**SUMMARY of CERTIFICATIONS**

**FEMA ACCREDITATION**

# HOUSATONIC RIVER and NAUGATUCK RIVER

# FLOOD PROTECTION PROJECTS

## SECTION 1

## ANSONIA and DERBY, CONNECTICUT

December 2010

MMI #1560-119 and #3118-03

***Prepared for:***

City of Ansonia
253 Main Street
Ansonia, CT 06401

City of Derby
One Elizabeth Street
Derby, CT 06418

***Prepared by:***

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## 1. INTRODUCTION

On May 9, 2008, the Federal Emergency Management Agency (FEMA) of the Department of Homeland Security notified the cities of Ansonia and Derby, Connecticut that FEMA would be providing updated flood maps for New Haven County and that the land behind the levees along the Housatonic River, Naugatuck River, and Beaver Brook known as the Derby and Ansonia Local Protection Projects will be remapped as areas protected by Provisionally Accredited Levees (PALs). In response to this notification, each municipality executed a Letter of Agreement and Request for PAL designation and an agreement to provide adequate compliance with the Code of Federal Regulations, Title 44, Section 65.10 (44 CFR 65.10). Under the terms of this agreement, the municipalities were to provide FEMA with the supporting documentation to show that the levees comply with the above-mentioned regulations by August 7, 2010. If documentation was not provided by this date, FEMA indicated that they will initiate a task order with their mapping consultant to revise the Flood Insurance Rate Map (FIRM) to redesignate the areas behind the levees as prone to flooding.

The Ansonia and Derby flood control projects under authorizations provided by Congress were constructed consecutively by the U.S. Army Corps of Engineers in the late 1960s and early 1970s, beginning with Ansonia as described briefly below and shown on Figure 1.

**Ansonia** - Located along the Naugatuck River and Beaver Brook tributary, the Ansonia Local Protection Project extends 9,260 feet along both sides of the Naugatuck River beginning at the Division Street bridge (municipal boundary between Derby and Ansonia) and terminating upstream near the Ansonia Copper & Brass Company hydroelectric plant. The project also extends along Beaver Brook from the confluence with the Naugatuck River to 400 feet above Central Street.

**Derby** - Located along the Naugatuck and Housatonic Rivers, the Derby Local Protection Project portion extends approximately 4,400 feet along the right (west) bank of the Naugatuck River

beginning at the Division Street bridge (municipal boundary between Derby and Ansonia) and terminating on the upstream side of the Connecticut State Route No. 34 bridge (Main Street) over the Naugatuck River. The portion of the project along the Housatonic River extends approximately 1,935 feet along the left (east) bank of the river beginning at the north abutment of the Bridge Street bridge and terminating at the Connecticut Route 8 (Commodore Hull bridge) embankment.

Prior to the preparation of this report, Milone & MacBroom, Inc. (MMI) offered an opinion that the collective Ansonia and Derby flood control project is comprised of the three hydraulically independent levee systems described below:

- Section 1 – The left (east) bank of the Housatonic River in Derby from Bridge Street to the confluence with the Naugatuck River/Route 8 embankment and the right (west) bank of the Naugatuck River from the Main Street (Route 34) bridge north through Derby to the embankment supporting Pershing Drive in Ansonia.

- Section 2 – The full length of the left (east) bank of the Naugatuck River from Route 115 north to the northern end of the Ansonia Copper & Brass Company property, including the Beaver Brook extension of the system from its confluence with the Naugatuck River up to and including the closed conduit system 400 feet above Central Street.

- Section 3 – The right (west) bank of the Naugatuck River along Riverside Drive north of Maple Street.

In February 2009, the cities of Ansonia and Derby requested permission from FEMA to pursue accreditation of the three systems independently. In correspondence dated April 2, 2010, FEMA concurred with the opinion that the three systems are hydraulically independent and notified the municipalities that mapping of these systems will be performed separately by FEMA and that accreditation of each levee system can be pursued independently. As more formally defined

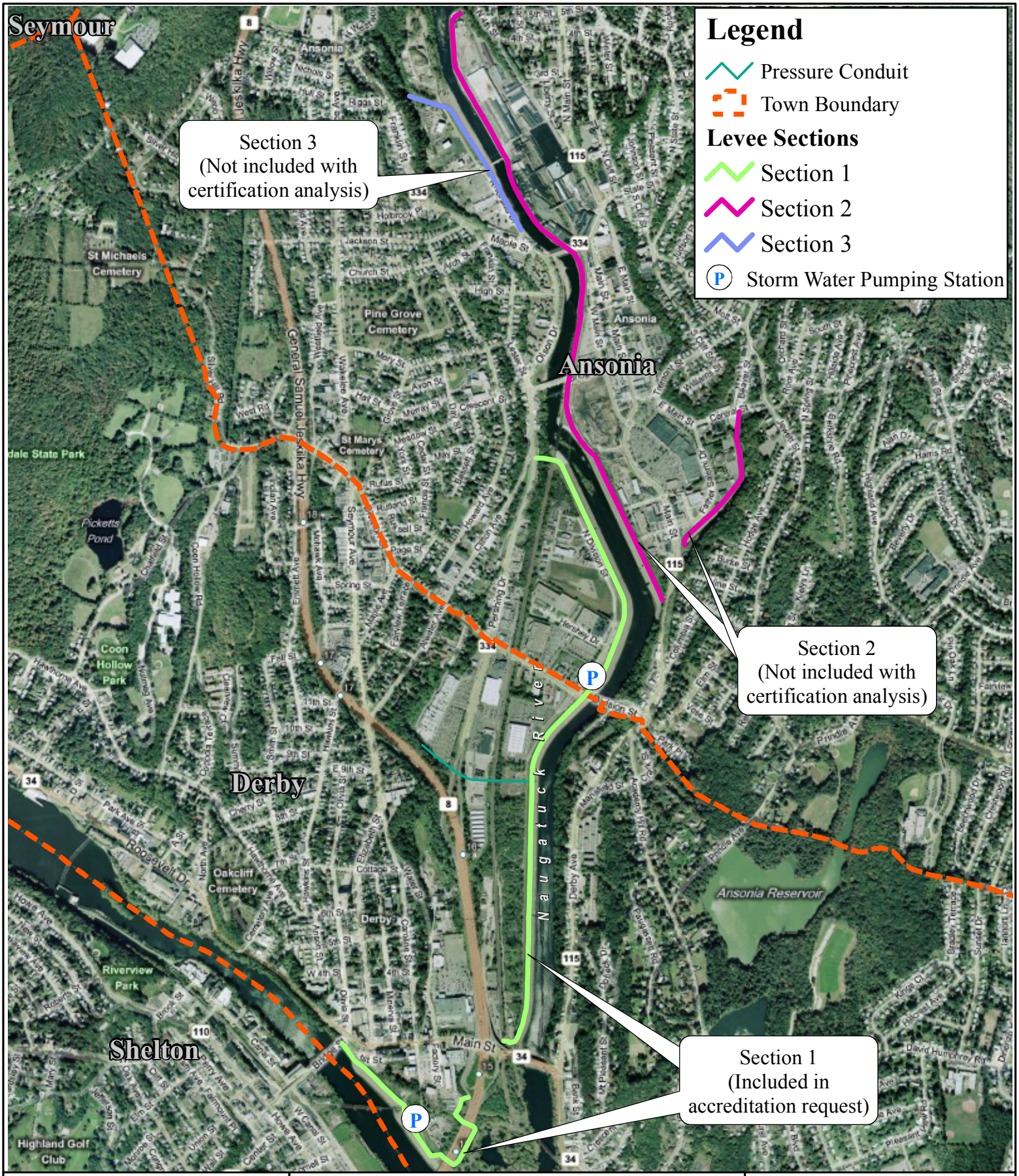
under Section 4 of this report, accreditation is a designation provided by FEMA, following receipt of the required supporting documentation prepared by a registered professional engineer, that a levee system provides protection from the base flood (the flood that has a one-percent chance of being equaled or exceeded in any given year).

Attached herewith is an exhibit showing a portion of panel 404 of 635 of the FEMA Digital Flood Insurance Rate Map (DFIRM) for New Haven County dated December 17, 2010. The exhibit shows the designation assigned for the areas that are protected by the levee and flood control systems and the corresponding labels indicating Zone X (shaded) and Area Protected by Levee.

Since Section 1 provides protection for both Ansonia and Derby, certification of the levee components in both cities is required in order to obtain accreditation from FEMA. Therefore, the municipalities have agreed to perform the certification analyses for this section concurrently and to request accreditation together. A more detailed description of Section 1 is provided starting on page 2 and within the supporting documentation provided in the appendices and is graphically depicted on Figure 2.

In June 2010, Ansonia and Derby retained MMI of Cheshire, Connecticut to perform the investigative and engineering services required to evaluate and certify Section 1 of the Housatonic River and Naugatuck River Flood Control Systems in accordance with 44 CFR Section 65.10 to support the municipalities' request to obtain accreditation from FEMA. Under these agreements, MMI entered into a separate contract with Paulus, Sokolowski & Sartor (PS&S) of Warren, New Jersey to perform the required geotechnical engineering analyses.

**PLEASE NOTE: The opinions of certification offered within this report are provided on behalf of Ansonia and Derby and apply only to Section 1. The City of Ansonia is pursuing accreditation of Sections 2 and 3 separately.**




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**Ansonia & Derby Flood Control Protection Systems**

**LOCATION:** Ansonia & Derby, CT

**MMI#:** 1560-119-5

**MXD:** H:\location_map _8.5x11.mxd

**SOURCE:** Microsoft Virtual Earth, CT DEP, City of Ansonia, City of Derby

N

**FEMA Certification Analysis**

**Map By:** SMG

**Date:** December 2010

**Scale:** 1"=1,500'

**SHEET:** Figure 1

## Legend

- Pressure Conduit
- Town Boundary
- P — Storm Water Pumping Station

Railroad Flood Gate Structure No. 4

Sluice Gate Structure No. 7

Sluice Gate Structure No. 5

Sluice Gate Structure No. 8

Ansonia WPCA Plant

Division Street Pump Station

Sluice Gate Structure No. 10

Sluice Gate Structure No. 11

48" Pressure Conduit

Flood Control Levee

Sluice Gate Structure No. 1

Flood Wall

Railroad Flood Gate Structure No. 1

24" and 36" Pressure Conduit

Railroad Flood Gate Structure No. 2A

Railroad Flood Gate Structure No. 3

Railroad Flood Gate Structure No. 2B

Sluice Gate Structure No. 2

Derby Pump Station

Derby WPCA Plant

Sluice Gate Structure No. 3


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**Ansonia & Derby Flood Control Protection Systems**
**- Section 1 -**

**LOCATION:**
**Ansonia & Derby, CT**

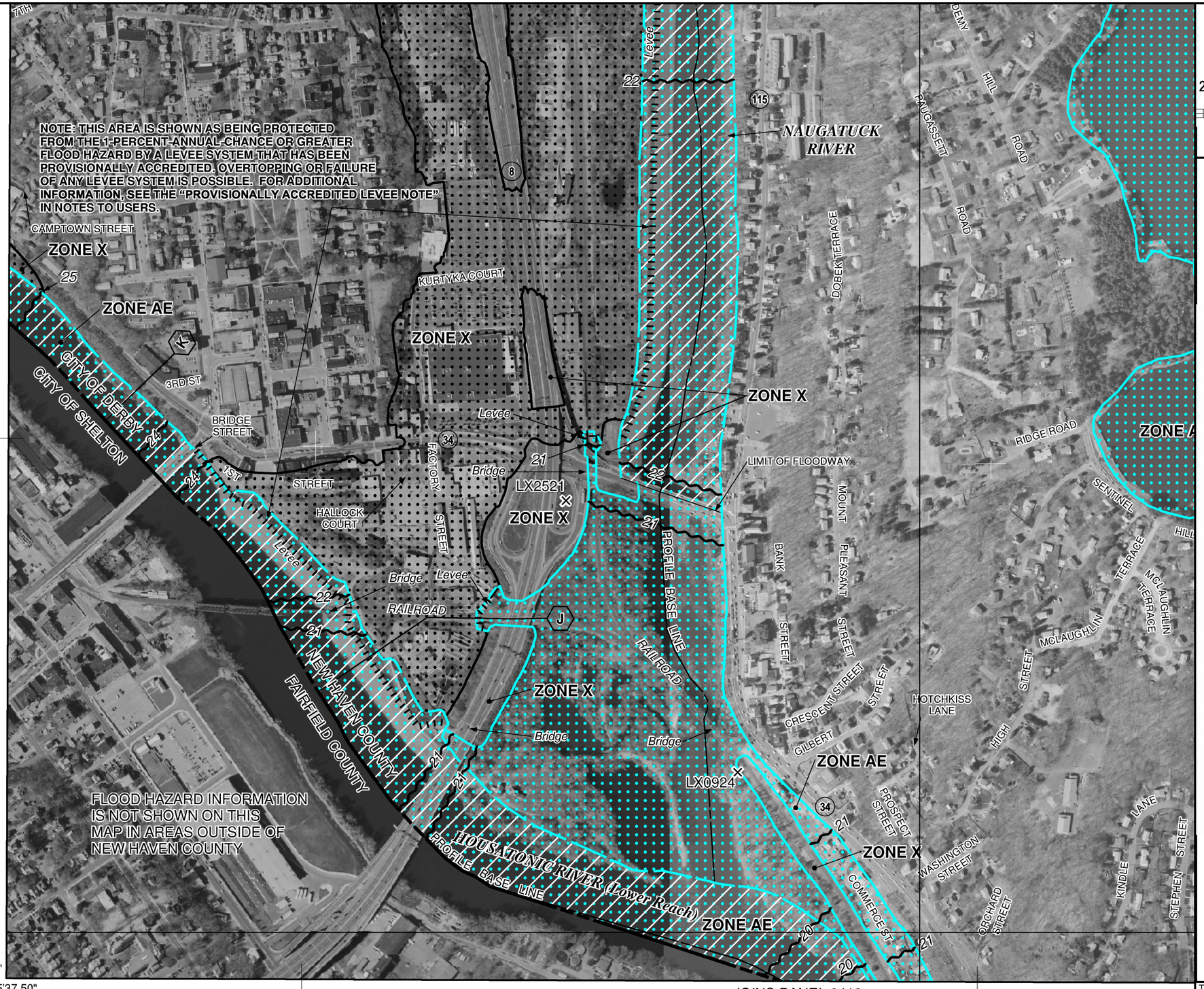
**MMI#: 1560-119-5**
**MXD: H:\location_map.mxd**
**SOURCES: Microsoft Virtual Earth, CT DEP, City of Ansonia, City of Derby**

N

**FEMA Certification Analysis**

**Map By: SMG**
**Date: December 2010**
**Scale: 1" = 700'**

**SHEET:**
**Figure 1**




MAP SCALE 1" = 500'

250 0 500 1000 FEET

0 150 300 METE

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0404H

# FIRM

## FLOOD INSURANCE RATE MAP

## NEW HAVEN COUNTY, CONNECTICUT

(ALL JURISDICTIONS)

**PANEL 404 OF 635**

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| ANSONIA, CITY OF | 090071 | 0404 | H |
| DERBY, CITY OF | 090075 | 0404 | H |

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**
**09009C0404H**

**EFFECTIVE DATE**
**DECEMBER 17, 2010**

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

## 2. FLOOD CONTROL SYSTEM DESCRIPTIONS

As indicated in Section 1 of this report, the opinions of certification offered herein apply to Section 1 of the flood control systems along the west (right) bank of the Naugatuck River and the system along the east (left) bank of the Housatonic River, which provide shared protection from the base flood for Ansonia and Derby. The systems constructed by the U.S. Army Corps of Engineers consist of the following main components as depicted in Figure 2, which are summarized below and represented on the as-built drawings provided to the municipalities by the U.S. Army Corps of Engineers upon completion of the original projects:

### Ansonia

- Approximately 3,300 linear feet of earthen levees with riverside riprap protection
- One railroad flood gate (Metro-North Railroad) – No. 4
- One pumping station (Division Street)
- Three sanitary sewer sluice gate structures associated with the Water Pollution Control Authority (WPCA) plant - No. 5, 7, and 8
- One stormwater sluice gate structure and 5'x6' concrete gravity outlet culvert - No. 8
- Interior drainage collection systems
- Continuous underdrains along the toe of levee embankment

### Derby

- Approximately 6,000 linear feet of earthen levees with riverside riprap protection
- Four railroad gates (Metro-North Railroad and Housatonic Railroad) – No. 1, 2A, 2B, and 3
- One pumping station (Caroline Street) with emergency generator power supply
- Three stormwater sluice gate structures – No. 1, 2, and 11
- One sanitary sewer sluice gate structure to the WPCA plant – No. 3
- 4'x4', 8'x6', and 5'x 5' concrete gravity outlet culverts
- One 24" pressure conduit
- One 36" pressure conduit

- One 48" pressure conduit and interior ponding area
- Interior drainage collection systems
- Continuous underdrains along the toe of levee embankment
- 10 relief wells
- Impervious soil blanket along the Route 8 highway embankment

The U.S. Army Corps of Engineers as-built drawings are provided in Appendix G and represent the constructed condition which, in general, based upon the investigations and confirmation surveys obtained during this certification effort, have remained unchanged. A summary of previous repairs, minor modifications, and adjacent construction projects that have occurred along the flood control systems is also provided in Appendix I. Specific mention of the modifications is also provided in each report when applicable to the certification criteria.

## 3. FEDERAL REGULATORY CRITERIA

In order to establish and/or maintain accreditation of a levee system, levee owners, the City of Ansonia and the City of Derby, are required to demonstrate compliance with Section 65.10 under Title 44, Chapter 1, Subchapter B, Part 65 of the Code of Federal Regulations (originally published under 51 FR 30316, dated August 25, 1986), which is provided below. For Section 1 of the levee protection system shared by Ansonia and Derby, subsections (b)(1)(ii), (iii), (iv); (b)(7); and (c)(3) described in further detail below are not applicable to the certifications offered herein.

### § 65.10 MAPPING OF AREAS PROTECTED BY LEVEE SYSTEMS.

**(a) General.**

For purposes of the NFIP, FEMA will only recognize in its flood hazard and risk mapping effort those levee systems that meet, and continue to meet, minimum design, operation, and maintenance standards that are consistent with the level of protection sought through the comprehensive flood plain management criteria established by §60.3 of this subchapter. Accordingly, this section describes the types of information FEMA needs to recognize, on NFIP maps, that a levee system provides protection from the base flood.

This information must be supplied to FEMA by the community or other party seeking recognition of such a levee system at the time a flood risk study or restudy is conducted, when a map revision under the provisions of part 65 of this subchapter is sought based on a levee system, and upon request by the Federal Insurance Administrator during the review of previously recognized structures. The FEMA review will be for the sole purpose of establishing appropriate risk zone determinations for NFIP maps and shall not constitute a determination by FEMA as to how a structure or system will perform in a flood event.

**(b) Design criteria**.

For levees to be recognized by FEMA, evidence that adequate design and operation and maintenance systems are in place to provide reasonable assurance that protection from the base flood exists must be provided. The following requirements must be met:

**(1)** ***Freeboard.***

(i) Riverine levees must provide a minimum freeboard of three feet above the water-surface level of the base flood. An additional one foot above the minimum is required within 100 feet in either side of structures (such as bridges) riverward of the levee or wherever the flow is constricted. An additional one-half foot above the minimum at the upstream end of the levee, tapering to not less than the minimum at the downstream end of the levee, is also required.

(ii) Occasionally, exceptions to the minimum riverine freeboard requirement described in paragraph (b)(1)(i) of this section, may be approved. Appropriate engineering analyses demonstrating adequate protection with a lesser freeboard must be submitted to support a request for such an exception. The material presented must evaluate the uncertainty in the estimated base flood elevation profile and include, but not necessarily be limited to an assessment of statistical confidence limits of the 100-year discharge; changes in stage-discharge relationships; and the sources, potential, and magnitude of debris, sediment, and ice accumulation. It must be also shown that the levee will remain structurally stable during the base flood when such additional loading considerations are imposed. Under no circumstances will freeboard of less than two feet be accepted.

(iii) For coastal levees, the freeboard must be established at one foot above the height of the one percent wave or the maximum wave runup (whichever is greater) associated with the 100-year stillwater surge elevation at the site.

(iv) Occasionally, exceptions to the minimum coastal levee freeboard requirement described in paragraph (b)(1)(iii) of this section, may be approved. Appropriate engineering analyses demonstrating adequate protection with a lesser freeboard must be submitted to support a request for such an exception. The material presented must evaluate the uncertainty in the estimated base flood loading

conditions. Particular emphasis must be placed on the effects of wave attack and overtopping on the stability of the levee. Under no circumstances, however, will a freeboard of less than two feet above the 100-year stillwater surge elevation be accepted.

**(2)** ***Closures***.

All openings must be provided with closure devices that are structural parts of the system during operation and design according to sound engineering practice.

**(3)** ***Embankment protection.***

Engineering analyses must be submitted that demonstrate that no appreciable erosion of the levee embankment can be expected during the base flood, as a result of either currents or waves, and that anticipated erosion will not result in failure of the levee embankment or foundation directly or indirectly through reduction of the seepage path and subsequent instability. The factors to be addressed in such analyses include, but are not limited to: Expected flow velocities (especially in constricted areas); expected wind and wave action; ice loading; impact of debris; slope protection techniques; duration of flooding at various stages and velocities; embankment and foundation materials; levee alignment, bends, and transitions; and levee side slopes.

**(4)** ***Embankment and foundation stability.***

Engineering analyses that evaluate levee embankment stability must be submitted. The analyses provided shall evaluate expected seepage during loading conditions associated with the base flood and shall demonstrate that seepage into or through the levee foundation and embankment will not jeopardize embankment or foundation stability. An alternative analysis demonstrating that the levee is designed and constructed for stability against loading conditions for Case IV as defined in the U.S. Army Corps of Engineers (COE) manual, "Design and Construction of Levees" (EM 1110–2–1913, Chapter 6, Section II), may be used. The factors that shall be addressed in the analyses include: Depth of flooding, duration of flooding, embankment geometry and length of seepage path at critical locations, embankment and foundation materials, embankment compaction, penetrations, other design factors affecting seepage (such as drainage layers), and other design factors affecting embankment and foundation stability (such as berms).

**(5)** ***Settlement.***

Engineering analyses must be submitted that assess the potential and magnitude of future losses of freeboard as a result of levee settlement and demonstrate that

freeboard will be maintained within the minimum standards set forth in paragraph (b)(1) of this section. This analysis must address embankment loads, compressibility of embankment soils, compressibility of foundation soils, age of the levee system, and construction compaction methods. In addition, detailed settlement analysis using procedures such as those described in the COE manual, "Soil Mechanics Design—Settlement Analysis" (EM 1100–2–1904) must be submitted.

**(6)** ***Interior drainage.***

An analysis must be submitted that identifies the source(s) of such flooding, the extent of the flooded area, and, if the average depth is greater than one foot, the water-surface elevation(s) of the base flood. This analysis must be based on the joint probability of interior and exterior flooding and the capacity of facilities (such as drainage lines and pumps) for evacuating interior floodwaters.

**(7)** ***Other design criteria.***

In unique situations, such as those where the levee system has relatively high vulnerability, FEMA may require that other design criteria and analyses be submitted to show that the levees provide adequate protection. In such situations, sound engineering practice will be the standard on which FEMA will base its determinations. FEMA will also provide the rationale for requiring this additional information.

**(c) Operation plans and criteria.**

For a levee system to be recognized, the operational criteria must be as described below. All closure devices or mechanical systems for internal drainage, whether manual or automatic, must be operated in accordance with an officially adopted operation manual, a copy of which must be provided to FEMA by the operator when levee or drainage system recognition is being sought or when the manual for a previously recognized system is revised in any manner. All operations must be under the jurisdiction of a Federal or State agency, an agency created by Federal or State law, or an agency of a community participating in the NFIP.

***(1) Closures.***

Operation plans for closures must include the following:

(i) Documentation of the flood warning system, under the jurisdiction of Federal, State, or community officials, that will be used to trigger emergency operation activities and demonstration that sufficient flood warning time exists for the

completed operation of all closure structures, including necessary sealing, before floodwaters reach the base of the closure.

(ii) A formal plan of operation including specific actions and assignments of responsibility by individual name or title.

(iii) Provisions for periodic operation, at not less than one-year intervals, of the closure structure for testing and training purposes.

***(2) Interior drainage systems.***

Interior drainage systems associated with levee systems usually include storage areas, gravity outlets, pumping stations, or a combination thereof. These drainage systems will be recognized by FEMA on NFIP maps for flood protection purposes only if the following minimum criteria are included in the operation plan:

(i) Documentation of the flood warning system, under the jurisdiction of Federal, State, or community officials, that will be used to trigger emergency operation activities and demonstration that sufficient flood warning time exists to permit activation of mechanized portions of the drainage system.

(ii) A formal plan of operation including specific actions and assignments of responsibility by individual name or title.

(iii) Provision for manual backup for the activation of automatic systems.

(iv) Provisions for periodic inspection of interior drainage systems and periodic operation of any mechanized portions for testing and training purposes. No more than one year shall elapse between either the inspections or the operations.

***(3) Other operation plans and criteria.***

Other operating plans and criteria may be required by FEMA to ensure that adequate protection is provided in specific situations. In such cases, sound emergency management practice will be the standard upon which FEMA determinations will be based.

**(d) Maintenance plans and criteria.**

For levee systems to be recognized as providing protection from the base flood, the maintenance criteria must be as described herein. Levee systems must be maintained in accordance with an officially adopted maintenance plan, and a copy of this plan must be provided to FEMA by the owner of the levee system when recognition is being sought or when the plan for a previously recognized system is revised in any manner. All

maintenance activities must be under the jurisdiction of a Federal or State agency, an agency created by Federal or State law, or an agency of a community participating in the NFIP that must assume ultimate responsibility for maintenance. This plan must document the formal procedure that ensures that the stability, height, and overall integrity of the levee and its associated structures and systems are maintained. At a minimum, maintenance plans shall specify the maintenance activities to be performed, the frequency of their performance, and the person by name or title responsible for their performance.

**(e) Certification requirements.**

Data submitted to support that a given levee system complies with the structural requirements set forth in paragraphs (b)(1) through (7) of this section must be certified by a registered professional engineer. Also, certified as-built plans of the levee must be submitted. Certifications are subject to the definition given at §65.2 of this subchapter. In lieu of these structural requirements, a Federal agency with responsibility for levee design may certify that the levee has been adequately designed and constructed to provide protection against the base flood.

## 4. DEFINITIONS

The definitions listed below are provided in 44 CFR Section 59.1 and 44 CFR Section 65.2 and are assumed in reference to the opinions of certification offered herein:

***Accredited levee system*** *is a levee system that FEMA has shown on a Flood Insurance Rate Map (FIRM) or Digital Flood Insurance Rate Map (DFIRM) as providing protection from the 1-percent annual-chance or greater flood. This determination is based on the submittal of data and documentation as required by Section 65.10 of the NFIP regulations. The impacted area landward of an accredited levee system is shown as Zone X (shaded) on the FIRM or DFIRM except for areas of residual flooding, such as ponding areas, which are shown as Special Flood Hazard Area [SFHA].*

***Area of special flood hazard*** *is the land in the flood plain within a community subject to a 1 percent or greater chance of flooding in any given year. The term "**special flood hazard area [SFHA]**" is synonymous in meaning with the phrase "**area of special flood hazard.**"*

***Base flood*** *means the flood having a one percent chance of being equalled or exceeded in any given year.*

***Certification by a registered professional engineer*** *or other party does not constitute a warranty or guarantee of performance, expressed or implied.*

***Certification of data*** *is a statement that the data is accurate to the best of the certifier's knowledge.*

***Certification of analyses*** *is a statement that the analyses have been performed correctly and in accordance with sound engineering practices.*

***Certification of structural works*** *is a statement that the works are designed in accordance with sound engineering practices to provide protection from the base flood.*

***Certification of as built conditions*** *is a statement that the structure(s) has been built according to the plans being certified, is in place, and is fully functioning.*

***Reasonably safe from flooding*** *means base flood waters will not inundate the land or damage structures to be removed from the SFHA [Special Flood Hazard Area] and that any subsurface waters related to the base flood will not damage existing or proposed buildings.*

## 5. CERTIFICATIONS AND CONDITIONS

The engineering analyses and reports attached with this Summary of Certifications are provided in support of Ansonia's and Derby's request for FEMA accreditation of Section 1 of the Housatonic River and Naugatuck River Flood Protection Systems described herein and collectively demonstrate compliance in accordance with the Code of Federal Regulations, Title 44, Section 65.10 (44 CFR 65.10). In order to facilitate future certifications, repairs, or modifications, the engineering reports for each criterion have been compiled separately.

The following conditions in addition to the definitions referenced above shall apply to the certifications provided herein.

These certifications and engineering opinions regarding the protection provided from the base flood are valid for 10 years from the date of this report provided the following has occurred:

1. The City of Ansonia and the City of Derby maintain compliance with the requirements outlined in the revised Operations and Maintenance (O&M) Manuals incorporated with this certification (Appendix G), which include but are not limited to:

a. Substantial compliance with the minimum required maintenance and operation procedures
b. Proper documentation and reporting at schedules prescribed in the O&M Manual
c. Submission of O&M documentation to the U.S. Army Corps of Engineers and FEMA as required
d. Monitoring activities identified in the O&M Manual during inspections by the U.S. Army Corps of Engineers or other authorized parties
e. Completion of repairs or maintenance identified by the U.S. Army Corps of Engineers or other parties that are necessary to maintain continued protection from the base flood

After 10 years or if any of the criteria listed above are not met or maintained, or if the following conditions listed below occur, the individual or collective certifications offered herein shall expire or become invalidated:

1. The City of Ansonia and/or the City of Derby determine or are notified that any part of the flood control system is defective and that said defect, which was not known when these certification analyses were performed, prevents the system from providing protection from the base flood.

2. The U.S. Army Corps of Engineers or other authorized government agency finds that Ansonia's and/or Derby's portion of Section 1 of the Housatonic and Naugatuck River Flood Control System described herein has fallen to an unacceptable rating level and the system(s) has been given a status of "inactive" or that substantial defects exist.

3. Modifications that are made to the requirements listed in 44 CFR Section 65.10, or any new local, state, or federal legislation, decision, or ruling that invalidates this certification for any reason.

1560-119and3118-03-d1410-rpt.doc

## OPINION OF CERTIFICATION

## FREEBOARD – 44 CFR Section 65.10(b)(1)

**OPINION OF CERTIFICATION**
**DESIGN CRITERIA – FREEBOARD**
**44 CFR Section 65.10(b)(1)**

Milone & MacBroom, Inc. offers the following engineering opinion (certification) in accordance with Title 44 of the Code of Federal Regulations, Chapter 1, subchapter B, Part 65, Section 65.10, subsection (b)(1)(i) and in support of the request for FEMA accreditation submitted by Ansonia and Derby for Section 1 of the Housatonic River and Naugatuck River Flood Control Systems described below:

- Section 1 – The left (east) bank of the Housatonic River in Derby from Bridge Street to the confluence with the Naugatuck River/Route 8 embankment and the right (west) bank of the Naugatuck River from the Main Street (Route 34) bridge north through Derby to the embankment supporting Pershing Drive in Ansonia

This certification is based upon the definitions and limitations described herein and the analyses and documentation provided in Appendix A of this report entitled, Engineering Report – Freeboard Analysis – Prepared by Milone & MacBroom Inc., dated December 2010, all of which are limited to determining the protection provided from the base flood (the flood that has a one-percent chance of being equaled or exceeded in any given year).

Based upon the information obtained and the results of the analyses performed, Milone & MacBroom, Inc. certifies the following:

1. A minimum freeboard of three feet above the elevation of the base flood is currently provided.
2. Within 100 feet upstream and downstream of the following structures, a minimum of four feet of freeboard above the elevation of the base flood is currently provided:
    - Bridge Street (bridge between Derby and Shelton)
    - Housatonic Railroad Bridge (between Derby and Shelton)
    - Commodore Hull Bridge (Route 8)
    - CT DOT/Metro-North Railroad Bridge over Naugatuck River - Ansonia
    - Division Street Bridge (Ansonia-Derby municipal boundary)
    - Main Street Bridge (Route 34) over Naugatuck River - Derby
3. At the upstream end of Section 1 of the levee system, 3.5 feet of freeboard above the elevation of the base flood is currently provided where the northern end of the levee terminates at the roadway embankment for Pershing Drive in Ansonia.

Michael J. Joyce, P.E.
Milone & MacBroom, Inc.
99 Realty Drive
Cheshire, CT 06410

Signature 12/14/10 Date



## OPINION OF CERTIFICATION

## CLOSURES – 44 CFR Section 65.10(b)(2)

**OPINION OF CERTIFICATION**
**DESIGN CRITERIA – CLOSURES**
**44 CFR Section 65.10(b)(2)**

Milone & MacBroom, Inc. offers the following engineering opinion (certification ) in accordance with Title 44 of the Code of Federal Regulations, Chapter 1, subchapter B, Part 65, Section 65.10, subsection (b)(2) and in support of the request for FEMA accreditation submitted by Ansonia and Derby for Section 1 of the Housatonic River and Naugatuck River Flood Control Systems described below:

- Section 1 – The left (east) bank of the Housatonic River in Derby from Bridge Street to the confluence with the Naugatuck River/Route 8 embankment and the right (west) bank of the Naugatuck River from the Main Street (Route 34) bridge north through Derby to the embankment supporting Pershing Drive in Ansonia

This certification is based upon the definitions and limitations described herein and the analyses and documentation provided in Appendix B of this report entitled, Engineering Report – Analysis of Closures – Prepared by Milone & MacBroom Inc., dated December 2010, all of which are limited to determining the protection provided from the base flood (the flood that has a one-percent chance of being equaled or exceeded in any given year).

Based upon the information obtained and the results of the analyses performed, Milone & MacBroom, Inc. certifies the following:

1. The following closure devices were constructed by the U.S. Army Corps of Engineers at each opening within the levee system, are currently operated and maintained by the City of Ansonia and City of Derby, respectively, and are capable of providing protection during the base flood:

   **Ansonia**
   Railroad Gate No. 4
   Stormwater Sluice Gate No. 10
   Sanitary Sewer Sluice Gates No. 6, 7, and 8
   Post-indicator valve – replaced as part of the recent WPCA plant upgrade
   Flap gates

   **Derby**
   Railroad Gate No. 1 – CT DOT/Metro-North Railroad
   Railroad Gate No. 2A – Housatonic Railroad spur to downtown Derby
   Railroad Gate No. 2B – Housatonic Railroad
   Railroad Gate No. 3
   Stormwater Sluice Gates No. 1, 3, 11
   Sanitary Sluice Gate No. 2
   Flap gates
   Post-indicator valve near Railroad Gate 2A/2B

2. In cases where repairs or modifications have been made to closure devices, compliance with the original design intent and protection from the base flood has been maintained.

Michael J. Joyce, P.E.
Milone & MacBroom, Inc.
99 Realty Drive
Cheshire, CT 06410




Signature 12/14/10
Date

## OPINION OF CERTIFICATION

## EMBANKMENT PROTECTION – 44 CFR Section 65.10(b)(3)

**OPINION OF CERTIFICATION**
**DESIGN CRITERIA – EMBANKMENT PROTECTION**
**44 CFR Section 65.10(b)(3)**

Milone & MacBroom, Inc. offers the following engineering opinion (certification ) in accordance with Title 44 of the Code of Federal Regulations, Chapter 1, subchapter B, Part 65, Section 65.10, subsection (b)(3) and in support of the request for FEMA accreditation submitted by Ansonia and Derby for Section 1 of the Housatonic River and Naugatuck River Flood Control Systems described below:

- Section 1 – The left (east) bank of the Housatonic River in Derby from Bridge Street to the confluence with the Naugatuck River/Route 8 embankment and the right (west) bank of the Naugatuck River from the Main Street (Route 34) bridge north through Derby to the embankment supporting Pershing Drive in Ansonia

This certification is based upon the definitions and limitations described herein and the analyses and documentation provided in Appendix C of this report entitled, Engineering Report – Embankment Protection Analysis – Prepared by Milone & MacBroom Inc., dated December 2010 and Appendix D – Geotechnical Evaluation Report – Embankment and Foundation Stability and Settlement, prepared by Paulus, Sokolowski & Sartor (PS&S), dated December 2010, all of which are limited to determining protection provided from the base flood (the flood that has a one-percent chance of being equaled or exceeded in any given year).

Based upon the information obtained and the results of the analyses performed, Milone & MacBroom, Inc. certifies the following:

1. The stone revetment along the riverward slopes of the levee originally placed by the U.S. Army Corps of Engineers was confirmed to be the appropriate size and installed to a depth and constructed to a slope that will continue to prevent appreciable erosion of the levee embankment during base flood conditions.

2. As documented in Appendix D, detailed stability, settlement, and seepage analyses have been performed for the levee embankment and foundation materials under various conditions of the base flood including steady state, high flood, and sudden drawdown. The results of these analyses support the finding that the embankment and foundation materials will continue to provide support for the revetment which, as indicated in Item 1 above, provides adequate scour protection during the base flood.

3. There are no abrupt transitions along the length of the studied levee and in general the levee embankments follow a linear alignment with one exception in the vicinity of Railroad Gate No. 4 and the CT/DOT/Metro-North railroad bridge. The U.S. Army Corps of Engineers constructed a bend in the alignment of the Naugatuck River to convey the flow of the river under the railroad bridge. Upstream and downstream of the bridge on both sides of the river, the U.S. Army Corps of Engineers installed large cut blocks of granite along the embankment and adjacent to the railroad abutments. Based upon the anticipated flow velocities, the granite revetment provided far exceeds the intermediate riprap protection required to adequately maintain slope stability during the base flood.

4. During base flood conditions, the limit of inundation is well within the protected channels constructed by the U.S. Army Corps of Engineers. Structures within the base flood limits that would be exposed to debris include the abutments and piers supporting the following structures within the limits of the flood control project:

    - CT DOT/Metro-North Railroad Bridge – Ansonia
    - Division Street Bridge – Ansonia/Derby
    - Main Street Bridge (CT Route 34) – Derby
    - Bridge Street (Derby-Shelton Bridge) – Derby/Shelton
    - Housatonic Railroad Bridge – Derby/Shelton
    - Commodore Hull Bridge (CT Route 8) – Derby/Shelton
    - Sluice Gate Structures #1, #2, #3, #11 – Derby
    - Sluice Gate Structures #8, #10 - Ansonia

    Damage to these structures caused by debris during the base flood is expected to be minimal and should not diminish the overall ability of the flood control system to provide protection from the base flood.

    The sluice gate structures listed above are accessed by bridges from the top of the levee embankment. The bottom of the access bridge to each sluice gate structure is at or above the water surface elevations during the base flood. Furthermore, closure of the required sluice gate structures occurs at water surface elevations well below the base flood when standard flood operating procedures are performed in accordance with the adopted Operation & Maintenance Manual.

5. The normal river depth along both the Housatonic River and Naugatuck River upstream from their confluence is relatively shallow and influenced by the tidal fluctuations of Long Island Sound. Therefore, the potential for ice jams or loading due to significant ice accumulation is limited and not expected to adversely impact the conveyance of the base flood.

Michael J. Joyce, P.E.
Milone & MacBroom, Inc.
99 Realty Drive
Cheshire, CT 06410

Signature 12/14/10 Date



## OPINION OF CERTIFICATION

## EMBANKMENT AND FOUNDATION STABILITY – 44 CFR Section 65.10(b)(4)

**OPINION OF CERTIFICATION**
**DESIGN CRITERIA – EMBANKMENT AND FOUNDATION STABILITY**
**44 CFR Section 65.10(b)(4)**

Paulus, Sokolowski and Sartor Architecture and Engineering Connecticut, P.C. (PS&S) and Milone & MacBroom, Inc. (MMI) offer the following engineering opinion (certification) in accordance with Title 44 of the Code of Federal Regulations, Chapter 1, subchapter B, Part 65, Section 65.10, subsection (b)(4) and in support of the request for FEMA accreditation submitted by Ansonia and Derby for Section 1 of the Housatonic River and Naugatuck River Flood Control Systems described below:

- Section 1 – The left (east) bank of the Housatonic River in Derby from Bridge Street to the confluence with the Naugatuck River/Route 8 embankment and the right (west) bank of the Naugatuck River from the Main Street (Route 34) bridge north through Derby to the embankment supporting Pershing Drive in Ansonia

This certification is based upon the definitions and limitations described herein and the analyses and documentation provided in Appendix D of this report entitled, Geotechnical Evaluation Report – Embankment and Foundation Stability and Settlement – Prepared by Paulus, Sokolowski & Sartor (PS&S), dated December 2010, and Appendix E – Engineering Report – Structural Stability Analysis – Floodwalls, Prepared by Milone & MacBroom, Inc., dated December 2010, all of which are limited to determining the protection provided from the base flood (the flood that has a one-percent chance of being equaled or exceeded in any given year).

Based upon the information obtained and the results of the analyses performed, PS&S certifies the following:

**SEEPAGE**

1. Internal embankment and foundation seepage analysis was performed using SEEP/W software at five representative cross sections. The hydraulic conductivity values used in PS&S's analyses were based on design parameters presented within U.S. Army Corps of Engineers' (USACE's) original design memorandum (No. 6). The USACE's hydraulic conductivity values were confirmed and/or supplemented by field investigation and the field and laboratory testing. The hydrologic loading was based on hydrographs presented within USACE's design memorandum that were modified for the base flood elevation. A precipitation event of 0.3 inches/hour was assumed to occur simultaneously during flooding to simulate a saturated ground condition. The calculated exit gradient based on USACE's design hydrograph was less than USACE's guidance value of 0.5.

2. At test boring location PSS 2, the calculated exit gradient may exceed guidance value of 0.5 for a flood duration greater than that on the hydrograph as the embankment section at this location contains more granular backfill than other locations.

3. Because excessive or uncontrolled seepage can result in a chronic adverse condition to water impoundment structures, PS&S recommends that the Operations and Maintenance Manual

should include measures to monitor landward seepage at all toe drain locations during peak flow conditions.

**SLOPE STABILITY**

1. The slope stability analyses were performed at seven representative cross-sections near recent test borings performed by PS&S using commercially available SLOPE/W software. The stability analyses were performed for steady state condition, base flood condition and sudden drawdown condition using geohydrologic regime (i.e., phreatic surface, pore water pressure and seepage forces) estimated from the SEEP/W analyses. The shear strength of the embankment material and the foundation soils were conservatively based on the design parameters presented within USACE's deign memorandum as the SPT values from recent test borings indicates substantially higher shear strengths. The slope stability analysis using Spencer's limit equilibrium method results in factors of safety greater than the minimum recommended values within USACE's guidance document.

2. Pseudo-static analysis for normal flow steady state condition results in factor of safety greater than those recommended in USACE's guidance document. Analysis considered a seismic event with peak horizontal ground surface acceleration of 0.163g for an earthquake with return period of 2500 years.

3. PS&S's recent test borings and the USACE as-built drawings support the interpretation that all organic materials that were observed within the historic test borings were over excavated and replaced by granular backfill at the time of initial levee construction. Therefore PS&S's analysis differs from the USACE's analysis in that our analysis utilized circular/rotational failure envelopes to calculate the lowest factor of safety. A circular failure surface is applicable if a discrete weak horizontal failure plane is not present. PS&S's analyses did not consider presence of any weak or soft layer at Elevation -10.0 with the assumption that these materials were removed. PS&S's analysis and conclusion regarding stability are only valid if all organic material were removed, as the results of our test borings suggest. PS&S did not duplicate USACE analyses and cannot comment on their analyses.

4. PS&S's opinion and conclusions assume that proper geotechnical-related operations and maintenance procedures will be implemented (e.g., filling of animal burrows, proper control of vegetation and routine observation of toe drains).

Joseph J. Lifrieri, Ph.D., P.E., C.P.G., P.P.
Senior Vice President
Paulus, Sokolowski and Sartor Architecture and Engineering Connecticut, P.C.
67A Mountain Boulevard Extension
P.O. Box 4039
Warren, NJ 07059



Signature

12/14/10
Date

## OPINION OF CERTIFICATION

## SETTLEMENT – 44 CFR Section 65.10(b)(5)

## OPINION OF CERTIFICATION

## DESIGN CRITERIA – SETTLEMENT
## 44 CFR Section 65.10(b)(5)

The following engineering opinion (certification ) is offered in accordance with Title 44 of the Code of Federal Regulations, Chapter 1, subchapter B, Part 65, Section 65.10, subsection (b)(5) and in support of the request for FEMA accreditation submitted by Ansonia and Derby for Section 1 of the Housatonic River and Naugatuck River Flood Control Systems described below:

- Section 1 – The left (east) bank of the Housatonic River in Derby from Bridge Street to the confluence with the Naugatuck River/Route 8 embankment and the right (west) bank of the Naugatuck River from the Main Street (Route 34) bridge north through Derby to the embankment supporting Pershing Drive in Ansonia.

This certification is based upon the definitions and limitations described herein, and the analyses and documentation provided in Appendix D of this report entitled, Geotechnical Evaluation Report – Embankment and Foundation Stability and Settlement – Prepared by Paulus, Sokolowski & Sartor (PS&S) dated December 2010, all of which are limited to the protection provided from the base flood (the flood that has a 1-percent chance of being equaled or exceeded in any given year).

Based upon the information obtained and the results of the analyses performed, PS&S certifies the following:

1. PS&S' borings did not encounter the presence of any soft compressible soils within the foundation material below the embankment levees or within the embankment levees. This observation is consistent with the USACE design memorandum which recommended removal of pockets of organic deposits within foundation soils prior to construction of the levee embankment. PS&S borings indicates presence of stiff gray silt with fine sand below the gravel layer in the northern portion of Naugatuck Dike (levee) in the southern portion of Naugatuck Dike and the gravel layer was underlain by medium fine sand and silt. PS&S obtained two Shelby tube samples of the underlying silts and sand stratum in the northern portion of Naugatuck Dike (from test borings PSS-1 & PSS-2). Two consolidation tests were performed on the undisturbed tube samples to evaluate its compressibility characteristics. Results of the laboratory testing indicate the silt and sand layer is highly over consolidated and therefore not prone to significant settlement.

2. Assuming that all compressible organic materials were removed during the levee construction, continued long-term settlement of the levees is unlikely because soils encountered within and below the levee are of a granular nature and the silt and sand stratum is highly over-consolidated. Furthermore, because the levees were constructed over 40 years ago, generally any primary consolidation related settlement due to embankment loadings would have occurred during and immediately following construction of the levees. Because the foundation materials and fill soils are of the type which normally shows a small amount of compressibility, approximately 4.6 inches of secondary consolidation related settlement was estimated at northern portion

of the Naugatuck Dike (borings PSS-1 & PSS-2) to have already occurred since construction of the embankments was completed. The calculations also indicate that one half inch or less of settlement of the underlying silt and sand stratum is anticipated to occur over the next 30 years. Settlements within southern portions of the Naugatuck Dike (levee) are expected to be much smaller due to the greater amount of sand in this stratum.

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Signature 12/14/10 Date

## OPINION OF CERTIFICATION

## INTERIOR DRAINAGE – 44 CFR Section 65.10(b)(6)

**OPINION OF CERTIFICATION**
**DESIGN CRITERIA – INTERIOR DRAINAGE**
**44 CFR Section 65.10(b)(6)**

Milone & MacBroom, Inc. offers the following engineering opinion (certification ) in accordance with Title 44 of the Code of Federal Regulations, Chapter 1, subchapter B, Part 65, Section 65.10, subsection (b)(6) and in support of the request for FEMA accreditation submitted by Ansonia and Derby for Section 1 of the Housatonic River and Naugatuck River Flood Control Systems described below:

- Section 1 – The left (east) bank of the Housatonic River in Derby from Bridge Street to the confluence with the Naugatuck River/Route 8 embankment and the right (west) bank of the Naugatuck River from the Main Street (Route 34) bridge north through Derby to the embankment supporting Pershing Drive in Ansonia.

This certification is based upon the definitions and limitations described herein and the analyses and documentation provided in Appendix F of this report entitled, Engineering Report – Interior Drainage Analysis, prepared by Milone & MacBroom, Inc., dated December 2010, all of which are limited to the protection provided from the base flood (the flood that has a one-percent chance of being equaled or exceeded in any given year).

Based upon the information obtained and the results of the analyses performed, Milone & MacBroom, Inc. certifies the following:

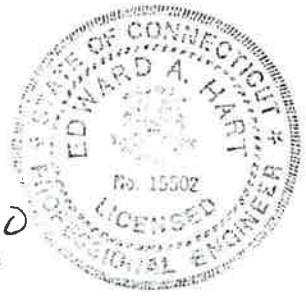
1. That the analysis included a compilation of as-built storm drainage provided by the Cities of Derby and Ansonia, supplemented with field survey data and field inspections. Existing land use and existing topography are based a combination aerial mapping and USGS mapping supplemented with available roadway plans, site improvement plans, field investigations and as-built plans provided by the Cities of Ansonia and Derby. It is our opinion that to the best of our knowledge and belief this information is accurate.
2. The extent of interior flooding is limited to specific defined areas on the landward side of the levee system in Derby between Main Street and the 48" pressure conduit and Sluice Gate #11. These areas have been analyzed, and the elevation during the base flood has been determined as well as those areas that will have average water depths of greater than one foot. Mapping is provided depicting these limits, and FEMA may wish to evaluate these limits and determine whether it warrants the remapping of the 100-year flood in this area.
3. That the Derby Pump Station contains sufficient capacity to evacuate the contributing flows during the 100-year storm without resulting in areas of ponding exceeding one foot.
4. That the Division Street Pump Station (Ansonia) contains sufficient capacity to evacuate the contributing flows during the 100-year storm without resulting in areas of ponding exceeding one foot.
5. Several areas interior to and above levee system contain undersized drainage system that may result in localized street flooding and ponding during the 100-year storm, as do many

urban storm drainage systems. We do not believe that any of these poorly draining areas should be mapped by FEMA other than the area previously mentioned.

Ted Hart, P.E.
Vice President
Milone & MacBroom, Inc.
99 Realty Drive
Cheshire, CT 06410

Ted Hart 12/14/10

Signature Date



**OPINION OF CERTIFICATION**

**OPERATIONS and MAINTENANCE PLANS AND CRITERIA**

**44 CFR Section 65.10(c) and (d)**

**OPINION OF CERTIFICATION**
**OPERATIONS and MAINTENANCE PLANS AND CRITERIA**
**44 CFR Section 65.10(c) and (d)**

Milone & MacBroom, Inc. offers the following engineering opinion (certification ) in accordance with Title 44 of the Code of Federal Regulations, Chapter 1, subchapter B, Part 65, Section 65.10, subsections (c) and (d) and in support of the request for FEMA accreditation submitted by Ansonia and Derby for Section 1 of the Housatonic River and Naugatuck River Flood Control Systems described below:

- Section 1 – The left (east) bank of the Housatonic River in Derby from Bridge Street to the confluence with the Naugatuck River/Route 8 embankment and the right (west) bank of the Naugatuck River from the Main Street (Route 34) bridge north through Derby to the embankment supporting Pershing Drive in Ansonia

This certification is based upon the definitions and limitations described herein and the following documentation provided as Appendix G of this report:

- Summary Report – Operations and Maintenance Plans and Criteria, prepared by Milone & MacBroom, Inc., dated December 2010,
- Operation & Maintenance Manual – December 2010 – Milone & MacBroom, Inc./City of Ansonia
- Operation & Maintenance Manual – December 2010 – Milone & MacBroom, Inc./City of Derby

Based upon the information obtained and our analysis of the municipal operations plans, Milone & MacBroom, Inc. certifies the following:

1. The City of Ansonia existing Operation and Maintenance Manual originally prepared by USACE and implemented in May 1973 has been updated to included the following:
    a. Compliance and reference to the current 44 CFR Section 65.10
    b. Current USACE Levee Owner Manuals
    c. Current USACE Levee Inspection Forms
    d. Current Emergency Personnel Contact Information
    e. Operations and Maintenance requirements specific to Section 1 of the shared Ansonia/Derby levee system

2. The updated O&M Manual was adopted by the Ansonia Board of Aldermen on December 14, 2010.

3. The City of Derby existing Operation and Maintenance Manual originally prepared by USACE and implemented in September 1973 has been updated to included the following:
    a. Compliance with and reference to the current 44 CFR Section 65.10
    b. Current USACE Levee Owner Manuals
    c. Current USACE Levee Inspection Forms
    d. Current Emergency Personnel Contact Information

4. The updated O&M Manual was adopted by the Derby Board of Aldermen on October 28, 2010.

Michael J. Joyce, P.E.
Milone & MacBroom, Inc.
99 Realty Drive
Cheshire, CT 06410




Signature 12/14/10
Date

**OPINION OF CERTIFICATION**

**AS-BUILT DRAWINGS**

**44 CFR Section 65.10(e)**

**OPINION OF CERTIFICATION**
**AS-BUILT DRAWINGS**
**44 CFR Section 65.10(e)**

Milone & MacBroom, Inc. offers the following engineering opinion (certification) in accordance with Title 44 of the Code of Federal Regulations, Chapter 1, subchapter B, Part 65, Section 65.10, subsections (e) and in support of the request for FEMA accreditation submitted by Ansonia and Derby for Section 1 of the Housatonic River and Naugatuck River Flood Control Systems described below:

- Section 1 – The left (east) bank of the Housatonic River in Derby from Bridge Street to the confluence with the Naugatuck River/Route 8 embankment and the right (west) bank of the Naugatuck River from the Main Street (Route 34) bridge north through Derby to the embankment supporting Pershing Drive in Ansonia

This certification is based upon the definitions and limitations described herein and the following documentation provided as Appendix G of this report:

- Operation & Maintenance Manual – December 2010 – Milone & MacBroom, Inc./City of Ansonia
- Operation & Maintenance Manual – December 2010 – Milone & MacBroom, Inc./City of Derby
- U.S. Army Corps of Engineers - As-built drawings - Housatonic River Flood Control – Ansonia-Derby – Naugatuck River, Connecticut
- U.S. Army Corps of Engineers - As-built drawings – Housatonic River Flood Control – Derby – Housatonic and Naugatuck Rivers, Connecticut

Based upon our review of the existing as-built drawings and field observations made during the course of the study, Milone & MacBroom, Inc. certifies the following:

1. The flood control systems within Section 1 as defined above were found to be in agreement with information originally represented on the USACE as-built drawings together with Operations and Maintenance Manuals which were provided to the municipalities following completion of the system construction. Therefore, it is our opinion that the existing documentation along with any updates and modifications referenced herein meet the requirements of 44 CFR Section 65.10(e).

2. Since the original USACE construction, there have been several projects constructed in the vicinity of the flood protection works including but not limited to the following:

    a. Naugatuck River Greenway – Derby – which included:
        i. The placement of fill against the floodwall – included in the Structural Analysis provided with this certification
        ii. Pedestrian bridge abutments and piers behind Railroad Gate No. 3 walls
        iii. Round rail wood fence on both sides of trail along the crest of the levee
        iv. Paved trail surface along the crest of the levee

v. Metro-North/Route 34 safety barrier wall adjacent to Railroad Gate No. 1
vi. Removal of 15" pipe – approved by USACE in 2005 during Greenway construction

b. Naugatuck Riverwalk – Ansonia (under construction) which includes:
   i. Excavation along rear of embankment
   ii. Paved trail surface
   iii. Repairs to toe drain system (currently under USACE review)
   iv. Round rail wood fence on both sides of trail along the crest of the levee

c. Williams Communications – Telecommunication conduit penetration adjacent to Railroad Gate No. 3

d. Sluice gate repairs performed by the City of Derby and their subcontractors to restore operation to damaged sluice gates

e. Derby Pumping Station – The repair and replacement of Pump #2

f. Derby Pump Station building – Modifications were made to the roof to provide additional access for the replacement of Pump #2.

g. Replacement of the Division Street bridge superstructure – installation of sheet piling to protect pile cap improvements

h. Ansonia WPCA plant upgrades

   i. Reconstruction and replacement of municipal interior drainage collection system
   ii. Replacement of gate valve at Sluice Gate Structure No. 8

Based upon the information obtained and the observations made, the projects listed above are expected to have no impact on the protection provided by the collective system during base flood conditions. In some cases, the improvements were performed at or above the FEMA water surface elevations for the base flood.

Michael J. Joyce, P.E.
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Signature 12/14/10 Date

