ENGINEERING REPORT

FREEBOARD ANALYSIS

HOUSATONIC RIVER and NAUGATUCK RIVER

FLOOD PROTECTION PROJECTS

SECTION 1

ANSONIA and DERBY, CONNECTICUT

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MMI #1560-119 and #3118-03

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1.0 PROJECT DESCRIPTION

In June 2010, Ansonia and Derby retained Milone & MacBroom, Inc. (MMI) of Cheshire, Connecticut to perform the investigative and engineering services required to evaluate and certify the Housatonic River and Naugatuck River Flood Control Systems in support of the municipalities' request to obtain accreditation from FEMA. The descriptions and supporting documentation included in this report were performed only for Section 1 of the Flood Control Systems which is explained and graphically depicted on Figure 1:

- 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.

1.1 Federal Regulatory Criteria

In order to establish and/or maintain accreditation of a levee system, 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. For the purposes of this report, Milone & MacBroom, Inc. (MMI) performed an analysis of the minimum freeboard above the water surface elevation of the base flood in accordance with Section 65.10(b)(1) of the NFIP, "Embankment Protection." which is provided below.

§ 65.10 Mapping of Areas Protected by Levee Systems

(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.

The analysis includes review of the future Flood Insurance Study (FIS) and the Digital Flood Insurance Rate Mapping (DFIRM) as prepared by FEMA. The base flood elevation (or the 100-year flood elevation) used for the purposes of this review is taken directly from the future DFIRM map #09009C0404H for New Haven County with an effective date of December 17, 2010 and corresponding preliminary FIS. While this information is not yet effective, it is the most current data provided by FEMA for the base flood elevations for the Housatonic and Naugatuck Rivers. The base flood data in the referenced materials is in North American Vertical Datum 1988 (NAVD 1988) while previous base flood data has been issued in National Geodetic Vertical Datum 1929 (NGVD 1929).

Several sources of information were compiled in order to complete the freeboard analysis. The primary sources of topographic information used to determine available freeboard are based primarily on aerial topography. The elevation of the existing walls along the Housatonic River in Derby is based on the "as-built" plans for the Derby Local Flood Protection Project from the U.S. Army Corps of Engineers (ACOE) and converted from NGVD 1929 to NAVD 1988. Field survey was used in order to verify some of the critical components of the system including spot checks of elevations on top of the levees, "as-built" mapping of recently constructed walking trails, and elevations of flood gate structures at railroad crossings. All aerial and field topographic data used for the freeboard analysis was established using the North American Vertical Datum of 1988.

2.0 EXISTING CONDITIONS

The levee systems in both local protection projects were designed to prevent flooding in Ansonia and Derby for the Standard Project Flood (SPF), or a larger storm than the base flood as defined by FEMA. Historical flood events including those from August and October of 1955 resulted in higher river elevations of the Naugatuck River than what is expected during the base flood.

Beginning from the northern reach of this freeboard analysis near the Metro-North bridge crossing in Ansonia, the sill elevation of 27 of the flood gate structure is itself just above the base flood level of ±26.5. The door provides an additional 12 feet of freeboard if closed and properly sandbagged at the base. The levee to the south of the railroad crossing to the Division Street bridge ranges in elevation from 34 just to the south of the railroad crossing to 32 at Division Street while the base flood ranges from 27 to 24 in the same reach. From Division Street to Main Street in Derby, the levee is built to an elevation of roughly 30, with the base flood at roughly 22. The remaining portion of the levee from Main Street along the Route 8 embankments up to Bridge Street on the Housatonic River consists of four flood gates at railroad crossings, the Route 8 embankment itself, concrete floodwalls along the Housatonic River, and earthen embankments elsewhere, all achieve at least the required freeboard according to Section

65.10(B)(1) of the NFIP. At Railroad Flood Gate Structure #1 near the Derby Train Station, approximately 6.6 feet of freeboard are provided above the base flood elevation, well above the required minimum and sufficient to protect against the base flood.

3.0 CONCLUSION

As described herein and shown on the attached drawings, the minimum freeboard throughout the entire limits of this review and within both communities exceeds the freeboard requirements set forth by Section 65.10(B)(1) of the NFIP. At a minimum, at least 6.5 feet of freeboard above the base flood is provided.

In addition, based upon the settlement analyses provided in Appendix D of the overall certification package entitled, Geotechnical Evaluation Report – Embankment and Foundation Stability and Settlement, prepared by Paulus, Sokolowski &Sartor, dated December 2010, loss of freeboard due to settlement of the levee system is not expected.

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APPENDIX A

FLOOD CONTROL LEVEE PLAN AND PROFILE EXHIBIT