

	Item Number	Items	Unit	Quantities	Unit Price	Cost
1	0201001A	CLEARING AND GRUBBING	LS	1	*	*
2	0202200	CHANNEL EXCAVATION - EARTH	CY	20	\$30.00	\$600.00
3	0202529	CUT BITUMINOUS CONCRETE PAVEMENT	LF	20	\$50.00	\$1,000.00
4	0210303	TURBIDITY CONTROL CURTAIN	LS	1	\$5,000.00	\$5,000.00
5	0213100	GRANULAR FILL	CY	30	\$60.00	\$1,800.00
6	0219001	SEDIMENTATION CONTROL SYSTEM	LF	50	\$20.00	\$1,000.00
7	0406128.20	BITUMINOUS CONCRETE PATCHING - FULL DEPTH	SY	25	\$150.00	\$3,750.00
8	0506040	PRECAST CONCRETE HEADWALL	EA	2	\$4,000.00	\$8,000.00
9	0601062	FOOTING CONCRETE	CY	10	\$750.00	\$7,500.00
10	0601064	ABUTMENT AND WALL CONCRETE	CY	10	\$750.00	\$7,500.00
11	0686000.42	42" R.C. PIPE - 0' - 10' DEEP	LF	40	\$325.00	\$13,000.00
12	0703012	MODIFIED RIP RAP	CY	15	\$105.00	\$1,575.00
13	0755001	NON-WOVEN FILTER FABRIC	SY	70	\$10.00	\$700.00
14	0815001	BITUMINOUS CONCRETE LIP CURB	LF	40	\$8.00	\$320.00
15	0944000	FURNISHING AND PLACING TOPSOIL	SY	100	\$7.00	\$700.00
16	0950005	TURF ESTABLISHMENT	SY	100	\$2.00	\$200.00
17	0970007	TRAFFICPERSON (UNIFORMED FLAGGER)	HR	60	\$40.00	\$2,400.00
18	0971001A	MAINTENANCE AND PROTECTION OF TRAFFIC	LS	1	*	*
19	0975004	MOBILIZATION AND PROJECT CLOSE-OUT	LS	1	*	*
20	0980001	CONSTRUCTION STAKING	LS	1	*	*
						\$0.00
Major Items Subtotal						\$55,045.00
Minor Items Subtotal (0% at Final Design)			20	% of Major Items Subtotal		\$11,009.00
Contract Items Subtotal						\$66,054.00

*** Other Item Allowances**

Clearing and Grubbing	4	% of Contract Items Subtotal	\$	2,642
M & P of Traffic	7	% of Contract Items Subtotal	\$	4,624
Mobilization	4	% of Contract Items Subtotal	\$	2,642
Construction Staking	3	% of Contract Items Subtotal	\$	1,982
Other Items Subtotal			\$ 11,890	

CONTRACT SUBTOTAL	\$ 77,944
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Inflation Costs (Simple Method)

Date of Estimate (provide date of estimate)	Jun-23		
Anticipated Bid Date (provide anticipated bid date)	May-24		
Base Years	0.9		
Annual Inflation (5.0% annually, 0% at Final Design)	5.0%		
Inflation Subtotal	4.5%	of Subtotal	\$ 3,507

TOTAL CONTRACT COST ESTIMATE (Rounded to nearest \$1000)	\$ 81,000
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Project Costs Summary (Construction Phase)				
Contract Cost Estimate (Line "G")				\$ 81,000
Contingencies	25.0%			\$ 20,250
Construction Engineering/Incidentals	0.0%			\$ -
ROW				\$ 5,000
Utilities				\$ 15,000
Engineering Design & Permitting				\$ 50,000
TOTAL PROJECT COST(Rounded to nearest \$1000)	LS			\$ 172,000

180 Research Parkway
 Meriden, Connecticut 06450
 (203) 238-1969

OPINION OF PROBABLE CONSTRUCTION COST

 Town **Town of Cromwell**
 Project **Drainage Improvements**
 Area **#10 Alternate B**
5X4 BOX

 Calculated by DL DATE 7/4/2023
 Checked by _____

	Item Number	Items	Unit	Quantities	Unit Price	Cost
1	0201001	CLEARING AND GRUBBING	LS	1	*	*
	0202259	CT BITUMINOUS CONCRETE PAVEMENT	LS	80	\$5.00	\$400.00
2	0203000	STRUCTURE EXCAVATION - EARTH (COMPLETE)	CY	70	\$35.00	\$2,450.00
3	0203100	STRUCTURE EXCAVATION - ROCK (COMPLETE)	CY	10	\$85.00	\$850.00
4	0204151	HANDLING WATER	LS	1	\$40,000.00	\$40,000.00
5	0210303	TURBIDITY CONTROL CURTAIN	LS	1	\$5,000.00	\$5,000.00
6	0213100	GRANULAR FILL	CY	30	\$72.00	\$2,160.00
7	0216000	PERVIOUS STRUCTURE BACKFILL	CY	140	\$65.00	\$9,100.00
8	0219001	SEDIMENTATION CONTROL SYSTEM	LF	200	\$8.00	\$1,600.00
9	0406128.20	BITUMINOUS CONCRETE PATCHING - FULL DEPTH	SY	30	\$125.00	\$3,750.00
	0503866	REMOVAL OF EXISTING CULVERT	LS	1	\$15,000.00	\$15,000.00
	0506040	PRECAST CONCRETE HEADWALL	EA	2	\$5,000.00	\$10,000.00
10	0601062	FOOTING CONCRETE	CY	30	\$750.00	\$22,500.00
11	0601064	ABUTMENT AND WALL CONCRETE	CY	20	\$850.00	\$17,000.00
12	0601125	5' x 4' PRECAST CONCRETE BOX CULVERT	LF	35	\$2,000.00	\$70,000.00
13	0703012	INTERMEDIATE RIPRAP	CY	15	\$90.00	\$1,350.00
14	0707009	MEMBRANE WATERPROOFING (COLD LIQUID ELASTOMERIC)	SY	20	\$179.00	\$3,580.00
15	0910184	METAL BEAM RAIL SPAN SECTION TYPE II	EA	2	\$4,500.00	\$9,000.00
	0911924	R-B END ANCHORAGE TYPE II	EA	4	\$4,500.00	\$18,000.00
16	0944000	FURNISHING AND PLACING TOPSOIL	SY	120	\$21.00	\$2,520.00
17	0950005	TURF ESTABLISHMENT	SY	120	\$6.00	\$720.00
18	0970001	MAINTENANCE AND PROTECTION OF TRAFFIC	LS	1	*	*
19	0970006	TRAFFICPERSON (MUNICIPAL POLICE OFFICER)	EST	1	\$5,000.00	\$5,000.00
20	0975004	MOBILIZATION AND PROJECT CLOSE-OUT	LS	1	*	*
21	0980001	CONSTRUCTION STAKING	LS	1	*	*
						\$0.00
Major Items Subtotal						\$239,580.00
Minor Items Subtotal (0% at Final Design)			20	% of Major Items Subtotal		\$47,916.00
Contract Items Subtotal						\$287,496.00

*** Other Item Allowances**

Clearing and Grubbing	1	% of Contract Items Subtotal	\$ 2,875
M & P of Traffic	1	% of Contract Items Subtotal	\$ 2,875
Mobilization	2	% of Contract Items Subtotal	\$ 5,750
Construction Staking	1	% of Contract Items Subtotal	\$ 2,875
Other Items Subtotal			\$ 14,375

CONTRACT SUBTOTAL	\$ 301,871
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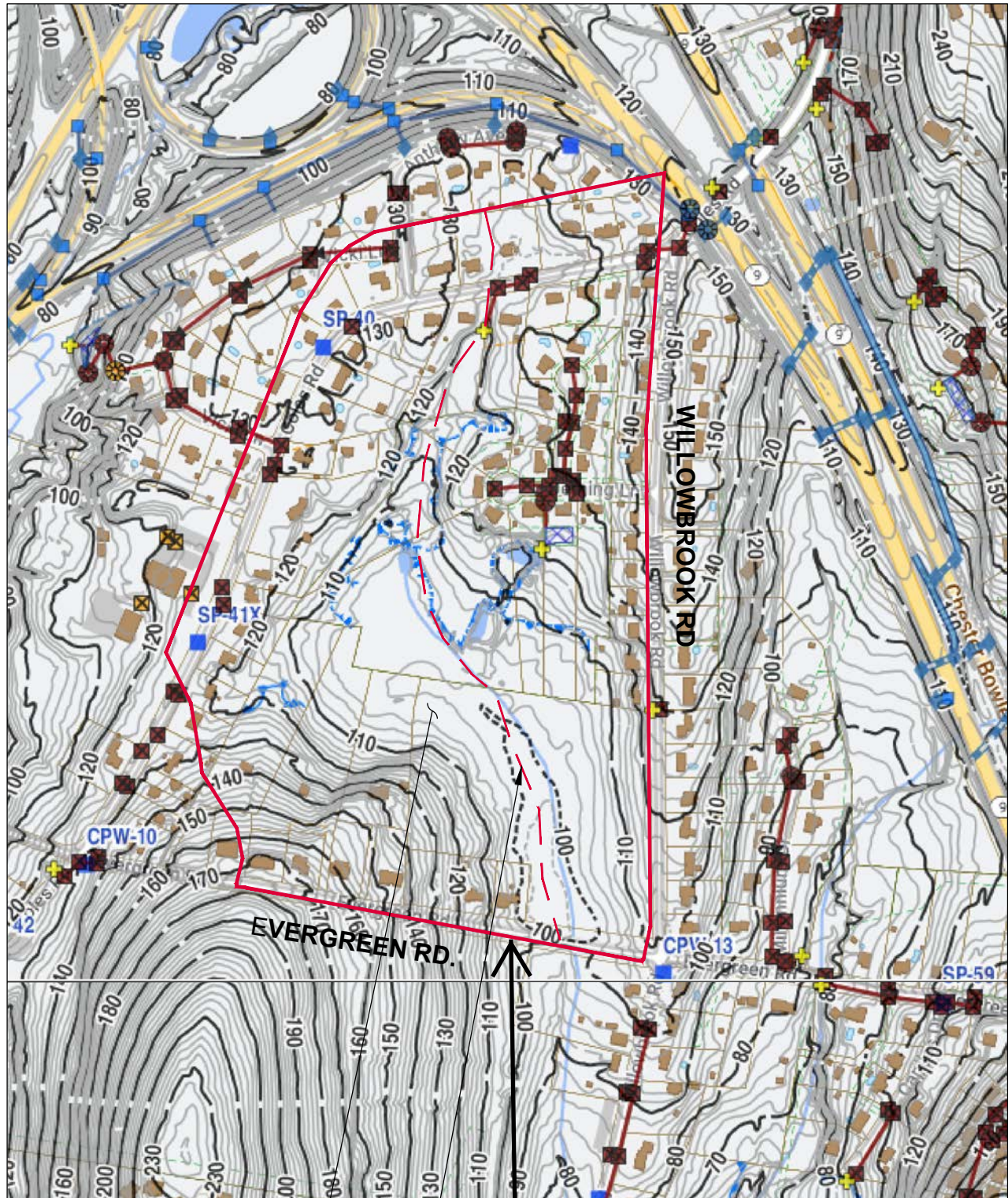
Inflation Costs (Simple Method)

Date of Estimate (provide date of estimate)	Jun-23
Anticipated Bid Date (provide anticipated bid date)	May-24
Base Years	0.9
Annual Inflation (5.0% annually, 0% at Final Design)	5.0%
Inflation Subtotal	4.5% of Subtotal \$ 13,584

TOTAL CONTRACT COST ESTIMATE (Rounded to nearest \$1000)	\$ 315,000
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Project Costs Summary (Construction Phase)			
Contract Cost Estimate (Line "G")			\$ 315,000
Contingencies	20.0%		\$ 63,000
Construction Engineering/Incidentals	LS		\$ -
ROW			\$ 5,000
Utilities			
Engineering Design & Permitting			\$ 80,000
TOTAL PROJECT COST(Rounded to nearest \$1000)	LS		\$ 463,000

AREA 10: DRAINAGE AREA FOR WILLOW BROOK WEST BRANCH CULVERT



DRAINAGE AREA =
90 ACRES

T_c FLOW PATH
TO CULVERT

Drainage Area boundary

NOT TO SCALE

CARDINAL
ENGINEERING ASSOCIATES

180 RESEARCH PKWY | MERIDEN, CT 06450 | 203-238-1969
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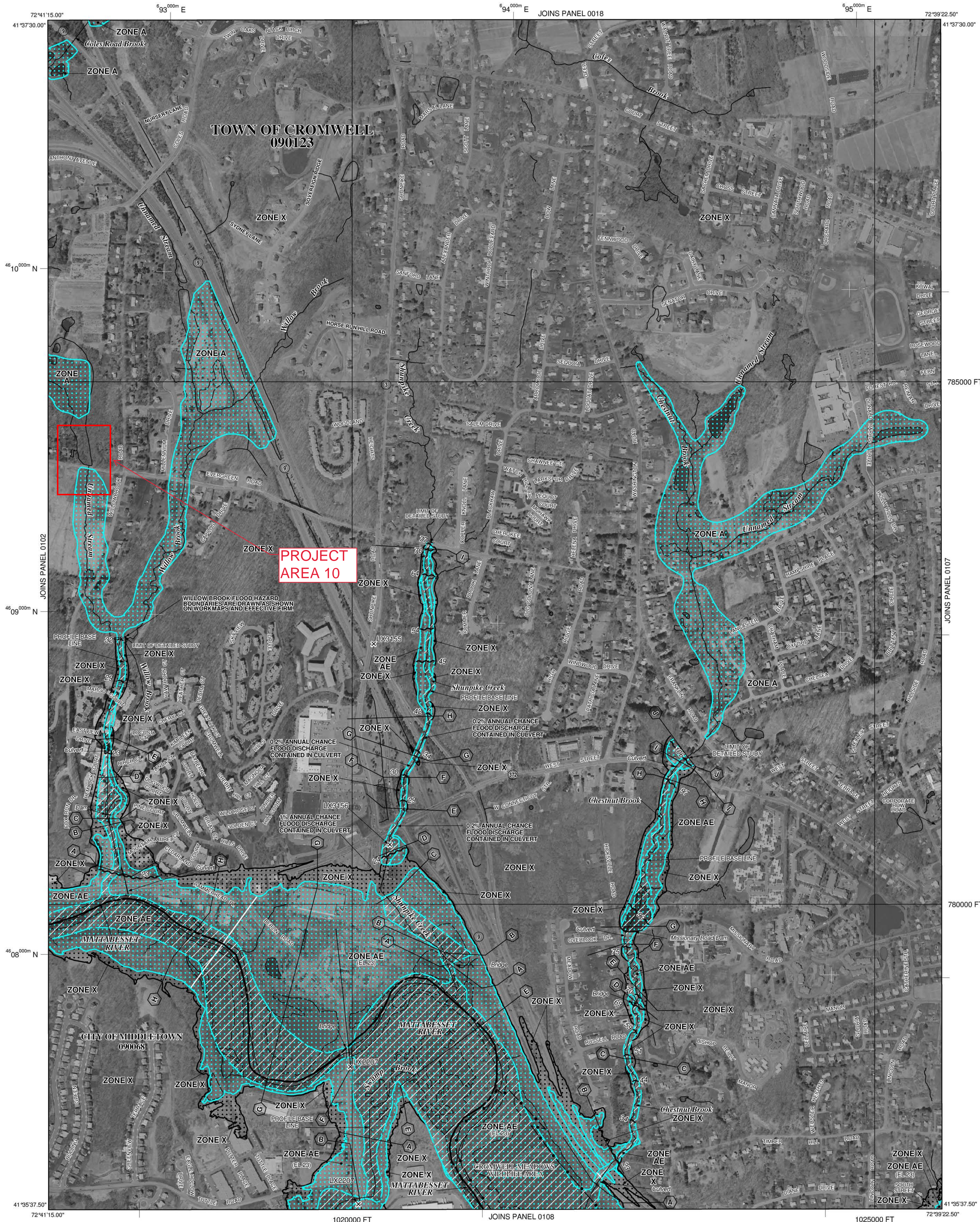
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Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at <http://www.msc.fema.gov/>.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call 1-877-FEMA MAP (1-877-336-2627) or visit the FEMA website at <http://www.fema.gov/>.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

- ZONE A** No Base Flood Elevations determined.
- ZONE AE** Base Flood Elevations determined.
- ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
- ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- ZONE AR** Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

- ZONE X** Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

- ZONE AE** Areas determined to be outside the 0.2% annual chance floodplain.
- ZONE D** Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- Base Flood Elevation line and value; elevation in feet*
- Base Flood Elevation value where uniform within zone; elevation in feet*

- * Referenced to the North American Vertical Datum of 1988 (NAVD 88)
- Transsect line
- Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 1000-meter Universal Transverse Mercator grid, zone 18
- 5000-foot grid : Connecticut State Plane coordinate system, (FIPSZONE 0600), Lambert Conformal Conic
- Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5 River Mile

- MAP REPOSITORIES
- Refer to Map Repositories list on Map Index

- EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
- August 28, 2008
- EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

- For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.
- To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

- MAP SCALE 1" = 500'
- 150 0 500 1000 FEET
- 150 0 150 300 METERS



MAP SCALE 1" = 500'

150 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0106G

FIRM

FLOOD INSURANCE RATE MAP

MIDDLESEX COUNTY,

CONNECTICUT

(ALL JURISDICTIONS)

PANEL 106 OF 450

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CROMWELL, TOWN OF	090123	0106	G
MIDDLETOWN, CITY OF	090068	0106	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
09007C0106G

EFFECTIVE DATE
AUGUST 28, 2008

Federal Emergency Management Agency

APPENDIX K

Rainfall Data



NOAA Atlas 14, Volume 10, Version 3
Location name: Cromwell, Connecticut, USA*
Latitude: 41.6049°, Longitude: -72.6955°
Elevation: 43.28 ft**
* source: ESRI Maps
** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps & aerals](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	3.96 (3.12-4.92)	4.84 (3.82-6.01)	6.26 (4.92-7.82)	7.45 (5.82-9.37)	9.08 (6.85-12.0)	10.3 (7.61-13.9)	11.6 (8.29-16.2)	13.0 (8.81-18.7)	15.1 (9.79-22.5)	16.8 (10.6-25.5)
10-min	2.81 (2.21-3.49)	3.43 (2.70-4.26)	4.44 (3.49-5.54)	5.28 (4.12-6.64)	6.44 (4.85-8.48)	7.31 (5.39-9.84)	8.22 (5.87-11.5)	9.24 (6.24-13.3)	10.7 (6.94-15.9)	11.9 (7.52-18.1)
15-min	2.20 (1.74-2.74)	2.69 (2.12-3.34)	3.48 (2.74-4.35)	4.14 (3.23-5.20)	5.05 (3.80-6.65)	5.73 (4.23-7.72)	6.45 (4.61-9.03)	7.25 (4.90-10.4)	8.39 (5.44-12.5)	9.32 (5.90-14.2)
30-min	1.50 (1.19-1.87)	1.83 (1.44-2.28)	2.36 (1.86-2.95)	2.81 (2.19-3.52)	3.41 (2.57-4.50)	3.87 (2.86-5.22)	4.35 (3.11-6.10)	4.89 (3.31-7.02)	5.66 (3.67-8.43)	6.29 (3.98-9.57)
60-min	0.955 (0.753-1.19)	1.16 (0.913-1.44)	1.49 (1.17-1.87)	1.77 (1.38-2.22)	2.15 (1.62-2.84)	2.44 (1.80-3.29)	2.74 (1.96-3.84)	3.08 (2.08-4.42)	3.56 (2.31-5.31)	3.96 (2.51-6.02)
2-hr	0.631 (0.502-0.778)	0.760 (0.604-0.938)	0.970 (0.768-1.20)	1.14 (0.900-1.43)	1.38 (1.05-1.82)	1.56 (1.17-2.10)	1.75 (1.27-2.46)	1.98 (1.34-2.83)	2.32 (1.51-3.44)	2.61 (1.66-3.95)
3-hr	0.489 (0.391-0.601)	0.587 (0.469-0.722)	0.748 (0.595-0.924)	0.882 (0.697-1.10)	1.07 (0.815-1.39)	1.20 (0.901-1.61)	1.35 (0.983-1.89)	1.53 (1.04-2.17)	1.80 (1.17-2.66)	2.03 (1.29-3.06)
6-hr	0.310 (0.250-0.378)	0.373 (0.301-0.456)	0.477 (0.383-0.585)	0.563 (0.449-0.694)	0.681 (0.525-0.885)	0.768 (0.580-1.02)	0.863 (0.634-1.20)	0.980 (0.669-1.38)	1.16 (0.759-1.70)	1.32 (0.839-1.97)
12-hr	0.189 (0.154-0.229)	0.229 (0.186-0.278)	0.296 (0.239-0.360)	0.351 (0.282-0.430)	0.427 (0.332-0.551)	0.483 (0.367-0.640)	0.544 (0.402-0.754)	0.619 (0.424-0.868)	0.733 (0.482-1.07)	0.832 (0.533-1.24)
24-hr	0.111 (0.091-0.133)	0.137 (0.112-0.165)	0.180 (0.147-0.217)	0.215 (0.174-0.261)	0.264 (0.207-0.339)	0.299 (0.230-0.395)	0.339 (0.253-0.469)	0.388 (0.267-0.541)	0.465 (0.307-0.673)	0.533 (0.342-0.787)
2-day	0.063 (0.052-0.075)	0.079 (0.065-0.094)	0.106 (0.087-0.126)	0.127 (0.104-0.154)	0.158 (0.125-0.202)	0.180 (0.139-0.237)	0.204 (0.154-0.283)	0.236 (0.163-0.328)	0.289 (0.191-0.416)	0.336 (0.216-0.492)
3-day	0.046 (0.038-0.054)	0.058 (0.048-0.068)	0.077 (0.064-0.092)	0.093 (0.077-0.112)	0.115 (0.092-0.147)	0.132 (0.103-0.173)	0.150 (0.114-0.208)	0.174 (0.120-0.240)	0.214 (0.141-0.306)	0.249 (0.161-0.364)
4-day	0.037 (0.031-0.043)	0.046 (0.039-0.055)	0.062 (0.051-0.074)	0.075 (0.062-0.089)	0.093 (0.074-0.118)	0.105 (0.082-0.138)	0.120 (0.091-0.166)	0.139 (0.097-0.192)	0.171 (0.113-0.244)	0.199 (0.129-0.290)
7-day	0.025 (0.021-0.029)	0.031 (0.026-0.036)	0.041 (0.034-0.048)	0.049 (0.041-0.058)	0.060 (0.049-0.076)	0.069 (0.054-0.089)	0.078 (0.059-0.107)	0.090 (0.063-0.123)	0.110 (0.073-0.156)	0.127 (0.082-0.184)
10-day	0.020 (0.017-0.024)	0.025 (0.021-0.029)	0.032 (0.027-0.038)	0.038 (0.032-0.045)	0.046 (0.037-0.058)	0.053 (0.041-0.068)	0.059 (0.045-0.080)	0.068 (0.048-0.093)	0.082 (0.054-0.116)	0.094 (0.061-0.135)
20-day	0.015 (0.012-0.017)	0.017 (0.014-0.020)	0.021 (0.018-0.024)	0.024 (0.020-0.028)	0.029 (0.023-0.035)	0.032 (0.025-0.040)	0.035 (0.027-0.047)	0.040 (0.028-0.053)	0.046 (0.031-0.064)	0.051 (0.033-0.073)
30-day	0.012 (0.010-0.014)	0.014 (0.012-0.016)	0.017 (0.014-0.019)	0.019 (0.016-0.022)	0.022 (0.018-0.027)	0.024 (0.019-0.030)	0.026 (0.020-0.034)	0.029 (0.021-0.039)	0.033 (0.022-0.046)	0.036 (0.023-0.051)
45-day	0.010 (0.009-0.012)	0.011 (0.010-0.013)	0.013 (0.011-0.015)	0.015 (0.013-0.017)	0.017 (0.014-0.020)	0.018 (0.015-0.023)	0.020 (0.015-0.026)	0.022 (0.015-0.029)	0.024 (0.016-0.033)	0.025 (0.017-0.036)
60-day	0.009 (0.008-0.010)	0.010 (0.009-0.011)	0.011 (0.010-0.013)	0.012 (0.011-0.014)	0.014 (0.011-0.017)	0.015 (0.012-0.019)	0.017 (0.012-0.021)	0.018 (0.013-0.024)	0.019 (0.013-0.027)	0.020 (0.013-0.029)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.
Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

PF graphical



NOAA Atlas 14, Volume 10, Version 3
Location name: Cromwell, Connecticut, USA*
Latitude: 41.5957°, Longitude: -72.6463°
Elevation: 28.84 ft**
* source: ESRI Maps
** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps & aerals](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.330 (0.260-0.409)	0.403 (0.317-0.500)	0.522 (0.410-0.650)	0.620 (0.483-0.776)	0.755 (0.569-0.990)	0.857 (0.632-1.15)	0.964 (0.689-1.34)	1.08 (0.732-1.55)	1.25 (0.813-1.85)	1.39 (0.880-2.10)
10-min	0.468 (0.369-0.580)	0.570 (0.449-0.708)	0.738 (0.579-0.920)	0.878 (0.685-1.10)	1.07 (0.806-1.40)	1.21 (0.895-1.63)	1.37 (0.975-1.90)	1.53 (1.04-2.19)	1.77 (1.15-2.63)	1.97 (1.25-2.98)
15-min	0.550 (0.434-0.682)	0.671 (0.528-0.833)	0.869 (0.682-1.08)	1.03 (0.805-1.29)	1.26 (0.948-1.65)	1.43 (1.05-1.92)	1.61 (1.15-2.24)	1.81 (1.22-2.58)	2.09 (1.36-3.09)	2.32 (1.47-3.50)
30-min	0.752 (0.593-0.933)	0.915 (0.721-1.14)	1.18 (0.927-1.47)	1.40 (1.09-1.76)	1.71 (1.29-2.24)	1.94 (1.43-2.60)	2.17 (1.55-3.03)	2.44 (1.65-3.48)	2.82 (1.83-4.18)	3.14 (1.99-4.74)
60-min	0.955 (0.753-1.18)	1.16 (0.913-1.44)	1.49 (1.17-1.86)	1.77 (1.38-2.22)	2.15 (1.62-2.83)	2.44 (1.80-3.28)	2.74 (1.96-3.82)	3.08 (2.08-4.39)	3.56 (2.31-5.27)	3.96 (2.50-5.98)
2-hr	1.26 (1.01-1.56)	1.52 (1.21-1.88)	1.94 (1.54-2.40)	2.29 (1.80-2.85)	2.77 (2.11-3.62)	3.13 (2.33-4.18)	3.51 (2.54-4.89)	3.96 (2.69-5.62)	4.63 (3.02-6.81)	5.20 (3.30-7.80)
3-hr	1.47 (1.18-1.81)	1.77 (1.41-2.17)	2.25 (1.79-2.77)	2.65 (2.10-3.29)	3.20 (2.45-4.17)	3.61 (2.71-4.82)	4.05 (2.95-5.64)	4.58 (3.12-6.47)	5.39 (3.51-7.88)	6.07 (3.86-9.07)
6-hr	1.87 (1.51-2.27)	2.25 (1.81-2.74)	2.86 (2.30-3.50)	3.38 (2.69-4.15)	4.08 (3.15-5.28)	4.60 (3.47-6.10)	5.17 (3.79-7.15)	5.86 (4.00-8.21)	6.91 (4.52-10.0)	7.82 (4.99-11.6)
12-hr	2.29 (1.87-2.77)	2.78 (2.26-3.36)	3.57 (2.89-4.33)	4.23 (3.40-5.17)	5.14 (3.99-6.60)	5.81 (4.42-7.65)	6.54 (4.83-8.99)	7.43 (5.10-10.3)	8.78 (5.77-12.7)	9.94 (6.36-14.6)
24-hr	2.69 (2.21-3.22)	3.31 (2.71-3.97)	4.32 (3.53-5.20)	5.16 (4.18-6.24)	6.31 (4.95-8.06)	7.16 (5.49-9.38)	8.09 (6.03-11.1)	9.25 (6.38-12.8)	11.1 (7.29-15.8)	12.6 (8.11-18.5)
2-day	3.05 (2.53-3.62)	3.81 (3.15-4.54)	5.06 (4.17-6.05)	6.10 (4.99-7.33)	7.52 (5.96-9.58)	8.56 (6.64-11.2)	9.72 (7.34-13.4)	11.2 (7.77-15.4)	13.7 (9.03-19.4)	15.8 (10.2-22.9)
3-day	3.32 (2.76-3.93)	4.16 (3.46-4.93)	5.54 (4.59-6.59)	6.69 (5.50-8.00)	8.26 (6.57-10.5)	9.40 (7.33-12.3)	10.7 (8.11-14.7)	12.4 (8.58-16.9)	15.1 (10.0-21.4)	17.6 (11.3-25.4)
4-day	3.56 (2.98-4.20)	4.46 (3.72-5.27)	5.93 (4.93-7.03)	7.14 (5.90-8.52)	8.82 (7.04-11.2)	10.0 (7.85-13.1)	11.4 (8.68-15.6)	13.2 (9.17-18.0)	16.1 (10.7-22.8)	18.7 (12.1-27.0)
7-day	4.22 (3.56-4.95)	5.22 (4.39-6.13)	6.86 (5.75-8.08)	8.22 (6.84-9.74)	10.1 (8.10-12.7)	11.5 (8.99-14.8)	13.0 (9.89-17.5)	14.9 (10.4-20.2)	18.1 (12.0-25.4)	20.9 (13.5-29.9)
10-day	4.89 (4.14-5.71)	5.95 (5.03-6.95)	7.67 (6.46-9.01)	9.11 (7.61-10.8)	11.1 (8.92-13.8)	12.5 (9.85-16.0)	14.1 (10.8-18.9)	16.1 (11.3-21.8)	19.3 (12.9-27.0)	22.1 (14.3-31.5)
20-day	7.03 (6.01-8.14)	8.15 (6.96-9.46)	10.00 (8.50-11.6)	11.5 (9.73-13.5)	13.6 (11.0-16.7)	15.2 (12.0-19.1)	16.9 (12.8-22.1)	18.8 (13.3-25.1)	21.7 (14.5-30.0)	24.1 (15.6-34.0)
30-day	8.84 (7.60-10.2)	10.0 (8.59-11.6)	11.9 (10.2-13.8)	13.5 (11.4-15.7)	15.6 (12.7-19.0)	17.3 (13.6-21.5)	19.0 (14.3-24.4)	20.8 (14.8-27.6)	23.4 (15.7-32.2)	25.4 (16.6-35.8)
45-day	11.1 (9.60-12.8)	12.3 (10.6-14.1)	14.3 (12.3-16.5)	15.9 (13.6-18.5)	18.1 (14.8-21.9)	19.9 (15.7-24.4)	21.6 (16.3-27.4)	23.3 (16.6-30.8)	25.6 (17.3-35.0)	27.2 (17.8-38.2)
60-day	13.0 (11.3-14.9)	14.2 (12.3-16.3)	16.3 (14.0-18.7)	17.9 (15.4-20.8)	20.3 (16.5-24.3)	22.1 (17.5-27.0)	23.8 (17.9-30.0)	25.5 (18.2-33.5)	27.6 (18.7-37.6)	29.0 (19.0-40.5)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

PF graphical

Date	Temperature (F)							Degree Days (base 65F)		Sun (LST)		Weather		Precipitation (in)			Pressure (inHg)		Wind	Maximum Wind Speed = MPH			
	Max	Min	Avg	Dep	ARH	ADP	AWB	Heat	Cool	Rise	Set	Weather Type	TLC	Snow Fall	Snow Depth	Avg Stn	Avg SL	Avg Speed	Direction = Degrees				
																			Peak Speed	Peak Dir	Sust. Speed	Sust. Dir	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
01	83	69	76	3.3				0	11	0420	1929	RA BR	1.02			29.83		3.2	13	330	10	340	
02	73	58	66	-6.9				0	1	0420	1929	TS RA BR	2.44			29.73		6.1	24	030	18	050	
03	64	58	61	-12.1				4	0	0421	1929	RA BR HZ	0.12			29.80		8.0	19	020	15	020	
04	75	57	66	-7.2				0	1	0421	1929	RA BR HZ	0.08			29.86		1.6	12	010	9	040	
05	76	61	69	-4.4				0	4	0422	1928	BR	0.00			30.02		4.1	17	170	13	160	
06	93	69	81	7.5				0	16	0422	1928	TS RA BR	0.36			29.90		6.4	38	330	25	320	
07	93	67	80	6.4				0	15	0423	1928	TS RA BR	0.47			29.89		5.0	42	320	30	320	
08	74	68	71	-2.8				0	6	0424	1927	TS RA BR	0.87			29.98		4.2	27	270	18	280	
09	84	68	76	2.1				0	11	0424	1927	TS RA FG BR	3.57			29.81		7.2	28	360	21	010	
10	81	69	75	1.0				0	10	0425	1926	BR	0.00			29.93		5.2	19	360	13	020	
11	79	67	73	-1.1				0	8	0426	1926	RA	T			30.08		5.5	18	180	14	170	
12	73	65	69	-5.2				0	4	0427	1926	RA BR	0.22			30.12		5.3	17	030	15	030	
13	73	67	70	-4.2				0	5	0427	1925	RA BR	0.01			30.22		2.4	10	060	7	050	
14	87	69	78	3.7				0	13	0428	1924	TS RA BR	0.35			30.11		4.6	20	350	15	020	
15	90	67	79	4.7				0	14	0429	1924	FG BR	0.00			30.03		4.0	16	170	12	190	
16	93*	73	83	8.6				0	18	0430	1923	TS RA BR HZ	0.10			29.96		5.6	29	290	21	280	
17	90	73	82	7.6				0	17	0431	1922	TS RA BR	0.08			30.01		3.9	14	230	10	250	
18	85	70	78	3.6				0	13	0431	1922	TS RA BR	0.80			29.93		4.8	21	200	15	180	
19	79	69	74	-0.5				0	9	0432	1921	RA BR	0.10			29.91		4.6	15	020	12	340	
20	87	66	77	2.5				0	12	0433	1920	BR HZ	0.00			29.85		3.9	18	340	15	340	
21	83	67	75	0.5				0	10	0434	1919		0.00			29.84		5.5	20	350	14	340	
22	84	61	73	-1.5				0	8	0435	1919		0.00			29.99		4.7	17	310	14	310	
23	83	62	73	-1.5				0	8	0436	1918		T			30.06		3.5					

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service
Current Location: Elev: 13 ft. Lat: 41.7352° N Lon: -72.6512° W
Station: HARTFORD BRAINARD FIELD, CT US WBAN: 72508714752 (KHFD)

Local Climatological Data
Hourly Precipitation
July 2021

Generated on 11/29/2022

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Date	For Hour (LST) Ending at																								Date	
	1 AM	2 AM	3 AM	4 AM	5 AM	6 AM	7 AM	8 AM	9 AM	10 AM	11 AM	NOON	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM	7 PM	8 PM	9 PM	10 PM	11 PM	MID		
01	T	T											T	T	0.02	T			0.06	0.37	0.42	0.15	T	T	01	
02	0.02	0.03	0.03	0.04	0.03	T	T				0.01	T	0.11	1.25	0.13	0.11	0.10	T	0.02	0.06	0.03	0.02	0.18	0.27	02	
03	0.06	T										0.01	0.01	T		T	T			0.02			T	0.02	03	
04		0.03	0.02	0.02	0.01																				04	
05																									05	
06	M	M	M	M	M	M	M	M	M	M							0.33	0.02	0.01						06	
07																	0.03	0.16			0.21	0.07			07	
08		0.40												T	0.02	0.08	0.16	0.07	0.05	0.01	0.04	0.04			08	
09		T	0.02	0.01	0.03	0.18	0.32	0.43	1.04	0.30	0.07	0.04									0.45	0.66	0.02	T	09	
10																									10	
11																	T							T	11	
12		0.01	0.07	0.02	T		0.05	0.01	0.05	T	0.01				T								T		12	
13				T	0.01																				13	
14				0.01	0.23																	0.10	0.01		14	
15																									15	
16																T	0.08	0.02							16	
17														0.04		0.03	0.01	T							17	
18	0.60	0.06	0.14	T									T												18	
19															T	0.02	0.07	0.01							19	
20																									20	
21																									21	
22																									22	
23																	T	T							23	
24																									24	
25				T	0.02	0.01	0.01	T	0.01			T													25	
26																									26	
27																			0.51	0.13			T		27	
28		0.01																							28	
29											T	T					T			0.01	0.11				29	
30														T	T										30	
31																									31	
Maximum Short Duration Precipitation																										
Time Period (Minutes)				5		10		15		20		30		45		60		80		100		120		150		180
Precipitation (inches)				0.29		0.43		0.49		0.58		0.87		1.09		1.16s		1.33		1.49		1.61		1.79		1.95
Ending Date Time (yyyy-mm-dd hh:mi)				2021-07-09 20:55		2021-07-09 20:59		2021-07-18 01:00		2021-07-09 21:10		2021-07-09 21:20		2021-07-09 21:30		2021-07-09 09:09		2021-07-09 09:09		2021-07-09 09:14		2021-07-09 09:18		2021-07-09 09:14		2021-07-09 09:18

Hourly, daily, and monthly totals on the Daily Summary page and the Hourly Precipitation Table are shown as reported by the instrumentation at the site. However, NWS does not edit hourly values for its ASOS sites, but may edit the daily and monthly totals for selected sites which will be reflected on the Daily Summary page.

T = Trace
s = Suspect
* = Erroneous
blank = No precipitation observed
M = Missing

Date	Temperature (F)							Degree Days (base 65F)		Sun (LST)		Weather	Precipitation (in)			Pressure (inHg)		Wind	Maximum Wind Speed = MPH							
	Max	Min	Avg	Dep	ARH	ADP	AWB	Heat	Cool	Rise	Set	Weather Type	TLC	Snow Fall	Snow Depth	Avg Stn	Avg SL	Avg Speed	Direction = Degrees							
																			Peak Speed	Peak Dir	Sust. Speed	Sust. Dir				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23				
01	70	61	66	-4.0				0	1	0516	1824	TS RA BR	4.43			29.80		6.1	30	360	21	360				
02	76	58	67	-2.7				0	2	0517	1823	RA BR	0.69			29.75		11.5	36	360	25	010				
03	75	54	65	-4.4				0	0	0518	1821		0.00			29.96		5.1	18	330	15	340				
04	80	55	68	-1.1				0	3	0519	1819		0.00			29.96		3.1	15	310	12	330				
05	73	61	67	-1.8				0	2	0520	1818	RA BR	0.17			29.83		4.4	22	190	16	190				
06	83	64	74	5.5				0	9	0521	1816	BR	0.01			29.75		5.0	23	240	16	280				
07	80	57	69	0.8				0	4	0522	1814		0.00			29.90		4.2	14	310	10	300				
08	83	61	72	4.2				0	7	0523	1813	BR	0.00			29.84		9.3	32	180	24	180				
09	75	67	71	3.5				0	6	0524	1811	TS RA BR	0.61			29.74		2.7	21	170	15	180				
10	76	55	66	-1.1				0	1	0525	1809		0.00			29.82		6.7	26	300	18	330				
11	78	53	66	-0.7				0	1	0526	1807		0.00			30.09		5.5	22	240	13	200				
12	83	62	73	6.6				0	8	0527	1806		0.00			30.01		7.4	23	210	16	190				
13	82	65	74	8.0				0	9	0528	1804		0.00			29.96		6.9	24	330	15	330				
14	77	59	68	2.4				0	3	0529	1802		0.00			30.03		3.6	15	190	12	180				
15	86*	69	78	12.8				0	13	0530	1800	RA BR HZ	0.07			29.93		6.6	27	190	21	190				
16	76	67	72	7.2				0	7	0532	1759	TS RA BR	0.29			30.16		5.5	15	070	13	020				
17	75	67	71	6.6				0	6	0533	1757		0.00			30.22		5.9	13	010	10	010				
18	83	66	75	11.1				0	10	0534	1755	BR	0.01			30.02		4.5	18	340	12	340				
19	76	58	67	3.5				0	2	0535	1753		0.00			30.11		5.3	20	010	15	010				
20	76	54	65	1.9				0	0	0536	1752	BR	0.00			30.30		2.7	15	180	12	170				
21	76	53	65	2.4				0	0	0537	1750	BR	T			30.34		2.5	14	160	10	170				
22	79	66	73	10.8				0	8	0538	1748	RA BR	0.30			30.11		5.7	21	160	16	170				
23	82	72	77	15.2				0	12	0539	1747		0.00			29.98		10.6	30	170	22	160				
24	77	58	68	6.7				0	3	0540	1745	RA BR	0.55			29.98		5.8	26	170	20	160				
25	77	52	65	4.1				0	0	0541	1743	FG BR	0.00			29.98		2.0	9	030	8	040				
26	73	55	64	3.6				1	0	0542	1741	BR	0.00			29.82		5.0	29	310	18	340				
27	77	52	65	5.0				0	0	0543	1740		0.00			29.88		7.0	29	190	18	200				
28	70	57	64	4.4				1	0	0544	1738	TS RA BR HZ	0.33			29.78		4.7	17	350	13	360				
29	67	50	59	-0.1				6	0	0545	1736		0.00			29.93		5.8	17	010	13	010				
30	63	48*	56	-2.7				9	0	0546	1734		T			30.04		5.9	20	360	15	010				
	76.8	59.2	68.0							Monthly Averages Totals			7.46			29.97	29.99	5.6								
	2.1	5.2	3.6	Departure from Normal (1981-2010)									3.98s													
Degree Days												Number of days with...														
	Monthly				Season-to-date				Temperature				Precipitation			Snow		Weather								
	Total		Departure		Total		Departure		Max		Min															
Heating	20		-79		24				>=90°		<=32°		<=32°		<=0°		>=0.01"		>=0.1"		>=1"		T-Storms		Heavy Fog	
Cooling	110		30		1009				0		0		0		0		11		8							
Date of 5-sec to 3-sec wind equipment change									Sea Level Pressure						Greatest...											
N/A												Date		Time		24-Hr...				Snow Depth						
									Maximum		30.40		21		0928		Precip		Snowfall							
									Minimum		29.61		02		0144		5.12									
															Date											
															01-02											
Station Augmentation																										
Name: N/A Lat: N/A Lon: N/A Elevation: N/A Distance: N/A Elements: N/A Equipment: N/A																										

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Local Climatological Data
Hourly Precipitation
September 2021
Generated on 11/29/2022

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Date	For Hour (LST) Ending at																								Date	
	1 AM	2 AM	3 AM	4 AM	5 AM	6 AM	7 AM	8 AM	9 AM	10 AM	11 AM	NOON	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM	7 PM	8 PM	9 PM	10 PM	11 PM	MID		
01						T	0.02	0.03	0.04	0.05	0.09	0.23	0.05	0.18	0.23	0.10	0.27	0.04	0.19	0.36	0.41	0.34	0.51	1.29	01	
02	0.31	0.27	0.10	0.01																					02	
03																									03	
04																									04	
05									T	T	0.01	T		T	T	0.02	0.06	0.08							05	
06					T	0.01																			06	
07																									07	
08																									08	
09		T	0.34					0.02	T	0.04	0.02	0.06	0.02	0.01	0.01	T	0.04	0.01	0.02	0.02	T	T	T		09	
10																									10	
11																									11	
12																									12	
13																									13	
14																									14	
15																					0.07	T			15	
16		T	0.07	0.05	0.11	0.04	0.01	T	0.01												T	T			16	
17																									17	
18																0.01									18	
19																									19	
20																									20	
21																							T		21	
22	0.01								T								0.01	0.03	0.17	0.08					22	
23																									23	
24		T		0.07	0.16	0.02	0.05	0.10	0.12	0.02	T	0.01	T												24	
25																									25	
26																									26	
27																									27	
28									T	0.01	0.04	0.14	0.10	T	T	0.03	0.01								28	
29																									29	
30	T		T																						30	
Maximum Short Duration Precipitation																										
Time Period (Minutes)				5		10		15		20		30		45		60		80		100		120		150		180
Precipitation (inches)				0.19		0.28		0.39		0.51		0.75		1.08		1.35		1.56		1.70		1.81		2.01		2.20
Ending Date Time (yyyy-mm-dd hh:mi)				2021-09-01 16:55		2021-09-01 23:39		2021-09-01 23:41		2021-09-01 23:38		2021-09-01 23:45		2021-09-01 23:43		2021-09-01 23:50		2021-09-02 00:03		2021-09-02 00:24		2021-09-02 00:28		2021-09-02 00:28		2021-09-02 00:28

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